BIOLOGICAL HANDBOOKS

Biology Data Book

Second Edition

VOLUME III

Biology Data Book

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VOLUME III

COMPILED AND EDITED BY

Philip L. Altman and Dorothy S. Dittmer

Federation of American Societies for Experimental Biology
BETHESDA, MARYLAND

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FOREWORD

This volume of the *Biology Data Book* completes the second edition of a three-volume compilation of evaluated reference data in the life sciences. The preparation of the 281 groups of tables, graphs, and diagrams–constituting some 2100 pages–required four years, and the cooperative efforts of 712 eminent scientists. These experts from all over the world contributed and reviewed the data, and in addition provided more than 18,000 literature citations from which the information was derived.

Volume I of the *Biology Data Book* was published in 1972, and consists of five sections covering GENETICS AND CYTOLOGY; REPRODUCTION; DEVELOPMENT AND GROWTH; MATERIALS AND METHODS; and PROPERTIES OF BIOLOGICAL SUBSTANCES. Also included are nine appendixes of useful general information. Volume II, published in 1973, contains many new tables in its sections on BIOLOGICAL REGULATORS AND TOXINS; ENVIRONMENT AND SURVIVAL; and PARASITISM. The section on SENSORY AND NEURO- BIOLOGY is entirely new to the Biological Handbooks Series; its 35 tables cover neurophysiology, neurochemistry, neuroelectric properties, electroencephalograms, and the special senses. Each of the three volumes is indexed independently, and can be purchased separately by those interested only in data limited to particular fields.

This 2100-page "library" of biological reference data concludes a publication program begun a quarter of a century ago in the National Academy of Sciences–National Research Council (NAS–NRC). Ten handbooks, five in biology and five in toxicology, were produced by the time the project was transferred to the Federation of American Societies for Experimental Biology (FASEB) in 1959. Under FASEB auspices, six biological handbooks have been completed, in addition to the present three-volume *Biology Data Book*. Except for Volumes II and III of this last publication, all of the books were financed by agencies of the federal government. Two of these agencies must be acknowledged for their long-term generous support: the U.S. Air Force for 22 years of assistance, and the National Institutes of Health/National Library of Medicine for 15 years.

Gratitude must also be expressed to the biologists who served on the NAS–NRC and FASEB Handbooks Committees, and on the advisory committees for each book in the series. The former selected the fields to be covered, and the latter selected the tables to be included in each volume and recommended the scientists most eminently qualified to compile the data. Since 1959, more than 3000 prominent scientists have participated in the evaluation, contribution, and review of over 6000 pages of quantitative and descriptive data, including nearly 54,000 source references. Without their expertise in providing the "best values" available, the Biological Handbooks Series could never have achieved its reputation for scientific excellence and accuracy. The unremunerated intellectual contributions of these dedicated authorities is sincerely appreciated.

Among those associated with the Handbooks Project since its inception are three distinguished biologists, who deserve special mention. One is Dr. J. W. Heim, who conceived the project, persuaded the NAS–NRC to assume responsibility for its establishment and operation, and provided Air Force funds to keep it solvent. Another is Dr. T. C. Byerly who was Chairman of the NAS–NRC Committee for the first 10 years of the project, and helped nurture it through its early days to maturity and eventual transfer to FASEB. The third member of this triumvirate is Dr. R. L. Zwemer, the only one of the original NAS–NRC Committee to serve the entire 25 years of the project's existence, including the last 15 years as Chairman of the FASEB Handbooks Committee. His efforts in enlisting the financial assistance of new sponsors through the years assured continuity of the undertaking; his unqualified support of, and interest in, the project merit a special salute. Drs. Zwemer, Byerly, and Heim were decisively instrumental in fostering, expediting, and maintaining the Biological Handbooks.

As a precaution against the introduction of errors in the volumes, all compilation, editing, indexing, and composition of copy have been performed within the confines of the Office of Biological Handbooks by a veteran staff. The product of their labors–the data books themselves–attest to the efficiency and devotion of this exceptional group of professionals. And no one better exemplifies the high standards of accuracy and meticulousness in the preparation of publication copy than the co-editor of the series for the past 20 years, Dorothy S. Dittmer.

With Volume III of the *Biology Data Book*, the publication program supervised by the Committee on Biological Handbooks and supported exclusively by government funds comes to an end, and a new series of data books begins. As in the past, the project will continue to be nonprofit. Future responsibility for policy and guidance has been assumed by the FASEB Publications Committee, and an Editorial Board has been formed to provide advice and recommendations in the preparation of new fascicles. Production time for future volumes will be cut in half, as a result of a new approach whereby the essential data for a discrete subject will be covered in approximately 300 pages. However, there will be no compromise in retrieving and disseminating the most useful, reliable, reference data available in the life sciences.

1 July 1974
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XIII. BLOOD AND OTHER BODY FLUIDS

APPENDIXES

X. NUTRITION, DIGESTION, AND EXCRETION

168. NUTRIENTS: CHEMICAL ELEMENTS

All organisms require carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur. These elements are universal constituents of protoplasm. *Abbreviations and Symbols:* Capital letters indicate data are pertinent to all organisms studied; lower case letters and symbols indicate data apply to one or more species or strains, but not to all forms studied. R and r = required (accumulation in the tissues of an organism is not alone sufficient evidence that an element is required); R̸ = not required; u= = utilized as effectively as, replaces wholly, or is interchangeable with, another element; U< and u< = can partially replace, or spare the use of, another element; s = stimulates growth or other processes; a = accumulates in the tissues; c = commonly present at similar concentrations in the food and tissues, but requirement is uncertain.

	Nutrient	Vertebrates	Invertebrates[1]	Insects	Protozoans[2]	Prokaryotes[3]	Algae	Fungi	Spermatophytes
1	Aluminum	R̸	....	R̸	R̸	R̸	R̸	R̸, c	r, s, a
2	Arsenic	R̸	a	R̸	R̸	R̸	R̸	R̸	R̸
3	Boron	R̸	R̸	R̸	R̸	r	r	r?	R
4	Bromine	U<	r?, a?[4]	R̸	R̸	R̸	R̸, a	r[5]	R̸
5	Calcium	R	r	r, c	R	r, s	R	R[6]	R
6	Chlorine	R	r	r, c	R̸	r	a	c	r, s
7	Chromium	r, a	....	R̸	R̸	u=	R̸	r	R̸
8	Cobalt	R	....	r?, s?	r	r	r	R	r
9	Copper	R	r	r, c	r	r	R	R	R
10	Fluorine	R̸, s	a	R̸	R̸	R̸	R̸	r[5]	R̸, a
11	Gallium	R̸	R̸	R̸	R̸	R̸	R̸	R̸, s	r
12	Iodine	R	r?, a	R̸	R̸	R̸, s	R̸, a	R̸	R̸, s
13	Iron	R	r	r	R	R, u<	R	R[7]	R
14	Magnesium	R	R	r	R	r	R	R[7]	R
15	Manganese	R	r[8]	r, a, c	r	R, u=	R	R, u<[9]	R
16	Molybdenum	r[10]	....	R̸	R̸	r[11], u<, s	R	r[12,13]	R, a
17	Potassium	R	R	R, a, c	R	r	R, a	R	R
18	Rubidium	R̸	....	R̸	R̸	u=, u<[14]	R̸	R̸	R̸
19	Selenium	R	....	R̸	R̸	R̸	R̸	R̸	R̸, a
20	Silicon	R̸, c	r	R̸	r	R̸	r	c	r
21	Sodium	R	....	r?, c	r	r	r, a	R	r?, s, a
22	Strontium	U<	....	R̸	R̸	u=	R̸, u=	R̸, s	R̸
23	Tungsten	R̸	....	R̸	R̸	R̸	R̸	s	R̸
24	Vanadium	R̸	r[15]	R̸	R̸, s?	R̸	r	r	R̸
25	Zinc	R	r?, a	r	r	r	r	R[8]	R
	Reference	4,15-17,22, 27,28,38,40, 43,44,46-51, 53,54,56-59, 64,69,70	5,8,10,13,20, 25,26	13,19, 30,31, 65,67	12,13,23,24, 32-34,42	6,9,21,29,36, 37,60,62,63	13,23,24, 38,39, 52	1,2,9,11, 14,18,21, 40,55,62, 63,66,68	3,7,13,26,35, 41,45,61,63

[1] Other than insects and protozoans. [2] Includes the colorless phytoflagellates. [3] Includes Schizomycetes, Rickettsiales, and Cyanophyta. [4] Occurs as dibromotyrosine in scleroprotein of certain corals. [5] Necessary in secondary fermentations. [6] Has a special role in sterol deficiency in oomycetes. [7] Several trace elements at relatively high concentrations are necessary for secondary metabolism. [8] In blood respiratory pigment of *Pinna nobilis (P. squamosa).* [9] Can replace magnesium in reactions involving adenosine triphosphate. Increases the longevity of *Torulopsis.* [22] [10] Xanthine oxidase factor. [11] Required for assimilatory nitrate reduction and nitrogen fixation by some bacteria and blue-green algae. [12] Required by *Pilobolus* as the growth factor coprogen. [13] Required by all fungi exhibiting nitrate reduction. [14] Replaces potassium in some organisms, and spares potassium in others. [15] In blood pigment of certain tunicates.

continued

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169. NUTRIENTS: LIPIDS

Abbreviations and Symbols: Capital letters indicate data are pertinent to all organisms studied; lower case letters and symbols indicate data apply to one or more species or strains, but not to all forms studied. R and r = required; R̸ = not required; rm = required by one or more mutants; U and u = utilized; u= = utilized as effectively as a related substance; U< = utilized less effectively than a related substance; U> = utilized more effectively than a related substance; s = stimulates growth or other processes; i = inhibits growth or other processes.

	Nutrient	Vertebrates	Insects	Protozoans[1]	Prokaryotes[2]	Algae	Fungi	Spermatophytes
	Sterols							
1	Cholesterol	R̸	r[3]	r[4]	r[5,6], s[7], i[8]	R̸	r[9,10]	R̸
2	7-Dehydrocholesterol	U	u=	R̸, u=[11]	r[5,6]	R̸	r[9,10]	R̸
3	Ergostanol acetate	R̸	...	R̸, u=[11]	r[5,6]	R̸	R̸	R̸
4	Ergosterol	U	u=	R̸, u=[11]	r[5,6], i	R̸	s[10,12]	R̸
5	Stigmasterol	R̸, s	u=	r[13]	r[5,6]	R̸	s[10]	R̸
	Long-Chain Fatty Acids & Their Derivatives							
6	Arachidonic acid	R̸[14], U>	s	....	....	R̸	R̸	R̸
7	Linoleic acid	R	r	u=	r[6]	R̸	R̸, rm	R̸
8	Linolenic acid	R̸[14], U<	u=	....	r[6]	R̸	r	R̸
9	Oleic acid	R̸	r	r, s, i	r[6]	R̸	r[12], rm	R̸
10	Palmitic acid	R̸	u	r[15]	r	...	r, s	...
11	Myrj G 2144[16]	R̸	R̸	R̸, s	R̸	R̸	R̸	R̸
12	Tween 80, 85[17]	R̸	R̸	R̸, s	r[6]	R̸	R̸	R̸

[1] Includes the colorless phytoflagellates. [2] Includes Schizomycetes, Rickettsiales, and Cyanophyta. [3] Apparently all insects need an exogenous sterol source and all insects devoid of symbionts need sterols in their diets, but several species utilize various other sterols as effectively as cholesterol; cholesterol (Δ^5-sterol) is apparently ineffective in *Drosophila pachea* which utilizes only a Δ^7-sterol, and in *Xyleborus ferrugineus* which uses only ergosterol ($\Delta^{5,7,22}$-sterol) & 7-dehydrocholesterol ($\Delta^{5,7}$-sterol); since their symbionts possibly may furnish sterols, *Oncopeltus fasciatus* and *Myzus persicae* may need none in food. [4] Required by various *Trichomonas* species. [5] Can be used by certain soil bacteria as the sole source of carbon and energy. [6] Required for growth of some *Mycoplasma* species. [7] Enhanced growth of some gram-negative bacteria at 0.1% in nutrient broth. [8] Inhibited growth of some gram-negative bacteria at 0.1% in nutrient broth. [9] Required only by *Labyrinthula vitellina* var. *pacifica,* which also requires fucosterol, campesterol, β-sitosterol, γ-sitosterol, brassicasterol, and poriferasterol. [10] Induces oospore and oogonium formation in Pythiaceae. [11] Utilized in place of cholesterol by *Trichomonas.* [12] Required for anaerobic growth of yeasts. [13] Required by *Paramecium aurelia* which also requires sitosterol. [14] Required by monogastric animals, in addition to linoleic acid. [15] Required by *Trichomonas gallinae.* [16] A synthetic detergent (polyoxalkaline derivative of oleic acid). [17] Synthetic detergents (sorbitan esters of fatty acids, e.g., oleic).

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