In connection with his psycho-physical law, Hering develops his theory in a mathematical form, which may be omitted here.

The theory of Hering has not the same wide bearing as that of Young and Helmholtz. It relates exclusively to the central processes. These are supposed to correspond to the sensations, to which we readily agree. No attempt is made to find out what is going on in the retina, under the influence of light; no attempt to follow the retinal processes up to the brain; even no attempt to point out the relation between light and sensation. The whole theory is based upon the sensations, and on the supposed corresponding processes (of D and A) in what is called, in the most general sense, *optic substance* (*Seh-substanz*).

I consider, therefore, that the theory is incomplete. Still, having been set forth in lucid terms, and logically developed; being also simple in its conception, and easy of comprehension, it has been received with assent by some physiologists, but chiefly by ophthalmologists.

At first sight, it appears to account in a nice and simple way for every form of colour-blindness. Where R and G could not be distinguished, they might be regarded as absent. It was simply *red-green blindness*, as they call it, neglecting every difference between red-blindness and green-blindness. Yellow and blue would be the only remaining sensations.

But we have seen that this is quite a mistake. A slight notice of the degrees of saturation and intensity of the colours in the different parts of the spectrum would have prevented it. R and G are confounded, not because they are absent, but because they belong to the same colour, W, of the dichromic system, being at the same side of the neutral stripe N; and Y, belonging quite as much to W, is not any better distinguished from red or green, provided they acquire the same saturation and intensity (e.g., on the revolving disc, by adding the required black or white). There cannot be a question of Y remaining, and of R and G being absent. For all of them, it is the same sensation, most likely approaching more to the red in green-blindness, more to the yellowish-green in red-blindness. To suppose that green and red are simply absent where they are confounded, is quite the same as to declare blue and violet absent because they cannot be distinguished the one from the other.

Objections have been advanced against Hering's theory, either directly or indirectly, by Bruecke, Von Kries, Küster, Kitto, Fick. In my own opinion, also, Hering has not succeeded either in his contention against Young and Helmholtz, or in making good his own theory.

My chief objections are these.

1. Wt and Bk may (generally speaking) be opposed to each other, as D and A; but there is no reason for opposing in the same way R and G, Y and Bl. Even Hering does not try to determine which of each pair should correspond to D, which to A. In fact, they all four are active in their specific line; all are in the same relation to D and A. Each of them is opposed to A, corresponding to Bk, the negative of Wt, and of every colour.

2. The simple colours are not *complementary*, as Hering's theory asserts. The complementary of R is not G, but bluish-green; that of Y is not Bl, but violet-blue. How, then, can they be considered antagonistic, as in Hering's theory they are?

3. The complementary colours (and the two colours of Hering's pairs) do not annihilate each other, but combine into white. This is proved by mixture. E.g., in the double spectroscopic violet (a saturated colour) and intense yellow, covering each other halfway, produce a white manifestly more intense than the yellow. Another yellow, equal in luminosity to the violet used, joined to the same intense yellow, does not produce a yellow intenser than the white resulting in the first experiment. Now, according to Hering's theory, the luminosity should be the sum in the last, the difference in the first; but manifestly it is the same in both.

Two complementary spectrum-colours, s and s' , pass through two slits illuminating the fundus of a dark chamber; I found, if $s = s'$, also $\frac{s+s'}{2} = s = s'$. I tried, also, to compare the acuity of vision at $\frac{s+s'}{2}$ and s or s' . The experiment presented a difficulty: in violet, blue, and even in green light, the retina, after being allowed to become sensitive by repose in darkness, presents a great central scotoma, occupying the yellow spot, and making it impossible to distinguish any letter at a luminosity under which, in red light, reading is extremely easy. Here we were reduced to experiments with indirect vision. Of this, the acuity was found equally good at $\frac{s+s'}{2}$ as at s or s' .

The scotoma mentioned I do not venture to explain. One of my assistants, Dr. Waelehl, is pursuing these interesting phenomena with the greatest care and industry.

4. White is not a direct, independent sensation: it is absent in the spectrum, where, in red-blindness or violet-blindness, the specific colour is absent.

5. The theory of Hering is quite insufficient to account for the different forms of colour-blindness.

AN ADDRESS

ON THE

STUDY OF PHYSIOLOGY IN RELATION TO MEDICINE.

Delivered at the opening of the New Physiological Institute, Trinity College, Dublin, November 1st, 1880.

By J. M. PURSER, M.D.,

King's Professor of the Institutes of Medicine.

ALTHOUGH the delivery, at the commencement of the session, of a formal introductory lecture has been wisely discontinued at this, as at most of the other Dublin schools, yet, on an occasion like the present, I feel it would be ungracious to you, and ungrateful towards my colleagues and the heads of the college, were I at once to plunge into the subject of our course without first bidding you welcome to this new building, and trying to present to you, as it were, a programme of the studies to be here followed, and without expressing publicly my sense of the wise and far-sighted liberality of the Board, who have, even at a time when money is not plentiful, supplied the necessary funds for the erection, furnishing, and maintaining of this institute. In this matter, I feel I may express your gratitude as well as my own; for, although my facilities for teaching are much advanced by the convenience which this place will afford, it is for your sake that the work has been done, and it is you who will benefit by the advantages which the ample space and appliances of this place offer. In this, as in most of the improvements in this school, the chief credit lies with Dr. Haughton, who, with the committee of which he is chairman, has in the kindest manner fallen in with all my suggestions, and in every way facilitated the carrying out of my wishes.

[Professor Purser, having contrasted the difficulties under which former courses of his lectures were conducted, in consequence of the ill-suited accommodation available, with the facilities which would now be at his disposal, to the great advantage of both student and professor, continued as follows.]

And now, gentlemen, I should like to endeavour to point out to you the position which the studies you have to pursue in this place occupy in regard to the whole course of your medical studies. It is too much the opinion among students, that each subject which they take up is distinct in itself, and has no relation to the other subjects in the course; that the chief object of anatomy is to pass the half, and that, once this is done, anatomy has served its purpose, and may be dismissed from the mind, in order to make way for those subjects whose utility will appear at the M.B. And I think we professors do not take sufficient pains to point out to you the connection which the different subjects we teach have with one another. I know that I am not singular in feeling that we take too little cognisance each of what the other is teaching; and that we endeavour too little to make our lectures and courses of practical instruction complementary one of the other, and continually to point out the unity of the whole medical curriculum. The ground which has to be traversed by a medical student in four years is enormous; and it is only by seeing clearly from the outset the whole lie of the country, and the course of the roads, that he will be able to make a straight and successful journey, avoiding false turns which may lead him altogether astray, or compel him to traverse the same part of the road twice over, and thus involve loss of time and energy.

The main point, I think, for students and teachers to bear in mind, is this: that you came here to learn medicine and surgery, not to be made anatomists, chemists, or physiologists; and that, if it were possible to teach you medicine and surgery as these should be taught, without teaching you anatomy, chemistry, and physiology, it would be dishonest on the part of the College to compel you to study these sciences, which are sometimes called accessory, but which I would call fundamental with regard to medicine. But this University does not believe this possible, and the smallest consideration will show the justice of this opinion.

The idea of the possibility of separating the study of medicine from that of the sciences on which it is based, is supported by the practice which prevails in this city more than anywhere else, and which is encouraged, I think mistakenly, by many eminent teachers; that is, the practice of attending hospital in the first year. To many students, this does no more harm than the loss of time involved; but to others, the injury is never recovered from. The injury consists in this: the student, after for a time attempting to understand things which, for want of preliminary knowledge, it is impossible for him to understand, gives up in despair, and becomes content to hear phrases and words which carry no meaning to him, and to use and repeat these expressions without having any clear understanding of their import, and to become addicted to that most pernicious and common habit, so fatal to all accurate thought and scientific advance, the habit of what the French call *paying oneself* with words. There is no feeling I would try to encourage so strongly in a student's mind, as the feeling of discontent which the knowledge of a word without a knowledge of its meaning should engender. But I am afraid this feeling of discontent finds but little place in the breasts of most students; and this fault is, in my opinion, largely due to their beginning their studies at the wrong end, and trying to learn the most complex and difficult things before they have mastered, or even begun to learn, the comparatively simple and easy elements of which these are composed.

The public have an idea of disease somewhat of this kind. They look on disease as something altogether distinct from the person diseased; and each disease has its own peculiar antidote, by which it may be expelled from the body it has invaded. This is the parasitic theory of disease in its crudest form, in which each disease or symptom is like a wild beast; and, as we can know the appearance, manners, and customs of a tiger without knowing anything of the man he eats, so we can know all about measles or small-pox without knowing anything of the body which is affected by these diseases. Many think that the study of the body in health is "theoretical", and something quite distinct from the study of the body in disease, which is "practical". But, gentlemen, this is not the medicine we wish to teach you. We wish you to know that, apart from the diseased man, we know next to nothing of disease; that disease is known only by the reactions which it produces in the animal body, by the disturbance it causes in the various functions; and that, unless these functions are known as they are performed in health, unless the various laws regulating their performance, the various means by which their performance can be influenced, are well understood, there can be no rational diagnosis of what are the disturbances under which the patient labours, or how the disturbed function can be brought back to its normal state.

An example will illustrate the two schools of medicine. Three patients come to you, all complaining of the same symptom, bad breathing or dyspnoea. The greater number of patients look on this symptom as a morbid entity, to be specifically treated, and to be exorcised out of the body by a more or less nauseous bottle. The enlightened practitioner, however, says to himself, "Here is a person suffering from dyspnoea, from a disturbance of the great function of respiration. This function, in order to be normally performed, involves three things: 1. The air must freely enter and leave the lungs; 2. The blood must flow freely through the pulmonary vessels; 3. The blood must contain sufficient hæmoglobin to carry the oxygen from the lungs to the tissues." In other words, the disturbance of respiration may be caused by lesion in the lungs, heart, or blood; and, examining with this view his patients, he finds that one has bronchitis—his air-tubes are choked with fluid, and the entrance of air is prevented; another has valvular disease of his heart, which prevents the even flow of blood through the lungs; while the third, with healthy heart and lungs, has a blood deficient in colouring matter. How these differences affect treatment is evident. Now, it would be a very easy thing, if such existed, to have what is vulgarly called a tip, or, scientifically, a specific, for bad breathing; while, to unravel the cause of bad breathing, or any other disturbed function, is difficult, and involves a knowledge of the healthy function, or, in other words, of physiology. And recognising this, and wishing you to follow the true, although difficult, path to real knowledge, the university has put physiology where it ought to be among the subjects which you are advised to study early; and, to facilitate your study, this place has been built.

Now, what is physiology? or what are the phenomena of the living body in a state of health? Many of these are of a purely physical character, such as the formation of the image on the retina, in a large part the circulation of the blood, the mechanism of locomotion, and many others. Others are purely chemical, as the change of the food in digestion, the taking up and giving off of oxygen by the blood, and a host of others. These are merely manifestations in the living body of the same

physical and chemical phenomena which are manifested in dead matter; but, as they form such a very important part of the processes which go on in the living body, it is necessary to learn physics and chemistry, or to learn to understand these phenomena in their simple manifestations, before you study them in the body, where they are much more difficult to investigate and understand. Besides these, we meet in physiology a large class of phenomena which can be explained neither by physics nor by chemistry; these we call vital, because they are peculiar to living beings. Now, persons who do not know any better, and some who ought to know better, object to physiologists, "You are following after a vain shadow. Your first business is to find out what life is, and yet you know no more of this than was known a thousand years ago." The plain answer to this is, that it is quite possible to study the phenomena of life, and the laws regulating these phenomena, without knowing anything of what life itself is. The laws of light were well studied while it was believed to be caused by particles of matter emanating from the luminous body. The laws of electricity were successfully investigated before anything was known, if, indeed, anything is yet known, as to what electricity is. So of the other physical forces, and the laws of chemical affinity; and, by the same experimental method, the laws of life must be studied, and are being studied, with a success which, considering the enormous complexity of the problems, is truly amazing. And, in considering the place of physiology among the sciences, you will see that it is an experimental science, much more closely allied to physics and chemistry than to comparative anatomy, zoology, or systematic botany.

On the importance of a study of human anatomy, however, it is unnecessary to insist. It is manifest that the first thing which must be done, in order to understand the working of a complex machine, is to know the parts of which it is composed; and every child recognises this, for, if you give it a mechanical toy, it takes the first opportunity of breaking it up, to see what the inside is made of. So, gentlemen, you are directed to begin your studies by breaking into the wonderful machine of our body after it has come to rest, and to learn how its various parts are constructed.

Thus I divide your studies into three great parts, each dependent on that which went before it: 1. Anatomy, physics, and chemistry—three independent studies; 2. Physiology, which involves all these; 3. Pathology, or morbid physiology, or medicine, whichever you like to call it, which involve all that went before.

Now, gentlemen, I have said your business here is to learn medicine; and you learn the other subjects only as stepping-stones to this. You do not come here to be made anatomists, or chemists, or physiologists. If you want to be an anatomist, you must give your life to it; and so of the other sciences. But you learn those parts of these sciences which are essential, in order that you may take the next step safely: so much anatomy, physics, and chemistry as are essential for physiology; so much physiology as is essential for medicine, of which you should know all that is known. Now, here I wish to point out what seems to me to be one of the chief uses of lectures. In his admirable inaugural address last year, Professor Macalister stated that one of the most important uses of lectures was to keep the student in advance of his text-books, by bringing under his notice new discoveries of importance—thus teaching him more than his books. This is unquestionable; but I would say that the chiefest use of lectures is to teach less than is in the text-books, but to teach it in a different way. In the text-book, the importance given to each part of a science is in relation to the other parts of the same science; and this is the relation they should hold, if you were about to learn the science for its own sake. But, in our case, each science is taught in order that the next may be learned; and hence to some parts an undue prominence should be given, while others should be passed over lightly, or altogether avoided. In this way, what may be called a partial and distorted view of each science is taught. Of course, it would be better if all medical men were complete anatomists, chemists, and physiologists; and, if your life could endure for a thousand long years, you might hope to become so; but in four you had better not expect to be able to accomplish this. Now, it would be easier to guide yourself through the complete study of a science than through such a partial one as that which I have described. In such a study, you must have the guidance of one who knows the whole subject, and can apply its parts in such a way as to support safely the great structure which is to culminate in a knowledge of medicine. Moreover, in such studies as ours, which deal with sciences that are continually fluctuating, the partial views of each of these which should be given the medical student are continually changing; and it is by presenting these changed pictures, as they arise, to his class, that the lecturer has the advantage over the writer. This value of lectures will, I think, never be superseded.

As I said before, I feel strongly—and I know this feeling is shared by

some of my colleagues—that there is not sufficient combination among us; that we each know too little what the other is teaching. In the ascending scale of studies which I sketched, each teacher should teach with a view to his successor, and each should be able to refer to what his predecessor has taught. Although I admit my deficiencies, I have for a long time tried to do this. I omit some chapters of physiology almost completely, which, although long and difficult, have but little bearing on medicine, in order to devote myself to those subjects whose understanding is essential in almost every clinical case. And many of you know that, in the hospital, I am never tired of showing how every case, from the simplest to the most severe, must be investigated by reference to the teachings of physiology.

You live, gentlemen, in a transitional period of medical education. You are compelled to take advantage of the modern practical methods of instruction, while you are not as yet emancipated from one of the great abuses of the old system, namely, the excess of lectures you have to attend. When, on this day, twenty-two years ago, I became a medical student, and heard my first lecture in this school, there was no practical instruction given here or elsewhere in Dublin, except practical dissecting-room anatomy. We used to hear the professor of chemistry sometimes speak of the chemical laboratory; but, so far as I know, no medical students ever worked in it. There was not a microscope in the whole school; nor, with the exception of Dr. Bennett, then himself a student, any one in the school who could use one. There were, practically speaking, no museums; and the extent to which anatomy was studied may be judged of by the fact, that the anatomical lectures were given to a scanty audience in the room which is now Dr. Aquila Smith's museum. Yet in those days we found the number of lectures quite enough to leave us little time for independent work. Now, while the number of lectures has increased, you have, in addition, two laborious and long courses of laboratory work to attend. Everyone admits that the present lecture system requires to be completely recast; but the practical question how this is to be done—to what branches of this overgrown tree the pruning-hook is to be laid—is not so easy to settle. Before long, however, I think some change must be made; and, although I cannot tell you what this change will be, I can pretty confidently tell you the direction in which it will tend. It will diminish the number of hours you are compelled to sit on benches listening to lectures, and will increase the number of hours you will be required to spend in using your eyes and fingers and brains in practical work in the dissecting-room, in the laboratories and museums, and in the most important practical department of all—the wards of the hospital. Whenever this change comes, it will be seen that Trinity College is not unprepared for it. Our school is now well provided. It has an unrivalled chemical laboratory, a noble dissecting-room; its pathological and anatomical museums are well housed, well arranged, easily accessible, and stored with ample and constantly increasing material; while this building, whose opening we celebrate to-day, will bear comparison with any similar institute in the kingdom. Of the work which has already been done in the other practical departments of the school it is unnecessary to speak. Here we are only beginners; we are only putting on our armour, and have our spurs yet to win; but we will endeavour not to fall behind our elder comrades. And I hope that throughout all time our three great practical departments—anatomy, chemistry, and physiology—will flourish side by side, and be a credit to the university and to our country.

HEBBURN.—This district has now lost the services of Mr. John Spear, through his appointment to the Local Government Board. The present officer of health, appointed, as it would appear, without being required to devote himself exclusively to public-health work, cannot be expected to rival Mr. Spear's sanitary activity; but it may be hoped that he will follow as closely as possible in the steps of his predecessor, and guide a reluctant authority into wise ways of thinking. Before he quitted office, Mr. Spear presented to the local board a report on the sanitary history of 1879, which records the lowest death-rate for Hebburn on record—20.1 per 1,000. The birth-rate (50.6 per 1,000) is unusually high; but Hebburn has a large youthful population. Doubtless to this high birth-rate must be ascribed in part the very large proportion (59 per cent.) of deaths under five years to the total deaths—a proportion which Mr. Spear records without comment. Zymotic diseases were by no means prevalent last year, the only one seriously fatal being whooping-cough. Twelve deaths were registered from diarrhoea, six in the summer quarter. The deaths from tubercular diseases numbered 34, of which 17, or 50 per cent., were caused by phthisis. Much still needs to be done in the direction of sanitary improvement. The question of the removal of refuse is especially one needing the early attention of the local board.

THE COMMUNICABILITY OF PUERPERAL FEVER BY THE MEDICAL ATTENDANT.*

By ANGUS MACDONALD, M.D.,

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It is difficult to imagine a subject within the whole range of practical medicine, on which it is more necessary that there should, if possible, be general agreement and acquiescence in reliable rules of action among professional men, than that which is the theme of the present paper.

According as correct views are accepted and acted upon by him, depend the peace of mind and comfort of the conscientious obstetrician in that sad hour of trial, which sooner or later falls to the lot of every experienced accoucheur, when it is his misfortune to meet with puerperal fever in his practice. Only by an intelligent and clear apprehension of the problem under consideration can just rules of conduct be established for the guidance of the obstetric practitioner, who is charged with the management of puerperal fever cases, so as to enable him to protect the interests of his patients on the one hand and prevent himself from being unnecessarily blamed or punished on the other.

It is accordingly of the highest importance that only correct and uniform ideas on the communicability of puerperal fever should be current throughout the profession. But it is more than doubtful whether at the present time such is the case. There appears to exist a kind of ill-defined dread of the ailment as a something whose degree of communicability is of terrible intensity, but the principles regulating which are very uncertain, so that the practitioner in a difficulty scarcely knows for certain what to do or not to do; what to avoid or not to avoid. With the exception of the writings of Dr. Matthews Duncan on this subject, the literature of puerperal fever contains few records of any efforts made to determine the limits in practice that may be allowable without risk, or to point out the value of modern antiseptics, when conjoined with strict caution, to deprive this calamity of at least a portion of its terrors.

As uncertainty of action on this head leads to much inconvenience and even danger, it is the duty of the physician-accoucheur, especially as on him centres the burden and the blame associated with an outbreak of puerperal fever, to do what in him lies to acquire and disseminate sound and reliable doctrines upon the subject of its transmissibility. This is all the more necessary, as there exists in the profession an undoubted tendency to press with undue severity upon the obstetrician in this matter, and to surround his path in practice with so many rules and restrictions as to remind one of the commands made by the Egyptian monarch of old to his Hebrew subjects in the matter of bricks.

The restrictions put upon the obstetrician, as a rule, take some such form as that he ought never to see a scarlet fever patient, or, in fact, any fever patient almost. As to erysipelas, he would hardly require to remain in the same district of the county in which a case of the disease is to be found; and if he happens to have a case of puerperal fever in his practice, then, in the interests of his patients, he must leave his practice for a period, varying according to his various advisers from eight days to eight weeks, or even more. It has been otherwise urged; and I have myself listened to a well-known physician, now deceased, when he argued that he believed the poison of puerperal fever entered the fluids of the medical attendant, and was evolved in his perspiration. Accordingly, such a person could not purify himself by any kind of ablation or disinfection, and unless he suspended the practice of his profession for a period sufficient to allow of his secretions removing the whole poison from him, his patients were not safe. Such a view is as grotesque as it is incorrect. I merely refer to it as an aggravated example of the kind of ill-defined ideas that float in the minds of the profession regarding the communicability of this disease.

But in passing we ought to ask whether the rules put upon us by some physicians and surgeons are acted up to by themselves, when placed in similar circumstances.

Suppose a physician is called to see a case of scarlet fever, does he for the next week or a fortnight decline to attend any case of pneumonia or of phthisis, except in the case of patients protected by a previous attack of scarlet fever? Or suppose a surgeon meets in his practice a case of phlegmonous erysipelas or of pyæmia, does he at once announce his determination to relinquish his practice for a week, or even a day, and hand over his amputations and resections, etc., to another? The answer to such questions is, that no one ever dreamed that such was necessary.

But I reply that those who are so fond of imposing hard terms upon

* Read in the Section of Obstetric Medicine at the Annual Meeting of the British Medical Association in Cambridge, August 1880.