NITROGEN BALANCE

State of protein nutrition can be determined by measuring the dietary intake and output of nitrogenous compounds from the body. Although nucleic acids also contain nitrogen, protein is the major dietary source of nitrogen and measurement of total nitrogen intake, gives a good estimate of protein intake.
State of protein nutrition

- mg of N * 6.25 = mg of protein

N is 16% of most proteins
Output of N from the body

- Urea, undigested (feces), sweat, shed skin

"The difference between intake and output of nitrogenous compounds is known as N balance"
Nitrogen balance studies show that the average daily requirement of protein is 0.6-0.8g of protein /kg body wt or approx 50g/day.
Average intake of protein in developed countries is about 80-100g/day i.e. 14-15% of energy intake.
Growing children have greater requirements than adults as they are increasing the protein in the body, they should be in positive N balance.

PROTEIN QUALITY

"The quality of a protein is a measure of its ability to provide the essential amino acids required for tissue maintenance."

1. **PDCAAS** (Lippincott)
2. **Net protein utilization = $\frac{\text{grams of proteins digested and assimilated}}{\text{grams of protein taken in diet}}$ x 100**
3. **Protein efficiency ratio = $\frac{\text{grams of wt gain}}{\text{grams of protein taken in diet}}$** in a specified time period

ESSENTIAL FATTY ACIDS

LINOLEIC ACID and LINOLENIC ACID

- Fluidity of membrane structure
- Synthesis of eicosanoids
- 5-10% of total calories

Mammals can synthesize unsaturated FA to a limited extent, they can introduce double bonds at Δ4, 5, 6 and 9, not beyond 9 i.e. Ω14, 13, 12 and 9.

In other words we can say that between Δ9 and Ωend they cannot introduce double bond.

So mammals cannot synthesize Ω3 and 6/Δ15 and 12 FA.

Plants can introduce double bonds at Ω3 and 6/Δ15 and 12.

Mammals have Δ4, 5, 6 and 9 desaturase, so they can synthesize Ω9 family of FA; however Ω3 and 6 FA must be supplied in the diet, in order to synthesize other members of Ω3 and 6 families.

n-3 OR Ω3 FATTY ACIDS (Lippincott)

n-6 OR Ω6 FATTY ACIDS (Lippincott)

PLASMA CHOLESTEROL LEVEL AND ITS IMPORTANCE (Lippincott)

TRANS FATTY ACIDS (Lippincott)

PUFA and LIPID PEROXIDATION

Chain reaction providing continuous supply of free radicals that initiate further peroxidation.

Effects

- Rancidity
- Tissue damage
- Inflammatory disease, cancer, atherosclerosis and aging

REQUIREMENTS FOR CARBOHYDRATES (Lippincott)
GLYCEMIC INDEX OF FOOD (Lippincott)
DIETARY FIBER (Lippincott)

ENERGY REQUIREMENT

"Number of calories/kJ that must be consumed per day to support growth and maintenance."

Units of energy

Calories

Joules

1 watt = 1J/sec

UNITS OF ENERGY

KILOCALORIE

"Amount of heat required to raise the temperature of 1 kilogram of water by 1°C."

1 kilocalorie = 1000 calories

KILOJOULE

A kilo joule is the energy required to lift a load of 1 kg by 1 meter."

1kJ = 0.239kcal

1kcal =4.184kJ

The energy content of the food is calculated from the heat released by the total combustion of food in a calorimeter. It is expressed in kcal, or Cal. The energy content of fat is more than twice that of carbohydrate and protein.

CALCULATING ENERGY EXPENDITURE

Respiratory quotient

"The number of CO_2 molecules discharged from the body per number of oxygen molecules consumed."

CO_2/O_2

The biochemical events of CO_2 production and O_2 utilization are a direct result of the oxidation of various fuels such as fat and glucose.

Respiratory gases can be measured and analyzed quite easily. These measurements can be used to calculate the amount of CO_2 produced and O_2 used by the body over any given period. RQ can provide remarkable insight into the overall behavior of energy fuels in the body. RQ is different for different fuels, for example RQ for the complete combustion of glucose is 1.0, and that for complete combustion of fat is 0.7. RQ studies can be performed to determine the type of fuel consumed during rest and exercise and in calculation of energy expenditure.

expired air is found out. Later the remaining gas is made to react with alkaline pyrogallate which absorbs O2. From this the concentration of O2 in the expired air is found out. RQ is calculated by formula:

.

RQ = Vol of CO2 exhaled / Vol of O2 utilized

CLOSED CIRCUIT METHOD

A Spiro meter is filled with O2 for inhalation by the subject. The subject inhales from and then exhales into the same apparatus. The expired gases are made to pass over a concentrated solution of NaOH which absorbs all CO2 present in these gases. As the subject continues breathing from and into the Spiro meter, the amount of O2 in the Spiro meter falls, resulting in a fall in the Spiro meter volume.

The decrease in the volume is automatically recorded on a calibrated paper which is wound on a drum, rotating at a prefixed speed. This fall in the volume gives the volume of O2 consumed. CO2 is liberated from the absorbent by adding H2SO4 to it. These reactions will take place

$NaOH + CO_2 \rightarrow Na_2CO_3$

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

The CO2 released from the absorbent is made to enter the Spiro meter resulting in an increase in the Spiro meter volume. This increase in the volume is automatically recorded on a calibrated paper which is wound on a drum, rotating at a prefixed speed. This increase in the volume gives the volume of CO2 exhaled by the subject. From the volume of O2 consumed and CO2 liberated, RQ can be calculated.

METABOLIC RATE

"It is the output of energy by a person which is expressed as kcals/ m^2 body surface area/ hr"

The body obtains energy by the oxidation of food. The oxidation of food results in production of heat. The energy output or the metabolic rate of an individual may be found out by measuring his heat production over a known period of time. There are 2 methods to determine the metabolic rate of a person.

Determination methods

- Direct calorimetry
- Indirect calorimetry

instructed to do the type of activity for which the metabolic rate has to be measured.
Water is allowed to flow through the chamber at a certain rate and the heat lost by the subject is used to raise the temperature of this water. The temperature of water on entering as well as on leaving the chamber is noted. In this way, the heat given off by the subject during a known period of time can be found out.
The subject also looses heat by evaporation of water from the skin and the respiratory tract. These water vapors are taken up by a chemical absorbent and their mass measured at the end of the experiment.
1 gram of evaporated water represents a loss of 0.5kcal, the total amount of heat lost by this route can be found out from the mass of water vapors given off by the subject. The number of kcal thus obtained is added to the amount of heat calculated from the rise in temperature of the water flowing thru the chamber. The total number of kcal lost/ hr is calculated.
Metabolic rate is determined by the formula.
Metabolic rate = kcal/m^2/hr
If body surface area is known, metabolic rate can be calculated.

INDIRECT CALORIMETRY

Steps:

1. Determination of RQ
2. Rate of O2 utilization
3. Use of table

Kcal of energy liberated/ liter of o2 consumed at specific RQ is determined by use of table

0.75	4.739
0.80	4.801
0.82	4.825
0.85	4.862
0.90	4.924
0.95	4.985
1.00	5.047

ENERGY BALANCE

Energy balance is the difference between energy intake and energy expenditure. Weight gain or loss is a simple but accurate way of indicating differences in energy balance. The use of energy fuels by a human being may be compared to the use of energy fuels by a fire. In both cases, the fuel donates its electrons to oxygen; the fuel is converted to CO2 and O2 to water. Heat is produced in both cases, and the amount of heat produced per gram of fuel oxidized is identical.

CALORIC REQUIREMENT

- AGE
- WEIGHT
- SEX
- PHYSIOLOGICAL FACTORS
- LEVEL OF ACTIVITY

ENERGY EXPENDITURE FOR VARIOUS ACTIVITIES

BASAL METABOLIC RATE

BMR is the rate of use of body's energy stores. It is determined while at rest after an overnight fast.

RESTING METABOLIC RATE

Measured under resting conditions within an hour or a few hours after consuming a meal.

Lying at rest	1.0 times BMR
Very light activity	1.5 times BMR
Light activity	2.5 times BMR
Moderate activity	5.0 times BMR
Heavy activity	7.0 times BMR

ISSUES IN ENERGY NUTRITION

The study of nutrition is highlighted by a number of interesting issues, such as obesity, lactation and diseases of the thyroid. In past BMR has been used in the diagnosis of diseases involving the thyroid gland. Persons with hypothyroidism have BMR ranging from 60-80% of the normal value. Those with hyperthyroidism have BMR 120-150% of normal. Hyperthyroidism results in abnormally high rate of fuel oxidation and heat production. BMR is also used sometimes, to evaluate patient's response to antithyroid drugs or to thyroid hormone replacement therapy.

PREGNANCY

Pregnancy is a period of great psychological stress for the woman as she is nurturing a growing fetus in her body. Fetal development is accompanied by many physiological, biochemical and hormonal changes occurring in the human body which influence the needs for nutrients and the efficiency with which the body uses them. These changes include:

Energy requirement

- Increase by 14% Should consume 300-500kcal/day in addition to basal requirement

Changes in pregnancy

- ↑ BMR
- Gastrointestinal changes
- Hormonal changes
- Changes in the body fluid
- Altered renal function

Diet in pregnancy

Need for calories, proteins, vitamins, minerals and water. Low fat dairy products should be consumed along with lean meats, fish, bread and whole grain cereals. Fruits and vegetables to ensure adequate intake of vitamins and minerals, fats containing mono and polyunsaturated FA should be consumed. Pregnant women are especially prone to

- ALCOHOL/ SMOKING
- OVER GRILLED, CHARRED
- OR BLACKENED FOODS
- PHOSPHORUS FROM SOFT DRINKS

Total weight gain

- 11 kg
- Infant 3.3kg
- maternal fat stores 3.3kg (30,000 kcal of energy)

Food utilized for

- Synthesis of new tissues
- Maternal and fetal
- Energy for increased biosynthetic activity
- Deposition of maternal fat

NEWBORN
0-0.5 yr
115 kcal/kg body weight/day
0.5-1 yr
105 kcal/kg body weight/day

REGULATION OF FOOD INTAKE (Lippincott)

ANTHROPOMETRIC STUDIES

- Height and weight
- Waist hip ratio
- BMI
- Skin fold measurements
- Densitometry
- Ultrasound
- Bioelectrical impedance
- Computed tomography
- Serum albumin level

WHR is used to assess the type of obesity (android or gynoid).
BMI is a measure of the total body fat. **Skin fold thickness** is measured by pinching the skin and using calipers to measure the layers of skin and subcutaneous fat. It is a fairly

Bioelectrical impedance involves connecting electrodes to the hands and feet and passing a mild electrical current through the body. Most organs and tissues conduct the electrical current, as they contain water and salts. However, the adipose tissue contains only about 14% water, by weight, and does not readily conduct electricity. The results give an indication of total body fat.
Computed tomography is used to study subcutaneous and visceral fat.

BODY MASS INDEX
OBESITY (Lippincott)
TYPES OF FAT/OBESITY (Lippincott)

- Anatomically
- Physiologically

BODY WEIGHT REGULATION (Lippincott)
FACTORS CONTRIBUTING TO OBESITY (Lippincott)

NUTRITIONAL DISORDERS

MALNUTRITION SPECTRUM
Protein calorie malnutrition is an all inclusive term which results from protein and/ or calorie deficiency in varying proportions. Whereas one of its manifestations is kwashiorkor, which is due to deficiency of proteins, the other end of the spectrum is represented by the clinical syndrome of marasmus, in which insufficient intake of food (calorie deficiency) is the most dominant feature. In practice, the majority of cases belong to “mixed malnutrition”, in which protein calorie deficiency of varying proportions coexist.

KWASHIORKOR
Deficiency of proteins
2-3 yrs age
“Disease of the deposed baby when the next one is born
MARASMUS
Deficiency of calories
Earlier age

Mild to moderate anemia
Poor appetite
Apathy
Fatty liver
Atrophy of pancreas, salivary gland and intestine

Anemia
Edema
Internal organs are small but do not exhibit morphological changes
Appetite is good