THE PHYSIOLOGICAL LABORATORY OF MCGILL UNIVERSITY, MONTREAL.

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With a Note by WESLEY MILLS, M.A., M.D.,
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THE present is a time of transition in the teaching of practical physiology. There is no settled standard of what should be expected of a medical student in this subject. It seems well, therefore, for those who have reached even a very temporary halting place to state their position, so that others may derive benefit from their experience, or assist them by friendly criticism. Even those who are not devoting their time especially to physiology, but who are daily using it in the practice, or perchance the teaching, of medicine, can help us in the solution of some of our problems if they will give expression to their views.

The opportunity of taking a forward step was afforded us at McGill two years ago by the erection of a large addition to our medical building through the munificence of Lord Strathcona and Mount Royal. At about the same time the Faculty of Medicine authorized the Professor of Physiology to spend between three and four thousand dollars on new apparatus. Advantage was taken of this combination of circumstances to reorganize the whole department. In the present account, however, it is intended to dwell especially on the provisions that have been made for students' practical work.

Laboratory Accommodation.

The main students' laboratory is a well-lighted room, 60 by 40 ft. in size. It is arranged for both experimental and chemical physiology, and can accommodate 80 students at a time.

The smaller rooms, seven in number, consist of a library, workshop, preparation room, and research laboratories. In connexion with the department, there is also a lecture theatre with a seating capacity for 250.

Furniture of the Students' Laboratory.

The students' laboratory (Fig. 1) contains ten working tables, with ample space between. Each table is arranged for eight students in four working couples. The tables are 40 ft. long by 6 ft. wide; the centre of each is occupied by four glass cupboards with disappearing doors. The cupboards are supplied with locks, and are used to store the apparatus needed for experimental physiology. Extending from these cupboards to the ends of the tables are stout wooden shelves supported on an ornamental framework. These shelves may be lifted upon the tops of the cupboards if extra space is needed, or may be taken down and used to rest bottles on during the course in physiological chemistry. When the shelves are in place each pair of students has a working space on the table 5 ft. long by 2 ft. deep. Underneath the tables are cupboards for storing the glassware, tripods, etc., used in physiological chemistry. At each end there is a good-sized porcelain sink with water tap.

Around the walls of the laboratory there are numerous addi-

tional cupboards for reserve apparatus, three draft cupboards, a switchboard, and a galvanometer, of which the last two items require special description.

The Switchboard and Electric Wiring.

Such a variety of electric currents are required for physiological work that it was thought well to supply some of them from a central source. This idea has been carried out at Jefferson Hospital Medical School, Philadelphia, but our arrangements are entirely different in their details from those adopted there. We have each student's cupboard supplied with a pair of binding screws which are connected by wires with a switchboard near the demonstrator's table. The switchboard is contained in a cupboard, and a photograph of it is shown in Fig. 2. The wires marked with a white cross lead down under the floor, and are carried all around the laboratory. From them side wires are given off to the binding posts in each cupboard.

By closing the various keys shown in Fig. 2 a considerable variety of currents may be distributed to the students. If the keys A and B are closed, connexion is made through the two wires passing down from B, with a battery of six large-sized Edison-Lalande cells. These have a capacity of 300 ampere hours. We usually have them arranged to give a 2-volt

current at low internal resistance. This current does very well for supplying the students' inductoriums for stimulating purposes. If the key A be opened and B be kept closed, the 2-volt current has to pass through a clock with an electric contact which makes and breaks the circuit every second. The clock is a large pendulum one, and adorns the wall of the laboratory. This current, interrupted once a second, may be used in connexion with an electro-magnet for slow time marking, as in experiments on the frog's heart or unstriated muscle. It is, however, chiefly employed for supplying

the students' inductoriums to furnish a periodical stimulus for fatigue experiments on frog's muscle. Sometimes we connect this same interrupted current with an electric bell, to mark the time for an ergograph experiment.

If the keys marked M and D are closed the students are supplied with a current for rapid time-marking, obtained as follows: The wires coming down from the ceiling to the key M are from the 110-volt alternating circuit, used to light the building. In this current the alternations number 66 per second, making 132 interruptions altogether. The rate has been frequently tested, and practically never varies. The key M connects this current with the transformer H, which is constructed on the principle of an inductorium with a secondary coil of very coarse wire. This transformer cuts down the voltage to any desired strength from 1 to 5 volts. The key D connects the transformer with the students' places, and supplies them with a current interrupted 132 times a second. By connecting this with an electro-magnet a student can get a beautiful time-marking in $\frac{1}{132}$ of a second. The transformer can supply enough current to keep ten or more electro-magnets going simultaneously. As rapid time-marking is seldom required by one experimenter for more than a few seconds at a time, we have never found the capacity of the transformer overtaxed. This current is used by the students

Fig. 1.—Students' Laboratory.

for timing the different phases of a simple muscular contraction.

If the key *x* be closed connexion is made with a battery of 50 Mesco dry cells, supplying a current of about 70 volts. This current is used by the students for working out the reaction of their own muscles to the constant current.

Fig. 2.—Switchboard.

In each cupboard there is a pair of sponge-electrodes, of which one has an interrupting handle, a commutator, and a

Fig. 3.

resistance tube. The resistance tube is made by bending a

piece of ordinary glass tubing to an acute angle, filling it with a very dilute solution of sodium chloride and fixing it to a standard by a clamp (see Fig. 3).

The sponge electrodes *x* are connected with the commutator *c*, and the commutator is connected directly with one of the binding posts in the cupboard and indirectly with the other, a resistance tube *r* full of salt solution being interposed. The connexion with the resistance tube is made by the wire from the binding post being passed into one limb of the tube and the wire from the commutator into the other limb. If the wires in the resistance tube be only pushed a little way into the solution, very little current is obtained, and we only get a kathodal closing contraction. If they be pushed gradually farther in, more current passes, and the various stages of reaction are obtained, until, finally, before the wires meet, we get kathodal opening contraction. With this device we have perfect success, and thirty or more pairs of students can work out the law of contraction simultaneously with the current furnished by fifty dry cells.

If the key *c* be closed connexion is made with a battery of twelve Edison-Lalande cells of 100 ampere hour capacity, arranged in series. This gives a current of about ten volts for Pflüger's law and electrotonus. I may remark incidentally that the students have experienced greater difficulty in obtaining success with the electrotonus experiments than with any others in the course. Pflüger's law, on the other hand, usually comes out very well, although a few get atypical results with the weak ascending current.

If the key *i* be closed the 10-volt current is sent to the galvanometer which will now be described.

Tory's Galvanometer.

The galvanometer that we have in use was especially designed for us by Professor H. M. Tory, of the Faculty of Arts in McGill. It has proved very satisfactory indeed. It is

Fig. 4.—Tory's galvanometer.

sufficiently sensitive to show the currents of frog's muscle, heart and nerve by the movements of a pointer which can be seen without telescope, or screen, or darkened room. At the same time it is practically unaffected by the neighbourhood of iron, or by movements of students about the laboratory.

The following description is kindly furnished by Professor Tory.

The galvanometer (Fig. 4) is one of the D'Arsonval type, the magnet, however, being an electro-magnet instead of a steel magnet, as is usually the case. The magnet is made of a bar of soft iron and is wound with two coils, so as to give it magnetic saturation on the passage through it of about half an ampère. The poles are about half an inch apart. The resistance of the coils is such that the required current can be obtained from batteries, or from a direct current lighting circuit through an incandescent lamp. The suspended coil is made of very fine wire, and is about $2\frac{1}{2}$ in. in length, weighing one ounce. The sensitiveness of the instrument depends on the current in the coils of the electro-magnet, on the number of turns of wire in the suspended coil, and the torsion of the suspension. To the lower end of the coil is attached an aluminium pointer enclosed in a small case, with its outer end bent vertically downwards over a small paper scale, the scale being so fixed that when the coil swings the pointer turns across the front of it (See Fig. 4). The front of the case is covered with mica. The weight of the coil can be taken from the suspension by turning a thumbscrew connected with a small lifter. The galvanometer is so sensitive that observations can be taken with a pointer, which usually require a telescope and scale, as the statements below show. Moreover, by cutting a small opening in the suspension tube a mirror is attached, so that by reflecting an incandescent light on a distant scale it may be used for class demonstrations. In this case the apparent movement of the coil is enormously increased.

This galvanometer of Professor Tory's is admirably simple and easy to use. The sensitiveness is quite sufficient for demonstrating the broad facts of electro-physiology and some of the nicer points. The experiments are first shown to the students, and they are then at liberty to repeat them for themselves. Things are so arranged that they can make their connexions without actually touching the galvanometer. The demarcation current of frog's muscle sometimes moves the pointer quite off the scale, and may always be well shown. The negative variation produced by tetanus causes a backward movement of the pointer through several spaces. A quite distinct to-and-fro movement is given by a beating frog's heart. The demarcation current of a frog's sciatic nerve may be seen pretty well, but the negative variation accompanying a nervous impulse is barely seen with a good preparation and is too slight to demonstrate to students. If the nerve be stimulated at regular intervals, however, the pointer will soon begin swinging to-and-fro in time with the stimuli. The currents from frog's eye, skin, and spinal cord all give good movements. A very distinct movement can be obtained by connecting the upper and lower surfaces of the tongue. Sufficient has been said to show that both as regards convenience and sensitiveness this galvanometer is eminently suited for students' work.

Apparatus Supplied to Students.

The contents of the glass cupboards on the students' tables are as follows:

Kymograph, supplied with automatic break key.
Dry battery (ammonium chloride).
Spring key.
Short circuiting friction key.
Inductorium.
Tetanus spring.
Platinum electrodes.
Non-polarizable brush electrodes.
Sponge electrodes.
Commutator.
Resistance tube.
Rheocord.
Time marker.
Two standards.
Clamps, assorted.
Muscle lever (also used for heart).
Brass rods, pulley, etc., used for heart work.
Moist chamber.
Muscle forceps.
Recording tambour.
Receiving funnel for pulse in carotid and for respiratory tracing (suprasternal notch).
Set of weights, scale pan, porcelain capsule.
Thermometer, seeker, beaker, thread, normal saline, saturated solution of zinc sulphate, frog board.

The kymograph was chosen after much consideration. It is a clockwork instrument made by the Chas. Willms Surgical Instrument Company, of Baltimore. Many advantages were recognized for the motor-driven instruments, but when it was found that a thoroughly strong clockwork kymograph could be obtained for 30 dollars, we decided to have the men as independent of one another as possible, and free from the danger of having their work interrupted by any accident to a motor. We have found our kymograph thoroughly satisfactory except for an occasional jerk with the very slow speed. The dry battery is used very often for the

inductoriums, leaving the switchboard free to supply a current for some other purpose, such as time-marking. It is also used for the weak and medium currents in working out Pfüger's law.

The inductoriums are based on the Harvard model, but are somewhat stronger and better finished. They were specially made to order. The rheocord is one designed for us by Professor Tory, and made in the McGill Physics Building; it is much like the one sold for the use of students by the Cambridge Scientific Instrument Company, except that instead of ebonite it is wound on slate, which has the advantage of being less affected by variations in temperature. A large part of the apparatus was made by the Chas. Willms Surgical Instrument Company, of Baltimore. The muscle lever and clamp are those designed by Professor Porter, and supplied by him under the name of the Harvard apparatus. We have numerous other articles of his invention about the laboratory, but they are not in the students' cupboards. Several of the instruments were designed by the physiological staff and made in Montreal.

The Laboratory Course.

There are 144 hours of practical physiology allowed by the time-table to each student. This is divided into 15 lessons of two hours each in the first year, and 38 lessons of three hours each in the second year. No attempt is made to cover the whole field of physiology in the laboratory. It is considered quite sufficient for medical students to perform a limited number of experiments under favourable conditions. The classes, which vary in size between 90 and 130, are divided into two divisions, so that there is plenty of room to spare in the laboratory. The number of instructors present to look after 50 or 60 men is usually three, which we find to be enough, as the men are supplied with full directions printed off from a copygraph, and it is not thought desirable to help them too much. They are expected to take careful notes, and are examined on them at the beginning of the following lesson. At this time, too, the best tracings taken are drawn on the board for the benefit of the whole class, and theory is briefly discussed. Any points of special difficulty that the written directions do not cover are also explained before they begin work. From half to three-quarters of an hour is taken up with this preliminary examination and explanation, leaving a little over two hours for actual experimenting. Many of the men, however, stay on beyond the allotted time when their first attempts have been unsuccessful. The ground covered by the experiments which the students perform for themselves is as follows:

First year: Simple lesson on blood, consisting of examination of clot serum, fibrin, and defibrinated blood, with a few simple tests; study of apparatus used for electrical stimulation with effects of different stimuli on themselves; preparation of muscle-nerve preparation, and study of the effects of various stimuli; elasticity of muscle; simple contraction; tetanic contraction; rheoscopic frog; exposure of frog's heart and study of cardiac cycle; Stannius's ligatures; isolated heart, last part to stop beating, etc.; simple lesson on food-stuffs; a similar one on digestion; reflex action in frog; examination of chick embryos at different dates, heart beat, brain, amnion, allantois, etc.

Embryology as far as this department is concerned is taught mainly by lectures, special demonstrations and lantern slides, but a practical course open to medical students is given by the Professor of Biology.

Second year: Blood, essentials for coagulation, salted plasma and oxalate plasma, proteids of serum, chemical tests for haemoglobin, spectra of haemoglobin and derivatives; muscle, minimal and maximal stimuli, make-and-break induction shocks, simple contraction, latent period, etc., fatigue and rest, electrotonus, Pfüger's law, law of contraction in body, unstriated muscle; frog's heart, inhibition reflexly and by stimulation of medulla, vagus and crescent, effect of cold and heat, pilocarpin and atropin; pulse; respiration, normal, forced, apnoea, cough; electro-physiology, heart and muscle currents demonstrated and repeated by those who choose; chemical physiology, eight lessons on food-stuffs, digestion and secretions; reaction time; three or four lessons on the special senses; examination of various types of placenta and other embryological specimens; repetition on white rat or rabbit of experiments on heart inhibition, with study of mammalian breathing, peristalsis, etc.

The lessons on physiological chemistry are supplemented by a course on clinical chemistry given by the Professor of Chemistry; and many demonstrations other than those referred to above are given before the class either in the laboratory or in the lecture room throughout the session. The lantern is also used freely.

Note by Professor WESLEY MILLS.

The Professor of the Department of Physiology holds the following views:

Neither the laboratory, nor the demonstration, nor the

lecture or didactic method is adequate in itself, but all these and others must be employed to secure the best results. As a matter of fact the number of methods of teaching is with us here increasing yearly. For a few years past, for example, the students of the second-year class have from time to time reported before their fellows, the professor acting as chairman, on a small number of original papers, and, this year especially, with surprisingly good results, both as regards the quality of the reports and the effect on the tone of the class. It is very easy to exalt technique unduly and very difficult to keep the field of physiology in good perspective in the student's mind, so that no small amount of the professor's energy is spent in not only utilizing, but correcting and supplementing, the results of the laboratory work—that is, its effects on the student's mind.

The above account of the laboratory, written at my suggestion by Dr. Morrow, who has been my chief assistant for some years, and to whose zeal and ability I gladly bear witness, will, I believe, meet the case. In designing, equipping, and arranging the work to be done in our laboratory we had the example of several of the leading American schools before us. Believing as I do that the physiology of the mammal is of great importance for medical students; that physiological principles are more than technique; that the law is higher than the demonstration; that all men should not be expected to do exactly the same work in the same way; that medical students are to apply physiology rather than advance it by discoveries, etc., the course as at present constituted will probably be considerably modified in the near future. In spite of the time and energy expended in the work of reorganization, etc., in the past two years we have been able to do some research, both of the nature of verification and discovery, each of which we hold to be of importance, and the former too little considered at present.

The greatest need of physiology in McGill at the present time is the establishment of a Fellowship for research. This principle has been amply recognized among us in connexion with pathology, and I am hoping that ere long this want will be met in the allied subject of physiology.

MEMORANDA:

MEDICAL, SURGICAL, OBSTETRICAL, THERAPEUTICAL, PATHOLOGICAL, Etc.

CONGENITAL GOÏTRE.

A VERY large number of readers must have been deeply interested by Dr. Hewetson's paper on Congenital Goitre in the BRITISH MEDICAL JOURNAL of March 21st. If only as a curious coincidence it is perhaps worth while to mention that on March 11th I communicated to the Pathological Society of Manchester a Preliminary Note on Hyperplasia of the Fetal Thyroid. This was based upon a case in which, as in Dr. Hewetson's, the mother had been given potassium chlorate during pregnancy. The child was born alive, but death occurred within an hour. The thyroid gland was uniformly enlarged and weighed 25 grams. The normal weight of the thyroid at birth I find to be about 1.5 gram. On microscopic examination, my specimen is not so vascular as Dr. Hewetson's. The acini are smaller and more closely packed, and the connective tissue is more firm in type. There is no colloid matter. On cutting sections of fetal thyroids at different ages I find the "parenchyma" in my specimen to resemble that of a fetus of about 6½ months' development. In normal fetal thyroids of 9 months' growth I find a considerable quantity of colloid material.

I note a further coincidence, for on March 11th, Dr. Angus Macdonald showed yet another example of congenital goitre after potassium chlorate to the Edinburgh Obstetrical Society. Of this we shall see the details in due course. Three days before labour, the mother of the fetus from which my own specimen was obtained had an eclamptic attack, which was treated by thyroid substance as advised by Nicholson. I therefore propose to submit the whole case to the Edinburgh Obstetrical Society before publishing any detailed account of it.

Manchester.

W. E. FOTHERGILL.

PROTRACTED BONE SUPPURATION.

MRS. H., aged 94, almost blind from cataract, and suffering from chronic bronchitis and emphysema, stated that when 4 years of age she met with an accident to her left shin bone, and that the medical man who saw her advised amputation,

and told her that if she did not submit to operation she would die within six months. When I saw her the middle of the tibia gave indications of diseased bone from the discharge and the state of the skin near. The liver was not markedly enlarged, and the heart, apart from signs of fatty degeneration, had no other signs of disease. The lungs were markedly emphysematous. The case is of interest as it shows how long a bone may suppurate without seriously affecting health.

Southfields, S.W.

J. REID, M.D., M.A. and C.M.

SIMILAR CONGENITAL DEFORMITIES IN MEMBERS OF THE SAME FAMILY.

DR. ESSLEMONT'S account in the BRITISH MEDICAL JOURNAL of February 7th induces me to put on record two cases, which interested me much at the time, of fetal malformations occurring in the same mother, the character of the malformation differing in each case only in degree.

The mother was a hard-working healthy woman, aged about 35 (I am writing from memory), who had three children. She had a normal confinement, at which a fine healthy boy was born, presenting nothing noticeable till it was found that no faeces were being passed. Examination of the rectum showed that it was occluded by a membrane. This was divided and stretched, and the bowels acted in a satisfactory manner. The child lived for a month or more, but sank into a marasmic condition, which had no connexion with its deformity, but rather with the parental idea that if it was not "all right," it had better not survive.

Two years or so after this, another apparently healthy child was born, whose muscular development and strength seemed to leave nothing to be desired, but its perineum was innocent of any orifices communicating with alimentary or renal systems. There was a tag of skin to represent a penis or scrotum. It lived for some days till the absence of drainage system in the body had time to assert itself, and then died.

The remarkable fact, to my mind, was the close similarity in each case of Nature's failure. In the first case, a comparatively minor fault—namely, neglecting to remove the membrane of the proctodoeal invagination; in the second, a serious error in neglecting to make any cloacal or proctodoeal invagination at all, pointing to the idea that what caused the failure in the first instance had gained in intensity in the second, and, further, that the failure was in the maternal organism, unless we regard the two cases as a remarkable coincidence.

We know a good deal of the cells and their divisions which result in the formation of the cellular layers by whose foldings and buddings the organs of the fetus are formed, in which we may trace phylogenetic reminiscences, but nothing of the forces which preside over the proper evolution of this architectural plan, and which fail in a remarkable and inexplicable way. These two cases suggest, as I have said, that it is in the maternal organism that we must look for the causes of these failures—in fact, to the vexed question of maternal influence and impressions.

Sevenoaks.

JAMES E. BLOMFIELD, M.A., M.B.Oxon.

CASE OF FIBROUS STRICTURE OF THE RECTUM FOLLOWING DYSENTERY.

SIMPLE fibrous stricture of the rectum due to dysenteric ulceration is so rarely met with among Europeans in the East, that the following case seems worthy of record.

A medical man who had resided five years continuously in India had his first attack of dysentery in 1898, which was followed by others in the two following years. None of the attacks were severe in character, and all appeared to yield readily to ordinary treatment. For several months prior to the diagnosis of stricture the patient suffered from great irregularity of the bowels, constipation being the primary condition but diarrhoea frequently occurring, being probably due to catarrhal enteritis from the irritation of retained faeces. Some "ribboning" of the stools had been noticed, but this was attributed to spasm of the sphincter due to some extero-internal piles which had developed as the result of residence in the tropics. When constipation became marked the patient suffered from frequent calls to stool, occasionally resulting in the passage of shrimp-like masses of faeces. This condition was, however, of rare occurrence, as the patient, like most Anglo-Indians, was careful to secure a free action of the bowels almost daily. The patient had been employed on plague work, and, as he had had no holiday for