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THE COMBE LECTURES ON PHYSIOLOGY.

Lectures

BY

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Lecture I.

SKETCH OF GEORGE COMBE.

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St Katharine's Hall, Aberdeen, was crowded on Saturday evening on the occasion of the delivery, by Professor Stirling, of the first of the series of eight lectures on physiology, which have been arranged for in connection with the Combe Trust. The audience included a host of prominent townsmen and many ladies, and the lecturer, who spoke rapidly, but in a strong and clear tone of voice, was followed in his remarks with the closest attention and interest. The chair was taken at seven o'clock by Mr John Miller, Sandilands, who said he had much pleasure in being present that evening at the commencement of the second course of the St Katharine's Hall winter lectures. This course would consist of eight lectures to be delivered on eight consecutive Saturday evenings by Dr Stirling, the Professor of Physiology in the University of Aberdeen. Dr Stirling, although a comparatively young man, had already attained an exceedingly good position. He had been a most successful student of physiology, and possessed a great knowledge of the human frame—(applause). It was his desire that the present series of lectures, which were under the auspices of the Combe Trust, should not have only a passing interest, but that those attending should take notes and be prepared at the end of the course to reply in writing to a number of questions, which would be submitted at an examination that would then take place on the subjects of the series of lectures. Prizes would be awarded to those who made the best appearance at the examination, but he felt assured that the honour of success would be thought more of by those taking part in the competition than the mere value of the prizes—(applause). He believed that not to one class alone, but to all who took an intelligent interest in them, the lectures would prove of great benefit—(applause).

Professor Stirling was heartily greeted. He said that in beginning this the first course of lectures on physiology in relation to the laws of health delivered in Aberdeen it would be necessary for him to say something regarding the object which their founder, George Combe, had in view. In instructions left to his executors, Combe explicitly stated that he was convinced that God governed the world in all its departments by fixed laws, physical, organic, moral, and intellectual ; that man, by becoming acquainted with his own constitution and its natural modes of action in relation to external objects, might to a greater or less extent discover the order and laws of God's secular providence, and that by acting in conformity with this order man might increase his own happiness to an extent at present unknown. He further set forth that he was desirous, as far as lay in his power, to promote the study, exposition, teaching, and practical application of these laws by experiment, observation, schools, lecturing, &c., with a view to induce men, particularly the working classes to acquire a knowledge of them, and to act in conformity with them in their daily lives, and thereby to realise the prosperity and enjoyment which God appeared to have placed within their reach—(applause)—and he directed his trustees to take such means as they thought best calculated to effect this object. Such was the high, intellectual, moral, and beneficent aim which George Combe had in view—(applause). But who was George Combe? As his biographer remarked Combe's name was now rarely mentioned in scientific circles, but he was a remarkable man, much in advance of his age and time in all that concerned the education and physical well-being of humanity. His guiding principle throughout life was that there is a great divine, moral government of the world, and that its laws were written in nature for the guidance of man. He was an earnest man, and, above all, a deeply and sincerely religious man. He was sincere in his convictions, and when once they were formed he acted fearlessly upon them, undismayed by the opposition of men, of which he had ample experience during his life-time. He was a man much in advance of his time. His views on education, although ridiculed when he gave expression to them, were the very views which every one now regarded as being just and true views of the principles of education. Combe desired that education should be practical, and that children ought to be taught that which would be useful to them in after-life, and that the teaching should be by objects placed before the pupil, and that, above all, instruction in the physical conditions necessary to health should form part of a general education—(applause). The laws of health, he considered, ought to be taught to women, because the lives of children depended almost exclusively on the care of the mother—(applause). He strongly advocated a compulsory system of education. This was more than 40 years before compulsory education became law in England —(applause). Combe was born in Edinburgh on October 21st, 1788, the day of the victory of Trafalgar, and very early in life his attention was directed to the necessity of those physical conditions being strictly absorved which were necessary to obtain a "sound mind in a sound body." In his autobiography he remarked that in 1800, "the family, his parents, 13 children were crowded into a few rooms of small dimensions. The laws of health depending on ventilation and ablution were wholly unknown. The mind was regarded as independent of the body, and everyone acted on this hypothesis." Combe was educated at the High School and also at the University of Edinburgh, and on completing his studies he obtained a partnership in a legal firm in Edinburgh, and passed as a member of the Society of Writers to the Signet. The philosophy of the human mind early attracted his attention, and he thought he had found in phrenology, of which nothing was heard now-a-days, a system which would guide him in all spheres of life. He produced many literary and philosophical works. The chief of these works were his papers on Education, and what was perhaps his greatest work, "The Constitution of Man." He died in 1858, having lived long enough to see the partial development of the principles of education which he had done so much by his writings to advance and establish on a firm footing, and so to pave the way for important practical issues — (applause). Departing from his sketch of George Combe, Professor Stirling said his endeavour would be to make the lectures of the present series sufficiently popular to interest those attending them in scientific matters, in matters concerning the different parts and the modes of action of the human body, so that they might in the most literal sense know themselves—(applause). Of the many skilled artisans who were present there were probably some acquainted with the construction of a watch, others with that of a steam-engine, and others with that of other pieces of human mechanism, but he thought he could assume that there were few among them there that evening who knew much about the working and structure of their own bodies. These lectures, then, were intended to show people how their bodies were built up, how the various parts of the body worked, how the different conditions which influenced health were to be studied, and especially to direct attention to the conditions that created disease, to show the practical value of pure air and water, of healthy and wholesome dwellings and unadulterated food, and, if possible, to make those attending the course wiser and better men and women—(applause). He said women in particular, for the very good reason that very much of the care of the infant devolved upon the mother, and because as was the infant so would be the adult—(applause). If a living being were looked at, no matter whether it were plant or animal, it would be found that the higher class consisted of great diversity of parts. The study of the structure and arrangement of these parts constituted anatomy, and the study of the numerous actions or functions, as they were technically termed, of the organisms constituted physiology. Some of the actions of the organisms such as the moving of the lips in speech, the contraction of a number of the muscles, or rather the result of that contraction, the contraction of the eyelids, the lifting of the eyelids, the heaving of the chest, and respiration were perfectly obvious, but there were a great many other actions going on that were not obvious, including the process of digestion and the various processes by which the thoughts were evolved in the brain, and to the aid of the physiologist other branches of science had then to be called in, viz., physics and chemistry, and experiments made upon animals, living or dead, or conclusions drawn from diseased action. The result of all that constituted the great, broad science of physiology. Physiology, it was therefore clear, was founded on anatomy. A man must know the structure and arrangement of the parts before he could proceed to study what they did. There was ceaseless change, constant wear and tear, in living organisms, even though it might not be quite observable. The changes went on in sleep the same as when the being was awake, only they were not then nearly so palpable. The bodies of those present were not the same as when they entered the room. They had given off certain materials and taken in certain new things. The physicist in the external world around us had to deal with two great factors in the physical universe — matter and energy. Matter was indestructible. The amount of matter in the universe could not be altered, but the form of it could. He illustrated this in the course of the evening by an experiment with a candle, showing that while the matter of which the candle consisted was destroyed by burning, yet something directly proportional to the amount of matter that disappeared in the burning was formed. As to energy, by that was simply meant the power of overcoming resistance, and one of the greatest strides in the domain of physics was the recognition of what was known as the "conservation of energy." The amount of energy in the universe was constant, but it could be transformed from one form into another. chemical energy could be converted into the energy of heat, and the energy of heat into the energy of motion. The converse was also the case. Motion could be transformed into heat. Thus it was that while by heating a thing one could get motion, by motion he could also get heat, and it might be light, as on a target when a big ball from a large gun impinged on it. In the case of the electric light the mechanical motion of the engine was transformed into electricity, and that again was transformed back into light. Besides heat and motion there were other forms of energy which had particular interest at the present time. One of these was electricity, which could be transformed into motion, as he proved by a simple experiment. Another was magnetism, and it was easy, as he showed with another experiment, to transform electricity into magnetism. Then there was the chemical form of energy, as in phosphorus and gunpowder and the burning candle. In explaining the relation of all this to physiology, Professor Stirling pointed out that food had to be supplied to the body and burned up to keep up the temperature or energy, the muscular and various other actions of our bodies. Our bodies might be compared to a machine, in so far as they were made up of matter, and capable of using up different forms of energy, and transforming one form of energy into another. But our bodies were peculiar. They differed from ordinary machines in respect that they were self-repairing to this extent, that while there was a certain tumbling down of various substances in them, there was coincident with that a growing up. As to the various changes that matter underwent, there was a literal statement of this fact in the words that Shakespeare put in Hamlet's mouth:—

> Imperial Cæsar, dead, and turned to clay,
> Might stop a hole to keep the wind away:
> O, that that earth, which kept the world in awe,
> Should patch a wall to 'xpel the winter's flaw.

In that there was a distinct statement of the doctrine that matter might actually form one part of one person's body at one time, and part of another person's body at another time. Where did matter and energy come from? Matter was first in the inorganic world around, outside us. That was eaten by plants and animals, and we ate the plants and the animals, so that matter went on in a never ceasing channel of change. Energy was given out by the sun. The earth absorbed energy from the sun, and then animals and plants, and through them man shared the energy. Thus in one sense we were distinctly "children of the sun." Chemists told us that our bodies consisted of exactly the same chemical elements as existed in the world around us, only they were combined in our bodies in a form different from that in which they existed in the world arouud us. Protoplasm was just composed of the same chemical elements as existed around us, only the elements in protoplasm were in peculiar combinations. It was well known that iron was a constituent of our bodies. When persons grew pale in appearance it was common to give them iron to make the colour come back to their faces. That was done upon the simple chemical assumption that iron was wanted for the small blood corpuscles. Lime also was an element that entered into the body. The bones required lime in order to make them hard and rigid. The human body might be said to consist of two tubes, perfectly separate from each other—one to the front and one to the back—and these tubes fulfilled entirely different functions. In the one behind lay the brain, and the brain continued down by a piece of nerve matter was the spinal cord, which was enclosed and protected by a series of bony arches. The trunk was divided into two parts, the chest above and the abdomen, or belly, below. These two parts or cavities were separated in man and all the higher animals by a partition, the midriff or diaphragm. In the case of man there were two pairs of appendages, the pair in front being designated as arms and that behind as legs, and in the class of higher animals there were never more than two pairs of appendages. As to the structure of the limbs, if a man's arm were examined it would be found that there was a bony core in the centre, and that on the core certain things were strung. There were great masses of flesh or beef termed muscles arranged over and acting on the different bones. The muscles required to be brought into relation with the nervous system, and thus we had running down a certain part of the arm these beautiful white cords, the nerves, and we had each muscle under the direction of the nerves whilst other nerves—sensory nerves— conducted impulses upwards towards the brain, where they were interpreted as sensation. There were also arteries and veins and other structures on which at present he would not dwell. The limbs differed from the trunk in the absence of any cavities other than the mere blood vessels. In the human skeleton there were some 200 bones, but there were more in the child than in the adult, because as the person became older certain bones became united with each other. The bones were hard on account of the presence of lime, and they had various functions. They performed certain protective functions, as, for example, in relation to the lungs and the brain. The bones further supported the various parts of the body, and they formed a series of levers. But bones, over and above these mere anatomical considerations, were something more. In the interior of bones, and especially of long bones, such as the thigh ones, there was in the centre a great marrow cavity, and in the end a number of finer cavities. These were intimately related with the making of blood. Some of the bones, as for instance the skull, were constructed on a different principle from the rest, being flat. The backbone, or vertebral column, was the important thing that characterised vertebrates such as man. In the child it was built up of 33 bones, all practically of the same type, and each one termed a vertebra. In the upper part of each there was a small tunnel, which was very apparent in the vertebra of a whale—(laughter)—and the bodies projected forward. The tunnels lodged the spinal cord, and from the rings a number of processes projected, and these processes served as surfaces for the attachment of muscles. In the upper part of the spinal cord there were seven vertebræ, peculiarly arranged, and then, further down, there were the dorsal vertebræ, of which there were twelve, and the lumbar vertebræ. The lower part of the spinal column was peculiar. The vertebra there began to be fused together. Five were fused together, and a triangular bone was formed, constituting the sacrum, and at the end of it was this miserable thing of four little bits which represented the tail in man—(laughter). The tail, of course, was rudimentary—(laughter)—and was turned in below. The tail which occurred in man was homologous with that which occurred in the higher animals—(laughter). It was not his intention to enter into any discussion of the Darwinian theory as to man's descent, but as relating to the humorous side of the question, he could not refrain from quoting the following lines by the late Lord Neaves :—

The thought that men had once had tails
  Caused many a grin full broad, O,
And why in us that feature fails
  Was asked of Old Monboddo.
He showed that sitting on the rump,
  While at our work we plod, O,
Would wear the appendage to the stump
  As close as in Monboddo.

—(great laughter). Resuming his subject the Professor said that the back-bones were fixed together by what were called intervertebral discs, which were possessed of great elasticity, and in this way acted as buffers, preventing a great number of shocks from reaching the cord. Where two vertebra joined there were two holes, and from these along the back-bone nerves were given out right and left. The skull was divided into two parts, the facial region and the cranium proper, in which lay the brain. In the child the cranium consisted of eight bones, but these became welded together later on so as to form the dome-like arch that was such an admirable protection for the brain. The skull on the outer surface where the bones united was all zig-zag, the bones interlocking, and so giving additional protection. In the interior of the skull it was otherwise. It was straight there where the bones were joined. What was the reason of that? It was because in the inner part of the skull an altogether different thing had to be dealt with. The inner part of the skull was hard, the outer tough. Tough things might be united together by interlocking digits, but in such a case as in the interior of the skull, which was very brittle, it was obvious that the parts should not be combined by brittle arrangements. In the face there were a great many bones, but they were all united together into one. The only movable one was the lower jaw. A large number of sense organs—eyes, ears, nose, mouth—were brought into relation with the skull or cranium. There was a big hole at the back part of the cranium which was for the spinal cord, and at the base of the brain there were various holes through which passed a number of nerves. The face of man was thrown under the cranial portion, while that of the ape projected forward, although among human beings there were some skulls that came very close to that of the ape—(laughter). In the spinal column there were a lot of beautiful curves. They were developed when the erect attitude was assumed, and along with the intervertebral discs they formed important aids in the diminution of shock. The development of lateral curves was a thing to be guarded against. It should be seen that children were not put into cramped attitudes, as the tendency to lateral curvature of the spine was frequently developed in them quite unawares in that way. Many people, again, got lateral curvature from the habit of having one hand in their pocket—(laughter). It was to be remembered that once the lateral curvatures were induced they were apt to become aggravated. The length of the human body was fairly constant. The difference lay mainly in the length of the limbs. The difference between people was less in the sitting than in the erect position, and in illustration of this he referred to the audience in front of him and a most amusing diagram behind him.

The lecture was splendidly illustrated by the numerous large diagrams that were shown, by human and other skeletons, and by the various experiments, which were so conducted that the lecture was entirely free from break.

Lecture II.

HYGIENE OF THE SKELETON.

From "Daily Free Press," *Jan.* 21, 1882.

On Saturday evening Professor Stirling delivered, in St Katharine's Hall, the second of the Combe series of lectures on physiology. The ticketholders crowded the hall in every part. The lecture was devoted to descriptions of the chest or thorax, the upper limb and its shoulder girdle, the lower limb and its pelvic girdle, the constituents of bone, the various kinds of joints, and the part played by these and by the muscles in animal movements. The most interesting points in the lecture, from the health point of view, were those relating to rickets, increase of spinal curvature, deformities of the foot, and the results of tight lacing with stays. It was stated that the bones of a child were soft and yielding, and that deformities of the bones were therefore most easily produced in early life. As people got older the bones tended to become more or less hard and brittle, because there was usually a slight increase of mineral matter. A child should never be placed on a high stool with its feet dangling in the air, because the inevitable consequence of that would be that the whole of the weight of the foot and fibula (leg bones) would be put upon the thigh bone, with the result that it would be bent in a greater or less degree. A child ought always to have its feet supported, and it should, besides, be taught to sit erect. Strained attitudes were apt to increase the spinal curvatures or give rise to curvatures in an opposite direction, viz., lateral curvatures, and so to lead to injury. Rickets were caused in children by bad air, and, above all, by living in those dark and semi-subterranean dwellings which were so far condemned by law, and to prevent the rickety condition arising, children ought to have plenty of pure air and good food, especially milk, and, according to the recommendation of some people, mineral matter in their food. The feet seemed to have suffered probably more by the pernicious practices that resulted in deformity than any other part of the human body except one—(laughter). The worst cases of deformity of the foot, as would readily occur to all, were those in connection with the custom resorted to on the part of ladies in the higher ranks and also certain of the lower social grades in China. It was generally when the Chinese girl was in her fifth year that the practice was begun, and while shortening the foot as was desired it entirely broke the arch of it. It was thus that the feet of Chinese ladies became miserable distorted things on which the poor creatures were bound to hobble along through life. The system was to cramp up the foot by a bandage, and this bandage was often allowed to remain on for months at a time. Sometimes the process entailed the loss of one or more toes—(laughter) —but that of course did not matter to the ladies, whose pleasure in the result was in proportion to the smallness of foot which was accomplished—(laughter). The name which was given to the foot when shortened was that of "The Golden Lily"—(laughter). In this country we differed in degree rather than in kind from the practice of the Chinese ladies. Boots, for one thing, were made too narrow, and so it came about that the toes, instead of being left parallel one with another, as when the foot was in its natural shape, were squeezed on the top of each other in the manner shown in some casts which the professor exhibited of feet of hospital patients, and which he contrasted with a cast of the foot in its natural shape. It was through wearing boots that were too narrow that bunions and a variety of deformities were caused. He showed some lasts which he had obtained from a shoemaker, and said that they seemed to indicate an erroneous idea as to making the foot symmetrical. The high-heeled boots worn by ladies were very destructive of the natural structure of the foot. The arch was entirely broken, and the weight was thrown forward upon the ball of the toes, instead of being distributed, and thereby there was hobbling instead of proper walking and a general impeding of progress. Further, the muscle of the calf was greatly relaxed; it therefore became shortened, and was largely thrown out of action, and, through disuse, was wasted. What should be done to obviate deformities of the foot was to wear boots with broad soles, and to have the inner sides of the boot parallel one with the other to give plenty of play for the toes, so that they might not be pinched up or cramped—(applause). Coming next to the subject of the wearing of stays and tight-lacing, the professor observed that it had been said by Charles Kingsley that silence, stillness, and stays were the great causes whereby there was so much unhealthiness among children. It was not of silence or stillness, however, that he wished to speak now, but of the habit of wearing stays. Charles Kingsley had made investigation into the time when stays first appeared on the scene. The earliest record, he mentioned, he could find of them was somewhere about 400 years after the Christian era, when certain Greeks were shipwrecked and cast on the coast of Africa. The shipwrecked people were surprised to find on their being thrown on the coast a miserable little-waisted girl who came from the far East, and the style of whose body the lecturer illustrated by a bust. The Greek ladies knew nothing of stays. They were strong, healthy, athletic women, athletic exercises being practised amongst them, and they regarded the little-waisted girl as a curiosity, and pampered and fed her till she became perfectly fat—(laughter). The old recorder had thought this worthy of being chronicled, because women whose bodies were constricted at the middle were then apparently exceedingly rare. It was evident that the Grecian ladies did not practice the use of stays — (laughter). Tight-lacing, when the practice was begun early and continued, permanently distorted the human form. What gave such distortion its serious aspect was the fact that it hindered the proper working of vital organs. Respiration, digestion, and the circulation of the blood were all interfered with by tight-lacing, and ill-health in women was consequently engendered. He strove to make very apparent the utter absurdity of the deformity that tight-lacing wrought by directing attention to the difference between the waist in a large figure representing the Venus of Milo, and that in a picture of a woman taken from an 1880 Paris fashion plate. Did men desire that women should tight-lace themselves so as to form a thing which one could span with two fingers?—(laughter). The human arm had not grown shorter within the last century—(great laughter). Tight-lacing was simply the setting up of a conventional standard against the natural one ; it was a pandering to a fashion which was at once absurd and injurious, and for the health of women themselves and for the health of posterity the sooner it was given up the better—(applause).

Lecture III.

HYGIENE OF THE MUSCULAR SYSTEM—FOODS.

From "Daily Free Press," *Jan.* 28, 1882.

Professor Stirling on Saturday night delivered the third of these lectures in St Katharine's Hall. The hall was crowded. At the outset, the Professor spoke of the relation of the muscular system to the action of the brain and the nerves. He pointed out how a muscle acted or contracted, and illustrated his remarks by experiments with the muscle of a frog. He said that there was one great point connected with the action of the mnscles, which was that if they were not used, they gradually became feebler and smaller. If used, they became larger. The former effect was well seen in the muscle of a person long confined to bed, when the muscles largely disappeared ; they were again restored when the person got exercise and plenty of air. The example of the other case was well seen in the arms of a blacksmith, who had great powerful muscles. A great number of people lived without developing their muscles at all, and he would counsel those who had not sufficient muscular exercise to use their muscles. To use the muscles in the proper way so as to get a sufficient amount of air at the same time was the great difficulty. In the summer time there were outdoor games, and he knew of no better game than lawn tennis, and it was strongly to be commended, because it could be played by both sexes. No game would do so much for girls, whose muscular system was not sufficiently used. In the case of boarding schools the mere promenading two and two sort of half melancholy process certainly could not take the place of vigorous exercise in the form of tennis. A man in middle life should be careful to take exercise, and nothing was better than walking a good many miles or the excellent game of golf. With regard to diet the Professor remarked that he could say but little and give only the broad principles which ought to guide one in connection with the subject. The subject was one which was hourly and daily before us, and it was evident on the face of it that there was a very intimate relation between the food and the health of the population. Food was necessary to repair the tear and wear which was going on in one's body. Whenever we did work something went out. It was a common saying that a boy of sixteen ate as much as his father; but the father's body was already built up, and the boy had to eat as much food as would enable his bones and muscles to grow. Every person in twenty-four hours required from two to four pints of water. It was not calculated as so many pints that we actually drank, but almost every food we took contained a quantity of water. An infant was not fed upon beefsteak, or a man upon milk. Milk was the food for an infant. With regard to feeding, he believed no end of damage was done to the child. Mothers seemed to have the opinion that arrowroot was the proper kind of food for a child. For the first seven or eight months of its existence a child should be fed upon milk, and those who feed their children with starch would rue it. Many mothers were in the habit of saying that the child got something of everything that was going. It survived in spite of that treatment, and not in virtue of it. The diet should be adapted to the climate and the work to be performed. An Esquimaux required an enormous amount of fat, and the stories were not exaggerated which spoke of him as eating fron 10 to 12 lbs. of blubber. Food should be taken before a person went to work. It was a most deleterious practice for a man to go to work before taking food. After taking a full meal one should not take violent exercise. The importance of cookery could not be overrated, and most men and women were fairly susceptible of the influence of good cooking. Beef which was not thoroughly well cooked was difficult to chew and difficult to digest. In fact, people did not take advantage of half the books on cookery. In some working men's houses the cooking was not what it ought to be. If the food was well cooked it saved labour to our teeth and stomach. There had been recently produced a very useful tablet on cooking for hanging up in kitchens. It was uncommonly good, and he could recommend it. Too little food caused starvation. If all food and drink were removed from a person, death would result in five, six, or ten days, and the person would die with extreme suffering. Under certain conditions of the nervous system, and provided the person got plenty of water, that person might live twenty, thirty, or even forty days. Tanner's experiment proved nothing. The experiments were conducted in a slovenly fashion and without proper supervision, and one did not care to believe any of his statements. Professor Stirling then referred to the various properties of food, animal and vegetable, such as milk, cheese, fish, wheat, oatmeal, rice, maise, arrowroot, macaroni, potatoes, &c. In connection with our drinks, he said that water was the drink all the world over. In this country we had tea, coffee, and cocoa. Tea was not a food, and coffee was not a food. There could be no doubt that, especially amongst females, the abuse of tea was so absurb that one was obliged to raise one's voice against the continual imbibition of it, which in many households seemed to go on from "early morn to dewy eve," some people actually sipping these substances at twelve o'clock at night. They produced most serious effects. It was undoubted that many of the cases of dyspepsia that occurred were largely due to the continual imbibition of tea. Cocoa was both meat and drink. He would say little on the subject of alcohol. It was used by all conditions of men and by all societies. The experiences of recent campaigns had clearly shown that soldiers in full receipt of rations and doing active service performed their work better without the artificial stimulant of alcohol than with it. If a person took a glass of whisky at a railway station he was covered with a glow of heat, but the temperature was actually lower in these circumstances than before the person had any stimulant. The best thing to take in a railway journey was coffee. Alcohol was absolutely injurious to a young, growing body, and every young, growing man or woman should abstain from the use of it. In certain circumstances it might be a substitute for food, but that was a very different thing from saying that it was to be substituted for food. If people were to take it at all, it should always be taken after food, and never on a light stomach. He would not discuss the question whether a small quantity of alcohol might not be good for man. He would refer those who wished to be informed on the subject on all its bearings to the writings on the subject.

Lecture IV.

FOOD AND ITS DIGESTION.

From "Daily Free Press," *Feb.* 4, 1881.

On Saturday evening Professor Stirling delivered, in St Katharine's Hall, the fourth of the series of Combe Lectures on Physiology. The hall was crowded in every part. The subject of the lecture was "Food and its digestion: how food is digested in the mouth and stomach." After referring to the process of digestion in such animals as the amœba, the hydra, and the anemone, the lecturer proceeded to consider the digestive system of higher animals —such as man – in which the process became complicated. The alimentary canal or digestive tract was a musculo-membranous tube with dilatations at certain parts, into which a variety of glands poured their secretions, such as saliva, gastric juice, bile. The food thereby underwent a change of condition, being rendered soluble and fit to be absorbed into the blood, either directly or indirectly. Digestion began in the mouth. Three processes took place there—insalivation, mastication, and swallowing. Saliva or spittle was secreted in certain glands, from which two or more pints per day were poured into the mouth and mixed with the food. Saliva had several physical functions; it moistened the mouth, assisting mastication and articulation, and it was necessary for taste and for the process of swallowing. Saliva had also important chemical effects on food; it contained *ptyalin*, a ferment which transformed starch into grape sugar, rendering the starch soluble in water, and fit to pass through the membranes. *Ptyalin* was not developed in children up to a certain age, and therefore it was positively poisoning a child to give it starchy food. To this error in feeding young children was to be attributed the fact that of the children born in this country one-half died before reaching the age of five years. The secretion of saliva was closely related to the nervous system, which was illustrated by a reference to the well-known Indian rice ordeal. Any strong feeling tended to stop the flow of saliva, and thus to make the mouth dry. Mastication was the process by which the food was broken up by the teeth, aided by the tongue, the cheeks, and the lips. The food was kept between the teeth on the one side by the cheeks and the lips, and on the other side by the tongue. The teeth were hard things fixed in special sockets all round the jaws. In no sense of the word did they belong to the group of structures known as bones; their hardness was due to lime-salts. Each tooth consisted of a crown, a neck, and a fang or root. The crown was the part that projected above the gum. The neck was the depression between the crown and the fang. There might be one or more fangs, which were curved outwards. In structure a tooth was not uniform. There were to be noted the enamel, the dentine, the cement, and the pulp-cavity. In the pulp-cavity were blood-vessels and nerves. The pain of the operation of extracting a tooth arose from the rupture of these blood-vessels and nerves, and from the resistance offered by the cement and the form of the fang. On the teeth depended digestion. To reduce the food-substances to a fine pulp, and thoroughly to mix them with the saliva, a good set of teeth—natural or acquired—was necessary. If one had no teeth, one ought at once to procure a set. If one had teeth, one ought to preserve them. Any dentifrice that contained an acid ought to be discarded, as it destroyed the enamel. Vegetable charcoal was perhaps the best dentifrice ; it was antiseptic, and not dear. The tooth-brush ought to be used once, if not twice, every day, both for the sake of cleanliness and to keep off decay. To clean the outside had an æsthetic effect; to clean the inside was as necessary as to clean the outside. And, in the by-going, the tongue ought to get a rub, it being a favourable place for putrefactive changes. We had two sets of teeth—the milk or temporary teeth, twenty in number, and the permanent teeth, thirty-two in number. A full explanation was given of the various kinds of teeth—incisors, canines, molars. How swallowing was performed was next considered. The first part of the process was voluntary, the second involuntary. When the food got to the back of the mouth, it got beyond one's control.

The food or drink did not fall down the gullet; it was propelled—it might be against gravity—in a rhythmical motion by the action of the walls of the tube. In its passage to the stomach, the food was prevented from passing into the windpipe and choking avoided, by a beautiful arrangement, which was clearly explained. When the food reached the stomach, it underwent certain changes and movements. The process of digestion was not confined to the stomach; a great part of the process went on in the intestines. The stomach was a muscular coat with a lining membrane which secreted gastric juice. The food was kept in the stomach till partially digested, when it passed into the intestine. Gastric juice, which was a watery fluid containing a ferment *pepsin*, acted on the albuminous constituents of food, rendering them diffusible. The food often reached the stomach in a badly prepared state. In these busy, hurrying times there was too much "bolting" of meals. The practice was due perhaps to taking one's meals alone, to reading while eating, or to lying too long in bed in the morning. The practice was strongly to be condemned, for sooner or later it led to dyspepsia, as badly-chewed food had to be broken down in the stomach and elsewhere by organs less capable of doing the mechanical work of the teeth. Besides, there was the danger of choking, and much pleasure in a good breakfast or dinner was lost. Also proper chewing was necessary for the complete admixture of the food with the saliva. The lecture concluded with a reference to the relation of the digestive organs to the nervous system. A tranquil condition of the nervous system was of immense importance for all the digestive processes. Many cases of dyspepsia were nervous in their origin. It was equally true that the digestive organs also acted on the nervous system. Let meals be social affairs, enlivened by agreeable conversation, and also let the food be properly prepared.

The lecture, which was illustrated by diagrams, specimens, and experiments, was frequently and cordially applauded by the large audience.

Lecture V.

FOOD AND ITS DIGESTION.

From "Daily Free Press," *Feb.* 13, 1881.

On Saturday evening the fifth of the series of Combe lectures on "Physiology" was delivered by Professor Stirling in St Katharine's Hall, Aberdeen. The attendance, as at all the former lectures of the course, was large. Professor Stirling, continuing his remarks as to digestion, said the gastric juice is formed by the walls of the stomach. It is not pre-formed, but the food in passing into the stomach excites the secretion of the juice. The two essential constituents present in the juice are spirit of salt or hydrochloric acid and a ferment called pepsin, and neither alone is equal to the work of digesting food; they must be combined. When albuminous food, such as the white of egg, enters the stomach, it is transformed into an extremely important and very diffusible substance known as pepsin, and is thus enabled to pass readily, as it would not otherwise do, into the blood, and so to come in close relation with the tissues. Gastric juice does not act upon any other constituent of our food. Milk undergoes a peculiar change in the stomach. When it reaches the stomach it becomes solid and curdles, and is then redissolved by the action of the gastric juice, and the albuminous portion of it is also transformed into peptone. When a child vomits some milk, mothers are wont to exclaim that the milk is in a curdled condition, as if that were something totally unnatural. The curdled is the natural condition of the milk, however. The substance which transforms the milk into peptone, or rather solidifies it, is a very special ferment in the gastric juice in addition to pepsin, which can be isolated. Darby's fluid meat is a form of peptones well known in commerce. It is dissolved in broth or something of that sort, and gives a fluid which is very readily absorbed from the stomach into the blood vessels. The recent tendency, indeed, in medicine and physiology, in the treatment of certain diseases of the digestive organs is to give people their food peptonised in this way. Milk or whey or flesh that has been transformed into the state of peptones are all now recognised forms of food for patients whose digestive apparatus cannot properly do the work of digesting. Ordinary glycerine is by far the best solvent for pepsin, and a solution of it has all the virtues of the dry powder of pepsin. The contents of the stomach are acted not only by the gastric juice—a chemical action—but also by the muscles of the stomach. The stomach is distended after a hearty meal; at other times it is much smaller. The muscles continually turn the food into the interior of the stomach, and by this means the gastric juice is thoroughly mixed with all the different particles of food. A number of animals, and particularly the cow, constantly "rasp" their hairy sides with their rough tongues and "rasp" off a great quantity of hairs. These hairs are swallowed by the cow, and after the cow is killed completely cylindrical hair balls are found in its stomach. It is obvious that these could not be formed unless the food were moved in a perfectly definite direction in the stomach. The stomach's motion is marked, in fact, by almost mathematical regularity. The food, after it is acted on by the gastric juice, is known by the name of chyme, which is produced in the shape of fine fluid matter about 20 minutes or half-an-hour after food goes into the stomach. This chyme passes to the pylorus, the pylorus relaxes slightly, and the fluid particles make their way into the gut. The more indigestible constituents of food remain for four, five, six, or more hours in the stomach until the pylorus becomes completely dilated. The walls of the stomach then contract upon them, and force them out into the gut, where they undergo further changes. Then there is the absorption or taking up of the products of digestion. The peptones pass into the blood-vessels in the wall of the stomach and afterwards into another set of vessels. A familiar example of absorption was furnished in the case of poison or of alcohol. Any person who takes alcohol in a "neat" condition knows that only some minutes after the alcohol has been swallowed, he begins to feel the exhilarating and other effects upon his nervous system. That fact is due to this—that the alcohol has actually passed from the stomach into the person's blood and been carried by the blood to the brain, where it acts upon the brain-cells. The absorption of alcohol, therefore, is an extremely rapid process. So is that of poison. In regard to certain poisons, the poisoning takes place within a very few minutes after the poison has been administered. The digestive process in the stomach is sometimes accompanied by the formation of gases. Several substances, sugars especially, when they decompose in the stomach, tend to the liberation of a quantity of gas in the stomach. Under these circumstances, of course, the stomach becomes enormously distended, and a very serious result takes place. The heart, in cases of dyspepsia and indigestion, not unfrequently suffers when, in fact, there is no actual disease of the heart, and it suffers in two ways. The walls of the stomach contain a great number of nerves, and when the stomach is over-distended by gas these nerves are irritated, and impulses pass up the nerves to the back of the neck, where they influence nerve centres that control the action of the heart. Gas also interferes with the heart in this way. The stomach, being distended, rotates upon itself and presses up upon the heart, thus embarrassing the action of the heart in a purely mechanical manner. The perverted chemical conditions in the stomach which give rise to the formation of gas have to be got rid of, and then the heart will go right of itself. As to the relative digestibility of food, it is very difficult to get precise information. It is admitted by every one that some fish are more digestible than flesh, and that white meats, such as chicken and several of the white muscles found in game, are more digestible than pork, beef, and mutton. In the classical case of Alexis St Martin, whose stomach, through a shot, was so exposed that its working could be seen by simply lifting a little flap in front of it, experiments were made by Dr Beaumont as to the length of time various substances remain in the stomach, and the following is a selection of the results :—

Rice and tripe, one hour ; apples, an hour a half ; sago, one hour and 45 minutes ; milk, two hours ; potatoes, two hours and a half ; beefsteak and mutton, three hours ; bread, cheese, and eggs (hard), three and a half hours ; veal, four hours and a half ; pork, five hours and 15 minutes.

It will be seen from this that rice, which is a starchy food, and tripe, which is just the stomach of the ruminant animals, left the stomach in one hour, so that there is in common experience a good physiological basis for a tripe supper—(laughter). Tripe seems to make the most digestible of suppers ; at anyrate it remains a shorter time in the stomach than any other food except rice, and, of course, it is far more nutritious than rice. Veal and pork are great offenders. Veal, which one would naturally suppose was a very digestible subject, is, on the contrary, not at all easily digested. But the greatest offender of all is roast pork, which takes five or six hours before it leaves the stomach to get round the pylorus. The time the stomach takes to empty is generally four or five hours ; under certain circumstances it is less. It is important that, in adults at least, the stomach should not be filled too frequently. An interval of four or five hours should elapse between meals, as otherwise the stomach will be kept constantly at work, and will not be given any time at all to recruit—(laughter). Those who take heavy suppers have to pay the penalty in disordered digestion or severe attacks of dyspepsia. But why does the stomach not dissolve itself when it dissolves flesh? Why does the gastric juice not eat a hole in the stomach? That is a very pertinent question. Those present would remember that the old alchemists were continually seeking a universal solvent, a something which would dissolve everything—(laughter). One cynical old gentleman propounded this question, which was very much to the point, "What are you to keep this solvent in ?"—(laughter.) Under some circumstances the stomach is actually dissolved. It is often found dissolved after death. In people who die after a full meal, the contents of the stomach, in many instances, are got in the belly, and experiments with animals show that it is not the fact of the stomach being alive that prevents it being digested by itself. Worms and many other animals live in the stomach, and are not digested. The problem, therefore, is a deep one, but he had not time to go further into the subject. This all who are fishers know, that the stomachs of fish are in not a few instances found digested. By far the most important part of digestion begins after the food goes out of the stomach into a complicated system of tube, of which there is about 20 feet. The intestine is divided into small and large. In its interior the small intestine, which winds downwards from the stomach till it reaches and joins the large intestine, is provided with a number of plaits or folds, which increase the mucous surface three or four fold, and keep the fóod from being propelled too rapidly through the tubes—before all the valuable properties are extracted from it. The muscular coating outside the intestine is a double one, consisting of fibres ranged longitudinally and fibres ranged circularly. The food from the stomach must all pass into the small intestine, the fatty particles pass into the complicated system of villi and through the absorbents or lacteals, which are part of the structure of the intestine, into a tube lying along the front of the back-bone, where it goes into the blood. A few inches from the end of the stomach the food as it proceeds downwards meets a tube. This tube is formed by the junction of two ducts, one from the liver and the other from the pancreas. The food, therefore, is subjected to the action of two new fluids, the bile formed in the liver and the pancreatic juice formed in the pancreas, which fluids are alkaline, and alter the condition of the food. The liver is a very respectable, very fashionable organ—(laughter). It is quite admissible for a person to say there is something wrong with his liver, whereas to say there is anything wrong with his stomach would be an indiscretion—(laughter). It is difficult to know why the line should be drawn so sharply between the two organs, which seem really to be of equal dignity. Such, however, is the way of society—(laughter). The liver lies on the right side, immediately under cover of the lower ribs, peeping out below the diaphragm or midriff. It is complicated in structure. It is supplied with a great quantity of blood, the network of bloodvessels in it being very close. It secretes bile. In both the upper and the lower part of it there are numerous little ducts, which all unite and form one, and in connection with it there is a small reservoir or bag known as the gall bladder, into which the bile goes when it does not pass into the intestine. The circulation of the liver is quite unique, and that is why it is so frequently affected by alcoholic and other stimulants. All the blood which circulates in the walls of the stomach, intestine, and spleen, is returned by the portal vein. This vein goes direct to the liver and splits up in a measure and then the blood is carried away upwards to the bloodvessels that go to the heart. Hence it is that various poisons are so often found in the liver, that alcohol so often affects it, and that it is so liable to get diseased. The liver forms sugar into a substance closely allied to starch, and all the substances we take in our food, except fats, are acted upon by the liver before passing into the blood, and that is why the liver is so important, and why very serious consequences are apt, under certain circumstances, to ensue when it becomes diseased. The influence of the liver upon the nervous system is very decided. The bile is poured out of the liver and goes down to the intestine. It is of a beautiful yellowish, golden brown; in the case of animals bile is usually green. Bile consists largely of water and of certain solids—about 14 per cent. The quantity of bile which we form daily is about three or four pints. Starches, which are acted on slightly in the mouth but not in the stomach, are transformed by bile into sugar, and bile, in addition, breaks up fats so as to form a beautiful emulsion like milk. The pancreatic juice transforms starch into sugar far more powerfully than saliva; it also makes fat into an emulsion, dissolves albumins, forms peptones and coagulates milk. The extreme importance of the pancreas as an organ is beginning to be realised, and it is now a common practice to administer to dyspeptic people pancreatic juice, which has all the virtues and properties of the real pancreatic juice, so that medicine is closely following on the results of research in physiology—(applause). If a fat is to be of any use to a person, it must admit of being melted at the temperature of the body. The chyle or emulsion into which fat is formed passes very much as mercury does through chamois leather into the lacteals on to the thoracic duct or great chyle vessel, which ends in a vein at the root of the neck, and thus reaches the blood. All other substances pass directly into the blood, but fatty particles take this round about way. The intestine secretes fluid itself. In the wall of the small intestine there are a number of very curious glands. It is these glands which are diseased in typhoid and gastric fever. After recovery from typhoid fever it is not uncommon to find persons, through exerting themselves in body, die suddenly, because the glands are lacerated, part of the wall of the intestine is eaten through, and the contents of the intestine fall out into the belly. In the small intestine there is an enormous number of nerves, and altogether the wonder is, considering how immense is the network of nerves in this part of the belly, that one is so free from pain, and not that there is an occasional twinge or spasm in the abdomenal region. The large intestine runs up one side of the belly, goes across under the stomach, and then proceeds downwards. Its contents have in the first place to go upwards, and here there is another argument against constricting the belly by tight lacing or other means—(applause). The contents of the intestine have enough to do, as it is, to ascend against gravity, but to put a constriction round the waist is to take a very effectual means of preventing the contents from passing upwards in the ordinary course—(applause). The small intestine terminates at the "ileo-cæcal valve" in the large intestine. As to the vermiform appendix, the lecturer said he would leave Professor Struthers to speak, as he had been investigating the subject, and would only remark that death is caused through the accumulation of cherrystones and other hard substances in this appendix, which otherwise seems to serve no purpose. The Professor concluded with some remarks as to blood, describing what it is as viewed microscopically. He maintained that in a court of law it would be impossible now to palm off the blood of bird, reptile, or beast, for human blood. He would, however, be a bold man who would stand up in a court of law and venture to swear that the blood he is dealing with is human blood, and not the blood of an ox or such like animal. He is quite entitled to say the stain on a weapon is blood, and a certain form of blood, but to condescend upon the particular animal whose blood it is is quite another matter. Blood when exposed to the air is greatly changed, and the life of a man ought not in the present state of knowledge to hang upon whatever judgment might be expressed in such a matter—(applause). Regarding blood corpuscles, a cubic inch would contain something like 70,000 millions of them, and to count all these, at the rate of 100 per minute, would take 1500 years—(great laughter). The colouring power of blood is great, but people are not to suppose the blood is coloured red simply that they may have red cheeks—(laughter). All human beings have got red blood, and so have all other animals, save a rare few which have blue blood—(laughter). A little blood goes a long way in colouring. A small drop of it will tinge a large quantity of water.

The lecture was illustrated by a number of experiments, which were much appreciated. The subject of next Saturday evening's lecture will be "The Blood and its Circulation."

Lecture VI.

THE HEART AND ITS CIRCULATION.

From "Daily Free Press," *Feb.* 20, 1882.

Professor Stirling, in the sixth of the series of Combe lectures on "Physiology," which was delivered to a large audience in St Katharine's Hall, Aberdeen, on Saturday evening, devoted himself to the subject of "The heart and its circulation." Blood, he said, is nothing more or less than a certain quantity of food influenced by the digestive process; it is the nutriment which the various tissues have to live upon. The term circulation as applied to the blood obviously implies that the blood moves in a circuit, *i.e.* passes from one part of the circuit, goes round in a definite direction, and returns by an opposite course to the point from which it started. Up to the time of William Harvey, in the beginning of the 17th century, it was thought that the blood moved in one direction in a set of vessels, and then came back again in these same vessels, thus ebbing and flowing like a tide. Harvey discovered that the blood left the heart in a particular set of vessels, and went to the tissues, and then was returned by another set of vessels, round a complicated channel, to the heart. It can be imagined what a state the practice of physic and surgery was in before Harvey's time, when such notions as that of the ebb and flow of the blood were the prevailing doctrines of the schools. The circulation of the blood is carried out by means of a great force-pump, the heart, situated in the chest. The heart is simply a muscular, hollow organ, which contains the blood. The blood is pumped in a perfectly definite direction, in obedience to the energy given off in the heart. The heart is popularly regarded as the seat of the emotions; in fact, in every day language, one uses the term heart when he means brain. How has this notion sprung up? It is because the heart is so largely supplied with nerves, and is so readily influenced by changes in the brain as to become, under certain circumstances, a fair index of the condition of the brain. The effect of the emotions on the heart is well pourtrayed by Shakespeare. Macbeth, when soliloquising as to what had been predicted by the witches whom he had met on the blasted heath, said—

> I am Thane of Cawdor:
> If good, why do I yield to that suggestion
> Whose horrid image doth unfix my hair
> And make my seated heart knock at my ribs
> Against the use of nature?

Clearly, under the stimulus of his emotions, and excited by the good things that the witches had prophesied were in store for him, Macbeth had marked palpitation of the heart, and he felt the beating of his heart inside his chest, as one not unfrequently does when subjected to various strong emotions. An important part of the business of the education which is obtained by meeting man with man and woman with woman is the restraining of the emotions, and much can be done in this direction; the heart can be, to a considerable extent, controlled in a curious way by paying attention to physical facts. The heart, of course, is one of the great citadels of life. It and the lungs and the brain, indeed, are the three great organs upon which life may be said practically to depend, and it was these that the old physicians called the tripod of life. When the heart is diseased, various complicated phenomena take place, which, when continued for a certain period, quickly cause the heart to cease to beat and life to come to an end. The heart contains a number of cavities in its interior. It consists of flesh that, with slight differences, is of the same kind as the flesh of the muscles, and when it contracts it forces out the blood. In connection with the heart there are a series of tubes. One set carry the blood out of the heart. These are known as arteries, and were first so called by the ancients, who had not got to the conception that they contained blood, but supposed that the air taken into the nostrils went down into these beautiful tubes, and so passed through the various parts of the body. The blood, after it has been carried all over the body by the arteries, is brought back to the side of the heart opposite to that from which it was forced out by another set of pipes or tubes, called the veins. That is a perfectly elementary and simple statement, which requires some slight modification when the circulation is taken as a whole. The lungs are placed one on each side of the chest, and midway between them, a little more to the left than to the right side, is the heart. The lecturer, with the aid of the heart and lungs of a sheep, described what the relation of the heart to the lungs is. The shape of the heart, he then pointed out, is thoroughly characteristic. The conception of that shape must not be taken from the hearts depicted in valentines or cards—(laughter). There was room for much curious speculation as to how the heart has assumed the shape it has on valentines and cards—(laughter). The heart, in respect of shape, is not at all like the thing that is popularly supposed to represent it. The Professor, to show the shape of the heart, produced the heart of a sheep, remarking, "This heart will do for yours or mine; it is practically the same"—(laughter). The heart, Professor Stirling subsequently observed, is so far conical. Its apex is directed downwards and to the left, and its size in a human being is, roughly speaking, the size of a closed fist. The heart lies in the pericardium, a membrane or bag containing fluid, and nearly all the organs of the chest have a covering like this. This membrane is lined by a serous membrane, which forms the inner surface of the bag, as it were. The surface of the heart is smooth and glancing, and so is the inner surface of the membrane, so that the heart moves quite easily in its bag. The pericardium is not unfrequently the seat of inflammation, and especially in cases of rheumatism. When the inflammation arises the two surfaces are no longer perfectly smooth. The two membranes being roughened rub the one against the other, and so give rise to a sound which is familiar to the physician. The physician detects the sound by applying his ear or the stethescope to the chest, and when he does so he at once knows that the person is suffering from pericarditis. In mammals, the class of animals to which man belongs, the heart is somewhat complicated; in the fish it is much more simple. A great partition divides the heart down the middle into right side and left side, and in the adult at least there is no direct communication between the one side and the other. Blood which is in the right side cannot pass through the partition into the left side, but must go through a series of tubes before it can get to the left side. The right side contains impure or venous blood and the left pure or arterial blood.

The two halves of the heart are similarly constituted. Each contains two apartments, an upper one termed the auricle, and a lower one termed the ventricle, there being thus a right auricle and a right ventricle, which open into each other by an orifice, and a left auricle and a left ventricle, which also open into each other by an orifice. Hanging down into the right ventricle is the tricuspid or right auriculo-ventricular valve, with its three cusps, while hanging down into the left ventricle is the bicuspid or mitral or left auriculo-ventricular valve, with its two cusps. The latter valve was called the mitral by the old anatomists, who were fond of giving fanciful names, because it is not unlike a bishop's mitre. The cusps permit of the blood flowing in one direction, but prevent it coming back. If it were not for the mechanism in the mitral and tricuspid valves it would be impossible to turn a somersault. The blood is brought to the right auricle of the heart by the superior and inferior venæ cavæ, or upper and lower hollow veins, passes through the orifice of the tricuspid valve into the right ventricle, from thence by the pulmonary artery through the lungs, where it is purified, and then it goes as pure blood through the pulmonary veins into the left auricle, the left ventricle, from which it is distributed over and next through the orifice of the mitral valve into the body by the aorta and its branches; and when it has done its work, it is returned to the right side of the heart by the veins. Why does the blood, when the ventricle contracts and propels it up to the pulmonary artery not fall back again into the ventricle? There are in the commencement of the pulmonary artery, as in that of the aorta, semilunar or half-moon valves, like pouches, which, after the blood has passed through, prevent its regurgitation or back-flow, and are capable of bearing a great strain. Whenever the valves become slightly affected with disease so much blood goes back, and the heart in consequence has so much more work to do. The wall of the heart is two or three times thinner on the right side than on the left. The reason is because the left ventricle has to force the blood through the aorta all over the body against enormous resistance, while the right ventricle has only to overcome the resistance in the lungs. All the right ventricle does is to force the blood through the lungs to the opposite side of the heart, and the resistance from the lungs is much less than the resistance all through the body. There are beautifully festooned attachments in connection with each of the cusps. When the ventricle contracts, if there was nothing to attach the long loose flaps, the tendency would be to push them back. The attachments allow them to go so far back, but not further. Something is wanted to compensate for the shortening of the ventricle, and so there are attached to each side of the ventricle the papillary muscles which contract simultaneously just as much as the heart shortens. The heart beats in one's body at a definite rate from the beginning to the end of life, the beating varying under different conditions. The apex or lower part of the heart comes very near the surface, and by putting the hand on the breast between the fifth and sixth ribs, one can feel that characteristic beating or thudding of the heart, which is most marked in cases of palpitation. The Professor said his heart was not sufficiently good, otherwise he would show it—(laughter)—and he had found no volunteer who would come and show his heart—(laughter). We have got indirect evidence of the beating of the heart in the pulse. That is due to the contraction of the ventricle, that propels a definite quantity of blood into the arteries. After the blood has been directed along the arteries, they dilate, and so the pulse is felt a certain fraction of a second after the heart beats in the chest. When the heart beats, it emits certain sounds, and when the physician places his stethescope to one's chest, he can hear the sound of the beating of the heart. With each revolution of the heart there are two sounds, the first and the second, caused partly by muscles and partly by valves. It is necessary to know the cause of the normal to be able to know the cause of the abnormal or diseased heart sound. The two auricles of the heart contract simultaneously, and the two ventricles contract simultaneously, each movement corresponding to a beat, and then the heart comes to a pause. This shows that the heart is not constantly working. With each beat a certain part of the heart is at rest. When the auricles contract the ventricles are at rest, and when the ventricles contract the auricles are at rest, and there is a time when both auricles and ventricles are at rest. In the case of the beating of the frog's heart nine parts of the time is taken up by the contraction of the auricles, thirty-one by the contraction of the ventricles, and the remaining sixty by pause, so that the frog's heart is longer in a state of pause than of actual work. The following is a statement of the at which the heart beats in different animals as indicated by the pulse :—Horse, 36 to 40 beats per minute ; ox, 35 to 50 ; ass, 45 to 50 ; sheep, 70 to 80 ; dog, 100 to 120 ; rabbit, 140 to 150 ; pigeon, 150 ; man, 70. The rate at which the heart beats in man at the various periods of life is as follows :—Before birth, 140 to 150 per minute ; new-born child, 130 to 140 ; 1st year, 115 to 130 ; 2nd year, 100 to 115 ; 3rd year, 95 to 105 ; 7th to 14th year, 80 to 90 ; 14th to 21st year, 75 to 85 ; 21st to 60th year, 70 to 75 ; old age, 75 to 80. Posture affects the beating of the heart, which is slower when one is in bed than when one is sitting, and is quickened by walking, and even more so by running. Food and stimulants, and the period of the day, also affect the beating of the heart. The heart beats most rapidly between eleven and twelve o'clock forenoon, and it is slower in sleeping than in waking hours. The lecturer, proceeding to make some experiments, did so in this wise—"These frogs have had their spinal cord and brain destroyed. They are dead in the eye of the law—(laughter)—and they are dead as far as sensation or consciousness goes. This particular frog here has had its heart exposed, and I wish to show you the movements of the frog's heart as they take place in the body. For this purpose I shall take a very simple apparatus, the simplest possible. I have the frog stretched out upon a frog plate, a bit of cork and a bit of wood joined together, and here I shall take a straw lever, which I shall allow to rest on the heart. It consists simply of two straws, a bit of cork, and two pins ; that is the whole thing—(laughter)." The lever, to enable it all the better to be seen, was provided at the end furthest from the heart with what seemed to be a little piece of red coloured paper, that gave the lever at that point the appearance of the bow-string end of an arrow. The other end of the lever was transfixed with a pin. With the movements of the frog's heart, the lever steadily rose and fell, and the lecturer continued—"There is the frog's heart doing the work. It is perfectly obvious this frog's heart can beat very well within the body though the brain and spinal cord have been destroyed, showing that the brain and spinal cord are immaterial to the frog—(laughter)—so far as the actual rhythm of the beating of the heart is concerned. The fall and rise of the lever represents the beats. But the heart beats outside the body as well as inside it. I shall take this same heart and cut it out of the body of the frog and place it under a lever similar to that already shown; and we shall find it is equally immaterial whether the heart is in the body or out of it—(laughter)—that is to say it will beat as well outside as it does inside—(laughter). It is beating a little more slowly, I see. Well, of course, it is a little disturbed—(great laughter). Suppose I warm it to show the effect of fever. Suppose this frog were suffering from fever—(laughter)—I will heat the heart by burning a light under it. You observe that it now beats very much quicker. The heat generated in the body is one of the conditions which induce the faster action of the heart in fever. I will show you the beating of the frog's heart in a way which will be more obvious to you than with such a small lever as this. I have excised the heart, and will place it on a slide in front of the magic lantern here, and you ought to see a view of the heart projected on the screen on the opposite side of the platform." The heat of the room and of the lantern detrimentally affected the heart, and a new one was got, the movements of which were plainly visible on the screen. The lecturer touched the heart now and again with the result of quickening the movements. He continued—"The difficulty about these hearts is that they are a little refractory—(laughter). I will now cut the frog's heart into two, and we shall find probably that that is equally immaterial to it—(laughter). The two parts of the heart beat as well separated from each other as when together—in fact, even better"—(laughter). This experiment was very successful, and next one consisted of throwing a view of a bigger heart on the screen. The lecturer said—"Observe what a slow, sluggish fellow this is. It is the heart of a tortoise—(laughter). The tortoise has been hibernating for such a lengthened period that it takes a long time to get warmed up—(laughter). It is going on itself now. I see it only wants to get heated up"—(laughter). The experiments with excised hearts show, Professor Stirling remarked, that the heart contains within itself some arrangement whereby it can contract. It is provided with a number of nerve cells which evolve energy, and stimulate it to contract. But, while the heart contracts by itself when cut out of the body, it is capable of being influenced by the nervous system in a most remarkable way. Running from the neck down each side of the chest to the heart, there is a most important nerve, known as the vagus or wandering nerve. It gives off branches to the stomach and lungs as well as to the heart. Experiments upon animals have shown that when this nerve is divided into two off goes the heart nearly twice as fast as before. If, after the nerve is divided, a current of electricity is passed through the lower end of the nerve the heart comes to a standstill, but goes on again. The deduction from these facts is that the vagus is the inhibitory nerve of the heart. The heart would go far quicker in virtue of the ganglia or nerve cells placed in it were it not for the vagus keeping it in. In cases where the action is interfered with by drugs, and especially by belladonna, the heart is caused to beat very rapidly, the action of the vagus being taken off. In the vagus we have a nerve upon which we can place our fingers and say, "given a stimulus to that and the heart's action will be arrested, and if the stimulus be sufficiently strong the heart may be stopped for ever," although instances of that occurring are rare. The action of the vagus is purely involuntary, and it is well for us that it is so. There is only one case known where a man had control over the vagus, and he experimented once too often and died. Another nerve that goes to the heart is the sympathetic one, which is also of extreme importance. If that nerve is stimulated the heart goes so much quicker. The dividing of this nerve has no effect, but if the end in connection with the heart is stimulated the heart goes much faster than before. The vagus is often the cause of the arrest of the heart's action in a peculiar way. If one takes a frog, exposes its intestines and taps the intestines with the handle of a scalpel the heart will come to a standstill, and will continue arrested as long as the tapping continues. This is owing to the enormous number of nerves distributed through the intestines. When these are tapped at their terminations, impulses are sent up to the brain and thence pass down the vagus, bringing it into action. This is what is called reflex action. It can be seen, therefore, why a violent blow on the stomach so frequently causes death, though no organ is ruptured, and also why a blow from a cricket-ball is so often fatal. There is a vast net-work of nerve-fibres in connection with the heart; and, when these are stimulated, impulses are sent along which, if they are sufficiently strong, suddenly arrest the heart's action once and for ever. Excessive emotion may arrest the heart's action. If certain portions of the brain are thrown into an excitable state, so as to give rise to those conditions which we know as emotions and the impulses go down to the region of the vagus, the heart will go quicker or slower according as the vagus action increases or diminishes. There are such things as fatal joy and fatal grief. Sophocles is said to have died at a very old age from fatal joy. The action of his heart seems to have been arrested in the reflex way. Philip V. of Spain died suddenly from grief at hearing that the Spanish soldiers were defeated, but in his case the heart was previously diseased, and death was due to rupture. The effect of depressing emotions is well depicted by Shakespeare in regard to the stabbing of Cæsar. Cæsar is not killed by the dagger of the assassin, but by the thought of the ingratitude of the person who stabbed him, this emotion being supposed to take effect in death before the stabs did. Antony says :—

> This was the most unkindest cut of all :
> For when the noble Cæsar saw him stab,
> Ingratitude, more strong than traitors' arms,
> Quite vanquish'd him : then burst his mighty heart ;
> And in his mantle muffling up his face,
> Even at the base of Pompey's statue,
> Which all the while ran blood, great Cæsar fell.

The condition of broken-heartedness is brought on by various affections of the nervous system, which result in the degeneration of the substances of the heart. Another poetic illustration by Shakespeare of the effect of the emotions on the heart is given in what Malcolm says to Macduff when the latter is horror-struck at hearing of the murder of his wife and children :—

> Merciful heaven !
> Give sorrow words : the grief that does not speak
> Whispers the o'er fraught heart, and bids it break.

Shakespeare supposed that the heart is actually broken through the pressure of the emotions, while it is really another change that takes place. Nightmare is generally due to the heart being temporarily arrested by the action of the vagus being brought into play through irritation in the stomach or elsewhere, which sends impulses up the spinal cord, and thence to the vagus. A person fainting—it is more frequently she than he—(laughter)—may be found swaying to and fro. The blood has been so far cut off from the brain and the person's ideas of his or her relation to space have become modified. The face grows rapidly pale, no blood passing to the face and little to the brain, the movement of the pulse is arrested, the heart stops, and respiration is greatly interfered with or nearly entirely arrested, and consciousness is abolished. Fainting may be caused by a disgusting or disagreeable sight or smell and also by great pain. Impulses in such ways arise which are conducted through the eye, or it may be through the nose or mouth—(laughter)—up to the upper part of the spinal cord, and then influence the vagus nerve with the result that the vagus action comes into play. When a person falls over in a faint the first thing to be done is, obviously, to restore consciousness. To prop the person up on a sofa or chair is to take the best possible way of not letting the blood get to the brain. What should be done is to keep the head lowest. It does not matter who or what the person is—(great laughter)—down with the head, and keep it down, as by this means the return of the blood to the brain is favoured. Then plenty of fresh air should be allowed to the person who has fainted. When a person faints it is usual for other people to crowd round. Make these people stand back, so that the person who has fainted may have plenty of the fresh air, and very soon consciousness will be found to return. If consciousness does not speedily return, however, a few drops of cold water poured from a height will exercise an enormous effect in inducing respiration and the rapid return of consciousness. It is easy by means of the water to know whether the faint is genuine or not, especially if there is a complicated or gorgeous piece of dress in question—(laughter). The lecturer said he was glad to read the speech which Dr Farquharson, M.P., made the other day on ambulance work when presenting certificates to policemen in connection with St John's Ambulance. The Professor was not sure but it would be an extremely good thing to have our policemen instructed in the more elementary rules regarding the treatment of injuries, and as to what to do in cases of fainting and so on—(applause). The thing that it is found to be possible to do in London ought to be done here and elsewhere, where policemen might under certain conditions easily save the lives of persons, who otherwise would die, if they only knew what to do when a certain artery was torn, and so on. In mining districts, especially in Wales, where accidents are continually occurring, many of our medical students teach ambulance drill to the miners, to whom it is of the greatest advantage, as it cannot fail to be also in the case of men engaged in the public service, as policemen are—(applause). In Paris one can always, by night and by day, find succour for the injured. There are men placed all over the city who are at all times ready to give assistance to people who have fallen into the river, or who have met with accident. It would be an excellent thing if our police were instructed so as to be able to give service in this way. Most policemen, however, are intelligent persons—(laughter). Death in cases of swimming, which it satisfies people to learn has resulted from cramp—a pain in the muscles of the leg which renders the leg perfectly rigid and sore—is often really due to the vagus action being brought into play through swimming after taking a large meal. The blood-vessels are in that case readily congested, and impulses are generated in the stomach, which are so powerful—an enormous area of the skin being, of course, stimulated by the cold water—as to induce the vagus action, and then the heart's action is arrested, it may be only temporarily, and the person sinks in the water and is drowned. Similarily, when gases accumulate in the stomach they very quickly give rise to the arrest of the heart's action, or, at any rate, to a modification of it, resulting in palpitation.

The lecture was illustrated by numerous diagrams, and by a number of experiments in addition to those enumerated, and a variety of animals' hearts.

Lecture VII.

THE CIRCULATION OF THE BLOOD.

From " Daily Free Press," *Feb.* 27, 1882.

Professor Stirling delivered, in continuation of his series of Combe lectures, in St Katharine's Hall, on Saturday night, a lecture on "The Circulation of the Blood." The hall was crowded to the door with a most intelligent and appreciative audience. The lecturer was aided by a number of diagrams of the human body and pictures, projected by means of a magic lantern on a screen, representing the system of blood circulation. After describing the blue or superficial veins, all conducting to and conveying towards the heart as a centre of life, he referred to the diseases to which veins are liable, such as varicose veins, which are most common in washerwomen and policemen through their remaining long in an erect position. He explained the difference between arterial or pure blood and venous or impure blood, the one being a bright red and the other a dark crimson, and their nature and uses, and quoted some passages from Shakepeare to show, in the light of physiological discoveries of later times, that the great dramatist's theory was that of ebb and flow, and not that of circulation, demonstrated by Harvey. The lecturer then shewed by some beautiful experiments the muscular structure of the arteries and the comparatively simple structure of the capillaries, and how in the veins the circulation is slower, and the pressure less than in the arteries, and the use of the valves in aid ing the circulation in the veins. The valves, he explained, were chiefly useful in the longer veins, such as those of the leg, in relieving the pressure upon them. By means of a mechanical model Professor Stirling exhibited the working of the valves. By another ingenious arrangement he demonstrated how the stream of blood flowing as from a pump so many times in a minute and causing the pulse, becomes uniform in the capillaries, and proving by the use of india-rubber tubing that the change from the interrupted to the regular flow is a purely physical problem. By another simple but ingenious contrivance he exhibited the beating of his pulse in the radial artery by its action upon a jet of gas. Professor Stirling then explained the effect of the circulation of the blood on the nervous system by keeping the blood vessels in a state of semi-contraction, and thereby only admitting a certain amount of blood. He showed the effect of dividing the sympathetic nerve in the neck of a rabbit in its growing state, which was to make the one ear grow longer than the other, owing to more blood being supplied to it than to the other. In describing the physiology of blushing, he showed how it is produced under the influence of various emotions which take place in the brain, and how it could be produced otherwise than involuntarily by means of nitrite of amyl, used for pine-apple flavouring, which paralyses the action of the sympathetic nerves, and accelerates the action of the heart. The act of involuntary blushing has nothing to do with the heart. It is, according to Darwin, of all the expressions the most human. Some monkeys grow red in the face, but that is through anger, and not as an involuntary act of blushing. On the subject of blood-letting, Professor Stirling gave some interesting and amusing facts. The barber's pole, he explained, with its pendant plate, was a symbol of the blood-letting which in former times was done by the members of that craft, who united chirurgery with hair-cutting—the white and red stripes on the pole representing the white bandage put round the limb to be operated on and the blood, while the plate was for receiving the blood. The lecture, which was interspersed with apt literary allusions, was most interesting and lucid, and was made plain to the commonest understanding by the ample equipment of diagrams and mechanical arrangements with which it was illustrated. The next lecture will be on "Respiration."

Lecture VIII.

RESPIRATION AND VENTILATION.

From "Daily Free Press" of *March* 6, 1882.

This season's series of Combe Lectures on "Physiology" was brought to a close on Saturday night. The lecture of that evening, like the seven that had preceded it, attracted an audience that filled St Katharine's Hall in every part. It was listened to with close attention, and the excellent experiments which accompanied it were watched with the keenest interest. A feature of the proceedings was the announcement by Professor Stirling of the result (as given in a local paragraph) of the written examination on the subjects treated of in the first seven lectures. Amongst those who were present were Lord Provost Esslemont, Mr J. F. White, Mr John Miller, Sandilands; Mr James Tulloch, jun.; Mr A. S. Cook, and Mr Lindsay.

Professor Stirling said that certain useless substances, such as carbonic acid and urea which the blood receives in return for the constituents it gives up to the tissues in circulating through them, require to be excreted or got rid of by several organs—viz., the lungs, skin, and kidneys, and partly also by the liver, the kidneys throwing off a large quantity of water and urea, the liver other substances, and the skin a great quantity of fluid known as perspiration, which is secreted in numerous tubes, and small, minute traces of other substances. The lungs lie in the chest, one on each side, above the diaphragm, and between them is the heart. The windpipe leads from the nostrils right to the back of the throat, and passing down comes in at the upper aperture in the chest, and subsequently it divides into two branches, the one for the right and the other for the left lung. The tubes go on dividing in two until they are no larger than the 50th part of an inch, and can only with difficulty be seen by the naked eye. They are called the bronchial tubes, and they terminate in the air cells or air vesicles of the lungs. The repeated division of the bronchial tubes and their ultimate termination in the air vesicles, of which there are some five or six millions in a lung, enormously increase the surface over which the air has to be distributed. A person should not breathe by the mouth, which is the aperture to the gullet that lies behind, but by the nose, which is the proper entrance to the windpipe. The air passes or ought to pass in through the nostrils and then goes in a peculiar way down into the lungs. With breathing through the mouth the mouth soon becomes very dry, but worse than that, cold air is sent to the lungs, which it ought not to be. It is very different when the breathing is through the nostrils. The nose is provided with a great number of complicated and beautifully curved bones, over which there flows a large quantity of blood. That blood, of course, is warm, and so when the air passes in through the nostrils it proceeds over a hot chamber in a furnace, as it were, and is heated up to the temperature of the body before it reaches the chest. The practice of wearing respirators over the mouth is a most absurd one. People would derive just as much good from not wearing as from wearing them—(laughter). The only possible advantage that the lecturer said he could see in respirators is that they may cause people to keep their mouths shut and breathe through their nostrils—(laughter)—they do not improve the air one way or another—(applause). The lungs are light spongy articles, and are readily inflated when air is blown into them. In animals that do not live in cities the lungs are usually of a rosy pink colour, but if the lungs of a dog or, better still, of a man living in a city, where there is a large quantity of soot in the air, are examined, it will be found that they are more or less pigmented. The blackened appearance is due to the particles of soot that are taken in in breathing and deposited in the lungs. In the lung of a miner there is invariably plenty of black material to be found, so much so that this kind of lung is known characteristically as a miner's lung. The windpipe is elastic, as is required in view of the lengthening of the neck, and in front is provided with a series of rings, which are masses of gristle, all bound together by membrane, and which keep the windpipe open, so that there is a ready entrance and egress for the air that has to pass in and out of the lungs. Behind, however, the windpipe is perfectly soft, and is filled up with membrane. There is good reason for this. Behind, in contact with the lungs, there is the gullet, and but for the circumstance that the windpipe at the part mentioned "gives" so far and a certain action is obtained forwards, large pieces of food could not be swallowed. At the upper part of the windpipe is placed the larynx or voice box, where voice is produced. The windpipe is lined with a very beautiful red membrane, which is perfectly smooth and glancing. This mucus membrane, which is continued from the nose downwards, and certain elements of which pass into the finest ramifications of the bronchial tubes, is covered by thousands upon thousands of pretty microscopic cells, covered with cilia or small microscopic vibratile bristles or hairs. The bristles all move in a definite fashion; they wave to and fro, and more rapidly and energetically in one direction than in another. The consequence is that there is a movement of the cilia, and everything that rests upon the cilia is carried forward. On awakening in the morning, if one has a cold, the first thing he does is to cough up some mucus from the back of the throat. The mucus has been carried out of the bronchial tubes while the person was asleep by the action of the cilia, which are continually moving at a certain definite rate, and in such a way as to carry the mucus in the bronchial tubes from within outwards. The glands in our bronchial tubes and windpipe are always forming fluid, and but for the cilia there would be no possible means of giving out this material. This is why bronchitis, which is especially deadly in the case of children—is so fatal a disease, for the essence of bronchitis is simply this—that the mucous membrane becomes inflamed, the cilia are thrown off, and then, as there is little or nothing to carry the mucus away from the lungs, the mucus accumulates, causing death very quickly when a certain stage of accummulation is reached. Outside the thin microscopic membrane of the air vesicles is a delicate network of capillaries, and the blood, coming in impure at one side, passes through this network over the air vesicles, goes away at the other side as pure blood, and is returned by the pulmonary veins to the heart, to be pumped through the body again. The function of respiration is just so to bring the air in relation with the blood that the thinnest possible partition will separate the blood from the air and allow the gases which are present in the blood to exchange with the gases that have been brought in by the air. The outer surface of the lungs is covered with a beautiful, glossy, and smooth membrane, far more delicate than any skin, and so arranged that the lungs cannot collapse in the chest till a hole is made in it; and it is the inflammation of this that gives rise to pleurisy. A description of the chest was furnished by the Professor, and it was pointed out that the midriff or diaphragm, which is arched on two sides and comparatively flat elsewhere, and has a bluish tendon or sinew in the centre and muscle ranged round about the sides, has a far greater function to perform than merely to separate the chest from the belly. It is a great inspiratory muscle. When it contracts or descends, the chest is enlarged from above downwards and is raised, and the pressure within the chest being thus diminished, the air is sucked in and goes right forward to the lungs. The chest being air-tight in every possible direction, the air can only come in by the windpipe. Expiration or breathing out takes place in virtue of the elasticity of the ribs and the weight of the chest. The chest has been raised by the muscles, and when these cease to act, the chest comes down, and the air is expelled. The rate of respiration varies according to age and sex, and, like the beating of the heart,is influenced by different other conditions, being increased, for example, by muscular exercise. A child breathes more quickly than a grown up person. In the case of adults, the chest generally rises and falls 17 times per minute, and each inspiration and expiration constitutes a respiration. The breathing of a woman is of a different type from the breathing of a man. Women breathe more by the upper part of the chest than men do. If one (to use the lecturer's phrase) watches the bosom of a woman, he will find that it naturally heaves to a much greater extent than the chest of a man, and a man breathes relatively more by the diaphragm than a woman does. The quantity of air taken in with each respiration is about 20, sometimes nearer 30 cubic inches. Whatever effort may be made towards that end, the lungs cannot possibly be emptied of air; a large quantity of air will remain in them despite every effort to exhaust them. The air before it gets to the residual air in the lungs must necessarily be mixed with air that is imperfectly pure, and there is therefore all the greater reason for breathing air that is perfectly pure—(applause). Air is a mere mechanical mixture of various gases. In pure air there is about 21 per cent. of oxygen and about 79 per cent. of nitrogen—the proportions being something near 1 to 4—minute traces of watery vapour, carbonic acid, and ozone. Oxygen is the essential and important substance. It is taken into the lungs and passes into the blood corpuscles. These corpuscles have a red pigment in them which has a great avidity for oxygen, and uses it up with great avidity whenever it gets the chance. The corpuscles carry the oxygen to the tissues, where it is used up. Oxygen is the life-giver; it is the substance which, when it unites with our tissues, forms various compounds, and gives rise to heat and energy. We can only keep up heat and energy by taking in plenty of oxygen. Oxygen supports flame or light to a very great extent. Nitrogen has not this power. It is a neutral gas, and is in the air to dilute oxygen. If we were to breathe pure oxygen our tissues would go on burning, and oxidize very quickly. Nitrogen prevents this. It is to oxygen what water is to brandy—(laughter). Carbonic acid exists in the air in extremely small quantity, and does not support combustion at all. It is so heavy that it can be poured from one vessel into another. When present in greatly undue quantity, as it often happens to be in certain wells and in brewers' vats, it rapidly extinguishes life. In respiration oxygen is diminished from four to five per cent., nitrogen is practically unchanged, and carbonic acid is increased by about as much as the oxygen is decreased—from ·04 to 4 per cent. In addition the air is saturated with watery vapour and is heated, as one finds if he breathes on his hand. By sulphuric acid or Condy's fluid it can be ascertained whether or not there is organic matter in the air. The acid blackens the matter, and Condy's fluid oxidizes it. The fluid, which is purple in colour, on being put into a glass, the water in which contains pure air, simply colours the water purple, but when it is put into a glass in which there is water containing air with organic matter it gives rise to a dirty yellow colour. Eight ounces of carbon and a quantity of water about nine ounces in weight are thrown off daily by the lungs. In breathing impure air, one is breathing a large quantity of carbonic acid and organic matter. Organic matter is the specially deleterious substance. Carbonic acid may arise to a considerable extent without being actually poisonous, but when it is mixed with organic material it becomes exceedingly poisonous. This is why overcrowding in towns is so dangerous, leading, as it does, to an accumulation of the emanations of humanity that brings in its train a number of diseases of which typhus and consumption are the two most remarkable. Where there is plenty of fresh air sweeping through the rooms or overcrowded buildings so as to take away the emanations of humanity, the death-rate as regards consumptions does not rise so very greatly; it is when there is such overcrowding that a sufficient amount of pure air is not admitted to carry away the impure matter given off from the lungs that the direst mischief is done. The well-known case of "The Black Hole of Calcutta" and what happened in the ship Londonderry give strongest proof of the fearful effects of breathing vitiated air. It is astonishing how great is the tolerance for bad air. People who are accustomed to breathe bad air and do not know what good air is—(laughter)—are very well satisfied with the bad air, but people who breathe good air and then go where the air is bad at once realise the difference. It is rather astonishing than otherwise that the people who in the back slums of our cities acquire a tolerance for bad air contrive to live at all in view of what is disclosed by experiments such as that which was made by Claude Bernard, the famous French physiologist. Bernard put a bird under a bell-jar, where it lived quite comfortably for a considerable time after the air became vitiated. A second bird, a sparrow, was then placed under the vessel. It died in a few minutes, owing to the lack of fresh air, but the other bird lived on for another hour or two. The first bird had become acclimatised; its tissues and other arrangements had come to be so adjusted that it could live with a modicum of oxygen. On the subject of ventilation, Professor Stirling said he found he had not time to enter, but he detailed a simple plan for ascertaining whether the air is pure or not. That plan is to take a bottle of about from 10 to 12 ounces in weight, and place a towel in it so as to fill it completely. After a time the towel should be pulled out, and then the air of the room will rush in and take its place. Half an ounce or so of lime water should now be poured down the side of the vessel, a glass stopper put in the bottle, and the bottle shaken vigorously. If the water becomes turbid and white it proves that the carbonic acid is above ·06 per cent., and that the air is therefore not sufficiently good for breathing. Testing the air of the hall in this way, the lecturer declared that it was certainly under the standard. There ought to be better ventilation in the hall—(applause)—for even with Tobin's system the ventilation was not what it should be, though it was better that evening than it had been on the occasion of several of the previous lectures. Proceeding, Professor Stirling said the end had now been reached of what was rather a long story—("No, no"). Before concluding, he intimated the result of the written examination that had taken place in regard to the first seven lectures, and he then remarked as to the lectures themselves, that it had been to him a great source of pleasure to deliver them. He thought the Combe trustees had done wisely and rightly in instituting lectures of the kind—(applause). They were taking the proper and most effectual plan for carrying out the object in view in arranging, not for disjointed lectures having no connection one with another, but for lectures, each course of which should be delivered by one man—(applause). The public were much more likely to be benefited, were much more likely to acquire a knowledge of some of the fundamental facts of science as applied to health through regular and steady attendance at a systematic course of lectures than through attendance at mere sporadic lectures, or by attending here one thing and there another—(applause). He was sure that a great number of those present, and particularly many of the working men, owed a great debt of gratitude to his colleague, Professor Struthers—(applause)—for having winter after winter laboriously and steadily given numerous lectures on anomatical, and partly also on physiological subjects—(applause). Professor Struthers had the merit of having largely cultivated the taste or stimulated the appetite of many of the inhabitants of Aberdeen in quest of science, and the lectures he had delivered had no doubt been of great value to a great number of those present in enabling them to understand many of the principles of physiology—(applause). All through the course of lectures which now ended it had been his steady aim to trench as little as possible on the province of the anatomist or chemist, and that was why the anatomical details he had given were so meagre. He had deemed it right to stick to the subject in hand, the subject of physiology. and to keep himself from wandering into cognate fields, however interesting they might be—(prolonged applause)

The lecture was admirably illustrated by diagrams. The respiration of a fish was shown by the projection on to a screen by a magic lantern of the figure of a fish swimming in water in a glass vessel, and it was explained that in the gills of fish there are a lot of blood vessels where the blood is exposed to the action of oxygen, the gills in this way performing physiologically exactly the same action that our lungs do for us. The movements of cilia were also demonstrated by means of the magic lantern. The experiments with the different gases were excellent. A lighted candle put into a jar of oxygen burned much more brightly than before. A piece of phosphorus which burned beautifully in common air increased in brilliancy of flame when placed in the jar, and a like result followed the depositing in the jar of a piece of lighted charcoal. A lighted candle was afterwards plunged into a jar full of nitrogen, and it went out at once, and on being relit and put amongst carbonic acid, which was easily poured from one jar into another, it was again extinguished. A flame from a gas jet, and the flame of a candle were done for by a jar of carbonic acid being held head downwards over them. If carbonic acid, said the lecturer, won't support combustion outside the body how can one expect it to support combustion inside the body ?—(applause.) Others of the experiments had reference to the increase of carbonic acid that takes place in the air in respiration. A candle would not burn in air thus rendered impure, and how, the lecturer asked, could it be expected that human beings could survive in air in which carbonic acid had been breathed over and over again —(applause).

Mr J. F. White, who came forward amid great applause, moved a very hearty vote of thanks to Professor Stirling for the admirable course of lectures which he had delivered—(applause). The large attendance at each lecture, and the constant and steady attention given proved that Professor Stirling had been in the highest degree successful in enlisting the interest of the public—(applause). This was not to be wondered at, considering the pains the professor had taken to illustrate his very clear and singularly brilliant lectures—(loud applause). The lecturer had done much in enforcing the laws of health, bringing them before his audiences by every means in his power—by reference to the skeleton and to the numerous diagrams that had always covered the walls, as well as by the specimens of parts from the lower animals which he had had on the table on each occasion, and still more remarkably, possibly, by the very choice and admirably managed series of experiments that he had conducted—(applause). In all these ways Professor Stirling had succeeded in bringing before his audiences what he believed they might call knowledge acquired—(applause). Rightly starting on the basis of the ignorance of his audiences as to the parts of the body, he had introduced them to a knowledge of the different parts of the body, and had then proceeded to illustrate the laws of health. These laws had been enforced in a way which he hoped would carry conviction to them all that there were many of the arrangements of their everyday life which really required to be carefully reconsidered—(loud applause). From the proper functions of the body the Professor had shown how in many cases evils arose from neglect, from ignorance, and perhaps most powerfully of all from the terrible tyranny of fashion—(laughter and applause). He was very sure that it was not Professor Stirling's fault if any of them after that time went on making their waists smaller than they were—(laughter and applause)—or artificially distorted their feet by wearing high heels under their insteps—(laughter and applause). Then, further, Professor Stirling had very wisely and properly pointed out a variety of ways in which the laws of health might be brought before people in many of the relations of everyday life. He had been much struck by what the Professor had said with reference to the evil that might be prevented if those more immediately at hand were able to take the proper and necessary steps in cases of accident. He suggested that Professor Stirling—and he was sure it would not give him much trouble—should draw up in reference to accidents a chart of rules that ought to be followed in something like the same form as the rules that were exhibited at bathing stations in regard to the restoration to life of people who were half-drowned. Such a chart printed and hung up in every workshop and factory would be extremely useful—(applause). In addition to scientific knowledge, Professor Stirling had given ample illustrations from Shakespeare. He seemed to know Shakespeare as well as he knew the bones of the skeleton—(applause). It was extremely pleasant to find from illustrations given from Shakespeare that Professor Stirling was able to show how their great dramatist, from his knowledge of science, as it existed in his day, was enabled to pourtray the passions and emotions of the heart—(applause). In treating the subject in this way, Professor Stirling had raised it from what might be called a strictly professional point of view, and taken it into a wider and higher area, giving listeners thus a means of acquiring a greater charm from reading their great authors—(applause). In addition to the vote of thanks to Professor Stirling, which was enthusiastically accorded, Mr White moved a vote of thanks to the Combe Trustees, whose selection of Professor Stirling he described as most fortunate—(applause). He hoped that the public of Aberdeen would be favoured at no distant date with a continuation of the series of Combe lectures now concluded—(applause). They all recognised the great work the Combe Trustees were doing—(applause).

Professor Stirling appropriately acknowledged the vote of thanks accorded to him. He expressed himself willing to act on the suggestion made by Mr White as to a chart of rules for the treatment of accidents, and he said he was glad that as an outcome, probably, of the lectures, ambulance lectures for the police had been started in Aberdeen—(applause). That augured well for the police themselves, and also for their clients, or whatever they might be called—(laughter and applause). He had had a letter from a gentleman who was a superintendent at the railway urging that similar ambulance lectures should be given to railway servants—(applause). The suggestion was well worth considering, and if ambulance lectures could be given to the police and railway servants together there was no reason why they should not so be given—(applause). In cases of railway accidents it would be of great benefit if railway servants could treat the injured properly—(applause).

On the motion of Professor Stirling, votes of thanks were subsequently given to Mr Miller, Sandilands, for presiding at the first lecture, and to Mr A. S. Cook for his exertions as secretary of the Lecture Committee.

For the compliments paid to himself and Mr Cook Mr Miller returned thanks, and dwelt on the work being carried on by the Combe Trustees and George Combe's desire to have the public acquainted with those physiological rules to which he paid such strict attention himself. He also praised Professor Stirling's lectures, and concluded by moving a vote of thanks to Mr J. F. White—(applause).

This having been given, the meeting ended.