



ELEMENTARY  
MORPHOLOGY AND  
PHYSIOLOGY  
FOR MEDICAL STUDENTS

*A Guide for the First Year  
and  
A Stepping-stone to the Second*

BY

J. H. WOODGER, D.Sc.

READER IN BIOLOGY IN THE

UNIVERSITY OF LONDON

AUTHOR OF *Biological Principles*

*The Axiomatic Method in Biology*

*The Technique of Theory Construction, &c.*

*THIRD EDITION*

LONDON  
OXFORD UNIVERSITY PRESS  
HUMPHREY MILFORD  
1943

OXFORD UNIVERSITY PRESS  
AMEN HOUSE, E.C. 4  
London Edinburgh Glasgow New York  
Toronto Melbourne Capetown Bombay  
Calcutta Madras  
HUMPHREY MILFORD  
PUBLISHERS TO THE UNIVERSITY

FIRST EDITION 1924  
SECOND EDITION 1935  
THIRD EDITION 1943

PRINTED IN GREAT BRITAIN

‘Had anatomists only been as conversant with the dissection of the lower animals as they are with that of the human body, the matters that have hitherto kept them in a perplexity of doubt would, in my opinion, have met them freed from every kind of difficulty.’

WILLIAM HARVEY: *On the Motion of the Heart and Blood in Animals.*

‘Medicine and surgery are therefore based on biology, and biology represents the institutes of medicine.’

‘The more we understand of the biological relations of both function and structure, the more easy does it become to detect and understand deviations from the normal, and to suggest methods of meeting the deviations and promoting recovery. Without this understanding we are simply groping in the dark, unable, except by rule of thumb, to diagnose the condition of a patient, or to see how he can be helped.’

DR. J. S. HALDANE: *The Institutes of Medicine and Surgery.*  
Address to the Middlesex Hospital Medical Society, March 6,  
1923.

## PREFACE TO THIRD EDITION

THE chief feature of this edition is the introduction of a new chapter on insects based on *Periplaneta americana*. For help in preparing this chapter I am much indebted to Drs. A. D. Imms and V. B. Wigglesworth. I am also indebted to Messrs. Methuen & Co., Ltd., for permission to use one figure from Dr. Wigglesworth's *Insect Physiology* and three from Dr. Imms's *Outlines of Entomology*.

The rest of the text has been thoroughly revised and improvements have been made in some of the illustrations. Two new illustrations have been added in addition to those for the new chapter.

MIDDLESEX HOSPITAL, MEDICAL SCHOOL

March 1943.

# FOREWORD TO THE STUDENT

ON

## PRACTICAL WORK AND METHOD OF STUDY

THE first step in the pursuit of any science is the observation of facts: in biological science, of facts about animals and plants. The second step consists in constructing hypotheses which will explain these facts and lead to the discovery of new ones.

Perhaps the chief difficulty that confronts the beginner learning a new science is the difficulty of 'seeing the wood for the trees'. This book is intended as a guide to the student in taking the second step; it attempts to present a vision of the wood, but it must be remembered that this picture will be clear or blurred according to the care the reader has taken to become personally acquainted with the trees. The theoretical book must assume that the student has already taken the first step, and has learnt something of the elementary facts of animal biology in the laboratory with the aid of such books as Marshall's *Frog*, and Marshall and Hurst's *Practical Zoology*. No book can take the place of careful personal observation, and observations must be recorded in simple but accurate and original drawings, for the beginner will soon learn that only by drawing will he be compelled to observe accurately. The use of a laboratory guide-book is necessary in view of the limited time available in a course of study intended as a preparation for examination, but the student should acquire the habit from the beginning of seeing whether the statements of the book agree with what he finds in nature, not of making his observations 'square' with the book. Every time the beginner slurs over the difficulty when he finds that his specimen does not conform to type, every time he looks only for what he is 'supposed to see', he shuts his mind more and more to the possibility of fresh discovery and weakens his ability to form an independent judgement. It must be remembered that in these early studies *the method of learning is quite as important as the matter learnt*, for it is at this time that the beginner will either form a true scientific method of approach to biological problems, or will merely acquire the habit of relying on authority. Which path he follows will determine his success or failure when, after examinations are over, he meets with problems not dealt with in the books and is called upon to make a decision for himself.

Just as the observation upon which interpretation rests must be personal, and acquired by the active use of the senses, so must the interpretation itself be made by an active effort of the reader's mind. The student should strive to connect his observations into an orderly whole, so that no fact is merely retained in his mind by an arbitrary effort of memory, but is connected by reasoned links to something else he has learnt in the subject. In this book he is invited to think about the facts he has learnt in the laboratory, and to consider how they may be connected with one another by reducing them to common terms, and by the attempt to discover the general laws which appear to underlie them.

Another stumbling-block to the beginner, especially in an anatomical science, is the difficulty of retaining the hosts of strange terms employed. Technical terms are unavoidable, because we have to deal with objects for which no everyday names exist, or to which common names are given in a loose uncritical way unsuitable for the accurate usage of science. These terms must be learnt before we can discuss the problems of biology; they form the vocabulary of a new language, which must be acquired before we can enjoy its literature. This difficulty can be overcome to some extent by avoiding all terms that are not absolutely necessary, by introducing them gradually, and by knowing something of their derivation, for many of them contain common Greek or Latin roots.<sup>1</sup>

#### *Note on Anatomical Illustrations.*

The reader as he works through this book should notice carefully the difference between a *drawing* and a *diagram*. The former attempts to depict accurately the structure of an animal or part as it appears directly to the eye. Its truth or falsity can be verified by any one with normal vision who cares to take the trouble to do so. A diagram, on the other hand, is an *interpretation*, an attempt to simplify the complexity of nature. All science consists in seeking to diagrammatize nature, to express diverse and particular facts in the most general and most comprehensive way, and so to enable the mind to deal with them in a way that would be impossible if it were compelled only to treat of particulars separately. A diagram is therefore the expression of a generalization, and its 'truth' will depend on the truth of the generalization it expresses. This is frequently very difficult to determine and is often a matter for discussion. The beginner is warned therefore not to confuse a diagram with a drawing, but to regard it as an aid to understanding.

<sup>1</sup> In this connexion the student should also refer to the glossary at the end of the book.

# CONTENTS

CHAPTER	PAGE
LIST OF ILLUSTRATIONS . . . . .	vii
FOREWORD TO THE STUDENT ON PRACTICAL WORK AND METHOD OF STUDY . . . . .	xv
I. INTRODUCTORY . . . . .	1
Science and Medicine.	
II. ANIMAL ORGANIZATION. THE FUNCTIONS AND THEIR ORGANS . . . . .	9
Animal behaviour. Animal motion. Energy and its sources. Nutrition. Transport of Materials. Respiration. Excretion. Co-ordination and Integration. Reproduction.	
III. THE TISSUES . . . . .	23
IV. THE CELL . . . . .	51
Cell Multiplication. Protoplasm. The Properties of Colloids.	
V. ANIMALS WITHOUT CELLULAR TISSUES. THE PROTOZOA . . . . .	61
Structure and Mode of life of Amoeba. Paramoecium and Euglena. Classification. Reproduction. Syngamy in Para- moecium, Plasmodium, and Monocystis.	
VI. ANIMALS WITH CELLULAR TISSUES. METAZOA . . . . .	85
Animals with two cellular layers. Coelenterates. Hydra and Obelia. Receptors and Effectors in Sponges and Co- elenterates.	
VII. ANIMALS WITH THREE FUNDAMENTAL CELLULAR LAYERS. FLATWORMS . . . . .	104
A Parenthesis on Parasitism. Distomum and Taenia. Proto- zoan and other parasites.	
VIII. ANIMALS WITH A CAVITY IN THE MESODERM. COELOMATES . . . . .	124
Lumbricus. The Annelids. Variations on the Coelomate Plan. The Coelomate Phyla. Chordata.	
IX. A DIGRESSION ON INSECTS . . . . .	147
The insect ground plan. <i>Periplaneta americana</i> . Classi- fication. Medically important insects.	
X. THE PRIMITIVE CHORDATA . . . . .	170
Amphioxus, its general structure and development. Cyclo- stomes and Gnathostomes.	



CHAPTER	PAGE
XI. THE CARTILAGINOUS FISHES . . . . .	192
Scyllium and the ground-plan of Vertebrate Organization.	
XII. THE TRANSITION FROM WATER TO AIR . . . . .	255
The Amphibia. Rana, its structure and development.	
XIII. CLOSER ADAPTATION TO A TERRESTRIAL LIFE . . . . .	302
The Mammalia. Introduction. Anatomy of <i>Lepus</i> . Classification of Mammals. Peculiarities of <i>Homo sapiens</i> .	
XIV. THE RACIAL HISTORY OF THE MAMMALS . . . . .	366
The Primitive Amphibia and Reptilia. The Mammal-like Reptiles. Phylogeny and Ontogeny.	
XV. INDIVIDUAL DEVELOPMENT . . . . .	383
Development of the Fowl and Rabbit.	
XVI. COMPARATIVE PHYSIOLOGY . . . . .	456
The Vital Functions Reconsidered. Contractility and Irritability. Proprioceptive Receptors. Chemical Co-ordination. Nutrition. Saprophytes. The physiology of Digestion in the higher animals. Respiration. Aerobic and anaerobic. Respiratory contrivances. Excretion.	
XVII. THEORETICAL BIOLOGY AND THE METHOD OF SCIENCE . . . . .	472
The nature of scientific theories. Biological theories. Genetics. Evolutionary theories. Psychological theory and the biological sciences.	
BIBLIOGRAPHY . . . . .	495
INDEX AND GLOSSARY . . . . .	497

## LIST OF ILLUSTRATIONS

FIG.		PAGE
1.	Diagrams illustrating various ways in which muscles are employed in animals . . . . .	10
2.	Scheme of the circulation of materials in the animal body . . . . .	19
3.	Columnar epithelium lining the intestine of a Monkey . . . . .	24
4.	Cubical epithelium forming the wall of a tubule . . . . .	25
5.	Ciliated epithelium from the lining of the Frog's mouth . . . . .	26
6.	Pavement epithelium from the lining of the body cavity of a Frog . . . . .	27
7.	Longitudinal section of a small artery . . . . .	28
8.	Stratified epithelium covering the tongue of a Dog . . . . .	29
9.	Transitional epithelium lining the moderately distended bladder of a Cat . . . . .	30
10.	Transitional epithelium lining the contracted bladder of a Dog . . . . .	30
11.	Thin film of subcutaneous areolar tissue . . . . .	32
12.	Longitudinal section of tendon . . . . .	33
13.	Stained section of cartilage . . . . .	34
14.	Ground section of bone . . . . .	35
15.	Fat cells in section from the human scalp . . . . .	36
16.	A few stretched unstriated muscle fibres from the urinary bladder of the Frog . . . . .	37
17.	Group of unstriated muscle fibres in transverse section . . . . .	38
18.	Striated muscle fibres in longitudinal section of a skeletal muscle . . . . .	39
19.	Diagram of a single myofibril very highly magnified . . . . .	40
20.	Striated muscle in transverse section . . . . .	41
21.	Cardiac muscle fibres in a longitudinal section of the wall of the human heart . . . . .	41
22.	Cardiac muscle fibres in the wall of the human heart in transverse section . . . . .	42
23.	Large motor nerve cell from the spinal cord of a Cat . . . . .	43
24.	Two fibres from a small muscle in the foot of a Rat, prepared to show the mode of termination of motor fibres in Muscle . . . . .	44
25.	Bipolar nerve cells from a ganglion in the ear of a Mouse . . . . .	45
26.	Unipolar nerve cell from a spinal ganglion of a Cat . . . . .	45
27.	Two medullated nerve fibres . . . . .	46
28.	Blood cells . . . . .	48
29.	Cells of a Newt showing stages of mitotic division . . . . .	54
30.	Diagram illustrating the reversal of phases . . . . .	58
31.	Drawings of cells prepared to show their cytoplasmic structures . . . . .	59
32.	<i>Amoeba proteus</i> . . . . .	62
33.	Method by which a floating <i>Amoeba</i> passes to a solid . . . . .	63
34.	Semi-diagrammatic drawing of the structure of <i>Paramoecium caudatum</i> . . . . .	67
35.	Spiral path of <i>Paramoecium</i> . . . . .	68
36.	Diagram of the avoiding reaction of <i>Paramoecium</i> . . . . .	69

FIG.	PAGE
37. <i>Euglena</i> . . . . .	70
38. Diagrams of the stages of conjugation in <i>Paramoecium</i> . . . . .	73
39. Scheme of the life-cycle of the benign tertian malaria parasite ( <i>Plasmodium vivax</i> ). . . . .	76
40. Stages in the life-cycles of <i>Plasmodium vivax</i> and <i>Plasmodium falciparum</i> . . . . .	77
41. Schematic longitudinal section of female <i>Anopheles maculipennis</i> . . . . .	79
42. Life-cycle of <i>Monocystis</i> . . . . .	80
43. Some details of the life-cycle of <i>Monocystis</i> . . . . .	81
44. A diagrammatic longitudinal section of <i>Hydra</i> magnified . . . . .	89
45. A transverse section of <i>Hydra</i> stained and seen under a low power of the microscope . . . . .	90
46. Diagrams illustrating the histology of <i>Hydra</i> . . . . .	91
47. Development of <i>Hydra</i> . . . . .	96
48. Diagrammatic section of a Medusa . . . . .	99
49. Diagram of a simple balancing organ . . . . .	101
50. Diagrams illustrating primitive conditions of the nervous system . . . . .	103
51. Generalized diagram of a free-living Flat-worm, from the dorsal surface . . . . .	105
52. Diagrammatic transverse section through a free-living Flat-worm . . . . .	106
53. Diagrams illustrating the excretory system of a Flat-worm . . . . .	108
54. Diagram of the life-cycle of <i>Distomum</i> . . . . .	112
55. Stages in the life-cycle of <i>Taenia solium</i> . . . . .	114
56. Diagram illustrating the position of the genitalia in a proglottis of <i>Taenia</i> . . . . .	115
57. Hook-worm egg in four-cell stage . . . . .	118
58. Hook-worm hatching in human faeces . . . . .	119
59. <i>Entamoeba histolytica</i> . . . . .	120
60. <i>Trypanosoma gambiense</i> . . . . .	121
61. Adult and larval forms of <i>Culex</i> and <i>Anopheles</i> . . . . .	122
62. Diagram of the Coelomate ground-plan . . . . .	125
63. Transverse section of an Earthworm behind the clitellum . . . . .	127
64. Drawing of the nephrostome of the Earthworm . . . . .	129
65. Diagram of the nephridium of an Earthworm . . . . .	130
66. Outline drawing of the isolated anterior end of the nervous system of the Earthworm . . . . .	131
67. Diagram illustrating the type of connexions of the nerve fibres met with in the nervous system of the Earthworm . . . . .	133
68. Diagram illustrating the circulation of the Earthworm . . . . .	135
69. Portion of the ovary of an Earthworm in section . . . . .	136
70. Stages in the formation of the spermatozoa in the vesicula seminalis of the Earthworm . . . . .	137
71. Longitudinal section of an Earthworm in the genital region . . . . .	138
72. The trochophore larva of a marine Annelid viewed from the left side . . . . .	140
73. Later stage in the development of the trochophore, in which the development of the segmented trunk is in progress . . . . .	141
74. Section of the insect integument . . . . .	148

FIG.	PAGE
75. Diagram to illustrate the segmentation of the insect body . . .	149
76. Drawing of a longitudinal section of <i>Periplaneta americana</i> . . .	151
77. Drawing of a transverse section of <i>Periplaneta americana</i> . . .	152
78. Longitudinal section through the junction of gizzard and mid gut of <i>Periplaneta americana</i> . . . . .	157
79. Transverse section of a Malpighian tubule with some cells of the haemolymph from <i>Periplaneta americana</i> . . . . .	158
80. Diagram of an ommatidium . . . . .	162
81. Drawings illustrating the histology of the reproductive organs of <i>Periplaneta americana</i> . . . . .	164
82. Stages in the development of an insect . . . . .	165
83. Transverse sections of an insect embryo at successive stages of development . . . . .	167
84. <i>Amphioxus</i> viewed from the left side . . . . .	170
85. Anterior end of <i>Amphioxus</i> cut in half longitudinally and viewed from the median aspect . . . . .	171
86. Diagram of the circulation in <i>Amphioxus</i> . . . . .	173
87. Anterior portion of spinal cord of <i>Amphioxus</i> . . . . .	174
88. The nerves of the anterior end of <i>Amphioxus</i> from the left side . . .	175
89. Diagrams illustrating the process of cleavage of the egg of <i>Amphioxus</i> . . . . .	178
90. Stages in the gastrulation of <i>Amphioxus</i> . . . . .	179
91. Later stages in the development of <i>Amphioxus</i> . . . . .	181
92. Transverse section of a young larva of <i>Amphioxus</i> , through the region of the first gill-cleft . . . . .	183
93. Diagrams illustrating the ground-plan of chordate organization . . .	186
94. Development of dermal denticles . . . . .	195
95. Mesenchyme from a thin section of an embryo . . . . .	196
96. Condensed mesenchyme in an early stage of chondrification . . . . .	196
97. Median aspect of the right half of the bisected anterior end of the larger spotted Dogfish ( <i>Scyllium catulus</i> ) . . . . .	198
98. Portion of the vertebral column of <i>Scyllium</i> from the left side . . .	199
99. Transverse section of a Dogfish embryo . . . . .	201
100. Transverse section through the trunk region of an advanced embryo of the Dogfish . . . . .	202
101. Development of the skull of the Dogfish . . . . .	203
102. Diagram illustrating the embryonic arrangement of the cartilages of the visceral arches in the anterior end of a Fish embryo . . . . .	204
103. Diagrams illustrating the arrangement of the cartilages in a visceral arch . . . . .	205
104. Anterior face of a gross section through the head of a Dogfish . . .	206
105. Anterior face of a gross section through a Dogfish in the region of the sinus venosus . . . . .	207
106. Posterior face of a section immediately in front of that shown in Fig. 105 . . . . .	208
107. Drawings of the fin skeleton of the Dogfish . . . . .	209
108. Gross transverse section through the head of a Dogfish ; posterior face of section drawn in Fig. 104 . . . . .	211
109. Section across a gill-bearing visceral arch of the Dogfish . . . . .	212

FIG.	PAGE
110. Transverse section through the trunk region of an adult Dogfish, near the anterior end of the liver . . . . .	214
111. Diagram of the paired venous spaces of the Dogfish from the left side . . . . .	215
112. Anterior face of section drawn in Fig. 106 . . . . .	217
113. Diagram of the unpaired dorsal and ventral vessels of the Dogfish . . . . .	218
114. Diagram of the primitive aortic arches from the left side . . . . .	220
115. Diagram showing the primitive condition of the gill-arch in the embryos of the lower Craniata . . . . .	223
116. Diagram of the mesodermal somites in the anterior region of a Gnathostome . . . . .	224
117. Eye muscles of a Dogfish . . . . .	225
118. Transverse section of the spinal cord of a Dogfish . . . . .	226
119. Diagram showing the mode of development of the neural tube in Craniates . . . . .	227
120. Diagrams illustrating the primary subdivisions undergone by the brain in development . . . . .	228
121. Transverse section through the medulla of the Dogfish's brain . . . . .	229
122. Transverse section passing through the optic lobes of the Dogfish's brain . . . . .	231
123. Median longitudinal section through the brain of a Dogfish . . . . .	232
124. Diagram of the segmentation of the anterior region of a Gnathostome . . . . .	234
125. Diagram of the olfactory apparatus . . . . .	235
126. Diagrams illustrating the structure of the Vertebrate Eye . . . . .	238
127. Diagrams illustrating the development of the eye . . . . .	239
128. Diagram of a simple nerve termination for the reception of tactile impulses . . . . .	240
129. An ampulla from the snout of a Dogfish . . . . .	242
130. Diagrams illustrating the structure of the membranous labyrinth . . . . .	243
131. Diagram of the components of the cranial nerves of the Fish . . . . .	246
132. Diagram of the urinary and genital ducts in Craniates . . . . .	250
133. Diagrams of the kidney tubules in the Craniata in transverse section . . . . .	251
134. High-power drawing of a section of the Frog's skin . . . . .	259
135. Low-power drawing of a section of the Frog's skin to show the two kinds of glands . . . . .	260
136. Mesenchyme in a more advanced stage than that in Fig. 95 . . . . .	261
137. Developing membrane bone in section . . . . .	262
138. Cartilage from the finger of a Kitten which is already to a great extent ossified . . . . .	263
139. Dorsal view of the chondrocranium of <i>Rana esculenta</i> . . . . .	264
140. Cartilaginous skull of <i>Rana esculenta</i> viewed from below . . . . .	265
141. Diagram of the generalized Pentadactyle Limb and Limb Girdle . . . . .	267
142. Median vertical longitudinal section of an entire young Frog . . . . .	270
143. Portion of the wall of the Frog's stomach in transverse section . . . . .	271
144. Vertical section of the mucous membrane lining the stomach of a Frog . . . . .	273
145. Section of a tubulo-alveolar gland . . . . .	274

FIG.	PAGE
146. Transverse section through the lung of the Frog . . . . .	275
147. Diagrams illustrating the development of the arterial arches in the Frog . . . . .	279
148. Transverse section through the trunk region of a young Frog, near its posterior end, through the ninth vertebra . . . . .	282
149. Diagram of the sympathetic chain in the Frog . . . . .	283
150. Semi-diagrammatic drawing of a transverse section of the Frog's Head to show the Auditory Apparatus . . . . .	285
151. Transverse section of a young Tadpole . . . . .	286
152. Transverse section of an advanced Tadpole . . . . .	287
153. Diagram of a section through a fully grown oöcyte of the Frog . . . . .	289
154. Ripe spermatozoon of the Toad . . . . .	289
155. Diagram to illustrate the phases of maturation of the germ cells . . . . .	290
156. Maturation divisions in the female Axolotl . . . . .	292
157. Stages in the fertilization of the egg of the Axolotl . . . . .	295
158. Diagrams showing the formation and closure of the blastopore in the egg of the Frog . . . . .	297
159. Sagittal sections through the Frog's egg during the stages shown in Fig. 158 . . . . .	298
160. Transverse sections through the Frog's egg to show the mode of formation of the notochord and mesoderm . . . . .	300
161. Part of a section of the lung of a Rabbit . . . . .	303
162. Vertical section of the skin of the human scalp . . . . .	307
163. A single lobule of the inactive mammary gland of the Rabbit . . . . .	308
164. Bones of the Rabbit's skull disarticulated . . . . .	311
165. Left half of a Rabbit's head cut in half longitudinally in the sagittal plane . . . . .	312
166. Drawings of the right periotic and tympanic bones of the Rabbit's skull . . . . .	315
167. Sections through teeth at various stages of development . . . . .	317
168. Ground section of human Incisor Tooth . . . . .	318
169. Left half of the larynx of a Goat cut in halves longitudinally . . . . .	323
170. Transverse section through the thorax of an advanced embryo of the Cat . . . . .	325
171. Diagram of the primitive arrangement of the aortic arches in mammals . . . . .	329
172. Diagram showing the derivation of the adult arteries in mammals . . . . .	329
173. Drawing of the ventral surface of a Goat's brain . . . . .	331
174. Dorsal view of a Dog's brain . . . . .	334
175. Transverse section through the brain of an advanced embryo of the Mouse . . . . .	335
176. Drawing of the median surface of the left half of a young Goat's brain cut into two in the sagittal plane . . . . .	336
177. Median sagittal section of the brain of an advanced embryo of the Mouse . . . . .	337
178. High-power drawing of small piece of the human cerebral cortex . . . . .	340
179. Diagram illustrating some of the connexions of somatic sensory nerve fibres in the Fish's brain . . . . .	342
180. Diagram showing some of the connexions of the mammalian brain . . . . .	343

FIG.	PAGE
181. Transverse section of the spinal cord of a Rabbit, with its ganglion and nerve shown on one side . . . . .	348
182. Diagrammatic interpretation of Fig. 181 showing the connexions of the components of a spinal nerve, with sympathetic nerves added . . . . .	349
183. Diagram of the auditory organ of the Rabbit . . . . .	351
184. Drawing of a model of the membranous labyrinth of the human ear . . . . .	352
185. Diagram of the cochlea of a Guinea Pig . . . . .	353
186. Diagram of a kidney tubule . . . . .	355
187. Portion of a section of the ovary of a Cat . . . . .	357
188. Section of the uterus of a young Dog . . . . .	358
189. High-power drawing of a small portion of a salivary gland of the Cat . . . . .	361
190. Ventral view of the pectoral girdle and sternum of the Duck-bill ( <i>Ornithorhynchus</i> ) . . . . .	363
191. Dorsal and palatal views of the skull of <i>Loxomma</i> . . . . .	370
192. Stages in the evolution of the lower jaw in the mammalian direction . . . . .	371
193. Tarsus and carpus of early terrestrial vertebrates . . . . .	372
194. Dorsal and palatal views of the skull of <i>Seymouria</i> . . . . .	374
195. Dorsal, palatal, and side views of the skull of <i>Varanosaurus</i> . . . . .	375
196. Dorsal and palatal aspects of the skull of <i>Gorgonops</i> . . . . .	377
197. Dorsal and palatal aspects of the skull of <i>Thrinaxodon</i> . . . . .	379
198. Dorsal and palatal views of the skull of <i>Dasyurus</i> . . . . .	379
199. Some primitive limb girdles . . . . .	380
200. Inner aspect of the lower jaw of <i>Diademodon</i> and of a mammalian embryo . . . . .	381
201. Two stages in the segmentation of the Fowl's egg . . . . .	385
202. Two sections of the edge of the blastoderm of the Fowl's egg . . . . .	387
203. Diagram of a Fowl's egg bisected longitudinally . . . . .	388
204. Drawing of the blastoderm of the Fowl's egg at the primitive streak stage . . . . .	388
205. Sections of the blastoderm of the Fowl, through the primitive streak . . . . .	389
206. Drawing of the blastoderm of the Fowl's egg after the appearance of the notochordal process . . . . .	390
207. Longitudinal sections of the blastoderm of the Fowl in the middle line, showing the development of the primitive streak and notochordal process . . . . .	392
208. Drawing of the central portion of the blastoderm of a Fowl's egg showing the beginning of the head fold . . . . .	394
209. Drawing of the anterior end of an embryo of the Fowl, with three to four somites . . . . .	395
210. Three transverse sections through an embryo of the same stage as that in Fig. 209 . . . . .	396
211. Drawing of the anterior end of an embryo of the Fowl with five somites . . . . .	397
212. Drawing of an embryo of the Fowl with seven somites . . . . .	398

FIG.	PAGE
213. Section AB through an embryo of seven somites . . . . .	399
214. Section CD through an embryo of seven somites . . . . .	400
215. Sections through the vascular area of the Fowl's blastoderm, showing two stages in the formation of a blood-vessel . . . . .	402
216. Section EF through an embryo of seven somites . . . . .	403
217. Section GH through an embryo of seven somites . . . . .	403
218. Longitudinal section through the anterior end of an embryo with eight somites . . . . .	404
219. Drawing of the anterior end of a blastoderm of the Fowl with eleven somites . . . . .	405
220. Section AB through an embryo with ten somites . . . . .	406
221. Section CD through an embryo with ten somites . . . . .	406
222. High-power drawing of a section through an embryo with thirteen somites in the region of the trunk . . . . .	407
223. Drawing of a Fowl embryo with fifteen somites . . . . .	408
224. Transverse section through the primary optic vesicles of an embryo with fifteen somites . . . . .	409
225. Section through embryo with fifteen somites at level CD (Fig. 223)	410
226. Section through the level EF (Fig. 223) of an embryo with seventeen somites . . . . .	411
227. Diagrammatic longitudinal section through the anterior end of an embryo of about the same age as that in Fig. 223 . . . . .	411
228. Drawing of an embryo of the Fowl with twenty-seven somites . .	413
229. Sections through the head of an embryo with twenty-seven somites . . . . .	415
230. Sections through the heart region of an embryo with twenty-seven somites . . . . .	417
231. Sections through the posterior heart region of an embryo with twenty-seven somites . . . . .	419
232. Section through the anterior intestinal portal (G. 1), and through the liver diverticula (G. 2) of an embryo with twenty-seven somites . . . . .	420
233. Diagram to illustrate the arrangement of the liver diverticula on their first appearance in the Fowl . . . . .	421
234. Section through the trunk region of a twenty-seven somite embryo	422
235. Section through the posterior end of the blastoderm of an embryo with twenty-seven somites . . . . .	422
236. Drawing of Fowl embryo with thirty somites . . . . .	423
237. Median longitudinal section through the head of a Fowl embryo with about thirty somites . . . . .	425
238. Longitudinal section, through the same embryo as that drawn in Fig. 237, to the left of the middle line . . . . .	427
239. Section through hind brain at the level of the otic vesicles and through the spinal cord of an embryo of thirty-four somites . .	429
240. Section through pharynx of an embryo with thirty-four somites .	429
241. Section through ductus venosus and mid brain . . . . .	430
242. Section through optic cups and posterior liver diverticulum of a thirty-four somite embryo . . . . .	431
243. Section through olfactory pit and trunk . . . . .	431



FIG.	PAGE
244. Section through trunk at level of vitelline arteries . . . . .	432
245. High-power drawing of a portion of a transverse section of a Fowl embryo with thirty somites at the same level as Fig. 244 . . . . .	433
246. Drawing of a model of the pharynx of a three-day Fowl embryo, from the ventral aspect . . . . .	434
247. Section through hind gut of an embryo with thirty-four somites . . . . .	436
248. Diagrams showing the formation of the amnion, chorion, yolk-sac, and allantois in the embryo of the Fowl . . . . .	437
249. Diagram of the fully formed foetal membranes of the Fowl . . . . .	438
250. Oöcyte of the Ferret in the telophase of the first maturation division . . . . .	440
251. Stages in the early development of the Rabbit . . . . .	441
252. Stages in the early development of the Rabbit . . . . .	443
253. Section through the wall of the uterus of a pregnant Rabbit showing the beginning of the attachment of the trophoblast . . . . .	444
254. High-power drawing of Fig. 253 through the place of attachment of the trophoblast . . . . .	445
255. Diagram showing two later stages in the development of the placenta . . . . .	446
256. Diagrams illustrating two stages in the formation of the foetal membranes in the Rabbit . . . . .	447
257. Diagram of the fully formed foetal membranes of the Rabbit . . . . .	449
258. An early stage in the development of the human ovum . . . . .	451
259. Two diagrams illustrating the development of the genital and associated ducts in the human embryo . . . . .	452
260. Drawing of the hinder region of an advanced Cat embryo showing the development of the urinary and genital ducts of one side . . . . .	453
261. Arrangement of the cranial nerves in the human embryo . . . . .	454
262. Drawing of a sagittal section of the pituitary body of a Cat . . . . .	459
263. Part of the wall of the small intestine of the Cat, showing the intestinal villi . . . . .	467
264. Section of the cortex of a Cat's kidney injected through the renal artery . . . . .	471
265. Diagrams of the Mendelian ratio . . . . .	481
266. Chromosomes of <i>Drosophila ampelophila</i> in an ordinary mitotic division . . . . .	482
267. Cross between a white-eyed male of <i>D. ampelophila</i> and a red-eyed female . . . . .	484
268. Cross between a red-eyed male and a white-eyed female . . . . .	485
269. Diagram illustrating the inheritance of colour-blindness in man . . . . .	486