

Agni-Beyond Digestive Fire – An Exploratory Study

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Abstract

NIRUKTI / DEFINITION- Agni in Ayurvedic classics can be referred as following,

अन्नाति उर्ध्वं गच्छित अग्नि 1

अग्नौ स्वनामग्रसिन्धो तेजो भेदे 11

(वाचस्पतयम)

That which having the tendency to move forwards and it is considered to be the type of **TEJAS**.

Keywords

Agni, Fire, Digestive, Ayurveda



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INTRODUCTION

अग्नि in आयुर्वेद is reflected in the concept of पित् of this system. The term पित् is derived from the root word तप to heat or to burn.

this term is seen to have three meaning viz.,

तप - सन्तापे, तप - दाहे, तप - ऐश्वर्य

1. तप - सन्तापे refers to the generation of heat.
2. तप - दाहे related to the act of burning of the nutrition.
3. तप - ऐश्वर्य refers to that factor which is responsible to make one achieve 8 kind of benefits.

From the point of view of आयुर्वेद पित् has been described as agni since it performs the fire-like actions such as

- paka which refers to pachan
- dahana burning combustion or oxidation.
- Parinama conversion
- Prakashan illumination.
- Varna/prabhakara to cause colour and luster
- In general sense the term kaya or body itself has been equated to agni

जाठरः प्राणिनामाग्निः काय इति अभिधियते

¹ ||

It is only the agni which is located in the pitta that gives rise to beneficial or adverse consequences according as it is in normal or abnormal state of functioning.

अग्निरेव शरीरे पित्तान्तार्गतः कुपिताकुपितः

शुभाशुभानि करोति ²

Clarifying the implication CHAKARPANI has observed that this term does not mean that the pitta of the body is flaming fire and it only refers to phenomenon of heat which is associated with fire.

“पित्तान्तार्गतः इति वचनेन शरीरे ज्वालादियुक्तावन्हि निषेधेन पितोष्मरूपस्य बन्हेः सद्भावं दर्शयति” ³

By implication heat is seen to be associated with function of pitta. There are two aspects of pitta vyapar the digestion of the food and its transformation into various functional and structural factors of the body.

A careful study of the existing editions of ancient Ayurvedic classics and allied literature shows that pita performs functions similar to those of Agni.

According to Charaka, Sushruta and Vagbhata, the composition of pitta is dominated by agni mahabhuta.

पित्तम आग्नेयम् ॥

As per Charaka's observation that, "The life of all living beings is food and world seeks food". Complexion, clearness of mind, good voice, longevity, understanding, ease and pleasure, satisfaction, growth and strength and intelligence are all dependent upon the food.

The body is outcome of the food. Even so, disease is also outcome of the food. The distinction between ease and disease arises on account of wholesome nutrition or the lack of it respectively.

Food is the factor which sustains and supports the deha dhatus(tissue elements), ojas(the factor of resistance to disease and decay), bala(strength and capacity to perform physical work), and complexion among others. This food depends upon Agni to contribute to the nourishment of the body. It is obvious that the body-elements or sharira dhatus cannot be nourished and developed when food is not properly digested by Agni.

WHETHER PITTA AND AGNI ARE SAME OR DIFFERENT ⁴

The question if pitta and Agni are identical or different has been raised. The passage under reference run as follows "It may now be asked, is pitta is same as Agni or something different. The question may be answered as stating that pitta is same as that of Agni, since it performs the function as PACHANA, DAHANA, similar action performed by fire hence, pitta is considered as the AANTRAGNI.

Out of various constituents of a living body, much importance has been rendered to pitta and it has been accepted that almost all the vital activities depend either directly or indirectly on the pitta.

By the term jatharagnipaka is meant the digestion of food under the influence of the jatharagni. The jatharagni was shown earlier to be a synonym of pachakapitta (agni) the other synonyms of its being: - KOSHTHAGNI, ANTRAGNI, KAYAGNI AND audrya – tejas.

Jatharagni describes the intestinal digestion and the process involved in it, in simple terms, or in other words, it seeks to generalize these processes. The term intestinal has been advisedly used here on the basis of description of the adho-amashya furnished by chakrapani data quoted elsewhere. it will be recalled that he

has also described this part of the amashya variously as agnashya and pachyamanasya meaning the organ of agni where the food is cooked or digested. The organ is also known as kshudraantra or small intestine and grahani.⁵

The term jatharagni would seem to stand for and comprise several factors such, for example as the several enzymes which participate in the digestion of the different components of food in the small intestine. In this sense jatharagni would represent a complex of substances isolated from others of its kind, present in this region of the alimentary canal.

The concept of agni of Ayurveda which refers to the manifold functions ascribed to pitta is at once comprehensive. It is only includes chemical agencies responsible for the aharapachana in the koshtha which leads to the separation sarabhaga of the ahara from the kittabhaga but also the metabolic events –energy, synthesis, and maintenance metabolism.⁶

HISTORICAL REVIEW

1. AGNI IN THE SAMKHYA SYSTEM - agni in the samkhya view is potentially present in the rajoguna of the mukaprakriti- the

other two gunas being, sattva and tamas. The phenomenon of tejas or agni – understood at the phenomenon level in many forms viz., the force of motion, radiation, heat, electricity and magnetism(including forces of cohesion and friction) is implicate in the concept of and potential in rajoguna of mulaprakriti. The origin of agni – both the physical and biological is, therefore to be traced to rajoguna of mulaprakriti.

2. AGNI IN NYAYA – VASHESHIKA

According to Nyaya-vaisheshikas, tejas, in which agni is implicit, is one of the navadravyas and it is represented by tejaswpramanu. One of the properties ascribed to tejas pramanu by nyaya vaisheshikas is heat.

3. UDAYANA- in his Lakshanavali has defined Tejas as that which is substratum of colour and which shares a common substratum with the absolute absence of taste.
4. KANADA RAHASYA- has stated that Tejas is that which has a

common substratum with colour but not with weight.

5. ACCORDING TO VYOMAVATI- quoted by umesh mishra the qualities of tejas can be summed up as follows- its colour is illuminating and touch is hot.
6. ACCORDING TO PRASASTPADA- the natural movements of tejas is upward. Its colour and touch do not undergo any chemical change, hence they are nitya and eternal in the pramanus and anitya or non-eternal in karya or products.
7. ACCORDING TO ANNAMBHATTA – in his Nyayabodhini on tarkasamgraha has stated “An unripe fruit ripens, under the influence of solar heat”.

Thus the study of Ayurveda presumes the possession of adequate knowledge of the physical, chemical, biological, and psychological theories furnished among others by the Nyaya and vaisheshika darshanas .

The concept of ANTRAGNI and PITTA have to be studied in the light of contribution made by these darshanas and

commentaries there on; to do otherwise will lead to such preposterous translation of PITTA as the liver bile which will be shown at a later stage to be MALA (KITTA i.e. waste product of the RAKTA).

Continuing from where we disagreed to the study in brief of the concepts of agni vis a vis Pakas it will be recalled that ayurvedic concepts of digestion and metabolism are based on the concept of Pitta.

It is therefore necessary in passing to make a brief reference again to the concept of pitta. Pitta , like VATA and KAPHA ubiquitously present in all the parts of the body. The functions, normal and abnormal it is generally stated to perform according to MARICHI as recorded in CHARAKA SAMHITA are as shown in the table.

AS PER CHARAKA SAMHITA NORMAL AND ABNORMAL FUNCTIONS OF PITTA

PAKTI- The promotion of digestion.	APAKTI- The impairment of the digestion
DARSHANA- the visual promotion.	ADARSHANA- the visual impairment
MATRAUSHAM A- responsible for the production of	AMATRAUSHMAN A- The impairment for the production of

normal body heat.	normal body heat.
PRAKRITI VRANA- the production of normal colour and complexion of the body.	VIKRITI VRANA- the causation of abnormal colour and complexion of the body.
SHAURYAM- courage	BHAYAM- Fear complex.
HARSHANAM- cheerfulness. PRASADANA – lucidity of the mind.	KRODHAM- anger, rage. MOHAM- confusion, clouding, thinking.

AS PER SHUSHRUTA SAMHITA NORMAL FUNCTIONS OF THE PITTA

PHYSICAL	MENTAL
Ragakrit – aids in normal colour of the body.	Medhakrit- aids intellectual functions.
Paktikrit – aids in digestion and metabolism.	
Ojokrit- aids in production of the ojus.	
Tejakrit- aids vision – light and colour.	

Ushmakrit- aids in production of the body heat.	
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AS PER ASTANGA HARDYAM NORMAL FUNCTIONS OF THE PITTA

PHYSICAL	MENTAL
Pakti- digestion and metabolism.	Buddhi- enables to know i.e. knowledge.
Ushma-production of the body heat.	Medha- promotes the intellect- memory.
Darshanam- enables the visual perception.	Dhi- promotes intelligence and understanding.
Prabha- production of luster of the body.	Dhairyam- responsible for courage.
Kshut- causes hunger and appetite.	
Trit- causes thirst.	
Ruchi- promotes desire and relish for food.	
Tanu mardavam- promotes the suppleness of the body.	

PACHAKA PITTA

The concept of pachaka pitta is fundamental importance, especially when studied in the light of some of the more recent developments in the field of GASTRO-ENTEROLOGY.

The concept- charaka has envisaged this concept in very general term as follows-

Koshthagni is the leader of all factors concerned with the digestion and metabolism in the body.

पंचभुतात्मकत्वेऽपि यतैजसगुणोदयात् ।

त्यक्त्वात्त्वं पाकादिकर्मणाऽनलिब्धतम ॥

पचत्यन्न विभजते सारकिङ्गौ पृथक् तथा ।

करोति बलदानेन पाचकं नाम तत्समृतम ॥

The concept of the pachaka pitta (KOSTHAGNI) has been described by three main authorities of ayurveda viz., CHARAKA, SUSHRUTA, and VAGBHATTA at distinct periods of time.

- According to CHARAKA – 500 B.C. “KOSTHAGNI (PACHAKA PITTA) is the leader of all factors concerned with the digestion and metabolism in the body of all living beings. The activities of all these factors normal and abnormal are derived from and dependent upon an

increase or decrease as the case may be, of JATHARAGNI.

- He proceeds to observe that the seat of agni in the region above the nabhi(umbilicus). The seat of agni also called as the GRAHANI, because it receives and retains the food for the duration of its digestion. The structure of grahani is supported by the agni. It retains the food which is still to be digested, while the the digested portion of itthe food is moved down to the pakwashya on either side.
- Pachaka pitta known variously as jatharagni, koshthagni, antragni, pachakagni and dehaagni etc.; while being located in its own place in area between amasaya and pakwasaya directly participates in the digestion of the food and at the same time, lends support to and augments the functions of the remaining pitas, present elsewhere in the body.
- It would be seen from the foregoing that the ayurvedic concept of agni includes, not only five types of pitas but also, the dhatwagni and bhutagni. It is clear from the classical ayurvedic texts that the enumeration

of the number of agni various from author.

- According to charaka samhita read together with its main commentary by the chakrapani datta, the number of agni enumerated are over 13 as shown below:-
 1. Antragni- 1
 2. Bhutagni-5
 3. Dhatwagn-7.
- On the other hand as per sushrutha is seen to have described only five agnis viz. pachakagni, ranjakagni, alochakagni, sadhakagni and bhrajakagni. There is however indirect reference in Sushtutha samhita to five bhutagni, in brief description made to the transformation which food stuffs undergo in the organism. When these agni n taken into the consideration the total no. of the agni avccording to the sushrutha would be ten.
- Vagbhata is seen rekoned in all the 23 agni.
 1. Pitta- 5.
 2. Bhutagni-5.
 3. Dhatwagni-7.
 4. Doshagni-3.
 5. Malagni-3.

GRAHANI AND PACHKA PITTA

Both sushruta and vagbhata have described this concept with a wealth of details. A reference was made earlier to the kala viz., the pittadhara kala that covers the regions between the amashya and pakwashya. It was then noted that kala that obtains between the amashya and pakwashya is where it obtains is spoken of as the grahani. The main function of this part of koshtha is support Gives to the pachaka pitta which is required for the digestion of the food brought to this part of the koshtha on its way to pakwashya. Sushrutha observes further that located as grahani is on the way to pakwashya. It aids in the sepration of the sara of the food from kitta it is because of these functions that this structure is known as grahani.

It is seen as already referred to elsewhere that in sushrutha's view that the integrity of grahani depends upon the agni and the latter is located in the former. Any impairment in the agni involves ipsofacto the integrity of grahani and vice a versa.

The foregoing represent a few important references which have an immediate bearing on pachaka pitta and kala, known as pittadhra kala vis a vis portion of the

koshtha, described as grahani. Stated in general term, we are called upon to study the concept of pachaka pitta on the background of pittadhra kala and grahani.

Pittadhra kala was discussed already and it was then shown that its description bears a very close resemblance to the mucosal covering, in particular of the small intestine.

As stated elsewhere, the pittadhara kala would also appear to be the structure that makes available the pachaka pitta. It is seen in addition that integrity of this kala depends upon pachaka pitta and the relationship that exists between the former and the latter is comparable to that between the structure and function.

The structure in the present case is the pittadhra kala and function among others is its secretion- the pachaka pitta.

The concept of pachaka pitta, as reflected in the citation above, studied together with the citation quoted earlier from Charaka Samhita that, "koshthaagni is the leader of all the agni open out many significant and far reaching possibilities.

They envisage an intimate generic relationship that is stated to exist between the pachaka pitta (agni) in the adhoamashya or small intestine, on the

other hand and the amshas i.e. parts or moieties of it present ubiquitously in the dhatus on the other.

- The increase of former (qualitative and quantitative) is stated to result in corresponding increase in the activities of the latter. An outcome of such increase and decrease as the case may be, of the pachakaamshas present in the dhatus has been stated to contribute to a decrease (atrophy-wasting) or an increase (hypertrophy) respectively of the dhatus, subject of course to the availability of indhana (fuel) to the dhatus in the poshaka dravyas (nutrient substances).
- The idea basic to the two kind of events discussed above can be illustrated with the examples of clinical conditions described in Ayurveda as atyagni or bhasmaka roga and mandaagni which in modern parlance correspond to hyper and hypo metabolism, respectively.
- Sushruta is stated to exhibit the condition atyagni or tikshna (bhasmaka roga) symptomatology described below:- The patient easily digests even a very heavy meal in an

exceedingly short space of time. He suffers from voracious hunger, parched throat, plate and lips and other discomforts – his all frequent and heavy meal notwithstanding

- Charaka furnishes more detail of this condition. They are : “ in a person afflicted with atyagni the food ingested is digested as rapidly as it consumed; having thus consumed the food, it is also begins to consume the dhatus or the tissues of the body , such as rakta or blood etc. the patient is then afflicted with debility and disease that leads to death. He feels relieved (satisfied) when he has eaten his food but feels faint on the completion of digestion of the food ingested.
- Vijayrakshita has stated that this condition is also spoken of as “bhasmaka” as in this state not only the food that is eaten but also the body tissues are burnt into ashes.
- The condition described above as atyagni(tikshanagni or bhasmaka, as it also called) is reminiscent of an analogous condition , described in modern medicine as hyper metabolism, usually associated with

hyperthyroidism. This condition is marked by gradual increase or speeded up cellular respiration which has been shown to result in the liberation of so much of heat that the affected person feels hot all the time. In spite of gluttonous eating, so much of food is burnt that the body weight may decrease; the person is constantly under the nervous strain and highly irritable by stimuli and, yet is unable to do sustained work due to the lack of fuel reserve. He suffers from the retarded growth.

- Mandagni described in Ayurveda in which the dhatus(tissue elements) are atated to mundergo vriddhi (increase, growth or hypertrophy) is comparable to hypo metabolism, usually associated with
 1. Hypothyroidism.
 2. Simmonds disease.

Hypo-metabolism associated with hypothyroidism is stated to occur due to low thyroxin availability. It will be recalled that the thyroxin activates cellular oxidative process throughout the body. Thus, in this condition, under reference, there is seen to be reduction in the oxidative reactions and the basal metabolic rate has been shown to

fall -25. It exhibits the following symptoms:- the development of myxedema, reduction in the mental and bodily vigour, loss of sex drive, loss of hair, and the abnormal thickening of the skin, as if much water has been accumulated in it- oedema or shotha which latter leads to an increased body weight, since less of food is burnt in the cells and much of it is stored up as fat- a condition which closely resembles the description of medo vridhhi and maamsa kshaya.⁷

Simmond's disease is stated to be due to failure of thyrotropic function of the pituitary gland which results in insufficiency of thyroxin availability. It is seen not to involve the thyroid as such in the morbidity. The basal metabolic rate, in this condition, is seen to be very low.⁸

These examples illustrate the condition described as atyagni and mandagni which according to Ayurveda, involve the tikshanata and mandata respectively of kayagni (pachakagni) and its amshas present in the dhatus.

TYPES

Making a classification of agni in ayurveda requires proper understanding of the location, its functions and disease arises due

to malfunctioning of the agni either due to over or hypo functioning. For better understanding the agni can be classified into following types. The subclassification can be made for better and easier understanding as follows:-

1. Classification based on the location.
2. Classification based on the action performed by it.
3. Classification based on the similar properties shown by other elements.
4. Classification based on the chemical/physical characteristic.
5. Classification based on the Dosha predominance.

➤ Classification based on the location—

- Jathragni.
- Bhutagni.
- Dhtawagni.
- Malagni.

➤ Classification based on the action performed by it---

अग्नि शारीरेषु चतुर्विधो विशेषो

बलभेदेन भवति तदथा –

तीक्ष्णो, मन्दः, समो, विषमक्षचेति ॥

(च.वि.६/१२).

Agni in ayurveda classified under four types

- Classification based on the similar properties shown by other elements
 - As PITTA.
 - As acha pitta.
 - As nueral control- SAMANA VATA.
- Classification based on the chemical/physical characteristic
 - As a liquid state.
 - As a dry state.
 - Concept of pithr paka and pilu paka vada.
- Classification based on the Dosha predominance.

विषमो वातेन, तिक्शणः पितेन, मन्द श्लेष्मणाः,

चतुर्थं सम सर्वसाम्यादति॥

(सु.सू.३५/२०).

DOSHAS PREDOMINANCE	TYPES OF AGNI
VATA	VISHAMAGNI
PITTA	TIKSHNAGNI
KAPHA	MANDAGNI
SAMA	SAMAGNI

1. **VISHAMAGNI**- As it is vata predominant, sometimes digests slowly, sometimes normally and sometimes produce Adhmana, Sula,

Udavarta, Atisara, Jathra, Gaurava, Antrakujana, Pravahana.

2. **TIKSHNAGNI**- As it is pitta predominant, digests even large quantities of all, too frequent meals; after digestion produces Galashosa, and Daha, Otha shosha, and Talushosha and Santapa.
3. **MANDAGNI**- As it is kapha pradhana- Cannot digest even normal diet properly causing udaragaurava, Sirogaurava, Kasa, Svasa, Praseka, Chardi and Gatrasedana.
4. **SAMAGNI**- As this is due to all the dosha, properly digests the normal diet.

AGNI W.S.R. TO HEALTHY STATE

Health as per WHO defined as “A state of physical, mental, spiritual and social well being not merely a absence of disease or infirmity”.

Ayurveda defines health as the equilibrium of the Doshas, Dhatus, Malas and Agni. Samagni refers to the equilibrium of all the three doshas and necessary to maintain the health.

समदोष समाग्निश्च समधातु मलक्रियः

प्रसनात्मेन्द्रिय मनः स्वास्थ्यः इति अभिधीयते ॥

It has been understood from the above said shloka that AGNI is one among the prime factor to maintain the health of a person. If there is any impairment in the agni leads to various consequences.

There are several other references in the ayurvedic classics which describes the importance of the agni and maintenance of health.

आयुर्वणो बलं स्वास्थ्यं उत्साहोपचयः प्रभा ।
ओजस्तेजोअग्नयः प्राणोक्षचोक्ता
देहाग्निहेतुकाः ॥
(च.चि.१५/३)

The dehaagni is the basis of strength, positive health, longrivity, complexion, increase of cheerfulness, luster and resistance to disease and decay.

As per Yoga-Ratnakar

अग्निमूलं बलं पुंसा रेतोमूलं तु जीवितम
तस्मात् सर्वं प्रयत्नेन वह्निं शुक्रं च रक्षयेत्
॥

The most recent aacharya yoga-ratnakarhas stated that agni is the mula of the bala in man as retasis the root of the life. Therefore

urged to need to carefully preserve agni and retas.

AGNI WITH W.S.R. TO DISEASED STATE

- As explained in the classics AAHARA is considered to be the factor which is responsible for the proper functioning of the body both physically and mentally.
- To do the proper PAKA of the AAHARA the main requirement is the good quality of the agni if that is lacking give rise to impaired digestion and leads to the manifestation of the various disorders.

अग्नि दोष मनुष्याणां रोगसंघा पृथिवधाः
मलवृध्या प्रजायन्ते
विशेषेण उदराणि तु ॥

(च.चि.१३/९)

- The branch of AYURVEDA i.e. KAYACHIKITSA which entirely deals with the AGNI- Its description, action and disease related due to the malfunctioning of the Agni.

कायस्यान्तरे अग्ने चिकित्सा
कायाचिकित्सा ॥

- Its not only in the AYURVEDA that the AGNI is the prime factor for manifestation of the disease. But even in the contemperoroy science we will get description as the GASTROINTENSTINAL disease root cause of all the disease manifestation.
- CONSTIPATION - Root cause of all the disease.
- INDIGESTION leads to all other disorders.

Hence, we can say that these are few scattered reference in the classic and other science to supports the importance of the Agni.

The disease which are to be concerned with the increase agni is to be considered due to increase and decrease of the agni---

The consequences which may happen due to the Mandagni or impaired or hypo functioning of the agni is the Ama

In the ayurvedic viewnearly all of the disease included under kayachikitsa, have their origin in Amadosha, Amadosha and Amavisha are conditions which are stated to occur due to the impairment of the agni.

APPLICATION

समानोग्नि समीपस्थः कोष्ठे चरति सर्वतः

अन्नं गृह्णाति पचति विवेच्यति मुञ्जति ॥

(अ.ह.सू.१२/८)

उष्मणोल्पबलत्वेन धातुमाधम अपाचितम् ।

दुष्टमाशयगतं रसमामं प्रचक्षते ॥

(अ.ह.सू.१३/२५)

Kayachikitsa one among the eight branches of the Ayurveda. In its scope, it embraces the entire field of medicine known today as internal medicine. Both chakrapani datta and Gangadhra sena have described it as Antragnichikitsa.

The term Antragni and Kayagni are synonymous.

दुष्यं देशं बलं कालम अनलं प्रकृतिं वयंः ॥

सत्त्वं सात्मयं तथाआहारवस्थाश्च पृथग्विधाः ।

सूक्ष्मसूक्ष्माः समीक्ष्यैषां दोषोषध निरूपणे ।

(अ.ह.सू.११/६६-६७)

A decrease or an increase of dhatus occur according as the tikshnata or mandata of the pachkaagni present in the dhatus.

As the flame of the forest fire tendes to increase or decrease according to the quantity of indhana so also is the case with Dhatu prampara.

(अ.ह.सू.१२/१०-१२)

CONCLUSION

Agni is the great entity explained in the Ayurvedic classics not only explained about the digestive functions but beyond the digestive functioning includes hormonal, neural endocrine and even beyond these.

The possible and sincere effort has been made to explain the functioning of the Agni as per Ayurvedic and modern perspective

Hence it can be concluded that Agni is beyond digestive functioning and a complex entity explained by our great Acharyas which is to certain extent explained and understood by the present physician need much more exploration for the better understanding of the disease and counter act the pathology and to provide a healthy and happy life for human beings.

REFERENCES

1. Introduction to Kayachikitsa – By C Dwarakanath, 3rd edition, pg- 46-50, pp-399.
2. Charaka samhita by Dr. Brahamanand Tripathi, reprint 2011, 13th chapter, pg-471, pg-1450.
3. Kayachikitsa by – Vidyadhar Shukla, Reprint 2005, pg-2005, pg-194, pp-640.
4. Sushruta Samhita, Sutra sthana by Kaviraj Ambika Dutt Shastri, Poorvadh reprint 2008, 5th chapter, pg-41, pp-286.
5. Fundamentals principal of Ayurveda – By C. Dwarakanath reprint 2003, pg-20, pp-211.
6. Concepts of Jathragani in Ayurvedic medicines – by Salavurao Gopal, 2nd edition, pp-408, pg-11.
7. Concepts of Jathragani in Ayurveda – A Patho-physiological Study by Vaidya S.N. Sharma, pg preface – 01,16, 122, pp-135.
8. Text book of medical physiology – by Guyton and hall 9th edition, pp1147, pg-909, chapter 72nd energetic and metabolic rate.