sis; the second part, to the occurrence, preparation, properties and reactions of the sugars and their allied derivatives.

Part I., which covers about 500 pages, discusses the sampling of sugars and sugar products; determination of moisture; densimetric analysis; the refractometer and its applications; theory and practical application of polariscopes; the specific rotation of sugars; methods of simple and invert polarization; qualitative methods for the identification of sugars, and methods for the analysis of sugar mixtures.

Part II., in some 260 pages, deals with the formation of sugars in nature, and their classification; the mono-, di-, tri- and tetrasaccharides, the amino-sugars, cycloses and the sugar alcohols and sugar acids.

The sugar-tables, which, for convenience, are grouped together in an appendix of 100 pages, are paged independently of the rest of the volume. They may therefore be bound separately for laboratory use.

An idea of the painstaking care with which this work has been prepared may be gained from the fact that the index alone fills 69 pages. The style in which the book is written is admirably clear and concise; the merits and demerits of the various methods given are objectively and dispassionately stated; the methods endorsed by the International Commission for Uniform Methods of Sugar Analysis—of which Commission Dr. Browne is a member—receive full consideration throughout. The text is illustrated by a number of well-chosen and well-executed cuts, and the general excellence of the typography and make-up of the book reflect great credit on the publishers.

Dr. Browne is certainly entitled to the most cordial appreciation and congratulations of his fellow-workers on this classic contribution to their store of knowledge.

F. G. WIECHMANN

Popular Guide to Minerals. By L. A. GRATACAP. New York, D. Van Nostrand Company. 1912. 330 pages, 74 plates and 400 figures. Price $3.00.

This book, as its name indicates, is intended chiefly for the general reader and student. It is designed largely to assist in the study and appreciation of the mineral collections to be found in our great museums. It is to be regretted that popular interest in minerals is by no means as widespread or as active to-day as it was twenty-five years ago and it is to be hoped, therefore, that this book may help to revive the study of minerals and to restore it to its proper place as one of the more interesting and popular branches of natural science.

The book contains a section on crystallography, followed by a discussion of the physical and chemical properties of minerals. The section devoted to the description of mineral species—in harmony with the purpose of the book—has been entitled, "Guide to Collections." An extensive history of the development of mineralogy follows and the book closes with a description of the fine Bement mineral collection which belongs to the American Museum of Natural History in New York City and of which the author of the book is curator.

The illustrations comprise first a series of more than seventy plates giving photographic reproductions of some of the finer and more striking specimens in the Bement collection. Mineral specimens offer many obstacles to successful reproduction in this way and nothing but praise can be said of the results achieved. It is to be regretted that the line figures used in the book, especially in its earlier sections, have not been reproduced as successfully.

W. E. FORD

YALE UNIVERSITY

SPECIAL ARTICLES

ANTAGONISTIC ACTION OF ELECTROLYTES AND PERMEABILITY OF THE CELL MEMBRANE

1. The writer observed years ago that the newly fertilized eggs of *Fundulus* die in a 5/8 *m* NaCl solution without forming an embryo, while the addition of a very small but definite amount of a salt with a bivalent metal (with

the exception of the heavy metals) caused them to live and form an embryo.[1] Seven years ago he formulated the hypothesis that this antagonistic action of salt was primarily due to the fact that the solution of only one salt in a sufficiently high concentration alters the membrane of the cells, thereby increasing its permeability, while this increase can be inhibited through the addition of the antagonistic salt.[2] In a recent paper a summary of the facts supporting this hypothesis was given.[3] According to this hypothesis, the pure NaCl solution slowly increases the permeability of the membrane, diffuses into the egg and kills the germ, while the addition of a small amount of $MgCl_2$, $CaCl_2$, $SrCl_2$, $BaCl_2$, etc., inhibits or retards this increase of the permeability and the death of the embryo. During the last year Osterhout has published confirmatory experiments on *Laminaria*.

This summer the writer has found a new method by which it was possible to test the validity of this hypothesis for the egg of *Fundulus*. This egg has a considerably higher specific gravity than sea water. It will float in a 12/8 *m* NaCl solution but not in a 11/8 *m* NaCl solution. The method consisted in putting the eggs into solutions of a higher specific gravity than that of a 12/8 *m* NaCl solution and observing how long they will float in such a solution. For these experiments eggs were used which had been fertilized at least three or four days previously. The following striking facts were found. If the eggs are put into a 3 *m* solution of NaCl they will float, but as a rule not longer than three hours. Then they will sink to the bottom of the test tube. Before sinking they lose water as is indicated by the collapse of the membrane and the shrinking of the yolk sac. Probably some NaCl enters into the egg. When we put eggs into a 10/8 *m* solution of $CaCl_2$ they float at first, but will sink in about 1/2 hour. If we use $CaCl_2$ solutions of a still higher concentration the eggs will shrink and fall to the bottom just as fast or still faster. If, however, we put the eggs into a mixture of 50 c.c. 3 *m* NaCl + 2 c.c. 10/8 *m* $CaCl_2$ they will float three days or longer at the surface of the solution. During this time the eggs do not shrink at all or very little and the embryo keeps alive. In a mixture of 50 c.c. 2 1/2 *m* NaCl + 1 c.c. 2 1/2 *m* KCl + 0.75 c.c. 2 1/2 *m* $CaCl_2$ some of the eggs floated on the surface as long as ten days, while in a 2 1/2 *m* solution of NaCl they did not float more than a few hours. The only possible explanation of these experiments is that the membrane of the eggs of *Fundulus* is practically impermeable to water and to salts in a physiologically balanced solution. If the egg, however, is transferred to a hypertonic non-balanced solution the natural impermeability of the membrane is gradually lost and water will diffuse out of the egg and its specific gravity increase to such an extent that the egg sinks.

When the eggs are put into pure solutions of each of the following salts, $MgCl_2$, $SrCl_2$, $BaCl_2$, above a density of 1.0634 the eggs will float at first but will shrink and fall to the bottom in less than an hour; the sinking begins the more rapidly the higher the concentration. This indicates that the higher the concentration the more rapidly does the salt increase the permeability of the membrane for water. If, however, a small but definite amount of any of these salts is added to 50 c.c. 3 *m* NaCl the eggs will float on the 3 *m* NaCl solution for a considerably longer time than if no salt with a bivalent metal is added. These experiments show that the toxic or injurious action of the pure NaCl solution observed in my experiments on the *Fundulus* egg was due to an annihilation of the specific impermeability of the membrane of the egg through the action of NaCl and the subsequent entrance of this salt into the egg, and that the antagonistic action of the salts with bivalent metals was due to the fact that they inhibited the increase of permeability of the membrane for salt and water.

2. In 1899 the writer published the fact that the addition of a sufficient amount of acid causes the muscle of a frog to swell in an

[1] *Pflüger's Archiv*, 88, 68, 1901; *Am. Jour. of Physiology*, 6, 411, 1902.

[2] *Pflüger's Archiv*, 107, 252, 1905.

[3] SCIENCE, 34, 653, 1911.

$m/8$ NaCl solution; that the muscle also begins to swell after some time in a neutral hypertonic NaCl solution, while it shrinks in a sufficiently hypertonic NaCl solution if the latter is rendered acid. He ventured the suggestion that this might be a protein reaction.[4] This suggestion has since been amply corroborated by the work of Hardy, Procter and Pauli. It was, moreover, found that this antagonism between acid and salt is much stronger for the system $H_2SO_4 — Na_2SO_4$ than for the system HCl — NaCl.[5]

These data were utilized to find out whether the specific impermeability of the membrane of the egg of *Fundulus* is due to lipoids or to proteins. It was found that when eggs are exposed to a $N/333$ solution of acetic acid for twenty minutes, their permeability increases to such an extent, that if they are put into a mixture of 50 c.c. 3 *m* NaCl + 1 c.c. 2 1/2 *m* $CaCl_2$ they sink in less than seven hours (while the normal eggs float in such a solution for three days). If, however, the acetic acid solution is made up in $m/2$ NaCl (instead of distilled water) an exposure of the eggs of twenty minutes or more to the acid solution does not injure the membrane. Such eggs will float in 50 c.c. 3 *m* NaCl + 1 c.c. 2 1/2 *m* $CaCl_2$ three days or longer. By the same method it was ascertained that in the system $H_2SO_4 — m/2\ Na_2SO_4$ the action of the acid was more effectively inhibited than in the system HCl — NaCl. From these experiments we are inclined to conclude that the increase in the permeability of the membrane for water and salt under the influence of acids is due to an alteration of the protein constituents of the membrane.

3. It was found that alcohols also increase the permeability of the membrane of the *Fundulus* egg for water (and possibly for salts). If eggs are put for sixty minutes into a grammolecular solution of methyl alcohol and then transferred to the test solution (50 c.c. 3 *m* NaCl + 2 c.c. 10/8 *m* $CaCl_2$) they will sink in less than eight hours (while the normal eggs float three days at the surface of such a solution). The relative efficiency of various alcohols for bringing about this increase in the permeability of the eggs was ascertained and it was found that each higher alcohol of the series is about three times as efficient as the preceding one. This is the well-known relation indicating effects on lipoids. The facts mentioned sub. 2 and 3 agree with the suggestion made by Natanson that cell membranes may be a mosaic of proteins and lipoids.

4. The increase in permeability caused by electrolytes and by alcohols is reversible if the eggs are put into sea water or into a $m/2$ solution of NaCl + KCl + $CaCl_2$ in the usual proportion. If the eggs are put into distilled water they may continue to live, and the fish may hatch, but the increase in permeability is not reversed. It can be shown that distilled water itself increases the permeability of the membrane very slowly.

JACQUES LOEB

ROCKEFELLER INSTITUTE,
NEW YORK,
October 22, 1912

[4] *Pflüger's Archiv*, Bd. 75, p. 388, 1899.

[5] Beutner, *Biochemische Zeitschrift*, Bd. 39, 280, 1912.

VITAL STAINING OF CHROMOSOMES AND THE FUNCTION AND STRUCTURE OF THE NUCLEUS

ONE difficulty in studying protoplasm, particularly of living mitotic figures, is due to the slight differences in the refractive index of the various structures in the living cell. Up to the present, no satisfactory study has been made on the living chromosomes.

Our studies have been confined chiefly to the testes of the squash bug, grasshoppers and crickets, which are very favorable on account of the large size of their cells, and the clearness of the nuclear figures.

The testes were teased in Ringer's fluid and stained with Janus green (diethylsafraninazodimethylanalin) and studied in hanging drops in the Barber moist chamber. By variations in the concentration of the dye beautiful differential staining of the various cellular elements was obtained.

Masses of cytoplasmic granules varying in their position in the spermatogonia, sperma-