



## ORIGINAL RESEARCH PAPER

## Unani Medicine

### CONCEPT OF BASAL METABOLIC RATE (BMR) IN UNANI SYSTEM OF MEDICINE: AN OVERVIEW

**KEY WORDS:** Hararat-e-Ghariziyah (Innate heat), BMR, Heat, Energy

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#### ABSTRACT

The basal metabolic rate (BMR) is the amount of energy needed while resting in a temperate environment when the digestive system is inactive. Heat (energy) is the most essential thing for living beings. In Unani system of medicine this energy is defined as a Hararat-e- Ghariziyah (Innate heat) which is considered essential for Life. It is assumed that all body functions are maintained by different Capacities/Faculties of the body and these capacities are dependent on Innate heat. Heat in the body is one of the most important component because for every work heat is the basic requirement. One of the concepts of ar rat Ghar ziyya (innate heat) is there which describes that for a cell to complete its life Ra bat Ghar ziyya and ar rat Ghar ziyya is necessary. Production of heat in the body is one of the most important and very necessary tasks because for every work heat is the basic requirement. Any deviation in this heat from its normalcy and moderation, the body functions get disturbed and extreme deviation of Innate heat from normalcy is thought to be cause of death.

#### INTRODUCTION:

Unani system of medicine is manifested by physical, subtle and spiritual apparent and is an evidence based medicine which deals with preservation of health nullification of diseases. The postulation of this medicine is purely on human body and his life in respect of health and disease. Life is considered a characteristic of structure (Tarkeeb), constitution (Mizaj), metabolism (Istehala), growth (Namu), response to stimuli and reproduction. Human being consume energy to maintain life's vital process and the expenditure of this total energy is affected by several factors. Although energy is vital for the sustenance of life, the balanced nutrition that delivers the required energy is as vital, and plays a role in improving health, prevent and treat diseases<sup>2,3</sup>.

Heat in the body is one of the most important component because for every work heat is the basic requirement. One of the concepts of Hararat Ghariziyya (innate heat) is there which describes that for a cell to complete its life Raṭubat Ghariziyya and Hararat Ghariziyya is necessary<sup>4</sup>. Production of heat in the body is one of the most important and very necessary tasks because for every work heat is the basic requirement. Hararat Badaniyya is different from Hararat Ghariziyya, as it is vital metabolic heat. Basal metabolic rate (BMR) is the reflection of Hararat Badaniyya, and it changes throughout the life in an individual and it varies among different types of Mizaj and population as grouped while Hararat Ghariziyya is the reflection of core temperature of the body<sup>5</sup>. Metabolic heat is produced when oxygen initiates electron transport chain for the ATP formation that results in metabolism and production of heat and energy. In this paper we will discuss the role of oxygen (component of Arwāh) and glucose (abstract of the dietary food) to form ATP (responsible for energy) and this reaction also results in production of heat. This will be described with the reference of classical Unani literature that will be analysed with the present knowledge of the topic.

Body composition is a biological technical term used to describe the different body compartments such as lean mass, fat mass, body water and bone mass and body fat percentage. Need to estimate body composition, energy expenditure of individual or population is important because it is a major determinant of food energy requirements<sup>6</sup>. It is the minimal activity of the body which maintains the functions of

respiration, circulation, and secretion. Since Basal Metabolic Rate (BMR) constitutes about 60-70% of the total energy expenditure, it has been widely used as the basis of the factorial. The BMR of an individual can simply be defined as the minimum metabolic activity required to maintain life and is a major component of total energy expenditure during physical and mental rest. Basal Metabolic Rate is usually expressed in terms of daily rates of energy expenditure<sup>7</sup>. BMR is measured under standardized resting conditions under physically and mentally at rest, 12-14 hours after a meal and in a neutral thermal environment. However, in practice it is for more difficult to achieve the conditions of 'Basal Metabolism' than it is to define them. Two significant developments over the last decade have influenced our understanding of energy requirements of humans and their implications in arriving at the numbers of individuals in population groups worldwide who are undernourished and do not receive adequate levels on a daily basis.

The usual method for determining BMR is to measure the rate of oxygen utilization over a given period of time certain conditions.

Heat is the basic requirement of the body for metabolic function and growth. This is produced in the cell by metabolic activity of food stuff and oxygen<sup>8</sup>. Heat energy is the source for all metabolic function. Innate heat is the primary source of life. This basic heat is transferred to offspring during the zygote formation. Each individual has its unique type of identity and temperament.

#### Hararat Ghariziyyah (Innate Heat)

The innate heat or Hararat Ghariziyyah is the basic, primal form of thermal energy in the organism, which powers digestion, metabolism and transformation. Hararat Ghariziyyah or innate heat is regulated by Tabiyat for the normal function of the body<sup>8</sup>. This Hararat Ghariziyyah, which is also found in other warm blooded animals, is produced by burning of Rooh and Ajza-e-Ghizai in the body. Rutubat-e-Ghariziyah or innate fluid is the quintessence or distillate of the natural faculty and its four Humors. Hararat Ghariziyyah is produced by burning of Rutubat-e-Ghariziyah. Hararat Ghariziyyah can be correlated with the Basal metabolic rate (BMR) as both gradually decline with age.

The *Ḥarārat Gharīziyyah* (Innate Heat) or Vital Metabolic heat is a fundamental concept in Galenic medicine, referring to a physiological heat proper to living beings. Originating in the heart, it takes part in the vital and organic functions of the human body. As instrument of the soul, it animates the body in a similar way to a bodily flame. It's nature and role is bound up with the definition of life within a theoretical framework combining natural philosophy and medicine. Consequently, physiological debates on innate heat often converged on cosmological, chemical, and embryological considerations on the origin, composition, and transmission of life.

In Renaissance Galenism, innate heat is traditionally described as a bodily substance of a subtle nature, transported by the spirit, and transmitted at birth through the seed. It is also related to the radical moisture, so that the *calidum innatum* often refers to the vital substance formed by the spirit, the innate heat, and the radical moisture. Within the human body, the innate heat is sourced in the heart and cooled down by the inspiration of air in the lungs during breathing. At the same time, it is spread through the whole body to operate the vital functions. In particular, it is the instrument of the vegetative soul in order to achieve the physiological operations of generation, growth, and nutrition. It is also in charge of forming the vital spirit in the left ventricle of the heart.

Jalīnūs states that, When the fire element touches the other elements in the body, it produces balance heat which is neither so extensive that it burns the body nor it is so light that it is insufficient for change to occur in the body. Innate heat is actually heat of *ʿUnṣūr-e-Nār* (Fire element) that is produced while attaining *Mizāj* (Temperament) and is responsible for body's consistency and remains in the body throughout the life<sup>10</sup>. Aristotle assumes that *Ḥarārat Gharīziyyah* is a divine heat; it differs from other kinds of heat. Ibn Sina has defined innate heat as a kind of heavenly heat, which is gifted by God along with *Nafs* at the time of Zygote formation. Ibn Rushd defines *Ḥarārat Gharīziyya* as *Ḥarārate Ṭabīʿat* which is responsible for all the physiological functions of the body<sup>11</sup>. Zakaria Razi is also of the same view that *Ḥarārat Gharīziyya* is the heat of fire, when it is balanced, it is known as *Ḥarārat Gharīziyya*, when it exceeds the normal it is called *Ḥarārat Gharība* (Hypothermia). S. I. Ahmed also narrates it in detail as the internal heat formed in human and by which body is maintained to a specific temperature that helps to perform normal body functions. It is also known as normal heat or normal temperature. When this heat exceeds the normal it is known as *Ḥarārat Gharība*, when it is lower than normal it is known as *Ḥarārat Muqassira*. He also supports the view of ancient physician, *Ḥarārat Gharīziyyah* is initially transferred to the offspring by the parents through sperm and ovum at the time of fertilization and is responsible for the development of fertilized ovum, later on it is produced constantly by the metabolic processes and chemical changes occurring in the human being.

*Hararat-e-Ghariziyyah* can be subdivided into *Hararat-e-Ghariziyyah Nauiyah* and *Hararat-e-Ghariziyyah Shakhshiyah*. *Hararat-e-Ghariziyyah Nauiyah* is synonyms to the *Hararat-e-badaniyyah*, *Hararat-e-tabiyyah* and Core body temperature.

### Production of Energy/Heat:

Tauleed-e-*Ḥarārat* (production of heat) really has to do with energy. According to the basic theory of *Kaifiyāt Arba'a* (four qualities), every matter has these four *Kaifiyāt* (*Ḥarārat*, *Burūdat*, *Yabūsāt*, *Raṭūbat*) in different proportions. Energy comes into body as food that we eat. Energy present in food constituents as *Hār Kaifiyāt* comes inside the body and just changes its form in such a way that body can get benefited. The concept is pretty well accepted that energy is neither created nor destroyed. Energy is transformed, converted, transported, and stored, in the human body. The measure of

the energy is in calories. A calorie is the amount of heat needed to heat one gram of water by one degree Celsius. Calories are the energy stored in food, as we take it into the body, energy is either transformed or stored<sup>12</sup>.

### Rūḥ-e-Naseem (Oxygen) And Tauleed Ḥarārat Badaniyya (Thermogenesis):

It is well known to us that a process of *Istihālāt* (metabolic changes) is going on in our body. This metabolism is composed of two processes: *Kaun* (anabolism) and *Fas d* (catabolism). In the production of energy and heat, the two factors participate i.e. *Rūḥ-e-Naseem* (Oxygen), which is absorbed into the blood from the inspired air and *Akhlāt-e-Latifa* that are obtained from the digested food. When action and reaction among *Madda-e- Rūḥ* and *Khilṭ-e- Lateef* takes place, or in other words burning of nutriment takes place with the *Rūḥ*, the energy and heat (*Ḥarārat Badaniyyah*) are produced, thereby the organs of the body became able to continue their respective functions. To maintain and fulfill the need of body for everything comes from *Ghidhā'* (food) which is a precursor to produce *Akhlāt*. Food is converted into different forms i.e. bolus to chyme prior to make its final state i.e. *Akhlāt* which are formed in liver, transported and circulated to whole body so that every organ up to its cellular level can get its nutrition and excrete their waste. *Akhlāt Kaseefa* made mass (organs) for the body while *Akhlāt Lateefa* combines with *Rūḥ Naseem* in alveoli.[7,9] *Rūḥ-e-Naseem* (Oxygen) and *Khilṭ Lateef* (*Khilṭ Dam*) produce energy and heat, which is utilised for the body functions. This oxidation is the key mechanism of *Tauleed-e-Ḥarārat*.

Abu Sahal Masihi had been called food as fuel and the external air as the precursor of *Rūḥ*. Ali Ibn Abbas Al-Majoosi in his book *Kamil* us Sana has mentioned that blood is the material for production of innate heat, most preferentially depends on the respiration and followed by nutriment.[10] Oxidation of one gram molecule of glucose yields 6,86,000 calories, and maximum of 38 ATPs are formed for each molecule of glucose degraded to carbon dioxide and water. One ATP gives rise to 12,000 calories. Therefore, only 4,56,000 calories of energy can be stored in the form of ATPs, signifying an overall maximum efficiency of energy transfer of 66 percent<sup>13</sup>. The remaining 34 percent of the energy liberates as heat and, therefore, cannot be used by the cells to perform specific functions and it is responsible to maintain body heat. The process of *ehtiraq* is highly organized and the energy is released in a controlled manner. This organized and controlled heat liberation is termed as *Thermoregulation*.

Innate heat has been defined by various ancient scholars in different ways but as per its reality there are two main schools of thought. According to Jalīnūs, Zakaria Razi and Ali Ibn Abbas Majoosi: innate heat is actually heat of Fire element that is produced while attaining *Mizaj* (Temperament) and is responsible for body's consistency and remains in the body throughout the life.

According to Jalīnūs (Galen) *Hararat-e-Ghariziyyah* is *Hararat-e-Nariyyah* *unsuriyyah* that is produced while attaining *Mizaj* and is responsible for body consistency and remains in the body throughout life.<sup>14</sup>

### The Lamp Of Light

The *Rutubat-e-Ghariziyyah* is oil and *Hararat-e-Ghariziyyah* is the flame. The burning of the lamp's flame is analogous to the basic evolution and progression of the human life. The lamp of life is first lit at conception and grows gradually. At childhood and growing age the flame of the lamp is small due to small amount of as *Rutubat-e-Ghariziyyah*. It reaches maximum at the puberty. The flame of the life is only warm not hot. The *Hararat-e-Ghariziyyah* is depend on quantity of *Rutubat-e-Ghariziyyah*, which varies according to age. Every human being is born with specific *Mizaj* (constitution) buildup by *Hararat-e-Ghariziyyah*<sup>15</sup>.

Ibn-e-Sina said that longevity and existence of the life is determined by the Hararat-e-Ghariziyyah. He explained that at the time of birth quantity of Rutubat-e-Ghariziyyah is more as compared to Hararat-e-Ghariziyyah. Rutubat provides Maddah (basic material) for growth while Hararat makes changes in that Maddah and causes of growth of the body in all three dimensions i.e. tool, arz and umuq.

The ancient physicians devided the entire period of life into four stages, on the basis of quantity of Rutubat-e-Ghariziyyah and Hararat-e-Ghariziyyah present in the body.

Concept of Hararat-e-Ghariziyyah is based on deep physiological insights and principles considered most important tool during the period of growth. The development of the body organs are depend on it.

At the stage of Sin-e-Wakoof deterioration of Hararat-e-Ghariziyyah starts and dissolution comes progressively. When persons reaches at the age of Sin-e-Shaikhukhat vital heat is about to diminish completely and Burudat occupies all the organs. When complete extinction occurs in and Hararat-e-Ghariziyyah Tabi'at is unable to perform it functions for continuation of life. Rutubat-e-Ghariziyyah is the fuel to produce Hararat-e-Ghariziyyah. This Rutubat-e-Ghariziyyah is the quintessence or distillate of the natural faculty and its four humors. If there is dissolution of Rutubat-e-Ghariziyyah, it eventually weakens the Hararat-e-Ghariziyyah. A decrease in Hararat-e-Ghariziyyah alters the Mizaj relatively towards the Burudat. Hararat-e-Ghariziyyah act as a common tool for all type of the Quwa which perform body function.

Ibn Rushd said that Hararat-e-Ghariziyyah is present in seminal fluid and semen is the form of concocted blood. Hence it can be said that it is present in the body since conception.

Tabiat (Physis) constantly stand to manage and try to maintain equilibrium of the body. Istehala is a continuous process in our body that produces energy in the form of ATP and heat.

The dissolution of Hararat-e-Ghariziyyah during Istehala is a continuous process. Loss of Rutubat-e-Ghariziyyah is replaced by various nutriments. Firstly nutriments convert to Kaylus (Chyme) then further processing occurs in the liver where Kaylus converts into Akhlat (Humors). These humors are transported to the body for nourishment and provide replenishment of dissolution of Hararat-e-Ghariziyyah.

Concept of Hararat-e-Ghariziyyah is a fundamental concept and is described as physiological heat suitable to living beings. This heat is originating in the heart and it takes part in vital functions of the human body<sup>15</sup>.

Innate moisture or Rutubat-e-Ghariziyyah is the primary source of heat production as Hararat-e-Ghariziyyah.

In the production of energy and heat, the two factors of Umoor-e-Tabaiyyah participate i.e. Johar-e-Rooh (Oxygen) from air and Akhlat-e-latifa from digested food. When the reaction takes place between Johar-e-Rooh and Akhlat-e-latifa that is the Interaq of nutrients (cellular respiration), the energy and heat are produced.

Aristotle was agreed that Hararat-e-Ghariziyyah is a devine heat and it differs from other kind of the heat.

Jalinoos (Galen) about Hararat-e-Ghariziyyah says, when fire element touched the other elements of the body, it produces balance heat which is neither so extensive that it burns the body nor it is so light that it is insufficient for change to occur in the body.

Rabban Tabri said that heart is the source of Innate heat. It

reaches from the heart to various body organs through arteries.

Zakariyah Razi says that, Hararat-e-Ghariziyyah is the heat of fire. When it is balanced, it is known as Hararat-e-Ghariziyyah and when it exceeds from the normal it is called Hararat-e-Ghariba.

Abu Sahal Masihi has called Ghiza as Waqud (fuel) and the external air as the Mabdah-al-rooh (Precursor of Rooh).

Ali abbas al-Majoosi in his famous book Kamil us Sana has mentioned that " blood is the material for production of the Innate heat, most frequently depend on the respiration and followed by nutriments. and it can be understood by metabolism and cellular respiration.

Ibn-e-Sina has defined Innate heat as a kind of heavenly heat which is gifted by God along with Nafs at the time of zygote formation.

Ibn-e-Rushd defines the Hararat-e-Ghariziyyah as Hararat-e-Badaniyyah which is responsible for all the physiological functions of the body. Life depends on Hararat and Rutubat, whereas Burudat and Yabusat leads to termination of life.

M.I. Khan mentioned that Hararat-e-Ghariziyyah is initially transferred to the offspring by the parents through the sperms and ovum at the time of fertilization and is responsible for the development of fertilized ovum, later on it is produced constantly by the metabolic process and chemical changes occurring in the human beings<sup>16</sup>.

S.I. Ahmad narrates it in detail as the internal heat formed in human and by which body is maintained to a specific temperature, that helps to perform normal body functions. It is also known as normal body heat or normal temperature. When this heat exceeds it is known as the Hararat-e-Ghareeba. He also support the view of ancient physicians, stating that the genes of parents are transferred with all their characters to the child through Semen (Nutfa) and ovum, likewise the Hararat-e-Naiyyah is also transferred at the time of fertilization.

The Hararat-e-Ghariziyyah is associated with a substance known as Rutubat-e-Ghariziyyah (Innate fluid) which every individual receives in life by his parents at the time of conception. The Rutubat-e-Ghariziyyah gradually dissolute daily along with body fluids, so there comes a time when whole of Rutubat-e-Ghariziyyah dissolute, extinguishing Hararat-e-Ghariziyyah.

ar rat Badaniyya is different from ar rat Ghar ziyyah, as ar rat Badaniyya helps Tab 'at to keep ar rat Ghar ziyyah at constant temperature which is responsible for various physiological functions. It helps Tab 'at by increasing or decreasing surface temperature in accordance to Asb b Fa'ila (efficient and co-efficient factors) responsible for heat loss or heat gain by different types of mechanism described above. ar rat Ghar ziyyah is core temperature while ar rat Badaniyya is shell temperature which is caused by basal metabolic rate.

### Modern Concept

BMR is the daily rate of energy metabolism an individual needs to sustain in order to preserve the integrity of vital functions. It must be measured under conditions, which, as far as possible, avoid the influence of the external environment, for example heat or cold, physical movement and the effects of food or drugs. If these conditions are observed, the result of the measurement is considered to represent the physiological and biochemical integrity of the individual concerned. In normal free-living persons, the amount of energy provided by their diet must cover the demands of



basal metabolism plus additional amounts needed for the physical activity associated with essential bodily needs, and also those imposed by the physical work involved in occupation, in engaging in social exchanges and in leisure activities.

The term 'basal' was used to distinguish between the energy expended while performing physical activity and being at rest. BMR represents the integration of minimal activity of all the tissues in the body under steady state conditions. It is usually expressed as heat production or oxygen consumption per unit body size. A more succinct definition of BMR was presented by Mitchell 2-20 who said, 'Basal metabolism of an animal is the minimal rate of energy expenditure compatible with life'. In order to begin our analysis, it is appropriate to briefly review the historical developments in the study of BMR. This approach will enable us to appreciate the primary purpose of the early measures of BMR and how its application has evolved with time.

### Thermogenesis In Modern Perspective

Foodstuffs are mainly composed of carbohydrate, protein and fat which oxidized in the cells and produces large amount of energy in the form of heat. The physiologic processes of the cells needed energy (in form of ATP) for muscular activities, to concentrate solute in case of glandular secretion and to effect other functions. ATP is present everywhere in cytoplasm and nucleoplasm of all cells. All the physiologic mechanisms that require energy for operation obtained directly from it. This is why ATP is known as energy currency of the cells. ATP is an energy rich molecule because its triphosphate unit contains two phosphoanhydride bonds. A large amount of free energy is liberated when ATP is hydrolysed to ADP and orthophosphate (Pi) or when ATP is hydrolysed to AMP and Pyrophosphate (Ppi). This ATP-ADP cycle is fundamental mode of energy exchange in the biological systems. If any of these macromolecules like glucose, fatty acids and amino acids is decomposed all at once large amount of energy wasted in the form of heat, fortunately these macromolecules undergo a stepwise decomposition resulting release of energy in small packets to form one molecule of ATP<sup>14</sup>. Hans Krebs described three stages in generation of energy from the oxidation of foodstuffs<sup>13</sup>.

In the first stage large molecule in food are broken down into smaller units. This process is digestion. Proteins are hydrolysed into amino acids, polysaccharides are hydrolysed into simple sugars and fats are hydrolysed into fatty acids and glycerols.

In second stage, these numerous small molecules are degraded into a few simple units that play a central role in metabolism. In fact, most of them-sugars, fatty acids and glycerol's and several amino acids are converted into acetyl unit of acetyl CoA. Some ATP is generated in this stage.

In third stage ATP is produced from complete oxidation of the acetyl unit of acetyl CoA. The third stage is consist of Krebs cycle and oxidative phosphorylation, which are final common pathway in oxidation of fuel molecules<sup>13</sup>.

For example, complete oxidation of one gram molecule of glucose releases 686000 calories of energy and only 12000 calories of energy are required to form one gram molecule of ATP. Energy would be wasted if glucose were decomposed all at once into H<sub>2</sub>O and CO<sub>2</sub> while forming a single ATP molecule. Fortunately, stepwise split (glycolysis, Krebs's cycle and electron transport system) of glucose occurs, forming a total of 38 moles of ATP for each mole of glucose metabolized by cells. In glycolytic process, a net gain of two moles of ATP occurs for each mole of glucose utilized. The efficiency of this process is that, only 43% of energy is utilized in formation of ATP while remaining 57% of the energy is lost in form of heat.

Similarly, in Krebs's cycle one molecule of ATP is formed. However, because each glucose molecule splits into two pyruvic acid molecules, there are two revolutions of the cycle for each molecule of glucose metabolized, giving a net production of two molecules of ATP. During entire process of glucose breakdown, a total of 24 hydrogen atoms are released during glycolysis and during the citric acid cycle. Twenty of these atoms are oxidized in conjunction with the chemiosmotic mechanism with the release of three ATP molecules per two atoms of hydrogen metabolized. This gives an additional 30 ATP molecules. The remaining four hydrogen atoms are released by their dehydrogenase into the chemiosmotic oxidative process in the mitochondrion beyond the first stage. Two ATP molecules are usually released for every two hydrogen atoms oxidized, thus giving a total of four more ATP molecules. Now adding all the ATP molecules formed, we find a maximum of 38 ATP molecules formed for each molecule of glucose degraded to carbon dioxide and water. Thus 4, 56,000 calories of energy can be stored in the form of ATP, whereas 6, 86,000 calories are released during the complete oxidation of each gram molecules of glucose. This represents an overall maximum efficiency of energy transfer of 66 per cent. The remaining 34 per cent of the energy becomes heat and, therefore, cannot be used by the cells to perform specific functions. Although this heat released in metabolic processes helps to maintain body heat. This process explains the statement of Ali Abbas Majoosi.

Abbas Majoosi in his famous book Kamil-us- Sina has mentioned that Blood is the material for production of innate heat most preferentially depends on the respiration and followed by nutriment and it can be understood by metabolism and cellular respiration.

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