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ON

Respiration

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Respiration.

I am aware of my inability to do any thing like justice in delineating even the most simple structure or function of the human organism; much less to describe the intricate and complex arrangments and offices of the respiratory organs. Nor, can I hope to do more than follow as an humble disciple in the footsteps of those illustrious philosophers whose untiring energy and deep researches brought so many of the hidden mysteries of nature to light, dispelling the clouds of ignorance and superstition that for ages retarded the progress of knowledge; and before whose transcendent genius the miserable theories and dogmas that were concocted in ignorance and nurtured in prejudice vanished in air, thus placing the science of Medecine upon the broad and firm foundation of truth, & thereby opening to the ardent student of nature a way full of beauty and interest, unfolding to his gaze, Man, the grandest and most wonderful work of God.

The function of respiration is one of the most interesting and important connected with life. Interesting, because it presents a variety of phenomena, the least of which cannot be comprehended without much thought and study. Important because by this process, carbon is removed from and oxygen conveyed to the blood thereby rendering it capable of sustaining the normal condition of the system, and partially producing ~~heat~~ heat, so necessary to the existence of warm blooded animals. — To cease to breathe in common acceptation of the phrase is to die. "And the Lord God formed man of the dust of the ground and breathed into his nostrils the breath of life and man became a living soul," is the Scriptural account of Man's created existence.

Reason, and the laws of nature, being our guides, the doctrine of no one can be received, no matter how ingeniously supported, unless proved by incontestable facts. Upon these premises, I

proceed – as far as my limited knowledge admits – to describe in the simplest manner the wonderful mechanism and powers of the respiratory organs.

The respiratory process in all Mammalia is carried on in the minute cavities of the lungs called air cells. – The lungs in man are situated on each side of the chest; embracing the heart, and are separated from each other by that organ and also by a membranous partition, the Mediastinum, a duplicature of the serous membrane lining the entire cavity of the thorax. – The lungs are two in number and are termed right and left respectively according to the side of the cavity in which they are lodged. Their form corresponds to that of the cavity of the chest, being convex anteriorly but concave posteriorly to receive the convexity of the heart. – Superiorly they terminate in a tapering cone the apex of which extends above the first rib.

Inferiorly they are broad and concave resting on the convex surface of the diaphragm the great muscle

which is the septum between the abdominal and thoracic cavities. ~ The right lung is somewhat larger than the left owing to the inclination of the heart to the left side. ~ It is also shorter in consequence of the great convexity of the liver forcing the right side of the diaphragm higher in the thorax than the left. ~ The lungs are divided into lobes & these are subdivided into lesser lobes or lobuli, each of which is separate and distinct from the other and performs the functions of a little lung, thereby resembling much the glandular structures. The number or size of these lobuli cannot be well ascertained for they are very numerous and therefore small. ~ The lungs are spongy in texture and lighter than water. The elements of which they are composed are the ramifications of the trachea, pulmonary arteries, and pulmonary veins, besides the organic elements appertaining to every living structure such as nerves, arteries, veins, lymphatics and areolar tissue. ~ The cavities of the respiratory

organs are made by the ramifications of the trachea or windpipe which is continued from the larynx where it receives the external air conveyed to it through the mouth and nose. ~ The trachea passes down in the front part of the neck into the thorax as low as opposite to the the second or third dorsal vertebra where it divides forming two tubes one passing to each lung into which they divide and subdivide until they are imappreciable. Their branchings are all alike, given off in pairs at each division. ~ The terminal branches of these tubes or bronchi as they are called enter the lesser lobuli of the lungs where they communicate with Thousands of air cells and terminate in them, or by a blind extremity. ~ The pulmonary artery which conveys the impure blood from the right ventricle of the heart to the lungs to be purified divides a short distance from its origin into two branches, one passing to each lung accompanying the corresponding bronchi in its ramifications forming on them and also on

the walls of the air cells a dense capillary network in which the radicles of the pulmonary veins begin; these ~~begin~~ unite to make larger trunks and finaly terminate in four large veins which convey the purified blood to the left side of the heart. ~ ~ The nerves that are distributed to the lungs are the pneumogastric and some fillaments of the sympathetic. ~ The lungs are nourished by the bronchial artery a branch given off from the aorta. The air cells are small cavities from one fourth to one twelfth of a line in diameter communicating freely with the small branches of the air tubes and are supposed to communicate with each other only in the lesser lobuli.

The cells are not regular in form but are for the most part four sided, their walls like those of the intercellular passages are very thin consisting only of a delicate elastic membrane overspread by the capillaries of the pulmonary arteries and veins; by this arrangement, the blood is almost surrounded by air, being separated from it only by this delicate

structure which is but a slight barrier to the absorption and elimination of certain elements. — As the blood circulates through the body it parts with its nutritive properties in supplying the decaying tissues and gathers impurities from them; it therefore becomes incapable of sustaining life, unless these impurities are removed & instead fresh supplies of nutriment added. This removal is accomplished by the lungs kidneys and other eliminating organs. — The nutrition is carried on by digestion assisted by respiration. Through absorption the nutritious elements reach the the blood, but by simple admixture with it, they do not become converted to a substance capable of supplying the losses sustained by the frame until the mixture has reached the lungs where it is made arterial blood by coming in contact with the air in the cells, the number of which is estimated at about six hundred million; there are sixteen or seventeen thousand clustered around each terminal bronchus. Hales says the air cells are about the hundredth part

of an inch in diameter and have a surface of forty thousand square inches; and that of the bronchi sixteen hundred and thirty five square inches, making the air surface of the lungs two hundred & eighty square feet which would be nineteen times greater than the surface of the whole body, which he estimates at fifteen square feet.

Although these estimates may not be altogether correct yet they give a good idea of the immense surface which the lungs have. The air is taken into these cavities by inspiration, an act which consists of the dilatation of the chest and its contents and is accomplished by muscles attached to the bony walls of its cavity.

After the air has been changed it is expelled by expiration which is nothing more than the elastic recoil or contraction of the walls of the chest and of the lungs themselves, after having been dilated by inspiration. The cavity of the chest is enclosed on all sides from the admission of air, by its investing membrane the pleura, which, like all serous membranes is a

chest sack. – It invests each lung and is reflected to the parietes of the chest, that portion in contact with the chest is called pleura costalis; that covering the lungs pleura pulmonalis. By this double covering it will be seen that the internal surface of the pleura costalis is in contact with the external surface of the pleura pulmonalis. These surfaces glide one upon the other and secret a lubricating fluid to facilitate their movement. – Air is conveyed through the open glottis — into the tubes and cells of the lungs & by their means the pressure of the atmosphere is conveyed to all parts of the cavity of the chest, thereby making the external and internal pressures equal. The force therefore which is required for the expansion of the chest in inspiration is not more than is necessary to move the weight of its walls and those of the abdomen, and to overcome their elasticity and also the elasticity of the lungs. When the chest is expanded the atmospheric pressure is somewhat less on the exterior of the lungs than

on their interior. This excess of pressure therefore impells more air into them through the trachea. When on the other hand the chest contracts the pressure is greater on the exterior of the lungs and air is forced out of them through the windpipe. The movements of respiration are to some extent under the control of the will, as we may increase or diminish them at pleasure, but cannot arrest them altogether nor for any great length of time. By a forced inspiration we increase the capacity of the chest but it will not retain this position longer than a certain time, but will contract in spite of us expelling the air and regaining its normal size. If on the contrary we endeavor to expel the air from the lungs by a continued expiration the chest will contract considerably, but it again assumes its original condition notwithstanding our efforts to the contrary. Many have attempted to explain the cause of the first inspiration of the newly born infant and of the regular alternations of

inspirations and respiration during life, but the explanations which have been offered are not altogether satisfactory.

In inspiration the cavity of the chest is enlarged in all directions but more in its vertical diameter than in any other owing to the great mobility of the diaphragm which in infancy and in tranquil breathing is almost the only muscle called into action. In adult males besides the movement of the diaphragm, there is considerable motion of the walls of the lower part of the thorax & sternum. In females the mobility is greater in the upper than in the lower part of the chest, a provision which is supposed to have been made to render respiration easy, when the lower part of the chest is encroached upon by the pregnant uterus. The quantity of air that is changed in the lungs in each act of tranquil breathing depends upon the size of the lungs mobility of the muscles of the chest, stature, weight, age, & sex. In young and middle aged men it is estimated at from twenty to twenty five cubic inches. Old persons breath deeper than the young & therefore change more air

in each act of respiration. The greatest respiratory capacity of the chest is indicated by the quantity of air expelled from the lungs after the deepest inspiration that can be made. This is called by Mr. Hutchinson the vital capacity and in healthy men five feet seven inches in height the quantity is estimated by him at two thousand & twenty five cubic inches, but for every inch above this standard it is increased eight inches and for every inch below it is diminished by the same amount. There can be no reason offered why a definite ratio should exist between the height of the body and the capacity of the chest, for the capacity of respiration does not depend very much upon the size of the thorax but upon the mobility of its walls. ~ There is not so much known of the effects of weight on this capacity, but it is less apparent than that of height. ~ This capacity in women is only half as great as stated above which refers entirely to men. In a healthy adult the number of respirations

ranges from fourteen to twenty in a minute.

Most of the force of the inspiratory muscles is employed in overcoming the elasticity of the lungs and the resistance of the walls of the chest. In usual breathing this force is sufficient to raise two hundred pounds, the power of the expiratory muscles is one third greater than that of the muscles of inspiration. The changes of the air in the lungs effected by these movements are assisted by the different conditions of the air itself. By the law of the diffusion of gases the carbonic acid evolved in the air-cells will independently of any respiratory movement tend to leave the lungs by diffusing itself into the external air, where it exists in less proportion. By the same law the oxygen of the atmospheric air will go to the air cells where its proportion is less than in the air external to the lungs or in the larger tubes. By this process the atmospheric air is greatly changed; it parts immediately with a portion of its main elements oxygen and nitrogen and when

exhaled it contains more carbonic acid and watery vapor than when inhaled. Many experiments have been made to ascertain the quantity of oxygen consumed in a given time; but owing to the fact that the amount consumed by the same animal differs under different circumstances, no two experimenters have agreed. The results obtained by Davy & Garnier who nearly agree are taken as nearest the truth. It appears from them that a man in one day will consume twenty five cubic feet of oxygen which is one fifth of the air he breathes, thereby rendering one hundred and twenty five cubic feet of air unfit for respiration in the twenty four hours. All observers agree that there is more oxygen absorbed through the lungs than is given off in the carbonic acid from that organ. The portion absorbed is probably given off in the carbonic acid and water exuded from the skin or unites with the sulphur and phosphorus to form part of the acids of the phosphates and sulphates excreted

in the urine. ~ It appears that the quantity of oxygen consumed depends much upon the condition of the functions and the state of the system generally; thus moderate exercise, agreable excitement even temperature and farinaceous food increase, while the contrary conditions tea and alcoholic drinks diminish it. The amount of carbonic acid exhaled from the lungs depends upon age, sex, & purity of the air &c. It has been ascertained that man in the prime of life exhales a greater quantity than in youth or advanced age. Women exhale less of this than men of the same age, the quantity increases until the age of puberty, when it abruptly ceases to increase, and remains stationary so long as they continue to menstruate; when however this function ceases from any abnormal cause their exhalation again augments, but when menstruation ceases naturally it soon decreases in the same ratio as in man. The quantity exhaled depends much upon temperature, being considerably increased cold &

diminished by heat. It is also augmented by farinaceous food, moderate exercise and is decreased by alcoholic drinks fasting and during sleep. The average quantity of carbonic acid given off by the lungs is about four & one half per cent of the respired air, provided the inspired be not charged with more than its usual amount of that gas. When so charged the quantity is less than this standard. As atmospheric air contains by volume four parts of nitrogen to one of oxygen it follows that they enter the lungs in this proportion; yet, nothing is positively known of the disposition made of the nitrogen in respiration, save, that it dilutes the oxygen which alone would have a deleterious effect upon the system. There is always some watery vapor exhaled in breathing which for the most part is the exudation of the water of the blood through the thin and moist membranes of the air passages and cells; it is also formed by the union of

the absorbed oxygen with the hydrogen of the blood. The quantity emitted is as a general thing sufficient to saturate the respired air. If however the inspired air be moist the amount absorbed by the air will not be so great as if it had been dry. The temperature of the respired air has much to do with the vapor for the higher the temperature the greater the amount of vapor required to moisten it. The changes which the blood undergoes are closely connected with and in a great measure dependent upon the changes of the air already imperfectly noticed.

The venous blood is made arterial by being deprived of half its carbon, and by receiving oxygen. The most obvious difference is in color, which from the dark crimson becomes a florid red. Of the many ingenious theories which have been proposed to account for these phenomena the one usually received is that of La Grange & Nassenpratz with some modifications advocated by Magnus & others. According to this theory the

oxygen absorbed into the blood from the air in the lungs is in part dissolved and perhaps in part loosely chemically combined with some of its ingredients. In this condition the oxygen carried in the arterial blood to all parts of the body. In the capillaries it is brought into near relation or contact with the elementary parts of the tissues, therein cooperating in the process of nutrition as in the removal of disintegrated parts of the tissues. About one half of the oxygen which the arterial blood contains disappears and a proportionate quantity of carbonic acid and water is formed. The venous blood which is the result of these impurities returns to the right side of the heart and thence to the lungs where these poisons are again eliminated and fresh supplies of oxygen added.

A similar function to the respiration of the adult exists in the foetus, as respects the changes produced on the blood, which no doubt is sent to the placenta

to be there aerated as it is in the lungs. In utero uterine life. This opinion is predicated upon the facts that when the circulation is prevented in the umbilical cord the foetus will die. There is an absolute necessity for aeration to every living thing, animal, or vegetable; birds receive air through the pores of the shell, but if the shell be geared the chick dies.

The sensible evidences of these changes being accomplished by the placenta are not so apparent as when performed in the lungs of the adult. There can be no difference detected between the arterial and venous blood of the foetus either in appearance or by chemical analysis, but from what has been said it is evident that a difference does exist for the apparent identity between the blood passing to the ~~xxxxx~~ placenta by the umbilical arteries and that returning by the vein cannot be real, as, it is from the blood carried ~~from~~ by the umbilical vein and distributed through the body that all the organs of the foetus

have to derive the material of their nutrition and development, and being deprived of these elements it must necessarily be different in the umbilical arteries from what it is in the umbilical veins.

This thesis submitted for your examination, from the nature of the subject alone would be imperfect, as it contains hidden mysteries yet to be revealed. My limited knowledge, and want of language cannot do the subject justice. More might indeed have been written, but if the object for which these pages are required be attained, it is enough. The only way in which I could have repaid the generosity of each and every member of your faculty, was by showing how highly the advantages bestowed upon me, were appreciated. The tree is known by its fruits, and under Providence, the fruit of years to come, shall show my deep gratitude and heart felt thanks for your personal kindness to, and patient teaching of, one who will endeavor to merit your regard.

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