Dr. Nadhim M.Jawad Ali
Department of Public Health
College of Veterinary Medicine
University of Basrah
Second Class- Animal nutrition

Energy

Bioenergy and its conversions:

The word energy is derived from a Greek word (enérgeia) that means work, and it is defined as the ability to accomplish work. There are forms of energy, including thermal, mechanical, magnetic, radiation energy, and chemical energy, in addition to the presence of renewable energy, which is energy generated from natural sources such as solar energy, hydroelectric energy, and wind energy. All forms Energy can be converted from one form to another using simple or complex technologies, such as converting chemical energy into electrical energy (batteries), thermal energy into mechanical energy (cars), solar energy into chemical energy (sugars in plants) or into electrical energy, wind energy into electrical energy.

All processes that occur in the body as a result of digestion and assimilation of food include changes in energy, and the production of energy in the body is considered a measure of the efficiency of the processes that occur in the body. Every chemical molecule is characterized by containing energy that it acquires during the process of its formation, and the effect of the chemical reaction results from the temperature difference between the reacting materials and the resulting materials. Of the interaction and symbolizes it ΔH, which may be positive or negative.

The calorie is the basic standard unit of thermal energy and is defined as the amount of heat needed to raise the temperature of water by one degree Celsius, i.e., for example, from 14.5°C to 15.5°C.

The use of the calorie was dispensed with due to its low value and was replaced by the kilocalorie (one kilocalorie equals 1000 calories) and was defined as the amount of energy needed to raise the temperature of 1 kg of water by one degree Celsius instead of 1 gram of water.

Importance of energy:

Energy is shared with protein in building the bodies of living organisms. Animals obtain their energy from consuming food through the process of metabolism, while plants obtain energy through the process of photosynthesis. In both forms, nutrients are ultimately transformed in the form of a high-energy compound called adenosine triphosphate. **Adenosine Try Phosphate** (ATP) is used by the organism (i.e. instantaneously and is not stored) in transferring energy between the body's cells to provide the energy needs for sustainment and production, after it is hydrolyzed

$ATP + H2O \longrightarrow ADP + Pi$

Gross energy (total energy): GE

It is the amount of heat resulting from the process of completely burning food in the bomb calorimeter in the presence of oxygen. It is measured in kilocalories/kg of food and is also called the heat of combustion of food.

the bomb calorimeter: the bomb calorimeter is a laboratory instrument used to measure the amount of a sample's combustion heat or heat power when excess oxygen combustion occurs.

the bomb calorimeter

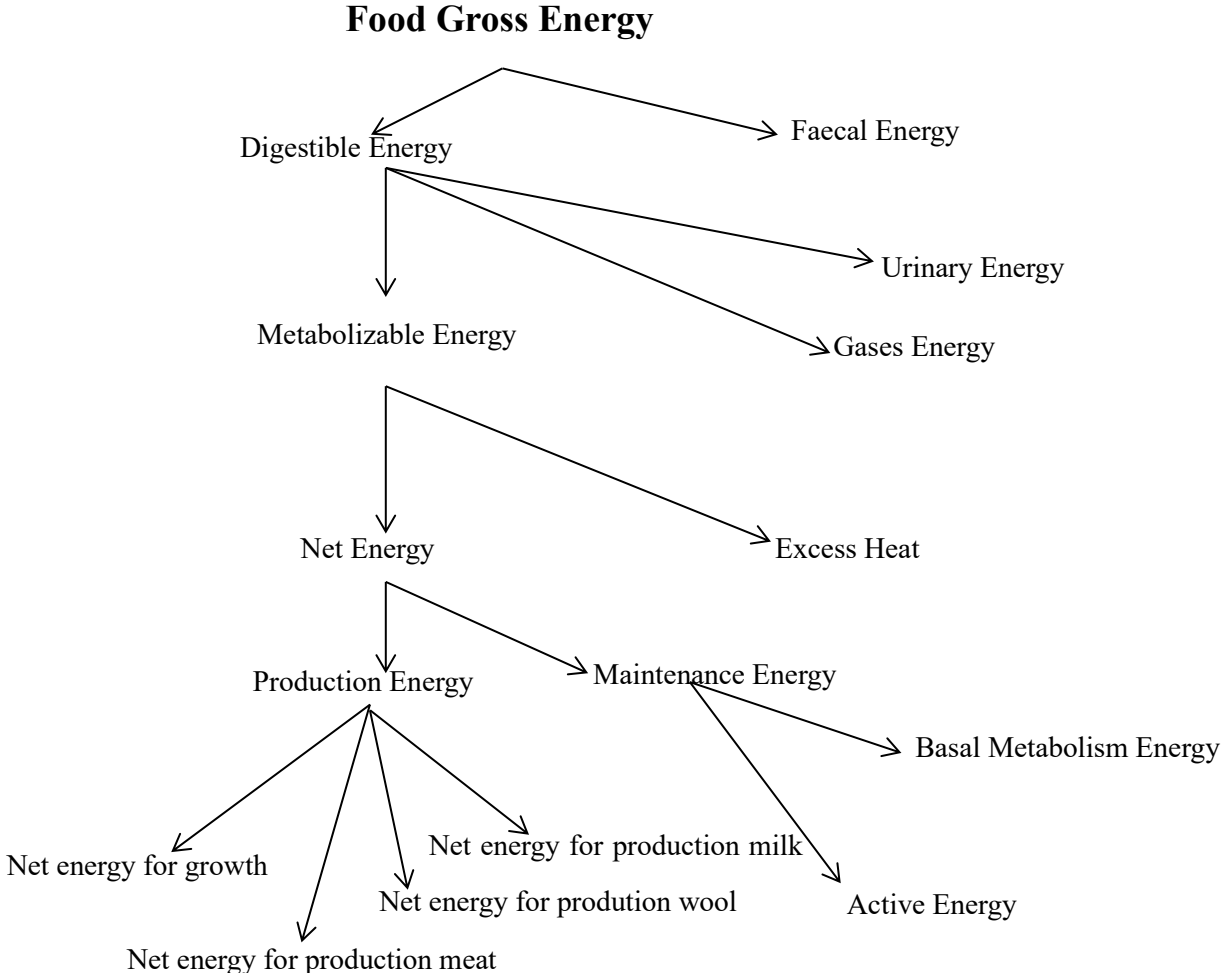
Fats contain twice as much energy as carbohydrates or proteins when oxidized:

1 gram of fat $\longrightarrow$ 9.4 calories

1 gm protein $\longrightarrow$ 5.65 calories

1 gm carbohydrates $\longrightarrow$ 4.15 calories

The total energy of food is partially utilized, and the other part is excreted with Faeces or urine or is lost from the body in the form of heat in excess of the body's need, which represents the part of food energy that is not utilized. The following figure shows a planed of the total food energy consumed and its fate during the process of digestion, absorption, and metabolism within the body:



Digested energy:

It is the difference between the total energy of food and the energy lost with faeces, and it can be estimated by measuring the **Total digestable nutrients** or directly via a calorimeter.

Faecal energy:

It is the amount of heat emitted by completely burning faeces in the calorimeter. It is also called the heat of combustion of faeces. It represents energy of food origin (undigested or unused food) and energy of non-food origin that comes from the

animal’s body and is represented by worn-out cells, mucous tissues, enzymes, bacteria, and others.

Urinary energy:

It is part of the energy excreted outside the body with urine, which comes from incompletely oxidized nitrogenous compounds inside the cells of the body and blood. It is also called internal urine nitrogen, which comes from the animal’s body and usually results from protein catabolism.

Energy lost from the body in the form of gases:

It is the energy excreted outside the body through belching or breathing and is represented by flammable gases such as methane gas, acetone gas, or hydrogen gas. It is important when calculating energy in ruminants, but it is not important and is not calculated in the case of single-stomach animals.

Metabolized energy:

It is the part of food energy ingested and digested by the animal, a large part of which is used to maintain the metabolic processes necessary for sustainment and production. It is estimated by the difference between the apparently digested energy and the energy lost in excreta and gases, or through the difference between the actual digested energy and the energy lost in excretions and gases.

Excess heat:

It is the increase in body temperature after eating food. It is estimated in a neutral environment, with a temperature ranging between the highest and lowest temperature that the body can tolerate. This is heat that is usually lost and unused in the body, except for using it to warm the body and maintain its temperature in the winter. It is measured using a special chamber to directly measure the amount of heat lost from the animal's body, called **Animal Calorimeter** or **Animal Chamer**.

Net energy:

It is the part of food energy that is completely used to sustain the body and production. It is estimated by the difference between metabolized energy and excess heat. It is less commonly used to express food energy than metabolized energy.

Maintenance energy:

It includes the energy of basic metabolism and the energy of voluntary movements in the case of maintenance and involuntary movements, such as heart movement. **maintenance energy** is defined as the minimum amount of nutritional energy necessary to maintain vital activities in the body and maintain the body's tissues failure to obtain these needs leads to processes of catabolism of the body's tissues to compensate for these needs, starting from the beginning with glycogen stored in the muscles, then fats and proteins. maintenance energy is measured under the following conditions:

1- The animal must be in a state of complete rest before and during the measurement.

2- The animal must be in a good previous state of nutrition.

3- To be in an isothermal environment (25°C).

4- The animal must be fasting or in a post-absorption (state to reduce excess heat).

In this case, the energy needs for maintenance are equal to the energy of basic metabolism, and in normal conditions and animal movement, it is not enough, and activity energy is added to it.

It is usually measured in the calorimeter chamber and the post-absorption state is achieved in ruminants after72 hours of food intake and 24 hours in monogastric animals. To avoid a state of post-absorption and heterogeneity between animals, maintenance needs are expressed in terms of the body's needs during the rest period, which is the minimum amount of nutritional energy necessary to maintain the body's vital activities and maintain its tissues while it is in a state of relaxation and comfort. Complete and good previous nutrition, and it is not necessary to be in a post-absorption state or an isothermal environment.

Production capacity:

It is the amount of food energy in excess of the body's need for maintenance, which is used to provide the body's energy needs for reproduction, growth, milk production, work, and other aspects of production, and its deficiency causes a decrease or cessation of production