EDO UNIVERSITY IYAMHO

Department of Biochemistry
BCH 315 – Food and Nutritional Biochemistry

Instructors: *Dr. Olerimi Samson E.*, email: olerimi.samson@edouniversity.edu.ng
Lectures: Thursday, 2pm ó 4pm, LT6, phone: (+234) 8062539665
Office hours: Mondays, 10am to 2pm, Office: College of medicine building, 1st floor, Rm 85.

General overview of lecture: Human dietary nutrient requirement and factors affecting the requirements. Food habits and intakes.Digestion, absorption.Metabolism and function of carbohydrates, lipids, proteins and aminoacids in mass.Consequences of excess and inadequate caloric intake, protein energy malnutrition.Kwashiorkor and marasmus. The vitamins: their chemistry, metabolism and function. The minerals: their metabolism and function. Animal and microbial nutrition. Feed formulation, food toxicants and detoxification mechanisms. Food stuff: Nutritive and energy values and protein quality. Nutritional disorders, prevention and therapy. Nutritional status and nutritional requirements.Assessment of nutritional status.

Public aspects of nutrition; nutrient requirement in relation to physical activity and ageing, diet and disease, obesity and under nutrition.Assessment of nutritional status; etiology of malnutrition.Environmental and social factors related to malnutrition.

Learning outcomes: At the completion of this course, students should be able to know:
  i.   Various types of food toxicants and food contaminants, their classification and detoxification methods.
  ii. The different forms of assessing nutritional status, the advantages and disadvantages of various nutritional statuses.
  iii. The nutritive and energy level in foods.
  iv. Diseases associated with malnutrition such as kwashiorkor, marasmus, micronutrient deficiency, obesity.

Assignments: Students will be given a minimum of three take-home assignments; students are also expected to design a term paper which will be presented in the classroom for about 10 ó 15 minutes. There will also be a mid-semester test. Students are to take end of semester examination based on what they have learnt in this course.

Grading: We will assign 10% of this class grade to take-home assignments, 10% for the mid-term test, 10 % for term papers design and presentation, and 70% for the end semester examination. The final exam will be comprehensive.

Textbooks: The recommended textbook for these classes are as stated:
Title: *Food biochemistry and food processing*

Main Lecture: Below is a description of the contents for my aspect of the course.

ENERGY VALUE

Energy is simply defined as the capacity to do work such as moving. Energy can be stored in various forms which are then used when required. The unit for energy is calorie or kilocalorie which may be used for the expression of energy value in food. Energy can simply be generated from the food consumed while energy is expelled as a result of metabolism and physical activity.The balance of energy is expressed by weight increase or loss or weight maintenance.

Nutrient can be defined as substances obtained from food and used in the body to promote growth, maintenance and repair. Nutrient may be essential or non-essential. The difference will be based on the obligatory need by the body.There are six classes of food based on the nutritional value, this include carbohydrate, fat, protein, vitamins, minerals, water. Only carbohydrate, protein and fat are energy yielding nutrient.

The energy yield of a gram of protein is 4 calorie, carbohydrate is 4 calorie and fat is 9 calorie.

Example calculate the energy value in a wrap of fufu, if the wrap contain 352g of carbohydrate, 105g of fat and 42g of protein

Carbohydrate ó 352x4 calories = 1408 calories

Fat ó 105x9 calories =945calories

Protein ó 42x4 calorie s= 168calories

Total =2521 calories or 2.521kc11al

Calculate the percentage of total energy intake for each nutrient.

Carbohydrate-1408/2521x100% = 55.85%

Fat ó945/2521x100% = 37.49

Protein ó168/2521x100% = 6.66%

In the maintenance of weight, energy intake should not exceed energy needs. If you eat more calorie than body uses, it might result to accumulation of fat.

Energy expenditure

The energy expelled is dependent on weight of the person, type of activity which is also dependent on the length of activity, speed of activity and metabolic rate.This energy requirement differ from person to person and are affected by gender, age, height and weight.

1. Basal metabolic rate (BMR) ó it composed of 2/3 of energy expenditure and support basic processes of life. Factors affecting BMR include;

i. Aging reduces BMR

ii. Height ó the taller the person, the higher the BMR

iii. Growth increases the BMR

iv. Body composition ó the fatter the individual, the decrease the BMR

v. Fever and stress can increase the BMR.

vi. Fasting, starvation and malnutrition slows BMR

vii. Premenstrual hormones can increase BMR

viii. Smoking and caffeine increase BMR

2. Physical Activity óIt is the most variable and changeable component of energy expenditure, it is voluntary and significant in weight loss and weight gain.The duration, frequency and intensity influence energy expenditure.

3. Thermic effect of food ó this is estimated to be 10% of total energy intake and involves digestion and absorption. Adaptive thermogenesis is the adjustment in energy related to environmental changes

Measurement of Body Composition

i. Body Mass Index (BMI)

ii. Waist circumference

iii. Fat fold measurement

iv. Hydrodensitometry

v. Bioelectrical impedance

vi. Air displacement plethysmography

vii. Dual energy X-ray absorptiometry (DEXA)

NUTRITIVE VALUE OF FOOD

The origin, chemical composition, functions are important factors to consider while planning a balanced meal because different food has different nutritional profile. The following common food nutritional value shall be consider.

1. Cereals and millets

2. Pulses (legumes)

3. Vegetables

4. Fruits

5. Animal foods

6. Nuts and oil seed

Cereals

This is the main source of carbohydrate and includes rice, wheat, maize etc. Cereals are deficient in certain essential aminoacids.

Rice- this is a staple food among about half of human race. Rice are rich inlysine compare to other cereal proteins and also a good source of vitamin B especially thiamine.Milling process (white or polish rice) is poor in nutritive value (75% thiamin,

15% protein and 60% riboflavin are wasted). People sustaining from this are prone to beriberi

Wheat- the limiting aminoacids in wheat are lysine and threonine.

Maize- fairly rich in fat, yellow variety of maize contain amount of carotenoid pigments. The proteins of maize are deficient in tryptophan and lysine. Some have excess of leucine which interfere with tryptophan to niacin and thus aggravatepellagra.

Pulses

These include peas and beans, red gram, green gram, lentils. Pulses are rich in protein minerals and group B vitamins such as riboflavin and thiamine.Pulses proteins are poor in methionine and cysteine.Germinating pulses contain a lot vitamin B and C. Soya beans are the richest among pulses and exceptionally rich in proteins. The limiting aminoacid is methionine.

Vegetables

These have large water content, low energy and protein content. They have varying amount of dietary fiber. They are classified as protective food.They are divided into 3 groups

 i. **Green leaves** ó This include cabbage, pumpkin leaf, amaranth etc.They are rich in carotenes, calcium, iron vitaminC, riboflavin and folic acid with exception of vitamin B12.Due to its low caloric value and large `bulk; they have important value in dietaries of obese people.

 ii. **Roots and tubers** ó This include potatoes, onions, and carrots.recommended daily intake is 50-60g for adult

iii. **Other vegetables**- tomatoes. Recommended intake is about 60-70gs, cauliflower

Nuts and Oil seed

These include groundnut, cashew nut, coconut, walnut,cotton seed, sesame seed, mustard seed etc. They contain good amount of fat and protein. They are also good source of vit B, calcium, phosphorus and iron.

Fruits

They are good source of vitamins and minerals. Most fruits contain significant amount of ascorbic acid like orange, guava, etc. Pawpaw and mango are excellent in carotene. Most fruits also contain minerals such as sodium, potassium,calcium and iron. Bananas and

mango are good source of energy.Some fruit contain cellulose which assist in bowel movement.

Animal foods

Foods of animal origin may include meat, fish, egg, milk, dairy products.They provide high quality protein and good amount of fat, minerals and vitamin.Vitamin B12 is one of the rare nutrient found only in animal food.Milk and Egg of cow and hen respectively, are most nearly perfect food of nature.

Milk -This is the best and most complete of all foods. It is a good source of all essential nutrients except Vitamin C.Milk contains all essential amino acids.Animal milk has 3 times more protein than human milk. Common proteins in milk are calcium caseinogenate, lactalbumin, lactoglobulin.

However human milk protein contain greater amounts of tryptophan and sulphur containing amino acid e.g.cysteine. Human milk has just fat of about 3.4 % while animal is about 8.8%. Human milk has higher percentage of linoleic acid and oleic acid than animal milk. Milk has lactose or milk sugar found only in milk. This readily fermented by lactic acid bacilli.

Human milk has more sugar than animal milk.Milk is particularly rich in calcium and contain all essential minerals e.g. calcium, phosphorus, sodium, potassium, manganese but poor source of iron.

Skimmed milk ó milk devoid of fats and fat soluble vitamins.

Toned milk- blend of natural milk and man made milk.contain1 part of water, 1 part of natural milk1/8 part of skim milk.

Vegetable milk; milk prepared from vegetable foods like soyabean and groundnut.

Egg- contain all nutrient except carbohydrate and vitamin C.Egg weighing 60g contains 6g protein, 6g fat 30mg calcium, 1.5 mg iron 70kcal energy.Egg protein has high biological value and digestibility.

FOOD TOXICANT AND DETOXIFICATION MECHANISMS

Food is very important in human life and it is required for its survival. Human can consume 30 tons of food all through life.Food consumed contains about 99% nutrient and 1% toxins, contaminants and additives.

Natural toxins can be

1. Endogenous toxins of plant origin

2. Natural contaminants; edible plant with toxins, toxic substance by animal and microbial toxins (bacterial toxin, mycotoxin).

Food contaminants can be described as substances included unintentionally in foods which may be harmless or hazardous to health. The ways by which food can be contaminated with toxins may include

1. Raw material- enviromental pollutants eg pesticides, toxins, chemicals, heavy metals.
2. During processing- filtering and cleaning agent, industrial plants.
3. During packaging and storage steps- platics, coating, toxins, tins etc.

Types of food contaminants/ toxins

1. Heavy metals eg arsenic, Cadmium, copper. Mercury, lead
2. Pesticide residues
3. Packaging materials
4. Nitrate
5. Biotoxin
6. Mycotoxin
7. Dioxin

Heavy Metals

i.   Mercury (Hg)

Mercury can be seen to contaminate agricultural produce such as fish, wheat etc. Some fungicides are mercury based; therefore food products treated with the fungicide will be contaminated.The tolerable weekly intake (TWI) is 300 g.

The primary target of mercury is the central nervous system known as minamata. Symptoms include numbness in the hand and feet, general muscle weakness, narrowing of field vision, damage to hearing and speech, paralysis, coma and death.

Other sources of mercury include volcanoes, gold production, cement production, battery production, and disposal of medical products such as thermometer.

ii.   Lead (Pb)

This is poisonous to animals as it damages the nervous system and causes brain disorders.Due to its resistant to corrosion, it is extensively used in construction industry such as external covering for roof, solder for electronics, PVC, lead paint, lead containing gasoline. TWI is 25 g/kg body wt

Toxicity includes hypertension, anemia, brain damage, kidney damage, miscarriage, reduce fertility of males.

iii. Cadmium (Cd)

Metal widely distributed in environment. Sewage sludge is important source of soil pollution with cadmium which is then use as fertilizer and soil conditioner.Cadmium is also found in battery, fossil fuel, electronic compounds, etc. Cadmium when consumed accumulates in human body especially in the liver and kidney. Toxicity can result to reduced body height, hypertension and multiple fractures. TWI is 0.4 to 0.5 mg in water

Flavonoids

These are plant pigments that are widely present in human food. They are phenolic compounds and present as -glucosides. They are divided into 6 groups; flavanone, flavone, anthocyanidin, isoflavon, chalcone, aurone. Sources of flavonoids are apples, apricots, blueberries, raspberries, strawberries, pears, cabbage, onions, tomatoes, fruit peel-oily orange peel.

Toxicity of flavonoids arecarcinogenics, however high amount of about 140g/day are not toxic. At low concentration, flaonoids are potentially anticarcinogenic because they can block and inhibit the excessive cell division characterized by cancer. They can inhibit enzymes such as protein kinases that are involved in cellular proliferation and tumor progression.

At high concentration of flavonoids they may promote cancer formation because they damage the chromosomes and DNA in cells leaving them more susceptible to cancer promotion.

Tannins

These are phenolic plant secondary compounds and are widely distributed through animal kingdom especially legumes which affect animal performance in many countries.Two subfamily is known based on degradation and botanical distribution

1. Hydrolyzable tannins include tannic acid, gallotannic acid, gallotannin
2. Condensed tannins are well known flavonoids

Sources include tea, fruits, coffee, cocoa. grape, wine.Toxicity can cause acute liver injury such as liver necrosis and fatty liver.Excessive quantities can inhibit the absorption of minerals such as iron and can then lead to anemia because they are metal ion chelators.It has also been shown to precipitate proteins which inhibits in some animals.

Cyanogenic Glycosides

It is a glycosides from cyanide formed by enzymatic hydrolysis.Sources include cassava, beans, sorghum, peas. Lethal intake is 0.5-3.5 mg/kg body weight.

Natural Contaminants

Microbial toxin

The existence of microorganism is related to food environment (water, PH, temperature, oxygen etc.). Microorganisms are degrading food components enzymatically and excrete their metabolites. The resulting is the loss of food structure or formation of off- smell regarded as spoilage. Bacterial toxins are classified as

    i.   Subunit toxins (clostridium botulinum)
    ii.   Membrane affecting toxin (S. aureus)
    iii.   Lesion causing toxins (C. perfringens, B. cereus)
    iv.   Immuno-active endotoxins (Gram negative bacteria toxin)

Clostridium toxins

The types include A, B.C, D, E, F, G. Symptoms include nausea, vomiting, headache, double vision, paralysis, respiratory problems. Mortality ranges from 30-65%.C. botulinum grows at PH >4.6 at 37 C.

Mycotoxin

These are secondary metabolites of fungi (Aspergillus, penicillium and fusarium) which can induce acute and chronic toxic effets such as carcinogenic and mutagenic in animals and humans.They are highly stable and resistant to cooking.Crops commonly affected are cereal, spices, soya beans, Peanut.

Aflatoxin B1 and B2 are produced by Aspergillusflavus and A. parasiticus while G1 and G2 are produced by Aspergillusparasiticus. Aflatoxins are potent toxins and are known for their carcinogens. Aflatoxins grow in high moisture and relatively high temperature.

Aflatoxin has been reported to be embryotoxic and tetratogenic. Early embryos are more susceptible than older embryos. Prevention is adequate post-harvest crop drying.Detoxification of aflatoxin is achieved by treatment with ammonia (NH4OH) at elevated temperature and pressure.

Ochratoxin A is involved in natural outbreaks of swine and cattle abortion. It passes the placenta and then accumulates in the muscle, liver and kidneys.Ochtatoxin can lead to facial clefts, encephaly, cranio- facial malformations.

NUTRITIONAL STATUS AND NUTRITIONAL ASSESSMENT

Nutritional status refers to the degree of balance between nutrient intake and nutrient requirement.Factors that can affect nutritional balance are physiologic, psychical, developmental, cultural and economic. Nutritional status can therefore be optimal, under or over nutrition.

Optimal nutrition ó sufficient nutrient are consumed daily per body needs. The demand may be increased during metabolic demand in growth, illness, pregnancy

Undernutrition- nutrient intake is inadequate to meet daily need and added metabolic demand. The groups at risk include infant, poor, pregnant women aging and sick individuals.

Overnutritionó the nutrient is in excess of the body needs. This may lead to obesity with a lot of complication.

Nutritional Assessment

This is the comprehensive analysis of an individual nutritional status that uses historical information, food intake data, anthropometric measurements, and physical examination and biochemical data.

The aim of nutritional assessment is to;

1. Identify individuals or population at risk of becoming malnourished and those who are malnourished.

2. Develop programs that meet the community needs which are defined by the assessment

3. Also measures the effectiveness of the nutritional programs and intervention once initiated

Methods of nutritional Assessment

These include direct methods and indirect method. Direct methods deal with the individual and measure objective criteria while indirect methods use community health indices that reflect nutritional influences.

The **indirect methods** consist of three categories;

1. Ecological variable including crop production

2. Economic factors such as per capital income, population density and social habits

3. Vital health statistics particularly infant and under 5 mortality and fertility index.

Direct Method of nutritional assessment

1. Clinical assessment

2. Anthropometric methods

3. Biochemical or laboratory method

4. Dietary evaluation method

Clinical Assessment

This is the simplest and most practicable method of knowing the nutritional group of individuals. It utilizes physical signs that are known to be associated with malnutrition and deficiency of vitamins and micronutrient.It involves

i. Good nutritional history

ii. clinical examination with attention to organs like hair, angles of the mouth, gums, nails, skin, eyes, tongue, muscles, bones, thyroid gland.

Advantage of clinical assessment include fast and easy, inexpensive, non-invasive

Disadvantage is that it does not detect early cases.

Anthropometric method

This is the measurement of the body height, weight, and proportions. It is very important in clinical examination of infant, children and pregnant women.It can evaluate both under and over nutrition.The drawback is that measured values reflects the current nutritional status and doesnøt differentiate between acute and chronic changes.

Other anthropometric measurements include mid-arm circumference, skin fold thickness, head circumference, head/chest ratio, hip/waist ratio.In adults, the international standard for assessing body size is Body mass Index (BMI).

BMI is the weight in kilogram divided by height square in meters i.e. Weight (kg)/height (m2)

WHO- Classification for BMI include

<18.5 is under weight

18.5-24.5 is healthy weight range

25-30 is overweight or at risk of obesity

30-40 is obese

>40 is mobidlyobese or very obese

BMI with obesity level is associated with type 2 diabetes and high risk of cardiovascular morbidity and mortality.

Advantages of anthropometry are

i. It has high sspecificity and sensitivity

ii. Measures many variables of nutritional significance eg weight, height, MAC, waist/hip ratio, etc

iii. The readings are reproducible and

iv. The values are numerical and gradable on standard growth charts.

v. They are not expensive and need minimal training.

Limitations include

i. Interobserver error in measurement

ii. Limited nutritional diagnosis

iii. problems with refernce standard i.e local versus international standard

Dietary assessment

This is assessed by 5 parameters

1. 24hrs dietary recall

2. Food frequency questionnaire

3. Dietary history since early life

4. Food diary technique

5. Observed food consumption

Laboratory Assessment

Haemoglobin estimation- it is the most important test and useful index of overall state of nutriton. It tell about anemia, protein and trace element nutrition.

Stool examination for for presence of ova and intestinal parasites.

Urine dip stick and microscopy for albumin, sugar and blood

Measurement of individual nutrient in body fluids e.g serum retinol, serum iron, urinary iodine, vit D

Detection of abnormal amount of metabolites in the urine e.g. Urinary creatinine/hydroxyproline ratio

- Analysis of hair, nails, and skin for micronutrients.

- Advantages is that it is useful in detecting early changes in body metabolism and nutrition before the appearance of overt clinical signs.

- It is precise, accurate and reproducible.

- Useful to validate data obtained from dietary methods e.g comparing salt intake in 24 hours urinary excretion.

- Limitations

- Time consuming

- Expensive

- They can not be applied on large scale

- Needs trained personnel and facilities.