CHAPTER V. FOOD HYGIENE

5.1. ENERGY NEEDS

5.1.1.BASAL METABOLISM AND REGULATION OF BODY TEMPERATURE

Energy (in the physical sense) is usually defined as the **power to do work,** and the body needs energy because it has certain indispensable work to perform. The energy needs of the average adult may be grouped into two main categories:

1. for internal work
2. for external work

The basic energy requirements covers internal work of the body and any possible need for heat to maintain normal body temperature.

5.1.1.1. BASAL METABOLISM

Basal metabolism represents the irreducible minimum of energy required to keep up the life processes-that is, for the internal work of the body. It is usually defined as the amount of energy required by the body lying at rest in a comfortable environmental temperature, relaxed, and without food.

FACTORS THAT INFLUENCE BASAL METABOLISM

The main factors that determine the basal metabolic energy requirement are:

1. body size;
2. age;
3. sex;
4. secretions of endocrine glands.

SUPPLEMENTARY FACTORS AFFECTING BASAL METABOLISM

Several factors may affect the determination of basal metabolic rate, which is why the standardised conditions of measurement include the stipulation that the subject must be awake, but physically and mentally relaxed, in a postabsorptive state (12 to 15 hours after eating), in a comfortable environment, and free from fever.

These factors are:

- sleep;
- muscle tonus;
- emotion and mental states;
- exercise;
- food;
- fasting;
- fevers.

5.1.1.2. RATE OF HEAT LOSS AND TEMPERATURE REGULATION OF THE BODY

Naturally if much heat is disipated from the surface of the body, more fuel is required to maintain the body's normal temperature, which is considerably above that of the surrounding air under ordinary circumstances.

The main factors which affect the rate at which heat is lost from the body surface are:

1. The relative amount of body surface;
2. The presence or absence of a layer of fat under the skin;
3. the relative amount of insulation: clothing, shelter;
4. The environment: temperature of the air, humidity of the air, movement of the air.

5.1.1.3. TOTAL ENERGY REQUIREMENT OF ADULTS

The total allowance for energy requirement must cover amounts needed for three purposes - internal work (basal metabolism), external work, and energy "cost" of the food intake.

Basal metabolism determinations on healthy adults have shown average values with the following ranges:

Men - 1600-1800 calories daily

Women - 1250-1450 calories daily

Basal metabolism is normally about 1 calorie per hour for each kilogram of body weight and goes on, of course, 24 hours a day.

The increase above the basal is proportional to the degree of activity as follows: for very light (sedentary) activity, add 30 percent of the basal; for light activity, 50 per cent; for moderate activity, 75 per cent; for strenuous or severe activity, 100 per cent (or more).

A brief description of what is meant by these varying degrees of activity follows:

Very light: Sitting most a day, studying, talking, about 2 hours of walking or standing.

Light exercise: Sitting, typing, standing, laboratory work, some walking.

Moderate exercise: Standing, walking, housework, gardening, carpentry, little sitting.

Strenuous exercise: Standing, walking, skating, outdoor games, dancing, little sitting.

Severe exercise: Sports such as tennis, swimming, basket, ball, football, running, heavy work, little sitting.

5.1.2. THE PROTEIN REQUIREMENT

There apears to be a wide range of protein intake to wich adults can adapt and maintained in good health.

Proteins are fundamental food components, both functionally and nutritionally. The characteristics of the proteins will influence how they will behave in a colloidal systems, how they contribute to the major roles of color, texture and flavor of foods.

Color - The role of protein in color of food is fairly ubiquitous but not clear cut. In most instances it may either play through its interaction or as part of a complex molecule. One of the biggest roles is through the Maillard Reaction, a browning reaction between an amine group and a reducing group of a carbohydrate. The reaction between proteins and sugars is the most common of these browning reactions which occur in baked products and a number of other foods. Selected color pigments, such as chlorophyll, are bound in the chloroplasts in a protein - lipid matrix.

Texture - Texture contributions of protein foods are not uncommon. For example, custards are protein gels where the gel strength is influenced by the ovalbumin denaturation. Another clear example is in the production of yogurt is influence by gelation of casein.

Flavor - The contribution of flavor is not as clear cut. Some proteins and the amino acids may add flavor. Amino acids may contribute bitterness, sweetness, and other flavors.

Protein is made up of hydrogen, carbon, oxygen and nitrogen and sometimes phosphorus and sulfur. These compounds are organized into the basic unit, amino acids. Amino acids are made up of a central pivotal carbon with bonded amino groups, hydrogen and a "R" group. The essentiality of the amino acid has to do with the physiology of the species.

Amino acids usually contain an amino group and a carboxyl group.

There are approximately 20 common amino acids:

- Alanine - nonessential
- **Arginine** - essential
- Asparagine - nonessential
- Asparatic acis - nonessential
- **Cysteine** - essential
- Glutamic acid - nonessential
- Glutamine - nonessential
- Glycine - nonessential
- **Histidine** - essential
- **Isoleucine** - essential
- **Leucine** - essential
- **Lysine** - essential
- **Methionine** - essential
- **Phenylalaine** - essential
- Proline - nonessential
- Serine - nonessential
- **Threonine** - essential
- **Tryptophane** - essential
- Tyrosine - nonessential
- **Valine** - essential

Relating this to the protein is important. The amino acids form the protein due to reaction between the amino group of amino acid and the carboxyl group of another.

5.1.2.1. FUNCTIONS OF PROTEIN IN THE BODY

The principal uses for protein in the body are:

1. For building new tissues in growth (childhood), pregnancy and lactation, building up adult after wasting illness or in athletic training;
2. For upkeep of tissues already built;
3. For energy;
4. As regulatory substances;
5. As a precursor for enzymes, antibodies, some hormones, and some of the B vitamines.

5.1.2.2. NITROGEN BALANCE

Because nitrogen is supplied in proteins and makes up (on the average) 16 percent of protein, we determine the nitrogen content of the food intake and of the excreta (urine and feces) and multiply these figures by the factor 6.25 (100+16) to give the corresponding values in grams of protein. The nitrogen of the urine represents a measure of how much protein has been broken down and oxidised in the body during a day.

5.1.2.3. MINIMUM PROTEIN REQUIREMENTS FOR ADULTS

Sherman has estimated that probably 0.5 g of protein per Kg, of body weight would suffice to meet the minimum requirement (35 g, daily for a 70 Kg man).

5.1.2.4. FACTORS THAT INFLUENCE PROTEIN REQUIREMENT

The most important factors influencing protein requirement that need to be considered are size, age, completeness of digestion and absorption, and the nature of the proteins eaten.

SIZE

The size of the individual is an important factor in determining the protein requirement. The total amount of protein needed for tissue upkeep is naturally dependent upon the amount of active tissues in the body; for this reason the protein requirement is established as so much per unit of body weight.

AGE

Rapidly growing young children may need two or three times as much protein per unit of body weight as adult do, do provide for protein storage in new tissues.

The high protein requirement of infants and young children is striking when considered per unit of weight, but the total amount needed by their smaller bodies is, of course, less than the amount needed by an adult.

COMPLETENESS OF DIGESTION AND ABSORBTION

Early experiments of Atwater and Bryant showed that, on an ordinary mixed diet, the proteins from animal foods have a "coefficient of availability" of 97, those from cereals, fruits, and vegetables, 83 to 85, and those from dried legumes only 78. Proteins are less completely digested and absorbed when they occur in foods mixed with much indigestible fiber or cellulose, as in a bulky vegetarian diet. This factor may be of considerable importance when abnormal conditions in the digestive tract greatly limit the digestion and absorption of food.

THE NATURE OF THE PROTEINS EATEN

The nature of proteins taken in food has such an important influence on the amount needed for tissue building or maintenance that this factor.

5.1.2.5. PROTEIN DEFICIENCY

There are many areas of the world, in underdeveloped and overpopulated countries, where protein-rich foods, especially those of animal origin, are either scarce or practically unavailable. In many parts of Asia, Africa, the West Indies, and Central and South America, milk is not available at all. Eggs and meats are so rare and costly as to be out of reach of the common people, while fish are available only in coastal regions to supplement the diet with animal protein.

In Central Africa, where it was first recognized and mortality from it is very high, it is known as kwashiorkor, which means "red boy". The name comes from

the odd reddish-orange color of the hair, as well as from a skin rash, characteristic of the disease. Other symptoms are weakness and nervous irritability, inability to digest and absorb food normally, edema, anemia, and fatty infiltration of the liver.

5.1.3. CARBOHYDRATES

All carbohydrates are either sugars or more complex compounds, such as starch, which are formed by the union of many sugar groups.

Carbohydrates are generally made up of monosaccharides, disaccharides, oligosaccharides, and polysaccharides. The molecular components, functional groups, structure and conformation will influence the functional properties of foods. It will influence the way the food behaves under different production, processing and preparation stresses.

The carbohydrates most important in nutrition and the groups to which they belong are as follows:

- Glucose, fructose, and galactose - monosaccharides, or simple sugars; sources: fruits, honey, corn syrup; galactose does not occur in free form in foods;
- Sucrose, maltose, and lactose - disaccharides, or double sugars; sources: beet and cane sugars, molasses, maple syrup, comes in many crystal sizes and grades (sucrose); low concentrations in plants and processed foods (maltose); milk and milk products (lactose);
- Starch, dextrins, glycogen, cellulose, and hemicelluloses - polysaccharides; sources: bananas, potatoes (starch), meat products and seafood (glycogen), cereals, fruits and vegetables (celluloses and hemicelluloses).
- All the food carbohydrates except lactose (milk sugar) are formed in the vegetable kingdom.

5.1.3.1. CARBOHYDRATE - RICH FOODS

A few highly refined substances - such artificially prepared foods as refined sugar and corn starch - are pure carbohydrate (99.5 and 88 percent respectively, the rest of the weight being due to small amounts of water).

Although highly milled dry rice and patent flour are more than four-fifths starch and have a total carbohydrate (starch) content of 81 and 76 percent respectively, they also contain protein in amounts of 7.5 to 10.5 percent.

Dry peas and beans carry over 20 percent of protein along with approximately 60 percent of starch; soy beans differ from other legumes in that they contain less starch and more protein and fat.

The legumes and whole grains also contain some indigestible fiber, and certain minerals and vitamins.

Foods of high sugar content (65 to 99 percent) include table sugars, honey, syrups, candies, cakes, jams, jellies, preserves, and dried fruits (dates, figs, raisins, prunes, apricots); others containing appreciable amounts are fresh fruits (9 to 23 percent) and soft drinks (8 percent). Taken in considerable quantities, these last two sources may contribute appreciable amounts of energy (calories).

The grains (wheat, corn, rice, rye, barley) and dry products made from them (dry break fast cereals crackers, breads) are rich in starch (50 to 85 percent); cereal pudings, potatoes, cooked legumes and cereals are of higher, but variable, water content, so they range in carbohydrate from about 10 to 20 percent.

Cooked rice, spaghetti, macaroni, and sweet potatoes are 23 to 32 percent carbohydrate, with 17 to 22 per cent.

Cooked breakfast cereals vary with water content but average about 11 percent starch.

The main contributions to the diet by carbohydrate - rich foods (sugar and starchy foods) are to:

1. Provide an economical energy supply.
2. Furnish some proteins, minerals and vitamins (whole grains and legumes).
3. Add flavor (sugars) to foods and beverages.

Carbohydrates also contribute to the structure due to sugar, sucrose, and serve as a flavor enhancer and sweetener due to all three sugars. In a more complex system such as a pineapple upside down cake, carbohydrates play many roles due to the presence of all categories of carbohydrates. The possible roles are:

- flavor enhancer and sweetener;
- flavor due to caramelization;
- serve as water binders;
- contribute to texture (starch), gluten (structure);
- serve as a hygroscopic nature/water absorbtion;
- serves as a source of yeast food;
- regulate gelation of pectin;
- disperse molecules of protein or starch;
- act to subdivide shortening for creaming;
- control crystallization;
- prevent spoilage;
- delay coagulation of proteins;
- structure due to crystals;
- effect osmosis;
- effect color of fruits.

5.1.4. FATS AND OTHER LIPIDS

All true fats are formed by union of fatty acids with an organic alcohol called glycerol or glycerin.

5.1.4.1. USES OF FATS

Some fats are used as spreads; others are used in cookery.

The satiety value of fats depends on the fact that fats slow digestion and the emptying time of the stomach meals that contain considerable fat remain longer in the stomach and so prevent the early recurrence of the "hunger pangs" that occur when it is empty.

This may be a good or a bad factor, depending on the amount of fat in the meal.

When food is scarce or when one is on a "reducing diet" small or moderate amounts of fat are a help in preventing hunger.

But when too much fat is taken, especially when it is intimately mixed with starch or protein, the meal may stay so long in the stomach as to cause discomfort.

The high-energy value of fats (weight for weight more than twice that of carbohydrate or protein) means that relatively small quantities of fat-rich foods decidely raise the caloric value of the diet.

Fat deposits in the human body may be either advantageous or disadvantageous, according to whether they are moderate or excessive.

Some deposition of fat, usually under the skin or about the abdominal organs, serves a useful purpose as a reserve store of fuel to be drawn on in time of need. Moderate deposits of fatty tissue also serve to support organs and protect them from the body surface, since fat is a poor conductor of heat.

But an overfed person goes on storing fat which he may never need to burn as body fuel; such excessive fat deposits cause undesirable weight gains and place undue strain on the heart and other vital organs.

5.1.4.2. FATTY FOODS

Fats and other fat-rich foods are useful in the diet for three main purposes:

1. As a concentrated source of body fuel.
2. For flavor and satiety value.
3. As carriers of fat-soluble vitamins and essential fatty acids.

The principal foods that are almost pure fat are butter, margarine, vegetable oil, and the cooking fats made from them (by hydrogenation). Those foods are generally used in moderate amounts at a time by being spread on or mixed into other foods low in fat content. (Mayonnaise is about 80 percent fat, but other types of salad dressings range between 40 and 60 percent).

Foods whose fat content ranges from 20 to 70 percent include cream and full milk cheeses, fat meats and poultry, chocolate, nuts, and peanut butter.

These foods are also generally used in moderation.

It must be remembered, however, that foods such as butter, margarines, salad oils, and cooking fats are "visible" fats, and we are conscious of how much of them we use. However we often fail to recognise that cream, cheese, nuts, and pastries contain a good deal of so-called "hiden" fat. Thus, the separated lean meat (cooked) still contains 6 to 15 percent "hidden" fat. It may even contain more in the case of choise cuts, in which the flesh is "marbled" with fat.

5.1.4.3. ESSENTIAL FATTY ACIDS

Hansen was the first to diagnose symptoms in infants of poor growth and eczematous skin lesions due to a deficiency of essential fatty acids.

Skin symptoms appear either with very low fat intake or with high intake (42 percent fat but with less than 0.1 percent as linoleic acid).

5.1.4.5. LIPIDS OTHER THAN TRUE FATS

The term lipid is applied to any substance that has physical properties similar to fats-that is oily or greasy in consistency and soluble in fat solvents. In addition to true fats and fatty acids, lipids include phospholipids and cholesterol.

Phospholipids and sterols are present in foods and are normal constituents of body tissues. They are concentrated especially in the liver, other glandular tissues, and in lesser amounts, in the blood and other tissues.

Cholesterol gives rise to an intermediate substance (7-dehydrocholesterol) from which vitamin D is formed by ultraviolet light when it penetrates the skin.

The bile acids, likewise derivatives of cholesterol, are formed in the liver and excreted by way of the bile into the intestine, from which some may be reabsorbed and used over again, others being excreted in the feces.

5.1.4.6. RELATION OF FATTY ACIDS AND CHOLESTEROL TO CORONARY HEART DISEASE

High blood cholesterol may be a causative factor in coronary heart disease and may be associated with a particular type of hardening of the arteries known as atherosclerosis.

This is a degenerative condition in which there is a tendency for cholesterol scales or mushy deposits of large lipoprotein molecules to form on the interior wall of arteries.

There is ample evidence to show that ingestion of considerable amounts of saturated fatty acids, or of animal fats which carry a preponderance of saturated fatty acids, tends to increase levels of total lipids and of cholesterol in the blood.

Conversely, the inclusion in the diet of a higher proportion of vegetable fats, rich in polyunsaturated content of lipids tend to diminish level of total lipids and cholesterol in the blood.

At present the consensus of competent medical opinion is that a good many people would do well to reduce their fat intake and at the same time substitute moderate amounts of polyunsaturated fats (vegetable oils, margarines) for animal fats, which are high in saturated fatty acids.

Such changes are recommended especially for over weight persons, those who have already had a heart attack or stroke, and those whose family histories suggest that they may be coronary prone.

5.1.4.7. PLACE OF FAT-RICH FOODS IN THE DIET

Only about 10 percent of the energy in the average diets of Asiatic peoples is furnished by fats, because over population requires that land be used for production of carbohydrate-rich foods, which furnish energy at the least cost, instead of for the production of more expensive meat and dairy products.

Among people of moderate means in most European countries fat intake may account for 10 to 25 percent of their total caloric intake.

5.1.5. THE BODY NEEDS MINERAL ELEMENTS AND VITAMINS

Carbon, oxygen and hydrogen (in varying proportions) are the chief constituents of practically all organic compounds found in the body, especilly fats, carbohydrates, and proteins. Nitrogen is an essential constituent of proteins.

These four elements make up 96 percent of the body weight and are supplied by carbohydrates, fats, and proteins in the foods we eat and in part by the water and beverages we drink and the oxygen in the air we breath.

Naturally occurring, inorganic substances are essential for human life, and provide a role in metabolic processes.

Bioavilability is the ease at which nutrients can be absorbed.

Electrolytes are made from minerals; these charged particles in a solution are capable of conducting electricity.