Digestion and Humours in the Metabolic Process

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Overview

There is an increasing incidence of obesity in the world. It is associated with an increased risk of many chronic diseases, from diabetes, hypertension, heart disease, strokes and cancers, to many digestive diseases. The World Health Organisation projects that, by 2015, approximately 2.3 billion adults will be overweight globally, and that at least 700 million people will be obese. Evidence supports the contribution of both excess energy intake and decreased energy expenditure as major contributing factors in the obesity epidemic. Research also suggests that a person's risk of becoming obese increased by 57% if a friend became obese.[1]

The age-old saying that 'you are what you eat' relates to the impact that food has in the body; from bad eating habits; whether it be from, for example, an excess of fats, salt and refined foods, to a deficiency of healthy fruit and vegetables. However, the efficiency of pepsis to digest, assimilate and metabolise nutrients and eliminate metabolic waste from the body, is as important, as any interruption to the stages of digestion over a prolonged period of time, will result in many diseases and chronic conditions. 'The relation between the quality of food and the quality of chyme gives us a clue to the how the ultimate components of the food travel'.[2]

Tibb recognises the uniqueness of each individual, and that each person should take responsibility for one's own health and wellbeing, by choosing and regulating the type of food consumed; breathing fresh, clean air; getting sufficient rest and sleep; managing emotional stress, exercising regularly and in moderation; and elimination of waste products.

As each person has a unique temperament, with a balanced mixture of humours and qualities, so is the prescription of lifestyle factors, which are tailored accordingly. An excess of the qualities of heat, moisture, coldness or dryness will have a negative impact on the body.

As food and drink are transformed into innate heat through the process of digestion, any interruption in this process will affect the production of the humours. The humours arise in the second stage of digestion in the liver; therefore all the processes of digestion are necessary in order to facilitate the absorption and assimilation of food, thereby increasing the efficiency of cellular and metabolic functioning. When the body is functioning at its optimal capacity through correct

lifestyle choices, which are suitable for each person's temperament, the rate and efficiency of metabolism will be enhanced.

Components of Digestion

The digestive system extends from the stomach to the anus. It consists of the alimentary tract and the accessory organs. The primary organs of the digestive make up the alimentary tract and include: the mouth, stomach, small and large intestines and the rectum. The accessory organs include: the teeth, tongue, liver and pancreas. The liver and gall bladder serve as exocrine organs, and the pancreas serves both as exocrine and endocrine organs.

The wall of the intestine has a large surface area for absorption, and it has villa, or finger-like projections, which contain blood vessels and lacteals. The lymphatic vessels originate in the villi. The ileum is the last part of the small intestine, which joins the large intestine at the cecum, and ends at the appendix.

The large intestine (1, 5 meters long) comprises the ascending, transverse and descending colon, which ends at the sigmoid colon and rectum. Salts and water are absorbed in the large intestine, so that the faeces (indigestible products) are formed and not in a fluid form. The intestines and abdominal cavity are covered by peritoneum (greater omentum), which acts as a heat insulator and prevents friction between abdominal organs.[3]

The Main Organs of Digestion

The main organs involved with digestion are the stomach, small and large intestines and the accessory organs of the liver, gall bladder and pancreas.

The Stomach

The temperament of the stomach is ***dry and hot.*** The stomach is a hollow muscular organ, which mixes and stores up to 2 litres of masticated food. Its main digestive function is to break down protein with the proteolytic enzyme pepsin, helped by hydrochloric acid. The stomach's muscular walls churn up the swallowed food, and mix it with digestive juices to produce *chyme*. The stomach's temperament allows it to tolerate the heat and acidity of the digestive process.

The temperament of the gastric exocrine glands is hot and moist. They secrete gastric juice into the stomach lumen which contains high levels of the pro-enzyme *pepsinogen*, which converts to the active form, pepsin, by the action of hydrochloric acid. This acid has a dry and hot temperament, which provides a high acidic environment in the stomach (pH about 2.0), and helps to destroy micro-organisms and break down food.

The stomach also secretes a form of mucus, which prevents the stomach lining from being digested by the pepsin and hydrochloric acid. The temperament of this this mucus is cold and moist. As the stomach possesses a dry and hot temperament, an increase in dryness can result in disorders such as gastric ulcers, gastritis and hyperacidity. Conversely, an abnormal increase in the quality moistness can lead to indigestion.[4]

The Oesophagus

The oesophagus is part of the stomach – it is narrow in the beginning and it becomes wider until it reaches the stomach for storage of food. The nature of the oesophagus is very close to muscle, while the nature of the stomach is very close to fat. The mucosal layers of the oesophagus are the same as those of the stomach.

- The ***inner*** and longer ***vertical*** folds of the oesophagus facilitate swallowing, and which ***pull*** the food and drink down into the stomach. It has lots of ***nerves*** which protects it and resists hard substances.
- The ***outer*** layers of the oesophagus on the lower part are more ***muscular*** and rough, with ***horizontal*** folds which are wider, which puts pressure on food to ***push*** it towards the stomach. Because the muscular layer has qualities of heat, it facilitates easier ingestion of food. The lower opening of the outer layer is the stomach orifice, which has nerves that come from the brain which attach to this opening. These nerves heighten the sensation of hunger and the need for nutrition.

Whereas the process of swallowing and pulling food into the stomach requires using layers that are closer together; the outer layer is for pushing as the layers are further apart to facilitate passing and pushing of food.[21]

The Small Intestines

The temperament of the small intestine is ***hot and moist.*** The digestive enzymes, namely lipase, trypsin and amylase, are secreted into the lumen of the small intestine from the pancreas. These enzymes are responsible for the breakdown of proteins, fats and carbohydrates, which are present in the chyme, into smaller substances. These in turn are acted upon by other digestive enzymes, such as peptidases and maltase, which results in the formation of the basic components of food – amino acids, fatty acids and glycerol, and monosaccharides. These are then absorbed through the intestinal wall into the body.

It is essential for the small intestine to maintain its hot and moist temperament, as any increase in the quality of heat can lead to a hot and dry qualitative imbalance. This in turn can result in disorders such as enteritis and duodenal ulcers. On the other hand, an abnormal increase in the quality of moistness can lead to under-activity of the small intestine, such as malabsorption of fats.

The Large Intestines

The temperament of the large intestine, or colon, is ***cold and dry.*** An abnormal increase in the quality of dryness can lead to piles, anal fissures, colitis and constipation. On the other hand, an abnormal increase in the quality of moistness can lead to diarrhoea.[4]

The Liver and Gall Bladder

The liver is on the right side of the stomach because the stomach is cone-shaped on its right side, which makes a good fit. Finger-like projections from the liver surround the stomach, which stabilises the liver on the stomach.[21] The seat of the power of metabolism is the liver, but the process is active in every tissue of the body. The liver regulates the endocrine/glandular systems and nutritional use, and produces biochemical energy, performing its functions of metabolism, enzymes and hormones. It is an accessory organ of the digestive system. The temperament of the liver is ***hot and moist*** and it is made up mainly of epithelial tissue. The moist aspect provides support and balance to the predominately dry quality of the surrounding organs and structures, by their continuous internal movement, thereby counteracting any excess of their dry qualities. The liver offers protection against excessive build-up of dryness, especially in the stomach (dry and hot) and the transverse colon (cold and dry). Other neighbouring structures include the diaphragm (dry and hot), the heart (dry and hot) as well as the lungs (hot and dry).

The functions of the ***liver*** include converting glucose (sugars) to glycogen (stored sugar); storage and filtration of blood, and it matures red blood cells; detoxification; thermal functioning; synthesis of the four humours; and storage of vitamins and minerals (Vitamin A, D, E, and K). The liver produces bile (hot and dry), which is stored in the ***gall bladder (dry and hot).*** Bile contains bilirubin, bile acids, cholesterol and phospholipids. The functions of ***bile*** include breaking down fats in the body; absorption of fat soluble vitamins – it helps convert beta-carotene into vitamin A; assimilation of calcium; promotion of peristalsis – the action of the colon which prevents constipation.[4]

Nutrients flow into the liver via the mesenteric vessels where they are further digested, which requires heat in the liver for this to occur. Food is totally digested in the liver which forms the four humours. Food that is not needed for digestion is excreted as chyle, which contains lymph and emulsified fat, extracted from chyme by the lacteals. The four humours are split in the liver, and they are directed to where they are needed, while excess humours are stored; i.e. the bilious humour in the gallbladder and the melancholic humour in the spleen.

The Pancreas

The temperament of the pancreas is ***hot and moist.*** It is a relatively small organ, about 15 cm in length and 100 gm in mass. It has dual endocrine (insulin secretion) and exocrine functions (digestive enzymes). The pancreas is the digestive system's main secretor of digestive enzymes. Pancreatic juice produces about 1.5 litres daily. It is an alkaline fluid, containing enzymes which are capable of digesting all food types –- proteins, fats and carbohydrates – all of which are secreted into the duodenum section of the small intestine, via a *papilla.*

Tibb regards the pancreas as 'the mattress for the stomach', and the liver as 'the blanket for the stomach'. The reason is that the two hot and moist organs (liver and pancreas) protect the two dry and hot organs (gall bladder and stomach). The pancreas is a structurally a sensitive gland, and needs to maintain a rigorous control of its hot and moist temperament. Any abnormal increase in the quality of heat can lead to a hot and dry qualitative imbalance, which can result in pancreatitis.

Conversely, an increase in the quality of moistness, can result in pancreatic insufficiency or under-activity.[4]

The Process of Digestion – simplified

The stomach performs digestion through its natural heat that comes from its muscles and the adjacent organs. Food and drink must be changed into smaller molecules of nutrients before they can be absorbed into the blood and carried to cells throughout the body. This involves four stages of digestion:

1. **Ingestion**
   Ingestion is the process by which food is taken in via the mouth, involving chewing and grinding of the teeth – mastication. Digestion is also known as pepsis, which begins in the mouth. The senses of smell, taste and the imagination stimulate the salivary glands (sublingual, submandibular and parotid) to secrete saliva that lubricates the food.
2. **Digestion and Metabolism**
   Digestion is the process or act of converting food into chemical substances that can be absorbed and assimilated.[5] Digestion involves two processes:
   a) **Mechanical digestion** is the process of chewing and grinding the food in the mouth with the teeth, as well as churning and mixing the contents of the food in the stomach. It is important that food is properly chewed and mixed in the mouth before swallowing, as the acidity of the stomach will block the enzymatic activity of salivary amylase.
   b) **Chemical digestion** is the process of stimulating enzymes to break down food into soluble particles before it is absorbed and assimilated by the body. Initially the salivary glands are stimulated in response to the thought of food, sight and smell. Salivary amylase breaks down carbohydrates, from the larger molecules of polysaccharides into the smaller molecules of di-saccharides, after which the bolus moves down into the digestive tract. After further processes, it is broken down into mono-saccharides.

   - There are many processes, enzymes and chemicals which are involved in the digestive process, some of which include:
     - **Amylase** - breaks down ***starches and carbohydrates;***
     - **Lipase** - breaks down ***fats;***
     - **Protease** - breaks down **proteins;**
     - **Cellulose** - breaks down fibre ***cellulose*** into smaller units;
     - **Lactase** - digestion of ***dairy*** products.

   Carbohydrates break down into → ***simple sugars,*** such as glucose;
   Proteins break down into → ***amino acids;***
   Fats break down into → ***fatty acids and glycerol.***
3. **Absorption and assimilation**
   Absorption is the process of the passage of the end products of digestion from the gastrointestinal tract into the blood and lymphatic vessels and the cells of the tissues.[5] Most of the absorption takes place in the ileum and jejunum of the small intestine. Absorption is facilitated by intestinal villi which increase the surface area. ***Assimilation*** is the incorporation of nutrient molecules into the cells of the body.[6] Cells utilise the nutrients to build up the cells structure as well as to repair any damage as a result of a prolonged poor diet or other incidental injury.

4. **Elimination**
   This is the final stage of digestion, in which metabolic waste products are excreted from the body, such as via the anus as faeces, kidneys by urination, skin by perspiration, as well as coughing, sneezing, nasal mucus, vomiting, flatulence, menstruation, ear wax and ejaculation.

Although pepsis is synonymous with digestion and metabolism, Hippocrates viewed ***pepsis*** as the 'digestion' of the environment, with respect to the organism which grows at the expense of the environment, taking from it what is necessary to sustain life and rejecting what is unnecessary. He viewed disease as a severe difficulty in the digestion, or pepsis, of the environment by the organism. Hippocrates understood the term for indigestion as dyspepsia,[7] which is also used today.

The digestive process

The following table shows the parts of the digestive process performed by each digestive organ, including movement of food, type of digestive juice used, and food particles broken down by that organ.

Organ	Movement	Digestive Juices Used	Food Particles Broken Down
Mouth	Chewing	Saliva	Starches
Oesophagus	Swallowing	None	None
Stomach	Upper muscle in stomach relaxes to let food enter and lower muscle mixes food with digestive juice	Stomach acid	Protein
Small intestine	Peristalsis	Small intestine digestive juice	Starches, protein, and carbohydrates
Pancreas	None	Pancreatic juice	Starches, fats, and protein
Liver	None	Bile acids	Fats

Table of Digestive Process (19)

The Tibb Perspective of Heat as an Integral Process in Digestion

Avicenna viewed digestion as a process by which foods are heated or 'cooked' by the body, whereby foods are broken down into smaller nutrient parts by the process of heating. [7] From a Tibb perspective, food is broken down into two stages: From the entry into the mouth up to arrival at the liver; and, from the liver until it is utilised by the cells, or thereafter eliminated.[7] Heat is necessary for the efficient functioning of each stage of the digestive process. This innate heat manifests in the Vital Faculty, which gives the body energy, and the Natural Faculty manifest as the 'digestive fire' and metabolic heat, which is responsible for the digestive process.

The outer layer of the lower part of the oesophagus, nearer the stomach, is more muscular, which is warmer, because of its dry and hot qualities, and this heat facilitates the ingestion of food.[49] The stomach receives heat from a fold of the peritoneum, called the omentum, which connects the stomach with other abdominal organs in front. The peritoneum is the only layer in the body that covers all the digestive organs. The omentum, is a thin layer of fat which covers the stomach and all the intestines, and which assists the stomach in the process of digestion. The omentum is also referred to as the 'heat guard' or 'heat protector', as its strong, viscous and sticky consistency is able to retain and resist heat. The stomach also performs digestion through its natural heat from the muscles (dry and hot) and adjacent organs.(21)

The quality of this heat is determined by the quality and nature of the foods which are consumed. If there is not enough heat in the body, the nutrients will be unable to be processed during each stage of digestion, which puts additional strain on the liver. This ultimately results in the build-up of mucous and bile in the body, thereby inhibiting peristaltic action, resulting in constipation from sluggish bowels. If there are any toxins in the body, as a result of partly digested food which is not completely absorbed and assimilated, putrefaction (decomposition) will occur from bacteria. Consequently the inadequate process of digestion will reduce the amount of oxygen to the body, as bacteria thrive in anaerobic environments. Chymus is partially digested food, which is very similar in nature and temperament to swallowed food. If chymus is not well digested the humours produced from it will be deficient, both qualitatively and quantitatively.

Physis responds to the invading bacteria by increasing the temperature of the body (fever) in an effort to facilitate elimination by heating away the excesses, in the form of a discharge, such as diarrhoea, vomiting, urination, sweating, rhinorrhoea, sneezing or tears. However, if there is a prolonged period of poor nutrition, and subsequent congestion in the body, Physis will have more difficulty in restoring the body and its parts to their former health, resulting in a recurrence of diseases and chronic conditions.

There is a change in the composition of the constituents of food by the process of heating. Heat is produced by the action of chewing; the production of enzymes which cause a chemical reaction; the action of hydrochloric acid in the stomach which provides additional heat to assist with the breakdown of nutrients into chyme. Chyme is transported through the small intestine where enzymes produce further heat before transporting it to the liver ***(gastric digestion).***

The parts of food which have the least amount of nutrition are eliminated via the colon and bladder. The most nutritious parts of the food are processed in the liver, where chyle is converted into the four humours ***(hepatic digestion***). Heat of the vital force energy transforms the parts into biochemical particles which are carried by the bloodstream through all parts of the body.[7] Every tissue absorbs nutrition by its attractive power and retains it by its retentive power ***(vessel digestion).*** The digestive force, together with the force of assimilation, converts the nutritive elements into tissue ***(tissue digestion).***[8]

Nerve Regulators for Digestion

1. **The Extrinsic nerves**
   These nerves come to the digestive organs from the brain or the spinal cord. They release two chemicals:

- ***Acetylcholine*** causes:
  - The muscle layer of the digestive organs to ***increase the force*** of moving the food and juice through the digestive tract, and
  - The stomach and pancreas to produce ***more digestive juice.***

- ***Adrenaline*** has the opposite effect, by:
  - ***Relaxing*** the muscles of the stomach and intestine, and
  - ***Decreases the flow of blood*** to these organs, thus slowing or stopping digestion.

2. **The intrinsic nerves**

- These nerves make up the dense network in the walls of the oesophagus, stomach, small intestine and colon.
- They are triggered to act when the walls of the hollow organs are stretched by food.
- They release many substances that speed up or delay the movement of food and the production of juices by the digestive tract.

Hormone Regulators for Digestion

The main hormones that control digestion are:

- **Gastrin** causes the stomach to produce ***hydrochloric acid*** for dissolving and digesting some foods. It also is responsible for normal cell growth in the lining of the stomach, small intestine and colon.
- **Secretin** causes the pancreas to produce ***sodium bicarbonate,*** which neutralises the gastric acid. Secretin stimulates the stomach to produce pepsin, an enzyme that digests protein, and stimulates the liver to produce bile.
- **Cholecystokinin** (CCK) is released from the endocrine cells of the upper small intestine, in response to amino acids and fatty acids in chyme. CCK causes the pancreas to produce the ***enzymes of pancreatic juice,*** and causes the gallbladder to empty.[9] The pancreatic enzymes (lipase, protease and amylase) help break down fats, proteins and carbohydrates. Pancreatic insufficiency is the inability of the pancreas to secrete the enzymes needed for digestion, which may lead to pancreatic cancer.
- **Ghrelin** is produced in the stomach and upper intestine in the absence of food, and ***stimulates appetite.***
- **Peptide YY** is produced on the digestive tract in response to food, and ***inhibits appetite.***[10]

The Three Phases of Gastric Secretion

1. **Cephalic phase**
   The senses of sight, smell, touch, taste or the thought of food stimulates the limbic system and vagus nerve from the medulla oblongata. The vagus nerve causes the preganglionic parasympathetic vagus nerve fibres to stimulate the postganglionic neurons in the enteric plexus of the stomach, which stimulate secretion by parietal and chief cells to stimulate gastrin by endocrine cells. Gastrin is then carried through the circulation back to the stomach, releasing pepsin and hydrochloric acid. This phase accounts for about ***30%*** of the reaction that occurs when a meal is consumed.
2. **Gastric phase**
   Distention of the stomach activates a parasympathetic reflex within the vagus nerves and through the medulla oblongata, which secrete gastrin, and an increased amount of pepsin and hydrochloric acid is released within the stomach. This phase involves both the humoral and neural reflexes and accounts for about ***60%*** of the reaction that occurs when a meal is consumed.

3. **Intestinal phase**
   When chyme reaches the duodenum, gastric secretions are no longer needed. Chyme will contain lipids whenever there has been a large production of hydrochloric acid, which causes the pH to drop to below 2, at which point gastric secretion is completely inhibited. This phase accounts for under ***10%*** of the reaction that occurs when a meal is consumed.[11]

The Influence of Humours in Digestion

The word **'humour'** is derived from the Greek word, meaning ***'chymos'- juice*** *or* ***sap.*** It is also referred to as ***'body fluids',*** and the human body was thought to have a ***mixture*** of the four humours, namely: ***Sanguinous, Phlegmatic, Melancholic*** and ***Bilious.*** A humour exists in a kinetic state, at all times adjusting and interspersing with the body fluids, tissues and parts.

The humours are the primary fluids that are manufactured from the digestion of food and drink, and which are processed and transformed in the liver. Any dysfunction in the liver will affect the quantitative and qualitative balance of the humours.

Humours and body fluids form the basis of all cells, from which tissues and complex structures of human beings, animals, plants and minerals are formed. They maintain ***temperamental balance*** (qualitatively); provide ***nutrition*** for the maintenance of the body's complex structure by replacing body's tissues; and provide the ***energy*** requirements for the various activities of the body.[12]

These four humours are different with regard to colour, appearance, composition, physical properties and proportion. According to Hippocrates, the functions of the body are regulated by the humours. The ratio of the Humours in the body is dependent on **Lifestyle Factors,** amongst other things, which directly influence the proportion of the **qualities.**

The Formation of Humours in Digestion

All four humours arise at the site of the liver, in quantity or predominance, according to the nature of the foods eaten and the degree of completeness of their digestion. The strength or weakness of the humours depends upon the ***amount of nutrition*** that is available in the blood, as well as the ***quantity*** which is assimilated by the body.[2] The proportions of the humours must maintain a certain quantitative and qualitative balance in accordance with the unique temperament of an individual.

The ***waste products*** of the first digestion in the stomach are eliminated by the intestine. The waste products of the second digestion in the liver are mostly eliminated in the urine, with only a small amount which is directed towards the spleen and gallbladder. Waste products from the third and fourth stage of digestion are partly eliminated via the skin through sweat, and from the ear, nose, nails and hair, as well as from boils and abscesses.[2]

Galen refined the humoral theory and determined that all diseases were the result of irregular or improper distribution of the four humours.

Hippocrates determined that all human diseases arose from bile and phlegm. The bile and phlegm produce diseases and when inside the body, one of them becomes **too moist, too dry, too hot,** or **too cold;** they become this way from foods and drinks, from exertions and wounds, from smell, sound, sight, and venery, and from heat and cold.[22]

Avicenna agreed that these four components (blood, phlegm, black and yellow bile), are the primary humours, but he added that the intracellular and extracellular fluids in the tissues are secondary humours.

According to Avicenna, the four primary humours are derived from the digestion of food and are utilised as nutrient components for the growth and repair of the organs, and to yield energy for work. The humours have a normal state as well as abnormal varieties. The worst abnormal humour is black bile, which is believed to be responsible for cancerous growth, and it is a toxin.[7]

A humour exists in a kinetic state, at all times adjusting and interspersing with the body fluids, tissues and parts.

All four humours arise at the site of the liver, in quantity or predominance according to the nature of the foods eaten and the degree of completeness of their digestion.

- The **blood** humour comes into being ***first,*** and is formed of the ***choicest parts*** of nutrients.
- Second, the **phlegm** humour arises and accompanies the ***second-level*** digestion nutrients.
- The **yellow bile** is composed of the ***third stage*** of digestion nutrients, which are the ***courser*** and less refined parts.
- The **black bile** is composed of the ***least digestible*** and usable parts of nutrients.[7]

The impact of Metabolism on the Body

Metabolism is the process in which the body gets energy from food. It is the sum of all the physical and chemical processes by which living organised substances are produced and maintained (anabolism); and also the transformation by which energy is made available for the use of the organism (catabolism).[5]

Metabolism is a biochemical process that governs how quickly and effectively the body is able to burn up calories into energy. During physical activity, as well as during rest, and during the process of digesting food, the body requires energy to fulfil all its functions.[13] The minimum amount of energy that the body needs to carry out these chemical processes is called the basal metabolic rate (BMR). A fast or slow metabolism is more accurately described as a fast or slow BMR.

The metabolic rate is influenced by many factors, including age, gender, body size and genetic predisposition. BMR decreases with age and the body may gain fat, but lose muscle. As muscles need more energy to maintain fat cells, people who have more muscle to fat ratio will generally have a higher BMR, which may account for the fact that men have a higher BMR as they have more muscle, heavier bones and less body fat than women. Genetic factors determine the size and growth of muscles, thereby affecting the rate of metabolism.

Professor James Timmons, a metabolism expert from Loughborough University, explains that overweight people may actually have a higher metabolism than their leaner people, because more energy is required to maintain a larger body size. He also maintains that the reason why a person gains weight is not because of a slow metabolism, but rather a higher calorie intake compared to the burning up of energy. Crash diets and other calorie-restricted diets can reduce the BMR as body is forced to break down muscle in order to utilise for energy. The lower the muscle mass, the slower the metabolism. With less muscle and a slower metabolism, it then becomes a lot easier to put body fat back on after coming off the diet.[14]

The Process of Metabolism

The process of metabolism is conducted by two powers:

1. ***Nutritive force*** is derived from the food which is consumed, which is produced in the liver. This is served by four servant forces, namely: attractive, retentive, digestive and propulsive;
2. ***Generative force*** is responsible for the growth and development of the human organism. This is served by three other forces, namely: receptive power, power to retain nutrition and assimilative power.[7,8]

Chishti refers to the ***liver*** as the ***'balance of the wheel of life'*** due to the major biological role that the liver performs. Many natural practitioners agree that the outcome of the recovery from cancer depends on the extent of liver damage.[7]

Therefore the liver needs a balance of the qualities of heat and moistness in order to maintain its optimal structure and functioning.

The Influence of the Thyroid Gland in Metabolism

The thyroid gland is mostly composed of epithelial tissue, and it is associated with the metabolic faculty, and to the main organ, the liver. Its temperament is ***hot and moist,*** with a dominant quality of heat. Over-activity of the thyroid gland (hyperthyroidism) arises from a qualitative imbalance, with excess heat, which leads to an over-production of thyroid hormones. This results in a rise in blood pressure, increased heart rate and a loss in body mass. Conversely, an under-active (hypothyroidism) arises from a qualitative imbalance, but with a reduction in heat and a rise in moistness. The production and secretion of the thyroid hormones are diminished, leading to lethargy and weight gain.

Iodine, which has hot and moist qualities, is necessary for the synthesis of thyroid hormones; a deficiency of which results in reduced production of these hormones. This leads to an increase in the secretion of the thyroid stimulating hormone from the pituitary. If this persists over time, a goiter (swelling on the neck) will develop from an enlarged thyroid.

The thyroid gland is the key to metabolism, as the hormone, thyroxin, determines the rate of the metabolic chemical reaction of the body. With an overactive thyroid, one burns off more calories, predisposing a person to be thin, nervous and very active; as opposed to an underactive thyroid, where the metabolic rate is very slow, predisposing a person to put on weight and being generally slow and more lethargic. Muscle tissue is metabolically active and uses energy even at rest; whereas adipose (fat) tissue does nothing at rest. Muscles move, requiring energy, while fat is just storage. Therefore increasing muscle tone, through exercise, such as weight-lifting, will dramatically increase metabolism.[15]

The Relationship between Food and Drink on Metabolism

Human beings preserve life through nourishment, in the form of food, which provides fuel for the body to carry out its functions and metabolism. Diet is one of the oldest and most respected healing agents, as, according to the Hadith, the ***stomach is regarded as the central basin of the body and the origin of many diseases.***[16]

"The origin of illness is in food; diet is the main medicine."
(Hippocrates)

The food and drink that one consumes is one of the lifestyle factors which are more easily able to be controlled by an individual. The quality and the quantity of food consumed directly affects the quality and quantity of the humours, as food is the raw material which the body uses to produce the four humours.

Food and drink have specific qualities and nutritional value, as well as medicinal and biochemical properties. Tibb classifies food according to the qualities of its nutritional components, into either heating or cooling, with appropriate levels of moisture or dryness.

Every food and drink, medication as well as different tastes, have specific inherent qualities**.** Heating foods and spices, such as chillies, ginger, cumin and cinnamon, increase the metabolic rate, whereas cooling foods, such as cucumber, decrease it. Heat facilitates digestion, as it increases the production of digestive enzymes in the gastro-intestinal tract. Heat also aids in the absorption and assimilation of food, thereby increasing the efficiency of cellular and metabolic functioning. Elimination of waste products with compete metabolic digestion is dependent on the correct amount of heat in the body.

Tibb evaluates food and diet in terms of their ability to enhance or impede metabolism. Meat which is roasted and fried has a slow rate of absorption, while liquids have a fast rate. The rate at which food is retained in the body depends on the compactness of the substance and digestive products in the blood; for example, figs and other fruits have a rapid rate of elimination from the body. Foods should be eaten according to the temperament and age of the individual and which is in season in order to create humoral balance.[7]

Factors affecting the metabolism of the body include:

- The ***temperament*** of the individual. If the quality associated with the food and drink is similar to the person's dominant temperament, the effects of the qualities will be enhanced, for example: A person with a dominant Bilious (hot & dry) temperament will be much more affected by heating foods, such as ginger; whereas a person with a dominant Phlegmatic (cold and moist) temperament will be least affected by the heating qualities of ginger.
- The ***health status*** and ***age*** of the individual. A compromised immune system may have difficulty metabolising the food and drink effectively, resulting in a qualitative and quantitative humoral imbalance, for example: chronic cirrhosis of the liver (coldness with dryness) interferes with the production of the humours, as well as the process of digestion and metabolism. Metabolism slows down in the elderly.
- The ***quality and quantity of food*** consumed will influence the ***qualitative and quantitative*** composition of the humours: Proteins have overall qualities of dryness; fats have overall qualities of heat; carbohydrates have overall qualities of moistness; minerals have overall qualities of cold and dryness, and water has overall qualities of cold and moistness. An excess in the quality of heat and dryness can result in disorders such as gastritis, ulcers and hyperacidity; whereas an excess in the quality of moistness can lead to indigestion. An excess amount of nutrients which the body is unable to digest will cause an imbalance of the humours, and the undigested food leads to a feeling of sluggishness.
- The ***ratio between heat and cold***: heating foods, such as ginger, increase the metabolic rate, whereas cooling foods, such as cucumber, decrease it.
- The ***ratio between moistness and dryness*** will either be associated with heating foods or cooling foods, and its effect on metabolism will vary accordingly.

The Gut as the second brain

The digestive tract is one of the most important immune support organs which contain more than 80% of one's antibody-producing cells. Scientists have discovered that there are two brains – the brain enclosed in the skull, and the one which is located in the gut, also referred to as the ***enteric nervous system.*** Although they are interconnected they function independently of one another.

Hippocrates referred to the stomach as the heart. His predecessors also considered that the orifice of the stomach was part of the heart.[49]

The gut contains one hundred million neurons, more than the spinal cord, with the major neurotransmitters, such as serotonin, dopamine, nitric oxide and norepinephrine being in the gut, together with neuropeptides and major cells of the immune system.

The stomach contains many sensory nerves which are stimulated by the release of stress hormones, which may result in diarrhoea. When the central brain is exposed to a frightening situation, stress hormones are released in an effort to prepare the body for fight or flight. However, in extreme conditions, the brain sends signals to the gut to tell it not to defecate while in the mode of fight or flight situation.

With extreme stress, the higher brain protects the gut by sending signals to immunological mast cells in the plexus, which secrets histamine, prostaglandin and other agents that produce inflammation in order to protect the gut. The inflamed gut release chemicals which then cause cramping and diarrhoea in an effort to rid the body of invading organisms. If this process is impeded by preventing diarrhoea, Physis is unable to protect the body, which may result in gastric related disorders, which, if occurring frequently, may result in damage to the lining of the gut, such as gastric ulcers.

Fear causes the vagus nerve to produce increases amounts of serotonin, which results in overstimulation of the gut, causing diarrhoea. When a person is said to be 'choking' with emotions, the nerves in the oesophagus are overstimulated, resulting in difficulty with swallowing.[18]

Dr Michael Gershon, a professor of anatomy and cell biology at Columbia Presbyterian Medical Centre in New York, conducted many studies in the gut-brain connection. One of his studies involved the side effects of Prozac, which revealed that Prozac can treat chronic constipation, as well as its more well-known function to treat anxiety. However, in larger doses Prozac causes constipation and may stimulate sensory nerves to produce nausea.

Gershon also conducted studies to try to determine whether or not the gut can learn and think for itself. His studies involved a group of paraplegics, whose spinal cords were destroyed, resulting in regular impaction of the bowels. A male nurse gave each one an enema at 10am each morning, and when he was replaced, his successor only gave the enemas when the impactions occurred. However, at 10am every morning, every patient had a bowel movement at the same time, without enemas.

When a person experiences an allergic reaction to certain foods such as shellfish, the mast cells in the gut become senstitised to antigens in the food. The next time the antigen is present, the mast cells call up a program, which releases chemical modulators to try to eliminate the threat, resulting in diarrhoea and cramping.

Other studies revealed that victims of Alzheimer's and Parkinson diseases suffered from constipation, because the nerves in their gut as well as in the brain were affected. Just as the central brain affects the gut, the gut's brain can talk back to the head. Most gut sensations that enter conscious awareness are negative ones, such as pain and bloatedness.[18]

Conclusion

All the stages of digestion are necessary in order to maintain efficient cellular and metabolic functioning; from ingestion and digestion of food and drink, both mechanical and chemical; to absorption and assimilation of nutrients and effective elimination of waste products.

Regulation of nerves and hormones play an integral role in ensuring that the process of metabolism runs smoothly, and that nutrients are adequately broken down by enzymes so that the body can more efficiently absorb and assimilate the broken down products of digestion.

The production of the humours is necessary for the growth and repair of the organs, and to yield energy for work. As the strength or weakness of the humours is dependent upon the amount of nutrition that is available in the blood, as well as the quantity which is assimilated by the body, it is necessary to consume food and drink which is best suited to an individual's temperament. Failure to do so will result in an imbalance of the ideal qualitative and humoral state of the unique temperament of an individual.

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