

A Text Book of
Embryology

Dr., Capt. N. Arumugam, M.Sc.,M.Phil.,Ph.D.,FZI,FIAES
Gold Medalist, Zoological Society of India,
Fellow, Indian Academy of Environmental Sciences,
Fellow, Zoological Society of India,
Principal and Head(Rtd.), Dept. of Zoology, Vivekananda College,
Agasteeswaram, Kanyakumari Dist - 629 701.

SARAS PUBLICATION

114/35G A.R.P. Camp Road, Periyavilai,
Kottar P.O., NAGERCOIL
Kanyakumari Dist. - 629 002. Tamil Nadu

Website : www.saraspublication.com

E-mail: info@saraspublication.com

Telephone : 04652 - 265026

Cell : 098421 23441

Fax : 04652 265099

A Text Book of Embryology

Copy right Publisher

Published by Saras Publication, Nagercoil

First Edition : 1974; Fourteenth Edition : 2010, Reprint : 2013; 15th Edition : 2014,
Reprint : 2015.

All rights reserved.

No part of this book may be reproduced in any form, by photostat, microfilm, xerography or any other means, or incorporated into any information retrieval system, electronic or mechanical, without the written permission of the copyright owner.

ISBN : 978-93-82459-76-7

Price : Rs. 390 /-

Pages : 504

Published by

SARAS PUBLICATION

114/35G,A.R.P. Camp Road, Periavilai,

Kottar P.O., Nagercoil,

Kanyakumari Dist -629 002.

Telephone : 04652 265026

Fax : 04652 265099

Cell phone : 09842123441

Visit us : Website: www.saraspublication.com

Contact us : E-mail: info@saraspublication.com

Preface

A student who has just entered the portals of colleges finds it difficult to understand the subjects taught to him. This difficulty is mainly due to his poor standard of English. While preparing this Book the authors had in mind this particular difficulty of our students. This Book is written in a very simple and easy style. It is up-to-date and exhaustive in covering the syllabus.

We are immensely thankful to the authors for their kind co-operation in preparing the Book. We are immensely thankful to Saras Printers and Binders, Sivakasi for neatly printing the book. Suggestions for the improvement of the book are always welcome.

-Publisher

Why to Buy this Book

- *This Book is written solely for Examination going Students.*
- *Examination oriented.*
- *Easy to Answer the Questions.*
- *Very Simple.*
- *Point by point description.*
- *Points are arranged sequentially.*
- *Hence easy to remember.*
- *High matter content.*
- *Neat Diagrams.*
- *Helps in Practical Examination.*
- *Helps in writing Observation Note Book.*
- *Helps in preparing Competitive Exams.*
- *Important topics are given as Highlights.*

**Every Life Science Student Must
Buy and Keep One Copy of this
Book**

Contents

1. Introduction		1 - 8
<i>The Programme of Development</i>	1	<i>Branches of Embryology</i> 7
<i>Historical Thoughts and Concepts</i>		<i>Scope of Embryology</i> 8
<i>Aristotle</i>	3	
2. Gametogenesis		9 - 20
<i>Primordial Germ Cells</i>	9	<i>Oogenesis</i> 14
<i>The Origin of Primordial Germ</i>		<i>Hormonal Control of Oogenesis</i> 18
<i>Cells in Different Chordates</i>	9	<i>Polar Bodies</i> 20
<i>Spermatogenesis</i>	10	
3. Spermatozoon		21 - 24
<i>Structure of Sperm</i>	21	<i>Functions of Sperm</i> 24
4. Egg		25 - 34
<i>Egg Membranes</i>	25	<i>Polarity</i> 33
<i>Patterns of Eggs</i>	29	<i>Origin of Polarity</i> 34
<i>Organization of Egg</i>	31	
5. Ovulation and Semination		35 - 40
<i>Ovulation</i>	35	<i>Induced Ovulation in Fisheries</i> 38
<i>Factors Affecting Ovulation</i>	37	<i>Semination</i> 39
6. Fertilization		41 - 52
<i>Physical Factors Involved in</i>		<i>Fertilization</i> 45
<i>Fertilization</i>	41	<i>Physiological Changes in</i>
<i>Chemical Factors Involved in</i>		<i>Fertilization</i> 50
<i>Fertilization</i>	43	<i>Activation</i> 51
<i>Cytological Factors Involved in</i>		
7. Parthenogenesis		53 - 58
<i>Natural Parthenogenesis</i>	53	<i>Significance of Parthenogenesis</i> 56
<i>Artificial Parthenogenesis</i>	56	
8. Cleavage		59 - 74
<i>Salient Features of Cleavage</i>	59	<i>Cytoplasm of Cleaving Cells</i> 70
<i>Planes of Cleavage</i>	61	<i>Molecular Changes During</i>
<i>Patterns of Cleavage</i>	62	<i>Cleavage</i> 73
<i>Factors Affecting Cleavage</i>	67	

9. Gastrulation		75 - 78
<i>Salient Features of Gastrulation</i>	75	<i>Exogastrulation</i> 77
<i>Gastrula</i>	75	
10. Fate Map		79 - 82
<i>Construction of Fate Map</i>	79	<i>Fate Map of Chordates</i> 82
11. Morphogenetic Movements		83 - 86
<i>Epiboly</i>	83	<i>Mechanism of Morphogenetic</i>
<i>Emboly</i>	83	<i>Movements</i> 85
12. Cell Lineage		87 - 92
<i>Using Vital Stains</i>	87	<i>Naming the Blastomeres</i> 89
<i>Natural Markings</i>	88	
13. Development of Ascidian		93 - 100
<i>Ascidian Tadpole</i>	97	<i>Retrogressive Metamorphosis</i> 99
14. Development of Amphioxus		101 - 116
<i>Blastopore</i>	108	<i>Larval development</i> 115
<i>Neurogenesis</i>	110	<i>Metamorphosis</i> 116
<i>Notogenesis</i>	111	
15. Development of Frog		117 - 140
<i>Grey Crescent</i>	120	<i>Neurogenesis</i> 130
<i>Cleavage</i>	120	<i>Notogenesis</i> 131
<i>Blastulation</i>	121	<i>Tadpole Larva</i> 135
<i>Events in Gastrulation</i>	125	<i>Gill Stage</i> 136
16. Organogenesis of Frog		141 - 172
<i>Tubulation</i>	141	<i>Development of Kidney</i> 164
<i>Development of Brain</i>	143	<i>Development of Reproductive</i>
<i>Development of Eye</i>	147	<i>System</i> 167
<i>Development of Ear</i>	151	<i>Development of Digestive</i>
<i>Development of Heart</i>	154	<i>System</i> 168
<i>Development of Blood vessels</i>	157	<i>Development of Gills</i> 170
<i>Development of Limbs</i>	161	
17. Development of Chick		173 - 192
<i>Fertilization</i>	175	<i>Blastula</i> 178
<i>Cleavage</i>	175	<i>Events in Gastrulation</i> 180
18. Development of Chick Based on Hours of Incubation		193 - 208
<i>Incubation</i>	193	<i>Types of Incubation</i> 193
19. Development of Mammal		209 - 220

VII

<i>Morula</i>	213	<i>Implantation</i>	214
<i>Blastocyst</i>	213		
20. Organogenesis of Chick and Mammals		221 - 244	
<i>Development of Central Nervous System</i>	221	<i>Development of Heart</i>	231
<i>Development of Eye</i>	226	<i>Development of Kidney</i>	234
<i>Development of Ear</i>	228	<i>Development of Limbs</i>	242
21. Development of Foetal Membranes in Chick		245 - 248	
<i>Chorion</i>	245	<i>Allantois</i>	247
<i>Amnion</i>	246	<i>Sero-Amniotic Raphe</i>	248
<i>Yolk Sac</i>	247	<i>Umbilical Cord</i>	248
22. Development of Foetal Membranes in Mammals		249 - 254	
<i>Chorion</i>	249	<i>Allantois</i>	252
<i>Amnion</i>	250	<i>Sero-Amniotic Raphe</i>	253
<i>Yolk Sac</i>	251	<i>Umbilical Cord</i>	253
23. Placenta		255 - 266	
<i>Characteristics of Placenta Based on the Type of Foetal Membranes</i>	255	<i>Based on the Nature of Contact</i>	259
<i>Based on the Distribution of Villi</i>	257	<i>Based on the Type of Tissues</i>	260
		<i>Development of Placenta</i>	263
24. Sexual Cycles		267 - 276	
<i>Oestrous Cycle</i>	267	<i>Pregnancy</i>	271
<i>Puberty</i>	268	<i>Parturition or Birth</i>	272
<i>Spermiation</i>	268	<i>Hormonal Control of Reproductive Cycles</i>	273
<i>Ovulation</i>	268		
<i>Menstrual Cycle</i>	269		
25. Pregnancy and Birth		277 - 280	
<i>Pregnancy</i>	277	<i>Parturition</i>	278
26. Neoteny		281 - 288	
<i>Neotonous Chordates</i>	281	<i>Evolutionary Significance of Neoteny</i>	286
<i>Types of Neoteny</i>	284		
<i>Factors Causing Neoteny</i>	285		
27. Gradient Theory		289 - 294	
<i>Types of Gradient Theories</i>	289	<i>Factors Affecting Gradients</i>	293
<i>Experimental Evidences</i>	290	<i>Mechanism of Gradient System</i>	294
28. Morphogenetic Fields		295 - 296	
<i>Characteristics of Morphogenetic Field</i>			295

VIII

29. Organizer		297 - 300
<i>Organizer in Amphibian Embryo</i>	297	<i>Neural Induction</i> 299
<i>Experiment</i>	297	<i>Chain of Inductions</i> 299
<i>Properties of Organizer</i>	298	<i>Chemical Nature of Induction</i> 299
<i>Structure of Organizer</i>	298	<i>Reciprocal Induction</i> 299
<i>Embryonic Induction</i>	299	<i>Mechanism of Induction</i> 300
30. Nuclear Transplantation		301 - 308
<i>Types of Transplantation</i>	301	<i>Serial Transplantation Experiment</i>
<i>Transplantation Technique</i>	301	<i>with Gastrula Nuclei</i> 305
<i>Serial Transplantation Experiments</i>		<i>Transplantation of Nuclei from</i>
<i>with Blastula Nuclei</i>	303	<i>Adults</i> 306
<i>Transplantation of Gastrula and</i>		<i>Nuclear Transplantation in</i>
<i>Neurula-nucleus</i>	304	<i>Acetabularia</i> 306
31. Nucleocytoplasmic Interaction		309 - 314
<i>Action of Cytoplasm on Nucleus</i>	306	<i>Protein Synthesis</i> 313
32. Differentiation		315 - 322
<i>Processes Involved During</i>		<i>Dedifferentiation</i> 321
<i>Differentiation</i>	316	<i>Metaplasia</i> 321
<i>Factors Causing Differentiation</i>	316	<i>Transdifferentiation</i> 321
33. Metamorphosis in Amphibia		323 - 330
<i>Ecological Changes</i>	323	<i>Changes</i> 325
<i>Morphological Changes</i>	323	<i>Thyroxine</i> 326
<i>Physiological and Biochemical</i>		<i>Sensitivity of Tissues</i> 328
34. Insect Metamorphosis		331 - 338
<i>Neurosecretion in Insects</i>	336	
35. Regeneration		339 - 350
<i>Laws of Regeneration</i>	339	<i>Regeneration</i> 346
<i>Survey of Capacity for</i>		<i>Regeneration Field</i> 347
<i>Regeneration in Animals</i>	339	<i>Inductive Interactions in</i>
<i>Types of Regeneration</i>	341	<i>Regeneration</i> 347
<i>Events in Regeneration</i>	342	<i>Wolffian Regeneration</i> 347
<i>Blastema</i>	343	<i>Axial Gradients and Polarity</i> 348
<i>Factors Influencing Regeneration</i>	344	<i>Regeneration and Embryology</i> 349
<i>Physiological Changes Involved in</i>		
36. Asexual Reproduction		351 - 356
<i>Fragmentation</i>	351	<i>Gemmule Formation</i> 353
<i>Fission</i>	351	<i>Cells involved in Asexual</i>
<i>Budding</i>	353	<i>Reproduction</i> 354

37. Birth Control		357 - 366
<i>Necessity for Birth Control</i>	357	
<i>Contraceptive Devices</i>	357	
		<i>Hormonal Method of Birth Control</i> 361
38. Infertility		367 - 370
<i>Types of Infertility</i>	367	
<i>Causes of Infertility</i>	367	
<i>Artificial Insemination</i>	368	
		<i>Necessity for Artificial Insemination</i> 369
39. Test Tube Baby		371 - 374
<i>Procedure</i>	372	
		<i>Laparoscope</i> 373
40. Rh Factor		375 - 378
<i>Erythroblastosis foetalis</i>	376	
		<i>Prevention of Haemolytic Disease</i> 376
41. Congenital Anomalies		379 - 382
<i>Inborn Errors</i>	379	
<i>Congenital Spherocytosis</i>	380	
<i>Milroy's Disease</i>	380	
		<i>Dystopia</i> 380
		<i>Congenital Polycystic Kidney</i> 380
		<i>Hypertrophic Pyloric Stenosis</i> 380
42. Cancer		383 - 396
<i>Characteristics of Cancer</i>	383	
<i>Properties of Cancer Cells</i>	384	
<i>Tumour Progression</i>	386	
		<i>Origin of Cancer</i> 389
		Highlights - Cancer Treatment 395
43. Aging		397 - 400
<i>Changes Occurring during Aging</i>	397	
<i>Causes of Aging</i>	397	
		<i>Apoptosis</i> 398
44. Invitro Fertilization		401 - 402
<i>IVF in Human Beings</i>	401	
		<i>Invitro Fertilization in Farm Animals</i> 401
45. Embryo Transfer		403 - 406
<i>ET in Farm Animals</i>	403	
		<i>Embryo Transfer in Humans</i> 404
46. Twins		407 - 410
<i>Identical Twins</i>	407	
<i>Fraternal Twins</i>	407	
		<i>Siamese Twins</i> 408
		<i>Importance of Twin Study</i> 410
47. Cloning		411 - 414
<i>Human Cloning</i>	411	
		<i>Embryo Transfer</i> 412
48. Transgenesis		415 - 424
<i>Transgenic Animals and their Uses</i>	415	
<i>Transgenic Mice</i>	415	
		<i>Retroviral Method</i> 415
		<i>Microinjection Method</i> 417
		<i>Embryonic Stem Cells Method</i> 418

<i>Transgenic Cattle</i>	421	<i>Transgenic Poultry</i>	422
<i>Transgenic Sheep</i>	421	<i>Transgenic Rabbits</i>	423
<i>Transgenic Goats</i>	421	<i>Transgenic Mosquitoes</i>	423
<i>Transgenic Pigs</i>	422	<i>Transgenic Fishes</i>	423
49. Amniocentesis			425 - 426
50. Embryo Culture			427 - 432
<i>Whole Embryo Culture</i>	427	<i>Methods of Embryo Culture</i>	428
<i>Organ Culture</i>	428	<i>Culture Medium</i>	430
51. Laboratory Experiments			433 - 446
<i>Observation of Spermatozoa</i>	433	<i>Observation</i>	438
<i>Observation of Egg</i>	433	<i>Observation of Chick Embryo by</i>	
<i>Induced Ovulation in Frog</i>	433	<i>Vital Staining</i>	439
<i>Artificial Fertilization in Frog</i>	434	<i>Temporary Mounting of Chick</i>	
<i>Artificial Parthenogenesis</i>	435	<i>Blastoderm</i>	440
<i>Culture of Tadpoles</i>	435	<i>Permanent Mounting of Chick</i>	
<i>Regeneration of Tail in Tadpoles</i>	435	<i>Blastoderm</i>	440
<i>Effect of Thyroxine and Iodine on</i>		<i>Culture of Chick Embryos in</i>	
<i>Amphibian Metamorphosis</i>	436	<i>Vitro</i>	442
<i>Incubation of Eggs</i>	438	<i>Salines, Stains and Fixatives</i>	444
<i>Removal of Chick Blastoderm and</i>			
52. Museum Specimens			447 - 462
<i>Yolk Sac Placenta of Shark</i>	447	<i>Primitive Streak Stage</i>	454
<i>Sperm of Frog</i>	448	<i>Sixteen Hours Chick Blastoderm</i>	455
<i>Egg of Insect</i>	448	<i>Twenty One Hours</i>	
<i>Egg of Frog</i>	448	<i>Chick Embryo</i>	455
<i>Egg of Hen</i>	449	<i>24 Hours Chick Embryo</i>	456
<i>Frog Two Cell Stage</i>	449	<i>Thirty Three Hours Chick</i>	
<i>Frog 4 - Cell Stage</i>	449	<i>Embryo</i>	456
<i>Frog 8 - Cell Stage</i>	450	<i>Forty Eight Hours Chick</i>	
<i>Blastula of Frog</i>	451	<i>Embryo</i>	457
<i>Gastrula of Frog</i>	451	<i>Seventy Two Hours Chick</i>	
<i>Yolk Plug Stage</i>	451	<i>Embryo</i>	457
<i>Neurula of Frog</i>	452	<i>Ninety Six Hours Chick</i>	
<i>T.S. of a Tadpole through the</i>		<i>Embryo</i>	458
<i>Eye Region</i>	452	<i>Seventy Two Hours Chick</i>	
<i>T.S. of Tadpole through</i>		<i>Embryo-T.S.</i>	
<i>Auditory Region</i>	453	<i>Through Brain and Eye</i>	458
<i>Tadpole Larva with External</i>		<i>Seventy Two Hours Chick</i>	
<i>Gills</i>	453	<i>Embryo- T.S. Through Heart</i>	459
<i>Eight Hours Chick Blastoderm</i>	454	<i>Seventy Two Hours Chick</i>	

<i>Embryo - T.S.Through Kidney</i>	460	<i>Zonary Placenta</i>	461
<i>Cotyledonary Placenta</i>	460	<i>Discoidal Placenta</i>	462
<i>Diffuse Placenta</i>	461		
53. Glossary			463 - 474
54. University Questions			475 - 478
55. Index			479 - 482



