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THIAMIN AND PLANT GROWTH¹

By Dr. WILLIAM J. ROBBINS

DIRECTOR OF THE NEW YORK BOTANICAL GARDEN

ALTHOUGH several investigators, including R. J. Williams (1920) and Lepeschkin (1924), had reported a favorable effect of vitamin B₁ or thiamin upon plant growth, their crude preparations contained other substances as well as thiamin, and their results could not be accepted as definitive. Indisputable evidence of the importance of thiamin for plants depended upon the availability of the pure compound. Isolated in crystalline form by Jansen and Donath as early as 1926, thiamin did not become generally available until 1934, largely as the result of the work of R. R. Williams and his associates.

Almost at once Schopfer (1934) demonstrated that *Phycomyces Blakesleanus* will not grow in a medium of mineral salts, asparagine and sugar unless supplied

with thiamin. The demonstration was so striking that further investigations with this organism and with others soon followed until it is now clear as the result of the work of Schopfer, Bonner, Knight and others that thiamin is as necessary in the physiology of plants as it is in the nutrition of animals.

My own interest in thiamin arose from a study of the nutrient requirements of excised roots, initiated in 1917 as the result of a paper by Jacques Loeb in which he suggested that a hormone is concerned in the formation of roots by the leaves of *Bryophyllum calycinum*. It was my opinion that Loeb had not eliminated sugar accumulation in the leaves as the "hormonal" factor, and the experiments on excised roots were initiated to attack that problem directly. In the twenty years since the original experiments a number of people have been associated with me and through their assistance one aspect or another of that problem and related ones

¹ Presented before the Section on the Botanical Sciences of the American Association for the Advancement of Science, Richmond, Va., December 28, 1938.

or in Van Giesen picrofuchsin. As an instance typical of the ease of use and reliability of the stain, a series of slides was stained for different lengths of time in a trial lot of this solution which contained only 10 grams each of ferrous and ferric alum, instead of the 20 as above described. The slides were then counterstained with Van Giesen picrofuchsin (5 minutes) in the usual manner. The slides stained 2 minutes were fairly satisfactory; those stained 4 minutes were nearly ideal; those stained 15 minutes could hardly be distinguished from those stained 4 minutes, and it was only when the staining was carried up to about an hour that the image showed signs of loss of detail from overstaining.

From these preliminary studies it is suggested that the combination of a high concentration of ferrous and ferric salts serves to maintain an oxidation-reduction equilibrium in the solution which is far more suitable for the formation and preservation of the selective blue hematoxylin-iron salt than is either the ferrous or the ferric salt alone. It appears that the stain, above described, is highly selective. It is relatively insensitive to variation in staining time and may be used as practically a progressive stain with little or no differentiation. This differentiation, when required, may be done by time rather than by inspection. The solution is far more stable than either Weigert's or Janssens' hematoxylin, is easily prepared and does not require any aging. This stain has not given satisfactory results when used in contact with at least some metals, as, for instance, monel.

In conjunction with Dr. Ralph Lillie, of the division of pathology, a more detailed study of this stain is being carried on at this institute in order to more accurately define its properties. Even with the data above presented, however, the question is raised as to whether or not many, or possibly even all, of our current iron hematoxylin stains would not be substantially improved by substitution of a mixture of ferrous and ferric salts or some equivalent oxidation-reduction mixture for the ferric salts now in current use.

No studies have as yet been made on the action of this stain on such cell organs as mitochondria. These considerations will be left to a later date.

WILTON R. EARLE

NATIONAL CANCER INSTITUTE,
U. S. PUBLIC HEALTH SERVICE,
WASHINGTON, D. C.

"SPOTTING" SPECIMENS FOR CATALOGUE NUMBERS

ENAMEL spots for catalogue numbers on minerals and fossils have been superseded in this department for some years by spots of clear Duco cement. Applied direct from the tube, the cement is more convenient to handle than paint, and it hardens more

rapidly. Its surface takes india ink well from a pen, and the inconspicuous character of the cement will be especially appreciated when numbers must be applied to transparent crystals.

A. S. WARTHIN, JR.

VASSAR COLLEGE

THE CARE OF SKULLS AND SKELETONS OF SMALL ANIMALS

BEFORE shipping small skulls and skeletons, or before allowing them to be cleaned by dermestid beetles, it is usually desirable to dry them as completely as possible.

The automobile, probably now used by the majority of collectors, makes an ideal desiccating machine. Small osteological specimens fastened under the hood by wire, in the hot air stream from the fan, become perfectly dry in a day or two, even in damp weather, if the automobile receives ordinary use. A minimum of preliminary cleaning is necessary, and brains need not be removed from skulls up to the size of a rat's. Enough muscle and tendon may be left on small skeletons to hold the bones firmly together. Fly eggs fail to hatch, and maggots quickly die under this treatment.

No claim to originality is made for this method, but it has proved so useful that it seems worthy of dissemination.

RICHARD M. BOND

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BOOKS RECEIVED

- BUSH, GEORGE L., ALLAN DICKIE and RONALD C. RUNKLE. *A Biology of Familiar Things*. Pp. 695. Illustrated. American Book Co. \$1.92.
- Department of Scientific and Industrial Research, Report for the Year 1937-38. Pp. iv + 203. British Library of Information, New York. \$0.90.
- FAUNCE, FRANCES A. and FREDERICK G. NICHOLS. *Secretarial Efficiency*. Pp. xiv + 601. Illustrated. McGraw-Hill. \$2.75.
- HESSLER, JOHN C. and HENRY C. SHOUDY. *Understanding Our Environment; An Introduction to Science*. Pp. ix + 661. 220 figures. Sanborn.
- MILLER, WILLIAM J. *Elements of Geology; with Reference to North America*. Second edition. Pp. viii + 524. 367 figures. Van Nostrand. \$3.50.
- MORRIS, PERCY A. *What Shell Is That? A Guide to the Shell-Bearing Mollusks of Eastern North America*. Pp. vii + 198. Illustrated. Appleton-Century. \$2.25.
- RICHARDSON, E. G. *Physical Science in Modern Life*. Pp. 256. 60 figures. Van Nostrand. \$3.00.
- The Romance of Exploration and Emergency First-Aid from Stanley to Byrd*. Pp. 160. Illustrated. Burroughs, Wellcome, New York.
- Science Reports of the Tôhoku Imperial University, Sendai, Japan; First Series (Mathematics, Physics, Chemistry), Vol. XXVII, No. 3, January, 1939*. Pp. 211-427. Illustrated. Maruzen, Tokyo.
- TOWNLEY, SIDNEY D. and MAXWELL W. ALLEN. *Descriptive Catalog of Earthquakes of the Pacific Coast of the United States, 1769 to 1928; Bulletin of the Seismological Society of America, Vol. 29, No. 1, January, 1939*. Pp. 297. University of California Press. \$1.00.

2 Outstanding Texts in Biology

TEXTBOOK of ZOOLOGY

By GEORGE EDWIN POTTER, Ph.D.,
Professor of Zoology,
Baylor University, Waco, Texas.

843 Pages, 440 Illustrations. PRICE, \$5.00

This NEW and DIFFERENT textbook of ZOOLOGY presents the animal kingdom in a logical and natural way, and carries the interpretation of the facts in terms of the principles involved. The author accomplishes the difficult task of striking an ideal balance between the necessity of presenting sufficient factual material and the opposite temptation of going into endless discussions of theories and rules. Bringing to a well-defined understanding of the principles involved in all of the living processes this book makes it possible for one to obtain a clear-cut knowledge of the complete biology of a series of representative animals, each representing, since it is a living organism, certain of these principles.

In a addition to the usual material found in Zoology texts, this book presents many practical and interesting phases such as Regeneration, Animal Distribution, Wildlife Conservation, Animal Behavior.

This textbook classifies the animal kingdom after first giving a historical review of zoology, with brief biographies and photographs of some famous zoologists. Then follows a discussion of protoplasm with numerous chapters, each devoted to some one phylum or class of animals. Chapter Four deals with protozoa in general; Chapter Six with Amebas; Chapter Seventeen with Mollusks, and so on. In the chapter on animal parasitism are discussions of many specimens that are parasitic to man. The later chapters concern wild life conservation, comparative embryology, genetics, comparative physiology, paleontology, and phylogenic relations of animal groups and the theory of evolution.

FUNDAMENTALS of BIOLOGY

By WILLIAM C. BEAVER, Ph.D.,
Professor of Biology,
Wittenberg College, Springfield, Ohio.

896 Pages, 299 Illustrations. PRICE, \$4.50

This book presents the more important biological facts briefly enough to permit a complete comprehension of the subject as a whole and serves as a skeleton to which such additional data may be added as seem desirable. It systematizes and condenses the present biological knowledge so that it can be more easily taught, visualized, and mastered.

Human biology is well stressed, especially in the chapters in which the various systems of animals are studied on a comparative basis. Separate chapters are devoted to a complete survey of both plant and animal kingdoms. The ten systems of animals are considered completely. This study is made on a comparative basis in order that the progressive development of each system may easily be followed from the ameba to man.

The general principles of biology are evolved from an actual study of typical, representative animals and plants. These principles are based on the actual study of the fundamental structures and functions of well-selected animals and plants.

Throughout the text, there is a logical sequence of materials; one point leading to another with a minimum of confusion. The text is divided into 5 parts, as follows: Introductory Biology; Animal Biology; Plant Biology; General and Applied Biology; and the Appendix. A feature of the book is the coverage on the Cell Principle and Cell Division for both animal and plant kingdoms, these subjects being amply considered to serve as a foundation for additional work.

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The PRINCIPLES of ELECTROCHEMISTRY

Duncan A. MacInnes

*The Rockefeller Institute
for Medical Research*

This entirely new treatise, 15 years in preparation, is both a readable and an extremely painstaking account of the science of electrochemistry as it is to-day. Careful arrangement of the subject matter and logical development of the concepts involved make it particularly desirable for use as a textbook. The basic principles of electrochemistry are discussed and critically evaluated; and the foundation thus laid is used as a basis for the introduction of more recent ideas, such as the extension of the Debye-Hückel theory, the application of the interionic attraction theory to electrolytic conductance, the use of the glass electrode and the Tiselius electrophoresis technique for the study of proteins. Every effort has been made to achieve the highest possible level of accuracy throughout the book.

It contains an excellent introduction to the thermodynamics of electrochemistry and it is particularly comprehensive in its treatment of electrode potentials. It gives the modern theoretical status of the basic principles of electrochemistry, with emphasis on the interionic attraction theory. The latter is a field to which the author has contributed invaluable experimental verification.

An unusual feature of the book, one not possessed by any other text in the field, is its extensive and critical evaluation of experimental data. It is a mine of experimental values, not merely abstracted from the literature, but critically presented and, where necessary, recomputed. On the experimental side there is a very complete presentation of transference numbers and a good account of the much discussed theory and practice of electrophoresis.

Dr. MacInnes, a member of the National Academy of Science, now in charge of electrochemical research at the Rockefeller Institute for Medical Research, was formerly a professor at Massachusetts Institute of Technology, is also a past president of The Electrochemical Society. This book will be indispensable to chemists, physicists, engineers, and biologists—in short to everyone who wishes to maintain close contact with one of the most important and fruitful developments of modern science.

An idea of the scope of the book is given by the table of contents as follows:

Introduction
Faraday's Law and Coulometers
Electrolytic Conductance and the "Classical" Theories of Dissociation
Electrical Transference
The Principles of Thermodynamics and the Galvanic Cell
Chemical Potential, Activity, and Related Quantities
The Debye-Hückel Method for the Theoretical Calculation of Activity Coefficients
Concentration Cells and the Validity of the Debye-Hückel Theory
The Effects of Gravity and Centrifugal Force on the Electromotive Force of Galvanic Cells
Standard Electrode Potentials from Galvanic Cells without Liquid Junctions
Thermodynamic Ionization Constants from the Potentials of Cells without Liquid Junctions
Thermodynamic Studies of Non-Aqueous Solutions
Galvanic Cells with Liquid Junction Potentials

Standard Potential Determinations of the Elements Involving Cells with Liquid Junctions, or Equilibrium Measurements
The Determination and Meaning of pH Values
The Standard Potentials of Electrode Reactions
"Oxidation-Reduction" Potentials
Potentiometric Titrations
The Interionic Attraction Theory of Conductance of Aqueous Solutions of Electrolytes
The Conductance of Electrolytes
The Conductance of Electrolytes in Non-Aqueous and Mixed Solvents
The Use of Conductance Measurements in Various Physico-Chemical Investigations
The Effect of Structure and Substitution on the Ionization Constants of Organic Acids and Bases
The Dielectric Constants of Liquids and the Dipole Moments of Molecules
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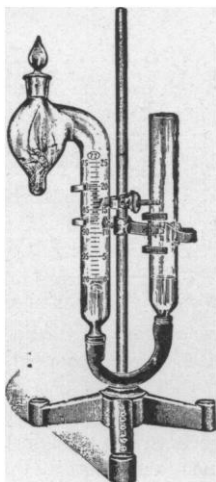
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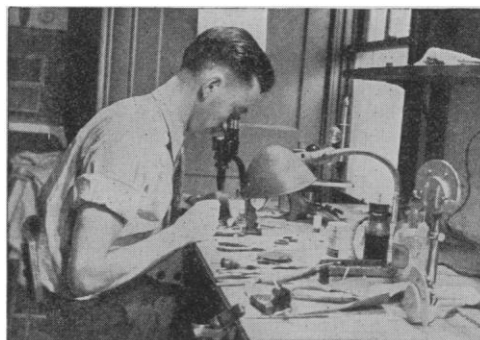
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Because of repeated requests we have resumed the manufacture of the well known plant physiology apparatus designed by Professor Ganong. The group comprises pieces which apply to growth, photosynthesis respiration, nutrient cultures, sap pressure, transpiration and geotropism. Each has been developed on the theory that it is far more economical to have an efficient appliance, ready for immediate use, rather than waste hours improvising make-shift contrivances. Even with the complications involved in physiological work valuable data have been derived from many of the classical experiments in plant physiology through the use of the Ganong appliances and because they have been so instrumental in developing the science they are deserving of a place in every plant physiology laboratory. Each is completely illustrated and described in our catalog No. 47. If not in your laboratory, write for a copy.

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