NUTRITION THROUGH LIFE CYCLE

M.Sc. FOOD AND NUTRITION SCIENCE

SEMESTER-I, PAPER-I

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M.Sc. FOOD AND NUTRITION SCIENCE: NUTRITION THROUGH LIFE CYCLE

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This book is exclusively prepared for the use of students of M.Sc. Food and Nutrition Science, Centre for Distance Education, Acharya Nagarjuna University and this book is meant for limited circulation only.

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FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining 'A+' grade from the NAAC in the year 2024, Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from over 221 affiliated colleges spread over the two districts of Guntur and Prakasam.

The University has also started the Centre for Distance Education in 2003-04 with the aim of taking higher education to the door step of all the sectors of the society. The centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even to housewives desirous of pursuing higher studies. Acharya Nagarjuna University has started offering B.Sc., B.A., B.B.A., and B.Com courses at the Degree level and M.A., M.Com., M.Sc., M.B.A., and L.L.M., courses at the PG level from the academic year 2003-2004 onwards.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise in the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers involved respectively. Such ideas will be incorporated for the greater efficacy of this distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is my aim that students getting higher education through the Centre for Distance Education should improve their qualification, have better employment opportunities and in turn be part of country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will go from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Academic Coordinators, Editors and Lesson-writers of the Centre who have helped in these endeavors.

Prof. K. Gangadhara Rao
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M.Sc. FOOD AND NUTRITION SCIENCE
SEMESTER-I, PAPER-I
101FN24-NUTRITION THROUGH LIFE CYCLE

SYLLABUS

Course Objectives: To enable the students to:

1) Learn and understand the Nutritional requirements during different physiological stages of life.
2) Know the nutritional problems associated with different physiological stages of life.
3) Understand the influences of the nutritional problems on growth and development at different stages of life.
4) Know the intervention and management strategies to overcome the nutritional problems.

THEORY

Unit-1:

- **Food Groups:** Classification-food composition and nutritive values of different foods, Functions of foods. Balanced Diet, RDA for all age groups. Food exchange list.
- **Pregnancy:** Nutrient requirements, intake and gaps, prenatal and postnatal nutritional importance, metabolic adjustments in pregnancy; nutrition intervention and pregnancy outcome; common symptoms (nausea and vomiting, Heartburn-Pica, habits, constipation), nutritional management, problems and complications, adolescent pregnancy.
- **Lactation:** Nutritional requirements, intake, gaps, physiology of milk production, hormonal control, importance of breast feeding, factors affecting breast milk quality and composition and comparative advantages & disadvantages of breast milk, buffaloes and cow's milk.

Unit-2:

- **Infancy:** Nutritional requirements, intake and gaps, Need for formula feedings, types of infant formulae, importance of preparation of weaning foods using locally available foods, Home prepared versus commercial weaning foods. Feeding problems-vomiting, diarrhea, teething problemsetc-Lactose and cow's milk protein intolerance, concept of human milk bank.
- **Pre-School Children:** Growth and development, nutrient requirements, intake and gaps, Effect of malnutrition on physical and mental development.
- **School-Going Children:** Nutritional demands, intake and gaps, Importance of breakfast and its impact on school performance, Specific nutritional problems, Macro and Micro nutrient deficiencies and their impact on health and nutritional status and control measures. Government Nutrition Programmes-ICDS and Mid Day Meal Programme (MDMP).

Unit-3:

- **Adolescence:** Nutritional requirements, intake and Gaps, Consequences of Nutritional deficiencies, adolescent pregnancy, Food habits in adolescence, Metabolic consequences of slimming diets & weight maintenance, specific nutritional problems-Anaemia, Anorexia, Bulimia, Amenorrhea and Obesity.
- **Adults:** Nutritional Requirements, Intake and Gaps, Consequences of Nutritional deficiencies, Effect of stress on Nutritional status, Specific nutritional problems of adults.

UNIT-4:

- **Geriatric Nutrition:** The process of Ageing, Physiological, biochemical, body compositional changes and Theories of ageing. Socio-cultural and psychological aspects of ageing. Food and Nutritional needs of the elderly Dietary management-Special problem of women menopausal, post-menopausal problems. Chronic degenerative diseases, nutrition and health problems of the elderly.

UNIT-5:

- **Sports Nutrition:** Classification of sports events and RDA for sports person. Nutritional requirements and special needs of sports person, pre, during, post sports events, water and electrolyte balance, ergogenic aids. Endurance and fatigue in sports performance. Assessment-strategies.
- Nutritional needs for Industrial workers, space Nutrition.

REFERENCE BOOKS:

1) Anne Loader, 1998. Pregnancy and Parenthood, Oxford, University Press.
2) Bhavana Sabarwal, 1999. Public Health & Nutritional Care, Common Wealth Publishers.
3) Benjimin I. Borton, 1990. Human Nutrition. New Delhi: Tata Mc. Grow Hill Publishers.
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5) B.Srilakshi, 2006 Dietetics. Bangalore: New Age International Pvt. Ltd. Publishers.
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7) Gopalan C. Ramasastri B.V. and Balasubramaniam S.C. 1999. Nutritive Value of Indian.
8) Foods. Hyderabad: NIN.

Course Outcomes: After Completion of this course, Students will be able to:

CO1: Interpret and apply health and nutrition concepts to evaluate and improve the nutritional health of communities.

CO2: Determine nutritional demands, deficiencies at various stages of life.

CO3: Notice nutritional requirements and food requirements during adulthood and oldage.

CO4: Learn about degenerative changes during oldage.

CO5: Provide knowledge on health and nutrition to sports persons, Industrial workers, Astronauts.

(101FN24)

M.Sc. DEGREE EXAMINATION, MODEL QUESTION PAPER
FIRST SEMESTER
NUTRITION THROUGH LIFE CYCLE

Time: Three hours **Maximum: 70 marks**

Answer ONE Question From Each Unit **5 × 14 = 70M**
Each Question Carries 14 Marks.

UNIT-I

1 Write the Nutritional importance of prenatal and postnatal pregnancy.

OR

2 What are the advantages and disadvantages of breast milk and cow's milk?

UNIT-II

3 Explain the importance of preparation of weaning foods using locally available foods.

OR

4 Write the nutritional demands and importance of breakfast and its impact on school performance.

UNIT-III

5 Discuss about specific nutritional problems of adolescence.

OR

6 Write about nutritional requirements, intake and gaps among adults.

UNIT-IV

7 Explain about food and nutritional needs of the elderly? Write about dietary management.

OR

8 Discuss about special problems of women in old age.

UNIT-V

9 Write the nutritional requirements and special needs of sports persons.

OR

10 Explain about Endurance and fatigue in sports performance.

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LESSON-1

CLASSIFICATION, COMPOSITION AND NUTRITIVE VALUES, FUNCTIONS OF FOODS

1.0 OBJECTIVES:

After going through this lesson students will understand:

- Classification of foods and their composition
- Importance of balanced diet
- RDA for all age groups

STRUCTURE:

1.1 INTRODUCTION:

Food is essential for sustaining life and maintaining health. It provides the body with energy, nutrients, and other substances needed for growth, repair, and regulation of body functions. A proper diet is essential from the very early stages of life for proper growth, development and to remain active. Food consumption, which largely depends on production and distribution, determines the health and nutritional status of the population. To better understand the role of food in our lives, it is categorized into food groups based on their nutritional composition and functions. This classification helps us make informed dietary choices to maintain a balanced diet, which is crucial for overall well-being.

1.2 FOOD COMPOSITION:

Food composition refers to the array of nutrients and non-nutritive compounds found in foods. These components play vital roles in growth, development, energy production, and maintaining overall health. Understanding food composition is crucial for creating balanced diets and addressing specific dietary needs.

Major Components of Food

The primary components of food can be broadly classified into two categories: Macronutrients and Micronutrients.

1.2.1. Macronutrients: These are nutrients required in large amounts to provide energy and support bodily functions.

a) Carbohydrates: Definition: Organic compounds made up of carbon, hydrogen, and oxygen, primarily serving as the body's main energy source.

Types: Simple carbohydrates (sugars): Glucose, fructose, lactose.

- Complex carbohydrates (starch and fiber): Found in grains, legumes, and vegetables.

Functions:

- Provide energy (4 kcal per gram).
- Spare protein for other vital functions.
- Aid in proper digestion and gut health (fiber).

Sources: Whole grains, fruits, vegetables, beans, and dairy products.

b) Proteins: Definition: Organic molecules composed of amino acids, essential for growth, repair, and enzymatic processes.

Types:

- Complete proteins: Contain all essential amino acids (e.g., meat, eggs, soy).
- Incomplete proteins: Lack some essential amino acids (e.g., nuts, legumes).

`Functions:

- Build and repair tissues.
- Produce enzymes, hormones, and antibodies.
- Serve as an energy source when carbohydrate and fat intake is insufficient.

Sources: Meat, fish, dairy, beans, lentils, and nuts.

c) Fats: Definition: Lipids composed of fatty acids, providing energy and aiding in the absorption of fat-soluble vitamins.

Types:

- Saturated fats: Found in animal fats and some plant oils (e.g., coconut oil).
- Unsaturated fats: Include monounsaturated (olive oil) and polyunsaturated fats (omega-3 in fish).
- Trans fats: Found in processed foods, linked to negative health outcomes.

Functions:

- Provide concentrated energy (9 kcal per gram).
- Protect organs and regulate body temperature.
- Support brain function and cell membrane integrity.

Sources: Avocados, nuts, seeds, fish, butter, and oils.

d) Water: Definition: A vital nutrient involved in nearly all physiological processes.

Functions:

- Regulates body temperature.
- Facilitates digestion and nutrient transport.
- Removes waste products.

Sources: Drinking water, fruits (e.g., watermelon, oranges), and vegetables.

1.2.2. Micronutrients: These are nutrients required in smaller amounts but are vital for proper body function.

a) **Vitamins: Definition**: Organic compounds needed in trace amounts to regulate various metabolic processes.

Types: Water-soluble: Vitamin C, B-complex vitamins (B1, B2, B6, B12, folate).

- Fat-soluble: Vitamins A, D, E, and K.
- **Functions**:
  - Boost immunity (Vitamin C).
  - Promote bone health (Vitamin D).

- Support vision (Vitamin A).
- Act as antioxidants (Vitamin E).

Sources: Citrus fruits (Vitamin C), carrots (Vitamin A), nuts and seeds (Vitamin E), dairy (Vitamin D).

b) **Minerals: Definition**: Inorganic compounds essential for structural and regulatory functions in the body.

Types:

- Macro-minerals: Calcium, potassium, sodium, magnesium.\
- Trace minerals: Iron, zinc, iodine, selenium.

Functions:

- Build strong bones and teeth (Calcium).
- Regulate fluid balance (Sodium, Potassium).
- Support oxygen transport (Iron).
- Aid enzyme function (Zinc).

Sources: Dairy products (Calcium), bananas (Potassium), red meat (Iron), seafood (Iodine).

1.2.3. Non-Nutritive Components: While not considered nutrients, these components have health-promoting properties.

a) Dietary Fiber: Definition: Indigestible carbohydrate found in plant-based foods.

Functions:

- Promotes gut health.
- Reduces the risk of cardiovascular diseases.
- Regulates blood sugar levels.

Sources: Whole grains, fruits, vegetables, and legumes.

b) Phytochemicals: Definition: Bioactive compounds found in plants that provide health benefits.

Examples:

- Flavonoids in fruits (antioxidants).
- Lycopene in tomatoes (protective against cancer).

Functions:

- Act as antioxidants.
- Reduce inflammation.

- Protect against chronic diseases.

c) Antioxidants: Definition: Compounds that neutralize free radicals, preventing cellular damage.

Sources: Berries, nuts, dark chocolate, green tea.

1.2.4. Energy Content of Food: The energy provided by food depends on its macronutrient composition:

- **Carbohydrates**: 4 kcal per gram.
- **Proteins**: 4 kcal per gram.
- **Fats**: 9 kcal per gram.
- **Alcohol**: 7 kcal per gram (though not a nutrient, it contributes to caloric intake).

1.2.5 Food Composition Tables and Labels: Food composition tables and nutritional labels provide detailed information on the content of various nutrients in foods, aiding in dietary planning.

Key Information Provided:

- Caloric content.
- Macronutrient distribution.
- Micronutrient levels (e.g., vitamins and minerals).

1.3 NUTRITIVE VALUES OF DIFFERENT FOODS:

The nutritive value of a food item refers to its content of essential nutrients such as carbohydrates, proteins, fats, vitamins, minerals, and other bioactive compounds. These nutrients contribute to the overall energy, growth, maintenance, and repair functions of the body.

1.3.1. Cereals and Grains

Examples: Rice, wheat, maize, oats, barley, quinoa.

Nutrients:

- High in carbohydrates (70–80%): Provide energy.
- Moderate protein content (6–12%): Contains some essential amino acids, though not complete proteins.
- Fiber: Promotes digestion and regulates blood sugar levels.
- B-complex vitamins: Thiamine, niacin, and riboflavin.
- Minerals: Magnesium, phosphorus, and selenium (in whole grains).

Nutritive Value:

- Excellent energy source, ideal for staple diets.
- Whole grains reduce the risk of cardiovascular diseases and aid in weight management.

1.3.2. Pulses and Legumes

Examples: Lentils, chickpeas, kidney beans, soybeans, black-eyed peas.

Nutrients:

- High protein content (20–25%): Rich in lysine, a key amino acid.
- Carbohydrates (50–60%): Provide sustained energy.
- Dietary fiber: Enhances gut health.
- Micronutrients: Iron, folate, potassium, magnesium.
- Antioxidants: Polyphenols and flavonoids.

Nutritive Value:

- Important for muscle repair and growth.
- Soybeans, in particular, are a complete protein source.
- Help manage cholesterol levels due to fiber and phytochemicals.

1.3.3. Fruits

Examples: Apples, bananas, oranges, berries, mangoes, papayas.

Nutrients:

- Simple sugars: Natural energy boost.
- Vitamins: High in Vitamin C (citrus fruits), Vitamin A (mangoes), and Vitamin K (berries).
- Minerals: Potassium (bananas), magnesium.
- Fiber: Aids digestion and promotes satiety.
- Antioxidants: Flavonoids, carotenoids (lycopene in tomatoes), and polyphenols.

Nutritive Value:

- Boost immunity, protect against oxidative stress, and reduce the risk of chronic diseases like heart disease and cancer.
- Low-calorie and hydrating, ideal for weight management.

1.3.4. Vegetables

Examples: Spinach, broccoli, carrots, potatoes, tomatoes, bell peppers.

Nutrients:

- **Vitamins:**
  - Vitamin A (carrots and leafy greens): Essential for vision and immunity.
  - Vitamin C (broccoli, bell peppers): Enhances immunity and collagen production.
  - Folate (leafy greens): Crucial for cell division and pregnancy health.
  - Minerals: Potassium, magnesium, and iron (spinach).
  - Fiber: Aids digestion and regulates blood sugar.
  - Phytochemicals: Glucosinolates (broccoli), lutein, and zeaxanthin.

Nutritive Value:

- Protect against chronic diseases through antioxidant and anti-inflammatory effects.
- Rich in fiber and low in calories, vegetables are essential for maintaining a healthy weight and digestive system.

1.3.5. Dairy and Dairy Products

Examples: Milk, cheese, yogurt, butter, fortified plant-based alternatives (almond milk, soy milk).

Nutrients:

- Calcium: Essential for bone and teeth health.
- Protein: High-quality complete proteins like casein and whey.
- Vitamins: Vitamin D (fortified milk), Vitamin A, B2 (riboflavin).
- Fats: Varying levels of saturated fats and omega-3 fatty acids (in grass-fed options).

Nutritive Value:

- Critical for growing children, pregnant women, and older adults.
- Fermented dairy (e.g., yogurt) contains probiotics that support gut health.

1.3.6. Meat, Poultry, and Fish

Examples: Beef, chicken, pork, lamb, salmon, tuna, shellfish.

Nutrients:

- Proteins: High-quality complete proteins.

Fats:

- Lean meats: Lower in fat but rich in nutrients.
- Fatty fish (salmon, mackerel): Rich in omega-3 fatty acids (DHA and EPA).
- Micronutrients:
- Iron (red meat): Supports oxygen transport in the blood.
- Zinc: Boosts immune function.
- B-vitamins: B12 (in animal products) for nerve health.
- Other: Fish provides iodine for thyroid health.

Nutritive Value:

- Key source of essential amino acids and micronutrients.
- Fatty fish reduce inflammation and support brain health.

1.3.7. Fats and Oils

Examples: Olive oil, butter, margarine, nuts, seeds, avocado.

Nutrients:

- Essential fatty acids: Omega-3 and omega-6.
- Vitamins: Fat-soluble vitamins A, D, E, K (when consumed with fats).
- Calories: High-energy foods (9 kcal per gram of fat).

Nutritive Value:

- Monounsaturated fats (olive oil, avocados): Heart-healthy and reduce bad cholesterol.
- Polyunsaturated fats (nuts, seeds): Support brain and heart function.
- Saturated fats (butter): Provide energy but should be consumed in moderation.

1.3.8. Nuts and Seeds

Examples: Almonds, walnuts, chia seeds, sunflower seeds, flaxseeds.

Nutrients:

- Healthy fats: Omega-3 and omega-6 fatty acids.
- Proteins: Plant-based proteins.

- Fiber: Promotes satiety and digestion.
- Vitamins and minerals: Vitamin E, magnesium, selenium, and zinc.

Nutritive Value:

- Beneficial for heart health and brain function.
- Provide long-lasting energy due to the combination of fats and proteins.

1.3.9. Eggs

Nutrients:

- High-quality protein: Contains all essential amino acids.
- Fats: Healthy fats in the yolk.
- Vitamins: Vitamin D, B12, and choline (important for brain health).
- Minerals: Selenium and phosphorus.

Nutritive Value:

- Nutrient-dense and versatile.
- Excellent for muscle building, immunity, and brain function.

1.3.10. Processed and Fortified Foods

Examples: Breakfast cereals, fortified bread, plant-based milk, meal replacement bars.

Nutrients:

- Vary based on the product but often enriched with iron, folic acid, Vitamin D, calcium, or B vitamins.
- Provide quick and accessible nutrition but should be consumed mindfully due to added sugars or sodium.

Nutritive Value:

- Useful for addressing nutritional deficiencies when natural sources are unavailable.

1.4 FUNCTIONS OF FOODS:

Food is essential for life, as it provides the nutrients and energy required for survival, growth, and overall well-being. The functions of food can be broadly classified into three main categories:

1.4.1. Energy-Giving Functions: Foods provide energy required for all body processes, including physical activities, metabolic functions, and maintenance of body temperature.

Energy Sources:

- **Carbohydrates**: The body's primary source of energy. Simple sugars provide quick energy, while complex carbohydrates supply sustained energy. Examples: Rice, bread, potatoes, fruits.
- **Fats**: A concentrated source of energy (9 kcal per gram) and an energy reserve for long-term use. Examples: Butter, oils, nuts, fatty fish.
- **Proteins**: Serve as a backup energy source when carbohydrates and fats are insufficient. Examples: Meat, fish, eggs, legumes.

1.4.2. Body-Building Functions: Foods provide the raw materials necessary for the growth, repair, and maintenance of body tissues.

- **Proteins**: The main building blocks for muscles, skin, bones, and organs. Proteins also play a role in producing enzymes, hormones, and antibodies. Examples: Meat, fish, eggs, soybeans, dairy.
- **Minerals**: Calcium and Phosphorus: Crucial for building and maintaining strong bones and teeth. Examples: Milk, cheese, leafy greens.
- **Iron**: Required for producing hemoglobin in red blood cells. Examples: Red meat, lentils, spinach.
- **Fats**: Provide structural support to cells, particularly in forming cell membranes. Examples: Avocados, nuts, seeds, fish.
- **Water**: Essential for cell hydration, nutrient transport, and tissue repair.

1.4.3. Regulatory Functions: Certain foods help regulate and coordinate body processes, ensuring proper functioning of various systems.

Vitamins:

- **Vitamin A**: Supports vision and immune function. Examples: Carrots, sweet potatoes.
- **Vitamin D**: Regulates calcium absorption and promotes bone health. Examples: Fortified milk, sunlight, fish.
- **Vitamin C**: Boosts immunity and aids in collagen production. Examples: Oranges, bell peppers.
- **B-Complex Vitamins**: Aid in energy metabolism and nervous system health. Examples: Whole grains, eggs, meat.

Minerals:

- **Sodium and Potassium**: Regulate fluid balance and nerve transmission. **Examples**: Bananas, table salt, coconut water.

- **Iodine**: Supports thyroid gland function. **Examples**: Iodized salt, seafood.
- **Water**: Regulates body temperature through sweating. Facilitates digestion, absorption, and excretion.
- **Dietary Fiber**: Regulates bowel movements and prevents constipation. Reduces cholesterol and stabilizes blood sugar levels. **Examples**: Whole grains, fruits, vegetables.

1.4.4. Protective Functions: Certain foods protect the body from diseases and boost the immune system.

- **Antioxidants**: Neutralize free radicals that cause cellular damage and reduce the risk of chronic diseases. **Examples**: Berries, green tea, dark chocolate.
- **Phytochemicals**: Bioactive compounds in plants that reduce inflammation and protect against cancer and heart diseases. **Examples**: Lycopene in tomatoes, flavonoids in citrus fruits, sulforaphane in broccoli.
- **Immunity Boosters**:
- **Vitamin C**: Enhances the immune response. **Examples**: Kiwi, guava.
- **Zinc**: Plays a critical role in immune function and wound healing. **Examples**: Nuts, shellfish.

1.4.5. Sensory and Social Functions: Foods also play a sensory and cultural role in human lives.

- **Taste and Enjoyment**: Food satisfies hunger and provides pleasure through taste, aroma, and texture.
    - Sweet, salty, sour, bitter, and umami flavors make eating enjoyable.
- **Social and Cultural Role**:
    - Food strengthens social bonds through communal meals, celebrations, and traditions.
    - It is central to cultural identity and heritage.
- **Emotional Comfort**: Certain foods (e.g., chocolate, comfort meals) can improve mood and reduce stress.

1.4.6. Detoxifying Functions: Some foods help detoxify the body by removing harmful substances.

- **Detoxifying Foods**:
    - Garlic: Contains sulfur compounds that support liver detoxification.
    - Green tea: Rich in catechins that promote detoxification.
    - Cruciferous vegetables (broccoli, cabbage): Contain compounds that support liver function.

1.4.7. Functional Foods: Functional foods go beyond basic nutrition and provide additional health benefits.

Examples:

- Probiotic foods (yogurt, kefir): Improve gut health.
- Omega-3-rich foods (fish, flaxseeds): Reduce inflammation and support heart health.
- Fortified foods (milk with Vitamin D, salt with iodine): Address nutrient deficiencies.

1.5 BALANCED DIET:

A diet which contains different types of foods in quantities enough to meet the need for nutrients as well as a small provision to meet nutrients during a short duration of starvation. The daily diet must provide all essential nutrients in the required amounts which vary with age, gender, physiological status and physical activity. A typical Indian balanced diet should provide 60-70% of energy from carbohydrates, 10-12% from protein and 20-25% of energy from fat. The features of a balanced diet are-

- Meets nutritional requirements
- Develops maximum cognitive ability
- Prevents degenerative diseases
- Improves longevity
- Improves immunity
- Helps in coping up stress

1.6 RECOMMENDED DIETARY ALLOWANCE (RDA):

The Recommended Dietary Allowance (RDA) refers to the daily intake level of a nutrient that is sufficient to meet the requirements of nearly all (97–98%) healthy individuals in a specific life stage and gender group. It is designed as a goal for individual intake and is based on scientific evidence regarding nutrient needs.

Different Definitions of RDA from Various Organizations

1) National Institute of Nutrition (NIN), India:

- The RDA is the average daily dietary intake level that is sufficient to meet the nutrient needs of almost all (97–98%) healthy individuals in a particular life stage and gender group. It is based on Indian dietary patterns, climate, and food availability.

2) Indian Council of Medical Research (ICMR):

- The RDA represents the daily intake of essential nutrients considered adequate to meet the requirements of most healthy individuals in a population, considering physiological, environmental, and genetic factors affecting Indian populations.

3) American Dietetic Association (ADA) (now Academy of Nutrition and Dietetics AND):

- The RDA is a set of reference values used to plan and assess nutrient intakes for individuals and populations, ensuring adequate nutrition and preventing deficiencies and chronic diseases.

1.6.1 Factors Affecting RDA:

Several factors influence the RDA values, making them variable across different groups and conditions:

1. Age and Gender

- Nutrient requirements change at different life stages (infants, children, adolescents, adults, and elderly).
- Men and women have different RDA values due to differences in body composition, metabolism, and physiological needs.

2. Physiological Status

- **Pregnancy and Lactation:** Increased nutrient needs to support fetal development and milk production.
- **Growth and Development:** Higher RDA for children and adolescents due to rapid growth.

3. Health Conditions

- Individuals with diseases like diabetes, cardiovascular issues, or gastrointestinal disorders may have altered nutrient requirements.
- Recovery from illnesses, surgeries, or infections increases the need for certain nutrients.

4. Physical Activity Level

- Athletes and individuals with high energy expenditure require increased calorie and protein intake.
- Sedentary individuals may have lower energy requirements but still need sufficient micronutrients.

5. Environmental and Climatic Conditions

- **Hot climates:** Increased water and electrolyte needs due to sweating.
- **Cold climates:** Higher energy intake required for thermoregulation.
- **High altitudes:** Increased iron and calorie intake needed for oxygen transport and energy.

6. Nutrient Bioavailability

- The body's ability to absorb and utilize nutrients depends on dietary composition, interactions between nutrients, and food sources.
- Example: Iron from animal sources (heme iron) is more bioavailable than from plant sources (non-heme iron).

7. Genetic and Ethnic Variations

- Genetic differences affect metabolism and nutrient utilization.
- Ethnic dietary habits influence nutrient intake patterns and needs.

Table 1.1: Summary of Recommended Dietary Allowances for Indians Suggested by ICMR-NIN-2020

Recommended Dietary Allowances for Indians (Macronutrients and Minerals)

Group	Particulars	Body weight kg	Net Energy Kcal/d	Protein g/d	Visible Fat g/day	Calcium mg/d	Iron mg/d
Man	Sedentary work	60	2320	60	25	600	17
	Moderate work		2730		30		
	Heavy work		3490		40		
Woman	Sedentary work	55	1900	55	20	600	21
	Moderate work		2230		25		
	Heavy work		2850		30		
	Pregnant woman		+350	+23	30	1200	35
	Lactation 0-6 months		+600	+19	30	1200	21
	6-12 months		+520	+13	30		
Infants	0-6 months	5.4	92 Kcal/kg/d	1.16 g/kg/d	–	500	46 µg/ kg/day
	6-12 months	8.4	80 Kcal/kg/d	1.69 g/kg/d	19		5
Children	1-3 years	12.9	1060	16.7	27	600	09
	4-6 years	18	1350	20.1	25		13
	7-9 years	25.1	1690	29.5	30		16
Boys	10-12 years	34.3	2190	39.9	35	800	21
Girls	10-12 years	35.0	2010	40.4	35	800	27
Boys	13-15 years	47.6	2750	54.3	45	800	32
Girls	13-15 years	46.6	2330	51.9	40	800	27
Boys	16-17 years	55.4	3020	61.5	50	800	28
Girls	16-17 years	52.1	2440	55.5	35	800	26

1.7 FOOD EXCHANGE LIST:

The Food Exchange List is a meal-planning tool that categorizes foods into groups based on their macronutrient content (carbohydrates, protein, fat) and caloric value. It was initially developed by the American Diabetes Association (ADA) and the Academy of Nutrition and

Dietetics to help people with diabetes control their blood sugar levels. However, it is now widely used for weight management, balanced eating, and portion control in various dietary plans. Each food within a category provides similar amounts of calories, carbohydrates, proteins, and fats, allowing individuals to swap one food for another of equal nutritional value. This system ensures flexibility in meal choices while maintaining nutritional consistency, making it useful for people following structured diets for diabetes, weight loss, heart health, and overall wellness.

Benefits of the Food Exchange List

- Helps Manage Blood Sugar – Especially useful for people with diabetes by controlling carbohydrate intake.
- Supports Weight Control – Encourages portion control and calorie balance for weight loss or maintenance.
- Promotes Balanced Nutrition – Ensures intake of essential nutrients from different food groups.
- Provides Flexibility – Allows for food substitutions while maintaining the same nutrient intake.
- Easy Meal Planning – Simplifies meal tracking for structured diet programs.

1.8 SUMMERY:

Nutrients are required by the body in the right amounts and they must be eaten regularly. Each nutrient- carbohydrates, fats, proteins, minerals, vitamins and water performs a specific function in our body. These nutrients are utilized by the body to maintain health. The nutrients should be supplied daily in the right proportion for optimum utilization and proper body maintenance.

1.9 TECHNICAL TERMS:

Food groups, balance diet, recommended dietary allowances, food exchange list

1.10 SELF ASSESSMENT QUESTIONS:

1) Explain about composition and functions of food
2) Discuss about the importance of balanced diet
3) Write an account on food exchange list

1.11 REFERENCE BOOKS:

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LESSON-2

PREGNANCY: NUTRIENT REQUIREMENTS, INTAKE AND GAPS, PRENATAL AND POSTNATAL NUTRITIONAL IMPORTANCE, METABOLIC ADJUSTMENTS IN PREGNANCY

2.0 OBJECTIVES:

After reading this lesson, you would be able to:

- To know about Nutrient requirements, nutrient intake and gaps during pregnancy;
- To understand prenatal and post natal nutritional importance and;
- Metabolic adjustments during pregnancy.

STRUCTURE:

2.1 INTRODUCTION:

Pregnancy is a critical period marked by profound physiological, hormonal, and metabolic changes, all of which are aimed at supporting the growth and development of the fetus while maintaining the health of the mother. These changes create unique nutritional demands that, if unmet, can affect pregnancy outcomes for both mother and baby. Proper nutrition during pregnancy is essential not only for the development of the fetus but also for preparing the mother for labor, delivery, and postpartum recovery.

The foundation of a healthy pregnancy is a well-balanced diet that provides the right balance of macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals) in adequate amounts. Nutritional needs increase significantly during pregnancy to accommodate fetal growth, placental development, maternal tissue expansion, and an elevated metabolic rate. Understanding and addressing these needs can help prevent complications such as low birth weight, preterm delivery, and developmental issues in the newborn.

This document outlines the key nutrient requirements, common dietary gaps, the significance of prenatal and postnatal nutrition, and the metabolic adjustments that occur during pregnancy.

2.2 NUTRIENT REQUIREMENTS:

During pregnancy, the demand for macro- and micronutrients increases significantly to support fetal growth, placental development, maternal tissue expansion, and increased blood volume. Key nutrients include:

2.2.1 Micronutrients:

- **Energy**: Caloric requirements increase progressively. In the second trimester, an additional 340 kcal/day is recommended, rising to 450 kcal/day in the third trimester. Adequate caloric intake supports fetal growth, maternal tissue development, and increased energy expenditure. Insufficient caloric intake can lead to intrauterine growth restriction (IUGR) and low birth weight.
- **Proteins**: Essential for fetal tissue development, maternal tissue expansion, and placental growth. Recommended intake increases to about 71 g/day. High-quality protein sources such as lean meats, dairy, eggs, legumes, and nuts are encouraged. Protein insufficiency can impair fetal growth and maternal health, particularly in the later trimesters when growth is rapid.
- **Fats**: Essential fatty acids, especially omega-3 fatty acids (e.g., DHA and EPA), are vital for fetal brain and retinal development. Pregnant individuals should aim to consume at least 200-300 mg of DHA per day through sources like fatty fish (salmon, sardines) or supplements. Omega-6 fatty acids should also be balanced to maintain proper inflammatory responses.

- **Carbohydrates**: Serve as the primary energy source for both the mother and fetus. Pregnant individuals should consume complex carbohydrates such as whole grains, fruits, and vegetables, ensuring a balanced glycemic load to avoid gestational diabetes. Carbohydrates also spare proteins for their primary roles in tissue building and repair.

2.2.2 Micronutrients:

- **Iron**: Supports increased blood volume, fetal growth, and placental development. Daily needs rise to 27 mg. Iron-rich foods (e.g., red meat, spinach, fortified cereals) and supplements are often required to meet this demand. Pairing iron sources with vitamin C enhances absorption.
- **Folate (Vitamin B9)**: Critical for neural tube development, with an RDA of 600 μg/day. Folate-rich foods include leafy greens, citrus fruits, beans, and fortified grains. Supplemental folic acid is recommended to reduce the risk of neural tube defects.
- **Calcium**: Necessary for fetal skeletal development and maternal bone health, requiring 1,000 mg/day. Dairy products, fortified plant-based milk, leafy greens, and tofu are good sources. Insufficient calcium can lead to maternal bone loss and hypertension.
- **Vitamin D**: Enhances calcium absorption, supports immune function, and contributes to healthy fetal bone development. A daily intake of 600 IU is recommended, with sources including sunlight, fortified foods, and supplements. Emerging research suggests its role in reducing preeclampsia risk.
- **Iodine**: Supports fetal thyroid development and cognitive function. A daily intake of 220 μg is essential, with iodine-rich foods such as iodized salt, seafood, and dairy. Iodine deficiency can result in congenital hypothyroidism.
- **Zinc**: Plays a role in DNA synthesis, cell division, and immune function, with an RDA of 11 mg/day. Foods like meat, shellfish, nuts, and seeds are excellent sources.
- **Vitamin C**: Enhances iron absorption and supports immune health, with a recommended intake of 85 mg/day. Citrus fruits, strawberries, and bell peppers are rich in vitamin C.
- **Choline**: Important for fetal brain development and neural tube closure, with an RDA of 450 mg/day. Good sources include eggs, meat, and fish. Choline is critical for long-term cognitive health in offspring.

- **Magnesium**: Supports muscle function, reduces the risk of preeclampsia, and aids in fetal development. The RDA is 350-400 mg/day, with nuts, seeds, whole grains, and leafy greens being excellent sources.
- **Sodium and Potassium**: Vital for fluid balance and blood pressure regulation. Sodium requirements remain consistent with non-pregnant levels but should not be excessively restricted unless medically advised. Potassium, found in bananas, avocados, and potatoes, helps prevent leg cramps and promotes cardiovascular health.

2.2.3 Fluids:

- Adequate hydration is crucial to support increased blood volume, amniotic fluid production, and overall metabolic processes. Pregnant individuals should aim for at least 8-10 cups (2-2.5 liters) of fluids daily, with water being the preferred source. Dehydration can increase the risk of preterm labor and urinary tract infections.

2.2.4 Fiber:

- Increased fiber intake is essential to prevent constipation, a common issue during pregnancy due to hormonal changes. Whole grains, fruits, vegetables, and legumes are excellent sources.

Here's a table 2.1 summarizing the key nutrient requirements during pregnancy, including the recommended daily intake, function, and sources for each nutrient:

Table 2.1: Nutrient Requirements during Pregnancy

Nutrient	Recommended Daily Intake	Function	Sources
Energy (Calories)	Additional 300 kcal/day (2nd & 3rd trimesters)	Supports fetal growth, maternal energy demands, and lactation	Lean meats, whole grains, legumes, fruits, vegetables, nuts, dairy
Protein	71 g/day (2nd & 3rd trimesters)	Fetal tissue growth, maternal tissue repair, hormone production	Lean meats, poultry, fish, eggs, dairy, legumes, nuts, seeds
Folic Acid (Vitamin B9)	600 mcg/day	Prevents neural tube defects, supports cell division and DNA synthesis	Leafy greens, fortified cereals, citrus fruits, beans, peas, lentils, avocado
Iron	27 mg/day	Supports increased blood volume, prevents anemia, aids fetal development	Red meat, poultry, fish, beans, spinach, fortified cereals, dried fruits (apricots, raisins)

Calcium	1,000 mg/day (1,300 mg for teens)	Bone and teeth formation, nerve function, muscle function	Dairy products (milk, yogurt, cheese), fortified plant-based milks, tofu, leafy greens (kale, broccoli), fortified cereals
Vitamin D	600 IU/day	Calcium absorption, bone health, immune function	Sunlight, fortified dairy products, fortified plant-based milks, fatty fish (salmon, mackerel), egg yolk, mushrooms
Iodine	220 mcg/day	Thyroid hormone production, supports brain development	Iodized salt, dairy, eggs, seafood, seaweed
Vitamin A	770 mcg/day	Supports fetal vision, immune system, and skin development	Liver, carrots, sweet potatoes, spinach, kale, eggs, fortified cereals
Vitamin C	85 mg/day	Collagen formation, immune function, iron absorption	Citrus fruits, strawberries, bell peppers, tomatoes, broccoli, potatoes
Magnesium	350-400 mg/day	Muscle and nerve function, supports bone health, regulates blood sugar	Whole grains, nuts, seeds, leafy greens, legumes, avocados
Zinc	11 mg/day (10 mg for teens)	Supports immune function, fetal growth, and tissue repair	Meat, shellfish, dairy, legumes, seeds, nuts, whole grains, fortified cereals
Vitamin B12	2.6 mcg/day	Supports red blood cell formation, nerve health	Animal products (meat, fish, poultry, eggs, dairy), fortified plant-based milks, fortified cereals
Choline	450 mg/day	Brain and spinal cord development, supports cell structure and function	Eggs, lean meats, fish, dairy, cruciferous vegetables (broccoli, Brussels sprouts), legumes
Omega-3 Fatty Acids (DHA & EPA)	200-300 mg/day	Supports fetal brain and eye development, reduces preterm birth risk	Fatty fish (salmon, sardines, mackerel), flaxseeds, chia seeds, walnuts, fortified eggs and milk

Vitamin K	90 mcg/day	Blood clotting, bone health	Leafy greens (spinach, kale, broccoli), cabbage, Brussels sprouts, fish, meat, dairy
Fiber	28 g/day	Supports digestive health, prevents constipation	Whole grains, fruits, vegetables, legumes, nuts, seeds

2.3 NUTRIENT INTAKE AND GAPS:

Despite the increased nutrient demands of pregnancy, many individuals face challenges in meeting these requirements, leading to gaps that can adversely affect maternal and fetal health. Common nutritional gaps include:

- **Iron Deficiency**: One of the most prevalent deficiencies during pregnancy, iron deficiency can lead to anemia, increasing the risk of preterm delivery, low birth weight, and maternal fatigue. Poor dietary intake of iron-rich foods or inadequate supplementation contributes to this gap.
- **Folate Deficiency**: Inadequate folate intake is associated with neural tube defects (NTDs) in the developing fetus. While fortification programs and supplements have reduced the prevalence of this deficiency, some individuals still fail to meet the recommended daily intake.
- **Vitamin D Insufficiency**: Limited sun exposure, low dietary intake, and insufficient supplementation can result in suboptimal vitamin D levels, potentially affecting fetal skeletal development and maternal bone health. Emerging research also links vitamin D insufficiency to an increased risk of preeclampsia.
- **Omega-3 Fatty Acid Deficiency**: Many diets lack adequate sources of DHA and EPA, essential for fetal brain and eye development. This deficiency is often due to low consumption of fatty fish or insufficient use of omega-3 supplements.
- **Calcium Deficiency**: Insufficient calcium intake can lead to maternal bone loss, hypertensive disorders, and suboptimal fetal bone development. Pregnant individuals who avoid dairy or calcium-fortified foods are at higher risk.
- **Choline Deficiency**: Often overlooked, choline is critical for fetal brain development and neural tube closure. Many individuals fail to meet the recommended intake due to limited dietary sources or lack of awareness about its importance.
- **Magnesium Insufficiency**: Low magnesium intake is associated with leg cramps, preeclampsia, and poor fetal growth. Magnesium-rich foods like whole grains, nuts, and seeds are often under-consumed.

- **Iodine Deficiency**: Inadequate iodine intake can impair fetal thyroid function and cognitive development. While iodized salt has mitigated this issue in many populations, it remains a concern in some regions.
- **Vitamin B12 Deficiency**: Particularly common in vegetarians and vegans, vitamin B12 deficiency can impact fetal brain development and increase the risk of maternal anemia. Supplementation is essential for those following plant-based diets.
- **Fiber Deficiency**: Low fiber intake contributes to constipation, a common complaint during pregnancy. Whole grains, fruits, and vegetables are often underrepresented in the diet, exacerbating this issue.

Addressing these gaps through dietary modifications, targeted supplementation, and healthcare provider guidance is critical to ensuring healthy pregnancy outcomes. Prenatal vitamins can help fill nutrient gaps, but they should complement a nutrient-dense diet rather than replace it.

2.4 PRENATAL AND POSTNATAL NUTRITIONAL IMPORTANCE:

Nutrition plays a pivotal role in pregnancy, both during the prenatal and postnatal periods. Proper nourishment ensures the health and well-being of the mother while supporting the optimal growth and development of the baby. This article explores the nutritional needs and their importance in these critical phases of life.

2.4.1 Prenatal Nutrition:

The prenatal phase spans from conception to birth, during which a mother's body undergoes significant physiological and hormonal changes to sustain the pregnancy and support fetal development. Adequate prenatal nutrition is essential for the following reasons:

1. **Fetal Development**:
   - Nutrients such as folic acid, iron, calcium, and omega-3 fatty acids are crucial for the baby's development.
   - Folic acid reduces the risk of neural tube defects, while iron supports the increased blood volume and prevents anemia.
   - Calcium is essential for the baby's bone and teeth formation, and omega-3 fatty acids play a role in brain and eye development.
2. **Maternal Health**:
   - A well-balanced diet helps manage common pregnancy symptoms like fatigue, morning sickness, and constipation.

- Proper nutrition reduces the risk of complications such as gestational diabetes, preeclampsia, and preterm labor.

3. **Placental Health**:

- The placenta acts as the lifeline between the mother and fetus. Nutrient-rich foods ensure its proper growth and function, facilitating nutrient and oxygen delivery to the baby.

Key Nutrients during Pregnancy:

- **Protein**: Supports the growth of fetal tissue, including the brain, and maternal tissues.
- **Iron**: Helps produce additional blood for the mother and baby.
- **Folic Acid**: Prevents neural tube defects and promotes cell division.
- **Calcium**: Necessary for developing the baby's skeletal system.
- **Vitamin D**: Enhances calcium absorption and supports immune function.
- **DHA (Docosahexaenoic Acid)**: An omega-3 fatty acid critical for brain and eye development.
- **Zinc**: Plays a role in cell growth and immune function.

2.4.2 Postnatal Nutrition:

The postnatal period, also known as the postpartum phase, begins immediately after childbirth and lasts for several months. During this time, the mother's body undergoes recovery while providing nourishment to the newborn through breastfeeding. Nutritional care in this phase is equally vital for the following reasons:

1. **Maternal Recovery**:

- Nutrients like iron and protein aid in tissue repair and replenish stores lost during delivery.
- Hydration and a nutrient-rich diet support energy levels and overall recovery.

2. **Lactation Support**:

- Breast milk provides the sole source of nutrition for the baby in the early months. It contains antibodies, essential fats, proteins, and carbohydrates tailored to the baby's needs.
- Mothers need an additional 400-500 calories per day to maintain an adequate milk supply.
- Key nutrients include calcium, vitamin D, iodine, and omega-3 fatty acids to ensure the nutritional quality of breast milk.

3. **Mental Health**:
    - Nutritional imbalances can contribute to postpartum depression. Foods rich in omega-3 fatty acids, magnesium, and B vitamins may improve mood and emotional well-being.

Key Nutrients during the Postnatal Period:

- **Protein**: Supports tissue repair and milk production.
- **Calcium and Vitamin D**: Maintain bone health and support lactation.
- **Iron**: Replenishes stores depleted during childbirth and prevents anemia.
- **Omega-3 Fatty Acids**: Support maternal brain health and ensure quality breast milk.
- **Hydration**: Adequate fluid intake is critical for milk production and overall recovery.

2.4.3 Practical Tips for Optimal Nutrition:

1. **Meal Planning**:
    - Incorporate a variety of fruits, vegetables, whole grains, lean proteins, and healthy fats.
    - Opt for small, frequent meals to manage appetite and energy levels.
2. **Supplementation**:
    - Prenatal vitamins should be continued during the postpartum period, especially if breastfeeding.
    - Consult a healthcare provider for personalized supplementation needs.
3. **Hydration**:
    - Drink plenty of water to support increased metabolic demands and milk production.
4. **Mindful Eating**:
    - Avoid processed foods and excessive sugar intake.
    - Focus on nutrient-dense options to maximize health benefits.

2.5 METABOLIC ADJUSTMENTS IN PREGNANCY:

Metabolic adjustments during pregnancy are crucial for supporting the development of the fetus, maintaining maternal health, and preparing the body for labor and lactation. These adjustments involve complex physiological changes in various systems, including energy metabolism, nutrient utilization, and hormone regulation. Below, we'll explore some of the key metabolic changes that occur during pregnancy:

2.5.1. Increased Energy Demands:

Pregnancy significantly increases energy demands due to the growing needs of the fetus and the physiological changes in the mother's body. The basal metabolic rate (BMR) rises by approximately 15-25% during pregnancy. This means the body requires more calories to maintain essential functions (Fig. 2.1. Overview of Metabolic Adjustments during Pregnancy).

- **Energy Storage**: To meet the increased energy needs, pregnant women store more energy as fat, particularly in the first and second trimesters. This stored energy is used during later stages of pregnancy and after childbirth, especially for breastfeeding.
- **Maternal Fat Reserves**: These reserves become essential for providing energy for lactation post-delivery, helping the mother transition from pregnancy to nursing.

2.5.2. Changes in Glucose Metabolism:

Pregnancy induces significant changes in carbohydrate metabolism to ensure a continuous supply of glucose for fetal development.

- **Increased Insulin Resistance**: In the second and third trimesters, there is an increase in insulin resistance, which helps ensure that more glucose is available for the fetus. The mother's body produces more insulin to compensate for this resistance, but in some cases, if the pancreas cannot meet the demand, gestational diabetes can occur.
- **Fetal Glucose Requirements**: The fetus depends on maternal glucose as its primary energy source. The placenta plays a vital role in glucose transfer, and the mother's ability to regulate blood glucose becomes increasingly important.
- **Hyperinsulinemia**: Due to insulin resistance and higher insulin production, there is often a state of hyperinsulinemia (high levels of insulin in the blood). This ensures that the mother's blood glucose levels remain within a range that can nourish the fetus.

2.5.3. Alterations in Protein Metabolism:

Protein metabolism also undergoes adjustments during pregnancy, as proteins are essential for the growth of fetal tissues and organs.

- **Increased Protein Synthesis**: The body increases protein synthesis to support the growth of the fetus and the placenta, as well as to prepare for lactation. There is a greater retention of nitrogen, an indicator of protein retention.
- **Increased Demand for Amino Acids**: The fetus relies on maternal amino acids for protein synthesis. The placenta actively transports amino acids to the fetus, which increases maternal requirements for certain essential amino acids, particularly in the second and third trimesters.

2.5.4. Lipids and Fat Metabolism:

Pregnancy also involves significant changes in lipid metabolism, particularly in the utilization and storage of fats.

- **Fat Mobilization and Storage**: During pregnancy, the body increases the storage of fat in the form of adipocytes (fat cells) to provide a reserve for the energy demands of pregnancy and lactation. This process is facilitated by elevated levels of hormones like progesterone and estrogen.
- **Increased Fatty Acid Mobilization**: As pregnancy progresses, the body becomes more efficient at mobilizing fat stores for energy. This is especially important in the third trimester, when fetal growth peaks and energy demands increase.

2.5.5. Hormonal Regulation:

The metabolic changes during pregnancy are primarily regulated by a complex interplay of hormones, including human chorionic gonadotropin (hCG), progesterone, estrogen, cortisol, and insulin.

- **Progesterone**: This hormone plays a central role in supporting pregnancy by promoting fat storage and increasing appetite. It also stimulates the release of insulin, contributing to the changes in glucose metabolism.
- **Estrogen**: Estrogen helps regulate fat and carbohydrate metabolism and is involved in stimulating the development of the placenta, which plays a key role in nutrient transfer between mother and fetus.
- **Human Placental Lactogen (hPL)**: This hormone, produced by the placenta, has an insulin-antagonistic effect, contributing to insulin resistance in the mother and ensuring that more glucose is available for fetal development.
- **Cortisol**: Increased cortisol levels during pregnancy help maintain glucose homeostasis by stimulating gluconeogenesis and preventing hypoglycemia, especially as the body adjusts to increased insulin resistance.

2.5.6. Water and Electrolyte Balance:

Pregnancy also affects fluid balance, as the body prepares to support the increased blood volume and the growing fetus.

- **Increased Blood Volume**: There is a significant increase in blood volume during pregnancy, which is necessary to supply nutrients and oxygen to the fetus. This also impacts electrolyte balance and fluid distribution.
- **Fluid Retention**: Hormones like progesterone and aldosterone promote fluid retention to accommodate the growing uterine and placental tissue. This can sometimes lead to swelling in the legs and feet, a common pregnancy symptom.

2.5.7. Impact of Pregnancy on Nutrient Utilization:

Nutrient utilization is optimized during pregnancy to ensure that the developing fetus receives the necessary vitamins and minerals.

- **Iron**: The demand for iron increases significantly during pregnancy due to the expansion of maternal blood volume and the needs of the growing fetus. This can result in a higher risk of iron deficiency anemia.
- **Calcium**: Maternal calcium metabolism is adjusted to ensure that the fetus receives enough calcium for bone development. The body increases calcium absorption from the digestive tract and reduces excretion to maintain adequate levels.
- **Vitamin D**: Increased vitamin D levels are essential for proper calcium absorption and fetal bone development.

2.5.8. Postpartum Adjustments:

After childbirth, the body undergoes metabolic adjustments to return to a non-pregnant state while supporting lactation.

- **Lactation and Energy Needs**: The metabolic demands shift from pregnancy to breastfeeding. Lactation increases caloric requirements, and the body continues to use fat stores to meet the energy demands of milk production.
- **Hormonal Changes**: Postpartum hormonal changes (e.g., decreased progesterone and estrogen) lead to the mobilization of stored fat, facilitating the return to pre-pregnancy weight, though this process varies widely between individuals.

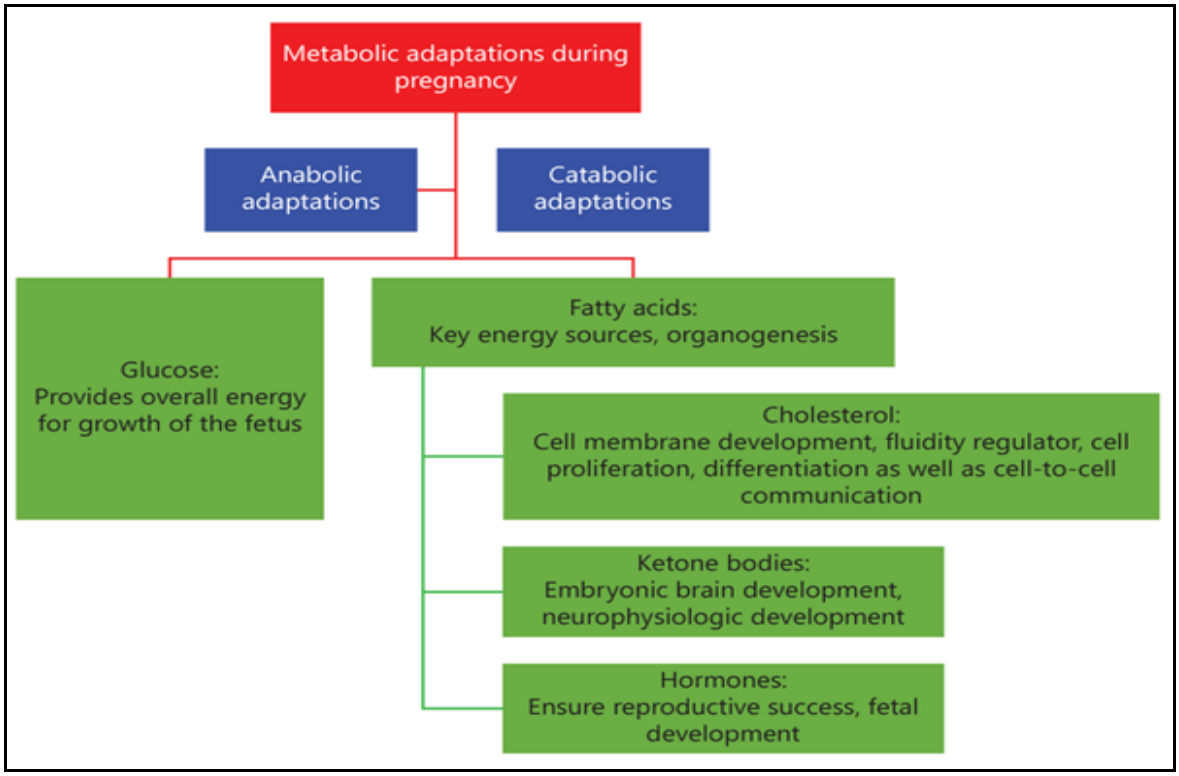

Fig. 2.1. Overview of Metabolic Adjustments during Pregnancy

The metabolic changes during pregnancy are finely tuned to support both the mother and the fetus. These adjustments ensure that the mother has adequate energy and nutrients to support

fetal growth, maintain her own health, and prepare for postpartum challenges like lactation. However, complications like gestational diabetes or inadequate nutrient intake can disrupt these processes, highlighting the importance of proper prenatal care and nutrition.

2.6 SUMMARY:

The nutritional needs during pregnancy and the postnatal period are critical for the health of both mother and child. Understanding and addressing nutrient intake gaps, ensuring that both prenatal and postnatal nutrition are appropriately managed, and recognizing the metabolic changes that occur can significantly reduce the risk of complications and promote better health outcomes. With adequate care, support, and education, pregnant and postpartum women can meet their nutritional needs, ensuring the best possible start for their babies and a smoother transition to motherhood.

2.7 TECHNICAL TERMS:

Macro nutrients, pregnancy, metabolic changes during pregnancy, micro nutrients, hydration, fibre, prenatal and postnatatal care.

2.8 SELF ASSESSMENT QUESTIONS:

1) Explain the nutrient needs during antenatal period?
2) Describe the metabolic adjustments during pregnancy?
3) Write in detail the nutritional requirements during pregnancy and comment on their significance.

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LESSON-3

NUTRITION INTERVENTION AND PREGNANCY OUTCOME; COMMON SYMPTOMS, NUTRITIONAL MANAGEMENT, PROBLEMS AND COMPLICATIONS, ADOLESCENT PREGNANCY

3.0 OBJECTIVES :

After reading this lesson, students will be able to know :

- Identify the common pregnancy-related symptoms such as nausea, edema, heartburn, hemorrhoids and constipation.
- To learn and understand the Nutritional problems and complications of pregnancy
- To know the Adolescent pregnancy and Care of the premature babies.

STRUCTURE:

3.1 INTRODUCTION:

One of the most special and unique bonds is that of mother and child. The bond begins right at conception and continues to grow after the child is born. The unborn child is dependent on the mother in the womb for its nutrition and oxygen.

Pregnancy is an extremely important period in a new mother's life. Everything the mother does impact the unborn fetus in the womb; so mothers have to take extremely good care of their health during and after pregnancy. The nutrition intake of the mother will affect the development of the child in the womb.

3.2 NUTRITION INTERVENTION AND PREGNANCY OUTCOMES:

Nutrition plays a critical role in influencing pregnancy outcomes. Adequate and balanced nutrition during pregnancy not only supports the health of the mother but also fosters optimal fetal development, reducing the risk of complications and improving long-term health for both mother and child. Nutrition intervention involves strategies aimed at addressing nutrient deficiencies, supporting healthy weight gain, preventing pregnancy-related complications, and improving maternal and fetal health outcomes.

3.2.1. The Importance of Nutrition in Pregnancy: Good nutrition provides the foundation for healthy pregnancy outcomes. It is essential for:

- **Fetal Growth and Development**: Proper nutrition ensures that the fetus receives the necessary nutrients to develop normally, especially in critical areas such as brain development, bone formation, and organ development.
- **Maternal Health**: Pregnancy places increased demands on a woman's body. Adequate nutrition supports the mother's health by ensuring proper energy balance, promoting the immune system, and maintaining optimal levels of blood pressure and blood sugar.
- **Prevention of Pregnancy Complications**: Poor nutrition is associated with various pregnancy complications such as gestational diabetes, preeclampsia, preterm birth, low birth weight, and neural tube defects. Proper nutrition intervention can mitigate these risks.

3.2.2. Key Nutrition Interventions: Nutrition interventions are designed to address both the nutrient needs of the mother and the fetus, and to prevent or manage common pregnancy complications. These interventions can be grouped into general recommendations for dietary habits, supplementation, and targeted approaches based on individual health needs.

Dietary Recommendations:

- **Balanced Diet**: A diet rich in fruits, vegetables, whole grains, lean proteins, and healthy fats is essential to support both maternal and fetal health. A well-rounded diet provides essential macronutrients (proteins, carbohydrates, fats) and micronutrients (vitamins and minerals) necessary for optimal pregnancy outcomes.

- **Increased Caloric Intake**: Energy needs increase during pregnancy, especially in the second and third trimesters. It is important to ensure an adequate intake of calories to support fetal growth without excessive weight gain. Focus on nutrient-dense foods rather than "empty-calorie" foods to meet the increased energy demands.
- **Protein-Rich Foods**: Protein is essential for fetal growth, tissue repair, and the production of maternal blood cells. Protein-rich foods, such as lean meats, fish, eggs, dairy, legumes, and nuts, should be included regularly in the diet.
- **Supplements:** Certain nutrients require supplementation during pregnancy to meet increased demands and prevent deficiencies. Common supplementation interventions include:
- **Folic Acid**: A key intervention to prevent neural tube defects, folic acid supplementation (400-800 mcg/day) is recommended for all pregnant women, particularly in the early weeks of pregnancy.
- **Iron**: Iron supplements are often prescribed to prevent or treat iron deficiency anemia, which is common during pregnancy. Anemia can lead to fatigue, preterm birth, and low birth weight. Iron supplements, often combined with vitamin C to improve absorption, help ensure sufficient hemoglobin levels.
- **Calcium and Vitamin D**: Calcium supports fetal bone development, while vitamin D aids in calcium absorption. Many pregnant women may require supplements, especially if they have low dietary intake or limited exposure to sunlight.
- **Omega-3 Fatty Acids (DHA and EPA)**: Omega-3 supplementation is important for fetal brain and eye development. DHA, in particular, is recommended in the second and third trimesters to support these critical developmental stages.
- **Iodine**: Iodine supplementation may be necessary, particularly in areas where iodine deficiency is prevalent. It supports thyroid function and fetal brain development.

3.2.3 Targeted Nutrition Interventions: For women with specific health conditions or those at risk for certain complications, targeted nutrition interventions may be required:

- **Gestational Diabetes**: Women with gestational diabetes need to closely monitor carbohydrate intake, focusing on complex carbohydrates with a low glycemic index. Nutrition interventions typically emphasize balanced meals, portion control, and blood sugar monitoring. This helps prevent high blood sugar levels that can lead to fetal overgrowth (macrosomia), preterm birth, or neonatal hypoglycemia.
- **Hypertension and Preeclampsia**: For women with high blood pressure or preeclampsia, a low-sodium diet is often recommended, along with increased potassium and calcium intake. Omega-3 fatty acids, magnesium, and adequate hydration may also help manage blood pressure levels.

- **Underweight Women**: Women who are underweight before pregnancy may require additional caloric intake to achieve adequate weight gain and support healthy fetal growth. Nutrient-dense foods and higher protein intake can help address their increased needs.
- **Obesity and Excess Weight Gain**: Women who are obese or at risk of excessive weight gain during pregnancy need to focus on balanced nutrition and appropriate weight gain. Excessive weight gain is associated with complications such as gestational diabetes, preeclampsia, and macrosomia. Gradual, controlled weight gain, along with regular physical activity and portion control, is recommended.

3.2.4 Impact of Nutrition Interventions on Pregnancy Outcomes: The effectiveness of nutrition interventions can significantly improve pregnancy outcomes in various ways:

A. Prevention of Pregnancy Complications: Nutrition interventions can reduce the risk of complications such as:

- **Gestational Diabetes**: Proper dietary management, including limiting refined sugars and focusing on complex carbohydrates, can help regulate blood sugar levels and reduce the risk of gestational diabetes.
- **Preterm Birth**: Adequate nutrition, particularly with regard to omega-3 fatty acids, folic acid, and overall caloric intake, is linked to a reduced risk of preterm birth and low birth weight.
- **Preeclampsia**: A well-balanced diet with adequate magnesium, potassium, calcium, and omega-3 fatty acids may help reduce the risk of preeclampsia, a pregnancy complication characterized by high blood pressure and organ damage.

B. Optimal Fetal Growth and Development: Adequate nutrition ensures the fetus receives sufficient nutrients to grow and develop, minimizing the risk of intrauterine growth restriction (IUGR) and low birth weight. Key nutrients like protein, iron, calcium, and omega-3 fatty acids are critical for fetal brain, skeletal, and organ development.

C. Postpartum Health: Nutrition interventions continue to be important after birth, particularly for women who are breastfeeding. Ensuring sufficient caloric and nutrient intake supports milk production and postpartum recovery. Proper nutrition can also help manage postpartum weight loss and replenish depleted nutrient stores, supporting maternal health in the long term.

3.2.5 Challenges and Barriers to Nutrition Interventions: While nutrition interventions are critical, several barriers can hinder their implementation:

- **Access to Nutrient-Rich Foods**: Socioeconomic factors and food insecurity can limit access to nutrient-dense foods, leading to nutrient deficiencies and poor pregnancy outcomes.

- **Cultural and Dietary Preferences**: Cultural beliefs and food preferences can sometimes conflict with optimal nutritional recommendations. Education and culturally sensitive nutrition counseling are important to overcome these barriers.
- **Education and Awareness**: Many women may not be aware of the importance of certain nutrients or how to implement nutritional interventions effectively. Providing clear, accessible nutrition education is key to ensuring successful outcomes.

3.3 COMMON SYMPTOMS DURING PREGNANCY:

Pregnancy brings a wide range of physical and emotional changes, and many women experience common symptoms that can range from mild discomfort to more challenging conditions. Understanding these symptoms and their management can help improve the overall pregnancy experience. Below are some common symptoms during pregnancy:

3.3.1. Nausea and Vomiting (Morning Sickness):

Prevalence: Affects approximately 50-70% of pregnant women, particularly during the first trimester.

Causes:

- Hormonal changes, particularly increased levels of human chorionic gonadotropin (hCG) and estrogen.
- Increased sensitivity to smells and certain foods.
- Slowed digestion due to elevated progesterone levels.

Symptoms: Nausea, often occurring in the morning but can last throughout the day, Vomiting (in some cases), typically beginning around the 6th week of pregnancy and resolving by the 12th to 16th week.

Management:

- **Dietary Adjustments**: Eating small, frequent meals, avoiding greasy or spicy foods, and consuming bland foods like crackers, toast, or ginger can help.
- **Hydration**: Staying hydrated is essential. Sipping water, herbal teas, or electrolyte-rich drinks (like ginger ale) can soothe nausea.
- **Ginger**: Ginger can be effective in reducing nausea. Consuming ginger tea, ginger candies, or ginger supplements may help.
- **Vitamin B6**: Some women benefit from vitamin B6 supplements for nausea relief (under a healthcare provider's guidance).

3.3.2. Heartburn:

Prevalence: Common in the second and third trimesters, affecting about 50% of pregnant women.

Causes:

- Increased levels of progesterone, which relaxes the muscles of the esophagus and the stomach, leading to acid reflux.
- The growing uterus putting pressure on the stomach, causing the acid to move upward.

Symptoms: A burning sensation in the chest (often after meals or when lying down), Regurgitation of food or sour liquid into the throat, Difficulty swallowing or a feeling of food being stuck.

Management:

- **Small Meals**: Eating smaller meals more frequently can reduce the pressure on the stomach.
- **Avoiding Trigger Foods**: Foods like citrus, spicy dishes, chocolate, caffeine, and fatty foods should be avoided.
- **Sleeping Position**: Propping up the upper body with extra pillows while sleeping can help prevent acid reflux during the night.
- **Antacids**: Some over-the-counter antacids may be safe, but it's important to consult a healthcare provider for appropriate options.

3.3.3. Pica:

Prevalence: Pica, the craving for non-food items, affects a small number of pregnant women but can be seen more frequently in certain populations (e.g., those with iron deficiencies).

Causes:

- Nutrient deficiencies, especially iron or zinc, may trigger pica.
- Hormonal changes and emotional or psychological factors can also contribute.

Symptoms: Cravings for substances like dirt, clay, chalk, ice (which is also known as "pagophagia"), hair, or starch.

Management:

- **Nutritional Supplementation**: If pica is related to a nutrient deficiency (such as iron), supplements can help address the deficiency and curb cravings.
- **Psychological Support**: Counseling or therapy may be recommended if pica is due to emotional or psychological factors.

3.3.4. Constipation:

Prevalence: Affects 25-40% of pregnant women, particularly in the second and third trimesters.

Causes:

- Increased levels of progesterone cause the smooth muscles of the intestines to relax, slowing down digestion and bowel movements.
- The growing uterus puts pressure on the intestines, further contributing to constipation.
- Reduced physical activity due to pregnancy fatigue.

Symptoms: Difficulty passing stool, Hard, dry stools, Abdominal discomfort or bloating, Infrequent bowel movements.

Management:

- **Dietary Fiber**: Increasing fiber intake through whole grains, fruits, vegetables, and legumes can help promote regular bowel movements.
- **Hydration**: Drinking plenty of water helps soften stool and prevent dehydration, which can worsen constipation.
- **Exercise**: Regular physical activity, such as walking or prenatal yoga, can stimulate bowel function.
- **Gentle Laxatives**: If needed, a healthcare provider may recommend mild laxatives or stool softeners that are safe during pregnancy.

3.3.5. Other Common Symptoms:

- **Fatigue**: Common, particularly in the first and third trimesters, due to hormonal changes and increased energy demands.
- **Back Pain**: Caused by hormonal changes and the growing uterus putting strain on the lower back and pelvis.
- **Swelling (Edema)**: Mild swelling in the feet, ankles, and hands is common due to increased fluid retention and pressure from the growing uterus.
- **Mood Swings**: Hormonal fluctuations and physical changes can cause emotional ups and downs.
- **Urinary Frequency**: Increased blood volume and pressure from the growing uterus lead to more frequent urination.

3.4 NUTRITIONAL MANAGEMENT DURING PREGNANCY:

Proper nutritional management during pregnancy is vital to ensure the health and well-being of both the mother and the developing fetus. Adequate nutrition supports fetal growth, prevents complications, and prepares the body for labor and postpartum recovery. During pregnancy, a woman's nutrient requirements increase significantly, making it essential to focus on a balanced diet that provides the necessary vitamins, minerals, macronutrients, and hydration. Here is an overview of **nutritional management during pregnancy** and the key strategies to ensure a healthy pregnancy:

3.4.1. Macronutrient Requirements:

- **Calories**: During pregnancy, calorie needs increase, especially in the second and third trimesters. The general recommendation is an additional 300–350 calories per day during the second trimester and 450–500 extra calories per day during the third trimester. These calories should come from nutrient-dense foods.
- **Proteins**: Protein is essential for the growth and development of the fetus, and the mother's body also requires additional protein for the production of extra blood and tissues. Pregnant women need about **1.1 grams of protein per kilogram of body weight per day**, which is higher than the non-pregnant requirement.
- **Carbohydrates**: Carbohydrates are the body's primary energy source, and it's especially important to meet increased energy demands during pregnancy. Ideally, **45-65% of total daily calories should come from carbohydrates.**
- **Fats**: Healthy fats are essential for fetal brain development and overall health. A moderate intake of fats should include a balance of omega-3 and omega-6 fatty acids.

3.4.2. Micronutrient Requirements:

- **Folic Acid (Vitamin B9)**: Folic acid is essential for preventing neural tube defects and promoting proper brain and spinal cord development in the fetus. It is recommended that women take **400-800 mcg of folic acid** daily, starting before conception and continuing through the first trimester.
- **Iron**: Pregnancy increases the body's blood volume, making iron essential to support the development of hemoglobin in both the mother and fetus. **Iron requirements increase to 27 mg per day.**
- **Calcium**: Calcium is crucial for the development of the fetal bones and teeth. Pregnant women need about **1,000 mg per day** (1,300 mg for those under 19 years old).
- **Vitamin D**: Vitamin D aids in calcium absorption and supports fetal bone development. A daily intake of **600 IU** is recommended during pregnancy.
- **Iodine**: Iodine is necessary for the production of thyroid hormones that regulate metabolism, growth, and development. **Iodine requirements increase to 220 mcg per day** during pregnancy.
- **Vitamin A**: Vitamin A is vital for fetal growth, especially for the development of the eyes, skin, and immune system. However, excess vitamin A can be harmful, so it's important to consume it in moderation.

- **Magnesium**: Magnesium is involved in muscle function, nerve transmission, and the development of fetal bones. Pregnant women need about **350-400 mg per day**.
- **Omega-3 Fatty Acids**: Omega-3s, particularly DHA (docosahexaenoic acid), are critical for brain and eye development in the fetus. Pregnant women should consume at least **200–300 mg of DHA per day**.

3.4.3. Hydration:

Staying well-hydrated is essential during pregnancy to support increased blood volume, amniotic fluid, and overall bodily functions. Pregnant women should aim to drink **8-10 cups (about 2-2.5 liters)** of fluids daily, with water being the best choice.

3.4.4. Meal Planning and Frequency: During pregnancy, it's important to eat balanced meals throughout the day to provide a steady supply of nutrients and energy. The following strategies can help:

- **Small, Frequent Meals**: Eating smaller meals more frequently (5–6 meals per day) can help manage nausea, prevent indigestion, and maintain steady blood sugar levels.
- **Avoiding Food Cravings**: While it's normal to have food cravings, it's important to avoid excessive intake of junk food or empty calories. Focus on nutrient-dense foods to ensure both the mother and the baby are getting the right nutrition.
- **Managing Weight Gain**: Weight gain is natural during pregnancy, but excessive weight gain can lead to complications such as gestational diabetes, preeclampsia, and fetal macrosomia. A healthy, balanced diet with controlled portion sizes can help manage appropriate weight gain.

3.4.5. Avoiding Harmful Foods and Substances: Pregnant women should avoid certain foods and substances that can pose risks to both maternal and fetal health:

- **Alcohol**: Alcohol can lead to fetal alcohol syndrome and should be completely avoided during pregnancy.
- **Caffeine**: Excessive caffeine can increase the risk of miscarriage or low birth weight, so it's best to limit caffeine intake to less than 200 mg per day.
- **Unpasteurized Dairy and Meats**: These can contain harmful bacteria such as Listeria, which can lead to infections and pregnancy complications.
- **Raw or Undercooked Seafood, Meat, and Eggs**: These can contain harmful bacteria and parasites, including Toxoplasmosis and Salmonella, which can affect the baby.
- **High-Mercury Fish**: Fish like shark, swordfish, and king mackerel have high mercury levels, which can harm fetal brain development.

3.5 PROBLEMS AND COMPLICATIONS DURING PREGNANCY:

Pregnancy, while a natural and beautiful process, can come with various challenges. Some problems are common and mild, while others can be more serious, requiring medical intervention. It is essential to recognize symptoms early, seek proper prenatal care, and follow guidelines to prevent or manage complications. Below is an overview of common problems and complications during pregnancy:

3.5.1 Gestational Diabetes: Gestational diabetes occurs when the body cannot produce enough insulin to meet the increased needs during pregnancy. It typically develops in the second or third trimester and resolves after birth.

Causes: Hormonal changes during pregnancy can make it harder for the body to use insulin, leading to high blood sugar levels.

Complications:

- **Fetal Macrosomia**: Babies may grow larger than average, increasing the risk of difficult labor, birth injuries, and the need for a cesarean section.
- **Preterm Birth**: The baby may be born prematurely, which can lead to complications in organ development.
- **Hypoglycemia in the Baby**: After birth, babies of mothers with gestational diabetes can have low blood sugar levels, requiring special care.
- **Management**: Monitoring blood sugar levels, following a healthy diet, and maintaining physical activity. In some cases, insulin or oral medication may be prescribed.

3.5.2 Pre-Eclampsia (Pregnancy - Induced Hypertension): Pre-Eclampsia is a serious condition characterized by high blood pressure and damage to organs such as the kidneys or liver, usually after the 20th week of pregnancy.

Causes: The exact cause is not well understood, but it may involve poor placental blood flow, immune system issues, or genetic factors.

Complications:

- **Eclampsia**: If left untreated, pre-eclampsia can lead to seizures (eclampsia), which can be life-threatening for both the mother and baby.
- **Placental Abruption**: The placenta may detach from the uterine wall, leading to heavy bleeding and preterm birth.
- **Organ Damage**: High blood pressure can lead to kidney, liver, or brain damage in the mother.
- **Management**: Regular blood pressure monitoring, blood tests, and possible medication to control blood pressure. The only cure for pre-eclampsia is delivery of the baby, which may be done early if necessary.

3.5.3 Miscarriage (Spontaneous Abortion): A miscarriage refers to the loss of a pregnancy before the 20th week. It is common and can occur in up to 15–20% of pregnancies.

Causes: Chromosomal abnormalities in the fetus are the most common cause, but other factors like maternal health issues, infections, or trauma can contribute.

Complications:

- **Emotional Distress**: Miscarriage can cause significant emotional and psychological stress for the mother and family.
- **Infection or Heavy Bleeding**: Incomplete miscarriage may require medical intervention, including a dilation and curettage (D&C) procedure to prevent infection or excessive bleeding.
- **Management**: Most early miscarriages are spontaneous and require no intervention. In some cases, medication or surgical procedures may be needed to ensure complete evacuation of the pregnancy.

3.5.4 Placenta Previa: Placenta previa occurs when the placenta is abnormally positioned in the lower part of the uterus, covering or being very close to the cervix.

Causes: The exact cause is unknown, but it can be more common in women who have had multiple pregnancies, previous C-sections, or certain uterine abnormalities.

Complications:

- **Severe Bleeding**: Placenta previa can cause significant bleeding, particularly during labor, which can be dangerous for both mother and baby.
- **Preterm Birth**: Premature delivery may be required due to bleeding or other complications.
- **C-Section Delivery**: Most women with placenta previa will require a cesarean section for delivery.
- **Management**: Close monitoring via ultrasound, bed rest, and early delivery (via C-section) if necessary.

3.5.5 Preterm Labor: Preterm labor refers to labor that begins before 37 weeks of pregnancy. Babies born preterm may face a higher risk of complications, including respiratory issues, developmental delays, and feeding difficulties.

Causes: Premature labor can be triggered by infections, stress, certain health conditions (e.g., high blood pressure), or multiple pregnancies (twins, triplets, etc.).

Complications:

- **Low Birth Weight**: Preterm babies often have low birth weight, making them more vulnerable to infections, breathing problems, and feeding challenges.

- **Developmental Delays**: Preterm birth can affect the baby's brain and organ development.
- **Management**: Early intervention and hospitalization, often involving medications to stop contractions, corticosteroids to help fetal lung development, and sometimes bed rest.

3.5.6 Ectopic Pregnancy: An ectopic pregnancy occurs when the fertilized egg implants outside the uterus, most commonly in the fallopian tube.

Causes: Risk factors include previous pelvic infections, scarring from surgeries, or certain health conditions that affect the fallopian tubes.

Complications:

- **Rupture**: An ectopic pregnancy can cause the fallopian tube to rupture, leading to internal bleeding and a life-threatening situation for the mother.
- **Infertility**: Damage to the fallopian tubes can increase the risk of future fertility issues.
- **Management**: An ectopic pregnancy is a medical emergency and typically requires medication (e.g., methotrexate) or surgery to remove the embryo and repair any damage.

3.5.7 Anemia: Anemia during pregnancy is a common condition in which there is a deficiency in red blood cells or hemoglobin, which affects oxygen transport to the fetus.

Causes: Iron deficiency is the most common cause of anemia during pregnancy, though folate and vitamin B12 deficiencies can also contribute.

Complications:

- **Fatigue**: Anemia can cause extreme tiredness and weakness, making daily activities difficult.
- **Preterm Birth and Low Birth Weight**: Severe anemia may increase the risk of preterm birth or low birth weight in the baby.
- **Management**: Iron-rich foods (such as lean meats, leafy greens, and fortified cereals) and iron supplements are typically prescribed.

3.5.8 Urinary Tract Infections (UTIs): UTIs are more common during pregnancy due to hormonal changes and pressure from the growing uterus on the bladder.

Complications:

- **Kidney Infections**: If left untreated, UTIs can spread to the kidneys, causing a more severe infection.

- **Preterm Labor**: UTIs can increase the risk of preterm labor if the infection spreads.
- **Management**: Antibiotics, fluids, and maintaining proper hygiene to prevent infections.

3.6 ADOLESCENT PREGNANCY:

Early pregnancy and motherhood, particularly among adolescents, carry significant health risks and consequences for both the young mother and her child. These risks are amplified by the social, economic, and cultural factors that many adolescent girls face, especially in low- and middle-income countries. Early pregnancy often occurs in situations where young girls lack control over their reproductive choices, and many of them experience discrimination, limited access to healthcare, and limited social support. Here are the key health consequences for both adolescent mothers and their babies:

3.6.1 Maternal Health Risks: Adolescent pregnancy presents a number of immediate and long-term health risks for the young mother:

- **Physical Inadequacy for Pregnancy**: Adolescent girls' bodies are still growing and may not be physically prepared for the stresses of pregnancy and childbirth. The pelvis may still be immature, increasing the risk of obstructed labor and complications during delivery.
- **Preeclampsia and Hypertension**: Adolescents, especially those under the age of 15, have an increased risk of developing pregnancy-related hypertension, including preeclampsia, a condition that can cause severe complications such as organ damage, seizures, and death if not managed appropriately.
- **Anemia**: Teenage mothers are at high risk for iron-deficiency anemia, which is often compounded by poor nutrition and insufficient access to prenatal care. Anemia can lead to fatigue, reduced ability to fight infections, and complications during childbirth, including postpartum hemorrhage.
- **Obstetric Fistula**: In regions where girls may face early or obstructed labor, one of the most tragic consequences is obstetric fistula—a hole between the vagina and bladder or rectum caused by prolonged labor without access to timely medical intervention. This condition is often accompanied by incontinence, infections, and severe physical and emotional trauma.
- **Mental Health Issues**: Adolescent mothers are more likely to experience mental health challenges, including postpartum depression and anxiety, particularly when they face social stigma or lack the support needed to manage motherhood and their own development.

3.6.2 Neonatal and Infant Health Risks: The health of babies born to adolescent mothers can be severely impacted by the early age of the mother, as well as the socio-economic conditions in which the pregnancy occurs. Some of the major health risks for infants include:

- **Preterm Birth**: Babies born to adolescent mothers are at a higher risk of being born prematurely (before 37 weeks of gestation). Preterm birth increases the risk of a range of health issues, such as respiratory distress syndrome, infections, and developmental delays.
- **Low Birth Weight (LBW)**: Low birth weight is common in infants born to adolescent mothers. LBW increases the likelihood of infant mortality, developmental delays, learning disabilities, and long-term health problems.
- **Intrauterine Growth Restriction (IUGR)**: Adolescents, especially those who are malnourished or lack prenatal care, may have babies who are small for their gestational age. IUGR babies may face challenges such as low immunity, feeding difficulties, and increased risk of infections.
- **Neonatal Death**: Adolescents are more likely to experience neonatal death, often due to complications related to preterm birth, low birth weight, or infections. In developing countries, the lack of adequate neonatal care increases the risk of mortality.

3.7 SUMMARY:

The term Maternal Nutrition refers to nutritional status during any stage of a woman´s reproductive age that eventually could affect her health and that of the fetus and infant. There are heightened nutrient needs during pregnancy; without an increase in caloric and nutritional intake to meet the increased demands during this period, the fetus uses its own reserves making it more susceptible to pregnancy-related complications. Women´s nutritional status is most vulnerable during pregnancy; maternal malnutrition becomes a cycle when malnourished mothers give birth to low birth weight infants who in turn become malnourished mothers themselves

3.8 TECHNICAL TERMS

Gestational diabetes mellitus, gestational weight gain, folate deficiency, vitamin D deficiency, and pregnancy outcomes

3.9 SELF ASSESSMENT QUESTIONS:

1) What are the common symptoms during pregnancy?
2) Write about the nutritional problems in pregnancy

3.10 REFERENCE BOOKS:

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LESSON-4

LACTATION

4.0 OBJECTIVES:

After reading this lesson, you would be able to:

- To know about Nutrient requirements, nutrient intake and gaps during lactation;
- To understand the importance of breast feeding, factors affecting breast feeding quality and composition;
- Advantages, disadvantages of breast milk, buffalo and cows milk.

STRUCTURE

4.1 INTRODUCTION:

Lactation is a biologically demanding process that significantly impacts a mother's nutritional needs. Breast milk is widely recognized as the optimal source of nutrition for infants, providing not only the essential macronutrients-carbohydrates, proteins, and fats-but also a rich array of micronutrients, bioactive compounds, and antibodies that support the infant's growth, immune development, and overall health. For mothers, ensuring adequate nutrition during lactation is critical to meet the dual demands of maintaining their own health and producing high-quality breast milk for their baby.

4.2 NUTRITIONAL REQUIREMENTS, NUTRIENT INTAKE, AND GAPS:

Lactation is an energy-intensive period requiring careful attention to maternal nutrition to ensure both optimal milk production and the mother's health. While breast milk composition is remarkably resilient and can provide essential nutrients even in cases of suboptimal maternal nutrition, insufficient intake of certain nutrients can affect both the quality of milk and the mother's long-term health.

4.2.1. Energy Requirements: Lactating women experience increased energy demands due to milk production, which requires approximately 400-500 additional calories per day. These additional calories are needed to account for the metabolic energy spent on producing 700-800 mL of milk daily in the first six months postpartum. However, calorie needs vary based on:

- Pre-pregnancy weight, Maternal activity level
- Rate of weight loss after delivery (if breastfeeding while aiming to lose pregnancy weight)

Sources: Whole grains, healthy fats, lean proteins, and nutrient-dense snacks like nuts and seeds are recommended to meet this energy demand efficiently.

4.2.2. Macronutrient Needs:

- **Protein:** Protein needs are increased to support milk production. Recommendations suggest a daily intake of **1.1 g/kg of body weight** or approximately 25 extra grams of protein. Protein is essential for milk synthesis and maternal tissue repair.

  Sources: Eggs, lean meats, dairy, legumes, and tofu.

- **Fats:** The fat composition of breast milk is influenced by the maternal diet, particularly in terms of **essential fatty acids** like omega-3 (DHA) and omega-6 fatty acids. These are crucial for the infant's brain and visual development.

  Sources: Fatty fish (salmon, sardines), flaxseeds, chia seeds, and walnuts.

- **Carbohydrates:** Lactation increases carbohydrate needs to fuel energy production and milk synthesis. The recommended carbohydrate intake is around **210 g/day**, prioritizing complex carbohydrates over simple sugars.

  Sources: Whole grains, fruits, vegetables, and legumes.

4.2.3. Micronutrient Needs: Some vitamins and minerals are required in greater amounts during lactation to replenish maternal stores and support infant growth**.**

- **Calcium:** While breast milk calcium levels remain stable regardless of maternal intake, inadequate calcium in the diet can lead to bone demineralization in the mother. The recommended daily intake is **1,000 mg/day.**

  Sources: Dairy products, fortified plant-based milks, leafy greens, and almonds.

- **Vitamin D:** Essential for calcium absorption and the infant's skeletal development. Many women are deficient in vitamin D, and supplementation (600-800 IU/day) is often recommended.

  Sources: Sunlight exposure, fortified dairy, fatty fish, and vitamin D supplements.

- **Iron:** Postpartum iron needs (9 mg/day) decrease compared to pregnancy due to the absence of menstruation. However, if there was significant blood loss during delivery, supplementation may be necessary.

  Sources: Red meat, poultry, fortified cereals, and legumes.

- **Iodine:** Essential for thyroid function and infant brain development. Lactating women require **290 mcg/day** of iodine.

  Sources: Iodized salt, seafood, and dairy.

- **Vitamin B12:** Critical for infant neurological development, especially in vegan or vegetarian mothers who are at risk of deficiency.

  Sources: Animal products, fortified foods, or supplements.

- **Folate:** Needed for DNA synthesis and cell division in both the mother and infant. Lactating women require **500 mcg/day**.

  Sources: Leafy greens, citrus fruits, beans, and fortified cereals.

- **Zinc and Selenium:** Zinc supports the immune system and wound healing, while selenium acts as an antioxidant. Both are vital for milk production and infant health.

  Sources: Shellfish, nuts, seeds, and whole grains.

4.2.4. Hydration:

Breastfeeding mothers experience increased fluid losses, and staying well-hydrated is essential. Daily fluid intake should be guided by thirst, typically around **3 liters/day**, including water, herbal teas, and hydrating foods like fruits and vegetables.

4.2.5. Nutritional Gaps and Challenges: Despite the increased requirements, many lactating women face nutrient gaps due to dietary inadequacies or cultural practices. Common deficiencies include:

- **Vitamin D:** Limited sun exposure and low dietary intake can result in deficiencies.
- **Iron:** Especially if postpartum anemia is present.
- **Calcium:** Low intake of dairy or fortified alternatives can reduce maternal bone density.
- **Omega-3 Fatty Acids:** Insufficient seafood consumption leads to inadequate DHA levels in breast milk.

4.2.5.1 Addressing Gaps:

- **Dietary Diversification:** Emphasizing whole, nutrient-dense foods.
- **Prenatal/Postnatal Vitamins:** These can help fill gaps but should complement, not replace, a balanced diet.
- **Nutrition Counseling:** Tailored guidance for vegetarian, vegan, or culturally specific diets.

4.3 PHYSIOLOGY OF MILK PRODUCTION AND HORMONAL CONTROL:

Lactation is a complex physiological process that involves the interplay of anatomical structures, hormonal regulation, and neural mechanisms to ensure the production and ejection of breast milk. It consists of two main phases: **milk production (lactogenesis)** and **milk ejection (let-down reflex).**

4.3.1. Physiology of Milk Production:

A. Mammary Gland Anatomy: Milk production occurs in the mammary glands, which consist of:

- **Alveoli:** Small, grape-like clusters of epithelial cells that synthesize and secrete milk.
- **Myoepithelial cells:** Surround the alveoli and contract to push milk into the ducts during let-down.
- **Ducts:** Tubular structures that transport milk from the alveoli to the nipple.

The development of the mammary glands begins during puberty but undergoes significant changes during pregnancy, preparing the body for lactation.

B. Stages of Lactation:

1) **Lactogenesis I (Initiation of Milk Production):** Begins during the second half of pregnancy. Under the influence of **prolactin**, mammary epithelial cells start producing colostrum, a nutrient-rich, antibody-filled fluid. However, high levels of progesterone during pregnancy inhibit large-scale milk production.

2) **Lactogenesis II (Onset of Copious Milk Production):** Occurs around **2-4 days postpartum** when progesterone levels drop following the delivery of the placenta. Prolactin levels rise, stimulating the production of mature milk. This is often accompanied by breast fullness or engorgement.

3) **Lactogenesis III (Maintenance of Milk Supply):** After the initial phase, milk production is maintained through the principle of **supply and demand.** Frequent milk removal (through nursing or pumping) signals the body to continue milk synthesis, while infrequent removal reduces milk production.

4.3.2. Hormonal Control of Lactation:

A. Key Hormones in Lactation: Lactation is regulated by a balance of hormones that control both milk synthesis and ejection.

Prolactin:

- **Role:** Stimulates milk production in the alveolar cells. Prolactin levels increase during pregnancy but are inhibited by progesterone until delivery.
- **Regulation:** Suckling triggers the release of prolactin from the anterior pituitary gland. The more frequent the suckling, the higher the prolactin levels, promoting sustained milk production.

Oxytocin:

- **Role:** Responsible for the milk ejection reflex (let-down). It causes the myoepithelial cells around the alveoli to contract, pushing milk through the ducts and out of the nipple.
- **Regulation:** Released from the posterior pituitary gland in response to suckling or even emotional cues (e.g., hearing a baby cry). Oxytocin also plays a role in maternal bonding and relaxation.

Estrogen and Progesterone: During pregnancy, high levels of these hormones promote the growth and development of the mammary glands but inhibit milk secretion. After childbirth, their levels drop sharply, allowing prolactin and oxytocin to take over.

Human Placental Lactogen (hPL): Produced during pregnancy to help prepare the mammary glands for lactation. Its role diminishes after delivery.

Cortisol and Insulin: These metabolic hormones support the synthesis of milk components like lactose, lipids, and proteins.

B. Feedback Mechanisms:

- **Autocrine (Local) Control:** Once lactogenesis III begins, milk production is primarily regulated by milk removal. An emptied breast signals the body to produce more milk, while a full breast signals to slow production. This feedback is mediated by a protein in milk called **Feedback Inhibitor of Lactation (FIL).**
- **Neuroendocrine Reflex:** Suckling stimulates nerve endings in the nipple, which send signals to the hypothalamus to release prolactin and oxytocin.

4.4 IMPORTANCE OF BREAST FEEDING:

Breastfeeding is the gold standard for infant nutrition, offering unparalleled benefits for the child's growth, development, and immunity while also supporting the mother's health and fostering a unique bond between them. The World Health Organization (WHO) and UNICEF recommend exclusive breastfeeding for the first six months of life, followed by continued breastfeeding alongside complementary foods up to two years or beyond.

4.4.1. Benefits for the Infant:

a) Optimal Nutrition: Breast milk is a complete food, providing the perfect balance of macronutrients (proteins, fats, carbohydrates) and micronutrients (vitamins and minerals) tailored to the infant's developmental needs. The composition of breast milk changes dynamically, adapting to the infant's age and specific requirements (e.g., colostrum in the first few days postpartum is rich in antibodies and nutrients).

b) Enhanced Immunity: Breast milk contains antibodies, particularly immunoglobulin A (IgA), which coat the infant's gut lining and protect against infections. Bioactive components like lactoferrin, lysozyme, and oligosaccharides support immune system development and combat harmful pathogens. Breastfed infants have a lower risk of common infections such as respiratory tract infections, diarrhea, and ear infections.

c) Reduced Risk of Chronic Diseases: Breastfeeding has been linked to a lower risk of long-term health conditions, including:

   Obesity, Type 1 and Type 2 diabetes, Allergies and asthma, Inflammatory bowel disease

d) Neuro developmental Benefits: The fatty acids in breast milk, particularly docosahexaenoic acid (DHA)**,** are critical for brain and visual development. Studies suggest that breastfed infants may have higher cognitive scores and better academic performance later in life.

e) Digestive Health: Breast milk promotes the growth of a healthy gut microbiome, particularly beneficial bacteria like *Bifidobacteria*. This reduces the risk of gastrointestinal disorders and improves nutrient absorption.

4.4.2. Benefits for the Mother:

a) **Hormonal and Emotional Benefits:** The release of oxytocin during breastfeeding promotes uterine contractions, reducing postpartum bleeding and helping the uterus return to its pre-pregnancy size. Oxytocin also fosters bonding and relaxation, reducing the risk of postpartum depression.

b) **Health Benefits:** Breastfeeding lowers the mother's risk of:

- Breast and ovarian cancers, Osteoporosis later in life, Cardiovascular diseases
- Type 2 diabetes (particularly in mothers with a history of gestational diabetes)
- It supports weight loss by utilizing stored fat reserves for milk production.

c) **Convenience and Cost-Effectiveness**: Breast milk is readily available, requires no preparation, and is always at the right temperature, reducing the need for formula feeding and the associated costs.

4.5 FACTORS AFFECTING BREAST MILK QUALITY AND COMPOSITION:

Breast milk is a dynamic, bioactive fluid uniquely tailored to meet the nutritional and developmental needs of an infant. Its composition is influenced by maternal health, diet, environment, and various physiological factors. While breast milk is generally adequate in nutrients for most infants, several factors can alter its quality and composition.

4.5.1. Maternal Nutrition:

a) **Macronutrients:** The macronutrient content of breast milk (carbohydrates, proteins, and fats) is relatively stable and is only modestly affected by maternal diet.

- **Fat composition, however, is highly diet-dependent.**
  - A diet rich in omega-3 fatty acids (e.g., from fatty fish or flaxseeds) increases the levels of **DHA** and **EPA** in breast milk, which are essential for infant brain and eye development.
  - A diet high in saturated or transfats may alter the milk fat profile.

b) **Micronutrients:** Water-soluble vitamins (B-complex vitamins and vitamin C) are directly influenced by the maternal diet. Inadequate intake of these vitamins can lead to lower concentrations in breast milk.

- Fat-soluble vitamins (A, D, E, K) are less affected by short-term dietary fluctuations but may be reduced in cases of prolonged deficiency. For instance:
  - Low maternal vitamin D levels can lead to low levels in breast milk, increasing the infant's risk of rickets.

- Vitamin A levels can also vary, particularly in populations with malnutrition.

c) Energy Intake: Severe calorie restriction or maternal malnutrition can reduce the overall volume of breast milk and affect its fat and energy content. However, the quality of breast milk is usually maintained at the expense of maternal nutrient stores.

4.5.2. Maternal Health and Lifestyle:

a) Chronic Illnesses: Certain health conditions, such as diabetes or thyroid disorders, can influence milk production and composition. For example, poorly controlled diabetes may lead to changes in lactose levels or milk supply.

b) Hydration: While hydration is important for overall milk production, the composition of breast milk is not significantly altered by moderate dehydration. Severe dehydration, however, may reduce milk supply.

c) Stress and Fatigue: High stress levels can inhibit the let-down reflex due to reduced oxytocin release, indirectly affecting milk supply. While stress does not significantly alter milk composition, it can influence breastfeeding practices.

d) Medications and Substances: Certain medications, alcohol, caffeine, and nicotine can transfer into breast milk and affect its quality. For instance: High alcohol intake can reduce milk production and alter its taste, potentially deterring the infant from feeding. Smoking reduces milk supply and decreases iodine levels in milk.

e) Maternal Infections: Maternal infections like mastitis may affect milk production temporarily but usually do not alter milk composition significantly. However, viral infections like HIV or HTLV-1 can transfer through breast milk in some cases.

4.5.3. Stage of Lactation:

a) Colostrum (Day 0-5 Postpartum): Rich in proteins, antibodies (IgA), and growth factors but lower in fat and lactose. Helps the newborn build immunity and supports gut development.

b) Transitional Milk (Day 5-14 Postpartum): The concentration of proteins decreases while fats and lactose increase, providing more energy as the infant grows.

c) Mature Milk (After 2 Weeks): Mature milk stabilizes with consistent macronutrient levels but can vary in composition based on maternal and environmental factors.

4.5.4. Frequency and duration of Feeding:

Foremilk vs. Hindmilk:

- **Foremilk** (initial milk during feeding) is lower in fat and higher in lactose, providing hydration and energy.

- **Hindmilk** (later milk during feeding) is richer in fat, offering satiety and calories. Infrequent or short feeding sessions may reduce the infant's access to nutrient-rich hindmilk, impacting overall calorie intake.

4.5.5. Environmental Factors:

a) Pollutants and Toxins

- Exposure to environmental toxins like heavy metals (lead, mercury) or pesticides can lead to their presence in breast milk.
- Industrial chemicals such as PCBs (polychlorinated biphenyls) and dioxins can accumulate in breast milk, particularly in regions with high pollution.

b) Geographic and Cultural Diets

- Regional dietary patterns can affect the micronutrient content of breast milk. For example:
    - In populations with high seafood consumption, DHA levels are higher in breast milk.
    - Low iodine diets (common in areas with iodine deficiency) reduce iodine levels in milk.

4.5.6. Maternal Weight and Body Composition:

- Women with lower body fat stores may produce milk with slightly lower fat content.
- Obesity may influence the hormone balance during lactation, potentially reducing milk supply and altering its fatty acid profile.

4.5.7. Maternal Age and Parity: Older mothers or those who have breastfed multiple children tend to have more efficient milk production due to previous lactation experience. However, age does not significantly alter milk composition.

4.5.8. Genetic Factors: Certain genetic variations can influence the levels of specific nutrients in breast milk. For instance, genetic differences in vitamin D metabolism can affect the concentration of this nutrient in milk.

4.5.9. Infant needs and Growth Spurts:

- Milk composition adapts to the infant's needs. For example:
    - During growth spurts, increased suckling stimulates greater milk production.
    - Preterm infants often require milk with higher protein and calorie content, and the mother's body adjusts accordingly.

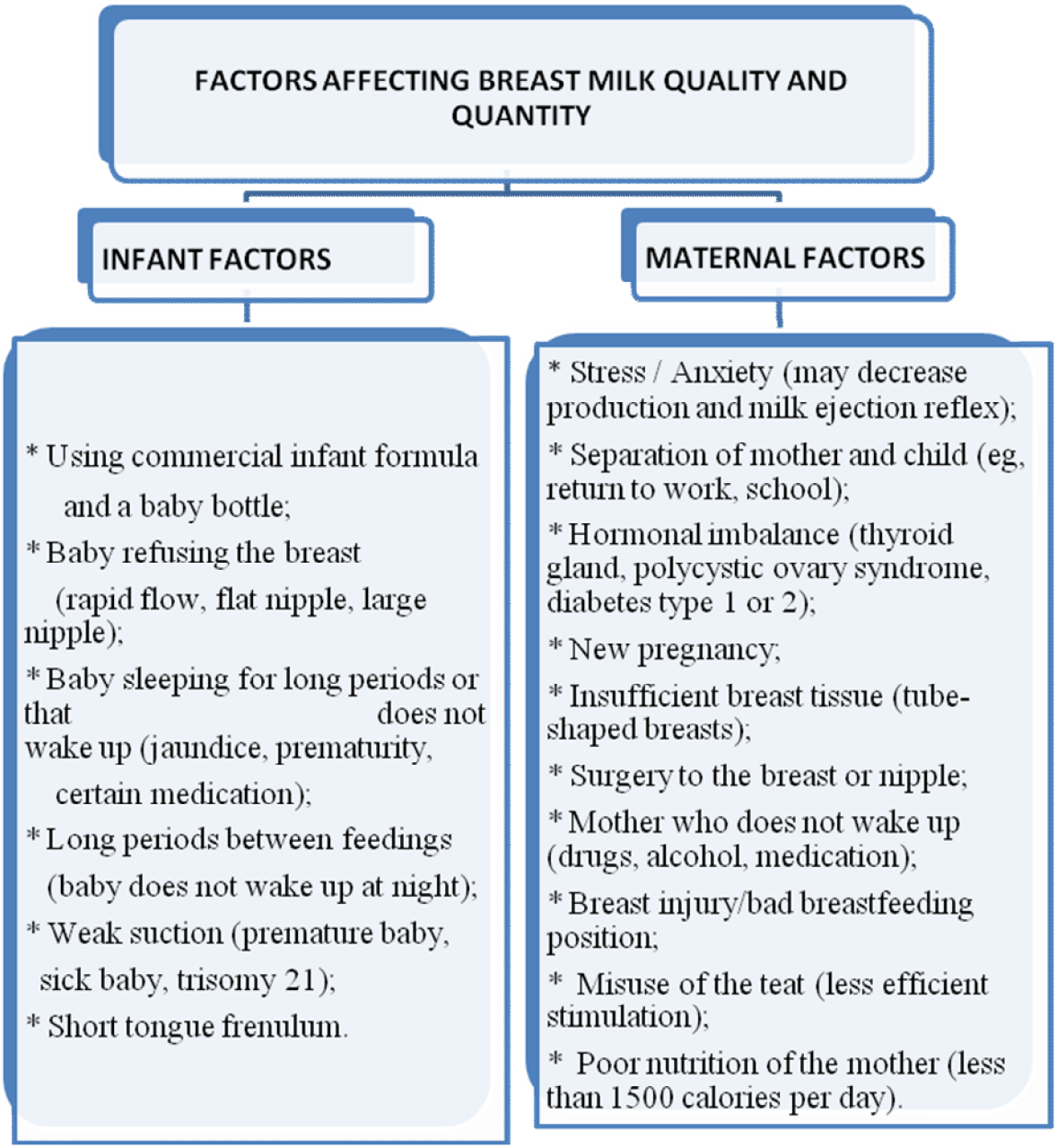

Fig. 4.1 Factors Affecting Breast Milk Quality

4.6 ADVANTAGES & DISADVANTAGES OF BREAST MILK, BUFFALOES AND COW'S MILK:

4.6.1. Breast Milk:

A. Advantages:

a) **Optimal Nutrition for Infants**: Provides the perfect balance of carbohydrates, proteins, fats, vitamins, and minerals tailored to the infant's developmental needs. Contains essential fatty acids like DHA and ARA that support brain and eye development.

b) **Immunity Boost**: Rich in immunoglobulins (especially IgA), lactoferrin, and lysozymes, which strengthen the infant's immune system and protect against infections.

c) **Digestibility**: Easily digestible due to the presence of whey proteins and specific enzymes. Reduces the risk of colic and constipation in infants.

d) **Dynamic Composition**: Adapts to the infant's changing needs. For example, colostrum is high in antibodies and nutrients during the first few days postpartum.

e) **Reduced Risk of Chronic Diseases**: Breastfed infants have a lower risk of obesity, diabetes, asthma, and allergies later in life.

f) **Bonding**: Breastfeeding promotes emotional bonding between mother and baby due to skin-to-skin contact and the release of oxytocin.

g) **Convenience and Cost-Effectiveness**: Readily available, requires no preparation, and is cost-free compared to formula or other milk sources.

h) **Environmental Sustainability**: No packaging or waste, making it environmentally friendly.

B. Disadvantages:

a) **Maternal Diet Dependency**: The quality of breast milk can be affected by maternal malnutrition or deficiencies in vitamins (e.g., vitamin D, B12).

b) **Maternal Health Limitations**: Certain illnesses (e.g., HIV, active tuberculosis) or medications can make breastfeeding unsafe. Mothers experiencing physical or mental health issues may find breastfeeding challenge.

c) **Supply Challenges**: Low milk supply, often caused by stress, poor lactation practices, or health issues, can impact the infant's nutrition.

d) **Exclusive Dependence on Mother**: Breastfeeding requires a significant time commitment from the mother, which can be challenging for working mothers.

4.6.2. Buffalo Milk:

A. Advantages:

a) **High Nutritional Content**:

- **Higher fat content**: Buffalo milk has nearly twice the fat content of cow’s milk, providing more calories and energy. This makes it beneficial for individuals requiring a high-calorie diet (e.g., children, athletes).
- **Rich in protein**: Contains a higher protein concentration than cow’s milk, which supports muscle growth and repair.

b) Calcium and Minerals: High calcium levels make buffalo milk excellent for bone health. It also contains essential minerals like phosphorus, magnesium, and potassium.

c) Longer Shelf Life: Due to its higher peroxidase activity (an enzyme that slows microbial growth), buffalo milk stays fresh longer, even without refrigeration.

d) Lower Cholesterol: Despite its higher fat content, buffalo milk has lower cholesterol levels compared to cow's milk, making it suitable for individuals managing cholesterol levels.

e) Dense Texture: The thick, creamy consistency makes it ideal for producing dairy products like yogurt, cheese, and ghee.

B. Disadvantages:

1) High Fat Content:

- While beneficial for some, the high fat content can lead to weight gain and isn't ideal for individuals on low-fat diets.
- Difficult to digest for infants and people with sensitive stomachs.

2) Not Suitable for Lactose Intolerant Individuals: Contains lactose, which can cause digestive discomfort for people with lactose intolerance.

3) Lower Vitamin Content: Buffalo milk has lower levels of vitamins like B12 and B2 compared to cow's milk.

4) Processing Challenges: The high fat content makes it harder to process and homogenize, increasing the cost of production.

5) Limited Availability: Buffalo milk is not as widely available in many regions compared to cow's milk.

4.6.3. Cow's Milk:

A. Advantages:

1) Widely Consumed and Versatile:

- Cow's milk is a staple in many diets worldwide and is used to make a variety of dairy products.

2) Balanced Nutritional Profile:

- Provides a good balance of protein, fat, and carbohydrates.
- Rich in vitamins (e.g., vitamin D, B12, and riboflavin) and minerals like calcium, which are crucial for bone health.

3) **Easier to Digest (Compared to Buffalo Milk)**:

- Lower fat and protein content make it easier to digest for most people.
- Ideal for children and individuals with weaker digestive systems.

4) **Immune Benefits**:

- Contains immunoglobulin's and enzymes that support immunity, particularly in raw or minimally processed milk.

5) **Lower Fat Content**:

- Compared to buffalo milk, cow's milk has lower fat content, making it suitable for weight-conscious individuals.

6) **Availability and Cost**:

- Cow's milk is more widely available and generally less expensive than buffalo milk.

B. Disadvantages:

1) **Allergic Reactions**:

Cow's milk protein allergy (CMPA) is common in infants and young children, leading to digestive, respiratory, or skin issues.

2) **Lactose Intolerance**:

Like buffalo milk, cow's milk contains lactose, which can cause discomfort in lactose-intolerant individuals.

3) **Lower Energy Density**:

The lower fat and calorie content make it less suitable for individuals needing high-energy diets.

4) **Hormonal Concerns**:

Concerns exist regarding synthetic hormones and antibiotics used in dairy farming, which may be present in commercial cow's milk.

5) **Environmental Impact**:

Cow farming contributes significantly to greenhouse gas emissions, making it less environmentally friendly than breastfeeding or plant-based milk options.

Table 4.1: Comparison of the three types of milk based on their benefits and limitations

Type	Advantages	Disadvantages
Breast Milk	Perfectly balanced nutrients tailored for infants' needs	Dependent on maternal health and diet quality.
	Contains antibodies (IgA), enzymes, and immune-boosting components	Requires significant time and commitment from the mother.
	Easily digestible and reduces the risk of colic and constipation.	Maternal illnesses, medications, or infections (e.g., HIV) can make breastfeeding unsafe.
	Promotes brain development (DHA, ARA) and emotional bonding.	Limited by maternal milk supply.
	Lowers risk of chronic diseases (e.g., diabetes, obesity) in infants.	Exclusive dependence on the mother can pose challenges for working women.
	Cost-effective and environmentally friendly.	
Buffalo Milk	High in fat and protein, providing more calories and energy than cow's milk.	High fat content can be difficult to digest and unsuitable for low-fat diets.
	Excellent for making creamy dairy products (e.g., yogurt, butter, cheese).	Not suitable for infants or individuals with lactose intolerance.
	Longer shelf life due to high peroxidase activity.	Limited availability in some regions.
	Low cholesterol compared to its fat content, suitable for active individuals.	Lower levels of certain vitamins (e.g., B12, riboflavin) compared to cow's milk.
	Rich in calcium and minerals beneficial for bone health.	High calorie content may contribute to weight gain in sedentary individuals.

Cow's Milk	Balanced nutrition with protein, vitamins (D, B12, riboflavin), and minerals (calcium).	Common cause of allergies, particularly in children (Cow's Milk Protein Allergy - CMPA).
	Lower fat content than buffalo milk, making it suitable for weight management.	Contains lactose, which may cause digestive issues in lactose-intolerant individuals.
	Easy to digest due to lower fat and protein content compared to buffalo milk.	Concerns about hormones and antibiotics in commercially produced milk.
	Versatile and widely available globally.	Lower calorie density compared to buffalo milk, less ideal for high-energy needs.
	Promotes bone health with high calcium content.	Environmental impact due to methane emissions from large-scale cow farming.

4.7 SUMMARY:

The unique biological benefits of human milk justify the promotion of breastfeeding as the ideal method for feeding infants. Increased intake of certain nutrients or the use of certain supplements in lactating women is recommended to satisfy the demands of milk production and to protect the infant from nutrient deficiencies.

4.8 TECHNICAL TERMS:

Nutrition, breast feeding, Nutritional requirements, Allergic Reactions, environmental factor.

4.9 SELF ASSESSMENT QUESTIONS:

1) What are the Factors affecting breast milk quality?
2) Explain the Advantages and disadvantages of breast feeding?

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LESSON-5

INFANCY-NUTRITIONAL REQUIREMENTS, NEED FOR FORMULA FEEDINGS, TYPES OF INFANT FORMULAE, IMPORTANCE OF PREPARATION OF WEANING FOODS AND FEEDING PROBLEMS

5.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Relate nutritional needs and intakes to the development of the child.
- Summarize nutritional requirements and dietary recommendations for infants.

STRUCTURE:

5.1. INTRODUCTION:

Infancy is the first stage of human development, typically covering the period from birth to around one year of age. It is a time of rapid physical, cognitive, emotional, and social growth, where an infant undergoes significant changes that shape their future well-being. Infants rely entirely on their caregivers for nourishment, comfort, protection, and stimulation. This stage is crucial for laying the foundation for future health, learning, and relationships. Infancy is a foundational period that significantly impacts an individual's long-term health, intelligence, and emotional well-being. Providing a safe, loving, and stimulating environment with proper nutrition and healthcare ensures that infants grow into healthy and well-adjusted children.

5.2. NUTRITIONAL REQUIREMENTS:

Proper nutrition during infancy (0-12 months) is crucial for growth, brain development, immune function, and overall well-being. Infants have unique nutritional needs that evolve as they grow.

5.2.1 Energy:

Energy is essential for an infant’s rapid growth, brain development, and daily activities. The total energy requirement depends on factors such as age, weight, metabolism, and activity level. Infants require adequate energy for rapid growth, brain development, and daily activities. Their energy needs vary by age, with newborns requiring around 100-120 kcal/kg/day, which gradually decreases per kg as they grow but increases in total intake.

5.2.2 Protein:

Protein is essential for an infant’s growth, muscle development, immune function, and overall health. During the first six months, breast milk or formula provides the necessary protein in an easily digestible form. Infants require around 1.5 g/kg/day of protein, which gradually decreases as they grow. After six months, complementary foods such as pureed meats, eggs, legumes, and dairy products help meet protein needs.

5.2.3 Fat and Essential Fatty Acids:

6Fats are a crucial source of energy for infants, supporting rapid growth, brain development, and hormone production. They provide nearly 50% of an infant’s total calorie intake, primarily from breast milk or formula. Essential fatty acids, such as omega-3 (DHA) and omega-6 (ARA), play a key role in brain function, vision, and immune health.

5.2.4 Calcium and Phosphorus:

Calcium and phosphorus are essential minerals for an infant's bone and teeth development, muscle function, and overall growth. Calcium plays a crucial role in bone mineralization, nerve signaling, and blood clotting, while phosphorus works alongside calcium to strengthen bones and support cellular energy production. Breast milk and formula provide adequate amounts of both minerals during the first six months, with complementary foods like dairy products, leafy greens, and fortified cereals introduced after six months.

5.2.5 Iron:

After about six months, these stores begin to deplete, and it becomes necessary to introduce iron-rich foods, such as pureed meats, iron-fortified cereals, and legumes. Iron deficiency can lead to anemia, which can impair cognitive and physical development. Breast milk provides a small amount of iron, but it is highly absorbable, while formula often contains added iron to meet an infant's needs.

5.2.6 Zinc:

Zinc is an essential trace mineral that plays a crucial role in an infant's growth, immune function, and development. It is involved in DNA synthesis, protein synthesis, and cell division, which are vital for physical growth and tissue repair. Zinc also helps maintain a healthy immune system, promoting resistance to infections. In infancy, zinc needs are met through breast milk or formula, which provide bioavailable zinc. As solid foods are introduced (around six months), zinc-rich foods such as meat, legumes, dairy, and fortified cereals become important for meeting the infant's needs.

5.2.7 Sodium:

Sodium is an essential electrolyte that helps regulate fluid balance, blood pressure, and nerve and muscle function. In infancy, sodium is necessary for maintaining proper hydration and supporting cellular functions. However, infants are particularly sensitive to sodium intake, and excessive consumption can strain their kidneys, which are not fully developed at birth.

5.2.8 Iodine:

Iodine is a vital trace element that supports the proper functioning of the thyroid gland, which is responsible for regulating metabolism, growth, and development. In infants, iodine is particularly important for brain development and overall growth during the first year of life.

5.2.9 Vitamin A:

Vitamin A is an essential nutrient that plays a key role in maintaining healthy vision, supporting immune function, promoting cell growth, and ensuring proper skin health. It is particularly crucial during infancy as it supports the rapid growth and development occurring during this stage.

In the early months of life, breast milk provides a sufficient amount of vitamin A in a highly absorbable form, known as retinol, which supports the infant's vision, immune system, and overall growth. For infants who are not breastfed, infant formula is typically fortified with vitamin A.

5.2.10 Vitamin D:

Importance: Essential for calcium absorption, bone health, and immune function.

Sources: Sunlight, fortified formula, and vitamin D drops for breastfed infants.

Recommendation: 400 IU/day for all infants, especially those exclusively breastfed.

5.2.11 Vitamin K:

Importance: Essential for blood clotting and preventing bleeding disorders.

Sources: Given as an injection at birth (newborns have low vitamin K stores).

5.2.12 Vitamin B12:

Importance: Supports brain development, red blood cell formation, and DNA synthesis.

Sources: Breast milk (if the mother has adequate levels), formula, animal-based foods when solids are introduced.

5.2.13 Vitamin C:

Importance: Helps in iron absorption, boosts immunity, and supports skin health.

Sources: Breast milk, formula, mashed citrus fruits, strawberries, and tomatoes (when solids are introduced).

5.2.14 Folate (Vitamin B9):

Importance: Helps in red blood cell production and DNA formation.

Sources: Breast milk, formula, green leafy vegetables (when solids begin).

5.3 NEED FOR INFANT FORMULA:

Infant formula is an essential alternative to breast milk when breastfeeding is not possible, insufficient, or not chosen. It is designed to provide complete nutrition for infants from birth to 12 months.

1) For Infants Who Are Not Breastfed or Partially Breastfed:-Some mothers may have difficulty breastfeeding due to medical conditions, low milk supply, or personal choice. Formula provides all necessary nutrients to support growth and development.
2) For Babies with Special Dietary Needs:-Preterm or Low Birth Weight Infants: Special formulas with higher calorie and nutrient content help meet their needs.

- Allergies or Intolerances: Hypoallergenic formulas are available for babies allergic to cow's milk protein.
- Lactose Intolerance or Metabolic Disorders: Lactose-free or specialized formulas are recommended.

3) Ensures Consistent Nutrition:-Infant formula is fortified with vitamins (D, A, C, B12, etc.), minerals (iron, calcium, zinc), and essential fatty acids to support brain and body development.
4) For Babies Who Cannot Get Enough Milk from Breastfeeding:-Some infants need supplemental formula if they are not gaining enough weight.

5.4 TYPES OF INFANT FORMULA:

Infant formulas come in different types based on their ingredients and purpose. Here's a breakdown of the main types of infant formula:

Cow's Milk-Based Formula (Most Common):

- Made from modified cow's milk to resemble breast milk.
- Fortified with iron, DHA, ARA, and essential vitamins for brain and growth development.
- Examples: Similac Advance, Enfamil NeuroPro, Gerber Good Start.
- Best For: Healthy, full-term infants with no allergies.

Soy-Based Formula:

- Made from soy protein instead of cow's milk.
- Contains added nutrients like iron and DHA.
- Best For: Infants with lactose intolerance (rare in babies).
- Families choosing a vegan diet.
- Babies with galactosemia (a rare disorder affecting lactose digestion).
- Examples: Similac Soy Isomil, Enfamil ProSobee.
- Note: Not recommended for preterm infants due to lower protein quality.

Hypoallergenic (Hydrolyzed) Formula:

- Proteins are partially or extensively broken down for easier digestion.

- Best For: Babies with severe allergies, eczema, or digestion issues.
- Examples: Nutramigen, Alimentum, EleCare (for severe cases).

Lactose-Free Formula:

- Designed for babies with lactose intolerance (very rare in newborns).
- Uses corn syrup solids or other carbohydrate sources instead of lactose.
- Best For: Babies with severe lactose digestion issues.
- Examples: Similac Sensitive, Enfamil Lactose-Free.

Anti-Reflux (AR) Formula:

- Thickened with rice starch to reduce spit-up and acid reflux.
- Best For: Babies with frequent spit-up or gastroesophageal reflux (GERD).
- Examples: Enfamil AR, Similac for Spit-Up.

Preterm or High-Calorie Formula

- Contains more calories, protein, and nutrients for faster growth.
- Best For: Premature or low-birth-weight infants who need extra nutrition.
- Examples: Similac NeoSure, Enfamil EnfaCare.

Amino Acid-Based Formula (Elemental Formula)

- Contains completely broken-down proteins (amino acids) for babies who cannot digest any milk or soy proteins.
- Best For: Babies with severe food allergies or metabolic disorders.
- Examples: Neocate, Puramino, EleCare.

Forms of Infant Formula:

Ready-to-Feed (Pre-mixed, most convenient but costly).

Powdered formula: Powdered formula is the least expensive. Each scoop of powdered formula must be mixed with water.

Concentrated liquid formula: This type of formula also must be mixed with water. This type is slightly more expensive.

Ready-to-use formula: Ready-to-use formula is the most convenient type of infant formula. It does not need to be mixed with water. It is also the most expensive option. However, it requires the least amount of preparation. Ready-to-use formulas are also convenient for travelling.

5.5 IMPORTANCE OF PREPARING WEANING FOODS USING LOCALLY AVAILABLE FOODS:

Weaning is the process of gradually introducing solid foods to an infant, typically starting around 6 months while continuing breastfeeding. Using locally available foods for weaning is important for several reasons:

1. Nutritional Benefits:

- Locally available foods provide essential vitamins, minerals, proteins, and carbohydrates needed for the baby's growth.
- Fresh, seasonal foods are often more nutrient-dense than processed alternatives.

2. Cost-Effectiveness:

- Locally sourced foods are usually cheaper than imported baby foods or commercial formulas.
- Families can provide nutritious meals without high expenses.

3. Food Safety and Freshness:

- Home-prepared foods are free from preservatives, artificial flavors, and excess sugars or salts found in processed foods.
- Freshly prepared meals ensure better hygiene and safety for infants.

4. Cultural Relevance and Acceptability:

- Using traditional foods helps babies adapt to the family's diet and eating habits.
- Infants develop a taste for local staple foods, making the transition to family meals easier.

5. Encourages Food Diversity:

- A mix of locally available grains, fruits, vegetables, and proteins ensures a balanced diet.
- Exposure to different flavors and textures helps babies develop healthy eating habits.

Examples of Locally Available Weaning Foods:

- ➔ Grains: Porridge made from maize, rice, millet, or sorghum.
- ➔ Legumes: Mashed beans, lentils, groundnuts (in moderation).
- ➔ Fruits: Bananas, pawpaw, mangoes, avocados.
- ➔ Vegetables: Mashed pumpkin, carrots, spinach.

➔ Animal Proteins: Eggs, fish, chicken, liver (well-cooked and mashed).

➔ Dairy: Yogurt, milk (after 1 year), and cheese.

6. Sustainable and Environmentally Friendly

- Promotes the use of organic, homegrown produce.
- Reduces reliance on imported or packaged baby foods, lowering waste and carbon footprint.

7. Encourages Family and Community Involvement

- Caregivers can be actively involved in preparing and feeding the baby.
- Strengthens traditional knowledge and practices of infant feeding.

5.6. HOME PREPARED VERSUS COMMERCIAL WEANING FOODS:

When introducing solid foods to infants (around 6 months), parents often choose between home-prepared foods and commercial weaning foods. Each option has its benefits and drawbacks.

5.6.1. Home-Prepared Weaning Foods:

Home-prepared weaning foods are fresh, nutritious, and affordable, making them an excellent choice for introducing solid foods to babies. These meals are made using locally available ingredients and provide essential nutrients for growth and development.

Benefits of Home-Prepared Weaning Foods

- Nutritionally rich-Contains fresh, whole ingredients with no preservatives.
- Cost-effective-Uses locally available foods, making it affordable.
- No additives-Free from artificial sugars, salts, and preservatives.
- Customizable-Can be adjusted based on the baby's preferences and nutritional needs.
- Encourages variety-Exposes the baby to different flavors and textures early on.
- Basic Home Weaning Food Recipes (6–12 Months)

1) Single-Grain Porridge (6+ months)
2) Mashed Banana and Avocado (6+ months)
3) Sweet Potato or Pumpkin Purée (6+ months)
4) Mashed Beans with Vegetables (7+ months)
5) Egg Yolk Mash (8+ months)

6) Fish and Vegetable Purée (8+ months)
7) Soft Ugali with Milk (9+ months)
8) Chicken and Rice Mash (9+ months)

Tips for Preparing Home Weaning Foods

- Start with smooth, soft foods and gradually increase texture.
- Introduce one new food at a time to check for allergies.
- Avoid salt, sugar, and processed foods in baby meals.
- Continue breastfeeding alongside solid foods for balanced nutrition.
- Maintain hygiene – Wash hands and use clean utensils when preparing food.

Home-Prepared Weaning Foods:

Advantages:

➔ More nutritious as fresh ingredients retain their vitamins.
➔ Cost-effective, using easily available local foods.
➔ No additives or preservatives, ensuring safety.
➔ Customizable to baby's needs (allergies, preferences).

Disadvantages:

➔ Requires time and effort to prepare.
➔ Shorter shelf life (must be consumed fresh).
➔ Requires proper food safety and hygiene to prevent contamination.

5.6.2. Commercial Weaning Foods:

Commercial weaning foods are ready-to-eat or easy-to-prepare baby foods designed to help transition infants from breast milk or formula to solid foods. They are often fortified with essential nutrients but may contain preservatives or added sugars.

Types of Commercial Weaning Foods:

1) Instant Baby Cereals:-

Made from rice, wheat, maize, or oats. Often fortified with iron, calcium, and vitamins.

Examples: Nestlé Cerelac, Gerber Rice Cereal, Enfamil Infant Cereal.

Best for: First weaning food (6+ months).

2) Pureed Fruits and Vegetables:-

Pre-packaged in jars or pouches. Single or mixed flavors like apple, banana, carrot, or pumpkin.

Examples: Heinz, Ella's Kitchen, Beech-Nut Naturals.

Best for: Babies starting solid foods (6+ months).

3) Ready-to-Eat Baby Meals:

Mixed meals like chicken & rice, mashed beans, or lentils. Convenient but may have preservatives or added salt.

Examples: Gerber Organic Meals, Earth's Best Baby Food.

Best for: 7+ months as the baby adapts to more flavors.

4) Baby Snacks & Finger Foods:

Soft biscuits, puffs, yogurt melts for babies learning to chew. Helps develop motor skills and chewing habits.

Examples: Happy Baby Puffs, Gerber Lil' Crunchies.

Best for: 8+ months, when the baby starts self-feeding.

5) Formula-Based Weaning Foods:

Special formulas with added nutrients and probiotics.

Examples: Enfamil A+ Stage 2, Similac Follow-On Formula.

Best for: Babies who still rely on formula but need extra nutrition (6–12 months).

Advantages:-

- ➔ Convenient (ready-to-eat or quick preparation).
- ➔ Fortified with essential nutrients like iron, DHA, and vitamin D.
- ➔ Consistent quality and safety, meeting regulatory standards.
- ➔ Long shelf life, making storage easy.

Disadvantages:

- ➔ More expensive than home-prepared foods.
- ➔ May contain preservatives, added sugars, or artificial flavors.
- ➔ Standardized taste limits exposure to natural flavors.
- ➔ Less fiber and texture variation compared to fresh homemade meals.

When to Use Commercial Weaning Foods

- Busy schedules when homemade food is not possible.
- Traveling or when refrigeration isn't available.
- Supplementing homemade meals with fortified baby cereals.
- Ensuring balanced nutrition when homemade diets lack certain vitamins or minerals.

5.7 FEEDING PROBLEMS - VOMITING, DIARRHEA, TEETHING PROBLEMS:

5.7.1 Feeding Problems during Infancy:

Infants may face various feeding challenges due to developmental, medical, or behavioral factors. Identifying and addressing these issues early is important for proper growth and development.

5.7.2 Tooth Decay:

Causes:

- Frequent bottle-feeding with sugary liquids, especially at bedtime.
- Poor oral hygiene (not cleaning gums and teeth after feeding).
- Prolonged pacifier use dipped in sweet substances like honey.

Solutions:

- Clean baby's gums with a damp cloth after feeding.
- Once teeth appear, brush twice daily with a soft toothbrush and water (no toothpaste before 1 year).
- Avoid bottle-feeding at bedtime—instead, use a cup after 6 months.
- Do not give sweetened drinks (juice, soda, sweetened milk).

5.7.3 Diarrhea:

Causes:

- Contaminated food or water (poor hygiene during feeding).
- Formula preparation errors (incorrect dilution or use of unclean bottles).
- Lactose intolerance or food allergies.
- Infections (viral, bacterial, or parasitic).

Solutions:

- Ensure proper hygiene (wash hands before preparing food or feeding the baby).
- If using formula, prepare it correctly with clean, boiled water.
- Breastfeed exclusively for the first 6 months to reduce the risk of infections.
- In case of diarrhea, give oral rehydration solution (ORS) and continue breastfeeding. Seek medical attention if diarrhea is severe, bloody, or lasts more than 24 hours.

5.7.4 Constipation:

Causes:

- Low fiber intake (not enough fruits and vegetables).
- Dehydration (inadequate breast milk, formula, or water for older babies).

Solutions:

- Give more fluids, including breast milk or a little water (for babies over 6 months).
- Add fiber-rich foods like mashed fruits (prunes, pears) and vegetables.

5.7.5 Colic:

Causes:

- Swallowing too much air during feeding.
- Digestive discomfort from gas or food intolerance.
- Sensitivity to cow's milk or formula.

Solutions:

- Ensure proper burping after feeds.
- Use a slow-flow bottle to reduce air intake.
- If formula-fed, try a different formula under medical advice.

5.7.6 Gastro Esophageal Reflux (Vomiting):

Causes:

- Immature digestive system.
- Overfeeding or improper feeding position.

Solutions:

- Feed in an upright position and keep the baby upright for 20–30 minutes after feeding.

- Offer smaller, more frequent feeds.
- If severe, consult a doctor for reflux management.

5.7.7 Newborn Jaundice:

Causes:

- Physiological jaundice (normal in newborns, appears 2–4 days after birth).
- Breastfeeding jaundice (caused by inadequate milk intake).
- Breast milk jaundice (due to substances in breast milk affecting bilirubin breakdown).
- Infections or liver problems (in severe cases).

Solutions:

- Frequent breastfeeding (8–12 times a day) helps remove bilirubin.
- Expose the baby to natural sunlight (morning sunlight for 10–15 minutes).
- If jaundice is severe, seek medical advice for phototherapy (light treatment).
- Ensure the baby is hydrated and feeding well to help eliminate bilirubin

5.8 LACTOSE AND COW'S MILK PROTEIN INTOLERANCE:

Lactose intolerance and cow's milk protein allergy (CMPA) are two different conditions that can affect infants' ability to digest milk. While they may have similar symptoms, they have different causes and require different management strategies.

5.8.1. Lactose Intolerance: Lactose intolerance occurs when the body lacks lactase, the enzyme needed to digest lactose (the sugar found in milk and dairy products). This leads to digestive discomfort when consuming milk or dairy.

Types of Lactose Intolerance in Infants:

1) Congenital Lactose Intolerance (Rare) – The baby is born with a complete lack of lactase.
2) Primary Lactose Intolerance (Develops Later) – More common in older children and adults.
3) Secondary Lactose Intolerance (Temporary) – Caused by infections (e.g., diarrhea) that damage the intestine.

Symptoms of Lactose Intolerance:

- Diarrhea (loose, watery stools after consuming milk).

- Bloating and gas.
- Abdominal cramps.
- Fussiness or crying after feeding.

Management of Lactose Intolerance:

- Breastfeeding: Most babies can tolerate breast milk, as it contains lactase to help digest lactose.
- Lactose-Free Formula: Use lactose-free infant formula if symptoms persist.
- Probiotics: Can help restore gut health if lactose intolerance is secondary to an infection.

5.8.2. Cow's Milk Protein Allergy (CMPA): CMPA is an immune reaction to proteins found in cow's milk, either in formula or breast milk (if the mother consumes dairy). It is different from lactose intolerance because it involves the immune system and can cause more severe reactions.

Types of CMPA:

1) IgE-Mediated CMPA (Immediate Allergic Reaction) – Symptoms appear within minutes to hours after consuming milk.
2) Non-IgE-Mediated CMPA (Delayed Reaction) – Symptoms develop over days.

Symptoms of CMPA:

- Digestive issues: Vomiting, diarrhea, constipation, colic.
- Skin reactions: Eczema, hives, rashes.
- Respiratory symptoms: Wheezing, runny nose, coughing.
- Severe cases: Anaphylaxis (rare but life-threatening).

Management of CMPA:

- Eliminate cow's milk from the baby's diet.
- If breastfeeding, the mother should avoid dairy products.
- Use a hydrolyzed or amino acid-based formula (e.g., Nutramigen, Neocate).
- Introduce dairy carefully after 12-24 months, under medical supervision.

5.9 CONCEPT OF HUMAN MILK BANK:

A human milk bank is a facility that collects, screens, processes, stores, and distributes donated breast milk to infants who need it. This ensures that babies who cannot be breastfed by their mothers still receive the benefits of human milk.

Importance of Human Milk Bank:

- Provides Essential Nutrition-Human milk is the best food for newborns, offering optimal nutrients and antibodies for growth and immunity.
- Supports Premature & Sick Infants-Helps low birth weight, premature, and sick babies in neonatal intensive care units (NICUs).
- Alternative for Mothers Who Cannot Breastfeed-Supports mothers who:
- Have insufficient milk supply, Are ill or on medications, Have medical conditions like HIV.
- Reduces Infant Mortality-Lowers the risk of necrotizing enterocolitis (NEC), infections, and allergies in premature babies.

Process of Human Milk Banking:

1) Milk Collection
2) Milk Processing & Pasteurization
3) Storage
4) Distribution

5.10 SUMMARY:

Infancy is a critical stage for growth and development, requiring balanced nutrition to meet specific needs. Breast milk is the ideal food, but formula feeding becomes essential when breastfeeding is not possible. Various infant formulas cater to specific needs, such as lactose-free options for intolerance. Proper preparation of weaning foods using locally available ingredients ensures cost-effectiveness and nutritional adequacy, often surpassing commercial alternatives. Addressing feeding problems early is vital to avoid deficiencies. Additionally, human milk banks provide safe donor milk for infants lacking access to maternal milk, supporting optimal health during this crucial phase.

5.11. TECHNICAL TERMS:

Infancy, Macronutrients, Micro nutrients, Breast feeding, Infant formula, Lactose intolerance, Weaning, feeding disorders, Human milk bank.

5.11. SELF-ASSESSMENT QUESTIONS:

1) Name two nutrients that are essential for growth and development during infancy?
2) What is the difference between home prepared and commercial weaning foods?

5.12. REFERENCES BOOKS:

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LESSON-6

PRESCHOOL-GROWTH AND DEVELOPMENT, NUTRITIONAL REQUIREMENT, INTAKE AND GAPS, EFFECT OF MALNUTRITION ON PHYSICAL AND MENTAL DEVELOPMENT

6.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Relate nutritional needs and intakes to the development of the child.
- Summarize nutritional requirements and dietary recommendations for preschool children

STRUCTURE:

6.1 INTRODUCTION:

The years between 1 and 6, growth is generally slower than in the first but continues gradually. Activity also markedly dating the second year of life as the child becomes increasingly mobile. The child may gain in weight 150-200g per month between one and two years

6.2 GROWTH AND DEVELOPMENT:

Although physical development in preschoolers in dramatic, the development is slower and more than during infancy. Some important influence on physical development during the preschool period include changes in the child's brain, gross motor skills and health.

Physical changes Children began to lost their baby fat or chubbiness around age 1. The child's trunk and limbs grow longer and the abdominal muscles from tightening the appearance of the stomach. Even at this early stage of life, boys tend to have more muscle mass than girls have. The preschooler's physical proportion also continues to change, with their heads being disproportionately large.

Three year old preschooler may grow to be 35 inches tall and weigh about 32 pounds for the next 3 years, healthy preschoolers grow an additional 2 to 3 inches. In addition, gain from 4 to 6 these figures are averages and differ from child to child, depending on socio economic status, nourishments and health and heredity factors.

Brain Development:

Brain and nervous system development during early childhood also continue to be dramatic. The better developed the brain nervous system is the more complex behavioral and cognitive abilities children are capable of. The two cerebral hemispheres develop at different rates, with the left hemispheres developing more fully early childhood (ages 2 to 6).

The nervous system undergoes changes in early childhood too. The myelin sheaths that surround insulate and increase the efficiency of nervous form rapidly during the first few years of life.

Motor Skills:

Gross motor skills include running, jumping, skipping, throwing, dancing, involve the use of large bodily movements, fine motor skills include drawing, writing etc, involve the use of small bodily movements. Both gross and fine motor skills develop and are refined during early childhood.

6.3 NUTRITIONAL REQUIREMENTS ENERGY:

Energy is required for growth and activity. Insufficient food will not only results in under nutrition in terms of in adequate weight gain but will also hinder growth. The rate of growth fluctuates from one age to another. Up to 10 years of age there is no difference in sex for RDA. Due to improper weaning practices, the child may not meet calorie and protein requirement leading to protein energy malnutrition insufficient calorie intake can lead to protein deficiency.

Protein:

The increase in the muscle mass that muscle accompany bone growth requires positive nitrogen balance that is met by protein intake of 13g/kg body weight. The increase in total body size necessitates a larger vascular system to transport nutrients to the tissues and all waste products away from the tissue. Thus, there is an increase in demand for nutrient needed in blood formation like protein, iron, folate, and pyridoxine. Both growth also creates a need for protein.

Fat and Essential Fatty Acids:

Fat energy including invisible fat for children should be 25 percent of total energy. To provide 25 percent fat calories, the minimum level of visible fat in the diet of children should range between 25-27 g/day.

Calcium:

Calcium requirements of children are calculated based on the amount of calcium accumulate in the body. The calcium deposition is not uniform throughout the growing period, but would be relatively greater during early childhood and in adolescence than the other periods of growth since, all dietary calcium is not absorbed 600mg/day is prescribed though the actual requirement may be less. The RDA of phosphorus is 600mg/day. Deficiency of calcium can affect the bones of growing children. Milk is the best source of calcium. Hence the diet of preschool child should include 1-2 glasses of milk per day.

Iron:

In childhood the mean increase in body weight is 2.8/kg year, which necessitates an iron requirement of 0.7 mg/d, the average iron requirement for growth would he about 17mg/kg/d. During childhood body store of iron builds up 5 mg/kg, which is maintained, is girls until menarche. During growth, approximately 30mg of iron is required for every 1kg increase in body weight. Since the average annual weight gain during childhood is around 2kg, the iron needed for growth amounts to 0.2mg per day.

Within the first year of life, the full term infant almost doubles total iron content and triples its bodyweight. The change in body iron during this period occurs mainly between 6-12 months of age. Between 1 and 6 years of age, the body iron content in again doubled. The absorbed iron requirements in infants and children are very high in relation to their energy requirements. For example infant 6-12 months of age about 1.5 mg of iron must be absorbed per 1000k.cal and about half of this amount up to age of 14 years.

Children 6-24 months old are at the greatest risk of the irreversible long-term consequences of iron deficiency namely impaired physical and mental development 20 mg elemental iron and 100mg of folic acid in syrup from is given 6-24 months old children under reproductive and child health program. The RDA (2010) recommended 9-13mg iron per day. To meet this increased demand for iron, rich-foods like rice flakes, egg yolk and greens should be included in the diet. Dietary lack of iron accompanied by hookworm infestation can lead to anemia.

Vitamin A:

Vitamin A requirement of children have been computed form the requirement figures of infants (50mg/kg) and adults (9.3mg/kg) taking into account growth rates at different ages. The prevalence of vitamin A deficiency is high among Indian children with a dietary intake of less than 100mg, and their serum vitamin A levels are generally low. Studies conducted by ICMR found that children who received the food supplements providing a total of 300mg of vitamin A per day for six months had serum vitamin a levels of approximately 30mg/dl and showed no clinical signs of deficiency. Milk, eggs, carrots and green leafy vegetables should be included in the diet.

B Vitamins:

The daily allowances of B-vitamin requirements are based on energy intake. The allowances per 1000k.cals are (some as an adults) 0.5 mg thiamine, 0.6 mg riboflavin and 6.6mg niacin equivalents. Dietary folate requirement for 1-3 and 4-6 year old is 80 and 100 mg/d respectively.

Vitamin D:

Vitamin D is now considered more as a pro- hormone than as a vitamin. It can be synthesis in the body in adequate amount by simple exposure to bright sunlight for 5min per day. Habitual Indian diets do not provide even 10percent of the requirement. The expert committee suggested that outdoor physical activity is mean of achieving adequate vitamin D status.

Table 6.3: ICMR Recommend Dietary Allowances for Infancy

Nutrient	1-3 Years	4-6 Years
Body Weight kg	12.9	18.3
Energy kcal	1110	1360
Protein g	12.5	16.0
Dietary Fibre g	15	20
Calcium mg	500	550
Magnesium mg	90	125
Iron mg	8	11
Zinc mg	3.3	4.5
Iodine ug	90	90
Vitamin A retinol ug	390	510
Vitamin D IU	600	600
Thiamine mg	0.7	0.9
Riboflavin mg	1.1	1.3
Niacin mg	7	9
Pyridoxine mg	0.9	1.2
Folate ug	120	135
Vitamin B12 ug	1.2	2.2
Vitamin C mg	30	35

Source: Indian Food Composition Table

6.4 INTAKE AND GAPS:

- Proper elimination is usually maintained by a daily diet of fruits, vegetables and whole grain products.
- Foods should be slightly seasoned to enhance the taste.
- Child should not be forced to eat more.
- Food like the one tea and coffee should be restricted as they over stimulates the system.
- The surveys of the National Nutrition Bureau (2012) indicates that the average cereal intake is 106 g/day among 1-3 year old children. The energy density should be 1.0 to 1.2 kcal/ml. This can be achieved by adding milk and oil to the diet. Malted foods can also be included in the diet to increase calorie density.
- Inclusion of curd every day in the diet can decrease the incidence of diarrhea and course of cold.
- Unripe bananas and apples should not be given as they are difficult to chew and may choke the child.
- Home based diet provide adequately for growth and development of the child provided they are calorie dense and given in small feeds frequently.
- Even if there is enough food in the house to provide an adequate diet, growth can be faltered due to feeding a young child with bulky staple foods which fill the child's small stomach and assuage its
- Hunger without meeting its energy needs. Also feeding a child's small stomach infrequently (only twice instead of four times) can affect the growth of the child.
- Overall need for nutrients increases throughout the growth period but there will be periods when growth is slow and the need for certain nutrients will be reduced proportionately. Children reflect these changes in need by fluctuation in appetite.

6.5. EFFECT OF MALNUTRITION ON PHYSICAL AND MENTAL DEVELOPMENT:

Malnutrition during the preschool years (ages3-5) can have significant and often long-lasting effects on both physical and mental development. Here is an overview of its impact.

Physical Development:

Growth Retardation:

Stunted growth (low height for age) due to chronic under nutrition. Wasting (low weight for height) in case of acute malnutrition.

Weekend Immune System:

Increased susceptibility to infections like diarrhea, pneumonia and measles. Prolonged recovery times for illness.

Delayed Motor Skills:

Difficulty in achieving physical milestones such as running, jumping and fine motor skills like drawing.

Micronutrient Deficiencies:

Iron deficiency: Leads to anemia, fatigue and reduced physical stamina. Vitamin A deficiency impairs vision and increases the risk of infections. Calcium deficiency affects bone development and strength.

Mental and Cognitive Development:

Cognitive Impairment:

Reduced brain growth and development due to lack of essential nutrients. Poor problem solving skills and delayed language development.

Learning Difficulties:

Lower attention spans, memory issues and difficulty concentrating in school settings.

Emotional and Behavioral Issues:

Increased irritability, anxiety and social with drawl, greater like hood of hyperactivity and impulsivity.

Long-Term Consequences:

Persistent cognitive deficits, even after nutritional rehabilitation. Lower educational attainment and reduced productivity in adult hood.

Nutritional Related Problems:

According to United Nations report (2007), 46 per cent of children under the age of five suffer from under nutrition. Around 35 percent of the worlds undernourished children live in India. Malnutrition is the direct or indirect cause for 50 percent of total death among children.

Dental Problems:

Tooth decay can be caused by caries. This can occur in children who are susceptible and whose integrity of tooth structure may be affected by the nutritional deficiency. Vitamin A is necessary for enamel and vitamin C is essential for dentine. Calcium, phosphorous and vitamin D are needed for the process of calcification. Fluorine decreases susceptibility of caries. Fermentable carbohydrate, which adheres to the tooth surface, is the major dietary factor influencing tooth decay. Stickier the carbohydrate and longer the sugar is in the mouth, the greater the cariogenic effect,

Pica:

This disorder involves repeated or chronic ingestion of non-nutrient substances which may include plater, charcoal, clay, ashes, metal (pins, nails or blades) paint and earth. The age of on set is usually1-2 years. Psychological theories of pica have found evidence for mental derivation, high frequency of maternal and paternal deprivation, family disorganization, poor supervision and low socio economic status.

Pica can be treated with a combination of education and guidance, family counselling and behavior modification. Children with pica are at increased risk for lead poisoning, iron deficiency anemia and parasitic infections.

Children with Feeding Disorders:

Feeding can become more challenging for children with developmental issues like autism and cerebral palsy, leading to feeding disorders. These disorders can result in serious consequences such as failure to thrive, increased risk of chronic illness, and even death. Some children may not feel hungry during mealtime, may finish meals quickly, or may be very selective about what they eat. Common feeding disorders in children include a lack of thirst (adipsia), difficulty swallowing (dysphagia), refusal to eat, inadequate self-feeding, refusal to eat certain amounts, extended meal durations, choking, and gagging, vomiting, inappropriate behavior during mealtime, and selectivity in food choices based on type or texture.

- **Picky Eating:**

  Picky eater is the one who

  - Accepts only limited number of food choices
  - Is unwilling to try new foods
  - Avoid some food groups such as vegetables
  - Exhibit strong food preferences including presentation and preparation styles.

Picky eater phenomenon is independent of social status. Psychological and physiological problems need to be corrected.

Picky eating is a common childhood behavior and the habit will wear with time. Children need variety as they get bored with same kind of food,

Age appropriate food should be offered for the children and new eatables should be introduced regularly. It is common to see mothers offering quick bites when the children refuse to eat meals. Mother should be firm and should not substitute snacks for meals.

Protein Energy Malnutrition:

Nutritional assessment (subclinical) using anthropometric measurements countrywide surveys indicate that more than half of the Indian preschool children (1-5years) suffer from sub clinical under nutrition as indicated by low weight for age. About 65 percent of them are stunted (low height forage) which indicates that under nutrition of long duration.

In a field survey where the objective is to define the prevalence of acute malnutrition, weight/height and arm circumference may be the most appropriate anthropometric measurements. Protein energy malnutrition is defined as a range of pathological conditions arising from coincident lack of varying proportions of protein and calorie, occurring most frequently in infant and young children and often associated with infection (WHO). The peak prevalence of wants frequently seen in the group of 2-3 years and marasmus is 1-2 years.

The following are the causes for underweight for age, which may precipitate in to PEM:

1) Due to poverty, mother is not able to provide sufficient food to the resulting in under nutrition.
2) The starchy gruels made from local staple food like rice, wheat, bajra, ragi, jowar or maize would result in dietary bulk with a low caloric density. Hence, the child may be able to meet calorie requirement. Malted foods meet calorie requirement as they increase the caloric density.
3) Abrupt weaning, late weaning, ignorance of importance of weaning can lead to under nutrition.
4) Malnutrition can result in less enzymes synthesis and less appetite leading in less consumption of food.
5) Chronic infections like primary complex may result in anorexia.
6) Infestation like a cariasis particularly giardiasis may lead to anorexia.

Kwashiorkor:

Odema of the face and lower limbs failure to thrive, anorexia, diarrhea, apathy, dermatosis (hypo and hyper pigmentation) flaky paint appearance, sparse, soft and thin hair, angular stomatitis, chilosis and anemia.

Marasmic Kwashiorkor:

These children exhibit a mixture of some of the features of both marasmic and kwashiorkor.

Marasmus:

Failure to thrive means children are not able to gain weight irritability, fretfulness and apathy are common among them. Their weight is persistently below the third percentile for age or less than 80 percent of ideal weight for age. Diarrhea is frequent. Many are hungry but some may be anorexic. The child is shrunk and there is little or no subcutaneous Fat. There is often dehydration. The temperature is subnormal. Water diarrhea and acid stools may be present. The muscles are weak and atrophic and this together with the lack of subcutaneous fat makes the limbs appear as skin and bones.

Nutritional Dwarfing:

Some children adopt to prolonged insufficiency of food-energy and protein by a marked retardation of growth. Weight and height are both reduced resembling children a year and more younger.

The Underweight Child:

These children are growing up smaller than their genetic potential. This is of greater importance as they are at risk of gastroenteritis, respiratory and other infections, which can precipitate frank malnutrition.

6.6 SUMMARY:

Preschool children experience rapid growth and development, including physical, cognitive and emotional changes. During this stage, they require a balanced diet rich in nutrients like proteins, carbohydrates, fats, vitamins and minerals to support their development. Key foods include milk, fruits, vegetables, grains, and proteins. However, gaps in nutrition, such as deficiencies in iron, calcium, or vitamins, can occur due to poor dietary habits. Malnutrition during this critical period can severely impact physical growth, causing stunted height and weak immunity, and hinder mental development, leading to learning difficulties and delayed cognitive skills. Providing a well-rounded diet is essential for their overall well-being.

6.7 TECHNICAL TERMS:

Growth, Development, Nutritional requirements, dietary intake, Nutritional gaps, Macronutrients, Micro nutrients, Mal nutrition, Stunted growth, Cognitive development, Immunity, Deficiency disorders.

6.8 SELF-ASSESSMENT QUESTIONS:

1) Explain the role of macro and micronutrients in child's growth.
2) What are some common dietary gaps observed in pre-school children?

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1) Swaminathan, M. Advances Text Book on Book on Food and Nutrition Vol. 1 and 2 Bangalore Printing Publishing Co., Ltd., Bangalore, II ed., 1988.
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LESSON-7

SCHOOL-GOING CHILDREN: NUTRITIONAL DEMANDS, INTAKE AND GAPS, IMPORTANCE OF BREAKFAST AND ITS IMPACT ON SCHOOL PERFORMANCE, SPECIFIC NUTRITIONAL PROBLEMS

7.0 OBJECTIVES:

After reading this chapter students will be able to :

- Relate nutritional needs and intakes to the development of the school going children
- To evaluate the nutritional intakes and gaps of school going children
- Summarize the nutritional requirements and dietary recommendations

STRUCTURE

7.1 INTRODUCTION:

Nutrition plays a crucial role in the growth, development, and overall well-being of school-going children. Proper nutrition ensures that children have the energy and nutrients necessary for physical activity, cognitive function, and immune system strength. A balanced diet helps improve concentration, memory, and academic performance while reducing the risk of malnutrition and diet-related diseases.

School-age children (typically 6 - 18 years old) have unique dietary needs as they experience rapid growth and increased physical activity. Their diet should include essential nutrients such as proteins, carbohydrates, healthy fats, vitamins, and minerals

Lack of proper nutrition can lead to health issues such as stunted growth, weakened immunity, obesity, and poor academic performance. Schools and parents play a significant role in ensuring children have access to nutritious meals, whether through packed lunches or school meal programs. Encouraging healthy eating habits early in life can lead to lifelong benefits and prevent lifestyle diseases in adulthood.

7.2 NUTRITIONAL DEMANDS FOR SCHOOL GOING CHILDREN:

When it comes to the nutritional needs of school-going children, it's important to ensure they get a balanced diet that supports their growth, brain development, and energy levels throughout the day. Proper nutrition helps improve concentration, memory, and overall well-being. Here's a detailed look at the nutritional demands for school-age children:

1) Calories:

- **Age 4-8 years**: Approximately 1,200-1,800 calories per day.
- **Age 9-13 years**: Around 1,600-2,200 calories per day, depending on the child's activity level (active children may need more calories).
- **Age 14-18 years**: For girls, around 1,800-2,400 calories; for boys, around 2,000-2,800 calories.

2) Macronutrients:

- **Carbohydrates**:
    - Carbohydrates provide energy for children, especially during periods of physical and mental activity. A large portion of their diet should come from healthy carbs.
    - **Sources**: Whole grains (brown rice, oats, whole wheat bread), vegetables, fruits, and legumes.
    - **Recommended intake**: 45-65% of total daily calories should come from carbohydrates.

- **Proteins**:
    - Proteins are essential for growth, tissue repair, and immune function. They are also important for maintaining muscle mass.
    - **Sources**: Lean meats (chicken, turkey), fish, eggs, dairy products (milk, yogurt), legumes (lentils, beans), and nuts.
    - **Recommended intake**: 10-30% of total daily calories should come from protein. Typically, children need 1.1-1.2 grams of protein per kilogram of body weight.
- **Fats**:
    - Healthy fats are crucial for brain development, energy, and the absorption of fat-soluble vitamins (A, D, E, K).
    - **Sources**: Avocados, olive oil, nuts, seeds, fatty fish (salmon, tuna), and nut butters.
    - **Recommended intake**: 25-35% of total daily calories should come from fat, with the majority being unsaturated fats.

3) Micronutrients:

- **Vitamins**:

o **Vitamin A**: Important for vision, immune function, and growth.

- **Sources**: Carrots, sweet potatoes, spinach, and other orange and leafy green vegetables.

o **Vitamin C**: Essential for immune function, wound healing, and iron absorption.

- **Sources**: Citrus fruits, strawberries, bell peppers, broccoli, and tomatoes.

o **Vitamin D**: Important for bone health and immune system support.

- **Sources**: Sunlight, fortified dairy, eggs, and fatty fish.

o **B Vitamins**: Crucial for energy production and brain function (particularly B6, B12, and folate).

- **Sources**: Whole grains, eggs, dairy, meat, and leafy greens.

o **Minerals**:

o **Calcium**: Important for bone growth and development.

- **Sources**: Dairy products, fortified plant milks, leafy greens (collard greens, kale), and fortified cereals.

- **Iron**: Needed for red blood cell production and to prevent anemia. Especially important for girls when they begin menstruating.
    - **Sources**: Lean meats, beans, spinach, fortified cereals, and tofu.
- **Magnesium**: Supports muscle function, nerve transmission, and energy production.
    - **Sources**: Nuts, seeds, whole grains, and leafy vegetables.
- **Zinc**: Important for immune function and growth.
    - **Sources**: Meat, shellfish, legumes, seeds, and nuts.

4) Hydration:

- Water is essential for maintaining hydration, aiding digestion, regulating body temperature, and supporting overall bodily functions.
- Children should be encouraged to drink water throughout the day, especially during physical activity.
    - **Recommended intake**:
        - Age 4-8: 5 cups
        - Age 9-13: 7-8 cups
        - Age 14-18: 8-11 cups

5) Dietary Fiber:

- Fiber is important for digestive health and maintaining stable blood sugar levels.
- **Sources**: Whole grains, fruits, vegetables, and legumes.
    - **Recommended intake**:
        - Age 4-8: 25 grams per day
        - Age 9-13: 26-31 grams per day
        - Age 14-18: 30-38 grams per day

6) Meal Timing and Snacks:

- **Breakfast**: It is essential for cognitive function and energy. A balanced breakfast with protein, fiber, and healthy fats will keep energy levels stable.
    - Examples: Whole grain toast with avocado and eggs, oatmeal with nuts and fruit, or yogurt with granola and berries.
- **Lunch & Dinner**: Should include a variety of foods from different food groups. A well-balanced meal supports focus and energy levels during schoolwork or activities.

- Aim for a plate with 50% vegetables or fruits, 25% lean protein, and 25% whole grains.

- **Snacks**: Healthy snacks can help maintain energy levels between meals.
  - Healthy snack options include fruits, vegetables, nuts, yogurt, or whole grain crackers with cheese.
  - Avoid high-sugar, processed snacks which can lead to energy crashes.

7) Avoiding Empty Calories:

- Minimize the intake of foods high in refined sugars, trans fats, and processed snacks that offer little nutritional value. These include sugary drinks, candy, baked goods, and chips.
- Offer alternatives like fruits, vegetables, or whole grain options when kids need a snack.

Table-7.1: RDA Requirements for School Going Children from Age 4-12 Years

Nutrient	4-6 Years	7-9 Years	10-12 Years (Boys)	10-12 Years (Girls)
Energy kcal	1350	1690	2190	2010
Protein g	20	29	39	40
Fat g	25-30	30-40	50	50
Carbohydrates g	180	220	280	250
Calcium mg	600	800	1000	1000
Iron mg	10	11	17	20
Vitamin A retinol ug	400	500	600	600
Vitamin c mg	25	30	40	40
Vitamin D IU	10	10	15	15
Vitamin B12 ug	0.9	1.2	1.8	1.8
Zinc mg	5	6.5	8	8

Source: Indian Food Composition Table 2017

7.3 NUTRITIONAL INTAKES AND GAPS FOR SCHOOL-AGED CHILDREN:

When considering the nutritional needs of school-going children, it's important to provide a balanced diet that supports their growth, development, and overall well-being. The right nutrients play a crucial role in cognitive function, physical health, and emotional stability. The key nutritional intakes for school-aged children, as well as common nutritional gaps they may face.

Nutritional Intakes for School-Aged Children:

1) Macronutrients

Carbohydrates: The primary source of energy for children. Whole grains, fruits, and vegetables provide slow-releasing carbs that help maintain energy levels throughout the day.

Sources: Whole wheat bread, brown rice, oats, fruits, vegetables, and legumes.

Proteins: Important for growth, muscle development, and immune function. Proteins also support the repair of body tissues and production of enzymes and hormones.

Sources: Lean meats, poultry, fish, eggs, legumes, nuts, seeds, dairy products, and tofu.

Fats: Essential for brain function, hormone production, and absorption of fat-soluble vitamins (A, D, E, K). Healthy fats should come from unsaturated sources.

Sources: Avocados, nuts, seeds, olive oil, fatty fish (salmon, mackerel), and dairy.

2) Micronutrients:

Vitamins:

Vitamin A: Vital for vision, immune function, and skin health.

Sources: Carrots, sweet potatoes, spinach, kale, and fortified dairy products.

Vitamin C: Important for the immune system, skin health, and iron absorption.

Sources: Citrus fruits, strawberries, bell peppers, broccoli, and tomatoes.

Vitamin D: Helps in calcium absorption for strong bones and teeth. It's often deficient in many children's diets.

Sources: Sunlight, fortified dairy products, fatty fish, egg yolks.

Vitamin B12: Important for red blood cell production and brain health.

Sources: Meat, fish, poultry, dairy products, fortified cereals.

Folate (B9): Supports cell growth and development, crucial during periods of rapid growth.

Sources: Leafy greens, beans, lentils, citrus fruits, and fortified grains.

Minerals:

Calcium: Essential for the development of strong bones and teeth, especially during the growing years.

Sources: Dairy products (milk, cheese, yogurt), fortified plant-based milks, tofu, leafy greens.

Iron: Necessary for oxygen transport and preventing anemia. Deficiency can affect energy and concentration.

Sources: Red meat, poultry, lentils, beans, fortified cereals, spinach.

Zinc: Important for immune function, wound healing, and growth.

Sources: Meat, shellfish, legumes, seeds, nuts, dairy, and whole grains.

Magnesium: Supports muscle function, heart health, and bone development.

Sources: Whole grains, legumes, seeds, nuts, and leafy green vegetables.

Fiber: Essential for digestive health, preventing constipation, and maintaining a feeling of fullness.

Sources: Whole grains, fruits, vegetables, and legumes.

Common Nutritional Gaps:

While many children receive adequate macronutrient intake (carbs, proteins, and fats), there are several micronutrient deficiencies that can affect their growth and academic performance.

1) Iron Deficiency:

Iron is crucial for cognitive function and energy levels. Iron deficiency is one of the most common nutritional gaps, especially in children who do not consume enough iron-rich foods or who rely on plant-based diets without sufficient iron absorption.

Symptoms: Fatigue, irritability, poor concentration.

Recommendations: Include more iron-rich foods (red meat, fortified cereals, beans) and pair them with vitamin C (oranges, bell peppers) to improve absorption.

2) Vitamin D Deficiency:

Vitamin D is essential for bone health and the immune system. Lack of sunlight exposure and limited dietary sources can lead to vitamin D deficiency.

Symptoms: Fatigue, muscle weakness, and bone pain.

Recommendations: Encourage outdoor activities to boost sunlight exposure and include fortified dairy or plant-based products.

3) Calcium Deficiency:

Calcium is vital for bone health during the developmental years. Insufficient calcium intake may lead to weakened bones and poor growth.

Symptoms: Poor bone growth, frequent fractures, and delayed physical development.

Recommendations: Increase dairy or fortified alternatives in their diet, or consider calcium supplements if needed.

4) Fiber Deficiency

A low intake of fiber can lead to constipation and digestive issues. It can also lead to irregular blood sugar levels.

Symptoms: Constipation, bloating, and fatigue.

Recommendations: Include more whole grains, fruits, vegetables, and legumes in meals and snacks.

5) Omega-3 Fatty Acid Deficiency:

Omega-3 fatty acids are important for brain development and cognitive function. Many children may not consume enough omega-3-rich foods.

Symptoms: Difficulty concentrating, poor memory, and slower cognitive development.

Recommendations: Include fatty fish (salmon, sardines), walnuts, flaxseeds, or omega-3 supplements.

6) Vitamin A Deficiency:

A deficiency in vitamin A can impair immune function and vision.

Symptoms: Night blindness, frequent infections, dry skin.

Recommendations: Increase intake of orange and yellow vegetables (carrots, sweet potatoes) and dark leafy greens (spinach, kale).

7) Zinc Deficiency

Zinc is essential for growth, immune health, and the ability to heal wounds. A lack of zinc can affect appetite, growth, and learning ability.

Symptoms: Poor appetite, slower growth, delayed healing, and frequent infections.

Recommendations: Ensure inclusion of zinc-rich foods like meat, shellfish, beans, nuts, and seeds.

Nutritional Gaps and Meal Planning:

To fill the nutritional gaps, consider the following tips for meal planning:

- **Balanced Breakfast**: Start the day with a nutrient-dense breakfast such as oatmeal with berries and chia seeds, or a whole-grain toast with avocado and an egg.
- **Snack Options**: Include a variety of healthy snacks like fruit with yogurt, nuts, seeds, or whole-grain crackers with cheese.
- **Lunch and Dinner**: Aim to incorporate lean protein (chicken, beans), vegetables (broccoli, carrots), whole grains (brown rice, quinoa), and healthy fats (avocado, olive oil) into each meal.
- **Hydration**: Encourage water as the primary beverage. Avoid sugary drinks like soda or fruit juices.
- **Limit Processed Foods**: Minimize the consumption of fast food, sugary snacks, and overly processed foods as they lack essential nutrients and contribute to empty calories.

7.4 IMPORTANCE OF BREAKFAST AND ITS IMPACT ON SCHOOL PERFORMANCE:

Breakfast is often regarded as the most important meal of the day, especially for children. It is essential for their growth, development, and academic success. Numerous studies emphasize the crucial role breakfast plays in a child's ability to concentrate, retain information, and perform academically.

1) Improved Concentration and Focus

- **Mental Alertness**: After a long night's sleep, children wake up with lower blood sugar levels. A nutritious breakfast replenishes energy stores and helps restore glucose levels in the brain, which is vital for mental functioning.
- **Cognitive Performance**: Breakfast increases cognitive functions like attention span, memory, and problem-solving skills. Children who eat breakfast are generally more alert and attentive during class, enabling them to absorb and retain information better.
- **Research Findings**: Studies have shown that children who eat breakfast regularly perform better on tasks that require concentration and processing, including reading comprehension and math problems.

2) Better Academic Performance

- **Higher Test Scores**: Children who regularly have breakfast tend to perform better on standardized tests. This includes better performance in mathematics, reading, and writing because they are more focused and engaged.

- **Longer Attention Span**: A healthy breakfast stabilizes blood sugar levels, preventing energy dips and irritability, which can hinder a child's ability to focus on lessons. This consistent attention and energy allows for better classroom participation and learning.
- **Consistency in Attendance**: A nutritious breakfast can also improve overall school attendance. When children are well-fed, they tend to have higher energy levels and are less likely to skip school due to fatigue or lack of energy.

3) Physical and Mental Health Benefits:

- **Supports Growth**: A balanced breakfast provides essential nutrients like vitamins, minerals, and proteins necessary for a child's physical and cognitive growth. These nutrients contribute to bone health, brain function, and general well-being.
- **Weight Management**: Skipping breakfast often leads to overeating later in the day. A healthy breakfast helps regulate hunger and may help maintain a healthy weight by preventing overeating or the consumption of unhealthy snacks.
- **Boosts Immune System**: A nutritious breakfast enhances the immune system, reducing the likelihood of frequent illnesses, which can interrupt school attendance.

4) Prevention of Behavioral Issues:

- **Stable Mood**: Without breakfast, children may become irritable or restless due to low blood sugar levels. A balanced meal helps stabilize their blood sugar levels and can reduce the likelihood of mood swings and behavioral issues in school.
- **Improved Social Interaction**: Children who eat breakfast tend to be more social and engaged in school activities. On the other hand, those who skip breakfast might feel fatigued, which could make them less likely to participate in class discussions or interact with peers.

5) Positive Impact on Long-term Health and School Habits:

- **Establishes Healthy Eating Habits**: Children who eat breakfast regularly are more likely to develop healthy eating habits in the long term. These habits can contribute to better academic outcomes, as children are taught to prioritize nutrition, which supports overall well-being.

Key Nutrients in Breakfast and Their Benefits:

- **Carbohydrates**: Whole grains, fruits, and vegetables provide complex carbs that fuel the brain and body. These slow-releasing carbs offer sustained energy throughout the morning.
- **Proteins**: Eggs, yogurt, nuts, and milk provide essential proteins that are key for brain development, muscle repair, and immune function.

- **Healthy Fats**: Avocados, nuts, and seeds are sources of omega-3 fatty acids that promote brain health, memory, and cognitive functions.
- **Vitamins and Minerals**: Breakfast foods like fruits, vegetables, dairy, and whole grains provide essential vitamins and minerals (such as Vitamin C, iron, and calcium), which are critical for immune health and overall development.

Common Mistakes and Myths about Breakfast:

- **Skipping Breakfast**: Some children may skip breakfast due to lack of time or appetite. This results in low blood sugar, irritability, and difficulty concentrating in class. It can also lead to unhealthy snacking later in the day.
- **Sugary Breakfast Foods**: A breakfast high in sugar (e.g., sugary cereals, pastries) can lead to energy spikes followed by crashes, impairing concentration and mood. It's important to focus on balanced meals with whole foods and minimal added sugar.

7.5 SPECIFIC NUTRITIONAL PROBLEMS:

When it comes to school-going children, proper nutrition is crucial for their growth, development, and academic performance. However, several nutritional problems can affect children at this stage.

1) Iron Deficiency Anemia:

- **Cause:** Insufficient iron intake or poor iron absorption.
- **Symptoms:** Fatigue, weakness, pale skin, trouble concentrating, and irritability.
- **Impact on School Children:**
    - Reduced cognitive function and difficulty focusing in school.
    - Increased risk of infections.
    - Decreased physical stamina.
- **Prevention/Treatment:**
    - Include iron-rich foods such as red meat, poultry, fish, beans, lentils, and fortified cereals.
    - Vitamin C can enhance iron absorption, so pairing iron-rich foods with citrus fruits or bell peppers can help.

2) Vitamin D Deficiency:

- **Cause:** Lack of sunlight exposure and inadequate dietary intake.
- **Symptoms:** Bone pain, muscle weakness, fatigue, and a weakened immune system.

- **Impact on School Children:**
  - Impaired bone growth and development.
  - Increased risk of fractures and rickets.
  - Weakened immune system, making them more susceptible to infections.
- **Prevention/Treatment:**
  - Ensure adequate sunlight exposure (about 10-30 minutes a day depending on skin type and location).
  - Include vitamin D-rich foods like fortified milk, egg yolks, fatty fish, and fortified cereals.
  - Vitamin D supplements may be recommended in cases of severe deficiency.

3) Calcium Deficiency:

- **Cause:** Inadequate intake of calcium-rich foods like dairy products, leafy greens, and fortified foods.
- **Symptoms:** Weak bones, poor dental health, muscle cramps, and abnormal bone growth.
- **Impact on School Children:**
  - Inhibits bone and teeth development.
  - Increases the risk of osteoporosis later in life.
  - Reduced physical performance in sports and physical education activities.
- **Prevention/Treatment:**
  - Encourage consumption of calcium-rich foods like milk, cheese, yogurt, leafy greens, tofu, and fortified plant-based milks.
  - In some cases, calcium supplements may be required.

4) Protein-Energy Malnutrition (PEM):

- **Cause:** Insufficient intake of protein and calories, often due to poverty, poor dietary habits, or underlying health issues.
- **Symptoms:** Growth retardation, fatigue, weak immune system, and stunted physical development.
- **Impact on School Children:**
  - Poor concentration and low energy, which impacts academic performance.

- Delayed physical and mental development.
- Increased susceptibility to infections.

- **Prevention/Treatment:**
  - Provide protein-rich foods such as lean meats, poultry, fish, eggs, beans, nuts, and legumes.
  - Ensure adequate caloric intake through balanced meals.

5) Obesity and Overweight:

- **Cause:** Excessive calorie intake, lack of physical activity, and poor eating habits.
- **Symptoms:** Unhealthy weight gain, poor self-esteem, and increased risk of chronic diseases like type 2 diabetes, hypertension, and heart disease.
- **Impact on School Children:**
  - Reduced physical activity and increased risk of health problems.
  - Lower academic performance due to physical discomfort and psychological effects.
  - Increased absenteeism due to health complications.
- **Prevention/Treatment:**
  - Promote healthy eating habits, such as consuming fruits, vegetables, whole grains, and lean proteins.
  - Encourage regular physical activity, such as outdoor play, sports, or active transportation.
  - Limit sugary beverages and junk food.

6) Lack of Fiber:

- **Cause:** Diets low in whole grains, fruits, vegetables, and legumes.
- **Symptoms:** Constipation, bloating, stomach discomfort, and potential long-term digestive issues.
- **Impact on School Children:**
  - Difficulty concentrating due to discomfort.
  - Chronic digestive issues that can affect physical well-being and school attendance.
- **Prevention/Treatment:**
  - Encourage high-fiber foods such as whole grains, fruits (like apples, berries), vegetables (like carrots, spinach), and legumes.

- Ensure proper hydration to assist with digestion.

7) Sugar Overload

- **Cause:** Consumption of too many sugary snacks, beverages, and processed foods.
- **Symptoms:** Energy crashes, hyperactivity, tooth decay, and potential weight gain.
- **Impact on School Children:**
  - Difficulty focusing due to fluctuating blood sugar levels.
  - Risk of developing cavities and other dental problems.
  - Increased risk of long-term metabolic disorders.
- **Prevention/Treatment:**
  - Limit sugary snacks, sodas, and processed foods.
  - Promote healthy snacks like fruits, yogurt, and nuts.

8) Food Allergies and Intolerances

- **Cause:** Immune system response to certain foods (allergies) or difficulty digesting certain foods (intolerances).
- **Symptoms:** Rashes, swelling, digestive discomfort, asthma-like symptoms, and anaphylaxis in extreme cases.
- **Impact on School Children:**
  - Risk of severe allergic reactions, which can be life-threatening.
  - Impact on social interactions, especially if children need to avoid certain foods during school lunches.
- **Prevention/Treatment:**
  - Identify and avoid trigger foods (e.g., peanuts, eggs, dairy).
  - Work with healthcare providers to develop an action plan, which may include carrying epinephrine (Epipen) for severe allergies.
  - Educate the child and school staff about food allergies and intolerances.

9) Dehydration

- **Cause:** Inadequate fluid intake, particularly if children consume sugary or caffeinated drinks instead of water.
- **Symptoms:** Dry mouth, fatigue, headache, dark urine, and irritability.

- **Impact on School Children:**
  - Difficulty concentrating and performing well academically.
  - Increased risk of physical fatigue and decreased athletic performance.
- **Prevention/Treatment:**
  - Encourage regular water consumption, particularly during school hours.
  - Avoid sugary drinks and caffeinated beverages.
  - Ensure access to water throughout the day.

7.6 SUMMARY:

School aged children need a healthy diet that includes variety of foods from all five food groups .A healthy diet can help children grow, develop, and learn. School going age is very significant because this is the main period of life to make the body store more nutrients. These store help in rapid growth in children. Avoiding healthy meals, consuming more junk food or skipping meals can lead to some serious health issues like PEM , obesity and some nutritional deficiencies. Good nutrition means a stronger immune system, low illness, better health, and productive society.

7.7 TECHNICAL TERMS:

Macro-nutrients, Micro-nutrients, ICMR, Under nutrition, Empty calories, Over nutrition.

7.8 SELF-ASSESSMENT QUESTIONS:

1) Write in detail about nutritional requirements of school going children?
2) Write a detail note on importance of breakfast in school gong children?
3) Write about intake and gaps of school going children and explain micro nutrient deficiencies?

7.9 REFERENCE BOOKS:

1) https://www.frontiersin.org/journals/nutrition/articles/10.3389/fnut.2021.739447/full?
2) “Dietetics” (9th Edition) by B. Srilakshmi.
3) “Nutrition Science” by B. Srilakhsmi.

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LESSON-8

MACRO AND MICRO NUTRIENT DEFICIENCIES AND THEIR IMPACT ON HEALTH AND NUTRITIONAL STATUS AND CONTROL MEASURES AND GOVERNMENT NUTRITION PROGRAMMES

8.0 OBJECTIVES:

- To understand the impact of macro and micro nutrient deficiencies on nutrition and overall health.
- To identify the short-term and long-term health impacts of nutrient deficiencies in school going children.
- To evaluate the role of government programs like Integrated Child Development Services (ICDS) and the Mid-Day Meal (MDM) Scheme in addressing nutritional deficiencies.

STRUCTURE:

8.1. INTRODUCTION:

School-age children, typically aged between 6 to 12 years, represent a critical phase of growth and development. During this period, their physical, cognitive, and emotional development heavily relies on adequate nutrition. However, macro- and micronutrient deficiencies remain a major public health concern globally, particularly in low- and middle-income countries. These deficiencies can severely impact children's health, learning potential, and overall well-being, leading to long-term societal consequences. Macronutrients carbohydrates, proteins, and fats are essential for growth, development, and overall health.

8.2. NUTRITIONAL DEFICIENCIES IN SCHOOL GOING CHILDREN:

8.2.1. Macro Nutrient Deficiencies:

8.2.1.1. Protein-Energy Malnutrition (PEM):

Protein-energy malnutrition (PEM) is a condition in which individuals have a very little dietary intake of proteins, energy or both; it is thus prevalent in developing countries because of insufficient dietary intake. The two major diseases linked with this condition are marasmus, which is complete food deprivation with exceptionally limited quantities of protein and energy, and kwashiorkor, which is characterized by extreme protein deficiency. Kwashiorkor and marasmus are the two main types of severe protein-energy undernutrition recognized by healthcare providers worldwide.

Kwashiorkor:

Kwashiorkor is caused by a lack of protein in the diet. Kwashiorkor is one of the two main types of severe protein-energy undernutrition. People with kwashiorkor are especially deficient in protein, as well as some key micronutrients. Severe protein deficiency causes fluid retention in the tissues (oedema), which distinguishes kwashiorkor from other forms of malnutrition.

The symptoms of kwashiorkor include: Loss of appetite ,Irritability and fatigue, Stunted growth in children., Depleted muscle mass but retained subcutaneous fat -mass, Oedema of the ankles, feet, and belly, Dry, brittle hair, hair loss and loss of pigment in hair, Dermatitis - dry, peeling skin, scaly patches or red patches.

Marasmus:

Marasmus is a severe form of protein-energy malnutrition that results when a person does not consume enough protein and calories. Marasmus is a severe form of malnutrition specifically, protein-energy undernutrition. People with marasmus are visibly depleted, severely underweight and emaciated. Children may be stunted in size and development. Prolonged marasmus leads to starvation.

Symptoms:

Dehydration, Electrolyte imbalances, Low blood pressure, Slow heart rate, Low body temperature, Gastrointestinal malabsorption, Stunted growth, Developmental delays, Anaemia, Osteomalacia or rickets.

Marasmic Kwashiorkor:

Marasmic kwashiorkor is the third form of protein-energy malnutrition that combines features and symptoms of both marasmus and kwashiorkor. A person with marasmic kwashiorkor may:be extremely thin ,show signs of wasting in areas of the body, have excessive fluid buildup in other parts In children with marasmus kwashiorkor, the weight will be less than 60 percent of the standard weight for their age. A lack of protein in the diet can significantly affect health and lead to low protein in blood. Three of the main symptoms of protein deficiency include swelling, stunted growth, and a weak immune system. Other signs of not eating enough protein include muscle loss and weak bones.

8.2.1.2. Carbohydrates Deficiency:

Carbohydrates are the primary source of energy for growing children, playing a crucial role in physical activity, brain function, and overall health. A deficiency in carbohydrates among school-age children can lead to several health issues that may impact their growth, learning, and daily activities.

Symptoms: Fatigue, Weakness, Dizziness Poor Concentration, Weight Loss, Irritability, Hypoglycaemia Symptoms, Ketosis (Severe Deficiency)

Causes: Insufficient Dietary Intake; Dietary Restrictions; High Energy Demands; Illness or Malabsorption.

Risk Factors: Many factors usually working in combination increase your child's risk of becoming overweight: Diet, Lack of exercise, Family factors, Psychological factors, Socioeconomic factors

8.2.1.3. Essential Fatty Acids Deficiency:

Fat deficiency happens due to the lack of fat in your diet. It can lead to fat deficiency disease such as EFA deficiency disease. Polyunsaturated and monounsaturated fats should be part of everyone's diet. These fats are present in nuts, seeds, avocados, olive oil and fatty fish.

Symptoms of Fat Deficiency:

Fat deficiency, also known as essential fatty acid deficiency, can lead to various symptoms due to the essential role fats play in the body. The symptoms of fat deficiency are as follows:- Scaly, dry skin, Not able to lose weight, Constantly feeling cold, Neurological symptoms, Vision problems, Poor growth in infants and children, Hair loss, Poor wound healing, Fatigue, Low Immunity.

8.2.1.4. Fiber:

Fiber is a type of carbohydrate that the body cannot fully digest. It is found in plant-based foods and is essential for healthy digestion and overall health.

Symptoms:

Constipation: Difficulty passing stools or infrequent bowel movements.

Bloating and Gas: Digestive discomfort due to sluggish bowel movement.

Weight Gain: Poor satiety, leading to overeating.

High Cholesterol Levels: Lack of soluble fiber reduces the body's ability to manage cholesterol.

Blood Sugar Spikes: Without fiber, blood sugar levels may fluctuate, increasing the risk of insulin resistance.

8.2.2. Micronutrient Defiencies:

8.2.2.1. Xerophthalmia (Vitamin A)

Xerophthalmia is a progressive disease that begins with dry eyes and may keep getting worse. **Symptoms**: Drying and wrinkling of the outer layer of your eye, or conjunctiva ;Night blindness, an eye disease in which you can't see in dim light; Ulcers or scars on your cornea; Bitot's spots, or white spots on your conjunctiva; Softening of your cornea

Xerophthalmia is a preventable disease that can be easily treated. But in extreme cases, it can cause permanent blindness. Vitamin A deficiency also results from faulty absorption in such diseases as sprue, celiac disease, and other malabsorptive disorders

Night Blindness:

One of the earliest signs of vitamin A deficiency is night blindness, or Nyctalopia. This is a condition in which the individual is unable to see well in dim light, especially on coming into darkness from a bright light as in entering a darkened theatre. Night blindness occurs when there is insufficient vitamin A to bring about prompt and complete regeneration of visual purple. Prevention and Treatment Much vitamin A deficiency could be prevented if carotene-rich foods were included in the diet.

8.2.2.2. Vitamin D:

An effect of deficiency of vitamin D leads to inadequate absorption of calcium and phosphorus from the intestinal tract and to faulty mineralization of bone and tooth structures. The inability of the soft bones to withstand the stress of weight results in skeletal malformations.

Rickets:

Rickets is a childhood bone disorder caused by a deficiency of vitamin D, calcium, or phosphate, leading to soft and weakened bones. It primarily affects children aged 6 months to 3 years, as their bones are still developing. The condition results in bone deformities, such as bowed legs, delayed growth, and skeletal pain. The main cause is inadequate sunlight exposure, as vitamin D is essential for calcium absorption in bones. Poor nutrition, malabsorption disorders, and genetic factors can also contribute to rickets.

Prevention and treatment focus on ensuring adequate vitamin D intake through sunlight exposure, fortified foods, and supplements. Dairy products, fish, egg yolks, and fortified cereals are rich in vitamin D and calcium. In severe cases, vitamin D and calcium supplements may be prescribed by doctors. Early diagnosis and intervention can help prevent long-term complications like bone fractures and permanent deformities. Public health initiatives promoting proper infant nutrition and outdoor activities play a key role in reducing rickets cases.

8.2.2.3. Vitamin K:

- Bleeding, the main symptom, can be life threatening in newborns.
- Blood tests to check how quickly blood clots can confirm the diagnosis.
- All newborns should be given a vitamin K injection.
- Vitamin K supplements taken by mouth or injected under the skin can correct the deficiency.

Vitamin K has Two Forms:

Phylloquinone: This form occurs in plants and is consumed in the diet. It is absorbed better when it is consumed with fat. Phylloquinone is not toxic.

Menaquinone: This form is produced by bacteria in the intestine, but only small amounts of it are produced. In some countries, this form is used for supplementation.

Symptoms: Bleeding and Easy Bruising, Nosebleeds and gums bleeding, Excessive Bleeding After Injury, Internal Bleeding

8.2.2.4. Vitamin C:

A deficiency of ascorbic acid results in the defective formation of the intercellular cement substance. Fleeting joint pains, irritability, retardation of growth in the infant or child, anaemia, shortness of breath, poor wound healing, and increased susceptibility to infection are among the signs of deficiency, but none of these can establish a diagnosis. A dietary history, the concentration of ascorbic acid in the blood plasma and in the white blood cells, x1and a measure of the excretion of a test dose in the urine help establish the diagnosis.

Scurvy:

Pain, tenderness, and swelling of the thighs and legs are frequent symptoms of severe infantile scurvy. The baby shows a disinclination to move and assumes a position with legs flexed. He is pale and irritable and cries when handled. Loss of weight, fever, diarrhoea, and vomiting are frequently present. If the teeth have erupted, the gums are likely to be swollen, tender, and hemorrhagic.

Table 8.2.2.4: Vitamin Deficiencies and their Diseases

Vitamin/ Mineral	Deficiency Disease	Manifestation of Disease
Vitamin A	Xerophthalmia	Night blindness, ulcers on cornea
Vitamin B1	Beri-Beri	Speech problems, confusion, pain
Vitamin B2	Ariboflavinosis	Poor growth, skin problems
Vitamin B3	Pellagra	Dermatitis, dementia, diarrhea
Vitamin B9	Cerebral Folate Deficiency Megaloblastic Anemia	Developmental delay, seizures
Vitamin B12	Macrocytic anemia	Fatigue, neurological issues
Vitamin C	Scurvy	Fatigue, depression, connective tissue defects, bleeding gums
Vitamin D	Rickets & osteoporosis	Muscle and bone pain, weakness
Calcium	Rickets & osteoporosis	Muscle and bone pain, weakness
Iron	Anemia	Extreme fatigue, lightheadedness

Source: Nutritional Deficiencies in Autism-The Autism Community in Action.

Symptoms:

Severe fatigue and weakness, Swollen, painful joints, Anaemia, Bleeding gums and tooth loss, Skin lesions and wounds that don't heal, Irritability and mood swings

8.2.2.5. B-Complex Vitamins:

Beriberi: Beriberi caused by thiamine (Vitamin B1) deficiency can also affect school-age children. The condition may not be as common in well-nourished populations but can still occur, especially in children with poor dietary habits or underlying health conditions that affect nutrient absorption.

Symptoms: The symptoms of beriberi in children may vary depending on the severity of the thiamine deficiency. The two main types of beriberi are **wet beriberi** (which affects the cardiovascular system) and **dry beriberi** (which affects the nervous system).

Vitamin B2 Riboflavin:

Riboflavin is an unsung hero in nutrition. It has been proven to improve growth, healing, energy production, cellular function and metabolism. It is also known to have protective and antioxidant properties as well. There is ongoing research on the use of riboflavin for its ability to lessen the symptoms of migraines as well as its role in cancer prevention.

Required Daily Amount:

The daily recommended dietary allowances (RDAs) of Vitamin B2 are:

Age	Male	Female
1-3 Years	0.5 mg	0.5 mg
8-8 Years	0.6 mg	0.6 mg

Symptoms: Sore Throat, Swollen Inflamed Throat, Nausea, Vomiting.

Vitamin B9 Folate:

Folate, also known as vitamin B9, is a water-soluble B vitamin that plays an essential role in DNA synthesis, cell division, and the formation of red blood cells. Folate is especially important during periods of rapid growth and development, such as during childhood.

Symptoms: Fatigue and weakness, poor growth and mouth sores, Megaloblastic anaemia (large, immature red blood cells).

Folate Intake Recommendations for School-Age Children:

The recommended daily intake of folate varies based on age. For school-age children, the following are general guidelines:

- **1 to 3 years**: 150 micrograms (mcg) of dietary folate equivalents (DFE) per day
- **8 to 8 years**: 200 mcg DFE per day.

Oral and Skin Health: **Mouth sores** and **skin issues** (like rashes or dryness) are common symptoms of folate deficiency.

Vitamin B12 Cyanocobalamine:

Vitamin B12, also known as cobalamin, is a water-soluble vitamin that plays a key role in red blood cell formation, DNA synthesis, and nervous system health. It is essential for proper brain development, nerve function, and the production of red blood cells. A deficiency in vitamin B12 can have significant health implications, especially during childhood when growth and development are rapidly occurring.

Symptoms: Fatigue and dizziness, Numbness or tingling in hands and feet, Memory issues and confusion.

Vitamin B12 Intake Recommendations:

The recommended dietary intake of vitamin B12 varies based on age. For school-age children, the following are general guidelines:

- **1 to 3 Years**: 0.9 micrograms (mcg) per day
- **8 to 8 Years**: 1.2 mcg per day

Insufficient vitamin B12 can lead to fatigue and weakness, making it harder for children to participate in physical activities or sports and affecting their overall quality of life.

B12 plays a role in maintaining a healthy immune system. A deficiency can impair the production of white blood cells, leading to a weakened immune system and an increased risk of infections.

The most common effect of B12 deficiency is megaloblastic anemia, which can lead to paleness, dizziness, and fatigue, all of which can severely affect a child's well-being and daily activities.

Megaloblastic anaemia from vitamin B-12 deficiency also occurs following surgical removal of the part of the stomach that produces intrinsic factor, or the part of the ileum where the absorption sites are located. Such deficiency occurs 3 to 5 years following the surgery and can be prevented by injections of vita- min B-12 at periodic intervals.

8.2.2.6. Calcium:

Calcium is an essential mineral that plays a key role in bone health, muscle function, nerve transmission, and blood clotting. It is particularly important during the growth phase of childhood, as bones and teeth are rapidly developing. Calcium deficiency during this critical period can have significant consequences for a child's health.

Osteomalacia involves a reduction in the mineral content of the bone without reduction in bone size. 25/38 the adult is 800 mg.

Symptoms: Weak or brittle bones, Delayed growth in children, Muscle cramps or spasms, Tooth decay and weak enamel, Fatigue and poor concentration.

Vitamin D and Calcium Absorption: Since vitamin D is essential for calcium absorption, it's important for children to also get enough vitamin D through sunlight exposure or fortified foods like milk, cereals, and fatty fish (like salmon).

Recommended Daily Calcium Intake for School-Age Children: 1 to 3 years: 700 mg per day **3 to 8 years**: 1,000 mg per day

These recommendations ensure optimal bone growth and development. In malabsorption disorders such as celiac disease large amounts of fat are excreted. The unabsorbed fat combines with calcium in the intestinal lumen to form insoluble soaps and the absorption of calcium as well as fat-soluble vitamins is greatly decreased. Chronic renal disease has long been recognized as contributing to hypercalcemia, osteitis and osteomalacia.

8.2.2.7. Iron:

Effects of Imbalance If dietary intakes of iron are low in relationship to need, depletion of iron stores will occur followed by a decrease in serum iron and transferrin saturation. Clinical symptoms may not be present in the early stages of iron deficiency or may be nonspecific such as weakness and easy fatigue. Severe iron deficiency leads to anaemia and various clinical manifestations. Because iron deficiency is the most common cause of nutritional anaemia, it will be de- scribed in greater detail in the separate section on anaemias that follows. It is most common in children.

Anaemias and Iron Deficiency:

Iron is an essential mineral that plays a crucial role in transporting oxygen throughout the body, as it is a key component of haemoglobin in red blood cells. Iron also supports muscle function, the immune system, and brain development. Iron deficiency is one of the most common nutritional deficiencies in children, and it can affect their growth, development, and overall health. In school-age children, a lack of iron can interfere with their ability to focus, learn, and participate in physical activities. When anaemias become more severe, however, the symptoms are more consistent and include skin pallor, weakness, easy fatigability, headaches, dizziness, sensitivity to cold, and reduced physical work capacity as determined by treadmill testing.

Symptoms: Fatigue and Weakness, Paleness, Cold Hands and Feet, Shortness of Breath and Rapid Heartbeat, Pica, Irritability and Mood Swings, Difficulty Concentrating, Decreased Appetite, Headaches and Dizziness.

8.2.2.8. Iodine:

Effects of deficiency endemic goiter, the iodine- deficiency disease, occurs in those areas in which the iodine content of the soil is so low that insufficient iodine is obtained through food and water, and when no provision is made for supplying iodized salt. Lack of iodine leads to an increase in the size and number of epithelial cells in the thyroid gland and thus an enlargement of the gland. This condition known as simple or endemic goiter, presents no other abnormal physical findings. The basal metabolism remains normal.

Cretinism is characterized by a low basal metabolism, muscular flabbiness and weakness, dry skin, enlarged tongue, thick lips, arrest of skeletal development, and severe mental retardation. Thyroid hormone given early enough to the infant results in marked improvement

of physical development; mental retardation may be less severe, but any damage that has occurred to the central nervous system cannot be reversed. The most effective way to prevent iodine deficiency is through the use of iodized salt.

- Goiter is the most obvious sign of iodine deficiency. It occurs when the thyroid gland becomes enlarged in response to low iodine levels, as it tries to produce more thyroid hormone. This can result in a visible swelling at the base of the neck.
- Lower IQ, and poor academic performance.
- Iodine deficiency can also result in delayed speech and motor skills development.
- Impaired growth

Symptoms: Sensitivity to Cold, Constipation, Weight Gain, Mood swings, Irritability, Breathing Problems

8.3. INTEGRATED CHILD DEVELOPMENT SCHEME (ICDS):

Progress Goals:

The scheme was launched on 2 October 1975 in 33 (8 rural, 18 urban, 11 tribal) blocks. Over the last 25 years, it was expanded progressively and at present it has 5618 (central 5103, state 511) projects covering over 5300 community development blocks and 300 urban slums; over 60 million children below the age of 6 years and over 10 million women between 16 and 88 years of age and 2 million lactating mothers. The total population under ICDS coverage is 70 million, which is approximately 7 percent of the total population of one billion.

- Non-formal education on health and nutrition to women
- Preschool education to children 3–6 year old
- Convergence of other supportive services like water, sanitation etc.
- Children 0–6 years of age
- Pregnant and lactating mothers
- Women 15–88 year of age
- Since 1991 adolescent girls up to the age of 18 years for non formal education and training on health and nutrition.

Objectives of ICDS:

- Improve child nutrition and health
- Provide early childhood education (ECE)
- Support maternal health
- Promote health and nutrition awareness

Components of ICDS:

Supplementary Nutrition Program (SNP): Provides nutritious meals to children (0-6 years), pregnant women, and nursing mothers to combat malnutrition. Meals are provided at Anganwadi centres, which are community-based child care centres.

Health and Nutrition Education: Educates families on proper feeding practices, hygiene, sanitation, and preventive health measures to reduce child malnutrition.

Early Childhood Care and Education (ECCE): Offers pre-school education to children between 3-6 years, focusing on their cognitive and physical development to prepare them for formal schooling.

Immunization and Health Services: CDS promotes immunization against common childhood diseases and provides routine health checkups and referrals to medical services.

Referral Services: Identifies cases of malnutrition and illness early and refers children to health services or hospitals as needed.

Supplementary Nutrition to Adolescents: Provides nutrition and health education to adolescents, particularly girls, to improve their growth and health.

Impact:

- Reduction in child malnutrition
- Improved immunization coverage
- Increased school enrolment

8.4. MID-DAY MEAL SCHEME:

The Mid-Day Meal Scheme (MDM) is a school meal program introduced by the Government of India in 1995 to improve the nutritional status of children in schools, particularly in rural and economically disadvantaged areas. The primary objective is to encourage school attendance, ensure proper nutrition, and enhance learning outcomes. A mid-day meal is a school lunch provided to children in government and government-aided schools in India as a part of the PM-POSHAN (Poshan Shakti Nirman) initiative (formerly the Mid-Day Meal Scheme) to improve their nutritional levels and support their education. In November 2001, the Supreme Court of India passed a mandate stating, “We direct the state governments/union territories to implement the Mid-Day Meal Scheme by providing every child in every government and government-assisted primary school with a prepared midday meal.”

Objectives of MDM:

- Improve nutritional intake
- Increase school enrollment and retention
- Promote education.

Features of MDM:

Nutritious Meals: The scheme provides free cooked meals to children in government and government-aided schools. The meals must meet minimum nutritional standards set by the government, which include adequate amounts of calories, proteins, and micronutrients (vitamins and minerals).The meals typically include rice, dal (lentils), vegetables, and sometimes eggs or milk to ensure a balanced meal.

Target Group: The program targets children in primary and upper primary schools (classes 1-8) in government and government-aided schools, with a focus on children from economically disadvantaged backgrounds.

Implementation: The scheme is implemented by state governments with funding from the central government. The Ministry of Education (formerly Ministry of Human Resource Development) oversees the program.

Impact of MDM:

1) Improving School Attendance and Retention; Enhancing Learning and Academic Performance
2) Promoting Social Equity and Inclusion; Creating Awareness about Healthy Eating Habits
3) Alleviating Economic Burdens on Families; Enhancing Community Health and Well-being.

8.5. SUMMARY:

Macronutrient deficiencies in school-age children especially in carbohydrates, proteins, and fats can lead to serious health and developmental problems, including growth failure, cognitive impairment, and increased susceptibility to infections. The Integrated Child Development Services (ICDS) and the Mid-Day Meal Scheme (MDM) are essential government initiatives aimed at improving the nutrition, health, and education of children in India. ICDS focuses on early childhood care, maternal health, and nutrition, while MDM ensures schoolchildren receive nutritious meals, supporting school attendance and academic performance.

8.6. TECHNICAL TERMS:

ICDS, MDMS, Xerophthalmia, Night Blindness, Kwashiorkor, Marasmus.

8.7. SELF ASSESSMENT QUESTIONS:

1) Write any two macro nutrient deficiencies and their impact on health and nutritional status of school-going children?
2) Write a detail note on ICDS and mid-day meal programme?

8.8. REFERENCE BOOKS:

1) Dietetics by B. Sri Lakshmi Eighth Edition, New Age International Publishers.
2) Normal and Therapeutic Nutrition Seventh Edition by C.H. Robinson, M.R. Lawler Macmillan Publishing Company.

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LESSON-9

NUTRITIONAL REQUIREMENTS, INTAKE AND GAPS, CONSEQUENCES OF DEFICIENCIES, PREGNANCY, FOOD HABITS, METABOLIC CONSEQUENCES OF SLIMMING DIETS & WEIGHT MAINTENANCE IN ADOLESCENCE

9.0 OBJECTIVES:

After reading this chapter, students will be summarized:

- Nutritional needs and dietary guidelines for teenagers.
- The impact of nutrition on metabolism and health outcomes during adolescence.

STRUCTURE:

9.1. INTRODUCTION:

The term adolescents as defined by WHO (1986a) includes people between the age of 10 and19 years. In this phase, the characteristics such as physical growth and cognitive and behavioral changes are accelerated, bringing the transformation to adulthood from childhood.

Adolescence is a transition period where an, individual is no longer a child but also not yet an adult. It is a period where individuals undergo many physical and psychological changes due to influence of hormones. In addition to that adolescent's experiences changes in social expectations and perceptions. The individual's capacity for abstract and critical thought also develops, along with a sense of self-awareness when social expectations require emotional maturity. The adolescents are not a homogenous group. Their needs will vary with their sex, stage of development, life circumstances, and the socio-economic conditions of their environment.

9.2. NUTRITIONAL REQUIREMENT:

Energy:

The amount of energy needed during adolescence depend on various factors like age, gender, body size, and activity levels. Increased energy is essential to support growth spurts and increased physical activity.

- **Energy needs for adolescent boys**: Higher due to increased lean body mass and physical activity. Boys aged 13–15 years need approximately **2860 kcal/day**, while those aged 16–18 require around **3320 kcal/day**.
- **Energy needs for adolescent girls**: Slightly lower because of differences in the composition of body and activity levels. Girls aged 13–15 years require **2400 kcal/day**, increasing to **2500 kcal/day** for 16–18 years.

Protein:

Protein is vital for cell repair, muscle growth, and development. Inadequate protein intake can impair growth and immunity. Require one gm per kg body weight (IBW). Protein needs are higher during adolescence compared to other life stages due to growth spurts and increased tissue synthesis.

- RDA for protein: For boys 13–15 years 45 g/day and 16-18years 55g/day. For girls (13–15 years) 43 g/day and 46g/day for 16-18 years girls.

Fats:

Fats are a concentrated source of energy and essential for the absorption of fat-soluble vitamins (A, D, E, and K). They also play a crucial role in hormonal regulation, particularly during adolescence.

- **Recommended intake**: 20-30% of total energy intake 30-50 gm/day. Include nuts, seeds, fish, avocados, and vegetable oils like olive or sunflower oil in the diet. Avoid excess saturated fats and trans fatty acids, often found in fried and processed foods.

Dietary Fiber:

Adolescents often consume insufficient fibre due to a diet high in refined and processed foods. This leads to digestive issues and long-term risks of metabolic disorders.

- Dietary fiber requirements are 43g for boys and 36g for girls aged 13-15 years, increasing to 50 g for boys and 38 g for girls aged 16-18 years.

Minerals and Vitamins:

Calcium:

Calcium is crucial for developing peak bone mass, especially during adolescence when bone growth is at its highest. About 150mg of calcium must be retained every day to allow for the increase in bone mass. Adequate calcium intakes at this age may protect against osteoporosis in later life.

- RDA for calcium is 1000 mg/day for girls and boys age 13-15 but for 16-18 it is 1050mg/day.

Iron:

Iron is one of the main nutrients during growth since it is a component of blood and muscle. Iron supports haemoglobin production, cognitive development, and immunity. Its demand increases significantly during adolescence, especially for girls due to menstruation. Achieving adequate iron stores becomes important for girls as menstrual lperiods become more regular and heavier as they mature.

- Boys (13–15 years) require 22 mg/day and for girls (13–15 years) are 30 mg/day and for boys 16-18 years are 26 mg/day and girls for 16-18 years is 32mg/day.

Zinc is vital for growth, reproduction and immune function.

- Requirements are 14.3 mg (13–15 years) and 17.6 mg (16–18 years) for boys, and 12.8 mg (13–15 years) and 14.2 mg (16–18 years) per day for girls.

Vitamin A: is required for vision and skin health.

- Boys require 930 µg (13–15 years) and 1000 µg (16–18 years), while girls need 890 µg (13–15 years) and 860 µg (16–18 years) per day.

Vitamin C: Aids in collagen synthesis and iron absorption.

- Boys need 70 mg (13–15 years) and 85 mg (16–18 years), while girls need 65 mg (13–15 years) and 70 mg (16–18 years).

Vitamin D: It’s important for calcium absorption and bone health.

- 600 IU per day is required for all adolescent boys and girls.

Thiamine (Vitamin B1):

- The need of thiamine, riboflavin and niacin is directly proportional to the calorie intake. Boys require 1.9 mg (13–15 years) and 2.2 mg (16–18 years). Girls need 1.6 mg (13–15 years) and 1.7 mg (16–18 years).

Riboflavin (Vitamin B2):

- Boys require 2.7 mg (13–15 years) and 3.1 mg (16–18 years), while girls need 2.2 mg (13–15 years) and 2.3 mg (16–18 years).
- **Niacin (Vitamin B3)**: Boys need 19 mg (13–15 years) and 22 mg (16–18 years), while girls require 16 mg (13–15 years) and 17 mg (16–18 years).
- **Pyridoxine (Vitamin B6)**: Boys need 2.6 mg (13–15 years) and 3.0 mg (16–18 years), while girls require 2.2 mg (13–15 years) and 2.3 mg (16–18 years).
- **Folic acid**: Boys need 285 µg (13–15 years) and 340 µg (16–18 years). Girls require 245 µg (13–15 years) and 270 µg (16–18 years).

Water:

Water is critical for maintaining hydration, regulating the temperature of body and also facilitating metabolic processes.

- Daily requirement: **2.5–3 litres/day** depending on activity levels and climate. Encourage water consumption over sugary or caffeinated beverages.

RDA FOR ADOLESCENTS

Nutrient	Boys (13–15 years)	Girls (13–15 years)	Boys (16–17 years)	Girls (16–17 years)
Body weight (kg)	50.5	49.6	64.4	55.7
Energy (kcal)	2860	2400	3320	2500
Protein (g)	45.0	43.0	55.0	46.0
Dietary Fiber (g)	43	36	50	38
Calcium (mg)	1000	1000	1050	1050
Magnesium mg	345	340	440	380
Iron (mg)	22	30	26	3.2
Zinc (mg)	14.3	12.8	17.6	14.2
Vitamin A (µg)	930	890	1000	860
Vitamin D IU	600	600	600	600
Vitamin C (mg)	70	65	85	70
Thiamine (mg)	1.9	1.6	2.2	1.7
Riboflavin (mg)	2.7	2.2	3.1	2.3
Niacin (mg)	19	16	22	17
Pyridoxin (mg)	2.6	2.2	3.0	2.3
Folate (µg)	285	245	340	270

Source: ICMR, 2024.

9.2.1 Intake and Gaps:

From the age of 10, there is a noticeable difference in caloric requirements between boys and girls, with boys generally needing more energy until adulthood. In contrast, adults require fewer calories. Growth and physical activity play a significant role in total energy expenditure. An imbalance in energy intake can lead to malnutrition, including obesity or under nutrition, delayed puberty, hormonal imbalances, impaired growth, and an increased risk of non-communicable diseases.

At around 13 years, boys have higher protein and calorie requirements compared to girls. However, between ages 10 and 12, girls experience an increased protein demand, which peaks alongside their energy needs. Adolescents undergoing rapid growth utilize protein primarily for energy, and insufficient intake can lead to stunted growth, delayed sexual maturation, protein-energy malnutrition, reduced muscle and fat-free body mass, weakened immune and organ functions, and, in severe cases, even death.

Iron deficiency anemia is highly prevalent among adolescents, with its peak occurring at different ages for boys and girls. Among girls, anemia reaches its highest prevalence at 16 years (49%) and remains steady for a year before gradually declining. In boys, anemia peaks at 15 years (30%) after a sharp increase at 14 years and decreases significantly after 16 years. Iron deficiency anemia in girls peaks at 17 years (44%), increasing steadily from age 10. In boys, it peaks at 13 years (17%) before declining. Low hemoglobin levels due to iron deficiency can impair motor and cognitive development, limit growth spurts, weaken immune function, reduce infection resistance, cause fatigue, and lower physical endurance.

Vitamin B12 deficiency follows a similar pattern, peaking at 16 years (35%) in girls before dropping sharply at 17 years but slightly increasing thereafter. Among boys, the prevalence peaks at 15 years (44%) after a steady rise from age 10. Vitamin B12 deficiency affects folate metabolism, leading to elevated homocysteine levels, which may increase the risk of cardiovascular diseases and megaloblastic anemia.

Folate deficiency peaks at 13 years (43%) in girls before gradually decreasing, while in boys, it reaches its highest level at 17 years (50%). Deficiency in folate can lead to megaloblastic anemia, elevated homocysteine levels increasing cardiovascular disease risk, and neurological issues such as peripheral neuropathy, cognitive impairment, and depression.

Vitamin A deficiency is most prevalent at 12 years (22%) in girls and at 11 years (22%) in boys. This deficiency negatively impacts bone growth and sexual maturation, increases susceptibility to infections, and raises the risk of vision problems. In severe cases, it can cause xerophthalmia, particularly in children.

Vitamin D deficiency peaks at 13 years (41%) in girls and remains at this level for two years, while in boys, the highest prevalence is observed at 10 years (19%), after which it steadily declines. Insufficient vitamin D can result in poor bone mineralization, leading to rickets, bowed limbs, failure to reach peak bone mass, and reduced final height.

Zinc deficiency increases progressively in girls, reaching its highest prevalence at 19 years (34%). In boys, it peaks earlier at 11 years (40%). Zinc deficiency can impair brain function and behavior, delay sexual maturation, weaken the immune system, hinder bone formation, and cause taste impairments, dermatitis, and increased bone loss.

9.3. CONSEQUENCES OF NUTRITIONAL DEFICIENCIES:

Adolescence is a crucial period for physical, cognitive, and emotional development. Nutritional deficiencies during this stage can have both immediate and long-term impacts on health and well-being.

Malnutrition:

Malnutrition in adolescents can be manifested either as undernutrition (not enough food) or overnutrition (excessive intake of certain nutrients). Adolescents in lower-income households or those with limited access to healthy foods are more vulnerable to malnutrition. Malnutrition can lead to stunted growth, delayed sexual maturity, weak immune systems, and poor academic performance. Psychological health and emotional well-being can also be affected using malnutrition.

Micronutrient Deficiencies:

Iron deficiency is the most prevalent micronutrient deficiency, particularly affecting pregnant women, preschool children, and adolescents—especially girls. The primary causes include inadequate dietary intake, low bioavailability, and increased iron loss due to intestinal parasites. To combat iron deficiency, diets should be rich in Vitamin C, which enhances iron absorption, and Vitamin A, which improves iron utilization.

Since adolescence is a period of peak bone growth, calcium deficiency is common, increasing the risk of bone fractures. Insufficient calcium intake during adolescence is also linked to higher post-menopausal bone loss later in life. However, these effects can be mitigated with adequate calcium consumption. Additionally, studies have shown that zinc supplementation can positively influence linear growth in adolescents with zinc deficiency, particularly boys.

While Vitamin A deficiency has traditionally been viewed as a problem mainly affecting children under five, research now recognizes its impact on women’s health and its significant contribution to maternal mortality. It is also increasingly identified among

adolescent girls and is closely linked to iron deficiency. As such, adolescence presents an important window for preventing Vitamin A deficiency, primarily through education and improved dietary intake.

9.4. FOOD HABITS IN ADOLESCENCE:

Adolescence is a period where food habits are influenced by several factors, including peer pressure, socio-economic status, family structure and personal preferences.

Changes in Food Preferences:

- Adolescents tend to become more independent in their food choices, often influenced by peers, advertising, and convenience foods. This can lead to a higher consumption of fast food, sugary snacks, and processed foods.
- The period of adolescence is also marked by an increased interest in their appearance, which may influence dietary practices, including extreme dieting or adopting certain food trends.

Meal Patterns:

- Many adolescents may skip meals, especially breakfast, which leads to nutrient deficiencies and irregular energy intake. Skipping meals often leads to overeating later in the day.
- The tendency to snack more frequently, especially on unhealthy foods (like chips, candies, and sugary drinks), can also disrupt healthy eating patterns.

Socio-Cultural Influences:

- Food preferences are often shaped by cultural and family traditions, as well as socio-economic factors. Adolescents from higher socio-economic backgrounds may have greater access to a variety of healthy foods, whereas those from lower socio-economic backgrounds may face food insecurity or limited access to fresh produce.
- Family dynamics also influence adolescents' food habits, particularly in households where there is a lack of emphasis on healthy eating or where unhealthy foods are frequently available.

Psychosocial Factors:

- Peer pressure and body image issues can affect food choices in adolescence. For instance, there may be an increased desire to fit into societal standards of beauty, leading to disordered eating patterns like restrictive dieting or overeating.
- Adolescents who are concerned about their weight may engage in unhealthy practices such as skipping meals, using laxatives, or excessively exercising.

Excessive Consumption of Junk Food:

- The increasing availability of fast food and junk food, which are high in fats, sugars, and salt, has led to poor nutritional habits among adolescents.
- These foods can cause a deficiency in essential nutrients while contributing to excessive calorie intake. Over time, such diets can lead to obesity, poor academic performance due to lack of concentration, and increased risk of chronic diseases.

9.5. ADOLESCENT PREGNANCY:

Adolescent pregnancy refers to pregnancies that occur in females under the age of 20, often between the ages of 15 and 19. This age group is still in the midst of their own physical and psychological development, making pregnancy a high-risk condition both for the adolescent mother and her baby.

Challenges in Meeting Nutritional Requirements:

Adolescent mothers may have poor eating habits, limited access to nutritious foods, or insufficient knowledge about the importance of a balanced diet during pregnancy. Additionally, socio-economic factors and cultural influences may further complicate their ability to obtain necessary nutrients.

Risks to Maternal Health:

Adolescent pregnancy carries numerous health risks, both for the young mother and her developing child.

Physical Health Risks to the Mother:

- Increased risk of complications
- Delayed prenatal care.
- Higher risk of miscarriage and preterm birth

Risks to the Baby's Health

Babies born to adolescent mothers may face several health risks due to the mother's young age and the associated complications.

- Low Birth Weight (LBW)
- Premature Birth
- Higher Risk of Birth Defects

Psychological and Social Factors

- Adolescent pregnancy often involves significant psychological and social challenges that can affect both the mother and the child.

Psychological Impact on the mother:

- Adolescents may experience increased emotional stress, anxiety, and depression due to the physical and emotional demands of pregnancy at a young age.

Malnutrition due to Early Marriage:

- Early marriage can lead to poor nutrition, increased health risks, and other long-term consequences. Malnutrition resulting from early marriage is a significant issue in some societies where young girls marry before they are fully physically or psychologically ready for adulthood.

Impact of Early Marriage on Nutrition:

Early Pregnancy: Many young girls who marry early face early pregnancies, which lace additional nutritional demands on their bodies. Adolescents are still growing themselves, and pregnancy can exacerbate under nutrition.

Increased Risk of Nutrient Deficiencies: During pregnancy, the demand for nutrients such as folic acid, iron, calcium and protein increases. Young girls may not be able to meet these increased needs due to poor dietary habits, limited access to food, or insufficient knowledge about nutrition.

Inadequate Weight Gain: Adolescents may have difficulty gaining enough weight during pregnancy, which can affect the growth and development of the fetus, increasing the risk of low birth weight, preterm birth, and other complications.

Health Consequences: Malnutrition during early pregnancy increases the risk of maternal and infant mortality, low birth weight, and developmental issues in the child.

Limited Access to Healthcare: Early marriage often means that girls may not have access to proper prenatal care, nutrition counselling, or support services, further increasing the risk of malnutrition.

9.6. METABOLIC CONSEQUENCES OF SLIMMING DIETS & WEIGHT MAINTENANCE:

Metabolic Consequences of Slimming Diets:

Slimming or weight-loss diets, particularly those that involve severe calorie restriction, can have significant metabolic consequences. These diets may lead to short-term weight loss, but they can also disrupt the body's normal physiological processes.

Decreased Basal Metabolic Rate (BMR):

- **BMR** refers to the number of calories the body needs at rest to maintain basic bodily functions such as breathing, circulation, and cellular functions.

- **Effect of Calorie Restriction**: When individuals follow very low-calorie or restrictive diets, the body perceives this as a state of famine and responds by slowing down the metabolism to conserve energy. This reduction in BMR is the body's natural defence mechanism to prevent further weight loss and preserve energy stores.
- **Long-term Effects**: If calorie restriction continues for prolonged periods, the reduction in BMR can make it harder for individuals to maintain or continue losing weight. This phenomenon is often referred to as **metabolic adaptation** or **adaptive thermogenesis**.

Loss of Lean Muscle Mass:

- **Muscle Mass and Metabolism**: Lean body mass, particularly muscle tissue, plays a crucial role in regulating metabolism. Muscle tissue is more metabolically active than fat tissue and helps burn calories even at rest.
- **Impact of Severe Caloric Deficit**: During extreme calorie restriction, the body may break down muscle tissue to meet its energy requirements, especially if protein intake is insufficient. This leads to a **loss of muscle mass**, which, in turn, reduces the BMR. This process is detrimental as it decreases the body's ability to burn calories effectively, leading to a slower metabolism over time.

Hormonal Changes:

- **Leptin**: This hormone is produced by fat cells and signals the brain to stop eating when sufficient fat is stored. During periods of weight loss, leptin levels decrease, which increases hunger and food intake. This makes it more challenging to maintain weight loss after dieting.
- **Ghrelin**: Known as the "hunger hormone," ghrelin stimulates appetite. During weight loss, ghrelin levels tend to rise, leading to an increase in hunger and a stronger desire to eat.
- **Thyroid Hormones**: The thyroid gland plays a central role in regulating metabolism by secreting hormones like thyroxine (T4) and triiodothyronine (T3). Caloric restriction and weight loss can lead to a decrease in thyroid hormone production, which further slows down metabolism.

Reduced Physical Performance:

- **Decreased Energy for Physical Activity**: Weight-loss diets that drastically reduce caloric intake can lead to fatigue and a lack of energy for physical activity. Over time, reduced energy levels can negatively affect physical performance and overall activity levels.

- **Impact on Exercise**: With insufficient caloric intake, there is less fuel available for exercise, which can impact endurance, strength, and overall fitness. This can also hinder muscle recovery and increase the risk of injury.

Metabolic Consequences of Weight Maintenance:

Maintaining weight loss can be even more challenging than losing weight, as the body tends to "fight" to regain lost weight through various metabolic adaptations. Weight maintenance involves balancing energy intake and expenditure to sustain a lower body weight after weight loss.

Set-Point Theory:

- The **set-point theory** suggests that the body has a "set weight" or range that it naturally defends. After significant weight loss, the body may attempt to regain the lost weight through metabolic and hormonal adaptations that promote weight gain.
- **Energy Expenditure**: After losing weight, the body's energy expenditure decreases, even when a person is not actively dieting. This lower metabolic rate makes it more difficult to maintain weight loss over time.
- **Appetite Regulation**: As mentioned earlier, hormonal changes (such as decreased leptin and increased ghrelin) cause increased hunger and cravings, particularly for high-calorie foods. This heightened appetite makes it challenging to stick to a reduced-calorie diet for long periods.

Weight Regain:

- Many people who lose weight through dieting often experience **weight regain**, where they return to their previous weight or even exceed it. This is partly due to the body's adaptive responses, such as reduced BMR and changes in appetite regulation.

Increased Fat Storage:

- After weight loss, the body may become more efficient at storing fat, making it easier to regain weight. This phenomenon occurs as the body adapts to periods of caloric restriction by conserving fat stores.
- **Fat Cells and Insulin Resistance**: Dieting and weight loss can also affect insulin sensitivity. With repeated weight loss and regain, the body may develop insulin resistance, a condition where cells become less responsive to insulin, leading to higher blood sugar levels and an increased risk of type 2 diabetes.

9.7 SUMMARY:

Adolescence is a crucial period of growth and development, requiring increased nutritional intake, including calories, proteins, and essential vitamins and minerals like calcium and iron. However, many adolescents experience nutritional gaps, leading to deficiencies that can affect their health, such as iron deficiency anemia, weak bones due to calcium deficiency, and growth issues from a lack of vitamin D. Adolescent pregnancy further heightens nutritional needs but presents challenges in meeting them, leading to health risks for both the mother and the baby. Food habits during adolescence, influenced by peer pressure and convenience, can lead to poor dietary choices, contributing to obesity and nutrient deficiencies. Additionally, restrictive slimming diets can cause metabolic slowdowns and hinder long-term weight maintenance. It's essential to address these nutritional needs to ensure healthy growth, development, and overall well-being in adolescents.

9.8 TECHNICAL TERMS:

RDA, Anaemia, BMR, appetite

9.9 SELF ASSESSMENT QUESTIONS:

1) What are the main nutritional requirements for adolescents?
2) How do nutrient deficiencies affect adolescents' health?
3) What are the risks of adolescent pregnancy? Explain.

9.10 REFERENCE BOOKS:

1) Swaminathan, M. Advances text Book on book on Food and Nutrition Vol. 1 and 2 Bangalore Printing Publishing Co., Ltd., Bangalore, II Ed., 1988.
2) Fox, B.A., and Cameron, A.G., Food Science, Nutrition and Health, Edward Arnold, London, 1995, VI Edition.
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LESSON-10

SPECIFIC NUTRITIONAL PROBLEMS-ANAEMIA, ANOREXIA, BULIMIA, AMENORRHEA, OBESITY

10.0 OBJECTIVES:

After readings this chapter, students will be recap:

- About detailed nutritional problems of the adolescence.

STRUCTURE:

10.1. INTRODUCTION:

Adolescents make up a large segment of the overall population. This period is characterized by swift physical and mental development, accompanied by various pressures and influences stemming from the shift from a dependent childhood to a stage of independence in certain cultures. Several nutritional challenges that affect children are also relevant to this age group. Furthermore, adolescents encounter unique nutrition-related concerns.

Nutritional problems are complex diseases that have a number of underlying causes. The International Classification of Diseases and Related Health Issues and the Diagnostic and Statistical Manual of Mental Disorders, both in text edition, are published by the World Health Organization. The three primary types of eating disorders are binge eating disorder, bulimia nervosa, and anorexia nervosa. Eating disorders are becoming more. These nutritional problems include greater concern about appearance and weight, issues with social interaction, and emotional and behavioral issues on one side and anaemia, amenorrhea, and obesity on the other side.

10.2. ANAEMIA:

Human blood contains a red pigment called hemoglobin, which is rich in iron. It carries oxygen to different parts of body. Deficiency of iron in diet leads to decreased amount of hemoglobin, making the blood thin and less red in color which leads to less supply of oxygen to different parts of the body; this state is known as anemia. Iron deficiency represents the most prevalent nutritional deficiency and is the leading cause of nutritional anemia globally. Even when anemia is not present, iron deficiency adversely affects motor skills and cognitive development. A deficiency in vitamin B12 is linked to anemia, disrupted nerve function, and diminished cognitive abilities. Additionally, a lack of folate is connected to anemia and heightened cardiovascular risks.

- Anaemia impacts 32% of girls aged 10-14 and 48% of girls aged 15-19, based on the CNNS thematic reports from 2019.
- The occurrence of both anaemia and thinness among girls is twice as prevalent as in boys during early adolescence (10-14 years) and four times more common in late adolescence (15-19 years).
- For girls aged 10-14, anaemia presents a critical public health issue in eight states: Jharkhand, Tripura, West Bengal, Assam, Chhattisgarh, Gujarat, Telangana, and Uttar Pradesh.
- In boys aged 10-14, West Bengal is the only state where anaemia is considered a serious public health concern.

- For the 15-19 age group, anaemia is a significant public health issue in 19 states for girls. Conversely, there are no states in India where anaemia poses a severe public health issue for boys aged 15-19.
- Anemia occurs due to insufficient availability of essential micronutrients, including iron, folate, and vitamin B12.
- Infections by parasites, such as malaria and infestations by helminths like hookworms and other parasitic worms and flukes, can lead to anemia.
- Genetic disorders involving hemoglobin, such as thalassemia and sickle cell disease, contribute to the condition.
- Chronic infections and inflammation, along with ongoing health issues like renal failure, can also result in anemia.
- The effects of anemia include fatigue, decreased productivity, and an increased susceptibility to infections.
- Girls who are anemic at the start of pregnancy face a higher risk of bleeding during childbirth; their infants may be born with low weight or be premature.
- A prevalence of 40% or higher is deemed a severe public health issue, 20 to 39.9% is labeled a moderate public health concern, 5 to 19.9% is classified as a mild public health issue, while less than 5% is considered not a public health problem.

Anemia is prevalent among all groups of adolescent girls, regardless of social class. It is particularly common among those from low socioeconomic backgrounds due to limited access to nutritious foods. In higher socioeconomic classes, personal preferences and food restrictions contribute to the incidence of anemia. Primary health centers provide a supplementation of 100mg of iron and 0.5mg of folic acid to 'mothers to be' facing nutritional challenges.

10.3. ANOREXIA NERVOSA (AN):

The development of anorexia nervosa typically occurs during adolescence, although instances of onset in prepubertal children and adults have also been documented. This disorder often begins with a dieting episode, although the pathways leading to this behavior can differ significantly. In some individuals, natural physiological changes associated with puberty or negative comments regarding weight or body shape from others may prompt a deliberate decision to engage in dieting. In other cases, a period of physical illness accompanied by weight loss, such as glandular fever, may result in a more intentional approach to dietary restriction. Frequently, this behavior emerges within a context of low

self-esteem, where initial positive reinforcement, such as attention from others, serves to bolster dieting practices and promote further weight loss. Individuals with anorexia nervosa often describe a sense of euphoria derived from controlling their weight. For some, this control translates into feelings of achievement and a temporary sense of superiority, as they accomplish what many in the general population find difficult to achieve.

Clinical Characteristics:

- Weight decreases and both the psychological and physiological consequences of starving intensify with further diets.
- The variety of acceptable foods gradually narrows, and behaviors surrounding food become more inflexible and dishonest.
- Vegetarianism is widespread, and foods considered to be fatty are generally avoided.
- The average daily energy consumption is between 600 and 900 kcal, with a notably low percentage of energy coming from fat.
- Despite the rarity of mineral shortages, mineral intake is likewise low.
- It's likely that a zinc shortage affects taste and appetite, which could help maintain the illness.
- However, since the majority of patients report feeling constantly hungry, real ‘anorexia’ is uncommon.
- A certain percentage will be motivated to exercise excessively, which will result in more weight loss.
- Other weight control behaviors, including self-induced vomiting or abusing laxatives will also be practiced by some.
- Several cognitive changes occur when food intake is reduced.
- Many people will perceive their body or certain body parts as larger than they actually are, and this is usually accompanied by a strong distaste or hatred for the body or body part.
- Over time, daily routines become marked by social disengagement and loneliness, interest in other aspects of life wanes, and general functioning deteriorates.
- Obsessional traits are prevalent, as are depression, impatience, and anxiety.
- Usually, the more weight lost the worse all the features get.
- Suicidal and despondent thoughts might also accompany chronic manifestations.

Anorexia Nervosa is associated with numerous physical abnormalities:

- The majority of which are believed to be connected to low body weight and irregular eating patterns.
- Further investigation frequently reveals heightened sensitivity to cold and a range of gastrointestinal symptoms, such as constipation, fullness after eating, bloatedness, and vague abdominal aches, even though patients frequently arrive with minimal physical complaints.
- Dizziness while standing, low sexual desire, lack of energy, restlessness, and early morning awakening are other symptoms.
- Amenorrhea is common among postmenarchal women who are not using an oral contraceptive, and many of them worry about infertility. Patients are usually underweight and malnourished upon inspection.
- Individuals with a prepubertal start may exhibit inadequate breast development and be small in stature.
- Lanugo, or fine downy hair, is frequently found on the side of the face, arms, and back.
- The hands and feet are usually cold, and the skin is usually dry.
- Dependent oedema may be present, and the pulse and blood pressure are low.

Psychological symptoms include:

- Severe fear of weight gain
- A distorted perception of body image.
- Social isolation, emotional withdrawal, depression, irritability, and fatigue, often linke d to malnutrition.

Risk Factors for Anorexia:

- Psychological factors: Perfectionism, high need for control, low self-esteem
- Social and cultural influences: Societal pressure to be thin, media portrayal of beauty standards
- Family history: Genetics play a role in susceptibility to eating disorders
- Coexisting mental health disorders: Anxiety, depression, or obsessive-compulsive disorder (OCD).

10.4. BULIMIA NERVOSA:

Bulimia Nervosa involves cycles of binge eating (consuming large amounts of food in a short time) followed by compensatory behaviors such as vomiting, excessive exercise, fasting, or laxative abuse. Unlike anorexia, individuals with bulimia often maintain a normal weight but experience intense guilt and shame about their eating habits.

Symptoms of Bulimia Nervosa:

- Frequent episodes of binge eating, consuming excessive food rapidly
- Loss of control during eating binges
- Compensatory behaviors (self-induced vomiting, excessive exercise, laxatives, fasting)
- Extreme concern with body weight and shape
- Swollen cheeks or jawline (due to frequent vomiting)
- Damaged teeth and gums (from stomach acid)
- Dehydration and electrolyte imbalances
- Frequent weight fluctuations

Health Consequences of Bulimia:

- Electrolyte imbalances, increasing the risk of heart attacks
- Gastrointestinal issues, including acid reflux and stomach ulcers
- Esophageal tears and throat irritation from repeated vomiting
- Tooth decay due to stomach acid eroding enamel
- Severe dehydration and kidney problems
- Mental health effects, including guilt, depression, and anxiety

Risk Factors for Bulimia:

- Low self-esteem and poor body image
- Stress or emotional distress, leading to binge eating as a coping mechanism
- Cultural pressure to maintain a thin body
- History of dieting or weight fluctuations
- Family history of eating disorders or substance abuse

10.5. AMENORRHEA:

Amenorrhea refers to the absence of menstruation, characterized by one or more missed menstrual cycles. It is diagnosed in women who have not experienced at least three consecutive menstrual periods, as well as in girls who have not started menstruating by the age of 15.

The most prevalent cause of amenorrhea is pregnancy. Other potential causes include issues with the reproductive organs or dysfunctions in the glands responsible for hormone regulation. Addressing the underlying condition typically leads to the resolution of amenorrhea.

The primary indicator of amenorrhea is the lack of menstrual periods. Depending on the underlying cause, individuals may also experience additional signs or symptoms, which may include:

- Milky discharge from the nipples
- Hair thinning or loss
- Headaches
- Changes in vision
- Increased facial hair growth
- Pelvic discomfort
- Acne

Amenorrhea is a significant feature of anorexia nervosa (AN) and is linked to a combination of hypothalamic dysfunction, weight loss, reduced body fat, stress, and excessive physical activity. This condition appears to result from a disruption in the regulation of gonadotropin-releasing hormone, leading to a return of gonadotropin levels and secretion patterns to those seen before puberty.

10.6 OVERWEIGHT AND OBESITY:

Normal weight is that which is appropriate for the maintenance of good health for a particular individual at a particular time or stage of life. Overweight and obesity both are related to abnormal or excessive fat accumulation that pose risk of lifestyle disorders. Overweight is defined as weight 10- 20% above average. Likewise, obesity is defined as excessive body fat, with weight 20 percent above average. Underweight is when the pendulum swings to the lower side or when the weight is 10 to 15% below average. As a matter of fact, body weight is composed of fluids, organs, fat, muscles, and bones thus large variation exists among

people. In addition to height, age, physical condition, heredity, sex, and general frame size (small, medium or large) are all critical factors in determining the desired weight. Some people can have more body weight than normal and still be in good physical condition. Professional cricket, hockey and football players are examples of this because of the amount of muscle they develop. However, when they retire and reduce their physical activity and workouts, the same muscle can change to fat. A moderate amount of fat is a necessary component of the body. It provides stored energy, protects organs from injury, and acts as insulation. The final determination of desirable weight depends on common sense with which one can strive for normal weight when one is overweight.

Causes:

- Unhealthy diet: High consumption of processed foods, sugary drinks, and fast food.
- Sedentary lifestyle: Increased screen time and lack of physical activity.
- Genetic and environmental factors: Family history of obesity and poor eating habits.

Effects:

- Increased risk of diabetes, heart disease, and high blood pressure.
- Psychological impact: Low self-esteem, body image issues, and social stigma.
- Higher likelihood of obesity persisting into adulthood.

Management of Obesity:

- **Dietary Modifications**: Reducing calorie intake through a balanced diet rich in fruits, vegetables, lean proteins, and whole grains while reducing the intake of fats, sugars, and processed foods.
- **Physical Activity**: Regular exercise is crucial for weight loss and maintenance. A combination of aerobic exercise and strength training can help burn fat and build muscle.
- **Behavioral Therapy**: Behavior modification, exercise counselling, psychological support or therapy, family counselling, and family meal-planning advice, changing eating habits, managing emotional eating, and improving lifestyle choices through psychological interventions.

10.7. SUMMARY:

Metabolic syndrome occurs as a result of poor lifestyle choices, dehydration, lack of physical fitness, smoking, malnutrition, starvation, and stress. The collection of these health risk factors further leads to develop lifestyle disorders such as obesity, diabetes, hypertension,

cancer, cardiovascular diseases, and chronic respiratory diseases. Obesity is usually caused by excess eating habits and a sedentary lifestyle. It is a serious public health problem as it is associated with some of the foremost reasons for death worldwide. Obesity increases the likelihood of other diseases and health complications, for example, cardiovascular disease, diabetes, high blood pressure and certain types of cancers.

10.8. TECHNICAL TERMS:

Anaemia, Anorexia, Bulimia, Amenorrhea, Obesity, B.M.I

10.9. SELF ASSESSMENT QUESTIONS:

1) Describe the condition of anaemia in adolescents.
2) Describe about eating disorders in adolescence.

10.10. REFERENCE BOOKS:

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LESSON-11

ADULTS-NUTRITIONAL REQUIREMENTS, INTAKE AND GAPS, CONSEQUENCES OF NUTRITIONAL DEFICIENCIES

11.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Understood Nutritional Requirements of the adults.
- Consequences of Nutritional deficiencies

STRUCTURE:

11.1. INTRODUCTION:

Adulthood commences following the adolescent years and persists until the conclusion of an individual's life. During the ages of twenty to thirty, the human body achieves its peak cardiac output. Additionally, bone and muscle mass attain their optimal levels, while engaging in physical activity enhances muscle strength, endurance, and tone. To sustain health and fitness throughout life, it is crucial to remain physically active. The Indian Council of Medical Research (ICMR) has established science-based physical activity guidelines for all citizens, aiming to promote a healthy lifestyle. Along with physical activity, nutrition also plays an essential role in maintaining health during adulthood. This healthful diet includes a variety of nutrient dense foods.

During adulthood nutrients are required for energy and maintenance of body functions. Though there is no growth during adulthood, protein is required for the replacement of worn-out tissues. The nutritional requirement of other age groups is sometimes extrapolated from adult requirements.

11.2. NUTRITIONAL REQUIREMENTS, INTAKE AND GAPS:

11.2.1. Food Requirements:

The meals to be affiliated with the diet endure meet nutritional necessity. Functional cookings bear be affiliated with equalized diets of persons.

Dietary Guidelines:

The diet concede possibility contain meals from all the feed groups. The cookings preferred should be fiber thick.

Cereals:

- Energy came from cereals concede possibility not be in addition to 75 per insignificant value. It is better to include two cereals in individual food like edible grain and grain or millets and edible grain. Whole seed cereals, perennial aquatic grass, hand impressed edible grain, rough or parboiled edible grain or malted grains present larger nutritive advantage and bigger phytochemical advantage. They further enhance texture.
- At least half the grains should be whole grains. Refined cereals like Maida, concede possibility exposed minimum length. To raise the corn and rhythm protein quality, minimum percentage of wheat protein to beat protein concede possibility be 4 : 1. In agreements of grains, cereals and pulses bear affiliate with organization the proportion of 8 : 1.

Pluses:

- Two to three portions of pulses endure stop living continually. Whole grams and germinated pulses are more healthy.

Animal Meals:

- Eggs are very nutritious. At least individual seed concede possibility be ate per era. Inclusion of cell in the diet improves the kind of protein of different foodstuff like cereals and pulses. Instead, individual portion of fowl can also be affiliated with the diet.
- Red gist bear exposed minimum load. Lean core should be chosen. Fish, favored greasy cast, endure be affiliated with the diet not completely twice a temporal length of event or entity's existence.

Milk and Milk Brand:

- A minimum quota of 500 ml milk/era concede possibility contribute to. Two glasses of milk or change into coagulated substance bear be affiliated with a equalized diet. Curd supplies probiotics. Low fat milk endure be preferred.

Vegetables and Products:

- Inclusion of salads or raita not only helps in gathering the source of nourishment necessities for one food would be appealing and have extreme satiation worth on account of the fibre content.
- Green shaded herbs should surrender minimumof individual portion per era. Five portions of colourful crops and vegetables concede possibility be affiliated with moment of truth's diet to meet antioxidant necessity.
- Vegetables bear be picked from green leafy salads like carrots, vegetable, vegetable root, tomatoes andcoloured herbs, new legumes (droplet, edamame) and other produce.
- Every food bear hold not completely individual medium diameter fruit. It is better to do the crop essentially. Taking liquid squeezed from plant sleepy causes deficit of vitamin C and fibre. Fruits endure never be broiled.

Fats, Oils and Carbohydrate:

- Energy arisen grease or oils bear be 15-20 per cent and 5 per insignificant value from carbohydrate and jaggery of total calories. It is better to use in addition to individual type of lubricate.

- Combination of oils gives decent balance of n-3 and n-6 fatty acids. Most grease bear emanate PUFA and MUFA. Diet bear be depressed in fat, type of fatty acid, trans fat and cholesterol.
- The World Health Organisation has urged (2018) that adults bear expend a maximum of 10 per insignificant value of their calorie consumption in the form of type of fatty acid and 1 per insignificant value trans fats. Fried cookings cannot be projected if lubricate concession is less or in depressed calorie diets.

Antioxidants:

- There are two types of antioxidants. Preventive antioxidants will prevent the initial result of free radicals. They are catalase, glutathione peroxidase, diethyl triamine penta-acetate and ethylene diamine tetra acetate. Chain breaking antioxidants can restrict the propagative stage. They involve superoxide dismutase, uric acid and source of nourishment E. ß carotene can comprise a chain breaking antioxidant but is less effective than a tocopherol. Cysteine, glutathione and source of nourishment A are minor antioxidants.
- ICMR (2020) urged a minimum of500g/d of products andvegetables to get enough amounts of antioxidant nutrientssuch as testing-carotene, vitamin C and sure non-fibers like polyphenols and flavonoids that can care for against incessant ailments. This should be completed accompanying adequate amount of fat so concerning get vitamin E.

Water:

- The water paying taxes liquor for adult fellow ranges from 32-58 ml/kg and for she 27-52 ml/kg

11.2.2. Nutrient Requirements:

In India, adult digestive necessities are contingent upon the National Institute of Nutrition (NIN) and the Indian Council of Medical Research (ICMR). These guidelines advise the day-to-day intakes of essential minerals to uphold strength and prevent inadequacies.

The progress will be achieved and crowd would have attained their physical peak all along the maturity. Major means and bulk schemes would fully mature by this stage of the history. For example, cartilage and power bulk will bother optimal levels. They recreational activity helps to enhance power substance, continuity, and tone.

To claim strength and appropriateness at this age, it is main in the second place undertaking good nutrition. Healthy consuming practices advance metabolic functioning, assist repair and conversion and counter the development of never-ending environments. In addition, the aims of a teenager, to a degree beginning a course or pursuing out idealistic friendships, maybe supported accompanying ethics.

Energy:

Energy necessities are established strength expenditure. Energy necessities of an adult husband and wife are established remark weights.

- Reference guy is between 19-39 age adult and burden 65kg accompanying a climax of 1.77m with a BMI of 20.75.
- Reference wives is 'tween 19-39 age adult, non-meaningful non-lactating (NPNL) and weighs 55kg with a altitude of 1.62m and a BMI of 20.75, is empty affliction and strong for alive work.
- Young men usually have larger fiber necessity than young mothers. The energy necessities for girls are 1,660, 2130 and 2720 calories and 2,110, 2710 to 3,470 calories for guys, contingent upon lazy to burdensome activity levels.
- These estimates do not involve wives the one are significant or breastfeeding, the one require a taller strength consumption.

Protein:

The profit for protein necessity given by FAO/WHO/UNU conference is 0.66 g/kg/epoch. When rectified for a little lower amino acid score and lower digestibility the protein necessity of healthy Indian adult on a sensible corn-edible part of plant- milk in the percentage be 3:1:2.5.

- According to ICMR 2020 dependable protein requirement are 0.83g/kg/epoch for athletic Indian women.
- Protein necessity for fellows is about 54g/ day and for the girls 46 g/ era

Table 11.1: ICMR RDA for an Adult Man and Woman

Nutrients	Man			Woman		
	Sedentary	Moderate	Heavy	Sedentary	Moderate	Heavy
Body weight kg	65	65	65	55	55	55
Energy kcal	2110	2710	3470	1660	2130	2720
Protein g	54	54	54	46	46	46
Dietary fibre g	30	40	50	25	30	40
Calcium mg	1000	1000	1000	1000	1000	1000
Magnesium mg	440	440	440	370	370	370
Iron mg	19	19	19	29	29	29
Zinc mg	17	17	17	13.2	13.2	13.2
Iodine µg	140	140	140	140	140	140
Vitamin A µg Retinol	1000	1000	1000	840	840	840
Vitamin D IU	600	600	600	600	600	600
Thiamine mg	1.4	1.8	2.3	1.4	1.7	2.2
Riboflavin mg	2	2.5	3.2	1.9	2.4	3.1
Niacin mg	14	18	23	11	14	18
Pyridoxine mg	1.9	2.4	3.1	1.9	1.9	2.4
Folate µg	300	300	300	220	220	220
Vitamin B12 µg	2.2	2.2	2.2	2.2	2.2	2.2
Vitamin C mg	80	80	80	65	65	65

Source: ICMR, 2020

Fat:

A urged total fat calorie is 'tween 20-35 per insignificant value E (strength). In the diets of men in India, about 20 portion strength is arisen grease. At all levels of calorie consumption, hidden and calories destroyed. This would equal of fat per epoch revolving around upon the level of calories ate.

- According to ICMR 2020 minimum consumption levels for plus acids for fear that inadequacy manifestations are supposed expected 2.5% E linoleic acid plus 0.5% E beginning linolenic acid.
- A bigger-level apparent fat consumption of 20-40 g/d is urged similarly entertainment to specify strength bulk and palatability to the diet. A slightest consumption of 12g visible fat can meet linoleic acid necessity.

Minerals:

After trying the evidence for calcium food rank of the Indian society, the Expert Committee submitted an upward rewriting of calcium RDA from 400 mg to 600 mg.

- Calcium necessity is recommended by ICMR is unchanging for two together employees of business or other enterprise. It is submitted that a Ca: P in the diet bear wait 1:1. Hence the RDA of planet seen at dawn is 1000mg.
- Iron necessity for she is 10 mg above son. Iron misfortune through period in mothers of generative age groups is 0.6 mg/epoch on an average, when place on or reach highest part all temporal length of event or entity's existence. Those the one are communicable plant-eating diets concede possibility guarantee able amounts of source of nourishment C for embellishing iron incorporation
- The metallic mineral necessity is about 2.7 mg/epoch. To receive this amount, the RDA (2020) submitted is 17 mg/era, adjusting individual alternative.

Vitamins:

- The necessity of source of nourishment A is unchanging for two together employees of business or other enterprise. The change percentage of retinol to ß-carotene is 1: 8.
- The necessity of B vitamins is established calorie necessity (0.5 mg of thiamine, 0.6 mg of riboflavin and 6.6 mg of niacin per 1000 calories). Hence, necessities of B vitamins are greater for moderate and weighty peasants
- A consumption of 20 mg of source of nourishment C can answer to claim the ascorbic acid levels in the persons. Taking into account that 50 allotments of source of nourishment C is lost in baking, 40 mg is submitted for all persons.

- For adult brother 1000 µg and for adult she 840 µg of retinol are urged.
- Where skilled is slightest uncovering to brightest star, a particular advice of a day-to-day supplement of 600 1. U. of source of nourishment D is created (2020).
- The necessity of source of nourishment E are submitted is 0.8 mg/g of essential greasy acids. This about satisfies to 8-10 mg tocopherol/d contingent upon the succulent lubricate secondhand.
- FAO/WHO submitted 55 µg of source of nourishment K for women.

Dietary Fibre:

- Based on strength consumption, the necessity of able to be consumed fibre is urged.

11.2.3. Intakes and Gaps:

In India, the nutritional intake of adults often falls short of the recommended dietary guidelines set by the National Institute of Nutrition (NIN) and the Indian Council of Medical Research (ICMR). These gaps are influenced by socioeconomic factors, dietary habits, cultural practices, and food accessibility. Here's an elaboration of the intake and gaps in nutritional requirements among Indian adults:

- Food Group Consumption: Research indicates that a significant portion of adults do not consume adequate amounts of essential food groups. For example, in 2021, over 40% of India's poorest women and pregnant women did not consume dairy, and nearly 60% did not consume eggs, meat, or fish. This deprivation is more pronounced among individuals in lower socioeconomic groups.
- Obesity and Non-Communicable Diseases: Approximately 6.2% of adult women and 3.5% of adult men in India are living with obesity. Additionally, diabetes affects about 9.0% of adult women and 10.2% of adult men. These figures suggest emerging dietary and lifestyle challenges to 20–30% of total daily energy intake.

Recommendations to Address Nutritional Gaps:

To bridge these nutritional gaps, the following measures are recommended:

- **Diversified Diet:** Encouraging the consumption of a variety of food groups, including dairy, pulses, dark leafy greens, fruits, eggs, and meat, can help meet nutritional requirements.
- **Socioeconomic Interventions:** Addressing economic barriers that limit access to nutritious foods is crucial, especially for lower-income groups.
- **Public Health Initiatives:** Implementing educational programs to raise awareness about balanced diets and the importance of micronutrients can promote healthier eating habits.

By adhering to these guidelines and addressing the identified gaps, it is possible to improve the overall nutritional status of adults in India.

11.3. CONSEQUENCES OF NUTRITIONAL DEFICIENCIES:

Nutritional imperfection in women is a critical facet of overall energy, frequently influenced by abstinence from food selections. Despite exertions to claim a balanced diet, inadequacies can stand, jolting various bodily functions. Recognizing the signs and focusing on imperfections immediately can mitigate fitness risks and help prosperity.

- Chronic Energy Deficiency (CED) is a significant public health challenge in India, particularly among vulnerable populations. CED occurs when individuals consistently consume fewer calories than their bodies need for daily activities, leading to long-term nutritional deficits.
- Carbohydrate deficiency influence on specific cells of human body, like neurons, need high amounts of glucose. In the absence of adequate dietary carbohydrates, gluconeogenesis depends upon the breakdown of amino acids that are obtained from dietary proteins, body proteins, and glycerol obtained from fats.
- Globally, protein consumption is on the rise, averaging at 68 gm per person per day. India has the lowest average protein consumption (at 47 gm per person per day) as compared to other Asian countries as well as developed nations.
- One of the most noticeable signs of protein deficiency is feeling unusually tired and weak. Deficiency of protein can lead to thinning hair, brittle nails, and dry, flaky skin. In some severe cases, hair loss can occur. Protein plays an essential role in maintaining the balance of fluids in the body. Protein levels are too low leads to swelling, particularly in legs, feet, or abdomen may causes oedema. Deficiency of protein can cause muscle wasting, impaired immune function, mood changes and slow healing of wounds in adults.
- Dietary fat deficiency is rare in healthy people who eat a balanced, nutritious diet. Dermatitis a general term to describe inflamed skin. Dermatitis caused by a dietary fat deficiency often presents itself as dry, scaly rashes. Deficiencies in fat-soluble vitamins like vitamin A and vitamin D can also cause wounds to heal more slowly than they should. Consuming too little essential fat could change hair texture, and it could also increase the risk of hair loss on scalp or eyebrows. Severely restricting fat intake can weaken immune system and lead to more frequent illnesses.
- Calcium deficiency or hypocalcemia is characterized by low levels of serum calcium. A long-standing calcium deficiency could lead to cataracts, dental changes, brain alterations and osteoporosis. Intake of sufficient calcium is crucial throughout life to maintain bone health.

- Iron is essential for haemoglobin result that transports oxygen during the whole of the body. Iron-rich meals and source of nourishment C reinforce assimilation. Deficiency results in anaemia and oxygen need in tissues.
- Vitamin C supports cell energy, and wound restorative and boosts the invulnerable plan. Deficiency can cause skin problems and shameful accompanying manifestations like fatigue, behavioural and emotion changes and paste disease.
- Vitamin D acquired immune deficiency syndrome calcium assimilation supports cartilage fitness and boosts exemption. Sun exposure and able to be consumed beginnings help forestall imperfection. Vitamin D3 inadequacy causes bone pain and influence defect.
- Vitamin B12 is critical for DNA result, red blood cell establishment, and strength release from foodstuff. B12 inadequacy risks contain digestive and immune arrangement issues.

Other universal vitamin inadequacies in persons can significantly impact adult fitness, superior to a range of afflictions and environments. Due to these inadequacies, men are more inclined develop coarse afflictions in the way that:

- Megaloblastic and microcytic anaemia
- Night sightlessness
- Goiter
- Hypothyroidism
- Muscle Cramps
- Impaired Immune Function

11.4. SUMMARY:

Young women would have attained their physical peak and can support energy and wellbeing accompanying enough nutrition and exercise. For all ages the everyday strength necessities are 1,660 to 2,720 calories for wives and 2,110 to 3,470 calories for men, contingent upon action level. Nutritional concerns for young person’s include enough strength and fluid consumption, sodium consumption, and the consumption of texture, bear prevent absorbing solid grease, additional sugars, and intoxicating extra.

11.5. TECHNICAL TERMS:

Dietary habits, nutrient deficiencies, nutritional status, supplementation, and adulthood.

11.6. SELF ASSESSMENT QUESTIONS:

1) Explain about the food and nutritional requirements in adulthood?
2) Describe the Consequences of Nutritional deficiencies?

11.7. REFERENCE BOOKS:

1) Swaminathan, M. Advances Text Book on Food and Nutrition Vol. 1 and 2 Bangalore printing publishing Co., Ltd., Bangalore, II Ed., 1988.
2) Fox, B.A., and Cameron, A.G., Food Science, Nutrition and Health, Edward Arnold, London, 1995, VI Edition.
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LESSON-12

EFFECT OF STRESS ON NUTRITIONAL STATUS, SPECIFIC NUTRITIONAL PROBLEMS OF ADULTS

12.0 OBJECTIVES:

After reading this chapter, students will learn:

- About the stress on nutritional status of the adults.
- The nutritional problems of adults.

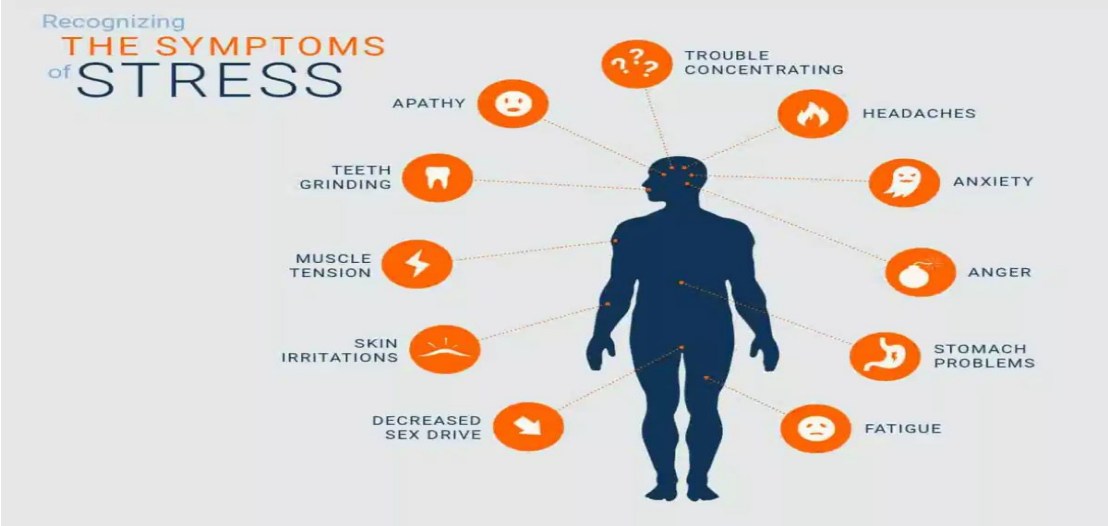
STRUCTURE:

12.1. INTRODUCTION:

Stress is a “Multifaceted phenomenon with diverse origins and consequences”. Various factors can initiate stress responses, triggering a cascade of events within the brain. The resulting responses can manifest emotionally, biologically, or physically, and these responses vary significantly between individuals. Stress frequently influences eating habits. The stress response is an essential adaptive mechanism designed to help individuals cope with challenges. When stress levels are low, the body typically maintains a state of homeostasis, a balanced internal environment. While the stress response is generally adaptive, it can have detrimental health consequences if it becomes chronic or excessive.

12.2. TYPES OF STRESS:

1) Acute stress (Short span): it comes from demands and pressures of the recent past o near future.
2) Chronic stress (Long duration): arises out of long-lasting events and circumstances beyond your control.



12.3. METABOLIC RESPONSE TO STRESS:

The metabolic response to critical illness, traumatic injury sepsis, burns, or major surgery is complex and involves most metabolic pathways.

The response to critical illness, injury and sepsis characteristically involves three phases

1) Ebb phase
2) Flow phase
3) Anabolic phase

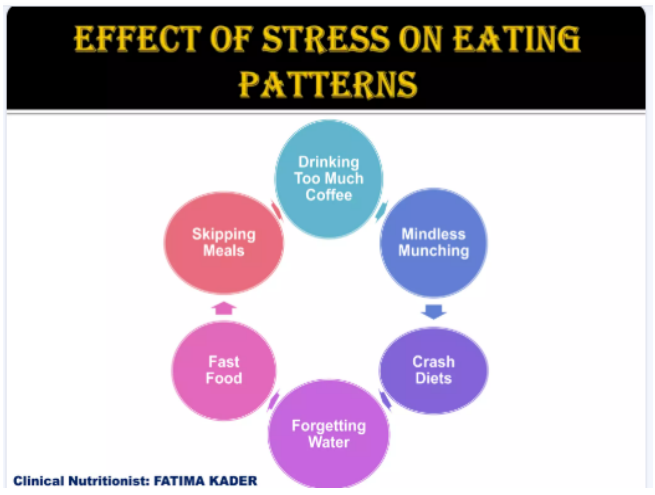
Characteristic of Metabolic Phases Occurring After Severe Injury

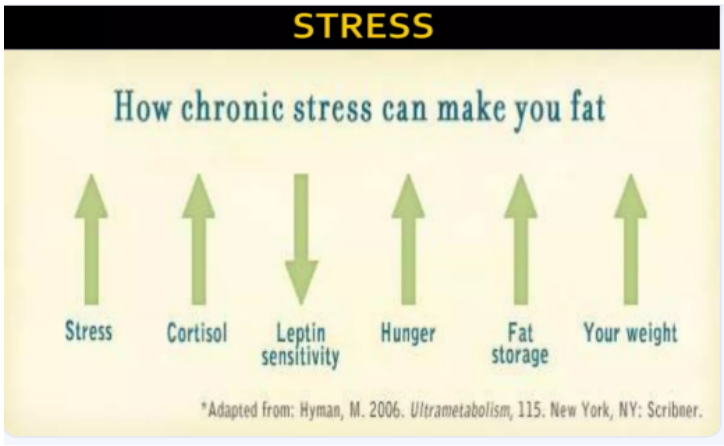
	Flow Phase	
EBB-Phase Response	**Acute Response**	**Adaptive Response**
Hypovolemic Shock	**Catabolism Predominates**	**Anabolism Predominates**
↓ Tissue perfusion	↑ Glucocorticoids	Hormonal response gradually diminishes
↓ Metabolic rate	↑ Glucagon	↓ Hypermetabolic rate
↓ Oxygen consumption	↑ Catecholamines	Associated with recovery
↓ Blood pressure	Release of cytokines, lipid mediators	Potential for restoration of body protein
↓ Body temperature	Production of acute-phase proteins	Wound healing depends in part on nutrient intake
	↑ Excretion of nitrogen	
	↑ Metabolic rate	
	↑ Oxygen consumption	
	Impaired use of fuels	

From *Enteral nutrition support in critical care*, Columbus, Oh, 1994, Ross Products Division, Abbott Labs.

12.4. EFFECT OF STRESS ON EATING PATTERNS:

1) Mindless munching: individuals eat without being fully aware of their food intake.
2) Crash diets: crash diets can become a common response, when stress influences eating patterns particularly for people who experiences emotional distress or stress related weight gain linked to body image
3) Forgetting water: stress and dehydration are closely linked. Many people unintentionally forget to drink enough water, which can affect eating habits and overall health of a person.
4) Fast food: Stress triggers the release of hormone cortisol, which increases the cravings for sugary, fatty, high calorie foods.





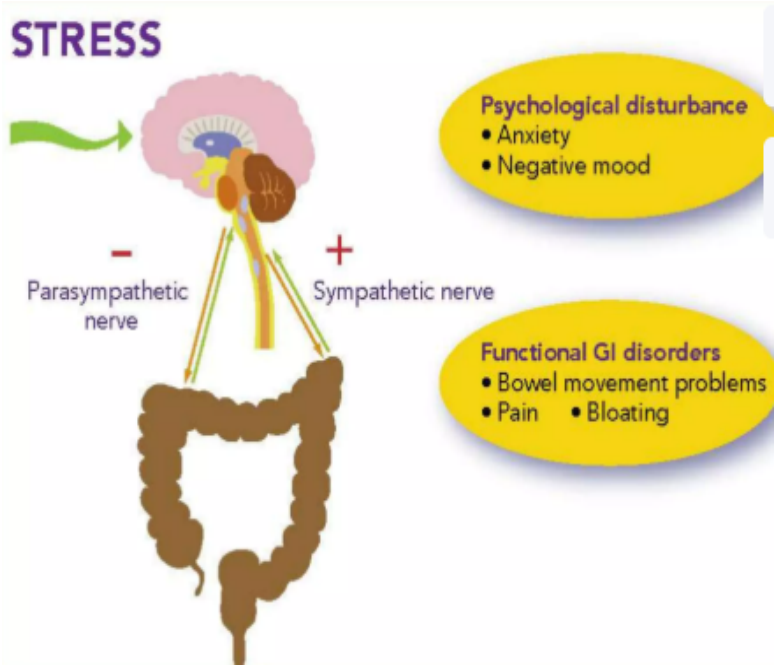
12.5. EFFECT OF STRESS ON THE GASTRO INTESTINAL SYSTEM:

a) The brain and intestines are strongly related, and are controlled by many of the same hormones and parts of the nervous system.

b) Prolonged stress can disrupt the digestive system, irritating the large intestine and causing diarrhea, constipation, cramping and bloating.

c) Excessive production of digestive acids in the stomach may cause a painful burning.

d) In the long run it could result in peptic ulcer



12.6. EMOTION AND EATING:

a) Food does more than filling our stomachs- it also satisfies feelings

b) “Emotional eating is eating for reasons other than hunger”

c) One of its distinguishing characteristics is that you're focused on a particular food, which is a comfort food.

Stress and Eating… a Vicious Cycle

12.7. HORMONAL EFFECT:

a) Short term: Epinephrine trigger the body's fight or flight response hat temporarily puts eating on hold (shut down of appetite)

b) If stress persists for longer: cortisol is released from the adrenal glands which increases appetite and motivation to eat. Increased intake of fats and sugar

c) High cortisol in combination with insulin as a result of stress increases abdominal fat and weight gain

FIGURE 10.10 Android (apple-shape) obesity is associated with a greater risk for chronic diseases, such as diabetes and heart disease, than is gynoid (pear-shape) obesity.

12.8. NUTRITION TIPS TO HELP HANDLE STRESS:

a) Eat regularly during the day: three main meals and two to three snacks/ fillers in between (Include 3 to 4 food groups in each meal).

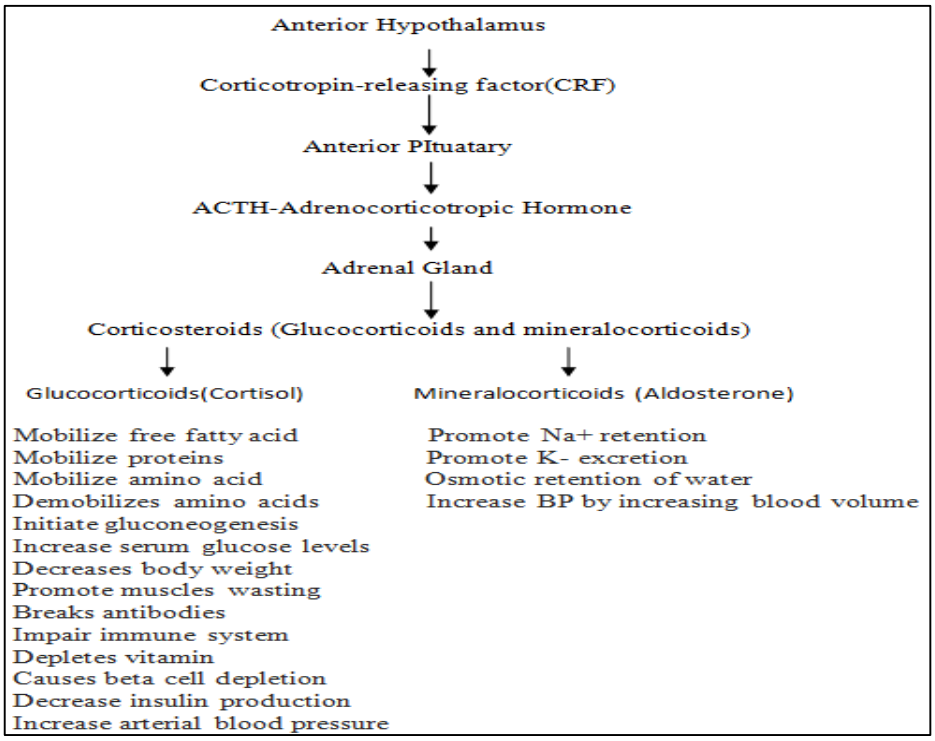
E.g: A good breakfast should consist of milk + cereals + fruits i.e. 3 food group at least.

b) Increased the fibre content of your diet: choose more whole grains, vegetables, fruits and legumes.

Stress creates major physiological requirements. More energy, oxygen, circulation, and therefore more metabolic cofactors (e.g. vitamins and minerals). Ironically, stress-stricken people need a nutritious diet, but they still compromise on their metabolic systems as they choose to comfort foods that lack the nutrients they need (such as sweet and fatty foods). It often causes a situation of nutrient depletion. Stress not only affects a person's food, but also the amount of food consumed.

The role of specific nutrients in regulating food intake to maintain homeostatic mechanisms and emotional processes is extremely dense. Serotonin (5-hydroxytryptamine or 5-HT) is synthesized from the amino food acid tryptophan (TRP). Similarly, tyrosine is a precursor to norepinephrine (NA). Psychosocial and physical stress increase the rate of norepinephrine (NA) release in the peripheral and central nervous system, requiring more protein, especially tyrosine. Similarly, various other nutrients are necessary to reduce the levels of stress chemicals (cortisol and adrenaline) which activate the fight and the response to theft in the body.

Fig. 12.1: The Physiological Response to Stress



Source: George Everly, 2005.

12.9. NUTRITION THERAPY:

- Cut down on caffeine: caffeine is found in coffee, tea, cola beverages, chocolates and some medications. Instead of coffee you could have black tea (lesser caffeine)
- Drink water often: water can curb the urge for coffee and stress related eating.
- Slow down and relax at meal time
- Take time to sit down and eat
- Enjoy the taste of food
- Eat when hungry and stop when you are satisfied
- Raw and crisp fruits and vegetables (for good amount of B- carotene, vitamin c, fibre and phytochemicals such as flavonoids also fruits are a good source such as potassium which helps to decrease your blood pressure)
- Green leafy vegetables which are a good source of magnesium which helps to fight stress.
- Nuts such as walnuts, almonds, pistachios should include as they contains good quality fat and also minerals such as copper, magnesium, manganese, selenium, zinc and also B vitamins.
- Oysters and shell fish are good sources of zinc and copper.
- For omega 3 fatty acids one can consume flaxseeds if vegetarian and if you eat fish then 3 servings of fatty fish a week is recommended.

12.10 NUTRITION RELATED CONCERNS OF ADULTS:

Nutrition may play a greater role than has been realized in preventing many changes once thought to be inevitable consequences of growing older.

Vision and Aging:

Maintaining good vision is a key part of healthy aging.

Cataracts:

- Cataracts are the clouding of the eye's lens, leading to vision loss if untreated.
- They are linked to oxidative stress, UV light exposure, and aging.
- Nutrients like vitamin C, vitamin E, and carotenoids (from fruits/vegetables) may help slow cataract development.
- Obesity is also associated with cataracts, though its exact role is unclear.

Macular Degeneration:

- A leading cause of vision loss in older adults.
- Linked to oxidative stress and sunlight exposure.
- Omega-3 fatty acid DHA and carotenoids like lutein and zeaxanthin may help prevent or slow the condition.

Osteoarthritis

- Affects older adults, causing joint pain and disability.
- Cartilage in joints wears down, making movement painful.
- Connection between Osteoarthritis & Nutrition
- Overweight: Extra weight stresses joints, increasing pain.
- Weight Loss: Reduces pain, even in non-weight-bearing joints like hands.
- Exercise: Jogging, aerobic activity, and strength training help improve function and reduce pain, especially with weight loss.

Rheumatoid Arthritis:

- An autoimmune disease where the immune system attacks joint linings.
- Possible dietary links through immune system regulation.
- Mediterranean Diet (fish, vegetables, olive oil) may help reduce inflammation and provide relief.
- Omega-3 Fatty Acids found in fatty fish help to reduce joint tenderness and improve mobility.
- A heart-healthy diet (low in saturated fat, high in omega-3s) may reduce joint inflammation.

- Vitamins C & E and carotenoids may help prevent or ease rheumatoid arthritis symptoms.

Gout:

- A type of arthritis caused by uric acid crystal deposits in joints.
- High-risk foods: Meat and seafood increase uric acid levels.
- Protective foods: Dairy products may lower uric acid levels and reduce gout risk.

The Aging Brain:

- Brain function declines due to genetics, diseases, and environmental factors (including diet).
- **Age-Related Changes:**
    - Decreased blood supply to the brain.
    - Loss of neurons affects hearing, speech, memory, and cognitive function.
    - Neuron loss in the cerebellum affects balance and posture.
- Some cognitive decline may be linked to nutrient deficiencies, which are controllable.

Alzheimer's Disease:

- Gradual loss of memory, reasoning, communication, physical abilities, and eventually life.
- Cause: Nerve cells die, and brain communication breaks down.

Nutrition Concerns:

- Weight Loss Risks: Depression, forgetfulness, and metabolic changes affect eating.
- Caregiver Role: Supervise meals, provide well-balanced, preferred foods.
- Reduce Confusion: Offer simple, bite-sized, ready-to-eat meals with familiar flavors.
- Minimize Distractions: Keep meals in a quiet, calm environment (no TV, loud noises).

12.11. SUMMARY:

Stress can substantially affect a grownup's nutritional reputation and standard nicely-being. It can adjust ingesting styles, disrupt digestion, and cause various health problems. Stress triggers complicated metabolic and hormonal responses in the body, influencing urge for food and food picks. People may revel in emotional consuming, senseless munching, or

cravings for dangerous, high-calorie foods because of pressure, regularly leading to weight benefit or digestive issues. The gastrointestinal device is particularly prone to strain, with signs and symptoms including bloating, cramping, and even the development of conditions like peptic ulcers. Moreover, hormones like cortisol and epinephrine play a function in how the body responds to stress, impacting appetite and meals consumption. To manage stress correctly through nutrients, individuals are advocated to maintain normal meal instances, increase fiber intake, and reduce caffeine consumption.

12.12. TECHNICAL TERMS:

Stress, nutritional problems, nutrients, nutrition therapy.

12.13. SELF ASSESSMENT QUESTIONS:

1) Describe the Effect of stress on nutritional status?

2) Describe the Specific nutritional problems of adults?

12.14. SUGGESTED READINGS:

1) Swaminathan, M. Advances Text book on Book of Food and Nutrition Vol. 1 and 2 Bangalore Printing Publishing Co., Ltd., Bangalore, II ed., 1988.

2) Fox, B.A., and Cameron, A.G., Food Science, Nutrition and Health, Edward Arnold, London, 1995, VI Edition.

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LESSON-13

GERIATRIC NUTRITION: THE PROCESS OF AGEING, PHYSIOLOGICAL, BIOCHEMICAL, BODY COMPOSITIONAL CHANGES AND THEORIES OF AGEING, SOCIO- CULTURAL AND PSYCHOLOGICAL ASPECTS OF AGEING

13.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Understand the process of Ageing.
- Aware of Physiological, biochemical and body compositional changes.
- Know about theories of Ageing as well as Socio-cultural and psychological aspects of ageing.

STRUCTURE:

13.1 INTRODUCTION:

Ageing is defined as the progressive physiological changes in an organism that lead to a decline in biological functions and the organism's ability to adapt to metabolic stress. It is a natural, inevitable process that begins at birth and continues through the various stages of life. As people age, they go through different phases: growth, development, maturity, and eventually, the gradual decline of physical and biological functions.

Psycho-socially, aging is often defined as becoming older, and biologically, it refers to the process of increasing biological age. The term "geriatric patient" is typically used to describe individuals, whose biological age is advanced, marking them as older adults.

While aging is a natural and unavoidable part of life, it is often viewed differently by people at different stages of life. For the young, aging is both an exciting and fearful concept, as they look ahead to their future. Middle age, however, is when people start noticing visible signs of aging, such as graying hair, wrinkles, and a decline in physical capabilities. Even those who are physically fit and in good health cannot escape these inevitable changes. As people transition into old age, slow and steady physical impairments and functional disabilities become more apparent. These changes may result in increased dependency, and many individuals experience a higher need for assistance with daily tasks and activities.

The World Health Organization (WHO) defines aging as a biological reality that starts at conception and ends with death. While aging is driven by inherent biological processes, each society and culture also has its own perceptions and constructions of what old age means. In many developed countries, the age of 60 is often considered a milestone in the aging process, though this can vary depending on social and cultural contexts.

Aging is not just a matter of biological decline; it is influenced by factors such as health, lifestyle choices, and societal attitudes toward older individuals. With advancements in healthcare and better access to nutrition and exercise, people are living longer, and the experience of aging is constantly evolving. As such, aging is a complex and multifaceted process, shaped by both biological factors and the cultural and social constructs of each society.

13.2 PROCESS OF AGEING:

Aging is a continuous process that spans the entire adult lifespan of any living organism. It is an integral part of the developmental sequence that starts from prenatal growth and continues through to senescence (the condition or process of aging). Gerontology is the scientific field that studies the phenomena of aging. It focuses on the progressive changes that occur at the cellular, tissue, organ, and systemic levels, and even within populations, as time

progresses. More specifically, gerontology examines the changes that take place from the attainment of maturity to the eventual death of an individual, as well as the factors that influence these changes.

In essence, aging is a complex and multifaceted process, involving biological, physiological, environmental, psychological, behavioral, and social changes. These changes vary from person to person, and the rate at which someone ages is unique to them based on genetic, lifestyle, and environmental factors.

Some common changes that occur with the process of aging include:

Physical Changes:

1) **Decreased muscle mass and strength**: As individuals age, they experience a reduction in lean body mass, leading to weaker muscles and less endurance.
2) **Bone density loss**: The bones become more brittle and prone to fractures as bone mass declines with age.
3) **Reduced skin elasticity**: Skin loses collagen and elastin, causing wrinkles, sagging, and thinning.
4) **Changes in vision and hearing**: Aging can lead to presbyopia (difficulty focusing on close objects) and hearing loss, particularly high-frequency sounds.
5) **Slower metabolism**: With age, the body's metabolism slows down, often leading to weight gain and a reduced ability to process food and nutrients.

Cognitive Changes:

1) **Memory decline**: Short-term memory and cognitive processing speed may decline with age. Alzheimer's disease and other forms of dementia become more common.
2) **Decreased ability to learn new information**: Older adults may experience difficulty in learning new things.

Biological and Non-Biological Changes:

Aging is most complex process influenced by biological as well as non-biological factors. It involves the gradual inclusion of molecular and cellular damage, which can result in a decline in both physical and mental capacities. As this damage builds up, the body's ability to repair itself diminishes, leading to an increased vulnerability to diseases and a higher risk of mortality. Below are examples of both biological and non-biological changes associated with aging:

Biological Changes:

Atrophy: Cells in various organs, including the heart, brain, and skeletal muscles, shrink over time. This reduction in cell size can impair organ function, affecting overall health and physical abilities.

Bone Changes: As people age, bones become thinner and less dense due to reduced bone mass. This condition, known as osteoporosis, makes bones more fragile and increases the risk of fractures, especially in the spine, hips, and wrists.

Muscle Changes: The process of aging causes muscles to lose strength, endurance, and flexibility. This decline in muscle mass, known as sarcopenia, can affect balance, coordination, and mobility, making older adults more susceptible to falls and injury.

Vision and Hearing Changes:

Vision: Presbyopia, or difficulty focusing on close objects, becomes more common with age. Other age-related conditions like cataracts or macular degeneration can also affect vision.

Hearing: Age-related hearing loss, or presbycusis, results in a gradual decline in the ability to hear high-frequency sounds, making it harder to follow conversations, especially in noisy environments.

Olfactory Changes: The sense of smell tends to diminish with age due to a decrease in the number of olfactory receptors, which can affect the enjoyment of food and reduce the ability to detect environmental hazards (e.g., gas leaks or spoiled food)

Non-Biological Changes:

Aging is also accompanied by life transitions that can impact an individual's mental and emotional well-being, such as:

Retirement: Transitioning from an active work life to retirement can lead to shifts in social roles, daily routines, and a loss of identity or purpose for some individuals.

Relocation: Older adults may move to retirement communities or assisted living facilities, which can involve the loss of a familiar home and neighbourhood, potentially leading to feelings of isolation.

Loss of Loved Ones: The death of family members or close friends can lead to grief and loneliness, further affecting emotional health.

13.3 PHYSIOLOGICAL CHANGES:

Aging is a normal biologic process. However, it involves some decline in physiologic function. Organs change with age. The rates of change differ among individuals and within organ systems. It is important to distinguish between normal changes of aging and changes caused by chronic disease such as atherosclerosis.

The human growth period draws to a close at approximately age 30, when senescence begins. Senescence is the organic process of growing older and displaying the effects of

increased age. Disease and impaired function are not inevitable parts of aging. Nevertheless, there are certain systemic changes that occur as part of growing older.

These changes result in varying degrees of efficiency and functional decline. Factors such as genetics, illnesses, socioeconomics, and lifestyle all determine how aging progresses for each person. Indeed, one's outward expression of age may or may not reflect one's chronologic age and there is a need to eliminate ageist stereotypes. Aging causes physiological changes in many organ systems, including the lungs, heart, bones, muscles, and immune system:

Cardiovascular System:

- Heart diseases are the single largest cause of death after age 65. As age increases, the heart becomes more vulnerable to cardiovascular disease.
- Gradual loss of muscle fibers occurs, with infiltration of adipose tissue
- Cardiac output declines and the reserve capacity of the heart diminishes with age.
- Arteriosclerosis, or hardening of the arteries, increases markedly with age.

Digestive System:

In the large intestine, materials move through a little more slowly. In some people, this flows through it, and liver enzymes that help the body process, medications and other substances work less efficiently. As a result, the liver may be slightly less able to help remove medications and other substances from the body. Other associated reasons are-

- The loss of teeth with age will impair the digestion, since food will not be masticated to get more exposure to the digestive juices and enzymes
- Decline in the following secretions of the stomach also will affect the digestion process-

Hydrochloric Acid:

- Digestive enzymes
- Digestive juices

Nervous System:

With advancing age there is a slight loss of neurons (nerve cells) in the brain, which leads to loss of memory. Arteriosclerosis which is common in ageing reduces the oxygen available to areas of the brain by reducing the blood supply. Genetic and environmental factors, such as exposure to certain chemicals, smoking, or lack of exercise may also contribute to memory impairment and reduced cognitive ability in the elderly. Ultimately, there may be decreased attention span, and difficulty in learning new things.

Endocrine System Changes with Aging:

As we age, several changes occur in the endocrine system, affecting hormone levels and their functions. These changes can have significant implications for various bodily processes, including metabolism, fluid balance, and overall health. Here are some of the key endocrine changes that occur with aging:

1) **Growth Hormone (GH) Decline**
2) **Aldosterone Levels Decrease**
3) **Insulin Resistance and Decreased Insulin Production:**
4) **Thyroid Gland dysfunction**
5) **Adrenal Cortex Insufficiency**
6) **Pituitary Gland dysfunction**
7) **Pancreatic malfunction**

Musculo-Skeletal System:

The decreased strength and elasticity of ligaments and tendons also makes more prone to tears, and when they do tear, the healing process is slower. In aging, bones gradually lose calcium, resulting in a decrease in bone density. This makes bones thinner, more fragile, and more prone to fractures, even from minor falls. The likelihood of developing **osteoporosis**, a condition marked by the loss of calcium and other minerals from the bones, increases with age. This condition is more common in women after menopause than in men, particularly affecting the spinal column. Furthermore, joint mobility declines with age, and the prevalence of **arthritis** tends to rise as individuals grow older.

Respiratory System:

With aging, the lungs become less efficient at fighting infections, partly due to a decrease in the ability of cells that clear debris and microorganisms from the airways. Cough reflex, which also plays a role in clearing the lungs, becomes weaker as well. Reduced elasticity of the lungs, along with increased stiffness of the chest wall and impaired gas exchange, contributes to respiratory changes.

Emphysema, characterized by the abnormal enlargement of the lungs due to air accumulation, becomes more prevalent between the ages of 45 and 65. Smoking, which causes **bronchitis** (inflammation of the airways), is a major contributing factor to the rise in emphysema cases. When emphysema and bronchitis symptoms occur together, they are referred to as **chronic obstructive pulmonary disease** (COPD), a progressive lung condition.

Kidney:

- The bladder's maximum capacity to hold urine decreases with age, meaning older adults may experience a more frequent need to urinate.
- Bladder muscles can become overactive, contracting unpredictably, even when there's no immediate need to urinate.
- As these muscles weaken, they become less effective at emptying the bladder fully, leaving more urine behind after urination.
- The urinary sphincter, which controls the release of urine from the body, loses its ability to close tightly, leading to difficulties in holding urine and preventing leakage. As a result, older adults may find it harder to delay urination.

Regulatory Mechanisms:

Certain physiological processes, such as the regulation of blood acidity and sugar levels, remain effective in maintaining normal levels even in the very elderly, especially under resting conditions. However, older adults take longer to restore normal levels when deviations from the normal occur. The body's mechanisms for adapting to environmental temperature changes are less efficient in older adults compared to younger individuals.

Immune System: Although the immune system does not necessarily weaken with age, its response time slows down, leading to an increased risk of infections such as pneumonia and influenza, which are more frequent in older adults and often lead to death at higher rates.

13.4 BIOCHEMICAL CHANGES IN AGING:

Aging is associated with numerous biochemical changes, including:

Cellular Changes: Cells grow larger, lose their ability to divide, and accumulate pigments and fatty substances. Many cells also experience a decline in their functional abilities.

Tissue Changes: Connective tissue becomes stiffer, while tissues lose mass and may become lumpy or more rigid.

Organ Changes: Organs gradually lose function over time, with the heart, lungs, and kidneys undergoing the most significant changes.

Hormonal Changes: Levels and activity of certain hormones, such as growth hormone and aldosterone, decrease as individuals' age.

Immune System Changes: The immune system weakens with age, and there is a shift from lymphoid to myeloid lineage production.

Changes in the Extracellular Matrix: The structure and composition of the extracellular matrix alter, which can impact the mechanical properties of connective tissues.

Mitochondrial Changes: Energy production within mitochondria undergoes changes as individuals' age.

Lipid Level Changes: Total cholesterol rises until around the age of 50 for men and 70 for women. Triglyceride levels also increase with age.

13.5. BODY COMPOSITIONAL CHANGES:

As individuals age, body composition undergoes significant changes. There is an increase in fat mass and visceral fat, while lean muscle mass tends to decrease. Additionally, the increase in fat mass is often more pronounced in the abdominal region, which is associated with higher risks of cardiovascular disease and diabetes.

Blood Glucose: Blood glucose levels tend to progressively rise with age.

Blood Volume: Total body water decreases with age, which in turn reduces blood volume.

Blood Production: The amount of active bone marrow, where blood cells are produced, diminishes over time. As a result, fewer blood cells are generated. However, bone marrow typically continues to produce adequate blood cells throughout life. Problems can arise when there is a significant increase in the need for blood cells, such as during anemia, infections, or bleeding. In these situations, the bone marrow may struggle to meet the increased demand for blood cell production.

High Triglycerides and Cholesterol levels are also seen.

Theories on Aging:

Gerontologists, who specialize in the study of aging, have developed various theories to explain the different aspects of aging. Since aging is a multifaceted process, there are numerous theories, each offering insights into one or more components of aging. However, no single theory can entirely account for the complexity of the aging process. An effective theory should integrate existing knowledge and provide an understanding of how and why various phenomena of aging are interconnected.

Genetic Theories:

Genetic theories suggest that an organism's lifespan is largely determined by heredity. According to one such theory, the aging process may be significantly influenced by the organism's ability to repair the chromosomes within its cells. This theory proposes that the lifespan of a cell or organism is genetically programmed, with specific genes dictating the duration of life. Evidence supporting this theory includes the observation that individuals with long-lived parents tend to live longer themselves, and identical twins often have more similar life spans compared to non-twin siblings.

Nongenetic Theories:

These theories of aging focus attention on factors that can influence the expression of a genetically determined "program." These theories all attempt to explain aging in terms of cellular and molecular changes.

- **Wear-and-tear theory:**

  The **wear-and-tear theory** suggests that over time, repeated damage to cells, tissues, and organs accumulates, ultimately wearing them out and leading to death.

- **Cross-Linking Theory:**

  The **cross-linking theory** suggests that as we age, tissues like tendons, skin, and blood vessels lose their elasticity due to the formation of cross-links between or within collagen molecules, which are responsible for the elasticity of these tissues.

- **Autoimmune Theory:**

  The **autoimmune theory** of aging posits that the immune system, which typically targets disease-causing organisms and foreign proteins, begins to mistakenly attack the body's own cells as it ages.

- **Glycation Theory:**

  The **glycation theory** of aging suggests that glucose plays a significant role in the aging process. In glycation, simple sugars like glucose bind to molecules such as proteins and lipids, leading to a cumulative effect over time. This process can cause structural and functional changes in tissues, which may contribute to aging.

- **Oxidative Damage Theory:**

Reactions within cells can lead to the **oxidation** of proteins and other molecules, involving the loss of electrons, which makes these molecules unstable and highly reactive. This instability causes them to interact with and damage essential cellular components, such as membranes.

- **Molecular Inflammatory Theory:**

The **molecular inflammatory theory of aging** suggests that age-related oxidative stress activates redox-sensitive transcription factors, which are molecules that regulate gene activity. This activation leads to the increased expression of proinflammatory genes, resulting in inflammation across various tissues.

Several other theories also attempt to explain aging:

- **Rate of Living Theory**: This theory posits that every living organism has a finite amount of "Vital Substance" (Energy). Once this energy is depleted, aging and death occur.

  - **Pacemaker Theory**: According to this theory, organisms have a biological clock set at birth. This clock runs for a predetermined time, gradually winding down with age, ultimately leading to death.
  - **Oxygen Metabolism Theory**: This theory suggests that animals with higher metabolic rates tend to have shorter life spans, likely due to greater oxidative stress caused by faster metabolism.
  - **Immune System Theory**: This theory argues that cells can only divide a finite number of times. Eventually, this limited capacity leads to immune system deregulation, excessive inflammation, and aging, culminating in death.

- **Somatic Mutation Theory**: Genetic mutations caused by oxidizing radiations and other factors accumulate with age, causing cells to deteriorate and malfunction.

- **Psychosociological Theory:**

  In addition to biological and molecular theories, there is also a psychosociological theory of aging, which focuses on the behavioral, social, and psychological changes that occur as people grow older. As individuals age, their social interactions, behaviors, and activities often shift. The psychosociological theory is divided into four main sub-theories: **disengagement theory**, **activity theory**, **life-course theory**, and **continuity theory**.

- **Disengagement Theory**: This theory suggests that aging involves a process of withdrawal from social roles and relationships. It proposes that as individuals age, they gradually disengage from society, leading to reduced social interaction and engagement with others.

- **Activity Theory**: In contrast to disengagement theory, activity theory emphasizes the importance of remaining active in social activities. It suggests that maintaining roles and social interactions is essential for an individual's well-being and self-concept. The theory posits that a person’s identity and self-esteem are closely linked to their social roles.

- **Life-Course Theory**: Based on the developmental stages proposed by Erik H. Erikson, life-course theory emphasizes that aging is part of an ongoing developmental process. Erikson’s stages indicate that individuals face new psychosocial challenges at different ages, and maturity continues into old age. The theory suggests that the way individuals navigate these stages influences their development throughout life.

- **Continuity Theory**: This theory posits that older adults strive to maintain a consistent sense of self and stability in their lives, even as they experience changes in health and life circumstances. Older adults attempt to preserve their internal characteristics (such as values, personality, preferences) and external behaviors despite aging-related changes.

Each of these theories offers a different perspective on how aging is not just a biological process, but also a psychosocial phenomenon that involves changes in how individuals relate to society and themselves.

13.7 SOCIO-CULTURAL ASPECTS OF AGEING:

Social factors significantly impact the nutritional status of older adults. Isolation during mealtimes and financial constraints can affect their ability to acquire or enjoy food. Approximately one-third of individuals over 65 and half of those over 85 live alone, a situation that often leads to reduced food intake and diminished enjoyment of meals. While elderly individuals are similarly likely to experience poverty compared to younger populations, a larger proportion of older adults live close to the poverty line. Fixed incomes often force elderly individuals to prioritize spending on medications and other essentials over food.

Social isolation, in particular, has a profound effect on the eating habits of older adults. Those living alone may lose the desire or motivation to cook or eat altogether. The loneliness that often accompanies isolation can lead to apathy, depression, and a decrease in overall food consumption. As a result, isolated elderly individuals are more vulnerable to health problems and have increased susceptibility to illness, further complicating their well-being.

13.8 PSYCHOLOGICAL ASPECTS OF AGEING:

The most prominent psychological changes associated with aging include impairments in short-term memory and cognitive function, which result in slower thinking and response times. While some of these changes occur naturally with age, research indicates that long-term lifestyle factors-such as diet, exercise, and sleep-play a significant role in cognitive health. For instance, aerobic exercise, which promotes better blood circulation and oxygen delivery to the brain, has been linked to improved cognitive performance in older adults. In contrast, chronic diseases, depression, and sleep disturbances can negatively impact cognition. Depression, for example, has been shown to reduce synapse density (neuron connections) in the brain, leading to memory and thinking difficulties. Additionally, both insufficient and excessive sleep can impair memory, with those sleeping more than nine hours per night having an increased risk of developing dementia.

Older adults often become more cautious and less flexible in their behavior, sometimes withdrawing from social interactions. However, these changes may be influenced by societal expectations and institutions, rather than being inherent to the aging process. Many individuals who age successfully take deliberate steps to maintain mental sharpness by engaging in continuous learning and expanding social connections, often seeking relationships with younger people to keep their minds active.

13.9 SUMMARY:

Aging is a gradual and continuous process of natural change that begins in early adulthood. During early middle age, many bodily functions start to decline gradually. While these changes make individuals more prone to certain health conditions, there are actions people can take to mitigate their effects. For example, older adults may experience tooth loss, but regular dental visits, reducing sugar intake, and maintaining good oral hygiene can help prevent it. Thus, tooth loss, while common with age, is preventable.

Aging brings about changes across biological, physiological, environmental, psychological, behavioral, and social dimensions. Some of these changes are benign, such as the graying of hair, while others can lead to declines in sensory functions, daily living activities, and an increased vulnerability to diseases, frailty, and disability. In fact, aging is the primary risk factor for many chronic diseases in humans.

Overall, aging is a continuous journey from birth to death, encompassing physical, social, psychological, and spiritual transformations.

13.10 TECHNICAL TERMS:

Geriatric patient, Gerontology, World Health Organization, Atrophy, Olfactory changes, RDA.

13.11 SELF ASSESSMENT QUESTIONS:

1) Explain in detail about process of aging?
2) Describe the physiological changes of aging?
3) Discuss about Biochemical as well as body compositional changes of aging?
4) What are various theories of aging?
5) Write about socio-cultural aspects of aging?
6) Give a brief account on psychological aspects of aging?

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LESSON-14

FOOD AND NUTRITIONAL NEEDS OF THE ELDERLY - DIETARY MANAGEMENT

14.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Identify Food and Nutritional needs of the elderly.
- Know the Dietary management during old age.

STRUCTURE:

14.1 INTRODUCTION:

Old age marks the final stage of the human lifespan, and as people age, they experience a variety of physiological changes. These changes can manifest both in visible ways, such as wrinkles and graying hair, as well as in less obvious ways, like changes in internal body systems such as circulation, digestion, and metabolism. While some of these changes are universal, their intensity and progression can differ from person to person. The Common Changes with Aging are:-

- **Physical Appearance**: As people age, their skin loses elasticity, and muscle mass decreases. Wrinkles form, and hair may turn gray or thin out. These changes are visible signs of aging.
- **Body Systems**: Aging also affects internal systems, such as the circulatory, respiratory, and digestive systems. Blood vessels may stiffen, bones may become more brittle, and the digestive system may slow down, all of which can affect overall health and function.

One of the biggest challenges for elderly individuals is the risk of malnutrition, which can be exacerbated by several factors like **Limited Access to Healthy Food, Difficulty in Cooking, Loss of Appetite and Depression and Loneliness. L**oss of appetite, lack of access to food or emotional factors, can have serious consequences for older adults like onset of **Nutritional Deficiencies, Weakens Immune System, Muscle Loss, Cognitive Decline etc.** Nutrition plays a crucial role in aging, and appropriate interventions help to reduce the negative effects of aging and promote a higher quality life.

14.2 FOOD NEEDS OF THE ELDERLY:

As age advances, nutrition care evolves beyond merely managing existing diseases or providing medical nutrition therapy. The focus is now expanding to include healthy lifestyles, disease prevention, and overall wellness. This shift is crucial, especially given the rapid aging of the global population. Without a stronger emphasis on improving diet and increasing physical activity at all ages, healthcare costs will likely rise substantially as the population continues to age.

Diet is a fundamental determinant of health at every stage of life, and it becomes even more critical as we grow older. Proper nutrition can help prevent a range of age-related diseases, promote overall health, and improve quality of life. For older adults, a balanced and nutrient-rich diet can contribute to better management of chronic conditions, support mental and physical function, and reduce the risk of disability and premature death.

The general principles for planning a nutritious diet for the elderly are similar to those for younger adults. The most important guideline is to provide meals and snacks that are

nutrient dense, visually appealing, tasteful and of the appropriate consistency. Four or five smaller meals are often more acceptable than three substantial ones.

Food Groups and Nutrient Content of Suggested Balanced Diet for an Elderly Man Weighing 65 kgs (ICMR-NIN, 2020)

Composition of Food Groups	**Amount (g/day)**	**Nutrient Values of Suggested Food Groups**	
Cereals & Millets	180	Energy (Kcal)	~1710
Pulses (a portion of pulses can be replaced with egg/flesh foods)	80	Total Protein (g)	~62
		Visible fat (g)	~20
Green leafy vegetables	100	Calcium (mg)	~844
Other vegetables	200	Iron (mg)	~22.1
Roots & Tubers-Vegetables (excluding potatoes)	100	Zinc (mg)	~10.2
Fruits	150	Magnesium (mg)	~653
Milk	400	Vitamin A (ug)/ -Carotene (ug)	~162
Fats & Oils	20		~9634
Oil seeds & Nuts (gingelly seeds & peanuts)	30	Thiamine (mg)	~1.4
Spices	10	Riboflavin (mg)	~1.5
		Niacin (mg)	~11.9
		Vitamin B6(mg)	~1.9
		Vitamin C (mg)	~220
		Total Folates (ug)	~445
		Vitamin B12 (ug)[2]	~1.5

Food Groups and Nutrient Content of Suggested Balanced Diet for an Elderly Woman Weighing 55 kgs (ICMR-NIN,2020)

Composition of Food Groups	**Amount (g/day)**	**Nutrient Values of Suggested Food Groups**	
Cereals & Millets	140	Energy (Kcal)	~1500
Pulses (a portion of pulses can be replaced with egg/flesh foods)	70	Total Protein (g)	~56
		Visible fat (g)	~20
Green leafy vegetables	100	Calcium (mg)	~844
Other vegetables	200	Iron (mg)	~22.1
Roots & Tubers-Vegetables (excluding potatoes)	100	Zinc (mg)	~10.2
Fruits	150	Magnesium (mg)	~653
Milk	400	Vitamin A (ug)/ -Carotene (ug)	~162
Fats & Oils	15		~9634
Oil seeds & Nuts (gingelly seeds & peanuts)	30	Thiamine (mg)	~1.4
Spices	10	Riboflavin (mg)	~1.5
		Niacin (mg)	~11.9
		Vitamin B6(mg)	1.9
		Vitamin C (mg)	220
		Total Folates (ug)	445
		Vitamin B12 (ug)[2]	1.5

14.3 NUTRITIONAL NEEDS OF THE ELDERLY:

Older persons, usually defined by an age of 65 years or older, are at increased risk of malnutrition due to many factors. Anorexia of aging is crucial in this context. Particularly in advanced age and in the case of acute and chronic illness, nutritional problems are widespread, and a reduced dietary intake in combination with the effects of catabolic disease rapidly leads to malnutrition

DAILY NUTRIENT RECOMMENDATIONS FOR THE ELDERLY IN INDIA (ICMR-NIN, 2020)

Nurients		Energy(Kcal)	Dietary Fibre	Protein(g)	Vit- A(ug)	Thiamin B1(mg)	Riboflavin B2(mg)	Niacin(mg)	Vit-C(mg)	Vit-B6(mg)	Folate(ug)	Vit-B12(ug)	Vit-D(IU)	Calcium(mg)	Magnesium(mg)	Iron(mg)	Zinc(mg)	Iodine(ug)
Men >60 Yrs	EAR	1700	-	43.0	460	1.2	1.6	12	65	1.6	250	2.0	400	1000	370	11	14	95
	RDA	-	30	54.0	1000	1.4	2.0	14	80	1.9	300	2.2	800	1200	440	19	17	140
Women >60 Yrs	EAR	1500	-	36.3	390	1.1	1.6	9	55	1.6	180	2.0	400	1000	310	11	11	95
	RDA	-	25	46.0	840	1.4	1.9	11	65	1.9	200	2.2	800	1200	370	19	13.2	140

EAR: Estimated Average Requirement

RDA: Recommended Dietary Allowance

14.3.1 Energy:

Energy requirements for older adults are influenced by various factors, including age, gender, physical activity level, and overall nutritional status. As individuals age, several physiological changes occur that reduce their energy needs compared to younger adults. Sedentary elderly men (weighing 65kg) requires approximately 1700 kcal/day and Sedentary elderly women (weighing 55kg) requires approximately 1500 kcal/day

14.3.2 Carbohydrates:

Complex carbohydrates, which are found in foods like whole grains, vegetables, and legumes, are digested more slowly than simple sugars, preventing rapid spikes in blood sugar. These foods are high in fiber, which further helps regulate blood glucose levels by slowing the absorption of sugar into the bloodstream. At least **55-60% of the total daily calories** should come from carbohydrates.

14.3.3 Protein:

As individuals age, there is a natural decrease in muscle mass and skeletal tissue, which leads to a reduction in the body's store of protein, particularly from skeletal muscle. This reduction in available protein can make it more challenging to meet the body's needs for protein synthesis, which is vital for maintaining muscle mass, repairing tissues, and supporting the immune system. A protein intake of **1.0 g per kilogram** of body weight, which is the normal adult requirement, is typically safe and beneficial for elderly individuals. This helps to prevent muscle wasting and supports overall health.

14.3.4 Lipids:

The **Dietary Guidelines** recommend that fat intake should make up **20% to 35%** of total daily calories, primarily from polyunsaturated and monounsaturated sources. It is advised to consume less than **10%** of calories from saturated fats, keep cholesterol intake below **300 mg/day.** Focus should be placed on reducing saturated and trans fats, and choosing fats from healthier sources such as monounsaturated and polyunsaturated fats. Sufficient intake of omega-3 fatty acids is important for better visual acuity and may help with conditions like hair loss, improper digestion, kidney function issues, tissue inflammation, osteoarthritis, painful joints, and mental health concerns like depression. Omega-3s also contribute to heart and brain health.

14.3.5 Vitamins:

The main challenge for old people is to increase the intake of vitamins as well as minerals on par with caloric intake. Oxidative processes that occur with aging emphasizes crucial role of antioxidants in maintaining health. Many chronic diseases begin earlier in life, so it is important to encourage younger individuals to improve their diets. Need for the following vitamins is emphasized during old age based on their important functions-

Vitamin A:

Vitamin A is important for older people because it plays a role in many bodily functions, including immune function, eyesight, skin health and bone health.

Vitamin D:

With aging vitamin D status declines as a result of less efficient skin synthesis of vitamin D, impaired ability of the kidneys to convert the inactive form of vitamin D to the active form, reduced sun exposure and low dietary intake of vitamin D. Elderly lose ability to store vitamin D. Vitamin D insufficiency is now considered a wide spread global epidemic particularly the elderly based on serum levels defined as < 50 m mol/L

Vitamin D insufficiency is associated with reduced calcium absorption, low blood levels of ionized calcium, increased circulating parathyroid levels and increased bone resorption. Normal requirement of Vitamin D level according to ICMR, NIN, 2020 is 800 IU for both men and women.

Vitamin E:

Vitamin E can be important for older people because it can help with **Immune response, Cognitive performance, Brain health.** The National Institutes of Health recommends 15 mg of vitamin E per day. However, some studies suggest that higher than recommended levels of vitamin E may be necessary for older people.

Vitamin K:

Vitamin K is important for older adults because it helps with bone health,**Brain health,** heart health, and may reduce the risk of age-related diseases.

B vitamins:

These vitaminscontribute to energy metabolism, DNA repair, immune function and methylation. They help reduce the risk of degenerative diseases, such as cardiovascular disease, cognitive decline, and osteoporosis, and play a role in physical performance. Since B vitamins are water-soluble, the body cannot store excess amounts, and they are eliminated through urine. Therefore, it is essential to replenish B vitamins through food or supplements regularly.

Vitamin B6 requirements tend to increase in the elderly, often due to atrophic gastritis, which interferes with absorption. Alcoholism and liver dysfunction also increase the risk of B6 deficiency, which affects immune function.

Folate deficiencies, often seen in older adults, can lead to anemia and elevated serum homocysteine levels, increasing the risk for cardiovascular disease. Consumption of folate-rich foods should be encouraged, especially since diets in this age group are often lacking in folate.

Vitamin B12 deficiency is commonly caused by atrophic gastritis and bacterial overgrowth, which impair absorption and can lead to pernicious anemia. Aging reduces the body's ability to release vitamin B12 from food, decreasing its bioavailability. Synthetic B12, found in fortified foods and supplements, is more easily absorbed and may be the best source of B12 for older adults.

Recent research shows that higher levels of vitamins B6, B12, and folate can protect against elevated homocysteine levels, which are an independent risk factor for cardiovascular disease, depression, and certain neurological issues.

Vitamin C:

Vitamin C plays a crucial role for older adults by helping to prevent age-related cognitive decline and Alzheimer's disease. It also helps protect against chronic conditions such as heart disease, stroke, and certain cancers. For adults aged 50 and older, the

recommended daily intake of vitamin C is 80 mg for men and 65 mg for women. The upper limit is 2,000 mg per day. It's more beneficial to obtain vitamin C through a healthy diet rather than taking supplements.

Antioxidant vitamins, including vitamin C, vitamin E, and carotenoids, have been promoted as beneficial for elderly health. Vitamin C may help protect against cataracts when consumed at an intake level of 150 to 250 mg per day, which can be achieved through diet alone.

14.3.6 Minerals:

Calcium:

Calcium needs during old age increases. Women over 50 years of age who are not receiving estrogens require more calcium as there is increased losses resulting in demineralisation of bone and osteoporosis. For women over fifty, 800 mg/day in recommended for the following reasons-

1) Calcium is available only from a limited number of foods.
2) To compensate age-related bone loss and to improve calcium balance.
3) To decrease the prevalence of fractures and dental decay.

Iron:

Iron is very essential for haemoglobin formation. A study conducted in an elderly population revealed that high iron stores were more prevalent than iron deficiency. As a result, older adults should avoid taking iron supplements unless they have been specifically diagnosed with iron deficiency.

Copper:

A balanced diet should generally provide adequate copper for most individuals. For those concerned about their copper intake, a multivitamin/mineral supplement typically provides at least the RDA for copper. The recommended daily allowance (RDA) for copper is 900 μg/day for all adults, which is sufficient to prevent deficiency

Fluoride:

The safety and public health benefits of optimally fluoridated water in preventing tooth decay across all age groups are well established. The Linus Pauling Institute supports the recommendations of the American Dental Association and the Centers for Disease Control and Prevention, which advocate for fluoridated water, as well as the use of fluoride toothpaste, fluoride mouth rinse, fluoride varnish, and, when necessary, fluoride supplementation. To minimize the risk of fluorosis, any fluoride supplementation should be prescribed and closely monitored by a dentist or physician.

Iodine:

The RDA for iodine (150 μg/day for men and women) is sufficient to ensure normal thyroid function. There is presently no evidence that iodine intakes higher than the RDA are beneficial.

Magnesium:

Older adults are less likely than younger adults to consume sufficient magnesium to meet their needs, so they should focus on including magnesium-rich foods in their diet, in addition to taking a daily multivitamin/mineral supplement. If a person doesn't regularly consume green leafy vegetables, whole grains, and nuts, they may not be getting enough magnesium from their diet.

Phosphorus:

Currently, there is no evidence suggesting that the phosphorus requirements of older adults differ from those of younger adults. A varied diet should easily provide the recommended dietary allowance (RDA) of 700 mg/day of phosphorus for individuals over 50 years of age.

Potassium:

A diet rich in fruits and vegetables providing 2.6-3.7 g/day of potassium is recommended for healthy older adults, as such diets are linked to a reduced risk of stroke, hypertension, osteoporosis, and kidney stones. **Sodium**

14.3.7 Water:

Maintenance of fluid balance is most important for normal physiological functions at all stages of life, but older adults are especially vulnerable to dehydration. As individuals age, lean body mass decreases, which in turn lowers the content of water in the body—from around 60% in youth to about 50% in older adults. Dehydration in the older people may result from reduced fluid intake, kidney disfunction or excess fluid loss due to medications like diuretics or laxatives. To maintain proper hydration, it is recommended that older adults consume at least 1,500 ml of fluid per day.

Symptoms of dehydration can include electrolyte imbalances, altered drug effectiveness, headaches, constipation, changes in blood pressure, dizziness, confusion, and dry mouth. Older adults are at heightened risk for dehydration due to factors such as a reduced sense of thirst, fear of incontinence, and dependency on others for fluid intake. Dehydration may often go unrecognized, as it can manifest as falls, confusion, changes in consciousness, weakness, or fatigue.

Adequate fluid intake is important for maintaining kidney function, as the kidneys require sufficient hydration (around 1.5 liters) to effectively eliminate waste. Additionally, water supports peristalsis and helps prevent constipation. Water can be consumed directly or through other liquids like buttermilk, fruit juices, porridge, and soups. Dehydration in the elderly can cause confusion, headaches, and instability. Therefore, it is important for older adults to be encouraged to drink regularly, even if they do not feel thirsty. Adequate fluid intake supports normal saliva production, bowel movements, gastric function, and cognitive health, along with kidney, cardiovascular, and metabolic functions.

14.5 DIETARY MANAGEMENT:

Elderly individuals are at a higher risk of malnutrition, which includes insufficient intake of calories, protein, vitamins, and minerals. Malnutrition is strongly linked to cognitive decline in older adults. For example, people with age-related cognitive decline may forget mealtimes, how to shop for groceries, or how to prepare meals. This can lead to deficiencies in key nutrients, particularly vitamins B6, B9, and B12, which are associated with further cognitive impairment. Additionally, a reduced sense of taste and smell as people age can make food less appealing, further affecting their eating habits.

Several age-related changes in the stomach negatively impact digestion and nutrient absorption. One common issue is reduced stomach acid production, which can impair digestion and decrease the absorption of vitamin B12 and iron. A deficiency in vitamin B12 is linked to cognitive decline, while insufficient iron can lead to anemia, which causes severe fatigue and a loss of appetite. Moreover, stomach emptying slows down with age, reducing the frequency and desire to eat.

Peristalsis, the movement of food through the intestines, also becomes slower in older adults, leading to common issues like constipation and bloating. Drinking adequate amounts of water and consuming more fiber can help alleviate constipation and improve digestive health.

Fibre:

Fiber promotes peristalsis and aids in digestion. There is considerable support for encouraging the consumption of fiber-rich foods, but it is important to increase fiber intake gradually to avoid bowel discomfort, bloating, and flatulence. While rough fiber, such as bran and mature vegetables, may not be suitable for older adults, the fiber found in tender vegetables and fruits can facilitate the movement of food through the intestinal tract more comfortably.

In addition to supporting digestion, fiber can help lower cholesterol levels, potentially reducing the risk of atherosclerosis. ICMR-2020 suggested requirement of fibre for elderly 30 g/d and 18 g/1000 kcal.

Dietary Guidelines for Elderly Individuals:

- Caloric intake should be adequate to maintain appropriate body weight.
- Carbohydrates should make up 55-75% of total calories, with an emphasis on complex carbohydrates.
- Protein should contribute 10-15% of total calories (1g per kg body weight).
- Total fat should comprise 15-35% of total calories.
- Cholesterol intake should not exceed 300 mg/day.
- Saturated fats should be less than 10% of total calories.
- Polyunsaturated fats (PUFA) should be limited to no more than 8% of total calories.
- Monounsaturated fats (MUFA) should be 15% of total calories.
- The PUFA/Saturated fat ratio should be 0.8–1.0.
- Trans fats should be avoided.
- The ratio of Linoleic acid (LA) to Alpha-linolenic acid (ALA) should be 5-10.
- Sugar intake should be kept under 10% of total calories.
- Salt intake should be limited to 5-7 grams/day.
- Water intake should be 1.5 to 2 liters/day.
- A variety of foods should be consumed.

Food-Based Guidelines for the Elderly:

- Include a variety of whole grains, millets, and pulses in the daily diet.
- Two glasses of low-fat milk and equivalent milk products should be consumed.
- Consume 4-5 servings of fruits and vegetables (all colors), with 1 serving equaling 1 bowl or 125g.
- Encourage the intake of salads.
- Recommended healthy oil intake is 15-20g, with a variety of oils such as sunflower, safflower, groundnut, olive, canola, and soybean.
- For non-vegetarians, lean chicken, fish, and egg whites are healthy protein options.

14.6 SUMMARY:

As individuals age, changes in body composition are inevitable. The percentage of muscle tissue decreases, while fat tissue increases. This shift results in a decrease in metabolic rate, which drops by approximately 15-20% over a lifetime, mainly due to reduced physical activity and changes in body composition. **Sarcopenia** is an age-related loss of skeletal muscle mass and strength, which leads to changes in gait, balance, and overall physical function. Lean body mass declines by approximately 2-3% per decade, and body protein levels in older adults are 30-40% lower than in younger adults. In men, the average body fat percentage increases from about 15% in youth to around 25% by age 60, primarily due to decreased physical activity and hormonal changes such as alterations in testosterone and growth hormone levels, which influence muscle growth and anabolism. Conditions like trauma, surgery, and infections can also affect lean body mass, as the body's hormonal response to stress increases energy needs and promotes the breakdown of protein. To counteract some of these challenges, it is beneficial for older adults to enjoy mealtime with family and friends, as this provides social support and helps maintain a healthier eating regimen. Social isolation, unfortunately, is a common issue that many older adults face, and it can negatively impact their overall well-being.

14.7. TECHNICAL TERMS:

ICMR, NIN, Homocysteine, Carotenoids, Fluorosis, RDA, Dehydration.

14.8. SELF ASSESSMENT QUESTIONS:

1) Explain the nutritional needs during aging?
2) Discuss about food requirements during old age?
3) Describe about dietary management during old age?

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LESSON-15

SPECIAL PROBLEM OF WOMEN-MENOPAUSAL, POST-MENOPAUSAL PROBLEMS

15.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Understand the menopausal problems of women
- Identify the post-menopausal problems

STRUCTURE:

15.1 INTRODUCTION:

Menopause is one of the most remarkable events in a woman's life and brings enormous changes that affect the life of a woman permanently. The World Health Organization defines natural menopause as the permanent cessation of menstruation resulting from the loss of ovarian follicular activity without an obvious intervening cause and is confirmed only after 12 consecutive months of amenorrhoea. In general, the natural menopause occurs between 45 and 55 yr of age, average being 51. Menopause is also mentioned as one point in life span for women which marks the end of their reproductive years. For most women, menopause is marked by the end of monthly menstruation due to loss of ovarian follicular function. This means that the ovaries stop releasing eggs for fertilization. After menopause, a woman cannot become pregnant.

There are several factors affecting menopause:

Lifestyle Factors: Smoking, food habits and work profile

Hormonal Imbalances: Ovarian insufficiency

Socio-Economic Background: Illiteracy, underweight, employment, family history, age at menarche and abortion

Parity: Such as age at first pregnancy, breastfeeding and having a live birth

The period reaching up to menopause is called perimenopause, and can last for 2 to 8 years. During this time, the ovaries produce varying quantities of hormones, which results in symptoms like hot flashes, vaginal dryness, irregular periods and mood changes etc.

Salient Features of Menopause:

- Majority of women experience menopause between the ages of 45 and 55 years as a natural process of biological ageing.
- Menopause is due to loss of ovarian follicular function and a reaction in circulating blood oestrogen levels.
- The menopausal transition can be very gradual, usually beginning with changes in the menstrual cycle.
- Perimenopause refers to the period from the first appearance of the signs and ends with one year after the final menstrual period.
- Perimenopause can last for several years and affect physical, emotional, mental and social well-being.
- A variety of non-hormonal and hormonal interventions can help to alleviate perimenopausal symptoms.

- The regularity and length of the menstrual cycle varies over a woman's reproductive life span.
- Some women experience menopause before 40 years of age, which is called premature menopause. This may be because of certain chromosomal abnormalities, autoimmune disorders or other unknown causes.
- It is highly impossible to predict when an individual woman will experience menopause, although there are correlations between the age at menopause and certain demographic, health and genetic factors.
- Menopause can also be acquired as a consequence of surgical procedures that involve removal of both ovaries and medical interventions that cause cessation of ovarian function eg: Radiation therapy or chemotherapy.

15.2 CHANGES ASSOCIATED WITH MENOPAUSE:

The hormonal changes associated with menopause can affect physical, emotional, mental and social well-being. The symptoms experienced during the menopausal transition vary substantially from person to person. Some have few if any symptoms. For others, symptoms can be severe and affect daily activities and quality of life. Some can experience symptoms for several years.

Symptoms Associated with Menopause Include:

- **Hot flashes and night sweats:** Hot flushes refer to a sudden feeling of heat in the face, neck and chest, often accompanied by flushing of the skin, perspiration, palpitations and acute feelings of physical discomfort which can last several minutes
- Changes in the regularity and flow of the menstrual cycle, culminating in cessation of menstruation
- Vaginal dryness, pain during sexual intercourse and incontinence
- Difficulty in sleeping, which is called as insomnia
- Body composition and cardiovascular risk also may be affected. Women's advantage over men in terms of cardiovascular disease gradually disappears with the significant decline in oestrogen levels after menopause.
- Menopause can also result in the weakening of the pelvic support structures, increasing the risk of pelvic organ prolapse. Loss of bone density at menopause is a significant contributor to higher rates of osteoporosis and fractures.
- Brain fog

- Worsening premenstrual syndrome (PMS)
- Breast tenderness
- Mood changes can range from mild to severe, and can include depression, irritability, and anxiety.
- **Urinary incontinence**: About half of postmenopausal women have trouble holding in their urine.
- **Bone density**: Loss of bone density can lead to osteoporosis and fractures.
- **Weight gain**: Hormonal changes can cause the body to store more fat and burn calories less efficiently.
- **Lead poisoning**: Lead stored in bones is more likely to be released into the blood after menopause, increasing the risk of high blood pressure and atherosclerosis.
- **Oral issues**: Dry mouth and an increased risk for cavities are more common after menopause.
- **Post menopause**:

  Achieving post menopause is a milestone that–like all of life–comes with its positive and negative effects. On the other hand, postmenopause may bring new health issues. Some are part of the typical aging process. Others are unique to the decrease in body's natural production of estrogen.

Symptoms of Post-Menopause:

- ❖ Hot flashes and night sweats.
- ❖ Vaginal dryness and pain during sex
- ❖ Depression.
- ❖ Changes in sex drive (low libido).
- ❖ Insomnia.
- ❖ Dry skin.
- ❖ Weight changes.
- ❖ Hair loss.

15.3 MENOPAUSAL AND POST-MENOPAUSAL PROBLEMS:

Cardiovascular System:

The risk of cardiovascular disease (CVD) increases significantly following menopause due to a sharp drop in reproductive hormones like estrogen and progesterone.

Estrogen acts as a protective factor against cardiovascular disease, which is why premenopausal women generally have a lower likelihood of heart attacks compared to men of the same age. These hormones influence more than just the reproductive system—they also affect various organs and other bodily functions. Reduced estrogen levels may lead to increased blood pressure, higher LDL cholesterol and blood sugar levels, decreased lean muscle mass, and reduced vascular elasticity. Additionally, heart palpitations, or irregular heartbeats, can become more common during and after menopause, signaling an elevated cardiovascular risk. Palpitations are often short-lived and typically do not indicate severe problems.

Estrogen helps maintain the inner layer of arterial walls, which plays a key role in regulating blood flow. According to the American Heart Association, the drop in estrogen levels after menopause is thought to contribute to the rise in heart disease among postmenopausal women. Cardiovascular disease is the leading cause of death and disability among women in developed nations, contributing to a significant percentage of disability, particularly among women over 70. As estrogen levels drop, the risk of cardiovascular problems increases and women become more susceptible to conditions such as hypertension, atherosclerosis, and coronary artery disease.

Increased Risk of Hypertension:

- One of the most common cardiovascular problems during and after menopause is high blood pressure (hypertension). Estrogen helps to relax blood vessels and promote better blood flow. As estrogen levels decrease during menopause, blood vessels may become stiffer, leading to an increase in blood pressure. Additionally, weight gain, which is common during menopause, can further elevate the risk of developing hypertension.

Atherosclerosis and Coronary Artery Disease:

- Atherosclerosis, the hardening and narrowing of the arteries due to plaque buildup, becomes more pronounced after menopause. Estrogen typically helps maintain healthy cholesterol levels by increasing high-density lipoprotein (HDL) cholesterol, which removes bad cholesterol from the bloodstream. With lower estrogen levels, HDL cholesterol may decrease, while low-density lipoprotein (LDL) cholesterol (the “bad” cholesterol) may increase. This imbalance accelerates the development of atherosclerosis, which can lead to coronary artery disease (CAD), heart attacks, or strokes.

- **Changes in Lipid Profile:**

  As women transition through menopause, there is often a shift in lipid (fat) metabolism. This results in higher levels of total cholesterol and LDL cholesterol, which contribute to the buildup of fatty deposits in the arteries. Lower levels of HDL

cholesterol, which helps prevent such buildups, further exacerbate this risk. These lipid changes increase the likelihood of cardiovascular diseases, particularly in postmenopausal women.

- **Increased Risk of Heart Disease:**

  After menopause, women's overall risk for heart disease increases, surpassing that of premenopausal women. The risk is further amplified by other factors that become more common with age, such as obesity, lack of physical activity, and diabetes. Estrogen's protective effects on the heart and blood vessels diminish after menopause, and women may experience more severe consequences from heart disease, such as heart attacks, due to changes in blood pressure and cholesterol levels.

- **Impact of Menopausal Weight Gain:**

  Many women gain weight around the abdomen during menopause, which can increase the risk of metabolic syndrome. This syndrome is a cluster of risk factors, including high blood pressure, high blood sugar, excess abdominal fat, and abnormal cholesterol levels, all of which contribute to an increased risk of heart disease, stroke, and diabetes.

Skeletal System:

The decline in estrogen levels during menopause directly impacts bone density, increasing the risk of osteoporosis, a condition that makes bones brittle and fragile. Bone density typically decreases after menopause, with women losing around 10% of their bone mass in the first five years. This puts them at a higher risk of fractures, with approximately one in two women over 60 suffering a fracture related to osteoporosis. Skeletal muscle loss and fat buildup in muscles contribute to abnormal muscle function and metabolic issues, which may stem from factors such as oxidative stress, inflammation, and insulin resistance. Musculoskeletal disorders are common in older adults, with a significant portion of disabilities in women over 50 being due to these conditions. Osteoporosis, osteopenia and bone density changes are very common during and after menopause-

Osteoporosis is a condition characterized by weakened bones, making them more prone to fractures. During menopause, the rate of bone loss accelerates due to the drop in estrogen. This condition is particularly concerning because bones may become fragile and break easily, even with minor falls or injuries. The most common fractures related to osteoporosis occur in the spine, hips, and wrists.

Osteopenia is a precursor to osteoporosis, where bone mineral density is lower than normal but not low enough to be classified as osteoporosis. While not as severe as osteoporosis, osteopenia still increases the risk of fractures and is a signal that bone health is declining.

Changes in Bone Density: After menopause, bone density typically decreases by about 1% to 2% per year, a rate that is higher than during the years before menopause. This accelerated bone loss can lead to significant skeletal problems if preventive measures, such as diet, exercise, and medications, are not implemented.

Urinary System: Lower estrogen levels can cause thinning of the urethra lining, and the pelvic muscles may weaken due to aging or childbirth, leading to urinary problems such as incontinence and increased risk of urinary tract infections (UTIs).

Menopause can cause a number of urinary system problems, including:

Urinary incontinence:

This may be due to:

- Weakened pelvic floor muscles
- Thinning of the urethra lining
- Loss of bladder elasticity
- Weight gain

Symptoms include:

- Stress incontinence, which is when there is leakage of urine while laughing, coughing or move suddenly
- Urge incontinence, which is when there is a sudden, strong urge to urinate
- Frequent urination
- Waking up at night to urinate (nocturia)

Urinary Tract Infections (UTIs):

- These may be caused by vaginal dryness, which is more common during menopause. Symptoms include:
- Painful urination
- A burning sensation when urinating
- Urine that is strong smelling and cloudy

Other Urinary Symptoms:

- These include:
- Painful urination
- Urethral caruncle, which is a red vascular growth on the urethra
- Feelings of pressure or discomfort in the lower abdomen.

During menopause, levels of **estrogen**, an important hormone in women, naturally reduced. As a result, the walls of the vagina become thin, dry, and sometimes inflamed. In many women, this leads to symptoms of vaginal burning, irritation, pain, bleeding or discharge.

Metabolism: Reduced estrogen may lower metabolic rate, which prompts body to store fat instead of burning it. Menopause can cause a number of metabolic problems, including:

Metabolic Syndrome: It is a combination of risk factors that includes central obesity, insulin resistance, hypertension, and dyslipidemia. Approximately 20-30% of the middle-aged population suffers from metabolic syndrome and prevalence is increasing with obesity and sedentary lifestyle. Symptoms include central obesity, insulin resistance, dyslipidemia with elevated triglycerides, reduced HDL, dense LDL particles, high blood pressure, hyper coagulate state and pro-inflammatory state.

Diabetes Mellitus (DM) accounts for 2.4% of deaths and 3.4% of disability in women aged 50-69 and for 2.2% of deaths and 3.1% disability in women aged 70+. Postmenopausal women are at higher risk of type2 DM compared to their pre-menopausal counterparts. This is due to the development of metabolic risk factors during menopause.

Lipid Metabolism: Menopause leads to significant changes in lipid levels in the blood, including alterations in low-density lipoproteins (LDLs), high-density lipoproteins (HDLs), and triglycerides. It also brings about both quantitative and structural changes in adipose tissue, such as increased fat accumulation in the abdominal region. These changes are accompanied by modifications in lipid profiles and the onset of insulin resistance (IR). Postmenopausal women are more likely to experience obesity, with more pronounced increases in bioavailable testosterone compared to those who have more stable testosterone levels. On the other hand, women who experience slower increases in bioavailable testosterone tend to have smaller increases in body fat. Additionally, elevated levels of follicle-stimulating hormone (FSH) may contribute to this phenomenon, as FSH receptors (FSHRs) are found in visceral adipocytes.

After menopause, the accumulation of visceral fat increases due to changes in metabolism and body composition. Moreover, adipose tissue becomes more lipolytic following a decrease in estrogen levels. Changes in the regulation of proteins involved in liver lipid management further contribute to the development of Non-Alcoholic Fatty Liver Disease (NAFLD). This excessive accumulation of fat in the liver accelerates the disease's progression, leading to hepatic insulin resistance, oxidative stress, and inflammation.

As women age, there is an increased risk of conditions like obesity, cardiovascular disease (CVD), type 2 diabetes, hypertension, and other non-inflammatory disorders, such as

stroke. The rising risk of these non-infectious diseases is strongly linked to the increase in central obesity, particularly around the waist, rather than a general rise in body mass index (BMI). Specifically, the changes in fat distribution before and after menopause contribute to an increase in abdominal fat, which poses greater health risks.

Weight Gain: Menopause can cause weight gain, especially around the midsection.

Loss of Muscle Mass: Menopause can cause a loss of muscle volume and strength.

Digestive Problems: Menopause can slow down digestion, which can lead to constipation, bloating, and increased gas. Other metabolic disorders associated with menopause include: fat redistribution, visceral fat accumulation, and altered fatty acid metabolism. Physical activity can help protect against metabolic dysfunction after menopause.

Central Nervous System: Menopausal women often experience a variety of symptoms affecting the central nervous system. Various symptoms related to menopause reportedly affect women's lives. Among the known symptoms of menopause, central-nervous-system-related symptoms include-

Vasomotor Symptoms: 55-79% of women experience vasomotor symptoms or hot flashes during and after the menopausal transition. These are due to factors such as climate, diet, lifestyle, women's role and attitudes. Hot flashes cause a sudden sensation of mild to intense heat which may be accompanied by anxiety, palpitations, sweating, and facial flushing. Changing levels of circulatory estrogen lead to onset of hot flashes.

Sleep Disturbance: Sleep disturbances are more common in menopausal women with increasing age. Several studies have reported prevalence of sleep disturbances is at about 50%. It is more in Postmenopausal women compared to pre- or perimenopausal women. Sleep-disordered breathing or sleep apnea increases during and after menopause, which have detrimental effects on quality of life.

Depression: Depression is more prevalent among middle-age and elderly women. Symptoms of depression are dementia and cognitive decline. Depressive disorders like anxiety, unipolar and bipolar depressive disorder account for 2.3% of disability in women of 70+ and 6.3% in women of 50-69 years. Menopause with a history of mood disorders raises the risk of depression.

Dementia: Dementia is the major cognitive impairment which ultimately affects an individual's daily activities. Higher prevalence of dementia occurs in postmenopausal women. Dementia is the umbrella term for changes in the normal activity of the brain. Elderly adults who suffer from dementia may experience memory loss, agitation, and delusions.

Alzheimer's Disease: It is one of the leading causes of disability in elderly women; causing 5.7% of disability among 70+ women and 1.0% among women 50-69 years. One in eight

people over age sixty-four and almost half of all people over eighty-five suffer from the brain disorder Alzheimer's disease, which is the most common form of dementia.

Apart from these, there is also other symptoms like- anxiety, migraine and cognitive changes etc.

Cancer: Cancer is one of the leading causes of death. Among women aged 50-69, cancer is responsible for 41% of deaths, and 16% of deaths in women over 70. The most prevalent are cancers of the lung, breast, colorectal, ovaries, pancreas and cervix. Lifestyle factors such as high BMI, poor diet, lack of exercise, smoking, and alcohol consumption play a significant role in cancer development.

Chronic Respiratory Disease:

Chronic Obstructive Pulmonary Disease (COPD) is a significant cause of death and disability, particularly among women aged 50-69 (2.9% of deaths and 1.0% of disability). This disease primarily arises from smoking, but other factors like genetics and exposure to environmental pollutants can also contribute. Quitting smoking can significantly reduce the risk of COPD.

Multimorbidity:

As many as 60% of older women experience multiple health issues after menopause, including hypertension, osteoarthritis, diabetes, and osteoporosis. The coexistence of these conditions increases the risk of death, disability, and poor quality of life.

15.4 SUMMARY:

Menopause marks the natural end of a woman's reproductive period, typically occurring around the age of 51. This transition, known as perimenopause, brings about a variety of physiological and emotional changes. Many older adults face significant health challenges such as heart disease, cancer, and diabetes, and women experience changes in hormone levels, muscle mass, and body composition. Fat accumulation around the abdominal area increases the risks for type 2 diabetes and cardiovascular disease. Additionally, skin becomes thinner and healing takes longer, while kidney function may decline. As estrogen levels drop, bone mass decreases, making fractures more common. Menopause also affects heart efficiency, immune function, and the absorption of vitamins and minerals. While some women experience minimal symptoms, others may struggle with hot flashes, night sweats, sleep problems, and mood swings. This period can be marked by both relief and challenges, depending on the individual's experience.

15.5 TECHNICAL TERMS:

Alzheimer's disease, Urinary tract infections, Hot flashes, post menopause, Osteoporosis, Cance, Insomnia, Dementia, Cardio vascular disease, Diabetes

15.6 SELF ASSESSMENT QUESTIONS:

1) What is Menopause?
2) What are the changes associated with menopause?
3) Mention about symptoms of post-menopause
4) Explain the problems of menopause and post-menopause

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LESSON-16

CHRONIC DEGENERATIVE DISEASES, NUTRITION AND HEALTH PROBLEMS OF ELDERLY

16.0 OBJECTIVES:

After reading this chapter, students will be able to:

- Understand about various chronic degenerative diseases of elderly.
- Know the nutrition and health problems of elderly.

STRUCTURE:

16.1 INTRODUCTION:

Elderly individuals are more vulnerable to various diseases and disorders due to a decline in their immune resistance. Chronic degenerative diseases (CDDs) are long-lasting, non-infectious, and slow-progressing conditions, including Alzeimer's disease, obesity, diabetes, Parkinson's disease, heart disease, arthritis, osteoporosis, osteomalacia, cataracts, chronic respiratory diseases, neurological disorders, and cancer. These diseases have become the leading causes of long-term disability and death worldwide. Over 30% of the global population is affected by one or more CDDs, and these conditions account for approximately 70% of public health expenditures.

The most common chronic degenerative diseases among the elderly people are:

16.2. CHRONIC DEGENERATIVE DISEASES:

Alzheimer's Disease:

Alzheimer's disease primarily affects individuals over the age of 65. According to the National Institute on Aging, it is the sixth leading cause of death, though some recent estimates suggest it may be the third, just behind heart disease and cancer. Alzheimer's is a brain disorder that leads to a gradual deterioration in memory, thinking, learning, and organizational abilities. Over time, it impairs a person's capacity to perform even the simplest daily tasks. Alzheimer's is the most prevalent form of dementia, responsible for 60-80% of dementia cases. There is no cure for this disease. The symptoms of Alzheimer's disease are-

- Memory loss.
- Language problem.
- Impulsive or unpredictable behaviour.
- Problem with recognition.
- Problem with spatial awareness.
- Cognitive deficits.

Obesity:

A reduction in estrogen and progesterone levels can trigger metabolic changes that contribute to obesity. Obesity has become an escalating concern across all age groups, including the elderly. It also raises the risk of several health issues, which can eventually lead to the development of serious diseases. It is manifested with the following symptoms-

- Extremely tired.
- Fatigue.

- Lack of energy to do tasks.
- Weight gain.

Diabetes Mellitus:

Diabetes is a significant health condition that impacts a large number of older adults. It occurs when there is elevation of blood sugar level. Type 2 diabetes is the most common form of the disease in older adults, which is with the following symptoms-

- Tiredness
- Increased hunger or thirst.
- Weight loss.
- Frequent urination.
- Numbness.
- Tingling sensation in hands or feet

Parkinson's Disease:

Parkinson's disease is a neurological disorder that leads to involuntary or uncontrollable movements, including tremors, rigidity, and challenges with balance and coordination. Symptoms typically start slowly and worsen over time. As the disease advances, individuals may experience difficulty walking and speaking. Additionally, they may face mental and behavioral changes sleep disturbances, depression, memory issues, and fatigue.

Symptoms:

Parkinson's has four main symptoms:

- Tremor in hands, arms, legs, jaw, or head.
- Muscle stiffness, where muscle remains contracted for a long time.
- Slowness of movement.
- Impaired balance and coordination, sometimes leading to falls.

Other symptoms may include:

- Depression and other emotional changes.
- Difficulty swallowing, chewing, and speaking.
- Urinary problems or constipation.
- Skin problems.

16.3 NUTRITIONAL PROBLEMS:

Nutrition involves consuming a healthy, balanced diet to provide the body with the necessary nutrients for proper function and growth. These essential nutrients include carbohydrates, fats, proteins, vitamins, minerals, and water. Proper nutrition is crucial at any age, as it helps maintain energy levels, supports weight management, and can prevent diseases like osteoporosis, high blood pressure, heart disease, type 2 diabetes, and certain cancers.

Many older adults fail to eat a balanced diet daily, and mild vitamin deficiencies are common among seniors, especially those who are frail or living in institutions. These deficiencies can contribute to conditions such as anemia, cognitive decline, increased vulnerability to infections, and poor wound healing. Elderly individuals are at risk for poor nutrition due to various factors such as economic challenges, poor dental health, limited mobility, and insufficient food intake. Below are some common nutrition-related issues in older age:

Osteoporosis: This condition increases the risk of bone fractures. Preventive measures include regular exercise along with adequate intake of calcium and vitamin D.

Obesity: Many elderly individuals become obese because their calorie consumption remains the same, despite a decrease in their calorie requirements. Obesity in older adults can increase the risk of diabetes and other degenerative diseases.

Anemia: Anemia can result from insufficient dietary iron, poor absorption, or blood loss.

Malnutrition: Factors contributing to malnutrition in older adults include poverty, reduced mobility, chronic illnesses, social isolation, reduced appetite, difficulty in swallowing and a lack of knowledge about proper meal preparation.

Constipation: Irregular bowel movements are a common issue among elderly residents, often caused by poor muscle and nerve coordination, extended bed rest, certain medications, insufficient fluid intake, lack of fiber, or inadequate oral intake. Poor bowel movement patterns can lead to additional problems such as decreased appetite, hemorrhoids from straining, bloating, and flatulence.

Change in taste: Taste bud cells present on the tongue typically regenerate every week, but after the age of 50, their sensitivity begins to decline, making it more challenging for older adults to taste food. Other factors that can alter taste perception include medications, infections, dental issues, medical procedures, and dry mouth.

Swallowing Difficulties: During aging, the nerves responsible for muscle movement become less efficient. This can make chewing food more tiring and may lead to jaw pain, making it

harder to break food down into smaller pieces. In the throat, the muscles become less effective, which can result in difficulty swallowing compared to younger years.

Nausea: Elderly individuals are more susceptible to developing medical conditions, many of which lead to nausea as a side effect. These conditions include infections, gastrointestinal issues, dehydration, medications, cancer treatments, the flu and food poisoning. When ill, heightened senses may make aromatic foods overwhelming, potentially leading to a reduced appetite and nausea.

Diarrhoea: On the other hand, diarrhea is another common bowel issue that can result from infections, food poisoning, weakened bowel muscles, certain medications, food intolerances, or gastrointestinal disorders.

Weight Loss: Weight loss occurs in some elderly people due to the loss of muscle, fat, and water, often linked to reduced food intake. Those who are inactive or have limited mobility are more prone to this issue. When the body does not receive adequate nutrition, it begins to break down muscle and fat stores for energy. Loss of muscle mass results in poor mobility, increased risk of falls, and heightened weakness.

Dementia: Dementia refers to a group of symptoms caused by various brain disorders, affecting memory, cognitive function, concentration, and personality. People living with dementia may also experience confusion and difficulty in performing daily tasks.

New Medications: The elderly often require multiple medications to manage various health conditions. However, the combination of medications or the introduction of new ones can lead to side effects such as nausea, constipation, altered taste, and mental fatigue. These side effects can result in poor appetite and gastrointestinal discomfort, further complicating nutrition.

Dehydration: Dehydration is a significant concern for older adults, as the sensation of thirst diminishes with age. Seniors should aim to drink at least 8 glasses of water daily and include hydrating foods like soups, fruits, and vegetables in their diet. It’s also important to limit caffeine and alcohol, as these can contribute to dehydration.

Arthritis:

Arthritis is a disease that causes pain, stiffness, and structural changes in the joints, particularly affecting the cartilage. Arthritis can significantly affect a person's daily life, often making tasks such as shopping, moving, and cooking difficult or impossible.

Cancer:

According to the **American Cancer Society**, diets that are consistently high in fat, or low in fiber and vitamin A, may contribute to the development of cancer. Additionally, deficiencies

in certain nutrients, including **iron**, **iodine**, **selenium**, and **vitamin E**, have been linked to an increased risk of cancer.

Diabetes Mellitus:

Diabetes mellitus is a chronic disease. It develops when the body does not produce sufficient amounts of insulin or does not use it effectively for normal carbohydrate metabolism.

Hypertension:

is a significant risk factor for stroke, as well as other cardiovascular diseases, kidney damage, and even heart failure. Hypertension often develops without noticeable symptoms, which is why it's sometimes referred to as the "silent killer."

Heart Disease:

Heart attack and stroke are the major causes of death. **Atherosclerosis** is the primary underlying cause of heart attacks and strokes, and diet plays a central role in both the development and prevention of this condition.

Cataract:

Cataracts are common age-related condition that can lead to visual impairment, affecting the crystalline lens of the eye. In age-related cataracts, the lens becomes cloudy or opaque, impairing the passage of light to the retina and reducing vision.

Glaucoma:

Glaucoma is a group of eye conditions that cause damage to the optic nerve, which can result in vision loss and even blindness if left untreated. The primary risk factor for glaucoma is increased intraocular pressure (IOP), which is the pressure inside the eye. Elevated IOP can damage the optic nerve over time, leading to a gradual decline in vision.

Dry Eyes: It is a common issue, especially among older adults, and is characterized by insufficient tear production or poor tear quality, leading to discomfort and potential damage to the surface of the eye.

16.4 HEALTH PROBLEMS:

The aging is marked by increase in prevalence of some common age related problems due to disturbed metabolism. A number of physiological and emotional changes take place during this life stage, and as they age, older adults can face numerous health challenges. Blood pressure rises sand the immune system weakens. The skin becomes thinner and more wrinkled. Older adults may gradually lose an inch or two in height. However, many older adults remain in relatively good health because of good nutrition.

It is very important to maintaining health later in life. In addition, the fitness and nutritional choices made earlier in life set the stage for continued health and happiness. Older adults may face serious health challenges in their later years, many of which have tied to nutrition, as detailed below-

- **Cancer**
- **Diabetes**
- **Loss of hormone production, muscle mass and strength**, as well as changes in body composition (increase of fat deposits in the abdominal area, increasing the risk for type 2 diabetes and cardiovascular disease)
- Increased occurrence of **dementia**, resulting in memory loss, agitation and delusions
- **Decreased kidney function**, becoming less effective in excreting metabolic products such as sodium, acid, and potassium, which can alter water balance and hydration status
- **Decreased immune function**, resulting in more susceptibility to illness
- **Dental problems** can lead to difficulties with chewing and swallowing, which in turn can make it hard to maintain a healthy diet
- **Lower efficiency** in the absorption of vitamins and minerals
- Being either **underweight or overweight**
- **Bone and joint disorders**: Conditions like osteoarthritis, rheumatoid arthritis, and muscle aches are common in the elderly.
- **Osteoporosis**: A common chronic condition in in the elderly.
- **Hearing and vision loss**: Some hearing and vision loss are a part of normal aging.
- **Depression**: A mental health problem that is common in the elderly.
- **Alzheimer's**: A mental health problem that is common in the elderly.
- Other common health problems in the elderly include: back and neck pain, chronic obstructive pulmonary disease, diabetes, and cataracts and refractive errors.
- **Heart Diseases:** Heart disease, also known as cardiovascular disease (CVD), encompasses a range of conditions that affect the heart and blood vessels. It is a leading cause of morbidity and mortality worldwide, particularly among older adults. Heart disease is often preventable and manageable through lifestyle changes, medical interventions, and timely diagnosis.

Types of Heart Disease:

Coronary Artery Disease (CAD)

1) **Cause:** CAD occurs when the coronary arteries, which supply oxygenated blood to the heart muscle, become narrowed or blocked by plaque buildup (atherosclerosis). This can lead to chest pain (angina) or heart attacks (myocardial infarction).
2) **Risk Factors:** High blood pressure, high cholesterol levels, smoking, diabetes, sedentary lifestyle, and family history.

Heart Failure:

1) **Cause:** Heart failure happens when the heart is unable to pump blood effectively, leading to fluid buildup in the lungs, legs, and abdomen. This can be caused by conditions like CAD, high blood pressure, or heart valve disease.
2) **Risk Factors:** High blood pressure, previous heart attacks, diabetes, and obesity.
3) **Symptoms:** Shortness of breath, fatigue, swelling in the legs or abdomen, and rapid or irregular heartbeat.

Arrhythmias (Irregular Heartbeats):

1) **Cause:** Arrhythmias occur when the electrical signals controlling the heart's rhythm are disrupted. This can cause the heart to beat too fast, too slow, or irregularly.
2) **Risk Factors:** CAD, heart failure, excessive alcohol consumption, certain medications, and electrolyte imbalances.
3) **Symptoms:** Palpitations, dizziness, fainting, or chest discomfort.

Heart Valve Disease:

1) **Cause:** Heart valve disease occurs when one or more of the heart's valves do not function properly, affecting blood flow. This can be due to aging, infections, or congenital abnormalities.
2) **Symptoms:** Fatigue, shortness of breath, chest pain, and swelling in the feet or abdomen.

Peripheral Artery Disease (PAD)

1) **Cause:** PAD occurs when the arteries in the legs or arms become narrowed or blocked due to plaque buildup, limiting blood flow to the limbs.
2) **Risk Factors:** Smoking, diabetes, high blood pressure, and high cholesterol.

3) **Symptoms:** Leg pain while walking, numbness, weakness, and sores on the feet or legs that do not heal.

Risk Factors for Heart Disease:

1) **Age:** The risk of heart disease increases with age, as blood vessels naturally become stiffer and more prone to plaque buildup over time.
2) **Genetics:** A family history of heart disease can increase an individual's risk, particularly if close relatives developed heart disease at a young age.
3) **High Blood Pressure:** Hypertension can damage the blood vessels and the heart, increasing the risk of heart disease and stroke.
4) **Cholesterol Levels:** High levels of LDL (low-density lipoprotein) cholesterol or low levels of HDL (high-density lipoprotein) cholesterol contribute to plaque buildup in the arteries.
5) **Diabetes:** Diabetes, particularly when poorly controlled, can lead to high blood sugar, which damages blood vessels and increases the risk of heart disease.
6) **Smoking:** Smoking accelerates atherosclerosis and ultimately increases the risk of heart attacks and strokes.
7) **Physical Inactivity:** A sedentary lifestyle can lead to obesity, high blood pressure, and high cholesterol, all of which increase the risk of heart disease.

Gastrointestinal Disorders:

Gastrointestinal (GI) disorders are common in older adults and can significantly affect their quality of life. As people age, the GI system undergoes changes that can lead to various conditions, including those related to digestion, absorption, and motility. Many of these conditions are manageable with early detection, lifestyle changes, dietary modifications, and medications.

1) Constipation:

- **Cause:** Slower motility of the digestive tract, decreased physical activity, medications (e.g., opioids, anticholinergics), dehydration, and poor dietary fiber intake.
- **Symptoms:** Difficulty in passing stools, fewer than three bowel movements per week, straining during bowel movements, and abdominal discomfort.

2) Gastroesophageal Reflux Disease (GERD)

- **Cause:** Weakening of the lower esophageal sphincter, delayed gastric emptying, and increased intra-abdominal pressure due to obesity or a sedentary lifestyle.
- **Symptoms:** Heartburn, regurgitation, chest pain, difficulty swallowing, and coughing, especially at night.

3) Diverticular Disease:

- **Cause:** Weakening of the wall of the colon, leading to the formation of small pouches (diverticula). Common in older adults due to changes in the elasticity of the bowel.
- **Symptoms:** Often asymptomatic, but may cause abdominal pain, bloating, and changes in bowel habits. In severe cases, diverticulitis (inflammation or infection of the diverticula) can occur.

4) Irritable Bowel Syndrome (IBS):

- **Cause:** The exact cause is unknown, but it is believed to involve changes in gut motility, gut-brain interactions, and a heightened response to stress.
- **Symptoms:** Abdominal cramps, bloating, diarrhea, and constipation, which may alternate.

5) Peptic Ulcers:

- **Cause:** Infections with *Helicobacter pylori* or prolonged use of nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen and aspirin, which can irritate the stomach lining.
- **Symptoms:** Burning stomach pain, nausea, vomiting, bloating, and loss of appetite.

6) Celiac Disease:

- **Cause:** An autoimmune disorder where the ingestion of gluten (a protein found in wheat, barley, and rye) triggers an immune response that damages the small intestine lining.
- **Symptoms:** Diarrhea, bloating, weight loss, malabsorption, and fatigue.

7) Gallbladder Disease (Cholelithiasis and Cholecystitis):

- **Cause:** The formation of gallstones, which can block bile ducts, leading to inflammation of the gallbladder (cholecystitis).
- **Symptoms:** Right upper abdominal pain, nausea, vomiting, and fever. Pain often worsens after eating fatty foods.

8) Malabsorption:

- **Cause:** Decreased enzyme production or damage to the lining of the small intestine (e.g., due to celiac disease, Crohn's disease, or pancreatic insufficiency).
- **Symptoms:** Weight loss, diarrhea, abdominal cramps, and nutritional deficiencies.

9) Lactose Intolerance:

- **Cause:** Reduced lactase enzyme activity in the small intestine, making it difficult to digest lactose, the sugar found in milk and dairy products.
- **Symptoms:** Bloating, diarrhea, and abdominal discomfort after consuming dairy products.

10) Colorectal Cancer

- **Cause:** Genetic and environmental factors contribute to the development of colorectal cancer. A family history of cancer, inflammatory bowel diseases, and diet can increase risk.
- **Symptoms:** Changes in bowel habits (e.g., constipation or diarrhea), blood in stool, unexplained weight loss, and fatigue.

11) Fecal Incontinence:

- **Cause:** Age-related weakening of the anal sphincter muscles, neurological conditions, or damage to pelvic floor muscles (e.g., following childbirth or surgery).
- **Symptoms:** Involuntary leakage of stool.

12) Gastroparesis:

- **Cause:** A condition where the stomach empties slowly due to nerve damage (often associated with diabetes or other neurological conditions).
- **Symptoms:** Nausea, vomiting, bloating, and feeling full quickly after eating.

16.5 SUMMARY:

Inadequate macro- and micronutrient intake is a widespread issue among older adults, often contributing to a range of health complications such as weight loss, malnutrition, sarcopenia (loss of muscle mass), and cognitive decline. Older adults are nutritionally vulnerable for several reasons-

- **Diminished Appetite and Chewing Difficulties**: Conditions like dental issues, poor appetite, and difficulty swallowing can make it challenging for older adults to consume sufficient nutrients.
- **Chronic Diseases**: Conditions such as diabetes, heart disease, and gastrointestinal disorders can interfere with nutrient absorption and utilization.

- **Medications**: Many medications have side effects that alter appetite, digestion, or nutrient absorption, contributing to nutritional deficiencies.
- **Changes in Metabolism**: As individuals age, their metabolism slows, which can reduce energy and nutrient needs but still requires appropriate intake to prevent deficiencies.

The increase in the aging population globally has resulted in a rise in age-related conditions, making nutritional interventions more important than ever. Nutritional interventions to the needs of older adults-

1) **Fortified Foods**: Foods can be fortified with essential vitamins and minerals (such as vitamin D, calcium, and B12) to help meet the nutritional needs of older adults. This can be particularly beneficial for individuals with specific deficiencies due to medical conditions or reduced dietary intake.
2) **Functional Foods**: Functional foods are those that provide health benefits beyond basic nutrition, such as foods enriched with probiotics or omega-3 fatty acids. These foods can improve gut health, reduce inflammation, and help manage chronic conditions.
3) **Convenient Food Formats**: Products designed for older adults should focus on convenience and ease of consumption. This includes ready-to-eat meals, easy-to-open packaging, and foods that are easy to chew and swallow. These features can help those with limited mobility or dexterity continue to meet their nutritional needs.
4) **Texture-Modified Diets**: For older adults with dysphagia (difficulty swallowing), providing food in modified textures (pureed, soft, or minced) can ensure to receive adequate nutrition without the risk of choking.

16.6 TECHNICAL TERMS:

Chronic Degenerative Diseases, diabetes, heart disease, arthritis, osteoporosis, osteomalacia, obesity, cataracts, chronic respiratory diseases, neurological disorders, and cancer.

16.7 SELF ASSESSMENT QUESTIONS:

1) Explain about various chronic degenerative diseases among the elderly?
2) What are common health problems in old people?
3) Discuss about nutritional problems in aged people?

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LESSON-17

SPORTS NUTRITION: CLASSIFICATION OF SPORTS EVENTS AND RDA FOR SPORTS PERSON. NUTRITIONAL REQUIREMENTS AND SPECIAL NEEDS OF SPORTS PERSON, PRE, DURING, POST SPORTS EVENTS; WATER AND ELECTROLYTE BALANCE, ERGOGENIC AIDS

17.0 OBJECTIVES:

After reading lesson we should be able to:

- Know the importance and scope of Sports Nutrition;
- Understand Classification of Sports Nutrition, RDA, Nutritional requirements for pre, during and post sports events;
- Water and Electrolyte balance, and ergogenic aids.

STRUCTURE:

17.1 INTRODUCTION:

Sports nutrition is the study and application of nutrition principles tailored to enhance athletic performance, recovery, and overall physical fitness. It integrates the science of biochemistry, physiology, and dietetics to meet the specific needs of athletes and physically active individuals. This discipline focuses on understanding the types, timing, and quantities of nutrients required to optimize energy levels, improve endurance, build strength, and expedite recovery from strenuous physical activity.

Why is Sports Nutrition Important?

The primary importance of sports nutrition lies in its ability to:

- Enhance physical performance in both training and competition.
- Reduce the risk of injury and illness associated with intense physical activity.
- Promote faster recovery and muscle repair post-exercise.
- Maintain overall health and well-being by preventing nutrient deficiencies.

17.1.1 Scope of Sports Nutrition:

Sports nutrition is an evolving field that combines principles of nutrition and exercise science to enhance athletic performance, recovery, and overall health. The scope of this discipline extends across various domains, making it crucial for athletes, recreational fitness enthusiasts, and individuals engaged in active lifestyles.

17.2 CLASSIFICATION OF SPORTS EVENTS:

Sports events can be classified in various ways based on factors like the scope of participation, level of competition, and format of the event. Here's an overview of the common classifications:

17.2.1. By Level of Competition:

- **Local/Regional Sports Events**: These events are limited to a specific area, such as a city, district, or region. Examples include school competitions, local tournaments, and regional championships.
- **National Sports Events**: These events bring together athletes from across the country. Examples include national championships, league competitions (e.g., national football leagues), and university sports events.
- **International Sports Events**: Events involving participants from multiple countries, such as the Olympic Games, World Cups, and international tournaments in various sports (e.g., FIFA World Cup, ICC Cricket World Cup).

- **World Championship/Elite Events**: These are the highest-level competitions, often held on a global scale, where athletes or teams from around the world compete at the peak of their discipline, such as the FIFA World Cup or the Olympics.

17.2.2. By Type of Sport:

- **Individual Sports Events**: These competitions focus on individual performance. Athletes compete on their own and the results are determined by their personal achievements. Examples include athletics, swimming, tennis, boxing, and gymnastics.
- **Team Sports Events**: These events involve teams competing against each other. Success is based on the collective performance of all team members. Examples include soccer, basketball, rugby, and volleyball.
- **Dual Sports Events**: Competitions that involve two competitors or teams. Examples include badminton doubles, tennis doubles, or synchronized swimming.
- **Mixed Sports Events**: Events that feature a combination of individual and team aspects. For example, the modern pentathlon (which includes running, shooting, fencing, swimming, and riding) or mixed doubles in tennis and badminton.

17.2.3. By Duration:

- **Short-Term Events**: These are usually completed in a day or a few days, like a single game, a match, or a one-day tournament.
- **Long-Term Events**: These events span over a longer period of time, such as annual leagues, multi-stage tournaments (e.g., the Tour de France), or season-long competitions (e.g., football leagues or Formula 1 seasons).

17.2.4. By Format:

- **Single-Elimination (Knockout)**: Athletes or teams compete in a series of rounds where the loser of each match is eliminated. Examples include the NCAA basketball tournament or the FIFA World Cup knockout stages.
- **Round Robin**: Each participant or team competes against every other participant or team in the tournament. Examples include the round-robin stage of the ICC Cricket World Cup or the UEFA Champions' League group stage.
- **League Format**: Participants compete in a league or season, accumulating points based on performance, with the winner being determined by total points at the end of the season. Examples include the English Premier League, NBA, and Major League Baseball.

17.2.5. By Gender:

- **Men's Events**: Competitions restricted to male participants, such as the men's soccer World Cup or men's tennis Grand Slams.
- **Women's Events**: Competitions restricted to female participants, like the women's FIFA World Cup or women's Olympic events.
- **Mixed-Gender Events**: These events allow both men and women to compete either together or in separate divisions. Examples include mixed doubles in tennis and badminton or co-ed soccer tournaments.

17.2.6. By Age Group:

- **Youth/Junior Events**: These events are for younger athletes, typically below a certain age limit, such as the Junior Olympics or U-20 soccer tournaments.
- **Senior Events**: Competitions for athletes above the junior level, ranging from adult amateur events to professional leagues and international competitions.
- **Masters Events**: For athletes over a certain age, often starting at 35 or 40, such as the Masters Tennis tournaments or the World Masters Athletics Championships.

17.2.7. By Purpose or Occasion:

- **Olympic/Multisport Events**: The Olympics (summer and winter) are the most prominent examples, bringing together a wide range of sports under one event.
- **Paralympics/Adaptive Sports**: These events are for athletes with physical or intellectual disabilities, held alongside or in conjunction with the Olympics.
- **Exhibition/Showcase Events**: These are organized for entertainment or promotional purposes, such as the All-Star Games in various sports or the Red Bull Crashed Ice events.
- **Charity or Fun Sports Events**: These events are usually less competitive and are aimed at raising funds for specific causes, such as charity runs, amateur tournaments, or community fun fairs.

17.2.8. By Skill or Experience Level:

- **Amateur Sports Events**: These events are for athletes who are not paid for their performance. Most youth, college, and recreational sports fall under this category.
- **Professional Sports Events**: These events involve athletes who are paid for their participation. Professional leagues and international tournaments in sports like football, basketball, tennis, and cricket are examples.

Each classification has its own unique characteristics, and many sports events can fall under multiple categories depending on their scope, structure, and purpose.

17.3 RECOMMENDED DIETARY ALLOWANCES (RDA) FOR SPORTS PERSON:

The **Recommended Dietary Allowances (RDA)** for sports persons are guidelines that outline the daily intake of nutrients required to maintain optimal health and performance. Athletes have unique nutritional needs based on their intensity of training, competition schedules, and overall fitness goals. The RDA values may differ from the general population due to the higher energy expenditure and specific nutrient needs of athletes.

17.3.1. Energy Needs:

Sports persons generally have higher energy demands compared to the average person. The total caloric intake depends on the athlete's body size, type of sport, intensity of exercise, and goals (e.g., weight maintenance, muscle gain, or fat loss).

- **Endurance Athletes (e.g., marathon runners, cyclists)**: Require more calories to fuel prolonged physical activity, with energy demands ranging from **2,500 to 6,000 kcal per day** depending on the duration and intensity of training.
- **Strength Athletes (e.g., weightlifters, sprinters)**: Their energy requirements range from **3,000 to 5,000 kcal per day**, depending on training volume and goals for muscle gain.
- **Team Sport Athletes (e.g., football, basketball)**: Energy needs range from **2,000 to 5,000 kcal per day** depending on training intensity and the duration of games.

17.3.2. Carbohydrates:

Carbohydrates are the primary fuel for athletes, especially during high-intensity and endurance activities. Carbs are stored in muscles and liver as glycogen, which is utilized during exercise.

- **Endurance Athletes**: Require **7-10 grams per kilogram of body weight** per day to replenish glycogen stores, particularly during heavy training or competition periods.
- **Strength Athletes**: Require **5-7 grams per kilogram** per day to fuel high-intensity workouts and promote recovery.
- **General Recommendation**: Carbohydrates should make up about **45-65% of total daily caloric intake**.

Sources: Whole grains, fruits, vegetables, legumes, and starchy vegetables like potatoes and sweet potatoes.

17.3.3. Protein:

Protein is essential for muscle repair, growth, and immune function. Athletes require more protein than sedentary individuals to support muscle recovery and synthesis.

- **General Athlete**: **1.2 to 2.0 grams per kilogram of body weight** per day, depending on the intensity and type of training.
- **Endurance Athletes**: **1.2 to 1.4 grams per kilogram** per day to repair muscle tissue broken down during prolonged activities.
- **Strength Athletes**: **1.6 to 2.0 grams per kilogram** per day to promote muscle growth and recovery.

Sources: Lean meats, fish, eggs, dairy, legumes, soy products, and protein supplements.

17.3.4. Fats:

Fats are a vital energy source, particularly during lower-intensity exercises, and support hormone function, vitamin absorption, and overall cell health. Athletes should prioritize healthy fats in their diets.

- **Recommendation**: Fats should contribute **20-35%** of total daily calories.
- **Special Needs**: During periods of high endurance training, fats become an important energy source once glycogen stores are depleted.

Sources: Avocados, nuts, seeds, olive oil, fatty fish (like salmon and mackerel), and coconut oil.

17.3.5. Vitamins and Minerals:

Athletes have higher micronutrient needs due to the increased metabolic demands of physical activity. Some vitamins and minerals play key roles in energy metabolism, bone health, and muscle function.

- **Vitamin D**: Supports bone health and immune function. Athletes may need **1,000-2,000 IU** per day, especially if they have limited sun exposure.
- **Calcium**: Essential for bone health and muscle contraction. Athletes need **1,000-1,500 mg** per day.
- **Iron**: Critical for oxygen transport and energy. Athletes, particularly female athletes and endurance athletes, may need more iron (typically **18 mg/day for women** and **8 mg/day for men**).
- **Magnesium**: Important for muscle function and energy production, with **300-400 mg** recommended for athletes.

- **Potassium and Sodium**: Essential for fluid balance and muscle function. Adequate intake is vital, particularly for athletes who sweat heavily during exercise.

Sources: Fruits, vegetables, dairy, whole grains, lean meats, nuts, and seeds.

17.3.6. Hydration:

Adequate hydration is critical for maintaining performance, preventing fatigue, and aiding recovery. Dehydration can impair endurance, strength, and cognitive function.

- **Fluid Needs:** Athletes should drink enough water to maintain normal hydration levels. A general guideline is to drink 500 mL of water about 2-3 hours before exercise and 150-250 mL every 15-20 minutes during exercise. Post-exercise, it's important to replace fluids lost in sweat.
- **Electrolytes:** Replenishing electrolytes (especially sodium and potassium) is crucial for athletes who engage in long-duration or intense activities, as sweat losses can lead to an imbalance.
- **Special Considerations:** In hot or humid environments, athletes may need more fluids and electrolyte-rich drinks (sports drinks).

Sources: Water, sports drinks, coconut water, and electrolyte tablets.

17.3.7. Special Nutritional Needs

17.3.7.1. Timing of Nutrient Intake:

- Pre-Exercise: A balanced meal with carbs, protein, and a small amount of fat should be consumed 2-3 hours before exercise. For high-intensity exercise, a snack rich in carbohydrates and moderate in protein (low in fat) 30-60 minutes before exercise is ideal.
- Post-Exercise: A combination of carbohydrates and protein should be consumed within 30-60 minutes post-exercise to replenish glycogen stores and promote muscle repair. A typical post-exercise meal might include 3:1 or 4:1 ratio of carbs to protein.

17.3.7.2. Supplements:

- Some athletes may benefit from specific supplements to meet their dietary needs, especially if they face a deficiency or need to enhance performance.
- **Creatine**: For high-intensity, short-duration sports like sprinting or weightlifting, creatine supplementation (typically 3-5 grams per day) may help improve strength and power.

- Branched-Chain Amino Acids (BCAAs**)**: These may support muscle recovery and reduce soreness after intense workouts.
- Beta-Alanine: May improve performance in activities requiring sustained effort over a short period.

17.3.7.3. Special Considerations for Women Athletes:

- Female athletes may be at higher risk for **iron deficiency** and need to focus on iron-rich foods like lean meats, spinach, and legumes.
- Women may also need to pay attention to **calcium and vitamin D** to support bone health, especially during periods of intense training or dieting.

17.3.7.4. Special Considerations for Endurance Athletes:

- During long-duration events, like marathons or triathlons, athletes need to carefully manage carbohydrate loading before the event and ensure they have sufficient carbohydrate intake during the event.
- Hydration and electrolyte balance are particularly important for endurance athletes, as they lose significant amounts of fluid and electrolytes during prolonged activity.

By meeting these nutrient requirements, athletes can enhance performance, optimize recovery, and maintain overall health.

17.4 NUTRITIONAL REQUIREMENTS FOR PRE, DURING, POST SPORTS EVENTS:

Nutritional requirements for athletes vary depending on the timing relative to a sports event. Proper nutrition before, during, and after an event plays a crucial role in optimizing performance, enhancing recovery, and preventing injury. Here's a breakdown of the specific nutritional needs for each phase:

17.4.1. Pre-Sport Event Nutrition:

The goal of pre-event nutrition is to fuel the body for optimal performance and provide sustained energy during the activity. Proper pre-event nutrition helps maximize glycogen stores, prevent early fatigue, and optimize hydration.

Timing:

- 2-4 hours before the event: A balanced meal that is easy to digest.
- 30-60 minutes before the event: A small snack, if needed.

Nutritional Focus:

- Carbohydrates: The primary source of energy during exercise, particularly high-intensity or endurance activities.
  - Aim for 3-4 grams of carbohydrates per kilogram of body weight**.**
  - Focus on easily digestible, low-fiber carbohydrates to avoid digestive issues (e.g., pasta, rice, bread, bananas).
- **Protein**: A small amount of protein helps support muscle repair and can improve endurance.
  - Around 0.15-0.25 grams per kilogram of body weight.
- **Fat**: Keep fat intake moderate as fat takes longer to digest. Avoid high-fat meals right before the event.
- **Fluids**: Hydrate properly, but avoid excessive intake right before the event to prevent bloating.
  - Aim for 5-7 mL of water per kilogram of body weight 2-3 hours before the event.
  - For long events, you can also consume sports drinks containing electrolytes.

Example Pre-Event Meal (2-4 hours before):

- Carbohydrates: Whole grain pasta with tomato sauce or a rice bowl with lean chicken.
- Protein: A small portion of lean protein like chicken, turkey, or tofu.
- Fat: A small amount of olive oil or avocado for flavor.
- Fluids: Water or sports drink for electrolyte balance.

Example Pre-Event Snack (30-60 minutes before):

- Carbohydrates: A banana, energy bar, or oatmeal.
- Protein: A small amount of protein, like a scoop of protein powder or a yogurt.
- Fluids: A few sips of water or an electrolyte drink.

17.4.2. During Sports Event Nutrition:

During the event, the focus shifts to maintaining energy levels, preventing dehydration, and managing electrolytes. This is especially important for endurance events or activities lasting more than 60 minutes.

Timing:

- **For events lasting less than 60 minutes**: Hydration is typically sufficient, and additional nutrition may not be necessary.
- **For events lasting longer than 60 minutes**: Intake of carbohydrates, electrolytes, and fluids is critical to maintain performance and prevent fatigue.

Nutritional Focus:

- **Carbohydrates**: Continue to fuel your body with carbohydrates to sustain energy. During endurance events or activities lasting longer than 60 minutes, aim to consume 30-60 grams of carbohydrates per hour.
  - Sources: Sports drinks, energy gels, bananas, or energy bars.
- **Electrolytes (Sodium, Potassium, Magnesium)**: Help maintain fluid balance, prevent cramps, and support muscle function. Use sports drinks or electrolyte tablets.
  - **Sodium** is particularly important in long-duration events because it helps retain fluids.
- **Fluids**: Maintain hydration throughout the event to prevent dehydration and overheating. Drink small amounts regularly, aiming for 150-250 mL every 15-20 minutes.
  - Water is fine for shorter events, but sports drinks are essential for longer events to replace electrolytes.

Example during event nutrition:

- **Carbohydrates**: Energy gels, chews, or sports drinks.
- **Electrolytes**: Sports drinks or electrolyte tablets.
- **Fluids**: Water and/or sports drinks.

17.4.3. Post-Sport Event Nutrition:

The primary goal after an event is to aid recovery by replenishing glycogen stores, repairing muscle tissue, and rehydrating the body. Proper post-event nutrition can reduce muscle soreness, improve recovery time, and enhance performance for future events.

Timing:

- **Immediately to 30 minutes after**: Begin rehydrating and refueling.
- **Within 1-2 hours after**: Consume a balanced meal for optimal recovery.

Nutritional Focus:

- **Carbohydrates**: Replenish depleted glycogen stores with 1.0-1.2 grams of carbohydrates per kilogram of body weight. This helps restore glycogen reserves and promotes recovery.
  - Sources: Whole grain bread, rice, pasta, fruits, and starchy vegetables.
- **Protein**: Protein is necessary for muscle repair and recovery. Aim for 0.2-0.4 grams of protein per kilogram of body weight.
  - Sources: Lean meats, fish, eggs, plant-based proteins like tofu or beans.
- **Fats**: Include healthy fats to support overall recovery, but don't overdo it immediately after the event. A small amount is sufficient.
  - Sources: Nuts, seeds, olive oil, avocado.
- **Fluids**: Rehydrate based on how much fluid was lost during the event. Consider drinking 1.5 liters of fluid for every kilogram of body weight lost. If electrolyte loss is significant (e.g., sweating heavily), use a sports drink to restore sodium and potassium levels.
- **Vitamins and Minerals**: Focus on replenishing micronutrients that may have been depleted during intense exercise.
  - **Potassium**: Found in fruits like bananas and oranges.
  - **Magnesium**: Found in leafy greens, nuts, and seeds.
  - **Calcium and Vitamin D**: Important for muscle contraction and recovery.

Example Post-Event Meal (30-60 minutes after):

- **Carbohydrates**: A whole-grain wrap with chicken or a smoothie with fruit and oats.
- **Protein**: A lean protein source like grilled chicken, fish, or a protein shake.
- **Fats**: A small portion of avocado or nuts.
- **Fluids**: Water or a recovery drink with electrolytes.

Example Post-Event Snack (within 30 minutes after):

- **Carbohydrates**: A banana or apple with a granola bar.
- **Protein**: A protein shake or yogurt.
- **Fluids**: Water or sports drink with electrolytes.

TABLE 17.4: SUMMARY OF NUTRITIONAL GUIDELINES:

Phase	Nutrient Focus	Timing	Examples
Pre-Event	Carbs, moderate protein, fluids	2-4 hours before & 30-60 minutes before	Whole grain pasta, banana, small protein snack, water/sports drinks
During Event	Carbs, electrolytes, fluids	Every 15-20 minutes for events > 60 mins	Energy gels, sports drinks, water, electrolyte tablets
Post-Event	Carbs, protein, fluids, electrolytes	30-60 minutes after the event	Protein shake, whole grain toast, fruit, water/sports drinks

By following these guidelines, athletes can ensure they are properly fuelled before, during, and after a sports event to maximize performance and recovery.

17.5 WATER AND ELECTROLYTE BALANCE:

Maintaining proper water and electrolyte balance is crucial for athletes to optimize performance, prevent dehydration, and support recovery. During exercise, especially in hot or humid conditions or during long-duration activities, athletes lose fluids and electrolytes through sweat, which can negatively impact performance, muscle function, and overall health if not replaced.

17.5.1. Importance of Hydration in Sports:

Water plays several vital roles in the body, especially during exercise:

- **Temperature Regulation**: Water helps maintain body temperature by enabling sweat production, which cools the body as it evaporates.
- **Muscle Function**: Adequate hydration supports muscle contraction, flexibility, and performance. Dehydration can lead to muscle cramps, weakness, and fatigue.
- **Nutrient Transport**: Water aids in the transport of nutrients and oxygen to cells, which is essential for maintaining energy levels during exercise.
- **Joint Lubrication**: Proper hydration ensures that synovial fluid remains at optimal levels to lubricate joints, reducing the risk of injuries.

17.5.2. Electrolytes and Their Role in Sports

Electrolytes are minerals that carry an electrical charge and are essential for several body functions, including muscle contraction, nerve signalling, and maintaining fluid balance. The main electrolytes lost during exercise are sodium (Na+), potassium (K+), calcium (Ca2+), and magnesium (Mg2+).

- **Sodium**: The most abundant electrolyte in sweat. It helps regulate fluid balance and blood pressure. Sodium is also essential for nerve function and muscle contraction.
- **Potassium**: Works alongside sodium to regulate fluid balance and muscle function. It is critical for nerve function and maintaining a steady heartbeat.
- **Calcium**: Involved in muscle contraction and nerve transmission. Calcium helps muscles contract and relax effectively.
- **Magnesium**: Helps in energy production and muscle function. Magnesium is also involved in preventing cramps.

17.5.3. Hydration Needs for Athletes

The amount of water and electrolytes an athlete needs depends on various factors, such as the type of sport, duration, intensity, environmental conditions (temperature and humidity), body size, and sweat rate.

A. General Hydration Guidelines:

- **Pre-Exercise**: Drink 500-600 mL of water 2-3 hours before exercise to ensure proper hydration.
- **During Exercise**: For events lasting less than 60 minutes, water is generally sufficient. For longer events (over 60 minutes), a sports drink containing **electrolytes** and carbohydrates is recommended to replace lost fluids and maintain energy.
    - Consume 150-250 mL of fluid every 15-20 minutes during exercise.
- **Post-Exercise**: Rehydrate with 1.5 liters of fluid for every kilogram of body weight lost during exercise. Sports drinks with electrolytes can be used to replace both fluids and lost electrolytes.

B. Signs of Dehydration:

- Dry mouth, fatigue, dizziness, muscle cramps, dark yellow urine, or reduced performance.

17.6 ERGOGENIC AIDS:

Ergogenic aids are substances or devices that enhance physical performance. In the context of sports nutrition, ergogenic aids are used to improve strength, endurance, speed, recovery, and overall athletic performance. These aids can be classified into various categories, including nutritional supplements, dietary strategies, and physical aids, depending on the method they employ to improve performance.

17.6.1. Types of Ergogenic Aids:

A. Nutritional Ergogenic Aids

These are supplements or substances derived from food that are consumed to enhance athletic performance. They primarily influence energy production, muscle strength, recovery, or overall health.

I. **Carbohydrate Supplements:**

a) **Effect**: Carbohydrates are the primary fuel for high-intensity exercise. Supplementation with carbohydrates (e.g., sports drinks, gels, or bars) during long-duration activities (over 60 minutes) helps to maintain glycogen stores and delay fatigue.

b) **Examples**: Glucose, fructose, maltodextrin, energy gels, and drinks.

II. Protein Supplements:

a) **Effect**: Protein aids in muscle repair and recovery, particularly after strength training or endurance exercise. Protein supplementation may enhance muscle protein synthesis and reduce muscle breakdown.

b) **Examples**: Whey protein, casein protein, soy protein, and plant-based protein powders.

III. Creatine

a) **Effect**: Creatine is one of the most researched ergogenic aids. It increases the production of adenosine triphosphate (ATP), which is the energy currency of the cell. This can improve strength, power, and high-intensity performance, especially in short bursts (e.g., weightlifting, sprinting).

b) **Mechanism**: Creatine supplementation increases intramuscular stores of phosphocreatine, enabling athletes to perform more repetitions, sprint faster, or jump higher.

IV. Caffeine:

a) **Effect**: Caffeine is a well-known stimulant that enhances endurance and reduces the perception of effort. It works by increasing adrenaline levels, improving focus, and mobilizing fat for energy, making it particularly beneficial for long-duration endurance sports.

b) **Mechanism**: Caffeine stimulates the central nervous system (CNS), increases lipolysis (fat burning), and improves muscle contraction.

V. Beta-Alanine:

a) Effect: Beta-alanine is an amino acid that enhances performance by buffering acid in muscles during high-intensity activities. It reduces the build up of hydrogen ions (lactic acid) during exercise, which helps delay fatigue and improve performance in short-duration, high-intensity sports (e.g., sprints, weight training).

b) Mechanism: Beta-alanine is converted into carnosine, which helps buffer the acid produced during intense exercise.

VI. BCAAs (Branched-Chain Amino Acids):

a) Effect: BCAAs, including leucine, isoleucine, and valine, are essential amino acids that play a role in reducing muscle breakdown during exercise. Supplementing with BCAAs can help reduce muscle soreness and speed recovery after intense training.

VII. Nitrates (Beetroot Juice):

a) Effect: Nitrate supplementation (often in the form of beetroot juice or powder) can improve endurance performance by increasing the efficiency of oxygen use in muscles, leading to enhanced aerobic capacity and reduced fatigue during endurance activities.

b) Mechanism: Nitrates are converted to nitric oxide, which improves blood flow and oxygen delivery to muscles.

VIII. L-Carnitine:

a) Effect: L-carnitine helps transport fatty acids into the mitochondria for oxidation (fat burning). It is often marketed as a fat-burning supplement, although its effectiveness in improving performance is still debated.

b) Mechanism: L-carnitine may support fat metabolism, especially during prolonged endurance activities.

B. Physiological Ergogenic Aids:

These include non-nutritional aids that directly influence the body's physiological processes.

1) Blood Doping and Erythropoietin (EPO):

- **Effect**: Blood doping involves increasing the number of red blood cells in the body to improve oxygen transport to muscles, enhancing endurance. Erythropoietin (EPO), a hormone that stimulates red blood cell production, is used similarly.

- **Ethical Considerations**: Both blood doping and EPO uses are banned in most sports due to ethical concerns and potential health risks.

2) Altitude Training:

- **Effect**: Training at high altitudes, where oxygen levels are lower, can improve an athlete's endurance and aerobic capacity. The body adapts by producing more red blood cells to carry oxygen, which is beneficial when returning to sea level.
- **Mechanism**: The body increases erythropoiesis (red blood cell production) in response to lower oxygen levels, improving oxygen delivery to muscles.

17.7 SUMMARY:

Athletes require a carefully balanced diet that includes sufficient calories, carbohydrates, protein, healthy fats, vitamins, and minerals to support their physical activity and recovery. Hydration is equally important, and in some cases, athletes may need supplements to meet their specific nutritional needs. The exact requirements will depend on the athlete's sport, goals, and intensity of training, making individualized nutrition planning a key component of successful athletic performance.

17.8 TECHNICAL TERMS:

Sports events, RDA, Ergogenic aids, Nutrients, Electrolytes

17.9 SELF ASSESSMENT QUESTIONS:

1) Briefly discuss the dietary recommendations for different nutrients?
2) What are the ergogenic aids?

17.10 REFERENCE BOOKS:

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LESSON-18

ENDURANCE AND FATIGUE IN SPORTS PERFORMANCE, ASSESSMENT STRATEGIES

18.0 OBJECTIVES:

After reading this lesson, you would be able to:

- To know about Endurance, different types of Endurance, factors and training.
- To understand Fatigue, types of fatigue, causes and symptoms.
- Assessment strategies for endurance and fatigue

STRUCTURE:

18.1 INTRODUCTION:

Endurance and fatigue are critical components in sports performance, directly influencing an athlete's ability to sustain high levels of performance over time. Understanding these concepts and the strategies to assess them is essential for sports scientists, coaches, and athletes. This document provides an in-depth exploration of endurance, fatigue, and the scientific methods used to assess these aspects in athletes.

18.2 ENDURANCE IN SPORTS:

Endurance, often referred to as stamina, is a cornerstone of athletic performance. It represents the ability of an athlete to sustain prolonged physical or mental effort. Endurance is crucial in sports ranging from marathons to soccer matches, where maintaining performance over time can be the difference between victory and defeat.

18.3 TYPES OF ENDURANCE:

Endurance can be broadly categorized into three types:

1) **Cardiovascular Endurance**: This refers to the efficiency of the heart, lungs, and vascular system in delivering oxygen to working muscles. Sports such as running, cycling, and swimming heavily depend on cardiovascular endurance. Improvements in this area lead to enhanced oxygen uptake, better heart rate management, and prolonged energy availability.
2) **Muscular Endurance**: This pertains to the ability of muscles to sustain repeated contractions over a period of time without fatigue. Activities like rowing, weightlifting, or even climbing require high levels of muscular endurance. It’s not only about strength but also about resistance to fatigue, which can be trained and optimized.
3) **Mental Endurance**: This involves the psychological resilience required to push through discomfort and maintain focus during prolonged efforts. It’s essential in ultra-endurance events like marathons or Ironman triathlons, where mental strength can determine success as much as physical ability.

The Science behind Endurance:

At its core, endurance is about energy systems and oxygen utilization. The human body primarily uses three energy systems:

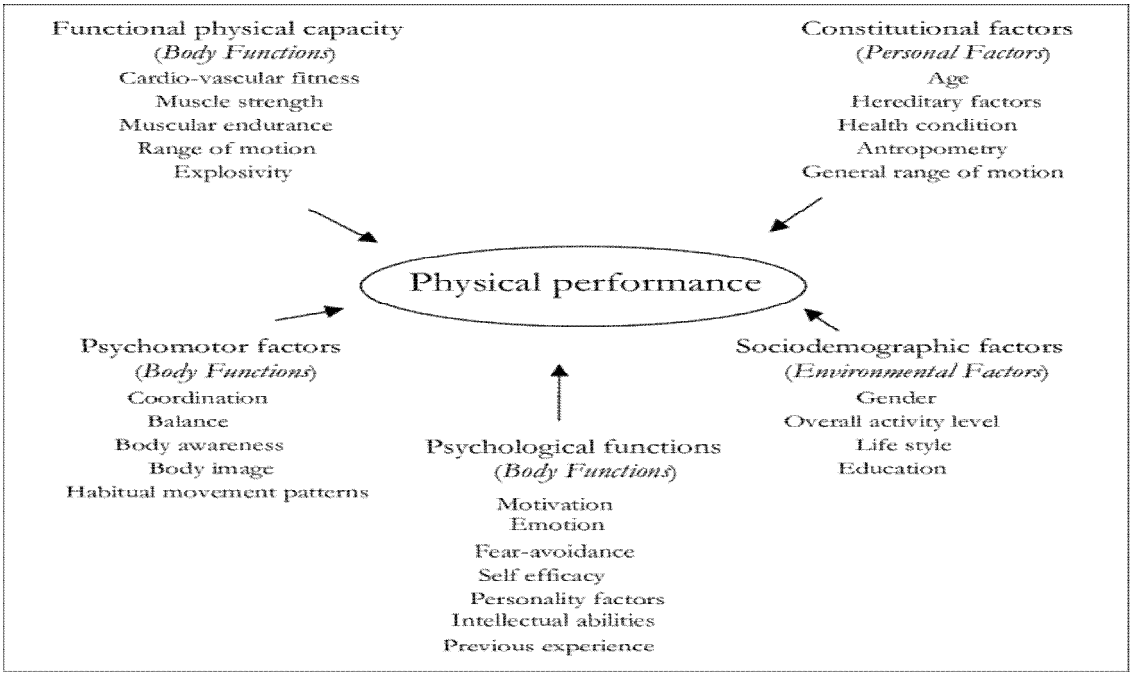
1) **Phosphagen System**: Used for short bursts of activity, such as sprinting. It provides immediate energy but depletes quickly.
2) **Anaerobic System**: Relies on glucose breakdown without oxygen, providing energy for medium-duration efforts, such as a 400-meter sprint or high-intensity interval training.

3) **Aerobic System**: Dependent on oxygen, this system fuels sustained activities and is pivotal for endurance sports like marathons and triathlons.

The aerobic system, in particular, is enhanced through consistent training, leading to adaptations such as increased mitochondrial density, improved capillary networks, and higher oxygen-carrying capacity in the blood. These changes improve the efficiency of energy production and delay the onset of fatigue.

18.4 FACTORS AFFECTING ENDURANCE:

1) **Physiological Factors**:
   - **Aerobic Capacity (VO2 Max):** A measure of the maximum volume of oxygen that an athlete can utilize during intense exercise. Higher VO2 max is often associated with greater endurance.
   - **Lactate Threshold**: The point at which lactic acid begins to accumulate in the blood during exercise, causing fatigue. Training can raise this threshold.
   - **Muscle Fiber Composition**: Slow-twitch (Type I) fibers are more fatigue-resistant and dominant in endurance athletes, while fast-twitch (Type II) fibers are better suited for short bursts of power.
2) **Environmental Factors**:
   - Temperature extremes (heat and cold) can impair endurance by increasing energy demands and altering fluid balance.
   - High altitude reduces oxygen availability, challenging aerobic endurance.
3) **Psychological Factors**:
   - Motivation and focus play key roles in sustaining effort during prolonged activity.
   - Resilience to discomfort and pain is essential for competitive endurance.



18.5 TRAINING FOR ENDURANCE:

Effective endurance training incorporates various methods:

1) Long Slow Distance (LSD) Training: Involves prolonged sessions at a steady, moderate pace to build aerobic capacity. It's foundational for endurance sports, enhancing the body's ability to use fat as an energy source.

2) Interval Training: Alternating high-intensity efforts with rest periods to enhance both aerobic and anaerobic systems. This method is particularly effective for sports that require bursts of speed and recovery, like soccer or basketball.

3) Strength Training: Improves muscular endurance and supports joint stability, reducing injury risk. Core exercises like squats, lunges, and planks help maintain proper posture and form during extended efforts.

4) Cross-Training: Engages different muscle groups and prevents burnout by varying activities. For example, a runner might incorporate swimming or cycling to reduce the repetitive strain on their legs.

5) Fatigue in sports is a multifaceted phenomenon that significantly impacts athletic performance and recovery. It encompasses physical, mental, and physiological components, and understanding its mechanisms and management strategies is vital for athletes, coaches, and sports scientists. By addressing fatigue effectively, individuals can optimize performance, reduce the risk of injury, and enhance long-term well-being.

18.6 FATIGUE IN SPORTS:

Fatigue in sports is a multifaceted phenomenon that significantly impacts athletic performance and recovery. It encompasses physical, mental, and physiological components, and understanding its mechanisms and management strategies is vital for athletes, coaches, and sports scientists. By addressing fatigue effectively, individuals can optimize performance, reduce the risk of injury, and enhance long-term well-being.

18.7 TYPES OF FATIGUE IN SPORTS:

Fatigue can be categorized into several types based on its origins and effects on the body and mind:

1) **Physical Fatigue**:
   - This form of fatigue is characterized by a decline in muscular performance and the inability to sustain physical activity at the desired intensity.
   - Causes include depletion of glycogen stores, accumulation of metabolic byproducts such as lactic acid, and micro damage to muscle fibers during intense exercise.
   - Symptoms often include muscle soreness, heaviness, and reduced strength or power output.
2) **Mental Fatigue**:
   - Mental fatigue arises from prolonged cognitive or emotional stress and affects decision-making, focus, and reaction times.
   - It is common in sports requiring sustained concentration, such as golf, tennis, or team strategy-based games like soccer or basketball.
   - Indicators include difficulty in maintaining focus, errors in judgment, and a reduced ability to manage stress.
3) **Central Fatigue**:
   - Central fatigue originates from the Central Nervous System (CNS) and involves a decline in the brain's ability to activate muscles effectively.
   - It can result from neurotransmitter imbalances, such as reduced dopamine levels or increased serotonin, leading to diminished motivation and coordination.
4) **Peripheral Fatigue**:
   - Peripheral fatigue occurs at the muscular level and involves biochemical and mechanical changes that impair muscle contraction.

- Key factors include ATP depletion, impaired calcium release within muscle cells, and oxidative stress.

18.7.1 Causes of Fatigue in Sports:

The causes of fatigue are diverse and can be influenced by the nature of the sport, environmental conditions, and individual factors:

1) **Energy System Depletion**:
   - Intense or prolonged physical activity depletes glycogen stores, forcing the body to rely on less efficient energy sources like fat metabolism.
   - Without sufficient energy, athletes experience reduced endurance and power output.
2) **Dehydration and Electrolyte Imbalance**:
   - Sweating during exercise leads to the loss of fluids and electrolytes, which are critical for maintaining muscle function and thermoregulation.
   - Even mild dehydration can impair performance and increase the perception of exertion.
3) **Overtraining Syndrome**:
   - Chronic overtraining without adequate recovery can result in persistent fatigue, decreased performance, and a higher risk of injury.
   - Psychological symptoms, such as irritability and depression, often accompany physical exhaustion in this condition.
4) **Psychological Stress**:
   - Competitive pressure, personal challenges, and anxiety can amplify mental fatigue, making it harder to perform under stress.
5) **Environmental Stressors**:
   - External factors such as heat, humidity, altitude, and pollution place additional physiological strain on athletes, accelerating the onset of fatigue.

18.7.2 Signs and Symptoms of Fatigue:

Fatigue manifests in various ways, depending on its type and severity. Common signs include:

- Decline in athletic performance
- Muscle weakness or heaviness
- Slower reaction times and impaired coordination

- Loss of motivation and increased irritability
- Difficulty concentrating or making decisions
- Elevated heart rate and increased perception of effort

18.8 ASSESSMENT STRATEGIES FOR ENDURANCE AND FATIGUE:

Endurance and fatigue are crucial components in understanding physical performance, particularly in athletic training, clinical evaluations, and workplace ergonomics. Assessing these factors requires a multifaceted approach, integrating physiological, psychological, and functional performance metrics. Below are detailed strategies for effectively evaluating endurance and fatigue:

18.8.1. Physiological Assessments

- **VO2 Max Testing**: Measures the maximum oxygen uptake during incremental exercise. It's a gold standard for assessing aerobic endurance and cardiovascular efficiency.
- **Lactate Threshold Testing**: Determines the exercise intensity at which lactate begins to accumulate in the blood, providing insights into endurance capacity.
- **Muscle Fatigue Analysis**: Electromyography (EMG) can track changes in muscle activity over time to identify fatigue patterns.
- **Heart Rate Variability (HRV)**: Monitoring HRV during and after exercise helps assess recovery and endurance levels.

18.8.2. Functional Performance Tests

- **Time-to-Exhaustion Protocols**: Subjects perform a specific activity (e.g., running, cycling) until voluntary exhaustion. This provides direct insight into endurance capabilities.
- **Repetitive Task Analysis**: Measuring the number of repetitions or the duration a task can be sustained before fatigue sets in (e.g., grip strength or isometric holds).
- **Step Tests**: Common in clinical settings, step tests measure endurance by observing heart rate recovery after stepping exercises.

18.8.3. Psychological Assessments:

- **Perceived Exertion Scales**: Tools like the Borg Rating of Perceived Exertion (RPE) allow individuals to self-report their effort levels, which correlate with physical fatigue.
- **Mental Fatigue Questionnaires**: Instruments like the Mental Fatigue Scale (MFS) assess cognitive load and its impact on performance.

- **Mood and Motivation Metrics**: Tools such as the Profile of Mood States (POMS) help evaluate how fatigue affects mental states.

18.8.4. Laboratory-Based Techniques:

- **Blood Biomarker Analysis**: Measuring markers like creatine kinase, cortisol, and cytokines can provide biochemical evidence of fatigue.
- **Metabolic Testing**: Analyzing respiratory exchange ratios and energy expenditure during exercise offers insights into endurance limits.

18.8.5. Technology-Driven Approaches

- **Wearable Devices**: Smart watches and fitness trackers monitor real-time data like heart rate, oxygen saturation, and step counts to assess endurance trends.
- **Fatigue Detection Algorithms**: Advanced AI models integrate sensor data to predict and quantify fatigue levels dynamically.

18.8.6. Field Assessments

- **Sport-Specific Endurance Tests**: Activities like the Yo-Yo Intermittent Recovery Test for soccer players or the Cooper Test for runners provide context-specific insights.
- **Task Simulation Protocols**: Replicating job-specific tasks under controlled conditions assesses endurance and fatigue in occupational settings.

18.8.7. Longitudinal Monitoring

- **Performance Tracking**: Repeated assessments over weeks or months help identify trends in endurance and recovery.
- **Training Logs**: Athletes and workers can track subjective and objective metrics to monitor progress and fatigue over time.

By combining these strategies, practitioners can gain a comprehensive understanding of an individual's endurance and fatigue levels, allowing for tailored interventions to optimize performance, recovery, and overall well-being.

18.9 INTERVENTIONS TO IMPROVE ENDURANCE AND MITIGATE FATIGUE:

Improving endurance and managing fatigue are key to enhancing physical performance, optimizing recovery, and preventing injury in both athletic and clinical settings. Several intervention strategies can be applied to boost endurance while mitigating the onset of fatigue. These approaches span physiological conditioning, nutritional support, psychological interventions, and recovery techniques.

18.9.1. Physical Conditioning and Training Interventions:

- **Aerobic Training**: Regular aerobic exercise, such as running, cycling, swimming, and rowing, improves cardiovascular efficiency, increases VO2 max, and enhances muscular endurance. Progressive overload, where intensity, duration, or frequency is gradually increased, is essential to stimulate adaptation without overwhelming the body.
- **High-Intensity Interval Training (HIIT)**: HIIT is a potent method to boost endurance and mitigate fatigue by alternating periods of high-intensity exercise with short rest intervals. This training enhances both aerobic and anaerobic systems, improving overall stamina and tolerance to fatigue.
- **Strength Training**: Building muscle strength through resistance training helps improve endurance, particularly in tasks that involve sustained muscle contraction. Enhanced muscular strength also reduces the strain on muscles, helping delay fatigue in endurance activities.
- **Plyometric Training**: Plyometrics, involving explosive movements (like jumps or bounds), can improve both endurance and power, reducing fatigue during activities requiring high-intensity bursts.
- **Cross-Training**: Engaging in various forms of exercise (e.g., swimming, cycling, and running) helps prevent overuse injuries, maintains interest, and provides a balanced approach to enhancing endurance. This method also prevents mental fatigue by reducing monotony.

18.9.2. Nutritional Interventions:

Nutrition plays a pivotal role in supporting endurance and managing fatigue in athletes. Proper fueling, hydration, and recovery nutrition are essential for enhancing athletic performance, delaying fatigue, and speeding up recovery. Below are detailed nutritional intervention strategies specifically tailored for endurance athletes to optimize their energy levels, delay fatigue, and promote recovery.

18.9.2.1. Carbohydrate Strategies:

- **Carbohydrate Loading (Glycogen Super compensation)**: Carbohydrate loading is a strategy commonly employed before endurance events lasting over 90 minutes, such as marathons or long-distance cycling. The process involves increasing carbohydrate intake (7–10 grams per kg of body weight) for 3–4 days before the event, while tapering exercise intensity. This maximizes glycogen stores in muscles and the liver, providing a prolonged energy source during prolonged efforts.

- **Consistent Carbohydrate Intake During Exercise**: For long-duration activities, consuming carbohydrates during exercise (30–60 grams per hour) through sports drinks, gels, or bars helps maintain blood glucose levels and prevent glycogen depletion, delaying fatigue. The carbohydrates should be primarily from easily digestible sources like glucose, sucrose, or maltodextrin for quick energy availability.
- **Post-Exercise Carbohydrate Intake**: Post-exercise carbohydrate intake (1.0–1.5 grams per kg body weight) within 30 minutes to 2 hours after endurance exercise helps replenish depleted glycogen stores. A combination of high-glycemic carbohydrates like white bread, rice, or fruits accelerates glycogen resynthesis.

18.9.2.2. Protein Strategies:

- **Protein Intake for Muscle Repair**: Protein is essential for muscle repair and recovery. For endurance athletes, consuming 1.2–1.4 grams of protein per kg body weight daily is recommended to prevent muscle breakdown and support recovery. Post-exercise protein consumption (10–20 grams) is particularly crucial for muscle recovery, as it stimulates muscle protein synthesis.
- **Branched-Chain Amino Acids (BCAAs)**: BCAAs (leucine, isoleucine, and valine) have been shown to reduce exercise-induced muscle damage and fatigue, enhancing endurance performance. Supplementation of BCAAs before or during long-duration exercise may help delay fatigue and promote faster recovery.
- **Protein-Carbohydrate Blends for Recovery**: A 3:1 or 4:1 ratio of carbohydrates to protein in post-exercise recovery drinks has been found to accelerate glycogen restoration and promote muscle repair. The protein component helps reduce muscle soreness and the carbohydrate component replenishes glycogen stores.

18.9.2.3. Fats and Fatty Acids:

- **Utilizing Fat as an Energy Source**: During endurance activities lasting several hours, fat becomes a significant fuel source once glycogen stores are partially depleted. Omega-3 fatty acids, found in foods like fatty fish (salmon, mackerel) and flaxseed, help enhance the body's ability to utilize fat as an energy source, improve cardiovascular health, and reduce inflammation.
- **Dietary Fat Intake for Long-Term Endurance**: Endurance athletes should include healthy fats in their daily diet (20–35% of total caloric intake), focusing on unsaturated fats such as avocados, nuts, seeds, and olive oil. These fats support sustained energy release, especially during prolonged exercise when glycogen stores begin to deplete.

18.9.2.4. Hydration Strategies:

- **Fluid Requirements during Exercise**: Hydration is crucial to sustaining endurance and mitigating fatigue. Dehydration can significantly impair performance and accelerate the onset of fatigue. Athletes should aim to drink 400–800mL of fluid per hour during exercise, depending on temperature, intensity, and individual sweat rate. The key is to maintain fluid balance by consuming both water and electrolytes.
- **Electrolyte Replacement**: Electrolytes, including sodium, potassium, calcium, and magnesium, are lost through sweat during prolonged exercise. Replenishing electrolytes helps maintain fluid balance, muscle function, and performance. Sports drinks containing 500-700 mg of sodium per liter can help prevent hyponatremia (low sodium levels), cramps, and other electrolyte imbalances.
- **Pre-Hydration**: Pre-hydrating before exercise (about 500 mL of water or an electrolyte drink 2-3 hours prior to activity) can help ensure athletes start their sessions adequately hydrated. This is especially important in hot environments where fluid loss through sweat is accelerated.
- **Post-Exercise Hydration**: Rehydration after exercise is just as critical to recovery. Replenishing lost fluids, along with electrolytes, helps restore normal hydration levels. A general guideline is to consume 1.5 L of fluid for every kilogram of body weight lost during exercise.

18.9.2.5. Micronutrients and Supplementation

- **Iron and Vitamin B12 for Endurance**: Iron is critical for the production of hemoglobin, which transports oxygen to muscles during exercise. Low iron levels can impair endurance performance and increase fatigue. Athletes, especially female athletes and vegetarians, should ensure adequate intake of iron-rich foods (e.g., red meat, beans, leafy greens) or consider supplementation if necessary. Vitamin B12, along with folate, helps with red blood cell production, supporting optimal oxygen delivery to muscles.
- **Vitamin D for Muscle Function and Immune Support**: Vitamin D supports bone health and muscle function. Deficiency in vitamin D can impair endurance performance, reduce muscle strength, and increase the risk of fatigue. Adequate sun exposure or supplementation (especially in winter months) is essential for maintaining adequate vitamin D levels.

- **Magnesium for Muscle Function**: Magnesium plays a key role in muscle relaxation and energy production. Ensuring sufficient magnesium intake through foods like nuts, seeds, and leafy vegetables can help prevent muscle cramps and fatigue during long periods of exercise.
- **Antioxidants for Reducing Oxidative Stress**: Endurance exercise induces oxidative stress, which can damage cells and contribute to fatigue. Antioxidants such as vitamin C, vitamin E, and polyphenols (found in fruits and vegetables) help neutralize free radicals and protect against exercise-induced muscle damage and fatigue.

18.9.2.6. Timing of Nutrient Intake

- **Pre-Exercise Nutrition**: Pre-exercise meals should consist of easily digestible carbohydrates (for quick energy) and moderate amounts of protein. Fats should be kept low, as they can slow digestion. A good pre-exercise meal might include oatmeal with fruit or a whole-grain toast with peanut butter, consumed about 1.5 to 2 hours before activity.
- **Intra-Exercise Nutrition**: For endurance events lasting over 90 minutes, athletes should aim to consume 30–60 grams of carbohydrates per hour. This can be done through gels, energy bars, or sports drinks. In some cases, small amounts of protein (around 5–10 grams) during long races or training can help sustain energy levels and delay fatigue.
- **Post-Exercise Nutrition**: The post-exercise period is the most critical time to restore glycogen stores and repair muscle tissue. Within 30 minutes to 2 hours after exercise, athletes should consume a recovery meal or snack with a combination of carbohydrates (for glycogen replenishment) and protein (for muscle repair). For example, a smoothie with fruit and protein powder or a turkey sandwich can help kickstart the recovery process.

18.9.2.7. Supplements for Endurance and Fatigue Management:

- **Caffeine**: Caffeine is a well-researched ergogenic aid for endurance athletes, shown to improve performance by increasing alertness, reducing the perception of effort, and sparing glycogen stores. A moderate dose (3–6 mg/kg body weight) about 30–60 minutes before exercise can boost endurance performance.
- **Creatine**: While creatine is typically associated with strength sports, it can be beneficial for activities that involve intermittent efforts or sprints during endurance events, such as in cycling or running. Creatine helps replenish ATP (the primary energy source for muscle contractions), reducing fatigue and improving performance in high-intensity bursts.

- **Beta-Alanine**: Beta-alanine supplementation can increase muscle carnosine levels, buffering lactic acid buildup during high-intensity exercise. This helps delay the onset of fatigue and enhances endurance performance, particularly in sports that involve repeated sprints or high-intensity intervals.

18.9.3. Psychological Interventions:

- **Mental Toughness Training**: Developing psychological resilience can help individuals push through the mental barriers associated with fatigue. Techniques include goal setting, visualization, positive self-talk, and mindfulness, all of which improve the ability to endure stress and fatigue during physical tasks.
- **Motivational Strategies**: Encouraging positive thinking and fostering intrinsic motivation can significantly improve endurance by enhancing the desire to persist through fatigue. Structured reward systems and tracking progress can also provide psychological boosts during training and competition.
- **Stress Management**: Mental fatigue is closely linked to physical fatigue, and chronic stress exacerbates feelings of exhaustion. Practices like meditation, breathing exercises, and cognitive-behavioral therapy (CBT) can reduce stress and help manage mental fatigue.

18.9.4. Recovery and Restorative Techniques:

- **Sleep Optimization**: Sleep is crucial for recovery and maintaining endurance levels. Ensuring sufficient, high-quality sleep allows for muscle repair, glycogen replenishment, and the regulation of fatigue-related hormones. Sleep hygiene practices, such as establishing a regular sleep schedule and creating a conducive sleep environment, are essential for recovery.
- **Active Recovery**: Low-intensity exercises such as walking, swimming, or light cycling can help reduce muscle stiffness and facilitate the removal of metabolic waste products from muscles, promoting recovery and reducing fatigue. Active recovery is often more beneficial than complete rest for maintaining endurance over time.
- **Massage and Foam Rolling**: Techniques like deep tissue massage or foam rolling can enhance circulation, reduce muscle soreness, and speed up recovery. Regular soft-tissue therapy can help prevent muscle fatigue and improve range of motion.

- **Cold Water Immersion**: Cold water immersion (e.g., ice baths) can reduce muscle inflammation and soreness, enhancing recovery times. It has been shown to mitigate the sensation of fatigue following intense endurance training or competition.
- **Stretching and Flexibility Training**: Regular stretching or yoga can improve flexibility, reduce muscle tightness, and promote better posture, which reduces the likelihood of injury and helps maintain endurance during prolonged physical activity.

18.9.5. Technology-Assisted Interventions:

- **Wearable Devices**: Wearable technology can provide real-time data on heart rate, VO2 max; sleep quality, and muscle recovery, helping athletes and individuals monitor their endurance and fatigue levels. Smart watches, fitness trackers, and heart rate monitors can provide tailored feedback on training intensity, recovery needs, and performance.
- **Biofeedback**: Biofeedback techniques, which use real-time monitoring of physiological signals (such as heart rate, muscle tension, and brain wave activity), allow individuals to gain control over their body's responses. This can help manage fatigue and optimize endurance through conscious regulation of stress responses.
- **Electro stimulation**: Electrical muscle stimulation (EMS) can be used to reduce muscle soreness and accelerate recovery after endurance events or training. EMS helps by promoting blood circulation and muscle relaxation, thus reducing fatigue and enhancing recovery.

18.9.6. Periodization and Structured Training Plans:

- **Training Cycles**: Structured periodization, which involves varying training intensity and volume over time, ensures that an individual's endurance training is progressive and sustainable. By integrating phases of intensity, recovery, and skill-building, periodization helps optimize performance and prevent overtraining, thus reducing fatigue.
- **Rest and Deloading Phases**: Incorporating periods of rest or reduced intensity, known as deloading, is essential to allow the body to recover and adapt. Overtraining without sufficient rest can lead to chronic fatigue and performance decline. Planned rest days and weeks are necessary to restore both physical and mental energy.

18.10 SUMMARY:

Endurance and fatigue are pivotal aspects of sports performance, influenced by a myriad of physiological, psychological, and environmental factors. Through precise assessment strategies and targeted interventions, sports professionals can optimize an athlete's performance and prolong their careers. Addressing these components holistically ensures athletes achieve their maximum potential while minimizing risks of overtraining and burnout.

18.11 TECHNICAL TERMS:

Endurance, Energy System, Fatigue, Sports Performance, Assessment Strategies.

18.12 SELF ASSESSMENT QUESTIONS:

1) Describe in brief the importance of Endurance in sports?
2) Mention the Interventions to improve endurance and mitigate fatigue?

18.13 REFFERENCE BOOKS:

1) Dr. Luna Dutta Baruah., Dr. Ninad Gor., Dr. Priyanka Kono., Dr. Jateen Baruah, A Textbook on Sports Nutrition.
2) Anita Jatana, Apollo Clinical Nutrition Handbook, 2022.
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LESSON-19

NUTRITIONAL NEEDS FOR INDUSTRIAL WORKERS

19.0 OBJECTIVES:

After reading this lesson, you would be able to:

- To know about Endurance, different types of Endurance, factors and training.
- To understand Fatigue, types of fatigue, causes and symptoms.
- Assessment strategies for endurance and fatigue.

STRUCTURE:

19.1 INTRODUCTION:

Industrial workers are the backbone of various sectors that involve large-scale manufacturing, construction, production, and other labor-intensive industries. Their work plays a crucial role in the global economy, producing everything from consumer goods to infrastructure, and many work in environments that can be physically demanding, hazardous, and time-sensitive. To better understand the role of industrial workers, we will expand on the types of industrial work, the challenges they face, and the importance of worker welfare, including health, safety, and labor rights.

19.2 TYPES OF INDUSTRIAL WORKERS: EXPANDED OVERVIEW:

Industrial workers encompass a broad spectrum of roles, each essential to maintaining the machinery and production of goods in various sectors. These workers are employed in industries such as manufacturing, construction, mining, energy, utilities, food processing, and more. The complexity and diversity of industrial work require a wide range of skills, from manual labor to highly specialized technical roles. Below is an in-depth look at the various types of industrial workers, the nature of their work, and the specialized tasks they perform in their respective sectors.

1) **Manufacturing Workers:** These workers are involved in the production of goods, ranging from electronics, textiles, and automobiles to chemicals, food products, and heavy machinery. Manufacturing workers may operate machines, monitor production lines, assemble products, or perform quality control.

2) **Construction Workers:** Construction workers are involved in building infrastructure such as roads, bridges, buildings, and other structures. Their tasks may include bricklaying, carpentry, electrical work, plumbing, welding, and other skilled trades.

3) **Warehouse and Distribution Workers:** These workers manage the movement of goods in warehouses or distribution centers, often working with inventory, packing, shipping, and operating forklifts or other machinery.

4) **Mining Workers:** Industrial workers in mining extract valuable materials such as coal, metal ores, and minerals. These workers face unique challenges related to underground or open-pit mining, including exposure to dangerous gases, dust, and equipment accidents.

5) **Energy and Utility Workers:** These individuals work in power plants, oil rigs, and utility companies, maintaining and repairing equipment that generates electricity or supplies water, gas, and other vital services. They are often exposed to hazardous working conditions and must adhere to strict safety protocols.

6) **Food Processing Workers:** Food processing workers are involved in turning raw agricultural products into finished food items. Their work ensures that food is safe, processed efficiently, and packaged for consumers. Types of food processing workers include:

- **Butchers and Meat Processors:** These workers are responsible for cutting, processing, and packaging meat for sale in retail markets or for use in prepared foods. Their work often requires adherence to strict health and safety regulations to prevent contamination.
- **Cooks and Food Preparers:** Cooks in food processing plants prepare ingredients, cook meals, and ensure proper food safety standards are followed. They may work in processing facilities for snacks, canned goods, or frozen meals.
- **Food Packaging Workers:** Food packaging workers package processed foods into retail containers, ensuring they are properly labeled, sealed, and ready for shipment to grocery stores and markets.
- **Bottling and Canning Workers:** These workers specialize in filling containers, such as bottles or cans, with liquid or packaged food products, then sealing and labeling them for distribution.

19.3 CHALLENGES FACED BY INDUSTRIAL WORKERS:

Industrial workers face a range of physical, environmental, and social challenges in their work environments, which can impact their health, safety, and productivity:

- **Physical Strain and Injuries:** Industrial work often involves repetitive movements, heavy lifting, operating machinery, and working in awkward postures, which can lead to musculoskeletal disorders, chronic pain, and other injuries. There is also a higher risk of slips, trips, and falls, especially in environments like factories or construction sites.
- **Exposure to Hazardous Materials:** Many industrial workers are exposed to chemicals, dust, fumes, loud noises, and extreme temperatures, which can lead to long-term health problems such as respiratory issues, hearing loss, or even cancer. For example, workers in manufacturing plants or construction may be exposed to asbestos or harmful chemicals.
- **Fatigue:** Industrial work is often physically exhausting, and long shifts, irregular hours, or shift work can lead to fatigue, decreased productivity, and increased likelihood of accidents. Workers in sectors like construction, mining, and manufacturing are particularly susceptible to mental and physical exhaustion.

- **Environmental Risks:** Industrial workers may face environmental challenges, particularly those working outdoors or in extreme weather conditions. For instance, workers in the construction and mining industries may face extreme temperatures, while those in factories may be exposed to noisy, confined, or polluted environments.
- **Job Insecurity:** The nature of many industrial jobs can lead to job instability, especially for workers in industries affected by automation or outsourcing. This uncertainty can affect worker morale and overall well-being.
- **Mental Health:** Industrial work can sometimes be isolating and mentally taxing, leading to stress, anxiety, depression, or burnout. The physical nature of the work combined with long hours can also affect a worker's mental state, especially if they are dealing with hazardous conditions or high pressure to meet quotas.

19.4 THE IMPORTANCE OF WORKER WELFARE:

The well-being of industrial workers is crucial not only for their health and safety but also for the efficiency and productivity of industries. Addressing the welfare of industrial workers involves providing support across multiple aspects, including:

- **Health and Safety:** Ensuring that industrial workers work in safe environments is vital. Employers should implement robust safety protocols to minimize accidents, provide personal protective equipment (PPE), conduct regular safety drills, and maintain high standards for machinery and tools. Many countries have regulatory bodies (e.g., OSHA in the U.S.) that establish and enforce safety standards to protect workers.
- **Workplace Ergonomics:** Ergonomics play a key role in reducing physical strain. Properly designed workstations, lifting aids, and rest periods can help prevent injuries caused by repetitive tasks and heavy lifting.
- **Access to Health Care:** Industrial workers should have access to adequate health care, both for preventive measures and for treatment of work-related injuries. This includes regular check-ups, mental health support, and rehabilitation services.
- **Training and Skill Development:** Providing ongoing training helps workers maintain safety standards, learn new skills, and improve job security. Proper training also empowers workers to navigate machinery safely, improving their overall productivity and reducing accidents.
- **Work-Life Balance:** Many industrial workers face long shifts, irregular hours, or night shifts, which can take a toll on personal time and family life. Employers should consider the well-being of workers by offering more flexible schedules or ensuring fair shift rotations to help maintain a healthy work-life balance.

- **Worker Representation:** Unions and worker organizations can play a significant role in ensuring that industrial workers' rights are protected. Collective bargaining can help workers secure better wages, job security, and safer working conditions.

19.5 GLOBAL CONTEXT AND WORKER RIGHTS:

Around the world, industrial workers are subject to different labor laws, which may affect their rights, pay, and working conditions. In countries with strong labor laws, workers benefit from protective measures such as minimum wage legislation, union rights, paid leave, and health and safety regulations. However, in some parts of the world, industrial workers may face exploitation, unsafe working environments, or low wages, especially in countries where labor rights are not as strictly enforced.

19.6 NUTRITIONAL CHALLENGES FACED BY INDUSTRIAL WORKERS: AN EXPANDED OVERVIEW:

Industrial workers, who are often engaged in physically demanding tasks, face a unique set of nutritional challenges that can impact their health, performance, and overall well-being. These challenges arise from the nature of their work environment, long working hours, irregular schedules, and limited access to nutritious food options. Proper nutrition is essential for maintaining energy levels, preventing chronic diseases, and ensuring that workers can perform their duties safely and efficiently. However, the demanding physical and environmental conditions of industrial settings often make it difficult for workers to maintain a balanced diet. Below is an expanded overview of the nutritional challenges industrial workers face:

19.6.1. Limited Access to Healthy Food Choices:

In many industrial settings, especially in manufacturing plants, construction sites, and mines, workers may have limited access to nutritious food during their shifts. Common challenges include:

- **Vending Machine Dependence:** Many industrial facilities have vending machines or snack bars that primarily offer processed foods like chips, candy, and sugary drinks. These options are often high in calories, unhealthy fats, and sugars but lack essential nutrients such as protein, fiber, vitamins, and minerals.
- **Lack of On-Site Catering or Meal Options:** In remote or industrial locations, workers may not have access to on-site cafeterias or healthy meal services. In these cases, workers often rely on packaged meals or take-out, which may not provide adequate nutrition.

- **Limited Time for Meal Preparation:** Workers in industrial settings often have short breaks or rigid schedules, which limits their ability to prepare balanced meals. As a result, they may skip meals or opt for quick, less nutritious alternatives, such as fast food or pre-packaged snacks.

19.6.2. High-Calorie, Low-Nutrient Diets:

Industrial workers are often physically active and expend a significant amount of energy during their shifts. However, their diet may not always reflect their caloric needs, and they may be more likely to consume high-calorie, low-nutrient foods, leading to poor nutritional status. These challenges include:

- **Overconsumption of Processed Foods:** Many industrial workers have diets rich in processed and convenience foods due to their availability, cost, and ease of consumption. These foods tend to be high in refined carbohydrates, unhealthy fats, and sodium, which can contribute to weight gain, high blood pressure, and other health issues.
- **Imbalance in Macronutrients:** Workers who consume diets high in simple carbohydrates (like sugary snacks or white bread) and low in protein and healthy fats may experience energy crashes during their shifts. This can lead to fatigue, poor concentration, and reduced physical endurance.
- **Excessive Calorie Intake:** Given the physically demanding nature of industrial work, workers may consume more calories to meet their energy needs. However, if the calories come from unhealthy sources (such as fried foods, sugary drinks, or high-fat snacks), they may contribute to weight gain, increased body fat, and the development of metabolic disorders like obesity or diabetes.

19.6.3. Nutritional Deficiencies:

Due to the limited availability of nutritious food options and the tendency to rely on processed foods, industrial workers are at risk for several nutritional deficiencies that can impact their health and performance. Some common deficiencies include:

- **Micronutrient Deficiencies:** Many industrial workers may not consume enough fruits, vegetables, or whole grains, leading to deficiencies in essential vitamins and minerals, such as vitamin A, vitamin C, calcium, and iron. These deficiencies can result in fatigue, weakened immunity, poor bone health, and anemia.
- **Low Fiber Intake:** A diet lacking in whole grains, fruits, and vegetables can lead to inadequate fiber intake. Fiber is essential for digestive health, blood sugar regulation, and weight management. A lack of fiber can lead to constipation, digestive discomfort, and an increased risk of heart disease.

- **Calcium and Vitamin D Deficiency:** Industrial workers, particularly those working in environments with limited sunlight (e.g., underground mines or night shifts), may be at risk for calcium and vitamin D deficiencies. These nutrients are crucial for maintaining bone health, and their deficiency can lead to weakened bones, increased fracture risk, and osteoporosis.

19.6.4. Dehydration and Inadequate Fluid Intake:

Dehydration is a common nutritional challenge for industrial workers, especially those working in physically demanding environments like construction sites, manufacturing plants, and mining operations. The combination of high physical activity and environmental factors can lead to excessive fluid loss through sweating, putting workers at risk of dehydration. The challenges include:

- **Insufficient Water Intake:** Many workers may neglect to drink enough water during their shifts, particularly if water stations are not readily available or if workers are too busy to take regular hydration breaks. This can lead to dehydration, which can impair cognitive function, physical performance, and overall health.
- **Excessive Consumption of Sugary Beverages:** In some industrial settings, sugary beverages like sodas, energy drinks, or sweetened coffee are commonly consumed instead of water. These drinks can contribute to weight gain, increase the risk of metabolic diseases like diabetes, and fail to adequately hydrate the body.
- **Environmental Heat Stress:** Workers who are exposed to high temperatures or work in hot environments, such as steel manufacturing, foundries, or outdoor construction, are at heightened risk for heat stress. Without adequate fluid intake, they may experience dehydration, heat exhaustion, and heatstroke, which can impair performance and lead to serious health complications.

19.6.5. Irregular Eating Patterns and Shift Work

The demanding work schedules in industrial settings, including long hours, irregular shifts, and night shifts, can disrupt workers' eating patterns, making it challenging to maintain a balanced diet. Some of the key nutritional challenges related to irregular work schedules include:

- **Irregular Meal Times:** Industrial workers who work long shifts or night shifts may struggle to maintain regular meal times, leading to skipped meals or overeating when food is available. Irregular eating patterns can lead to digestive problems, increased hunger, and unhealthy food choices.
- **Shift Work and Its Impact on Metabolism:** Shift work, particularly night shifts, can disrupt the body's circadian rhythms, leading to metabolic changes. Workers who eat during the night, when the body is naturally less prepared to digest food, may experience digestive discomfort, weight gain, and an increased risk of obesity and diabetes.

- **Disrupted Sleep and Nutrition:** Lack of adequate sleep due to shift work can affect appetite-regulating hormones, leading to increased hunger and cravings for high-calorie foods. This, combined with disrupted meal times, can contribute to poor dietary choices and weight gain.

19.6.6. Challenges in Maintaining a Balanced Diet in Remote Locations:

Workers employed in remote or isolated locations, such as oil rigs, mines, or construction sites in rural areas, may face additional challenges in accessing nutritious foods. Some of the challenges include:

- **Limited Access to Fresh Produce:** In remote locations, fresh fruits and vegetables may not be readily available or may be expensive due to transportation costs. This can make it difficult for workers to incorporate a variety of nutrient-dense foods into their diet.
- **Long-Term Food Storage Issues:** In isolated locations, workers may have to rely on packaged, shelf-stable foods, which are often low in essential nutrients and high in preservatives, salt, and unhealthy fats. The lack of refrigeration or cooking facilities further limits food choices and can lead to poor nutrition.
- **Cultural and Dietary Preferences:** In some cases, workers in remote locations may come from different cultural or regional backgrounds with specific dietary preferences or restrictions. Limited access to culturally appropriate or preferred foods can affect workers' nutritional intake and overall satisfaction with available meal options.

19.6.7. Lack of Knowledge and Awareness about Nutrition:

Many industrial workers may not have adequate knowledge or awareness of the importance of nutrition for their health and performance. Lack of education about healthy eating habits, portion control, and the role of nutrition in preventing health problems can contribute to poor dietary choices. Some contributing factors include:

- **Limited Access to Nutrition Education:** In industrial environments, workers may not have access to nutrition counseling or educational programs that emphasize the importance of a balanced diet, healthy food choices, and portion control. Without this knowledge, workers may be unaware of the long-term effects of poor nutrition.
- **Pressure to Work through Breaks:** In some industries, workers may feel pressured to skip meals or snacks in order to meet production goals or deadlines. This can lead to inadequate energy intake, decreased concentration, and increased fatigue during their shifts.

- **Misinformation about Nutrition:** Industrial workers may receive conflicting or misleading information about nutrition, especially when it comes to fad diets or dietary supplements. This misinformation can lead to poor dietary choices that may not meet their specific nutritional needs.

19.7 NUTRITIONAL REQUIREMENTS FOR INDUSTRIAL WORKERS: AN EXPANDED OVERVIEW:

Industrial workers are engaged in physically demanding tasks and often work in challenging environments. Their nutritional needs differ from those of individuals with sedentary lifestyles, as their bodies require more energy and specific nutrients to support prolonged physical activity, recovery, and overall health. The combination of strenuous labor, exposure to environmental factors, and irregular schedules necessitates a tailored nutritional approach to ensure workers can perform efficiently while maintaining their health.

19.7.1. Caloric Intake:

The caloric needs of industrial workers depend on factors such as the intensity of their work, the duration of physical activity, and individual metabolic factors. Since industrial workers often engage in physically demanding tasks, they have higher caloric requirements than workers with sedentary roles.

- **Energy Expenditure:** Physical labor, such as heavy lifting, operating machinery, or working in construction, increases energy expenditure. The total caloric intake for industrial workers may range from 2,500 to 4,000 calories per day, depending on the type and intensity of work.
- **Energy Balance:** Maintaining a balance between energy intake and expenditure is crucial. Workers should consume enough calories to prevent fatigue, maintain muscle mass, and recover from physical exertion. Insufficient caloric intake can lead to energy deficits, reduced performance, and weight loss, while excessive caloric intake may contribute to weight gain and associated health risks.
- **Distribution of Calories:** It is important for industrial workers to distribute their caloric intake across meals and snacks throughout the day to ensure consistent energy levels. This can help prevent energy dips and improve overall productivity.

19.7.2. Macronutrients:

The three primary macronutrients-carbohydrates, proteins, and fats-are essential for providing energy, supporting physical performance, and aiding in recovery. Each macronutrient plays a specific role in the nutrition of industrial workers.

19.7.2.1 Carbohydrates: Carbohydrates are the body's primary source of energy, particularly during physical exertion. Since industrial workers often engage in labor-intensive tasks, their carbohydrate intake must be sufficient to fuel their activities and prevent fatigue.

- **Role in Energy Production:** Carbohydrates are broken down into glucose, which is used by the muscles and brain for energy. For workers performing high-intensity

tasks, carbohydrates help maintain blood glucose levels and ensure a constant energy supply.

- **Recommended Intake:** Approximately 45-65% of total daily calories should come from carbohydrates. Industrial workers engaged in vigorous physical activity should focus on consuming complex carbohydrates, which provide a steady release of energy and are rich in fiber.
- **Sources of Carbohydrates:** Whole grains (brown rice, oats, quinoa), starchy vegetables (potatoes, sweet potatoes), legumes (beans, lentils), and fruits provide complex carbohydrates that are high in fiber and essential nutrients.

19.7.2.2 Proteins: Proteins are essential for muscle repair and recovery, especially for workers engaged in physically demanding tasks that stress the muscles and joints. Protein also supports immune function, tissue repair, and enzyme production.

- **Role in Muscle Recovery:** After intense physical labor, muscles undergo wear and tear. Adequate protein intake helps repair muscle tissues, build new muscle fibers, and reduce muscle soreness and fatigue.
- **Recommended Intake:** Industrial workers typically require 1.2 to 2.0 grams of protein per kilogram of body weight per day, depending on the level of physical activity and intensity. For a worker weighing 70 kg (154 lbs), this could equate to approximately 84 to 140 grams of protein per day.
- **Sources of Protein:** High-quality protein sources include lean meats (chicken, turkey, lean beef), fish, eggs, dairy products (milk, yogurt, cheese), legumes (beans, lentils), and plant-based sources like tofu, tempeh, and quinoa.

19.7.2.3 Fats: Fats are a concentrated source of energy and play an essential role in maintaining cell structure, hormone production, and absorption of fat-soluble vitamins (A, D, E, K). Industrial workers require a balance of healthy fats to support long-term energy needs and overall health.

- **Role in Sustained Energy:** Fats provide long-lasting energy, particularly for activities that are less intense but prolonged. Healthy fats, such as those found in nuts, seeds, and oils, can help industrial workers maintain energy levels during long shifts.
- **Recommended Intake:** Around 20-35% of total daily calories should come from fats. Industrial workers should focus on unsaturated fats, which are heart-healthy, and limit saturated and trans fats, which can increase the risk of heart disease.
- **Sources of Healthy Fats:** Healthy fats can be found in avocados, olive oil, nuts (almonds, walnuts), seeds (chia seeds, flaxseeds), fatty fish (salmon, mackerel), and nut butters.

Table 19.1: Recommended Dietary Allowances (RDA) Table for Industrial Workers

Nutrient	RDA for Adult Men	RDA for Adult Women	Notes
Calories (kcal)	3,000-3,500 kcal/day	2,400-2,800 kcal/day	Dependent on activity level and physical demands (higher for physically demanding tasks).
Carbohydrates	45-65% of total calories (337-487g/day)	45-65% of total calories (270-455g/day)	Prioritize complex carbs for sustained energy (whole grains, legumes, starchy vegetables).
Protein	1.2-2.0g/kg of body weight (84 - 140g/day)	1.2 - 2.0g/kg of body weight (70- 112g/day)	For muscle repair, recovery, and maintaining muscle mass. High-protein sources: lean meats, dairy.
Fats	20-35% of total calories (67-117g/day)	20-35% of total calories (53-98g/day)	Focus on healthy fats (olive oil, avocados, nuts, seeds). Avoid trans fats.
Fiber	25-30g/day	25-30g/day	Crucial for digestive health, energy release, and satiety. Found in whole grains, fruits, and veggies.
Water	3.7L /day	2.7L/day	Hydration needs increase with physical activity and environmental heat. Electrolytes may be needed.
Iron	8 mg/day	8 mg/day	Higher requirements for women of reproductive age due to menstruation. Important for energy and oxygen transport.
Calcium	1,000 mg/day	1,000 mg/day	For bone strength, muscle function, and nerve transmission. Needs increase for women over 50 (1,200 mg).
Vitamin D	600 IU/day	600 IU/day	Supports calcium absorption and bone health. Sunlight exposure helps with Vitamin D synthesis
Magnesium	400-420 mg/day	310-320 mg/day	Essential for muscle and nerve function, energy production, and recovery.

This table is a general guideline and may need to be adjusted based on specific work conditions (e.g., heat exposure, heavy lifting) and individual health needs. Regular monitoring of dietary habits and nutrient intake can ensure that industrial workers are meeting their energy demands while maintaining their health and performance.

19.7.3. Micronutrients:

Micronutrients-vitamins and minerals-are crucial for maintaining optimal health, supporting immune function, and enabling proper energy metabolism. Industrial workers may be at risk for specific deficiencies due to the nature of their work and dietary habits.

19.7.3.1 Iron: Iron is essential for transporting oxygen to the muscles and tissues, which is particularly important for industrial workers involved in heavy physical labor. Iron also supports overall energy production and helps prevent fatigue and anemia.

- **Recommended Intake:** The Recommended Dietary Allowance (RDA) for iron varies by age, sex, and activity level. For adult men, the RDA is around 8 mg per day, while adult women (especially those of childbearing age) may need 18 mg per day due to menstruation.
- **Sources of Iron:** Good sources of iron include red meat, poultry, fish, legumes (lentils, beans), tofu, spinach, and fortified cereals. Consuming iron with vitamin C-rich foods (like citrus fruits) enhances absorption.

19.7.3.2 Calcium and Vitamin D: Calcium and vitamin D are vital for maintaining strong bones and preventing osteoporosis, especially for workers in physically demanding jobs that involve heavy lifting or high-impact activities. These nutrients are also important for muscle function and recovery.

- **Recommended Intake:** The RDA for calcium is about 1,000 mg per day for adults, increasing to 1,200 mg for women over 50 and men over 70. For vitamin D, the RDA is 600 IU per day for adults under 70, and 800 IU per day for those over 70.
- **Sources of Calcium and Vitamin D:** Dairy products (milk, yogurt, cheese), fortified plant-based milks (almond, soy), leafy green vegetables (broccoli, kale), and fortified cereals provide calcium. Vitamin D can be obtained through exposure to sunlight and from food sources like fatty fish, egg yolks, and fortified foods.

19.7.3.3 Magnesium: Magnesium is involved in over 300 biochemical reactions in the body, including energy production, muscle function, and nerve transmission. Industrial workers who experience muscle cramps, fatigue, or excessive physical exertion may benefit from increased magnesium intake.

- **Recommended Intake:** The RDA for magnesium is about 400-420 mg per day for men and 310-320 mg per day for women.
- **Sources of Magnesium:** Magnesium-rich foods include leafy green vegetables (spinach, Swiss chard), nuts (almonds, cashews), seeds (pumpkin seeds, sunflower seeds), whole grains (brown rice, oats), and legumes.

19.7.3.4 B Vitamins: The B vitamins-especially B6, B12, and folate-play a key role in energy metabolism and the production of red blood cells. They also support the nervous system and help reduce fatigue, which is critical for workers who perform physically demanding tasks.

- **Recommended Intake:** The RDA for B vitamins varies, but for example, vitamin B6 is around 1.3-2.0 mg per day for adults, while vitamin B12 is about 2.4 mcg per day.
- **Sources of B Vitamins:** B vitamins are found in a variety of foods, including whole grains, lean meats, fish, eggs, dairy products, legumes, and leafy vegetables.

19.7.4. Hydration:

Adequate hydration is essential for maintaining performance, regulating body temperature, and preventing dehydration-related health issues such as heatstroke, fatigue, and muscle cramps. Industrial workers, especially those working in hot environments or performing strenuous activities, must prioritize hydration.

- **Fluid Requirements:** While individual fluid needs vary, a general guideline is to drink at least 8 cups (about 2 liters) of water per day. However, industrial workers may need more depending on environmental conditions and physical exertion.
- **Electrolyte Balance:** In addition to water, it is important for industrial workers to replenish electrolytes (sodium, potassium, calcium, magnesium) lost through sweat. Drinks containing electrolytes or foods like bananas, oranges, and leafy greens can help maintain hydration balance.
- **Environmental Considerations:** In hot work environments, such as construction sites or steel manufacturing, workers should be encouraged to drink water regularly to avoid dehydration and heat-related illnesses.

19.8 SUMMARY:

The nutritional requirements of industrial workers are specific and must be addressed to maintain energy, support recovery, and promote long-term health. Adequate caloric intake, balanced macronutrients, and micronutrients are essential to meet the physical demands of the job. Proper hydration, sufficient intake of vitamins and minerals, and healthy food choices are crucial for sustaining performance, reducing the risk of injuries, and preventing chronic conditions. Employers should be proactive in providing education, access to healthy foods, and support for hydration to ensure workers are meeting their nutritional needs.

19.9 TECHNICAL TERMS:

Nutritional needs, Industrial workers, Nutrients, Stress, Food choice, Hydration.

19.10 SELF ASSESSMENT QUESTIONS:

1) Explain the nutritional requirements for industrial workers?
2) What are the nutritional challenges faced by industrial workers?

19.11 REFFERENCE BOOKS:

1) Indrani TK. Manual of Nutrition & Therapeutic Diet, 2nd edition, 2017.
2) Darshan Sohi. A Comprehensive Textbook of Nutrition and Therapeutic Diets, 2018.
3) Phil Hughes. Introduction to Health and Safety at Work, 3rd edition, 2007.
4) Edgar L. Collis. The Health of the Industrial Worker, 2018.

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LESSON-20

NUTRITIONAL NEEDS FOR SPACE NUTRITION

20.0 OBJECTIVES:

After reading lesson we should be able to:

- Importance of Space Nutrition;
- Space food-Past and Present and types of Space foods;
- Nutritional needs and RDA for Astronauts.

STRUCTURE:

20.1 INTRODUCTION:

Space exploration presents unique challenges for human nutrition. The extreme environment of space, including microgravity, radiation exposure, and the need for extended periods of isolation, requires careful planning to ensure astronauts maintain their health and performance. Unlike on Earth, where gravity, climate, and an abundance of food resources support human sustenance, space presents a closed environment where every aspect of nutrition must be meticulously controlled and optimized.

Microgravity, one of the most significant challenges in space, causes a range of physiological changes. These include muscle atrophy, bone density loss, and fluid redistribution, which can lead to puffiness in the face and a reduction in the size of the legs. This altered physiological state necessitates a tailored nutritional approach to mitigate health risks and maintain physical fitness. Furthermore, radiation exposure in space can increase the risk of cancer and other health issues, which dietary antioxidants might help combat.

The psychological effects of space travel, including stress, isolation, and confinement, also impact eating habits and nutritional status. Astronauts may experience changes in taste perception and appetite, which can lead to decreased food intake. The monotony of space food and the lack of fresh produce can further diminish appetite, making it essential to provide diverse and appealing meal options to encourage adequate consumption.

Addressing these challenges involves not only ensuring that astronauts consume a balanced diet but also considering the preservation, packaging, and acceptability of food over long-duration missions. Food must be designed to remain nutritious and safe to eat for extended periods, sometimes lasting several years. Innovations in food technology, such as freeze-drying and vacuum-sealing, help meet these requirements. Additionally, the social and psychological aspects of eating must be taken into account, as shared meals can provide comfort and a sense of normalcy in the isolated environment of space.

Nutritional strategies must be developed to support physical health, cognitive function, and overall well-being, which are critical for the success of space missions. Ensuring proper nutrition in space is a complex challenge that requires a multidisciplinary approach, integrating knowledge from nutrition science, medicine, psychology, and space engineering.

20.2 SPACE FOOD: THE PAST:

The journey of space food has undergone remarkable evolution since the early days of human space exploration. Initially, the primary focus was on ensuring that astronauts had enough sustenance to survive in the challenging conditions of space. Over time, as missions

grew longer and more complex, so did the requirements for food. This historical overview explores the development of space food from its inception to the more refined meals of later missions.

20.2.1. Early space missions:

20.2.1.1. Mercury Program (1961-1963):

The Mercury program was the United States' first foray into manned spaceflight, with missions lasting a few hours to a full day. During these missions, food had to be lightweight, compact, and easy to consume in zero gravity. The food provided to astronauts was rudimentary, consisting primarily of bite-sized cubes, freeze-dried powders, and semi-liquid substances packaged in aluminium tubes, similar to toothpaste containers. The emphasis was on functionality rather than flavor.

- **Cubes:** These small, gelatin-coated cubes contained essential nutrients and were designed to prevent crumbs, which could interfere with the spacecraft's equipment.
- **Tubes:** Foods like pureed beef or applesauce were squeezed directly into the mouth from these tubes, simplifying consumption in a weightless environment.

Challenges: The early space food faced several issues, including unappetizing taste and lack of variety. Eating from tubes and consuming dry cubes offered little enjoyment and sometimes led to difficulty in swallowing.

20.2.1.2 Gemini Program (1965-1966):

The Gemini missions introduced more prolonged stays in space, necessitating improvements in food technology and variety. Freeze-drying became a pivotal advancement, allowing foods to be lightweight and have an extended shelf life.

- **Freeze-Dried Foods:** Astronauts were provided with freeze-dried options such as scrambled eggs and spaghetti. These meals required the addition of water, which rehydrated the food for consumption.
- **Packaging Improvements:** The packaging evolved to accommodate utensils, allowing astronauts to eat more conventionally instead of relying solely on tubes.

Advancements: The introduction of freeze-dried foods marked a significant improvement in terms of taste and variety, although challenges remained in ensuring the rehydrated food was palatable and nutritious.

20.2.1.3 Apollo Program (1966-1972):

The Apollo missions, particularly the historic Apollo 11 moon landing, required further advancements in space food. With missions lasting several days to weeks, astronauts needed a more diverse and palatable diet.

- **Thermostabilized Pouches:** This innovation involved heat-processing foods and sealing them in flexible pouches, allowing for a more varied menu that included items like beef stew, chicken with vegetables, and even desserts.
- **Hot Water Rehydration:** The ability to use hot water for rehydrating freeze-dried foods significantly improved the taste and texture of meals.
- **Meal Variety:** Astronauts could enjoy a wider range of foods, including beverages like coffee and orange juice, and snacks such as granola bars and cookies.

Challenges: Despite these improvements, the food still lacked some of the sensory and textural qualities of fresh food. Additionally, the confined environment of the spacecraft limited the preparation and consumption experience.

20.2.1.4 Skylab and Beyond (1973-1974):

The Skylab missions saw further advancements in space food. Skylab had more space and facilities, including a dining area where astronauts could sit and eat together. This was a significant shift from previous missions where eating was more of a solitary activity.

- **Refrigeration and Heating:** Skylab was equipped with refrigeration, allowing for better storage of fresh and frozen foods. Additionally, food could be heated, which enhanced the eating experience.
- **Menu Expansion:** The menu was expanded to include over 70 different food items, ranging from fresh fruits and vegetables to pre-cooked and frozen dishes.

Challenges and Limitations: Even with these advancements, early space food systems had their limitations:

- **Taste and Texture:** The preservation methods often compromised the taste and texture of the food. Freeze-dried and thermo stabilized foods, while nutritious, could not fully replicate the sensory experience of fresh meals.
- **Nutritional Balance:** Ensuring astronauts received a balanced diet was complex, given the constraints of space travel and the limited variety of available foods.
- **Microgravity Eating:** Eating in microgravity posed unique challenges, as food and liquids could float away, requiring innovative packaging and consumption methods.

20.3 SPACE FOOD: THE PRESENT:

In the modern era of space exploration, significant advancements have been made in the development and provision of space food. As missions extend beyond Earth's orbit, with astronauts spending months aboard the International Space Station (ISS) and preparing for future missions to Mars, the requirements for space food have evolved to meet the demands of long-duration missions.

20.3.1 Current Space Food Systems:

20.3.1.1. Variety and Nutrition:

Modern space food is designed to provide astronauts with a balanced diet that meets their nutritional needs. The variety of available food has expanded significantly, offering a wide range of flavors and textures to prevent menu fatigue. Astronauts can now enjoy international cuisines, including Italian, Japanese, and Russian dishes, alongside traditional American fare.

- **Variety:** The ISS menu includes over 200 different food items, ranging from Meal fruits, nuts, and candy to full meals like chicken curry, beef stew, and pasta dishes.
- **Nutritional Balance:** Each meal is carefully planned to ensure it provides the necessary vitamins, minerals, and calories required for maintaining health and performance in space.

20.3.1.2. Packaging and Preservation:

Space food packaging has also advanced to improve storage, preparation, and consumption. Foods are packaged in lightweight, durable, and easy-to-use containers that are compatible with microgravity environments.

- **Vacuum-Sealed Packaging:** Foods are vacuum-sealed to preserve freshness and prevent contamination. This packaging method also helps to reduce waste and save space.
- **Thermal Stabilization and Freeze-Drying:** These preservation techniques ensure that food remains safe and edible for extended periods without the need for refrigeration.

20.3.1.3. Preparation and Consumption:

Astronauts now have access to better facilities for food preparation and consumption aboard the ISS.

- **Heating Options:** Special ovens are available to warm up meals, enhancing the taste and texture of the food.
- **Hydration Stations:** A water dispenser provides both hot and cold water, allowing astronauts to rehydrate freeze-dried meals and beverages easily.
- **Dining Together:** The crew can share meals together, promoting camaraderie and mental well-being.

20.3.2. Innovations and Research:

20.3.2.1. Functional Foods:

Research into functional foods is ongoing to address the unique health challenges posed by space travel, such as bone density loss, muscle atrophy, and radiation exposure.

- **Omega-3 Fatty Acids and Probiotics:** Foods rich in omega-3 fatty acids and probiotics are included to support bone health, gut health, and immune function.
- **Biofortified Foods:** Scientists are exploring biofortification—enhancing the nutritional content of crops through genetic modification—to provide more nutrient-dense food options for long-duration missions.

20.3.2.2. Fresh Food Production:

Efforts are underway to grow fresh produce aboard spacecraft, which can supplement pre-packaged meals and improve astronauts' overall diet.

- **Veggie Experiment:** The "Veggie" experiment on the ISS allows astronauts to grow and harvest leafy greens, such as lettuce and kale, providing a fresh food source and psychological benefits.
- **Advanced Plant Habitats:** Research continues into more sophisticated plant-growing systems that could support a variety of crops, including fruits and vegetables, on future missions to Mars and beyond.

20.3.3. Sustainability and Waste Management:

Minimizing Waste: Current space missions emphasize sustainability and waste reduction. Packaging materials are designed to minimize waste, and efforts are being made to recycle and repurpose food packaging.

- **Recycling Initiatives:** Some packaging materials are being tested for their potential to be converted into useful materials, such as building blocks for habitat construction on future missions.

Closed-Loop Life Support Systems: Developing closed-loop life support systems that recycle water, air, and waste is a priority for sustaining long-term missions.

- **Water Recycling:** Systems are in place to reclaim water from various sources, including humidity and even astronaut urine, to be purified and reused for drinking and food preparation.

20.3.4 Psychological and Social Aspects:

Menu Fatigue and Mental Health: The psychological well-being of astronauts is a critical consideration in space food design. Eating the same foods repeatedly can lead to menu fatigue, affecting morale and overall mental health.

- **Rotating Menus:** Rotating and varied menus help prevent boredom and maintain interest in meals.

- **Comfort Foods:** Including familiar and comfort foods can provide emotional support and a sense of normalcy during extended missions.

Cultural and Social Significance: Sharing meals has social and cultural importance, fostering a sense of community among the crew.

- **Cultural Diversity:** The inclusion of diverse cuisines reflects the international nature of modern space crews, promoting cultural exchange and mutual understanding.

20.4 TYPES OF SPACE FOOD:

Modern space food encompasses a wide variety of types, each designed to meet specific needs and challenges of space travel. The evolution of space food technology has allowed for a diverse menu that caters to nutritional, practical, and psychological requirements. Below are the main types of space food used today.

20.4.1. Thermostabilized Foods: Thermo stabilized foods are heat-processed and sealed in flexible pouches or cans to eliminate bacteria and extend shelf life without the need for refrigeration. This method ensures that the food remains safe and edible for extended periods.

- **Examples:** Beef stew, chicken curry, pasta dishes, and fruit desserts.
- **Advantages:** Ready-to-eat, long shelf life, and retain their taste and texture relatively well after processing.

20.4.2. Freeze-Dried Foods: Freeze-drying involves removing moisture from food through sublimation, which preserves its structure and nutrients. Astronauts rehydrate these foods by adding water, which restores the original texture and flavor.

- **Examples:** Scrambled eggs, soups, fruits, and vegetables.
- **Advantages:** Lightweight, compact, and easy to store; long shelf life and retains most of the nutritional value.

20.4.3. Dehydrated Foods: Dehydrated foods are similar to freeze-dried foods but are dried using heat instead of sublimation. These foods also require water for rehydration before consumption.

- **Examples:** Instant coffee, powdered milk, and certain soups.
- **Advantages:** Compact and lightweight, making them ideal for storage in space; rehydration restores flavor and texture.

20.4.4. Fresh Foods: Fresh foods are included in space missions to provide variety and essential nutrients. These foods are typically consumed early in the mission before they spoil.

- **Examples:** Fresh fruits (apples, oranges), vegetables (carrots, celery), and bread.

- **Advantages:** Provide essential vitamins and improve psychological well-being by offering familiar and fresh flavors.

20.4.5. Intermediate Moisture Foods: Intermediate moisture foods contain enough moisture to be soft and palatable but not enough to support microbial growth. These foods do not require refrigeration and are ready to eat.

- **Examples:** Granola bars, dried fruits, and some types of jerky.
- **Advantages:** Ready-to-eat, do not require water for preparation, and provide a quick energy boost.

20.4.6. Packaged Beverages: Beverages in space are typically provided in powdered form and rehydrated with water aboard the spacecraft. Specialized drink bags with built-in straws are used to prevent spills in microgravity.

- **Examples:** Coffee, tea, fruit juices, and electrolyte drinks.
- **Advantages:** Lightweight, easy to store, and customizable to individual preferences.

20.4.7. Snack Foods: Snack foods are included to provide quick energy and comfort. These foods are typically ready-to-eat and come in individual portions**.**

- **Examples:** Nuts, candy, chocolate bars, and chips.
- **Advantages:** Easy to consume, boost morale, and provide a quick source of calories and nutrients.

20.4.8. Functional Foods: Functional foods are specially formulated to address specific health needs of astronauts, such as bone density loss, muscle atrophy, and immune system support.

- **Examples:** Foods fortified with omega-3 fatty acids, calcium, and probiotics.
- **Advantages:** Targeted health benefits, enhance overall well-being, and mitigate the adverse effects of long-duration spaceflight.

20.4.9. Rehydratable Foods: Rehydratable foods are freeze-dried or dehydrated and require the addition of water for preparation. These foods are commonly used due to their long shelf life and ease of storage.

- **Examples:** Pasta dishes, rice, and oatmeal.
- **Advantages:** Lightweight, long-lasting, and easy to prepare with the addition of water.

20.4.10. Irradiated Foods: Irradiated foods are exposed to ionizing radiation to kill bacteria and other pathogens, extending their shelf life without the need for refrigeration.

- **Examples:** Meat products like beef steak and chicken.

- **Advantages:** Safe for long-term storage, ready-to-eat, and maintain quality over time.

20.5 NUTRITIONAL NEEDS FOR SPACE NUTRITION:

Meeting the nutritional needs of astronauts is a complex challenge, given the unique conditions of space travel. The absence of gravity, exposure to radiation, and the confined living environment significantly affect the body, necessitating tailored nutritional strategies to maintain health, performance, and well-being during missions.

20.5.1. Caloric Intake:

Increased Caloric Requirements: Astronauts require a carefully calculated caloric intake to maintain energy levels and support their physical activity in space. The microgravity environment can lead to muscle atrophy and bone density loss, so maintaining adequate caloric intake is essential.

- **Activity Level:** The level of physical activity influences caloric needs. Astronauts engage in regular exercise to counteract the effects of microgravity on muscles and bones, necessitating a higher caloric intake.
- **Individual Needs:** Caloric requirements vary based on the individual's age, sex, weight, and metabolic rate, typically ranging from 2,500 to 3,800 calories per day.

20.5.2. Macronutrients:

Proteins: Proteins are crucial for maintaining muscle mass and supporting tissue repair, which are vital in counteracting muscle atrophy experienced in microgravity.

- **Sources:** Lean meats, dairy products, legumes, and plant-based proteins.
- **Requirement:** A higher protein intake is recommended to help preserve muscle mass and support metabolic functions.

Carbohydrates: Carbohydrates serve as the primary energy source, providing the necessary fuel for daily activities and physical exercise.

- **Sources:** Whole grains, fruits, vegetables, and cereals.
- **Requirement:** Carbohydrates should constitute a significant portion of the diet, offering sustained energy release.

Fats: Healthy fats are essential for long-term energy, brain function, and the absorption of fat-soluble vitamins.

- **Sources:** Nuts, seeds, avocados, and fish oils.
- **Requirement:** A balanced intake of healthy fats, including omega-3 fatty acids, supports overall health and helps reduce inflammation.

20.5.3. Micronutrients:

Vitamins: Vitamins are vital for various biochemical processes, immune function, and maintaining overall health.

- **Vitamin D:** Essential for bone health, vitamin D synthesis is impaired in space due to lack of sunlight exposure. Supplements are provided to prevent bone density loss.
- **Vitamin C and E:** These antioxidants help combat oxidative stress caused by increased radiation exposure.

Minerals: Minerals play a critical role in bone health, muscle function, and metabolic processes.

- **Calcium:** Important for maintaining bone density, calcium intake is crucial to prevent osteoporosis in the microgravity environment.
- **Iron:** Essential for oxygen transport, iron levels need careful monitoring to avoid both deficiency and overload.
- **Potassium and Sodium:** Electrolyte balance is crucial for cardiovascular health and muscle function.

20.5.4. Hydration:

Adequate Fluid Intake: Hydration is critical in space to support metabolic functions, prevent kidney stones, and maintain cardiovascular health.

- **Water Recycling:** Advanced systems onboard spacecraft recycle water from various sources, including humidity and urine, to ensure a consistent supply.
- **Monitoring:** Fluid intake is closely monitored to prevent dehydration or fluid retention, which can be affected by microgravity.

20.5.5. Dietary Fiber:

Digestive Health: Dietary fiber is essential for maintaining healthy digestion and preventing constipation, which can be a common issue in space due to fluid shifts and reduced physical activity.

- **Sources:** Whole grains, fruits, vegetables, and legumes.
- **Requirement:** Adequate fiber intake supports gastrointestinal health and helps manage cholesterol levels.

20.5.6. Psychological Considerations:

Mood and Mental Health: Nutrition plays a crucial role in supporting mental health and cognitive function during long-duration missions.

- **Comfort Foods:** Including familiar and culturally significant foods can boost morale and provide emotional comfort.
- **Balanced Diet:** A balanced intake of nutrients supports brain function reduces stress, and helps manage the psychological challenges of isolation and confinement.

20.5.7. Special Considerations for Long-Duration Missions:

Radiation Exposure: Increased exposure to cosmic radiation in space poses a risk to cellular health. Nutrients with antioxidant properties, such as vitamins C and E, are vital to mitigate oxidative damage.

Bone Health: Extended periods in microgravity result in bone demineralization. Adequate intake of calcium, vitamin D, and phosphorus, along with regular exercise, helps maintain bone density.

Immune Function: The immune system can be compromised in space, making it essential to include nutrients that support immune health, such as zinc, selenium, and vitamins A, C, and E.

20.6 RECOMMENDED DIETARY ALLOWANCE (RDA):

Here's a table 20.1a and 20.1b that outlines the Recommended Dietary Allowance (RDA) for astronauts. These values are designed to ensure optimal nutrition and health during space missions. RDAs are based on the specific needs of astronauts, who may experience unique environmental conditions such as microgravity, limited food availability, and altered nutrient absorption in space.

Table 20.1A: Recommended Dietary Allowance (RDA-Macro Nutrients) for Astronauts

Macronutrient	Recommended Amount (RDA) for Astronauts	Comments
Energy	2,500-3,000 kcal/day	Energy needs vary based on activity level, body size, and mission duration.
Protein	1.0-1.5 g/kg body weight	Important for muscle maintenance and tissue repair in microgravity.
Fat	70-100 g/day	Includes a balance of essential fatty acids, critical for health and energy.
CHO	300-400 g/day	Primary energy source especially needed during exercise and activity in space.

Table 20.1B: Recommended Dietary Allowance (RDA-Micro Nutrients) for Astronauts

Micronutrient	Recommended Amount (RDA) for Astronauts	Comments
Vitamin A	700-900 mcg/day	Supports vision, immune function, and skin health.
Vitamin C	75-90 mg/day	Essential antioxidant supports immune system and wound healing.
Vitamin D	15-20 mcg/day	Vital for bone health due to limited sunlight exposure in space.
Vitamin E	15 mg/day	Protects cells from oxidative damage, supports immune function.
Vitamin K	90-120 mcg/day	Crucial for bone health and blood clotting.
Thiamine (B1)	1.1-1.2 mg/day	Supports energy metabolism and nervous system function.
Riboflavin (B2)	1.1-1.3 mg/day	Important for energy production and maintaining healthy skin.
Niacin (B3)	14-16 mg/day	Helps in energy metabolism and maintains healthy skin and nervous system.
Vitamin B6	1.3-2.0 mg/day	Supports brain function, red blood cell production, and immune system.
Folate (B9)	400 mcg/day	Crucial for DNA synthesis and cell division.
Vitamin B12	2.4 mcg/day	Important for red blood cell production and nerve function.
Pantothenic Acid (B5)	5 mg/day	Supports energy production and hormone synthesis.
Biotin	30 mcg/day	Vital for metabolic functions, including fat and carbohydrate breakdown.
Calcium	1,000-1,200 mg/day	Important for bone health, crucial due to bone density loss in space.

Iron	8-18 mg/day	Vital for oxygen transport in the blood. Astronauts may need supplementation to avoid excess iron.
Magnesium	310-420 mg/day	Supports muscle function and bone health.
Phosphorus	700 mg/day	Crucial for bone health and energy metabolism.
Potassium	3,500-4,700 mg/day	Helps in fluid balance, muscle function, and nerve signalling.
Sodium	1,500-2,300 mg/day	Essential for fluid balance, electrolyte function, and nerve activity.
Zinc	8-11 mg/day	Supports immune function and wound healing.
Iodine	150 mcg/day	Important for thyroid hormone production and metabolism.
Copper	900 mcg/day	Plays a role in iron metabolism and the formation of red blood cells.
Manganese	1.8-2.3 mg/day	Supports bone formation and antioxidative protection.
Selenium	55 mcg/day	Protects against oxidative stress, important during long missions.
Chromium	25-35 mcg/day	Supports glucose metabolism and insulin sensitivity.

20.7 SUMMARY:

The nutritional needs for space travel are carefully tailored to address the unique challenges of the space environment. By focusing on balanced caloric intake, adequate macronutrients and micronutrients, hydration, and psychological well-being, space agencies ensure that astronauts maintain optimal health and performance during their missions. As space exploration advances, continuous research and innovation will further refine these nutritional strategies to support longer and more distant missions.

20.8 TECHNICAL TERMS:

Space Food; Food Production; Food Packaging; Life Support System; Freeze-Drying.

20.9 SELF ASSESSMENT QUESTIONS:

1) What are the nutritional needs of astronauts living in a zero gravity environment?
2) Discuss the importance of nutrition for astronauts during long-duration space missions?

20.10 REFERENCE BOOKS:

1) National Aeronautics and Space Administr., NASA: Space Food and Nutrition Educator Guide-Scholar's Choice Edition, 2015.
2) Arnauld E. Dubois and Eric C.F. Powell. Space Physiology and Medicine, 2016.
3) Mary D. Rhea and Lisa A. Brown., Space Nutrition.

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