that the student should be studying anatomy during all the three years of his curriculum, down to the very end of his studentship But we must admit the wisdom of it then. At that time human anatomy was the one branch of knowledge which had achieved anything like complete development, and which successive generations of able teachers had shaped into an engine of mental training of the highest value. It was then the mainstay of medical scientific teaching. It was in the dissecting-room that the student, of the time of which we are speaking, acquired the mental attitude which prepared him for the bedside. He there learnt to observe, to describe, to be accurate and exact, and the time spent there was wisely judged to be the most precious of his apprenticeship ; the shaping of his mind by help of orderly arranged facts was perhaps even of greater value than the mere acquisition of the facts, important as this might be.

The authorities of the time were, I venture to repeat, in my opinion wiser in their generation in making this well-developed, adequately taught science of anatomy the backbone of the medical student's education ; they were wise in making relatively little demand on the student in respect to the other sciences cognate and preparatory to medicine, the value to him of which consisted then chiefly in the facts which they embodied ; they were also wise in giving him leave to defer his study of them until his knowledge of something of the needs of his future profession should have opened his eyes to the value of those sciences as mere records of facts.

I also, however, venture to think that the advance of these sciences since then has greatly changed their bearing towards the medical student, no less than towards medicine. What was wisdom in the forefathers is not necessarily wisdom in us the children. I have no wish to take advantage of the occasion of this lecture to make an excursion into the troubled land of medical education. But I feel sure—indeed I know—that I am only saying what the man whose name these lectures bear always felt, and indeed often said, when I suggest for consideration the thought that while some choice out of that advancing flood of science which is surging up around us, and all of which has some bearing on the medical profession, some choice as to what must be known by him who aspires to be the instrument of the cure and prevention of disease is rendered necessary by the struggle for existence—a decided and even narrow choice, lest the ordinary mind be drowned in the waters which it is bid to drink. In making that choice, we should remember that an attitude of mind once gained is a possession for ever, far more precious than the facts which are gathered in with toil, and flee away with ease. This should be our guiding principle in demanding of the medical student knowledge other than that of disease itself.

The usefulness, and so the success, of a doctor is largely dependent on many things which belong to the profession viewed as an art, on quickness of insight, promptness of decision, sleight of hand, charm of manner, and the like—things which cannot be taught in any school. But these are in vain unless they rest on a sound and wide knowledge of the nature of disease, on a sound and wide grasp of the science of pathology ; and this can be taught. By a sound and wide grasp, I mean such a one as will enable him who has it to distinguish, as it were by insight, among the new things which almost every day brings to him that which is a solid gain, from that which is a specious fallacy. Such a grasp is only got by such a study as leads the mind beyond the facts into the very spirit of the science.

But what we call pathology is a branch—a wide and recondite branch, but still a branch of that larger science which we call physiology ; it employs the same methods, but applies them to special problems. So much are the two one that it would doubtless be possible to teach pathology to one who knew no physiology ; such a one would learn physiology unawares. But at a great waste of time. For physiology, in its narrower sense, being older, has become organised into an engine which can be used for leading the mind quickly and easily into the spirit and methods of true pathological inquiry. The teaching of it as an introduction to pathology is an economy of time. That, I take it, if compulsion be justifiable at all, is the justification of its being a compulsory study.

Further, the methods of physiology, in turn, are the methods of physics and of chemistry, used hand in hand with other methods special to the study of living beings, the general methods of biology. And here again it is an economy of time that the student should learn these methods each in its own science, and this is the justification for making these sciences also compulsory. But in all the regulations which are issued concerning these several ancillary sciences, this surely should be kept in view, that each science should be taught not as a scientific accomplishment of value in itself, but as a stepping-stone to professional knowledge, of value because it is the best means of bringing the student on his way to that.

(*To be continued.*)

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meeting of the Chemical Section of the British Association at Liverpool was not signalised by the announcement of any sensational discovery. Papers were, however, read on a number of the subjects which are at present occupying the attention of our foremost chemists, and it is to be hoped that the discussion on chemical education may help in attracting the attention of the public to that most important subject.

After the President's very interesting address, which, as was pointed out by Sir F. Abel, dealt with an industry of which the development had been mainly due to the labours of English chemists, many of whom worked in the immediate neighbourhood of Liverpool, the ordinary business of the Section was commenced with a paper on "Reflected Waves in the Explosion of Gases," by Prof. H. B. Dixon, E. H. Strange, and E. Graham. The rate of propagation of an explosion in a gaseous mixture can be ascertained by photographing the flash, as it passes along a short glass tube, on a sensitive film revolving at a known rate, and then measuring the angle through which the image has been rotated. A number of photographs of this kind were exhibited. They reveal the existence of a second wave, which passes back along the tube in the opposite direction to the flash, and at a much slower rate. This wave is probably set up by the explosion wave when it reaches the end of the tube, and by measuring its velocity the authors are enabled to estimate the maximum temperature of the gases immediately in the wake of the explosion wave. The maximum temperatures, obtained with a number of different mixtures, lie between 3000° and 4000°, and are thus of the same order as those found by Bunsen, by Berthelot, and by Mallard and Le Chatelier for the temperature of the explosion itself.

Sir G. G. Stokes expressed the opinion that the luminosity which accompanied the reflected wave might be due, not to any chemical action, but to the temporary compression of the gases, which had only cooled slightly below their point of luminosity.

The only paper on the subject of the Röntgen rays which found its way into the Chemical Section was one in which Dr. J. H. Gladstone and Mr. W. Hibbert drew a contrast between the action of metals and their salts on ordinary light and on the new rays. All the metals, except in exceedingly thin films, are opaque to light, whilst their compounds with electronegative radicles—the metallic salts—are transparent, or only exhibit a selective absorption. With the Röntgen rays the relations are quite different. The metals exhibit all degrees of opacity towards these rays, lithium being almost transparent, platinum and gold practically opaque, whilst the opacity of the other metals seems to follow the order of their atomic weights. In the salts the metals seem to retain their own absorptive power, and the absorption of a solution of a salt appears to be the sum of the absorptions of the metal, the acid radicle, and the solvent.

A paper on the "Limiting Explosive Proportions of Acetylene, and Detection and Measurement of this Gas in the Air," was read by Prof. F. Clowes. The possibility of the introduction of acetylene as an illuminant renders a knowledge of these factors of considerable practical importance. The detection and estimation of the gas in air can be carried out by the well-known flame-cap test, so small a proportion as 0·25 per cent. being readily distinguishable. A convenient portable apparatus was exhibited for carrying out the test at any desired place. All mixtures of air and acetylene which contain from 3–82 per cent. of the latter are explosive, this being a wider range of explosibility than is shown by any other gas. Carbon is deposited during the combustion of all mixtures containing more than 22 per cent. of acetylene. In a later communication the author showed that the flame cap test can also be applied to the detection and estimation of carbon monoxide in air, with about the same degree of sensitiveness as with acetylene. A short note on "The Accurate Estimation of Oxygen by Absorption with Alkaline Pyrogallol Solution" was also read by Prof. Clowes.

Dr. A. W. Titherley, of University College, Liverpool, gave a short account of his work on the "Amides of the Alkali Metals and some of their Derivatives." The amides of sodium, potassium, lithium, and rubidium have been prepared in the pure state. They all readily dissolve the corresponding metal, forming blue solutions. Their melting points do not vary regularly with the atomic weight of the metal, since lithamide melts at 380–400°, sodamide at 155°, potassamide at 270°, and rubidamide at 285°. The potassium and sodium compounds do not yield the nitride when heated, as has been stated by previous investigators. Analogous derivatives of the alkyl amines have also been prepared, and promise to be of great interest.

Several communications on physical chemistry were received by the Section, the first of which was a paper by Prof. Oscar Liebreich, on "Diminution of Chemical Action due to Limitations of Space." Certain reactions take place much less readily near a liquid surface than in the interior of a liquid, and the author terms this region of diminished action the "dead space." This remarkable fact has led the author to the conclusion that liquid friction is of influence on the phenomena of chemical action, and that in small enclosed spaces—spaces in which the fluid is, as it were, solidified—the reaction is retarded.

Dr. Wildermann read a paper supplementing that which he brought before the Association at its last meeting on "The Velocity of Reactions before perfect Equilibrium takes place." For a number of cases of crystallisation of liquids and solutions he has now been able to obtain experimental evidence which establishes the complete applicability of the thermodynamic equation to the rate of reaction, as well as to provide a statical explanation for the well-known fact that the velocity of a reaction is independent of the amount of a solid substance present, which cannot readily be explained on kinetic grounds.

In a short note on "The Behaviour of Litmus in Amphoteric Solutions," Dr. T. Bradshaw opposed the view that the violet colour produced when a mixture of sodium dihydrogen phosphate with the ordinary disodium hydrogen phosphate is added to a solution of litmus is due to a special compound, probably an acid salt, of the litmus acid. The author considers that the violet colour is caused by the simultaneous presence of small amounts of blue and red litmus, the shade varying with the proportions of the two sodium salts which are present, whilst taken separately one of the salts has an acid, and the other an alkaline reaction to litmus.

Prof. Max Bamberger read a short paper on "Excrescent Resins," and described a number of crystalline substances which he had succeeded in extracting from them. Messrs. A. G. Green and A. Wahl contributed a paper on "The Constitution of Sun Yellow or Curcumine and allied colouring matters." These substances have been supposed by Bender to contain the azoxy-group $-\mathrm{N}\overset{\mathrm{O}}{\diagup\!\diagdown}\mathrm{N}-$, but this does not account for the great stability of the compounds towards oxidising agents, nor for the difficulty of reduction to diamidostilbenesulphonic acid. These properties are better explained by supposing that one of the nitrogen atoms is present as an azine group, whilst the other acts as a pentad and is combined with oxygen, the characteristic ring, $\begin{array}{l}\mathrm{C{=}NO{-}C}\\ |\qquad\quad |\\ \mathrm{C{=}N{-}\!{-}C}\end{array}$ being therefore present. It appears probable that oxyphenine, chloramine yellow, and other dyes have a similar constitution.

Dr. F. E. Francis read an interesting paper on "Abnormalities in the behaviour of Ortho-derivatives of Orthamido- and Orthonitro-benzylamine," in which he drew attention to the remarkable influence on the behaviour of certain compounds of the presence of substituted groups in the ortho-position. Thus, for example, whilst most of the derivatives of orthamidobenzylamine yield a triazine when treated with nitrous acid, no such compound can be obtained from the orthamidobenzyl derivatives of orthotoluidine, orthanisidine, and orthochloraniline. A number of other instances were also adduced.

In a paper on "Nitrates: their Occurrence and Manufacture," Mr. W. Newton, after describing the ordinary method of extracting sodium nitrate, drew attention to the fact that the rocky stratum overlying the caliche contains 15 to 20 per cent. of nitrate, and that, although this has to be broken through before the caliche can be removed, the whole of the nitrate in it is at present neglected. The total production of nitrate, which was only 58,000 tons in 1860, amounted to 1,218,000 tons in 1895.

Prof. Ramsay gave a detailed account of the very remarkable and abnormal properties of helium. When this gas is fractionally diffused through a piece of pipe-stem, it may be separated into two portions, which differ in density, one of them having the density 1·874 and the other 2·133. These two portions nevertheless show exactly the same spectrum when they are examined under the same conditions, the difference between the spectra of the two fractions, which was observed by Runge and Paschen, being due to a difference of pressure. The refractive indices of the two portions are directly proportional to their densities, whilst this relation does not hold for other gases. A further abnormality exists in the rates at which the two fractions diffuse. The relative rate of diffusion of each fraction, compared with hydrogen, is about 15 to 20 per cent. more rapid than that calculated from the density, according to Graham's law. No satisfactory explanation has yet been arrived at, and the author proposes to submit other gases to fractional diffusion, in order to see whether they also yield two fractions of different density. Such a result would seem to point to the conclusion that the atoms of any substance are not all alike in weight, but vary about an average value, as suggested by Crookes. In the discussion which followed, Prof. Dixon pointed out that Graham's law of diffusion is based solely on experiments made with gases composed of polyatomic molecules. The President suggested that, as both helium and argon have no chemical affinities, it is not extravagant to look upon them as the first examples of a new kind of matter, differing in many respects from ordinary matter.

Dr. F. Hurter, in a paper on the "Manufacture of Chlorine by means of Nitric Acid," touched upon a phase in the development of the chlorine industry which had only been lightly treated in the presidential address. The principle of all the methods proposed for this purpose is the decomposition of hydrochloric acid by nitric acid, with the ultimate production of an oxide of nitrogen and free chlorine. The oxide of nitrogen is then reoxidised to nitric acid, and the process thus rendered continuous. All the methods hitherto proposed for this purpose labour under the fatal disadvantage that the treatment involved necessitates the concentration of a very large amount of sulphuric acid, the expense connected with which is fatal to the economical conduct of the process. The great difficulty of finding a material which will withstand the strong acids employed was brought forward by Mr. E. K. Muspratt as a further objection to the process.

Prof. J. Dewar gave an interesting account of several points in connection with "Low Temperature Research." Owing to the relative pressures of oxygen and nitrogen in the air, these two gases, although possessing different boiling-points, condense at almost exactly the same temperature when air is cooled. The method employed for measuring low temperatures consists in using a system of five thermo-junctions, so arranged that three of them are kept at 0°, whilst the other two are of the same metals but in the inverse order, so that when one of them is cooled, the other must be heated in order to preserve equilibrium. The low temperature to be observed is thus balanced by a high temperature which can easily be read off. Helium appears to be less easily condensible than hydrogen, and, moreover, possesses an abnormally low refractivity and real molecular volume. It is a remarkable fact that fluorine, the most active of all the chemical elements, in these respects resembles helium, the least active of all. The ratio of the refractivity of hydrogen to that of chlorine is almost the same as that of helium to that of argon, and it is quite possible that a substance may yet be discovered which will be intermediate between these two elements, just as fluorine is intermediate between hydrogen and chlorine.

A new and convenient form of Schrötter's apparatus for the estimation of carbon dioxide was exhibited by Dr. C. A. Kohn, who also, in conjunction with Dr. T. L. Bailey, showed an aspirator worked by a small electric motor. Dr. J. Haldane gave an interesting demonstration of his colorimetric method of estimating small amounts of carbon monoxide in the air, which has recently been described in NATURE (vol. liv. p. 207). Chemists will be interested to learn that the continued inhalation of a small proportion of the gas is much more dangerous than the momentary reception of a large quantity of it into the lungs. The best antidote is the inhalation of oxygen. Rapid motion almost always produces collapse when more than 30 per cent. of the blood has been saturated with the gas.

Chemical education formed the subject of no less than three communications to the Section, almost the whole of one sitting being devoted to this important question.

Sir H. E. Roscoe, in opening a discussion on "Chemical Education in England and Germany," laid emphasis on the necessity for a training in the methods of research for those who were to be the leaders of industry. He also pointed out that, although great industries have in the past arisen and are now developing in England, our manufacturers do not show the same appreciation of the value of a thorough scientific training as those of Germany. A further difficulty is offered by the inefficiency of many of our secondary schools. A number of speakers took part in the discussion, agreement with Sir H. E. Roscoe's position being generally expressed. Some difference of opinion existed, however, as to where the reform was to originate; many speakers being in favour of calling in parliamentary aid, whilst others advocated the gradual training of public opinion on the point.

The subject of "Science Teaching in Elementary Schools" was dealt with by Dr. J. H. Gladstone, on behalf of the Committee appointed to investigate this question. Continued progress is being made in the teaching of science subjects in elementary schools. The Committee is strongly of opinion that the time has come when the educational authorities should lay down a scheme of elementary experimental science to be taken by every scholar before he is allowed to specialise into the various branches of science. An all-important point is to train teachers to regard science teaching as a means of mental culture, and to teach accordingly.

In practical illustration of the requirements laid down in the last sentence of the report, Miss L. Edna Walter read a paper, in which she recounted her experience of the teaching of science in girls' schools. The system of instruction is practically a continuation of the kindergarten system, applied to elementary scientific notions. The children are taught by being made to perform, and even to originate, simple physical measurements and experiments, and are encouraged to form their own notes into books of reference. After passing through such a preliminary course, the children are introduced to a course in practical chemistry such as that suggested by Prof. Armstrong, or that adopted by the Association of Head Masters.

Several of the Committees of the Association presented important reports of the work carried out during the past year. Mr. C. F. Cross read the report of the Committee on "The Constituents of Barley Straw," The results obtained make it appear probable that the furfuroid constituents of the cereals are not, as has hitherto been supposed, secondary products of assimilation, but are directly built up by the plant. The furfuroids appear to form a very large group, comprising a number of different substances, which differ in their susceptibility to yeast, and yield osazones of different melting-points. The cereal plants are distinguished by the great proportion of grain which they produce, the amount being no less than 40 per cent. of the weight of the entire plant. It appears probable that during the period of production of seed, part of the necessary material is derived from the tissues of the stem and leaves.

Prof. Bedson presented the report of the Committee which has been engaged in the examination of the "Proximate Constituents of Coal." Ordinary coal is practically insoluble in all reagents, but can be converted by treatment with dilute hydrochloric acid and potassium chlorate into soluble products, the composition of many of which has been ascertained. By repeated treatment, no less than 75 per cent. of the coal can be dissolved. Brown coal appears to behave in a similar manner.

The Committee on "The Isomeric Naphthalene Derivatives" reports that work has now been begun on the important subject of isomeric change, especially in the sulphonic acids and other derivatives of the naphthols.

The report of the Committee on "Quantitative Methods of Electrolysis" is of very great practical value, and comprises four distinct papers. One of these deals with a very convenient arrangement of the necessary electrical instruments, whilst the others treat of the determination of bismuth, antimony, and tin. The separation of the last two can only be satisfactorily accomplished when there is less tin than antimony present.

The Committee on the "Action of Light on Dyed Fabrics" has also been active during the past year, a large number of dyed fabrics having been tested in this respect.

Advantage was taken of the favourable position of Liverpool to inspect several of the more important chemical works in the district.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE President of this Section devoted his address mainly to stratigraphical geology, and we may well follow his example, and consider the papers presented to the Section in a similar order. Beginning with the oldest rocks, the first paper to claim attention is that by Sir W. Dawson, on pre-Cambrian Fossils. A valuable portion of this paper summarised our knowledge of the succession of Canadian rocks of high antiquity. He regards Matthew's *Protolenus* zone of New Brunswick as the equivalent of the *Olenellus* zone, and beneath this occurs a mass of greenish slates and conglomerates with a few doubtful fossils, such as brachiopods, ostracods, and protozoans. These Etcheminian rocks rest on the Huronian rocks, which contain worm-burrows, sponge spicules, and laminated forms comparable to *Cryptozoon* and *Eozoon*. Under these comes the Grenvillian system, or Upper Laurentian rocks, with *Eozoon* in the limestones, and at the base the orthoclase gneiss and hornblendic schists, which constitute the Lower Laurentian. The author exhibited a series of lantern slides showing the structure and composition of *Eozoon canadense*, amongst them being many very beautiful decalcified specimens, which none of those who criticised the paper attempted to explain.

Dr. G. F. Matthew's paper, which followed, endeavoured to recognise the larval characters of entromostraca, brachiopods, and trilobites in those faunas which preceded that of *Paradoxides*. He showed that in the young of trilobites from the *Paradoxides* beds the following larval characters were striking: (1) the predominance of the cephalic over the caudal shield; (2) the long, narrow, parallel-sided glabella; (3) the absence of eyes; (4) absence of movable cheeks; (5) absence or smallness of thorax; (6) the pygidium is at first small and of one segment. Such larval characters are to be observed in pre-Paradoxidian trilobites, and the author particularised *Ptychoparia*, *Solenopleura*, and the trilobites of the *Protolenus* fauna, such as the type-genus, *Ellipsocephalus*, and *Micmacca*. Similar conclusions were arrived at with regard to the Obolidæ, and to such ostracods as *Beyrichonia* and *Hipparicharion*.

Sir Archibald Geikie referred to some rocks, hitherto described as volcanic agglomerates, in Anglesey. Although the material of which the rocks were composed is volcanic, he now regards the brecciated and conglomeratic structure as due to earth-movement. The hard bands have been broken and rounded into fragments, the softer crushed and stretched out into a broken slate or phyllite.

Mr. Greenly dealt with a similar subject, and he referred to the quartzite lenticles, which about Beaumaris vary from one-quarter of an inch to one foot in length, but at Pen-y-parc attain a length of 700 feet, to the action of earth-movement. They were originally beds, but had been crushed and pinched off till they formed mere lenticles. The same author announced the discovery, in Central Anglesey, of bands of Sillimanite gneiss occurring where the gneiss is traversed by sills and bands of granite, to which there are no chilled edges. These Sillimanite gneisses are like those described by Mr. Horne and the author from Eastern Sutherland, where they are also associated with hornblendic gneiss of Hebridian aspect.

Ancient rocks of a very different character were dealt with by Mr. W. W. Watts, who gave some notes on his recent work in Charnwood Forest. The volcanic rocks had been mapped in detail on the six-inch scale, and the divisions correlated from one part of the country to another. Their age was still in doubt, but was not likely to be newer than Cambrian, while the unlikeness to the Cambrian system is shown at Nuneaton, and the direction of movement in the anticline pointed to a greater antiquity. A set of views was shown to illustrate the remarkable character of the scenery produced by the old rock, whose features dated back to pre-Triassic, and probably pre-Carboniferous, times. The old hills and valleys were beautifully preserved under a mask of Triassic marl, which was only now being slowly removed in places.

Messrs. Howard and Small made a very interesting communication on the rocks of Skomer Island, likewise illustrated