PREKSHA DHYANA : HUMAN BODY

PART II

HEALTH CARE

J.S. ZAVERI

THIRD EDITION

JVB

"SCIENCE OF LIVING" SERIES—III

PREKSHA DHYANA : HUMAN BODY

PART II—HEALTH CARE

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Introduction

Although mankind has always been a prey to a variety of ills and diseases, population growth, technology-based hectic way of life and rapidly changing conditions of modern life-style, the needs of health-care have grown explosively and it has taken on an importance never before equalled. Basic to the care of the health is a thorough knowledge of the human body.

In the previous part, we have already dealt with the structures and the functions of the important systems of the body. In this part we shall mainly deal with the conditions of the human body, both in health and in disease. Modern life-style has created a revolution in our way of life, dramatically increasing mobility and bringing with them a host of new problems affecting the health sciences. The clothes we wear and the foods we eat contain chemical substances that did not exist a century ago.

With the knowledge of the functions of our internal organs, we must become aware of their disfunctions and the abuses to which we subject them. We must, for example, think of our diet and its effect on our digestive system and, in particular, on liver. Cramming our stomach with fatty foods and alchohol is detrimental to our liver and gall bladder. Then again, just as we value the normal civilized practices of external cleanliness—bathing, tooth-cleaning, etc.—as a measure of self-respect, so must we value the proper cleaning of our internal organs as a monitor of our good health. We often resort to laxatives and liver pills to offset the vague ill-health of indigestion, constipation and billiousness. But these off-the-shelf remedies, while providing temporary relief by cathartic action, create a repetition of the conditions they are supposed to cure. We must, therefore,

learn to *prevent* constipation etc. by a sensible diet, physical exercises and natural rhythm of the bowel movement rather than try to cure it by laxatives. *Prevent* the erosion of your liver, decay of your teeth, inflammation of your stomach and filling of your lungs with tar deposits.

Fortunately science has provided means to more profound knowledge of the body and has also provided us with an unprecedented arsenal of weapons in the fight against disease and death.

Do you know :

That more than 40 elements are critical for the proper functioning of the body and must be supplied by food intake?

That pasteurization of milk destroys its natural vitamin 'C' content?

That antibiotics kill the population of friendly intestinal bacteria, leaving the body without its normal supply of valuable vitamins which were produced by the intestinal bacteria?

That continuing physical activities and a regular programme of yoga and exercises could effectively retard the aging process?

That a short period of scientific relaxation can invigorate us more efficiently than a long period of sleep?

And finally :

What produces psychological distortions, (such as cruelty, hatred, retaliation) in human tendencies and irrational behaviour in man?

That meditational practice is not an irrational emotional or religous experience but a deliberate mental operation of scientific psycho-therapy to maintain perfect emotional health?

This small booklet is an attempt to give you answers to these and scores of other irritating questions regarding health and diseases, aging and death. Needless to say that it would be difficult for the reader to grasp the significance of the words in this booklet unless he has acquired basic knowledge of anatomy & physiology which has been dealt with in Part I.

This modest effort is dedicated to all those who are desirous of living a vigorous youthful life upto the last breath by maintaining physical, mental and emotional health.

Preksha-Dhyana can be learnt and practised by anybody without distinction of caste, colour, country or creed. There is no communal or theological bias nor does it insist on any particular theological belief.

We are grateful to Yugapradhana Acharya Shri Tulsi and his successor-designate Yuvacharya Shri Mahapraj[illegible] for their constant guidance. These two great spiritual saints have truly blessed the entire human race with the boon of *Preksha-Dhyana,* and we are confident that all and sundry will be benefited by learning and practising this universal and easy-to-learn technique of *Preksha-Dhyana.*

There permanent training centres have been established viz. 1. Tulsi Adhyatma Nidam at Jain Vishva Bharti, Ladnun, (Rajasthan), 2. Adhyatma Sadhana Kendra at Mehrauli, New Delhi, 3. Tulsi Sadhana Shikhar at Rajsamand (Rajasthan).

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1

Scientific Complete Breathing

To Breathe is to Live

It is possible to live without food for many days, without water for several days but without air, normally, not more than a few minutes. Thus breathing is the great vital source of energy. It is life. Each and every activity of life is intimately connected with the process of breathing.

One aspect of the function of breathing is to supply the cells[1] of our body with oxygen and the other one is to eject carbon dioxide from them. Energy-production in the cells needs oxygen. Carbon dioxide is a by-product of energy-releases and if allowed to accumulate, it will poison the cells.

Supreme importance of proper breathing cannot be overstressed. Unfortunately, only a few really breathe properly and completely. Rest of us breathe more or less badly. In fact, an average person today is not breathing, but is merely avoiding suffocation. Many of the symptoms of poor health are caused by insufficient oxygenation of blood, and slow circulation. Not only are the nerves, glands and vital organs inadequately nourished, but the excretory systems cannot function properly and the bodily waste-products are not removed efficiently. Those who breathe badly have to struggle with problems in all directions : health, profession, emotinal life. Not only do we breathe badly, but often the purity of the air leaves much to be desired. Consequently our nervousness and irritability increases and even the slightest physical effort may leave us

1. See "Respiratory System" in Part I of this book.

exhausted. Worst of all, our resistance to disease is reduced drastically and we develop greater susceptibility to germs and infections. Correct breathing, by ensuring complete ventilation of the lungs, immunizes us against diseases like T.B. In the following paragraphs we shall see how this can be done.

The Process of Breathing

The lungs themselves have no muscles and hence play only a passive role in breathing. The mechanical power required for the process of breathing is supplied by (a) the raising and lowering of the diaphragm, (b) the contraction and expansion of intercostal muscles and (c) raising and lowering of the upper part of the thorax called clavicle or collar bone. A slight vacuum in the lung compartment enables the lung to expand and collapse with each inhalation and exhalation respectively.

At the start of a breath, the pressure inside the lungs is the same as the outside air-pressure (760 mm. of mercury). Then the intercostal muscles contract, moving the rib-cage upwards and outwards and at the same time the diaphragm contracts and moves downwards. The size of the chest cavity is thus increased and the inside pressure falls by 2 or 3 mm. of mercury. To equalise the pressure-difference, the air rushes into the lungs. Inhalation ends with the relaxing of the diaphragm and the intercostal muscles, reducing the chest volume. Inside pressure rises by about 3 mm. and forces used air back into the atmosphere.

The fresh air inhaled in the alveoli[1] has an oxygen tension of 100 mm. and very little carbon dioxde, while the blood in the capillaries arrive with an oxygen tension of 40 mm. and carbon dioxide tension of 46 mm. To establish equi-

1. The estimate of the number of alveoli in an adult human body varies between 250 millions to 600 millions. Total area of the surface of all alveoli is estimated to be 750 sq. ft. or 70 sq. metres, equivalent to the area of a tennis court.

librium, carbon dioxide enters the alveoli and oxygen goes into the capillary blood. Fully oxygenated blood with 100 mm. tension and 100% saturation leaves the lungs for the left side of the heart and aorta. Haemoglobin, which fills the red blood cells (and colours the blood) is a chemical compound which combines with oxygen and readily releases it to the cells when reqired . The process of combination which takes place in the lungs turns the purplish reduced haemoglobin into bright-red oxy-haemoglobin. The delivery of oxygen to the cells is the function of another organ—the heart—pumping oxygen-bearing haemoglobins in the blood to all parts of the body. Thus, the process of internal breathing which occurs in the active tissues of the body, consists of the release of oxygen and carrying away carbon dioxide for delivery to the lungs. If the oxygen-tension falls below 40 mm. of mercury, the oxygen saturation of the blood falls precipitously; oxygen-supply to the tissues reduces to zero and they may die.

While the regulation of most of the important systems of the body, notably the heart rate, is under automatic control, that of breathing is both autonomous as well as voluntary. The normal rhythmic pattern of respiration is maintained by nerve-information fed back to the respiratory centre (which is located in the medualla oblongata) by the respiratory muscles and lungs. The centre is under many other influences and can also be affected by voluntary activity, e.g. one can hold the breath for short intervals. The respiratory centre is sensitive to changes in the carbon-dioxide content, oxygenation and acidity of the blood that passes through the centre as well as that in the carotid arteries. Rhythmic impulses from the centre pass down through the spinal cord to the intercostal muscles and the diaphragm. Rise in the level of blood-carbon-dioxide or acidity stimulates the centre. Consequently it alters the impulses to the muscls of breathing in order to co-ordinate rhythm, rate and depth of breathing with other activities of the body.

Art of Breathing : Importance of Proper Breathing

In proper breathing, firstly air is inhaled through the nose, with mouth closed. In this way most of the bacteria, dust and other impurities are filtered out by the moist lining of the nose and the mucous membranes. Mucus, in addition to acting as a filter, also has germicidal properties. While travelling this somewhat longer road, the air is also humidified and warmed to proper body-temperature. That is why it is so important to cultivate the habit of breathing through the nose, and never through the mouth.

Secondly, in proper breathing, we have to reverse the familiar procedure of pulling in our abdomen while inhaling. A pulled-in stomach may give us a smart appearance (as in a parade) but it effectively compresses the diaphragm and prevents air reaching the base of the lungs. We must learn to allow the abdomen to expand on inhaling and to pull it in while exhaling. It is easier to practise this lying down, until the new habit is firmly established.

In a single day we breathe about 23000 times. Depen-deing upon one's posture as well as physical and emotional state, the average volume of air taken in a single breath is 1/2 to 1 litre. With proper attention, this volume may be increased upto 4 to 5 litres. In other words careful re-orien-tation of our breathing system can increase at least five-fold our ability to use oxygen and eliminate carbon dioxide. Most of us breathe shallowly in short staccato jerks, at the rate of 15 to 18 breaths a minute. Because we feel no breathless discomfort form our shallow breathing, we are not even aware of its shallowness. However, we can train ourselves to breathe more slowly and more deeply, though without pause between inspiration and expiration. The rate can be easily reduced by 4 to 5 breaths a minute, i.e. 25 to 33 percent. Slower rate results in reduction of wear and tear in the entire body, less work for the heart, lower blood pres-sure and quieter nerves.

Complete Breathing

The difference between bad breathing and scientifically complete breathing lies mostly in the method and its practice.

First thing is to breathe properly. In fact, however, it is to re-learn because everyone did know it in one's infancy. Because one is perpetually under stress and tension, breathing is usually incomplete, hasty, superficial and sometimes even gasping. Logicallly, therefore, proper breathing, depends firstly on removal of tension. Hard (tense) abdominal muscles encumber every breath. Immobilised diaphragm and inflexible rib-cage hinders the entry of air into the lungs more efficiently than a tight belt or a corset. First step, therefore, is to remove the internal girdle by relaxing these muscles.

Exhalation : Scientific breathing begins with a slow, calm and complete exhalation. If the inspiratory muscles are relaxed, air begins to be expelled from the chest by its own weight. Contraction of the abdominal muscles then helps to evacuate the lungs furhter by raising the diaphragm. Because of the spongy nature of the lung-tissues, there is always a residue of used air in the lungs. This residual air, together with the fresh air taken in by inhalation, makes up the actual air available for further processing. More complete the evacuation, greater the volume of fresh air to enter the lungs and purer the air in contact with alveolar surfaces. Unless we first breathe out fully, it is impossible to breathe in correctly.

Inhalation : Having emptied the lungs the next step is to fill them up to the maximum extent, the total volume of air which the lungs are able to contain is known as the vital capacity, which is about 6 litres. Before one can contemplate to increase this capacity, full use must be made of what is already available.

Mention has already been made of 3 sets of muscles, surrounding the lungs, which take part in the breathing process. They are :

1. Intercostal muscles which are attached to the upper and lower margins of the ribs and which move the rib-cage upwards and outwards on contraction and in the opposite direction on relaxation.
2. Diaphragm, the most important muscle in breathing, a strong dome-shaped sheet of muscle that lies at the bottom of the chest and roofs the abdominal cavity. When contracted, it descends pressing down the abdominal organs and lengthening the chest cavity.
3. Clavicle muscles which are operated by raising the collar bone. In this way the upper part of the lungs receives fresh air.

Complete inspiration incorporates the use of all the three sets of muscles in one single, full and rhythmic action. The air should enter in a continuous flow without gasping.

Complete Breathing Technique

An excellent way to learn the technique is lying down flat on a hard surface—preferably on the floor using a mat or a rug. Keep your arms parallel to the body and the legs straight but not stiff. To concentrate the mind entirely upon the action of breathing is of the utmost importance. It is a good idea to close the eyes to help increase concentration.

Phases of Action

1. Evacuate the lungs with a slow and silent exhalation. Pull in the stomach to contract the abdominal muscles. This action will raise the diaphragm high up in he chest cavity like a piston in a cylinder, reducing chest volume and thereby getting rid of the greatest possible amount of used air. With the lungs empty, hold the breath just for a second or so before the inhalation commences.
2. Slowly lower the diaphragm allowing fresh air to enter the lungs. Relax the stomach and allow it to expand and rise. This action flattens the diaphragm and the lungs gradually fill with air from the bottom. The abdominal muscles should remain relaxed

throughout the inhalation which should be slow, easy and silent[1]

3. Expand the ribs without straining by contracting the intercostal muscles. This action leads to the inflation of the central portion of lungs, by the entry of a fairly large volume of air though not as large as in the previous phase.
4. While air is being inhaled, complete the filling of lungs by raising the collar-bone towards the chin, without, however, raising the shoulders. The action permits the entry of the air in the uppermost portion of the lungs. This phase is useful only when it is preceded by the other two phases of inhalation given above, since only a small quantity of air enters the lungs.

With the last phase of operation the lungs are completely filled with air. The total action should not produce any discomfort or fatigue. Practise complete breathing as consciously as possible. Gradually, habit of complete respiration can be acquired and the quality of breathing will constantly improve. Remember that both inhalation and exhalation must be silent, slow, continuous and easy.

Once this technique of complete breathing is established, further benefits may be gained by learning time-control. Firstly, there can be a pause between inhalation and exhalation and the length of the pause will be dictated by the amount of practice. Secondly, the exhalations can last twice as long as the inhalations. To start with a ratio of 1 : 1 : 2 between inhalations, retention and exhalation is practical and can be slowly increased to 1 : 2 : 2. There is no benefit whatsoever in holding the breath with bursting lungs and swimming head, which merely causes discomfort and quick exhalation.

Benefits of Complete Breathing

Already it has been state that without oxygen there can be no life. Adequate supply of oxygen is essential for

1. Respiration has acquired correct slowness if it is inaudible. If audible, inhaling is being done hastily.

the proper functioning and vitality of the cells. It is therefore vitally important to breathe correctly so that every cell can receive oxygen. The optimum interchange of gases in the lungs occurs when the breathing is deep, complete and slow. According to physiologists, it is necessary for the breathed-in air to remain in the alveoli for 10 to 20 seconds in order to achieve maximum interchange of oxygen and carbon-dioxide.

Apart from this basic necessity, it is also essential that the lungs themselves are properly ventilated by proper breathing. The dark, warm, humid and badly ventilated lungs are ideal breeding ground for minute but dangerous germs.

Another important correlation between correct breathing and circulation is the so-called suction effect. The heart is capable of acting only as a forcing pump driving the blood into the arterial network. It has no suction action on the venous blood which travels against gravity towards the heart. Powerful suction action can be developed by the lungs as a result of complete scientific breathing. Deep, slow breathing enables the lungs to literally suck up the excess blood accumulated in organs like liver. Proper rhythmic motions of the diaphragm and rib-cage have the effect of improving the venous circulation throughout the organism. Thus the proper interaction of the two driving forces of heart and lungs can optimise circulation of blood.

Finally, every organic or functional disorder is amenable to the influence, if not always the cure, of controlled and conscious breathing. Even when it is not enough to cure infectious disease, it supports the struggle which rids us of them and provides the body with ways of avoiding them.

"To breathe is to live" is undoubtedly a good adage but to breathe correctly that is slowly, silently and deeply is to live long and keep healthy.

Once the technique of complete breathing is learnt, it can be practised anywhere and at any time. In fact, it could and should become the habit rather than an exercise. Complete way of breathing should become the normal way.

Additional Breathing Exercises

1. Alternate Breathing

Practise scientific complete breathing first through one nostril and then through the other. You can practise sitting cross-legged on the floor or on a chair but you must hold your spine straight, head immobile and body relaxed.

Place your right thumb on your right nostril, and the ring finger on the left; keep the index and middle fingers lightly touching the forehead. First close the right nostril with your thumb pressed and breathe slowly and deeply through the left one. After completing the inhalation, close the left nostril and open the right one and exhale slowly. Now inhale through the right and exhale through the left. Repeat the process several times keeping up the rhythm.

2. Bellows Breath (bhastrikā)

It consists of a series of very quick inhalations and exhalations—one inhalation and one exhalation in one second. Aid exhalations with quick inward contractions of the abdominal muscles. The pause comes after the inhaling and exhaling and not in between them. It may take quite some time to work down to the time of one second and at the start it is better to concentrate on the performance of the exercise rather than on timing.

3. Cleanising Breath (kapālabhāti)

Take a deep breath and exhale in short sharp puffs aided by quick inward jerks of the abdominal muscles and the diaphragm. Continue the sharp exhalations until the lungs are empty and then inhale again. The breath is not

held between inhalation and exhalation. A round of ten inhalations/exhalations should be enough. Further rounds can follow, if necessary.

It is probably the most efficient way of clearing the sinuses and nasal passages. (It is, therefore, advisable to keep handkerchief in hand).

The efficiency of the exercise lies in (i) the strength of the inward abdominal stroke which gives the required force to the exhalations and (ii) the speed of the exhalation, i.e. the number that can be crammed in before the air is exhausted. Former is more important than the latter.

Breathing Exercises for Asthma and Bronchitis Patients[1]

Regular breathing exercises can provide a valuable safeguard against the frequency and severity of acute attacks. Together with routine prophylactic treatment to relieve congestion and reduce bronchospasm exercises can contribute to you comfort and sense of well-being. They help you to improve posture, encourage relaxation and boost confidence.

Appropriate breathing exercises can help you and others with asthma or bronchitis to use your lungs correctly, especially to breathe out completely. They teach you to relax, to concentrate on expiration, and to use the lower part of the chest and abdomen. They can be combined with mobilizing movements of the shoulders, girdle and spine.

Exercises should be performed regularly for 10 minute morning and evening and during the day if possible. For maximum relief, please follow instructions carefully.

Note

1. Blow your nose before starting the exersies; loosen all clothing.

1. A service from winthrop.

2. These exercises may cause wheezing when carried out successfully; cough up any loosened mucus.
3. You will find a mirror useful since it enables you to watch your chest movements.

Forward Bending Exercises

1. Sit with feet apart, arms relaxed at sides. Take in a small breath. Breathe out slowly, while dropping head and bending forward until head is between knees and back is bowed.
2. Straighten back, starting at lowest part by pulling in abdominal muscles. Breathe in while gently expanding lower ribs, unbend rest of back; lastly the shoulders and head.
3. Breathe out, keeping head up and shoulders relaxed. Repeat four times, rest, repeat.

Diaphragmatic Breathing

Relax and lie down with knees bent, the right hand on the upper abdomen, so that its movement towards the spine is felt on full expiration. (The aim is gradually to increase the length of expiration—to about 15 seconds—without causing any sudden gasping intake of breath).

1. Take in a gentle breath through the nose. Breathe out, hissing through the mouth, sinking the upper abdomen and lower chest as much as possible.
2. Relax the upper abdomen and lower chest while air is gently and silently taken in. Your hand will rise with the abdomen. Exhale. Repeat eight times. Rest. Repeat 12 times. Rest.

Side Expansion Exercise

Sit with back against a chair, shoulders down, with hands on either side of the chest to feel the sideways movement. (To relax the shoulders, you may find this exercise easier to learn when lying down) as in the exercise for diaphragmatic breathing).

1. Inhale gently through the nose.
2. Breathe out, hissing through the mouth, bringing the hands as closely together as possible. Press lightly with the palms at the end.
3. Breathe in gently, expanding the lower ribs outwards against the hands. Exhale.

Repeat series eight times. Relax with arms at sides for one minute. Repeat.

Preventing an Attack

An attack often can be prevented if you start controlled breathing, when you feel one coming on; this helps morale. If an attack starts while at work or elsewhere away from home, these positions are useful in gaining control.

1. Sitting down with elbows on knees and shoulders relaxed.
2. Leaning back in chair against a wall with feet apart or standing or sitting with elbows resting on low wall or desk.

Repeated Recitation of the Vowels

Many a good and beneficial practice has no definite attraction, simply because they have not been examined properly. Some may discard them as superstitions and turn away. And yet, they deserve at least an objective examination through unprejudiced experience and sometimes even scientific study, before being rejected as a practice. Vocal repetition of *om* and *arham* is such a practice. It is a unique sound and its repetition has many beneficial effects not only on the physical level but also upon mental and emotional levels.

The technique : Take a deep breath and exhale slowly, the slow passage of the expelled air causing the vocal cords to vibrate in an evenly continuous sound. At the end of the exhalation, close the mouth and by drawing in the stomach, expel the remaining air, making a deep humming sound

which produces vibrations in the cranium. Repeat seven or nine times. Observe that : By making the uniform sound, rate of exhalation is not only slow but regular and smooth. Total exhalation ensures that the inhalation will also be full, deep and easy.

Physiological Effects of Vibrations

The sound of the vowel reverberates in the entire chest-cavity including the rib-cage. Vibrations reach the air in alveoli, stimulating and revitalising the pulmonary cells resulting in a more efficient exchange of gases. The final humming reverberates in the brain causing cranial nerves to viabrate and get rejuvenated.

It has been scientifically established[1] that;

(i) Vibrations produced by the sounding of vowels during exhalation massage the internal organs.

(ii) Vibrations reach the deep-lying tissues and nerve cells.

(iii) Increase in the circulation of blood in the tissues and organs involved revitalises them.

Mental Effects of Vibration

The effects on the mind are even more significant than on the body. It is well known that the most complex emotions can be produced by music through vibrations. Experiments have proved that under the influence of the internal vibro-massage, muscles and nerves relax, reducing depressions and inferiority complex.

We talk to ourselves even when we are not speaking aloud and we form sentences in the mind. There is a close connection between the mechanism of thinking (i.e. forming

1. This has been established by Dr. Laser-Lasario after tenty-five years of scientific study of the effects produced by vocal vibrations on the human body.

connection between the mechanism of thinking (i.e. forming sentences in brain) and mechanism of speech which involves an enormous expenditure of nervous energy. During the repetition of *om* or *arham* the mental processes engaged in forming sentences are inhibited, thus conserving the nervous energy.

Vibrations also produce soothing electro-magnetic waves which resonate through the body. Recent study of physiologists shows that these vibrations produce significant effects on the endocrine system which has profound influence on the mental states, emotions and behavioural patterns of an individual. The vibrations help to establish a more balanced equilibrium between the sympathetic and the parasympathetic components of the autonomic nervous system.

2

Chemistry of Life

At this very second, thousands of chemical reactions are taking place in your body. Various constituents of the body are joining together or being split apart or undergoing intricate exchanges and rearrangements. The sum total of all the chemical reactions that go on in the living organism is called metabolism[1]. Some of these reactions result in a build up of body structure; they form the category of anabolic reactions. Catabolic reactions, on the other hand, are the breakdown reactions of the body. Both go on constantly in a bewildering interplay that is life.

Chemical Constituents of the Body

The substance of life, **protoplasm** is a complex mixure of inorganic and organic compounds. None of its elements is unique to living things. owever, the distribution of the elements in the living and non-living worlds is quite different. And even more important is that the element in living organisms are confined into an assortment of complex compounds, many of which have no counterpart in the non-living world. The main constituents of protoplasm are : water, inorganic salts, proteins, carbohydrates, lipids (fats) and nucleic acids.

Water : Water is the most abundant compound in the body, constituting more than 65 percent of the total body weight. It is one of the simplest compounds yet one of the most imortant. A human being can survive for only a few days without taking water.

1. Discussed in detail in chapter No. IV of this book.

Water serves a great variety of functions in the body. It provides the fluid medium in which the chemical reactions of the cells take place; it furnishes the major transport medium for distributing oxygen, nutrients and other substances as well as carrying away waste products. It is important in excretion of wastes through the kidney etc. and it plays a key role in the body's temperature-control mechanisms. The water content of the tissues is continuously monitored in the brain.

Inorganic Salts : $4\frac{1}{2}$ percent of the weight of the body is comprised of inorganic salts—partly in dissolved form dissociated into ions[1] and partly in combination with organic compounds.

Sodium and chloride ions are the most abundant ions in the body fluids; within the cell, potassium and phosphate ions are the major inorganic constituents. Calcium phosphate is the major constitutent of bones. Various other ions in smaller amounts, some in barely detectable traces are also present. Some of these trace elements are constituent of key enzyme systems, wihout which the normal reactions in the body could not take place. The acid-base balance, coagulation of blood, transport of oxygen and carbon dioxide, nerve conductivity, muscle contraction and coordination of metabolic activities—these all need inorganic salts.

Carbohydrates : Carbohydrates contain three elements : carbon, hydrogen and oxygen combined in the ratio $C_xH_{2y}O_y$. They include sugars and starches and are the major sources of energy. Glucose is the form of simple sugar that is carried in the blood. It is an essential nutrient for all body-cells, particularly brain-cells. Starch consists of many glucose-units linked together. Whatever glucose is not immediately needed is synthesized into glycogen, which is stored within liver and muscle tissues.

1. An atom that loses its neutrality and becomes a charged particle is called an ion.

Lipids (Fats) : Although one does not like to be 'fatty', fats and other fatty substances also do play some valuable roles in the body. Fat-deposits serve as a source of reserve energy. Gram for gram, fats yield more than twice as many calories as carbohydrates and are thus a more economical means of energy-storage. They play an important role in maintaining normal cell permeability and thus regulate the flow of materials into and out of cells. They aid in transport of fat soluble vitamins.

Proteins : There are about 100,000 different kinds of proteins in the human body. Human proteins differ from those of other species and there are differences from one person to another. They are formed by linking together of smaller units called amino acids. Some are huge with molecular weight in the millions of moles.[1] There are about twenty naturally occurring amino acids.

Next to water, proteins are the most abundant substances in most cells, forming 10 to 20 percent of the cell-mass. Most of them can be grouped in one of the two main classes : (i) structural proteins and (ii) functional proteins.

Structural proteins are present in cell membranes and hold the cell-structure together. Most of them are in the form of long fibrous threads and provide tensile strength for the cell-structure.

Functional proteins include enzymes and hormones that regulate the body's activities. Enzymes are the organic catalysts, without which most of the chemical reactions in the body would not proceed. Many enzymes catalyze only a single chemical reaction with a single set of reactants and do not act even on somewhat similar compounds, thus forming a lock and key relationship. Usually they exist in complex with co-factors such as vitamins and metal ions.

1. Even the most complex molecules of life, containing millions of atoms, weigh only a small fracton of a gram. A gram molecular weight, called a mole, contains 6.20×10^{23} molecules of the compound.

Hormones control and coordinate the activities of the cells, tissues and organs of the body. Nucleo-proteins are complexes of proteins and nucleic acids and carry the hereditary blueprints for all the body's structures and activities.

A continuous supply of protein is needed for growth of new and repair of old tissues. But the food proteins are not used as such. They are first digested and broken up into their constituent amino acids and then built up into the characteristic proteins of the body.

Nucleic Acids were first discovered in the cell nucleus (hence the name), but actually they are also found in the cytoplasm of the cell, outside the nucleus. The amount of information contained in the chromosomes (23 pairs) of a single human cell is estimated to "a thousand books of 500 pages" each. It is encoded in nucleic acid molecules. More than a dozen Nobel Prize winners have received their awards for work in the field of the chemicals of heredity.

There are several kinds of nucleic acids each with its own function in the cell. The master plans are carried in DNA (deoxyribonucleic acid)[1] molecules. Working parts of the plans are passed on through several types of RNA (Ribonucleic acid) and ultimately translated into proteins. DNA and RNA molecules are constructed from sugar, phosphate and nitrogen base components. Structurally they are similar in some respects and different in others.

Like proteins, the nucleic acids in foods are not utilized as such, but are digested into their constituents and resynthesized as needed.

The basic knowledge of the chemistry of life is essential to understnad and appreciate the importance of "Nutrition" needed for growth, development and health, and is discussed in the next chapter.

1. 'Ribose' is a type of sugar with five carbon; 'glucose' has six carbons.

3

Nutrition

We need continual supplies of foods and water to provide energy for body-activities and building materials for growth and repair. Though we may subsist on a wide variety of diets, optimum growth development, and health require a balance of nutrients. A balanced diet must contain not only proteins, carbohydrates and fats, but also vitamins, minerals and water as well as a certain amount of indigestible fibre to keep the intestinal peristalsis[1] stimulated.

Water

About two-third of the total body-weight is water. Besides playing a key role in the body's heating and cooling systems, water acts as a solvent for chemical reactions and a carrier fluid in the body's circulating systems. Water is lost from the body in urine, feces, sweat and exhalation. It must be replaced in the daily food intake. The most obvious source is water and beverages, fruits and vegetables.

Carbohydrates

Carbohydrates—sugars and starches—make up the largest single component of human diet. It is a necessary constituent, because it is the body's preferred energy source. Any available glucose is metabolized first, before proteins or fats. Without sufficient carbohydrates in the diet, proteins will be metabolized for energy and there may be an actual wasting of body-proteins. Carbohydrates, in the form of starches, predominate greatly in products made from

1. Peristalsis is the name given to the slow automatic wave like movement along the whole of the alimentary canal propelling the contents onwards.

flour—breads, biscuits, etc.—cereal products and in vegetables such as potatoes. Sugar is added in most processed foods now available in market. Only the three elements—Carbon (C), Hydrogen (H) and Oxygen (O) combined in the ratio $C_xH_{2y}O_y$ constitute all carbohydrates; proportion of hydrogen atoms to oxygen atoms being the same as in water (H_2O).

Glucose and its variant forms are simple sugars (monosaccharides). Sucrose, maltose and lactose are disacharides i.e. two simple sugars joined together. Starches are more complex sugars consisting of many monosaccharides linked togther. Cellulose, a polysaccharide in the vegetable kingdom, is a major constituent of the diet but is not available to the human body as a nutrient, since we lack the appropriate enzymes to digest it. It comes from fruits, vegetables, bran i.e. skin of the whole cereal grains. The cellulose-fibre passes through the digestive tract essentially unchanged, but the 'bulk' helps to satisfy hunger and is important for stimulating bowel function. Substantial proportion of fibre in the diet relieves problems of chronic constipation. Carbohydrates are often regarded as prime culprits in causing obesity (fatness). But a high fibre diet is filling without fattening. Evidence is also accumulating that such a diet may help to lower the rates of both cancer (by speeding the passage of potential carcinogens out of the body) and of heart-disease (bran and other fibres promote the excretion of excess cholesterol). Whole wheat (brown bread and unpolished rice etc.) are more valuable and their value must be reappreciated.

Proteins

Proteins are necessary in the human diet for the amino acids. The proteins available in different foods differ widely in the assortment of amino acids and their proportion, but no one protein contains all of the twenty-three or so, naturally occurring amino acids. Actually the human body

is capable of converting certain amino acids to others and even build them up from non-protein sources (carbohydrates and fats). But it is unable to synthesize eight[1] essential ones which must be supplied by the diet to maintain health. Others are not essential in the diet (though essential to the body) since they can be synthesized in the body.

All the amino acids needed for growth and maintenance of the body are available in the protein supplied by milk. Some vegetable notably the legumes (peas, beans), lentils, ground-nuts etc. also supply substantial amounts of high quality protein. One can live healthfully on a vegetarian diet by giving importance to legumes and by combination of other foods that mutually supplement each other's deficiencies. Since the digestion splits the protein molecules into their constituent amino acids, it makes no difference to the body how the amino acids are supplied. Unless sufficient amounts of essential amino acids are provided regularly, even if the diet is quite adequate for caloric requirement, a protein deficiency syndrome may develop. In children, protein-deficiency results in a retardation of growth, lethargy and mental retardation.

Proteins of wheat, corn and peas etc are simple proteins containing only amino acids. Proteins of milk, egg etc. are conjugate proteins i.e. combined with non-protein substances.

Fat : Butter, Oil, etc.

A little fat goes a long way as far as the calories are concerned. Fats are more economical sources of energy for the body (9 calories/gm, vs. 4 calories/gm. for carbohydrates and proteins). Moreover, in most foods, proteins and carbohydrates represent less than 25 percent of the total weight of the food; (the rest is water). But fat is 100 percent fat.

1. Valine, leucine, isoleucine, phenylalanine, threonine, methionine, lysine and tryptophan.

There has been a great deal of controversy about the possible implication of fats in the development of heart disease. Similarly for some time cholesterol was regarded as the prime villain in the development of atherosclerosis—the build-up of fatty deposits in the artery-walls. Heart patients are strongly urged to drastically reduce and limit their cholesterol intake. Recently it has been realised that cholesterol level is not always correlated with the condition for the artery-walls and even on a cholesterol-free diet the body can synthesize abundant amount. Indeed, cholesterol is a vital substance for the body; it is found in all the cells and fluids of the body and in the blood. Current research seems to indicate that the "prudent diet" should include a certain proportion of unsaturated fats which are naturally found in vegetables and seed oils. Hydrogenation[1] improves their storage-qualities but eliminates their unsaturation. Cholesterol level in the blood is now believed to be more reliable predictor of heart-attack risk than the total cholesterol levels. A diet rich in saturated fat and/or cholesterol contribute to obesity (fatness) and build-up of fatty deposits inside artery walls. Unsaturated fats prevent cholesterol deposition and physical activity removes it from the artery walls.

Vitamins

If you eat a balanced diet, you do not need vitamin pills. Unfortunately, processing and storing of foods often tend to remove or destroy vitamin constituents, e.g. the pasteurisation of milk destroys milk's natural vitamin C content. The manufacture of flour, involving removal of hull and bran from the grains, strips of many of their vital ingredients especially the B-complex vitamins. The discarded hull and bran provide a highly nutritious fodder for livestock.

1. Vegetable oils are subjected to the process of hydrogenation so that they can be preserved. The process, unfortunately changes the appearance to that of ghee without, however, bestowing the values of real 'ghee'.

Vitamins are organic substances that are needed in very small amounts for the normal metabolic processes and cannot be manufactured by the body itself. Most of them act as co-factors for enzymes in the body. At least a dozen vitamins have been established as needed in human nutrition, while many more are suspected to be essential to good health. Most animals can synthesize all the vitamin C they need, whereas human beings need a regular dietary intake of this vitamin. Plants do not need to take in any vitamins. They synthesize all that they need. Plant substances, in fact, provide major sources of vitamins in the human diet.

Vitamins are grouped into two basic categories according to their solubility. Vitamins A, D, E, and K are soluble in fats and oils. They require the presence of bile in the intestines to be absorbed; a defect of fat-absorption thus leads to their deficiencies. They tend to be stored in the body for relatively long periods and thus a steady in-take is not vital. On the other hand, if the levels of intake are high, accumulation may become a problem. The varied group that makes up the B complex and vitamin C are water soluble and are not stored in the body. As exesses are rapidly excreted, cummulative overdoses do not present a problem but a steady daily source must be ensured.

Vitamin A plays an important role in the chemistry of vision and its deficiency results in night blindness. It is also involved in growth processes and the maintenance of the skin and mucous membranes. Massive overdoses produce toxic effects including headache, nausea etc. Carrots are a rich source of percusor of this vitamin, which itself is produced in the body.

Vitamin B Complex : Strange as it may appear, the members of the B complex group are neither chemically similar nor are their effects similar. Their grouping together was merely an accident of history. They are all water soluble and are found together in various foods; some members of this group are :

B_1 (Thiamine) : Discovery of the first of this group was named B_1. Its deficiency initially causes loss of appetite and indigestion; then an involvement of the nervous system, loss of motor-function and ultimately beriberi including enlargement of heart. Nervous system and cardiac muscle are particularly vulnerable to vitamin B_1, (thiamine) deficiency. Yeast, whole grain cereals (especially the hulls and brans), milk, legumes, (beans etc.) and nuts are rich food source of this vitamin. Its minimum daily requirement varies with the body size and calories utilised per day.

Vitamin B_2 (Riboflavin) was originally isolated from milk. A good part of the body's requirement of this vitamin is normally produced by the bacteria inhabiting the intestines, but a part must be consumed in food. Its deficiencies are usually mild and result in dermatitis, inflammation of the tongue and cracking of the corners of the mouth. It gnerally occurs together with a deficiency of other B vitamins. Food sources for this vitamin include ground-nut, wheat-germ and vegetables such as spinach.

B6 and B12 B_6 deficiency can cause anemia, dermatitis and convulsions. Fortunately its deficiency is rare. Its sources are the same foods that provide abundant supplies of the other B complex vitamins viz. wheat-germ, milk etc. It is also synthesized by intestinal bacteria. B_{12} is necessary for growth and maturation of red blood cells. Very small quantities—just micro-grams—are needed. Its deficiency causes anemia, weakness and numbness of limbs and finally in a complete loss of ability to control them.

Niacin : Yeast, groundnut, wheat-germ, legumes and milk are good food sources of vitamin Niacin. It is also synthesized by bacteria in colon. Its deficiency can result in dementia, diarrhea etc.

Pantothemic acid, folic acid and biotin are other members of the group. They are all synthesized by the bacteria in the intestines. Folic acid is also supplied by fresh

leafy green vegetables. Yeast, milk, grains, vegetables and nuts are other food sources for these vitamins.

Vitamin C : Human beings are one of the few animal species that need a dietary supply of this vitamin. Some years ago, large doses of vitamin C (one to ten grams daily), as a preventive for the common cold, was proposed by the Nobel Prize winner—L. Pauling. According to the latest evidence, taking large doses of this vitamin does indeed reduce the average incidence of colds and lessens the severity of those that occur. Besides, it has been found to exert a cholesterol-clearing action on hardened arteries. Pauling has also reported an anti-cancer activity and large doses of the vitamin have, indeed, significantly prolonged the lives of terminal cancer patients.

Experiments on treating scurvy victims, (swollen and painful joints, fragile bones, bleeding gums and loosened teeth), with various foods showed that fresh citrus fruits cleared up the condition. The actual vitamin which was isolated and studied in the early 1930s, was named ascorbic acid. A vitamin C deficiency interferes with the healing of wounds and produces weight-loss, weakness and the other symptoms of scurvy just mentioned.

The best sources of this vitamin are fresh fruits and vegetables, specially, the citrus fruits (oranges, lemons, grape fruit), tomatoes and strawberries. Leafy green vegetables are also a good source, provided there is not too great loss of vitamin in cooking. (Heat, combined with exposure to light, causes a breakdown of the vitamin and large quantities of water used in cooking may dissolve it out of foods).

Vitamin D is actually manufactured in the body but only under special condition viz. in skin exposed to sunlight. Being a typical fat-soluble vitamin, it is stored in the body for long periods. People who work outdoors and have a large portion of their skin exposed to sunlight need only minimal amount in diet. Melanin in the dark-skinned people, screen

out a large fraction of the sun's rays. Vitamin D_2 (calciferol) is the commercial form of vitamin D.

This vitamin increases calcium-absorption from the gastrointestinal tract and also helps to control bone-formation and resorption. Its deficiency in children causes rickets (bones are soft and fragile and the skeleton becomes malformed). In adults, it leads to softening of the bones, skeletal deformities and frequent fractures. Milk and butter are good sources for this vitamin. Since this vitamin is commonly added to processed foods, a possible overdose in quite likely.

Vitamin E : This is so widespread in foods that actual deficiencies are virtually unknown. Children with cystic fibrosis may have it as a result of malabsorption in the intestines. This vitamin acts as an antioxidant, preventing the oxidation of unsaturated fats. It also provides protection against action of radiation and environmental pollution. Food sources of vitamin E are wheat-germ, oil, whole wheat products, lettuce, milk and butter.

Vitamin K : This vitamin is essential for blood-clotting. It is produced by the intestinal bacteria. Taking antibiotic may kill the population of beneficial intestinal bacteria together with the invading pathogens and the body is without its normal supply of vitamins. At such times, a dietary intake of this vitamin, which is otherwise produced in sufficient quantities, is necessary. It is present in most foods, especially spinach and other leafy vegetables and tomatoes. Its deficiency slows the process of blood-clotting and haemorrhage occurs readily. It is often given routinely before surgery and before delivery to control possible haemorrhages

The table giving information on major vitamins is given in appendix A.

Minerals : Minerals constitute about 4% of the body-weight. As many as 40 elements are critical for the proper

functioning of the body. Some, such as calcium and phosphorus of bones, are present in sizable quantities; others are needed only in minute amounts. These are often referred to as trace elements or micronutrients. Minerals are lost daily in the urine, feces and sweat and must be replaced by the intake of foods. As mineral salts help to maintain acid-base balance and participate in various body-functions such as conductivity, coagulation of blood etc., their deficiency can produce disease or poisoning. Some important minerals and their functions are given here.

Calcium is the most abundant element. 99% of it is found in the bones and teeth. Yet the other one percent is vital for cell activities. It is involved in muscle-and-heart-contraction, in nerve-conduction and blood-clotting. A daily intake of 1 gram is needed to maintain an optimum concentration in the body fluids. But children and nourishing mothers have increased requirements. Bones and teeth will be demineralized, if the diet is deficient in calcium. Milk and milk-products are the best food-sources, but it is also supplied by leafy vegetables.

Phosphorus is also an abundant and vital element. About 80 percent is combined with calcium in the bones and teeth. It is also an essential constituent of the nucleic acids, ATP, etc. Daily requirement is about 1.5 gram, but incrased amounts (equal to that of calcium) are needed by growing children and nursing mothers. Foods that are rich in calcium (e.g. milk) also provide good supplies of phosphorus. It is also found in beans and nuts.

Sodium is found mainly in the extra-cellular fluid with only traces inside the cells. It plays a major role in the acid base balance and osmotic pressure. Table salt (sodium chloride) is commonly and routinely added to many foods, but the average diet provides ample amounts of sodium even without salting. Person with heart-disease must severely restrict their salt intake as it is believed to be contributing to the development of hypertension (high blood-pressure).

Normally kidneys maintain optimum levels by reabsorbring it from urine. When, however, sodium-loss is copious by sweating, it must be promptly replaced; otherwise, weakness, cramps and diarrhea may result.

Potassium : In contrast to sodium, it is found mainly inside the cells. Beside the water-balance, it plays a role in nerve and muscle-activity. Either high or low levels produce abnormalities of the heart action. Most foods contain potassium and dietary deficiencies are extremely rare.

Iron is key mineral in the body. It is a constituent of the haemoglobin in the red blood cells, myoglobin of sketetal muscles and various enzymes. It is not one of the more abundant elements. Actually the adult body contains only about 4.5 grams (compared to 125 grams of potassium). About half of this is contained in the haemoglobin. Iron is stored in the body, but the storage is limited and a regular intake in the diet is necessary. Women lose significant amount each month in menstrual flow and thus have increased requirements and often suffer from deficiency. Beans, peas, whole wheat, spinach and prunes supply abundant amount of iron.

Magnesium is widely distributed in the body. Most of it is in the bones but it is also present in the cells and blood-serum. It is a key cofactor in the metabolism of glucose and ATP. Excess concentration in the extra-cellular fluid depresses the conduction of nerve impulses and the muscular action. It is chemically similar to calcium. It is widely distributed in foods, green vegetables being especially good sources.

Copper and Manganese are trace elements which are vital to the body, being constituent of or activating a number of metabolic enzymes. Copper participates in the formation of haemoglobin, though it is not an actual part of it. The entire body content of copper is only about 100 mg. and yet its deficiency (as may occur in infants on an exclusive milk diet) will result in anemia and other serious consequences. Normal diet provides adequate amounts of manganese; excess of this mineral is toxic.

Chlorine, Iodine, Fluorine are members of the same chemical family. Chlorine is distributed throughout the body in the form of chloride ions which diffuse into red blood cells to maintain ionic equilibrium. It is also a part of the hydrochloric acid in the stomach. It is supplied by common salt.

Iodine is found mainly in the thyroid gland. It is essential for the synthesis of the hormone thyroxine. In inland areas, the food and water-supply tend to be iodine-deficient resulting in goitre and other problems. Dietary iodine can be provided by the use of iodized salt. Fluorine is deposited in teeth and bones. It is not certain whether it is needed in the diet, but it is commonly used to prevent tooth decay. In excess it can produce mottling of teeth and skeletal deformities. It is natural constituent of drinking water in some localities.

Zinc and Cobalt are found in most food and tap-water. Zinc is an integral part of numerous enzymes and is involved in such vital body-functions as the transport of carbon dioxide in the blood, energy metabolism and digestion.

Cobalt is an essential constituent of vitamin B_2 which is necessary for the maturation of red blood cells.

The table giving information on major minerals is given in appendix B.

Other mineral elements which are also essential for normal body-functions include sulphur (a constituent of proteins), chromium (participates in glucose metabolism), molybdenum (plays a role in enzyme activity), selenium (important in liver function), and vanadium (necessary for growths).

Some trace minerals that find their way into food or drinking water can be dangerous to health. Industrial water pollution has been adding to the problem. Mercury-residues

can cause severe neurological damage. Cadmium (leaking out of water-pipes into drinking water) has been implicated in the development of heart-disease. It is naturally present in wheat but the grain also contains zinc, which prevents the absorption of cadmium. When bran is removed to refine wheat flour, most of the zinc is removed, altering the mineral balance and leaving the cadmium.

A Balanced Diet

Knowledge of complex interaction of nutrients as discussed above help us in choosing a balanced diet and in fostering the development of better nutrition. Whatever the diet may be, it should provide adequate calories to supply the body's energy needs. Carbohydrates (starches and sugars) with some fat are thus essential. Enough protein must be provided for tissue-building and repair—65 to 100 grams of proteins daily intake is recommended for adults. Besides all the necessary vitamins and minerals, the adequate diet should also provide sufficient water and enough fibre to promote good bowel-function.

A variety of foods helps to ensure that all the dietary needs of the body will be met. Each of the major food groups should be adequately represented by one or more members: (a) cereal and grain products (b) milk and milk products (c) fruits and vegetables (d) legumes (beans, peas) (e) nuts and dry fruits.

Caloric Requirement

No matter how inactive one may be, rate of energy-expenditure will not fall below a certain basic value. This is the minimum level of energy expenditure required to maintain the basic cell and body functions—basal metabolic rate (BMR). Energy-consumption will rise sharply when one moves round and does physical work. Energy-consumption is measured in Calories. Just existing at a minimal level, energy-consumption is about 1600 to 1800 Calories a day for man on the average and 1300 to 1500 for a woman.

Slightest exertion—sitting up, standing, walking,[1] exercising—uses up additional Calories. Thus the amount of physical exertion a person normally does is an importnat determinant of caloric requirement. For example, a sedentary worker (student, office-clerk, typist etc.) would need 2200 to 2500 Calories a day. One engaged in more strenuous activity (metal-worker, painter) has a daily expenditure of about 3000 Calories. A hard worker may use as many as 8000 Calories in a day. If the food-intake does not supply this requirement, weight will be lost as body's reserves are utilised; if more Calories are taken in than are used, the residue will be stored as fat, and weight will be gained. Mental exertion, no matter how intense and tiring, does not use up many Calories. Emotional stress does cause some increase in energy expenditure through a speeded up heart rate, increased breathing-rate etc.

Physical activity is a primary factor but not the only one determining caloric requirements. Body-size is an important factor. Age is also another one : growing children need far more calories in proportion to their size than adult and the caloric requirement gradually decreases throughout adulthood. Thus a person of middle age will put on weight if he continues to eat the same diet as in earlier years.

Obesity and Dieting

Obesity (fatness) or overweight is a major health problem of the modern times. It is caused by consistently takeing in more calories than one uses. The excess is converted to fat and stored in the body. Obesity can develop gradually and insidiously. We not only eat too much, not only eat the wrong foods but often eat too much of the wrong foods. Abundance of food combined with a sedentary way of living contributes to the problem. In a new cases, the problem

1. Sleeping 60 Cal/hour — Walking 200 Cal./hour
   Basal 70 Cal/hour — Swimming 500 Cal/hour
   Standing 100 Cal/hour — Running 600 Cal/hour

may have a specific organic cause—a disorder involving thyroid, pituitary or other glands. When it also tends to run in family, it suggests that a hereditary factor may be involved. Since the hunger and satiety centres which regulate the food intake is in the hypothalamus, its abnormality may be involved. Children who are overfed by anxious mothers, develop more fat cells and have problems when they are adults.

A compelling reason to avoid overweight is that it increases the probability of a premature death. Excess bodyweight puts a constant strain on the heart in several ways. It must pump harder to supply enough blood to the muscles which must work harder to move the extra weight. The fat deposits require copious blood supply. Millions of extra capillaries are formed adding resistance to the circulation and raising the blood-pressure. Fat persons are more prone to the hardening of arteries, gall stone formation, kidney-inflammation and other diseases.

The most reliable way to lose weight and to keep it off is to make a drastic change in eating habits. Our food today is not what our ancestors normally ate. Not only has a great deal of its value been removed, but almost all the food we buy has been processed and contains some kind of preservative.

The diet of our ancestors contained a relatively small amount of sugar supplied mainly by fruits. Refined cane sugar (sucrose) did not become a significant factor in the human diet, until about 200 years ago; since then sugar consumption has risen steadily. According to some researchers, sugar may be the main culprit in the development of atherosclerosis. For those who have not been fortunate enough to inherit a strong pancreas, continual high intake of sugar can "burn out" glandular cells of this organ[1], leaving it unable to regulate the body's carbohydrate metabolism.

1. For the function of pancreas, see Part I of this book.

A reduction in total caloric intake, enough to produce a small but steady weight loss (1/2 to 1 kg. per week) is more effective than food dieting. Sudden introduction of any radically new diet can cause stomach upset. A severe reduction of total calories or a restriction to just one or few specific foods, seems to show results at first but the initial weight loss is mainly a loss of water and soon the weight stops at a constant value. By this time the dieter is chronically hungry, irritable and thoroughly fed up. His resolution usually goes by default the next time he sees somebody eating a cream cake. Dieting is abandoned and the lost weight regained quickly. Incorrect diet (incorrect both in quantity and content) can cause as many problems of ill health as can the tensions of modern living. True, it is difficult to depart from one's eating habits and plan, unfortunate though they may be. There are, however, great many ways in which we can improve our nutritional picture without radically changing our way of life. A few easy tenets with regard to eating combined with a gradual change in the diet will improve our health considerably. An increase in physical activity and regular exercise will also contribute to the weight-loss by increasing energy-expenditure. This again should be a permanent change in habits rather than crash programme of strenuous exercises that may put too great a strain on the unconditioned heart. Regular exercise also lowers the risk of heart-attack. Crash reduction of the total food intake also reduces the intake of vitamin, minerals and water. Leafy vegetable are usually low in calories, high in vitamins and minerals. They satisfy hunger and promote good bowel function.

Tenets for eating

(1) Eat moderately : leave one quarter of your stomach empty. The slight feeling of hunger will disappear after a few days' regular practice.

(2) Make maximum use of the food intake. Chew mouthful thoroughly before swallowing. Properly masticated food attains a soft paste-like consistency and slips easily down the throat.

Stage by Stage Plan for Healtheir Diet

First Stage : Avoid all food containing preservatives. Eliminate the use of refined white sugar. Avoid sweets, jams and such other foods which contain white sugar. Demarara (unprocessed brown) sugar, jaggery (gur) and honey can be used to sweeten instead of white sugar. Substitute brown bread in place of white. Avoid white flour products as far as possible.

If you are not a vegetarian, discontinue or drastically reduce (if your are unable to avoid it altogether at once) meat and meat-products.

If you are using chemical salt, discontinue it and substitute sea-salt.

Second Stage : Eliminate use of pepper, chillies and other hot spices. (Turmeric and other condiments can be used). Discontinue tea and coffee; substitute them with milk and fruit, juice or fresh fruits. Further reduce meat from your meals.

Third Stage : Avoid meat completely. Increase the use of cereals, dry fruits, nuts, vegetables and salads and milk to give a full nutritional picture.

Substitute fresh fruits for sweet desserts and pastries.

Eliminate deep-fried foods.

When you have completed the last stage, food has assumed its proper place in your life. This does not, however, mean that you cease to enjoy your meals. In fact you may develop a keener sense of taste. An occasional meal, outside the above plan of diet, does little damage, so long as you remember to eat moderately and chew thoroughly.

Disastrous results of bad habits of drinking and smoking have been dealt with in chapter VII of this book.

4

Metabolism of Food

We, human beings, like the other living things on planet Earth, are chemical beings, whose bodies are made up mainly of carbon compounds. We are active organisms and we get the energy to power our activities from chemical compounds contained in the foods and drinks consumed by us. Building materials for growth and repair are also obtained from foods, but they rarely come in ready-to-use forms. Carbohydrates, proteins and fats in the foods must be first broken down into simpler components (by digestive processes) in order to pass through cell-membranes and enter the body-cells; within the cells the products of digestion are subjected to further chemical reactions. In *catabolic* reactions, food materials are torn down into smaller units or oxidized to release the energy stored in their chemical bonds. In *anabolic* reactions, substances are built up into more complicated compounds—the characteristic chemicals of the body. Both breakdown and building up—or synthetic reactions—go on constantly in the body cells. The term metabolism refers to the sum total of all the anabolic and catabolic reactions of the body.

The catabolic reactions supply energy for activities such as muscle-contractions, transmission of nerve-impulses etc. The chemical energy stored in foodstuffs is also converted to other energy-forms such as heat and electricity. The energy is temporarily stored in convenient units in the ATP molecules. This "energy currency" permits a controlled release of energy as it is needed; if the energy were released all at once, as in a fire, it might destroy the cells.

Metabolic reactions must go on continually as long as life continues. If the energy-substrates are not replenished by food intake, the body-tissues themselves will be metabolized. The first preference for energy supply is given to the carbohydrates and fats. The amino acids from proteins are used mainly as building materials. Catabolism takes first priority. Anabolic processes are deferred if there are not enough materials available for both.

Carbohydrate Metabolism

A lump of sugar or a piece of fruit can give "instant energy" to a tired person. Food-sugar in the form of glucose is quickly absorbed through the stomach-lining and is carried by the blood-stream to the cells. Simple food substances such as water, simple salts, simple sugars, alchohol, some drugs do not need further digestion and can be absorbed directly through the stomach-lining. Complex sugars and starches make their effect felt less rapidly, but they too contribute to the body's energy reserves. Glucose is the main product of starch digestion and virtually all the sugar in the blood is in the form of glucose. Some of the major alternatives in the body for the sugars absorbed from the digestive tract are as follows : they may—

1. pass into the circulation as blood-sugar.
2. be carried to the liver and converted to glycogen and stored there,
3. be converted to glycogen in skeletal muscles,
4. be converted to lipids and stored in fat deposits,
5. be converted to amino-acids,
6. be oxidized in the tissues as energy sources,
7. be excreted in the urine (as in the disorder diabetes).

Blood-sugar

When food is eaten, the blood-sugar level rises to a peak and then falls rapidly. A high blood-glucose concentration triggers an automatic regulatory mechanism in which

the endocrine portion of pancreas pours out the hormone insulin which promotes the transport of glucose into the tissue cells. With the drop in sugar-level, secretion of insulin also decreases. On the other hand, where blood-sugar level falls below normal, other regulatory mechanisms come into play. These promote breakdown of glycogen in the liver and the release of glucose into the blood decrease glucose utilization, mobilize lipids from the cells and enhance glucose-absorption from the intestine.

The liver plays a pivotal role in the carbohydrate metabolism. Here, much, of the glucose is removed and synthesized into glycogen. If in abundance, some of the glucose is converted into fat and stored. When the glucose-supply is low, liver breaks down glycogen to glucose. Under some conditions, liver can synthesize glucose from non-carbohydrate sources. During starvation, first the glycogen-reserves are exhausted. Then the fat-deposits are called upon. Finally the tissue-proteins are broken down and their amino-acids used for producing glucose and energy.

Protein Metabolism

Apparently the body goes to a great deal of wasted effort. Proteins are first broken dwon into amino-acids by the digestive processes, absorbed into the blood-stream, delivered to the cells and then build back into proteins again. However this round-about procedure is necessary for two reasons : first, the food-protein molecules are too large to pass through cell-membranes, and second, the food proteins are not the (chemically) right proteins for the human body. All the proteins of all living organisms on earth, though differing from species to species, are built up from the same basic set of building materials viz. about twenty odd different *amino-acids*. Thus after the food-proteins are broken into their components, no matter from where they originally come from—a plant or an animal—they can be synthesized into human proteins.

Anabolism usually predominates over catabolism in protein metabolism. Besides synthesis of tissue-protein, a large portion of the food-proteins is used for a variety of non-protein synthesization.

Catabolism occurs in the liver. Amino-acids in excess of the body's synthetic needs are de-aminised to, ultimately, form urea which is excreted. A gram of protein releases about 4 calories of heat, the same as a gram of carbohydrate and less than one-half that of fat.

Protein-digestion is a long drawn-out process. Small amounts of amino-acids absorbed from the digestive tract are transported through the body and quickly resynthesized into body-proteins. Cells and tissues can store protein, but each type of tissue has an upper limit to the amount of protein it can store, and excess amino-acids are catabolized or excreted in the urine.

Protein-synthesis is so important a factor in growth and tissue-formation that its metabolism is influenced by many endocrine hormones. Growth hormone, androgens (especially testosterone), thyroxin as well as adrenal cortical hormones all directly or indirectly promote cell and tissue-formation.

Fat (Lipid) Metabolism

The sedentary way of life, combined with a diet with more calories than the body needs each day, turns one of the strong point of human metabolism into a negative factor. Excess fats, above what the body needs, are deposited in characteristic deposits. Excess carbohydrates and even protein can be converted into fats and stored. Fat yields 9 calories per gram.

Immediately after a meal, the fat-concentration in the blood may rise. As the fat-laden blood passes through certain tissues—adipose[1] tissue, heart-muscle and skeletal muscles—fat is converted to glycerol or fatty acids. Glycerol is

1. A specialized variety of loose connective tissue. It acts as a firm but resilient packing around and between organs, nerves etc. protecting them from injury.

catabolised like glucose; the fatty acids can be oxidized for energy (except in nerve-tissue which uses only glucose for energy), or can be stored after resynthesization by the fat-cells of the adipose tissue. Fat is also a vital constituent of tissue and cells.

Though the fat deposits scattered through the body often seem all too permanent, actually they are in a dynamic state, with a breakdown, re-synthesis and exchange with the plasma fat. It has been found that as much as half of the total fat-reserve changes position each day, and even in the most obese person, the fat is not the same fat that was stored two or three weeks before.

The liver plays a key role in fat metabolism. It synthesizes fatty acids from carbohydrates, and saturates, unsaturates and oxidizes them by a specialized process. When carbohydrate metabolism is abnormally low, as in starvation or diabetes, increased amounts of fatty acids are utilised for energy.

The role of cholesterol is still cloaked in controversy. It is absorbed from the intestine; but even when kept on a cholesterol-free diet, the body synthesizes its own cholesterol. It is a constituent of bile-salts and is used in the formation of several hormones including cortisone and progesterone.

Insulin is the main regulator of fatty acid mobilization facilitating their transport into the cells. Several other hormones—epinephrine, adrenal cortical hormones, growth hormone, and the thyroid hormone—increase fat-mobilization. Sympathetic innervation of the adipose tissue has a similar effect. The levels of blood-glucose and fatty acids are inversely related. When the glucose is high, the fatty acid level is low and vice versa.

Water Metabolism

We produce a great deal of metabolic water. Water is formed in the oxidation of glucose, proteins and lipids. A total of about 375 millilitres of water is produced in the human body

every day, but in order to maintain homeostasis[1], we need about 10 time that amount. Water not only participates in reactions of digestion and other reactions but is also lost in urine, feces, sweat etc. Food and drinks make up the difference of our daily fluid needs. Most solid foods also contain substantial amounts of water.

Energy Metabolism

Virtually all the processes and activities that go on in the human body require a continual supply of energy. The energy that powers the human body is chemical energy. The energy metabolism of the body consists of a sequence of reactions that has much in common with the burning of a *sigree* or a stove. Fuel is oxidized by oxygen in both cases, releasing the energy and forming carbon-dioxide and water. But there are a number of important distinctions. A fire burns rapidly and the energy released is given off all at once in the form of heat and light. The burning of the fuel in the body proceeds in a series of small controlled steps; much of the energy released in each step is recaptured and stored. Chemical energy is used in the body to do work. It may be converted to mechanical energy (to lift a load) or electrical energy (for transmission of nerve-impulses) or it may be used as chemical energy to build up complex body chemicals.

Part of the body energy is given off as heat at the time of release. Further energy is lost as heat during the performance of the work. Ultimately all the chemical energy is directly or indirectly converted to heat, but heat-production is not entirely useless. It helps to maintain body-temperature at the optimum level for enzyme-catalyzed reactions. But often the heat production is in excess of the body's needs and special mechanisms are provided to get rid of the excess. Although the energy of food is not used directly as heat, it is customarily measured in heat units; the unit commonly used in physiology is called Calories.[2]

1. Optimum internal conditions of health.

2. Spelled with a capital C. It is the amout of heat required to raise the temperature of 1 kg. of water by 1° C.

5

The Dynamic Balance of Body Fluids

Regulation of Total Body Fluids

A human body passes through an evolution as it develops. An embryo is 97% water, a newborn infant is 77% and an adult man only about 60 to 65%. Because of more water-free adipose tissues in a woman, water-content is 54%. The composition of the fluid media remains relatively constant. The dynamic equilibrium is maintained by the complex interaction of respiratory, circulatory, digestive, excretory, endocrine and nervous systems. It is one of the most important aspects of homeostasis i.e. optimum internal conditions of health.

There is a high degree of internal organisation—structural differentiation and compartmentalization—of the body fluids. About two-thirds of the total body fluid is intracellular (found within the cells). Interstitial fluid which bathes the cells, fluid in the blood and lymph vessels, the cerebrospinal fluid and some other special fluids are extracellular.

Water enters the body through the digestive tract in the form of liquid intake and food consituents. It leaves the body through the lungs, kidneys, the bowel and the skin. To maintain balance, intake must precisely balance the output. If the lost fluid is not replaced promptly, the person would rapidly become dehydrated, placing an increasing strain on the body systems. On the other hand, if fluid intake exceeded output, edema—an excess fluid in the interstitial space—would result, placing a strain on the cardiovascular system. A dynamic equilibrium is maintained by

continual adjustments both of intake—through the thirst mechanism and of output—mainly by variation of urine formation.

Input

The mechanism of thirst is apparently simple, but actually rather complex and not entirely understood. A drying of mucous membrane of the mouth and a cessation of saliva flow play an important role in the immediate sensation of thirst and serve as a stimulus to fluid intake. But these sensations are controlled by the thirst centre in the hypothalamus. When the extracellular fluids are too concentrated, impulses from the control centre somehow give rise to the sensation of thirst. The feedback system is tuned to conditions of excess loss of fluid. For example, hot weather or participation in sports or other strenuous exercises force us to drink frequently, because fluid pours out by the sweat glands as the body works to dissipate the excess heat. The moistening of the mouth and the distension of the stomach, resulting from the act of drinking, initiate feedback impulses which turn off the stimulation of the thirst centre. When large quantities of fluids are taken in, water is rapidly absorbed from the intestinal tract into the plasma compartment. Both the blood volume and cardiac output may be temporarily increased. But soon the fluid passes into the interstitial compartment and the kidneys step up their elimination of water. Balance is rapidly restored. Thus within the body there is a continual interchange of water and other materials among the compartments. Interstitial fluid plays an important role in the body's fluid dynamics.

Output

We have an efficient system of sweat glands to lose heat through evaporation of water. Even on a cool day, we continually lose water through the skin. This mechanism is an important part of the body's temperature-control-system but maybe a threat to the body's fluid-balance, if intake is limited. Under normal condition the fluid-loss through

skin is about 500 ml. per day. Exhaled air is also laden with moisture. Water-loss through the lungs varies the humidity and temperature of the air. On the average, it comes to about 300 ml. per day. Under extreme conditions, loss through the skin and exhaled air may reach as much as 20 litres per day.

Dietary fibre makes bowel function more rapid and effective. The feces are softer and move more rapidly through the bowel. A lack of fibre and an insufficient fluid intake may result in the feces becoming hard and difficult to pass, setting up a vicious cycle of constipation. Normally 200 ml. of water is lost in the feces each day.

Kidneys are the main spillway for the body's excess water. It provides wide latitude for regualtion of fluid output. The average daily output in the urine is about 1500 ml., but this amount may vary greatly, depending on the fluid-intake and the amount of water lost through other channels of excretion. If intake is less, or if more water is lost in sweating or diarrhea, the kidneys put out small amounts of concentrated urine. If intake is excessive, it is excreted by producing large quantities of dilute urine. Regardless of fluid-intake, a certain minimum amount of urine must be produced, containing sufficient water to keep dissolved the excreted wastes.

Body Water-reserves

One type of stress that the body is sometimes called on to bear is a loss of water. Prolonged vomiting or diarrhea can place strenuous demands on the body's water reserves. Under such conditions, people with the large percentage of body-water stand the best chance for survival. Obesity is one factor that reduces the body's fluid reserves, since adipose tissue is essentially water-free. The progressive tissue-dehydration that occurs in old age produces great depletion of water-reserve.

Practical Considerations

A pregnant woman is usually advised to cut down on salt in her diet to avoid troublesome swelling of feet and ankles. Fluid retention may also be a problem during menstrual periods. An excess of fluid in the interstitial space is called 'edema'.

Obstruction of the venous system or a local dilation of arterioles may raise the capillary blood-pressure causing fluid to leak out. Lymphatic drainage may be blocked by a tumor or inflammation, causing excess fluid to build up in the tissue spaces. When the kidneys fail to put out enough urine, edema results. An imbalance of electrolytes[1] in the body produces a disturbance of the fluid-balance and vice versa.

Profuse sweating, diarrhea etc. can result in dehydration (decrease in the fluid-volume). Consequently, circulation is impaired, the blood-flow to the kidneys is reduced, and waste-products accumulate. Fluids must be replaced promptly either by mouth or by direct infusion into the blood-stream in order to prevent permanent damage.

Burns over large areas present special problem, since they exude large quantities of plasma. When patients cannot take in sufficient liquids and food by mouth, intravenous infusion of carbohydrate solutions provides a ready source of energy and effective replacement of fluid.

Repeated enemas of water may wash out ions and produce electrolyte imbalance. It is preferable to use an isotomic solution of common salt (sodium chloride 0.85%) for such treatment.

1. Electrolytes are substances which dissociate into ions in solution becoming capable of carrying an electric-current.

6

Dysfunction and Disorders

Homeostasis

We are subjected to continual changes in the conditions of the external environment—light and darkness, heat and cold, humidity and dryness. We have mechanisms for maintaining a relatively constant internal environment, despite changes in the external world. For instance, our body temperature is kept constant within a relatively narrow tolerance, inspite of wide fluctuations of the external conditions. As we have seen in the previous chapter, chemical composition of the body fluids is well-controlled too.

Homeostasis is the central theme of the physiologists' studies. In a sense, virtually everything in this book relates to homeostasis in one way or another. it is not a static condition but a dynamic equilibrium, a matter of continual adjustment for maintenance of equilibrium between the organism and the environment.

Normal values or normal ranges of values of various body-indices given in this book are characteristics of the healthy body. Abuses to which we subject our internal organs result in their dysfunctions and lead to the disorders of the system with which they are associated. Homeostatic mechanisms may become less efficient. The body temperature may rise, or specific components of the blood may be higher or lower than normal. Consequently body defences lose their normal efficiency; body indices deviate from the normal and give indication of disease. Such deviations are clinical clues to the diagnosis of diseases. Restoration of homeostasis is essential to life and health.

In this chapter we shall deal with some of the major disorders of various systems.

I. Disorders of Circulatory System

Blood Clotting (Abnormalities)

The organs and systems of the body are intricately interrelated into a smoothly functioning whole. But a disorder in one part can have far-reaching and sometimes unexpected effects on other organs and systems. Thus abnormalities of blood clotting can be caused by defects or damage to a variety of organs. For example, liver disease may give rise to clotting abnormalities that may result in severe or even fatal blood loss. Vitamin K, that may be obtained in the diet and is also synthesized by the bacteria that live in the intestines, is essential too. A heavy course of antibiotic might cause a deficiency by wiping out the intestinal flora together with the pathogens. Bone marrow damage also produces a failure of the normal clotting mechanisms. When the number of blood platelets fall below about 70,000 per cubic mm. of blood, excessive bleeding occurs. Each time a tiny capillary ruptrues, blood escapes out into tissues. Damage to the bone marrow by drugs or irradiation and pernicious anemia can cause this disorder.

Another disorder caused by a deficiency of one or more of the blood clotting factor is *haemophilia* or "bleeder's disease". Normally a bruise or a cut is a minor incident, quickly healed and forgotten. But a haemophiliac could literally bleed to death with a 'minor' cut. It is a hereditary disease and occurs far more often in males than in females. This disease probably had a major effect on the course of world history : the only son of Czar and Czarina who was a haemophiliac set in motion a chain of events that led to the Russian revolution. Prophylactic treatments with antihaemophiliac factor (AHF), extracted from stored old blood, can in many cases permit haemophiliacs to lead a relatively normal life.

Haemorrhage is the escape of blood from the blood vessels. Uncontrolled bleeding is a serious threat to life. As a first-aid measure, excessive bleeding is most effectively controlled by direct pressure at the site of the injury. Gauze applied over the bleeding surface can help by promoting the breakdown of platelets, initiating the reactions of clotting. The body has an assortment of mechanisms for compensating a moderate loss of blood (e.g. loss by donation). The capacity of the system is decreased by vaso-constriction. The liver and spleen contract and sent their blood reserves into the veins. Tissue fluids diffuse into the vessels. Thus plasma volume is regained in a few hours; plasma proteins are restored more slowly and formed elements (viz. red blood-cells, white blood-cells, platelets) may take a month or more. In more severe haemorrhage, symptoms of shock may develop : the pulse rapid and weak, the skin pale, clammy and cold. If more than 30 to 35 percent of the total blood volume is lost, the body cannot compensate rapidly enough. Unless a blood transfusion is administered quickly, the victim may die.

Fatal heart-attacks are caused by a blood clot lodging in the coronaries of the heart, blocking flow of blood and causing irreparable damage to the heart muscle. Normally blood clotting oceurs when a blood vessel is damaged, to stop the loss of blood. Sometimes, however, clots form inside an undamaged blood vessel. The clot is called *thrombus* and partial or complete blocking of a blood vessel is called *thrombosis*. A travelling thrombus is called an *embolus*. Ultimately, if the embolus reaches a vessel that is too narrow, it may plug the vessel. The amount of damage caused by an embolus depends on the region in which it lodges. A coronary embolus can cut off the supply of oxygen to the heart and cause a heart-attack. An embolus carried to the blood vessels of the brain may result in a stroke causing a loss of part of the mental function or death.

What causes clot-formation inside a blood vessel? The introduction of any foreign substance into the blood stream—even a large air bubble introduced during the improper administration of an injection—might provide a nucleus for

platelet congregation and result in thrombosis. Prolonged bed rest—in operation and illnesses—in which there is a pooling of blood in the vessels of extremities, can also result in clot-formation. Eventually the clots break loose and may be carried to the pulmonary arteries. Early ambulation is, therefore, recommended in operations.

Fortunately, the body has an assortment of natural mechanism for coping with the danger of thrombosis. First of all, the inner surface of the blood vessels is extremely smooth as well as coated with a very thin film of a negatively charged protein substance which repels the clotting factor. *Antithrombin*, normally present in the blood, also acts to remove thrombin from the blood and inhibit clotting. *Helapin*, a powerful anticoagulant is secreted into the blood by most cells of the connective tissues around the capillaries. It prevents clotting in several ways. *Dicumarol* and *hirudin* are substances not found in the body, but can be adminstered to reduce the risk of thrombo-embolism.

If an important blood vessel of the body is blocked (by a clot), the obstruction deprives body-tissues of vital supplies of oxygen and nutrients. Poisonous waste products build up in the starved tissues and if they are part of key organ, the damage that results may lead to death. Thus clearing a clot may literally be a race against death. In a healthy body clot formation and dissolution go hand in hand to some extent. One of the plasma proteins, when activated, resembles the enzyme *trypsin*. It literally digests a blood clot, dissolving it away.

Atherosclerosis and Arteriosclerosis

Atherosclerosis, the building up of fatty deposits in the artery walls, narrows the blood-vessel-lumen (i.e. the interior capacity), raising the blood-pressure, forcing the heart to work harder against the increased peripheral resistance and increasing the possibility of thrombosis. A progressive deposition of fatty deposits (mainly cholesterol) in the inner layer of the arteries produces hardening of the arteries—

arteriosclerosis. Later on, fatty deposits calcify and reduce the elasticity of the blood-vessel promoting hypertension. The roughened surfaces of the plaque may rupture and disintegrate fragile platelets and initiate the clotting mechanisms. Normally the blood flows rapidly enough to disperse the clotting factors, but atherosclerosis can slow down circulation sufficiently to permit clot-formation to begin. Three causes have been identified for the plaque-formation—(i) fatty diet, (ii) high sugar intake and (iii) hypertension.

Arteriosclerosis or "hardening of the arteries" is commonly considered a disease of old age, but it may begin in childhood and show no symptoms for many decades. The earlier condition of soft fatty deposits is referred to as atherosclerosis as mentioned above. When the deposits clacify and harden, they reduce the elasticity of the arteries. Besides the blood clot which may be formed, the lipid core of the plaques themselves may also break away and be carried through the blood stream as an embolus.

Hypertension

A resting systolic blood-pressure above 140 mm of mercury is classified as hypertension (high blood-pressure). Some of the cases are found to be the result of specific disease or disorders, such as arteriosclerosis, kidney-disease etc. But in vast majority of cases, no definite cause can be discovered. When the blood-pressure is high, the heart must work harder to pump blood and eventually it enlarges; and if it cannot meet the demands placed on it, it may fail. Hypertension also sets up a vicious cycle involving the kidneys. When the blood-supply to the kidneys is reduced due to narrowing of the arterioles, the kidneys react by secreting their hormone renin which raises the blood-pressure still further and compounds the problem. A weak spot in the artery-walls anywhere in body may cause it to balloon out or even rupture.

Probably tens of thousands of lives can be saved each year if every one had his or her blood-pressure checked regularly. About one sixth of the population has high B.P., but many are completely unaware of this condition. They stand a

much higher than average risk of suffering heart-attack. Early detection of high blood-pressure can bring it under control.

Vasodilation (widening of the diameter of the bloodvesels as a result of the relaxation of the vascular smooth muscles) decreases the blood-pressure. People can be taught to lower their blood-pressure by learning the technique of relaxation and the use of bio-feed back equipment. In time, the person is gradually able to lower the B.P. at will.

Anemia is characterised by deficiency of haemoglobin due either to a decreased number of red blood cells or to an insufficient amount of haemoglobin per cell. It,can be caused by a variety of factors. The average red blood cell lives only about 120 days. Thus, an entire new supply of functioning red cells, each with the appropriate cargo of haemoglobin must be constantly produced. If insufficient raw materials are available, and if blood cells are lost faster than new ones can be produced, anemia can result.

Vitamin B_{12} is a key compound in process of DNA formation and is essential in the maturation of the red blood cell. It is supplied by a well-balanced diet. If it is lacking in the diet or is not properly absorbed, anemia can result.

Radiations, certain industrial chemicals and some drugs may damage the bone marrow and prevent it from forming new red cells.

II. Disorders of the Respiratory System

The respiratory tract is one of the gateways into the body. Despite the formidable array of defences, it is vulnerable to a variety of illnesses caused by the insidious onslaught of air-pollution and other environmental dangers. Besides, a surprising number of people choke to death, because an insufficiently chewed piece of food is mis-swallowed and it blocks the trachea.

Modern immunization programmes, increased standards of sanitation and antibiotics have brought freedom from fear of many diseases that used to be scourges. Infections such as

diphtheria and whooping cough, which used to kill large numbers of young children, have now become rare. The incidence of tuberculosis has dropped sharply and the pneumonia death rate has been lowered drastically. On the other hand, certain factors in the modern environment are promoting a rise in respiratory (and other) ailments that were either non-existent or only minor problems in the past. The effluvia of factories and vehicles and the personal air-pollution by cigarette-smoking has brought a rise in lung-cancer and emphysema. Air-conditioning can dry the mucous membranes of the respiratory passages making us more vulnerable to infection.

Asthama

Asthama is a special type of allergic reaction that can be terrifying to the patient. The condition is characterized by edema (excess fluid) in the bronchioles, secretion of thick mucus and bronchial spasm. It results in laboured breathing and wheezing. Outflow of the air is obstructed more than the inflow and the lungs become distended. Asthamatic attacks may be caused by pollen and/or food sensitivities. A psychological component may also be present since attacks are often precipitated by an emotional crisis.

Bronchitis is a chronic dilation of the bronchi, characterized by spasms of coughing and production of large quantities of pus-containing sputum. Dyspnea[1] and fever are common symptoms. Fatigue, malnutrition and exposure to cold can contribute to the onset of this disorder.

Common Cold

Common Cold is an inflammation of the mucous membrane of the nose. Symptoms include an actue congestion of nose and increased secretion. The swelling of the membrane and accumulated secretions make breathing difficult. Fever and headache may also occur. Colds are caused

1. Dyspnea : sensation of "air hunger" : caused by either hypoxia i.e. insufficiency of oxygen or hypercapnia i.e. an elevated carbon.

not by one or two specific pathogens but by more than 100 different viruses. And the vaccines provide protection only against a few of them. Children upto the age of six are most susceptible to colds while people over the age of 45 seldom catch cold, probably as a result of accumulated immunity to cold viruses.

Colds are usually relatively mild illnesses that run their course in about a week. However, the infection may spread producing sinusitis, conjunctivitis and middle ear or mastoid infection. Besides, they lower the body defences and may prepare the way for bronchitis, meningitis or pneumonia. The use of a large dose of vitamin "C" may prevent the cold.

Influenza

Influenza is caused by a group of viruses and is highly contagious. Common symptoms are fever, bodyaches, general weakness and inflammation of the mucous membranes of the respiratory tract. Outbreaks periodically sweep through the world. The fact that there are several types of viruses and that they have exhibited a great tendency to mutate into new violent forms means that immunity from the disease is difficult.

Pneumonia

Pneumonia is an acute infection in which lung tissue or the walls of the bronchi are inflammed. It is usually caused by a bacterium, pneumococcus. (A viral pneumonia is similar to influenza). Chills, chest-pain, fever, coughing and delirium are frequent symptoms. It occurs most often in young children and in the aged. Now that effective antibiotics are available, this disease is much less feared.

(Pulmonary) Fibrosis

In this disorder, the normal lung-tissue is replaced by fibrus tissue. The elasticity and capacity of the lungs are reduced and respiration is difficult. Chest-pain, a dry cough

and fatigue after slight exertion are common symptoms. Later, breathing becomes more laboured. *Silicosis* and *black lung* are fibrosis of the lungs caused by inhalations of air laden with silicon dioxide or carbon particles in the mines.

Emphysema

Emphysema is one of the fastest growing diseases in the modern world. It is a disease of old age and results from the effects of smoking and air-pollution. In this disease, walls of the alveoli are atrophied and thinned; bronchioles are obstructed and total surface of the respiratory memberane is greatly reduced, sometimes to less than one quarter of the normal value. The capillary bed around the alveoli is also reduced. All these changes are irreversible and lead to increasing dysnea. The disease progresses over many years and the chronic straining to draw breath produces a barrel shaped chest and distended lungs.

Lung Cancer

The result of smoking that has most captured the public imagination is the development of carcinoma of the lung or lung cancer. This is a neoplastic growth, malignant and often fatal, which is more than 20 times as prevalent in smokers. As the malignant cells multiply, they suffocate the normal cells and destroy tissue. Removal of affected segments or of an entire lung by surgery is often resorted to as treatment.

Tuberculosis (T.B.)

Tuberculosis is sometimes called consumption. About half of us become infected with this disease at one time or another, but when the general health is good, the body's defences can usually contain the invading pathogens called tubercuse bacilli. They invade the lungs and the infected area becomes walled off by fibrous tissue forming "tubercle". Sometimes the bacilli spread producing tubercles in various sites.

The reduced vital capacity, decreased membrane-area and increased membrane-thickness make breathing progressively more difficult and less effective. A diseased lobe may be removed surgically. Effective specific drugs such as streptomycin are now available and the disease is much less feared now than before.

III. Disorders of Digestive System

With some thirty feet of alimentary canal, it is no wonder that disorders of the digestive system are among the most common causes of visits to doctors.

Antacids and laxatives are, perhaps, one of the most widely used medicines sold over the counter. In many cases, however, these are unnecessary and may even be harmful.

Indigestion

Indigestion or Dyspepsia is a vague term used loosely for a variety of digestive system. Any one or more than one of the following conditions may be the cause of disorder :

Spasm of the esophagus
Inflammation of the stomach-wall
Peptic ulcer
Cancer of the stomach
Gall-bladder diseases
Intestinal disorder
Emotional upsets.

Obviously no one medicine can be a panacea for such a diverse assortment of ills. Persistent indigestion should be a warning signal to search the root of the disorder. Chewing a few antacid tablets neutralises the gastric acid. But, in fact, the presence of a fairly strong hydrochloric acid is essential for proper stomach function. Indeed, inadequate production of this acid due to atrophy of acid producing mucosa in the stomach is a common cause of gastritis and chronic diarrhea. This responds well to a dose of dilute hydrochloric acid solution after meals.

Food-poisoning

Food-poisoning is the result of eating foods or drinking water contaminated with bacteria or their toxins or with other poisons. The contamination may be introduced by the food-handlers who might carry the germs in their nose, hands, nails etc. This illness is characterized by various combinations of nausea, vomiting, abdominal cramps, diarrhea, fever and prostration and usually lasts for 12 to 24 hours. High standard of sanitation, particularly after excretion, proper cooking, adequate covering and refrigeration of foodstuffs prevent most bacteria-caused food-poisoning.

Constipation

The failure to have a regular bowel movement every day is viewed with alarm and quickly dosed with laxatives which when taken habitually can decrease the tone of the large intestine and set up a vicious cycle producing *constipation*. A frequent cause of the disorder is the habit of failing to respond to an urge to defecate, putting the action off until a more convenient time. The excessive resorption of water from the feces that occurs during constipation produces large, hard fecal masses that are difficult to pass. The straining that is necessary to eleminate them may give rise to haemorrhoids and anal fissures, which in turn cause pain and bleeding in later defecations promoting further constipation. Fruits, vegetables and whole grain cereals which contain a consdierable amount of indigestible fibre, have a stimulating effect on the bowel. Fats may also stimulate bowel function; undigested fats have a lubricating effect, while partially digested fats are mildly irritating to the intestinal walls and stimulate peristalsis.

Diarrhea

Diarrhea is an excessive elimination of semi-fluid feces. It may be the result of an infection in the gastro-intestinal tract or of excessive parasympathetic stimulation of large intestine. When infected, the irritability of the inflammed

mucosal lining promotes peristalsis, sweeping the intestinal contents out of the body faster and helping to get rid of the infection. But this protection mechanism, if prolonged, may cause harm by producing dehydration and decreasing the absorption of needed nutrients. The other form of diarrhea is commonly experienced in times of stress such as in a student during an examination.

Many people neglect a simple but valuable means of monitoring their health; observation of the appearance of the stools. Many disorders of the digestive tract show up in the changes in the consistency and general appearance of the stools. A disorder of the liver and biliary system may be reflected in clay-coloured stools, for the normal colour is imparted to feces by the bile pigments. Bleeding from the upper part of the tract results in black tarry-looking stools. Red streaks are an indicatien of fresh blood which may come from haemorrhoids or from cancer of the rectum. In parasitic infections eggs, segments or whole worms may be present in the stools.

Dental Caries, Pyorrhea

Tooth-decay is a gradual disintegration of the enamel and dentin caused by acid producing bacteria. An inflammatory infection or degeneration of the gums and cementum may lead to loosening and loss of teeth. Cause include poor oral hygiene, local irritants such as cigarette smoke, allergies and vitamin deficiencies. Proper washing of the mouth and teeth after each meal and at bed time would go a long way to prevent the disease.

Hiatus Hernia, Heartburn, Esophagitis

The opening in the diaphragm, through which the esophagus enters the abodominal cavity and joins up with stomach, is called hiatus. This enlargement of this opening is hiatus hernia. A portion of the stomach may then protrude upward alongside the esophagus through the enlarged opening. Highly acidic stomach contents may regurgitate into the

esophagus, particularly when one sleeps or lies down horizontally or when stomach is full, causing burning sensation of the lining of the esophagus. This is called heartburn, which has nothing whatever to do with the heart. Frequent irritation of the esophagus lining produces inflammation, bleeding and ulcers. Pain, a burning feeling, difficulty in swallowing and in breathing are symptoms of esophagitis. Hyperacidity without hernia may also cause heartburn and corrosion of the esophagus lining. such persons are advised to sleep with their upper trunk raised, to prevent regurgitation of the acid. It would also be advisable to avoid heavy meals in the evening and avoid acidity-producing foods such as tomatoes, strong tea or coffee, deep fried foods etc.

Ulcers and colitis

The region of the duodenum near the pylorus is a frequent site of ulcers. The formation of ulcers in the stomach occurs most often on the posterior wall at the pyloric end. Those ulcers are caused by an over-production of gastric acid which eats a hole in the stomach-lining or duodenum. They are characterized by burning pain. Normally alkaline digestive juices from gall-bladder and pancreas neutralise the stomach-acid as it enters the duodenum. But if the acid is too strong to be neutralised, corrosion and ulcers will result. Colitis is inflammation of colon (large intestine). It may be accompanied by ulcers (ulcerative colitis).

Haemorrhoids (piles), Fissures, Fistula

Haemorrhoids or *piles* are varicose veins in the anal canal which may become filled with blood clots thrombosed causing pain, bleeding and protrusion. Fissure is infection of small crypts in the tissues adjacent to the anus. It can lead to an ulcer of the anal canal which appears as a crack in the skin at the anal margin and produces pain on defecation. The infection may spread through the wall of the anus producing an abscess, which may burst through either internally or externally, forming a chronically discharging fistula. Chronic constipation is the most frequent causes of these disorders.

Cirhosis, Hepatitis and Jaundice

These are diseases of the liver. Cirhosis is a degenerative disease, caused by chronic overconsumption of alcoholic drinks progressively interfering with its function. Hepatitis is an inflammation of the liver caused by viral or bacterial infection transmitted through contaminated food or water. It is also caused by transmission of viruses from infected person through blood transfusion. It may be accompained by jaundice, fever and enlargement of the liver. Jaundice is a yellowish coloration of the skin and mucous membranes due to the presence of bile pigments in the circulation. When the liver or biliary apparatus is diseased, these pigments enter circulation instead of being eliminated through the intestines.

IV. Disorders of The Muscles

Spasms

Sudden involuntary and painful muscle contractions are the commonest disorders of the muscular system. Backaches are spasms of the muscles in the lumbar region which follow stress or strain. Stiff-neck involves spasms of the neck-muscles on one side. When a spasm is prolonged, it becomes a cramp. Spasms may occur not only in skeletal muscles but in smooth ones as well.

Contracture

Contracture is a painful condition in which muscle-fibres are shortened in the resting position. It may result from strenuous exercise (muscle fatigue), or from long periods of inactivity, when the muscles do not receive sufficient exercise. Bed rest, for example, may cause the muscle-fibres to adjust themselves to a shorter length, corresponding to a flexed limb, and then they must be painfully and patiently exercised to be lengthened again.

Polio

Poliomyelitis (Polio) was one of the most dreaded diseases of childhood for many years. It sometimes killed but

more often left its young victims crippled for life with paralyzed limbs and withered muscles. The development of effective vaccines against the polio virus has nearly wiped out the disease. Parents are advised to get their children immunized against polio in good time to prevent the onslaught of the disease.

For an understanding of such disorders of the muscular system, the following concept is of key importance. The functioning unit of a muscle is not the individual muscle-cell but rather the motor unit—the combination of a motor nerve and the muscle fibres that it innervates. Anything that damages either the muscle or the nerve may result in a loss of muscle-function. Thus polio is not a disorder of the muscles in the first place, but a disease of the nervous system in which the virus infection can destory the neurons. The muscle atrophy (wasting or withering) that often follows the disease is a result of the disuse of the muscle innervated by the damaged neurons or controlled by a damaged centre in the brain stem. The treatment includes regular exercising of the affected muscles.

Atrophy, Hypertrophy and Dystrophy

Muscles tend to *atrophy* (waste away) with disuse—either in paralysis or due to continued inactivity. When muscles are subjected to prolonged vigorous contractions, the opposite occurs. They hypertrophy i.e. grow larger. As far as the skeletal muscles are concerned, gradual enlargement is not a disorder but a positive change making them stronger and more effective. The key to body-building is to progressively increase the load on the muscles; regular exercise will not produce hypertrophy, if maximum contractions are not involved. The aim of exercise is to condition the muscles and keep them ready for use and not to tire them.

Hypertrophy is a pathological condition for the heart-muscle. Heart tends to enlarge when it is overworked, e.g. when arteries are clogged with fatty deposits. The resulting increased force of contraction may cause great discomfort.

Two rather mysterious diseases have become a source of anxiety lately. These are *dystrophy* and *myasthenia gravis.* Evidence indicates that these may be autoimmune diseases.[1]

Muscular Dystrophy is a tragic disease in children in which a normal child suddenly becomes clumsy, falls frequently and then progressively loses the use of muscles, thus becoming entierly helpless. The muscles appear enlarged due to large fat deposits while the actual fibres atrophy and the contractile function becomes ineffective.

In *myasthenia gravis,* the skeletal muscles become extremely weak. Facial muscles are first affected and the condition spreads to other muscles until victim is incapacitated.

V. Disorders of the Joints

The movements of the elderly people may be accompanied by clearly audible clicks, snaps and creakings (hence the cliche "creaking joints"). Degenerative changes in the joints, that develop with age, include a reduction of the secretion of lubricating synovial fluid, replacement of flexible cartilage by unelastic bone, and the formation of bony spurs around joints, which make movements quite painful. In addition, the joints, at any age, are vulnerable to a variety of injuries and ills.

Sprain, Dislocation, Fracture

Sprain is the injury caused by a sudden wrenching of a joint which may tear or stretch its attachments. It is accompanied by swelling, redness and pain.

Dislocation, a more serious condition than a sprain, is a displacement of one of the bones or an internal derangement of the parts. The shoulder and knee are most vulnerable to this disorder. A shoulder dislocation can be cor-

1. See chapter No. 7 for autoimmune diseases.

rected by pulling the arm away from the trunk and rotating it suitably. Most common injury to the knee is a crushing or tearing of one of the cartilages. The condition is extremely painful and the knee may have a tendency to lock suddenly. Removal of the damaged cartilage is often the only effective treatment. (The knee can function more or less satisfactorily even without the cartilage). Foot-ball players and other athletes may acquire a "trick knee" by tearing the ligaments that lash the bones together. The knee may unexpectedly give way. A flexible (elastic) bandage may be used to provide support.

A *fracture* is the breaking or cracking of a bone. If the skin is unbroken, it is a simple fracture. If the broken ends of the bone protrude outside, it is a compound fracture. In a comminuted fracture the bone is splintered into small fragments.

Herneated Disc (Slip-disc)

Between each pair of vertebrae there is an intervertebral disc, a compressible, cushion-like pad composed of tough fibrous tissue and eartilage and filled with a protein solution. Damage to the sorrounding tissues may cause disc to bulge or slip out of its normal position, and cause backpain. If the disc presses on the sciatic nerve, pain in the legs *(sciatica)* will also be experienced. Bed-rest and painkillers are generally prescribed. Remedial exercises may also be used. Regular practice of suitable postures and exercise can prevent the recurrence.

Arthritis, Rheumatism, Rheumatic Fever

Arthritis—an inflammation of the joint, is probably the most widespread crippling disease. Fifty varieties are known; the most common are : osteoarthritis, rheumatoid arthritis and gouty arthritis. Osteoarthritis is a degenerative disease, which occurs in middle and old age. The constant wear and tear on weight-bearing joints (e.g. knees) produces a softening

thinning and ultimate disintegration of the joint cartilages. Increased function, due to reduced lubrication, irritates the periosteum, stimulating proliferation of bony-growths on the joint surfaces.

Rheumatoid arthritis results in fusion of the bones of the joint and a total loss of mobility. Its cause is still unknown. It begins with the inflammation and thickening of the synovial membrane and tissue which damages the joint cartilage. Tough fibrous material, then, limits motion in the joints. Ultimately the fibrous tissue may become calcified and converted to bone and then fuse together.

Gout is characterized by an increase in the uric acid level of blood and the formation of deposits of urates in the joints. Inflammation and damage to the particular cartilages result.

No cure for arthritis has yet been found. However, considerable progress has been made in the surgical repair of arthritic joints.

Rheumatism is a common, rather loosely used term for an inflammation of the fibrous connective tissue. The affected joints become tender and stiff, and the victim's movements become limited and painful. The *fibrositis* may travel from one joint to another. Fortunately there is no permanent damage to the joints and recovery can be complete. In a related condition e.g. when tendons of the hand are affected, the hand may become locked into a clawlike position, with the patient unable to extend the fingers.

Rheumatic fever is a bacterial disease caused by *streptococcus pyogenes*. The initial symptoms involve the joints. It begins with a sudden intense inflammation of the synovial tissues, tendons and other connective tissues around the joints, accompanied by fever and pain. After a time, the pain and inflammation of the joints may subside, but the disease may cause permanent damage to the heart-valves which is later manifested as *rheumatic heart disease*.

7

Diseases and (Body's) Defences

Throughout life a human being is constantly at war. Enemies lurk both without and within. Potentially harmful microbes swarm in air, water, food, and on the surfaces of objects handled and used by human beings. They assemble at the major entrances into the body, ready to slip inside, if there is a breach in the defences. Some even exist inside the body, kept at bay by the body defenders, but ready to assail, multiply and spread, if exposure, malnutrition or mental stress temporarily lowers the resistance.

Homeostatic mechanisms involving the circulatory, the excretory, the neuro-endocrine and other systems normally function to maintain the dynamic equilibrium of body processes. They are a major line of protection against disease. But one weak link, for example, a heart rendered less efficient by degenerative changes, can lead to a chain reaction of physiological catastrophe. Even the body itself can sometime become its own enemy, attacking its own cells instead of the invaders.

Some major types of diseases alonwith the body's powerful defences are discussed here.

Diseases

A complete catalogue of the diseases and afflictions that can beset humanity would make one blanch. There are literally thousands of them. Most of them would fit under one of a few basic categories: bacterial, viral, fungus and other parasitic diseases, cancer and degenerative diseases. The causes of some diseases that afflict us have not yet been determined.

Bacterial Diseases

Bacteria are microscopic single-celled organisms with a rather primitive structure. A single baeterium, under favourable condition, can give rise to 2,50,000 descendents—which can fit comfortably on the head of a pin—in a matter of hours. It is this potential to multiply to staggering numbers that makes bacteria so dangerous. They can be classified in three main types : (i) rod-shaped bacilli (ii) spherical cocci and (iii) corkscrew-shaped spirilla.

Not all bacteria are pathogenic (i.e. cause diseases). Some actually perform useful services to plants and ultimately to animals and human beings. Some bacteria living in the human intestinal tract, not only do not cause disease but contribute vitamins for the nutrition of their host.

Pathogens of typhoid, scarlet and rheumatic fevers, tuberculosis, cholera, pneumonia, syphilis and food-poisoning are some of the disease-causing bacteria. The causes and means of transmission of these and other diseases remained obscure until the 19th century. The germ theory of disease—that contagious diseases are caused by microscopic germs and are transmitted (directly or indirectly) form one infected organism to another—was the result of the work of Pasteur in 1865. Pathogen of T.B. was discovered by Robert Koch in 1882. Later, causative agents of many bacterial diseases were identified and the means by which they were transmitted were determined.

Germs of infectious diseases may be transferred by direct contact with a sick person or by less direct routes, e.g. food-handlers, who do not take appropriate sanitary measures after excretion, can spread disease from their hands to food and from there to the consumers of food. Flies that alight on excrement and then on food can spread bacteria; biting insects can deposit or inject disease-germs into their victims.

After the germ has gained access into the body by one means or another, an incubation period follows. During this time, bacteria multiply without any outward sign of infection. After a period that varies from a few hours to a matter of weeks or months, depending on the disease, the numbers of the pathogens are so great that the normal life-processes of the host are disturbed and symptoms of disease become manifest. Pitched battles are carried on within the body between the body-defences and the invaders.

The harm caused by pathogenic germ is usually produced by poisons manufactured by them. These are of two types : exotoxins and endotoxins. Exotoxins diffuse out from the bacterial cell into the tissues of the host organism. These are proteins and are powerful poisons. Those of tetanus, for example, are far more powerful than any snake venom. Endotoxins are produced within the bacterial cell and are released when the cell disintegrates. They are less poisonous than exotoxins. Bacteria of typhoid (fever) produce endotoxins. Generally bacteria produce either exotoxins or endotoxins, but not both.

Viral Diseases

Viruses are micro-organisms. Some pathogenic viruses are so tiny that they cannot be seen with the most powerful optical microscope and pass through a filter, fine enough to trap the smallest bacteria. They are so rudimentary that many scientists do not consider them to be truly alive. They lie at the very borderline of life. Viruses can reproduce only within a living host.

Many diseases including poliomyelitis, influenza, measles, yellow fever and the common cold are traced to viruses. Virus-caused disease can be prevented by vaccines, in which the genetically changed attenuated virus has lost most of its virulence but still retains enough similarity to the original form to produce immunity to the original disease.

Fungus Diseases

Familiar bread-mold and pencillin are fungi. Air, soil and water teem not only with microbes, but with micorscopic spores of fungi and the effects of fungi on our lives are far greater than is realized. Fungus diseases of human beings range from common skin-infection such as ringworm to severe systemic mycosis. Fungi normally feeding on decomposing matter in the soil may wreak havoc on the human beings, if they are accidentally introduced by inhalation or through a wound. On the credit side are the yeasts and numerous antibiotic producing fungi.

Other Parasitic Diseases

Millions of people are infested with tapeworms feeding inside one's intestinal tract and other parasites. Parasites that afflict human beings are: amoebae, responsible for amoebic dysentery, plasmodia that produce malaria, protozoa such as trypanosomes of sleeping sickness, and various flat worms and round worms.

A well-adapted parasite does not kill its host or even sicken very severely. Trouble arises when it is transmitted to a new host. For example, trypanosome infestation, that causes sleeping sickness, is endemic among the native tropical African animals. But for them it is only a minor inconvenience. When, however, the trypanosomes carried by tsetse flies enter the human beings and their livestock, they run wild. Multiplying explosively in their blood streams, they destroy blood cells. Then they move on to the nervous system, destroying tissues of the brain and spinal cord, producing lethargy and often death. The malaria-parasite is transmitted to human beings (and other animals) by the bite of an infested mosquito which has drawn blood from an infested person. Malaria is the most prevalent disease in the world.

Filariasis (Elephantiasis)

One of the most bizarre diseases, transmitted by a mosquito-bite, is filariasis. Larvae of parasitic filarial worms are injected under the skin by a mosquito carrying infected

blood. The larvae make their way into the lymphatic system where they mature into hairlike worms about two inches long. They obstruct the lymphatics and prevent the return of fluid to the blood stream. The result is edema, i.e. accumulation of fluid in the tissue spaces. In extreme cases, an affected limb swells up to a gigantic size.

Advances against parastic diseases have been achieved through two major approaches : first through drugs that kill the parasites (quinine for malaria) and second through environmental control of the intermediate host (extermination of mosquitoes).

Parasites, in living off their victims' tissues and body-products, sap the energies of the hosts, leaving them in a debilitated state. Then the victim can fall prey to bacterial or viral diseases that may in turn prove fatal.

Cancer

Cancer strikes the young as well as the old, although it becomes far more prevalent in middle and old age. If you ask people what disease they fear most, the answer will invariably be—cancer. Cancer is an insidious disease in which the cells exhibit a wild uncontrolled growth. Whereas normal heathy cells "recognize" their neighbours and cease growing upon contact with them, cancer-cells show no such recognition and continue wild growth, piling over one another, literally choking out their normal neighbours. Cancer may attack virtually any tissue of the body : lung, brain, breast, skin, bone, blood, liver and so on. A critical factor in the deadliness of this disease is the phenomenon of migration (metastasis). Cancer cells dislodge from their original site, enter the blood stream or lymph channels and are dispersed to other regions of the body. They continue the growth patterns of the original cancerous tissue at the new sites.

Why do cells suddenly run wild and how can the process be controlled or reversed? Despite extensive research, the field still holds more questions than answers.

The experimental evidence seems to indicate that in some manner DNA play a fundamental role in cancer. The nature of this role is obscure. There is considerable evidence also that a virus plays a strategic role in the onset of at least some human cancers, but whether viruses are causative factors in all cancers is not known. Further evidence seems to indicate that virus invasion (or DNA mutation) will not result in cancer, unless certain contributing factors called carcinogens are present at the same time. Certain chemical substances such as mycotoxins (poisons produced by fungi) have been shown to be carcinogens. Exactly how they act is still unclear.

Immune system is also involved in the prevention and development of cancer. It is believed that little cancers are continually getting started, being recognized as foreign, and then being killed by the body's defence mechanisms[1] before they can cause trouble. In a cancer victim, however, the defence mechanism has somehow failed to recognize the cancer cells as foreign and has allowed them to multiply unhindered.

For years the standard treatments for cancer have been surgery, radiation and chemotherapy. If the cancer is caught before migration, a cure can be affected by cutting out the affected tissues and any sorrounding ones suspected of harbouring cancer cells. Deep-seated cancers may be destroyed by exposure to radiations. Finely focused beams of X-rays, radio-active cobalt, gold and other radiation-sources are used. Recently *laser beams* which can be focused far more sharply than X-rays have been used. One of the problems with chemotherapy is that drugs kill not only cancer-cells but normal ones as well. The drugs may be so toxic that doses sufficient to eradicate cancer also kill the patient. In "combination chemotherapy" an antidote is given in sequence to resuce the patient from the drug's toxic effects.

1. See "B and T cells" in this chapter.

Perhaps the most promising approaches against cancer are those that involve bolstering or stimulation of the body's own defence mechanisms. These include injections of immunostimulators to mobilize the body's defences.

Degenerative Diseases

Some key part and systems of the human body gradually deteriorate with age, wear out and break down. Some of the degenerative changes due to aging process, such as the progressive loss of nerve-cells, decalcification of bones, were discussed in a previous section. Degenerative diseses of the heart and blood-vessels are not only number one killer of this age but also contribute to senility, (through a less efficient supply of blood to the brain), deafnes, kidney-failure, etc. Building up of fat-deposits in the artery walls raise the blood-pressure, overloading the heart and increasing the possibility of the thrombosis whichcan cause damage to heart, brain or other vital organs. Hardening of the arteries can force a gradual slow-down of activities and a blunting of mental acuity.

What causes degenerative diseases? Are they a natural slowing down of the body's built-in 'clock' or are they pathological processes, which could be arrested or reversed? Current feeling among the medical community is that the degenerative heart-disease is mostly produced by the combined factors of a whole life-style. Over-consumption of carbohydrates and saturated fats, an over-sedentary life and the constant stressful conditions and responsibilities are believed to contribute to building up of fat-deposits and hypertension. Prevention is the most important feature of the treatment and management of heart-disease. A prudent and balanced diet, a regular programme of exercise including postures (geared to one's physical condition), a life- style that cuts down unnecessary tensions, regular relaxation and meditation are approaches that can positively reduce the risk of heart-attack.

The Body's Defences

The body's defences operate 24 hours-a-day throughout our lives. If these defences are breached, illness and even death may follow. Skin is the first of several lines of defence to fall back upon. Few micro-organisms can penetrate trough unbroken skin. The mucous membranes that line the oral and nasal cavities are covered with a sticky mucus that immobilizes microbes. Antimicrobial secretions add to the defence of these and other portals into the body. Sterilizing acid-bath deals with the microbes that reach the stomach.

Formidable as these defences are, they can be breached and frequently are. Microbes can, then, slip pass and penetrate. When infection occurs, additional defences are called on. These may be either non-specific defence-mechanism such as interferon[1] or specific immune responses.

Tonsils

Removing the tonsils to prevent recurrent throat and ear infections was a medical fad sometime ago. Paradoxically, tonsils frequently fell victims to the surgon's knife precisely because they were doing their job. The tonsils guard the doors of the respiratory tract which is an open invitation to a world filled with germs. Tonsils, located at the back of the throat, are actually one of three separate pairs of lymphatic structures that provide a protective barrier for the mouth, throat, larynx, trachea and lungs. They contribute lymphocytes and immune substances to the body's defences and must not be removed, unless due to recurrent severe infections, they swell and block the respiratory and digestive passages.

1. Interferon is a chemical (protein) produced by body which protects the cells against practically all virus. It can also be synthetically manufactured.

Antibodies

It is known for a long time that the body is capable of producing proteins called antibodies, which react with invading microbes, inactivating or killing them. A variety of antibodies are found in the circulating blood even in a healthy person. They are all proteins called immunoglobulins. Five groups have been found, differing in chemical properties and biological functions. Some provide most of the specific immunity against microbes. Some are involved in allergic reactions. The total picture of antibody-production and the action of the immunity-system as a whole is, however, very complex indeed.

B and T Cells and Antibodies

There are two major classes of lymphocytes. They are called B-Cells and T-Cells. Percusors of both are originally formed in the bone-marrow. Some of these then migrate to the thymus gland where they are transformed into T-lymphocytes (T for thymus). The other percusors take a different route. In birds, the transformation into B-Cells occurs in a gastrointestinal structure called bursa (B for bursa). Human beings do not have a bursa and although it is believed that a comparable site exists, it is not yet known where or what it is.

There are structural as well as functional differences betwen the two types of lymphocytes. T-Cells somehow help B-Cells to become active antibody producers. T-Cells can also suppress B-cell activity. This role is important in the recognition of "self" cells and chemicals that keep the antibody system from destroying our own body tissues. T-Cells can also act directly as killers. Another important function of the T-Cells is to conduct an immune surveillance. If a body-cell becomes malignant, patrolling T-Cells which perceive it as antigen (i.e. foreign), are sensitized and attack it and other similar cells. It is believd that body-cells become malignant at the rate of one everyday, but are promptly

killed off by T-Cells. Thus an efficient surveillance by T-Cells is an important defence against cancer and other diseases caused by antigens. While T-Cells travel through the body (most of the circulating lymphocytes are T-Cells) and exert effect locally, B-Cells remain in the lymph-nodes and the synthesized antibodies are sent out through the blood-stream to the site where they are needed.

Antibodies fight invading microbes in several ways, e.g. they prevent viruses from attacking to the host cell-membranes and thus prevent them from multiplying.

Immunity

We can have a life-time protection against many diseases by developing active immunity, either stimulated by an actual attack or provoked by vaccines. Vaccines have dramatically changed our lives. The control of small-pox through vaccines has been so successful that this disease has finally disappeared entirely from the face of the earth. Many doctors never see a single case of diphtheria which was a major childhood-killer before vaccines. Emergency protection provided by an injection of antibodies that someone else has produced against the disease, is called passive immunity. In such cases, it is wise to obtain a vaccination to develop active immunity after the emergency is over, because the introduced antibodies are rapidly lost from the body.

The antibodies that are transferred to the fetus and then to the infant, through its mother's milk confer passive immunity to any disease for which the mother possesses antibodies, and provide valuable protection during the time when the infant's own immunity system is not yet functioning effectively.

Autoimmune Diseases

The body is constantly at war. Its defenders are dedicated to the task of killing all foreign invaders. But some-

times they fail to recognize, and attack and kill the very cells they have been entrusted to defend. The results are disastrous for the body. Such a failure to recognize its own cells can result from a number of causes which result in the production of antibodies or sensitized lymphocytes againt the body's own cells. Autoimmune damage may also occur accidentally, if the release of chemicals by the system kills not only the invaders but also the normal cells—the "innocent bystanders". Some form of arthritis, anemia, some muscular disorders and other diseases are believed to be the results of autoimmune reactions.

Hypersensitivity and Allergy

A hypersensitive immunity system reacts to environmental antigens— such as microscopic pollen grains, dust particles to an inappropriately extreme degree as though they were major threats to life. Such a complex of immune responses is called allergy and the antigens that cause it are called allergenes. They may be caried in the air and inhaled; they may be constituents of food; or they may come in contact with the skin. In susceptible individuals, allergens stimulate the production of a special class of antibodies. The result is watery eyes, sneezing, bronchial spasm (asthma) or skin rashes.

8

Growth, Aging, Death

Growth

The life of a human, from conception to death, may be viewed as a continuous process—a series of events that follow one another in a programmed sequence, varying in details but leading to the same ultimate conclusion.

A living organism grows by the intake of food which is broken down into its constituent simpler substances which are then re-assembled into specific needs of the organism. Waste products are excreted, but the total of the materials, taken in, exceeds the amount returned to the environment, and there is a net increase in the size and weight of the organism. Cell-division—increasing the total number of cells—is the main process of growth.

Growth in size and weight, however, is not the whole story. The dramatic development of a fertilized ovum into a baby and that of a baby into an adult involve another improtant process, viz. differentiation—an increasing specialization of cells for specific functions. During childhood, the body and its parts only grow in size, but are constantly modified and reshaped permitting the mastery of new skills. During adult life, active growth ceases; cells that wear out or are destroyed by accident or disease are replaced and a dynamic equilibrium is maintained. But ultimately the repair processes become less efficient and cannot adequately replace the day-to-day losses. Slowly various body-functions deteriorate.

Human growth is not a steady process. Dropping steadily throughout prenatal life, the rate of growth con-

tinues to fall after birth. In the nine months from conception to birth, a human fetus, increases its size and weight about 10 billionfold. In the first year after birth, it triples its weight and adds about 50 percent in height. Then follow a period of consolidation and the growth settles down for a time to a steady 2 to 3 kgs. and 5 to 7 cms. a year. The flow of sex hormones during adolescence sparks a sudden growth spurt adding as much as 15 to 18 cms. in a year. After this spurt, there is a rapid deceleration. Growth in height stops entirely by the age 18 to 21 in boys and 16 to 18 in girls. The onset of maturity may be delayed by a variety of factors such as undernourishment, but growth eventually ceases.

The programmed sequence of growth and its completion may hold important clues to the prolongation of vigorous life. Interactions of the hormones of the pituitary with other hormones and with control-centres in the brain may be key factors in the working of the built-in clocks that determine human growth and development. Thyroid hormone also stimulates growth, especially of the skeleton and nervous system through a general stimulation of metabolism. During the adolescent growth-spurt, sex hormones produced by the gonads and adrenal cortex further stimulate growth. Cells, too, seem to have a built-in clock that determines their specific life-span. Some believe that growth ceases when the hormonal processes that trigger D.N.A. synthesis and cell division somehow break down in aging cells. The maximum number of divisions, liver cells and other would undergo, in the human body, in a ife-time of 100 years is about 50[1]. After this they cease dividing and ultimately die.

Although growth in height ceases at adulthood, there may be a net increase in weight in later years. The tendency to gain weight in middle age occurs, because there is usually a decrease in physical activity but no comparable reduction

1. This is known as "hayflick limit."

of appetite. The sedentary adult, thus, takes in more calories than the body can use up and the excess is stored as fat[1]. A careful programme of exercise and diet only can stop the weight-increase.

Aging

Aging or senescence is a biological process characterized by a gradual deterioration of the structures and functions of the body, resulting in an increased susceptibility to accident and disease. No sooner has maturity been reached than a progressive decline in the body's efficiency begins. Different organs and tissues age at different rates. Nerve and muscle-cells show an earlier decline in the functional capabilities than tissues such as those of liver and pancreas, in which active cell-divisions continue longer.

Some of the most tragic changes are observed in the central nervous system. A combination of loss of nerve cells, which are not replaced, a slowing of the nerve-conduction and reduction of circulation to the brain results in a progressive decline of mental efficiency. The sense of the aging person become less acute. There is a progressive hearing loss. The eyes become prone to various degenerative diseases and a reduction of the ability of the eye muscles to accommodate the lens results in hypermetropia i.e. farsightedness. Taste is also dulled as taste-buds are progressively lost. A lengthening of reaction time and growing lapses of memory become apparent. Learning is more difficult for older people, partly because of the reduced mental efficiency and partly because of interference from previously acquired knowledge.

Various degenerative changes occur in the circulatory system. The heart-muscle may be partially replaced by fribrous or fatty material. Deterioration of the elastic fibres stiffen the artery-walls and calcified fatty deposits within them may weaken them so that they burst when the blood-pressure is raised by emotion or straining or may lead to circulation-blocking blood-clots.

1. "Fat" and "fifty" are often together.

Calcium salts are deposited around the fibres resulting in the loss of resiliency of the chest and the stiffness of movement of the joints. While calcium is creating problem by being deposited in places where it should not be, it is being dissolved out of the bones, weakening them and making them more susceptible to fractures.

Aging upsets the fluid-balance; there is a gradual loss of tissue fluid throughout life, causing them to dry up. Filtration-rate in the kidneys drops. Complex hormonal changes occur. In women, it brings a dramatic cessation of menstruation (menopause). In men the deterioration of sexual activity is more gradual, it declines and may cease entirely.

At least some of the above changes are, however, avoidable effects of ignorance, attitudes and modern conditions. In people living away from the barrage of noise that continuously assails the ears of city-dwellers, a high degree of hearing acuity is retained upto extreme age. The inactivity resulting from the attitude to "take it easy" may be a significant factor in the loss of calcium from the bones. The resultant weakness and fragility of the bones compel further inactivity thus perpetuating a vicious cycle. In one study, a group of 60 year olds was placed on a supervised programme of exercises. 10 years later they were found to be physiologically younger than they were at 60. If we know precisely how the body ages, we might be able to modify and perhaps prevent and even reverse the aging process. Researchers in aging scrutinize various body-systems as possible biological clocks, e.g., it is known that the thymus reaches its zenith of development in adolesence and then gradually atrophies. The levels of thymosin in the blood fall in the increasing age. Simultaneously, activity in the immunological system intensifies. But the decrease in efficiency of immune surveillance by the T-cell results in the imperfect lymphocytes making errors of the "self" cells for enemy invaders. Similarly various control-centres of the

hypothalamus and its hormones which work through the pituitary to control and coordinate glands of the endocrine system, have been implicated in the functioning of various cyclic processes in the body. The aging process may be started by blocking the action of thyroxin. Other researchers consider the environmental influences on the body and its cells to accelerate the aging process. They view the major causes of aging as lying in the "wear and tear" resulting from the continual stress condition, radiations and chemical mutagens.

The information-molecules of the cell gradually become blurred with errors reducing the efficiency of the protein-synthesizing apparatus. The faulty enzymes produced may, then, cause a further deterioration of the templates, compounding the damages. The accumulation of enough non-functional or abnormal cells in an organ will impair its functioning and sine the organs of the body are inter-related, the deterioration of one organ may produce a spreading wave of damage to others, ultimately resulting in aging and death.

Thus aging is a complex process with many contributing factors not necessarily mutually exclusive. "Haylick limit" of cells-division agrees with the concept of an inherently finite life-span with an upper limit for human beings of about 110 to 120 years. Hence it is clear that any effort to prolong life beyond this limit is not likely to succeed. Though the actual life-span could never be changed, knowledge of some of the factors discussed above would not only reduce the probability of dying in younger age-groups but also extend the period of vigorous life, avoiding the miseries of old age.

Knowledge of the role of nutrition and dieting could be used in checking the tendency to gain weight in middle age. Deficiencies of vitamins C and B which accelerate the aging process could be avoided. Careful control on the intake of salt, sugar and fat would prevent the development of hypertension,

hardening of the arteries and overloading the heart. Continuing physical activities and a regular programme of exercises including breathing exercises would keep one physiologically young for a long time. regular practice of relaxation will prevent the damage to the cells, revitalising and rejuvenating them. Certain meditational practices such as concentrated perception of sychic centres would produce rejuvenating effects on thymus, prevent the "aging hormone" blocking the action of thyroxin and generally balance and harmonise the synthesization of hormones of the endocrine system. It would also prevent and reverse the impairment of mental functions (due to degenerative changes in the brain) which is the most pitiful aspect of senility.

Death

Death may be defined as the cessation of all metabolic processes. In human being, death usually results from the failure of some vital organ, due to accident, disease or degeneration. The effects of the failure spread throughout the inter-related systems of the body. Regardless of which organ was the first to fail, the effects ultimately reach the circulatory system and the heart stops. Deprived of the oxygen and nutrients delivered by this system, the cells of the body begin to die off. Nerve cells are the most vulnerable: irreparable brain-damage sets in about four or five minutes after the stopping of the heart. Death of the cells means rapid and irreversible changes in their structure and a lysis of their membranes and contents, because the organizing influence is gone.

At one time, stoppage of the heart was the accepted definition of "clinical death". Yet, now it is often possible to resuscitate a person who has seemingly 'died' by electrical stimulation or even mere manipulation of heart and lungs. Certain enzyme-levels in the cerebrospinal fluid have been found to be correlated recently with the true status of the body.

9

Health-hazards

An endless variety of health-hazards—such as exhaust from cars and trucks, smoke, soot and industrial dirt from the factories, vapours from oil and other noxious chemicals—relentlessly threaten our health almost every day. On the one hand, supersonic speeds for travelling has enormously accelerated our rate of living, resulting in constant sympathetic dominance, hypertension and heart-diseases. On the other hand, ironically a sizable percentage of our people lead a sedentary life, nurture a "take-it-easy" attitude and suffer the miserable consequences of the physical inactivity. Mechanical gadgets have, indeed, taken away the drudgery from the domestic chores of our womenfolk. It has also deprived them of the benefits of the physical exercises which kept their bodies supple, graceful and healthy. Diabetes mellitus is as rampant as obesity, destroying their traditional tendency of self-help and making them subservient to the hired help. Our social habit of offering sweets, biscuits, tea, coffee, alchoholic drinks and cigarettes to visiting friends, compound the health problem enormously. Wearing high-heels corsets, jeans and other tight clothes, though fashionable, result in injurious postures. The restful "hard bed" has been replaced by the foam-rubber mattress which deprives the spine of a much needed rest during night. Result: backache, slip-disc etc.

In this short chapter, some of the health-hazards are briefly discussed. Regular practice of postures (*asanas*) can assist in warding off some of the hazards. Detailed discussion of postures will be found in another book in this series. Relaxation (discussed in the next chapter) is another excellent tool for fighting the hazard of tension and improve mental health.

Pollution

In these days, in large cities, SMOG (smoke and fog) is a usual and inescapable phenomenon. Industry and automobiles spew a devil's brew of pollutants into the air. They include carbon dioxide, carbon monoxide, oxides of sulphur, nitrogen and lead, and fluorine compounds. When weather conditions combine to concentrate these pollutants close to the ground level, the result is smog. The lungs of the modern city-dwellers are insidiously subjected to the corrosive and debilitating effects of pollutants every moment of every day and night. They create respiratory diseases and problems of all kinds especially emphysema, and may cause death of the very young and the very old. Carbon monoxide (CO) is a product of incomplete combustion and is present in the air through automobile exhausts, leaking furnaces and industrial fumes. Colourless, odourless and imperceptible, it is a particularly insidious and dangerous poison. And the worst danger presented by carbon monoxide in air is that compared to oxygen, it has several times greater affinity for reaction with haemoglobin, and it competes successfully with oxygen for being carried by the haemoglobin; and this reaction is not readily reversible. Thus haemoglobin-molecules that have combined with CO to form the compound *carboxyhaemoglobin* are just as effectively removed from their oxygen-carrying function as though the blood containing them had been lost from the body by haemorrhage. A victim of carbon monoxide poisoning may gradually succumb to the effects of lack of oxygen, without realizing anything is wrong. It is believed that the impairment of judgement caused in drivers by the effects of carbon monoxide in the air of congested streets and highways may be a major cause of automobile accidents.

Another type of pollution is that of water. A variety of dangerous chemicals such as caustics, solvents and other organic compounds from the industrial waste contribute largely to the pollution of water. We ourselves also contribute

to it with organic wastes, detergents and other chemicals that are washed and flushed down our drains everyday. These wastes do not conveniently disappear but may find their way in the human diet.

Yet another growing area of pollution is noise pollution. Deleterious psychologial and physiological effects have been found to result from prolonged exposure to high noise levels. Little do those who attend the discotheques and listen to rock and roll music realise the dangers to which they are exposing themselves. Exposure to high noise levels triggers a general stress reaction involving the adrenal hormones and their effects on blood-pressure, heart-rate as well as on other organs and systems of our body. It is known in some cases, to develop permanent constriction of the blood-vessels.

Drinking and Smoking

The body is the machine which enables us to progress through life. It is good sense not to abuse it but to maintain it in good health. This is simple logic; but we are not particularly logical as far as our life is concerned. We fear death, and yet hasten it in almost every conceivable way by the very life that we have created, by ignorance, by inaction, by tension and by a thousand abuses, through dangerous bad habits cultivated by us as part of our way of life. Drinking and smoking have become a part of our culture. There are constant social pressures to drink and/or smoke and one often hesitates to take a personal stand for fear of ridicule. But basically, most drinkers like to drink and enjoy the effects produced by alchohol without realizing that they are heading towards psychological dependence and physical addition. By a phenomenon of 'tolerance', one must take progressively larger doses to achieve the same effect. It is estimated that drinking is a problem for at least ten percent of drinkers. After heart disease and cancer, alchoholism is considered the third ranking health problem. It can cause irreparable damage to the tissue of the brain

and liver. Remember that the liver plays a major role in detoxifying poisons that have entered the body. A large proportion of automobile accidents are caused because drivers' co-ordination, reflexes and judgement were impaired by a few drinks taken before driving.

Smoking

Every cigarette packet and advertisement must carry the statutory warning : "Cigarette smoking is jnjurious to your health." Smoking causes a variety of diseases, promoting the development of emphysema and heart-disease and producing a chronic cough. The result of smoking, however, that had most captured the public imagination, some years ago, is the development of lung cancer. This is a growth, often malignant and often fatal, which is more than 20 times as prevalent in smokers than in non-smokers. As the malignant cells multiply, they crowed out normal healthy cells and destroy tissue. Emphysema is a pathological enlargement of the alveoli. Many bronchioles are obstructed, the walls of the alveoli are atrophied and thinned out, and the total surface of the respiratory membrane is drastically reduced. These conditions are irreversible. Eventually, hypoia[1] and hypercapnia (an elevated carbon dioxided tension in the blood) cause death.

Today smoking is considered a major cause not only of lung cancer but of cancer of the larynx, oral cavity (mouth) and esophagus and a contributing factor in development of malignancy in the bladder, pancreas and kidney.[2]

1. See chapter VI of this book.

2. Source : TIME magazine, March 8, 1982. Besides, it has published some excerpts from the Surgeon-General of U.S.A.'s report:

Last week's report form Surgeon-General, C. Everett Koop was the most serious indictment of smoking yet made. The conclusion: "Cigarette smoking is clearly indentified as the chief preventable cause of death in our society and the most important public health issue of our time."

The report (also) warns non-smokers exposed to cigarette smoke. Smoke emitted into the air form a smouldering cigarette sometimes. includes carcinogens in higher concentrations than those inhaled by a smoker. Non-smokers should avoid being in smoke-filled rooms.

Cigarette-smoke paralyses the celia in the lining of the trachea and bronchi, and stops their clearing actions, so that they cannot whisk up the dust-laden mucus upward to the pharynx, to be ultimately expectorated. If the habitual smoker stops smoking, this clearing function is reactivated in several months.

Drugs : Use and Abuse

A growing number of people is using a veriety of drugs to produce a feeling of relaxation, or stimulation or a euphoric high. Unfortunately a drug that is free of any harmful effect is yet to be discovered. Most drugs are addictive, i.e. after their use for a while, body-metabolism changes and the user comes to depend on a continuous supply of the drugs. If the use is suddenly stopped, painful conditions and even death may result. There is also a *psychological dependence* (even if there is no physical addiction) producing a chemical 'crutch' out of the drug. Many drugs damage vital body-organs such as liver or brain.

Narcotics such as *opium, morphine* are the depressants of central nervous system. They can bring relief from pain or anxiety and can produce euphoria and hallucinations. But, they are highly addictive and for centuries have created serious health problems besides driving the addicts to crime to support habit.

Caffeine (in tea, coffee, beverages and chocolates) and *nicotine* (in cigarettes and other tobacco products) are the more commonly used *stimulants*. Both have a powerful stimulating effect on the central nervous system. On the other hand they are contributing factors in heart-disease. Excessive use of caffeine may produce irritability and insomnia, while smoking has been implicated in lung disease and cancer. Though physical addiction here may be disputable, psychological dependence is beyond doubt.

Amphetamines such as *marijuana, L.S.D.*, sometimes called psychedelic drugs, work by increasing the release of

a natural stimulant, norepinephrine. Over-excitation may occur to the point where the user cannot sleep and euphoria alternates with periods of deep despair. Long use of these drugs may lead to hallucinations, delusions and violent behaviour. The LSD molecule is chemically very similar to the neuro-transmitter scrotonine and it is believed to interfere with the normal working of the brain cells. It produces hallucinations that may be extremely pleasant fantasies or frightening nightmares. During the 'experience' the user's judgement is usually distorted causing harm to themselves and/or others. A 188-page report on the effects of marijuana, issued by the Institute of Medicines of the National Academy of Science (U.S.A.), concludes :

"Among other things, the principal active element in marijuana, delta-9 tetrahydrocannabinol (THC), like alchohol, impairs motor coordination, the ability to follow a moving object and to detect a flash of light. Since these functions are necessary for safe driving, their impairment "may suggest a substantial risk." It also hampers short-term memory, slows learning and produces distortions of judgement, including reactions of panic and confusion. Heavy use may lead to cancer of the respiratory tract and seriously impair the lungs."

Postures

Well-meaning reminders to stand up straight or not to slump may be annoying but are useful.

Development and maintenance of good posture is an important key to the feeling of well-being and keeping the body ready to respond effectively to all the demands of your daily activities. Our body is engaged in a constant struggle against gravity. Now, we know that every object (including our body) behaves as though all its weight were concentrated at a single point—centre of gravity. When this point is well supported, the force acting upward effectively counteracts the downward pull of gravity. But if the centre

of gravity is shifted, the object has to topple over. Wearing high heels shifts the centre of gravity forward and there is a tendency to lean backward with the upper part of the trunk producing a deepening of the spinal curvature as the postural muscles compensate.

In 'correct' standing position, the head is held high and balanced easily on the neck, the abdomen is held in and the chest is allowed to expand freely. The shoulders should not sag forward and *the arms hang freely*. Remember that good posture is not a stiff military 'standing to attention' but a relaxed position. Correct sitting position is similar, with the spinal cord and neck in a straight line, not stiff but relaxed. Deviations may result in backaches and even deformities.

Lying down horizontally is the posture usually assumed for resting and sleeping, but too much bed-rest has its drawbacks.

"The modern man and woman leads a soft life," says Dr. R.H. Dastur[1]; "cars are well cushioned for comfort. In the office we sit or slump on soft cushioned chairs. Higher the status, softer is the cushioning. At home we lounge on overstuffed sofas or soft rubber cushions. And the worst culprits are the ultra soft mattresses temptingly inviting us to sink into slumber all night and suffer backache all day. Faulty postures further strain the overtired muscles and produce backache.

"Spondylogenis backaches are the most frequent and are caused by pain arising from the spinal column, discs ligaments, back mucules and joints. In most of the cases there is nothing wrong with their spine or discs. The back-aches are due tc sprains or strain of muscles, tendons or ligaments resulting from faulty posture, slouching for hours at the desk or standing for hours at parties. Low backache is a protest from these tensed muscles against ill-treatment."

1. Times of India, Sunday Review, May 23, 1982.

Dr. Dastur recommends :

— Sleep on a thin firm mattress with a wooden board underneath. Don't sleep on foam rubber mattress.

— Sit or stand in the correct posture—head high, back straight, abdomen pulled in.

— Do not sit for prolonged periods—get up and stretch your legs from time to time.

— Prolonged standing in one place puts great pressure on the spine. Shift your weight from one foot to the other to relieve the strain.

— Learn to relax when under stress.

— Do not lift a heavy load (suitcase; full bucket) with straight knees from the floor. Bend your knees and lift it up.

10

Relaxation

Age of Tension

The existence of mental stress as a part of modern life-style has been universally accepted. Frequent stressful situations such as worries about overdue bills, shortages of essential commodities, unemployment, crime and such other modern concerns affect us not only mentally but also undermine our physical health. Any condition that needs behavior adjustment could be regarded as stressful situation. Whenever one encounters such a situation, an innate mechanism is automatically put into action. Thereby conditions which are not conducive to the optimum balanced functioning of the autonomic nervous system are brought about. This results in what is called sympathetic dominance and appropriate physiological changes, viz. rise in blood-pressure, acceleration of heart-rate, increased metabolic activity and respiration, and a rise in blood sugar.

The stress mechanism begins its functioning with the adrenal glands increasing its secretion and output of specific hormone—epinephrine—which in turn activates the sympathetic nervous system. Hyperfunction of the adrenals seems to be the price we must pay for our modern stress-oriented society. The adrenal flow is brought to excess by pain, fear, rage, excitement or any of the painful emotions. Excessive adrenal output was very much necessary as activating force in the 'fight or flight' primitive age of the man. But excessive use of any of nature's forces will sooner or later pauperize these forces. Today our fighting and running away may not be as crude as the primitive man's but it is still as destructive to our body. Our jealousies, hates, fears, struggles for wealth,

power, position, our lusts and superstitions—all call upon the reserve supply of adrenal secretion until the glands are exhausted. The system is under constant shock and the reserve energy is under call all the time. Under too long continued stress, the endocrine system first breaks down and then ceases to function altogether. The adrenals stop sending out the supply of epinephrine. Consequently the heart slows, the blood-vessels relax and the brain loses its blood-supply and unconsciousness may follow. A general condition of collapse may ensue and if adrenalin is not supplied by artificial means to give a chance to the latent forces within to recuperate, death may follow.

Tranquilizers, the pills of modern pharmacology, may bring an apparent temporary respite, but in the long run the remedy proves worse than the disease. Question then arises : are we destined to be doomed by our environment or are we capable of adapting ourselves so as to aviod, at least, the more injurious effect of the daily stress?

Fortunately, we do also possess an innate protective mechanism, which, if activated, produces physiological condition that is diametrically opposite to the 'fight-or-flight' response. Nobel-Laureate, Swiss Physiologist, Dr. Walter has called this mechanism 'tropotrophic response', and described it as a protective mechanism against overstress promoting restorative processes. Dr. Herbert Benson, M.D. has termed this reaction as the 'relaxation response'. It is possible to train ourselves to activate this mechanism and to reverse the hyperfunction of the adrenal through controlled mental practice, viz total relaxation.

What is Relaxation?

Relaxation is the most direct and harmless antidote to tension. Without it there is no chance of peace, health or happiness, although one might possess everything else to make one happy. If one learns the technique of relaxation and practises it every day for 1/2 to 3/4 an hour, he would remain relaxed in any situation.

For proper appraisal of relaxation, we must know the muscular functions. Muscles contract with lightening speed when stimuli is applied to the connecting nerve. Skeletal muscles allow us action of movement at will. To understand the action of movement, the muscles, may be compared to an electro-magnet and the nerve, which stimulates it to action, to the electric wire which connects it to the brain.

During sleep, practically no current circulates in the nerves and the electro-magnet is almost entirely demagnetized; most of the muscles are relaxed and limp except those which are necessary for reasons of security and survival.

When one is resting, a weak current flows through the nerve, barely magnetizing the muscles and the muscles are in a quiescent state. Whenever one moves or is engaged in physical activity, the current increases in response in the order from the brain, activating the electro-magnets. The muscles contract, the arm bends and the fist clenches. The number of minute motors set in motion is proportional to the intensity of the effort.

All the three states described above, normally, occur many times a day. The fourth state, abnormal yet frequent, is the state of hypertension. Perpetually tightened jaws, frowning brows and hardened stomach-muscles are some of the visible signs of this state. In this state, electro-magnets are overmagnetized by a strong current leaving muscle-groups in a state of permanent contraction, quite often unnecessarily. This results in a colossal waste of nervous as well as muscular energy, because there is a constant leakage of current. The amount of energy thus wasted will depend upon the number of motor muscles activated rather than on their size or strength because the nervous impulse needed to contract a small facial muscle is practically the same as a large leg muscle. Thus the total loss of energy will be proportional to both the number of motor nerves and the strengh of current flowing in each of the conductor

wires. Besides, every day millions of old, useless and dead cells are replaced by young, healthy ones in all our tissues except nerves. Nerve-cells are never renewed or replaced. Their numbers keep on decreasing as we get older. If we injure them, by, for example, overwork in the form of mental stress, they are lost for ever, leaving behind irreparable gaps. Now, it is possible to disconnect the wires carrying current to the electro-magnets i.e. muscles, more efficiently than in sleep, by conscious and voluntary action. This reduces the flow of current almost to nil and the output of energy to the minimum. This is what is meant by total relaxation.

Relaxation, if properly done, can relieve tension and fatigue more effectively in half an hour than many hours of indifferent sleep. It is an exercise of the mastery of conscious will over the body. Will, however, is not the tyrant with dictatorial powers, cracking the whip, but as gentle and patient as a loving mother with an obstinate child. In other words, relaxation can never be acquired by force, constraint or violence, but by persuasive auto-suggestions. It is thus a sophisticated form of hypotonia. In time, relaxation could become a habit, not a mechanical one, but an effortless conscious way of life. If one can remain relaxed under the most exasperating conditions, he has truly achieved mastery of conscious will over body.

The Technique of Relaxation

Normally relaxation is to be practised in a lying-down position (it can also be done in a sitting posture), but before lying down, create a suitable atmosphere for the exercise. Standing up recite loudly. "It is essential for me to relax to get rid of the physical, mental and emotional tensions and I shall devote myself wholly to the exercise of relaxation." Having thus resolved, try to set aside your worries. Take a deep breath and stretch yourself fully, taking your arms above your head and standing on your toes. Do this

3 to 4 times. Then lie down and repeat the stretching operation again 3 to 4 times. Relaxation is an exercise in non-activity which is its basic principle. Don't think that you are going to do something, but let yourself go. This is essential. Now you are ready to start the practice of relaxation.

Always relax on a hard surface. Lie down on a blanket on the floor on your back, legs slightly apart (about 10-12 inches between the heels), arms gently alongside the body, palms turned up. The head must be laid very carefully on the floor so that there is no tension in the neck. If this is not comfortable, a folded towel may be kept under the neck. Later, do without it, but complete comfort is essential.

Since breathing and relaxation are linked together, pay attention to your breathing first. If it is shallow, hasty and/or encumbered, or if its rhythm is irregular, regularise it by autosuggestion. The breathing should become calm, slow and rhythmic but not necessarily deep. The stomach rises and falls rhythmically and silently without effort. Having regulated the breathing, forget it, and commence stage by stage relaxation of every muscle in each part of the body from the toes in the feet to the top of the head. The body itself will remain entirely motionless (except for the slight rise and fall of the abdomen) and the Conscious Will will slowly move over every part, patiently persuading it to relax.

Proceed in small steps, beginning with the toes of the right foot, working systematically upwards in each limb, in turn. Relax the toes, instep, heel and upto the ankle joint of the right limb. Move upwards in small steps from joint to joint i.e. from the ankle to the knee, relaxing the calf muscles and then from the knee to the hip joint relaxing the thigh muscles. Now repeat the same process with the left limb. Both the limbs from waist downwards are now relaxed and lifeless. In the next stage, relax the muscles of the abdomen at the hip, around the waist and at the base

of the spine; then abdominal walls in the front and back upto the hip. Now relax all the internal organs inside the abdominal cavity, viz. kidneys, intestines, spleen, pancreas, stomach and liver. Next, relax the chest muscles round the rib cage in the front as well as the back. The lungs and the heart inside the chest cavity have already been slowed down adequately. Having relaxed the whole trunk up to the top of the chest and collar bone, proceed to relax each arm in turn, first the right and then the left, from the fingers and thumb to the shoulder. Again upwards in small step from joint to joint, first the thumb, fingers and the palm upto the wrist, then from wrist to the elbow and from elbow to the shoulder blades. This brings us upto the neck. In the next stage relax the neck i.e. the top of the back, the nape and the throat.

We have now come to slightly more difficult part of the technique. It is comparatively easy to relax the large skeletal muscles of the trunk and limbs, but, because of our tight-lipped posture, it is more difficult to relax the facial muscles. However, we have to proceed with the work with confidence and patience. Begin with relaxing the jaws, when the lower jaw falls without opening the mouth. Inside the mouth, the teeth must be unclenched and the tongue becomes limp. Next come to the facial muscles which surround the lips, mouth, nostrils and the cheeks. Then relax each in turn and come to the eyes. Eyelids are gently closed over the eyeballs without pressing them. Each eye is meticulously relaxed in turn. Now move over to the forehead and temples. Finally relax the whole scalp from right to left and back to front, upto the top of the head. Having gone over the whole body, from feet to head, the operation may be repeated, as in the meantime some muscles might have recontracted. This second round will be much quicker than the first, followed by a third if necessary. It should be remembered that the auto-suggestion is followed by an experience of relaxation in each portion of the body. The next stage is to recognize the state of relaxation. Having remained completely motionless, the first sign of relaxation is

the sensation of gravity. Do not fight against the force of gravity, let it pull at your trunk and limbs which become heavier and heavier. Let the shoulders sink down. When the whole body has become relaxed, there is an acute perception of the state of relaxation which is no longer auto-suggestion but a real experience. Once this stage is reached, the body is forgotten and the consciousness reveals its separate existence.

What is the physiological mechanism behind this feeling? As we have seen, while the muscles were being relaxed progressively, less and less current flew in the connecting motor nerves, giving them a chance to rest. Ultimately, the whole motor mechanism became passive and reposed. This was followed by their counterparts, the sensory nerves which are responsible for transmitting sensations to the brain. Thus, while conscious self was quite wakeful and alert, the body—physical self—was gradually becoming bereft of consciousness, giving a realistic experience of the detachment of the non-material consciousness from its material counterpart. Total relaxation is characterized by an actual experience of floating outside one's body, and this is definitely not auto-suggestion or hypnosis but realisation of a real fact.

Reverting to the physiological shell, almost all the nerve-cells are revitalized. They are enjoying a much needed recess period, free from the burden of controlling the household chores of movements and transmission of sensations to the brain. No wonder, then, that a short period of relaxation can invigorate more effciently that a long period of restless sleep. And this brings up a question of relationship between relaxation and sleep. It must be quite clear from the above that going to sleep while practising relaxation is quite contrary to the purpose of the exercise. Relaxation may, however, be practised before going to sleep ending in peaceful slumber.

Physical relaxation is precondition for the psychical relaxation which is dealt with in another section of this book. When the relaxation exercise is over, you have to recall the muscles and nerves to their normal state of work-

ing. Do this by allowing your Conscious Will to go over each part of the body from head to feet, breathing regularly and consciously.

Golden Silence

Would you believe that a public speaker uses a great deal more nervous energy than a labourer doing a lot of strenuous work with his muscles does? This is because the total amount of nervous energy required is proportional to the *number* of motor units[1] and not the *size* of the muscles. Almost equal amount of nervous impulse is necessary to contract a small facial or vocal muscle as for a large leg muscle. Thus an orator who puts a large number of small muscles to work expends much more energy than a labourer; a steno-typist uses more than a blacksmith does. That is why silence is so valuable in conserving and preventing the avoidable waste of energy.

What happens when you speak? An idea which forms in your mind, must first be instantly translated into words with accurate grammar and syntax. In order to allow you to speak, precise orders must be sent out to the muscles of the vocal chord to contract, relax and vary the amount of air used. Contractions of the muscles of tongue, lips, and face require thousands of small motor nerves, each expending its own quota of energy, to participate in the act of speaking. In fact, a speech, lasting perhaps a couple of hours may completely exhaust an average person. You can prevent this colossal waste of energy only by observing SILENCE.

But it is not enough to stop speaking aloud. Silence really means that the mental process of speech must also be halted as this can be as exacting as loud talk in terms of nervous energy. This is because almost every motor unit named above, except the vocal chord, has to go through the same motions as are necessary for loud speech. Thus internal silence is as essential as the external or vocal silence.

1. A motor-unit is composed of muscle and the nerve-tissues innervating it.

11

Maintain Emotional Health

So far, in this book, we have dealt with the physical and physiological aspects of the human body. Apart from giving some basic knowledge of the structural and funtional organization of nervous system, little has been said about our mental states and tendencies. Various aspects of the disease and the disorder of the digestive and other important systems have been discussed together with the needs of health care. While dealing with the endocrine system interaction between feeling and behaviour has been briefly discussed. And the role of emotional upsets as a component of the cause of various illnesses has been pointed out occasionally. However, the influence of emotional crisis on our mental and emotional health and behaviour merits examination in greater details.

The Limbic System

It has now been established that symptoms of disorders such as peptic ulcers, insomnia, palpitations, spasms, asthma etc. can result from emotional rather than physical causes. 'Psychosomatic[1] illnessess' is the medical term for the dysfunction of the somatic organs resulting from mental or emotional disorder. Obviously, therefore, care and maintenance of physical health necessitates care and maintenance of mental and emotional health.

Our thoughts and actions are influenced to one degree or another by emotions. Love and hate, envy, revenge, selfishness and altruism—all these play an important part in our behavioural patterns.

1. Psyche=Mind, Soma=Body.

The portions of the brain mainly concerned with emotions lie in an integrated network called the *limbic system* which includes the thalamus, the hypothalamus, part of the reticular formation, limbic region of the cerebral cortex and some other areas of the brain.[1]

It is the limbic system that colours our mental states and emotions. Its function might be considered as the maintenance of a sort of emotional homeostasis—it recognizes disturbances of mental equilibrium—resulting from the primal drives of hunger or sex, a danger or threat or a less tangible worry or disappointment. The emotional "tag" that this system places on such upsets helps the higher brain to recognize the problems and take steps to restore equilibrium.

In animals, the limbic system provides a set of instincts, i.e. automatic reactions to the informations gathered by their senses from the environment. Primal drives are the unlearned instincts—hunger, sex, anger, fear and aggression. They not only generate feelings but also command appropriate action that satisfies the need. Animals just act out instinctive rituals of eating, courtship and fighting. In human beings, reasoning and learning—functions of the higher brain—are given a greater importance. Man, also, does feel angry, hungry and sexually aroused. But he can modify his action. Because he has the reasoning mind, man can control his responses to the insistence of the instinctive drives, with rational decisions made in the higher brain. Other emotional responses based on equally powerful feelings not necessarily instinctive but learned, interact with the basic feelings. They may reinforce a primal drive or countermand it. Sometimes the emotional promptings of the limbic system may clash with rational decisions. Frequent struggle between the limbic system and the higher brain can cause conflicts that are finally expressed in psychosomatic ailments.

1. Viz. the septal area, the hippocampus and the amygdala.

Uniquensses of Man

According to the theory of evolution, man represents the culmination of the process of evolution. Human mind and personality are unique and constitute the highest product yet achieved by the cosmos. In many respects, no doubt, man is also an animal like any other. But possession of some basic human characteristics makes him a very peculiar and in many ways a unique animal. Two unique characteristics of man are more relevant to our discussion than other. The first is his reasoning mind, his capacity for conceptual thinking and rational decisions, and the second is the relative unification of his mental processes as against the much more rigid compartmentalisation of animal mind and behaviour. Animal behaviour is essentially irrational and arbitrary due to the rigidity of their instincts. Human behaviour, on the other hand, being relatively free from arbitrary canalisation of instincts, is likely to show more rationality instead of irrationality. Abandonment of rigidity of instincts and the provisions of association-mechanism by which any activity or mood, whether in the spheres of knowing, feeling or willing, can be brought into relation with any other, brings about unified mental control for man.

Psychological conflicts Produce Distortions

Unfortunately, for man the unified control is not a pure blessing. The advantages derived from the mental unity are mixed up with emotional conflicts and inevitable tensions. Conflicts result from a clash between two dominating but opposing impulses simultaneously demanding action. They may also result from, as mentioned above, incompatibility between the insistence of the limbic system and the rational decisions. The result may be sheer inaction or mental tension. Other animals are not susceptible to mental tension, because a single urge at a time takes command over its machinery of action. Alas! such an easy way out is not available to man due to the existence of the hidden unconscious component in the human mind. Thus man is perhaps the only organism, inevitably subject to harmful neurosis.

The mechanism normally available to man for minimising conflict is forcible banishment of one of the two opposing impulses to the realm of unconscious mind and the very process of banishment is itself unconscious. From the darkness of the sub-conscious dungeon, the frustrated but self-assertive emotion would persist in form of crude urges to violent aggression and cruelty which is all the more dangerous for not being consciously recognised. Thus the roots of irrational fear, hate, cruelty, retaliation and such other emotional distortions and disorders lie in the process called 'repression' by psychologists. Repeated conflicts and frequent 'repression' inflict lasting distortions on the psyche and produce undesirable and evil determiners of human behaviour such as cruelty, vindictiveness, militarism etc., and result in imbalance of emotional homeostasis. Many of the mental illnesses such as neurosis, psychosis, schizophrenia and manic-depressive psychosis can be traced back to emotional crisis. Some forms of mental illness can lead to an inability to function or ultimately to suicide. Some other forms manifest themselves as psychosomatic disorders, which themselves, in turn, result in serious somatic diseases. Thus the search for causes and cure of all illnesses ends in the imbalance of the emotional homeostasis and its rational treatment.

The Cause

Significant progress in endocrinology, in the recent years, has established that all the emotions and impelling driving forces are generated by the synthesization of the chemical messengers called hormones and neurohormones secreted by the endocrine system and special cells of the nervous system. Microscopic amounts of these powerful chemicals are released in the blood- stream and participate not only in every bodily function but profoundly influence the mental tendencies of an individual. The primal—unlearned—instincts are meant to be aids to survival and self-preservation by nature; but intense and conflicting instincts

are not only embarrassing but can sometimes be harmful. And as we have seen, unconscious repression of these forces could be even more dangerous. Repression, therefore, has no positive value, as a method for establishing emotional balance. Recreation from games and sports provides one kind of emotional outlet, e.g. playing football or climbing mountains could provide excellent outlets for ventilating anger. An erotic urge may be sublimated into higher creative activities like painting, music, exploration or research. Canalisation of aggressive urges into conscious constructive channels or sublimation of the 'libido' into higher type of creative activities, are desirable and beneficial antidotes to the poison of repression. They are, however, incapable of a permanent prevention of the recurrence of distortion producing conflicts. Conscious reasoning and rational judgment alone can prevent the relegation of the conflict-producing urges to the dungeons of subconscious to become psychological dynamite. For the maintenance of emotional health, development of sound conscious reasoning and strong rational judgement is necessary. Progressive development of the reasoning mind—the unique attribute of mankind—would purge out the repressive forces which distort the rational behaviour. As stated above, endocrine products are the prime movers which generate the powerful forces of all the instincts and urges, passions and emotions in man. Human behaviour under emotional stress. anxiety and conflict is governed by the synthesization of hormones. Hence the remedy for emotional diseases lies in the transmutation of hormones.

. . . and the cure

Systematic meditational practice has the power to produce changes in the electrical activity of the nervous system as well as transmute the synthesization of the secretion of the endocrine system. This has now been established by the use of bio-feedback and other scientific measuring equipments. Meditation was until recently looked upon as

an item of Eastern mysticism. But it has now been irrefutably proved by scientific observations that the meditative state produces symptoms that are diametrically opposite to those produced during the state of stress and emotional upset. And since hypertension and other psychosomatic illnesses are caused by frequent triggering of stress mechanisms, meditational practices can prevent and cure such illnesses. Meditational practice is not an irrational, emotional or religious experience but a deliberate mental operation of psycho-analysis. It is, in fact, a form of psycho-therapy for eradicating the forces which produce and would continue to produce psychological distortions, emotional crisis, mental disorders and irrational behaviour, if not destroyed. It is a "process of remedying inner incompleteness and reducing inner discord" as aptly stated by William James.

Some Important Minerals Required by the Body

MINERAL	FOOD SOURCE	DAILY ALLOWANCE	FUNCTION	RESULT OF DEFICIENCY
Calcium	Milk, cheese, leafy vegetable	1 g.	Formation of bones and teeth; blood clotting; muscle contraction; nerve conduction	Rickets, bone demineralisation
Phosphorus	Milk, cheese	1.5 g.	Formation of bones and teeth, energy metabolism, nerve and muscle action	Bone demineralisation; metabolic disorders
Potassium	Most foods	1 to 2 g.	Nerve and muscle action	Abnormalities of heart action, nerve disorders
Sodium	Most foods, table salt	2.5 g.	Acid-base balance, fluid balance	Weakness, cramps, diarrhea, dehydration
Iron	Whole wheat, beans, peas, spinach, prumes	18 mg.	Constituent of haemoglobin myoglobin and enzymes	Anemia, digestive disorders

MINERAL	FOOD SOURCE	DAILY ALLOWANCE	FUNCTION	RESULT OF DEFICIENCY
Magnesium	Green vegetables	400 mg.	Neuro muscular transmission, a factor in metabolism of glucose and A.T.P.	Hyper-irritability vasodilation. Excesses bloc nerve conduction.
Copper	Most foods	2 mg.	Synthesis of haemoglobin.	Anemia
Manganese	Normal diet	Unknown	Activates enzymes	Infertility, menstrual irrgularities
Zinc	Most foods	15 g.	Part of enzymes, participation in Co_2 transport, digestion	Retarded growth and sexual maturation, dermatitis
Cobalt	Most foods, tap water	1 mg.	Constituent of vitamin B_2	Anemia
Chlorine	Most foods, table salt	3.5 g.	Hydrochloric acid chloride shift	Diturbance of fluid balance
Iodine	Iodized salt	0.25 mg.	Formation of thyroid hormones	Hypothyroidism goitre
Fluorin	Drinking water	Unknown	Strengthens teeth and bones	Dental caries, weak bones

mg. Thousandth part of a gram.

Some Important Vitamins Required by the Body

VITAMIN		FOOD SOURCES	DAILY ALLOWANCE	RESULT OF DEFICIENCY
1		2	3	4
A	(Retinol)	Carrots, fruits, vegetables	5000 I.U.*	Night blindness
B_1	(Thiamine)	Yeast, whole-grain cereals, milk, legumes, nuts	1.5 mg.	Loss of appetite, indigestion, beriberi
B_2	(Riboflavin)	Milk, cheese, yeast, wheat germ, leafy vegetables	1.7 mg.	Dermatitis, inflammation of the tongue
	Niacin	Yeast, wheat germ, legumes, milk, groundnut	20 mg.	Dementia, diarhea, dermatits,
	Pantothenic acid	Yeast	10 mg.	Studend growth, gray hair, numberness, pain in feet
B_6	(Pyridoxine)	Yeast, wheat germ, milk	2 mg.	Anemia, dermatitis convulsions, susceptibility to infection
	Biotin	Yeast, milk, vegetables, nuts, grains	0.3 mg.	Dermatitis, listlessness, muscle pains

1	2	3	4
Folic acid	Vegetables, cereals	0.4 mg.	Anemia, sprue, growth retardation
B_{12} (Cyanoco-balamin)	Milk	6 micro gram	Pernicious anemia
C (Ascorbic acid)	Citrus fruits, tomatoes, leafy vegetables	60 mg.	Scurvy, weight loss, weakness, lossened teeth, fragile bones, swollen joints
D_2 (Calciferol)	Milk, butter	400 I.U.*	Rickets, soft and fragile bones etc.
D_2 (7-deydro-cholesterol)	Milk, butter	20 micro gram	Effect of overdose : kidney stones, calcium deposits in soft tissue etc.
E Alpha-to-Copherol	Wheat germ, oil, milk, butter	30 I.U.*	
K	Leafy vegetables, tomatoes	Unknown	Slow blood clotting and haemorrhage.

I.U. = International Units.
mg. = Thousandth part of a gram.
micro gram = Millionth part of gram.

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