Section

7

Nutrition, Vitamins and Minerals

Chapter

26 Nutrition

COMPETENCY BI 8.2

At the end of this chapter learner should be able to describe the types and causes of protein energy malnutrition and its effects.

COMPETENCY BI 8.3

At the end of this chapter learner should be able to provide dietary advice for optimal health in childhood and adult, in disease conditions like diabetes mellitus, coronary artery disease and in pregnancy.

COMPETENCY BI 8.5

At the end of this chapter learner should be able to summarize the nutritional importance of commonly used items of food including fruits and vegetables (macromolecules and their importance).

Specific Learning Objectives	
BI 8.2.1	Define protein energy malnutrition (PEM).
BI 8.2.2	Discuss various types of PEM.
BI 8.3.1	Discuss dietary advice for optimal health in adults.
BI 8.5.1	Describe the role of macromolecules in diet.
BI 8.5.2	Explain the importance of carbohydrates in diet (starch, sucrose and dietary fibers).
BI 8.5.3	Describe importance of dietary fats.
BI 8.5.4	Discuss benefits of essential fatty acids and atherogenic effect of trans fatty acids.
BI 8.5.5	Elaborate importance of dietary proteins (essential amino acids).

NUTRITION

Macronutrients

Balanced diet: A balanced diet is defined as one which contains a variety of foods in such quantity and proportion that need for energy and all nutrients are adequately met for maintaining health, vitality and general wellbeing.

Major macronutrients providing energy are the following:

- Carbohydrates
- Lipids
- Proteins

65–80% of total energy intake should be provided by carbohydrates, 10–30% by lipids and 7–15% by proteins.

Proximate principle of the food: Carbohydrates, lipids and proteins are called proximate principle of the food items.

Unit of energy: The unit of energy is calorie (cal).

Definition of a calorie: It is defined as the amount of heat required to raise temperature of 1.0 g of water by 1°C (specifically from 15°C to 16°C).

$$1 \text{ kcal} = 4.12 \text{ kJ}$$

Calorific value of various food items: Calorific value is defined as 'amount of heat energy obtained by burning 1.0 g of food stuff completely in the presence of oxygen.

Calorific value of different food stuffs is determined in an apparatus called bomb calorimeter. Calorific value of (Table 26.1):

- Carbohydrate—4 kcal/gram
- Protein—4 kcal/gram
- Lipid—4 kcal/gram
- Alcohol—7 kcal/gram

TABLE 26.1 Calorific value, RQ, SDA of various food items

Nutrient	*RQ*	*Calorific value*	*SDA*
Carbohydrate	1.0	4 kcal/gram	5%
Protein	0.8	4.2 kcal/gram	30%
Lipid	0.7	9 kcal/gram	15%
Mixed diet	0.85	—	10%
Alcohol	—	7 kcal/gram	—

DIETARY REFERENCE INTAKE (DRI)

DRI is a quantitative estimate of the nutrient amount which should be consumed to prevent deficiencies and to maintain the optimum health.

Under DRI, following definitions are to be considered:

1. **Estimated average requirement (EAR):** Amount of nutrient estimated to meet the nutrient requirement of half (50%) of healthy individual in an age and gender group.
2. **Recommended dietary allowance (RDA):** Amount of nutrient estimated to meet the nutrient requirement of 97–98% of healthy individual population.

   Consumption of nutrient in excess and less quantity than RDA is associated with various disease states.

   RDA may be calculated as per following formula:

   $$RDA = [EAR + 2\,SD]$$

3. **Adequate intake (AI):** It is useful, if the experimental data is not available to calculate the EAR or SD, in that case adequate intake is defined. It is defined as the amount of nutrient estimated to meet the requirement of most of the individuals in a population.
4. **Tolerable upper intake level (UL):** It is the highest average intake of a nutrient that poses no risk for adverse health effect for almost all the individuals in a population.

BASAL METABOLIC RATE (BMR)

- It is minimal energy required by the body to sustain life and maintain vital function of the body.
- It is defined as 'energy expenditure by the body when at rest (physical, emotional and digestive) but not asleep, under thermal neutrality (at 25°C), estimated after 12 hours of fasting'.

Determination of BMR

1. Open circuit system, e.g. Tiscot and Douglas method.
2. **Closed circuit method:** BMR measured by Benedict-Roth metabolism apparatus.

Normal Value of BMR

Adult male: 35 kcal/m^2/hour

Adult female: 32 kcal/m^2/hour.

For easier calculation BMR for adult may be taken as 24 kcal/kg/day.

Factors Influencing BMR

1. **Age:** BMR of children is much higher than the adult. Maximum BMR is seen at the age of 5 years.
2. **Sex:** Women normally have lower BMR than men.
3. **Surface area:** BMR is directly proportional to surface area expressed as kcal/m^2/hour.
4. **State of nutrition:** BMR lowered in condition of malnutrition, starvation and wasting diseases.
5. **Exercise:** BMR increases during exercise.
6. **Drugs:** Drugs like caffeine, benzedrine, epinephrine, nicotine, alcohol, etc. increase the BMR.
7. **Hormones:** Thyroid hormones, adrenal medulla and anterior pituitary hormones increase BMR.
8. **Pregnancy:** BMR of pregnant mother after 6 months of gestation rises.
9. **Climate:** In cold climate BMR is increased.

Clinical Aspect (Pathological Variations in BMR)

1. **Fever:** Infections and febrile diseases elevate BMR usually in proportion to increase in temperature.
2. **Diseases:** BMR increased in diseases characterized by increased activity of cells, e.g. leukemia and polycythemia.
3. **Endocrine diseases**
   a. BMR is increased in hyperthyrodism, Cushing's disease, Cushing's syndrome also in acromegaly.
   b. BMR is reduced in hypothyroidism and Addison disease.

RESPIRATORY QUOTIENT (RQ)

RQ is 'ratio of volume of CO_2 produced by a volume of O_2 consumed during a given time by utilizing one gram of proximate principle' (Table 26.1).

RQ = volume of CO_2 produced/volume of O_2 consumed

a. RQ of the carbohydrate is 1.
b. RQ of the protein is 0.84.
c. RQ of the fat is 0.71.
d. RQ of mixed diet is about 0.85.

Clinical Aspects

1. **In acidosis:** During acidosis, CO_2 output is greater than O_2 consumption, hence RQ increased.
2. **In alkalosis:** RQ will fall, because respiration is depressed and CO_2 is retained in body and less CO_2 is produced.
3. **Febrile conditions:** Increase RQ.
4. **In diabetes mellitus:** RQ will fall initially because energy is supplied by oxidation of fats.

SPECIFIC DYNAMIC ACTION (SDA)/DIET INDUCED THERMOGENESIS

- This is the energy utilized in the processing of food like digestion, absorption, active transport, etc.
- This energy is utilized from previously available energy, so actual energy produced from the food is lesser than that of calculated value.
- SDA can be considered as activation energy needed for a chemical reaction.
- Proteins have greatest SDA, amounting to about 30% above its caloric value. Carbohydrate and lipid have SDA of 5% and 15% respectively (Table 26.1).
- For mixed diet, SDA may be calculated as 10%.

How to Calculate the Energy Requirement of a Normal Person

Factors taken into consideration for calculation of energy required by a normal person is the following:

a. Energy required for BMR
b. Physical activity based energy requirement
c. SDA of the food
d. Only additional requirement in pregnancy and lactation.

a. Energy required for BMR

For an adult, BMR is 24 kcal/kg body weight/day. So, according to the body weight, the energy required for BMR is to be calculated.

b. Physical activity based energy requirement:

Physical work may be sedentary, moderate or heavy. Energy requirement varies according to physical activity done by a person (as per his job requirement).

Sedentary worker require least energy (30% of BMR) to perform work. Moderate worker will require energy which is 40% of BMR but the heavy worker will need energy which is 50% of BMR.

c. SDA of mixed diet should be 10% of (a + b).

d. During pregnancy additional 300 kcal/day and during lactation additional 500 kcal/day energy has to be added in above calculation.

Calculate the energy required per day for a healthy adult of 60 kg doing moderate work.

Per day energy calculation for a 60-year-old male doing moderate work is shown in Fig. 26.1.

	Energy Required		
For BMR	24 × 60	=	1440 kcal
Moderate activity	40% of BMR	=	$\frac{40}{100}$ × 1440
		=	576 kcal
Subtotal (1)		=	**2,016 kcal**
Now,			
SDA @ 10% for mixed diet (2)		=	$\frac{10}{100}$ × 2,016
		=	**201.6 kcal**
Total (1) + (2)	= 2,016 + 201.6		
	= 2,217.6		
Round off (nearest of 50)	= 2,250 kcal		

Fig. 26.1: Energy calculation per day for a 60-year-old male doing moderate work

GLYCEMIC INDEX

It is defined to describe the effect of carbohydrate on blood glucose level. It is defined as effect of 50 grams of carbohydrate in a particular food on blood glucose level compared to 50 grams of glucose.

In other words,

It is a ratio of incremental area under glucose tolerance curve after 50 g of test meal to that of incremental area under glucose tolerance curve after 50 g of reference meal (glucose).

Simple carbohydrates like glucose have high glycemic index compared to complex carbohydrates such as starch (Table 26.2 and Fig. 26.2).

TABLE 26.2 Glycemic index of various food items

• Potato chips	80–90
• Bread	70–79
• White rice (polished)	70–79
• Parboiled (brown) rice	60–69
• Banana	60–69
• Beans, peas	40–49
• Legumes, peanuts	35–40
• Milk	35–40
• Ice cream	35–40

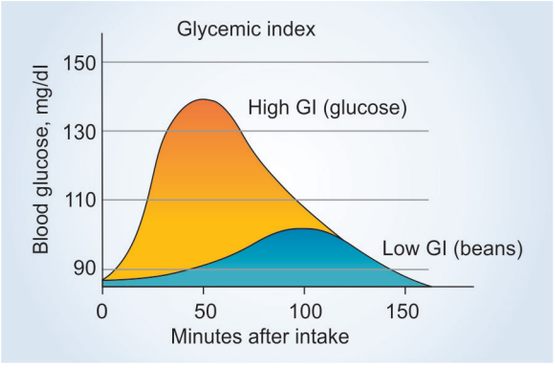

Fig. 26.2: Glycemic index

DIETARY FIBER

They are those components of the food that can not be broken down by human digestive enzymes. It is incorrect however to assume that fiber is indigestible since some fibers are, in fact, at least partially broken down by intestinal bacteria (Fig. 26.3).

Dietary fibers are undigestible and unavailable carbohydrates.

Fig. 26.3: Food rich in dietary fiber

Insoluble fiber increases stool bulk, improves gut motility and decreases transit time.

Daily requirement of dietary fiber for an healthy adult:

Male: 38 g/day

Female : 25 g/day

Examples of dietary fibers are:

1. Cellulose
2. Hemicellulose
3. Lignin
4. Pectins
5. Gums

Nutritional Indices of Protein

1. **Biological value (BV) of protein:** Ratio of nitrogen retained and nitrogen absorbed during a specific interval.

   BV = Nitrogen retained/Nitrogen absorbed × 100
2. **Net protein utilization (NPU):** Ratio of nitrogen retained to that of the nitrogen intake multiplied by 100.

   NPU = Nitrogen retained/Nitrogen intake × 100

Limiting amino acid: Amino acid deficient in a protein is known as limiting amino acid.

Methionine is the limiting amino acid in the pulses. Lysine is limiting amino acid in the cereals.

Nitrogen balance: When dietary nitrogen intake (calculated as 16% of protein intake) is equal to daily loss through urine, faeces, and sweat, it is called state of nitrogen balance.

When intake is excess of loss, it is said to be positive nitrogen balance.

When loss is excess of intake, it is said to be negative nitrogen balance.

Factors which lead to positive nitrogen balance (Fig. 25.4)

a. Period of growth
b. Pregnancy

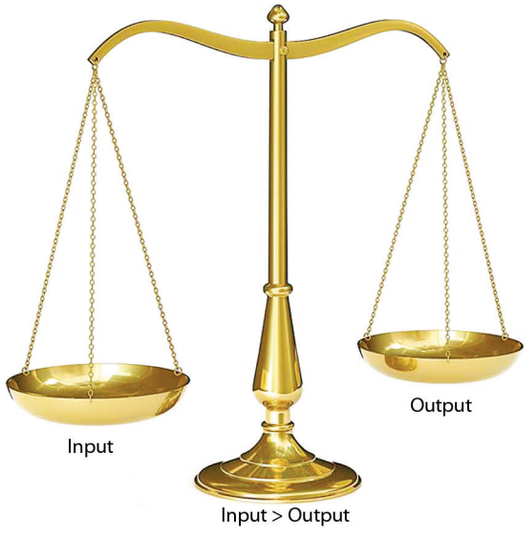

Fig. 26.4: State of positive N_2 balance

c. Lactation
d. Convalescence
e. Hormones like insulin, growth hormone, androgens.

Factors which lead to negative nitrogen balance (Fig. 25.5)

a. *Acute illness:* Surgery, trauma, burns
b. *Chronic illness:* Malignancy, uncontrolled diabetes mellitus
c. Protein deficiency in malnutrition
d. Starvation

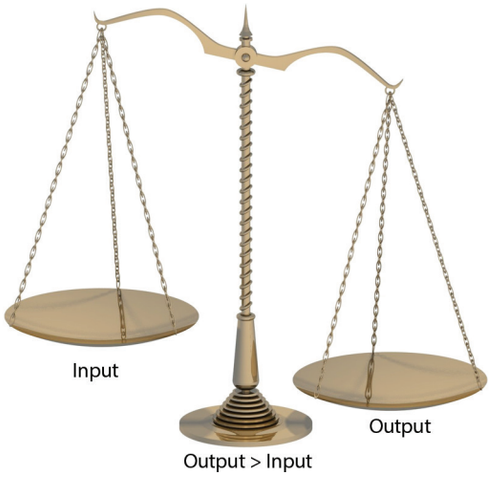

Fig. 26.5: State of negative N_2 balance

PROTEIN ENERGY MALNUTRITION (PEM)

Marasmus

Due to continuous deficiency of both dietary energy and protein (Fig. 26.6)

- No oedema
- Thin skin
- Frequent diarrhoea
- Weight loss of the baby
- Face shrunken
- Good appetite

Fig. 26.6: Marasmus child

Kwashiorkor

- Due to isolated deficiency of protein alone along with adequate supply of calorie.
- Oedema is a characteristic sign (Fig. 26.7).
- Hypoalbuminemia
- Puffy face

Fig. 26.7: Kwashiorkor (protuberant abdomen and puffy face to note)

- Abdomen protuberant
- Poor appetite

Biochemically such patients show altered value of serum protein, deficiency of mineral, vitamin, electrolyte imbalance due to associated infection and diarrhoea.

Fig. 26.8 shows the comparison of kwashiorkor and marasmus patients.

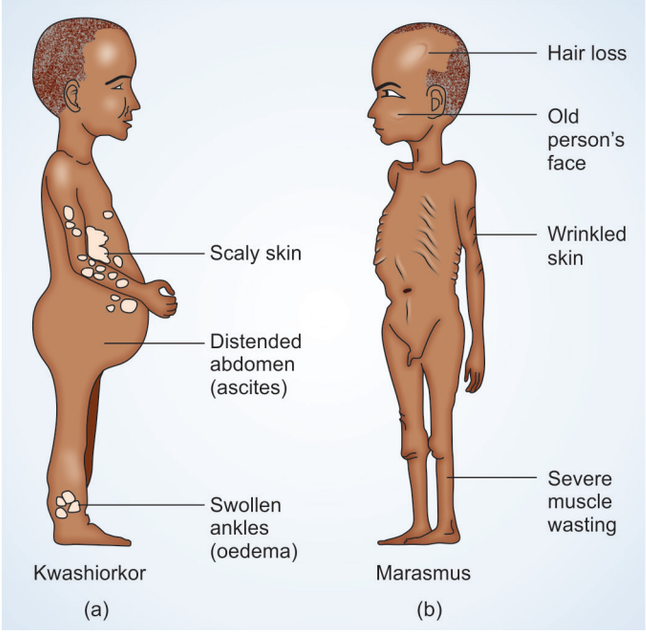

Fig. 26.8: Comparison of kwashiorkor and marasmus