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Human Physiology

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Professor John Tyndall writes of his work: "I can not help thinking that this discovery of magneto-electricity is the greatest experimental result ever obtained." We must remind the reader, however, that in the discovery of magneto-electricity the name of Faraday should be accompanied by that of Joseph Henry.

In 1837 Joseph Henry was in Great Britain and became personally acquainted with England's great physicists, Faraday, Wheatstone, and Daniell.

John Frederic Daniell invented his cell in 1836 which grew out of his contact with Faraday and which he described in a letter to Faraday. In the original cell the concentrated copper sulphate solution and dilute sulphuric acid were separated from each other by an animal membrane—the windpipe of an ox.

Reference has already been made to Benjamin Franklin. He founded in Philadelphia the American Philosophical Society, which has continued until the present time. Although Franklin never met Count Rumford either in America or in France, he had acquaintance with Madame Lavoisier (while her first husband was still living) as is shown in Sparks' Franklin, Volume X, pages 361-2, as quoted in the Life of Count Rumford by George E. Ellis.

The final scientist in this group is Professor John Tyndall who was born in Ireland in 1820 and lived in England after his twenty-first year. At one time he studied chemistry under Bunsen. After a year in Berlin he delivered a lecture at the Royal Institution in 1853, concerning which it is stated that "it took his audience by storm." He was elected professor of natural philosophy in the institution and there he carried on his researches which were in the domain of heat. "He possessed extraordinary powers of popularizing difficult subjects, especially through his books, such as **Heat as a Mode of Motion.**"

In concluding this short and imperfect sketch of the lives and work of Count Rumford, Benjamin Franklin, Joseph Henry, Michael Faraday, Samuel Langley, Thomas Young, Sir Humphrey Davy, and John Tyndall, our labor will be lost if it does not suggest a few points of interest for classes or science clubs. What may be done in physical science may be repeated in any of the other sciences by a study of the publications of the Smithsonian Institution.

The following works have furnished most of the foregoing information: **Encyclopedia Brittanica, Publications of the Smithsonian Institution, Cajori's History of Physics.** S. F. Hersey.

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HUMAN Physiology

As a small boy I recall sitting near the front of the room in a rural school with my legs swinging vigorously several inches from the floor, and listening while a large group of older boys and girls attempted to recite the names of the bones of the body as well as many other parts. The class appealed to me principally because it seemed to give great pain to the participants, and because it was still a long way off so far as I was concerned. With much less glee do I recall the time a few years later when I was promoted to the class in which I also was supposed to learn physiology.

In retrospect I can perceive that physiology was probably the correct term, because by no stretch of the imagination could it be called human physiology inasmuch as it was lacking entirely in the human element. We would have welcomed an opportunity to learn something about ourselves—what made the wheels go around inside us, or whatever it was that happened, but nothing like that was suggested. We began by learning the names of the bones. We had no conception of what they really looked like or how they were put together. The rest of the course was much the same. Not once was there a comparison of the subject matter with our own bodies.

Later, while attending high school, I elected to try my luck at physiology again. The results were much the same as before. The course resulted in the acquisition of a few more names and a hazy conception of a few more physiological processes.

I still was not satisfied that physiology needed to be a dry formal subject, and subsequent observation has taught me that when it is such the teacher is usually at fault. Teachers, of course, may rise up in protest and say that they cannot conduct laboratory work because of a lack of physiological equipment. It is undoubtedly true that good equipment is a distinct aid, but it is not true that a course in physiology needs to lack in practical illustrations even when little equipment is available. There is no intent to imply that physiology in the high schools of the state is as poorly taught as it was when I was exposed to it. The following suggestions are offered merely in the hope that they may slightly increase the teacher's stock in trade of practical physiological illustrations and make the study of physiology really human.

In order to understand the mechanics of digestion first ask the members of the class to hold the tongue between the teeth and attempt to swallow. The attempt will show the importance and the action of the tongue in swallowing. With the finger placed on the front of the hyoid bone on the front of the ''adams apple'' repeat the act of swallowing. The lifting of this bone during this act may lead to a better understanding of the arrangement of the muscles of the throat and how the act of swallowing is accomplished. If a stethoscope is available, it is interesting to listen to the opening of the cardiac valve as food passes from the esophagus into the stomach, and to compute the time of its passage. If water is swallowed it can be heard to precede the peristaltic wave along the esophagus and strike the cardiac valve. When the peristaltic wave has reached the stomach the valve will open and allow the water to pass thru. Much the same phenomena can be observed by pressing the ear close to the region at the bottom of the esophagus.

It will probably be of some aid if the foregoing suggestions are accompanied by a discussion of the other means of studying the act of swallowing, such as the hunger balloon by means of which the peristaltic waves can be traced on the smoked drum of the kymograph, or the use of the x-ray with the drinking of liquids containing barium sulphate, or the eating of foods containing bismuth.

We hear much of the churning action which takes place in the stomach. Students sometimes think that the stomach must turn flip flops in order to mix the food thoroughly. A simple way to illustrate the peristaltic waves which do the mixing in the stomach as well as serving to carry food thru the intestines, is to place a marble in a rubber tube which is slightly smaller in diameter than the marble. By squeezing the tube back of the marble and forcing it along the tube, we have a creditable illustration of a bolus of food being carried along by a peristaltic wave. Again this should be accompanied by a discussion of the use of the hunger balloon and the bismuth meal as a means of studying the action of the stomach.

Probably the best way to illustrate the mechanical action of the stomach and intestines is to make use of some animal such as a rabbit or guinea pig. The writer has caught ordinary cotton tails and used them for this demonstration. They may be put under the influence of ether or killed by turning gas into the container. An incision along the abdominal wall will expose the viscera in the abdominal cavity, and if this is done shortly after a meal all the types of intestinal movement can be plainly seen. This will include peristaltic rushes, segmentation, and rythmic swaying of the intestines, as well as the peristaltic movement in the lower end of the stomach.

Another interesting experiment that requires almost no equipment is to test the rate of absorption and elimination of potassium iodide from the body. Secure a few four-grain capsules of potassium iodide and have selected members of the class each swallow one. Prepare a series of test tubes containing very thin starch paste and a few drops of nitric acid. A few minutes after swallowing the capsules the mouth should be rinsed with water and a few cubic centimeters of saliva collected and added to the first tube of starch paste. Continue doing this every two minutes until the blue color which developes indicates the presence of iodine in the saliva. This may occur in anywhere from four to twenty minutes. Now a discussion of the path followed by the iodine and the processes thru which it went will give a good insight into the processes of absorption and circulation of food.

The action of the enzymes in digestion is also easily illustrated. By putting a small amount of starch paste into some saliva in a test tube and allowing a few minutes for incubation, a test for sugar with Fehling's solution will soon show that starch is turned into sugar. Mixtures may be made and kept at different temperatures to show the most desirable temperature for enzyme action. This might be followed by a study of the effects of yeast etc. to show the presence of enzymes outside of the body. With a teaspoon the secretion from the parotid gland may be collected and tested for its action as compared with the action of the submaxillary and sublingual glands. A simple way to collect the latter is to rinse the mouth with water and then put pieces of gauze between the cheeks and the upper teeth to stop the flow from the parotid gland. The saliva thus collected will be from the other glands and will not contain digestive enzymes.

These are simple demonstrations but may well lead to a discussion of how the important facts regarding the mechanics and chemistry of digestion have been discovered. A person who has carefully observed a simple digestive tract will not have much difficulty in understanding the formation of a ''Pavlof pouch'' or an intestinal fistula as a means of studying the chemistry of digestion.

Other systems can be as simply demonstrated as the digestive. A look thru the web of a frog's foot with an ordinary microscope is worth more to a student as a basis for the understanding of the circulation of the blood than several hours spent in reading and discussion. The action of the autonomic system in regulating the rate of heart beat and breathing can be beautifully illustrated by breathing thru a long tube, in which case the accumulated carbon dioxide in the body will soon cause a marked increase in heart action. The mechanical action of the lungs can be illustrated nicely by means of an ordinary rubber balloon. Cut the bottom from a bottle and cover it with a piece of rubber dam. Now insert a glass tube into the mouth of the balloon, and tie securely. Also insert the tube into a cork with a hole bored thru it. Place the balloon inside the bottle, and press the cork down so that the bottle shall be tightly stopped. By stretching out the rubber dam, which closely resembles the diaphragm, the pressure in the bottle is reduced and the balloon will be caused to expand. On letting go of the rubber dam the balloon will contract again. If a rat is available, its lungs can be used in the same way to form an even better illustration.

Space does not permit a further discussion, but the simple devices for illustrating the principles of human physiology are almost endless. Most important of all, probably, is the making of the students feel that they are studying about themselves, and that in so doing they are studying a mechanism the like of which man has never been able to invent. If they have gained this impression they have undoubtedly been studying *human* physiology.

H. Earl Rath.