remain, and 90 per cent. of this gives 855 lb. of clean steam available for the turbine. "Since modern exhaust steam turbines with a full load and a vacuum of 28½ in. can be guaranteed under the above conditions to use not more than about 27 lb. per horse-power, this gives 31·6 horse-power per hour per ton of slag per hour."

In his paper on the use of liquid ferro-manganese in the steel processes, Mr. Axel Sahlin points out most of the methods of adding ferro-manganese are wasteful both from the point of view of heat efficiency and the percentage of manganese oxidised. He describes a new type of arc furnace invented by Mr. Ivar Rennerfelt, which he claims has been successfully used for this purpose. This furnace is fitted with three electrodes so placed that, when the current is turned on, the arcs, instead of passing directly between the points of the electrodes are deflected downwards, forming an inverted arrow-head or "fleur-de-lys" with a height of 6 to 12 in. Adjustment is made so that the point of the "arrow-head" impinges on the surface of the metal. Manganese smoke was noticed for a few minutes after charging, but then ceased to be evolved. The tests which have been carried out indicate that for the melting of one ton of 79 per cent. ferro-manganese, charged into an empty and pre-heated furnace, about 450 units are required. This corresponds to a furnace efficiency of 78–79 per cent., and is very much better than anything that has been achieved with other types of electric furnace. Moreover, analyses showed that there was not only no loss of manganese and iron in the melting process, but even a gain of 0·6 per cent. in each case.

The industrial production of electrolytic iron now appears to be entering the "practical" stage. An account is given by Prof. Guillet of the manufacture of such iron in the form of tubes of considerable size. The direct production of sheets is also contemplated. The iron is deposited on a revolving kathode from a neutral solution of iron salts (the composition of which is not given), the electrolyte being maintained neutral by the circulation of the liquid over the surface of the iron. From time to time the liquid receives additions of iron oxide with the object of reducing the deposition of hydrogen on the kathode. In this way currents of 1000 amperes per square metre have been successfully employed, and an iron of excellent quality is said to have been obtained. Analyses show that it is very low in the usual impurities even when prepared from very impure pig-iron. When freshly prepared it is hard and brittle, partly on account of the fact that it has been deposited in a condition of strain and partly because it contains hydrogen. The former aspect is well seen in the photomicrographs, which reveal a typical martensitic structure, and it is interesting to observe that the normal polygonal structure of a pure metal is not obtained until the annealing has been carried to 800°–900° C. Photographs of the crushing tests of tubes indicate a very remarkable degree of plasticity. The direct production of sheets without rolling would certainly be an important technical achievement and such material on account of its high degree of purity would have important applications in electrical machinery. H. C. H. CARPENTER.

PAPERS ON HEREDITY.

STUDENTS of heredity have followed with the greatest interest Dr. L. Doncaster's experimental and cytological work with the Magpie Moth (*Abraxas grossulariata*). In the last number of the *Journal of Genetics* (vol. iv, 1914, pp. 1–21, plates i–iii) he brings forward further interesting results on the relations between chromosomes, sex-limited transmission, and sex-determination in that insect. He confirms the observation that in a strain of Abraxas, which in each generation produces families consisting entirely of females, the oogonia have only fifty-five chromosomes instead of the fifty-six normal to the species. It is thus established that the females are here heterozygous as regards sex-character, whereas in many insects the males are known to be heterozygous. Dr. Doncaster found that one female of this remarkable strain carried fifty-six chromosomes, while other females of the same brood had clearly fifty-five. "In the same brood there was failure of sex-limited inheritance of the *grossulariata* character [as contrasted with the factor producing the variety *lacticolor*] in two cases, in such a way that the *grossulariata* mother transmitted this character to two of her daughters (out of a total of sixteen) instead of, as normally happens, only to her sons. It is suggested that this may be correlated with the extra chromosome found in one female of this family, the *grossulariata*-bearing chromosome having become separated abnormally from the sex-chromosome."

Another noteworthy recent paper on the problems of inheritance is Dr. Leon J. Cole's account of the relations of the principal colours in Pigeons (*Rhode Island State College*, Bulletin 158). He concludes that there are four principal factors concerned—two for the pigments black and red, an intensity and an extension factor. The absence of the intensity factor makes black dun and red yellow, while the absence of the extension factor produces blueness. "Reversion to the wild blue Rock Pigeon type in domesticated pigeons is due simply to a recurrence of the particular combination of factors which are present in *C. livia*." White plumage is explained by the presence of an unknown number of pigment-inhibiting factors which are supposed to check the appearance of colour on different regions of the body.

THE PLACE OF WISDOM (SCIENCE) IN THE STATE AND IN EDUCATION.[1]

"So soon as men get to discuss the importance of a thing, they do infallibly set about arranging it, facilitating it, forwarding it, and rest not till in some approximate degree they have accomplished it."—CARLYLE.

THIS, doubtless, is a true statement; the difficulty is, however, to persuade men of the importance of a thing. We come to persuade you. As an association we are now eighty-four years old: our main purpose has been to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress—let me also add, its application to culture and to the public service.

By holding meetings, year after year, in the principal towns of the British Isles, the association has at least brought under notice the fact that science is a reality, in so far as this can be testified to by several hundreds of its votaries meeting together each year to consider seriously and discuss the progress of the various departments. On the whole, dilettanti have had little share in our debates. The association has already carried the flag of knowledge outside our islands, thrice to Canada and once to South Africa; now, at last, we make this great pilgrimage to your Australian shores; still we are at home. What message do we bring with us?

In 1847, when this city was but an insignificant town, it was visited by an Englishman who afterwards became eminent not only in science but also

[1] From an address to the Educational Science Section of the British Association at Melbourne, August 14, by Prof. Henry E. Armstrong, F.R.S.

as a literary man—Thomas Henry Huxley; he was then surgeon on board the surveying ship *Rattlesnake*. In 1848 Huxley visited Sydney, and there met the gracious lady, only recently deceased, who became his wife. In after years he achieved a great reputation on account of his services to education.

Lecturing in London in 1854, he defined science as "trained and organised common sense"—a definition often quoted since; none could be more apposite, though it must be remembered that "common sense," after all, is but an uncommon sense.

A few years later, in a public lecture at South Kensington, Huxley spoke to the following effect:—

"The whole of modern thought is steeped in science; it has made its way into the works of our best poets and even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit and indebted for his best products to her methods. I believe that the greatest intellectual revolution mankind has yet seen is now slowly taking place by her agency. She is teaching the world that the ultimate court of appeal is observation and experiment and not authority; she is teaching it the value of evidence; she is creating a firm and living faith in the existence of immutable moral and physical laws perfect obedience to which is the highest possible aim of an intelligent being.

"But of all this your old stereotyped system of education takes no note. Physical science, its methods, its problems and its difficulties, will meet the poorest boy at every turn, and yet we educate him in such a manner that he shall enter the world as ignorant of the existence of the methods and facts of science as the day he was born. The modern world is full of artillery: and we turn our children out to do battle in it equipped with the shield and sword of an ancient gladiator.

"*Posterity will cry shame on us if we do not remedy this deplorable state of things. Nay, if we live twenty years longer, our own consciences will cry shame on us.*"

These words were uttered in 1861. Now, after more than fifty years, not twenty merely, we still go naked and unashamed of our ignorance: seemingly, there is no conscience within us to cry shame on us. I have no hesitation in saying that, at home, at all events, whatever your state here may be, we have done but little through education to remedy the condition of public ignorance which Huxley deplored. In point of fact, he altogether underrated the power of the forces of ignorance and indifference; he failed to foresee that these were likely to grow rather than to fall into abeyance. In England, what I will venture to term the Oxford spirit still reigns supreme—the spirit of the literary class—the medieval spirit of obscurantism, which favours a backward rather than a forward outlook.

Wherein was Huxley out in his forecast? In 1861 the claim of science was already strong, but think what has been done since that time—what we can now assert of its conquests! In the interval, even within my recollection, the whole of our ironclad fleet has been created, rifled cannon, smokeless powder and dynamite have been introduced, and this last, in combination with the discovery of the causes of yellow fever and malaria, has made the Panama Canal possible, an entirely revolutionary work of man's interfering hands. The *Great Eastern*, which could not be launched at first on account of her size—as a lad, I saw her sticking in the stocks—was always a failure, because she was outside the fashion of her time, yet has given rise to a host of ocean leviathians of far larger size; the steam-turbine has entered into rivalry with the reciprocating steam-engine; cold storage has revolutionised ocean transport, so that fresh food can be carried from this continent to remote England and Europe. Electricity, then a puling infant, is grown to giant size; not only have we deep-sea telegraphy and mechanical speech in the form of the phonograph and telephone, but wireless communication, the electric light, electric transmission of power, electric traction—even the waterfalls of the world are tamed through the turbine and made subservient to our will for motive purposes or in the production of temperatures bordering on those of solar heat, by means of which, too, we can draw food for plants, at will, from our atmosphere by combining its constituents into the form of a fertiliser. The use of oil-fuel in the internal-combustion engine has been made possible and, in a few short years, our streets have been cleared of horse conveyances and crowded with motor-vehicles; such engines are coming into use everywhere and have enabled us successfully to perform the feat which Dædalus vainly attempted—we even talk of flying from New York to London, across the vast Atlantic, to spend the week-end. The cyanide process has been introduced into gold-mining and is enabling us to unearth a fabulous wealth; a vast array of gorgeous colours has been produced, and Dame Nature so outwitted that we make indigo and madder out of the tar which in old days was put only upon fences; Pasteur's work has made Listerism possible, so that nothing is now beyond the surgeon's art and bacteriology is become the handmaid of preventive medicine and sanitary science; not only paper but a silk is made artificially from wood-pulp and the finest of scents are conjured out from all but waste materials. A multitude of other discoveries of practical value might be referred to.

Not so long ago, when scientific research was spoken of, the cry was always *Cui bono?* What's the good of it all? Now, no one has the patience to listen to a recital of the benefits accruing to mankind from its operation; for all the achievements I have referred to *are not the work of mere inventors* but primarily the outcome of scientific discovery: thus our modern command of electricity is very largely traceable to the labours of the great philosopher Faraday, who worked in an ill-lighted and cramped laboratory in the Royal Institution in Albemarle Street, London, with no other object than that of contributing to the advancement of knowledge.

Perhaps the greatest of all the scientific achievements of our time remains to be mentioned—the promulgation of the doctrine of evolution by Charles Darwin. Few perhaps can realise what this means for mankind, the intellectual advance it constitutes—that through it we have at last acquired full intellectual freedom and the belief that it rests with ourselves alone rightly to order our lives; that by it all dogmas have been undermined.

Science is come into being and has prospered only since freedom of thought was secured: on no other terms can it be. It is well that we should bear this in mind. The growth of numbers and of democracy may well involve a restriction of freedom in all directions—none are so intolerant as the ignorant.

If in science, to-day, we have something unknown to former civilisations, what is its influence to be on the future of the world, in particular on the future of the white people? If we are not to suffer the rise and fall which all previous civilisations have passed through—rather let me say, if the period of our fall is to be retarded beyond the period our forerunners enjoyed, it will be solely because we wield and use the powers science has put into our hands: not so much those of abstract science but the broad wisdom which the proper cultivation of science should confer; hence it is that I desire to urge the absolute importance of giving, through science, a place to the cultiva-

tion of wisdom in the State and therefore in education.

Clearly, two new forces are at work in the world: not science alone but also a broad and altruistic Socialism, both the outcome of the intellectual freedom man has acquired since the deposition of the Churches. The one is gradually leading us to base our actions upon knowledge and to be practical through the use of theory; the other is leading us gradually, though slowly, to have consideration for one another, to recognise how helpless are the majority, how greatly they stand in need of the guidance of the few who are capable of leading. But we shall need to order our Socialism by science to make it a wise Socialism. The signs are only too numerous that a wave of political despotism may come over us. Either, as time goes on, science will be more and more of service in guiding the social machine—or that machine will perish, from the very complexity of its organisation and the inability of the units to understand their place, to understand the need of subordinating their individual inclinations to communal interests; most important of all, to understand their inability to recognise and require competent leadership—for science is aristocratic in its tendencies: indeed, I shall claim that real science—wisdom—is for the very few.

With all the marvellous growth of achievement to which I have referred, there has been no proportionate growth of public intelligence. Our Admiralty, and to a far less extent our War Office, have called science into their service, but our public departments generally will have none of it. Even the elements of an understanding of the methods of science are not thought to be essential to the education of a Civil Servant; such knowledge is not required even in the highest branches of the Indian Service—no politician is for one moment supposed to need it: we are governed almost entirely by the literary spirit.

The spirit of the age, in fact, is in no way scientific, though ease and comfort are now provided on an unprecedented scale through the agency of science, the engineer acting as chief interpreter. Why do we still go naked and unashamed of our ignorance of "science"? One main reason is that the party in power is unscientific; but at bottom, I believe, the difficulty is a far greater one and probably innate in our disposition. It cannot well be supposed that man is by nature disposed to be scientific. The scientific fraternity, at any time, are, and probably always will be, but a small party—a set of freaks, sports from the multitude. They think and talk in a language of their own, as musicians do. The multitude may listen to them at times, with more or less of pleasure, as they do to music; but it is impossible, and probably always will be impossible, for the many to appreciate the methods and results of the scientific worker. Science, in reality, is a form of art and true artists are never numerous; moreover, it is admitted that they are born—like Topsy, they must grow, for they are not to be made in numbers. Our schools are for the most part in literary hands: and it would almost appear that literary and scientific interests are antagonistic, so unsympathetic has been the reception accorded to science by the schools.

Parenthetically, let me here deny the accusation not infrequently made by literary writers that the scientific fraternity are trying to oust literary studies from the schools. Nothing could be further from the truth. We are always craving for better literary training; our complaint is that the methods and subject-matter of literary training are far from being properly developed and, especially, that English is neglected in the schools. Huxley stated the real situation in saying, "Science and literature are not two things but two sides of the same thing."

The rise of science is due to the introduction of the experimental method. Mr. Balfour, in arguing, as he has done recently, that science rests upon many unprovable postulates and therefore does not differ in method from metaphysics, has made assertions which cannot be allowed to pass as correct. True science rests wholly upon fact and upon logic: all else is mere provisional hypothesis—a garment we are prepared to put aside at any moment if cause be shown. We are well aware that human nature is always intervening to spoil our work; it is human to err and false doctrine may easily occupy the attention for a time, but we are fully conscious of our limitations and prepared to admit them, whilst we feel that we are ever advancing towards security of knowledge.

The method of science, indeed, is the method of the Chancery Court—it involves the collection of all available evidence and the subjection of all such evidence to the most searching examination and cross-examination. False evidence may be tendered and for the time being accepted; but sooner or later the perjury is discovered. Our method, in fact, goes beyond that of the courts: we are not only always prepared to reconsider our judgments but always searching for fresh evidence; we dare to be positive only when, time after time, the facts appear to warrant a definite conclusion. But there are few instances in which we have travelled so far. The Newtonian theory of gravitation, the Daltonian theory of atoms, are two striking examples of generalisations which fit all the facts, to which there are not known exceptions; should any exception be met with we should at once doubt the sufficiency of such theories. In cases such as Mr. Balfour has discussed—the problems of metaphysics and of belief—experiment and observation are impossible: we can only resort to speculative reasoning; our belief, if we have one, is necessarily founded upon intangibilities and desires.

> There was a door to which I found no key:
> There was a veil past which I could not see;
> Some little talk awhile of Me and Thee
> There seemed—and then no more of Thee and Me.

The awful problem before us at the present time is to decide which direction we will take, to what extent and in what way we have the right to teach things which transcend our knowledge; the way in which truth lies may be clear to some of us but can never be to the majority. Those who wrap up such matters in a tangle of words are not helpful, to say the least. However mellifluous the terms of Bergsonian philosophy may be, they do not bear analysis when the attempt is made to interpret them; their effect is merely sensuous, like that of cathedral music.

But in order that she may lead, science must herself set an unimpeachable example—far too much that is now taught under the guise of science is pure dogma; in fact, the philosophy of the schools is mostly dogma. The true legal habit of mind is insufficiently cultivated and but rarely developed even among scientific workers—our logic is too often imperfect. In science, as in ordinary life, party politics run high and scientific workers are usually, for the time being, party politicians. We are too often crass specialists, always very human: indeed, whatever the lines along which evolution has taken place, they cannot well have been such as to favour in any considerable degree the development of the proclivities which distinguish the scientific inquirer: time after time, doubtless, he has been knocked on the head.

The difficulties under which science labours in our schools are partly internal, partly external. Tradition and the type of mind of the average teacher favour

set lessons and literary study by blocks of learners; the extra cost of the work is considerable, when the expense of the special requirements is taken into account; more time and more individual effort are demanded both from teacher and from taught; freedom is hampered by the need of considering the requirements of external examinations; finally, the universities have done but little to help, and though the schools have more or less unwillingly recognised that there is some value in scientific studies, in consequence of the persistent demands men such as Huxley have made, more especially because it is seen that there is money in them, none the less there is still no real demand for them on the part of the public. Of this and, in fact, of nearly all the real problems of education the public are too ignorant to be judges.

Having been more than forty years not only a teacher but also a student of students and of teachers, of educational methods, and of the conditions under which teaching is carried on, I have been led to form very definite opinions, the more so as I have been able to regard the problems not only from the pedagogic side, but also from that of the chemist and biologist—with some knowledge of the mechanism.

My view—and it is one that I desire to press to a logical conclusion—is that we must recognise that human ability is not merely a limited quantity but that it varies enormously not only in quantity but also in quality: the human orchestra contains a great variety of instruments differing in tone and range, but nature, like man, makes few instruments of superlative excellence, a vast number of very poor quality and only a moderate proportion of serviceable type. If science can tell us anything, it is that the democratic and republican ideal of equality is the veriest moonshine—a thing that never has been and never will be. And education can do very little to alter the state of affairs: it cannot change the instrument, at most it can develop its potentialities, and it may easily, by careless handling, do damage to the working parts. To take a special case, of interest at the moment, no contention is less to be justified, I believe, than that which has been put forward frequently, of late years, on behalf of women—that their disabilities are in no small measure due to the fact that we have neglected their education: give them time to educate themselves and they will be as men in all things. Years ago, at our Stockport meeting, I ventured to express the difference by saying that woman is not merely female man but in many respects a different animal: the two sexes have necessarily been evolved to fulfil different purposes. Nothing is more instructive in the history of modern educational progress than the fact that women have asked merely for what men have: at the universities they have attended the men's courses; not one single course have they demanded on their own account. Higher teaching in relation to domestic science so-called has only been thought of very recently and mainly because men have urged its importance. Most serious and, I believe, irreparable injury is being done to women, in London especially, by forcing them to undertake the same studies and to pass the same university examinations as the men: and the damage is done to the race, not merely to individuals, as the effect of education, whether direct or indirect, is clearly to diminish the fertility of the intellectual. Some day, perhaps, when the present wave of selfishness has passed over us, a rational section of women will found a woman's university where women can be taught in ways suitable to themselves without injury to themselves. In saying these things, of course, I am laying myself open to the charge of narrowness—in deprecation I can only say, that what we are pleased to call education is, for the most part, so futile in substance and in its results that I shall not mind in the least if I am accused of decrying it: in my opinion, we shall all be better without most of it, men and women alike. So far as so-called intellectual education is concerned, learning to read seems to me to be the one thing worth doing: at present it is the thing most neglected in schools.

To develop a rational system, we need to take into account man's past history and to apply evolutionary and biological conceptions. Education, as we know it and practise it, after all is a modern superstition—something altogether foreign to the nature of the majority of mankind; it is based on the false assumption that we can all be intellectual; whereas most of us can only use our hands. But the schools neglect hands and attempt the impossible by trying to cultivate non-existent wits. Man is doubtless pretty much what he was, and it is useless trying to make of him what he has never been.

We are seeking to educate all. What does this mean? Practically that we are seeking to teach all to read. But when they have learnt, what are the majority to read—what will they care to read? At the schools for young gentlemen, the reading taught hitherto has been mostly the reading of Latin and Greek. We know the result—the number of persons above school age who can and do read either language is negligible. Some of us learn French, scarcely any learn German, Spanish is all but neglected: when, therefore, we visit the Continent of Europe or South America we can only mumble a few words of the language of the country, and usually allow the foreigner we visit to speak broken English for us: few of us read his literature.

The vain attempt is made to put us in touch with the past but no real effort is exerted to bring us into contact with the present. We have not yet taught English in our higher schools, but are beginning to think of doing so—to this end, we are urging that attention be paid to so-called classical literature, forgetting, of course, that for the most part this was written for grown-ups and not as food for babes of school age.

The difficulty is still greater in the case of those who have only passed through the elementary schools—the literature that will appeal to most of these will be very limited in scope. Our newspapers show pretty clearly what will go down: not much—but it represents what is going on in life. In London, when the theatres are under discussion, it is often said that people want to be amused, not instructed; to cudgel our dull brains is a dull business to most of us. It seems to me that this doctrine should be applied more than it is in the schools. At all events, we shall do well to remember the words of the wise pundit in Rudyard Kipling's "Kim": "Education—greatest blessing when of best sorts—otherwise no earthly use."

To discover the best sort for each sort of student is our difficulty—who will do it? Here comes my point. Not the present race of schoolmaster or of educational authority. By placing classical scholars in charge, we seem unconsciously to have selected men of one particular type of mind for school service—men of the literary type; and this type has been preferred for nearly all school posts, mainly because no other type has been available, this being the chief product of our universities. Such men, for the most part, have been indifferent to subjects and methods other than literary—I verily believe not because they have been positively antagonistic or lacking in sympathy, but rather because of their negative antagonism: of an innate ability to appreciate the aims and methods of any other school of thought than their own, especially on account of their entire

ignorance of the experimental method. I believe, moreover, that the difference is fundamental and temperamental, not to be overcome by training. Oxford, owing to the bait of its classical scholarships, seems to have attracted an entirely peculiar type of ability and to stand alone in consequence; at Cambridge, owing to the hold obtained by mathematics, the field has been divided, but the mathematician, in his way, is often as unpractical by nature as the classic; fortunately, of late years, owing to the rise of the medical school and that of natural science, other elements have been introduced and the university has a future of infinite promise in consequence, if it will but realise that its primary function is to inculcate wisdom rather than to give purely professional training.

Sympathy is only begotten of understanding; the literary type of mind apparently does not and cannot sympathise with the practical side of modern scientific inquiry, because it has neither knowledge of the methods of experimental science nor the faintest desire for such knowledge.

We need a more practical type of mind for our schools. Pessimist though I may appear to be, having watched with close attention, all my life, the great struggle that has been going on in and between schools—having had the great good fortune also myself to be one of the early workers in the province of technical education, and having been associated with the development of one of the greatest of our boarding schools (Christ's Hospital)—I am, of course, aware that very great progress has been made, and am, in every way, hopeful of the future in store for those who are unaffected by present prejudices. In my experience, the men to whom the progress has been due have, in all cases, been trained in a broader school than that of Oxford; the few escapes from Oxford who have been successful reformers have been the exceptions which prove the rule, as they have shown themselves to be gifted with practical instincts: to such men the Oxford literary training has been of extreme value. Oxford will not gain its full value until all types of ability are represented in fair proportion by its students, not one almost exclusively. When this step is taken, the incubus of the Oxford spirit will no longer be upon us: it will then be possible for us to regard education as "a preparation for life"—a formula often used but usually honoured, hitherto, in the breach, rarely if ever in the observance, in our schools.

There must be no misunderstanding. The representatives of literary training rely chiefly on a past into which it is well not to look too closely and must always work with borrowed capital in the days to come: our side has no distant past worth speaking of, but is hopeful of a glorious future, in that it will always be adding to its knowledge; we desire to do their party all possible justice, and shall ever be in need of their assistance and more than grateful for the service they render us; but it must be war to the knife if they will not recognise that, in a progressive age, they cannot lead any longer, that we shall decline to put up in future with the conceit and narrowness of outlook of the classical scholar.

The argument I have applied to the teacher is equally applicable to the taught—boys and girls, indeed students generally, are of different types; they have different orders of ability and cannot be treated as if all were alike. In the beginning, we may tempt them with all sorts of scholastic diet, but only, in the main, in order to discover their aptitudes; when these are found, they should be the main line of attack. In saying this, I am not arguing in favour of extreme specialisation but against time being wasted in attempting the impossible. Some of us can learn one thing, others another: the schools try to force too many into one mould. It is essential that we should try to lay certain foundations but useless to proceed when we find that some of them cannot be laid.

This doctrine is applicable especially to the selection of scholars and to the training of teachers and of evening-class students. We select our scholars almost entirely by literary tests—the result is that we select persons of literary aptitude rather than those gifted with practical ability for every kind of service: like necessarily breeds like. By insisting on "grouped courses" we too often oblige students to take up subjects to which they are incapable of paying attention with profit: most of us, probably, have found out that there are many subjects which we simply cannot learn, try as we may.

My own experience with students has satisfied me that they not only vary in ability but that the different classes are of very different types of mind: the engineer tends to be constructive but not analytical; the analytical introspective habit of mind is more highly developed in the chemist; the biologist rarely has mathematical proclivities. It is useless to attempt to teach all in the same way, and many can learn only very little.

The explanation of Huxley's failure to forecast the future of science lies, apparently, in the fact that men generally *are not* attuned to her ways. I am inclined to think that the "mere man of letters" *will continue* to ignore and despise science—he will lack the peculiar mental capacity to assimilate scientific teaching. Only the few will rise to a proper understanding of the mysteries and be masters of their subjects, though many may be trained to be skilful mechanics.

The extent to which the multitude can receive instruction is a matter of primary importance. If, as Huxley has said, the greatest intellectual revolution mankind has yet seen is now slowly taking place by the agency of science—if she be teaching the world that the ultimate course of appeal is observation and experiment, not authority; teaching it the value of evidence: then must we strive to teach all, in some measure, what constitutes evidence, what observation and experiment are.

I believe much can be done in this direction, having made the attempt with hundreds of unwilling students in my time, students of engineering who had not only made up their minds that they were not going to learn chemistry as it was not their subject, but were incapable of ever entering into the spirit of the work—one of my sons was amongst them. At an early period, having realised that it was useless to waste my time and theirs in the struggle, and that it would not help them in the long run, to give them chemical tips which they lacked the sense to appreciate and to apply, I made up my mind, therefore, that it was desirable instead to develop any detective or inventive spirit that might be in them, so advised them to read detective stories instead of a text-book and ask themselves what the stories taught them: how the detectives set to work. Their attention was secured by urging them also to think what would be their position, later in life, when they were called upon to act for themselves and to get new knowledge for themselves, if they had not learnt to think for themselves. We have then set them to work to solve a series of problems in the laboratory. The course, in fact, was a combined laboratory-lecture course, the lectures being on and always subsequent to the laboratory work. In not a few cases, in after years, when I have met old students, they have told me spontaneously that, much as they had objected to the pressure put upon them, our insistence on their learning to do something themselves had proved to be of extreme value. Long experience has convinced me that anyone who has once learnt to make simple measure-

ments and observations and to ask and answer a definite question experimentally is on a different mental and moral plane from that occupied by those who have had no such training.

Such teaching is possible even in elementary schools —given competent teachers; but a new race of teachers will be required to carry the work into effect, should it be decided to make the attempt at all generally.

The great mistake that has been made hitherto is that of attempting to teach the elements of this or that special branch of science: what we should seek to do is to impart the elements of scientific method and inculcate wisdom, so choosing the material studied as to develop an intelligent appreciation of what is going on in the world. It must be made clear, in every possible way, that science is not a mere body of doctrine but a method: that its one aim is the pursuit of truth.

If we are to progress in these matters, a system must soon be developed which is broader and better than that under which we now muddle along—at present the real problems of education are all but neglected; even if the official mind were capable and desirous of promoting progress, the work of administering rules and regulations—of keeping the machine going—is so great that no time is left for thought.

We have seen the error of our ways sufficiently to give up payment by results and are all but ashamed that we were ever misled by Robert Lowe to adopt such a soul-killing policy. But none the less our entire educational system is still in the grips of commercialism, and, in this respect, as a nation, we stand alone, I believe. Scholarships, prizes of one kind or another, examinations are the perpetual feast of British education. Examinations, in fact, are a regularised and very lucrative branch of industry—mostly in the hands of certain firms who diplomatically shelter themselves under the ægis of this or that educational body; but the universities are the greatest sinners. Valuable as examinations may be within certain narrow limits and for certain definite purposes, there is little doubt that our general ignorance is in no small degree determined by our worship of the examination fetish. So long as the system prevails, the education of our youth will not be in accordance either with their capacity or their requirements but on lines corresponding to those by which prize cattle are raised for show—they will be trained to develop some specially catching point.

The examinations are an inheritance from the literary rule. It is possible to test on paper whether a man be "well read," but faculty as distinct from capacity cannot be so determined. What is worse, by forcing students to commit a large body of doctrine to memory, the attention becomes fixed merely upon what others have done and little time or inclination is left them to acquire a knowledge of method—the faculty of thinking for themselves and applying their knowledge. No class suffers more seriously than medical students under the system—their preliminary training is all but entirely didactic, and the time spent upon it all but wasted; we need not wonder that medicine has made so little advance, the practitioners being in no way trained in the use of scientific method.

To improve our system we need to get rid of our blind British belief in "men of affairs," especially in the "man of business," so-called, really the man of commerce, as persons capable of ordering everybody's affairs and everybody's business. The commercial man, the financier or the lawyer, would never think of calling us in to manage his proper business—why should he be thought competent to manage ours? Results show that he is not, as my argument in this address would lead us to expect would be the case.

No one will seek, for one moment, to minimise the progress made or fail to recognise that infinite credit is due to those who have controlled the work of education thus far; hitherto, however, progress has been made in providing accommodation and getting scholars to school and college: the art of teaching has made no corresponding advance—nor will it, I believe, until the onus is cast more directly upon the teachers and they are forced to exercise greater forethought in the direction of collective action—until they are placed in a position to be sole managers of their own affairs and called upon to row together as entirely self-chosen crews. At home, excepting at our ancient universities, "governing bodies" are paramount everywhere—not the teachers; and too often the sense of responsibility and power of initiative of the teacher are further diminished by the interposition of a principal, who may be a man of all affairs except that in hand—the work of teaching.

If the conclusion at which I have arrived be correct —that science is not for the multitude and can never be generally appreciated or even fashionable—in view of the part which it is clearly destined to play in education and in daily life, on account of its infinite and far-reaching influence upon our well-being—the responsibility cast upon the few representatives of science is very great; in support of our civilisation and in order that wisdom may prevail more generally, they must organise its forces effectively.

Whilst individuality is the mainspring of scientific progress, collective action is required to provide full and proper opportunity for the workers and to promote the success of their inquiries. At present, scientific workers are organised merely for the purpose of providing means of publishing the results of their studies, in no way either for defence or offence; our societies are not effective even for the purposes of debate and criticism. Thus, our chief English scientific society, consisting of some 500 members representative of all the various branches of physical and biological science, is little more than a rabble—its fellows are such individualists that scarce half a dozen of us can ever agree to work seriously together for a common purpose, and the irresistible influence we might exercise if we could be unanimous as to our objective is lost to the community. Most unfortunately, the society has no influence whatever either on political or on public opinion; it makes no attempt either to guide the public or to give dignity and importance to the cause of science in the eyes of the community. Its meetings are dull, and its belated publications by no means represent the scientific activity of its fellows. The presidents of the society have too often been appointed at an age when the propagandist spirit is no longer paramount, when they have no particular scientific message left in them to deliver. And they occupy the chair too long; this arises chiefly from the fact that however clear each one of us may be that individually he is fully competent to hold the office, we all agree in finding some objection to every name that is suggested; to overcome this difficulty a short tenure is desirable, so that the compliment can be paid and encouragement given to the various sciences in turn; no one should be appointed to such an office who is more than sixty to sixty-five years old, as most of us have used up our ideas and have lost our virility by that age. The other officers also hold their positions too long, but members of the council have far too short a life—consequently all the power is centred in the official body; attempts that have been made to organise the whole society in sections representative of the various sciences have always been defeated by the official party.

Unless our scientific societies can be made more

generally effective, if scientific workers are incapable of learning lessons from administrative life, it stands to reason that the collective interests of science and of the body scientific must remain unrepresented and unvoiced—to the great detriment of progress and of the public.

Science must be organised, in fact, as other professions are organised, if it is to be an effective agent in our civilisation; the problems pressing upon us are of such magnitude and of such infinite importance that we can no longer afford to be without wisdom.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At Emmanuel College the exhibition of 50*l.* offered to a research student commencing residence in the present term has been awarded to L. Harrison, University of Sydney, for research in zoology. An additional exhibition of 50*l.* has been awarded to A. J. Philpot, University of London, for research in physics.

THE authorities of the Imperial College of Science and Technology, including the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College, have information of some three hundred of their present staff and students who are now serving with the forces of the Crown, but they have no means of knowing to what extent old members of the college have answered their country's call. They desire it to be known that they will be glad to receive from these or their friends any particulars in respect of service and welfare which may be of interest to the college. The registrar will be glad to deal with any matters of this kind.

IN 1902 Dr. and Mrs. Christian A. Herter, of New York, gave to the Johns Hopkins University the sum of 5000*l.* "for the formation of a memorial lectureship designed to promote a more intimate knowledge of the researches of foreign investigators in the realm of medical science." According to the terms of the gift, says *Science*, some eminent worker in physiology or pathology is to be asked each year to deliver lectures at the Johns Hopkins University upon a subject with which he has been identified. The selection of the lecturer is to be left to a committee representing the departments of pathology, physiological chemistry, and clinical medicine, and if "in the judgment of the committee it should ultimately appear desirable to open the proposed lectureship to leaders in medical research in this country there should be no bar to so doing." The eighth course of lectures on the Herter foundation will be given by Dr. T. Lewis, lecturer on diseases of the heart, University College Hospital Medical School, London.

A COPY of the current calendar of University College, University of London, has been received. It is arranged on the same general lines as in previous years and provides full particulars as to the preparation for various degrees of the University, the scholarships, and exhibitions available, the facilities for post-graduate study and research, lists of graduates from the college, and much other useful information. A full account is given at the end of the volume of the assembly of the faculties of arts, laws, science, engineering, and medical sciences held last July when Sir Archibald Geikie presided. The provost, Dr. T. Gregory Foster, in his report on the work of the session 1913–14, pointed out that the progress of the college in the matter of buildings and equipment, as well as of endowment, continues to be greatly advanced by the work of the equipment and endowment fund committee, which was established in 1902. The completion of the new school of architecture and the erection of the building for the department of applied statistics and eugenics, as well as that for chemistry, had been seriously hindered owing to the labour disputes—in fact, little work had been done on either building for more than twenty weeks. The delay caused the greatest inconvenience, and it has also largely increased the cost of both buildings. The college is still short of the funds necessary to complete the equipment of the new chemical laboratories, and is looking anxiously for a benefactor who will come forward and provide the amount yet needed. It is also looking for a benefactor who will give the funds requisite for the purchase of All Saints' Church and its equipment as a great hall for the college. Rapid development of the work in almost every department, the demand and necessity for the institution of new courses and new departments, make it more difficult every day, with the present accommodation, to progress with the times and to meet the new requirements. The provost then went on to announce the grant of 30,000*l.* by the London County Council, and said that at least another similar amount is necessary to complete the works in progress. The calendar also includes a list of the honours and appointments of former students and other persons connected with the college, and a comprehensive list of original papers and other publications from the various departments of the college during the session 1913–14.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 5.—M. P. Appell in the chair.—G. **Bigourdan**: The passage of Mercury across the sun of November 7, 1914. Precautions are suggested for the observations of the forthcoming transit of Mercury.—J. **Boussinesq**: Addition to a recent note on the coefficient of filtration with sand with more or less fine grains. Calculation of the coefficient for the heterogeneous sand used by Darcy in his experiments.—L. **Landouzy**: The auxiliary hospital of the institute, No. 265.—A. **Laveran**: Experimental infection of mice by *Leishmania tropica*. Twelve white mice were inoculated, eight males and four females. None of the latter were infected, but six out of the eight males developed the disease, of which full details are given.—E. **Delorme**: General considerations on the treatment of wounds received in battle. Disease in the French Army is almost non-existent, dysentery and typhoid fever scarcely reaching the figures in times of peace. The conditions under which the present campaign is being carried out differ from those in 1870 in that battles are carried on continuously for days and weeks, and prompt removal of the wounded from the firing line is impossible. It follows that by the time the wounded are received at the rear suppuration has in many cases already set in. This especially applies to wounds caused by shrapnell and fragments of shell, in which infection by earth is common. As a result cases of gaseous gangrene and tetanus are widespread, and necessitate a complete change in the surgical practice at the front. Hospitals must now be concentrated as close to the firing line as possible, and the work to be done at these hospitals is sketched out. The frequency of complications due to gaseous gangrene and tetanus is specially mentioned, and the best means of dealing with them close up to the firing line discussed.—Remarks by A. **Laveran** on the preceding communication. Suggestions as to the best means of using anti-tetanus serum.—Observations of M. **Roux**. Remarks on anti-tetanus serum.—Reply of L. **Landouzy** to the communication of E. Delorme.—E. **Maurant**: Ephemeris of the