

optic nerve. Light passes across these, but it does not excite the nerves in passing through them. The nerves are transparent, and the light produces no effect upon them directly. If it did, your whole field of view would be confused, because it is known that when a nerve is excited the sensation is referred to a particular part no matter where the nerve may be affected. Suppose you could isolate, say in the thigh, a particular nerve leading to the great toe, and pinch it without hurting its neighbours, you would feel the pinch not where the nerve is pinched, but in the great toe. So, here, if these nerve-fibres were excited by the passage of light through them, then the sensation corresponding to the excitement of a particular nerve-fibre, which would be that of a definite point in the field of view, would be excited by an external luminous point lying anywhere in the curve in which the surface generated by a straight line passing through the optical centre and intersecting the fibre in question would cut what we may call the celestial sphere, and the correspondence between the subjective points in the field of view and objective external points would be lost. And the fact that the visual nerves are not affected by light which passes across them is further shown by the well-known experiment of the blind spot, where the optic axis passes out of the eye-ball, not in the axis of vision but to one side, towards the nose, so that an object whose image falls on the blind spot of one eye is seen by means of the other.

But now comes a question, and here we enter on uncertain and debated ground—How is it that the nerves are stimulated by the light at all?

We have reason to believe that these rods and cones form the means by which the light, acting on them, causes the stimulation of the nerve. As I have said, they consist of two elements, an inner and outer; the outer from the centre of the eye, *i.e.* the inner as regards the body, being of that remarkable structure which I have described. It has been questioned which of these two elements it is that you are to regard as the percipient organ. I do not know that physiologists have decided that question. I have looked into a paper of Max Schultze's—in fact I have it on the table—and he inclines to the opinion that it is the outer element. Now is there anything in the outer element which can conceivably form a means of stimulation of the nerve, when that element is acted on by light?

I have spoken of the way in which it is composed of laminae which come to pieces when dissected, after a certain amount of maceration. I do not know whether it may not be rash to say what I am about to say, because I do not know that physiologists have suggested it—it is merely an idea which occurred to myself, so you must take it for what it is worth. I was reading an account of the electric organ of electrical fishes, such as the torpedo. It is a very remarkable organ, occupying a considerable space in these fishes. It has a columnar structure, and the column again consists of laminae placed one over the other. It has a structure which may roughly be compared to that of the basaltic columns in the Giant's Causeway, only here you must think of laminae as more numerous and not having that curved surface shown in the Giant's Causeway. Now nobody questions that somehow or other this is an organ by means of which these fishes are enabled to give a shock, and the idea, of course, is suggested, are not these laminae like the plates of a battery? Is not one of these columns, roughly speaking, something like a galvanic battery? But how the battery is charged and discharged we do not know. In this case it depends, no doubt, on the will of the animal as to what he does, and nobody knows how he brings that about.

Now it strikes me that there is a remarkable apparent analogy between the outer member of the rods and cones, and these columns in electrical fishes. This gives rise to the suspicion that possibly these outer members may act the part of a microscopic battery, being charged somehow or other. But how are they to be charged? Well, before I go on to enter into any speculation on that I may mention that some years ago Prof. Dewar and Mr. McKendrick made some remarkable experiments, the results of which are given in a paper published in the *Transactions* of the Royal Society of Edinburgh. When an eye is dissected out, and the cornea is connected through a wire with non-polarising electrodes to the middle of the section of the optic nerve, the wire being led through a delicate galvanometer, it is found that there is a certain amount of electric current passing. Now it was found that when the eye (having been in darkness) was allowed to have light shining upon it, there was a change in

this current, and a change again when the light was cut off. It is true that the total change was only a small fraction of the whole; but still that there should be any change at all produced by the action of light is a remarkable thing. It looks very much as if the stimulation of the nerve had something or other to do with the production of electric currents; but those, if they are produced, we must suppose to be produced in some way by the action of light. How may we imagine light to act so as to produce them? It has been discovered that in the layer of pigment cells in the retina there is a substance, called visual purple, of a purple colour, which is acted on by light, and is made first yellow and then nearly colourless. We have thus a substance that is capable of being acted upon by light, as very many substances are. I do not say that it is by any means proved that that is the substance, or even that there is any substance, which is acted upon by light in the way demanded; yet it seems very probable that the change produced by the action of light, whether it be on visual purple, or some other substance associated with it, may give rise to something which may, so to speak, charge this microscopic battery and stimulate the nerve-fibre which is attached to it. We know the rate of the vibrations of light of various kinds; and the rapidity of vibrations is so enormous, ranging about 400 millions of millions of vibrations in a second, that we can hardly imagine that the organism of our bodies is calculated to be set in vibration in a corresponding period. In that respect the sense of sight differs notably from the sense of hearing. In hearing the tympanum of the ear is thrown into vibration, and the vibrations are not so enormous in number in such a time as one second but that the corresponding nerves may actually be mechanically agitated, and thereby in some way stimulated. We can hardly imagine that the visual nerves are acted upon in this sort of way directly by the luminous vibrations, but they may be indirectly. Here, again, I may throw out a possible conjecture, though I am less disposed to receive it myself than that which I have just mentioned. We know there are substances which when acted upon by light continue to shine in the dark. In some cases the action ceases almost instantly after the exciting light is cut off; for instance, a solution of the salts of quinine, where the rapidity of cessation of the effect is amply sufficient to tally with the rapidity of cessation of visual sensation when light is cut off.

There are various other matters connected with the perception of light which are of great importance to our well-being and to our enjoyment which I have not ventured to touch upon at all. It would take a great deal too long to go into two which I will only just mention. One is the provision in the two eyes, and in the muscles which move them, which enables us to obtain single vision notwithstanding that the two eyes are at work. Nothing is easier than to obtain double vision in which the images seen by means of two eyes occupy different positions in the field of view. There are very remarkable contrivances for bringing about singleness of vision in the habitual use of both eyes.

Then, again, we do not see light merely as light, but we see a great variety of colour. We can distinguish one light from another light by its colour, and not by its intensity only. It would take me a great deal too long to give you any idea of what is known (which after all is not much) as to the way in which that is effected.

#### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Woodwardian Museum has been greatly enriched by the generosity of Prof. T. Wiltshire, Treasurer of the Geological Society and Secretary of the Palæontographical Society, who has presented to the University a large collection of Cretaceous fossils. The collection includes nearly all the known British species, as well as many not yet described. This addition will probably make the Woodwardian collection of Cretaceous fossils the finest in the country. The thanks of the University have been voted to Prof. Wiltshire, who is himself a Cambridge graduate.

Sir William Turner, F.R.S., of Edinburgh, has been appointed an Elector to the chair of Anatomy, and Lord Walsingham, F.R.S., an Elector to the chair of Zoology and Comparative Anatomy, in place of the late Right Hon. T. H. Huxley.

The Vice-Chancellor, Mr. C. Smith, Master of Sidney Sussex College, is suffering from the shock of a fall from his bicycle last week, and will probably be unable to resume his duties for some

time to come. We learn, however, that he is making satisfactory progress towards recovery. The Provost of King's College, late Vice-Chancellor, is acting for him.

DR. A. WEISMANN has been granted the degree of Doctor *honoris causâ* by the University of Utrecht.

Science states that at the annual meeting of the Chicago Alumni of Mount Holyoke College, on October 24, Dr. D. K. Pearson offered to give £30,000 to the College, provided the alumni would raise an additional £10,000.

A MEMORIAL from the London School of Medicine for Women was considered at a meeting of the Council of the Royal College of Surgeons of England, last week, and it was resolved that—"The Council of the Royal College of Surgeons of England, although in favour of granting the petition of the officers and teachers of the London School of Medicine for Women, do not see their way to admit women to the Conjoint Examination in face of the adverse vote of the meeting of the Fellows and Members of this College and the expressed opinion of the Royal College of Physicians."

At a meeting of the Council of University College, Dundee, on Monday, the question of the relations of the college to St. Andrews University was considered. It was decided to address a letter to her Majesty's Commissioners expressing the willingness of the Council to consider carefully any suggestion from the Commissioners with a view to removing the difficulties in which, by recent events, the University and the college had been placed, and in particular to meet the Commissioners and the University Court to discuss anew any proposals which might form the basis of a new agreement between the two institutions and secure to each the advantages provided for in the Universities Bill of 1889.

THE following are among recent appointments:—Prof. S. L. Barton to be professor of mathematics in the University of the South, Seewanee, Tennessee; Dr. A. Macfarland to be lecturer in physics in Lehigh University; Dr. G. B. van Vleck to be associat. professor of mathematics in Wesleyan University; Prof. C. A. Waldo to be professor of mathematics at Purdue University; Prof. K. Zickler to be professor of technical electricity in the Technische Hochschule at Brünn; Dr. R. Dzieszlewski to be professor of the same subject at Lemberg Technische Hochschule; Dr. F. Mehres, extraordinary professor of physiology in the Bohemian University at Prague, to be professor; Dr. F. R. von Höhnelt to be professor of botany and technical microscopy in the Technische Hochschule at Vienna; Dr. H. Klinger to be professor of chemistry at Königsberg; Dr. E. Waelsch to be extraordinary professor of mathematics in the German Technische Hochschule at Brünn.

A CONFERENCE of the leading teaching and examining bodies of the kingdom and of representative County Councils which are in a position, under the County Councils Act, to contribute funds for the purpose of technical instruction, was held last week, under the auspices of the London Chamber of Commerce, at Drapers' Hall, Sir Albert K. Rollit (President of the Chamber) presiding. The conference agreed to a resolution approving the principle of the co-ordination and simplification of the present system of examinations in commercial subjects, and the matter was referred to the Commercial Education Committee of the London Chamber of Commerce to consider details and formulate a scheme to carry this resolution with effect, it being understood that the Chamber would enlarge its Committee for this purpose by the addition of some members of the conference. Perhaps now that the Chamber of Commerce has taken steps to organise commercial education, it may go on, and, in the course of time, do something for instruction in science.

FROM statistics in the *Deutscher Universitäts Kalender* it appears that the number of persons attending lectures in German universities during the winter semester of 1894-95 was 33,021, of whom 8755 were in attendance at Berlin, 1587 at Bonn, 1350 at Breslau, 1168 at Erlangen, 1216 at Freiburg, 556 at Giessen, 843 at Göttingen, 775 at Greifswald, 1643 at Halle, 1230 at Heidelberg, 667 at Jena, 532 at Kiel, 737 at Königsberg, 3112 at Leipzig, 852 at Marburg, 3561 at Munich, 421 at Münster, 420 at Rostock, 980 at Strassburg, 1184 at Tübingen, and 1492 at Würzburg. At Berlin, however, the matriculated students numbered only 5631, the remaining 3724 being persons who had received permission to attend lectures without being enrolled as

*cives academici*; at Leipzig there were 127 of such students, and at Munich only 86. In the law department (including camera-lics and forestry) there were at Berlin 1667, at Leipzig 985, and at Munich 1230 students; in the medical department (including surgery and pharmacy) at Berlin 1220, at Leipzig 752, and at Munich 1168; in the philosophical department (including philology, mathematics, &c.) at Berlin 1660, at Leipzig 856, and at Munich 700.

SEVERAL noteworthy points are referred to in the Report of the City and Guilds Technical College, Finsbury, for the session 1894-95, in addition to the usual statistics and statements as to the number and quality of the students and the work of the different departments. During the session a number of students entered the College with scholarships from various County Councils and other bodies. A few of these were able to obtain the full benefit from the instruction given, but some of them had gained their scholarships when too childish to benefit properly by the College system. Others suffered from imperfect preliminary training, having been crammed to pass examinations rather than trained how to learn. And the result of it all is that the Principal points out that care must be exercised in future, and influence brought to bear upon the educational advisers of the various County Councils as to their selection of scholarship holders. As a step towards the better selection of qualified candidates, it is proposed to introduce a slight modification into the entrance examination of the College. As with other Colleges on the same status, it appears that amongst the newly-admitted students every year there are a number who have never been taught to take notes, to write original descriptions, or even to use indices or books of reference. The presence of these students has been found greatly to retard the general course of teaching, and causes much waste of time. The time of lecturers and demonstrators is taken away from their proper work to teach the new students things which they ought to have learned at school. As a step toward remedying this matter, it is proposed in future to lay more stress upon the English subjects in the entrance examination, by giving them greater prominence, and by assigning higher marks for such as *precis writing* and composition. In concluding his report, Prof. Thompson has something to say about the future of the College. The large Technical Institutes which have sprung up during the past few years, in various parts of London, have affected the trade-classes at the College to a certain extent, and have also diminished the numbers of students attending the elementary classes. But these Institutes have only affected the elementary part of the work, and the indications are that the more advanced students from the elementary work of the Institutes should pass to the Technical College to carry it on. No institution in London is attempting to give in its evening classes instruction of so thoroughly scientific a character as is given at that College; the instruction is, indeed, admirably suited to supplement the work of the various Polytechnics. It is therefore proposed to develop the courses of special lectures given at Finsbury, and to raise the scientific standard of the evening class work, so as to make the College a focus for the higher branches of study, and for more specialised classes than those of the Technical Institutes.

### SCIENTIFIC SERIALS.

*Bulletin of the American Mathematical Society*, vol. ii. No. 1, October 1895.—The number opens with accounts of the proceedings at the second summer meeting of the American Mathematical Society, held at Springfield, Mass., on August 27 and 28, and of the proceedings at the meeting of Section A of the American Association, held at the same place, from August 29 to September 4. The papers at each meeting are given in abstract, and two of them are printed in full, viz. on the differential equations of certain systems of conics, by R. A. Roberts, and asymptotic lines on a circular ring, by Prof. Maschke. The results in the former paper are principally deduced by means of elliptic integrals and the first class of hyper-elliptic integrals, and from these are derived theorems concerning doubly infinite porisms of curvilinear polygons. The latter paper contains an application of elliptic functions to curves drawn on the surface of a circular ring.—Prof. F. Morley communicates a short note on a generalisation of Weierstrass's equation with three terms.—The notes contain various items of interest, and the list of publications is unusually full.