

THE  
BIOLOGICAL BASIS  
OF HUMAN NATURE

---

H. S. JENNINGS

HENRY WALTERS PROFESSOR OF ZOOLOGY AND DIRECTOR  
OF THE ZOOLOGICAL LABORATORY IN THE  
JOHNS HOPKINS UNIVERSITY



NEW YORK  
W · W · NORTON & COMPANY, INC.  
PUBLISHERS

Copyright, 1930  
W · W · NORTON & COMPANY, INC.  
70 Fifth Avenue, New York

PRINTED IN THE UNITED STATES OF AMERICA  
FOR THE PUBLISHERS BY THE VAIL-BALLOU PRESS

TO CALVIN B. BRIDGES

*to whose profound and constructive investigations all  
students of Genetics are deeply indebted*

## PREFACE

This volume is an attempt to present those aspects of modern experimental biology that are of most interest in considering the problem of human personality and society. It deals with the origin, development and nature of the traits which distinguish individuals, and which in man make up character; and with some of the relations of these matters to social questions. The material is drawn mainly from the relatively new sciences of Genetics and Experimental Embryology. An effort is made to present it in non-technical language, though for a few important things unknown to common speech the technical terms are the only ones available.

The first five chapters summarize the biological foundations for the matters dealt with later. They are necessarily more technical than the others; they are compelled to present certain points that have not yet become familiar, but which in time will be a part of the every-day knowledge of all educated persons. Understanding of the more general questions dealt with in later chapters depends absolutely on a grasp of the matters presented in these chapters.

Chapters six to eight deal with the relations of this fundamental knowledge to certain more problematical questions of life and mind, chapter eight presenting certain historical aspects of these matters. Chapters nine to twelve inclusive take up the application of this knowledge to some social problems. Chapter thirteen stands by itself; it is speculative. The three final chapters are devoted to aspects of the problem of evolutionary change.

References to sources, and other comments, are gathered into notes at the end of each chapter. They are designed merely as keys by which the reader may follow further any subjects which interest him. The books or papers referred to

will usually be found to contain titles of other works along the same line, through which the entire field of knowledge may be explored. Z~

For permission to make use of material previously published in the form of articles or addresses, the author is indebted to the *Forum*, *Plain Talk*, *Science*, and the *Survey-Graphic*. He is indebted for important aid in the preparation of the volume to Louise B. Jennings, Ruth Stocking Lynch, and Harold Heath.

Baltimore, January 4, 1930.

# CONTENTS

## INTRODUCTION

xvii

### I. THE ORIGINAL DIFFERENCES BETWEEN INDIVIDUALS; AND THEIR CONSEQUENCES

I

The Genes – The Genetic System – How the Genetic System Works in Heredity – Likeness and Unlikeness of Parents and Offspring – What Kinds of Characteristics Depend on Genes? – Notes and References.

### II. HOW DO WE KNOW THAT THE GENES ARE REALITIES? HOW DO WE KNOW THAT THEY AFFECT CHARACTERISTICS?

36

Nature of the Evidence – The Clue: the X-Chromosome and the Characteristics that Follow It – Characteristics that Follow Chromosomes Having a Particular Origin – Several Characteristics Following a Particular Chromosome – Is the Chromosome Composed of Diverse Parts? – Other Chromosomes – The Laws of Inheritance are the Rules of Distribution of the Parts of the Chromosomes – Given Characteristics Diversely Inherited in Different Matings – Linkage of Characteristics – Maps of the Genes – Summary – Notes and References.

### III. HOW DO THE GENES ACT IN PRODUCING THE INDIVIDUAL? THE NATURE OF DEVELOPMENT

76

Interaction of Genes and Cytoplasm – Earliest Developmental Processes: Ground Plan of the Body Laid Down in the Cytoplasm of a Single Cell – Ground Plan Laid Down under Influence of Mother's Genes Exclusively – Introduction of Genes from the Father – Cell Division, with Accompanying Developmental Processes – A Fundamental Question of Development: Its Answer – Dependence on Cytoplasmic Parts already Produced within the Cells – De-

pendence on the Cellular Environment – Role of Adjustment to Conditions – Limitation of Power of Adjustment – Diverse Situations in Different Cells and in Different Organisms – Diverse Types of Developmental Processes in Certain Organisms – Summary on the Nature of Development – Notes and References.

IV. THE NATURE OF DEVELOPMENT, CONTINUED 102

Different Development Due to Diverse Genes – Diverse Periods at Which Genes Come into Action – Through What Means Do Diverse Sets of Genes Produce Diverse Characteristics? – Production of Diverse Sexes – Hormones in Development – Hormones in Amphibian Development – Diverse Parts React Differently to the Same Hormone – Diverse Species React Differently to the Same Hormone – Hormones as Intermediate Steps Between Genes and Developed Characteristics – Harmonic and Environmental Action – Notes and References.

V. ROLE OF ENVIRONMENT IN DETERMINING THE CHARACTERISTICS OF INDIVIDUALS 122

What the Genes of a Cell Produce is Determined by the Internal Environment – Application to Individuals as Wholes – Hormones Producing Outside the Body – Does the External Environment Affect What the Genes Produce? – Natural Conditions Affect What the Genes Produce – Examples of Environmental Action on Gene Products – Relation of Inheritance to Environment – Heredity and Environment in Relation to Characteristics-in-Themselves – Heredity and Environment in Relation to Differences between Particular Individuals – Are There Characteristics not Affected by the Environment? – A Question of Particular Fact, Not of General Principle – Notes and References.

VI. THE RELATIVE IMPORTANCE OF HEREDITY (GENES) AND ENVIRONMENT 139

Are Differences between Individuals More Frequently Due to Diversity of Genes or to Diversity of Environment? – Physical Characteristics – The Situation in Man – Identical Twins – Physiological Characteristics – Diseases – Diversities Resulting from Past Environment – Notes and References.

VII. GENES AND ENVIRONMENT IN RELATION TO THE MIND

152

Does Genetic Constitution Have a Role in Determining Mental Characteristics?—Is the Modern Knowledge of Genetics Applicable to Man?—Are Mental Differences Produced by Diversity of Genes? By Diversity of Environment?—What Kinds of Mental Diversities Result from the Two Classes of Factors?—What Kinds of Mental Differences Arise from Diversity of Genes?—What Kinds of Mental Differences Arise from Diversity of Environment?—Identical Twins—Individuals that Are not Twins—Interplay of Genes and Environment—Relative Importance of Genetic Constitution and of Environment for Mental Diversities—Rules of Inheritance in Relation to the Mind—Correlation in Mentality between Parents and Offspring—Notes and References.

VIII. RECENT TRANSFORMATION OF THE KNOWLEDGE OF HEREDITY AND DEVELOPMENT; ITS BEARING ON INTERPRETATIONS OF THE INDIVIDUAL AND HIS CHARACTERISTICS

186

Trial and Error in the Progress of Science—Notions of Heredity Reached in Early Stages of Knowledge—Unit Characters and Representative Particles—Mendel's Discovery—Identification of the Representative Particles—What Characteristics are Units?—All Characteristics Hereditary—Bearing on Human Problems—Further Discoveries—Same Characteristic Sometimes a Unit, Sometimes Many Units—Single Characteristic Dependent on Many Genes—Why Characteristics Behave as Units—Same Characteristic Inherited by Diverse Methods—Collapse of Unit Characters and Representative Particles—Resulting Change of Interpretation—Transformation of Knowledge of Development—Disproof of the Mosaic Theory—Nature of Development—Bearing on Interpretation of Heredity—Relation of Genes and Environment in Development.

IX. BIOLOGICAL FALLACIES AND HUMAN AFFAIRS

203

I. Fallacy of Non-Experimental Judgments—II. Of Attribution to a Single Cause—III. Of Drawing Negative Conclusions from Positive Observations—IV. Of Two



pendence on the Cellular Environment – Role of Adjustment to Conditions – Limitation of Power of Adjustment – Diverse Situations in Different Cells and in Different Organisms – Diverse Types of Developmental Processes in Certain Organisms – Summary on the Nature of Development – Notes and References.

#### IV. THE NATURE OF DEVELOPMENT, CONTINUED 102

Different Development Due to Diverse Genes – Diverse Periods at Which Genes Come into Action – Through What Means Do Diverse Sets of Genes Produce Diverse Characteristics? – Production of Diverse Sexes – Hormones in Development – Hormones in Amphibian Development – Diverse Parts React Differently to the Same Hormone – Diverse Species React Differently to the Same Hormone – Hormones as Intermediate Steps Between Genes and Developed Characteristics – Hormonic and Environmental Action – Notes and References.

#### V. ROLE OF ENVIRONMENT IN DETERMINING THE CHARACTERISTICS OF INDIVIDUALS 122

What the Genes of a Cell Produce is Determined by the Internal Environment – Application to Individuals as Wholes – Hormones Producing Outside the Body – Does the External Environment Affect What the Genes Produce? – Natural Conditions Affect What the Genes Produce – Examples of Environmental Action on Gene Products – Relation of Inheritance to Environment – Heredity and Environment in Relation to Characteristics-in-Themselves – Heredity and Environment in Relation to Differences between Particular Individuals – Are There Characteristics not Affected by the Environment? – A Question of Particular Fact, Not of General Principle – Notes and References.

#### VI. THE RELATIVE IMPORTANCE OF HEREDITY (GENES) AND ENVIRONMENT 139

Are Differences between Individuals More Frequently Due to Diversity of Genes or to Diversity of Environment? – Physical Characteristics – The Situation in Man – Identical Twins – Physiological Characteristics – Diseases – Diversities Resulting from Past Environment – Notes and References.

VII. GENES AND ENVIRONMENT IN RELATION TO THE MIND

152

Does Genetic Constitution Have a Role in Determining Mental Characteristics?—Is the Modern Knowledge of Genetics Applicable to Man?—Are Mental Differences Produced by Diversity of Genes? By Diversity of Environment?—What Kinds of Mental Diversities Result from the Two Classes of Factors?—What Kinds of Mental Differences Arise from Diversity of Genes?—What Kinds of Mental Differences Arise from Diversity of Environment?—Identical Twins—Individuals that Are not Twins—Interplay of Genes and Environment—Relative Importance of Genetic Constitution and of Environment for Mental Diversities—Rules of Inheritance in Relation to the Mind—Correlation in Mentality between Parents and Offspring—Notes and References.

VIII. RECENT TRANSFORMATION OF THE KNOWLEDGE OF HEREDITY AND DEVELOPMENT; ITS BEARING ON INTERPRETATIONS OF THE INDIVIDUAL AND HIS CHARACTERISTICS

186

Trial and Error in the Progress of Science—Notions of Heredity Reached in Early Stages of Knowledge—Unit Characters and Representative Particles—Mendel's Discovery—Identification of the Representative Particles—What Characteristics are Units?—All Characteristics Hereditary—Bearing on Human Problems—Further Discoveries—Same Characteristic Sometimes a Unit, Sometimes Many Units—Single Characteristic Dependent on Many Genes—Why Characteristics Behave as Units—Same Characteristic Inherited by Diverse Methods—Collapse of Unit Characters and Representative Particles—Resulting Change of Interpretation—Transformation of Knowledge of Development—Disproof of the Mosaic Theory—Nature of Development—Bearing on Interpretation of Heredity—Relation of Genes and Environment in Development.

IX. BIOLOGICAL FALLACIES AND HUMAN AFFAIRS

203

I. Fallacy of Non-Experimental Judgments—II. Of Attribution to a Single Cause—III. Of Drawing Negative Conclusions from Positive Observations—IV. Of Two

Distinct Classes of Characteristics, Hereditary and Environmental – V. Of Heredity as a Force Set off from Other Conditions – VI. Of Heredity as Requiring Likeness – VII. Of Implied Premises that are Rejected when Stated – VIII. Fallacy that Showing a Characteristic to be Hereditary Proves It Not Environmental – IX. That Showing a Characteristic to Be Environmental Proves It Not Hereditary – X. That Heredity is All-Important – XI. That Environment is All-Important – XII. That Stopping the Breeding of Defectives Stops the Production of Defectives – XIII. That Superior Individuals Must Have Come from Superior Parents – XIV. That Biology Requires an Aristocratic Constitution of Society – Positive Contributions of Genetics to Human Affairs – Notes and References.

X. WHAT CAN WE HOPE FROM EUGENICS? 223

The Problem of Eugenics – Is the Aim of Eugenics a Desirable One? – “Tampering with the Germ Plasm” – Is the Aim of Eugenics a Practicable One? – Therapeutic or Environmental Measures – Family Eugenics – Racial Eugenics – How Are We to Get Rid of Defective Genes? – Method Used in Improvement of Animals – What Eugenic Measures are Practicable in Man? – Cessation of Propagation of Defectives – How Far Does This Get Rid of Defective Genes? – Feeble-mindedness as an Example – Dependency and Delinquency – Slowness of Eugenic Action – Two Great Advances Required – Recognition of Normal Carriers of Defective Genes – Need for Improved Environment, for Eugenic Purposes – Prospects for Eugenics in the Future – Notes and References.

XI. THE BIOLOGICAL BASIS OF MARRIAGE AND THE FAMILY 253

Marriage and the Family Not an Invention of Man – Interference of Reproduction with the Individual Career – Different Systems – Single-Parent System – Two-Parent System: Difficulties Introduced – Differentiation into Male and Female: the Problems of Feminism – Economic Dependence of the Female – Coöperative Career of the Two Parents – One Male Mated to Many Females – One Male Mated to one Female – Temporary Unions – Life-long Unions – Independent Origin of Monogamous Family in Different Animals – Functions of the Family Taken by So-

ciety – Systems Found in Man – Partial Development of the Family – Temporary Families: Difficulties – Abolition of the Family; Biological Consequences – Monogamy as the Outgrowth of the Biological Situation in Man – Notes and References.

**XII. RACE MIXTURE AND ITS CONSEQUENCES** 269

What are the Results of Race Mixture? – Results When Very Diverse Organisms Mix – Incompatibility of Chromosomes – Sterility – Incompatibility of Structures and Functions Resulting from the Different Genes – Disharmonious Combinations – Harmonious Combinations – The Situation in Man – No Incompatibility of Chromosomes in Man – No Incompatibility of Fundamental Structures and Functions – Is there Disharmony in Details? – What is the Race? – Advantages of Race Crossing: Hybrid Vigor – Disadvantages: Lack of Harmony in Details – Favorable Combinations – Mental Characteristics – Do Races Differ Mentally? – Are Certain Races Superior? – Race Crossing and Social Systems – General Result of Crossing: New Combinations – Notes and References.

**XIII. BIOLOGY AND SELVES** 290  
Notes and references

**XIV. HOW THE INHERITED CONSTITUTION BECOMES CHANGED. THE ORIGIN OF DIVERSE ORGANIC TYPES** 300

Dependence on Changes in the Genetic System – Two Types of Change: in Organization and in Materials – Consequent Appearance of New Types – Changes in the Organization of the Genetic System – Change in Number of Sets of Chromosomes – Addition or Subtraction of One or Two Chromosomes – Change in Structure of Particular Chromosomes – Great Number of New Types So Produced – Changes in the Material of the Genetic System: Gene Mutation – Cause of Gene Mutation – Same Gene Changeable in Different Ways – Diverse Characteristics Produced – Most Mutated Genes Recessive – Where Mutations Occur – Frequency of Gene Mutations – Great Role of Selective Elimination – Disadvantageous Effects of Mutations – Relation to Progressive Evolution – Is Man Undergoing Mutation? – Summary – Notes and References.

XV.	ENVIRONMENT AND THE FUTURE OF THE RACE. INHERITANCE OF ACQUIRED CHARACTERS	329
	Direct Action of External Agents in Modifying Genes – Radiations – Other Agents – Injury to Genes by Bad Living Conditions – The Protozoa – Higher Organisms – Effects of Alcohol – Inheritance of Acquired Characters – In the Lowest Organisms – In Higher Organisms – Evidence Against the Inheritance of Acquired Characters – False Alarms – Supposed Cases of the Inheritance of Acquired Characters – Racial Change through Selective Elimination – Does Environmental Improvement Cause Racial Deterioration? – Need for Eugenic Measures – Notes and References.	
XVI.	DIVERSE DOCTRINES OF EVOLUTION : THEIR RELATION TO THE PRACTICE OF SCIENCE AND OF LIFE	359
	Mechanical Evolution – Emergent Evolution – Consequences for Science and for Life – Notes and References.	
	INDEX	379

## ILLUSTRATIONS

1.	The fertilized egg of the starfish	2
2.	Arrangement of genes in genetic system	4
3.	Structure of chromosomes	5
4.	Chromosomes in the condensed condition	6
5.	Chains in genes in two parents	12
6.	Results of defective genes	13
7.	Results of defective genes	14
8.	Inferior parents may produce superior offspring	15
9.	Results of defective genes	18
10.	Defective parents yielding normal offspring	19
11.	How parents with heredity defects may produce offspring with none	20
12.	How parents with no defects may produce offspring with defects	22
13.	Grand-parental genes in the offspring	23
14.	The fruit-fly	37
15.	Male and female groups of chromosomes in <i>Protenor</i>	39
16.	Male and female groups of chromosomes in <i>Lygaeus</i>	40
17.	Male and female groups of chromosomes in the fruit-fly	41
18.	Chromosome combinations in the formation of germ cells	42
19.	Continuation of Figure 18	43
20.	Bar-eye and normal eye in <i>Drosophila</i>	45
21.	Inheritance of eyes in <i>Drosophila</i>	46
22.	Inheritance of a recessive characteristic	47
23.	Course of inheritance of a recessive character	49
24.	Course of inheritance of white eye and red eye in <i>Drosophila</i>	51
25.	Descent of a recessive, defective X-chromosome	52

26.	Defective X-chromosome derived from the original male parent	53
27.	Two types of ova in <i>Drosophila</i>	55
28.	Different types of fertilized eggs	56
29.	Results of breeding in X-chromosome	59
30.	Typical Mendelian inheritance	63
31.	Map of the X-chromosome	72
32.	Cell of a <i>Drosophila</i>	73
33.	Individuals in earliest stages of development	77
34.	Transformation of the condensed chromosomes	79
35.	Stages in the development of a sea urchin	82
36.	Rejection from the egg of member of pair of chromosomes	85
37.	Separation of cells in the sea urchin	89
38.	Cells of a developing Ctenophore	90
39.	Early stages of development of the frog	93
40.	Head of normal and eyeless <i>Drosophila</i> s	106
41.	Germ gland in the pig	109
42.	Axolotl and <i>Amblystoma</i>	125
43.	Abnormal abdomen in <i>Drosophila</i>	129
44.	Reduplicated legs in <i>Drosophila</i>	131
45.	The 48 chromosomes of man	155
46.	Egg about to divide	271
47.	Chromosomes of three species of <i>Drosophila</i>	272
48.	Development of a hybrid	275
49.	Cross between a Great St. Bernard dog and a Dachshund	281
50.	Different groups of chromosomes producing diverse types of organism	305
51.	Chromosomes of three different species of <i>Drosophila</i>	314