one or another functional individual. In every case senescence follows and death is the price of sexual reproduction. The length of time during which asexual reproduction may prolong the existence of functional individuals carrying original zygotic constituents is a matter to be determined only by experiment and observation. It is not essentially different in the Protozoa and the Metazoa.

When we turn to those primitive forms of life in which sexual reproduction has not as yet made itself apparent, we are faced by the fact that it would appear at first sight that death can not possibly be a phenomenon where sexual reproduction is unknown. This is true, however, only if the original genetic complex remains unchanged. Should there, however, occur in the life cycle of the Protozoa and other primitive organisms, including the bacteria, a periodic and recurrent reorganization of the nuclear structure involving permutations in the genes, we will be forced to admit that every such organization carries with it inevitably the seeds of death of the previous individual. The genetic complex which existed prior to the reorganization vanishes when that reorganization ensues and a new individual in every sense of the word comes into control of the organization.

I have brought forward this concept of the normality of senescence and death among the most primitive organisms as one which may be helpful in directing discussion and research into the nature, structure and periodical changes in the mechanism of heredity and the mechanism of organismal control of these simplest forms of life. It may perhaps be helpful and serve to facilitate progress if we emphasize the similarities of organisms and seek to find the common processes underlying them all rather than to emphasize their differences and thus obscure our vision of the more fundamental problems of life.

C. A. KOFOID

PRUNING THE ACADEMIC TREE[1]

THERE is little reason to offer excuse for discussing the method of presenting a scientific subject, if one but remembers that each science is rapidly expanding and as it does so the subject matter and pedagogical methods must be modified. We can not be content to teach as our forefathers taught even though they in their time were successful. Not so long ago there were naturalists who studied and taught all phases of science and the student obtained a certain advantage which is lost by our present system of special teachers. The intimate inter-relationships of the sciences are largely lost in the maze of special detail. The broad, inaccurate naturalists' teaching of earlier days had to give way to the closely analytic, specialized method of the last decade, but now the immense accumulation of data must be synthesized into the truly general, fundamental principles so as to free the students' time for further specialized study.

We all have been inclined, on the whole, to teach as though our students were going to be specialists in our particular subjects instead of realizing that this, in all likelihood, will be the one time in their course when they will come in contact with our subject. There is much that a specialist must know which but fogs the issue for one gaining general knowledge or training. We too often lose sight of the college ideal of education and attempt to turn out ambulating encyclopedias rather than individuals who are trained to organize and apply.

Each increase of knowledge has seemed to call for the addition of a requirement for graduation without greatly affecting the curricula already prescribed. The result packs the students' hours from entrance to graduation with one continuous procession of informational courses until, should the student by chance have a free hour in his program, he really feels guilty. Well might be inscribed over the gates of many of our colleges "Leave thought behind all ye who enter here" for small time is left for such intellectual processes.

We must cut the Gordian knot of required subjects for every hour of college life whenever possible in order that opportunity for individual selection may enter. We must recognize that in general elementary courses only the principles and not the details stick or are of ultimate value. Our work must be so planned that the student's life shall not be one

[1] Read before the North Dakota Academy of Science, May 5, 1922.

galaxy of memorizing of facts accepted on authority but rather that he may have opportunity to coordinate and prove his acquisitions and so become different from the trained ape from which so many to-day are fearful of having descended.

In all subjects there is something of recognized value to the well-trained mind but the time is past when we may know much about all things. We must present only the essentials of our subject to our students and let them judge whether they would go farther. Moreover, the increase in knowledge means that there are more fields for the student to investigate and as teachers we must eliminate many of the weeds in our intellectual gardens. Can this be done without making the student superficial? Our experience makes us feel certain that he will be better off under the proposed plan than under the cramming system.

It is becoming more and more evident that all living organisms, both plant and animal, are a unit in the principles which govern them. It is these fundamental ideas which are of importance to the great majority of students and it is these which they will carry away with them as the best heritage of an elementary biological course. Why then burden them with mastering a mass of detail, so soon to be forgotten?

In biology it has been the custom to start with the Amœba and end with man, hitting as many forms in between as time and the budget would permit. In one institution a student was heard to remark that specimens flowed past at such a rate that if he chanced to look around he lost a view of several. There are few teachers to-day who can make such a "type" course interesting and the student loses the great basic principle of life in viewing its numerous manifestations. It is far better to demonstrate the principles thoroughly with a few well chosen forms. We want the students to have at the end of their course a realization that metabolism, irritability, movement, reproduction and growth are the principles or characteristics of living matter. If this can be done and the student then brought to a realization of the organic variations which successfully carry on these functions, he has acquired about all of biology that will be useful to him. If his first experiences hold his attention then he may go on into the more advanced and specialized courses. We will in this method sacrifice only the time-honored, traditional and more or less useless detail. The fundamentals will stand out sharply in relief and in that form will not readily slip away.

Thus instead of two elementary courses, one in botany and one in zoology, a single course in the fundamental principles of biology may be developed with the cooperation of both departments. The student can not be a botanist or a zoologist from such a course, but neither will he be from an elementary course in either. He may, on the other hand, get a more comprehensive view of life and its essential applications to his than from a more specialized course in botany or zoology. Thus the general student is better served, but what shall we say of those who need special phases of either subject? They are better served in advanced courses where smaller numbers of students make for greater opportunity.

This plan has been put into operation at the North Dakota Agricultural College with what appear, from first returns, to be satisfactory results. Instead of six terms of elementary work in botany and zoology, two in the principles of biology are given. These are followed for special groups of students by special courses especially fitting their needs. Thus those who specialize in the agronomic phases of agriculture have three terms of advanced botany in place of one or possibly two heretofore. Likewise the animal husbandry students are especially served in the advanced courses in zoology. A unique feature of this plan is the complete cooperation of two departments in outlining and conducting the introductory course, not breaking the continuity of the subject matter into separate terms of botanical and zoological work. Thus unnecessary duplication is eliminated and every subject of discussion is strengthened by the presentation from both points of view.

The educational ideal would be to offer the student an opportunity of getting a rapid survey of all branches of learning that he might better be able to choose his field of interest. This not being entirely possible it is desirable that our general courses be pared to the core and we may rest assured that the subjects will gain rather than lose in their value to the students.

Students have justly complained that so many required subjects fill the curricula that they can not elect in their special field of interest during their last two years. At Barnard College the students have petitioned for such general survey courses in many subjects as that outlined here for biology.

Most of our academic trees carry much dead wood. Can not other collegiate subjects profitably eliminate much detail which now seems sacred in the elementary course and thus open the way for more intensive study in the later years of the students' curriculum?

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COOPERATION OF THE GOVERNMENT IN SCIENTIFIC WORK

IN view of the growing interest in cooperation as a means of advancing scientific work for the public benefit, the National Research Council in 1921 appointed a committee to study the nature and extent of cooperative scientific work carried on by the federal government and outside agencies as well as the principles which should guide in such work. This committee consisted of E. W. Allen, chief, office of experiment stations, United State Department of agriculture, chairman; Edwin F. Gay, president, New York Evening Post, Inc.; M. W. Glover, bureau of chemistry, United States department of agriculture; N. C. Grover, geological survey, United States Department of the Interior; Vernon Kellogg, permanent secretary, National Research Council; and E. B. Mathews, state geologist for Maryland and professor of geology, Johns Hopkins University.

The committee's report, which has just been made public by the council, shows a great diversity as to types of work, agencies cooperating, nature of cooperation, terms of agreement and extent of participation of the parties to it. The inquiry revealed 553 separate cooperative projects, involving more than 1,100 cooperative undertakings, since many of the projects involve the work of several cooperators. Of the 553 separate projects, 360, or nearly two thirds, fall under the head of research, the acquisition of new knowledge by the method of systematic scientific investigation; others deal with routine testing and technical service; gathering of statistics; enforcement of regulatory laws or measures; and the like.

The federal agencies engaged in the cooperative work included some 23 bureaus and independent establishments of the government, and the outside cooperating agencies included various branches of the state governments, municipalities, chambers of commerce, state and endowed universities, agricultural colleges and experiment stations, botanical gardens, and similar institutions, as well as associations and societies of various kinds and numerous industrial concerns and private individuals.

The forms of agreement or understanding entered into between the cooperating parties are very diverse. As a rule, however, they are quite definite, and in general, "convey the impression of having been developed in the spirit of cooperation and with a view to avoiding misunderstanding."

The combined cost to federal and outside cooperators of the definitely organized scientific work in which the government is concerned aggregated, as far as the available data show, more than $41,000,000 for the year under consideration. Of this, over $14,000,000 came from the federal government and nearly $27,000,000 from outside agencies. If the assistance other than money is included, it appears that the outside cooperating agencies are putting in fully two dollars for every one supplied by the government. As the report states, however, "the influence of the federal government in stimulating new movements for the application of science can rarely be measured by the amount of funds it has contributed. It has served to nationalize many types of effort important to the intelligent advancement of the country, and has greatly hastened the development of such measures."

Of the federal agencies concerned, the United States Department of Agriculture has the largest number and the widest range of coopera-