capillary pressure; and, finally, preservation of the balance between the osmotic pressure of the fluid inside the blood-vessels and outside in the tissues. It was shown that considerable success had been reached in this problem by the experiments of Professor Bayliss and others.

A final point dealt with was the treatment of tetanus by administration of "anti-tetanus serum." This serum is obtained from the blood of horses which have been subjected to gradually-increasing doses of tetanus-toxin, the poison produced by the tetanus-bacillus. The high efficiency of this anti-toxic serum when used as a prophylactic was first demonstrated on man on a large scale by its employment in the first autumn of this war. Curves illustrating the statistics were shown. The severe outbreak of tetanus which ensued in the troops at the outset of the campaign was checked and practically stopped almost instantaneously by the orders that every wounded man, as soon as possible after being wounded, that is to say, at the first field casualty-station, should receive a small injection of anti-tetanus serum from the immunized horse. But the efficacy of the serum when once signs of tetanus have appeared in the patient is far less satisfactory. The remainder of the lecture was devoted to discussion of why this should be, and in what ways the difficulty may be, at least in part, overcome.

Charles S. Sherrington

PRE-MEDICAL TRAINING IN CHEMISTRY[1]

As a country we are rubbing the sleep out of our eyes and wishing we had split the kindling and brought up the coal the night before. The alarm clock has been ringing for some time, but we have preferred our dreams of ease to the realities of necessities.

The medical profession is awake and trying to start the water boiling, but finds it can not lay the fire. The wood and coal are at hand, but the knowledge of their proper use is lacking. Now, more than ever, do progressive physicians realize the dependency of successful practise on a well-founded knowledge of the chemistry of the human body, and more than ever do they irritably contemplate their lack of preparation.

This lack of preparation in a science so obviously fundamental to rational understanding of the human mechanism as to require no elaboration, at present exists; that a continuation of this condition should be allowed is a parody upon our intelligence.

The futility of expecting the physician to utilize all possible sources of relief to suffering without a knowledge of the application of basic chemical principles to the body reactions is apparent.

It is equally as absurd to expect the medical student to appreciate or assimilate the possibility of chemistry being a practical science for his uses, if he does not have sufficient foundation in this subject before he enters the medical school. The medical school is fundamentally a school of applied science. It is where the individual is taught science as applied to the human body. Any attempt to teach a student biological chemistry without his having received an adequate foundation in the fundamental principles of chemistry in general, and to expect him to know much of anything when we are through with him, is as idiotic as to try to teach calculus to men who have yet to know algebra. The foundation must be laid in the pre-medical work.

It is only in recent years that the teaching of elementary chemistry has been dropped from the medical curriculum. Unfortunately however even to-day it is only the few schools interested in turning out doctors instead of groups of men competent to pass State-board examinations, that have adapted themselves to the logical demand of the times as justified by the ever-increasing applicability of chemical

[1] Read before the Division of Biological Chemistry, American Chemical Society, Boston, September, 1917.

science to medical practise, and brought about this necessary change.

It is admitted that plausible excuse for this disorderliness exists. The appearance of chemistry as a real aid to diagnosis and treatment from the Stygian darkness has been not only remarkable for the rapidity of its development, but amazing in its stability. A new phase in medical knowledge has been produced through the pressure of the discoveries of countless investigators. And it is not surprising that the now should-be obsolete system clings tenaciously to the older but invalid conceptions.

It is well recognized that the efficient practise of medicine entails a scientific knowledge of ever-widening scope. It is therefore of the greatest importance that a proper selection of scientific information be presented to the prospective medical student for his assimilation. Purposeless instruction, from the point of view of the pre-medical student, is haphazard and yields results that are worse than nothing.

Conscientious objectors will mentally raise the objection that the pre-medical requirements are already well set down in the regulations of the various medical schools and by the American Medical Association. From the quantitative standpoint this is largely true, but from the point of quality the field is barren. And whereas these dicta were sufficient for the time and admirable in that an appreciation of the increasing importance of chemistry to the practise of medicine was shown, yet such advantages are now possible to be derived from a more exact definition of requirements that a change is imperative, else stagnation will set in. For mark you, while directions are given that so much inorganic, and so much organic, and so much advanced chemistry should be given, nothing is said about what of inorganic, and what of organic or what of advanced should be taught. To chemists it is a matter of individual experience that any of the various branches of the science can well occupy the studies of a lifetime.

So why try to make the pre-medical student a chemist. He wants to be a doctor, and he wants to learn what of chemistry there is that can help him to be a better doctor. But instead of getting what he wants he is put through the mill with the students who wish to enter upon chemistry as a life work, gets so far and no farther, wonders what it is all about, takes a good dose of physic in the form of an examination and gets rid of all he had taken in. If the college instructors of pre-medical students should look upon them as a problem in research, the results would never see the light.

Now this pre-medical training in chemistry is essentially a question of *what* instead of *how much,* and the decision as to the subject-matter to be offered for utilization is not especially difficult if one cares to look into a biological chemistry for a few hours. What the pre-medical student needs is to learn the fundamental principles common to all chemical reaction. He does not need encyclopedic details. Principles are to details as granite is to points in the work, they should not be obscured by a fog of wearying and relatively unimportant details. Let me illustrate: the understanding of the nature of oxides is a principle, the number and formulæ of the oxides of iron is an unessential detail, and again, the phenomena of isomerism is a principle, the ability to enumerate all possible isomerides of a given compound is detail.

Principle must not be subordinated to detail.

Human health and happiness rests to a great degree in the physician's hands. The true physician must be a true diagnostician. He can not be a diagnostician if he lacks power of observation and ability to carry on deductive reasoning. Where better can he gain this fundamental training than in chemistry? And can he get this point of view in a mind befuddled with inconsequential detail? Another essential attribute of the efficient doctor is technique. The ability to rapidly, smoothly and accurately carry on delicate manipulations is a prime requisite for adequate medical service. What teaches this better than intensive training in quantitative analysis? Can we conclude from the results handed over to us that these things have been done? We can not.

Any teacher of biological chemistry in a medical school knows how flimsy a chemical structure has been erected in the minds of the students coming to him, and that the information acquired is about as useful as is a cobweb for catching fish.

The causes of this are self-evident. Probably the most satisfying reason lies in the newness of the possibilities of the application of the science of chemistry to diagnosis and treatment. The collegiate instructor has failed to appreciate the progressive utilization of chemistry by the biological sciences. There is a chasm between what the instructor knows and attempts to teach to the pre-medical student and what the pre-medical student needs. And as a result the student falls into the chasm, and is lost. It is the job of the collegiate instructor to bridge the gap through constructive cooperation. The medical-school instructor has not been sufficiently insistent on preliminary requirements from a qualitative standpoint, nor has he shown any special inclination to relate the needs of the situation. These facts when coupled with the disinclination of the college teacher of chemistry to break away from the classical and now obsolete methods of teaching and inaugurate a system adapted to the demands of the times give some explanation of what at present confronts us. There is at hand a supply of potential useful information that lacks efficient assimilation because of the lack of understanding of fundamental principles.

The remedies are obvious—an attempt by the collegiate instructor in chemistry to learn something of what chemistry is doing in biology, a measure of cooperation between teachers of biological chemistry and the pre-medical instructors, a willingness on the part of the latter to recognize the validity of the wishes of the former, an outline of preparedness from the qualitative point of view, and a realization that true preparedness rests on understanding, while understanding can only come when detail is subordinated to principle.

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SCIENTIFIC EVENTS

BRITISH EXPERIMENTAL STATION FOR FUEL RESEARCH

The Fuel Research Board of the Department of Scientific and Industrial Research has issued a report, signed by Sir George Beilby, the director of fuel research, describing the scheme of research they have adopted and their plan for the establishment of a fuel research station on an industrial scale.

It is stated in the London *Times* that in a previous report, which has not been published, they stated that they had in view two main lines of research: (1) A survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, and (2) an investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal by processes of carbonization and gasification.

At one time it was thought that the former line of inquiry could be proceeded with in advance of the second, but further consideration has shown them to be so interdependent that they can be most satisfactorily dealt with side by side. However, in preparation for the organization of the first line of inquiry, an experimental study of standard methods for the examination of coal in the laboratory has been made, and as the result of work carried out for the board in the Fuel Laboratory of the Imperial College of Science a test has been elaborated which, by direct weighing and measurement, gives the yields of gas, oil, water and carbonaceous residue that result from carbonization at any definite temperature.

Among the problems to be investigated are:

1. Can the 35 to 40 million tons of raw coal used every year for domestic heating be replaced wholly or partially by smokeless fuel, solid or gaseous, prepared by the carbonization of this coal?

2. Can adequate supplies of fuel for the Navy be obtained by carbonizing the coal at present used in its raw form for industrial and domestic purposes?

3. Can supplies of town gas be obtained more economically and conveniently by methods of car-