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PRESIDENT'S ADDRESS.

SCIENCE REQUIRED FOR A GENERAL EDUCATION.

BY JOHN L. TILTON.

At first I thought that for this occasion I would prepare a paper on one of the important lines of recent scientific discussion. After the kind acceptance by Professor Chamberlin of our invitation to address us this evening I gave up all intention of preparing a paper, thinking that the address which we are about to hear would render the presentation of a related subject by me undesirable; but when I found that the omission of a paper styled the "Presidential Address" would be considered an unacceptable "innovation," I immediately decided to present briefly a pedagogical question which has been forced upon my attention again and again, and I doubt not has been the occasion of much thought on the part of every teacher present; a question that demands the thoughtful consideration of every scientist engaged in educational work. The question is this: What sciences should be required *for a general education?*

As I view the field, the time is past in which there is a failure to recognize the value of a critical examination of scientific data, a logical development of scientific theory, and a consideration of the important bearing of such data and theories upon modern life; though there may be a partial failure of such recognition on the part of some whose education is purely literary. Indeed, we rejoice to see the evidence of scientific method applied in all branches of education, notably in sociology, psychology and history; and we are glad that all lines of education can combine to establish care in gathering data, and correct method in developing thought; but amid the great numbers of authors and topics for study, and the pressure of other worthy courses for recognition, there seems to be no generally accepted conclusion as to just what sciences should be included in a course designed to give a general education. In conversation with men from various colleges it is not uncommon to find evidence of attempts even in recent years to reduce required scientific work to a minimum, regardless of the importance of the various branches both in modern life and in education; while among teachers of science there are those who favor specialization in one branch of science without a general knowledge of other sciences as a prerequisite, except so far as immediately necessary to the subject in which there is to be specialization.

There is much to be said in favor of work involving specialization and original research. That various and deep problems are involved in the full investigation of any subject seems to be overlooked by those who decry the narrowness of the specialist; and the breadth of education that has often preceded specialization is a source of surprise to the critic. It is not my purpose to discuss the need and value of specialization. That courses leading to such an end have places in modern education seems recognized by all, but, on the other hand, a peculiar condition confronts us that we should not overlook. Many high schools graduate students who have had much of language and little of science,

and colleges admitting such graduates permit them to elect still more of language and a minimum of science. The problem then becomes, what sciences shall be required of those who, having learned to love other subjects, now shun science, either because they do not know what they lack, or because the small amount which they have had has given them the impression that they cannot shine in that line of work with a desired brilliancy. Indeed, dislike of science and failure at first to excel in it are often due to a complete lack of opportunity which has left the student unaware of his own ability, and developed love for other studies to the exclusion of science. This unfortunate result will be reproduced constantly in such public schools as exclude both nature and science from consideration in the grades, and, if they present them at all in the high school, present them under the guidance of teachers who have themselves likewise neglected science. Our colleges must now, and apparently for many years to come, have among their students graduates of such smaller high schools, and for such students must seek to determine the amount and character of science which should be required.

Permit me to briefly present a solution of the problem as follows: Besides the physical geography which is so commonly taught in the lowest grade of the high school, serving as a supplementary course in geography, a pre-requisite for history and parts of literature, and also serving as a science, there should, for a general education, be required somewhere in a high school or in the early part of a college course a study of the facts and the general principles of biology, physics and chemistry.

The work in biology should develop a knowledge of the life around us so often overlooked, and a knowledge of the great groups of animals and plants, as well as of the laws which biologists have worked out, and the prominent theories; in short, it should give the student a general view of this great field of science. This can be accomplished with due regard to abnormal sensibility which the teacher sometimes discovers in a pupil.

The work in physics is that work in science now most commonly well presented in a high school. It should develop a knowledge of the general facts and principles of the subject, and a knowledge of their application in our civilization.

The work in chemistry should open the eyes of the student to the action of forces all around us unrecognized by those who have neglected the subject. It should reveal to him the facts made use of in our great industries, and present the theories concerning the constitution of matter and the laws of chemical change.

It does not seem desirable to present here a discussion of the importance of a knowledge of these three great fundamental lines of study, nor to discuss the necessity of laboratory methods, as well as of recitations and of illustrated lectures. With a knowledge of these three subjects properly developed the student is ready to grasp the meaning of processes which he sees in the industrial world, and of literature which involves these sciences. Because of study of these three fundamental subjects he is the better enabled to study our civilization in a comprehensive manner and to fill the place of a useful and well-informed citizen.

With all the important bearings of these subjects they are divergent in their relations. Omitting astronomy, which is generally included with mathematics rather than with science, there remains one other requirement which should follow these courses in biology, physics and chemistry. That requirement is

geology, the keystone in the scientific part of a general education, resting upon the facts of physics, chemistry and biology, binding them all together, and completing a solid, well-grounded arch, above which may be reared philosophy concerning the past, present and future. Without the use of the facts, principles and logical deductions of geology, there can be no proper, well-grounded conception of what the earth has been and now is; no proper conception of the working of Deity in the universe; no proper conception of what life has been, and no proper view of the relationships of present life; thus no adequate comprehension of that great branch of modern reasoning expressed in that far-reaching, commonly misunderstood word, evolution. Here, too, side views of physiography and meteorology, so necessary to an understanding of the sequence and effects of base leveling, rejuvenation and climatic changes of the past, as well as of the climate and topography of the present, can and must be presented for those who may have neglected courses in those subjects.

Thus geology, the final scientific subject required for a general education, is so broad in its scope, so deep in its subject-matter, and so high in its relation to other studies, that, when thus presented, it should be left till the latter part of the college course.

In the various colleges here represented the details of the courses of necessity differ. The plans for each student who wishes to specialize in science are well and carefully laid; but can we not, for the sake of a well rounded education, see that those who do not wish to specialize in science and while seeking what they imagine to be a general education, neglect science, shall be required to study these fundamental facts, principles and theories so necessary to a good general education?