the exposure to direct sunlight. Possibly the temperature had some effect." It is further to be noted that in every case of induced apogamy "normal embryos were produced when conditions permitted fertilisation." Now the conditions of prevention of fertilisation, exposure to light, and possibly also a high temperature, all lead to a plethoric state, which we may thus recognise as a precursor of induced apogamy, possibly also of apogamy at large.

On the other hand, the circumstances which precede or accompany apospory are commonly those of deficient nutrition. In the case of Ugo Brizi's *Funaria*, it is mentioned that the capsules were atrophied and buried in the soil, where they could not obtain nourishment by their own assimilation. In the induced apospory of Stahl and Pringsheim the growths appear upon parts of the chopped up seta, isolated from their usual sources of supply. Among Ferns, the conditions of nutrition which precede apospory have not been noted in all cases; but the following facts are interesting. *Athyrium Filix-foemina* var. *clarissima* is a pale chlorotic Fern with exiguous leafage, while the more or less complete arrest of the sporangia is a concomitant of apospory. In *Polystichum angulare* var. *pulcherrimum* there is no obvious disturbance of the vegetative organs, but I have specially noted the sporal arrest, which, in the specimens examined by me, appeared to be complete. This is, then, a concomitant of apospory, though it may be uncertain how far there is a casual connection. In the case of apospory in *Pteris aquilina*, reported by Farlow, there is an irregular diminution of leaf-area in the pinnules which show apospory; this is accompanied by various stages of abortion of the sporangia, though some fully-matured spores were found. Here, as also in *Polystichum angulare*, the tips are specially affected. Farlow remarks, "the sporangia became more and more irregular the nearer they were to the tip." In the case of *Scolopendrium vulgare*, the plants which showed apospory at so peculiarly early a stage had been raised by Mr. Lowe from prothalli which had been repeatedly divided, a process calculated to affect the physiological condition. The aposporous plants of *Trichomanes alatum*, *pyxidiferum*, and *Kaulfussii*, were all cultivated under artificial conditions, and are characteristically shade-loving plants, a habit which must affect their nutrition. Perhaps the most interesting case, however, is that described by Atkinson in *Onoclea*. In plants from which, by removal of the foliage leaves, the sporophylls had been induced to change their character and develop as foliage leaves, the sori were arrested. "When the leaf has lost so much of its reproductive function that the sporangia are becoming rare or rudimentary in the sorus, apospory frequently occurs, and the placenta develops among the rudimentary sporangia prothalloid growths." Here is, again, a case of deficient nutrition; the assimilating leaves, after formation, but before they could have carried their functions far, were removed. The plant makes an effort to supply their place at the expense of spore-production; arrest of sori and sporangia is the result, accompanied by cases of the direct vegetative transition to the prothallus. From these examples we see that deficient, or, at least, disturbed nutrition is frequently, perhaps always, a concomitant of apospory. Thus there is some countenance for the view that apospory and apogamy follow on converse conditions of nutrition.

We may next inquire how these converse conditions may lead to the changes in question; and especially the state of the nuclei ought to be considered. Owing to practical difficulties of observation the behaviour of the nuclei in apogamy and apospory has not been directly followed. But if the nuclear difference between the two generations be as it is believed, nuclear changes will be closely connected with these vegetative transitions. What could appear more natural than that apogamy, which presumably involves a doubling of the chromosomes, should follow a condition of plethora, and that apospory, which presumably involves a halving of the chromosomes, should follow deficient nutrition?

One further fact in either case appears to me to be specially noteworthy, that the changes are not confined to a single cell. The directly apogamous bud of *Nephrodium Filix mas* may perhaps be referable to a single cell, but Dr. Lang shows by numerous examples that the transition from characteristic tissue of the gametophyte to that of the sporophyte may arise at various points, and involve considerable tracts of tissue. Similarly I have shown in the case of apospory that the change may affect not one cell only, but cell-groups at various and distinct points on the same individual. It would seem that there is a widespread disposition of the tissues to undergo the change.

For my own part, I think the usual attitude on the chromosome question has been too absolute and arithmetical. Evidence is accumulating from various sources that the usual numbers are not strictly maintained; it is known that in vegetative cells there are often considerable differences of the number of chromosomes from those in the sexual cells of the same plant, while observers have noted the irregularities in the divisions of the pollen-mother-cells in such plants as *Hemerocallis* and *Tradescantia*. If there be any causal connection between the number of chromosomes and the morphological character of the sporophyte and gametophyte, irregularities such as these at least countenance the idea of nuclear instability being possible; it will be a question for special treatment and investigation how far nuclear instability is connected with disturbed nutrition. But into the mechanism of the presumable nuclear change, and the question whether it be sudden or gradual, we cannot enter with any more than a speculative interest, in the absence of direct observations. Whatever the nuclear details may be, I regard it as a matter of very great importance to recognise that special conditions of nutrition commonly accompany, if indeed they do not actually determine, those changes which we term apospory and apogamy. But the story of the past is not simply a matter of conditions of nutrition, as we see them now influencing Archegoniate plants in their present highly specialised state. The real question is a purely historical one, How *did* the present state of things come about?

(*To be continued.*)

THE TEACHING OF SCIENCE IN ELEMENTARY SCHOOLS.[1]

YOUR Committee are able to report that the quantity, if not the quality, of the teaching of science subjects in elementary schools has made progress during the past year. The following table, made up from the return issued by the Education Department, gives the figures for the scientific class subjects as compared with English. In the report for last year it was mentioned that the number of school departments taking object lessons would greatly increase, as the Government code of regulations announced that they would become obligatory in the three lower standards on and after September 1, 1896. We now see the result, so far as the schools are concerned whose school year ended between August 31, 1896, and August 31, 1897, but the full effect cannot appear until the next year's return, the whole of which will be in the obligatory period.

Class Subjects—Departments	1890–91	1891–92	1892–93	1893–94	1894–95	1895–96	1896–97
English	19,825	18,175	17,394	17,032	16,280	15,327	14,286
Geography	12,806	13,485	14,256	15,250	15,702	16,171	16,646
Elementary Science	173	788	1,073	1,215	1,712	2,237	2,617
Object Lessons ...	—	—	—	—	—	1,079	8,321

The number of departments in "schools for older scholars" for the year 1896-97 was 23,080, all but 10 of which took one or more class subjects. But history was taken in 5133 departments, and needlework (as a class subject for girls) in 7397 departments, and sundry minor subjects in 1056, making, with the other four subjects of the table, a total of 55,456. This shows an average of more than 2½ class subjects to each department; but it must be borne in mind that the same subject is not always taken in all the standards, in which case three class subjects will appear in the return.

It was remarked in the last report that "the increased teaching of scientific specific subjects in the higher standards is the natural consequence of the greater attention paid to natural science in the lower part of the schools." The following table shows the correctness of this inference:—

[1] Report of the Committee, consisting of Dr. J. H. Gladstone (Chairman), Prof. H. E. Armstrong (Secretary), Prof. W. R. Dunstan, Mr. George Gladstone, Sir John Lubbock, Sir Philip Magnus, Sir H. E. Roscoe, and Prof. S. P. Thompson. (Read before Section B of the British Association at the Bristol Meeting.

Specific Subjects—Children	1891-92	1892-93	1893-94	1894-95	1895-96	1896-97
Algebra	28,542	31,487	33,612	38,237	41,846	47,225
Euclid	927	1,279	1,399	1,468	1,584	2,059
Mensuration...	2,802	3,762	4,018	5,614	6,859	8,619
Mechanics	18,000	20,023	21,532	23,806	24,956	26,110
Animal Physiology	13,622	14,060	15,271	17,003	18,284	19,989
Botany	1,845	1,968	2,052	2,483	2,996	3,377
Principles of Agriculture ...	1,085	909	1,231	1,196	1,059	825
Chemistry	1,935	2,387	3,043	3,850	4,822	5,545
Sound, Light, and Heat ...	1,163	1,168	1,175	914	937	1.040
Magnetism and Electricity	2,338	2,181	3,040	3,198	3,168	3,431
Domestic Economy	26,447	29,210	32,922	36,239	39.794	45,869
Total	98,706	108,434	119,295	134,008	146,305	164,089

It appears that the mathematical subjects still command the most favour on the part of the teachers, algebra having taken a very remarkable lead. All the physical sciences have increased even more than might have been expected from the increase of scholars. The principles of agriculture is the only subject that shows an actual decrease.

Estimating the number of scholars in Standards V., VI., and VII. at 615,000, the percentage of the number examined in these specific subjects, as compared with the number of children qualified to take them, is 26·6; but it should be remembered that many of the children take more than one subject for examination. The following table gives the percentage for each year since 1882, and shows that science is gradually recovering from the great depression of about eight years ago:—

	Per cent.		Per cent.
1882-83	29·0	1890-91	20·2
1883-84	26·0	1891-92	19·7
1884-85	22·6	1892-93	20·2
1885-86	19·9	1893-94	20·9
1886-87	18·1	1894-95	22·7
1887-88	16·9	1895-96	24·2
1888-89	17·0	1896-97	26 6
1889-90	18·4		

The Returns of the Education Department here given refer to the whole of England and Wales, and are for the school years ending with August 31. The statistics of the London School Board are brought up to the year ending with Lady Day, 1898. They also illustrate the great advance that has been made in the teaching of elementary science as a class subject, and they give the number of children as well as the number of departments.

Years	Departments	Children
1890-91	11	2,293
1891-92	113	26,674
1892-93	156	40,208
1893-94	183	49,367
1894-95	208	52,982
1895-96	246	62,494
1896-97	364	86,638
1897-98	322	70,626

The last year shows an apparent falling-off in the teaching of this subject, but, as has been mentioned above, the Government having made the giving of object lessons obligatory in the lower standards, 442 departments, with 75,993 children, have already adopted them. This has caused a reduction in the teaching of "Elementary Science" under that name; but, taking the two subjects together, this must be regarded as a very considerable gain.

The Education Department continues to meet the objection against the limitation under the Code by which only two class subjects are allowed to be taught, by adding combined courses of study. This year a new course of this character has been introduced into Schedule II., described as "Elementary Science and Geography Combined." And as, under the present regulations, one of the class subjects must be such as can be taught by means of object lessons in the lower standards, some such subject as the combined one above mentioned must be taken. A copy of the scheme is given in the Appendix, by which it will be seen in the lower standards the phenomena of the land and water are to be illustrated experimentally as an introduction to geographical science.

A similar principle has been adopted in respect of the specific subjects. Hitherto chemistry has formed a course of itself, and physics has been divided into two separate courses, the one dealing with sound, light, and heat, and the other with magnetism and electricity; but they formed only three out of the nineteen subjects from which choice could be made. A separate course of elementary physics and chemistry combined has now been introduced, which is set out in the Appendix, and which is admirably adapted for experimental investigation at the hands of the students themselves.

The work under the Evening Continuation Schools Code continues to progress, as will be seen from the following table:—

Science Subjects	Units for Payment							
	England and Wales				London School Board			
	1893-4	1894-5	1895-6	1896-7	1893-4	1894-5	1895-6	1896-7
Euclid	595	1,086	1,648	2.270	10	29	7	—
Algebra	3,940	6,657	10,374	14,260	316	302	535	714
Mensuration ...	14,521	32,931	41,772	50,748	279	374	452	369
Elementary Physiography	2,554	4,045	6,590	6,325	37	9	5	—
Elementary Physics and Chemistry ...	6,500	7,850	6,749	5,183	79	200	152	129
Science of Common Things	6,223	10,350	12,906	18,293	231	262	468	556
Chemistry ...	3,484	7,814	8,222	9 641	212	455	404	488
Mechanics ...	841	1,148	1,458	2,196	230	197	209	127
Sound, Light, and Heat ...	500	1,046	861	1.156	—	15	11	7
Magnetism and Electricity ...	2,359	4,451	5,073	6,990	662	776	783	939
Human Physiology...	5,695	8,395	7,825	10 047	91	68	56	49
Botany	336	547	905	1,080	5	91	97	32
Agriculture ...	3.579	4,991	4,694	4.061	—	—	—	—
Horticulture ..	438	1,140	1,812	1,911	—	—	—	—
Navigation ...	42	69	142	99	—	—	—	—
Totals ...	51,607	92,520	111,031	134,260	2,152	2,778	3,179	3,410

It is again evident that the mathematical subjects are rapidly increasing in favour, and that agriculture is decreasing. It will be noticed with satisfaction that the science of common things is receiving greatly increased attention, but it is a matter of regret that there is a decrease in the time given to elementary physiography, and still more so in the case of elementary physics and chemistry. Agriculture would become a more valuable and probably a more popular subject of study if a really good practical course were devised.

An important change has been taking place in Scotland. The Code of the Scotch Education Department now admits of the possibility of gaining the full class grant, although only two subjects are taken. As one of these must be English, and in the higher standards provision must be made for history or geography or both, the teaching of science as a class subject has been greatly reduced during the last two years. But a new article in the Code for 1895 offers a special grant of a shilling on the average attendance of boys who are satisfactorily taught "elementary science"; and this has far more than made up the deficiency. In fact the aggregate total of children learning elementary science in the Scotch schools has risen from 34,151 in 1894-95 to 85,671 and 133,855 respectively in the two succeeding years.

Your Committee have frequently referred to the anomaly that pupil teachers are not obliged to receive any instruction in natural science, although they may have to give instruction in such subjects, either specifically or in the form of object lessons; indeed, if they should be in charge of a class of the three lower standards it would be obligatory upon them to give such object lessons. A Departmental Committee, consisting of the Rev. T. W. Sharpe, Her Majesty's Chief Inspector of Schools, as Chairman, and several Inspectors and Principals of Training Colleges and Pupil-teacher Centres, have reported upon the pupil-teacher system. They recommend that the age for entering as pupil teachers should be raised, and that the interval between the elementary school and their apprenticeship should be passed at a secondary school. This would by no means ensure that the young people would receive any instruction in science during that period of their career. No alteration is proposed

in the optional science course prescribed by the Code of the Education Department, except that the Queen's Scholarship examination is to be limited to the elementary stage of physiography prescribed in the syllabus of the Science and Art Department. With regard to the college course the recommendation is singularly weak, science being placed as an optional subject, without any definite course of study prescribed. For the first two years it is laid down that of the optional subjects not more than two must be taken out of a list of four or six respectively, some of which from their very nature are almost sure to be taken in preference.

An important letter has been addressed to the Right Hon. Sir John Gorst by Sir Philip Magnus, the Chairman of the Joint Scholarship Board, in conjunction with the Chairmen of its four educational committees. They point out the necessity of securing the proper training of those who will be teachers of scientific subjects, and that the instruction of pupil teachers in science is now often carried on, under great pressure, by a system of cram, and even by persons who have not themselves any satisfactory knowledge of modern scientific methods. They suggest as a remedy that the first part only of the elementary stage, physiography, be compulsory; that the teaching of this subject be recognised only where it is given with proper accessories, all pupils performing the experiments in a series of at least twenty-four lessons of two hours' duration; and that inspectors should be required particularly to report whether proper apparatus and accessories are provided.

In last year's report your Committee referred to what Mr. Heller was doing in respect of the teaching of science in the schools of the London School Board. He has since obtained a better appointment at Birmingham, but the syllabus of lessons which he prepared is still employed in the schools. This of course requires that the masters and mistresses should be qualified for carrying it out, and for this purpose classes of twenty-four hours are conducted for their benefit by the science demonstrators. These gentlemen have lately agreed upon two separate syllabuses for masters and mistresses, which follow in general the scheme they are expected to teach to their scholars. The classes of a similar kind that have been carried on hitherto have been appreciated by the teachers, and the Board are increasing their laboratory and other accommodation for the purpose. It is recognised that it will be necessary to continue these teachers' courses for some years, in order to overcome the difficulty which now exists in consequence of the general want of practical experiment in such instruction in science as has been given in the course of training of most class teachers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 194th meeting of the Junior Scientific Club was held in the Physiological Lecture Room of the Museum at 8 p.m. on Wednesday, November 16. After the election of new members, Mr. A. F. Walden (New College) brought forward his motion respecting the appointment of a Committee to act with the Treasurer of the Robert Boyle Lecture Fund. The motion was carried, and the Club elected Mr. A. E. Boycott (Oriel) and Mr. A. S. Elford (St. John's) to serve on the Committee. Mr. A. D. Darbishire (Balliol) read a paper on natural selection among Lepidoptera. His remarks were illustrated by several cases of butterflies. Mr. J. E. Marsh (Balliol) followed with a paper on the constitution of camphor, in which he attempted to survey all the recent work on the subject.

MR. ERNEST WILSON has been appointed professor of electrical engineering at King's College, London, in succession to the late Dr. John Hopkinson.

DR. GIUSEPPE SANARELLI, of the Uruguayan Medical School and Director of the Hygienic Institute at Montevideo, whose discovery of the microbe of yellow fever has brought him much distinction, has, the *Lancet* states, been offered by Dr. Baccelli (Minister of Public Instruction) the chair of Hygiene in the University of Bologna, left vacant by Prof. Roncati.

THE two first formal steps towards the establishment of a Midland University, to be called the University of Birmingham, were taken on Friday last, at a meeting of the Court of Governors of Mason University College. In reference to the scheme, the Management Committee reported that, in their opinion, the University to be established in Birmingham should be a teaching University, as distinguished from a University which only examines students for degrees. The University should therefore have the control and direction of all the teaching as well as the examining of students. With this end in view the Committee recommend that, if an agreement can be made with the governors of Mason University College, the University should be allowed to absorb the college. In this case the college would cease to exist as a separate institution, and its endowments, buildings, equipment, and staff would be transferred to the University. The Committee have had under consideration the financial position of the University. They are of opinion that, in order to completely carry out the above scheme, an endowment of not less than 200,000*l.* is required beyond that already held by Mason University College. Such an endowment would just double the present endowment of the college. The Committee expressed their opinion that every effort should be used to at once increase the endowment fund in order that an endowment of not less than 200,000*l.* may be obtained to enable the University to start under favourable conditions.

Mr. Chamberlain moved the two resolutions, one recommending that steps be taken to absorb and include Mason College in the new University; and the second, authorising the Council of Mason College to take the necessary measures to obtain a Royal Charter for the establishment of the University. In presenting these resolutions Mr. Chamberlain remarked: "I think our ideal may be stated in a few words to be the creation in Birmingham of a great centre of universal learning, of an institution which should provide for the intellectual cultivation of mind in the broadest possible sense, and which shall maintain for ever in the city the highest standard of intellectual eminence. We desire that in this school all acquired knowledge should be taught and explained, and we further desire that knowledge should be advanced by original research, and by the willing co-operation of those who are engaged as professors and teachers. The enormous development of science requires undoubtedly an extended application of the means of instruction. Of course, there is special reason why science should take a very prominent place in connection with a University which is situated in the centre of a manufacturing and commercial district, and it would, in my opinion, be pedantry were we to pretend that we did not attach the highest importance to this branch of our work, and did not intend that it should be distinctly carried out and should give to the University a special position of its own."

REFERRING to the address delivered by Mr. Chamberlain on the subject of a University of Birmingham, and referred to above, the *Times* remarked on Monday: "Those who carefully study German commercial methods are well aware that the chief cause of German success at the present time is the German manufacturers' respect for science. There is at the present moment at Düsseldorf a chemical company which employs thirty-three trained chemists, picked University men, who are paid good salaries with a share of the profits due to any invention which they may make; this company pays very high dividends, and its business has increased by leaps and bounds. It would be interesting, but not encouraging, to learn what has been the parallel history of the chemical works on the Tyne. This points to one way in which a Birmingham University, properly equipped, worked and encouraged, may affect the commercial prosperity of the city."

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No 10.—Gravitational constant and mean density of the earth, by F. Richarz and O. Krigar-Menzel. The gravitational constant, *i.e.* the constant which has to be inserted in the equation for determining the attraction from the product of the masses and the inverse square of their distance apart, when C.G.S. units are chosen, was found by the method of weighing a mass at two different altitudes above the earth's surface. The result arrived at was $6{\cdot}685 \times 10^{-8}$. The value for the mean density of the earth was $5{\cdot}505 \pm 0{\cdot}009$.—Surface tension in narrow capillary tubes, by P. Volkmann. When measurements are made on freshly-drawn capillary tubes, the results are well in accordance with the known laws, whatever the substance and diameter of the tubes. In old and wide tubes the surface tension is higher