

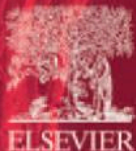
GRAY'S

# ANATOMY FOR STUDENTS



Richard L. Drake   A. Wayne Vogl   Adam W. M. Mitchell

Fifth Edition



Includes BONUS e-only chapters –  
by body system and neuroanatomy essentials!

# Index of Clinical Content

## 1 The body

### In the Clinic

- Radionuclide imaging 11
- Accessory and sesamoid bones 14
- Determination of skeletal age 15
- Bone marrow transplants 16
- Bone fractures 17
- Avascular necrosis 17
- Epiphyseal fractures 18
- Degenerative joint disease 22
- Arthroscopy 23
- Joint replacement 24
- The importance of fascias 25
- Placement of skin incisions and scarring 25
- Muscle paralysis 25
- Muscle hypertrophy/atrophy due to gender-affirming hormones 25
- Muscle atrophy 25
- Muscle injuries and strains 26
- Atherosclerosis 27
- Varicose veins 28
- Anastomoses and collateral circulation 28
- Lymph nodes 31
- Dermatomes and myotomes 37
- Referred pain 49

### Available online only<sup>1</sup>

*Appendicitis*

## 2 Back

### In the Clinic

- Spina bifida 74
- Vertebroplasty 75
- Scoliosis 76
- Kyphosis 77
- Lordosis 77
- Variation in vertebral numbers 78
- The vertebrae and cancer 79
- Osteoporosis 80

- Back pain 82
- Herniation of intervertebral discs 82
- Joint diseases 83
- Ligamenta flava 85
- Vertebral fractures 85
- Surgical procedures on the back 87
- Nerve injuries affecting superficial back muscles 103
- Discitis 107
- Fractures of the atlas and axis 107
- Paraplegia and tetraplegia 107
- Lumbar cerebrospinal fluid tap 111
- Herpes zoster 114
- Back pain—alternative explanations 115

### Available online only<sup>1</sup>

*Cauda equina syndrome*  
*Cervical spinal cord injury*  
*Psoas abscess*  
*Dissecting thoracic aneurysm*  
*Sacral tumor*  
*Ankylosing spondylitis*  
*Atlas fracture*  
*Lumbar puncture*  
*Cervical facet syndrome*  
*Spinal cord infarction*

## 3 Thorax

### In the Clinic

- Axillary tail of breast 141
- Chest masculinization surgery 142
- Breast cancer 142
- Cervical ribs 151
- Collection of sternal bone marrow 153
- Rib fractures 153
- Surgical access to the chest 161
- Thoracostomy (chest) tube insertion 162
- Intercostal nerve block 162
- Diaphragmatic paralysis 165
- Pleural effusion 169
- Pneumothorax 169

<sup>1</sup> All Clinical Cases are available online at [eBooks.Health.Elsevier.com](https://eBooks.Health.Elsevier.com).

COVID-19 179  
 Imaging the lungs 182  
 High-resolution lung CT 182  
 Bronchoscopy 183  
 Lung cancer 183  
 Pericarditis 190  
 Pericardial effusion 190  
 Constrictive pericarditis 190  
 Valve disease 203  
 Clinical terminology for coronary arteries 207  
 Heart attack 208  
 Common congenital heart defects 210  
 Cardiac auscultation 211  
 Classic symptoms of heart attack 211  
 Are heart attack symptoms the same in men and women? 211  
 Cardiac conduction system 213  
 Ectopic parathyroid glands in the thymus 219  
 Venous access for central and dialysis lines 222  
 Using the superior vena cava to access the inferior vena cava 222  
 Coarctation of the aorta 224  
 Thoracic aorta 224  
 Aortic arch and its anomalies 224  
 Abnormal origin of great vessels 224  
 The vagus nerves, recurrent laryngeal nerves, and hoarseness 228  
 Esophageal cancer 232  
 Esophageal rupture 232

## Available online only<sup>1</sup>

*Pulmonary embolism*  
*Cervical rib*  
*Lung cancer*  
*Chest wound*  
*Broken pacemaker*  
*Coarctation of the aorta*  
*Aortic dissection*  
*Pneumonia*  
*Esophageal cancer*  
*Venous access*  
*Cystic fibrosis with bronchiectasis*  
*Cardiac tamponade*  
*Mitral regurgitation*  
*Pancoast tumor*  
*Patent ductus arteriosus*

*Sinus of Valsalva aneurysm*  
*Subclavian steal syndrome*  
*Aorto-iliac occlusive disease*

## 4 Abdomen

### In the Clinic

Surgical incisions 272  
 Laparoscopic surgery 273  
 Cremasteric reflex 294  
 Masses around the groin 296  
 Peritoneum 300  
 The greater omentum 304  
 Epithelial transition between the abdominal esophagus and stomach 311  
 Duodenal ulceration 311  
 Examination of the upper and lower gastrointestinal tract 312  
 Meckel's diverticulum 314  
 Computed tomography (CT) scanning and magnetic resonance imaging (MRI) 314  
 Carcinoma of the stomach 314  
 Appendicitis 318  
 Congenital disorders of the gastrointestinal tract 322  
 Bowel obstruction 323  
 Diverticular disease 325  
 Ostomies 326  
 Annular pancreas 334  
 Pancreatic cancer 334  
 Segmental anatomy of the liver 337  
 Gallstones 339  
 Jaundice 341  
 Spleen disorders 341  
 Vascular supply to the gastrointestinal system 350  
 Hepatic cirrhosis 355  
 Surgery for obesity 364  
 Psoas muscle abscess 370  
 Diaphragmatic hernias 371  
 Hiatal hernia 372  
 Urinary tract stones 380  
 Urinary tract cancer 381  
 Nephrostomy 382  
 Kidney transplant 383



Investigation of the urinary tract 384  
 Abdominal aortic stent graft 388  
 Inferior vena cava filter 390  
 Retroperitoneal lymph node surgery 393

### Available online only<sup>1</sup>

*Traumatic rupture of the diaphragm*  
*Chronic thrombosis of the inferior vena cava*  
*Carcinoma of the head of the pancreas*  
*Metastatic lesions in the liver*  
*Liver biopsy in patients with suspected liver cirrhosis*  
*Hodgkin's lymphoma*  
*Inguinal hernia*  
*Ureteric stone*  
*Intraabdominal abscess*  
*Complications of an abdominoperineal resection*  
*Caval obstruction*  
*Diverticular disease*  
*Endoleak after endovascular repair of abdominal aortic aneurysm*  
*Colon cancer*  
*Intussusception*  
*Splenic rupture*  
*Zollinger-Ellison syndrome*

## 5 Pelvis and perineum

### In the Clinic

Gender affirming surgeries—lower body 430  
 Bone marrow biopsy 434  
 Pelvic fracture 436  
 Common problems with the sacro-iliac joints 438  
 Pelvic measurements in obstetrics 444  
 Defecation 446  
 Digital rectal examination 450  
 Carcinoma of the colon and rectum 452  
 Iatrogenic injury of the ureters 453  
 Bladder stones 456  
 Suprapubic catheterization 457  
 Bladder cancer 457  
 Bladder infection 460  
 Urethral catheterization 460  
 Testicular tumors 461  
 Ectopic testes 461  
 Vasectomy 462

Prostate problems 466  
 Ovarian cancer 469  
 Imaging the ovary 469  
 Hysterectomy 470  
 Tubal ligation 472  
 Carcinoma of the cervix and uterus 473  
 Intersex 474  
 The recto-uterine pouch 474  
 Pudendal block 484  
 Prostatectomy and impotence 487  
 Robotic prostatectomy 488  
 Abscesses in the ischio-anal fossae 497  
 Hemorrhoids 497  
 Emission and ejaculation of semen 503  
 Erectile dysfunction 503  
 Phalloplasty and metoidioplasty 506  
 Vulvoplasty and vaginoplasty 506  
 Urethral rupture 508

### Available online only<sup>1</sup>

*Varicocele*  
*Pelvic kidney*  
*Ovarian torsion*  
*Sciatic nerve compression*  
*Left common iliac artery obstruction*  
*Iatrogenic ureteric injury*  
*Ectopic pregnancy*  
*Uterine tumor*  
*Uterine fibroids*  
*Epididymitis*  
*Erectile dysfunction*  
*Pelvic fracture*  
*Puerperium*  
*Rectovaginal fistula*

## 6 Lower limb

### In the Clinic

Pelvic fractures 543  
 Femoral neck fractures 547  
 Intertrochanteric fractures 548  
 Femoral shaft fractures 548  
 Varicose veins 559  
 Deep vein thrombosis 559  
 Vascular access to the lower limb 563

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Trendelenburg's sign 567  
 Intramuscular injections 571  
 Compartment syndrome 580  
 Muscle injuries to the lower limb 589  
 Peripheral vascular disease 593  
 Obturator nerve damage 595  
 Meniscal injuries 599  
 Collateral ligament injuries 604  
 Cruciate ligament injuries 605  
 Degenerative joint disease/osteoarthritis 605  
 Examination of the knee joint 606  
 Anterolateral ligament of the knee 607  
 Popliteal artery aneurysm 609  
 Calcaneal (Achilles) tendon rupture 615  
 Neurological examination of the legs 617  
 Footdrop 625  
 Common fibular nerve injury 625  
 Talar beak 631  
 Fracture of the talus 632  
 Ankle fractures 635  
 Bunions 639  
 Osteoarthritis of the first tarsometatarsal joint 639  
 Plantar fasciitis 648  
 Morton's neuroma 655  
 Clubfoot 656

## Available online only<sup>1</sup>

*Knee joint injury*  
*Osteomyelitis*  
*Varicose veins*  
*Fracture of neck of femur*  
*Deep vein thrombosis*  
*Ruptured calcaneal tendon*  
*Popliteal artery aneurysm*  
*Anterior talofibular ligament tear*  
*Femoral hernia*  
*Groin injury*  
*Iliopsoas tendinitis*  
*Iliotibial band syndrome*  
*Nerve entrapment syndrome*  
*Pes cavus*

## 7 Upper limb

### In the Clinic

Fracture of the proximal humerus 689  
 Fractures of the clavicle and dislocations of the acromioclavicular and sternoclavicular joints 695  
 Dislocations of the glenohumeral joint 696  
 Rotator cuff disorders 697  
 Inflammation of the subacromial (subdeltoid) bursa 698  
 Quadrangular space syndrome 705  
 "Winging" of the scapula 712  
 Imaging the blood supply to the upper limb 722  
 Trauma to the arteries of the upper limb 722  
 Subclavian/axillary venous access 722  
 Injuries to the brachial plexus 732  
 Breast cancer 734  
 Rupture of biceps tendon 740  
 Blood pressure measurement 741  
 Radial nerve injury in the arm 748  
 Median nerve injury in the arm 748  
 Supracondylar fracture of the humerus 751  
 Pulled elbow 751  
 Fracture of the olecranon 751  
 Developmental changes in the elbow joint 752  
 Fracture of the head of the radius 753  
 "Tennis" and "golfer's" elbow (epicondylitis) 753  
 Elbow arthritis 753  
 Ulnar nerve injury at the elbow 754  
 Construction of a dialysis fistula 756  
 Fractures of the radius and ulna 760  
 Transection of the radial or ulnar artery 769  
 Anterior interosseous nerve palsy 770  
 Fracture of the scaphoid and avascular necrosis of the proximal scaphoid 783  
 Kienbock's disease 784  
 Median artery 785  
 Carpal tunnel syndrome 785  
 Dupuytren's contracture 787  
 Snuffbox 788  
 De Quervain's syndrome 789  
 Tenosynovitis 789  
 Trigger finger 789  
 Allen's test 801  
 Venipuncture 801  
 Ulnar nerve injury 803  
 Radial nerve injury 805

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*Winged scapula*  
*Complication of a fractured first rib*  
*How to examine the hand*  
*Shoulder problem after falling on an outstretched hand*  
*Brachial plexus nerve block*  
*Median nerve compression*  
*Immobilizing the extensor digitorum muscle*  
*Torn supraspinatus tendon*  
*Shoulder joint problem*  
*Clavicular fracture*  
*Extensor tendon injury of the hand*  
*Hand infection*  
*High meridian nerve palsy*  
*Radial fracture*  
*Rotator cuff impingement syndrome*

**8 Head and neck****In the Clinic**

Craniosynostosis 853  
 Medical imaging of the head 853  
 Fractures of the skull vault 854  
 Hydrocephalus 859  
 Cerebrospinal fluid leak 860  
 Meningitis 860  
 Brain tumors 860  
 Stroke 865  
 Endarterectomy 867  
 Intracerebral aneurysms 867  
 Scalp and meninges 873  
 Head injury 874  
 Types of intracranial hemorrhage 874  
 Tuberculosis of the central nervous system 876  
 Emissary veins 876  
 Concussion 876  
 Clinical assessment of patients with head injury 876  
 Treatment of head injury 877  
 Increased intracranial pressure and coning 877  
 Superior sagittal sinus thrombosis 878  
 Cranial nerve lesions 885  
 Overview of cranial nerves 885  
 Facelifts and Botox 893

Parotid gland 898  
 Facial nerve [VII] palsy (Bell's palsy) 906  
 Trigeminal neuralgia 906  
 Scalp laceration 911  
 Orbital fracture 913  
 Horner's syndrome 916  
 Examination of the eye 925  
 The "H-test" 926  
 Glaucoma 933  
 Cataracts 933  
 Ophthalmoscopy 934  
 High-definition optical coherence tomography 936  
 Otitis media 942  
 Examination of the ear 942  
 Swimmer's ear 943  
 Surfer's ear 943  
 Tympanic membrane perforation 943  
 Mastoiditis 946  
 Lingual nerve injury 972  
 Dental anesthesia 974  
 Central venous access 990  
 Jugular venous pulse 998  
 Thyroid gland 1005  
 Thyroidectomy 1006  
 Thyroid gland pathology 1006  
 Ectopic parathyroid glands 1007  
 The vertebral arteries 1017  
 Recurrent laryngeal nerve palsy 1019  
 Clinical lymphatic drainage of the head and neck 1024  
 Cricothyrotomy 1050  
 Tracheostomy 1050  
 Exogenous testosterone and vocal cord mass 1050  
 Laryngoscopy 1050  
 Surgical approach to the pituitary gland 1061  
 Deviated nasal septum 1062  
 Head and neck cancer 1105

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*Multinodular goiter*  
*Extradural hematoma*  
*Complication of orbital fracture*  
*Parotid duct calculus*  
*Stenosis of the internal carotid artery*  
*Posterior communicating artery aneurysm*  
*Recurrent epistaxis*

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*Pituitary macroadenoma*

*Branchial cyst*

*Epiglottitis*

*Otosclerosis*

*Scalp laceration*

*Scaphocephaly*

*Temporal arteritis*

*Tonsillitis*

# 1

# The Body

## ADDITIONAL LEARNING RESOURCES for Chapter 1, The Body, CAN BE FOUND ON THE ACCOMPANYING EBOOK

- Short Questions—these are questions requiring short responses, Chapter 1

### **What is anatomy? 2**

- How can gross anatomy be studied? 2
- Important anatomical terms 2

### **Imaging 5**

- Diagnostic imaging techniques 5
- Nuclear medicine imaging 8

### **Image interpretation 10**

- Plain radiography 10
- Computed tomography 11
- Magnetic resonance imaging 11
- Nuclear medicine imaging 11

### **Safety in imaging 12**

### **Body systems 13**

#### **Skeletal system 13**

- Cartilage 13
- Bone 14
- Joints 18

#### **Skin and fascias 24**

- Skin 24
- Fascia 24

#### **Muscular system 25**

#### **Cardiovascular system 26**

#### **Lymphatic system 29**

- Lymphatic vessels 29
- Lymph nodes 30
- Lymphatic trunks and ducts 30

#### **Nervous system 31**

- Central nervous system 31
- Functional subdivisions of the CNS 32

#### **Other systems 47**

---





## What is anatomy?

Anatomy includes those structures that can be seen grossly (without the aid of magnification) and microscopically (with the aid of magnification). Typically, when used by itself, the term *anatomy* tends to mean gross or macroscopic anatomy—that is, the study of structures that can be seen without using a microscope. Microscopic anatomy, also called histology, is the study of cells and tissues using a microscope.

Anatomy forms the basis for the practice of medicine. Anatomy leads the physician toward an understanding of a patient's disease, whether he or she is carrying out a physical examination or using the most advanced imaging techniques. Anatomy is also important for dentists, chiropractors, physical therapists, and all others involved in any aspect of patient treatment that begins with an analysis of clinical signs. The ability to interpret a clinical observation correctly is therefore the endpoint of a sound anatomical understanding.

Observation and visualization are the primary techniques a student should use to learn anatomy. Anatomy is much more than just memorization of lists of names. Although the language of anatomy is important, the network of information needed to visualize the position of physical structures in a patient goes far beyond simple memorization. Knowing the names of the various branches of the external carotid artery is not the same as being able to visualize the course of the lingual artery from its origin in the neck to its termination in the tongue. Similarly, understanding the organization of the soft palate, how it is related to the oral and nasal cavities, and how it moves during swallowing is very different from being able to recite the names of its individual muscles and nerves. An understanding of anatomy requires an understanding of the context in which the terminology can be remembered.

### How can gross anatomy be studied?

The term *anatomy* is derived from the Greek word *temnein*, meaning “to cut.” Clearly, therefore, the study of anatomy is linked, at its root, to dissection, although dissection of cadavers by students is now augmented, or even in some cases replaced, by viewing prosected (previously dissected) material and plastic models, or using computer teaching modules and other learning aids such as virtual and augmented reality experiences.

Anatomy can be studied following either a regional or a systemic approach.

- With a **regional approach**, each *region* of the body is studied separately and all aspects of that region are studied at the same time. For example, if the thorax is to be

studied, all of its structures are examined. This includes the vasculature, the nerves, the bones, the muscles, and all other structures and organs located in the region of the body defined as the thorax. After studying this region, the other regions of the body (i.e., the abdomen, pelvis, lower limb, upper limb, back, head, and neck) are studied in a similar fashion.

- In contrast, in a **systemic approach**, each *system* of the body is studied and followed throughout the entire body. For example, a study of the cardiovascular system looks at the heart and all of the blood vessels in the body. When this is completed, the nervous system (brain, spinal cord, and all the nerves) might be examined in detail. This approach continues for the whole body until every system, including the nervous, skeletal, muscular, gastrointestinal, respiratory, lymphatic, and reproductive systems, has been studied.

Each of these approaches has benefits and deficiencies. The regional approach works very well if the anatomy course involves cadaver dissection but falls short when it comes to understanding the continuity of an entire system throughout the body. Similarly, the systemic approach fosters an understanding of an entire system throughout the body, but it is very difficult to coordinate this directly with a cadaver dissection or to acquire sufficient detail.

## Important anatomical terms

### The anatomical position

The anatomical position is the standard reference position of the body used to describe the location of structures (Fig. 1.1). The body is in the anatomical position when standing upright with feet together, hands by the side, and face looking forward. The mouth is closed and the facial expression is neutral. The rim of bone under the eyes is in the same horizontal plane as the top of the opening to the ear, and the eyes are open and focused on something in the distance. The palms of the hands face forward with the fingers straight and together and with the pad of the thumb turned 90 degrees to the pads of the fingers. The toes point forward.

### Anatomical planes

Three major groups of planes pass through the body in the anatomical position (see Fig. 1.1).

- **Coronal planes** are oriented vertically and divide the body into anterior and posterior parts.
- **Sagittal planes** also are oriented vertically but are at right angles to the coronal planes and divide the body into right and left parts. The plane that passes through the center of the body dividing it into equal right and left halves is termed the **median sagittal plane**.

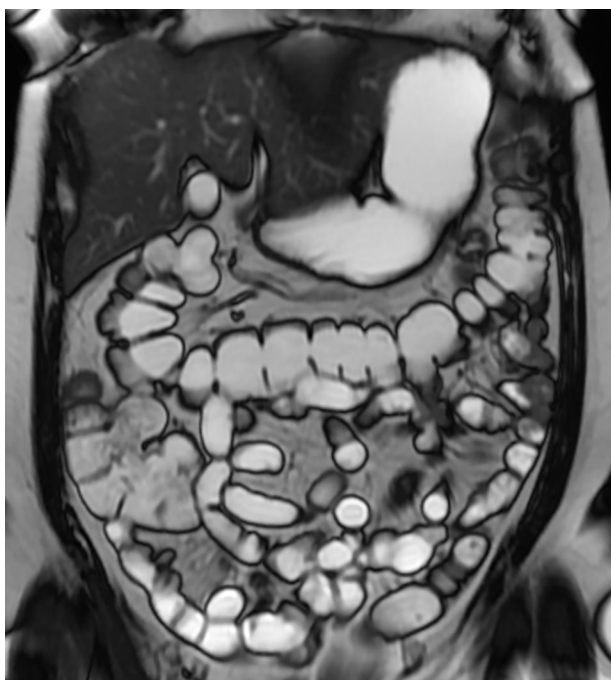
substance that attenuates X-rays more than bowel loops or arteries do normally. It is, however, extremely important that these substances are nontoxic. Barium sulfate, an insoluble salt, is a nontoxic, relatively high-density agent that is extremely useful in the examination of the gastrointestinal tract. When a **barium sulfate suspension** is ingested, it attenuates X-rays and can therefore be used to demonstrate the bowel lumen (Fig. 1.4). It is common to add air to the barium sulfate suspension by either ingesting “fizzy” granules or directly instilling air into the body cavity, as in a barium enema. This is known as a double-contrast (air/barium) study.

For some patients it is necessary to inject contrast agents directly into arteries or veins. In this case, iodine-based molecules are suitable contrast agents. **Iodine** is chosen because it has a relatively high atomic mass and so markedly attenuates X-rays, but also, importantly, it is naturally excreted via the urinary system. Intra-arterial and intravenous contrast agents are extremely safe and are well tolerated by most patients. Rarely, some patients have an anaphylactic reaction to intra-arterial or intravenous injections, so the necessary precautions must be taken. Intra-arterial and intravenous contrast

agents not only help in visualizing the arteries and veins but, because they are excreted by the urinary system, can also be used to visualize the kidneys, ureter, and bladder in a process known as **intravenous urography**.

## Subtraction angiography

During angiography it is often difficult to appreciate the contrast agent in the vessels through the overlying bony structures. To circumvent this, the technique of subtraction angiography has been developed. Simply, one or two images are obtained before the injection of contrast media. These images are inverted (such that a negative is created from the positive image). After injection of the contrast media into the vessels, a further series of images are obtained, demonstrating the passage of the contrast through the arteries into the veins and around the circulation. By adding the “negative precontrast image” to the positive postcontrast images, the bones and soft tissues are subtracted to produce a solitary image of contrast only. Before the advent of digital imaging this was a challenge, but now the use of computers has made this technique relatively straightforward and instantaneous (Fig. 1.5).



**Fig. 1.4** Barium Sulfate Follow-Through. (MRE – magnetic resonance enterograph).



**Fig. 1.5** Digital Subtraction Angiogram.

# 2

# Back

## ADDITIONAL LEARNING RESOURCES for Chapter 2, Back, CAN BE FOUND ON THE ACCOMPANYING EBOOK

- Self-Assessment—National Board—style multiple-choice questions, Chapter 2
- Short Questions—these are questions requiring short responses, Chapter 2
- Interactive Surface Anatomy—interactive surface animations, Chapter 2
- PT Case Studies, Chapter 2
  - Low back instability
  - Stenosis
  - Herniated nucleus pulposus
  - Atlanto-occipital dysfunction
  - Atlanto-axial dysfunction
  - Mid-cervical dysfunction
  - Cauda equina syndrome
  - Cervical degenerative joint disease
  - Cervical radiculopathy
- Clinical Cases, Chapter 2
  - Ankylosing spondylitis
  - Atlas fracture
  - Cervical facet syndrome
  - Dissecting thoracic aneurysm
  - Lumbar puncture
  - Psoas abscess
  - Sacral tumor
  - Spinal cord infarction

## FREE Online Anatomy and Embryology Self-Study Course

Anatomy modules 23 through 25

## Conceptual overview 53

### General description 53

### Functions 54

- Support 54
- Movement 54
- Protection of the nervous system 55

### Component parts 56

- Bones 56
- Muscles 57
- Vertebral canal 59
- Spinal nerves 60

### Relationship to other regions 61

- Head 61
- Thorax, abdomen, and pelvis 62
- Limbs 62

### Key features 62

- Long vertebral column and short spinal cord 62
- Intervertebral foramina and spinal nerves 63
- Innervation of the back 63

## Regional anatomy 64

### Skeletal framework 64

- Vertebrae 64
- Intervertebral foramina 72
- Posterior spaces between vertebral arches 73

### Joints 80

- Joints between vertebrae in the back 80

### Ligaments 83

- Anterior and posterior longitudinal ligaments 83
- Ligamenta flava 83
- Supraspinous ligament and ligamentum nuchae 83
- Interspinous ligaments 84

### Back musculature 88

- Superficial group of back muscles 88
- Intermediate group of back muscles 94
- Deep group of back muscles 96
- Suboccipital muscles 101

---

**Spinal cord 103**

Vasculature 104

Meninges 108

Arrangement of structures in the vertebral canal 109

Spinal nerves 111

***Surface anatomy 116***

Back surface anatomy 116

Absence of lateral curvatures 116

Primary and secondary curvatures in the sagittal plane 117

Useful nonvertebral skeletal landmarks 118

How to identify specific vertebral spinous processes 119

Visualizing the inferior ends of the spinal cord and subarachnoid space 120

Identifying major muscles 121

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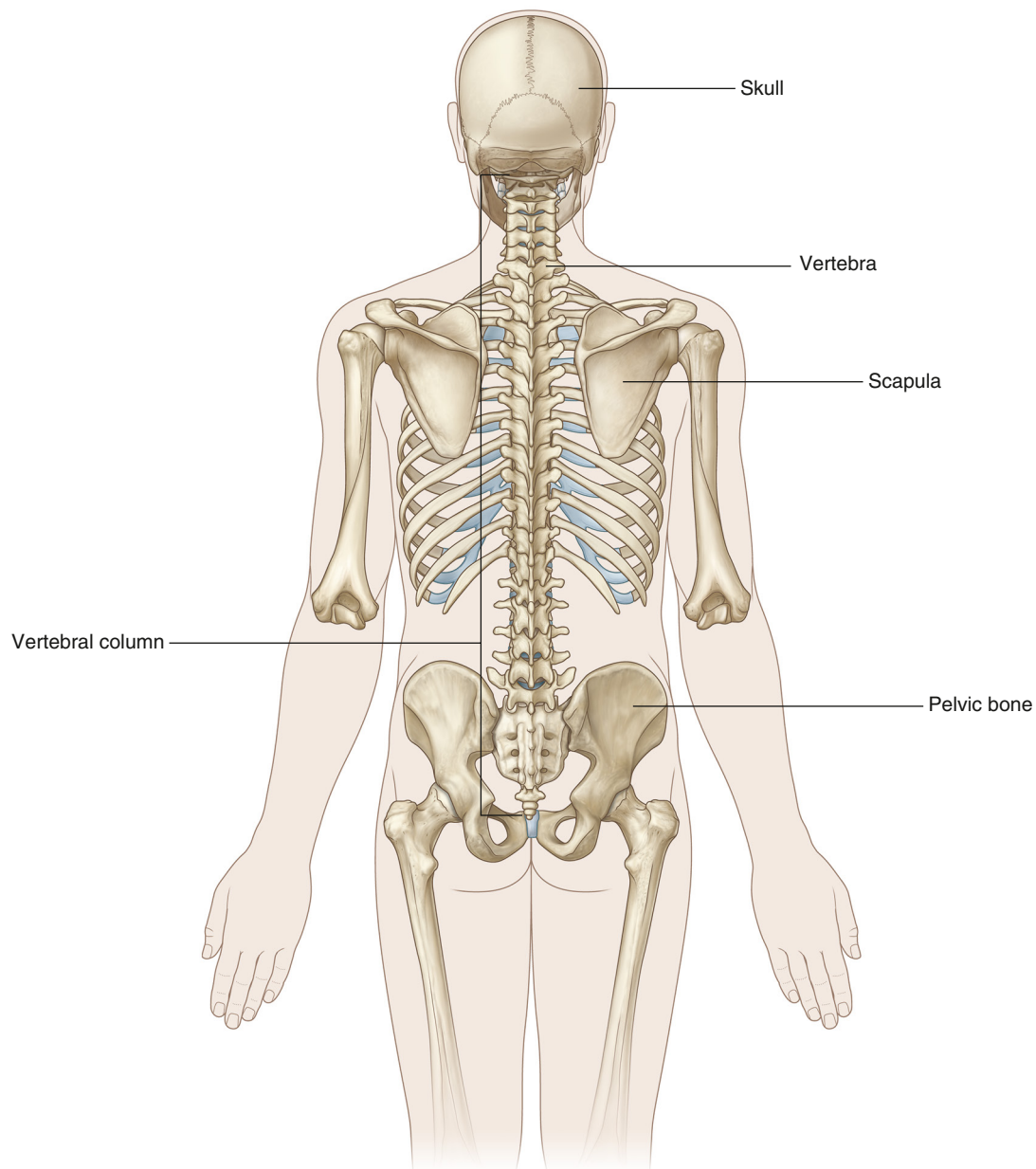


## Conceptual overview

### GENERAL DESCRIPTION

The back consists of the posterior aspect of the body and provides the musculoskeletal axis of support for the trunk. Bony elements consist mainly of the vertebrae, although proximal elements of the ribs, superior aspects of the pelvic bones, and posterior basal regions of the skull contribute to the back's skeletal framework ([Fig. 2.1](#)).

Associated muscles interconnect the vertebrae and ribs with each other and with the pelvis and skull. The back contains the spinal cord and proximal parts of the spinal nerves, which send and receive information to and from most of the body.



**Fig. 2.1** Skeletal Framework of the Back.



# 3

# Thorax

## ADDITIONAL LEARNING RESOURCES for Chapter 3, Thorax, CAN BE FOUND ON THE ACCOMPANYING EBOOK

- Self-Assessment—National Board—style multiple-choice questions, Chapter 3
- Short Questions—these are questions requiring short responses, Chapter 3
- Interactive Surface Anatomy—interactive surface animations, Chapter 3
- Clinical Cases, Chapter 3
  - Aortic dissection
  - Broken pacemaker
  - Cardiac tamponade
  - Cervical rib
  - Chest wound
  - Coarctation of the aorta
  - Cystic fibrosis with bronchiectasis
  - Esophageal cancer
  - Lung cancer
  - Patent ductus arteriosus
  - Pneumonia
  - Sinus of Valsalva aneurysm
  - Subclavian steal syndrome
  - Venous access

## Free Online Anatomy and Embryology Self-Study Course

- Anatomy modules 4 through 9
- Embryology modules 61 through 64

## Conceptual overview 125

### General description 125

#### Functions 126

- Breathing 126
- Protection of vital organs 126
- Conduit 126

#### Component parts 126

- Thoracic wall 126
- Superior thoracic aperture 128
- Inferior thoracic aperture 128
- Diaphragm 129
- Mediastinum 130
- Pleural cavities 130

#### Relationship to other regions 132

- Neck 132
- Upper limb 132
- Abdomen 132
- Breast 133

#### Key features 134

- Vertebral level TIV/V 134
- Venous shunts from left to right 134
- Segmental neurovascular supply of thoracic wall 136
- Sympathetic system 138
- Flexible wall and inferior thoracic aperture 138
- Innervation of the diaphragm 139

## Regional anatomy 140

### Pectoral region 140

- Breast 140
- Muscles of the pectoral region 143

### Thoracic wall 144

- Skeletal framework 144
- Intercostal spaces 151

### Diaphragm 163

- Arterial supply 164
- Venous drainage 164
- Innervation 164

**Movements of the thoracic wall and diaphragm during breathing 164**

**Pleural cavities 166**

Pleura 166

Lungs 170

**Mediastinum 185**

Anterior mediastinum 185

Middle mediastinum 186

Superior mediastinum 217

Posterior mediastinum 229

***Surface anatomy 238***

Thorax surface anatomy 238

How to count ribs 238

Surface anatomy of the breast in women 239

Visualizing structures at the TIV/V vertebral level 239

Visualizing structures in the superior mediastinum 240

Visualizing the margins of the heart 241

Where to listen for heart sounds 242

Visualizing the pleural cavities and lungs, pleural recesses, and lung lobes and fissures 242

Where to listen for lung sounds 244

## Conceptual overview

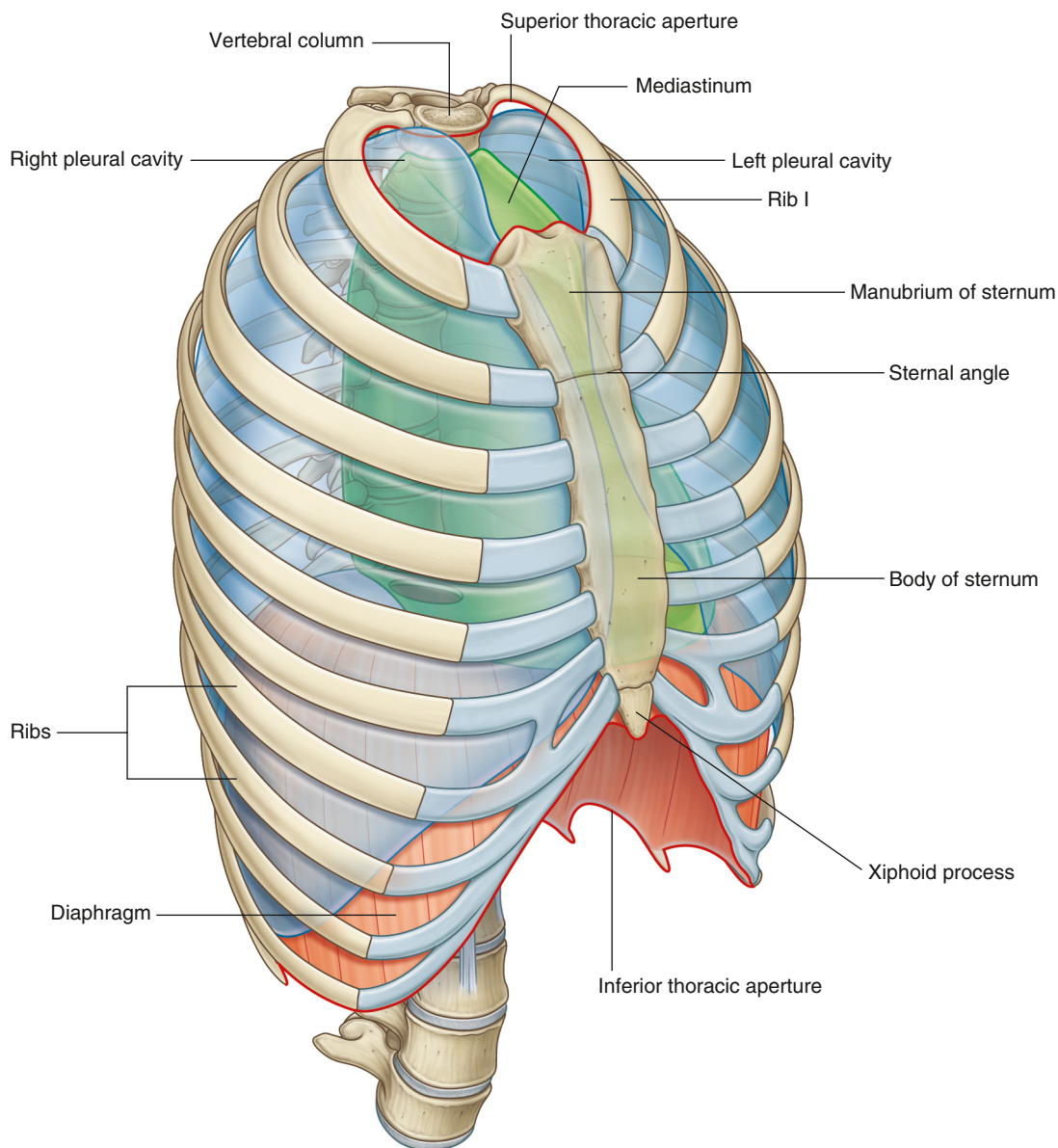
### GENERAL DESCRIPTION

The **thorax** is an irregularly shaped cylinder with a narrow opening (superior thoracic aperture) superiorly and a relatively large opening (inferior thoracic aperture) inferiorly (Fig. 3.1). The superior thoracic aperture is open, allowing continuity with the neck; the inferior thoracic aperture is closed by the diaphragm.

The musculoskeletal wall of the thorax is flexible and consists of segmentally arranged vertebrae, ribs, and muscles and the sternum.

The **thoracic cavity** enclosed by the thoracic wall and the diaphragm is subdivided into three major compartments:

- a left and a right pleural cavity, each surrounding a lung, and
- the mediastinum.



**Fig. 3.1** Thoracic Wall and Cavity.



# 4

# Abdomen

## ADDITIONAL LEARNING RESOURCES for Chapter 4, Abdomen, CAN BE FOUND ON THE ACCOMPANYING EBOOK

- Self-Assessment—National Board—style multiple-choice questions, Chapter 4
- Short Questions—these are questions requiring short responses, Chapter 4
- Interactive Surface Anatomy—interactive surface animations, Chapter 4
- Clinical Cases, Chapter 4
  - Aorto-iliac occlusive disease
  - Caval obstruction
  - Colon cancer
  - Complications of an abdominoperineal resection
  - Diverticular disease
  - Endoleak after endovascular repair of abdominal aortic aneurysm
  - Hodgkin's lymphoma
  - Inguinal hernia
  - Intraabdominal abscess
  - Intussusception
  - Liver biopsy in patients with suspected liver cirrhosis
  - Ureteric stone
  - Zollinger-Ellison syndrome

## Free Online Anatomy and Embryology Self-Study Course

- Anatomy modules 10 through 17
- Embryology modules 65 and 66

## Conceptual overview 249

### General description 249

#### Functions 250

- Houses and protects major viscera 250
- Breathing 252
- Changes in intraabdominal pressure 252

#### Component parts 253

- Wall 253
- Abdominal cavity 254
- Inferior thoracic aperture 256
- Diaphragm 256
- Pelvic inlet 257

#### Relationship to other regions 257

- Thorax 257
- Pelvis 257
- Lower limb 258

#### Key features 259

- Arrangement of abdominal viscera in the adult 259
- Skin and muscles of the anterior and lateral abdominal wall and thoracic intercostal nerves 262
- The groin is a weak area in the anterior abdominal wall 263
- Vertebral level LI 265
- The gastrointestinal system and its derivatives are supplied by three major arteries 265
- Venous shunts from left to right 267
- All venous drainage from the gastrointestinal system passes through the liver 268
- Abdominal viscera are supplied by a large prevertebral plexus 270

## Regional anatomy 271

### Surface topography 271

- Four-quadrant pattern 271
- Nine-region pattern 272

<b>Abdominal wall</b>	<b>274</b>
Superficial fascia	274
Anterolateral muscles	276
Extraperitoneal fascia	282
Peritoneum	282
Innervation	283
Arterial supply and venous drainage	285
Lymphatic drainage	286
<b>Groin</b>	<b>286</b>
Inguinal canal	288
Inguinal hernias	294
<b>Abdominal viscera</b>	<b>298</b>
Peritoneum	298
Peritoneal cavity	299
Organs	306
Arterial supply	342
Venous drainage	353
Lymphatics	357
Innervation	357
<b>Posterior abdominal region</b>	<b>365</b>
Posterior abdominal wall	366

Viscera	373
Vasculature	386
Lymphatic system	392
Nervous system in the posterior abdominal region	394

## ***Surface anatomy***     **402**

Abdomen surface anatomy	402
Defining the surface projection of the abdomen	402
How to find the superficial inguinal ring	403
How to determine lumbar vertebral levels	404
Visualizing structures at the L1 vertebral level	405
Visualizing the position of major blood vessels	406
Using abdominal quadrants to locate major viscera	407
Defining surface regions to which pain from the gut is referred	408
Where to find the kidneys	409
Where to find the spleen	409

## ***Clinical cases***     **409.e1**



## Conceptual overview

### GENERAL DESCRIPTION

The abdomen is a roughly cylindrical chamber extending from the inferior margin of the thorax to the superior margin of the pelvis and the lower limb (Fig. 4.1A).

The **inferior thoracic aperture** forms the superior opening to the abdomen and is closed by the diaphragm.

Inferiorly, the deep abdominal wall is continuous with the pelvic wall at the **pelvic inlet**. Superficially, the inferior limit of the abdominal wall is the superior margin of the lower limb.

The chamber enclosed by the abdominal wall contains a single large **peritoneal cavity**, which freely communicates with the pelvic cavity.

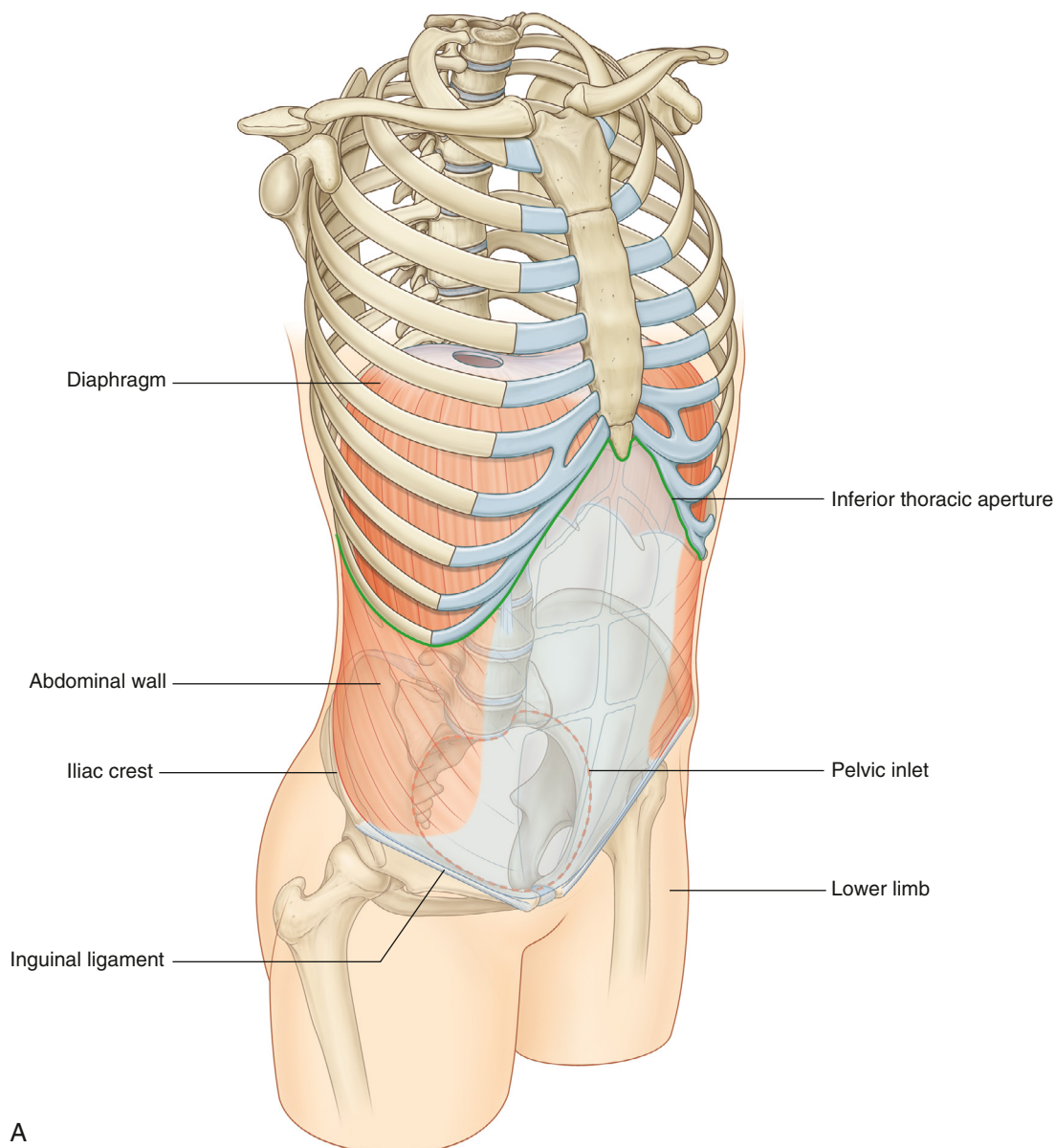


Fig. 4.1 Abdomen. (A) Boundaries.

# 5

# Pelvis and Perineum

## ADDITIONAL LEARNING RESOURCES for Chapter 5, Pelvis and Perineum, CAN BE FOUND ON THE ACCOMPANYING EBOOK

- Self-Assessment—National Board—style multiple-choice questions, Chapter 5
- Short Questions—these are questions requiring short responses, Chapter 5
- Interactive Surface Anatomy—interactive surface animations, Chapter 5
- Clinical Cases, Chapter 5
  - Ectopic pregnancy
  - Iatrogenic ureteric injury
  - Left common iliac artery obstruction
  - Ovarian torsion
  - Pelvic kidney
  - Sciatic nerve compression
  - Uterine fibroids
  - Uterine tumor
  - Varicocele

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- Anatomy modules 18 through 22
- Embryology modules 68 through 70

### Conceptual overview 413

#### General description 413

#### Functions 413

Contain and support bladder, rectum, anal canal, and reproductive tracts 413

Anchor the roots of the external genitalia 415

#### Component parts 416

Pelvic inlet 416

Pelvic walls 416

Pelvic outlet 418

Pelvic floor 419

Pelvic cavity 419

Perineum 420

#### Relationship to other regions 422

Abdomen 422

Lower limb 423

#### Key features 424

The pelvic cavity projects posteriorly 424

Important structures cross the ureters in the pelvic cavity 425

The prostate in men and the uterus in women are anterior to the rectum 426

The perineum is innervated by sacral spinal cord segments 426

Nerves are related to bone 427

Parasympathetic innervation from spinal cord levels S2 to S4 controls erection 428

Muscles and fascia of the pelvic floor and perineum intersect at the perineal body 429

The course of the urethra is different in men and women 429

---

## **Regional anatomy 431**

### **Pelvis 431**

- Bones 431
- Joints 436
- Orientation 438
- Differences between men and women 438
- True pelvis 439
- Viscera 450
- Fascia 474
- Peritoneum 474
- Nerves 479
- Blood vessels 488
- Lymphatics 494

### **Perineum 495**

- Borders and ceiling 495
- Ischio-anal fossae and their anterior recesses 497
- Anal triangle 497
- Urogenital triangle 499

Somatic nerves 508

Visceral nerves 510

Blood vessels 511

Veins 511

Lymphatics 514

## **Surface anatomy 515**

Surface anatomy of the pelvis and perineum 515

Orientation of the pelvis and perineum in the anatomical position 515

How to define the margins of the perineum 515

Identification of structures in the anal triangle 517

Identification of structures in the urogenital triangle of women 518

Identification of structures in the urogenital triangle of men 518

## **Clinical cases 522.e1**

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## Conceptual overview

### GENERAL DESCRIPTION

The pelvis and perineum are interrelated regions associated with the pelvic bones and terminal parts of the vertebral column. The pelvis is divided into two regions:

- The superior region related to upper parts of the pelvic bones and lower lumbar vertebrae is the **false pelvis (greater pelvis)** and is generally considered part of the abdominal cavity (Fig. 5.1).
- The **true pelvis (lesser pelvis)** is related to the inferior parts of the pelvic bones, sacrum, and coccyx, and has an inlet and an outlet.

The bowl-shaped **pelvic cavity** enclosed by the true pelvis consists of the pelvic inlet, walls, and floor. This cavity is continuous superiorly with the abdominal cavity

and contains elements of the urinary, gastrointestinal, and reproductive systems.

The perineum (see Fig. 5.1) is inferior to the floor of the pelvic cavity; its boundaries form the **pelvic outlet**. The perineum contains the external genitalia and external openings of the genitourinary and gastrointestinal systems.

### FUNCTIONS

#### Contains and supports the bladder, rectum, anal canal, and reproductive tracts

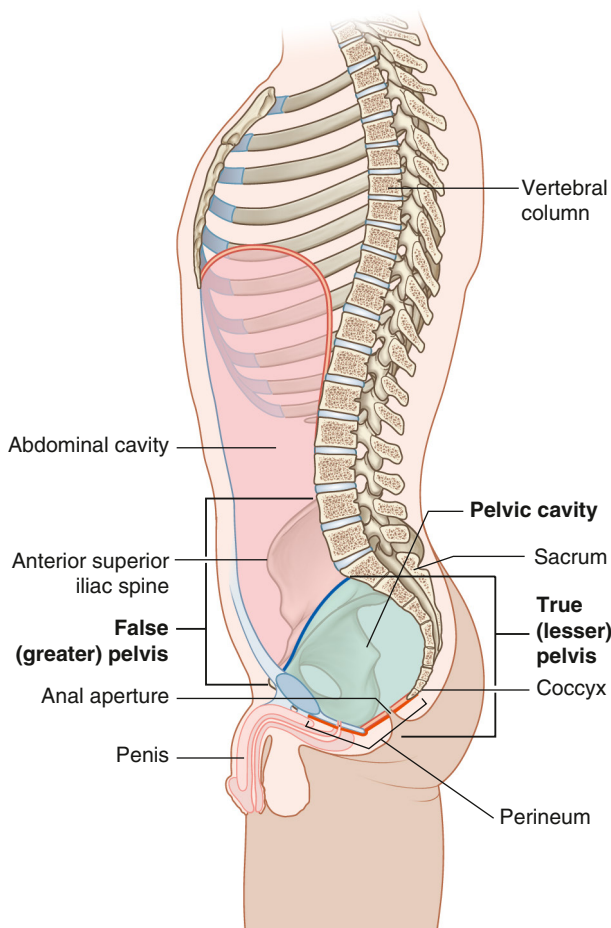
Within the pelvic cavity, the bladder is positioned anteriorly and the rectum posteriorly in the midline.

As it fills, the bladder expands superiorly into the abdomen. It is supported by adjacent elements of the pelvic bone and by the pelvic floor. The urethra passes through the pelvic floor to the perineum, where, in women, it opens externally (Fig. 5.2A) and in men it enters the base of the penis (Fig. 5.2B).

Continuous with the sigmoid colon at the level of vertebra SIII, the rectum terminates at the anal canal, which penetrates the pelvic floor to open into the perineum. The anal canal is angled posteriorly on the rectum. This flexure is maintained by muscles of the pelvic floor and is relaxed during defecation. A skeletal muscle sphincter is associated with the anal canal and the urethra as each passes through the pelvic floor.

The pelvic cavity contains most of the reproductive tract in women and part of the reproductive tract in men.

- In women, the vagina penetrates the pelvic floor and connects with the uterus in the pelvic cavity. The uterus is positioned between the rectum and the bladder. A uterine (fallopian) tube extends laterally on each side toward the pelvic wall to open near the ovary.
- In men, the pelvic cavity contains the site of connection between the urinary and reproductive tracts. It also contains major glands associated with the reproductive system—the prostate and two seminal vesicles.



**Fig. 5.1** Pelvis and Perineum.



# 6

## Lower Limb

### ADDITIONAL LEARNING RESOURCES for Chapter 6, Lower Limb, CAN BE FOUND ON THE ACCOMPANYING EBOOK

- Self-Assessment—National Board—style multiple-choice questions, Chapter 6
- Short Questions—these are questions requiring short responses, Chapter 6
- Interactive Surface Anatomy—interactive surface animations, Chapter 6
- PT Case Studies, Chapter 6
  - Achilles tendinitis and tendinosis
  - Anterior lateral shin splints
  - Eversion ankle sprain
  - High ankle sprain
  - Patellofemoral pain syndrome
  - Plantar fasciitis

*See more PT Case Studies online*

- Clinical Cases, Chapter 6

### Free Online Anatomy and Embryology Self-Study Course

Anatomy modules 26 through 31  
Embryology module 71

### Conceptual overview 525

#### General Description 525

#### Function 527

- Support the body weight 527
- Locomotion 527

#### Component parts 529

- Bones and joints 529
- Muscles 533

#### Relationship to other regions 535

- Abdomen 535
- Pelvis 535
- Perineum 535

#### Key features 535

- Innervation is by lumbar and sacral spinal nerves 535
- Nerves related to bone 540
- Superficial veins 540

### Regional anatomy 541

- Bony pelvis 541
- Proximal femur 544
- Hip joint 548
- Gateways to the lower limb 552
- Nerves 553
- Arteries 556
- Veins 558
- Lymphatics 560
- Deep fascia and the saphenous opening 561
- Femoral triangle 562

#### Gluteal region 564

- Muscles 564
- Nerves 569
- Arteries 572
- Veins 573
- Lymphatics 573

#### Thigh 573

- Bones 574
- Muscles 579



Arteries 590  
Veins 593  
Nerves 594  
Knee joint 596  
Tibiofibular joint 607  
Popliteal fossa 607

**Leg 610**

Bones 610  
Joints 612  
Posterior compartment of leg 613  
Lateral compartment of leg 620  
Anterior compartment of leg 622

**Foot 625**

Bones 627  
Joints 631  
Tarsal tunnel, retinacula, and arrangement of major structures at the ankle 640  
Arches of the foot 642  
Plantar aponeurosis 643  
Fibrous sheaths of toes 643  
Extensor hoods 644  
Intrinsic muscles 644

Arteries 651  
Veins 653  
Nerves 653

***Surface anatomy 657***

Lower limb surface anatomy 657  
Avoiding the sciatic nerve 657  
Finding the femoral artery in the femoral triangle 658  
Identifying structures around the knee 658  
Visualizing the contents of the popliteal fossa 660  
Finding the tarsal tunnel—the gateway to the foot 661  
Identifying tendons around the ankle and in the foot 662  
Finding the dorsalis pedis artery 663  
Approximating the position of the plantar arterial arch 663  
Major superficial veins 664  
Pulse points 665

***Clinical cases 665.e1***

## Conceptual overview

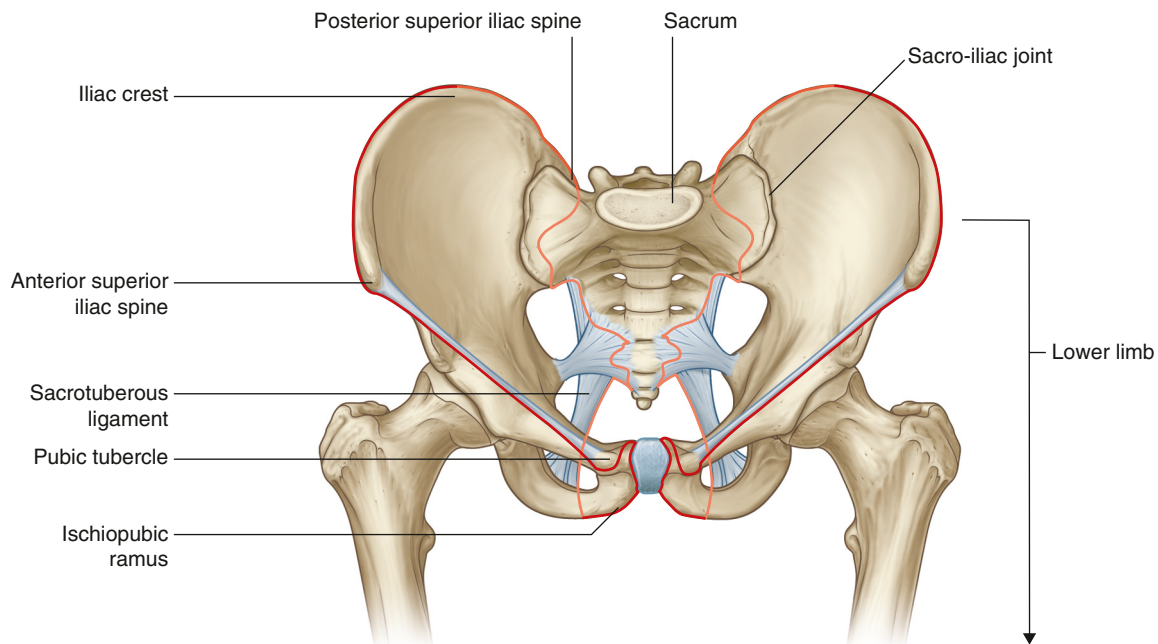
### GENERAL DESCRIPTION

The lower limb is directly anchored to the axial skeleton by a sacroiliac joint and by strong ligaments, which link the pelvic bone to the sacrum. It is separated from the abdomen, back, and perineum by a continuous line (Fig. 6.1), which:

- joins the pubic tubercle with the anterior superior iliac spine (position of the inguinal ligament) and then continues along the iliac crest to the posterior superior

iliac spine to separate the lower limb from the anterior and lateral abdominal walls;

- passes between the posterior superior iliac spine and along the dorsolateral surface of the sacrum to the coccyx to separate the lower limb from the muscles of the back; and
- joins the medial margin of the sacrotuberous ligament, the ischial tuberosity, the ischiopubic ramus, and the pubic symphysis to separate the lower limb from the perineum.



**Fig. 6.1** Upper Margin of the Lower Limb.

## ادامه دارد ...

برای مطالعه ادامه کتاب، می توانید با  
مراجعه به سایت انتشارات اندیشه رفیع،  
اقدام به تهیه آن نمایید.



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