. What do yon mean by Respiratory Quotient ? What are the factors affecting it ?

The respiratory quotient is the ratio between the volume of carbon dioxide evolved and the volume of oxygen utilized in oxidation during a given time. The normal RQ in a healthy adult with a mixed diet is 0·85.

Factors affecting Respiratory Quotient : The different factors are :

(a) Role of Food Stuffs :

(1) *On Carbohydrate :* The RQ for carbohydrate is 1. The complete oxidation of glucose, for example, may be represented as follows :

$C_6H_{12}O_6+6O_2 \rightarrow CO_2+6H_2O$

(glucose)

$$RQ = \frac{CO_2}{O_2} = \frac{6}{6} = 1$$

(2) *On Fat :* It has lower RQ because the oxygen content on its molecule in relation to the carbon content is quite low. So, it requires more oxygen from the outside. The RQ for fat is 0·7. The complete oxidation of tripalmitin, for example, may be represented as follows :

$2C_{51}H_{98}O_6 + 145O_2 \longrightarrow 102CO_2 + 98H_2O.$

(Tripalmitin)

$$RQ = \frac{CO_2}{O_2} = \frac{102}{145} = 0 \cdot 703$$

(3) *On Protein :* The oxidation of protein cannot be so readily expressed because their chemical structure is variable. By indirect methods, the RQ of proteins has been calculated to be about 0·8.

(4) *RQ of Mixed diets under variable conditions* : In mixed diets containing varying proportions of protein, carbohydrate and fat, the RQ is about 0·85. As the proportion of carbohydrate metabolism is impaired as in diabetes, the RQ is lowered. The conversion of fat to carbohydrate would lower the RQ below 0·7.

(b) In Hydrogen-ion concentration : In acidaemia, RQ rises due to hyperpnoea. (2) In alkalimea, RQ falls as the breathing is depressed.

(c) During Muscular Exercise : (1) During exercise RQ rises above one, due to the breakdown of plasma bicarbonate by lactic acid, liberating large volume of CO_2 which are eliminated from the lungs. (2) During recovery from violent exercise, RQ falls below normal due to CO_2 being retained in the blood to reform bicarbonates.

(d) High Altitude : RQ increases due to increased pulmonary ventilation caused by anoexia.

(e) Starvation : (1) RQ is about one due to the combustion of carbohydrate for one or two days. (2) RQ falls below normal because the body is living on its own fats and proteins in the second and final stages of initiation.

(f) Diabetes : RQ falls below normal because body is burning only by proteins and fats.

(g) Voluntary Hyperpnoea : RQ increases considerably above one, due to the elimination of large amount of CO_2 without increase in O_2 consumption.

Meaning of Specific Dynamic Action (S.D.A):

All foodstuffs, after being ingested, increase the rate of heat production though the subject is in a basal state. This increased heat production due to ingestion above the basal metabolic rate (B.M.R) is known as Specific Dynamic Action (S.D.A) or calorigenic action of foods. It can be expressed at cost of metabolism of the various food substances.

The highest Specific Dynamic Action (S.D.A.) is shown by protein and is about 30%, whereas others, e.g., carbohydrate 6%, fat about 4%. By this it is meant that, if a quantity of protein, carbohydrate or fat, each having energy value of 100 calories, be given separately to an animal (whose basal metabolism is 100 cal) the actual heat production will be 130,106 and 104 calories respectively.

The extra heat comes from the combustion of the tissue substances causing loss of body weight. To prevent this loss of weight, the subject must be supplemented extra calorific allowance for the S.D.A. of the food itself.

Facts About Specific Dynamic Action (S.D.A):

The following facts about S.D.A. are noteworthy:

i. Specific Dynamic Action (S.D.A.) starts within an hour of taking food becomes maximum in about the third hour and is maintained at this level for several hours.

ii. Liver is the site of S.D.A. of proteins, because proteins fail to exert S.D.A. after removal of liver. But it is not the seat of S.D.A. of carbohydrates and fats. Because the removal of liver does not affect it.

iii. In fasting and under-nutrition the S.D.A. of all foodstuffs increases.

iv. During positive nitrogen balance, S.D.A. of protein does not seem to occur.

v. In order to exhibit S.D.A the animal must have a temperature above 33°C. Below this temperature the S.D.A. of foodstuffs becomes less and less apparent.

vi. The S.D.A. of protein cannot be utilised in any other way. It is a waste heat and lost. But the case is different with fats and carbohydrates. Their S.D.A. can be utilised in the performance of work. Hence, when exercise is done with a food containing these substances, the extra heat due to S.D.A. is not seen, because it becomes used up in the energy exchanges underlying muscular action. For this reason high protein diet is not suitable for heavy muscular work. S.D.A. of protein is useful in maintaining heat balance in cold climates.

Cause of Specific Dynamic Action:

1. S.D.A. of Proteins:

The following observations are significant:

i. That S.D.A. is not due to the synthesis of body proteins from the amino acids of food. Because proteins do not exert any S.D.A. upon growing infants or upon those subjects where nitrogen balance is positive.

ii. That S.D.A. is not due to any specific-stimulating action of some amino acids. Although it is seen that S.D.A. of protein depends upon the following amino acids only-glycine, alanine, glutamic acid, tyrosine and phenylalanine, yet it is not due to the effects of these amino- acids. Because they exert no S.D.A. in infants.

iii. S.D.A. of protein is exerted only when proteins are breaking down. Breakdown of amino acid include three processes—first deamination, secondly, the changes undergone by the non-nitrogenous part, and thirdly, the changes undergone by the nitrogenous part. It has been shown that the first two processes are not responsible for S.D.A.

S.D.A of proteins is shown during the change undergone by the nitrogenous part. S.D.A. is due to largely associated with the nature of deamination, i.e., oxidative deamination [transformation into urea). ATP also helps in the urea formation. For the synthesis of ATP energy is required which leads to increased metabolism.

2. S.D.A. of Carbohydrates:

It is suggested that it represents the energy liberated in excess of that required for the conversion of glucose into glycogen. After a fast, when glycogen store is depleted, ingested glucose (which is mostly converted into glycogen) exhibits pronounced S.D.A. Glucose with thiamine exerts more S.D.A., since thiamine promotes and accelerates fat synthesis from carbohydrate.

3. S.D.A. of Fats:

According to Lusk (Plethora theory), it is due to more rapid oxidation of fats in the cells owing to their increased concentration in the tissue fluids (plethora) after absorption due to rate of digestive product reaching the tissue exceeds the rate of utilisation.

Conclusions:

Three applications may be made of these facts:

i. The high S.D.A. of proteins should be made use of in cold climates by giving a protein rich food.

ii. While prescribing adequate diet, proper allowance should be made for the S.D.A. of proteins, otherwise tissue substances will burn and the subject will lose weight.

iii. B.M.R. of a subject should be determined avoiding the period during which S.D.A. develops.

Recommended dietary allowances (RDA)

- **The recommended dietary/daily allowances (RDA) represents the quantities of the nutrients to be provided in the diet daily for maintaining good health & physical efficiency of the body.**

- The RDA represents the average daily dietary intake that is sufficient to meet the nutrient requirement of nearly all (97%-98%) healthy individuals in a population.
- The RDA is to be used as a guide for the individual
- **RDA is ONLY a target**
- Intake less than the RDA does not necessarily indicate that the need of that particular individual have not been met.
- However, the risk of deficiency is low if intake meets the RDA.

Why RDA is important?

- National Family Health Survey and UNICEF Reports , 46% of preschool children and 30% of adults in India suffer from moderate and severe grades of protein-calorie malnutrition
- Over 50% women (particularly pregnant women) and children suffer from iron deficiency anaemia (IDA),
- diseases such as obesity, diabetes, hypertension, cardiovascular diseases and cancers
- Iodine Deficiency Disease (IDD) has been considerably reduced after the introduction of universal iodised salt

Factors affecting RDA

- **Sex:**
- **The RDA for men is about 20% higher than that of women.**
- **Iron is an exception as the requirement is greater in menstruating women.**
- **Additional requirements (20-30% above normal) are needed for pregnant & lactating women.**

- **Age:**
- **In general, the nutrient requirement is much higher in the growing age.**
- **For instance, the protein requirement for a growing child is about 2 g/kg body wt/day compared to 1 g/kg body wt/day for adults.**

REFERENCE MAN AND REFERENCE WOMAN

REF.MAN:

Age:20-39 yr
Wt.:60 kg
Healthy, fit for active work
He spends 8 hr daily on occupational work (moderate activity)
While not at work he spends 8 hr in bed,
6 hr sitting & moving around,
2 hr walking & household work

REF.WOMAN:

Criteria same as for man except wt. 50 kg

RDA (per day) for Indians (ICMR)

Group	Particulars	Body Wt. kg	Net Energy kC	Protein gm	Fat gm	Ca mg	Fe mg
Man	Sedentary	60	2425	60	20	400	28
	Moderate	"	2875	"	"	"	"
	Heavy work	"	3800	"	"	"	"
Woman	Sedentary	50	1875	50	"	"	30
	Moderate	"	2225	"	"	"	"
	Heavy work	"	2925	"	"	"	"
	Pregnancy	"	+300	+15	30	1000	38
	Lactation (0-6 m)	"	+550	+25	45	"	30
	Lactation (6-12 m)	"	+400	+18	"	"	"

RDA (per day) for Indians (ICMR)

Particulars	Retinol mcg	Beta Carotene mcg	Thiamin mg	Ribo-flavin mg	Niacin mg	Vit. C mcg	Folic Acid mcg	Vit. B 12 mcg
Sed.	600	2400	1.2	1.4	16	40	100	1
Mod.	"	"	1.4	1.6	18	"	"	"
Heavy	"	"	1.6	1.9	21	"	"	"
Sed.	"	"	0.9	1.1	12	"	"	"
Mod.	"	"	1.1	1.3	14	"	"	"
Heavy	"	"	1.2	1.5	16	"	"	"
Preg.	"	"	+0.2	+0.2	+2	"	400	"
Lact. 0-6 m	950	3800	+0.3	+0.3	+4	80	150	1.5
Lact. 6-12 m	"	"	+0.2	+0.2	+3	"	"	"

RDA (per day) for Indians (ICMR)

Age	Body Wt. kg	Net Energy kC	Protein gm	Fat gm	Ca mg	Fe mg
0-6 m	5.4	108/kg	2 g/kg	-	500	-
6-12 m	8.6	98/kg	1.6g/kg	-	"	-
1-3 yr	12.2	1240	22	25	400	12
4-6 yr	19.0	1690	30	"	"	18
7 9 yr	26.9	1950	41	"	"	26

RDA (per day) for Indians (ICMR)

Age	Body Wt. kg	Retinol mcg	Beta Carotene mcg	Thiamin mg	Vit. C mcg	Folic Acid mcg
0-6 m	5.4	350	1200	55(mcg)	25	25
6-12 m	8.6	"	"	50(mcg)	"	"
1-3 yr	12.2	400	1600	0.6	40	30
4-6 yr	19.0	"	"	0.9	"	40
7 9 yr	26.9	600	2400	1.0	"	60

Uses of RDA

- Basis for all feeding program (school lunch program)
- To interpret food consumption record
- To understand nutritional needs
- Guidelines for public food program
- To develop and evaluate the new food product
- To develops the nutritional education program

Biological Value (BV)

Biological Value (BV) is a measure of the proportion of the absorbed protein from food which becomes incorporated into the proteins of the organism's body.

B.V. = (N retained/N-absorbed) x 100

Egg and human milk have BV = 90-100;
Meat and fish have BV = 75–80;
Wheat protein - 50;

Biological Value of Proteins	
Egg	94
Milk	90
Rice	83
Quinoa	83
Fish	76
Beef	74
Soybeans	73
Whole wheat	64
Beans	58

High Biological Value (HBV) - Protein foods containing all of the essential amino acids including, meat, fish, cheese, eggs, milk and also soya.

Low Biological Value (LBV) - protein foods that lack one of the essential amino acids including, peas, beans, lentils, cereals such as rice, wheat flour, pasta, nuts and seeds.

1. **Biological value (BV) =**

$$\frac{\text{N intake - (fecal N + urinary N)}}{\text{N intake - fecal N}} \times 100\%$$

- BV is defined as that percentage of N absorbed from the GI tract is available for productive body function.
- estimate of the efficiency of use of the absorbed protein for combined maintenance and growth.

2. Net Protein Utilization [NPU]

- NPU is an index that takes into account the relative digestibility of proteins.

- Because even the best mixture of amino acids will be less available for use in the body it is packaged in a protein that is only partially digested.

- NPU = BV x digestibility.

$$NPU = \frac{\text{N retained}}{\text{Dietary N}} \times 100 = \frac{\text{Dietary N} - [\text{Urinary N} + \text{Faecal N}]}{\text{Dietary N}} \times 100$$

- Proteins are generally easy to digest. Most proteins are 90% or more digestible. Thus is most cases, NPU approximates the BV.