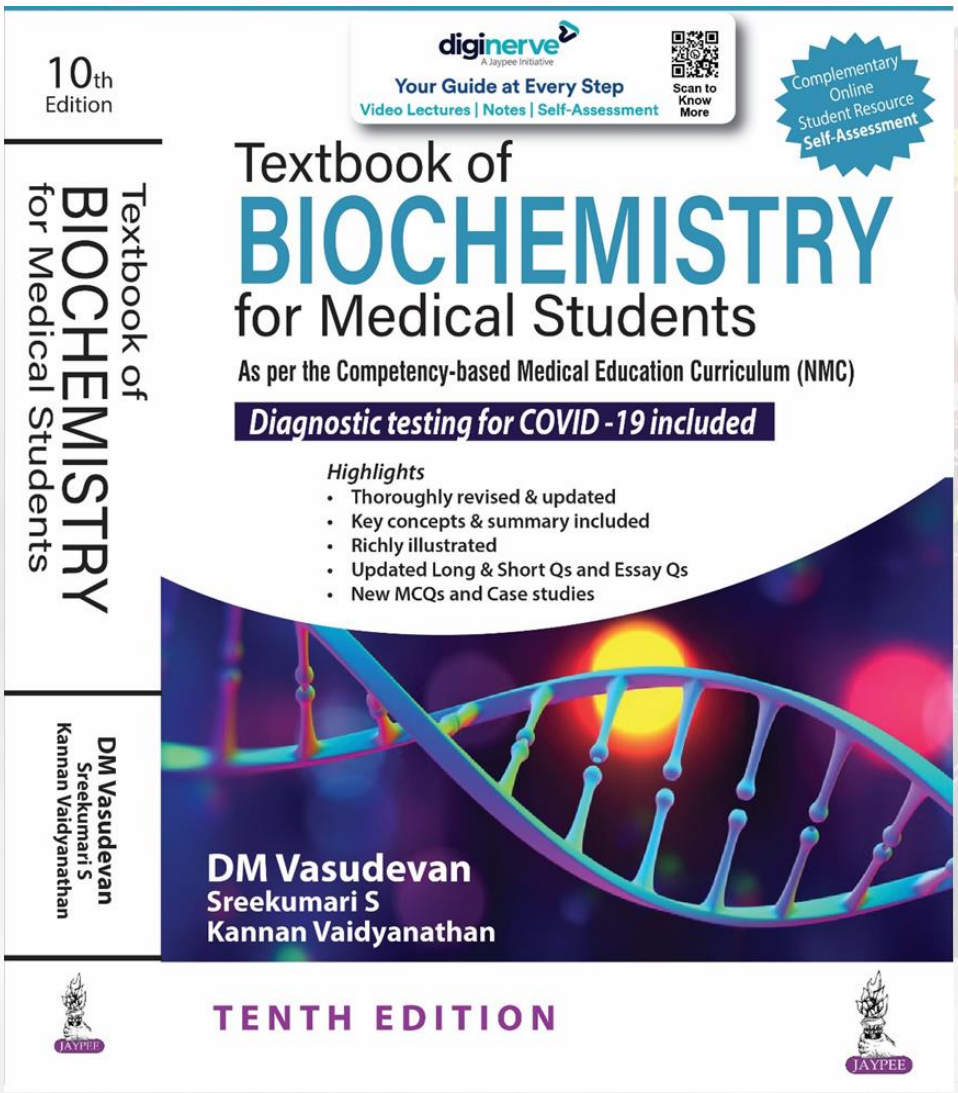
Chapter 31:

Nutrition



Textbook of

BIOCHEMISTRY

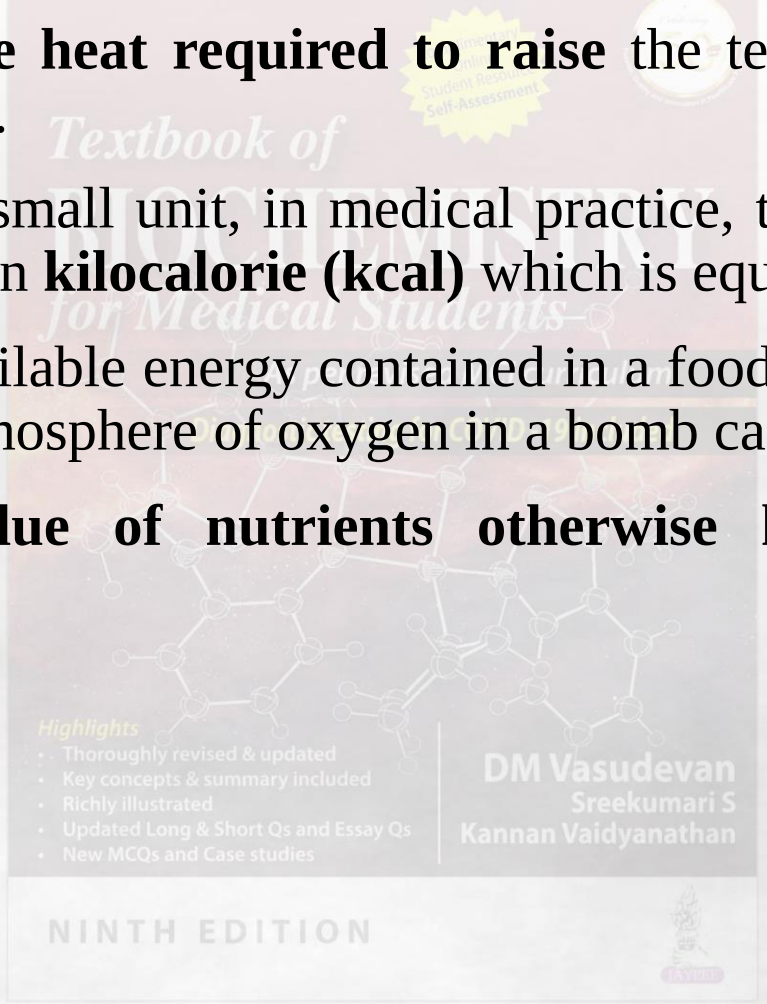
for Medical Students

By DM Vasudevan, *et al.*

TENTH EDITION

Calorific Value

- The energy content of food materials is measured in calories.
- **One calorie is the heat required to raise** the temperature of 1 g of water through 1oC.
- Since it is a very small unit, in medical practice, the energy content is usually expressed in **kilocalorie (kcal)** which is equal to 1000 calories.
- The maximum available energy contained in a food can be measured by burning it in an atmosphere of oxygen in a bomb calorimeter.
- The **calorific value of nutrients otherwise known** as "**energy density".**

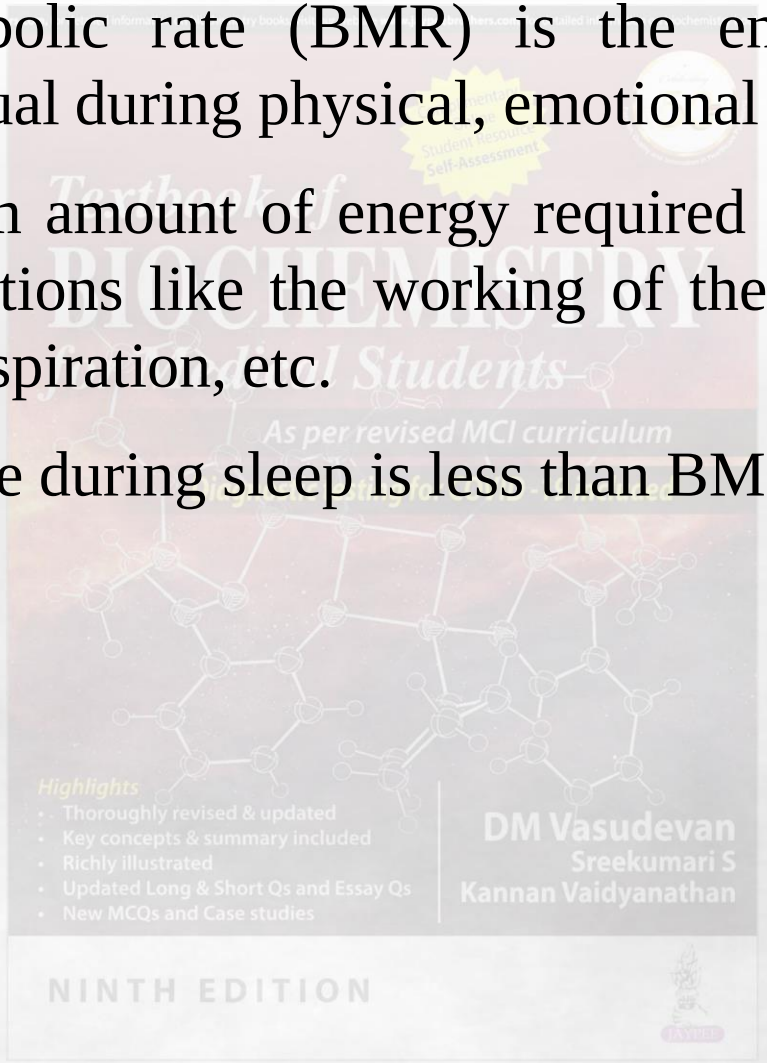


Respiratory Quotient (RQ)

- Respiratory quotient is defined as the ratio of volume of CO2 produced in L/g to the oxygen consumed in L/g.
- **RQ of carbohydrates is 1; RQ of fats is 0.7;** that of proteins is 0.8.
- **For a mixed diet it is between 0.7 and 1, often** around 0.82-0.85.
- When the rate of utilization of fat increases in relation to carbohydrates, RQ falls.
- This happens in diabetes mellitus, when utilization of carbohydrate is reduced.
- The RQ is lowest when ketolysis is very active.

Basal Metabolic Rate

- The basal metabolic rate (BMR) is the energy required by an awake individual during physical, emotional and digestive rest.
- It is the minimum amount of energy required to maintain life or sustain vital functions like the working of the heart, circulation, brain function, respiration, etc.
- The metabolic rate during sleep is less than BMR.

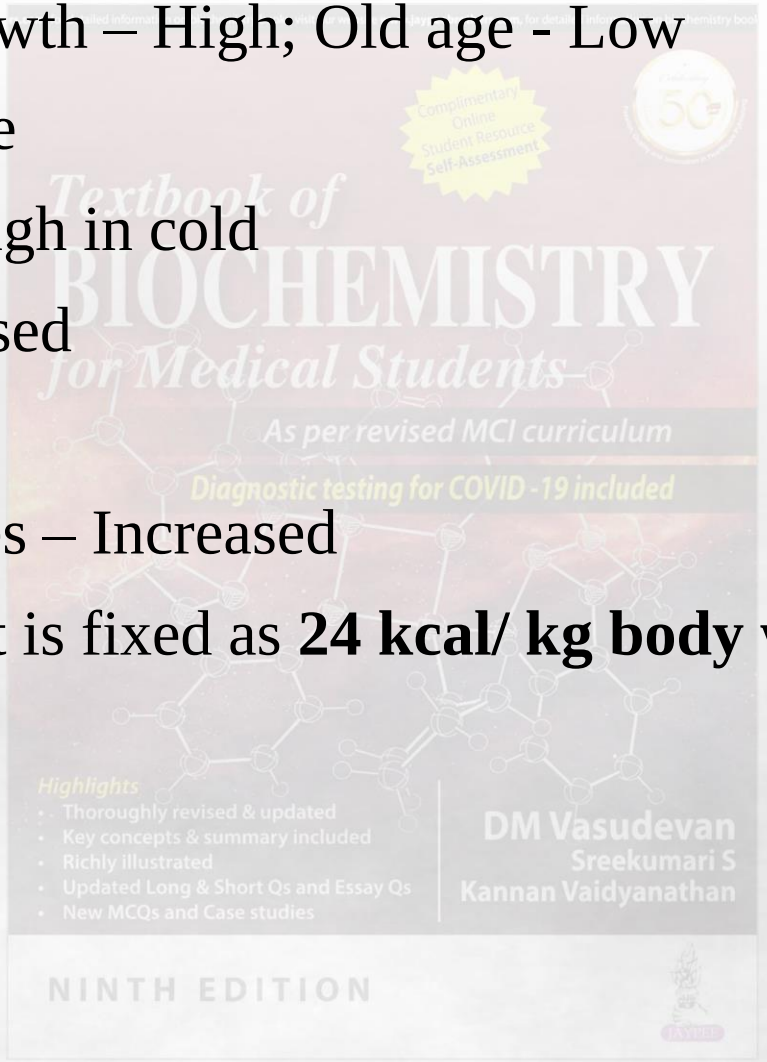


Basal Metabolic Rate values

Age group	BMR value
Male, 19-30 yr	2100
Male, 31-60 yr	2100
Male, > 60 yr	1700
Female,19-30 yr	1700
Female,31-60 yr	1700
Female,>60 yr	1500

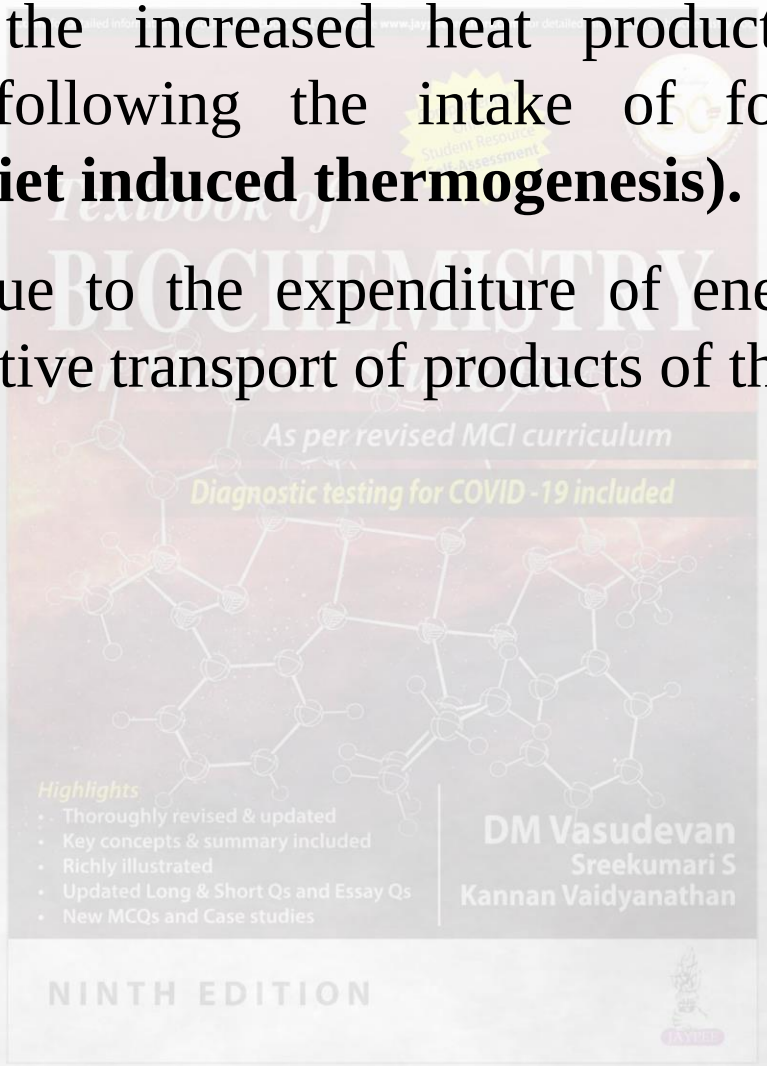
Factors Affecting BMR

- Age – Active growth – High; Old age - Low
- Sex – Males more
- Temperature – High in cold
- Exercise - Increased
- Fever - Increased
- Thyroid hormones – Increased
- BMR for an adult is fixed as **24 kcal/ kg body weight/day.**



Specific Dynamic Action (SDA)

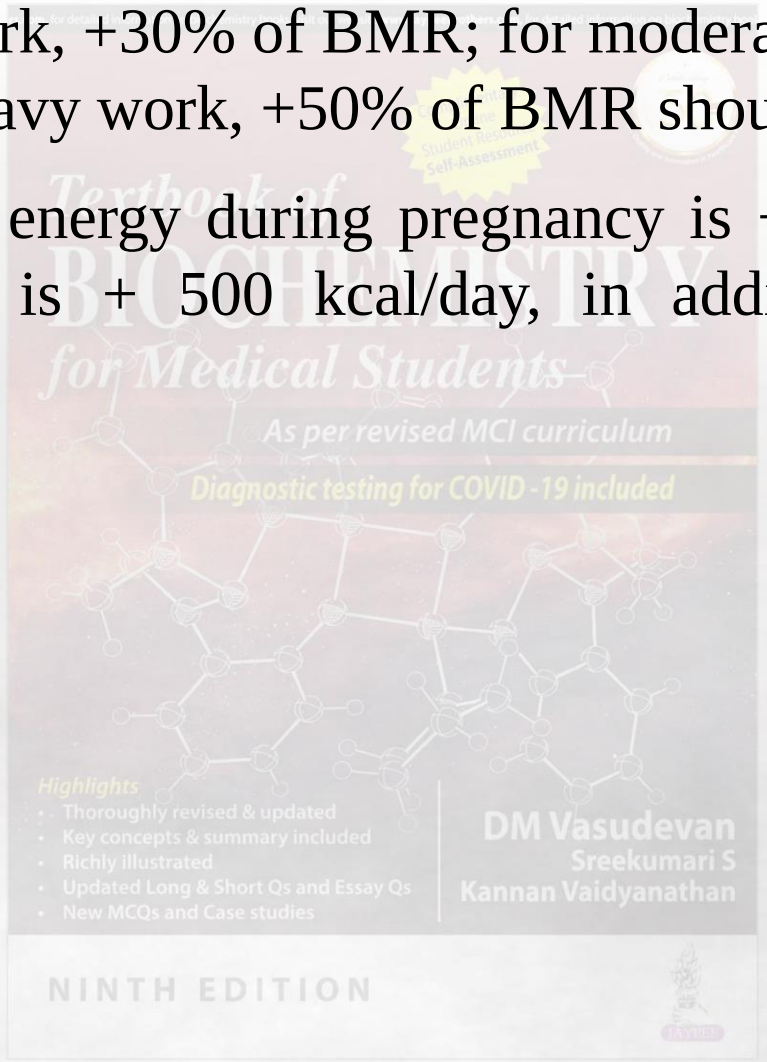
- This refers to the increased heat production or increased metabolic rate following the intake of food (**thermogenic effect of food) (diet induced thermogenesis).**
- Part of this is due to the expenditure of energy for digestion; absorption and active transport of products of the digestion.



Activity	Energy (above SDA)
Eating	28
Writing	30
Driving a car	63
Type writing (Fast)	100
Walking	140
Cycling (2 km / hr)	175
Running	490
Swimming (3.5 km / hr)	550

Physical Activity

- For sedentary work, +30% of BMR; for moderate work, +40% of BMR; and for heavy work, +50% of BMR should be added.
- Requirement for energy during pregnancy is +300 kcal/day, and during lactation is + 500 kcal/day, in addition to the basic requirements.

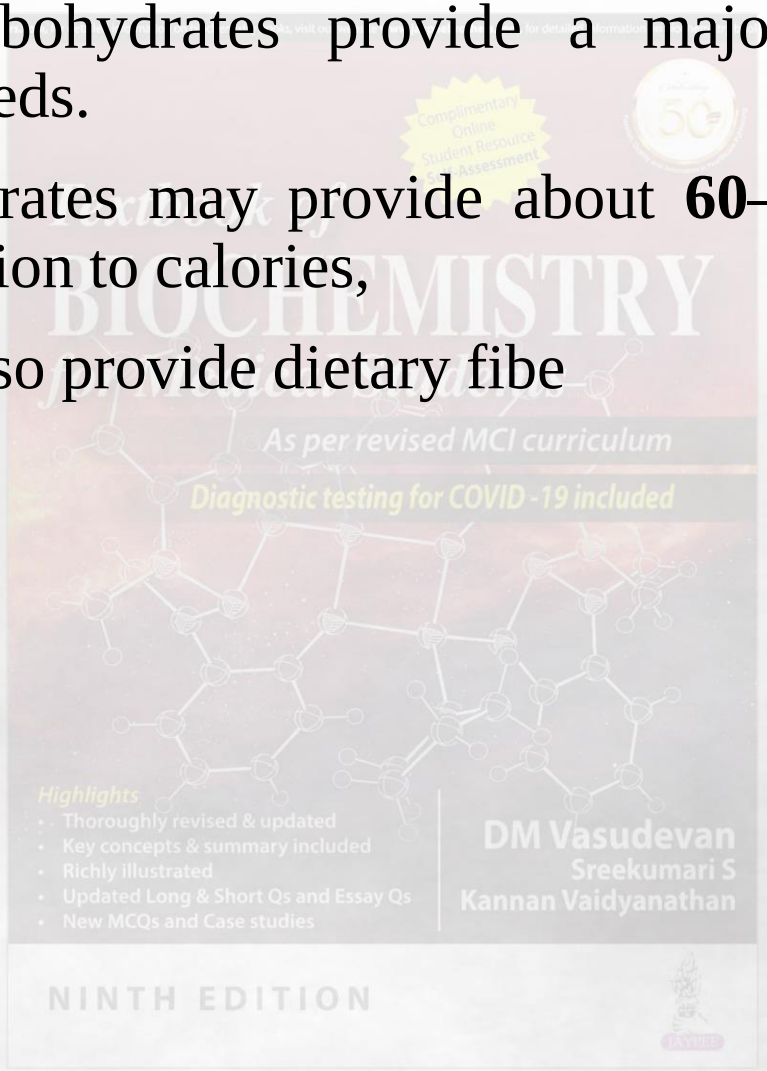


Calculation for Energy Requirement

For a 55 kg person, doing moderate work		
For BMR	= 24 × 55 kg	= 1320 kcal
+ For activity	= 40% of BMR	= 528 kcal
Subtotal	= 1320 + 528	= 1848 kcal
+ Need for SDA	= 1848 × 10%	= 184 kcal
Total	= 1848 + 184	= 2032 kcal
Rounded to nearest multiple of 50		= 2050 kcal

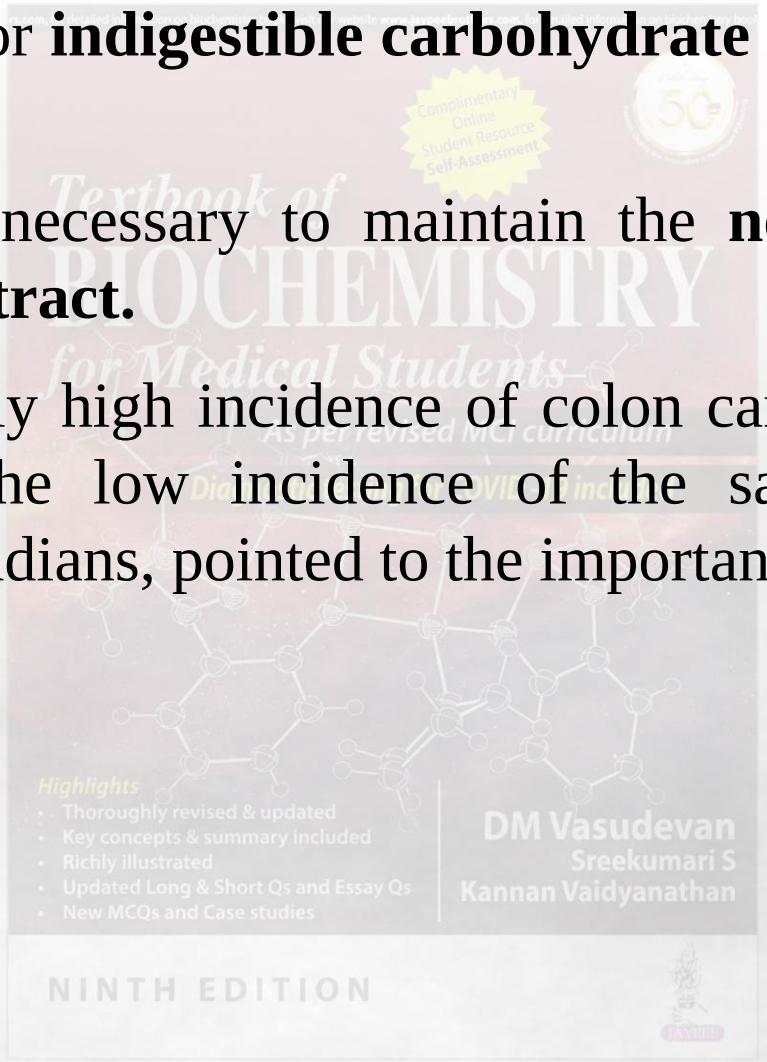
Importance of Carbohydrates

- The dietary carbohydrates provide a major fraction of the body's energy needs.
- Ideally carbohydrates may provide about **60–65% of the total calories**. In addition to calories,
- Carbohydrates also provide dietary fibe



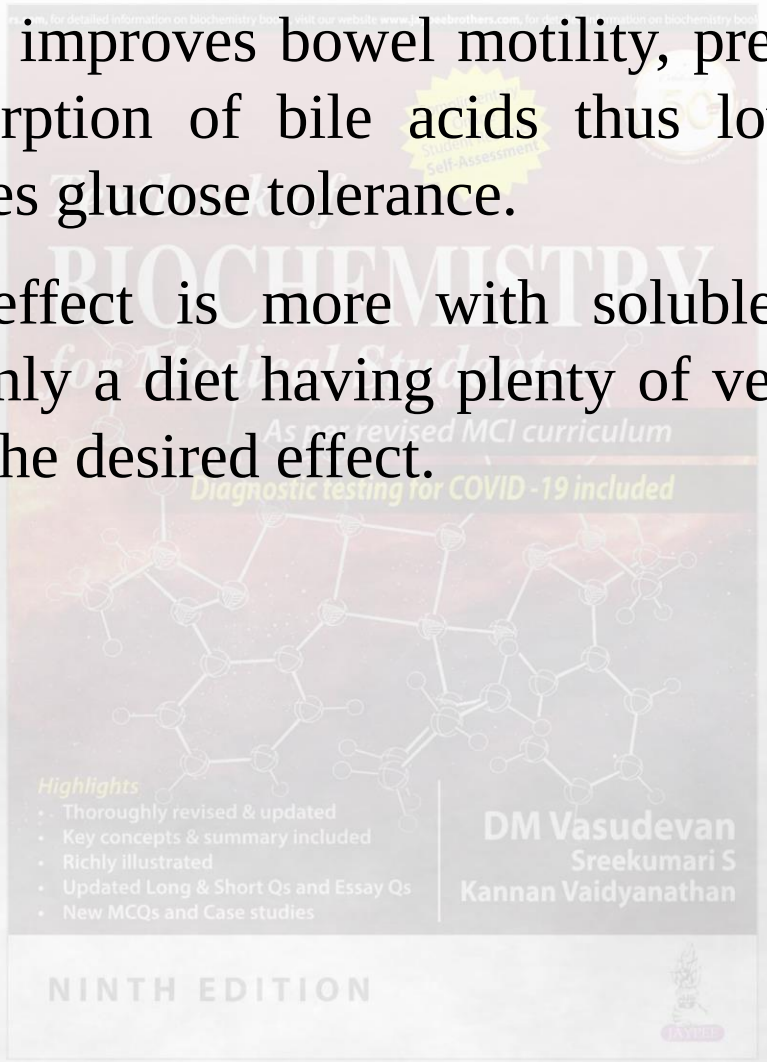
Dietary Fiber

- The unavailable or **indigestible carbohydrate** in the diet is called dietary fiber.
- Dietary fiber is necessary to maintain the **normal motility of gastrointestinal tract.**
- The comparatively high incidence of colon cancers in developed countries, and the low incidence of the same in vegetarian population like Indians, pointed to the importance of dietary fiber.



Fiber	Chemical Nature	Physiological effect
Cellulose	Glucose polymer	Retains water in feces, promotes peristalsis, increases bowel motion
Hemi-cellulose	Pentoses, hexoses	Retains water in feces, increases bile acid and uronic acid exretion
Lignin	Aromatic alcohols	Antioxidant, anti cholesterologenic
Pectins	Carbohydrate derivative	Absorbs water, slows gastric emptying, binds bile acid and excretes

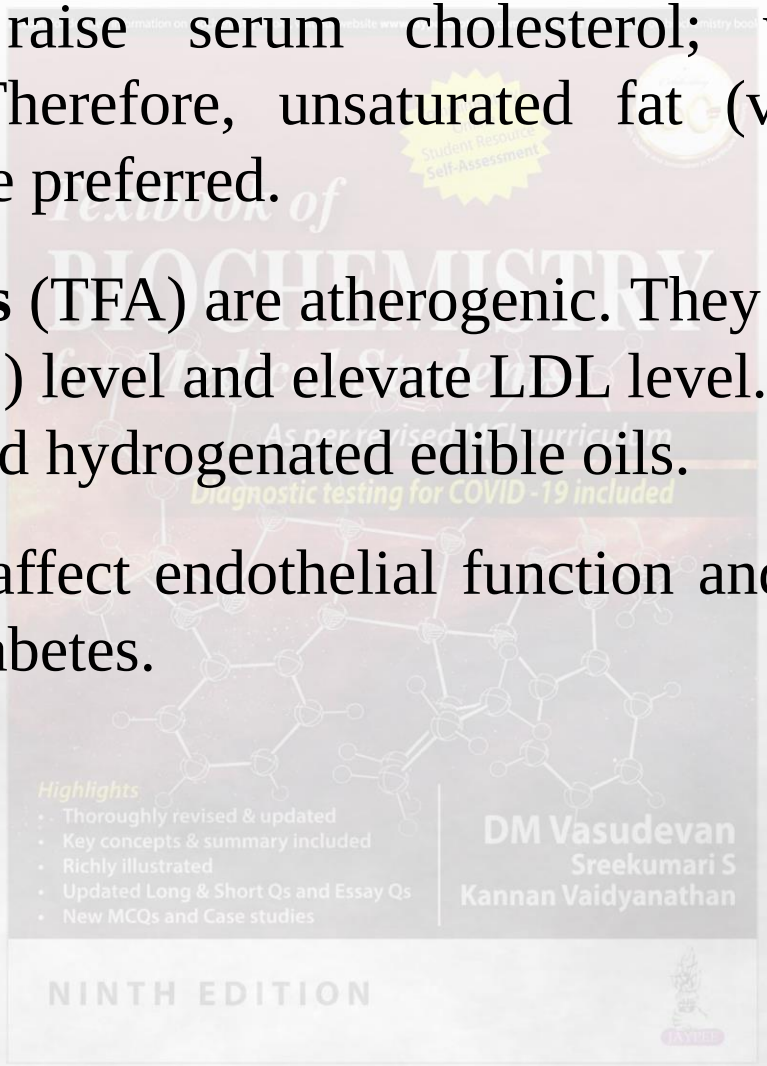
- Diet rich in fiber improves bowel motility, prevents constipation, decreases reabsorption of bile acids thus lowering cholesterol level and improves glucose tolerance.
- The beneficial effect is more with soluble fiber present in vegetables and only a diet having plenty of vegetables and green leaves will have the desired effect.



Nutritional Importance of Lipids

- Fats provide a concentrated source of energy.
- A minimum intake of lipids is essential since the requirements of fat soluble vitamins and essential fatty acids are to be met.
- **Visible fat** or fat consumed as such are butter, gheeand oils. Recommended daily intake of visible fat is 10% of calories or 20 g/day; in pregnancy 30 g/day and during lactation 45 g/day.
- **Invisible fat** or fat present as part of other food items are egg, fish, meat, cereals, nuts, and oilseeds. Even cereals contain 1 g of fat per 100 g.

- Saturated fats raise serum cholesterol; while unsaturated fats lower it. Therefore, unsaturated fat (vegetable oils and fish oils) are to be preferred.
- **Trans fatty acids** (TFA) are atherogenic. They lower high-density lipoprotein (HDL) level and elevate LDL level. TFA are present in dairy products and hydrogenated edible oils.
- TFAs adversely affect endothelial function and aggravate insulin resistance and diabetes.

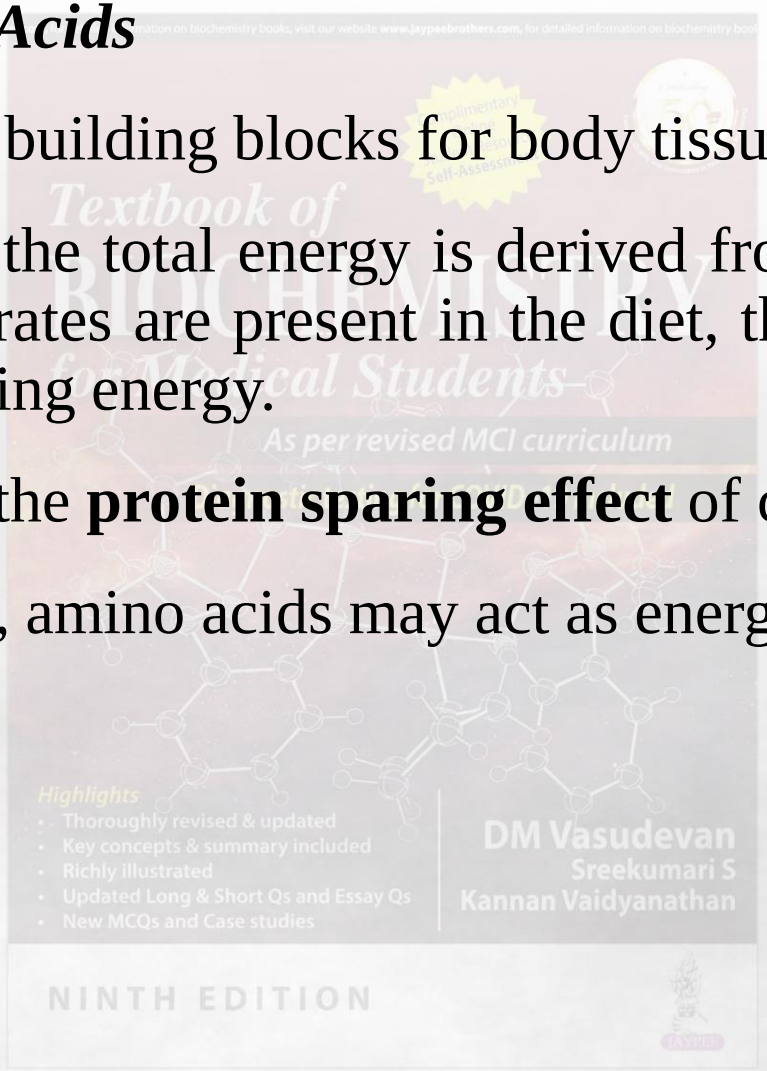


Recommended Daily Intake of Fat

- The ideal fat intake is about 15–20% of total calories, out of which about 25–30% may be PUFA. This will be a total of about 20–25 g of oils and about 3 g of PUFA for a normal person.
- **Excess of PUFA** may lead to production of free radicals, which is injurious to the cell. PUFA should not be more than 30% of total fat.
- Moreover, the fat content should be such that saturated fatty acid (SFA): monounsaturated fatty acid (MUFA): PUFA may be in 1:1:1 ratio. Further, cholesterol intake should be <250 mg/day.

Importance of Proteins

- ***Essential Amino Acids***
- Proteins form the building blocks for body tissues.
- Only 10–15% of the total energy is derived from proteins. When enough carbohydrates are present in the diet, the amino acids are not used for yielding energy.
- This is known as the **protein sparing effect** of carbohydrates.
- During starvation, amino acids may act as energy sources.

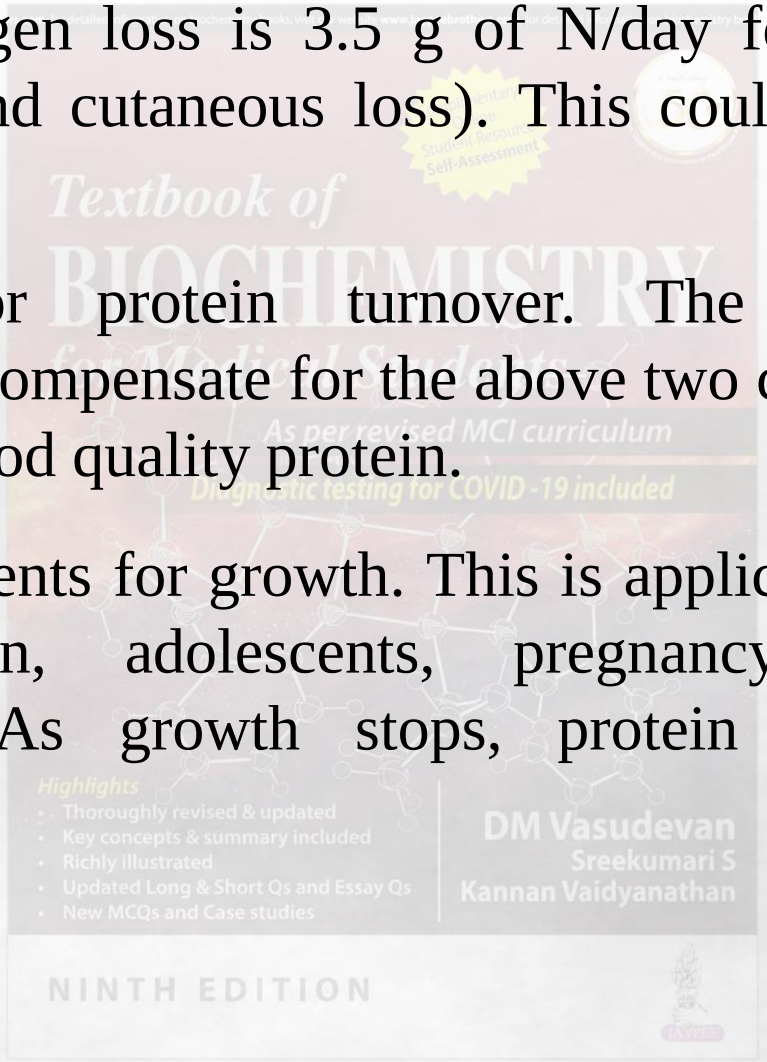


Recommended Protein Allowances

Infants	2.4 gm/ kg body weight / day
Children upto 10 years	1.75 gm/ kg body weight / day
Adolescent boys	1.6 gm/ kg body weight / day
Adolescent girls	1.4 gm/ kg body weight / day
Adults	0.8 gm/ kg body weight / day
Pregnancy	2.0 gm/ kg body weight / day
Lactation	2.5 gm/ kg body weight / day

Maintenance of Nitrogen Balance

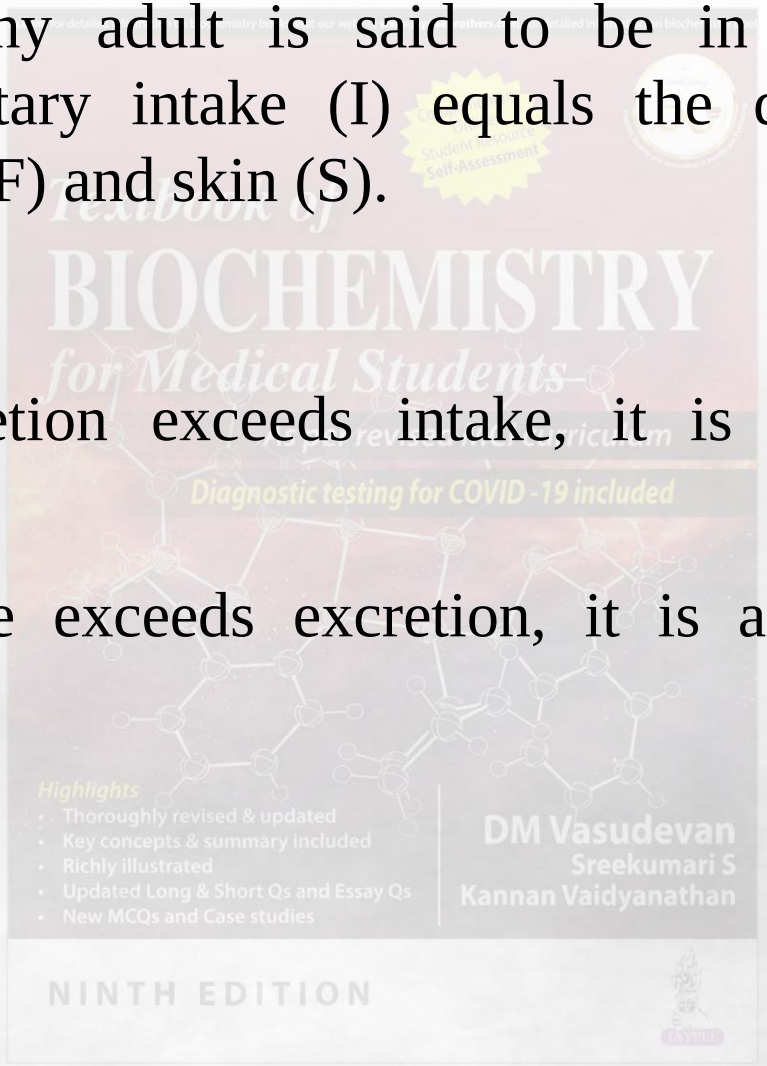
- Obligatory nitrogen loss is 3.5 g of N/day for a 65 kg person (urinary, fecal and cutaneous loss). This could be equivalent to 22 g of protein.
- Requirement for protein turnover. The minimum daily requirements to compensate for the above two categories are 0.75-0.8 g/kg wt of good quality protein.
- Protein requirements for growth. This is applicable in the case of infants, children, adolescents, pregnancy, lactation and convalescence. As growth stops, protein requirement also decreases.

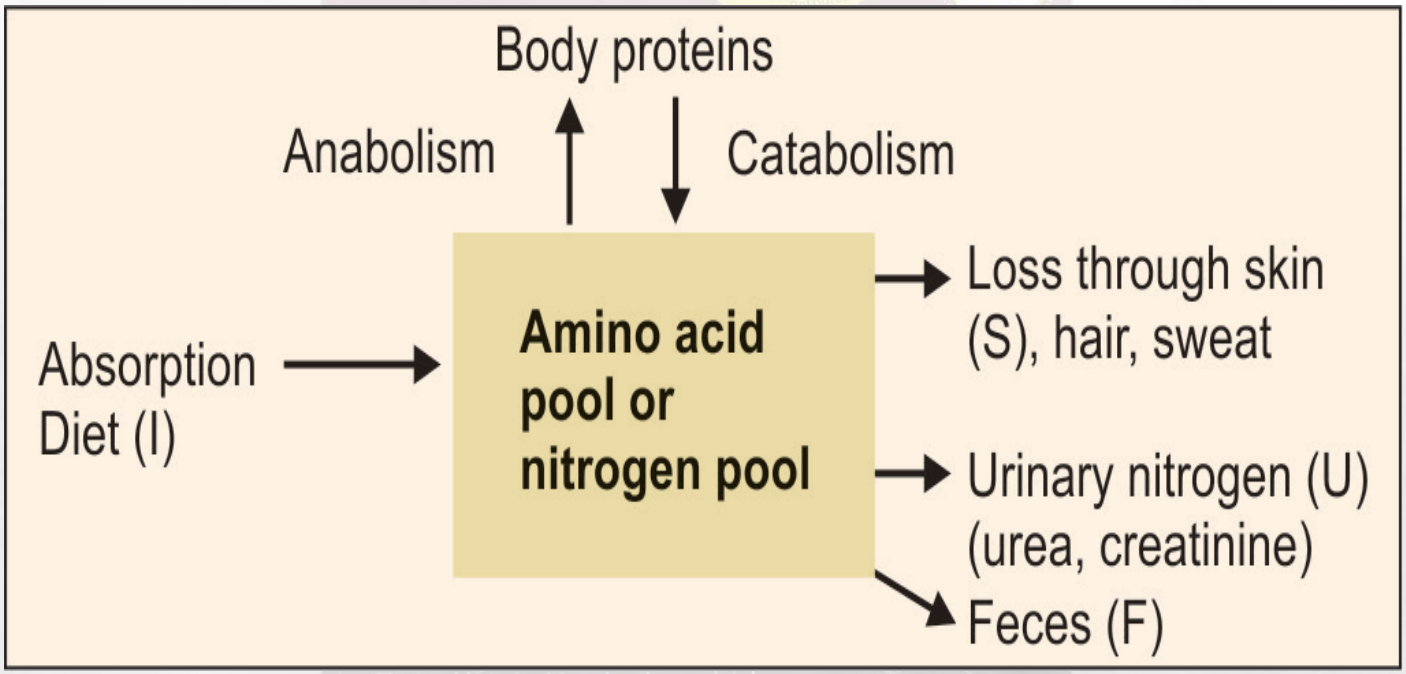


- As per the WHO/FAO recommendation, the safe levels of protein intake for an adult is 0.75–0.8 g/kg/day.
- For the synthesis of body proteins, all the essential amino acids should be supplied in adequate quantities at the same time.
- The non-essential amino acids can be synthesized, provided there is enough supply of proteins in total.
- Only 3 amino acids (alanine, aspartate and glutamate) are truly dispensable, as they can be synthesized from pyruvate, oxaloacetate and alpha-ketoglutarate respectively; and these precursors are generally available in plenty.

Nitrogen Balance

- A normal healthy adult is said to be in nitrogen balance, because the dietary intake (I) equals the daily loss through urine (U), feces (F) and skin (S).
- I = U + F + S
- When the excretion exceeds intake, it is **negative** nitrogen balance.
- When the intake exceeds excretion, it is a state of **positive** nitrogen balance.




Body proteins
Anabolism
Catabolism
Absorption
Diet (I)
Amino acid pool or nitrogen pool
Loss through skin (S), hair, sweat
Urinary nitrogen (U) (urea, creatinine)
Feces (F)

- **Factors Affecting Nitrogen Balance**

i. **Growth:** During the period of active growth, a state of positive nitrogen balance exists. On an average when a person gains 5 kg, about 1 kg proteins are added to the body. For this, about 160 g of nitrogen has to be retained, so he/she has to be in positive nitrogen balance.

ii. **Hormones:** Growth hormone, insulin and androgens promote positive nitrogen balance, while corticosteroids cause a negative nitrogen balance.

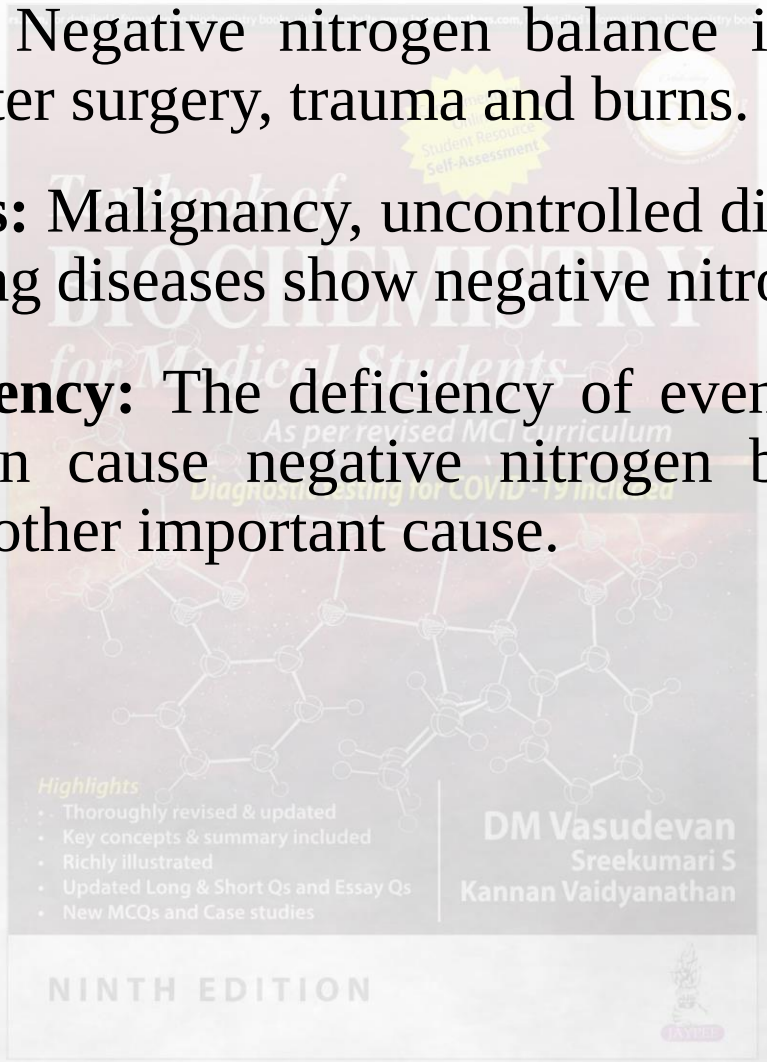
iii. **Pregnancy:** A pregnant woman will be in a state of positive nitrogen balance due to the growth of fetus.

iv. **Convalescence:** A person convalescing after an illness or surgery will be in positive nitrogen balance, due to active regeneration of tissues.

v. **Acute illness:** Negative nitrogen balance is seen in subjects immediately after surgery, trauma and burns.

vi. **Chronic illness:** Malignancy, uncontrolled diabetes mellitus and other debilitating diseases show negative nitrogen balance.

vii. **Protein deficiency:** The deficiency of even a single essential amino acid can cause negative nitrogen balance. Prolonged starvation is another important cause.



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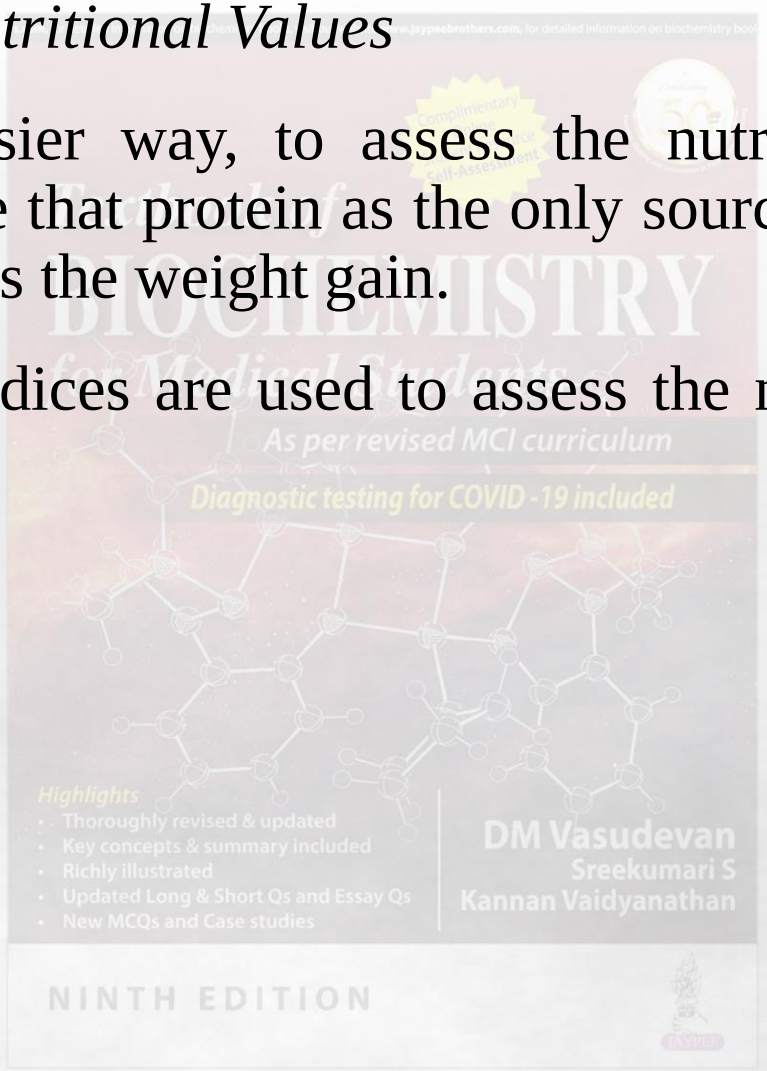
Nutritional Values (Nutritional Indices)

- *Assessment of Nutritional Values*
- The modern, easier way, to assess the nutritional value of a protein, is to give that protein as the only source of nitrogen to an animal, and assess the weight gain.
- The following indices are used to assess the nutritional value of proteins.



- *Biological Value (BV) of Protein*
- It is the ratio between the amount of nitrogen retained and nitrogen absorbed during a specific interval.

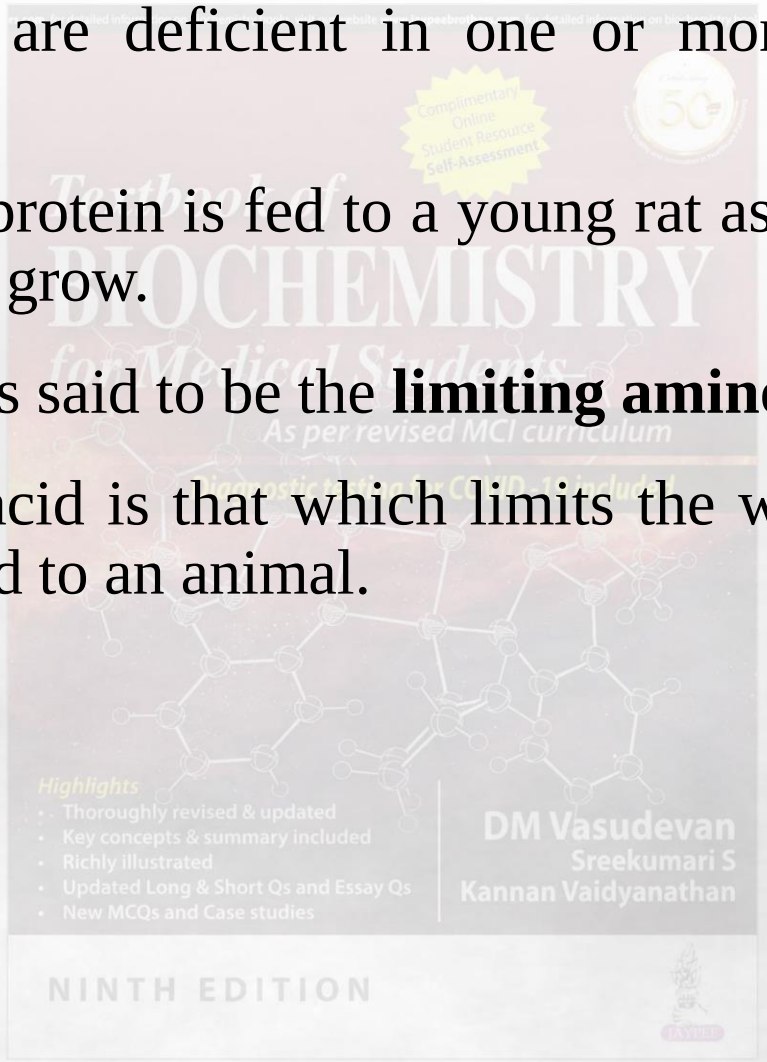
$$BV = \frac{\text{Retained nitrogen}}{\text{Absorbed nitrogen}} \times 100$$

- *Net Protein Utilization (NPU)*

$$NPU = \text{Retained nitrogen/intake of nitrogen} \times 100$$

Limiting Amino Acids

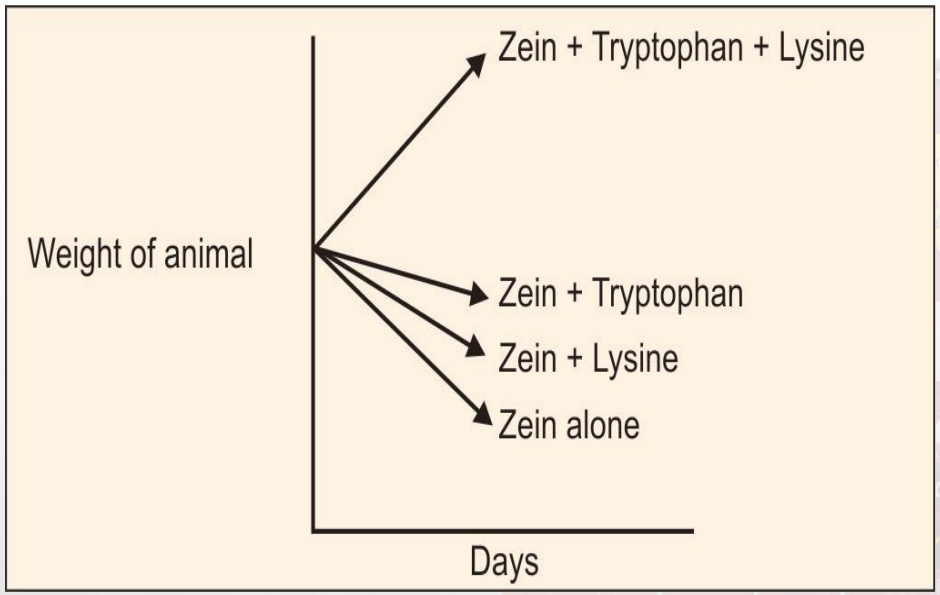
- Certain proteins are deficient in one or more essential amino acids.
- If this particular protein is fed to a young rat as the only source of protein, it fails to grow.
- This amino acid is said to be the **limiting amino acid**.
- Limiting amino acid is that which limits the weight gain when a protein is supplied to an animal.



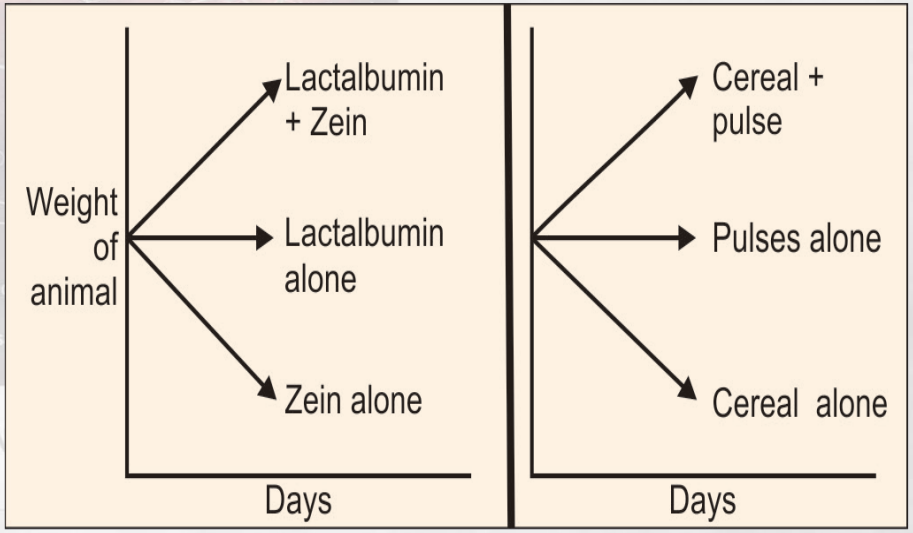
Mutual Supplementation

- This problem may be overcome by taking a mixture of proteins in the diet.
- **Mutual supplementation of proteins** is thus achieved.
- For example, pulses are deficient in methionine, but rich in lysine.
- On the other hand, cereals are deficient in lysine, but rich in methionine.
- Therefore a combination of pulses plus cereal (e.g. *chapati* + *dal*) will cancel each other's deficiency and become equivalent to first class protein.
- The supplementation effect of proteins may be seen in weight gain in animals

Identifying the limiting amino acid



Two second class proteins, when combined, are equivalent of the first class protein



Limiting amino acids in proteins

Protein	Limiting amino acid	Protein supplemented to rectify deficiency
Rice	Lys, Thr	Pulse proteins
Wheat	Lys, Thr	Pulse proteins
Gelatin	Tryptophan	Milk proteins
Zein	Tryptophan, Lys	Milk proteins
Tapioca	Phe, Tyr	Fish proteins
Bengal Gram	Cys, Met	Cereals

Protein Energy Malnutrition

- It is the most widespread nutritional problem in developing countries; predominantly affecting children.
- At one end of the spectrum of malnutrition is **marasmus** (Greek word, "to waste"), which results from a continued severe deficiency of both dietary energy and proteins (primary calorie inadequacy and secondary protein deficiency).
- At the other end of the spectrum is **Kwashiorkor**, where isolated deficiency of proteins along with adequate calorie intake is seen.
- Kwashiorkor means "sickness the older child gets, when the next child is born", a term from the local language of Ga tribe of Ghana.

WHO Classification of Malnutririon

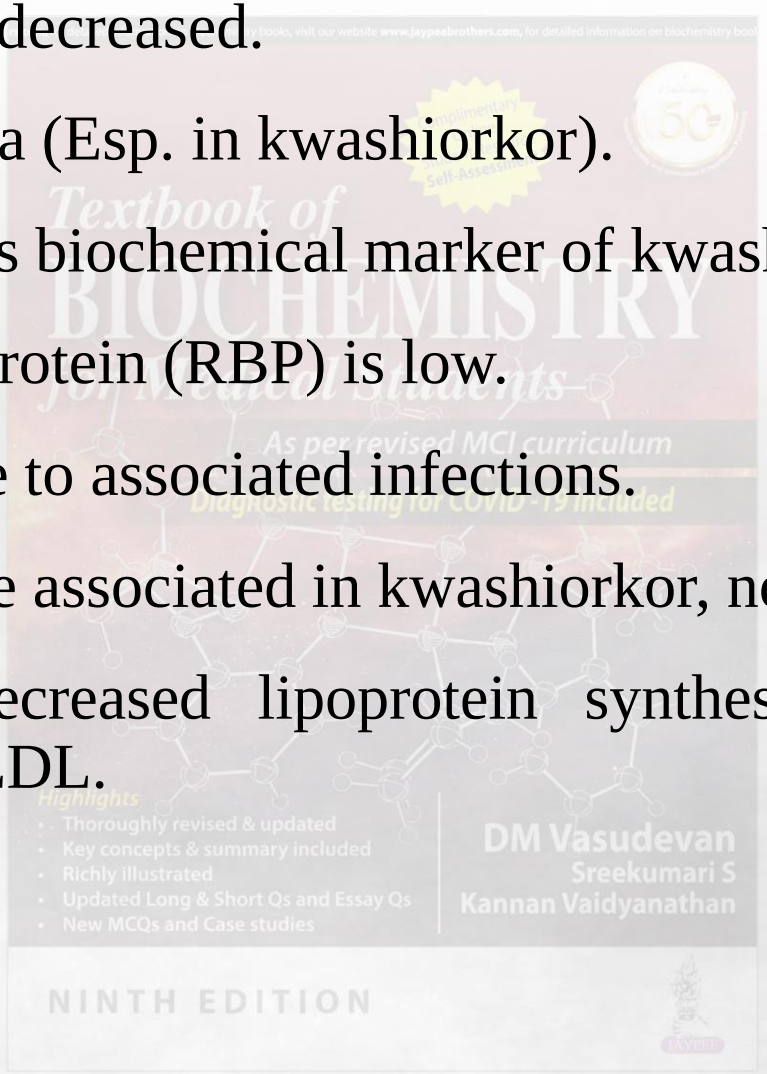
Type of PEM	% body weight compared to Std. weight	Edema	Deficiency in weight for height
Kwashiorkor	80 – 60	+	+
Marasmic kwashiorkor	< 60	+	++
Marasmus	< 60	Nil	++
Nutritional dwarfism	< 60	Nil	Nil
Underweight child	80 – 60	Nil	Nil

Child with Kwashiorkor

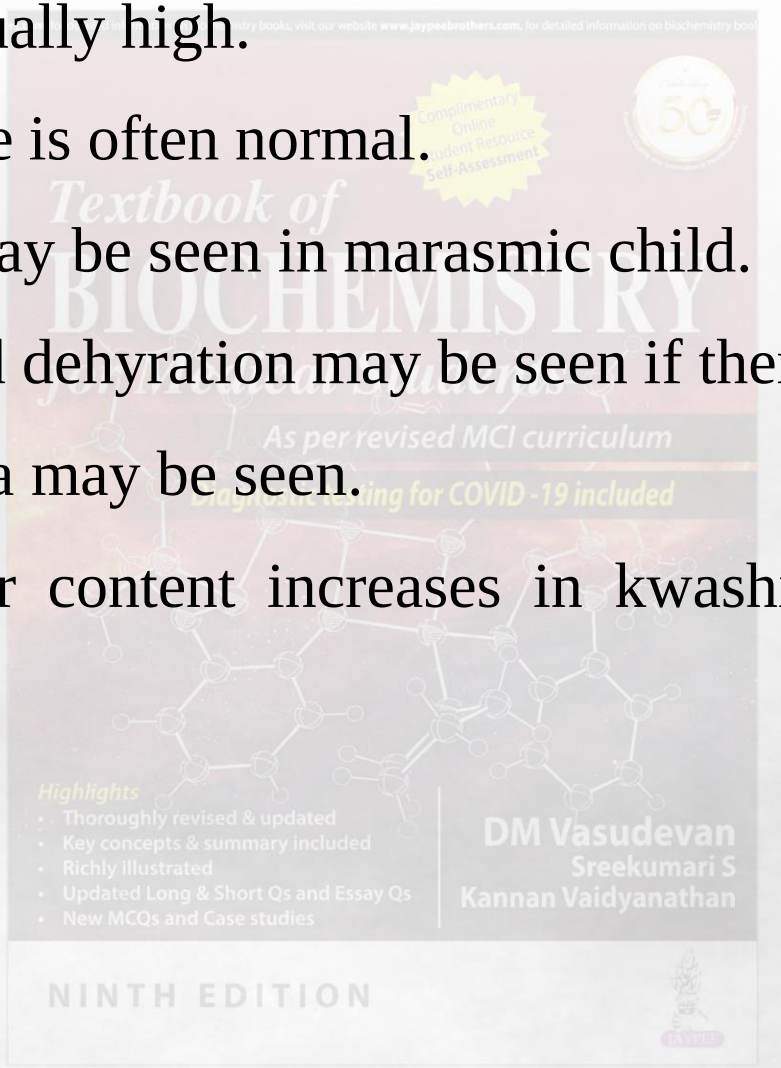
Child with marasmus

Biochemical Features

- Metabolic rate is decreased.
- Hypoalbuminemia (Esp. in kwashiorkor).
- Value < 2 gm/dl is biochemical marker of kwashiorkor.
- Retinol binding protein (RBP) is low.
- IgG increases due to associated infections.
- Fatty liver may be associated in kwashiorkor, not in marasmus.
- It is due to decreased lipoprotein synthesis and decreased availability of VLDL.



- Serum FFA is usually high.
- Glucose tolerance is often normal.
- Hypoglycemia may be seen in marasmic child.
- Hypokalemia and dehyration may be seen if there is diarrhea.
- Hypomagnesemia may be seen.
- Total body water content increases in kwashiorkor up to 60% weight.



Comparison Between Kwashirkor and Marasmus

	Marasmus	Kwashiorkor
Age of onset	< 1 yr	1 – 5 yrs
Deficiency	Calorie	Protein
Cause	Early weaning and repeated infections	Starchy diet after weaning; precipitated by acute infection
Growth retardation	Marked	Present
Attitude	Irritable and fretful	Lethargic and apathetic
Appearance	Shrunken with skin and bones only; dehydrated	Looks plump due to edema on face; lower limbs also show edema
Appetite	Normal	Anorexia

Comparison Between Kwashirkor and Marasmus (Contd.)

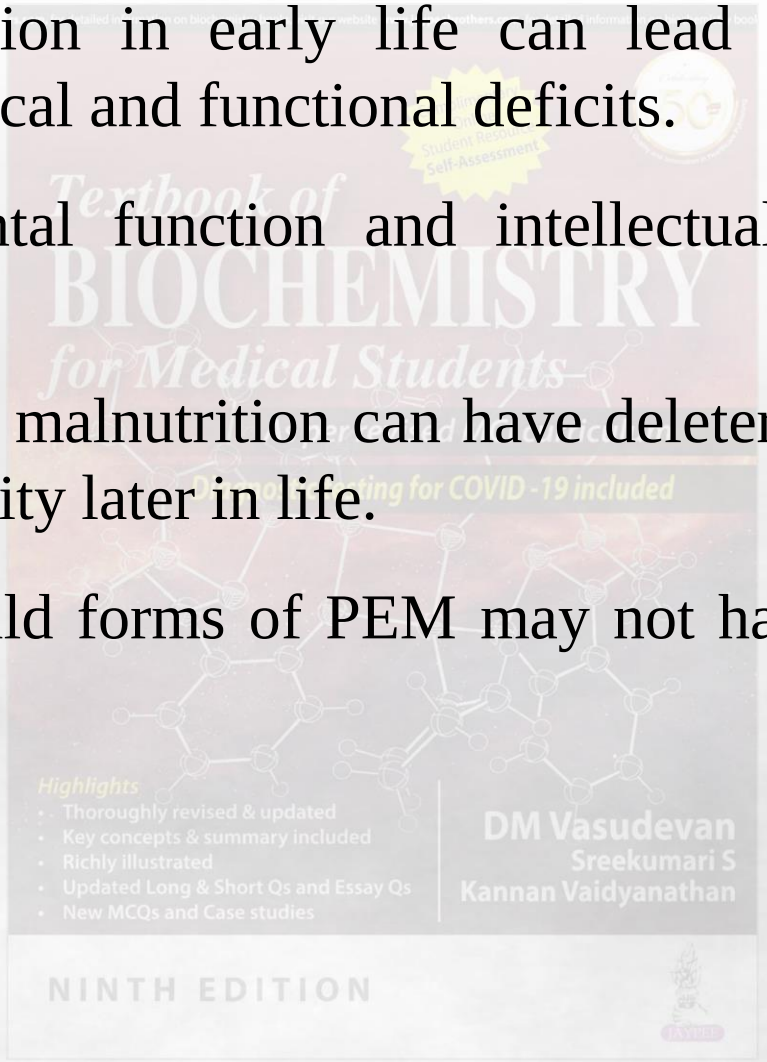
	Marasmus	Kwashiorkor
Skin	Dry and atrophic	"Crazy pavement dermatitis" due to pealing, cracking and denudataion
Hair	No characteristic change	Sparse, soft and thin hair; curls may be lost
Associated features	Other nutritional deficiencies; watery diarrhea. Muscles are weak and atrophic	Angular stomatitis and cheilosis are common, watery diarrhea. Muscles undergo wasting. Crawling and walking are delayed.
Serum albumin	2 – 3 gm/dl	< 2 gm/dl
Serum cortisol	Increased	Decreased

Treatment of PEM

- Optimal response is observed with diets providing 150 – 200 kcal/kg body weight and 3 – 4 gm protein/kg body weight.
- A mixture of three parts of vegetable proteins (Bengal grams or peanuts) and one part of milk protein is very effective.
- Malnourished children tolerate fats very well and may form a major source of calories in the diet up to 30%.
- Monitored by disappearance of edema, rise in serum albumin level and gain in weight.

Sequelae of PEM

- Severe malnutrition in early life can lead to permanent and irreversible physical and functional deficits.
- Changes in mental function and intellectual potential due to malnutrition
- Severe persistent malnutrition can have deleterious effects on the intellectual capacity later in life.
- Moderate and mild forms of PEM may not have any sequelae if corrected in time.



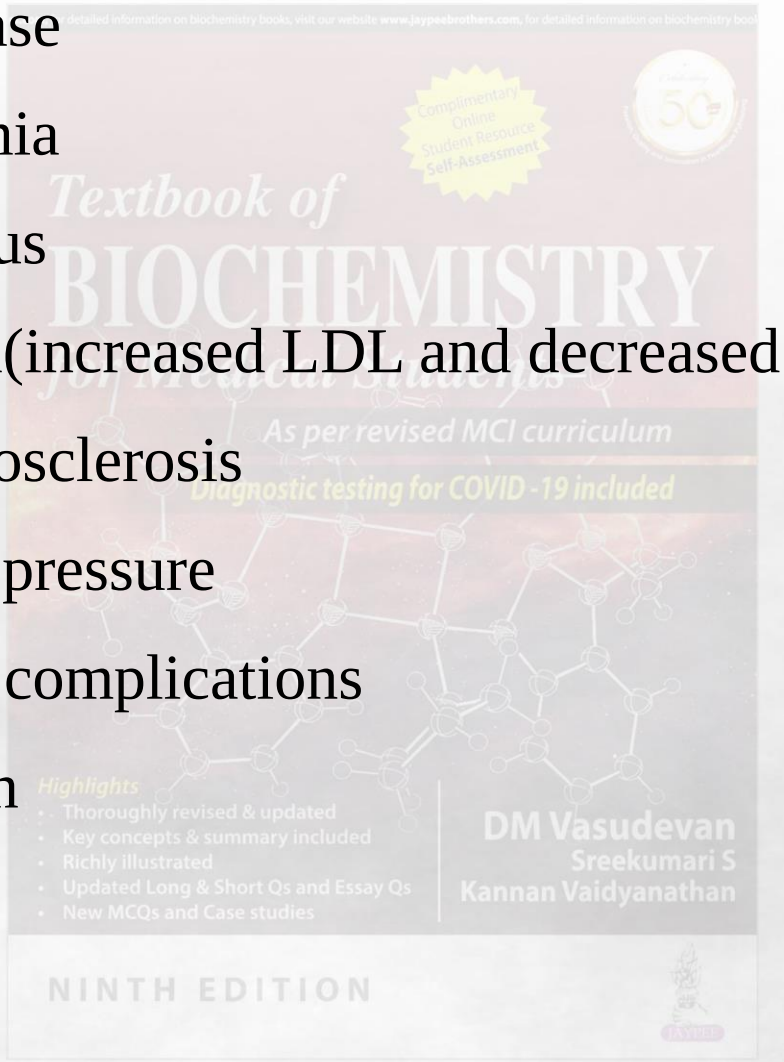
Obesity

- Malnutrition may be of two types; undernutrition or overnutrition.
- The latter is otherwise called obesity.
- Obesity is the most prevalent nutritional disorder in developed countries.
- All over the world, obesity is prevalent in affluent people.
- This is because human race is accustomed to poverty and malnutrition from time immemorial, and the body is designed to store energy whenever available.
- This is the first generation in history, where foodstuffs are in plenty.
- So, by habit people eat more and get obese.

- Obesity is the condition in which excess fat has accumulated.
- This is due to the increased energy intake and decreased energy expenditure.
- The **obesity index (body mass index, BMI)**, is calculated as W/H2 (where W = weight in kg and H = height in meters); it is used to assess the obesity.
- A person is obese when BMI exceeds 27.8 kg/m2 in men and 27.3 kg/m2 in women (excess of 120% of desirable body weight).
- Obesity can occur only as a result of ingestion of food in excess of the body's needs.

Obesity Increases the Risk of

- ✓ Metabolic disease
- ✓ Hyperinsulinemia
- ✓ Diabetes mellitus
- ✓ Hyperlipidemia(increased LDL and decreased HDL)
- ✓ Increased atherosclerosis
- ✓ Elevated blood pressure
- ✓ Cardiovascular complications
- ✓ Premature death



The **obesity index**, or Body Mass Index (BMI) = W / H^2 (Where W = weight in kg and H = height in meters).

A person is obese when BMI exceeds 27.8 kg/m^2 in men and 27.3 kg/m^2 in women (excess of 120% of desirable body weight).

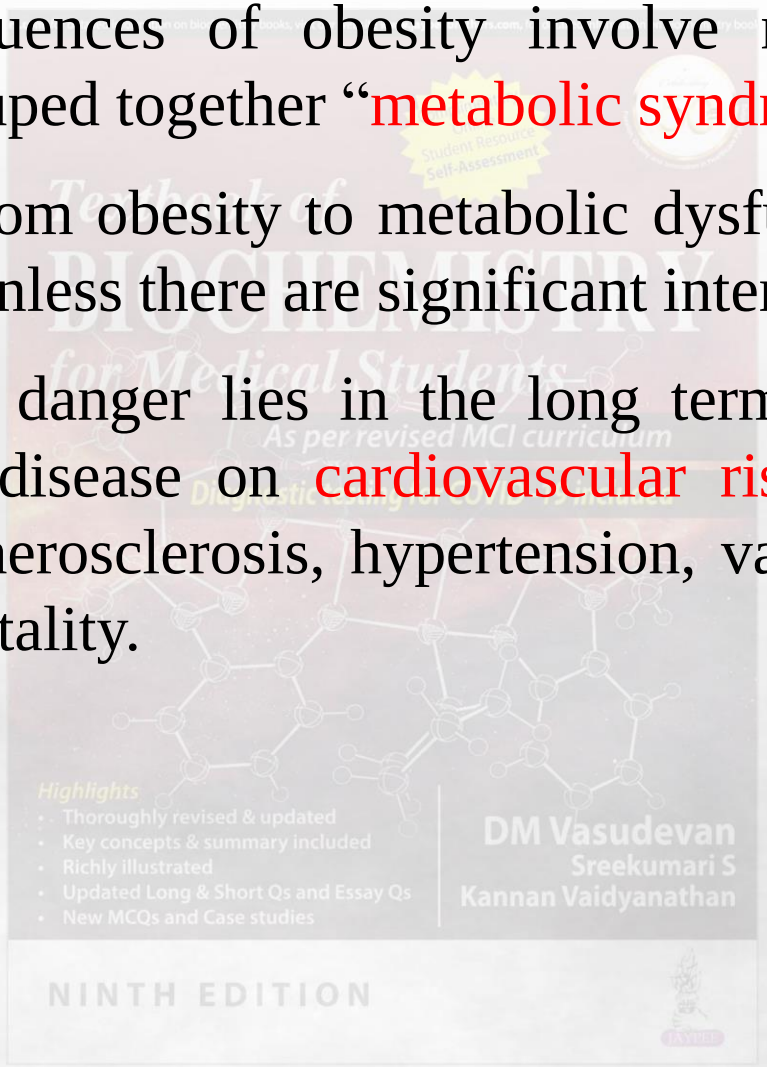
Central obesity may be Android or apple type (abdominal in males) and gynecoid (around breast, hips and thighs in women).

Obesity can occur only as a result of ingestion of food in excess of the body's needs. The major causes are excess food and lack of exercise.

The early consequences of obesity involve metabolic changes that have been grouped together "metabolic syndrome".

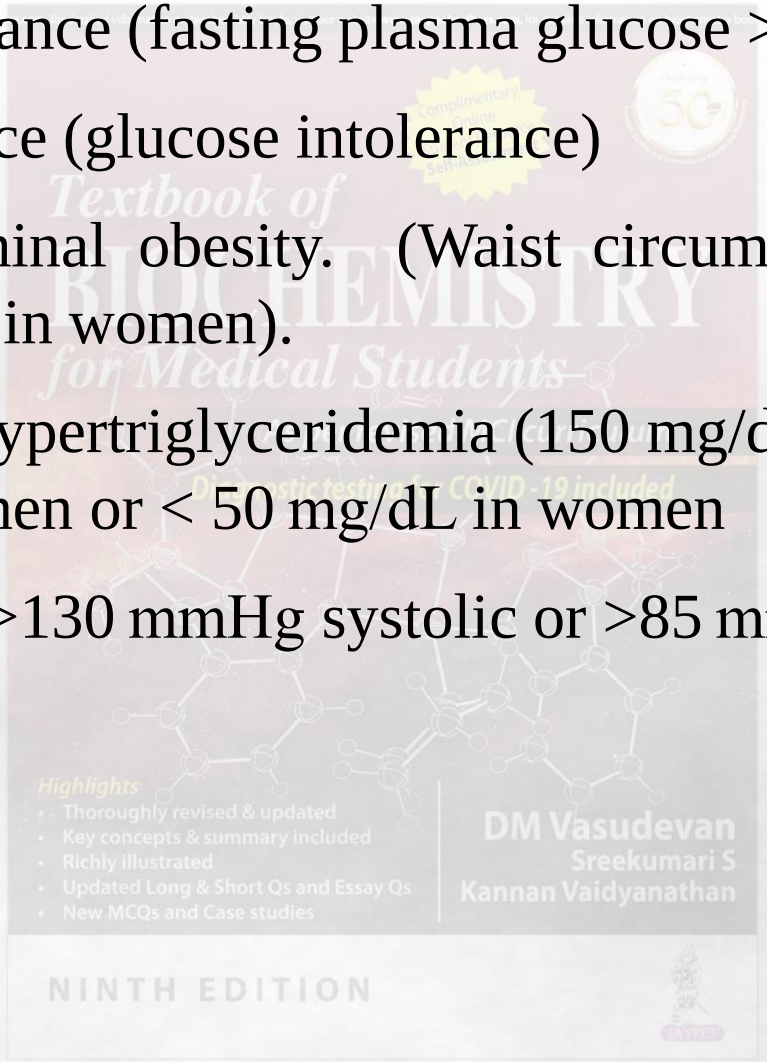
The progression from obesity to metabolic dysfunction to diabetes ultimately occurs unless there are significant interventions.

However, the real danger lies in the long term effect of obesity related metabolic disease on cardiovascular risk associated with greater rates of atherosclerosis, hypertension, vascular disease and cardiovascular mortality.



Metabolic Syndrome

1. Glucose intolerance (fasting plasma glucose >100 mg/dl)
2. Insulin resistance (glucose intolerance)
3. Central /abdominal obesity. (Waist circumference >90 cm in men or >80 cm in women).
4. Dyslipidemia hypertriglyceridemia (150 mg/dl) HDL cholesterol <40 mg/dL in men or < 50 mg/dL in women
5. Hypertension (>130 mmHg systolic or >85 mmHg diastolic)



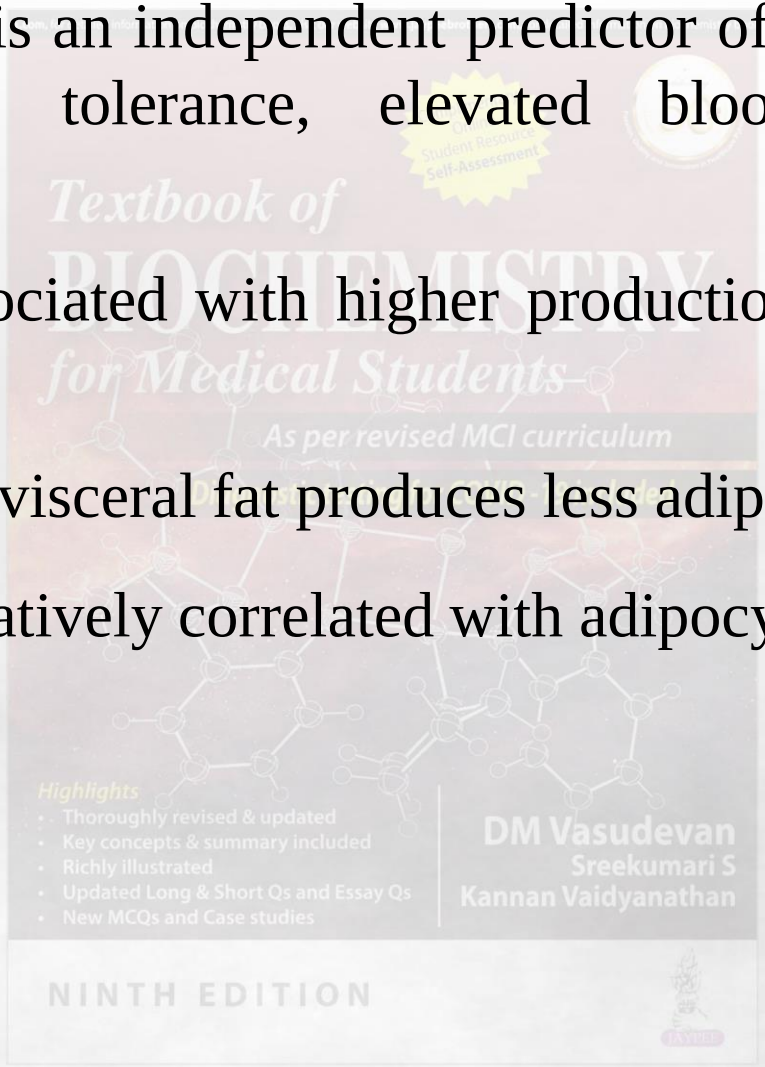
Visceral Obesity

Visceral adiposity is an independent predictor of insulin sensitivity, impaired glucose tolerance, elevated blood pressure, and dyslipidemia.

Visceral fat is associated with higher production of TNF-α, IL-6, and CRP.

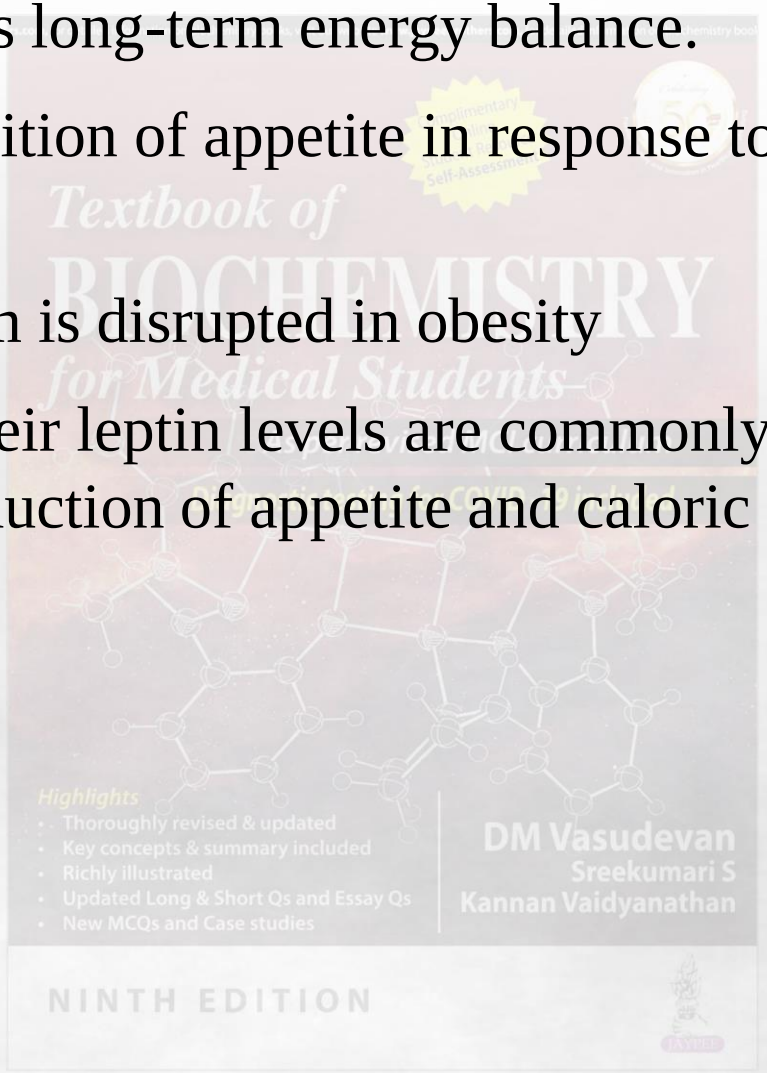
On the other hand, visceral fat produces less adiponectin.

Adiponectin is negatively correlated with adipocyte size.



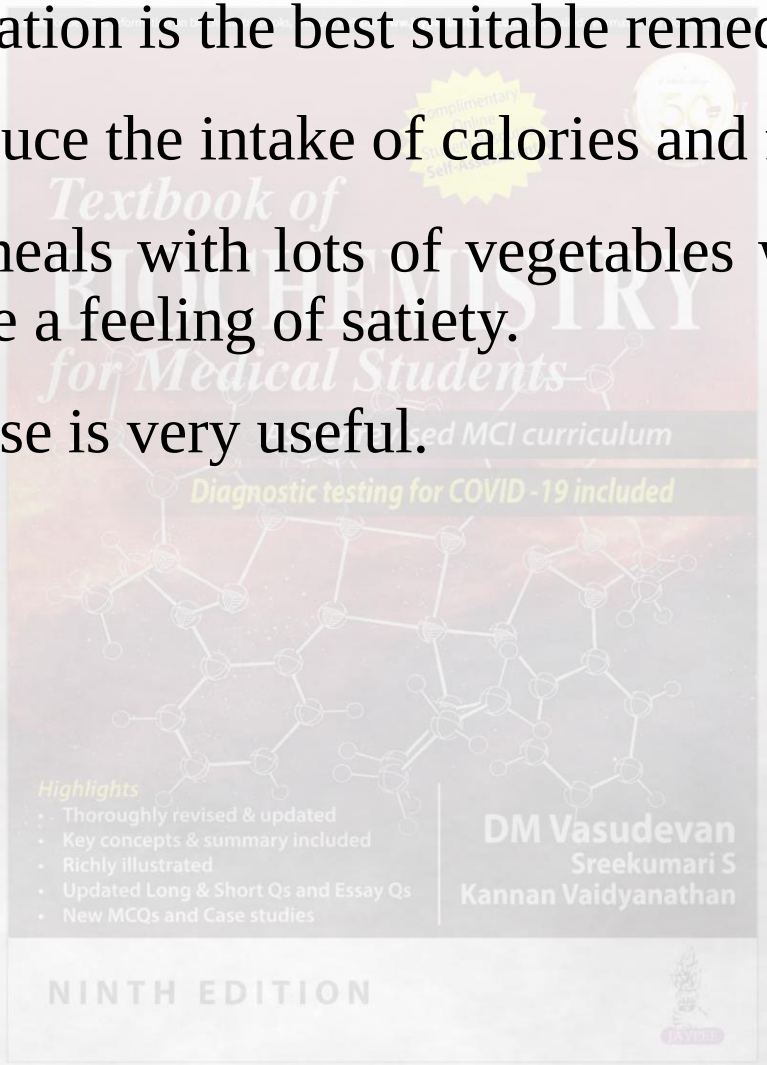
Leptin Resistance

- Leptin regulates long-term energy balance.
- long-term inhibition of appetite in response to formation of body fat.
- This mechanism is disrupted in obesity
- Even though their leptin levels are commonly elevated, this does not result in reduction of appetite and caloric intake.



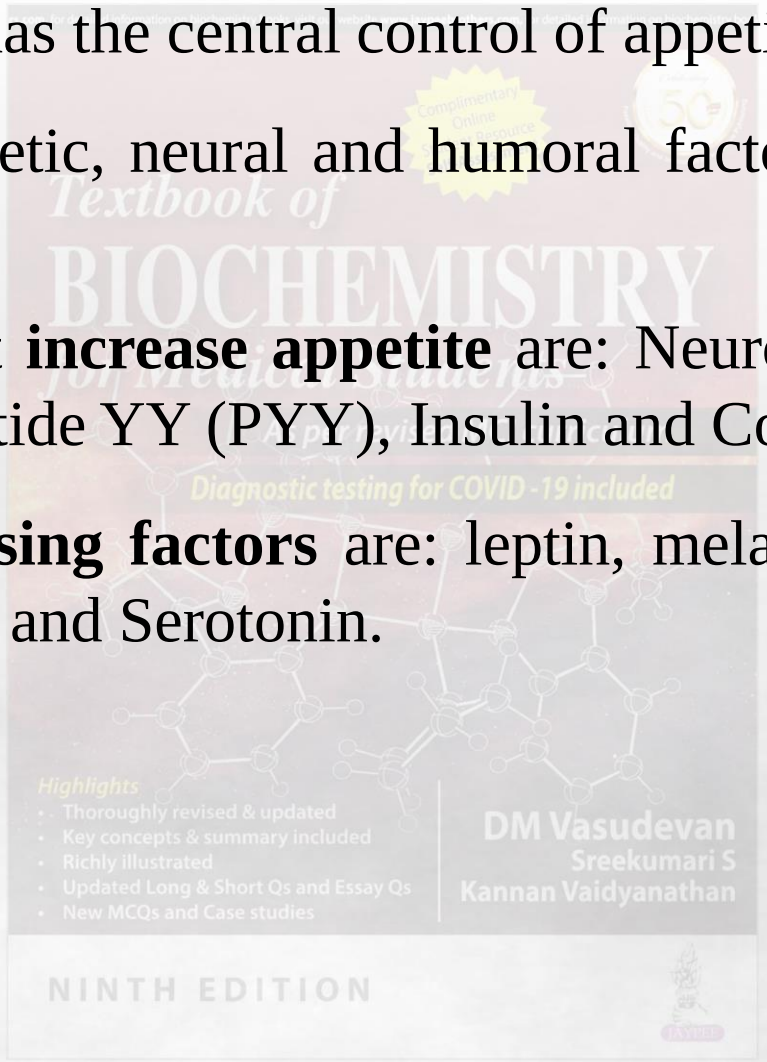
Treatment of Obesity

- Lifestyle modification is the best suitable remedy.
- The goal is to reduce the intake of calories and fat.
- Frequent small meals with lots of vegetables will make the food palatable and give a feeling of satiety.
- Controlled exercise is very useful.



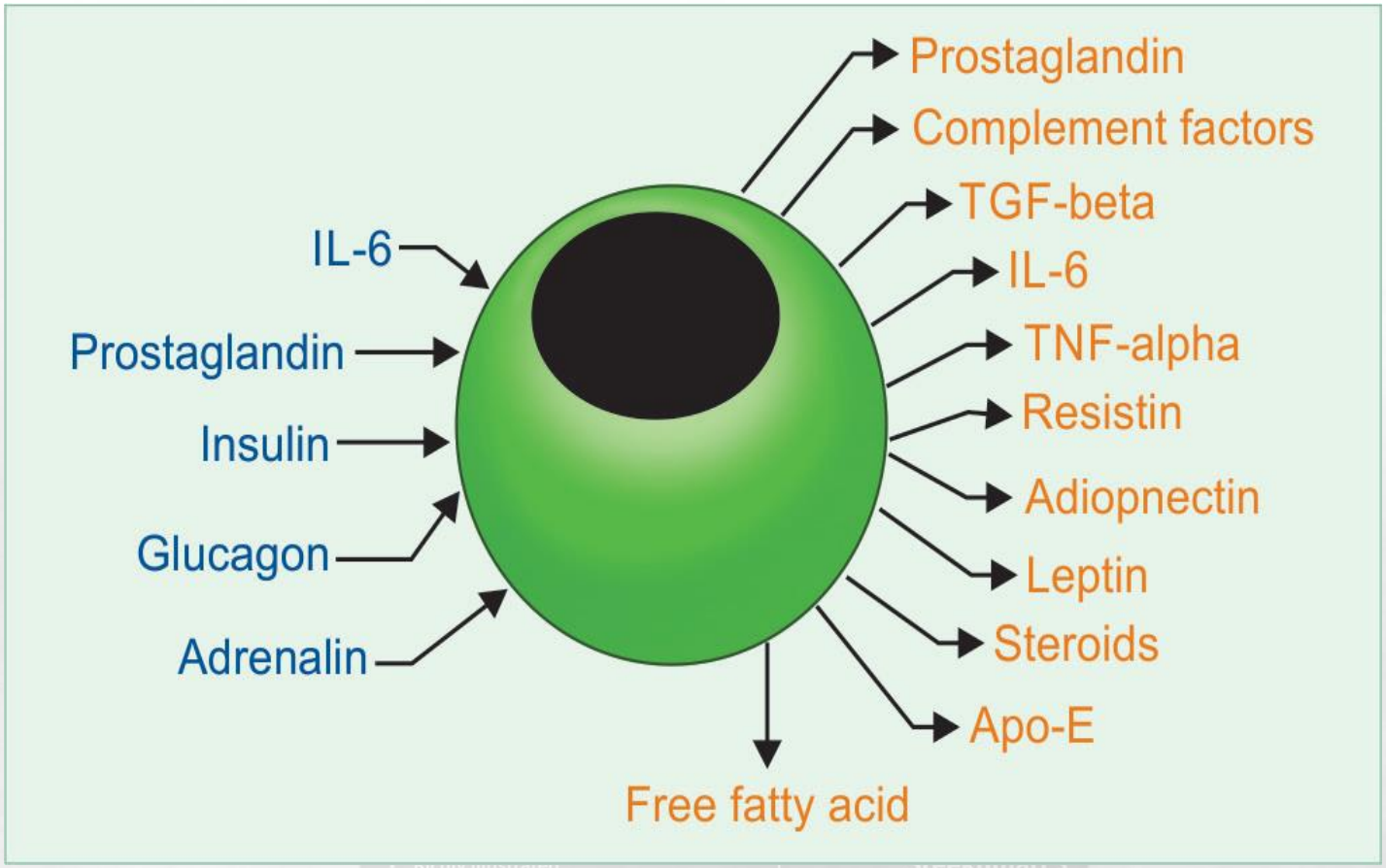
Regulators of Appetite

- **Hypothalamus** has the central control of appetite.
- Psychologic, genetic, neural and humoral factors are involved in the control.
- Polypeptides that **increase appetite** are: Neuropeptide Y (NPY), Ghrelin, Polypeptide YY (PYY), Insulin and Cortisol.
- **Appetite decreasing factors** are: leptin, melanocyte stimulating hormone (MSH), and Serotonin.



- **Leptin** (Greek *leptos* = thin) is a hormone secreted by adipocytes.
- It is mainly produced by white adipose tissue.
- It functions as a satiety signal.
- It is an index of the energy reserve in the body.
- When the energy reserve is adequate, leptin levels are increased and this would suppress further food intake.
- Leptin inhibits neuropeptide-Y secretion, and so when fat depots are full, appetite is decreased.
- Obesity is associated with leptin resistance and high levels of leptin in plasma.
- There is an "adipoinsular axis", with insulin promoting leptin secretion and leptin inhibiting insulin release.

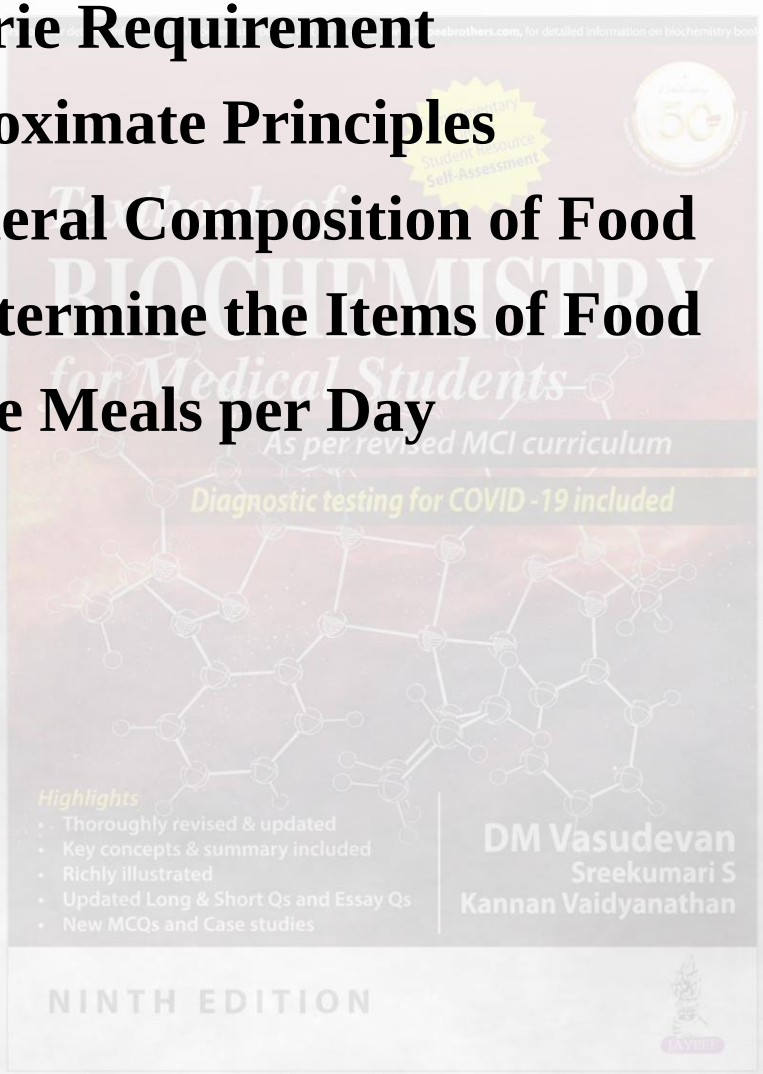
- **Neuropeptide-Y**, a hypothalamic polypeptide, stimulates desire for carbohydrates. The action is to inhibit insulin secretion.
- **Ghrelin** is secreted mainly by adipocytes. It stimulates hunger and appetite by acting on the hypothalamus. Plasma level of Ghrelin is increased in fasting state, which produces hunger signals.
- **Non-esterified fatty acids** (NEFAs) are primarily released from adipose tissue during fasting. Circulating NEFAs reduce glucose uptake, to promote lipid burning as a fuel source in most tissues, while sparing carbohydrate for neurons.



Adipose tissue as an endocrine organ.
(IL: interleukin; TGF: transforming growth factor; TNF: tissue necrosis factor)

Prescription of Diet

- First Step: Calorie Requirement
- Second Step: Proximate Principles
- Third Step: General Composition of Food
- Fourth Step: Determine the Items of Food
- Fifth Step: Three Meals per Day



First step in the prescription of diet

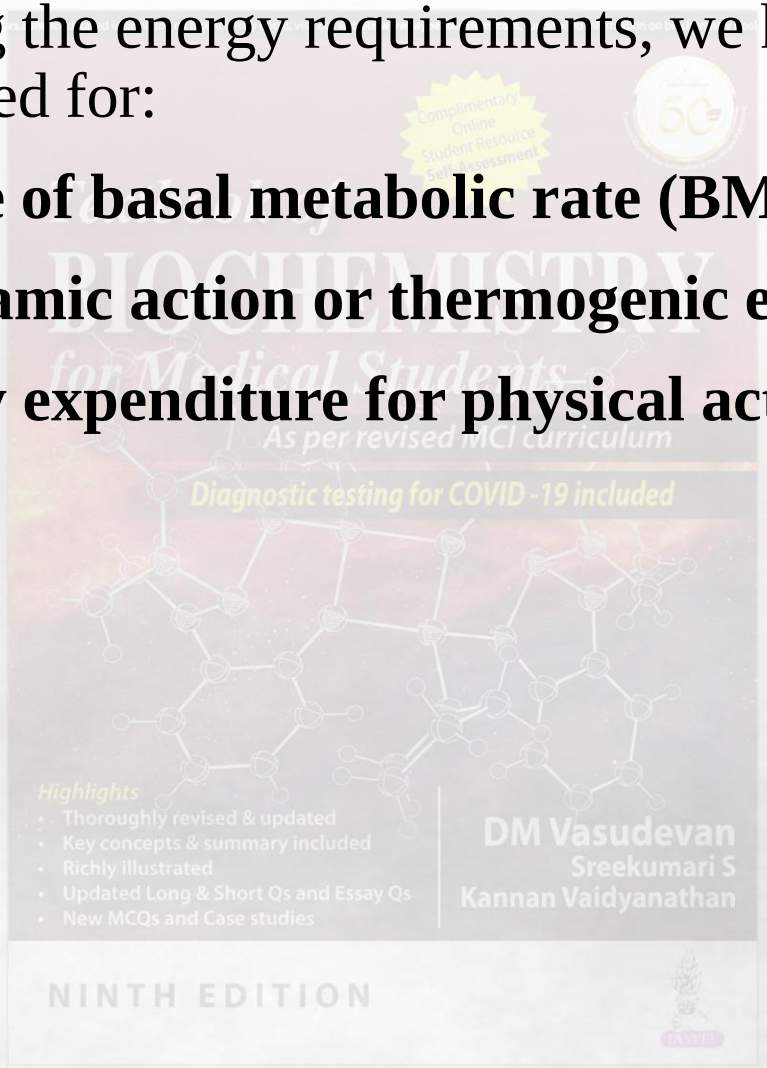
Energy required + SDA	**2000 kcal**
Protein	55 g
Calcium	1000 mg
Iron	20 mg

Prescription of diet; 2nd step

Proteins	**55 g**
Fats:	40 g
Carbohydrates	355 g
Calories	2000 kcal
Calcium	1000 mg
Iron	20 mg

Energy Requirements of a Normal Person

- While calculating the energy requirements, we have to consider the energy required for:
  - **Maintenance of basal metabolic rate (BMR)**
  - **Specific dynamic action or thermogenic effect** of food
  - **Extra energy expenditure for physical activities.**



Calculation for Energy Requirement for 55 kg Person Doing Moderate Work

For BMR	24 x 55 kg	1320 kcal
+ For activity	40% of BMR	528 kcal
Sub total	1320 + 528	1848 kcal
+ Need for SDA	1848 x 10%	185 kcal
Total	1848 + 185	2033 kcal
Rounded off	Nearest 50 kcal	2000 kcal

A Diet for a 60 kg Sedentary Man

	Vegetarian	Non vegetarian
Cereals	240 g	350 g
Pulses	90 g	60 g
Vegetable Oil	55 ml	25 ml
Milk	300 ml	150 ml
Leafy vegetable	350 g	200 g
Sugar	25 g	25 g
Fish / Meat		60 g

A Diet for a 60 kg Sedentary Man

Cereals	240 g
Pulses	90 g
Vegetable Oil	55 ml
Milk	300 ml
Leafy vegetable	350 g
Sugar	25 g

Important Points for Prescribing a Diet

1. It should be a balanced, well planned diet containing all essential nutrients.
2. The diet should be simple, locally available, palatable and digestible.
3. Adequate protein content with essential amino acids should be supplied. This is achieved by a cereal-pulse mixture with additional animal proteins, if necessary.
4. Calorie intake should be correct and should balance energy expenditure.
5. Special care should be taken to see that adequate quantity of calcium and iron are obtained from the diet. The absorption of these minerals is reduced by other factors in Indian diet.
6. Should have variety and should not differ very much from the habitual diet of the person.
7. Should provide adequate roughage.

Diet for Patients with Diabetes

Management of diabetes is by dietary control and exercise. The main aim is to keep the blood sugar level as far near the normal values, for as many hours, as possible in a day. The overall blood glucose level will be increased if there is a steep rise in blood sugar after every meal.

a) An average Indian diabetic diet should have 1800 kcal/day, 60% to be derived from carbohydrates, 20% from protein (1-1.2 g protein/kg body weight) and the remaining 20% calories from healthy fat.

b) Give the total calories in small divided doses, so that a small quantity of food is taken at frequent intervals, with the distribution of calories such that, breakfast 15%, mid-morning snack 5%, lunch 30%, evening tea 10%, dinner 35%, bedtime snack 5%. Bed time snack prevents mid night/early morning hypoglycemia.

Diet for Patients with Diabetes

c) Green leafy vegetables are increased, and tubers are restricted.

d) The diet should have a low glycemic index, so that elevation in blood sugar is minimal. Half of the grains consumed should be whole grains (unpolished rice and whole wheat flour) oatmeal, ragi, rice, rotis, bread etc. Refined carbohydrates are reduced.

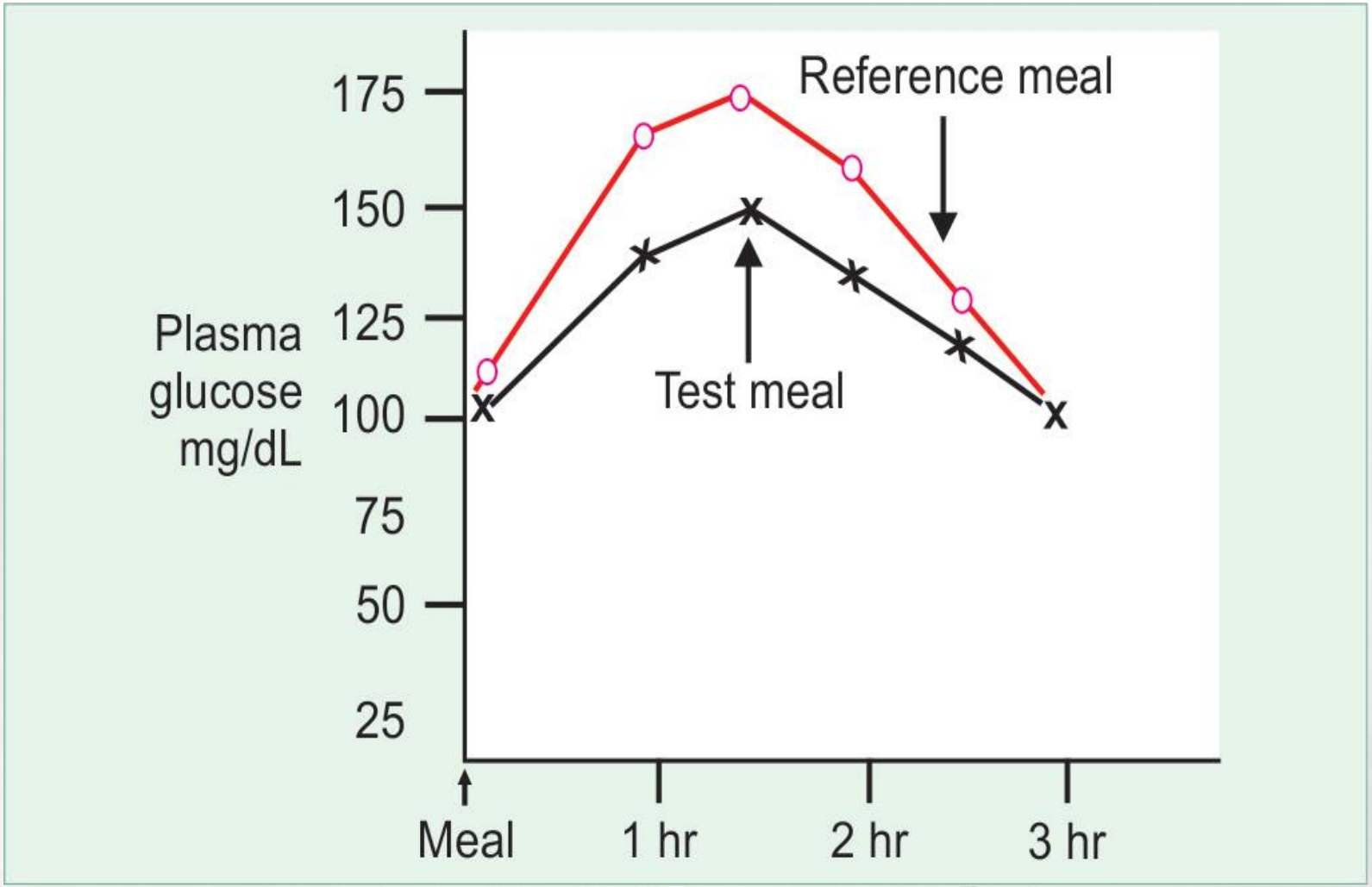
e) Foods to be avoided: Foods with a high glycemic index, refined sugars, fried items, pastries, candies, and sweetened beverages and processed food high in salt and low in fibre are to be reduced. Sweets and sucrose are strictly avoided. (Jaggery, an alternative source of sucrose is beneficial, since it is a good source of iron). Alcohol is to be avoided.

Glycemic Index

It is assessed by the glucose tolerance test (comparing it with a reference meal). The reference meal is always taken as 50 g of glucose.

$$\text{Index} = \frac{\text{Incremental area under glucose tolerance curve after 50 g test meal}}{\text{Incremental area under curve after 50 g of reference meal (glucose)}} \times 100$$

As a general rule, the glycemic index of carbohydrate is lowered if it is combined with protein, fat or fiber, preferably at least two of the three.



Glycemic index curve.

Glycemic index of food items

Item of food	Glycemic index
Potato chips	80-90
Bread	70-79
White rice (polished)	70-79
Parboiled (brown) rice	60-69
Bananas	60-69
Beans, peas	40-49
Legumes, Peanuts	35-40
Milk	35-40
Ice cream	35-40

Diet for Patients with Heart Disease

When the patient develops heart failure, fluid intake is to be limited to 30 ml/kg/day (1.5 - 2 L). The BMI and waist circumference are to be maintained.

Food items known to be rich in cholesterol (egg yolk, liver, brain, kidney) are to be consumed in limited amounts. Vegetables, cereals and pulses do not contain any cholesterol. On the other hand, vegetable sterols will inhibit cholesterol absorption.

Saturated fats raise serum cholesterol; while unsaturated fats lower it. Therefore, unsaturated fat (vegetable oils and fish oils) are to be preferred. Polyunsaturated fatty acids (PUFA) are present in vegetable oils and fish oils. The omega-3 fatty acids from fish oils decrease the plasma lipoproteins, (VLDL and LDL) and thereby decrease the risk of coronary artery disease. Trans fatty acids (TFA) are atherogenic.