
# FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

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**INAUGURAL LECTURE SERIES 37**

**29TH OCTOBER, 2015**


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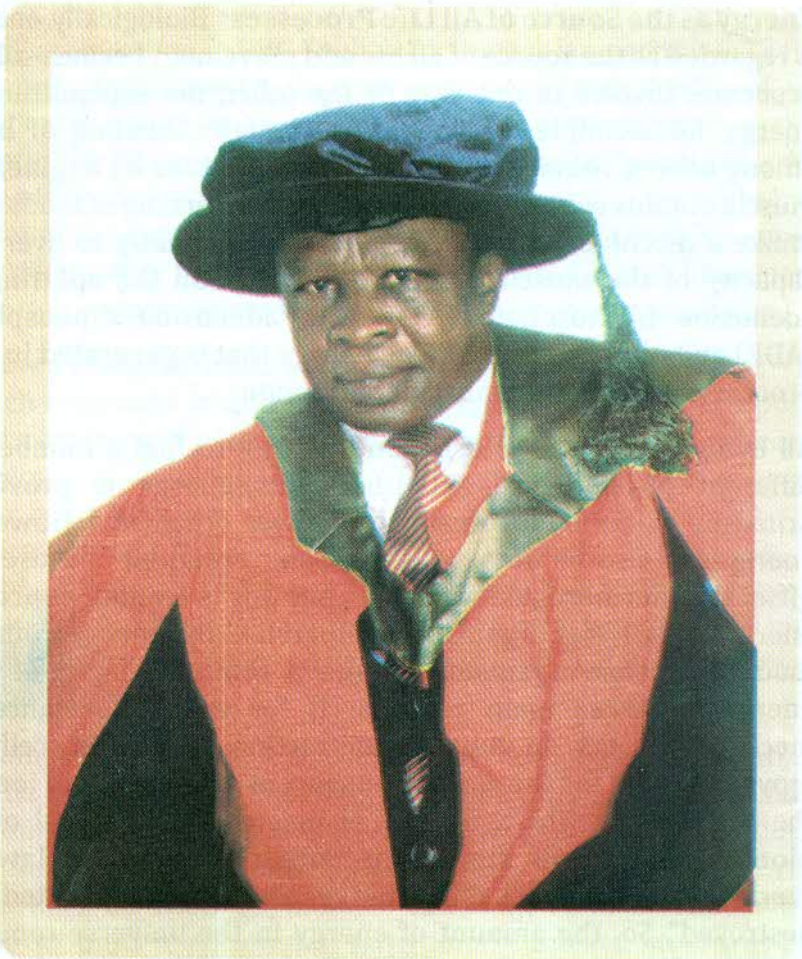

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## INTRODUCTION

**Energy as the Source of All Life Processes**: Biologically, energy is regarded as the source of all life and movement because all life processes involve in one way or the other, the expenditure of energy, for example, growth, tissue repairs, heating of body among others, require energy expenditure. Like an engine, the muscle obtains energy essentially from the burning of foods. But unlike a machine, animals need energy constantly to live. The capacity of the muscle for work depends on the splitting of adenosine triphosphate (ATP) into adenosine diphosphate (ADP) and phosphoric acid. The energy that is generated in this process is what powers muscle contraction.

All living things use calorie continuously to fuel a number of different physiological activities. This energy is provided primarily by the food consumed by these organisms. However, energy can also be obtained from solar radiation and used to offset the thermoregulation needs but this is a minor source of energy to the living organisms compared to the energy from the food. The living organisms require a continual input of free energy for three main reasons (i) for the performance of mechanical work in muscle contraction and other cellular movements.(ii) for the active transport of molecules and ions in the body.(iii) for the synthesis of macromolecules and other biomolecules from simple precursors. The first law of thermodynamics states that "energy can be neither created nor destroyed". So, the amount of energy in the universe remains constant. However, energy can be converted from one form to another (Jeremy *et al.*, 2002).

The continuous supply of energy that is used by the body is provided through the food consumption. In a short time the two sources of energy may not balance, as the food is eaten in a discontinuous manner. However, the process of digestion tends to even out the energy supply and demand over time. Since

animals cannot match consumption with their immediate metabolic requirement there is the need for energy storage.

A pillar according to BBC English Dictionary is a narrow, tall solid structure that is used to support part of a building. A pillar of any particular group is an active and important member of that group. The Bible records that God went ahead the people of Israel in a pillar of cloud to guide them in the day and in the night by a pillar of fire to give them light (Exodus 13:21-22). In this context, the pillar either in form of cloud or fire was to guide or illuminate. The two main purposes which this lecture is set out to achieve.

Today's inaugural lecture centers on food energy, a topic that is so much neglected in nutritional discussions, seminars, symposia and even in most of the students' research studies. The principal objective of choosing this topic is to create awareness or bring into remembrance, for those that know, the significance of energy of food in our daily living. Erroneously, close to 95% of research output in animal production, in recent time, see protein as the sole purpose for conducting nutritional research. It is high time this trend is reversed or modified and food energy is given the required attention.

Attempt will be made in this lecture to restrict the discussion, as much as possible, to food energy or calorie. Food calorie is the amount of energy obtained from food, available through cellular respiration. It is expressed in kilojoules (kJ) or food calories (labeling: EU kcal, US/Canada, calories). Food calorie or the 'calorie' units used often in nutritional contexts, measures the amounts of energy1,000 times greater than the units, in scientific contexts, known as calories or gram calories ('cal'). Food calories are largely referred to, less ambiguously, in nutritional contexts, as kilocalories (kcal). One food calorie is equal to 4.184 kilojoules. The energy requirements of man and animals was originally measured and expressed in terms of "thermochemical kilocalories" until the change to SI (*Systeme Internationale*) units.

Thermochemical kilocalories is usually referred to loosely as kilocalories or 'calories'; and was originally defined as the quantity of heat required to raise the temperature of one gram of water from 14.5 °C to 15.5 °C . The physicists make use of two of such units, one a thousand times greater than the other and is written with capital C while the smaller one is written with small c (Wikipedia, the free encyclopedia).Within the European Union both kilocalorie (kcal) and kilojoules (kJ) appear on the nutrition labels. In many other countries only one of the units is displayed.

In theory, food energy can be measured in different ways, such as Gibbs free energy of combustion or the amount of adenosine triphosphate (ATP) generated by metabolizing the food. Conventional food energy measurement is based on heat of combustion in a bomb calorimeter and corrections that take into account the efficiency of digestion and absorption, urea production and other substances in the urine are made. It is possible to measure the amount of energy associated with any particular food by completely burning the dried food in a bomb calorimeter, a method known as direct calorimetry. Direct calorimetry gives a systematic over estimate of the amount of calorie that actually enters the blood through digestion. This is because it also burns the indigestible dietary fibre and does not account for faecal losses.

Most fundamental works were carried out on the calorie value of foods and feeds by Rubner in 1885 in Germany and by Atwater, 1901 in America. Rubner's analysis resulted in values 4.1 calories (per gram) for mixed proteins, 9.3 calories (per gram) for a variety of fats and 4.1 calories (per gram) for carbohydrates as heat of combustion. Atwater improving on the work of his master (Rubner) analysed the urine of 46 people and arrived at the figures 4.0, 9.0 and 4.0 as the values for calculating available energy values of individual foods. In spite of decades of discussions, interpretations and scrutiny, no significant

modifications have been made to the 4, 9, 4 figures for proteins, fats and carbohydrates as the most accurate average figures for use in the calculation of human food values and nutritional needs.

**SOURCES OF ENERGY:**

The primary source of energy on earth is the electromagnetic radiation from the sun. This is the source of the energy required to sustain virtually all life processes on this planet, ranging from the simplest unicellular micro-organisms to the most complex animals including man, each depends on the combination of solar energy and photosynthetic activity of the plant cells. In the process of photosynthesis, green plants are capable of trapping 1.0 % of the solar energy, $CO_2$ is absorbed from atmosphere and $O_2$ is liberated. The radiant energy absorbed by the green plants is transformed into stable high potential chemical energy in a process described as photosynthesis, $6CO_2 + 6H_2O \rightarrow 6O_2 + C_6H_{12}O_6$. For the complete process, sunlight and chlorophyll are very essential. The stored energy of the plants is taken by animals since the animals cannot manufacture their own food due to lack of chlorophyll. When the carbohydrates are ingested and metabolized in the body, the process of photosynthesis is precisely reversed in respiration as follows:

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

Chemotrophs, animals inclusive, obtain chemical energy through the oxidation of foodstuffs generated by phototrophs (Donald *et al.*, 2008). At any given time in cells, thousands of energy transformations are taking place simultaneously. These reactions that transform carbohydrates and fats into cellular energy are called catabolic reactions or catabolism.