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THE CELL

IN

DEVELOPMENT AND HEREDITY

BY

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THIRD EDITION

WITH CORRECTIONS

"Natura nusquam magis est tota quam in minimis"

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PREFACE TO THE FIRST EDITION

THIS volume is the outcome of a course of lectures, delivered at Columbia University in the winter of 1892-93, in which I endeavored to give to an audience of general university students some account of recent advances in cellular biology, and more especially to trace the steps by which the problems of evolution have been reduced to problems of the cell. It was my first intention to publish these lectures in a simple and general form, in the hope of showing to wider circles how the varied and apparently heterogeneous cell-researches of the past twenty years have grown together in a coherent group, at the heart of which are a few elementary phenomena, and how these phenomena, easily intelligible even to those having no special knowledge of the subject, are related to the problems of development. Such a treatment was facilitated by the appearance, in 1893, of Oscar Hertwig's invaluable book on the cell, which brought together, in a form well designed for the use of special students, many of the more important results of modern cell-research. I am glad to acknowledge my debt to Hertwig's book; but it is proper to state that the present volume was fully sketched in its main outlines at the time the *Zelle und Gewebe* appeared. Its completion was, however, long delayed by investigations which I undertook in order to re-examine the history of the centrosomes in the fertilization of the egg,—a subject which had been thrown into such confusion by Fol's extraordinary account of the "Quadrille of Centres" in echinoderms that it seemed for a time impossible to form any definite conception of the cell in its relation to inheritance. By a fortunate coincidence the same task was independently undertaken, nearly at the same time, by several other investigators. The concordant results of these researches led to a decisive overthrow of Fol's conclusions, and the way was thus cleared for a return to the earlier and juster views founded by Hertwig, Strasburger, and Van Beneden, and so lucidly and forcibly developed by Boveri.

The rapid advance of discovery in the meantime has made it seem desirable to amplify the original plan of the work, in order to render it useful to students as well as to more general readers; and to this end it has been found necessary to go over a considerable part of the ground already so well covered by Hertwig.¹ This book does not, however, in any manner aim to

¹ Henneguy's *Leçons sur la cellule* is received, too late for further notice, as this volume is going through the press.

PREFACE TO THE THIRD EDITION

I MUCH appreciate the kind indulgence accorded to this work even in later years when it had become in many respects urgently in need of reconstruction. I now offer a third edition, rewritten throughout and much enlarged, with the following comment.

The first edition, planned in the early nineties and published in 1896, attempted to outline a new and rapidly growing subject which, in spite of many difficulties of detail, already showed broader bearings of remarkable general interest. Nearly thirty years have since gone by, in the course of which cellular biology has expanded in ever widening circles. Its general interest has grown correspondingly; but so, also, have its technical complexities and difficulties. To attempt a revision of the work at this day strictly along the original lines, and in equally brief form, would therefore have been impracticable, even were it desirable.

The year 1900, in which the second edition appeared, is memorable for the rediscovery of Mendel's long forgotten laws of heredity. This event opened a new era in the course of which the whole subject of the cell in relation to heredity and development has been made over. Cytology was from the beginning closely affiliated with anatomy, histology and embryology, and hardly less closely with general physiology and genetics. Since 1900 its coöperation with these subjects, and with cell-physiology, biophysics and biochemistry, has been one of the most striking features in the biological progress of our time; and the study of the cell has thus become so diversified that no single work could possibly cover more than a small portion of it.

It is with good reason, therefore, that in recent years extended general treatises on cellular biology have largely gone out of fashion in favor of more circumscribed works dealing with particular aspects of the subject, and thus making possible a more intensive treatment. Since 1900 many admirable works of this type, and some of broader scope, have appeared, and much has thus been gained in the way of thorough and critical analysis; nevertheless I have ventured to think that the need of a work of somewhat more synthetic type has not disappeared.

No work written with such an aim can escape shortcomings in many directions, nor can it fail to be largely colored by individual bias. Every

writer must treat the subject from the standpoint given by those fields of work in which he is most at home; and at best he can only try to indicate a few of the points of contact between those fields and others. I have desired to hold fast as far as possible to the general plan followed in the original work. Now, as then, I have written frankly from the standpoint of a zoölogical student of cytology and embryology, without pretence of competence to touch on other fields in more than an incidental way; and, as before, while always holding in view the needs of technical students and teachers of the subject, I have tried not wholly to lose sight of the interests of more general readers.

The work has grown to large proportions, but so has the subject; and the latter fact must be my apology for the necessarily scant treatment accorded to many important topics. I much regret this as affecting the botanical side of the subject; for in principle, botanical and zoölogical cytology are inseparable, though often in practice treated as distinct. My shortcomings in this direction are, however, more than compensated by Professor Sharp's excellent *Introduction to Cytology*, which appeared in 1921, written primarily from the standpoint of a botanist. The coöperative *General Cytology*, written by a group of biologists under the editorship of E. V. Cowdry (*University of Chicago Press*, 1924), did not appear until nearly the whole of the present work was already in type, and too late for more than the insertion of a few references to it.

I would especially emphasize the fact that it has not been possible to list or refer to the whole vast literature of the subject. For the most part the literature-lists include only works cited in the text or of interest for other particular reasons; and the same is true of the terms included in the glossary. At the end of each chapter, as in the first edition, will be found a short selected list of titles relating especially to its subject-matter, comprising for the most part works of more comprehensive scope or containing useful reviews of the literature. More abbreviated references to these will be found also in the final general literature-list.

I am indebted to the authorities of the Cambridge Press for permission to copy Figs. 285, D, F; 287, 290 and 385; to the Yale Press for use of the electrotypes of Figs. 1, 28, 45-47, 53, 68, 69, 172, 173, 186, 348, 459, 509, 513, 514, 520, and 523; to Professor T. H. Morgan for use of the drawing for Fig. 444; to Professor Martin Heidenhain for permission to reproduce Fig. 52, taken from his great work *Plasma und Zelle*; and to a large number of investigators from whose works other figures have been copied. Acknowledgment for all such figures is made in the legends. Those for which no acknowledgment is made are original or taken from earlier works by the writer.

Especial acknowledgments are due to Mabel T. Hedge, Helen E. Fernald, and Helen Daniels (Mrs. D. B. Young) for their artistic and conscientious work in the preparation of illustrations and for much other aid; and also to Alice E. Sheppard and Martha L. Clark (Mrs. W. W. Bennett).

E. B. W.

COLUMBIA UNIVERSITY, NEW YORK,
December, 1924.

TABLE OF CONTENTS

| | PAGE |
|---------------------------|------|
| LIST OF FIGURES | xxv |

INTRODUCTION

| | |
|---|----|
| General significance of the Cell-Theory. History of the Cell-Theory; the three Periods of its Development. Its Influence upon the Study of Anatomy, Physiology, Pathology, Embryology and Heredity. The Protoplasm-Theory and the Germ-Cells. Origin of Cells. Cell-Division and the Law of Genetic Continuity. Preformation and Epigenesis. Theories of Heredity. The Foundation of Cytology. Fertilization of the Egg. The Chromosomes. Studies in Cell-Lineage. Experimental Embryology and Cell-Physiology. The Rediscovery of Mendel's Laws of Segregation and the modern Study of Genetics and Cytology. Outline of Chapters. | I |
| Literature | 18 |

CHAPTER I

GENERAL MORPHOLOGY OF THE CELL

| | |
|---|----|
| I. GENERAL SKETCH, INTRODUCTORY | 21 |
| II. THE CYTOSOME AND ITS FORMED COMPONENTS | 28 |
| 1. The Central Bodies | 29 |
| 2. The Cytoplasmic Granules | 31 |
| 3. Fibrillæ | 40 |
| 4. Plastids | 43 |
| 5. Chondriosomes | 45 |
| 6. Golgi-Apparatus | 48 |
| 7. Vacuoles | 54 |
| 8. Cell-Membrane | 54 |
| III. PROTOPLASM. ITS COMPOSITION AND STRUCTURE | 57 |
| 1. Terminology | 57 |
| 2. Chemical and Physical Properties of Protoplasm | 59 |
| 3. Fibrillar Theories of Protoplasm | 63 |
| 4. Coagulation Phenomena | 65 |
| 5. The Alveolar or Foam-Theory of Protoplasm | 68 |
| 6. Critique of the Alveolar Theory | 72 |
| 7. The Granule-Theory of Protoplasm | 74 |
| IV. THE NUCLEUS | 78 |
| A. GENERAL STRUCTURE | 82 |
| B. THE NUCLEAR COMPONENTS | 84 |
| 1. The Nuclear Membrane | 85 |
| 2. The Nuclear Framework. | 85 |
| 3. The Nucleoli | 91 |
| 4. The Enchylema or Ground-Substance | 96 |
| 5. Other Structures | 96 |

| | PAGE |
|--|------|
| V. QUANTITATIVE RELATIONS | 97 |
| VI. THE CELL IN RELATION TO THE MULTICELLULAR BODY | 101 |
| VII. POLARITY AND SYMMETRY OF CELLS | 106 |
| Literature I | 111 |
| CHAPTER II | |
| CELL DIVISION | |
| INTRODUCTION. | 114 |
| I. GENERAL OUTLINE OF INDIRECT DIVISION OR MITOSIS | 117 |
| II. KARYOKINESIS. GENERAL HISTORY OF THE CHROMOSOMES | 121 |
| 1. Prophases | 121 |
| 2. Metaphase | 127 |
| 3. Anaphases | 131 |
| 4. Telophases | 133 |
| 5. History of the Nucleoli | 141 |
| III. CYTOKINESIS. HISTORY OF THE ACHROMATIC FIGURE | 142 |
| A. THE AMPHIASTRAL TYPE | 142 |
| 1. Spindle | 143 |
| 2. Asters | 144 |
| 3. Central Bodies | 145 |
| 4. Origin of the Amphiasier | 146 |
| B. ANASTRAL TYPES OF MITOSIS | 150 |
| C. DIVISION OF THE CYTOSOME | 157 |
| 1. Constriction or Furrowing | 157 |
| 2. Phragmoplast. "Cell-Plate Formation" | 159 |
| 3. Meristic Division in the Cytosome | 162 |
| 4. Monocentric Mitosis. Monasters | 168 |
| 5. Multipolar Mitosis | 172 |
| IV. THE MECHANISM OF MITOSIS | 174 |
| 1. General Analysis | 174 |
| 2. Fibrillar Hypotheses | 178 |
| 3. Dynamical Hypotheses | 184 |
| 4. Division of the Chromosomes | 198 |
| V. MITOSIS IN LOWER ORGANISMS | 199 |
| 1. In lower Metazoa and Metaphyta | 199 |
| 2. In Protista | 201 |
| VI. DIRECT DIVISION. AMITOSIS | 214 |
| 1. General Outline | 214 |
| 2. Physiological and theoretical Aspects | 215 |
| Literature II. | 224 |

CHAPTER III

REPRODUCTION AND THE LIFE CYCLE

| | |
|--|-----|
| I. THE REPRODUCTIVE PROCESSES IN GENERAL | 227 |
| II. SEXUAL REPRODUCTION. SYNGAMY AND ITS EFFECTS | 232 |
| 1. Senescence, Syngamy and Rejuvenescence | 233 |

TABLE OF CONTENTS

xvii

| | PAGE |
|--|------|
| 2. Increase of Vigor by Heterosis | 247 |
| 3. Syngamy, Heredity and Variation | 248 |
| 4. Syngamy, Meiosis and the Chromosome-Cycle | 250 |
| Literature III | 254 |

CHAPTER IV

THE GAMETES

| | |
|--|-----|
| I. THE GAMETES OF ANIMALS | 257 |
| A. THE ANIMAL OVUM | 257 |
| 1. General Structure | 257 |
| 2. The Oöplasm | 260 |
| 3. The Egg-Nucleus or Germinal Vesicle | 266 |
| 4. The Egg-Envelopes | 272 |
| 5. Promorphological Features of the Ovum | 275 |
| B. THE ANIMAL SPERM | 278 |
| Introductory | 278 |
| 1. Structure of the flagellate Sperm. | 279 |
| 2. Atypical flagellate Sperms | 295 |
| 3. Non-flagellate Sperms | 297 |
| 4. Dimorphism and Polymorphism of the Sperms | 299 |
| 5. Conjugate Sperms | 305 |
| II. THE GAMETES OF PLANTS | 305 |
| 1. The Ovum | 306 |
| 2. The Sperm | 307 |
| III. ORIGIN, GROWTH AND DIFFERENTIATION OF THE GERM-CELLS | 310 |
| A. GENERAL OUTLINE | 310 |
| 1. Introductory. Terminology | 310 |
| 2. The Germ-Line. Primordial Germ-Cells | 314 |
| 3. Differentiation of the Primordial Germ-Cells | 320 |
| B. THE AUXOCYTES | 329 |
| C. GROWTH AND DIFFERENTIATION OF THE OÖCYTE. | 331 |
| 1. The Egg and its accessory Cells | 331 |
| 2. General History of the oöplasmic Components | 338 |
| 3. The History of the Nucleus | 349 |
| D. ORIGIN AND DIFFERENTIATION OF THE SPERM | 356 |
| 1. Source of the sperm-forming Materials. The Spermatocyte Divisions | 357 |
| 2. Composition and General History of the Spermatid | 363 |
| 3. Further History of the Sperm-formation. Spermioteleosis. | 368 |
| IV. THE GAMETE-FORMATION IN PLANTS | 387 |
| Literature IV | 391 |

CHAPTER V

FERTILIZATION, PARTHENOGENESIS AND RELATED PHENOMENA

| | |
|--|-----|
| I. FERTILIZATION OF THE ANIMAL EGG | 395 |
| A. GENERAL SKETCH | 395 |

| | PAGE |
|---|------|
| B. UNION OF THE GAMETES | 404 |
| 1. General Conditions of Fertilization | 404 |
| 2. Approach of Egg and Sperm | 405 |
| 3. Reaction of the Egg. Entrance of the Sperm | 409 |
| 4. Monospermy, Dispermy, and Polyspermy | 416 |
| C. HISTORY OF THE PRONUCLEI | 422 |
| 1. General | 422 |
| 2. Movements of the Pronuclei | 422 |
| 3. Conjugation of the Pronuclei. General History of the Chromosomes | 426 |
| D. THE CYTOPLASMIC STRUCTURES | 434 |
| 1. The Acrosome | 435 |
| 2. The Chondriosomes | 435 |
| 3. The Central Bodies and Cleavage-Amphiaster | 438 |
| 4. Boveri's Theory of Fertilization | 440 |
| II. FERTILIZATION IN PLANTS | 449 |
| III. TRANSITIONAL CONDITIONS | 458 |
| 1. Partial Fertilization | 458 |
| 2. Gynogenesis | 460 |
| 3. Androgenesis | 464 |
| 4. Merogony | 465 |
| 5. Summary | 466 |
| IV. PARTHENOGENESIS | 467 |
| 1. Natural Parthenogenesis | 467 |
| 2. Artificial Parthenogenesis | 472 |
| Literature V | 486 |

CHAPTER VI

MATURATION AND REDUCTION. MEIOSIS

| | |
|---|-----|
| INTRODUCTION | 488 |
| I. GENERAL SURVEY | 488 |
| II. EXTERNAL ASPECTS OF MEIOSIS | 492 |
| 1. In Animals | 492 |
| 2. In Plants | 496 |
| III. INTERNAL PHENOMENA OF MEIOSIS | 498 |
| A. INTRODUCTION | 498 |
| 1. Historical and Theoretical | 498 |
| 2. Preliminary Outline | 503 |
| 3. General Characteristics of the Divisions | 508 |
| B. THE HETEROTYPIC DIVISION | 511 |
| Introductory | 511 |
| 1. The Heterotypic Chromosomes. Forms and Spindle-Attachments | 511 |
| 2. Course of the Division | 515 |
| C. THE INTERKINESIS AND THE HOMEOTYPIC DIVISION | 532 |
| D. THE GROWTH-PERIOD OF THE AUXOCYTES | 535 |
| Introductory | 535 |
| 1. Outline of the Stages | 536 |
| 2. General Result | 548 |

TABLE OF CONTENTS

xix

| | PAGE |
|--|------|
| IV. SYNAPSIS AND DISJUNCTION | 549 |
| A. THE PROBLEM OF SYNAPSIS | 549 |
| Introductory | 549 |
| 1. Parasynapsis or Parasyndesis | 550 |
| 2. Telosynapsis or Metasyndesis | 557 |
| 3. Synapsis and the Anaphasic Duality | 561 |
| 4. Late Conjugation. Diakinetic Phenomena | 563 |
| 5. Critical | 565 |
| 6. The Mechanism of Synapsis | 566 |
| B. DISJUNCTION AND SEGREGATION | 569 |
| 1. The Reduction-Division | 569 |
| 2. Order of the Divisions | 572 |
| V. INDIRECT EVIDENCE. GENERAL ASPECTS. SUMMARY | 574 |
| Literature VI | 577 |

CHAPTER VII

REPRODUCTION AND SEXUALITY IN LOWER ORGANISMS

| | |
|--|-----|
| I. GENERAL SURVEY | 581 |
| 1. Types of Conjugation | 581 |
| 2. Relation of the Gametes to the vegetative Cells | 582 |
| 3. Physiological Differences of the Gametes | 585 |
| 4. Structure of the Gametes | 589 |
| 5. Gametes and Gametocytes. Coenogametes | 594 |
| 6. Chromidial Formation of Gametes. Chromidiogamy. | 596 |
| II. ILLUSTRATIVE EXAMPLES | 597 |
| 1. Hologamy and Isogamy with Gametic Meiosis | 597 |
| 2. Hologamy and Isogamy with Zygotic Meiosis | 602 |
| 3. Merogamic Syngamy and Meiosis | 606 |
| 4. Partial or temporary Conjugation | 607 |
| 5. Endomixis and Parthenogenesis | 613 |
| III. GENEALOGICAL CONSIDERATIONS | 615 |
| 1. The Origin of Syngamy | 615 |
| 2. The Origin of Meiosis | 616 |
| 3. Antithetic Alternation of Generations | 617 |
| Literature VII | 629 |

CHAPTER VIII

SOME ASPECTS OF CELL-CHEMISTRY AND CELL-PHYSIOLOGY

| | |
|---|-----|
| I. GENERAL VIEW | 633 |
| 1. The Cell a Colloidal System | 633 |
| 2. The Cell a Chemical Machine | 635 |
| II. CHEMICAL RELATIONS | 637 |
| 1. General | 637 |
| 2. The Proteins and their Derivatives | 640 |
| 3. Staining-Reactions of the Cell-Substance | 645 |

| | PAGE |
|---|------|
| III. GENERAL PHYSIOLOGICAL RELATIONS BETWEEN NUCLEUS AND CYTOSOME | 653 |
| 1. General | 653 |
| 2. Nuclear Size and Cytoplasmic Growth | 654 |
| 3. Nucleated and non-nucleated Cell-Fragments | 657 |
| 4. Form, Position and Movements of Nuclei | 662 |
| IV. THE NUCLEUS AND THE PROBLEM OF HEREDITY | 666 |
| Literature VIII | 668 |

CHAPTER IX

SOME PROBLEMS OF CELL-ORGANIZATION

| | |
|--|-----|
| INTRODUCTION | 670 |
| I. THE CENTRAL APPARATUS | 672 |
| 1. The Central Body and its Relation to the Astral Formations | 673 |
| 2. Division of the Centers and Astral Systems | 680 |
| 3. The supposed Origin of Central Bodies <i>de novo</i> | 684 |
| 4. Central Bodies, Blepharoplasts and Basal Apparatus | 690 |
| II. CHROMIDIA, CHONDRIOSOMES AND GOLGI-BODIES | 700 |
| 1. Chromidia | 700 |
| 2. Chondriosomes | 706 |
| 3. Golgi-Apparatus | 714 |
| 4. Summary and Critique | 716 |
| III. PROTOPLASMIC STRUCTURE AND METASTRUCTURE | 717 |
| IV. DUALISTIC CONCEPTIONS OF THE CELL-SUBSTANCE | 722 |
| 1. The Cytoplasm. Archiplasm, Kinoplasm. Morphoplasm and the "Superior Protoplasm" | 723 |
| 2. The Nucleus. Trophochromatin and Idiochromatin | 724 |
| V. THE KARYOPLASMIC RATIO | 727 |
| VI. HISTORICAL PROBLEMS OF THE CELL | 732 |
| Literature IX | 739 |

CHAPTER X

CHROMOSOMES AND SEX

| | |
|--|-----|
| I. SEX AND THE GERM-CELLS | 742 |
| II. SEX AND FERTILIZATION. THE SEX-CHROMOSOMES | 748 |
| A. MALE DIGAMETY | 749 |
| 1. The Simple XO-XX or <i>Protenor</i> Type | 749 |
| 2. The Simple XY-XX or <i>Lygaeus</i> Type | 764 |
| 3. Compound Types. The X-Complex | 772 |
| 4. Linkage of the Sex-Chromosomes | 779 |
| 5. Sexual Dimegaly of the Sperms | 782 |
| B. FEMALE DIGAMETY | 783 |
| 1. Sexual nuclear Digamety of the Ova | 784 |
| III. SEX-CHROMOSOMES AND PARTHENOGENESIS | 787 |
| 1. General Relations of Parthenogenesis to Sex | 787 |
| 2. Sex in Diploid Parthenogenesis | 789 |

TABLE OF CONTENTS

| | PAGE |
|---|------|
| 3. Sex in Haploid Parthenogenesis | 794 |
| 4. Problematical Cases | 803 |
| 5. Sex in Artificial Parthenogenesis | 806 |
| 6. Sexual Dimegaly of the Ova | 806 |
| IV. SEX-CHROMOSOMES IN HERMAPHRODITES, INTERSEXES AND GYNANDRO- MORPHS | 808 |
| 1. Hermaphrodites and Intersexes | 808 |
| 2. Gynandromorphs | 811 |
| V. SEX-CHROMOSOMES IN PLANTS | 812 |
| VI. GENERAL CONSIDERATIONS | 815 |
| 1. Physiological Problems | 815 |
| 2. Morphological Problems | 822 |
| 3. Conclusion | 824 |
| Literature X. | 825 |

CHAPTER XI

MORPHOLOGICAL PROBLEMS OF THE CHROMOSOMES

| | |
|---|-----|
| I. THE INDIVIDUALITY OR GENETIC CONTINUITY OF THE CHROMOSOMES | 828 |
| 1. Origin of the Theory | 828 |
| 2. General Evidence | 830 |
| II. DIFFERENTIATION WITHIN THE CHROMOSOME-GROUPS | 834 |
| 1. Differences of Size and Form | 834 |
| 2. Paired Condition of the Chromosomes in the Diploid Groups | 837 |
| 3. Differences of Behavior. Autosomes and Heterochromosomes | 839 |
| III. THE CHROMOSOMES OF HYBRIDS | 841 |
| 1. Relations of the Haploid and Diploid Groups | 841 |
| 2. The Meiosis of Hybrids | 844 |
| IV. NORMAL CHROMOSOME-NUMBERS | 853 |
| V. DEVIATIONS FROM THE FUNDAMENTAL CHROMOSOME-NUMBERS | 868 |
| 1. Somatic Cells and Germ-Cells | 869 |
| 2. Reduplication. Polyploidy | 870 |
| 3. Supernumerary and missing Chromosomes. Non-Disjunction. Frag- mentation | 872 |
| 4. Chromosome-Linkage | 879 |
| VI. PERMANENT CHANGES OF CHROMOSOME-NUMBER | 884 |
| VII. SPECIFIC EVIDENCE OF GENETIC CONTINUITY | 890 |
| 1. Relations of the Chromosomes in Telophase, Interphase and Prophase | 890 |
| 2. The Chromonema-Hypotheses | 896 |
| 3. The Prochromosomes | 901 |
| VIII. ORGANIZATION OF THE CHROMOSOMES | 903 |
| 1. Chromosomes as compound Bodies. | 903 |
| 2. Chromosomes as linear Aggregates. The Chromomeres. | 906 |
| Literature XI | 913 |

TABLE OF CONTENTS

CHAPTER XII

HEREDITY AND THE CHROMOSOMES

PAGE

| | |
|---|-----|
| I. QUALITATIVE DIFFERENCES OF THE CHROMOSOMES | 916 |
| II. CYTOLOGICAL BASIS OF THE MENDELIAN PHENOMENA | 923 |
| 1. General Outline | 923 |
| 2. Mendelian Segregation and the Reduction-Division | 928 |
| 3. Random Assortment of Chromosomes in Meiosis | 931 |
| 4. Linkage | 938 |
| 5. The Chromosomes of Certain Mutants | 942 |
| 6. The Genetic Phenomena in Chromosome-Linkage and Non-Disjunction | 945 |
| 7. Deficiency. Duplication | 948 |
| III. RECOMBINATION PHENOMENA. CROSSING-OVER AND THE CHIASMATYPIC THEORY | 949 |
| IV. ADDITIONAL EVIDENCE | 963 |
| 1. Evidence from certain reciprocal Crosses | 963 |
| 2. Artificial Parthenogenesis and Crossing | 966 |
| 3. Heterogeneous Crosses | 970 |
| 4. Hybrids from Giant Eggs | 972 |
| 5. Merogonic Hybrids | 973 |
| V. CONCLUSION. CHROMOSOMES AND DETERMINATION | 975 |
| Literature XII | 976 |

CHAPTER XIII

GROWTH, CELL-DIVISION AND DEVELOPMENT

| | |
|---|------|
| INTRODUCTION | 980 |
| I. GEOMETRICAL RELATIONS OF CLEAVAGE-FORMS | 982 |
| A. SOME GENERAL RULES OF CELL-DIVISION | 982 |
| B. THE GEOMETRICAL FORMS OF CLEAVAGE | 985 |
| 1. Orthoradial Type | 986 |
| 2. Spiral Type | 986 |
| 3. Bilateral Type | 993 |
| 4. Special Modifications | 995 |
| II. PROMORPHOLOGICAL RELATIONS OF CLEAVAGE | 1006 |
| 1. Special Promorphology | 1007 |
| 2. Axial Relations of the primary Cleavage-Planes | 1012 |
| III. PROMORPHOLOGY OF THE OVUM | 1014 |
| 1. Polarity. The Egg-Axis | 1014 |
| 2. Bilateral Symmetry | 1019 |
| 3. General Interpretations | 1021 |
| IV. GROWTH, CELL-FORMATION AND MORPHOGENESIS | 1025 |
| 1. The Limits of Growth and Cell-Division | 1025 |
| 2. Cell-Division and Morphogenesis | 1029 |
| Literature XIII | 1032 |

CHAPTER XIV

DEVELOPMENT AND HEREDITY

| | PAGE |
|--|------|
| I. INTRODUCTORY | 1035 |
| 1. Statement of the Problem | 1036 |
| 2. The Idioplasm Theory | 1037 |
| II. THE LOCALIZATION PROBLEM | 1040 |
| A. THEORIES OF GERMINAL PRELOCALIZATION | 1040 |
| B. THE MOSAIC THEORY | 1042 |
| 1. Foundation and early History of the Theory | 1042 |
| 2. Its later Establishment | 1046 |
| 3. The Development of Totipotent Blastomeres | 1050 |
| 4. The Theory of Qualitative Nuclear Division | 1057 |
| C. CYTOPLASMIC PRELOCALIZATION | 1062 |
| 1. The Development of Egg-Fragments | 1062 |
| 2. "Mosaic Eggs" and "Regulative Eggs" | 1067 |
| 3. Mosaic Cleavage and Totipotence | 1076 |
| 4. Single Embryos from Double Eggs | 1079 |
| 5. Summary | 1081 |
| III. LOCALIZATION AND DIFFERENTIATION | 1083 |
| 1. Cleavage, Localization and Differentiation | 1083 |
| 2. Immediate Causes of Differentiation | 1085 |
| 3. Organ-forming Substances. Experiments with the Centrifuge | 1087 |
| IV. ORGANIZATION OF THE EGG AND ITS GENESIS | 1093 |
| 1. Localizing Activities prior to Cleavage | 1094 |
| 2. Experiments on Cytoplasmic Prelocalization | 1098 |
| 3. Rôle of the Sperm in Localization. | 1102 |
| V. THE MECHANISM OF DEVELOPMENT | 1106 |
| VI. PREFORMATION AND EPIGENESIS. HEREDITY | 1110 |
| VII. CONCLUSION. MECHANISM AND VITALISM | 1114 |
| Literature XIV | 1118 |
| | |
| . GLOSSARY | 1123 |
| | |
| GENERAL LITERATURE LIST. LITERATURE ABBREVIATIONS | 1145 |
| | |
| INDEX OF AUTHORS | 1205 |
| | |
| INDEX OF SUBJECTS | 1217 |

LIST OF FIGURES

| FIG. | INTRODUCTION | PAGE |
|-----------|--|------|
| 1. | Epidermis of larval salamander | 3 |
| 2. | Section of growing root-tip of onion | 5 |
| 3. | <i>Amæba proteus</i> . A unicellular animal | 7 |
| 4. | Cleavage of the ovum in the holothurian <i>Synapta</i> | 10 |
| 5. | Diagram of herèdity | 13 |
| CHAPTER I | | |
| 6. | Diagram of a cell | 23 |
| 7. | Spermatogonia of salamander | 24 |
| 8. | Group of cells, showing cytosome, nucleus and central bodies | 26 |
| 9. | Living cells of salamander larva, showing cytoplasmic fibrillæ | 27 |
| 10. | Leucocytes; nucleus, central bodies, aster | 29 |
| 11. | Epithelial cells with central bodies and asters | 30 |
| 12. | Mitochondria and other chondriosomes in embryonic cells | 35 |
| 13. | Cells of the pancreas in Amphibia | 37 |
| 14. | Chromidia; scattered nucleus in <i>Trachelocerca</i> | 39 |
| 15. | Striated muscle-cells; myofibrils | 40 |
| 16. | Nerve-cell; neurofibrils | 41 |
| 17. | Ciliated cells; epithelial fibrillæ | 42 |
| 18. | Epithelial fibrillæ in columnar cells | 43 |
| 19. | Plastids and chondriosomes in plant-cells | 44 |
| 20. | Varying forms of the Golgi-apparatus in nerve cells | 49 |
| 21. | The Golgi-apparatus in epithelial cells | 51 |
| 22. | Various forms of the Golgi-apparatus | 53 |
| 23. | Fibrillar and reticular structures in coagulated protoplasm | 63 |
| 24. | Coagulation artifacts imitating cell-structures | 65 |
| 25. | Coagulation artifacts under different conditions | 67 |
| 26. | Alveolar structure according to Bütschli | 69 |
| 27. | Alveolar structure of protoplasm | 71 |
| 28. | Structure of protoplasm in echinoderm-eggs | 73 |
| 29. | Cytoplasmic granules as figured by Altmann | 75 |
| 30. | Nuclei from the crypts of Lieberkühn | 79 |
| 31. | Labyrinthine nuclei from spinning glands of <i>Platyplax</i> | 81 |
| 32. | Chromidial nuclei of bacteria and flagellates | 82 |
| 33. | Nuclei of bacteria | 84 |
| 34. | Special forms of nuclei | 86 |
| 35. | Nuclei from salivary gland of <i>Chironomus</i> | 88 |
| 36. | Prophase-nucleus from early blastoderm of fish <i>Coregonus</i> | 90 |
| 37. | Nuclei with karyospheres from spermatocytes of insects and myriapods | 92 |
| 38. | Races of different size in <i>Paramæcium</i> | 98 |

| FIG. | PAGE |
|--|------|
| 39. Comparative size of very small cells | 99 |
| 40. Plasmodesms or cell-bridges in <i>Volvox</i> | 103 |
| 41. Plasmodesms or cell-bridges in animal tissues. | 105 |
| 42. Polarity and central bodies in epithelial cells | 109 |
| 43. Polarity and bilateral symmetry in a unicellular animal | 111 |
| CHAPTER II | |
| 44. Remak's scheme of division | 115 |
| 45. Diagram of the prophases of mitosis | 118 |
| 46. Diagram of the middle phases of mitosis | 119 |
| 47. Diagram of the closing phases of mitosis | 120 |
| 48. Prophases of mitosis in primary spermatocytes of the salamander | 123 |
| 49. Middle phases of mitosis in the cleavage of <i>Ascaris</i> | 124 |
| 50. Final phases of mitosis in salamander cells | 125 |
| 51. Early figures of spiremes | 126 |
| 52. Formation of the spireme and chromosomes in epithelial cells of salamander larva | 128 |
| 53. Spireme-formation and early splitting in spermatogonia of <i>Ascaris</i> | 129 |
| 54. Prophases of the chromosomes in root-tips of <i>Naja</i> | 130 |
| 55. Prophases and telophases of the chromosomes in root-tips of <i>Vicia</i> | 131 |
| 56. Types of chromosome-attachments in the somatic mitoses | 132 |
| 57. Chromosome-attachments in root-tips | 134 |
| 58. Later stages of mitosis in <i>Toxopneustes</i> | 135 |
| 59. Supposed chromonema-formation in the telophases | 137 |
| 60. Teleokinesis in spermatogonial mitosis of grasshopper | 138 |
| 61. Telokinetic movements of the centers in <i>Blaps</i> | 140 |
| 62. Telokinesis in first cleavage of <i>Crepidula</i> | 142 |
| 63. Early prophases in <i>Ascaris</i> , for central bodies | 147 |
| 64. Polar caps and anastral spindles in plants | 151 |
| 65. Multipolar spindle-formations in sporocytes of <i>Equisetum</i> | 152 |
| 66. Multipolar spindle-formation in <i>Cassia</i> | 154 |
| 67. Mitosis in pollen-mother-cells of the larch | 155 |
| 67a. Cell-plate formation in plants. The phragmoplast | 160 |
| 68. Chondriokinesis in spermatocytes of Hemiptera | 164 |
| 69. Dictyokinesis in spermatocytes of Hemiptera | 166 |
| 70. Monocentric mitosis in the living eggs of sea-urchins | 169 |
| 71. Monocentric mitosis in sea-urchin eggs | 171 |
| 72. Monocentric mitoses | 172 |
| 73. Pathological mitoses in human cancer cells | 173 |
| 74. Diagrams of cleavage in dispermic sea-urchin eggs | 176 |
| 75. Mitosis in binucleated eggs of sea-urchins | 177 |
| 76. Van Beneden's theory of mitosis | 179 |
| 77. Heidenhain's rubber models of mitosis | 181 |
| 78. The effect of ether on mitosis in sea-urchin eggs | 183 |
| 79. Multipolar mitoses in dispermic sea-urchin eggs | 185 |
| 80. Diagrams of polarized fields | 187 |
| 81. Magnetic models of mitosis | 190 |

LIST OF FIGURES

xxvii

| FIG. | PAGE |
|--|------|
| 82. Surface-tension and cortical currents in oil-drops | 194 |
| 83. Surface-tension and cortical currents in mitosis and oil-drops | 196 |
| 84. Mitosis and central bodies in algæ | 200 |
| 85. Mitosis in <i>Oxnerella</i> | 203 |
| 86. Mitosis in <i>Trichomonas</i> | 205 |
| 87. Mitosis in <i>Amæba tachypodia</i> | 206 |
| 88. Mitosis in <i>Astasia</i> | 207 |
| 89. Mitosis in <i>Oxyrrhis</i> | 209 |
| 90. Mitosis in <i>Centropyxis</i> | 211 |
| 91. Mitosis in <i>Euglypha</i> | 212 |
| 92. Amitosis in leucocytes of the frog | 214 |
| 93. Amitosis in various cells | 216 |
| 94. Artificially induced figures simulating amitosis | 220 |
| 95. Polymorphic nuclei in cleavage-stages | 221 |
| 96. Nuclear amitosis in living cells | 223 |

CHAPTER III

| | |
|--|-----|
| 97. Progressive "senescence" in cultures of <i>Stylonychia</i> | 239 |
| 98. <i>Uroleptus mobilis</i> | 240 |
| 99. Curve of life-cycles in <i>Paramæcium</i> | 241 |
| 100. Curve of life-cycles in <i>Paramæcium</i> , showing endomictic periods | 244 |
| 101. Curves showing rejuvenescence following conjugation in <i>Uroleptus</i> | 246 |
| 102. The chromosome-cycle in animals | 249 |
| 103. Diploid and haploid chromosome-groups in <i>Echinus</i> | 251 |
| 104. Diploid and haploid chromosome-groups in aphids and crayfish | 252 |
| 105. Chromosomes and heredity | 253 |

CHAPTER IV

| | |
|--|-----|
| 106. Ovum of the cat within the ovary | 258 |
| 107. Eggs of <i>Dentalium</i> prior to entrance of the sperm | 260 |
| 108. Growing oöcytes of <i>Unio</i> and <i>Epeira</i> | 266 |
| 109. Karyospheres in germinal vesicles of <i>Nephelis</i> | 268 |
| 110. Germinal vesicles of reptiles | 270 |
| 111. Immature oöcytes of myriapods and insects | 271 |
| 112. The egg of an insect | 272 |
| 113. The micropyle in <i>Argonauta</i> | 273 |
| 114. The micropyle in the ganoid <i>Lepidosteus</i> | 274 |
| 115. Egg-capsule, egg and embryo in <i>Chimæra</i> | 275 |
| 116. Bilaterality of the egg of the cockroach | 276 |
| 117. Sexual dimegaly of the eggs in <i>Dinophilus</i> | 277 |
| 118. Diagram of the flagellate sperm | 280 |
| 119. Structural details of the sperm | 282 |
| 120. Primitive sperms with "nebenkern" type of middle-piece | 284 |
| 121. Sperms of fishes and protochordates | 287 |
| 122. Sperms and spermiogenesis of frogs | 288 |
| 123. Sperms of Amphibia | 290 |

| FIG. | PAGE |
|---|------|
| 124. Sperm of the toad <i>Bombinator</i> | 291 |
| 125. Sperms of reptiles and birds | 292 |
| 126. Sperms of mammals | 294 |
| 127. Aberrant types of flagellate sperms. | 296 |
| 128. Non-flagellate sperms of Crustacea | 297 |
| 129. Sperms of decapods | 298 |
| 130. Oligopyrene sperms and their formation in <i>Paludina</i> | 301 |
| 131. Apyrene sperms of Lepidoptera | 302 |
| 132. Conjugate sperms | 305 |
| 133. Sperms of <i>Chara</i> | 307 |
| 134. Sperms of algæ, mosses, and ferns | 308 |
| 135. Diagram of the germ-line in animals | 311 |
| 136. Early segregation of the germ-cells in a hydro-medusa | 312 |
| 137. Primordial germ-cells in <i>Miastor</i> | 313 |
| 138. Primordial germ-cells in <i>Chironomus</i> | 314 |
| 139. Primordial germ-cells and germ-line in <i>Cyclops</i> | 316 |
| 140. Primordial germ-cells in vertebrates | 317 |
| 141. Oöcyte of <i>Apanteles glomeratus</i> | 318 |
| 142. Early germ-cells in <i>Litomastix</i> | 319 |
| 143. The germ-line in <i>Sagitta</i> | 321 |
| 144. The germ-line in <i>Ascaris</i> | 322 |
| 145. The germ-line in <i>Ascaris</i> , cont. | 324 |
| 146. Germ-line in <i>Ascaris</i> and in <i>Dytiscus</i> compared | 325 |
| 147. Egg-formation and diminution in beetles | 327 |
| 148. Diminution in polar spindles of Lepidoptera. | 328 |
| 149. Diagram of early auxocyte | 329 |
| 150. Idiozome and Golgi-bodies in spermatocytes of <i>Proteus</i> | 330 |
| 151. Oöcyte and nurse-cell in <i>Ophytrocha</i> | 332 |
| 152. Ovary of aphid with oöcyte and nurse-cells | 333 |
| 153. Egg and nutritive cells in insects | 334 |
| 154. Ovarian egg and follicle-cells in <i>Helix</i> | 335 |
| 155. Egg and nutritive cells in <i>Dytiscus</i> | 336 |
| 156. Connections between follicle-cells and oöcyte in vertebrates | 337 |
| 157. Young human oöcyte with vitellogenous (pallial) layer | 339 |
| 158. Yolk-nucleus, pallial layer and yolk-formation in spiders | 342 |
| 159. Yolk-nucleus and pallial substance in spiders and myriapods | 344 |
| 160. Oöcytes and secondary nuclei in Hymenoptera | 348 |
| 161. Germinal vesicles of the elasmobranch egg | 349 |
| 162. Later stages of the germinal vesicle in fishes. | 352 |
| 163. Germinal vesicles of <i>Melamphaës</i> and <i>Gyllotalpa</i> | 355 |
| 164. Chondriosomes and sperm-formation in insects | 358 |
| 165. Spermatocyte-divisions and centrioles in <i>Pygæra</i> | 359 |
| 166. Chondriosomes and sperm-formation in <i>Paludina</i> | 360 |
| 167. The same, continued | 362 |
| 168. Chondriosomes and sperm-formation in <i>Opisthacanthus</i> | 363 |
| 169. Chondriosomes in the spermatocytes of <i>Centrurus</i> | 365 |
| 170. Chondriosomes and sperm-formation in <i>Centrurus</i> | 366 |
| 171. Movements of the spermatid-components in Hemiptera | 368 |

LIST OF FIGURES

xxix

| FIG. | PAGE |
|---|------|
| 172. Nebenkern and acroblast in Hemiptera | 370 |
| 173. Diagrams of types of sperm-formation with reference to the central apparatus | 374 |
| 174. The central apparatus in the spermiogenesis of <i>Phalangista</i> | 375 |
| 175. Mitochondria and sperm-formation in vertebrates | 377 |
| 176. Chondriosomes and sperm-formation in vertebrates | 379 |
| 177. Centrioles in the spermiogenesis of the guinea-pig | 380 |
| 178. Chromatoid bodies in the spermiogenesis of <i>Pentatoma</i> | 383 |
| 179. Spermiogenesis in pteridophytes | 386 |
| 180. Spermiogenesis in <i>Marsilia</i> | 387 |
| 181. Spermiogenesis in <i>Polytrichum</i> | 389 |
| 182. Formation of sperms in cycads | 390 |

CHAPTER V

| | |
|---|-----|
| 183. Fertilization of the egg of <i>Physa</i> | 396 |
| 184. Entrance and rotation of sperm in <i>Toxopneustes</i> | 397 |
| 185. Karyogamy in the sea-urchin type | 399 |
| 186. The sea-urchin type of fertilization | 400 |
| 187. The <i>Ascaris</i> -type of fertilization | 401 |
| 188. <i>Ascaris</i> -type and sea-urchin-type compared | 402 |
| 189. Different conditions of the egg when ready to receive the sperm | 404 |
| 190. Entrance-cone, fertilization-membrane and entrance of the sperm in <i>Toxop-</i> <i>neustes</i> | 410 |
| 191. Entrance of the sperm in <i>Nereis</i> | 414 |
| 192. Polar rings in <i>Clepsine</i> | 416 |
| 193. Pathological polyspermy in <i>Ascaris</i> and sea-urchins | 417 |
| 194. Normal polyspermy in insects | 418 |
| 195. Polyspermy in the frog's egg | 420 |
| 196. Paths of the gamete-nuclei in <i>Toxopneustes</i> | 424 |
| 197. Fertilization in <i>Ascaris</i> | 427 |
| 198. Fertilization in <i>Pterotrachea</i> | 428 |
| 199. Fertilization in <i>Nereis</i> | 430 |
| 200. Fertilization in <i>Cyclops</i> | 431 |
| 201. Gonomery in <i>Cyclops</i> | 432 |
| 202. Gonomery in <i>Crepidula</i> | 434 |
| 203. Entrance of the sperm with chondriosomes in <i>Mytilus</i> | 436 |
| 204. Mitochondria in the fertilization of <i>Ascaris</i> | 437 |
| 205. Fertilization in <i>Thalassema</i> | 439 |
| 206. Fertilization in <i>Crepidula</i> | 443 |
| 207. Central bodies in fertilization of <i>Cerebratulus</i> | 445 |
| 208. Fractional fertilization in <i>Nereis</i> | 446 |
| 209. Fertilization of etherized eggs in <i>Toxopneustes</i> | 448 |
| 210. Fertilization of <i>Crepidula</i> eggs in hypertonic sea-water | 449 |
| 211. Fertilization in <i>Pilularia</i> | 450 |
| 212. Fertilization in <i>Nephrodium</i> | 451 |
| 213. Fertilization in <i>Zamia</i> | 452 |
| 214. Fertilization in <i>Torreya</i> and <i>Taxodium</i> | 453 |
| 215. Fertilization in <i>Pinus</i> | 455 |

| FIG. | PAGE |
|---|------|
| 216. Embryo-sac and fertilization in orchids | 456 |
| 217. Fertilization in <i>Lilium</i> | 457 |
| 218. Double fertilization in <i>Lilium</i> | 458 |
| 219. Partial fertilization in <i>Echinus</i> | 459 |
| 220. Gynogenesis in <i>Rhabdites</i> | 461 |
| 221. Gynogenesis in Amphibia | 462 |
| 222. Androgenesis in <i>Chaetopterus</i> | 464 |
| 223. Polocytes of sexual and parthenogenetic eggs compared | 468 |
| 224. Parthenogenesis in <i>Artemia</i> | 470 |
| 225. Parthenogenesis in <i>Artemia</i> | 471 |
| 226. Artificial parthenogenesis in <i>Asterias</i> | 478 |
| 227. Comparison of larvæ from parthenogenetic and fertilized eggs | 480 |
| 228. Chromosomes and central bodies in artificial parthenogenesis | 481 |
| 229. Artificial parthenogenesis in <i>Thalassema</i> | 483 |

CHAPTER VI

| | |
|--|-----|
| 230. Diagram of the three types of meiosis | 489 |
| 231. Diagram of the origin and meiotic divisions of the sperm | 490 |
| 232. Diagram of the origin and meiotic divisions of the egg | 491 |
| 233. Formation of the polocytes by the egg | 493 |
| 234. Polocytes in the egg of the mouse | 494 |
| 235. Giant polocytes in the eggs of platodes and snails. | 495 |
| 236. General view of the meiotic divisions in the seed-plants | 497 |
| 237. Diagram of the meiotic (polar) divisions in the female | 499 |
| 238. The meiotic (polar) divisions in the egg of <i>Ascaris</i> | 501 |
| 239. Meiosis in eggs of <i>Zirphæa</i> and <i>Thalassema</i> | 502 |
| 240. Diagram of the meiotic divisions in the male | 504 |
| 241. Meiotic divisions in the spermatogenesis of <i>Ascaris</i> | 506 |
| 242. The meiotic divisions in the spermatogenesis of <i>Salamandra</i> | 507 |
| 243. Anastral polar spindles | 508 |
| 244. The tetrads of <i>Tomopteris</i> | 510 |
| 245. Diagrams of non-terminal attachments of tetrads | 512 |
| 246. Diagrams of terminal attachments of tetrads | 513 |
| 247. Heterotypic chromosomes of urodeles in metaphase and anaphase | 514 |
| 248. Heterotypic chromosomes of urodeles | 516 |
| 249. Diagram of longitudinal tetrads | 517 |
| 250. Heterotypic chromosomes in seed-plants | 518 |
| 251. Diagrams of transverse tetrads | 520 |
| 252. Heterotypic chromosomes in seed-plants | 521 |
| 253. Metaphase-tetrads in the meiosis of grasshoppers | 522 |
| 254. Diagram of origin of rod-tetrads and double-crosses | 523 |
| 255. Tetrads of the grasshopper <i>Phrynotettix</i> | 525 |
| 256. Heterotypic chromosomes of urodeles | 526 |
| 257. Diagram of origin of single and double rings | 527 |
| 258. Double-ring tetrads in grasshoppers | 528 |
| 259. Diagram of the division of heterotypic double crosses and rings | 530 |
| 260. Various conditions of the nuclei during the meiotic interkinesis. | 533 |

LIST OF FIGURES

xxxī

| FIG. | PAGE |
|---|------|
| 261. The homeotypic division in seed-plants | 534 |
| 262. Diagram of the stages of meiosis | 537 |
| 263. Early stages of meiosis in the cat | 538 |
| 264. Early stages of meiosis in the rabbit | 539 |
| 265. Presynaptic stages of meiosis in grasshoppers | 540 |
| 266. Earlier stages of meiosis in Hemiptera | 542 |
| 267. Presynapsis, synapsis and sex-chromosomes in Hemiptera | 543 |
| 268. Diakinetic figures in grasshoppers | 546 |
| 269. Parasynapsis in <i>Tomopteris</i> | 547 |
| 270. Details of parasynapsis in <i>Tomopteris</i> | 551 |
| 271. Parasynapsis in grasshoppers | 552 |
| 272. Stages of meiosis in seed-plants | 553 |
| 273. Strepsinema in plants and animals | 555 |
| 274. Relation between parasynapsis and telosynapsis | 557 |
| 275. Loop-formation in <i>Lilium</i> | 559 |
| 276. Meiosis in <i>Oenothera</i> | 560 |
| 277. Diakinetic disjunction and reconjugation in <i>Lepidosiren</i> | 563 |
| 278. Telokinetic movement of presynaptic nucleus in <i>Batrachoseps</i> | 567 |
| 279. Stages of meiosis in <i>Dendrocœlum</i> | 568 |
| 280. Parasynapsis in <i>Dendrocœlum</i> | 570 |
| 281. Meiosis in the fly <i>Asilus</i> | 575 |

CHAPTER VII

| | |
|---|-----|
| 282. Endogamy, hologamy and gametic meiosis in <i>Actinophrys</i> | 583 |
| 283. Hologamy in <i>Spirogyra</i> | 584 |
| 284. Merogamy in <i>Polystomella</i> | 585 |
| 285. Sex-relations in the conjugate algæ | 587 |
| 286. Some gametes and gamete-like flagellates | 589 |
| 287. Zoöspores and isogametes in <i>Ulothrix</i> | 590 |
| 288. Conjugation in <i>Stylorhynchus</i> | 591 |
| 289. Fertilization in <i>Basidiobolus</i> | 593 |
| 290. Isogamy and anisogamy in gametes of algæ | 594 |
| 291. Heterogamy in <i>Volvox</i> | 595 |
| 292. Reproduction in green algæ | 596 |
| 293. Fertilization in <i>Pyronema</i> | 598 |
| 294. Fertilization in <i>Albugo candidus</i> | 599 |
| 295. Conjugation and gametic meiosis in diatoms | 600 |
| 296. Nuclear cycle in <i>Amœba diploidea</i> | 602 |
| 297. Zygotic meiosis in <i>Spirogyra</i> | 603 |
| 298. Zygotic meiosis in <i>Closterium</i> | 605 |
| 299. Diagram of conjugation of <i>Paramœcium caudatum</i> | 607 |
| 300. Early stages of conjugation in <i>Paramœcium caudatum</i> | 608 |
| 301. Later stages of conjugation in <i>Paramœcium caudatum</i> | 609 |
| 302. First maturation-division in <i>Paramœcium caudatum</i> | 610 |
| 303. Later stages of maturation in <i>Paramœcium caudatum</i> | 611 |
| 304. Conjugation in <i>Vorticella</i> | 612 |
| 305. Comparison of conjugation and endomixis | 614 |

| FIG. | PAGE |
|---|------|
| 306. Fertilization and zoöspore-formation in <i>Cedogonium</i> and <i>Bulbochæta</i> | 618 |
| 307. Megaspore quartet-formation in seed-plants | 619 |
| 308. The parallel between meiosis in the animal ovum and in the megaspores of higher plants | 620 |
| 309. Antithetic alternation of generations in rusts | 623 |
| 310. Sexual process in the rusts | 625 |
| 311. Alternation of generations in <i>Cutleria-Aglaozonia</i> | 626 |

CHAPTER VIII

| | |
|---|-----|
| 312. Chromosomes in the germinal vesicle of <i>Pristiurus</i> | 651 |
| 313. Normal and giant forms in <i>Spirogyra</i> | 655 |
| 314. Cells and nuclei from trispermic frog-larvæ | 657 |
| 315. Non-nucleated fragments in <i>Stylonychia</i> | 658 |
| 316. Regeneration in <i>Stentor</i> | 660 |
| 317. Nucleated and non-nucleated fragments of <i>Amæba</i> | 661 |
| 318. Membrane-formation in fragments of plant-cells | 662 |
| 319. Position of the nuclei in growing plant-cells | 663 |
| 320. Eggs and nurse-cells in <i>Forficula</i> | 665 |

CHAPTER IX

| | |
|---|-----|
| 321. Diagram of central bodies and astral systems | 673 |
| 322. Central bodies in the cleavage of <i>Cerebratulus</i> | 674 |
| 323. Mitosis with intra-nuclear central bodies in <i>Ascaris</i> | 675 |
| 324. Central apparatus in the polar mitoses of <i>Unio</i> | 676 |
| 325. The central bodies in <i>Heliozoa</i> | 677 |
| 326. The astral system in <i>Wagnerella</i> | 678 |
| 327. Central bodies in the cleavage of <i>Ascaris</i> and of sea-urchins | 679 |
| 328. Division of the centers in <i>Arion</i> and <i>Thysanozoön</i> | 681 |
| 329. Structure of asters and central bodies in <i>Arion</i> and <i>Rhynchelmis</i> | 682 |
| 330. History of the central bodies in <i>Rhynchelmis</i> | 683 |
| 331. Cytasters in the artificial parthenogenesis of <i>Toxopneustes</i> | 685 |
| 332. Cytasters and other phenomena in the artificial parthenogenesis of <i>Toxopneustes</i> | 686 |
| 333. Division of cytasters in artificial parthenogenesis | 687 |
| 334. Cytasters and centrioles in enucleated egg-fragments | 688 |
| 335. Astral formations and cytasters under various conditions | 689 |
| 336. Basal apparatus, flagella and fission in <i>Crithidia</i> | 691 |
| 337. Basal apparatus in flagellates | 693 |
| 338. Basal apparatus and its division in flagellates | 694 |
| 339. Mitosis in the choanocytes of sponges | 695 |
| 340. Basal apparatus and division in <i>Bodo</i> | 696 |
| 341. Blepharoplast and centriole in <i>Collodictyon</i> | 697 |
| 342. Chromidia and gamete-nuclei in <i>Arcella</i> | 700 |
| 343. Chromidial formation of nuclei in <i>Arachnula</i> | 702 |
| 344. Supposed production of chromidia in animal ova. | 704 |
| 345. Chondriosomes and myofibrils | 708 |
| 346. Chondriosomes and plastids in plant cells | 710 |

LIST OF FIGURES

xxxiii

| FIG. | PAGE |
|---|------|
| 346a. Division of mitochondria in Protozoa | 713 |
| 347. Golgi-bodies and chondriosomes in germ-cells and embryonic cells | 714 |
| 348. Golgi-bodies, chondriosomes and yolk-formation in <i>Ciona</i> | 715 |
| 349. Karyoplasmic ratio in young larvæ of sea-urchins | 728 |
| 350. Chromosome-number and cell-size in <i>Solanum</i> | 729 |
| 351. Karyoplasmic ratio in centrifuged <i>Crepidula</i> eggs | 732 |

CHAPTER X

| | |
|---|-----|
| 352. Mendelian back-cross and sex-cross | 744 |
| 353. Sex-predetermination in mosses | 747 |
| 354. The sex-chromosomes in <i>Anasa</i> | 750 |
| 355. Male and female diploid chromosome-groups in insects | 751 |
| 356. The chromosome-pairs in the sexes of <i>Protenor</i> | 753 |
| 357. The chromosome-cycle in <i>Ancyracanthus</i> , male | 755 |
| 358. The chromosome-cycle in <i>Ancyracanthus</i> , female | 756 |
| 359. The X-chromosome in <i>Photinus</i> and <i>Ascaris</i> | 757 |
| 360. The X-chromosome in <i>Gryllus</i> | 759 |
| 361. The X-chromosome in early maturation-stages of <i>Phrynotettix</i> | 760 |
| 362. Progressive heteropycnosis in <i>Tryxalis</i> | 761 |
| 363. Male-producing and female-producing spermatid-nuclei in <i>Protenor</i> | 762 |
| 364. Sex-chromosomes in <i>Lygæus</i> | 765 |
| 365. The XY-pair in <i>Diptera</i> | 767 |
| 366. The XY-pair in <i>Coleoptera</i> | 768 |
| 367. Sex-chromosomes in <i>Ascaris felis</i> | 769 |
| 368. Various forms of the simple XY-pair in insects | 770 |
| 369. Sex-chromosomes in <i>Oncopeltus</i> | 771 |
| 370. Double X-element in arthropods | 772 |
| 371. Multiple X-elements in <i>Ascaris</i> | 774 |
| 372. Compound XY-pair in various species | 776 |
| 373. XY-pair with double X in <i>Tenodera</i> | 777 |
| 374. XY-pair with triple and quadruple X in Hemiptera | 778 |
| 375. XY-pair with quintuple X in <i>Acholla</i> | 779 |
| 376. XY-pair with octuple X in <i>Ascaris incurva</i> | 780 |
| 377. Linkage of X-chromosome with an autosome | 781 |
| 378. The X-complex in <i>Blaps</i> | 782 |
| 379. Diagram of diploid parthenogenetic life-cycles | 788 |
| 380. Diagram of mixed and haploid parthenogenetic life-cycles | 789 |
| 381. Sex-chromosomes in <i>Aphis saliceti</i> | 790 |
| 382. Sex-chromosomes in <i>Phylloxera</i> | 791 |
| 383. Chromosome-groups in the honey-bee | 796 |
| 384. Spermatocyte-divisions in Hymenoptera | 798 |
| 385. Male (haploid) and female (diploid) chromosome-groups in <i>Neuroterus</i> | 799 |
| 386. Sexual dimegaly of the eggs in rotifers | 802 |
| 387. Sex-chromosomes in hermaphroditic nematodes | 810 |
| 388. Sex-chromosomes in plants | 813 |
| 389. Possible evolution of the sex-chromosomes | 824 |

CHAPTER XI

| FIG. | PAGE |
|---|------|
| 390. Rabl's diagrams of chromosome-individuality | 829 |
| 391. Abnormal mitosis in <i>Hemerocallis</i> | 830 |
| 392. Abnormal fertilization in <i>Ascaris</i> | 831 |
| 393. Chromosomes from double egg | 832 |
| 394. Differences of size and shape among the chromosomes | 835 |
| 395. The chromosome-pairs in various plants and animals | 836 |
| 396. The diploid chromosome-groups in Diptera | 838 |
| 397. The <i>m</i> -chromosomes of Hemiptera | 840 |
| 398. Chromosomes of <i>Ascaris</i> hybrids | 841 |
| 399. Chromosomes of hybrid moths | 842 |
| 400. Chromosomes of hybrid fishes | 844 |
| 401. Heterotypic mitosis of <i>Drosera</i> hybrids | 846 |
| 402. Diagram of meiosis in <i>Hieracium</i> hybrids | 847 |
| 403. Diploid chromosome groups in roses | 848 |
| 404. Meiosis in microsporogenesis of hybrid roses | 850 |
| 405. Types of meiosis in <i>Hieracium</i> hybrids | 851 |
| 406. The chromosomes of hybrid moths | 852 |
| 407. Reduplication. Haploid, diploid and tetraploid chromosome-groups | 871 |
| 408. Non-disjunction of the XY-pair in <i>Metapodius</i> | 873 |
| 409. Supernumerary Y-chromosomes in <i>Metapodius</i> | 874 |
| 410. Meiosis with supernumerary Y-chromosomes in <i>Metapodius</i> | 875 |
| 411. Supernumerary <i>m</i> -chromosome in <i>Metapodius</i> | 876 |
| 412. Variations of chromosome-number in <i>Oenothera</i> | 878 |
| 413. Spermatogonial metaphase-groups in Orthoptera | 880 |
| 414. Chromosome-linkage in <i>Hesperotettix</i> | 882 |
| 415. Linkage of the X-chromosomes in <i>Drosophila</i> | 883 |
| 416. First cleavage in <i>Ascaris</i> | 891 |
| 417. Chromosome-grouping in sister-cells of <i>Ascaris</i> | 892 |
| 418. Genetic continuity of chromosomes in <i>Ascaris</i> | 893 |
| 419. Karyomeres and chromosomes in fish-embryos | 894 |
| 420. History of the chromonema in <i>Paris</i> | 898 |
| 421. Spermatogonial prophases in <i>Triton</i> | 899 |
| 422. Prophase chromonema-formation in Orthoptera | 900 |
| 423. Prochromosomes in plant-cells | 901 |
| 424. Structure of the sex-chromosomes in <i>Notonecta</i> and <i>Lygæus</i> | 904 |
| 425. Cross-sutures in chromosomes of copepods | 905 |
| 426. Cross-sutures in chromosomes of plants and animals. | 906 |
| 427. Organization of spireme-threads in <i>Phrynotettix</i> | 909 |
| 428. Chromomeres in the bivalent chromosomes of <i>Dendrocælum</i> | 910 |
| 429. Nuclear structures in living cells of <i>Dissosteira</i> | 912 |

CHAPTER XII

| | |
|--|-----|
| 430. Multipolar mitosis in dispermic sea-urchin eggs | 917 |
| 431. Dispermic and dwarf larvæ of sea-urchins | 918 |
| 432. Nuclei in sea-urchin larvæ from dispermic eggs | 919 |

LIST OF FIGURES

XXXV

| FIG. | PAGE |
|--|------|
| 433. Diagrams of chromosome-distribution in dispermic eggs | 921 |
| 434. Diagrams of chromosome-distribution in dispermic eggs | 922 |
| 435. Chromosome-pairs and bivalents in <i>Syrbula</i> | 924 |
| 436. Diversity of the bivalents in <i>Brachystola</i> | 926 |
| 437. Segregation in <i>Chlamydomonas</i> following zygotic meiosis | 930 |
| 438. Heteromorphic bivalents in Orthoptera | 932 |
| 439. Heteromorphic chromosome-pairs and bivalents in <i>Trimerotropis</i> | 933 |
| 440. Heteromorphic chromosome-pairs in <i>Trimerotropis</i> | 935 |
| 441. Random assortment of heteromorphic chromosome-pairs in <i>Trimerotropis</i> | 936 |
| 442. Chromosome recombinations in F ₁ offspring of <i>Circotettix</i> | 937 |
| 443. Diagram of sex-linked heredity | 940 |
| 444. Sex-linked heredity in <i>Drosophila</i> | 941 |
| 445. Supernumerary chromosomes from non-disjunction in <i>Drosophila</i> | 947 |
| 446. Correns' diagram of crossing-over | 951 |
| 447. Diagram of serial alignment of units in the chromosomes of a homozygote | 952 |
| 448. Diagram of heterozygotes | 953 |
| 449. Diagrams of the chiasmatype-theory | 955 |
| 450. Diagram of mitosis, synapsis, and crossing-over | 956 |
| 451. Diagrams of four-strand and two-strand crossing-over | 957 |
| 452. Diagrams of double-cross-overs | 958 |
| 453. Diagram of Janssens' interpretation of multiple ring-tetrads | 959 |
| 454. Division of double and triple ring-tetrads without chiasmatype | 960 |
| 455. Chromosomes in reciprocal crosses of sea-urchins | 964 |
| 456. Normal and hybrid sea-urchin larvæ | 967 |
| 457. The chromosomes in combined parthenogenesis and crossing in sea-urchins | 968 |
| 458. Gamete-nuclei in heterogenous fertilization | 971 |
| 459. Merogonic sea-urchin hybrid | 974 |

CHAPTER XIII

| | |
|---|------|
| 460. Geometrical relations of cleavage-planes in plant-structures | 983 |
| 461. Soap-bubble models of spiral cleavage | 987 |
| 462. Spiral type of cleavage in <i>Polygordius</i> | 988 |
| 463. Diagram of quartet-formation in spiral cleavage | 989 |
| 464. Spiral type of cleavage in <i>Trochus</i> | 990 |
| 465. Cleavage in dextral and sinistral gastropods | 992 |
| 466. Bilateral cleavage in <i>Clavelina</i> | 994 |
| 467. Bilateral cleavage in <i>Styela (Cynthia)</i> | 995 |
| 468. Bilateral cleavage in the cephalopod | 996 |
| 469. Bilateral cleavages following earlier spiral ones | 998 |
| 470. Early cleavage in <i>Nereis</i> | 999 |
| 471. The eight-cell stage in various eggs | 1000 |
| 472. Meroblastic cleavage in <i>Loligo</i> | 1001 |
| 473. Teloblasts in the earthworm | 1003 |
| 474. Rudimentary cells in cleavage | 1004 |
| 475. Sperm centers and cleavage-centers in fertilization of <i>Nereis</i> | 1005 |
| 476. Segmenting eggs of <i>Ascaris</i> | 1006 |

| FIG. | PAGE |
|--|------|
| 477. Spiral cleavage in three gasteropods | 1008 |
| 478. Early stages of cleavage in <i>Patella</i> | 1009 |
| 479. Middle stages of cleavage in <i>Patella</i> | 1010 |
| 480. Young larval stages of <i>Patella</i> | 1011 |
| 481. Diagram of values of the ectoblast-quartets | 1015 |
| 482. Polarity and beginning of cleavage in the egg of <i>Dentalium</i> | 1016 |
| 483. Early cleavages in <i>Dentalium</i> | 1017 |
| 484. Later cleavages in <i>Dentalium</i> | 1018 |
| 485. Bilaterality of the egg in <i>Loligo</i> | 1020 |
| 486. Bilaterality of the egg in insects | 1021 |
| 487. Eggs of the insect <i>Corixa</i> | 1022 |
| 488. Attachment of the oöcyte and micropyle-formation | 1025 |
| 489. Reversal of symmetry in regeneration | 1027 |

CHAPTER XIV

| | |
|--|------|
| 490. Half embryos of frog from blastomere of 2-cell stage | 1038 |
| 491. Partial development of isolated blastomere-groups | 1040 |
| 492. Partially double larva of ctenophores from partially separated blastomeres | 1041 |
| 493. Development of isolated blastomeres in <i>Patella</i> | 1043 |
| 494. Development of isolated ectomeres in <i>Patella</i> | 1044 |
| 495. Development of isolated trochoblasts in <i>Patella</i> | 1045 |
| 496. Partial larvæ from isolated blastomeres of <i>Dentalium</i> | 1047 |
| 497. Differentiation of isolated cells of <i>Dentalium</i> | 1048 |
| 498. Partial embryos from isolated blastomeres of <i>Styela</i> (<i>Cynthia</i>) | 1049 |
| 499. Half and whole cleavage in sea-urchin eggs | 1051 |
| 500. Normal and dwarf gastrulas of <i>Amphioxus</i> | 1052 |
| 501. Dwarf and twin embryos of <i>Amphioxus</i> | 1053 |
| 502. Double headed tadpoles of the salamander | 1054 |
| 503. Half cleavage of isolated $\frac{1}{2}$ -blastomere of <i>Cerebratulus</i> | 1055 |
| 504. Dwarf whole larvæ from isolated blastomeres of <i>Cerebratulus</i> | 1056 |
| 505. Sea-urchin eggs segmenting normally and under pressure | 1058 |
| 506. <i>Nereis</i> eggs segmenting normally and under pressure | 1060 |
| 507. Diagram of distribution of nuclei normally and under pressure | 1061 |
| 508. Cleavage of <i>Dentalium</i> egg after removal of polar lobe | 1062 |
| 509. Egg and larvæ of <i>Dentalium</i> , normal and after removal of polar lobe | 1063 |
| 510. Sections of normal and of lobeless larvæ of <i>Dentalium</i> | 1065 |
| 511. Embryos of <i>Dentalium</i> from egg-fragments | 1066 |
| 512. Polarity and cleavage in the egg of <i>Paracentrotus</i> | 1068 |
| 513. Continuation of 512 | 1070 |
| 514. Promorphological relations of the first cleavage-plane in the frog | 1071 |
| 515. Diagram of prelocalization in the eggs of sea-urchins and snails | 1072 |
| 516. Diagram of prelocalization in the eggs of tunicates and hydromedusæ | 1073 |
| 517. Embryos from upper and lower quartets of <i>Cerebratulus</i> | 1074 |
| 518. Double frog-tadpoles | 1077 |
| 519. Normal and giant larvæ of sea-urchin | 1080 |
| 520. Differentiation without cleavage in <i>Chaetopterus</i> | 1084 |

THE CELL
IN DEVELOPMENT AND HEREDITY

| FIG. | PAGE |
|--|------|
| 477. Spiral cleavage in three gasteropods | 1008 |
| 478. Early stages of cleavage in <i>Patella</i> | 1009 |
| 479. Middle stages of cleavage in <i>Patella</i> | 1010 |
| 480. Young larval stages of <i>Patella</i> | 1011 |
| 481. Diagram of values of the ectoblast-quartets | 1015 |
| 482. Polarity and beginning of cleavage in the egg of <i>Dentalium</i> | 1016 |
| 483. Early cleavages in <i>Dentalium</i> | 1017 |
| 484. Later cleavages in <i>Dentalium</i> | 1018 |
| 485. Bilaterality of the egg in <i>Loligo</i> | 1020 |
| 486. Bilaterality of the egg in insects | 1021 |
| 487. Eggs of the insect <i>Corixa</i> | 1022 |
| 488. Attachment of the oöcyte and micropyle-formation | 1025 |
| 489. Reversal of symmetry in regeneration | 1027 |

CHAPTER XIV

| | |
|--|------|
| 490. Half embryos of frog from blastomere of 2-cell stage | 1038 |
| 491. Partial development of isolated blastomere-groups | 1040 |
| 492. Partially double larva of ctenophores from partially separated blastomeres | 1041 |
| 493. Development of isolated blastomeres in <i>Patella</i> | 1043 |
| 494. Development of isolated ectomeres in <i>Patella</i> | 1044 |
| 495. Development of isolated trochoblasts in <i>Patella</i> | 1045 |
| 496. Partial larvæ from isolated blastomeres of <i>Dentalium</i> | 1047 |
| 497. Differentiation of isolated cells of <i>Dentalium</i> | 1048 |
| 498. Partial embryos from isolated blastomeres of <i>Styela</i> (<i>Cynthia</i>) | 1049 |
| 499. Half and whole cleavage in sea-urchin eggs | 1051 |
| 500. Normal and dwarf gastrulas of <i>Amphioxus</i> | 1052 |
| 501. Dwarf and twin embryos of <i>Amphioxus</i> | 1053 |
| 502. Double headed tadpoles of the salamander | 1054 |
| 503. Half cleavage of isolated $\frac{1}{2}$ -blastomere of <i>Cerebratulus</i> | 1055 |
| 504. Dwarf whole larvæ from isolated blastomeres of <i>Cerebratulus</i> | 1056 |
| 505. Sea-urchin eggs segmenting normally and under pressure | 1058 |
| 506. <i>Nereis</i> eggs segmenting normally and under pressure | 1060 |
| 507. Diagram of distribution of nuclei normally and under pressure | 1061 |
| 508. Cleavage of <i>Dentalium</i> egg after removal of polar lobe | 1062 |
| 509. Egg and larvæ of <i>Dentalium</i> , normal and after removal of polar lobe | 1063 |
| 510. Sections of normal and of lobeless larvæ of <i>Dentalium</i> | 1065 |
| 511. Embryos of <i>Dentalium</i> from egg-fragments | 1066 |
| 512. Polarity and cleavage in the egg of <i>Paracentrotus</i> | 1068 |
| 513. Continuation of 512 | 1070 |
| 514. Promorphological relations of the first cleavage-plane in the frog | 1071 |
| 515. Diagram of prelocalization in the eggs of sea-urchins and snails | 1072 |
| 516. Diagram of prelocalization in the eggs of tunicates and hydromedusæ | 1073 |
| 517. Embryos from upper and lower quartets of <i>Cerebratulus</i> | 1074 |
| 518. Double frog-tadpoles | 1077 |
| 519. Normal and giant larvæ of sea-urchin | 1080 |
| 520. Differentiation without cleavage in <i>Chaetopterus</i> | 1084 |

LIST OF FIGURES

xxxvii

| FIG. | PAGE |
|--|------|
| 521. Development of centrifuged sea-urchin eggs | 1088 |
| 522. Three types of cleavage in dispermic eggs of <i>Ascaris</i> | 1090 |
| 523. Abnormally segmenting eggs of <i>Ascaris</i> | 1091 |
| 524. Localizing activities in the ascidian egg. | 1095 |
| 525. Localizing activities in the egg of <i>Myzostoma</i> | 1097 |
| 526. Polarity of the egg in <i>Cerebratulus</i> | 1098 |
| 527. Cleavage of entire eggs and egg-fragments in <i>Cerebratulus</i> | 1100 |
| 528. Dwarf larvæ of <i>Cerebratulus</i> from egg-fragments.. . . . | 1101 |
| 529. Entrance-point of the sperm and first cleavage-plane in <i>Nereis</i> | 1105 |