

FUNCTIONAL HUMAN ANATOMY

James E. Crouch

THIRD EDITION

Functional Human Anatomy

JAMES E. CROUCH, Ph.D.

*Professor of Zoology, Emeritus
San Diego State University
San Diego, California*

THIRD EDITION



LEA & FEBIGER • 1978 • PHILADELPHIA

Copyright © 1978 by Lea & Febiger. Copyright under the International Copyright Union. All rights reserved. This book is protected by copyright. *No part of it may be reproduced in any manner or by any means, without written permission from the publisher.*

• First Edition, 1965

Reprinted September, 1965
Reprinted September, 1966
Reprinted June, 1967
Reprinted June, 1968
Reprinted January, 1970
Reprinted November, 1970

Second Edition, 1972

Reprinted November, 1972
Reprinted September, 1973
Reprinted September, 1974
Reprinted July, 1975
Reprinted June, 1976
Reprinted November, 1976

Library of Congress Cataloging in Publication Data

Crouch, James Ensign, 1908–
Functional Human Anatomy.

Bibliography: p.
Includes index.

I. Anatomy, Human. I. Title. [DNLM: 1. Anatomy.
QS4 C952f]
QM23.2.C75 1978 611 77-8884
ISBN 0-8121-0597-4

Published in Great Britain by Henry Kimpton Publishers, London

PRINTED IN THE UNITED STATES OF AMERICA

PRINT NO. 6 5 4 3 2 1

Functional Human Anatomy

DEDICATED

*to my wife, Mary, for her patience
and understanding*

PREFACE

I express my deep appreciation to the thousands of people who have used the first two editions of *Functional Human Anatomy*. Because of their support, I am privileged to continue to extend my teaching efforts beyond the formal classroom setting. I am particularly grateful to those who have presented in writing their comments and constructive criticisms of the book. This third edition will be better as a result of their active interest and participation.

The present edition retains the same approach and philosophy as the first and for that reason the *Preface* to the first edition is repeated here and should be read carefully.

The major changes in the third edition are as follows:

1. The illustrations have been carefully reviewed and an effort has been made toward more uniformity and greater clarity in presentation and labeling. Color has been added where needed for emphasis. Some new illustrations have been added and a few old ones replaced or modified. We have been fortunate to have the services of Mrs. Martha Lackey who not only is a skilled illustrator but has a capacity for approaching the material from a student's point of view.

2. Minor additions and changes have been made in Chapter 1, *Point of View*, and in Chapter 3 on the *Basis of Structure and Function* in which the section on the cell has been largely rewritten and brought up to date with improved illustrations.

3. The chapters on the nervous system and organs of general and special sense have been

placed after the chapter on skeletal muscles. Making the information on nerves available early in the book should aid in the understanding of function in the maintenance systems of the body. The nervous system chapter has been divided into four chapters.

4. The circulatory system has also been broken into four chapters for ease of handling in the educational process.

5. The endocrine system has been completely revised to bring functional concepts up to date.

6. "Readings" have been added at the end of each chapter. Major works in anatomy such as *Gray's Anatomy* are useful in the study of any chapter but are not repeated in all chapters.

I am indebted to Martha Lackey for her outstanding illustrations and full cooperation and to Dr. Roger Marchand for his careful reading of the manuscript, constructive criticism, and positive suggestions. Also, I thank Mrs. Helen Morris and Mrs. Jackie McClanahan for their typing and editorial help.

I continue to appreciate and enjoy the privilege of working with the editors and staff of Lea & Febiger, Publishers. Their humane attitude, cooperation, confidence, and support make this work pleasant and professionally rewarding. I particularly thank John F. Spahr, George H. Mundorff, and Thomas J. Colaiezzi, with whom I have worked closely.

As author I assume full responsibility for any errors or omissions in the book. They should reflect in no way upon those who are mentioned in this preface or in the preface to the first edition as having had a part in the project.

JAMES E. CROUCH

San Diego, California

PREFACE TO FIRST EDITION

"ANATOMY is destiny" is a phrase which came to mind frequently during the writing of this book. The truth in this statement of Sigmund Freud's is apparent to one who sees anatomy as encompassing the whole range of structure from subatomic particles to gross anatomical organization. While an elementary textbook of Human Anatomy certainly cannot presume to range over such a broad area, it should try to help students to see the potential and feel the challenge that is, in reality, there. In living anatomy, in the broad sense, is found the basis of all function. In living and dead bodies or in their fossil remains is revealed the life of both the present and the past, and, indeed, the means or mechanism for seeing into the future.

While any beginning course in Human Anatomy must be largely descriptive, engaging the student in dissection and memorization, it need not be only this. Certainly, the interrelationships of the structure of the body and the general functions of its organs and systems should receive repeated mention and emphasis. In addition, excursions into histology, embryology, and comparative anatomy at appropriate points in a course can add interest because they give meaning to the anatomy of man. Embryology and comparative anatomy in particular enable us to see man as continuous with all of nature and at the same time to emphasize his unique characteristics. If human anatomy can be taught with these overtones, it not only can give the student a knowledge and understanding of his own structure, but can help him to formulate a

philosophy of life. It is the aim of this book to bring this added dimension to the study of human anatomy.

The systematic rather than the regional approach to anatomy is used in this book. It involves the students in fewer difficulties and is more appropriate for the majors in physical and health education, nursing, physical and occupational therapy, and art, as well as for others who take this course. Each system is discussed in sufficient depth to give a good basis for physiology, kinesiology, and other sciences into which the students may go for further training. Also, it should serve well medical and dental students as a means for either quick preview or review of the body. No effort has been made to emphasize one system more than another.

The first chapter, called "Point of View," sets the philosophical tone of the book, defines and classifies man, and states some of the problems of our day. It suggests how man, using his unique characteristics, has created these problems and how he might resolve them or be destroyed. Chapter Two is a consideration of basic terminology, while Chapter Three reviews in a very minimal way protoplasm and the cell as the basis of structure and function. Although students should have biology as a prerequisite to human anatomy, experience indicates that a brief review is helpful.

A short presentation of descriptive embryology constitutes the fourth chapter. It carries the individual through the period of the embryo and lays the foundation for further discussion of

development in the chapters dealing with the body systems. If an instructor or a student does not wish to include this material, it is so arranged that it can be easily excluded from assignments. It is my belief however, that some knowledge in this field enhances one's understanding of adult structure.

A chapter called "Organization of the Body" completes the introductory part of the book. It deals primarily with histology, although it describes the organization of cells into tissues, tissues into organs, and organs into systems. It names and describes briefly each system. Histology, like embryology, is also made a part of the discussion of the anatomy of each system, thus keeping it constantly before the student. It leads naturally into a consideration of the integumentary system.

Comparative anatomy receives no special chapter consideration, although it is woven into the whole fabric of the book. It makes the student constantly aware of his evolutionary past and suggests again his own position in the stream of life.

Each chapter is concluded by questions which are arranged in the same sequence as the material presented in the chapter. They thus serve as a review and a means of emphasizing important points, enabling the student to evaluate his progress in anatomy.

The terminology throughout the book, with few exceptions, is based upon the International Nomenclature adopted by the International Congress of Anatomists meeting at Paris in July 1955. The most important terms for the student are printed in boldface type for emphasis and in many cases alternate terms or the old terminology are given in parentheses and in italics after the more acceptable names. This seems a necessary service to the student since the old terminology so often is found in reference books which are still widely used.

The great majority of the illustrations were drawn specifically for this book and therefore relate closely to the text material. Some of them are quite complex, attempting to show important relationships; others, as many of those on the muscular system, are simplified to emphasize action. Where the labeling on a given illustration goes beyond the text material, those labels which are most important to the beginning student are printed in boldface type.

A glossary is placed at the end of the book. It provides help in pronunciation of terms and gives their derivation and meanings as well. Since anatomy is in part a study in language, the student should get into the habit of using regularly this section of the book.

It is with pleasure that I acknowledge my indebtedness to the many who have contributed directly or indirectly to the general body of knowledge of anatomy from which one draws so heavily in the writing of a book. Among them are the works of Gray, Cunningham, Morris, Sobotta, Spalteholz, and Grant. I also acknowledge the help, encouragement, and inspiration which I have received from my colleagues in zoology, biology, nursing, and physical education and from the many students who have studied anatomy with me.

Special recognition and thanks go to those who have read parts of the manuscript and have given the benefit of their constructive criticisms: the late Dr. Gordon Tucker, Dr. Charles L. Brandt, Dr. Mabel A. Myers, Dr. Fred W. Kasch, Dr. Gerald Collier, and Dr. Harry H. Plymale. Leon L. Gardner, M.D., read the entire manuscript and made many constructive suggestions. John R. Blake, M.D., read the chapter on the circulatory system. Their help is deeply appreciated.

Four of my students—Jo Ann Smith, Mary Bevington, Linda Wood, and Roger Marchand—read parts of the manuscript. Jo Ann Smith,

Mary Bevington, and Marilyn Boland did most of the typing. To each of them I give my thanks.

For the illustrations I am indebted to Mr. Joseph M. Yuhasz, Mrs. Martha B. Lackey, Mrs. Loretta Douglass, Dr. James Koevenig, Mr. Kenneth Raymond, and Mr. Al Rowen for their excellent work. I am particularly appreciative of the efforts of Mrs. Lackey who entered the project late, but who enabled me to complete the book within a reasonable time. Mr. Bruce Lightheart and Mr. Roger Marchand provided the photomicrographs and I appreciate their contributions to the book.

The illustration on page 20 is from Vesalius,

San Diego, California

Andreas, *Icones anatomical*, 1934, New York, courtesy of the New York Academy of Medicine.

It was Dr. Charles Moritz who encouraged me to write this book and his company, Lea & Febiger, who furnished the necessary support, cooperation and confidence. I acknowledge with thanks the opportunity which they have made available to me.

If there are errors or omissions in the book, I alone assume full responsibility for them. They should reflect in no way upon those who are mentioned as having had a part in the project.

JAMES E. CROUCH

CONTENTS

1. Point of View	3	
Man's place in the world of life		A sense of direction
Classification of man		Anatomical position
Phylum Chordata		Terms of direction
Diagnostic characteristics		Planes of reference
Other characteristics		Units of measurement
Individual man		Questions
Heredity		Readings
Social man		
Family, the biological and social unit of our society		3. The Basis of Structure and Function
Ethical man		
Man's destiny		
Questions		
Readings		
2. Basic Terminology	9	
Anatomy—A definition		Protoplasm
Gross anatomy		Definition
Regional anatomy		Metabolism
Surface anatomy		Excitability
Systematic anatomy		Contractility
Microscopic anatomy		Reproduction and growth
Cytology		
Histology		Cells
Organology		Cell theory
Developmental anatomy		Shape, size, and numbers of cells
Embryology		Cell structure and function
Postnatal development		Regulation of cell growth and reproduction
Ontogeny		Neoplasm
Comparative anatomy		Mitosis
Organic evolution		Questions
Phylogeny		Readings
		4. Origin and Development of the Individual—Embryology
		Meiosis and fertilization
		Orientation and definition
		Meiosis
		Fertilization

Genetic importance		fibrous connective tissue)	
Embryology		Fibrous membranes	
Definition		Lamellar connective tissue	
Cleavage		Special connective tissue	
Differentiation—blastocyst formation		Mucous	
Implantation		Elastic	
Germ layer formation		Reticular	
Embryonic disc and mesoderm		Adipose	
Neural tube		Pigmented	
Somites		Lamina propria	
Celom formation		Cartilage	
External form		Bone	
Fetal membranes and placenta		Blood and lymph	
Dynamics of development		Muscle and nervous tissues	
Anomalies		Questions	
Questions		Readings	
Readings			
5. The Organization of the Body	50	6. The Integument (Skin)	72
Tissues, organs, and systems		Definition	
Definition and scope		Functions of the integument	
The whole body		Structure of the integument	
Epithelial tissues		Epidermis	
Structures and functions		Stratum basale	
Classification		Stratum spinosum (germinativum, mucosum)	
Simple squamous epithelium		Stratum granulosum	
Simple cuboidal epithelium		Stratum lucidum	
Simple columnar epithelium		Stratum corneum	
Simple columnar ciliated epithelium		Dermis, or corium	
Pseudostratified columnar epithelium		Papillary layer	
Pseudostratified columnar ciliated epithelium		Reticular layer	
Stratified squamous epithelium		(Subcutaneous layer)	
Stratified cuboidal epithelium		Hair and nails	
Stratified columnar epithelium		Hair	
Stratified columnar ciliated epithelium		Nails	
Transitional epithelium		Glands of the integument	
Glands		Sebaceous glands	
Epithelial membranes		Sudoriferous glands	
Mucous and serous membranes		Mammary glands	
Connective tissues		Blood and lymphatic vessels	
Classification		Nerves and nerve endings	
Connective tissue proper		Questions	
Loose connective tissue		Readings	
Dense connective tissue			
Regular connective tissue		7. General Osteology and Arthrology	83
Tendons and ligaments (white		General osteology	
		Definition and functions	
		Classification of bones	

- Surface features
- Structure of bone
- Blood supply
- Chemical composition
- Development and growth of cartilage and bone
 - Intramembranous ossification
 - Endochondral ossification
- Skeletal disorders
- General arthrology
 - Definition and functions
 - Classification of articulations
 - Fibrous joints
 - Cartilaginous joints
 - Synovial joints
 - Types of synovial joints
 - Movements in articulations
 - Bursae and tendon sheaths
 - Blood and nerve supply of joints
 - Disorders of the joints
- Questions
- Readings

8. The Axial Skeleton 102

- The skull
 - Classification of bones
 - Anterior view of skull
 - Orbital fossae
 - Nasal fossae
 - Lateral view of the skull
 - Temporal fossae
 - Infratemporal fossae
 - The skull from below
 - Hard palate
 - Choanae
 - Pterygoid fossae
 - Mandibular fossae
 - The cranial cavity
 - Anterior cranial fossa
 - Middle cranial fossa
 - Posterior cranial fossa
 - The cap of the skull
 - Foramina of the facial and cranial regions
 - Development of the skull
 - Dermatocranium
 - Chondrocranium
 - Splanchnocranium
 - The skull from birth to old age

- Fontanelles
- The bones of the skull
- The vertebral column
 - Definition and function
 - Characteristics of a vertebra
 - Regional differences
 - Specialized vertebrae
 - First cervical—atlas
 - Second cervical—axis
 - Seventh cervical—vertebra prominens
 - Sacrum
 - Coccyx
 - Curvatures of the vertebral column
 - Abnormal curvatures
 - Articulations and movements of the vertebral column
 - Symphyses
 - Synovial joints
 - Development of the vertebral column
 - Anomalies
- The thorax
 - Scope and functions
 - Sternum
 - Ribs and costal cartilages
 - Movements of the thorax
 - Development of the thorax
 - Applied anatomy
- Questions

9. The Appendicular Skeleton 142

- Definition and functions
- Pectoral girdle
 - Clavicle
 - Sternoclavicular joint
 - Coracoclavicular joint
 - Acromioclavicular joint
 - Scapula
- Upper limb
 - Humerus
 - Shoulder joint
 - Ulna
 - Radius
 - Elbow joint
 - Radioulnar joints
 - Bones of the hand
 - Carpus
 - Metacarpus
 - Phalanges

Joints of the hand and wrist	
Radiocarpal or wrist joint	
Intercarpal joints	
Midcarpal joint	
Carpometacarpal joints	
Metacarpophalangeal joints	
Interphalangeal joints	
Pelvic girdle	
Ilium	
Ischium	
Pubis	
The bony pelvis	
True	
False	
Male and female pelvis	
Joints of the pelvis	
Sacroiliac	
Symphysis pubis	
Sacrococcygeal	
Lower limb	
Femur	
Hip joint	
Movement of the hip joint	
Patella	
Tibia	
Fibula	
Knee joint	
Semilunar cartilages	
Cruciate ligaments	
Other ligaments	
Movements of knee joint	
Injuries to the knee joint	
Tibiofibular articulations	
Superior tibiofibular	
Interosseous	
Inferior tibiofibular	
Tarsus	} Foot
Metatarsus	
Phalanges	
Arches of the foot	
Medial longitudinal	
Lateral longitudinal	
Transverse	
Ankle joint	
Intertarsal joints	
Tarsometatarsal joints	
Intermetatarsal joints	
Metatarsophalangeal joints	
Interphalangeal joints	
Questions	
Readings for Chapters 8 and 9	

10. General Myology	176
Definition and functions	
Kinds of muscle tissues	
Smooth muscle	
Cardiac muscle	
Skeletal muscle	
Gross structure of skeletal muscles as organs	
Microscopic structure of skeletal muscle organs	
Blood and lymph vessels of skeletal muscles	
Nerve supply of skeletal muscles	
Motor units	
Muscle tonus	
Embryological development of muscle tissues	
Myogenesis	
Morphogenesis of skeletal muscles	
Questions	
Readings	
11. The Skeletal Muscles and Fasciae	188
Mechanics of muscle action	
Roles of muscles	
Prime mover	
Antagonist	
Synergist	
Fixator	
Levers	
Fiber direction and muscle action	
Gravity	
Fasciae	
Bursae and tendon sheaths	
Classification of muscles	
Names of muscles	
Muscles of the axial skeleton	
Muscles of the head and neck	
Facial muscles	
Muscles of mastication	
Muscles of the tongue	
Muscles of the pharynx and palate	
Cervical fasciae	
Cervical triangles	
Lateral cervical muscles	
Suprahyoid muscles	
Infrahyoid muscles	
Anterior vertebral muscles	

<ul style="list-style-type: none"> Lateral vertebral muscles Posterior vertebral muscles Muscles of the vertebral column Prevertebral muscles Postvertebral muscles <ul style="list-style-type: none"> Transversocostal muscles Transversospinal muscles Muscles of the thorax <ul style="list-style-type: none"> Fasciae Muscles of the outer wall of the thorax Muscles of the inner wall of the thorax Muscle of the floor of the thorax Muscles of the abdomen <ul style="list-style-type: none"> Fasciae Anterolateral muscles Posterior muscles Transversalis fascia Subserous fascia Muscles of the pelvis Muscles of the perineum Muscles of the upper limb <ul style="list-style-type: none"> Muscles connecting the axial skeleton and the shoulder girdle Muscles connecting the axial skeleton and the arm Muscles connecting the shoulder girdle and the arm Muscles of the arm Muscles of the forearm Intrinsic muscles of the hand <ul style="list-style-type: none"> Fascia of the hand Practical considerations Muscles of the lower limb <ul style="list-style-type: none"> Muscles of the hip Muscles of the thigh Muscles of the leg Intrinsic muscles of the foot Questions Readings Table of muscles 	<ul style="list-style-type: none"> Classification of neurons Neuroglia Nerves Tracts Ganglia Nuclei and nerve centers Peripheral nerve endings Neuron functions <ul style="list-style-type: none"> Excitability and the nerve impulse The nerve impulse <ul style="list-style-type: none"> Additional characteristics of the nerve impulse Synapse <ul style="list-style-type: none"> Anatomy of synapses Functional characteristics of synapses Reflex arc <ul style="list-style-type: none"> Characteristics of reflex responses Questions Readings
<p>12. The Nervous System—Basic Organization and Functions 279</p> <ul style="list-style-type: none"> Functions General Plan Nervous tissue Neurons 	<p>13. The Spinal Cord and Spinal Nerves 296</p> <ul style="list-style-type: none"> Spinal cord <ul style="list-style-type: none"> External features Regions and segments Cross section Meninges Spinal nerves <ul style="list-style-type: none"> Plexuses Spinal cord, spinal nerves, and reflex arcs Spinal cord, spinal nerves, and reflex action <ul style="list-style-type: none"> Reciprocal innervation Questions Readings
<p>14. The Brain and Cranial Nerves 312</p> <ul style="list-style-type: none"> Brain <ul style="list-style-type: none"> Early development Brain stem <ul style="list-style-type: none"> Medulla oblongata Pons Mesencephalon Diencephalon Cerebellum Cerebrum 	

Surfaces, poles, and fissures	
Sulci, gyri, and lobes	
White matter	
Basal ganglia (nuclei)	
Conditioned reflexes	
Ventricles of the brain	
Cerebrospinal fluid	
Meninges of the brain	
Dura mater	
Pia mater	
Arachnoid	
Cranial nerves	
Review—Conduction pathways of the nervous system	
Questions	
Readings	
15. Autonomic Nervous System	368
Visceral efferent neurons	
Sympathetic division	
Parasympathetic division	
Autonomic reflex arc	
Visceral afferent neurons	
Questions	
Readings	
16. The Organs of General and Special Sense (Receptors)	374
Classification of receptors	
Organs of general sense	
Free nerve endings	
End-bulbs of Krause	
Brushes of Ruffini	
Tactile corpuscles of Meissner	
Pacinian (lamellated) corpuscles	
Neuromuscular spindles	
Neurotendinous end organs	
General visceral receptors	
Special visceral receptors	
Organs of special sense	
Chemoreceptors	
Olfactory organs	
Taste organs	
The ear	
External ear	
Middle ear	
Internal ear	
Equilibrium	
Hearing	
Deafness	
Comparative anatomy	
The eye	
Eye and camera	
Structure of the eyeball	
Tunics of the eyeball	
Microscopic anatomy of the retina	
Refracting media of the eye	
Accessory organs of the eye	
Questions	
Readings	
17. The Circulatory System—An Overview	402
Cell environment	
Organs of circulation	
Cardiovascular system	
Lymphatic system	
Functions	
Circulatory fluids and tissues	
Homeostasis	
General plan of cardiovascular system	
Closed system	
Double system	
Pulmonary circuit	
Systemic circuit	
Portal circulation	
Comparative anatomy	
Embryology	
Questions	
Readings	
18. The Heart	412
Size, position, and relationships	
General structure and function	
Heart wall	
Parietal pericardium	
Right atrium	
Right ventricle	
Left atrium	
Left ventricle	
Arteries of heart wall	
Veins of heart	
Summary	
Interventricular septum	
Skeleton of heart	
Conduction mechanism of heart	
Extrinsic nerves of heart	

Heart sounds		Mouth	
Practical considerations		Lips and cheeks	
Questions		Gingivae and teeth	
Readings		Practical considerations	
19. Blood Vessels	427	Tongue	
Arteries		Palate	
Vessels of the microcirculation—		Salivary glands	
capillaries		Pharynx	
Venules		Nasal pharynx	
Veins		Oral pharynx	
Valves		Laryngeal pharynx	
Vasa vasorum		Tonsils	
Pulmonary circuit		Mechanisms of chewing and	
Systemic circuit		swallowing	
Systemic arteries		Development of palate and pharynx	
Aorta and its branches		Palate	
Ascending aorta		Pharynx	
Aortic arch and its branches		Tubular digestive organs	
Arteries of the upper limb		Structural plan	
Descending thoracic aorta and its		Glands	
branches		Blood supply	
Descending abdominal aorta and its		Nerve supply	
branches		Esophagus	
Arteries of the lower limb		Abdomen and peritoneal cavity	
Systemic veins		Stomach	
Portal system		Development	
Fetal circulation		Microscopic anatomy	
Changes in cardiovascular system at		Functions	
birth		Enzymes	
Questions		Movements of the stomach	
Readings		Disorders	
20. Lymphatic System	463	Small intestine	
Lymph capillaries		Microscopic anatomy	
Lymph vessels		Duodenum	
Movement of lymph		Jejunum	
Practical considerations		Ileum	
Lymph nodes		Functions	
Practical considerations		Large intestine	
Other lymphatic organs		Cecum	
Practical considerations		Colon	
Questions		Rectum and anal canal	
Readings		Microscopic anatomy	
21. The Digestive System	470	Functions	
Organs of digestion		Liver	
Development of the digestive system		Gallbladder and bile ducts	
		Microscopic anatomy	
		Development	
		Functions	
		Disorders	
		Pancreas	

Microscopic anatomy		Functional considerations	
Functions		Filtration	
Development		Reabsorption	
Questions		Secretion	
Readings		Acidification	
		Concentration	
22. The Respiratory System	516	Kidney disorders	
Functions		Ureters	
Respiratory organs		Microscopic anatomy	
Nasal cavities		Innervation	
Special considerations		Function	
Pharynx		Urinary bladder	
Larynx		Microscopic anatomy	
Laryngeal cavity		Urethra	
Muscles of larynx		Female	
Microscopic anatomy		Male	
Trachea and bronchi		Prostatic	
Microscopic anatomy		Membranous	
Mediastinum		Spongy	
Pleurae		Microscopic anatomy	
Lungs		Innervation of bladder and urethra	
Borders and surfaces		Urination	
Fissures and lobes		Practical considerations	
Bronchopulmonary segments		Embryology	
Minute structures of the lung		Kidneys	
Breathing and lung function		Urinary bladder	
Disorders of the respiratory system		Urethra and urogenital sinus	
Development of the respiratory system		Questions	
Questions		Readings	
Readings			
23. The Urinary System	540	24. The Reproductive System	561
Pathways of excretion		The nature of reproduction	
Organs of the urinary system		The reproductive organs	
Special considerations		The perineum	
Kidneys		Male reproductive system	
Size, location, and attachments		Scrotum, testis, and epididymis	
Macroscopic section		Appendages of the testis and epididymis	
Pelvis and calyces		Microscopic anatomy	
Medulla		Ductus deferens and seminal vesicle	
Cortex		Microscopic anatomy	
Microscopic anatomy		Spermatic cord	
Renal tubules		Formation of scrotum and descent of testis	
Glomerular capsules, proximal convoluted tubules, loops of Henle, distal convoluted tubules		Practical implications	
Collecting tubules		Prostate and bulbourethral (Cowper's) glands	
Blood vessels		Penis	
Innervation		Vessels and nerves	