UNIVERSITY OF PAPUA NEW GUINEA
SCHOOL OF MEDICINE AND HEALTH SCIENCES
DIVISION OF BASIC MEDICAL SCIENCES
DISCIPLINE OF BIOCHEMISTRY AND MOLECULAR BIOLOGY

LECTURE: NUTRITION AND NUTRIENTS – An Overview
BACHELOR OF NURSING

What is nutrition? Utilization of foods by living organisms

- Areas of Human nutrition: Over-nutrition, Under-nutrition and Ideal or optimal nutrition
- Major nutrition problems in developing countries:
  - Under-nutrition: Synonymous with Malnutrition
  - Nutritional deficiency diseases common among infants and adults particularly women

What are the Major Indices of Food Quality?

- CALORIC VALUE (also called ENERGY VALUE) and
- NUTRITIVE VALUE

What is Caloric Value (Energy Value) of a food?

- Actual amount of calories (energy) that the body derive from the food or expected to be derived from the food

What is the Energy content (heat of combustion) of a food?

- Total amount of energy obtained from the food when it is completely incinerated in a bomb calorimeter in the laboratory

Is the Caloric value (energy value) of a food the same as the Energy content (energy of combustion) of the food?
Answer: No it is not. Why??

- Amount of energy that the body can derive from the food is **<u>less</u>** than the energy content of the food as determined via the bomb calorimeter. **WHY??**

Answer:

- Because the energy yielding nutrients (Carbohydrates, Fats and Proteins) are not completely digested in the Gastrointestinal Tract (GIT), and even the digested fractions are not always completely absorbed from the GIT.
- Nitrogen atoms in proteins cannot be oxidized in the body; they are converted to urea and excreted in the urine (Ureotelic organisms).

By definition:

Caloric Value = Energy Content of food – Energy Loss during digestion of food

- ENERGY CONTENT (HEAT OF COMBUSTION) OF FOODSTUFFS IS ALWAYS HIGHER THAN THE CALORIC VALUE.

How can the caloric value of food be calculated?

- By convention the Caloric Value of food or diet is calculated from the macronutrient (Carbohydrate, Fat and Protein) content of the food or diet.

- For foods containing alcohol, the amount of alcohol present in the food must be included in the calculation.
- If the amount of Protein, Carbohydrate and Fat are known, then the Caloric Value of the food or diet can be calculated using the formula:

Caloric Value (Kcal) = (P x p) + (F x f) + (C x c)

- Where P, F and C represent the amounts (expressed in grams) of Protein, Fat and Carbohydrate, respectively, in the food as determined by chemical analysis or obtained from Food Composition Tables.
- The p, f and c, denote the energy conversion factors (i.e. **ATWATER Energy Factors**) for protein, fat and carbohydrate respectively. {1.0 Kilocalorie ≡ 4.18 KJ of energy}

Respective Atwater Energy Factors are as follows:
- 1.0g Protein is equivalent to 4.0Kcal of energy
- 1.0g Fat is equivalent to 9.0Kcal of energy
- 1.0g Carbohydrate is equivalent to 3.75Kcal of energy
- 1.0g Alcohol is equivalent to 7.0Kcal of energy

TAKE NOTE:
- **Atwater Energy Factor expresses the Caloric Value of 1.0g of the respective macronutrient**.
- **Atwater Energy Factors permit the calculation of Metabolizable Energy of a mixed diet with a considerable degree of accuracy**.

How can the Metabolizable Energy (Caloric Value) of a food or diet be calculated?

Question:
Calculate the amount of energy in Kcal derivable on consumption of a diet containing 50.0g protein, 10.0g dietary fat, 200.0g available carbohydrates and 5.0g of ethanol. If the Energy content (heat of combustion) of the diet is 1500.0Kcal, what percentage of the energy content is (metabolizable energy) available to the body?

Answer to the question:
Atwater factors are as follows: Protein 4.0Kcal/g; Fat 9.0Kcal/g; Carbohydrate 3.75Kcal/g; Ethanol 7.0Kcal/g.

By definition:
- Caloric value of the protein = 50 x 4 = 200.0Kcal
- Caloric value of dietary fat = 10 x 9 = 90.0Kcal
- Caloric value of available carbohydrates = 200 x 3.75 = 750.0Kcal
- Caloric value of ethanol = 5 x 7 = 35.0Kcal

Total Caloric value = 200kcal + 90kcal + 750kcal + 35kcal = 1075.0 Kcal
Caloric value (Metabolizable energy) of the diet = **1075.0Kcal**.

Percentage of energy available to the body can be calculated as follows:

$$\frac{\text{Caloric value}}{\text{Energy content}} \times 100\% =$$

Thus:

$$\frac{1075}{1500} \times 100 = 71.7\%$$

NUTRITIVE VALUE OF FOOD:

What is the nutritive value of food?

- Nutritive value of a food refers to the amount of nourishment that is actually derivable from the food.

Is the nutritive value of food the same as the nutrient composition of food?

- Nutritive value of food is not the same at its nutrient composition
- Nutrient compositions of most major foodstuffs have been determined and the data are available in appropriate Food Composition Tables.
- A major significance of the Food Composition Table is that it facilitates easier comparison of nutrient contents of different foodstuffs, and it is easier to select a mixture of foodstuffs to meet the nutrient requirements of selected diets.

TAKE NOTE:

Food Composition Tables can only serve as a guide

- Food composition tables are not universal standards,
- Nutrient composition of foodstuffs are usually specific for regions/countries, because of crop varieties and the composition of the soil on which the crop or foodstuff was grown – in the case of plant based foods.
- Quality and quantity of some animal-based foodstuffs may depend to a large extent on the dietary regimen and physiological status of the livestock

What are the major Essential Macronutrients?

Essential Amino Acids (EAA):

- Amino acids that cannot be synthesized in the body
- They must be obtained from proteins in the diet.
  - Acronym for essential amino acids **– TV TILL PM /or (PVT TIM HALL** for premature infants).
- Cysteine and Tyrosine may be formed from the essential amino acids Methionine and Phenylalanine respectively
- Thus, if sufficient amount of Cysteine and Tyrosine are present in the diet, they spare the dietary requirement for Methionine and Phenylalanine

Dietary Essential Fatty Acids (EFAs):

- Polyunsaturated Fatty Acids that cannot be synthesize in the body
    - **Omega-6 and Omega-3** series of fatty acids
        - Omega-6 series: Linoleic Acid and Arachidonic Acid
        - Omega-3 series: Linolenic Acid, Timnodonic acid (EPA), Cervonic Acid (DHA)
    - Arachidonic acid is a semi-essential, or partially essential fatty acid because it can be derived from Linoleic acid or Linolenic acid

What do you understand by the term "Protein Quality"?

- Egg and Milk proteins are usually considered as High-quality proteins because:
    - They contain all the essential amino acids in biologically available forms and in the proportions required for adequate nutrition
    - The body efficiently utilizes these proteins
    - They are used as reference standards against which other proteins are compared

- Quality of a protein is measured by comparing the proportions of essential amino acids in the protein with the proportions in a standard or reference protein, such as Egg or Milk protein
- The closer the proportions are the higher the protein quality

Why is the biological value of plant proteins said to be zero?

- Meat proteins are of high protein quality,
- Plant proteins are of low protein quality,
    - Plant proteins are usually relatively deficient in one or more essential amino acids. For example:
        - Maize (corn) is deficient in Tryptophan and Lysine;
        - Wheat and other cereals are deficient in Lysine;
        - Rice is deficient in Lysine
        - Beans are deficient in Valine
        - Soybeans are deficient in Methionine
        - Potatoes are deficient in Leucine
        - Cassava are deficient in Methionine

- Deficiency of an essential amino acid in a given protein can be made up by the abundance of that essential amino acid in another protein in a mixed diet. This phenomenon is known as Complementary.
    - Example: A diet made up of Cereals and Soybeans mixed together provides a satisfactory intake of all the essential amino acids.

NON-NUTRIENTS:

Non-nutrients in foods can be separated into two major groups:

- Non-Toxic Non-nutrients and Toxic Non-nutrients

Non-Toxic Non-nutrients:

- Major non-toxic non-nutrients with beneficial effects are those classified as dietary fibers (Roughage).

Dietary Fibers:

- Dietary fibers are non-toxic non-nutrient component of food that cannot be broken down by human digestive enzymes.
- Bacterial enzymes in human intestine can breakdown some of the dietary fibers.
- Chemically, dietary fiber can be defined as:
  - Non-starch polysaccharide and Lignin, which includes cellulose, and non-cellulose polysaccharides.
  - Non-cellulose polysaccharides include:
    - Hemicelluloses (arabinoxylans); Pectin, Plant Gums, Mucilage, and Inulin.
    - Lignin is a group of polyphenolic compounds of diverse molecular weights.

What are some of the biological effects of dietary fiber?

- Dietary fiber has a laxation effect on the functioning of the GIT.
- Dietary fiber increases faecal bulk.
- Dietary fiber lowers plasma cholesterol level.
- Dietary fiber decreases nutrient availability.
- Dietary fiber reduces glycaemic response to carbohydrate–containing meals.
- Consumption of staple diets that are deficient in dietary fibers has been implicated in the etiology of a number of human GIT diseases, such as cancer of the colon and rectum, diverticular disease of the colon, hemorrhoids and appendicitis.

What are some of the factors that affect the bioavailability of nutrients?

- Several factors influence the bioavailability of nutrients:
  - Stability to cooking or processing;
  - Chemical form in which the nutrient is present in foodstuffs;
  - Nature of other constituents of the ready to eat diet or foodstuff
  - Efficiency or physiological status of the digestive system of the individual
- Some non-nutrients in foodstuffs may have negative influence on Bioavailability of nutrients: OXALIC ACID; PHYTIC ACID; PROTEINASE INHIBITORS, AVIDIN.
  - Oxalic acid forms oxalate precipitate with dietary calcium;
  - Phytic acid forms insoluble phytates with Ca, Fe, Zn and other divalent metals.

MICRONUTRIENTS: VITAMINS AND MINERALS:

- Micronutrient deficiency, now referred to as Vitamin and Mineral Deficiency (VMD), is widespread among women and children in resource limited (developing) countries
- "VMD deprives a billion people world-wide of Intellect, Strength &Vitality"
- Individuals with multiple deficiencies are in a state of Micronutrient Starvation
  - They suffer from the "**Hidden Hunger**" that secretly suppresses their immune response, increasing the risk of developing infectious diseases
- Adequate amount of micronutrients are needed at all ages,
- Effects of inadequate intake are particularly serious during periods of rapid growth, early childhood, pregnancy and lactation
- Iron, Zinc, Iodine and Selenium among others are very important for Physical and Cognitive development of children

MINERAL ELEMENTS:

- Two major groups of dietary elements:
  - **Macroelements** are usually required in amounts greater than 100 mg per day
    - Examples are: Calcium, Phosphorus, Potassium, Sodium, Magnesium, Chloride, and Sulfur
  - **Microelements** or **Trace elements** are required in amounts less than 100 mg per day.
    - Examples are: Iron, Iodine, Zinc, Selenium, Copper, Manganese, Cobalt, Molybdenum, Chromium, Fluorine, Silicon, Vanadium, Tin, Arsenic, and Nickel.

SOME FORGOTTEN TRACE ELEMENTS: IODINE, ZINC, SELENIUM

How important is Iodine?

- Iodine is essential for the biosynthesis of Thyroid hormones:
  - Thyroxine (T 4) and Tri-Iodothyronine (T 3)
- Inadequate intake of dietary iodine or regular consumption of diet containing anti-metabolites (Goitrogens) of Iodine metabolism can impair biosynthesis of Thyroid hormones, leading to a Spectrum of diseases: Iodine Deficiency Disorders (IDD)
- **Iodine Deficiency (ID) is regarded as the single most common cause of preventable mental retardation and brain damage in a population where the intake of iodine is insufficient**
- Severe ID that leads to Endemic Cretinism has been reduced World-wide because of implementation of dietary iodine supplementation programs {Universal Salt Iodization (USI) strategy}

What are some of the consequences of Iodine deficiency?

- Some clinical consequences of ID:
  - Severity can vary from Mild Intellectual Blunting to Frank Cretinism,
    - May include Gross Mental Retardation, Deaf Mutism, Short Stature (Stunting), and various other defects
  - Mild to Moderate ID is prevalent in several countries including PNG
  - Of great prevalence are the more subtle degrees of mental impairment, which occur in apparently normal children with low dietary intake of iodine
    - Manifestations range from small neurological changes, to impaired learning ability and underperformance in school, including poor performance on formal tests of Psychomotor functions
- Dietary ID in Pregnant and Lactating women may have serious consequences:
  - Maternal ID can compromise the Thyroid status of the Fetus and Neonate
    - Maternal Thyroxine (T4) is required for Neurodevelopment of Fetus during the first half of gestation
    - Fetal Neurodevelopment is most vulnerable to damage during early gestation in women with Mild to Moderate ID
- Maternal milk is the major source of Iodine for Neonates
- Importance of adequate intake of Iodine by Lactating mothers cannot be overemphasized
- In women of childbearing age: ID can cause Infertility and set the stage for Miscarriage, Abortion, or Stillbirth during pregnancy

What are some of the metabolic functions of Zinc?

- Zinc is present in over 300 Metallo-proteins with wide range of biochemical functions
- Metallo-proteins that require Zinc for normal functioning include:
  - **Regulatory and transport proteins such as**:
    - **Gustin:**
      - Polypeptide in Saliva that is essential for normal development of taste buds, (this account for the decreased taste acuity in Zn deficient individuals)
    - **Metallothionein:** (Zn induces biosynthesis of MT in GIT)
    - **Gene-Regulatory Proteins** (e.g., "Zinc fingers" – involved in sequence-specific DNA recognition and Gene expression)
      - Nucleoproteins involved in DNA Replication and Transcription

  - **Zn as Co-factors for many Enzymes**:
    - Carbonic Anhydrase (regulation of HCO_3^- ion),
    - Alcohol Dehydrogenase:
      - Alcohol causes increase loss of Zinc in urine
    - Nucleoside Phosphorylase:
      - Decrease activity cause by Zinc deficiency may result in accumulation of toxic levels of Nucleotides, leading to impaired cell division or cell death
    - Alkaline Phosphatase (ALP): important in bone and placenta
    - Lactate Dehydrogenase (LDH): regulatory role in major tissues
    - Glutamine Synthetase: regulatory role in major tissues (kidneys, brain)
    - Glutamate Dehydrogenase (GDH): major role in nitrogen metabolism
    - Prolyl Hydroxylase: Major role in post-translational modification of Collagen
    - Porphobilinogen (PBG) Synthase: major role in Heme biosynthesis
    - RNA and DNA Polymerases: growth and differentiation

  - **Zn acts to modulate metabolism of Vitamin A**:
    - Biosynthesis of Retinol-binding protein
    - Conversion of Retinol to Retinal:
      - A process that is necessary for vision, thus the impaired dark adaptation in Zn deficient individuals
    - Transportation of Retinol from Liver, to other organs is possible only if hepatocellular secretion can take place via Zinc accumulation on Retinol-binding protein

ZINC NUTRITURE IN INFANTS:

- **First Six months of life**: Period of rapid growth. Zn intake varies with mode of feeding
  - Relatively high Zinc requirements during this period can be met satisfactory by Zinc content in breast-milk for most "**healthy"** infants
    - Healthy breast-fed infants usually do not develop Zinc deficiency, because of the high bioavailability (80%) of Zinc in breast milk,

  - Zinc content in Cow's milk is higher than in human breast milk, but the bioavailability (35%) is lower

        - High bioavailability of Zinc in human breast milk is due to the high levels of Citrate and Lactoferin, compared to the high Phytates, Calcium and Casein in Cow's milk
- **From Six months to Two years of age**, adequacy of Zinc intake becomes highly dependent on the amount and bioavailability of Zinc from Complementary foods
    - Breast-fed infants, and Low birth weight infants may be at risk for Zinc deficiency because of:
        - Increased requirements,
        - Potentially lower intake and/or
        - Lower absorption efficiency
- Zinc content of breast milk falls with duration of lactation
- Prolonged breast-feeding without adequately prepared Complementary foods may reduce Zinc intake, thereby increasing the risk of Zinc deficiency in infants
- Zinc deficiency may occur in children fed with Cow's milk, because of the high levels of Phytate, Calcium and Casein that impairs Zinc absorption
- Same holds true for Soymilk, which contains high levels of Phytate

TAKE NOTE:
- Zinc supplementation enhances Linear Growth and significantly reduces incidence of Anemia in children
    - Stunted children benefit more than non-stunted children;
    - Children up to 24 months of age benefit more than older children

SELENIUM (Se):
- Selenium is a co-factor in Glutathione Peroxidase, a major Antioxidant in cells
- Selenium is an essential component of De-Iodinase (Type 1) that catalyzes conversion of Thyroxine (T_4) to Tri-Iodothyronine (T_3)
    - De-Iodinase contains a specific Amino Acid called **Seleno-Cysteine**
- Conversion of T4 to Reverse T3 is catalyzed by enzyme called 5'-De-Iodinase that does not require Selenium
    - Deficiency of Selenium results in decreased conversion of T4 to T3, which at the same time causes an increase in the conversion of T4 to reverse T3 (rT3), by 5'-Deiodinase that does not contain Seleno-Cysteine
- Deficiency of both Selenium and Iodine causes the severest forms of iodine deficiency disorders:- Myxoedematous Cretinism

WATER SOLUBLE VITAMINS:
- Most of them are Coenzymes or Prosthetic groups for enzymes.
- Dietary forms of some vitamins must be converted into the Coenzyme form, which is the biologically active form of the vitamin. (Energy is required for this process)
- Most water-soluble vitamins are of plant origin, with the exception of Vitamin B_{12}, which is found mainly in foods of animal origin.
- Urinary excretion of water-soluble vitamins or their derivatives may serve as an index of their dietary intake.
- It is essential that vegetarians and others, who avoid animal foods, include a source of Vitamin B_{12} in their diet, either as a supplement or as fortified foods.
- Fermented products and yeast extracts contain substances, which are chemically similar to vitamin B_{12} but do not function in the body in the same way as the vitamin. Therefore these foods cannot be regarded as rich in vitamin B_{12}.

Water soluble Vitamins: Biological active forms and Metabolic Functions

Common Names & Chemical Nature	**Biologically Active / Coenzyme forms**	**Metabolic functions of biologically active forms**
Thiamine or Vitamin B_1	Thiamine Pyrophosphate (**TPP**)	Coenzyme in Oxidative Decarboxylase reactions (Pyruvate, Alpha-Oxoglutarate, Alpha-Keto-butyrate
Riboflavin or Vitamin B_2	❑ Flavin Adenine-Dinucleotide (**FAD**), ❑ Flavin Adenine-Mononucleotide (**FMN**)	Coenzyme in some Dehydrogenase reactions, and in some Red-Ox reactions
Niacin: Nicotinic Acid; Nicotinamide	❑ Nicotinamide Adenine-Dinucleotide (**NAD**) ❑ Nicotinamide Adenine Dinucleotide Phosphate (**NADP**)	Coenzyme in several Dehydrogenase reactions, and in several Red-Ox reactions
Pyridoxine, Pyridoxal, Pyridoxamine (Vitamin B_6)	Pyridoxal-Phosphate **(B_6-Phosphate)**	Coenzyme in several enzymes: Amino Acid Decarboxylase, Transaminases, Delta-amino-Laevulinic Acid Synthetase (ALA-Synthase)
Pantothenic Acid	❑ Coenzyme A, ❑ Acyl-carrier Protein (ACP)	Carrier of Acyl groups in Acylation reactions
Cobalamin (Vitamin B_{12})	❑ Methyl-Cobalamin, ❑ 5'-Deoxyadenosyl Cobalamin	Coenzyme for One-carbon transfer reactions ($-CH_3$)
Folic Acid, Folate, Foliacin (Vitamin M)	Tetra-hydro-folic acid, Tetra-hydro-Folate (**FH_4, or THF**)	Coenzyme for One-carbon transfer reactions
Ascorbic Acid, (Vitamin C)	L-Ascorbic Acid, Dehydro-Ascorbate	Reducing Agent (electron donor), Antioxidant
Biotin	Prosthetic group of Carboxylases	Carrier of active CO_2 in carboxylation reactions

FAT SOLUBLE VITAMINS:

Fat Soluble Vitamins: Biological active forms and Metabolic Functions

Common Names & Chemical Nature	**Biological Active Forms**	**Metabolic functions of Active forms**
❑ Retinol (Vitamin A), ❑ All trans Retinol	11-cis Retinal,	❑ Prosthetic group in visual pigments, ❑ Cofactor role in biosynthesis of Cholesterol, ❑ Role in membrane biogenesis ❑ Role in cell differentiation
❑ Cholecalciferol (Vitamin D_3) ❑ Calciferol or Ergocalciferol (Vitamin D_2)	1,25-Dihydroxy-Cholecalciferol, 1,25-DihydroxyVitamin D_3	❑ Absorption of Calcium in GIT, ❑ Reabsorption & Mobilization of Calcium and Phosphate in Bone
Tocopherols (Vitamin E)	Alpha-Tocopherol, Beta-Tocopherol	Antioxidants protecting polyunsaturated fatty acids in membranes,
Phytomenadione (Vitamin K)	Vitamin K	Cofactor in Post-translational gamma-carboxylation of N-terminal Glutamic acid residue in blood clotting factors

What are some of the functions of Vitamin A?

- Vitamin A is involved in Visual cycle
  - Rhodopsin = **11-cis-Retinal** + Opsin

- Vitamin A is involved in biosynthesis of Transferrin (Iron transporter)
  - Vitamin A deficiency causes non-responsive Iron deficiency anemia

- Vitamin A is involved in regulation of growth and differentiation
  - It is essential for biosynthesis of:
    - Glycoproteins required for normal growth regulation
    - Glycosaminoglycans (GAGs), which are components of Mucus (Mucin) secreted by epithelial cells
- In Vitamin A deficiency status:
  - Differentiation process slows down,
  - Keratin producing cells replace Mucin-producing cells in epithelial tissues in the Eyes, Lungs and Gut
  - Reduction in Mucus secretion leads to drying of epithelial tissues in the Eyes, Lungs and Gut,
  - Excess Keratin production causes Keratinization {e.g., in eye – causing Xerophthalmia (dry eyes)} which can result in blindness

How do you calculate the Basal Metabolic Rate (BMR)?

- Variables needed to calculate the BMR: Weight (kg), Height (cm), and Age (yrs) (Not applicable to very muscular and obese individuals)

- **BMR Formula (kcal/day)**:

- **For Women**:
- BMR = 655.0 + (9.6 x Weight in kg) + (1.8 x Height in cm) – (4.7 x age in yrs)

- **For Men**:
- BMR = 66.5 + (13.8 x Weight in kg) + (5 x Height in cm) – (6.8 x age in yrs)

What is the Harris Benedict Equation (HBE)?
- It is used to calculate total daily energy expenditure (DEE)
- DEE is calculated by multiplying the Basal Metabolic Rate (BMR) by an activity factor. (Not applicable to very muscular and obese individuals)

How is the DEE calculated?
- Harris Benedict Equation is used to calculate Daily Energy Expenditure (DEE)
- Multiplying the BMR by the appropriate activity factor for the individual

  - Sedentary (little or no exercise): = **BMR x 1.2**

  - Lightly active (light exercise 1-3 days/week): = **BMR x 1.375**

  - Moderately active (moderate exercise 3-5 days/week) = **BMR x 1.55**

  - Very active (exercise 6-7 days/week) = **BMR x 1.725**

  - Extra active (very hard exercise) = **BMR x 1.9**

Question: If the BMR of a male student with sedentary life style is 1650.0kcal/day, calculate the daily energy expenditure (DEE) of the student.

Answer: The activity factor for individuals with sedentary life style is 1.2. If the BMR of the student is 1650.0 kcal/day, the DEE = 1650.0 x 1.2 = 1980.0 kcal/day

HIV / AIDS:

What is the Energy and Macronutrient intake for People living with HIV/AIDS?
- HIV/AIDS specifically affects Nutritional status of PLWHA because it:
  - Increases energy requirements, Reduces food intake, and Adversely affect nutrient absorption and metabolism
- Responsiveness of PLWHA to nutritional interventions depends on:
  - Viral load, Stage of the disease, Concurrent treatment, Body Mass Index and Presence or absence of Opportunistic Infections

- PLWHA have greater energy needs than uninfected individuals,
  - Extent of increased energy needs depends on progression and stage of HIV infection

  - In **Asymptomatic PLWHA**:
    - Energy needs are **10% higher** than the accepted levels for healthy non-HIV infected persons of the same age, sex and physical activity level
    - Increase energy is needed to maintain body weight and physical activity, which are highly desirable for preserving quality of life

  - In **PLWHA with symptoms or any opportunistic infection**:
    - Energy needs are **20% to 30% higher** than the acceptable level for health non-HIV infected persons of the same age, sex and physical activity level
      - Increase energy is needed to support weight recovery during and after HIV related illnesses

  - *The 20 to 30% increase in energy intake may not be easily achievable because of poor appetite, inadequate dietary intake or other reasons caused by acute infection/illness*
  - *However, food intake should be encouraged and increased to the extent possible, particularly during the period of recovery*

- Estimated increased energy requirements for PLWHA are to:
  - Compensate for increased level of Resting Energy Expenditure (REE)
  - Allow for normal Activity-related Energy Expenditure (AEE),

- Both of which together represent the Total Energy Expenditure (TEE)
  - TEE = REE + AEE

- Amount of Macronutrients consumed by PLWHA should be the same as for non-HIV infected adults

- Recommended ranges of values are that:
  - Proteins should contribute 12% to 15% of total energy intake;
  - Fat should contribute about 30% to 35% of total energy intake
  - Carbohydrates should contribute about 50 – 55% of total energy intake

UNGASS Declaration:

- Declaration of the commitment by **United Nations General Assembly Special Session** (UNGASS) dedicated to HIV/AIDS recognizes the need to integrate Food and Nutrition support as part of a Comprehensive Response to HIV/AIDS

- UNGASS Declaration of June 2006, Article 28 States that:
  - **"… all people at all times, will have access to Sufficient, Safe, and Nutritious Food to meet their dietary needs and food preferences for an Active and Healthy Life, as part of a comprehensive response to HIV/AIDS"**

- According to the UNGASS Declaration:
  - **"All member states of the United Nations General Assembly MUST recognized that where Anti-Retroviral Therapy is necessary, Food is a Key Element in Strategies to Promote Adherence to it and its efficacy"**

- Efficacy of HAART treatment partly depends on the nutritional status of PLWHA
- Therefore, Nutritional Assessment and Counseling should be an integral part of all HIV/AIDS treatment programs

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