

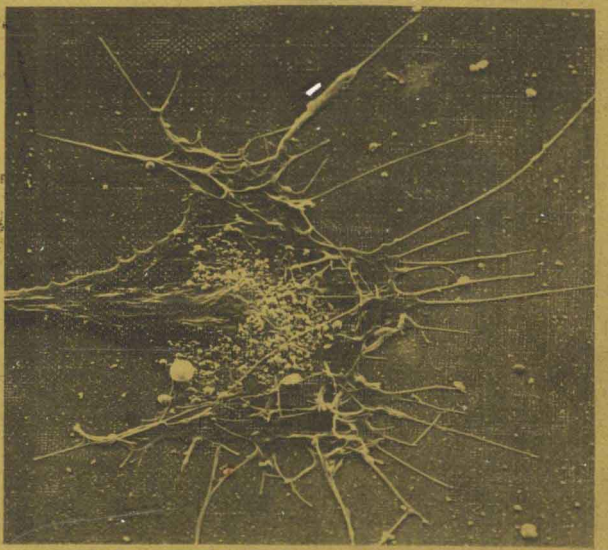
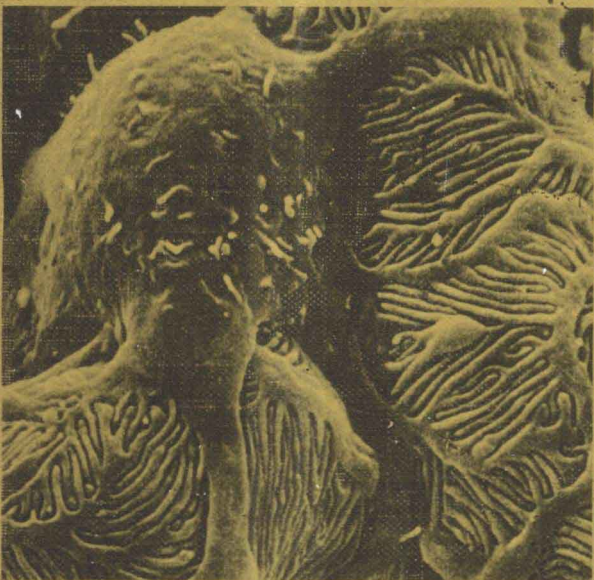
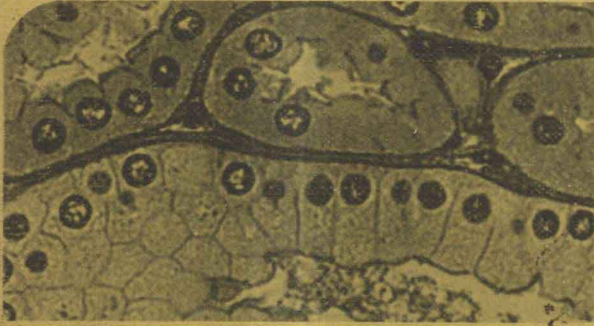
Bailey's Textbook of HISTOLOGY

Wilfred M. Copenhaver, Ph.D.

Douglas E. Kelly, Ph.D.

Richard L. Wood, Ph.D.

SEVENTEENTH
EDITION



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Preface to The Seventeenth Edition

Since the last edition of this textbook was published (1971) there have been marked advances in histology and its related fields as a result of well conceived experimental studies combined with improved techniques. A wealth of new information has been obtained by electron microscopy through improvement in technical methods, such as those for freeze-fracture replication, improvement in instrumentation, and improvement in our interpretive abilities. Results obtained by scanning electron microscopy have also provided a better understanding of structure in three dimensions. As a result, a number of the older electron micrographs used in previous editions of this textbook have been replaced and numerous additional ones that reflect some of the recent advances have been included. Numerous light micrographs of thin (1 to 2 μm) sections of plastic-embedded tissue fixed by vascular transfusion have been added to provide better light microscopic detail and to give better correlation between light and electron microscopy.

In histology, as in other disciplines, new research not only answers some questions but also raises many new questions. In this revision, as in previous ones, we have tried to make the more important points stand out somewhat from the accompanying details. We have tried to present the material in a manner that is most useful

for students and we have provided selected references for those who wish to pursue particular topics in more detail.

At the University of Southern California, we have found it advantageous to teach human embryology in a closely integrated fashion with histology. Students learn the embryonic body plan and emergent organ systems as arenas in which the differentiation of the basic cells and tissues is occurring. They learn the cells and tissues as products of developmental processes and recognize thereby both essential differences and similarities among differentiated cellular populations. In this spirit, we have departed somewhat from the usual histology textbook format to include an expanded chapter on early human development and to include added embryological insight into most discussions of tissues and organs. We hope this will prove helpful to the wide variety of patterns in which courses in microscopic anatomy are taught.

This textbook has been rewritten a number of times since the first six editions by Frederick R. Bailey, M.D., between 1904 and 1926. However, the book still contains passages and illustrations incorporated by many others into subsequent editions. A resumé of these contributions before the 15th edition is given in a part of the 15th edition Preface, which is reprinted on page vii of this edition.

The present edition also contains some text material and a number of illustrations in the chapters on the cell, nervous tissue, and sense organs which were added by Drs. Richard and Mary Bunge, who participated in the 16th edition revision.

A number of illustrations included in this textbook have been obtained from colleagues at other universities and we are grateful for their generosity. Credits for those illustrations are given in the figure legends. We are also grateful to Dr. Mikel Snow for providing the brief text of the section on muscle regeneration, to Mr. Pete Mendez and some of his students,

who provided new drawings, and to technicians, secretaries, and many other colleagues who have contributed immeasurably to the preparation and the content of the book.

Finally, we wish to express our appreciation to the Publishers for their cooperation and assistance in the production of this book and for their patience in awaiting its completion.

WILFRED M. COPENHAVER, PH.D
DOUGLAS E. KELLY, PH.D.
RICHARD L. WOOD, PH.D.

Excerpts from the Fifteenth Edition Preface

A brief resumé of the history of this textbook seems appropriate at this time (1964). The first edition was written by Professor Frederick R. Bailey at the College of Physicians and Surgeons and was published by William Wood and Company in 1904. Professor Bailey, with assistance from Professor Oliver Strong on the nervous system, continued the book through the sixth edition, published in 1920. Although the text has been rewritten by a number of authors since the time of Professor Bailey, it has adhered to his objective of emphasizing fundamentals.

Professors Oliver S. Strong and Adolph Elwyn revised the seventh edition (1925) and a part of the eighth edition (1932). Professors R. L. Carpenter, C. M. Goss, and A. E. Severinghaus participated with Professor Philip E. Smith and myself in completing the eighth edition (1932) and in the subsequent revisions of the ninth and tenth editions. The text retains valuable contributions made by them.

Professor Philip E. Smith served as editor of the ninth and tenth revisions and as coauthor of the eleventh, twelfth, and thirteenth editions. His contributions of

material plus his sound editorial judgment had an important role in whatever success the textbook achieved during editions eight to thirteen inclusive. Professor Dorothy D. Johnson assisted with the thirteenth edition and became coauthor in the fourteenth edition. She made particularly valuable contributions to the chapters on the digestive system, respiratory system, and endocrine glands. It is regretted that unavoidable circumstances prevented Professor Johnson from participating in this edition.

I am indebted to Mr. Robert Demarest for all new drawings for this edition and for those which were added in the previous edition. I am also indebted to Mr. Carl Kellner (now retired) for the drawings which appeared first in editions nine to thirteen inclusive.

Many valuable suggestions have come from my colleagues at Columbia and from those in other schools. I am indebted particularly to Professor Thomas E. Hunt for a number of constructive suggestions.

WILFRED M. COPENHAVER, PH.D.

Introduction

All living organisms consist of minute elements which are called cells. These cells are the smallest structural units possessing those properties which we commonly associate with life. They are able to nourish themselves, to grow, to respond to stimuli, and to reproduce. Some organisms, the protozoa, consist of one cell only; the higher types, metazoa, may consist of infinite numbers of cells varying greatly in structural characteristics. Each of these multicellular organisms starts its existence as a single cell, the fertilized ovum, which by a process of proliferation and differentiation gives rise to the adult body. At first the cells of the developing embryo are similar in shape and structure. As growth continues, differentiation leads to the formation of groups of specialized cells, each group differing in structure from the others, each group adapted to subserve one or more specific functions. These specialized groups form the *tissues* of the adult body. At a very early period the cells of the embryo become separated from each other by the formation of varying amounts of intercellular substance, which may be the result of cellular secretion or actual modifications of cellular substance. In some of the tissues this intercellular material assumes enormous proportions. Thus the adult body is composed of cells and intercellular material, all elements so interrelated as to form a normally functioning machine.

Histology in a restricted sense is the study of the tissues of the body, but because the tissues are composed of cells and their products, a knowledge of the structure and activities of the cell must necessarily form the basis of histology. The first two chapters of the book are therefore given to a discussion of cells in general, the first of these dealing with cells after fixation and the second with living cells. Each of these chapters obviously supplements the other. Succeeding these, the structure of the tissues is presented. This is followed by the microscopic anatomy of the various organs.

Over the years, histologists have tended to categorize the various cells and tissues of the body. They have classified them largely according to apparent differences, somewhat more than according to similarities. Textbooks of histology have tended to emphasize the categorizations, and students often dismiss their study of histology once they have memorized the essential differences that distinguish the categories under scrutiny. Yet we now understand ever more clearly that the similarities and common properties are as important as the differences. Nature has, in fact, not designed separate, distinct categories, but rather has evolved a spectrum of structural and functional possibilities around which the living organism is fabricated. Thus, in histology it is ultimately more important to interrelate

and compare the properties of cells and tissues than it is simply to separate and name them.

Whereas histology is a structural science and complements at finer levels of resolution anatomical knowledge gained from dissection, its intimate relation to biochemistry, physiology, and pathology must be emphasized. The cell is a unit not only of structure but also of physiological activity. The formation of the specialized tissues is the structural expression of a physiological division of labor. The structures seen under the microscope assume a meaning only in the light of their functional significance. Thus the structure of muscles and glands can only be studied by constant reference to contraction and secretion. Normal physiological processes are associated with normal

structure; abnormal processes are usually expressed in the altered structure and relationship of the cells and intercellular substance.

Recognition of these considerations, then, implies an awareness of increased breadth in the discipline of histology. To understand cells and tissues is to appreciate the common properties they have shared since their embryonic ancestry, the subtle and dramatic special propensities they have acquired during maturation, the minuteness of their most important parts, the delicate metabolic balance within which they normally operate, and the ease with which all of this can be altered to give conditions we define as disease. Understanding cells and tissues is not unlike understanding people and societies.

Contents

Preface to the Seventeenth Edition	v
Excerpts from the Fifteenth Edition	
Preface	vii
Introduction	ix

CHAPTER 1

The Cell	1
Methods of Study	2
Preparation of Material	2
The Microscope	5
Chemical and Physical Properties of Protoplasm	9
Nucleic Acids	12
Amino Acids and Proteins	13
Lipids	14
Carbohydrates	15
Structural and Functional Organization of Cells	15
The Nucleus	17
The Cytoplasm	23
Ribosomes	23
Granular Endoplasmic Reticulum	26
Agranular Endoplasmic Reticulum	28
The Golgi Apparatus	33
Lysosomes	35
Peroxisomes	41
Centrosome, Centrioles	42
Mitochondria	43
Filaments	46
Microtubules	48
Cell Membrane	49
Cytoplasmic Inclusions	53

General Considerations	54
Cell Form and Cell Size	54
Cell Life and Cell Death	54
References	55

CHAPTER 2

Studies of Living Cells	61
Cell, Tissue, and Organ Culture	61
Morphology of the Living Cell	63
Experimental Manipulation of Living Cells	64
Vital and Supravital Staining	64
Micromanipulation and Microdissection	64
Cinematography	66
Activities of Living Cells	67
Intracellular Movements	67
Cellular Locomotion	68
Phagocytosis and Pinocytosis	68
Observation of Living Cells in situ	69
Cytological Analysis in Cell Culture	69
Determination of Karyotype	69
Cloning	72
Cellular Aggregation	72
Heterokaryons	72
Other Uses of Cell and Tissue Culture	72
Observations on Organized Tissue in Culture	73
Cell Differentiation	74
The Operon	76
Cell-to-Cell Interactions	78

Cell Division	79
DNA Replication	79
Mitosis	80
Prophase	80
Metaphase	81
Anaphase	87
Telophase	87
General Considerations of Mitosis ..	87
Meiosis	88
References	88

CHAPTER 3

General Features of Vertebrate Development	90
Early Morphogenesis	90
Gastrulation	91
Differentiation and Histogenesis	94
Neurulation	94
Neural crest	97
Somites and Embryonic Axis	97
Somatic and Splanchnic Mesoderm ..	98
Body Folds and Formation of the Primitive Gut	98
Relationship of Histology and Embryology	101
References	102

CHAPTER 4

Epithelium	103
Classification	104
Special Cytological Characteristics ..	107
Intercellular Attachments	108
Modifications at the Free Surface ..	122
Basal Modifications and Developmental Stabilization	126
Vascular Supply to Epithelia	128
Simple Epithelia	129
Simple Squamous Epithelium	129
Simple Columnar Epithelium	129
Pseudostratified Epithelium	130
Stratified Epithelia	131
Stratified Squamous Epithelium ..	131
Stratified Columnar and Stratified Cuboidal Epithelium	134
Transitional Epithelium	134
Other Patterns of Epithelial Organization	135
Epithelial Repair	139
Membranes	140
Serosus Membranes	140
Mucous Membranes	140
References	140

CHAPTER 5

The Connective Tissues	142
Embryonal Connective Tissues	142
The Connective Tissue Compartment ..	143
Adult Connective Tissue	144
Loose Connective Tissue	144
Connective Tissue Cells	144
Connective Tissue Fibers	151
Origin of the Connective Tissue Fibers	155
Ground Substance	158
The PAS Reaction in Connective Tissues	159
Functions of Loose Connective Tissue	159
Dense Connective Tissue	160
Reticular Connective Tissue	161
Adipose Tissue (Fat)	164
Pigmented Connective Tissue	166
Blood and Nerve Supply of Connective Tissue	166
The Macrophage System	167
References	168

CHAPTER 6

The Connective Tissues: Cartilage and Bone	170
Cartilage	170
Hyaline Cartilage	170
The Cells	170
The Intercellular Substance ..	172
Development and Growth	174
Elastic Cartilage	176
Fibrous Cartilage	176
Bone (Osseous Tissue)	178
Gross Organization of Bone Tissue ..	178
Organic and Inorganic Components of Bone	179
Microscopic Structure	180
Nonlamellar (Woven) Bone	184
Development and Growth of Bone ..	184
Cell Types in Osteogenesis	185
Osteogenic or Osteoprogenitor Cells	186
Osteoblasts	186
Osteocytes	189
Osteoclasts	189
Intramembranous Bone Formation ..	190
Calcification	191

Further Growth and Resorption of Intramembranous Bone . . .	191
Intracartilaginous (Endochondral) Bone Formation	192
Stages in Intracartilaginous Bone Formation	192
Osteons	196
Development of Short Bones	196
Remodeling of Bone	196
Healing of Fractures	198
The Periosteum and Endosteum . .	198
Marrow	198
Red Marrow	198
Yellow Marrow	198
Blood Vessels and Nerves	200
Lymphatics	201
Nerves	201
Joints (Articulations)	201
Synarthrosis	201
Diarthrosis	201
References	204
CHAPTER 7	
Blood and Lymph	206
Blood Plasma	207
Red Blood Corpuscles (Erythrocytes) .	207
White Blood Corpuscles (Leukocytes) .	212
Types of Nongranular Leukocytes (Agranulocytes)	212
Lymphocytes	212
Monocytes, or Large Mononu- clear Leukocytes	216
Types of Granular Leukocytes (Granulocytes)	218
Neutrophils	218
Eosinophils	222
Basophils	223
Blood Platelets	223
Chylomicrons and Hemoconia	224
Lymph	225
Disposal of Corpuscles	225
Development of Blood Corpuscles (Hemopoiesis)	225
Blood Development in Bone Mar- row	228
The Granulocyte Series	228
General Considerations of Gran- ulocytopoiesis	230
The Erythrocyte Series	230
General Considerations of Erythropoiesis	232
Megakaryocytes and Platelet Formation	232
Development of Lymphoid Ele-	

ments	233
Lymphocytes	233
Monocytes	233
Embryonic Development of Blood Cells	235
References	237
CHAPTER 8	
Muscle	240
Smooth Muscle	240
Skeletal Muscle	247
Fibers	249
Myofibrils	251
The Sarcoplasm	260
Changes during Contraction	262
Connective Tissue	266
Muscle-Tendon Attachment	266
Blood Vessels	267
Nerves	267
Regeneration	267
Cardiac Muscle	269
Fibers	269
Intercalated Discs	274
Connective Tissue of Cardiac Mus- cle	274
Blood Vessels and Nerve of Cardiac Muscle	275
Conduction System	275
Regeneration of Cardiac Muscle . .	277
References	277
CHAPTER 9	
Organization of Nervous Tissue	279
Basic Organization	282
The Spinal Nerve	285
The Autonomic Nervous System	285
Sympathetic Division	286
Parasympathetic Division	288
References	289
CHAPTER 10	
Nervous Tissue	290
The Neuron	290
Classification of Neurons by Shape	292
The Nerve Cell Body	293
Nucleus of the Nerve Cell	293
Cytoplasm of the Nerve Cell Body	294
Dendrites	298
Axons	298
Axoplasmic Transport	299

Axon Terminals, Synapses, Receptors, and Neurotransmitters	299
Neuroglia	307
Astrocytes	308
Protoplasmic Astrocytes	308
Fibrous Astrocytes	308
Oligodendrocytes	308
Microglia	310
Ependyma	312
Peripheral Glia	312
Peripheral Myelination	315
Central Myelination	319
The Peripheral Nerves	323
Epineurium	325
Perineurium	325
Endoneurium	325
The Ganglia	326
Cranial and Spinal Ganglia	326
The Autonomic Sympathetic and Parasympathetic Ganglia	327
Degeneration and Regeneration of Nerve Fibers	328
Nerve Terminations	331
Terminations of Somatic Efferent Fibers	333
Terminations of Visceral Efferent Fibers	333
Classification of Terminations of Afferent Fibers	334
Nonencapsulated Afferent Endings	337
Encapsulated Afferent Endings	338
References	343

CHAPTER 11

The Spinal Cord, Cerebellar Cortex, and Cerebral Cortex 345

Investments of the Brain and Cord and the Fluid Spaces	345
The Cerebrospinal Fluid	346
Choroid Plexuses	347
The Arachnoid Villi	348
The Fluid Compartments and the Blood-Brain Barrier	349
The Spinal Cord	350
Gray Matter	351
White Matter	351
The Cerebellar Cortex	351
General Structure	351
Function	353
The Cerebral Cortex	354
General Structure	354

Function	356
References	356

CHAPTER 12

The Circulatory System 358

The Blood Vascular System	358
Capillaries	358
Types of Capillaries	361
Correlation of Capillary Structure and Function	363
Arteries	366
Arterioles and Small Arteries	366
Medium-Sized Arteries	367
Large Arteries	370
Special Forms of Arteries	372
Aging of the Arteries	373
The Carotid and Aortic Bodies	373
The Carotid Sinus	374
Veins	374
Small Veins	374
Medium-Sized Veins	374
Large Veins	375
Special Features of Certain Veins	375
Valves	376
Portal Vessels	376
Arteriovenous Anastomoses	377
Blood Vessels, Lymphatics, and Nerves of the Blood Vessels	377
Vasa Vasorum	377
Lymphatics	378
Nerves	378
The Heart	378
Endocardium	378
Myocardium	378
Epicardium	380
Valves of the Heart	381
Impulse-Conducting System	381
Blood Vessels	384
Lymphatics	385
Nerves	385
The Lymph Vascular System	387
Lymph Capillaries	388
Lymph Vessels	388
Thoracic Duct	388
Development of the Circulatory System	388
Blood Vessels and Heart	388
Lymphatics	389
References	389

CHAPTER 13

Lymphatic Organs	391
Lymphatic Tissue	391
The Lymph Nodes	392
Cortex and Medulla	392
Lymphatic Vessels and Sinuses	397
Blood Vessels	398
Nerves	398
Functions	399
Development	400
Hemolymph Nodes	400
The Tonsils	401
The Palatine Tonsils	401
The Lingual Tonsils	402
The Pharyngeal Tonsil	403
Blood Vessels of Tonsils	403
Lymphatic Vessels	404
Nerves	404
Functions	404
Development	404
The Thymus	404
Blood Vessels	407
Lymphatics	408
Nerves	408
Functions	408
Development	408
The Spleen	409
Blood Vessels	409
Union of Arteries and Veins	415
The Splenic Pulp	415
Lymphatics	418
Nerves	418
Functions of the Spleen	418
Development	421
References	421

CHAPTER 14

The Integument	423
The Skin	423
Epidermis	424
Epidermis of Palms and Soles	424
Epidermis of the General Body	
Surface	429
Color of the Skin	429
The Dermis or Corium	430
Glands of the Skin	431
Sweat Glands (Glandulae Sudoriferae)	431
Sebaceous Glands	434
The Hair	435
Structure of the Hair	435
Hair Follicle	435

Muscles and Glands of the Hair	
Follicle	438
Replacement of Hairs	440
The Nails	440
Blood Vessels, Lymphatics, and Nerves of the Skin	442
Blood Vessels	442
Lymphatics	443
Nerves	443
Development of the Skin and its Appendages	444
References	445

CHAPTER 15

Glands	447
Structure and Classification	447
General Structure of Secretory Cells	447
Classification of Glands	448
Exocrine Glands	452
Simple Tubular Glands	452
Simple Tubuloalveolar Glands	452
Simple Alveolar Glands	453
Compound Tubular Glands	453
Compound Tubuloalveolar Glands	453
Compound Alveolar Glands	453
Architecture of Compound Glands	453
Development of Glands	453
Endocrine Glands	454
References	454

CHAPTER 16

The Digestive System	455
General Features of the Alimentary Canal	455
The Mouth	456
Lips and Cheeks	456
Gums	456
Hard Palate	457
Soft Palate	458
Floor of the Mouth	458
The Tongue	458
Glands of the Tongue	461
Nerve Supply	461
The Teeth	461
Enamel	461
Dentin	465
Cementum	467
Periodontal Membrane	467

CHAPTER 18	
The Urinary System	577
The Kidney	577
The Uriniferous Tubules	578
The Renal Corpuscle	578
Terminal Uriniferous Tubule	582
Collecting Tubules	590
Blood Vessels	594
Lymphatics	600
Nerves	601
The Excretion of Urine	601
The Renal Pelvis and Ureter	603
The Urinary Bladder	604
The Urethra	607
The Male Urethra	607
The Female Urethra	608
Development of the Urinary System	608
References	609

CHAPTER 19	
The Male Reproductive System	611
The Testis	612
The Semiferous Tubule	612
Spermatogenesis	621
Spermiogenesis	622
The Mature Spermatozoa	623
Tunica Albuginea	626
Interstitial Cells	626
Blood Vessels	628
Lymphatics	628
Nerves	628
The Genital Ducts	628
Straight Tubules and Rete Testis	628
Ductuli Efferentes	628
Ductus Epididymidis	629
Ductus Deferens	631
Storage of Sperm	634
Vestigial Structures in Testis and Epididymis	635
Accessory Genital Glands	636
The Seminal Vesicles	636
The Prostate Gland	637
The Bulbourethral Glands	639
The Penis	640
Blood Vessels	641
Lymphatics	642
Nerves	642
Internal Secretion of the Testis	642

Semen	643
References	643

CHAPTER 20	
The Female Reproductive System	645
The Ovary	645
The Follicles	646
Growth and Maturation of the Follicles	649
Ovulation	651
Atresia	652
Oogenesis	654
The Corpus Luteum	656
Interstitial Cells	658
Hormones of the Ovary	658
Blood Vessels	658
Lymphatics	658
Nerves	658
Vestigial Structures	658
The Fallopian Tubes	659
The Uterus	660
Myometrium	661
Endometrium	662
Relation of Menstruation to Ovulation	666
Blood Vessels	669
Lymphatics	670
Nerves	670
The Uterus during Pregnancy	670
The Placenta	672
Function of the Placenta	676
Other Uterine Changes during Pregnancy	678
The Vagina	678
The External Genitalia	681
The Mammary Glands	682
Connective Tissue Framework (Stroma)	682
Ducts	683
Nipple and Areola	683
Glandular Epithelium	684
The Inactive Mammary Gland	684
The Mammary Gland during Lactation	684
The Mammary Gland of the Male	686
Hormonal Control of the Mammary Gland	686
Blood Vessels	687
Lymphatics	688
Nerves	688

Developmental of Urinary and Repro-	
ductive Systems	688
References	691

CHAPTER 21

The Endocrine Glands	693
The Hypophysis Cerebri	694
Macroscopic Structure	694
Blood and Nerve Supply	695
Microscopic Structure and Func-	
tion	697
Pars Distalis	697
Functions of the Anterior Hy-	
pophysis	701
Pars Intermedia	704
Neurohypophysis	705
Pars Tuberalis	707
Pharyngeal Hypophysis	707
The Thyroid Gland	708
Structure	708
Blood Vessels	716
Nerves	716
Function	716
The Parathyroid Glands	716
Structure	716
Blood Vessels and Nerves	717
Function	717
The Adrenal Glands	717
Cortex	718
Medulla	720
Blood Supply	722
Nerves	722
Function	723
Postnatal Involution of Human	
Adrenal Glands	724
The Paraganglia	724
The Pineal Body	725
References	728

CHAPTER 22

The Organs of Special Senses	731
The Eye	731
Tunica Fibrosa	734
The Sclera	734
The Cornea	735
The Limbus	737
Tunica Vasculosa	737
The Choroid	739
The Ciliary Body	740
The Iris	742
The Iris Angle	744
The Retina	745
The Rod Cells	747
The Cone Cells	751
Retinal Modification in the	
Maculae Lutea and Fovea	
Centralis	755
Retinal Interneuronal Associa-	
tions and Functions	757
Blood Vessels of the Retina ..	758
The Ora Serrata	758
The Pigment Epithelium	758
The Optic Nerve	758
The Lens	760
The Zonula Ciliaris	762
The Vitreous Body	762
The Eyelids	763
The Lacrimal Glands	764
The Ear	765
The External Ear	767
The Middle Ear	768
The Internal Ear	769
The Osseous Labyrinth	770
The Membranous Labyrinth ..	770
The Vestibule	770
The Cochlea	772
The Organ of Corti	776
Physiology of the Auditory Mecha-	
nism	781
The Organ of Smell	784
The Organ of Taste	786
References	787
Index	789

The Cell

The goal of anatomical study is not just the acquisition of an accurate, static visualization of the structural elements of living systems. Rather, such visualization must lead eventually to an appreciation of those elements as dynamic, changing entities in the flux of activity that is life. Living *structure* is the fabric upon which *function* is organized; neither can be understood without reflection upon the other. Anatomists have traditionally striven to visualize and describe as directly as possible the structural components of cells, tissues, and organs in a manner which is most representative of the living state. It is a difficult task, for important structure is often not rendered visible unless the cell or tissue is killed, and the anatomist must try somehow to assure himself that death has not rendered a distorted image of the living state. Moreover, anatomists have found repeatedly that the most challenging aspects seem to lie just beyond the resolution of the naked eye or microscopic tools at hand. Hence, the major challenge has been to develop better methods for accurate visualization of ever smaller parts.

We have recently seen an enormous expansion of histology and cytology, the youngest of the anatomical sciences. Utilizing the methods of histochemistry, light and electron microscopy, and tissue culture, cytological studies have clarified much of the structure of subcellular elements. These revelations, combined with new knowledge

from biochemistry and cell physiology, have led to a firmer basic understanding of many of the ongoing processes of the living cell.

Neither the term “cell” nor the term “cell concept” will be new to readers of this text. The 19th century histologist Leydig defined a cell as “a mass of protoplasm containing a nucleus.” This simple and useful description is still appropriate for animal cells today, for the minimal structural unit of protoplasm is that unit having available the genetic material (within the nucleus) which allows it to carry out, relatively independently, all of the vital functions necessary to sustain life. Although cells in higher organisms may develop considerable dependence on one another, each retains within its nucleus identical sets of genetic information necessary to carry out all cell functions. Cells which lose their nuclei may continue to function for some time because the nucleus previously made provision for the manufacture of all of the substances needed during the remaining life of the cell.

The term *protoplasm* denotes the entire living substance of the cell. This includes the cell body and its extensions and the nucleus which lies in it. The substance of the cell outside the nucleus is called *cytoplasm*; the substance of the nucleus is *karyoplasm* or *nucleoplasm*. The entire cell is circumscribed by a membrane termed the *plasma membrane* or *plasmalemma*.