Introductory Human Biology

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NO. 1, OF A BASIC COURSE

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Introductory Human Biology

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A Lifeways Project

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Introductory Human Biology Vol.1

A Basic Course by G. E. Carakar

SIDE I

Band 1: The Cell

Cell is a Latin word meaning space. It is the unit of structure in all living things, plant and animal. It is important because the condition of the cell in the human body reflects the condition of the body. This is understandable because cells added together make tissues, tissues added together make organs, (for example, the heart and the liver is an organ), the organs added together make a system. The human body is a system, a human system.

The Jensen brothers in the year 1650 and a Dutch storekeeper Anton Von Leeuwenhoek worked on grinding lenses for microscopes, and later an Englishman named Robert Hook (about 1670) discovered the cell. It was a great moment in history. Now we know that the cell is the unit of function since cells carry on all the activities of the body. Some small animals are composed of only one cell, like protozoa and euglena. The human body is made of trillions of cells. These one-celled animals must see that they have food, protection, and reproduce their own species, or as a species they will disappear from the earth, just as man would. Nutrition, protection, and reproduction are basic essential life functions.

The cell is a mass of colorless or grey-yellow substance called protoplasm made of carbon, hydrogen, oxygen, nitrogen, phosphorus, and several other elements; also about 70% of the protoplasm is water. Protoplasm is also called the living substance of the cell or the physical basis of life. It is really a bridge between the living and the non-living. It is the only substance in man's body capable of growth and repair. Two German scientists, Schwamm and Schleiden (in 1838 and 1839) and Schultz, discovered four things about the cell: that all living things are made of cells; all cells can come only from living cells; all cells have protoplasm; and, very important, that the activity of the cell decides the activity of the whole body. That is to say, the cell works as a mirror. It reflects the health or the disease tissue of the body.

The French scientist, Felix Dujardin, discovered protoplasm in a one-celled animal. Later Brown, an English scientist, discovered the nucleus. All cells have a nucleus except in the blood, where we find the red blood cell without a nucleus. The cell in man, or the animal cell, is surrounded by a thin moist membrane, and in the center of the cell there we find the nucleus. It, too, is surrounded by a thin membrane. The protoplasm found inside the nucleus is called Nucleoplasm. Outside the nucleus it is called the cytoplasm. But the parts added together, the nucleoplasm and the cytoplasm, of course make up all the protoplasm. The outer thin membrane around the cell on the outside and the membrane around the nucleus in the middle of the cell enable nourishment to pass into the cell and wastes to pass out. The nucleus plays an important part in reproduction, and it also regulates the activity of the cell.

We have said that protoplasm is the very living substance of the cell, the physical basis of life, but it is the nucleus which controls reproduction. It contains genes, the carriers of heredity, and the dramatic new DNA molecule discovered by a group of scientists like Crick, Watson, Wilkins, and others; the DNA molecule which we are now told is the very secret of life itself, which we feel will help doctors have a new look at disease, lessen medical errors, and perhaps lessen birth mental defects, like feeble mindedness. The cytoplasm carries on all life functions of the cell, except reproduction. Remember that cytoplasm is that part of protoplasm outside the nucleus. There are also centrosomes in the cell which form asters or star-like structures during mitosis, or cell division, in production.

There is one strange one-celled animal which has both animal and plant characteristics. It is euglena. Also in our cells is what we call the nucleolus. Biologists are not quite sure what the nucleolus does, except that it disappears during reproduction and later returns. The German scientist Von Mohl made popular the word protoplasm, that living substance in the cell, and Parkinge was the man who named it. Remember that Felix Dujardin discovered it. Cells added together make tissues; tissues added together make organs; these organs added together make a whole body. The heart is an organ.

In health and especially in disease science goes directly to the cell, for the condition of one cell effects others around it. The longest cell in the body is the nerve cell. Cells differ, some form various tissues and organs. The cells that make the blood are different in appearance, whereas the cells that make up the skin and the stomach and the lungs and the muscles and the heart differ too. It is the cell which breaks down and is threatened when disease strikes, and it is the cell which is functioning properly when we are in good health.

Band 2: Reproduction and the Determination of Sex

Mammals are placed above all other groups of life, but it remained for man, the most advanced mammal, to gain domination of the Earth. In structure man resembles all other mammals, but in intelligence, he is far superior. The bat is a mammal, the only flying mammal; the whale is a mammal. All mammals have certain things in common. The young are born alive and nourished during development in the body and are therefore viviparous, except in the duckbill and spiny anteater, two rare exceptions.

To continue, in mammalia, the young are born alive and nourished after birth by milk secreted by mammary glands of the female. The body is mostly covered by hair. Mammalia also has a large cerebrum which is the largest part of the brain and is highly developed. Mammals possess a diaphragm which divides the thoracic cavity from the abdominal cavity. Two sets of teeth are present, so are fleshy lips. Mammals also have a high circulatory development and finally, mammalia has seven cervical neck vertebrae.

Mammals have a highly efficient method of reproduction. Eggs develop in female organs called the ovaries. Two of these ovaries are found in the lower abdominal cavity of the female. Several eggs may mature at the same time originating from both ovaries; here we see the reason for the multiple births as in the case of rabbits and other animals. On the other hand only one egg may develop, as in the case of the horse, the cow or the elephant.

When an egg matures it leaves the ovary and passes along a little pipe line called an oviduct. The walls of the oviduct are lined with tiny hair like projections or cilia which sweep the egg along, down toward the position where it is to be fertilised. It is in the oviduct where fertilisation takes place, and this union between the egg and sperm must take place within six hours after the egg has taken up residence in the oviduct, or the egg loses its ability to be fertilised. The egg is sterile after 6 hours.

Assuming the egg to be fertilised we see that the head of the sperm penetrated the egg, found its way to the center of the egg and upon contact with the nucleus of the egg, released its chromosones which then are exchanged and mixed with those of the female chromosones. Here, at the point of fertilisation, the sex of the child is determined. Division of the cells begins immediately. The young embryo now moves along the oviduct to the uterus, with which the duct is connected. Here the young organism is nourished. The growth of the mass of cells continues and the movement of this cell mass is down toward the uterus.

The age of the youngest embryo yet studied is one week; at this stage the implanted embryo consists of a hollow sphere of cells known as a blastocyst. Distinct germ layers have been developed within two weeks. Three germ layers are formed. They are the ectoderm, mesoderm and the ectoderm. Each germ layer is responsible for the development of certain areas of the embryo, the ectoderm for the skin, the nervous system and the receptors. (Receptors are sense organs which receive stimuli.)

The endoderm gives off the lining of the lungs, the alimentary canel, the liver, pancreas and the respiratory organs. The mesoderm layer gives rise to the muscles, heart, blood vessels and blood, the skeleton, ovaries, testes and the system of excretion. Science believes that it is the mesoderm layer which became involved with thalidomyde, the drug taken by pregnant women to offset morning sickness.

As the embryo continues to develop an absorbing structure known as the placenta spreads over the entire membrane of the uterus. A cord called the umbilical tube leads from the placenta to the embryo. Blood flows from the embryo in arteries which lead through the umbilical cord to the placenta. The arteries branch into numerous thin walled capillaries in the placenta. Here the blood of the embryo comes into close contact with the blood of the mother. Note that the fetal and maternal blood do NOT mingle; blood returns from the placenta to the embryo through a vein in the umbilical cord. As the blood from the embryo circulates through the placenta, it receives oxygen and dissolved particles from the blood of the mother. Carbon dioxide and other cellular wastes are poured into the mother's blood stream, for eventual elimination.

Early in the second month the buds of the arms and legs of the child appear, the major internal organs begin to take shape, and in about 6 weeks the bones and muscles begin to form. By the third month the embryo is recognised as a primate, a member of the highest form of mammalia. The face is definite, the nostrils are distinct, and the external ears are forming. By the end of the eighth week the tail has been usually incorporated into the body, and in the 11th and 12th week, the external genitals become evident. By the fourth month the embryo is now called a fetus, and is clearly seen as a human being. At the end of its development or when the period of gestation of 9 months is over, the fetus is forced through the canal leading from the uterus.

Soon after the mammal or baby is born, the placenta is loosened from the wall of the uterus and passes through the birth canal. In primitive tribal societies and lower animals, the mother cuts the umbilical cord with her teeth and there by separates the young child or animal from the placenta. Birth brings a sudden change in the new born child. For example: body nourishment must now come from its own digestive system. In the majority of cases, milk is supplied by the mother through the mammary glands in her breasts.

Periods of gestation vary. The shortest is the oppusum (13 days). Actually the young are born prematurely and several can be placed in a teaspoon. They continue to develop in the brood pouch of the mother where the mammary glands are located.

The longest period of development takes place in the case of the elephant (approximately 20 to 22 months), in the whale (20 months), while in the cat and dog the period of gestation is the same (63 days). In the human the period of gestation is 36 weeks, and the nearest gestation period to that of man is the cow, which takes 41 weeks.

Band 3: How The Sex of a Child is Determined

The sex of a child is determined at the moment of fertilisation. By fertilisation we mean the union of the egg from the female ovary, and the sperm from the testis of the male. That fertilisation is the point at which the sex of a child is determined, can be proved by making reference to identical twins. They began life as one individual, but became separated in the two cell-stage, but are always the same sex. Determining sex is, however, purely the result of a chance union of a sperm and an egg. In humans and in most animal life the sex is actually determined by the sperm alone.

Now, the chromosones in the cells of females are called "X" chromosones. Chromosones are rod-shaped, gene bearing bodies formed in the nucleus of the cell during cell division. While the female chromosones are called "X" chromosones, those of the male are both "X" and "Y". Now we know that in the sex cell of the female there are two "X" chromosones, and we also know that in the male cell there is only one "X" chromosone and one "Y" chromosone.

When an oocyte becomes an egg there is a reduction of the number of chromosones, through a special process which biologists call meiosis. An oocyte is a sex cell; meiosis is a process of reduction, in which the chromosones are halved. Right at this point each cell receives an X chromosone. A similar procedure occurs with the male; meiosis or reduction division takes place. Since each spermatocyte always contains one X and one Y chromosone, we know that half the sperms will receive an X chromosone but the other half will receive a Y chromosone.

Now we get to the crucial point. If the egg having only X chromosones is fertilised by a sperm with an X chromosone from the male, then the fertilised egg will have two X chromosones, then the child will be a female. On the other hand, if the sperm happens to be lacking the X chromosone, but has the Y chromosone, then the child will be a male. We know now that the cell of the female ovary possesses two X chromosones; the male sperm has one X and one Y chromosone. Whatever the male passes on to the female will determine the sex of the child. If the male passes on the Y chromosone, then the child will be a male. If the male, however, passes on the X chromosone, then the child will be a female. Note that it is the male that determines the sex. That is to say, whatever chromosone, X or Y, determines the sex. That is to say, whatever chromosone, X or Y, the male passes on, that determines the sex of the child. This we call the X-Y theory of sex determination.

There are times when the sex of a child might be altered. Very rare and very unusual, these changes are due to what we call primary sex stimuli. This may be due to the destruction of glands in the body, or a change in hormone production and secretion, or the destruction of an X chromosone, changes in chemical composition, changes in diet, shock, emotional upheaval, chemical changes in the body.

Note that the sex cells in the male and the testis, and of the ovary in the females of the human, each have 46 chromosones. That is, 23 pair in each. That makes a total of 92, 46 more than we actually need for a new born baby or a new individual. Thus we see the necessity of reduction division, in which the chromosones of the male and the female cells are divided in half. This we called meiosis.

Band 4: The Basis of Heredity

Environment and heredity determine the make-up of the individual. Heredity is involved with body size, hair colour, skin colour, eye colour, and some traits may be inherited. Environment are all those factors, both living and nonliving, which make up the surroundings of the organism. In some respects all members of a species are alike; this we call species characteristics. Then there are individual characteristics, which makes the individual different from other people. Some of these unusual traits are passed on from parent to offspring.

The cell is the unit of heredity. That is, the character of an organism is expressed through its cells, but the nucleus is the center of heredity. The material here in the cell with which we are concerned is the chromatin. Once thought to be the only very substance of heredity. The chromatin net identifies the threads which make up the substance chromatin. Note that the chromatin in all the nuclei of cells of a single organism is identical. During cell division the chromatin changes to form several rod-shaped bodies called chromosones. They appear as dark elongated pieces inside the nucleus. Chromosones consist of large numbers of tiny particles arranged in strands. The particles we call genes have been shown and proved to be the bearers of heredity.

But recently science has discovered a molecule in the nucleus of the animal cell called the DNA molecule, which is reported to be the only substance able to cause heredity changes, through being transferred from cell to cell. Four basic sugars are the chief actors or characters in this milestone in medical - biological history. They are adenine, thymine, cytosine and guanine. The DNA molecule is called by some the very secret of life.

Every organism in a particular species possesses a constant number of chromosone. Humans have 46 and these appear in pairs. Man with 46, actually has 23 pairs.

The formation of body cells is called mitosis. Mitosis is the division of chromosones, but before mitosis takes place the period of life known as the interphase stage must take place. It is after the interphase stage that mitosis takes place or begins. While mitosis is a continuous stage, there are only four general phases: the first being the prophase in which the chromatin net condenses into ribbons. The second, metaphase, the chromosones are seen to arrange themselves along the imaginary center of the cell, called the equator. In the third, anaphase, 2 sets of chromosones move in opposite sides to respectives poles. Finally in the fourth, telephase, stage we see the formation of two daughter nuclei or two new cells.

During sexual reproduction the sperm of the male and the egg of the female have 46 or 23 pairs of chromosones each. The natural question is: why is it that the offspring does not have 96 chromosones? The answer is that reduction division takes place. This we called formerly meiosis. Note that having a double number is termed a diploid number; that is, there are 96 chromosones, but through the process of meiosis, the total from the sperm and the egg, while first added together, now is halved, or reduced by 50%, meaning haploid. Diploid means double the number, haploid means half the number.

Original cells divide and form oogonial cells, which mature, each becoming a primary oocyte (an oocyte being an egg before maturation). Now this primary oocyte divides, forming a secondary oocyte and a small polar body. Now the secondary oocyte divides into what is known as an ootid which matures into the egg ready for fertilisation. Finally a mature sperm unites with the mature egg during fertilisation, each contributing a set of chromosones. Immediately after fertilisation the zygote begins a period of rapid division.

From a four celled stage to an eight celled stage, and so on until a large number of cells are produced, forming a hollow sphere which is called the blastula. This is the early stage of development of an individual. Not long afterwards the blastula forms a deep pocket. This produces two layers known as the blastula; the blastula producing the endoderm (inside layer) and the ectoderm layer. Then the third layer forms between these two layers. This third layer is the mesoderm. Now "ecto" means outside and "endo" means inside, "meso" (from the Greek) means middle. Thus we have the endoderm, the outside. Now we have an inner layer, middle layer, and outside layer, and so the division goes on, and the development of a new individual is assured. And so is the heredity make up of the individual determined from the instant the egg and the sperm unite.

SIDE II

Band 1: Human Inheritance

A special study has developed called eugenics. It deals with human inheritance, and the founder of this important study was an Englishman, Sir Francis Galton. Eugenics actually means good birth, and Galton felt that we need a science which deals with the influences that improve the inborn qualities of a race.

Today we know that through the study of family records, certain traits for good or bad are inherited, just as we inherit eye colour and size of body. Through this study we can make some definite conclusions in so far as mental ability, scholarship, moral strength and weaknesses are concerned. The study of case histories or family histories if the task of the eugenist.

Much has been learned from the study of twins, both fraternal and identical. In the case of the fraternal twins we know that they develop from separate eggs which were fertilised by different sperm. Fraternal twins live in the exact same environment; yet they may be totally different in physical characteristics, personality, emotional set-up and mental ability.

These variations aid in evaluating just what kind of characteristics are heredity and what are environmental. We are forced to ask ourselves can acquired skills be inherited? Or can these acquired skills be transmitted to the offspring in any degree at all? Certain individuals inherit tendencies which lead them toward a particular kind of activity. Coordinated finger movements, for example, may lead to the belief that the person ought to be a musician. But to be a musician requires first long hours of practicing and concentration. Only the inherited or native ability may be passed onto the next generation, and even if it is not developed, that native ability will be passed onto the next generation. What we are trying to say here is that inborn characteristics, which had important influences on the success of these individuals, may be passed on. But is prenatal influence possible? Prenatal means before birth. The sex of the child, like the heredity of the child, was determined at the time of fertilisation, but thoughts, emotional upsets, and experiences good or bad can in some way alter the heredity qualities and the development of the child.

Inherited traits are eye and hair and skin colour, body stature, or build. These we call physical traits. There is evidence that personality traits and aptitudes may also be inherited.

Deformities are carried by defective genes or by recessive genes or by genes which express a characteristic more in some people than in others. When paired with normal genes these traits disappear. It must follow then that when genes are mixed up, undesirable traits do not appear in unrelated people. It must also follow then that people who are closely related and intermarry make undesirable traits appear often.

We now come to the area which deals with sex-linked characteristics in the human race -- we will recall that X chromosones determine the sex of the child. They also determine abnormal traits, such as red-green colour blindness, a condition in which these colours appear as shades of gray. But while the female chromosone carries the gene for color blindness, it is recessive to a normal gene. That is to say, if we have a colour blind gene chromosone uniting with a normal X chromosone, we will <u>not</u> get colour blindness.

However, in the case of the male, only one X chromosone is present. Here we see the single coloured gene combined with a Y chromosone. Lacking a gene for the character X prime, Y will produce the defect. This explains why red-green colour blindness is much more common in males than in females.

What other characteristics are associated with sex? Certain genes produce characters in one sex and not in both (in a man but not in a woman), even though they are carried by both the male and female. For example, the bright plumage of certain male birds which do not appear in females, and roosters with large combs. These result from the influence of sex hormones. Baldness is an example of a sex influenced character. In this case it is clear to see that the gene for baldness is dominant in males but recessive in females.

And so then, on to inheritance of blood types. There is type A, B, AB and O. These letters have a meaning. They refer to a protein substance known as antigen which produce antibodies in the blood. Some people have A antigen, others have B antigen, some people have both, that is AB; while those who have neither are classified OO. Blood type is an inherited characteristic controlled by three kinds of genes.

If you have type A you could have received type A from each parent AA, or you could have received A from one parent and O from the other. This would make the recipient AO. The same is true of a person with type B. It is the result of receiving B from one parent and B from another, making the combination BB. A B could also be combined with an O, but B is overwhelmingly stronger and more dominant than O. If one parent transmits an A gene and the other a B, we have in the offspring AB, which will produce both antigens, since neither A nor B is dominant over each other. Type O blood, lacking both antigens, results when neither dominant gene is present. Thus we get OO blood type.

In the RH factor, four pairs of genes are involved in the inheritance of this factor, and reports indicate that perhaps six pairs of genes might be involved. Persons with RH positive genes produce RH antigens. Thus it is difficult to diagram the results of crosses between various RH types.

Does one inherit mental ability? This is difficult to determine, but the modern method through the administration of intelligence tests is used. First the score of the mental age is found, then the mental age is divided by the chronological age. The result is multiplied by 100. Thus we introduce a term into our scientific vocabulary known as the IQ. But these methods contain flaws, since the variable factor is included in the study. A variable factor is one over which we have no control. For example, persons taking a mental test at the time of illness or mental strain may result in an inaccurate intelligence test result.

Environment, we know, is a powerful factor that influences human development. We know that living under conditions that are unfavourable, the individual has less chance to prove his native intelligence and reach his goal. Then again, good environments bring out hidden desirable good traits in the individual, while bad environment tends to stifle these values.

Genes alone will never produce fine quality. Whatever the potential that might be locked up in the genes, the end product, the level of the individual, cannot be properly achieved unless there is education, training, practice, and experience.

Finally, biology students might remember that there are three sex linked diseases. They are baldness, hemophilia, and colour-blindedness. These tend to occur only in the male.

Band 2: Structure of the Human Body

Because of his highly developed brain man is more advanced than other organism. His intelligence directs him. He has organised his habits and mental faculties. He is in a position far above that of any other kind of animal.

His body is made up of cells. Which combined make tissues, and tissues make organs. These organs make up the system or the organism.

Body regions in man include the cranial region - formed by bones of the skull. In this cavity the brain safely lies. The head also contains the sense organs which are located near the brain, to which impulses are transmitted, along nerves.

Below the cranial region is the thoracic cavity formed by the ribs, the breast bone and spinal column. This thoracic cavity are found the lungs, trachea, the heart and other organs. Separating the thoracic cavity from the abdominal cavity is a muscular partition known as the diaphragm. In the abdominal cavity we find the stomach, the liver, pancreas, intestines, spleen, kidneys and in the case of the female - the ovaries. Note that protection for the contents of the abdominal cavity is by the vertebral column at the back and layers of skin and muscles on the front.

In man there are approximately 207 bones--bone is a living tissue--it is moist and requires nourishment--Part of bone is nonliving, but there are parts made of living cells and mineral deposits. In the early stages, of development, of the embryo, bone is merely cartilage, and a few membranes. But later, deposits of minerals in the form of calcium phosphate and calcium carbonate fill in the spaces. Between these ossification takes place--and while it continues through childhood, it continues also at a reduced rate throughout persons whole life. Meanwhile bones grow along lines of stress--that is to say, they become heaviest and strongest where the strain is the greatest.

Outside the bone is a strong membrane called the periosteum, rich in blood supply, it is able to provide nourishment for the bone, aids in repairing bone injuries and also, this periosteum provides a surface to which muscles are attached. - inside the bony layer is that part of the bone which contains the deposits of mineral matter--there are found numerous canals called haversian canals--which transport nourishment to the living cells of the bone tissue--. Large bones have a hollow interior and contain a soft tissue known as marrow which is richly supplied with blood vessels and nerves. There is red marrow, from which red blood corpuscles and one type of white blood cells are formed. The yellow marrow fills the central cavity of the bone, normally it is inactive but may produce red blood corpuscles in time of abnormal blood loss through injury or disease. Bones are also supported by cartilages.

Not all cartilage is replaces by bone---the ear, trachea, larynx are examples of cartilage, --which secretes a fluid known as synovial fluid necessary for the lubrication of joints. In the knee or shoulder we find a small sac or pocket, called the BURSA--it serves as a shock absorber or a cushion between bones. Joints are where bones meet--the elbow is a hinge joint--the hip and shoulder is a ball and socket joint--the femur or thigh bone fits into the socket of the hip bone--or the pelvis. These joints are held in place by strong connective tissue called ligaments.

Some bones are only partially movable--ribs attached to the vertebrae are an example; but immovable bones are like skull bones. Others are angular gliding and pivot joints in their order, wrist and ankles--vertebrae--and finally the pivot joint involves the head on the spine.

Since we have the general structure of the human body--we have the muscles which make up half the body weight--Almost 400 muscles enable the body to move. - some muscles we control - these are voluntary muscles--others are involuntary, such as the function of breathing, excretion, circulation, digestion - other muscles are both voluntary and involuntary--the eyelids-the diaphraghm. --

Three kinds of muscle cells are found in the body; the striated -- cells with bands -- and many nuclei, the smooth -- spindle shaped cells with one nucleus--and finally the cardiac., branched striated fibres--.

Where the tendon attaches the muscle to the bone--is the point or origin of the muscle--while the tendon at the other end of the muscle is known as the insertion--. Muscles which bend joints are flexors--those those that straighten joints are extensors-- Note that a slight tension always exists between one muscle and another--this we call a state of tone--

The heart or cardiac muscle is similar to striated muscles -- but the cells are branched and contain specialised discs--and the action of the heart is unlike that of any other muscle--the beat of the heart goes from cell to cell throughout the whole muscle.-- The heart beat originates in a small mass of tissue at the top of the heart known as the sino-auricular node--from here the beat is carried through the muscle to the auricular-ventricular-node, from which point it relayed to the heart muscles in the lower chamber.

Muscles produce movement. Those which are attached to bones by tendons are skeletal, or striated--smooth muscles form layers in the walls of the stomach, intestines and the arteries--these are involuntary muscles.

Band 3: <u>Respiration</u>

The life process - Respiration - is the exchange of gases between cells and their environment. In man respiration, involves two phases. External, which is the exchange of gases between the atmosphere and blood, and internal respiration, which is the exchange between the blood and the tissues.

Air enters at the nose, (at the nostrils) which are divided by a septum, a small partition, then enters nasal passages above the nasal cavity. Tiny hairs in the nostrils filter dirt, while, some foreign particles lodge in the nervous membrane.

Air now passes through the pharynx, a cavity to the trachea (the windpipe) which is protected by a lid or flaplike structure called the epiglottis. Inside the larynx, (or Adam's Apple) - is the enlarged end of the trachea, inside which are the vocal chords protected by cartilages that are shaped like horseshoes.

Note that Cilia - tiny hairlike protections are in constant motion and carry dust and dirt from the trachea and its branches toward the throat and mouth.

At its lower end, the trachea divides into two Bronchi or branches, each branch going to a lung where they are sub-divised into many small Bronchial Tubes. These Bronchial Tubes end in air sacs or in the walls of these air sacs are found the alveoli or the air cells, which make up the Lung tissue.

The total area of the Alveoli in the Lungs is about 2000 sq. ft. or more than 100 times the surface area of the body.

The lungs occupy the body from the shoulders to the Diaphragm, except that area taken up by the heart - the trachea, esophagus and the blood vessels.

A thin lining - known as the pleural membrane (and Moist) covers the lungs and chest cavity.

Now to the Blood Supply -

The Pulmonary Artery brings dark blood to the lungs. Dark blood has no oxygen and must be returned to the Lungs for a fresh supply. At the lungs the pulmonary artery divides into an extensive network of capillaries or blood vessels which surround each air cell. The moist wall of both the cell and capillary aid the exchange of oxygen gases from the air to the blood and Carbon Dioxide and water from the blood to the air. The pulmonary veins now return the blood with a supply of oxygen in it, to the heart.

Note that Carbon Dioxide has a higher concentration in the lung capillaries - therefore, it diffuses out, as does the moisture, to an area of lesser concentration. This we know as diffusion - a process whereby molecules of one substance spread out through another.

Lungs completely filled have approximately 300 cubic inches of air. However, only 30 cubic inches of air are involved in normal breathing - this we call - Air.

Lungs do not draw in air - neither do they expand the chest, since they, do not contain muscle - what actually happens is this: - enlargement of the chest cavity involves a contraction of rib muscles which pulls ribs upward and outward - next the Diaphragm contracts, which increases the size of the chest cavity from below. Also abdominal muscles relax permitting compression of the abdominal organs by the Diaphragm.

Inhaling and Exhaling occurs from 15 to 25 times per minute. This, of course, varies. Body position, age and activity alter the figures, for the greater the oxygen need in the tissues, the more rapidly the lungs must function to supply the necessary oxygen. An abundance of Carbon Dioxide stimulates breathing - an oxygen surplus on the blood has the opposite effect.

Blood in the lung capillaries absorb oxygen from the air cells - and once this oxygen is in the blood it combines with Hemoglobin, containing a red pigment. This pigment gives blood its red color because it contains an iron compound. A small amount of the oxygen in the blood is absorbed into the body tissues. In the first place what we breath in is only 1/5 oxygen - and only 1/4 of it is absorbed by the blood in the lungs - and what's more, the Hemoglobin in the blood gives up only 1/3 of the oxygen it is carrying on the tissues.

In the tissues of the body oxygen is used to oxidise food, so as to assure the release of energy - this goes on very rapidly in the muscles - for example when Glucose is oxidised, Lactic Acid is produced - then part of this Lactic Acid is again oxidised to form CO_2 and H_2O. What is left of the Lactic Acid seems to be changed back to Glycogen for re-use in the muscle tissues. If oxygen is lacking Lactic Acid increases and produces fatigue.

During the times of muscular action the need for oxygen is greater than the body can supply. The lungs cannot take in oxygen fast enough - nor can the blood deliver it rapidly enough. So the body builds up what we call an Oxygen Debt. When breathing is restored to a normal level the oxygen debt is paid.

We have said that Respiration is also concerned with the release of energy, but metabolism, part of this investigation concerns all the vital body processes, both physical and chemical, which are concerned with the activity maintenance and growth of an organism.

Metabolism, is therefore, concerned with the growth and maintenance of the body through the assimilation of food. Food substance during assimilation are reorganized to form new protoplasm. This building up process of metabolism we call Anabolism. This protoplasm we know is the living substance of all cells.

But as in all types of protoplasmic activity, energy is required, and this means waste or a tearing down process during, this activity. This is called CATABOLISM.

Now we know that oxygen is necessary for oxidising food for the release of energy - that Metabolism involves all the physical and chemical processes of the body--and that Metabolism is divised into two parts - ANABOLISM, the building up activity, and CATABOLISM, the tearing down activity.

The rate of oxidation in the body, may be measured directly, by determining the amount of heat, which is given off from the surface of the body. For this purpose we use an instrument called a CALORIMETER.

Even when the body is at rest or completely inactive, respiration, oxidation and the release of energy are contriving. The activities for this, or to make this possible, are included in the term BASAL METABOLISM.

When the amount of oxygen intake is measured for the whole body, we call it the basal metabolism rate. External factors influence the rate of breathing and the rate of oxidation. These factors are temperature, moisture, oxygen and CO_2 in the air, or in a room which then involves the factor of ventilation.

As for CO_2 death can be caused by what is incorrectly termed Carbon Dioxide poisoning. Actually nothing is poisoned, it is the tissue in the body that is starved through the lack of Oxygen - these problems become acute in air travel above 20 thousand feet - when sensory organs and sensory nerves are affected - this we call ANOXIA.

In space travel the Oxygen supply might be provided by a small green plant called Alga.

LITHO IN U.S.A.