tions for medical research in this country, seventeen, or nearly two thirds, are in connection with medical schools. The report also intimates that the "great growth of the spirit of research in this country" accompanied "the phenomenal development which medicine has undergone in recent years." In fact, the growth of medical research has been in direct proportion to the increase in the number of full-time, salaried professors in medical schools. This increase has been influenced, to a certain extent at least, by the inclusion of the possession of full-time teachers and the conduct of resarch work as one of the ten requisites in the basis[2] on which the Council on Medical Education rated medical schools in its first published classification. Since full-time teachers were urged chiefly in the laboratory branches, the development of research has been most rapid in that division of the medical school. Only a few medical colleges were amply financed to provide full-time professors in clinical departments and, therefore, only a few have all departments, laboratory and clinical, carrying on active research. With larger numbers of full-time clinical professors medical research in medical schools will attain to a higher degree of efficiency than is possible where that research is in isolated laboratory departments. There can not fail to be better results where all departments of the medical school are interested and cooperating in research, since then any department has the advantage of all the resources of the medical school; any discovery may be tried out under adequate facilities and safeguards and its value established or disproved. In fact, a modern medical school, with its skilled faculty; with its laboratories thoroughly equipped for medical instruction and research, and with an abundance and variety of clinical material at its command, constitutes the ideal arrangement for medical research. On the other hand, the medical school can not reach its highest efficiency in teaching unless it is permeated by the spirit of investigation that is engendered by research. The student can not fail to be benefited. He appreciates better the importance of the fundamental medical branches; that the training in the medical school merely admits him to the field of medicine with its limitless possibilities for usefulness, and that his future success depends on investigation, on keen observation, on accuracy of judgment, and on the skill with which he applies his knowledge. Graduates of medical schools in which research is a prominent feature of the work will be better able than those of other schools to cope with the multiform problems which confront the modern practitioner of medicine.—*Journal of the American Medical Association.*

the Committee on Medical Research of the Association of American Medical Colleges, read at the Annual Meeting in Chicago, February 6, 1917.

2 "Essentials of an Acceptable Medical College." Report of the Council on Medical Education to the House of Delegates of the American Medical Association, June 6, 1910, *The Journal of the American Medical Association*, June 11, 1910, p. 1975, paragraph 12 and p. 1976, paragraph 8.

SCIENTIFIC BOOKS

Metamorphic Geology. By C. K. Leith and W. J. Mead. Henry Holt & Co., New York. 1915.

Metamorphism as defined by the authors embraces "all mineralogic, chemical and physical changes in rocks subsequent to their primary crystallization from magma." That is, it includes all changes produced by weathering, disintegration, decomposition and deposition by sedimentation or from solution, as well as those processes that solidify by crystallization and rearrangement, and thereby form crystalline schists. In this sense all rocks except unaltered igneous rocks are metamorphic rocks, namely, soils, sedimentary strata, and crystalline schists. While a comprehensive treatment of all manner of alterations which may take place in rock masses is the logical and satisfactory method, it would seem advisable to employ some other term for the whole process than metamorphism, which has acquired through long usage a more restricted application.

Naturally the subject is separated into two parts, that of the destructive alterations, and that of constructive ones, which, following

Van Hise, are designated as katamorphic and anamorphic.

The object of the book is said by the authors to be the presentation of the current knowledge of this comprehensive subject in some perspective by means of quantitative methods of comparison and discussion. They say "It is not a handbook of metamorphism in which one may expect to find an adequate description of metamorphic details." There is no description of a metamorphic rock anywhere in it. It is evidently prepared for students who have a knowledge of the petrography of all kinds of rocks, and the ability to determine minerals optically and chemically. It is, in fact, a book for advanced workers in petrology and for geologists interested in the broad problems of sedimentation and the redistribution of mineral matter in various ways.

The authors are unable to follow Van Hise in the emphasis he placed on his so-called zones of katamorphism and anamorphism, for, as they remark, so many other factors than depth enter into the processes of alteration that at any depth, or at the same depth at different times, the changes may be in opposite directions for different kinds of rocks. Or, as they have also expressed it, "Depth is only one of the factors determining intensity of conditions. Igneous intrusion, mineral and chemical composition, the differential stress conditions, etc., all play their parts."

In Part I. the decomposition, or katamorphism, of rocks is discussed with respect to several types of rocks as illustrated by specific instances, such as a granite from Georgia, and a gabbro or diabase. Another example is the production of bauxite from nephelite-syenite, which is called an "acid igneous rock," and the production of laterites from "basic" igneous rocks. The decompositions of ores and of sedimentary rocks are also discussed. In each case the mineral and chemical changes, as well as those of volume and density, are considered in general terms. This is followed by a speculative discussion of the probable redistribution of the constituents of the average crystalline and igneous rock during decomposition. The speculative character of the discussion rests upon its apparent quantitative elements, since it is necessary to assume definite quantitative values for factors concerning which there can be no definite quantitative knowledge. Moreover the petrographical basis of the discussion is open to serious question in that it assumes that all igneous rocks may be embraced under the terms "acid" and "basic," or granites and basalts (!), and that estimates of the average composition of these have definite values. The value of deductions derived from general averages of highly complex factors is always doubtful for the reason that an average is too often a graveyard of facts.

Part II. deals with the construction or integrating changes in rocks, or anamorphism. It includes cementation, dynamic metamorphism and contact or thermal metamorphism. Various types of rocks are considered with reference to these possible modes of transformation; clays, sands, carbonates, igneous rocks, mineral deposits and ores. The cleavage and textures of the crystalline schists are discussed at considerable length, and the discussion closes with a general review of the results of anamorphism and of the probable processes, the conclusions being of special interest and importance, but too extensive to be cited here.

There follows, in Part III., a general discussion of metamorphism in the broad sense in which the authors use the term, which is made to include a discussion of the origin of residual clays and soils, glacial deposits, transported clays and muds, sands and sandstones, calcareous sediments and crystalline schists. In the case of the schists it is found from an investigation of chemical data that "chemical criteria do not satisfactorily discriminate schists of sedimentary and igneous origin." They fail in those cases where other criteria fail. The discussion also considers ocean, lake, river and underground solutions as by-products of the metamorphic cycle, and the authors suggest that the metamorphic cycle be made the basis for the genetic classification of commercial mineral products.

In concluding the discussion they say that "The metamorphic cycle may be regarded as indicative of a great pulsational alteration of the earth's surface, kept going through the running down of energy and its escape from the earth," and they remark further that this view of the significance of the metamorphic cycle involves a slight modification of the prevalent interpretation of Hutton's law of uniformitarianism in that while the same series of processes are operating to-day as in the past they are now working on different propositions and distributions of substances than formerly, with consequently slightly different results.

A fourth part of the book is devoted to suggestions as to laboratory work in metamorphism, which by reason of its very general character appears to have been prepared as suggestions for instructors of laboratory students rather than for the students themselves. The book is a valuable contribution to the broad geological problems connected with changes of all kinds which take place in rocks, but its title is somewhat misleading.

J. P. IDDINGS

SPECIAL ARTICLES

A PLANT MEMBRANE FOR DEMONSTRATING OSMOSIS

THE writer has noted with interest that the authors of recently published text-books in botany are still advocating the use of egg membranes and parchment membranes for the demonstration of osmosis. It is unfortunate that botany teachers should limit themselves to animal membranes, parchment membranes, or celloidin membranes in demonstrating to students this very important phenomenon in plant physiology. This is especially true when we have readily available a natural plant membrane which serves the purpose admirably. I refer to the testa of the lima bean.

Osterhout[1] has suggested the use of the testa of the lima bean in some osmosis experiments of rather limited visual value. In the botanical laboratories of Kansas University Professor W. C. Stevens[2] has used this membrane in the type of osmosis demonstration providing for a rise of the more rapidly diffusing liquid in a glass tube of narrow diameter. In our own classes we have found the experiment so satisfactory that the method is here presented in detail.

Two days before the experiment is to be set up, place a number of clean lima beans on clean moist paper or absorbent cotton in a glass jar and cover with a glass plate. As germination progresses some of the seed coats will split almost as soon as swelling begins. Others will stretch greatly without splitting. The latter will best serve for the experiment. It is also important to discard any which show signs of bacterial or mold activity. After selecting the bean to be used carefully split the testes through the micropyle and hilium and remove the two halves. Each will serve as an osmotic membrane. Soak the membranes in water for a few minutes to remove any wrinkles. With ordinary narrow rubber bands fasten the membranes tightly over the smooth ends of two clean glass tubes with inside diameters of 4–7 mm. Sugar or salt solutions may now be run into the tubes from the open ends, using a wire or fine glass rod to direct the flow. The tubes should be filled to a height of two or more inches and the level marked with accuracy. Be careful to avoid bubbles. The tubes may now be supported vertically by ring stands with the bean testa in contact with water in a glass dish. The height of the liquid in the tube will rise almost immediately and will continue to do so for several days. The usual variations of such experiments as to the liquids used may be satisfactorily employed with this membrane.

The writer has found this experiment the most simple of the osmosis demonstrations to set up. Five minutes is adequate with the apparatus at hand. With ordinary care the results are satisfactory in nine cases out of ten. The students appreciate a real plant membrane to illustrate plant osmosis. It is advisable if time permits to set up the egg experiment also for its general biologic value.

As to the value of osmosis demonstrations in elementary college courses in botany, we use

[1] Osterhout, W. J. V., "Experiments with Plants," 1906.

[2] Shull, C. A., "Semipermeability of Seed Coats," *Bot. Gaz.*, LVI., 183, 1913.