Human Nutrition

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Topics

bbreviations

ABCD = Anthropometry biochemical clinical and dietary methods AIDS = Acquired Immuno Deficiency syndrome BMR = Basal Metabolic Rate

CO_2 = Carbon Dioxide

EAA = Essential Amino Acids

EBF = Exclusive Breast Feeding

ENA = Essential Nutrition Actions

EPI = Expanded Program of Immunization

FP = Family Planning

GDP = Gross domestic product

GMP = Growth Monitoring Programme

HDL= High Density Lipoprotein

HFA = Height For Age

HIV = Human Immuno Deficiency Virus

IDD = Iodine Deficiency Disorder

IEC = Information, Education and Communication

IMCI = Integrated management of Child Illness

LBW= Low birth weight

LDL = Low Density Lipoprotein

NSI = Nutrition Surveillance Information

PEM = Protein Energy Malnutrition

PMTCT = Prevention Mother to Child Transmission PUFA= Poly Unsaturated Fatty Acids RDI = Required Dietary Intake

STI = Sexual Transmitted Infections

TWS = Timely warning system

WFH = Weight For Height

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Introduction

Many children do not get enough of the right food to eat. They do not grow well, they become ill, many die or they do not grow up as clever, as healthy.

Causes and consequences of poor nutrition are better understood now, and so are the ways to prevent and manage it. Low food intake and infections are the immediate causes of malnutrition. The underlying causes are insufficient household food security, inadequate childcare and insufficient basic health services in the community. It includes poor living conditions, lack of education, heavy physical work, and frequent childbearing. And the basic causes are economic structure, political and ideological superstructure.

The mortality among preschool children is extremely high in developing countries in general and in Ethiopia in particular. It is quite clear that malnutrition in combination with infection, more often than not is, the cause of high morbidity and mortality in Ethiopia. Micronutrient deficiencies such as vitamin A, iodine and iron are the most prevalent in Ethiopia and it affects mothers and children at large.

The entire efforts in the preparation of this lecture note require that the elements of nutrition should be understood by Health Extension

Students and their Instructors for the implementation of nutrition interventions.

UNIT ONE

General Nutrition

Learning objectives

At the end of this unit, students will be able to:

- ☐ Define Food, Nutrition, Diet and Malnutrition
- ☐ Understand best practices and harmful traditions, which affect nutrition,
- ☐ Explain the dietary guidelines,
- ☐ Outline the important causes of malnutrition,

Definitions

Food: - is defined as any solid or liquid which when ingested will enable the body to carry out any of its life function.

Most foods are made up of several simple substances, which we call nutrients. There are six nutrients each of which has specific function in the body. Those that supply energy are the carbohydrates and fats. Those responsible for growth and repair of tissues cells are proteins. Those, which regulate chemical process in the body, are the vitamins and minerals. Water is present in most foods and is an indispensable component of our bodies. It is the means of transportation for most nutrients and is needed for all cellular activities.

Nutrition: - is the sum total of the process by which living things receive and utilize the necessary materials for survival, growth and maintenance of worn out tissues.

Malnutrition: - is the condition that results from an imbalance between dietary intake and requirements. It includes under nutrition, which results from less food intake and hard physical work and over nutrition results from excess food intake and less physical activities.

Diet: - is defined as food containing all the nutrients in a sufficient amount and in proper ratio.

Roughage: - is defined as food fibres which enable the body to get rid of waste products, which would otherwise become poisonous to the body. It prevents gastrointestinal disorders (gastritis, appendicitis, gallbladder stone and constipation) and metabolic disorders (diabetes mellitus, hypertension, ischemic heart disease and colon cancer).

Dietary guidelines

- ☐ Eat a wide variety of foods
- ☐ Maintain healthy weight
- ☐ Choose a diet low in fat, saturated fat, and cholesterol
- ☐ Choose a diet with plenty of vegetable, fruits and grain products
- ☐ Use sugar in moderation
- ☐ Use salt and sodium in moderation
- ☐ If you drink alcoholic beverage, do so in moderation.

Food groups

- ♦ Milk, cheese, yoghurt
- ♦ Meat, poultry, fish and alternates
- ♦ Fruits and vegetables
- ♦ Bread and cereals
- ♦ Fats, sweets and alcohols

Why human beings need food?

Human beings need food to provide energy for the essential physiological functions like:-

- ☐ Respiration
- ☐ Circulation
- ☐ Digestion
- ☐ Metabolism
- ☐ Maintaining body temperature.
- ☐ Growth and repair body Tissues

An adequate supply of nutrients is needed to maintain all the functions of the body and daily activities at maximum efficiency, thus ensuring healthy living. Health and nutrition are closely linked and to ensure proper development and life quality they must be adequate from early childhood on and most vulnerable groups are infants, young children, pregnant women and lactating mothers.

Diets in public health practice

- ☐ Resettlement areas,
- ☐ HIV/AIDS patients,
- ☐ Displaced compatriots due to natural and man made disasters.

It is important to make sure that any recommended ration scale is compared with acceptable standards and that its use is not likely to cause deficiency disease

Major causes of malnutrition

- ☐ Lack of knowledge in selecting foodstuff with high nutritive value
- ☐ Poverty and infectious diseases
- ☐ Drought
- ☐ Uneven distribution of the available foods
- ☐ Social arrest and civil conflicts,
- ☐ Transport problems (inaccessibility)
- ☐ Increased populations
- ☐ Inadequate weaning
- ☐ Farming technique-insufficient
- ☐ Poor management of resources
- ☐ Topographical differences in different regions (variation in productivity)
- ☐ Loss of food through destruction by insects
- ☐ Exploited land due to planting the same type of food crop for many years, erosion because of overgrazing and moreover the farmers could not use the fertilizers due to many reasons.

Harmful traditional practices with regard to nutrition

- ☐ During period of fasting important nutrients are not eaten, such as milk, eggs, butter, meat, fish, meal pattern, etc.
- ☐ Pork is forbidden for religious and cultural reasons
- ☐ Lack of sun light (lack of Vitamin D) during infancy to protect the child from the “evil eyes”

- ☐ Discrimination in feeding among family members, adults before children, adult males over adult females
- ☐ Practising heavy meals once, may be twice a day
- ☐ Giving butter to neonate to swallow, hoping to keep the intestine smooth
- ☐ Delay to start complementary food
- ☐ Refusing to give the child meat for fear of infection
- ☐ Feeding children with diluted milk
- ☐ Feed children with left over and may be contaminated food

Best practices which favor nutrition

- ☐ Breast feeding
- ☐ Mixing of foods E.g. Injera with wat prepared from
  - Cereals
  - Legumes
  - Vegetable
- ☐ Traditional use of dark green leaves “Hbesha Gommen.”
- ☐ Eating cereals in the form of kolo (roasted) and nefro (cooked)
- ☐ Additional high calories and high protein diet for pregnant and lactating mothers
- ☐ After the 7th day of delivery the mother and the child warm in the sun every morning
- ☐ Eating inset (false banana) which prevents constipation
- ☐ Special care for children and lactating mothers
- ☐ Drinking sour milk and cured milk

- ☐ Local beverages are constituted from different cereals
- ☐ Eating wild fruits from the forest e.g. Enjory, Kega, Sholla,
- ☐ Honey mixed with butter is eaten in the morning
- ☐ Giving to children a tea-like drink made out of Abish (fenugreek) is rich in protein (27 gm/100gm)
- ☐ Good hospitality and sociability
- ☐ Eating of raw vegetables and cereals
- ☐ Taking care of elders.

Good nutrition must meet the needs of varying ages and activities and always with individual differences. Therefore, the planning of food to meet especial needs begins with:

- Pregnant women
- Nursing mothers
- Infants
- Adolescents and
- Adults

A well-nourished individual:-

- ☐ Is alert mentally and physically fit
- ☐ Has optimistic outlook on life
- ☐ Has good resistance to infection
- ☐ Shows numerous other signs of good health such as an increased life span extending the active and vigorous period of life.

The energy requirements of individuals depend on

- Physical activities
- Body size and composition
- Age may affect requirements in two main ways
  - During childhood, the infant needs more energy because it is growing
  - During old age, the energy need is less because aged people are engaged with activities that requires less energy.
- Climate: Both very cold and very hot climate restrict outdoor activities.

In general feeding is dependent on the controlling centres, appetite and satiety in the brain. There are a variety of stimuli, nervous, chemical and thermal, which may affect the centres and so alter feeding behaviour.

Daily calorie requirements of individuals

- ☐ Infants 1 - 3 years need 1,000 cal/day
- ☐ Children 5 years need 1,500 cal/day
- ☐ Children 5 – 8 years need 1,800 cal/day
- ☐ Children 10 – 12 years need 2,000 cal/day
- ☐ For adolescents and adults calorie requirements depend on the degree of physical activities

From 13 – 20 years of age

Office worker	Heavy work
2, 800 cal/day	3,500 cal/day

Adults

2,300-cal/day	2,700 cal/day

Very heavy work up to 4,000 cal/day

For pregnant woman, the daily figure must be increased by 150 calories for the first trimester and 350 for the second and third trimester. For the nursing mother the daily figure must be increased by 800 calorie.

Staple foods

Staple foods are foods, which form the largest part of a nation's diet. They are of plant origin and are classified into three main groups Š
The grain and cereals

Š The roots and tubers

Š The starchy fruits

Discussion questions

1. Define food**,** nutrition**,** diet and malnutrition
2. Explain the dietary guidelines
3. Why human beings need food? Discuss
4. Mention the fundamental causes of malnutrition
7. Discuss the traditions that favor the nutrition condition
8. Explain traditions that could be harmful to nutritional status.

UNIT TWO

Carbohydrates

Learning objectives

At the end of this unit, the students will be able to:

- ☐ Mention the sources of carbohydrate
- ☐ Understand the different types of sugars
- ☐ Explain the digestion, absorption and metabolism of carbohydrates
- ☐ Describe the hormone responsible for metabolism

Carbohydrates provide a great part of the energy in all human diets. In the diet of poor people, especially in the tropics, up to 85% of the energy may come from this source. On the other hand, in the diet of the rich people in many countries the proportion may be as low as 40%. However, the cheapest and easily digestible fuel of humans is carbohydrate.

Carbohydrates are components of body substances needed for the regulation of body processes. Heparin, which prevents blood from clotting, contains carbohydrate. Nervous tissue, connective tissue, various hormones, and enzymes also contain carbohydrate. Ribose, another carbohydrates are part of Deoxyribonucleic acid (DNA) and ribonucleic acid RNA), the substance that carry the hereditary factors

in the cell. Carbohydrate is also a component of a compound in the liver that destroys toxic substances.

Carbohydrates are necessary for the proper use of fats. If carbohydrate intake is low, larger than normal amounts of fats are called on to supply energy. The body is unable to handle the excessive breakdown of fat. As a result, the fat does not burn completely, and abnormal amounts of certain breakdown products accumulate in the blood, causing a condition known as ketosis.

Types of carbohydrates

Monosaccharides:

- ☐ Glucose
- ☐ Fructose
- ☐ Mannose
- ☐ Galactose

Disaccharides:

- ☐ Sucrose (a disaccharide present taste sugar)
- ☐ Lactose (a disaccharide present in milk)
- ☐ Maltose (a disaccharide present in starch)

Sugar alcohol: is found in nature and also prepared commercially. Mannitol and dulcitol are alcohol derived from mannose and

galactose. Both have a variety of uses in medicine and food manufacture.

Honey: is a mixture of glucose and fructose. It is a balanced diet as it contains all the nutrients in sufficient amount and proper ratio. Honey has also medicinal effect. The bees first cover the beehive with antibiotics to prevent the growth and multiplications of micro-organisms. If you keep honey for a long time, it will not be spoiled because of antibiotics.

Glycogen: is the animal equivalent of starch present in the liver and muscle. In most foods of animal origin it is a negligible source of dietary carbohydrate. The glycogen in the liver is a reserve fuel and it serves between meals and over night. The breakdown of glycogen in the liver is facilitated by the hormone glucagons.

Starch: is one form of carbohydrate that is stored in granules in the roots and seeds of plants.

Table. 1. Carbohydrate content of some food

Food	Carbohydrate
Sugar	100%
White Flour	80%
Honey	76%
Biscuit, semi-sweet	75%
Jam	69%
Chocolate, milk	59%
White bread	50%
Potatoes	21%
Apple	12%
Peas	11%
Carrots	5.4%
Milk	4.7%

Digestion and absorption of carbohydrates

The digestion of carbohydrates begins in the mouth by Ptyalin (amylase) produced by the salivary glands. No carbohydrate digestion takes place in the stomach. Digestion occurs mainly in the small intestine through the action of pancreatic and intestinal juices:

- ☐ Amylase
- ☐ Lactase
- ☐ Sucrase
- ☐ Maltase

- Dextrin is degradation products of starch in which the glucose chains have been broken down to smaller units by partial hydrolysis.
- Dextran is a carbohydrate polymer obtained from bacterial cell wall. This has no part in dietetics but is used in medicine as plasma expander.

Table. 2. Summary of carbohydrate digestion

Site of action	Carbohydrate	Enzyme	End – product
Mouth	Starch	Amylase in saliva (ptyalin)	Dextrin- maltose Glucose
Small intestine	Starch	Amylase in pancreatic juice	Dextrin- maltose glucose maltose
	Dextrin	Enzyme in brush border of small intestine	Glucose
	Maltose		Glucose
	Sucrose	Maltase	Glucose & fructose
	Lactose	Sucrase	
		Lactase	Glucose & Galactose

In Health and with normal diet, the available carbohydrate is digested and absorbed completely in the small intestine. If an excess of unabsorbed carbohydrate arise due to a disorder of the absorption mechanisms or occasionally to excessive intake, the osmotic pressure (effects) leads to retention of fluids in the lumen and as the result there will be watery diarrhoea. This diarrhoea is known as osmotic diarrhoea.

The tissues use as fuel a mixture of glucose and fatty acids. But the brain normally uses only glucose and requires around 80g daily.

In starvation glucose may be provided by gluconeogenesis from the amino acids in tissues proteins, mainly from muscle proteins, but fats cannot be converted into glucose. With prolonged starvation the brain adapts and can then utilize fatty acids and ketone.

The two hormones, which control the metabolisms of carbohydrates, are insulin and glucagons

- Insulin is secreted by the beta cells of the islets of Langerhans and the secretion is stimulated by:
  - Hyperglycemias
  - Parasympathetic nervous activity

Function of insulin

- To facilitate glucose transport to the liver and muscle cells
- To facilitate formation of glycogen in the liver and muscle cells
- To incorporate formation of protein from the amino acids.

Glucagons is secreted by the alpha cells of the islet of Langerhans and the secretion is stimulated by

- ☐ Hypoglycaemia
- ☐ Sympathetic nervous activity

Function of glucagons

To facilitate the breakdown of glycogen in the liver and muscle cells into glucose

Discussion questions

1. What are carbohydrates and their importance?
2. What are the sources of carbohydrates?
3. Discuss the digestion and absorption of carbohydrates.

UNIT THREE

Proteins

Learning objectives

At the end of this unit, students will be able to:

- ☐ Understand the importance of proteins
- ☐ Describe the digestion and absorption
- ☐ Understand the signs and symptoms of protein energy malnutrition
- ☐ Explain criteria for referral of PEM cases to the nearest health facility.

Proteins have long been recognized as fundamental structural elements of every cell of the body. Specific proteins and protein derivatives have been recognized as functional elements in certain specialized cells glandular secretion, enzymes and hormones.

Proteins in natural foods differ widely in the number and the proportion of the 22 or more amino acids. A good quality or a complete protein is the one that supplies all the essential amino acids in sufficient quantities and in proper ratio for normal growth and maintenance. In general all proteins from animal source, such as meat, poultry, fish, eggs, milk and milk products provide good quality proteins.

Source of proteins

- Milk and milk products such as cheese, ice cream all derive their protein from milk.
- Meat, poultry, and fish are all forms of animal tissues
- Eggs are in a class by themselves a protein food of high nutritive value.
- Vegetables are poor source of protein.
- Legumes provide more than 4 or 6 percent. They are listed as meat alternates in the four-food group chart because they provide one of the better quality plant proteins.
- Bread and cereals make an important contribution to the protein of the diet, the protein of uncooked grain ranges 7 to 14 percent.

Digestion and absorption of protein

The digestion of protein in the alimentary tract is accomplished by the action of several proteolytic enzymes in the gastric, pancreatic and intestinal juices. Any of these enzymes that have the power to attack native proteins must be secreted in an inactive form to prevent damage to the tissues where they are formed.

Types of enzymes

- Pepsinogen is secreted by the gastric juice and activated by the Hydrochloric acid
- Trypsinogen is secreted by pancreatic juice and activated by entropeptidase

- Chemotrypsinogen is secreted by pancreatic juice and activated by the active tripsin
- Peptidase intestinal juice

Table 3 Summary of protein digestion

Site of action	**Protein**	**Enzyme**	**End – Product**
Stomach	Protein	Pepsin in acid	Large peptide
	polypeptides	Trypsin chemotrypsin	poly peptides
		Peptidase (secreted	
	Polypeptide	by mucosal cells of	
- Small	dipeptides	small intestine	Polypeptides
intestine			Dipepetides
			Amino acids
		Enter portal blood	

Liver	Peptides Amino acids

Body tissues Portal

The Amino Acid Pool

The amino acids from the food or from the body tissues enter a common pool, which is drawn upon for the synthesis of proteins, hormones, enzymes, blood protein and nucleic acids, or some of the amino acids are degraded for energy needs.
Proteins are absorbed as amino acids. Ideally, they are used to build or maintain body proteins. If carbohydrates and fats are not meeting the energy needs of the body, amino acids can be used to provide energy.

Danger of the weaning period

The weaning period is fraught with dangers for a large proportion of the world's children and nutritional disorders are common at this time of life. In the West a general awareness of the nutritional needs of the weanling, together with the ability of the average family to provide the necessary foods, have helped to remove most of the dangers of the weaning period. In the peasant society of developing countries, however, parents are generally are unaware of the dietary needs of children, and several customs associated with weaning are likely to give rise to nutritional deficiencies.

In the traditional society of Ethiopia, weaning is commonly abrupt and unplanned. Often it is brought by the occurrence of another

pregnancy. There are superstitions and beliefs concerning the effects of another pregnancy on the quality of the breast milk. It is believed that the heat from the womb “poisons” the milk in the breast. They also think that the baby in the womb is jealous of the older sibling on the breast. It is therefore considered urgent that the child should be taken off the breast immediately. The mother may apply potions (bitter material) to the nipples so that when the child takes the breast the sharp bitter taste makes him/her give up suckling. The child has very close relationship with the mother, the mother takes him/her back wherever and whenever she goes to fetch water or to bring firewood, the child has also access to breast milk on demand. The child sleeps on her back, but this intimacy will be interrupted when the mother knows that she is pregnant for the subsequent child. This is a psychological blow for the child and causes poor appetite and as the result the child can develop protein energy malnutrition.

Protein energy malnutrition (PEM)

PEM is today the most serious nutritional problem in Africa and other developing countries. Its two clinical forms are Kwashiorkor and Marasmus.

The diseases occur mostly in children between one and three years of age, after they have been taken of the breast.

Although there is no final clarity about the etiology of kwashiorkor in biomedical terms, it is nevertheless, clear that it is related to nutritional deficiencies. Therefore, all factors that could possibly contribute to the child malnutrition in general should be avoided. These include:

- ☐ Seasonal food shortage
- ☐ Unfavorable family condition,
- ☐ Inadequate water supply and sanitary facilities,
- ☐ Certain traditional attitudes during pregnancy, prenatal period, breast-feeding and weaning periods, and
- ☐ All infectious diseases, which generally reduce immunity.

Other diseases may sometime play an important role in precipitating the onset of kwashiorkor in already malnourished child. E.g.

- ☐ Gastrointestinal tract infection
- ☐ Diarrhea
- ☐ Intestinal worms share the diet and cause other ill- health and poor appetite
- ☐ Constipation
- ☐ Childhood diseases such as measles, whooping cough, etc,

Signs and symptoms of kwashiorkor

- ☐ Growth failure occurs always
- ☐ Wasting of muscle is also typical but may not be evident because of edema

- ☐ There may be mental change
- ☐ Hair and skin color change
- ☐ Diarrhea and vomiting
- ☐ Sign of other micronutrient deficiencies

Skin changes

Mild: localized hyper pigmentation and skin cracks

Moderate: skin peals off, desquamation.

Severe: superficial ulceration, bleeding

Hair changes

Hair changes are classified into three categories

Mild: beginning of visible color and structural changes

Moderate: color and structural changes, loss of hair

Severe: loss of hair together with ulceration of head

Physiological functions of the various systems are markedly disturbed with

- ☐ Diarrhea
- ☐ Electrolyte disturbance
- ☐ Circulatory insufficiency
- ☐ Metabolic imbalance
- ☐ Poor renal functions

Hence the child with kwashiorkor should be thought of as an emergency in need of referral to the nearest health facility.

Nutritional Marasmus

- ☐ There is a failure to thrive
- ☐ Irritability, restlessness and diarrhea are frequent.
- ☐ Many infants are hungry, but some anorexic.
- ☐ There are little or no subcutaneous fats.
- ☐ The weight is much below the standard for age.
- ☐ Temperature may be subnormal.
- ☐ The abdomen may be shrunken or distended with gas.
- ☐ Because of the thinness of the abdominal wall, peristalsis may be easily visible.
- ☐ The muscles are weak and atrophic and this makes the limbs appear as skin and bone
- ☐ Evidence of vitamin deficiencies may or may not be found.

Criteria for referral to the nearest health facility

- ☐ Substantial weight def.<60%WAF or <70% HFA
- ☐ Severe generalized edema and any of the following:
    - Anorexia
    - Diarrhea and vomiting
    - Dehydration
    - Loss of consciousness and convulsion
  - ☐ Severe anemia <15%of Hematocrit
  - ☐ Respiratory distress
  - ☐ Hypothermia <35.5^{0}c
  - ☐ Jaundice

After discharge management of PEM

- ☐ To prevent relapse and future deterioration, through nutrition education and demonstration of the parents.
- ☐ To achieve long term follow up by health extension workers with the view of helping child and the family.

Child status after discharge from hospital

- ☐ Mental state has improved as shown by smiling, response to stimuli, awareness, and interest in the surroundings
- ☐ Appetite has returned and he/she is eating well
- ☐ Shows physical activity
- ☐ Temperature is normal
- ☐ No vomiting or diarrhea
- ☐ No edema
- ☐ Starting to gain weight.

Discussion questions

- ☐ What are the importance of proteins?
- ☐ Mention the source of proteins and type of amino acids
- ☐ Discuss the digestion and metabolism of protein
- ☐ Why is weaning period crucial?
- ☐ Protein Energy Malnutrition is very serious in developing countries, why?
- ☐ What are the signs and symptoms of Kwashiorkor and Marasmus?

- ☐ Why is the child with PEM considered as an emergency?
- ☐ Mention the criteria for referral.

UNIT FOUR

Lipids

Learning objectives

At the end of this unit, students will be able to:

- ☐ Classify lipids
- ☐ Identify the source of lipids
- ☐ Explain the importance of lipids
- ☐ Describe digestion and absorption of lipids
- ☐ Tell the importance of essential fatty acids

Definition

Lipids: - are a group of organic compounds that are insoluble in water but soluble in organic solvents. Lipids are fats and oils.

Lipids

- ☐ Are the form of stored energy in animals
- ☐ Have high energy value 9 kcal/gm of fat
- ☐ Act as carriers for fat soluble vitamins
- ☐ Are palatable giving good taste and satiety
- ☐ Serve as insulator preventing heat loss from the body
- ☐ Lubricate the gastrointestinal tract
- ☐ Protect the delicate organs such as Kidney, Eyes, heart and the like.

Classification of lipids

Lipids are classified into 3 on the basis of their chemical structure.

ƒ Simple lipids = Fats and oils

☐ Compound lipid = Phospho-lipids and lipoproteins

☐ Derived lipids= fatty acids and sterols

☐ Human beings cannot synthesize the Poly Unsaturated Fatty Acids (PUFA), hence they are termed as essential FA.

☐ Saturated fatty acids tend to raise blood cholesterol level.

☐ Polyunsaturated Fatty Acids lowers blood cholesterol and large amounts of unsaturated Fatty Acids are of vegetable origin and have lower melting point.

Phospholipids, sterols and lipoproteins

Phospholipids are structural compounds found in cell membranes. They are essential components of enzyme systems and are involved in the transport of lipids in plasma.

Sterols

☐ These are precursors of vitamin D, which are found both in plants and animals. Cholesterol in animal's tissues, egg yolk butter. Ergosterol in plants

☐ Lipids are transported in the blood in the form of lipoprotein (soluble fat protein complexes).

☐ They are 25-30% proteins and the remaining as lipids

Lipoprotein

These are compound lipids that contain both protein and various types and amounts of lipids. They are made mostly in the liver and are used to transport water-soluble lipids throughout the body and the types of lipoproteins are VLDL, LDL, HDL, and Chylomicrons.

Low-density lipoprotein (LDL)

This is composed mainly of cholesterol. LDL. Transports cholesterol from the liver to the tissues. High serum level of LDL greatly increases the risk of *atherosclerosis "* is a disease in which fatty deposits collect along the inside walls of large or medium - sized arteries. These deposits clog or narrow the passageway. If blood clots become lodged in the narrowed vessels, the blood flow to the heart or brain many be partially or completely blocked, resulting in a heart attach or stroke". Diets that are high in saturated fatty acids are associated with elevation in LDL cholesterol.

Cholesterol is found only in animal products. Plant foods, regardless of their fat content, do not contain cholesterol. Cholesterol is a fatlike lipid that normally occurs in the blood and all cell membranes. It is a major part of brain and nerve tissues. Cholesterol is necessary for normal body functioning as structural material in the body cells, and in the production of bile, vitamin D and a number of hormones including cortisone and sex hormone.

Hereditary, diet, exercise, and other conditions affect blood cholesterol levels. Persons with high blood cholesterol levels appear to be more likely than those with normal levels to develop atherosclerosis.

No recommended dietary allowance has been established for total fat or essential fatty acids; however, the reduction in total fat is recommended.

The essential fatty acids are:

- ☐ Linoleic acid
- ☐ Linolnic acid
- ☐ Arachidonic acid

- Essential Fatty Acids are needed for the normal functioning of all tissues
- Essential Fatty Acids form a part of the structure of each cell membrane.
- Essential Fatty Acids help transport nutrients and metabolites across the cell membrane
- Essential Fatty Acids are also involved in brain development
- Essential Fatty Acids are needed for the synthesis of prostaglandin

Linoleic acid: occurs abundantly in vegetable oils such as:

- ☐ Corn oils
- ☐ Cottonseed oils
- ☐ Soybeans oils
- ☐ Sesame oils
- ☐ Sunflower oils

Digestion of fats

In the mouth

Enzyme – lingual lipase

End products – diglycerides

In the stomach

Enzyme – Gastric lipase

End products – Fatty acids, glycerol, diglycerides and monglycerides

In small intestine

Triglycerides, diglycerides

Enzyme – Pancreatic lipase

End products – monglycerides, fatty acids, glycerol

Food source of fats

- ☐ Animal – Fish, butter, beef, pork, and lamb
- ☐ Plant - vegetable, fruit avocado, nuts, margarine, cooking oils

Discussion questions

1. What are lipids and their importance?
2. How do you classify lipids?
3. What are the essential fatty acids?
4. Explain the process of digestion?
5. Why are people afraid of cholesterol?
6. Discuss LDL, and lipoproteins

UNIT FIVE

Basal Metabolism

Learning objectives

After the end of this unit, the students will be able to:-

- ☐ Understand what basal metabolism is.
- ☐ Explain factors that affect basal metabolism.

Definition

Basal metabolism: is the energy required to carry on vital body processes at rest, which include all the activities of the cells, glands, skeletal muscles tone, body temperature, circulation, and respiration. In persons who are generally inactive physically, basal metabolic needs make up the largest part, about two thirds, of the total energy requirement.

Factors affecting basal metabolism

Size and shape

The greater the skin area, the greater will be the amount of heat lost by the body and, in turn, greater the necessary heat production by the individual. E.g. tall person needs more food than short person with the same weight.

Age and growth

They are responsible for normal variation in basal metabolism. The relative rate is highest during the first and second years and decreases after that, although it is still relatively high through the ages of puberty. During adult life there is a steady decrease in rate with a marked drop in old age.

Sex

Sex probably has little effect on metabolism. Women have a lower metabolism than men. Women usually have a less fat and less muscular development than men.

Climate

Climate has little effect on BMR, which is always measured in a room temperature.

Racial

Differences in metabolism have been noted. Eskimos have been reported to have a BMR above accepted standards.

State of nutrition

In starvation or under nutrition the BMR is lower.

Diseases

Diseases such as infection or fevers raise the BMR in proportion to the elevation of the body temperature.

The internal secretion of certain glands such as the thyroid and the adrenal, affect metabolism. Hyperthyroidism accelerates metabolism by increasing production of thyroxin.

Sleep,

Sleep varies depending on individuals, some are restless and others are quiet.

Pregnancy

After four months of gestation the BMR will increase.

Discussion questions

1. What do you understand about basal metabolism?
2. Explain factors that affect basal metabolism.

UNIT SIX

Vitamins

Learning objectives

At the end of this unit, students will be able to:

- ☐ Define vitamins
- ☐ Identify the types of vitamins
- ☐ Describe the functions of vitamins
- ☐ Explain the characteristics of vitamins
- ☐ Understand deficiency syndrome of vitamins

Definition

Vitamins: are defined as organic compounds, other than any of the amino acids, fatty acids and carbohydrates that are necessary in small amounts in the diet of higher animals for growth, maintenances of health and reproduction.

All animals need vitamins, but not every vitamin that has been discovered is needed in the diet of each animal species. E.g. humans and guinea pigs need Vitamin C, but dogs, rats, do not need vitamin C in their diet because they can synthesis this vitamin in their bodies.

Classification of vitamins

- ☐ Vitamin A (Retinol)
- ☐ Vitamin B_1 (Thiamine)
- ☐ Vitamin B_2 (Riboflavin)
- ☐ Vitamin B_6 (pyridoxine)
- ☐ Vitamin B_{12} (Cyanocobalamine)
- ☐ Niacin
- ☐ Panthotonic Acid
- ☐ Folacin
- ☐ Biotin
- ☐ Vitamin C (Ascorbic acid)
- ☐ Vitamin D (Cholecalciferol)
- ☐ Vitamin E (Tocopherol)
- ☐ Vitamin K (Antihemorrhagic vitamin)

These vitamins are found in wholesome foods, milk, vegetables, fruits, eggs, meat, beans, wholegrain cereals etc.

Function of vitamins:

- ☐ To promote Growth
- ☐ To promote Reproduction
- ☐ To promote Health & vigor
- ☐ To promote Nervous activity
- ☐ To promote Normal appetite
- ☐ To promote Digestion

- ☐ To promote Utilization
- ☐ To promote Resistances to infection.

Groups of vitamins

- ☐ Water soluble Vitamins are (C and B group)
- ☐ Fat-soluble Vitamins are (A, D, E, and K)

Characteristics of water soluble vitamins

- ☐ They are widely distributed in natural foods
- ☐ B_{12} is found only in animal products
- ☐ Soluble in water and absorbed in the intestine
- ☐ Excess will be excreted, thus not toxic.
- ☐ Most functions of these vitamins are as co-enzymes
- ☐ They are important for energy production
- ☐ They are heat labile

Characteristics of fat - soluble vitamins

- ☐ Metabolize along with fats
- ☐ Resistance to heat
- ☐ Stored in the liver and adipose tissue
- ☐ Slow to develop deficiency syndrome
- ☐ Present only in certain foods, mostly in animal products, oily foods, yellow and green vegetable
- ☐ Excess can be toxic to the body.

Function of vitamin A

- ☐ It controls the general state of the epithelial cells and reduces the risk of infection.
- ☐ It is required for the regeneration of two pigments, visual purple in the rods of retina and visual violet in the cones of the retina. These two pigments are responsible for vision in dim and bright light
- ☐ It aids growth and development during childhood
- ☐ It helps to keep the cornea of the eye in healthy condition.
- ☐ Dietary Vitamin A is required for the growth and survival of all animals and it is present in most biological tissues.
- ☐ In the visual system the retina is dependent on Vitamin A and its metabolites.
- ☐ In the auditory system vitamin A plays a role in the maintenance of the middle and inner ear and it also helps the olfactory system,
- ☐ It is required for reproduction, embryonic development and bone formation.

Who is affected by Vitamin A deficiency?

Vitamin A deficiency is a major health problem in many developing countries. Many children do not survive. Recent research findings suggest that improving vitamin A status amongst deficient populations can significantly reduce young child mortality. The population groups

at highest risk of the deficiency are infants and young children under five years.

Vitamin A deficiency in Ethiopia

Vitamin A deficiency is a major public health problem in Ethiopia, where prevalence of Bitot's Spots is high.

Vitamin A deficiency occurs when vitamin A intakes (or liver stores) fail to meet daily metabolic requirements. The most common cause is inadequate consumption of vitamin A – rich foods. Deficiency also occurs when there is problem of absorption, conversion or utilization of vitamin A or when there are repeated infections of diseases such as measles or diarrhea. In the absence of foods containing oils or fats in the diet, vitamin A is not well absorbed and metabolized.

Animal source of vitamin A

The best sources of vitamin A is animal products such as organ meat like liver, whole milk and milk products, eggs, butter, cheese, and fish liver oils. Animal sources contain preformed active retinol, which can be used effectively by the body. The best source of vitamin A for infants is breast milk. The mother's secretion of vitamin A into breast milk, however, is related to her own vitamin A status.

Plant source of vitamin A

Plants contain beta-carotene that can be converted into vitamin A by the body. The best plant sources of vitamin A are orange, yellow colour fruits and vegetables (papaya, mango, pumpkin, tomatoes, carrots, yellow sweets potatoes) and dark green vegetables such as spinach (Kosta), kale (Gommen) and Swiss chard. Gommen is one example of a traditional plant source rich in vitamin A commonly consumed in the Ethiopian diet. Gommen is available to most poor people for at least 6 months in a year.

Table. 4. Vitamin A content of Foods of Animal Origin

Source (per 100 gm of food)	Vitamin A (Retinol) in Milligram)
Fish liver oil	145,000
Liver, ox	840
Butter, cow's	730
Kidney, Ox	300
Special baby food milk powder	300
Egg	200
Chicken	85
Milk, whole cow's	40
Goat milk	25

Table: 5. Vitamin A content of foods of plant origin

Source (per 100 gm of food)	Vitamin A (retinal equivalent
Carrot raw	1,100
Sweet potato, raw yellow	510
Mango, Ripe, without skin	400
Lettuce, raw	325
Avocado, raw	90
Tomatoes, raw	75
Papaya, raw	75
Guava, raw	48
Watermelon	42

Source: Technical centre for agricultural and rural cooperation and Food and Nutrition Cooperation, 1987 (FAO).

What are the consequences of vitamin A deficiency?

Vitamin A deficiency has long been associated with blindness. But more importantly, vitamin A deficiency is associated with increased morbidity and mortality among young children. Improvement of vitamin A levels among deprived populations has been associated with reduction in young child mortality. In countries like Ethiopia, where diarrhea, acute respiratory infection, and measles are among

major causes of child mortality, improved vitamin A status is likely to have a much greater role in reducing young child mortality.

The common symptoms of vitamin A deficiency

- ☐ Night blindness: The child cannot see in the dark. He/she has to go in to the house early in the evening
- ☐ Conjuctival xerosis: The conjuctival covering the white surface of the eyeballs become dry and rough instead of being moist, smooth and shining. The child cannot open and close his/her eyes because it is painful.
- ☐ Bitot's spots: A foamy or cheesy accumulation, which forms in the inner quadrant of the cornea in the eyes. The cornea the central transparent part of the eye becomes cloudy. It reflects more advanced vitamin A deficiency, but tends to be reversible with treatment.
- ☐ Corneal ulceration: an ulcer on the cornea may leave scar, which can affect vision.
- ☐ Keratomalacia: The eyeballs become opaque and soft, jelly like substance; hereafter there will be a rapid destruction of the eyeball and no hope of recovery after the condition reached the stage of keratomalacia.

Diagnostic criteria for vitamin A deficiency at the community level, WHO identifies a vitamin A deficiency as a major public health

problem if prevalence of any one of the following in children below six years of age exceeds the prescribed levels.

Table: 6. Identifications of vitamin A deficiency at the community level

Vitamin A deficiency sign/symptoms	Who cut - off level for identifying a public health problem
Night blindness	>1%
Bitot's Spot(s)	>0.5%
Conjuctival Xerosis/ulceration/keratomalacia	>0.01%
Corneal scar	>0.05%

Source: WHO/UNICE, 1994

Prevention of vitamin A deficiency

- ☐ A diet containing plenty of vitamin A is the best.
- ☐ Breast-feed infants for at least one year. Do not discard the 1st breast milk soon after delivery.
- ☐ At 6 months start to feed infants with dark green vegetables, yellow and orange fruits and if possible, some finely chopped and well cooked liver.
- ☐ Include some fats in the child's diet

- ☐ Children with diarrhea, measles, respiratory and other serious infections need extra vitamin A.
- ☐ Pregnant and lactating mothers should eat foods rich in vitamin A every day.
- ☐ Tell families that night blindness is an early warning sign of xerophthalmia (Vitamin A deficiency).
- ☐ Teach school children to look for night blindness in young children.
- ☐ Learn which vitamin A rich food is available in the locality

Strategies to control and eliminate vitamin A deficiency

- ☐ Universal supplementation of vitamin A
- ☐ Food fortification
- ☐ Food diversification

Universal supplementation of vitamin a capsules (short term strategy)

- ☐ Children 6-59 months of age
- ☐ Lactating mothers
- ☐ Pregnant women
- ☐ Targeted diseases i.e. Measles, diarrhea, acute respiratory infection, xerophthalmia and PEM.

Fortification of foods

Fortification of a widely consumed centrally processed staple food with a nutrient is one way of controlling deficiencies of certain

nutrients such as iron, vitamin B_1 and vitamin A in many countries. Fortification of a nutrient is the addition of the deficient nutrient supplements in processed dietary components in factories. In industrialized countries the most commonly fortified food products are

- ☐ Wheat flour
- ☐ Bread
- ☐ Milk products
- ☐ Infant formulas
- ☐ Weaning foods.

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In Ethiopia, the most important foods to be fortified are

- ☐ Sugar
- ☐ Salt
- ☐ Oil

Food diversification

Food diversification is an important strategy, which is considered as a long term and sustainable strategy for the prevention of vitamin A deficiency. In this regard, people should be encouraged to grow and consume vitamin A rich foods at a vast scale in all regions

Vitamin B_1 (Thiamine)

The vitamin B_1 (thiamine) plays an important part in the utilization of carbohydrates, cereals, roots and tubers are especially rich in carbohydrates and if these foods are to be properly utilized, it is

essential that the daily food intake should supply sufficient vitamin B_1. It occurs particularly in cereals but it is localized on the outer surface of the grain close to the sheath.

Vitamin B_1 deficiency

1. **Acute Beriberi (Dry Beriberi)**

   Symptoms:

☐ Epigastric pain

☐ Nausea & Vomiting

Š Urgent Cardiac sign of cardiac failure & death

2. **Wet Beriberi**

   Symptoms**:**

- ☐ Gradual onset
- ☐ Loss of power of limbs
- ☐ Gradually develops edema and ascitis

3. **Chronic Beriberi**

   Symptoms*:*

- ☐ Paralysis of the lower extremities
- ☐ Cramping of the calf muscle
- ☐ Coldness of the feet
- ☐ Stabbing pain on walking
- ☐ Absence of knee and ankle jerks.

Vitamin B_2 (Riboflavin)

Vitamin B_2 is found in many foods, especially in milk, certain vegetables and meat. It plays a very important role in assisting the various chemical activities, which are essential to life such as cellular oxidation, co-enzymes, and function of the nervous system

Deficiency of vitamin B_2 is characterized by:

- ☐ Angular Stomatits with fissuring at the angle of the mouth
- ☐ Cheilosis (Red shiny lips)
- ☐ Glossitis (inflammation of the tongue)
- ☐ Scrotal dermatitis
- ☐ Lacrimation
- ☐ Corneal vascularization

Vitamin B_6 (Pyridoxine)

It is one of the vitamins about which little is known. It is found in both animal and plant foods. The animal foods include chicken, fish, kidney, liver, pork, eggs, and plant foods include wheat germ oils, soybeans, brawn rice, peanuts and walnuts. Dairy products and vegetables are poor sources. Yeast is an important source of B_6.

Deficiency of Vitamin B_6

- ☐ Occurs in combination with deficiencies of other B-complex vitamins.
- ☐ Nervous disturbance such as irritability and insomnia is observed.

- Muscular weakness, fatigue and convulsion have been recorded in infants.

Vitamin B_{12} (Cobalamin)

According to the present evidence this vitamin is found only in animal products.

Source of vitamin B_{12}

The content of liver and kidney is high, the content of fish, milk and meat is medium, and however, the source of B_{12} has not been widely investigated.

Deficiency of vitamin B_{12}:

- The red blood cells are abnormally large and are reduced in number
- Stomatits
- Lack of appetite
- Poor coordination in walking & mental disturbance

Note: The body effectively regulates the vitamin from bile and other secretions. This accounts for its long biologic effectiveness. Vegetarians who eat no animal products develop a vitamin B_{12} deficiency only after 20 to 30 years.

Source of Niacin

- ☐ Meat, liver, fish, poultry
- ☐ Peanut, peas, beans, and whole grains
- ☐ Milk, eggs, and cheese are poor source, however, they are good source of Tryptophan (one of the essential amino acids), which is converted to Niacin

Functions of Niacin

It affects a number of important metabolic activities needed for the maintenance of healthy skin and the proper functioning of the nervous and digestive system. Niacin is a coenzyme in energy metabolism along with other B-complex vitamins.

Deficiency of Niacin

Niacin deficiency is common in areas where the staple food is Maize because Maize is low in Niacin and Tryptophan one of the essential amino acids which is a precursor of Niacin.

Early signs and symptoms of Niacin deficiency

- ☐ Fatigue, poor appetite,
- ☐ Weakness, mild digestive disturbance,
- ☐ Anxiety, irritability,
- ☐ Pellagra (a prolonged niacin deficiency), which is characterized by the 4Ds which are:
    - Diarrhea

- Dermatitis
- Dementia and finally
- Death if the disorder is untreated. The skin is dry, scaly, and cracked and the condition is aggravated by exposure to heat or light.

Vitamin C (Ascorbic Acid)

- ☐ Found in fresh vegetables and citrus fruits
- ☐ Vegetables and fruits should not be left soaked in water for a long time since it is soluble in water
- ☐ Cooking itself destroys about half of the vitamin C present in the food
- ☐ The best way to make sure of a regular intake of vitamin C is to eat raw fruits or salad every day.

Functions of vitamin C

- ☐ Helps the formation of various body tissues, particularly connective tissues, bones, cartilage and teeth.
- ☐ Stimulates the production of red blood cells,
- ☐ Helps resistance to infection and neutralizes poisons.

Vitamin C is unstable and easily destroyed. Foods lose almost half of their vitamin C content when they are cooked and when the foods are kept hot after they have been cooked. Drying, storage, bruising, cutting, and chopping of fruits and vegetables lead to the loss of

vitamin C. Potatoes boiled in their skin retain most of their Vitamin C. Therefore, to ensure a regular intake of vitamin C is to take fruits and vegetable every day.

Deficiency of Vitamin C

- ☐ Weakness of the wall of the capillaries,
- ☐ Gum bleeding,
- ☐ Loosening of the teeth,
- ☐ Browsing of the skin and petechia
- ☐ The bones become painful, swollen and brittle
- ☐ General weakness and anemia may result if the disorder is not treated.
- ☐ Skin abnormalities such as adult acne may be the earliest sign of scurvy
- ☐ Hardening and scaling of the skin surrounding the hair follicles and hemorrhages surrounding the hair follicles also point to scurvy
- ☐ The skin of the forearm, legs and thighs is most affected
- ☐ Scurvy: symptoms include weakness, fatigue, restlessness, and neurotic behavior, aching bones, joints, and muscles.

Vitamin D (cholecalciferol)

Vitamin D is known as the antirachtic vitamin and chemically as calciferol. The two most important vitamin D compounds are ergocalciferol (vitamin D_2) and cholecalciferol (vitamin D_3). These

substances are formed from precursors in plants, animal and in the skin and are converted to vitamin D. by the ultraviolet rays of the sun.

Vitamin D is stored in the liver mainly; some is stored in the brain, bones and skin as well. It undergoes changes in the liver, and in the kidneys that convert it to active, hormone like form.

Functions of vitamin D

- ☐ Absorption of calcium and phosphorous
- ☐ The presence of vitamin D is essential to the activity of the parathyroid hormone in removing calcium and Phosphorous from the bone in order to maintain normal serum levels of calcium.
- ☐ Stimulates the reabsorption of Calcium by the kidney when serum calcium level is low.
- ☐ Bone formation

Source of vitamin D

- ☐ Fish liver oil is a rich source of vitamin D.
- ☐ A nonfood source is the sunlight for the action of sunlight on the skin changes the cholesterol to vitamin D.

Deficiency of vitamin D

It leads to rickets, which is characterized by weakness and deformity of bones. Rickets generally occurs between the six months to the second year of life, during the weaning period.

On examination the skull bone of rachitic child, we will find the following characteristics:

- ☐ Depression will be seen along the suture
- ☐ The forehead is prominent
- ☐ The anterior fontanel remains wide open
- ☐ The abnormalities give the head the general appearance of a box
- ☐ If you press the skull bone with your thumb of a rachitic child, it will remain depressed and this known as craniotabus.
- ☐ The chest is narrow and deformed
- ☐ The long limbs curve and may take the shape of a bow and the sufferers are referred as bowlegs or it may take the opposite shape i.e. the knees may knock together and the sufferers may be described as knock-knees.
- ☐ The vertebral column may curve, causing Kyphosis.
- ☐ Rickets in adults is known as osteomalacia, the bones become soft and very painful.
- ☐ In women it causes difficult labor, as the pelvis becomes contracted, thus narrowing the birth canal.

Vitamin k (Antihemorrhagic vitamin)

This vitamin can be synthesized by the action of bacteria in the intestinal tract of a healthy person. It is also found in liver, fish, and green vegetables. Daily requirement is not known. Cooking does not destroy it. The liver requires vitamin K for the formation of prothrombin a substance needed for clotting mechanism of blood.

Deficiency of vitamin K

A person deficient in Vitamin K shows a tendency to bleed profusely whenever blood vessels are injured. The treatment and prevention is to provide with high content of vitamin K foods and give vitamin K injection to stop active bleeding.

Discussion questions

1. Define vitamins.
2. State the general functions of vitamins.
3. What are the characteristics of water and fat soluble vitamins?
4. Why vitamin A deficiency disease is a very serious health problem?
5. How can we control and prevent vitamin deficiency diseases?

UNIT SEVEN

Mineral Salts

Learning objectives:

At the end of this unit, students will be able to:

- ☐ Define minerals
- ☐ Describe the functions of minerals
- ☐ Understand the sources of minerals
- ☐ Identify the deficiency of minerals
- ☐ Explain the importance of water

Definition

Minerals: are inorganic elements occurring in nature. They are inorganic because they do not originate in animal or plant life but rather from the earth's crust. Although minerals make up only a small portion of body tissues, they are essential for growth and normal functioning of the body. The body can make most of the things it needs from energy foods and the amino acids in proteins but it cannot make vitamins and minerals.

Benefits of minerals

- ☐ Minerals are essentials both as structural components and in many vital processes,
- ☐ Some form hard tissues such as bones and teeth
- ☐ Some are in fluids and soft tissues

- For normal muscular activity the ratio between potassium and calcium in the extra cellular fluid is important.
- Electrolytes, sodium and potassium are the most important factors in the osmotic control of water metabolism
- Some minerals may act as catalysts in the enzyme system, or as integral parts of organic compounds in the body such as:
  - Iron in hemoglobin
  - Iodine in thyroxin
  - Cobalt in vitamin B_{12}.
  - Zinc in insulin and
  - Sulfur in thiamine.

Plants, animals, bacteria, and other one celled organisms all require proper concentration of certain minerals to make life possible.

The principal minerals, which the body requires.

Calcium	Chlorine	Iron
Phosphorus	Sodium	Iodine
Magnesium	Potassium	Sulfur

Animals, in trace quantities, use minerals and these are: Copper, Manganese, Cobalt, Zinc, and Fluorine. Other trace elements are present in animal tissues, but their functions are uncertain and these are Aluminum, Arsenic, Boron, Cadmium, and Silicon.

In natural foods, minerals present in various forms mixed or combined with:

- ☐ Protein
- ☐ Fats and
- ☐ Carbohydrate

Iron

Sources of Iron

- ☐ Beef, liver, egg yolk
- ☐ Wheat and Teff
- ☐ Dark green vegetables, onions & fresh fruits.

Daily requirements for men and women are 8 to 10mg and 10 to 18 mg respectively. For pregnant and lactating mother the requirement increases to 20mg. Absorption of iron is enhanced in the presence of vitamin C.

Functions of Iron

It is an essential component of hemoglobin, responsible for the red coloring of blood and for the transportation of oxygen to the tissues.

Causes of Iron Deficiency

- ☐ Insufficient iron in diet
- ☐ Blood loss during menstruation
- ☐ Hook worm infestation

Causes of anemia are multiple and the main causes are nutritional deficiencies, which represent more than half of all cases, blood loss through hemorrhage, destruction of red blood cells by infections such as malaria and parasitic infections, genetic defects of red blood cells and infections by most of febrile diseases and chronic diseases like tuberculoses.

Consequences of anemia

- ☐ Delayed psychomotor development and cognitive performance in children and adolescence.
- ☐ Neurological manifestation in children and adolescents.
- ☐ In adults, anemia with hemoglobin concentration reduces work capacity, mental performance and tolerance to infections.
- ☐ When the level of hemoglobin concentration falls below 4g/ld it may cause death from anemic heart failure.
- ☐ can also cause increased maternal mortality due to adverse immune reaction,
- ☐ Maternal anemia can cause prenatal infant loss, low birth weight and prematurity,
- ☐ Prenatal deaths
- ☐ Reduces work capacity in adults and learning ability in children.

Strategies for prevention and treatment of iron deficiency

- ☐ Supplementation of iron tablets (with folates) preferably with vitamin B_{12} and vitamin C
- ☐ Dietary improvement of iron rich foods
- ☐ Changing of dietary habits and food preparation practices through nutrition education
- ☐ Fortification of foods with iron
- ☐ Control of malaria infection
- ☐ Control of febrile and chronic diseases,
- ☐ Promotion of hygiene and sanitation,
- ☐ Education, information and communication on iron supplementation,
- ☐ Networking and collaborating with relevant sectors on issue,

Who needs more iron?

- ☐ Pregnant women require much higher amount of iron than is met by most diets.
- ☐ Many infants beyond 6 months of age need more iron than is available in breast milk and common weaning foods.
- ☐ Infants with low birth weight have less iron stores, and are thus at a higher risk for deficiency after two months of age.

Therefore, it is important that pregnant women routinely receive iron supplements. In places where anemia prevalence is high,

supplementation should continue into the postpartum period, to enable them acquire adequate stores of iron.

Iodine

Iodine is one of the micronutrients, which is highly essential for regulation of physical growth and neural developments.

Iodine is an essential component of the thyroid hormones, thyroxin. Failure to have adequate level of iodine in the blood leads to insufficient production of these hormones, which affect many different parts of the body, particularly muscle, liver, kidney, and the developing brain.

Sources of Iodine

- ☐ Milk and sea food
- ☐ Drinking water
- ☐ Plant source depends on whether or not iodine present in the soil
- ☐ Iodized salt

Functions of Iodine

- ☐ It is required for normal physical and mental growth.
- ☐ It is required by the thyroid gland for the production of thyroxin, which regulates the metabolic rate.

Iodine is naturally found in the top soil, most of the areas in Ethiopia specially in the high lands, the top soil is eroded with deforestation,

soil erosion and flooding, thus the crop we grow for food do not have iodine in them and as a result leads to iodine deficiency. People of all ages and sexes are vulnerable but become acute in fetus, children, pregnant women and lactating mothers.

Livestock suffer from iodine deficiency in the same way that humans do. They eat the same iodine deficient food and drink the same iodine deficient water. The introduction of iodized salt in their diet will improve their health and productivity; livestock fed iodized salt will produce iodine rich milk and meat. An iodine deficient diet will lead to increased stillbirth and miscarriages and a reduced yield of milk, eggs, meat and wool.

How do we prevent Iodine Deficiency Disorder?

Iodine Deficiency Disorder can be eliminated by the daily consumption of iodized salt. That is why Universal Salt Iodization is a crucial mid-decade goal of Ethiopia.

Why salt is iodized?

Salt has been chosen as vehicle for the supply of iodine because it is used universally by all ages, sexes, socio-economic, cultural and religious groups throughout the year. Iodized salt is also a preventive and corrective measure for iodine deficiency and is the most effective low cost, long-term solution to a major public health problem.

How long do we need to use iodized salt?

Iodized salt has to be used on a daily basis as long as one lives in an iodine deficient environment. This is the only safe and long-term solution to a problem that affects many Ethiopians.

The benefits of iodized salt

- ☐ Universal Salt Iodization can lead to an increase of the average intelligence of the entire school age population.
- ☐ The Iodization of salt will mean saving hundreds of thousands of Ethiopian children.
- ☐ Iodine enhances intellectual and cognitive development of whole generations.

The major consequences of iodine deficiency

- ☐ Mental retardation
- ☐ Defects in the development of nervous system
- ☐ Goiter
- ☐ Physical sluggishness
- ☐ Reduced work capacity
- ☐ Impaired work performance
- ☐ Decreased average intelligence
- ☐ Loss of memory
- ☐ Inability to produce enough milk for offspring
- ☐ Lower birth weight
- ☐ Growth retardation

- ☐ Dwarfism
- ☐ Deaf-mutism
- ☐ Cretinism
- ☐ Reproductive failures (abortion, prematurity, stillbirth)
- ☐ Increased childhood morbidity and mortality
- ☐ Economic stagnation and
- ☐ Impotency.

Discussion questions

1. What are the functions of minerals?
2. What are the causes of iron deficiency anemia?
3. What are the prevention and control methods of iron deficiency anemia?
4. What are the causes of iodine deficiency?
5. What are the outcomes of iodine deficiency?
6. What are the prevention and control methods of iodine deficiency?

UNIT EIGHT

Water

Learning objectives

At the end of this unit, the students will be able to:-

- ☐ Explain the importance of water,
- ☐ Tell the sources of water and the relation to body function,
- ☐ State the distribution of water in the body,
- ☐ Describe the normal and abnormal water loss from the body.

Importance of water

- ☐ Water, next to oxygen is the body's most urgent need. It is more essential than food. Without water, nutrients are of no value to the body.
- ☐ Failure to understand the role of body water contributes to health problems such as indigestion and constipations and even to needless death.
- ☐ Infant and children have a greater proportion of water than old persons, and obese persons have proportionately less water than lean persons,
- ☐ Water is taken in the form of water itself, beverages, such as coffee, tea, fruit juices, and milk; and soups,
- ☐ Solid foods contribute the next largest amount of water, as much as 25% to 50% of water requirements,

- Fresh vegetables and fruits are 80% to 90% water; meat is 50% to 60% water, and even bread is about 35% water,
- The sensation of thirst usually is a reliable guide to water intake. Except in infants and sick persons, especially comatose person who cannot respond to the thirst stimulus.
- If losses are not replenished, heat exhausting and possibility heat stroke may occur,
- Dehydration can occur rapidly in comatose patients and in disabled or elderly persons with brain impairment that are unable to respond to the sensation of thirst,
- Other conditions, such as fever, diabetes mellitus, vomiting, diarrhea, and the use of drugs such as diuretics also increase water need.

Body water

- About half of the adult body weight is water 55% for man and 47% for woman.
- About 2000 to 2500 cc of water is eliminated every day from the body carrying waste products with it.
- The lost water has to be replaced in the form of fluid or foods containing water.
- Although some water is formed, as end products of food metabolism, from 6 to 8 glass of water should be drunk every day,

Water in relation to body function.

- ☐ It is an essential component of blood and lymph and the secretion of the body, as well as the more solid tissues.
- ☐ Moisture is necessary for the normal functioning of every organ in the body.
- ☐ Water is the universal medium in which the various chemical changes of the body take place.
- ☐ As a carrier water aids in digestion, absorption, circulation and excretion.
- ☐ It is essential in the regulation of body temperature.
- ☐ Lubrication of joints and movement of the viscera in the abdominal cavity
- ☐ Waste products are transported to the blood in watery solution and eliminated by the kidneys.

Table. 7. Body water components in the reference man

Model	Compartment	Kg	%
Molecular	Total body H_2O	40	100
Cellular	Intra cellular	23	57
	Extra cellular	17	43
Tissue	Plasma	2.8	7
	Interstitial	8	20
	Bone	2.8	7
	Connective tissue	2.8	7
	Intra-cellular	1.6	4
Anatomical body water distribution			
Total body water	40 kg		
Extra cellular	17 kg		
Intra cellular	23 kg		

Normal loss of water

- From the skin, as perspiration
- From the lung, as water vapor
- From the kidney, as urine
- From the intestine, in the fasces

Abnormally

- ☐ Due to kidney disease
- ☐ If there is excessive perspiration due to high environmental temperature.
- ☐ Due to diarrhea and vomiting
- ☐ Due to hemorrhage and burn

Dehydration

The term dehydration implies more than changes in water balance. There are always accompanying changes in electrolyte balance. When the water supply is restricted or when losses are excessive the rate of water loss exceeds the rate of electrolyte loss. Then the extra cellular fluid becomes concentrated and osmotic pressure draws water from the intra-cellular fluid into the extra-cellular fluid to compensate. This condition is called extreme thirst and dehydration.

Discussion questions

1. Discuss the distribution of water in the body.
2. Mention the importance of water,
3. Describe the factors causing dehydration.

UNIT NINE

Growth And Development

Learning objectives:

At the end of this unit, the students will be able to:

- ☐ Understand components of weight during pregnancy
- ☐ Risk factors, which have an influence on a child's nutritional state
- ☐ Describe low birth weight and its causes
- ☐ Explain the nutrition of the mothers
- ☐ Assess the nutritional status
- ☐ Tell uses of nutritional assessment.

It is worth remembering that the fetus development in 40 weeks from the two cells joined at conception into an independent infant with a functioning nervous system, lungs, heart, stomach, and kidneys. To support this rapid growth and development major changes takes place in the mother's body. Under normal conditions the mother's weight increases by 20 per cent during pregnancy.

Components of weight gain during pregnancy.

ƒ Fetus, placenta, amniotic fluid	4750gms
ƒ Uterus and breasts	1300gms
ƒ Blood	1250gms
ƒ Water	1200gms
ƒ Fat	4000gms
Total	**12500gms**

Causes for low weight gain during pregnancy

- ☐ Low food intake,
- ☐ Many women continue to do hard physical activities like carrying wood and water, and do other strenuous jobs until childbirth.

Many factors cause variation in weight at birth, but in developing countries the mothers' health and nutritional status and her diet during pregnancy are probably most important. Low birth weight (LBW) is defined as being below 2.5kg. There are two main reasons for L.B.W:

- ☐ Premature or early delivery
- ☐ Retarded fetal growth

Causes of premature delivery

- ☐ Poor maternal nutrition,
- ☐ High maternal blood pressure
- ☐ Acute infections
- ☐ Hard physical work
- ☐ Multiple pregnancies
- ☐ In many cases the cause is unknown

Causes of retarded fetal growth

- ☐ Fetus, due to infections such as Rubella and syphilis
- ☐ Placenta, if it is abnormally small or with blockage
- ☐ Mother, maternal nutrition and health
- ☐ Anemia
- ☐ Acute or chronic infections such as TB

Mothers are often the key care takers for the children in the household. They have to be healthy and need the time, the knowledge and the right environment to carryout their duties.

Proper care of children

- ☐ Appropriate hygiene and sanitation
- ☐ Safe food preparation and storage
- ☐ Successful breast feeding and adequate weaning practice
- ☐ Psychosocial care such as attention, affection and encouragement
- ☐ Equitable health services and a healthy environment,
- ☐ Spacing of child birth.

Children at risk

High risk factors which often have influences on a child's nutritional states are the followings:

- ☐ Low birth weight
- ☐ Twins or multiple births
- ☐ Many children in the family
- ☐ Short intervals between births
- ☐ Poor growth in early life
- ☐ Early stopping of breast milk < 6 moths
- ☐ Introduction of complementary feeding either too early or too late
- ☐ Many episodes of infections
- ☐ Illiterate mothers,

- ☐ Resources scarcity,
- ☐ Recent migration of mother to the area,
- ☐ Children with single parent.

Assessment of nutritional status

Nutritional assessment is the process of estimating the nutritional position of an individual or groups, at a given point in time, by using proxy measurement of nutritional adequacy. It provides an indication of the adequacy of the balance between dietary intake and metabolic requirement.

Uses of Nutritional Assessment

It should aim at discovering facts to guide actions intended to improve nutrition and health.

- ☐ Diagnostic tool; (individual and group)
  - Does a problem exist – identify
  - Type of problems
  - Magnitude of the problem
  - Who are affected by the problem
- ☐ Monitoring tool (individuals and group)
  - Requires repeated assessment over time
  - Has the situation changed?
  - Direction and magnitude of change

- ☐ Evaluation tool (individual or group). To what extent has the intervention, treatment, or programme had the intended effect (impact)

Anthropometrics assessment

It is the measurement of the variation of physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition.

Anthropometrics assessment of growth

Common measurements include;

- Stature (height)
- Body weight
- Skin fold
- Mid Upper Arm Circumference (MUAC)

Indices derived from growth measurements;

- Weight-for-height,
- Height-for-age,
- Body Mass Index (BMI) = Weight in Kg divided by Height in metre square that is $Wt/(Ht)^2$

The Waterlow Classification

Waterlow pointed out two different types of deficit: a deficit in ***WEIGHT-FOR-HEIGHT*** (wasting) and a deficit in ***HEIGHT-FOR-AGE*** ('stunting').

1. Waterlow has suggested classification based on wasting (current malnutrition) or stunting (chronic malnutrition)

   WFH = 80% of the Reference standard

   or –2.5D below the median

   HFA = 90% or – 2.5D below the median

Table: 8. Waterlow classification

		Weight	
		Above	Below
Height	Above	Normal	Acute malnutrition
	Below	Nutritional Dwarfism	Chronic Malnutrition

Identification malnutrition superficially

Changes in the superficial tissues or in organs near the surface of the body, which are readily seen or felt upon examination. These include changes in:

- Eyes
- Skin
- Hair
- Thyroid gland

Common indicators

- ☐ Edema
- ☐ Dyspigmentation of the hair
- ☐ Angular Stomatits
- ☐ Corneal lesions
- ☐ Swelling (enlargement) of glands

Discussion questions

1. Why do women increase during pregnancy?
2. State causes for low weight gain during pregnancy.
3. What are the two main reasons for low birth weight?
4. What are the nutritional risk factors which have an influence on a child's nutritional state?

UNIT TEN

Nutritional Surveillance

Learning objectives

At the end of this unit, the students will be able to:

- ☐ Understand the objectives of nutritional surveillance
- ☐ Describe the uses and users of Nutritional Surveillance
- ☐ Explain the nutritional outcome indicators
- ☐ Understand timely warning and copping mechanisms.

Nutritional surveillance: is defined as the measurement of the frequency and distribution of nutrition related diseases or problems using regularly collected and available information. It comprises the compelling and analysis of nutrition information for decision making relative to national or regional polices or programme planning. Nutritional surveillance could be concerned with everything that affects nutrition, from food production, distribution, and intake to health status itself.

Objectives of nutritional surveillance

- ☐ To provide information so that decision can be more favorable to nutrition
- ☐ To increase the allocation of resources to improve the nutrition of the malnourished in drought and famine condition.

Potential users of Nutritional Surveillance Information (N.S.I)

- ☐ Ministry of health
- ☐ Ministry of agriculture,
- ☐ Government and nongovernmental organizations.

Nutritional outcome indicators

- ☐ Prevalence of malnutrition among preschool children (<80% WFH)
- ☐ Prevalence of birth weight infants (<2.5kg)
- ☐ Prevalence of stunting in school entrants (<90% HFA)
- ☐ Estimate of infant and/or child mortality rate.
- ☐ Quality of housing
- ☐ Water supply
- ☐ Sanitation and literacy rate.

Discussion questions

1. Define nutritional surveillance
2. What are the objectives of nutritional surveillance?
3. What are the uses and who are the users of nutritional surveillance information?
4. What are the nutritional outcome indicators used in nutritional surveillance?

UNIT ELEVEN

Nutrition Intervention

Learning objectives:

At the end of this unit, students will be able to:

- ☐ Understand methods of intervention
- ☐ Mechanisms of intervention
- ☐ Describe the criteria for successful intervention

When there is a nutritional problem in a community, if the magnitude and the causes of the problem are known, we will plan to do intervention.

Methods of nutrition intervention

- ☐ Food fortification
- ☐ Food for work
- ☐ Price subsidization
- ☐ Supplementation
- ☐ Family planning
- ☐ Integration of nutrition with health
- ☐ Price policy

Mechanisms of nutrition interventions

There are five principal mechanisms through which all interventions work.

- ☐ Availability of food at local or regional level. Making the required foods more available with the respect to place and time.
- ☐ Accessibility to food and availability of foodstuff at the household level. Making the required foods more accessible and available to the households
- ☐ Food utilization at household level. Making better use of available foods. Food processing such as fermentation, preparing weaning food.
- ☐ Distribution within the household.
  - ¾ Intra household distribution of food
  - ¾ Supplementation
  - ¾ Education
- ☐ Physiological utilization
  - ¾ Health service activities and environmental sanitation
  - ¾ Primary health care
  - ¾ Environmental health

Criteria used for successful interventions

- ☐ Relevance of the intervention to solve the problem at hand
- ☐ Feasibility
- ☐ Integratability
- ☐ Effectiveness
- ☐ Ease in targeting
- ☐ Cost effectiveness

- ☐ Ease in evaluation
- ☐ Long-term continuation

Discussion questions

1. What are the five principal mechanisms through which all nutrition interventions work?
2. Mention the criteria for successful intervention.

UNIT TWELVE

Essential Nutrition Actions Approach

An action oriented approach to nutrition...

If we use ENA approach to nutrition, estimated decrease of child mortality is 25%. The seven essential actions and the six contact points should be included in the curricula of all health science students.

There are seven action areas:

1. Promotion of Breastfeeding

Key messages

- Timely initiation of breastfeeding (1 hour of birth)
- Exclusive breastfeeding until six months
- Breastfeed day and night at least 10 times
- Correct positioning & attachment
- Empty one breast before switching to the other

Estimated decrease of child mortality is 13% if the child is optimally breastfed

2. Appropriate Complementary Feeding

Key messages:

- Introduce appropriate complementary foods at 6 months
- Continue breastfeeding until 24 months & more

- Increase the number of feeding with age
- Increase density, quantity and variety with age
- Responsive feeding
- Ensure good hygiene (use clean water, food and utensils)

3. Feeding of the sick child

Key messages:

- Increase breastfeeding and complementary feeding during and after illness
- Appropriate Therapeutic Feeding.

4. Women's nutrition:

Key messages:

- During pregnancy and lactation
  - ¾ Increase feeding
  - ¾ Iron/folic Acid Supplementations
  - ¾ Treatment and prevention of malaria
- De-worming during pregnancy
- Vitamin A Capsule after delivery

5. Control of Vitamin A Deficiency:

Estimated decrease of child mortality is 2%

Key messages:

- Promote breastfeeding: source of vitamin A
- Vitamin A rich foods

- Maternal supplementation
- Child supplementation
- Food fortification

6. Control of Anaemia

Key messages:

- Supplementation of women and children (IMCI)
- De-worming for pregnant women and children (Twice/year)
- Malaria control
- Iron rich foods
- Fortifications

7. Control of Iodine Deficiency Disorders:

Key messages

Access and consumption by all families of iodized salt

How the Essential Nutrition Actions expands coverage of nutrition support in the health sector:

There are six critical contact points in the lifecycle

1. During Antenatal Care

- Pregnancy: TT
- Antenatal visit, Iron/Folic Acid
- De-worming
- Maternal diet
- EBF

- Risk signs, FP, STI prevention
- Safe delivery, iodized salt

2. Delivery;

- Safe delivery,
- EBF,
- Vitamin A, Iron/Folic Acid
- Diet, FP and STI, Referral

3. Postnatal and Family Planning:

- EBF, Diet, Iron/Folic Acid
- FP, STI prevention
- Child's vaccination

4. Immunizations:

- Vaccination, Vitamin A
- De-worming
- Assess and treat infant's anemia
- FP, STI, Referral

5. Well child and GMP:

- Monitor growth
- Assess and counsel on feeding
- Iodized salt
- Check and complete vaccination
- Vitamin A/de-worming

6. Sick child:

- Monitor Growth
- Assess and treat per IMCI

- Counsel on feeding
- Assess and treat for anemia,
- Check and complete vitamin A
- Immunization/de-worming

Need to integrate ENA into other health programme

1. a) Child survival EPI+
   b) Community IMCI
   c) Health facilities IMCI
2. a) Reproductive Health
   b) Women's Nutrition
   c) Lactational Amenorrhea Method
3. a) National immunization Days Polio and Measles
4. a) Nutrition programme positive deviance community
   GMP
5. a) Infectious Diseases, Control of Malaria,
   Tuberculoses HIV/AIDS (PMTCT)

How the Essential Nutrition Actions expand coverage outside the health sector?

Need to integrate ENA into other sectors

1. a) Schools, Adolescent nutrition
   b) De-worming
   c) Iron supplementation
   d) School lunch

2. a) Agriculture, food diversification
   b) Food security
   c) Women's farmers clubs
3. a) Emergency women to women support
4. a) Sanitation, clean water & sanitation
   b) Public health education
   c) Prevention of diarrhoea, malaria, ARI
5. a) Micro-credit, income generation
   b) Nutrition education

The most visible evidence of good nutrition is a taller, stronger, healthier child who learns more in school and become productive, happy adults who participate in society.

Malnutrition dose not need to be severe to pose a threat to survival. Worldwide, fewer than 20% of deaths associated with childhood malnutrition involve severe malnutrition; more than 80% involve only mild or moderate malnutrition.

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