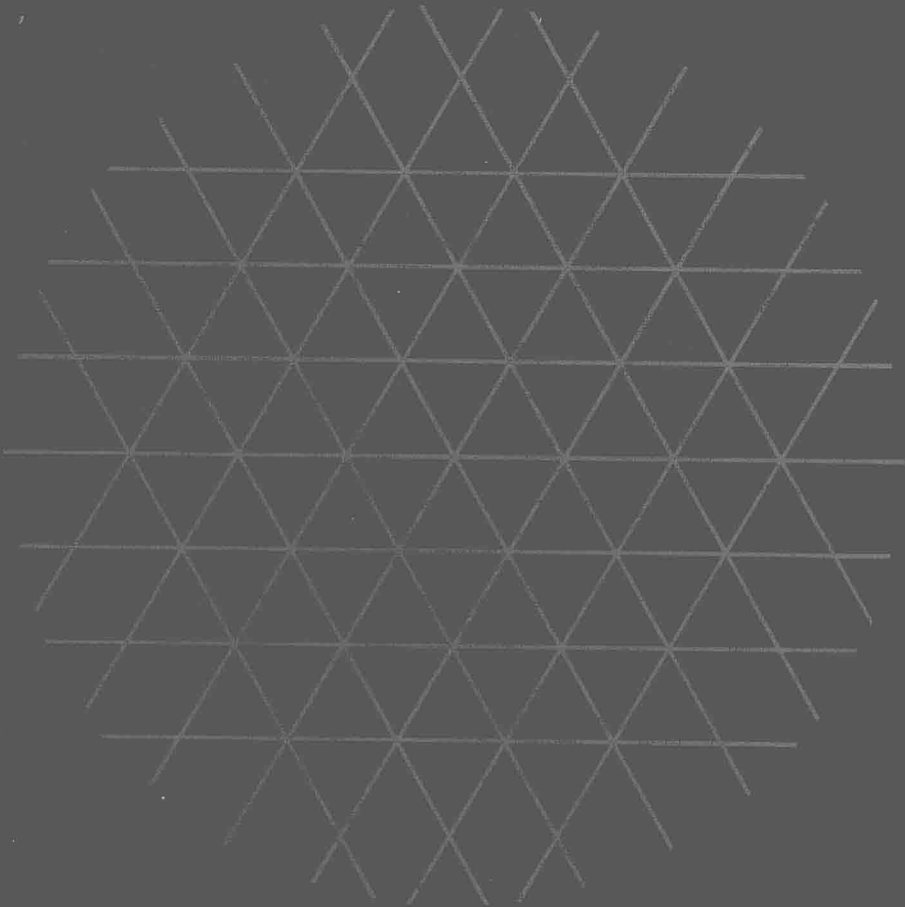


TEACHER'S EDITION



BIOLOGICAL
SCIENCE

interaction
of
experiments
and
ideas



SCIENCE

interaction of experiments and ideas

Biological Sciences Curriculum Study

PRENTICE-HALL, INC., ENGLEWOOD CLIFFS, N. J.

Teacher's Edition Biological Science: Interaction of Experiments and Ideas

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BIOLOGICAL SCIENCE: INTERACTION OF EXPERIMENTS AND IDEAS

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BSCS SPECIAL PUBLICATIONS, BSCS, Boulder, Colorado

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FOREWORD

In 1959, the American Institute of Biological Sciences established the Biological Sciences Curriculum Study for the improvement of biological education at all levels. Since that time a number of working groups have been organized by the BSCS on various campuses both in the United States and abroad. Hundreds of American biologists and high school teachers, along with biologists from other nations, have been involved in the programs of the BSCS. Primary support for the work of the BSCS has been provided by the National Science Foundation. Among other activities, the BSCS has produced three versions of a first course in biology, each of which is currently in wide use in American high schools.

Since the advent of the BSCS Versions there has been an increasing demand for a second course in biology that would build upon the major BSCS themes. Such a course, while designed with high school seniors in mind, should also be useful in a variety of collegiate programs.

In planning to satisfy this demand, it was decided that the major emphasis in such a second course should be upon laboratory investigation, in depth, of selected areas of biology. The assumption is made that students who have had a general background in a first biology course, and who are interested in continuing their study of biology, would profit intellectually from an opportunity to experience laboratory work that partakes of actual research.

The present book, *Biological Science: Interaction of Experiments and Ideas*, is the culmination of a three-year program of testing experimental editions in classrooms throughout the United States. The second course materials were developed by a team of biologists under the supervision of Mr. Norman Abraham, Associate Director of the BSCS.

Teachers, students, and others who use this volume are invited to send their recommendations for improvement to the Director, Biological Sciences Curriculum Study, Post Office Box 930, Boulder Colorado, 80301. The BSCS would be happy to respond to requests for information about its other programs, including the Versions, Laboratory Blocks, Pamphlets, Films, Research Problems, Teacher's Handbook, Newsletters, and other items.

We hope that *Interaction of Experiments and Ideas* will serve to guide a substantial number of students and teachers into valuable and interesting pathways in science.

BENTLEY GLASS
Chairman, BSCS

ARNOLD B. GROBMAN
Director, BSCS

ACKNOWLEDGMENTS

In preparing this book, the writers have greatly benefited from the advice and assistance of many individuals. A considerable amount of experimental material has been adapted from the four BSCS Laboratory Blocks; *Plant Growth and Development*, Addison E. Lee, University of Texas; *Regulation in Plants by Hormones—A Study of Experimental Design*, William P. Jacobs and Clifford E. LaMotte, Princeton; *Animal Growth and Development*, Florence Moog, Washington University; and *Microbes: Their Growth, Nutrition, and Interaction*, Alfred Sussman, University of Michigan.

In designing the investigations on animal behavior, the authors have had the valuable advice and technical assistance of Vincent G. Dethier, University of Pennsylvania.

Joseph J. Schwab, University of Chicago, through his contributions to the BSCS, has provided much of the inspiration for presenting science as inquiry that pervades this and other BSCS publications.

Leonard Reynolds, Chairman, Mathematics Department, Yuba City Union High School, gave valuable assistance in editing the sections involving mathematics.

Individuals who have helped to guide the philosophy and practical implementation of the BSCS Second Course through active membership on a policy committee for the program include: Manert Kennedy, Fraser High School, Fraser, Michigan; Clarence Lange, Clayton High School, Clayton, Missouri; Addison E. Lee, Science Education Center, University of Texas, Austin; and Lester Heward, Capuchino High School, San Bruno, California.

Marjorie Behringer and Don Davis, Laboratory Block Project Associates at the University of Texas, assisted by conducting research into various aspects of yeast metabolism.

We are indebted to the Literary Executor of the late Sir Ronald A. Fisher, F. R. S., Cambridge, to Frank Yates, F. R. S., Rothamsted, and to Messrs. Oliver & Boyd Ltd., Edinburgh, for permission to reprint Tables II and IV from their book *Statistical Tables for Biological, Agricultural, and Medical Research*.

An acknowledgment would not be complete without mention of the hundreds of BSCS writers, committee members, test teachers, students, and reviewers who have individually and collectively influenced the preparation of this book through their contribution to the total BSCS program. Although it is impossible for us to acknowledge these contributors individually, we are grateful for their help.

NORMAN ABRAHAM, SUPERVISOR

The BSCS Second Course
Boulder, Colorado

PREFACE

Interaction of Experiments and Ideas differs considerably from the kind of biology course usually found at the senior high school or beginning college level. This BSCS course is an outgrowth of the underlying principles that have guided the BSCS program from its inception. The principal focus of *Interaction of Experiments and Ideas* is upon laboratory investigations that may take days or even weeks to complete and that often require parallel study of the literature.

The BSCS Second Course was born in the minds of a group of university biologists and high school teachers who believe that the best way to teach a second course in biological science is to involve students in activities that are most like those of the professional biologist. The authors believe that this approach to learning science is of as much value to the layman who takes a course in biology as to the potential biologist.

The success of the Second Course depends not only on what is presented, but also on how it is presented. The student's edition is not self-contained in the usual sense; this is where the teacher's edition has its role—to serve as a companion to the student's edition. The teacher's edition contains photographed pages of the student's edition and a great deal more. It is not intended merely as an "answer book," as a guide to preparing solutions, or as a list of bibliographical references, although it does contain all these. Wherever possible, the textual material that would reveal answers to questions or solutions to laboratory investigations has been omitted from the student book and placed in the teacher's edition. This edition also contains numerous pages of information relative to teaching the course. The teacher's edition pages are numbered independently of the student's book. Since the pages from the student's book are photographically reproduced, their page numbers will appear the same in the teacher's edition. The margin sometimes contains answers to questions asked the students, comments relating to work the students are doing, and other comments deemed applicable to teaching the Second Course. The blank areas of the margin may be used by the teacher for notes and plans for presenting the course.

Only a classroom teacher can accurately anticipate and deal with the diverse ability of his students. No text, laboratory manual, or teacher's guide can hope to match the capacity of the individual teacher in his ability to encourage students towards greater achievement in education.

The authors believe that if the suggestions in the teacher's edition are carefully followed, the student will gain a rich experience from the study of biology.

NORMAN ABRAHAM
Supervisor

CONTENTS

		T. E. page	Text* page
PART ONE	THE NATURE OF BIOLOGICAL SCIENCE		
PHASE ONE	ORIENTATION	5	2
Section One	The Meaning of Science	6	3
Section Two	The Increase of Biological Knowledge	10	7
Section Three	The Role of Inquiry in Biology	12	9
PHASE TWO	PROCESSES OF BIOLOGICAL INVESTIGATION	17	11
Section Four	Hypotheses and the Design of Experiments	19	12
	INVESTIGATION 1: The Problem	20	13
	INVESTIGATION 2: A New Hypothesis	25	18
	Parallel Reading: Fermentation and Energy	27	20
	PRINCIPLES OF EXPERIMENTAL DESIGN	30	23
	INVESTIGATION 3: A Study of Variables	31	24
	Pattern of Inquiry 1: Interaction of Variables	34	26
	INVESTIGATION 4: A New Problem	36	26
	Pattern of Inquiry 2: Refining Hypotheses	38	27

*The page numbers in the left-hand column refer to pages in the teacher's edition. Those in the right hand column are the corresponding pages in the student text.

	T. E. page	Text page
Section Five Problems in the Control of Variables	42	28
UNCERTAINTY IN SCIENCE	42	28
INVESTIGATION 5: Temperature as a Variable	44	30
Parallel Reading: Enzymes and Fermentation	47	32
INVESTIGATION 6: Enzyme Concentration as a Variable	50	35
Section Six Problems in Measurement	54	38
Pattern of Inquiry 3: Evaluation of Data	55	39
Parallel Reading: Fermentation and Respiration	58	40
INVESTIGATION 7: Measuring Rates of Respiration	59	42
Pattern of Inquiry 4: The Respiratory Ratio	65	47
Section Seven Statistical Evaluation of Data	69	48
Discrete Variables	71	50
Continuous Variables	71	50
Populations and Samples	71	50
Statistical Computations	73	52
Mean	74	53
Normal Distribution	75	54
Variance	76	55
Standard Deviation	78	57
Standard Error of the Mean($s_{\bar{x}}$)	81	60
PROBABILITY AND TESTS OF SIGNIFICANT DIFFERENCES	82	61
Null Hypothesis	84	63
The t Test	84	63
Chi-Square	93	71
Chi-Square with More Than Two Attributes	97	75
Comparison of t and Chi-Square Tests	98	76
Section Eight The Literature of Biology	99	77
Scientific Journals	100	78
Scientific Papers	102	80
Review Articles	111	89

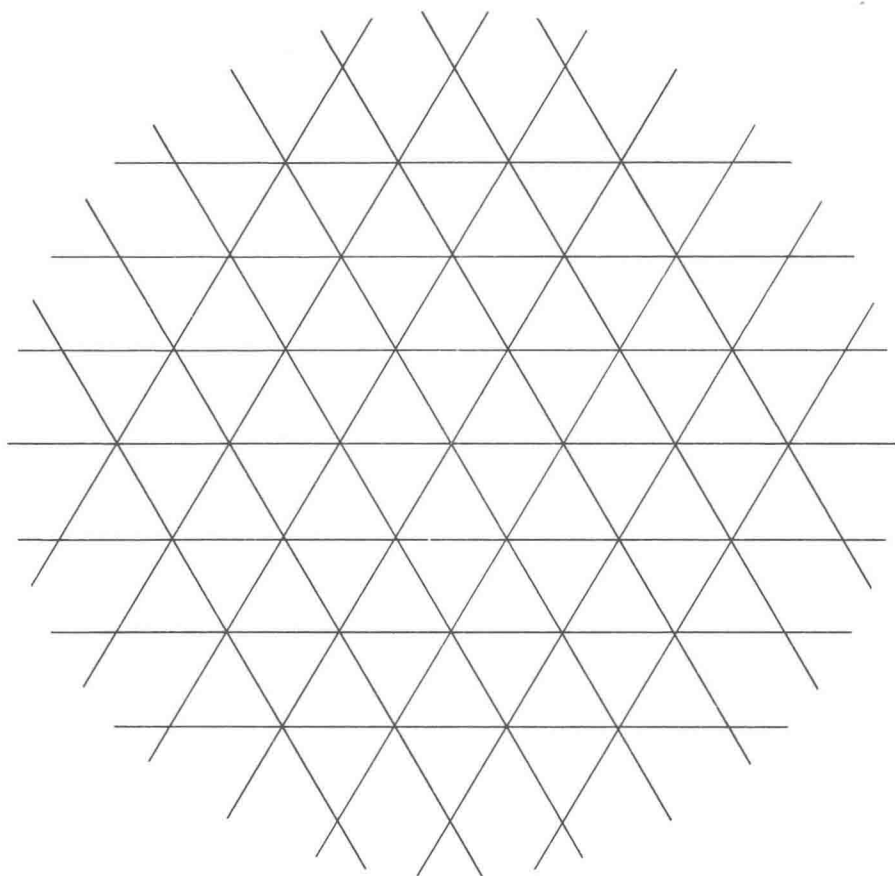
	T. E. page	Text page
SEARCHING THE LITERATURE	111	89
Biological Abstracts	112	90
Personal Records	117	95
SUMMARY	119	97
PROBLEMS	120	98
DESIGN OF EXPERIMENTS	121	99
PART TWO EXPERIMENTS AND IDEAS IN BIOLOGICAL INVESTIGATIONS		
PHASE THREE GROWTH AND INTERACTIONS OF POPULATIONS	124	102
Section Nine Population Dynamics	125	103
STUDY OF POPULATIONS BY THE USE OF MICROBES	125	103
Exponential or Logarithmic Growth	126	104
Logarithms and the Calculation of Growth	128	106
Plotting the Microbial Growth Curve	133	111
Characteristics of the Microbial Growth Curve	134	112
MICROBIAL METHODS AND TECHNIQUES	136	114
Culturing Microorganisms	136	114
Laboratory Rules	140	118
Transfer of Agar Cultures	140	118
Volumetric Transfer of Broth Cultures	142	120
The Hemocytometer	143	121
Counting the Cells in a Yeast Suspension	146	124
INVESTIGATION 8: Growth of a Yeast Population	148	126
Pattern of Inquiry 5: Factors Affecting Population Development	153	130
MUTATION FREQUENCY	155	131
INVESTIGATION 9: Determining Mutation Frequency in Bacteria	157	133

		T. E. page	Text page
Section Ten	Interaction Without Cell Contact	160	136
	INVESTIGATION 10: The Interaction of Two Mutants of a Bacterium	161	137
	Parallel Reading: Pigmentation in <i>Serratia marcescens</i>	162	138
	INVESTIGATION 11: A Verification of Results	164	140
	INVESTIGATION 12: A Study of Interactions Between Unknown Mutants	165	141
	INVESTIGATION 13: Preparation of a Scientific Paper	166	142
Section Eleven	Interaction Following Cell Contact	168	144
	HETEROKARYOSIS IN <i>ASPERGILLUS</i>	168	144
	REPRODUCTION IN <i>ASPERGILLUS</i>	169	145
	INVESTIGATION 14: Confirmation of Strains and Genotypes	174	148
	INVESTIGATION 15: Heterokaryosis and Complementation	178	152
	INVESTIGATION 16: Genetic Recombination at Meiosis	183	156
	INVESTIGATION 17: Selection and Isolation of Diploids	187	160
	INVESTIGATION 18: Genetic Recombination at Mitosis	188	161
PHASE FOUR	GROWTH, DEVELOPMENT, AND BEHAVIOR OF INDIVIDUALS	192	165
Section Twelve	Growth and Development in Plants	193	166
	MEIOSIS	193	166
	LIFE HISTORY OF A FLOWERING PLANT	193	166
	Pattern of Inquiry 6: Developing Seedlings	199	172
	INVESTIGATION 19: Enzyme Activity in Germinating Seeds	200	172
	INVESTIGATION 20: Isolation of an Enzyme	202	174
	INVESTIGATION 21: Testing for Seed Viability	203	175
	Pattern of Inquiry 7: Factors Affecting Seed Germination	205	177

	T. E. page	Text page
Parallel Reading: Some Concepts of Light Energy	207	178
INVESTIGATION 22: Effects of Light on Germination of Seeds	209	181
INVESTIGATION 23: The Effects of Different Wavelengths of Light on Germination of Seeds	211	182
INVESTIGATION 24: Mineral Requirements of Sorghum Plants	213	184
Section Thirteen Growth and Development in Animals	217	188
Gametogenesis	218	189
The Beginning of an Individual: Fusion of Gametes	219	190
Preparatory Technique 1: Obtaining Frog Pituitaries	220	191
Preparatory Technique 2: Injecting Pituitaries	222	193
Preparatory Technique 3: Fertilization <i>in Vitro</i>	222	193
Preparatory Technique 4: Establishing and Maintaining Frog Embryo Cultures	224	195
INVESTIGATION 25: Development of the Frog Embryo	226	197
Summary of Development of the Frog Embryo	229	200
Parallel Reading: The Genetic Control of Differentiation	232	203
REGENERATION	234	205
Regeneration of the Tadpole's Tail	235	206
INVESTIGATION 26: Observation of Regenerating Tissues	235	206
Parallel Reading: Regeneration in Other Multicellular Organisms	238	208
Section Fourteen Hormonal Regulation	239	209
Hormonal Regulation in Animals	239	209
Hormones in Frogs	240	210
Hormonal Control in the Frog Embryo	241	211
INVESTIGATION 27: Hormonal Control of the Development of Frog Embryos	242	212
INVESTIGATION 28: Control of Development in Chicks	246	215
INVESTIGATION 29: The Gonads of Hormone-Treated Chicks	251	219
Parallel Reading: Regulation in Plants	253	221
INVESTIGATION 30: The Effect of Light on the Growth of Seedlings	253	221
Parallel Reading: A Brief History of Our Knowledge of Auxins	254	222

	T. E. page	Text page
INVESTIGATION 31: A Biological Assay	259	227
INVESTIGATION 32: Effect of Gibberellic Acid	264	232
INVESTIGATION 33: Effects of Growth Regulating Substances on Plants	268	236
Parallel Reading: Hormonal Influence on Plants—A Series of Papers	272	240
Section Fifteen Animal Behavior	296	264
Kinds of Behavior	302	270
Orientation in Animals	310	278
Communication Among Animals	314	282
Section Sixteen Analysis of Behavior	323	289
Preparatory Technique 1: Culturing Blowflies	325	291
Preparatory Technique 2: Anesthetizing Flies	326	292
Preparatory Technique 3: Handling Flies	327	293
INVESTIGATION 34: The Effect of Food Contact on Locomotion	328	294
INVESTIGATION 35: Detection of Food	330	296
INVESTIGATION 36: Sensitivity to Sucrose	331	297
INVESTIGATION 37: The Relation of Food Selection to Nutrition	334	300
INVESTIGATION 38: Selection of Protein and Sugar	336	302
Genes and Behavior	336	302
Summary	340	306
 PART THREE CONCLUSIONS AND BEGINNINGS		
 PHASE FIVE SCIENCE AND SOCIETY	342	308
Section Seventeen Responsibilities of the Scientist	343	309
"The Inquiring Mind" by L. A. DuBridge	343	309

	T. E. page	Text page
Section Eighteen The Role of Controversy in Science	351	317
THE USE OF INSECTICIDES	352	318
“Insecticides in the 20th Century Environment” by George C. Decker	353	319
Letter Replying to George C. Decker by Dr. Samuel A. Graham	362	328
TOO MANY PEOPLE?	366	332
“Forecasting the Future” by Sir Charles Darwin	367	333
“Forecasting the Future?” by Fred Hoyle	379	345
THE COURSE IN RETROSPECT	382	349
APPENDICES		
APPENDIX A General Laboratory Requirements	387	353
APPENDIX B Laboratory Requirements for Each Investigation	396	362
APPENDIX C Preparation of Chemical Solutions	412	378
APPENDIX D Preparation of Culture Media	420	386
APPENDIX E Maintenance of Living Organisms	425	391
APPENDIX F Math Tables	428	394
APPENDIX G Bibliography	432	398
INDEX	449	417



PART ONE THE NATURE
OF BIOLOGICAL SCIENCE

IN BROKEN IMAGES

by *ROBERT GRAVES*

He is quick, thinking in clear images;
I am slow, thinking in broken images.

He becomes dull, trusting to his clear images;
I become sharp, mistrusting my broken images.

Trusting his images, he assumes their relevance;
Mistrusting my images, I question their relevance.

Assuming their relevance, he assumes the fact;
Questioning their relevance, I question the fact.

When the fact fails him, he questions his senses;
When the fact fails me, I approve my senses.

He continues quick and dull in his clear images;
I continue slow and sharp in my broken images.

He in a new confusion of his understanding;
I in a new understanding of my confusion.*

* Acknowledgment is given to International Authors N. V. for permission to reprint "In Broken Images" by Robert Graves from *COLLECTED POEMS*, Doubleday & Co., Inc., © 1955 International Authors N. V.

The authors of the Second Course found that scientists differed sharply in their reactions to the poem, "In Broken Images," by Robert Graves. Some thought it was very perceptive, others were indifferent about it, and still others thought it had nothing to contribute. We feel that it expresses in a brief literary form a main objective of this course.

Although the poem may arouse your interest, as it did ours, you will probably find that the full range of its meanings will come to the students only slowly during the course of the year. We leave it to you to determine whether or how it should be used in your course.