5 Food Values

Contents at a glance

Can you recall?

1) What is the difference between Calorie and Kilocalorie?
2) Can we measure the energy released from food?
3) Which nutrients in food give energy?
4) Can energy be stored in body?

Energy is the ability to do work. The energy contained in food can either be trapped within the chemical constituents of the body or used to produce heat and body movement.

Energy is a precisely defined property of chemical compounds and other physical systems. The major sources to provide energy are carbohydrate, lipid and protein in the diet. Water, vitamin and minerals do not provide energy but they are important for other body activities. The energy of carbohydrate, lipid and protein is made available to the body, when these compounds are oxidised and release the energy during respiration / metabolism.

5.1 Definition of Kilocalorie

All forms of energy are interconvertible. The energy value of food is expressed in Kilocalories and determined by complete combustion of food in container surrounded by specific amount of water.

Definition : One Kilocalorie is defined as the amount of heat energy required to raise the temperature of 1Kg of water by 1^0C from 15^0C to 16^0C at normal atmospheric pressure.

The unit of energy which has been used in nutrition for a long time is the Kilocalorie (Kcal). However, the International Union of Nutritional Science (IUNS) have adapted "Joule" as the unit of energy in place of Kcal.

Definition: A joule is defined as the energy required to move 1kg mass by 1 metre by force of 1 newton. One newton is the force needed to accelerate 1kg mass by 1 m/scc.

The international conversion factor is 1 Kcal = 4.184 Kilojoules (KJ)

Physiological fuel value:

The amount of energy actually available to the body from a given amount of nutrients is called physiological fuel value. Difference between the physiological fuel values and gross fuel values is as follows

Table 5.1 : Difference between physiological fuel values and gross fuel values

Physiological fuel values	Gross fuel values
The amount of energy actually available in the body from a given amount of nutrient	Amount of energy released from the nutrient after complete combustion (in bomb calorimeter or oxy calorimeter).
In the human body the processes of digestion does not proceed with 100% efficiency.	All the nutrient are completely oxidised
In human body fibres are not digested and hence energy is not utilized.	In calorimeters the fibre present in the food is burnt and its energy is calculated.
During the protein digestion energy is lost as urea due to incomplete oxidation.	Protein is also completely oxidised.
The physiological fuel values Carbohydrate-4Kcal Protein-4 Kcal Fat-9 Kcal	The gross fuel values Carbohydrate-4.10 Kcal Protein-5.65 Kcal Fat-9.45 Kcal

5.2 Methods to determine the calorific values:

The amount of energy released from foods and the amount of energy expended by an individual can be obtained by Direct and Indirect calorimetry.

Table 5.2 Calorimetry equipment with their purpose

Direct Calorimetry	Indirect Calorimetry
Equipment and purpose a) Bomb Calorimeter – Energy value of food b) Atwater and Rosa respiration calorimeter- Energy expenditure during BMR/REE or at light activity	Equipment and purpose a) Benedict's oxy calorimeter- Energy Value of food b) Benedict-Roth respiration apparatus- BMR determination c) Douglas bag- Energy expenditure during work

Direct Calorimetry

a) Bomb Calorimeter:

Principle : Direct Calorimetry

Purpose : Determination of energy value of food

Method : It consists of a heavy steel bomb with tight cover, which is placed inside a vessel of containing water. The foodstuff is placed in a small crucible inside the bomb is filled with oxygen at high pressure and the food stuff ignited by means of electric leads. The material in bomb burns and produces heat which is absorbed by water and results in rise in temperature which can be measured by following equation.

$q = mc\Delta T$

where q = the energy evolved (J)

m = mass of the water (g)

c = the specific heat capacity of the water = 4.18J/Kg

ΔT = the temperature change in the water

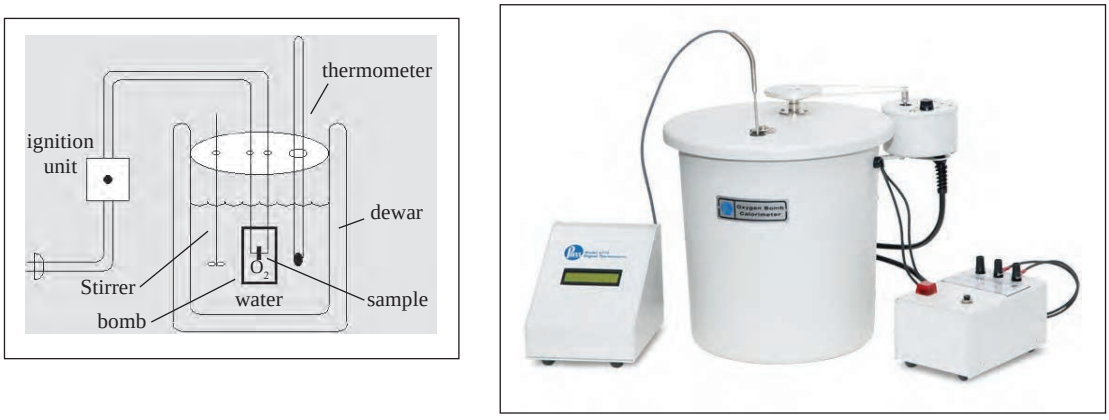


Figure 5.1 : Diagram of bomb calorimeter

b) Atwater and Rosa respiration calorimeter:

Principle : Direct calorimetry

Purpose : Determinaton of Energy expenditure during BMR/ REE or a light activity.

Method :

In this method the subject is placed in calorimeter, a small room with heavely insulated walls. The heat generated by the subject is taken up by water, pumped through the series of finned pipes which pass through the calorimeter.

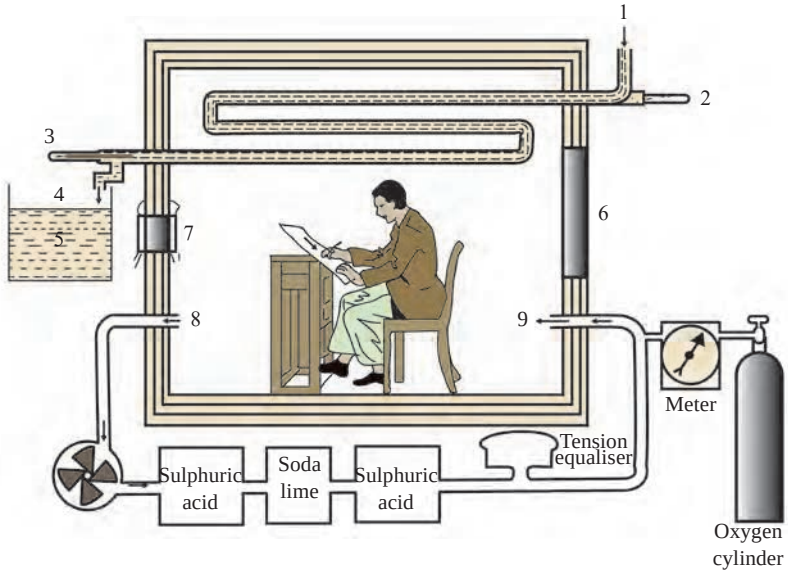


Figure 5.2 : Atwater and rosa respiration calorimeter

Multiplying the difference in temperature between the incoming and outgoing water, by volume of water flowing, heat output can be obtained.

BMR	-	Basal Metabolic Rate
REE	-	Resting Energy Expenditure

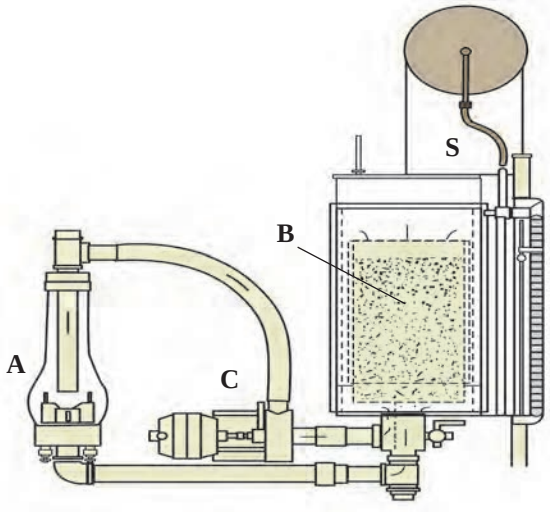
Indirect calorimetry :

a) Benedict's oxy calorimeter

Principle : Indirect calorimetry

Purpose : Determination of energy value of food

Method : In this method an organic substance is completely combusted in calorimeter or in the human body, oxygen is consumed in amounts directly related to the energy liberated as heat.



A : Combustion chamber
B : Lime soda container
C : Motor blower unit
S : Spirometer for measuring the oxygen

Fig. 5.3 : Benedict's oxy Calorimeter

b) Benedict - Roth respiration apparatus

Principle : Indirect calorimetry

Purpose : Determination of BMR

Method : In this method subject wears a nose-clip and breathe through a mouthpiece, which is connected to the apparatus by two tubes. The subject breathe-in the oxygen through respiratory valve and breath-out the carbon dioxide into spirometer bell. The amount of oxygen used recorded on the revolving drum by the pen attached. Using the Kymograph basal metabolism is calculated.

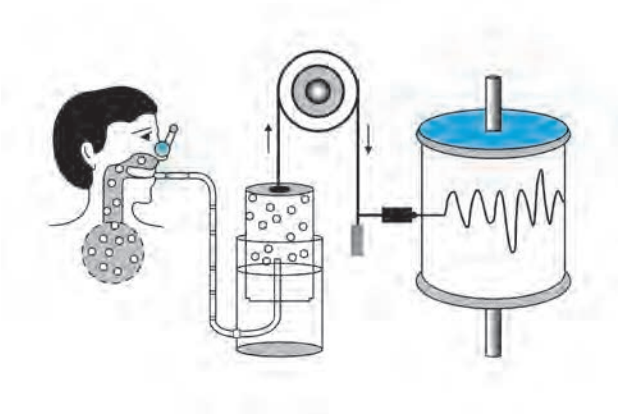


Fig. 5.4 : Benedict - Roth respiration apparatus

c) Douglas bag

Principle : Indirect Calorimetry

Purpose : Determination of energy expenditure during work

Method : The Douglas bag is used for determining energy expenditure during work. The subject wear the Douglas bag of 100 liters capacity, which is partially filled with expired air. The subject breath-in the atmospheric oxygen through nose and breath-out the carbon dioxide through mouth. This carbon dioxide is passed though corrugated pipes in Douglas Bag. The gas collected in Douglas bag is then analyzed for volume and compositing.

Fig. 5.5 : Douglas bag

5.3 Basal metabolic rate (BMR) :

Metabolism comprises everything that goes on inside the body to maintain and build tissues, produce energy and ensure good health.

Metabolism: The whole range of biochemical processes that occur within a living organism. Metabolism consists of anabolism (the buildup of substances) and catabolism (the breakdown of substances). The term metabolism is commonly used to refer specifically to the breakdown of food and its transformation into energy.

Basal metabolism refers to the basic or least amount of energy the body needs to survive when at rest. It is number of calories required to keep your body functioning at rest.

Basal Metabolic Rate is defined as the amount of energy required to carry on the involuntary functions of the body. It includes functional activities of various organs such as brain, heart, liver, kidney and lungs, etc.

The BMR of an average Indian man is 1750-1900 Kcal/day.

Factors influencing basal metabolic rate: There are many factors that affect BMR. These include:-

1. **Body size and surface area:** Both are major factors influencing BMR. On the basis of height and weight of the individual, surface area can be calculated. More the surface area, higher the BMR.
2. **Body composition:** Adipose or fatty tissue has an influence on BMR. Lower the body fat percentage, higher the BMR.

Do You Know ?

The lower body fat percentage in the male body is one reason why men generally have a 10-15% higher BMR than women.

3. **Age:** BMR reduces with age i.e. it is inversely propotional to age. Children have higher BMR than adults.
4. **Gender:** Men generally have a faster metabolism than women.
5. **Diet:** It affects the BMR both immediately as well as over a long period. BMR of strict vegetarians is 11% lower than meat eaters.
6. **Climate:** Exposure to cold temperature causes an increase in the BMR, so as to create the extra heat needed to maintain the body's internal temperature.
7. **Genetics** (Race): Some people are born with faster metabolism and some with slower metabolism. This may be due to dietary differences between the races.
8. **Hormonal state:** Thyroxine is the key regulator which speeds up the metabolic activity of the body. If thyroxine is more BMR will be increased whereas too little thyroxine reduces the BMR.
9. **Psychological state:** Anxiety and tension tend to increase the metabolic rate.
10. **Pregnancy:** The BMR is increased during pregnancy and lactation. This increase can be due to increase in women's weight.
11. **Exercise:** Exercise increases the BMR by building the extra lean tissues. Lean tissues is more metabolically required than fat tissues which causes more calories to burn during sleeping also.
12. **Active substances:** Caffeine and nicotine can increase the BMR.
13. **Body temperature / health :** For every increase of 0.5^0 C in internal temperature of the body, the BMR increases by about 7% e. g. fever also increases BMR.

Do You Know ?

The determination of BMR is the principal guide for diagnosis and treatment of thyroid disorders.

Activity-1

Calculating your energy needs:

Determine your BMR. It is generally held to be equal to about 1 calorie per kilogram per hour. This method is applicable to people who lead a moderately active life. (Does not apply it to heavy workers or athletes).

Step 1- Find your weight in kilograms (kg)

Step 2- Multiply the number of kilograms of body weight by 24 (hours per day).

Step 3- Multiply the answer in step 2 by 0.5% (50%).

Step 4- Add answers in step 2 and 3.

The total sum is your minimum daily calorie requirement.

Example:

Step 1- A person weights 50 kgs.

Step 2- 50 × 24 = 1200

Step 3- 50% of 1200 = 600

Step 4- 1200 + 600 = 1800 Kcal is total minimum requirement.

5.4 Body mass index (BMI)

- Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight and obesity in adults. BMI is an estimate of body fat.
- Body mass index (BMI) is defined as the weight in Kilograms divided by the square of the height in meters (Kg/m^2).
- **Formula to calculate Body Mass Index (BMI):**

$$BMI = \frac{Weight\ (kg)}{Height\ (m)^2}$$

- The International classification of adult underweight, overweight and obesity according to BMI is indicated in Table 5.3.

Table 5.3 : Body mass index (BMI)

Classification	BMI score (kg/m^2)
Underweight	<18.5
Normal	18.5 - 24.9
Overweight	25.0 - 29.0
Obese	30.0 - 40.0
Extreme Obese	>40.0

Points to remember

- Humans need energy for all activities.
- We get energy from carbohydrate, protein and fat.
- Energy value is expressed in Kilocalories.
- Bomb calorimeter is an equipment used for direct calorimetry.
- Basal metabolic rate is the amount of energy required to carry on the involuntary work of the body. BMR or basal metabolic rate is defined as the rate at which the body uses energy, when it is in resting stage, in order to keep the vital functions going on such as breathing, pumping blood to maintain body temperature, etc.
- BMI or basal metabolic index is the estimation of fat by which we can catagorise individuals into underweight, normal weight, overweight and obese.

Exercise

Q. 1 (a) Select the most appropriate option:

i. _____ does not provide energy.
(Protein, vitamins, fats)

ii. The energy value of food is expressed in _____.
(Kilocalories, kilograms, grams)

iii. _____ is an equipment used in direct calorimetry.

(Benedict's oxy calorimeter, Benedict's – Roth respiration calorimeter, Bomb calorimeter)

iv. An adult having BMI of 32 will come under_____.

(underweight, normal weight, obsese)

(b) Match the following:

A		B	
i.	Carbohydrate	a.	Benedict's oxy Calorimeter
ii.	Fat	b.	17 BMI
iii.	Indirect calorimetry.	c.	Bomb Calorimeter
iv.	Direct Calorimetry	d.	9 Kcal
v.	Underweight	e.	4 Kcal
		f.	32 BMI

(c) State whether the following sentences are true or false:

a. The amount of energy actually available to the body from a given amount of nutrients is called Physiological fuel value.

b. The gross fuel value of carbohydrate is 4 Kcalorie.

c. Bomb calorimeter is based on indirect calorimetry.

d. A person having 20 BMI will come under obese category.

Q. 2 Answer in brief

i. 1 Kilocalorie is equal to how many joules.

ii. Douglas bag is based on which calorimetry.

iii. Give examples of direct colorimetry.

iv. Give examples of Indirect calorimetry.

Q. 3 Short answer question

a. Define Kilocalorie.

b. Define joule.

c. Give the table of Calorimetry equipment with their purpose.

d. Explain Benedict's oxy-calorimeter.

e. Give difference between physiological fuel value and gross fuel value.

Q. 4 Long answer question

a. Explain the structure of bomb calorimeter with the help of diagram.

b. Define BMR. Explain the factors affecting it.

c. Define BMI. Explain how will you calculate BMI?

❖ Project.

i. Give the ingredients and their Physiological fuel value of any 5 recipes.

e.g. Aloo Paratha (100 gms) having composition of 60% carbohydrate, fat 20% and protein 12%. Calculate the energy values.

• **Energy value of Aloo Paratha:**

Carbohydrate: 60%

Energy value of carbohydrate 1gm = 4kcal.

So 60 × 4 = 240 kcal

Fat: 20%

Energy value of fat 1gm = 9 kcal.

So 20 × 9 = 180 kcal.

Proteins: 12%

Energy value of Protein 1gm = 4 kcal.

So 12 × 4 = 48 kcal.

Total calories = 240 + 180 + 48

= 468 kilocalories.

ii. Calculate BMI of 5 Adults and categorise them into underweights, normal, overweight and obese.