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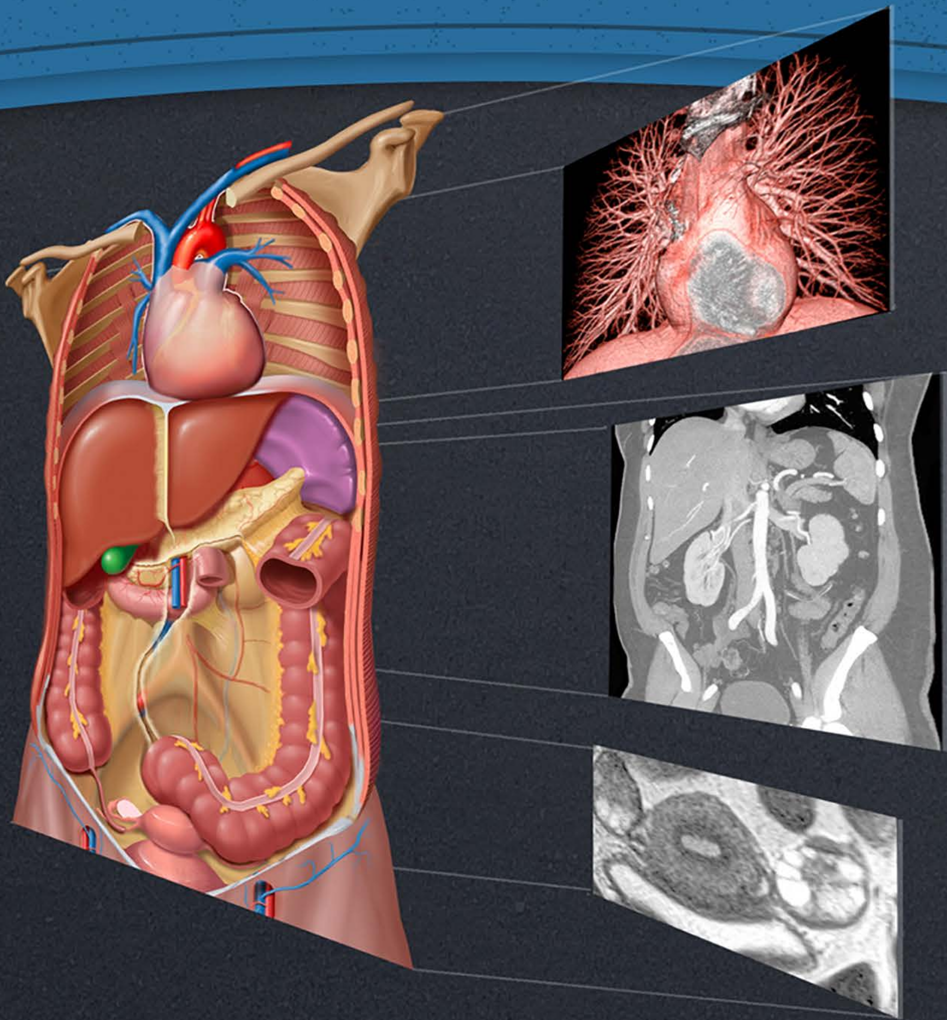
IMAGING ANATOMY
Chest·Abdomen·Pelvis

SECOND EDITION



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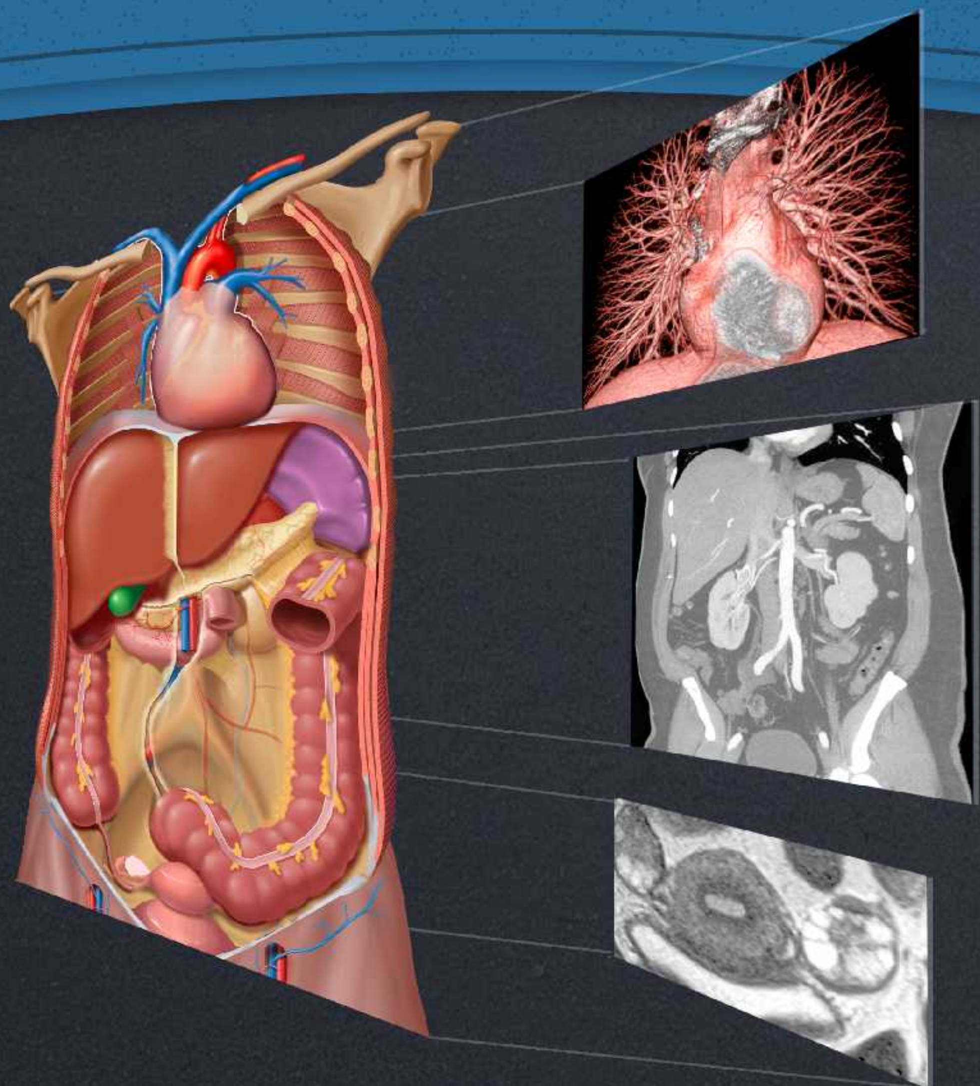

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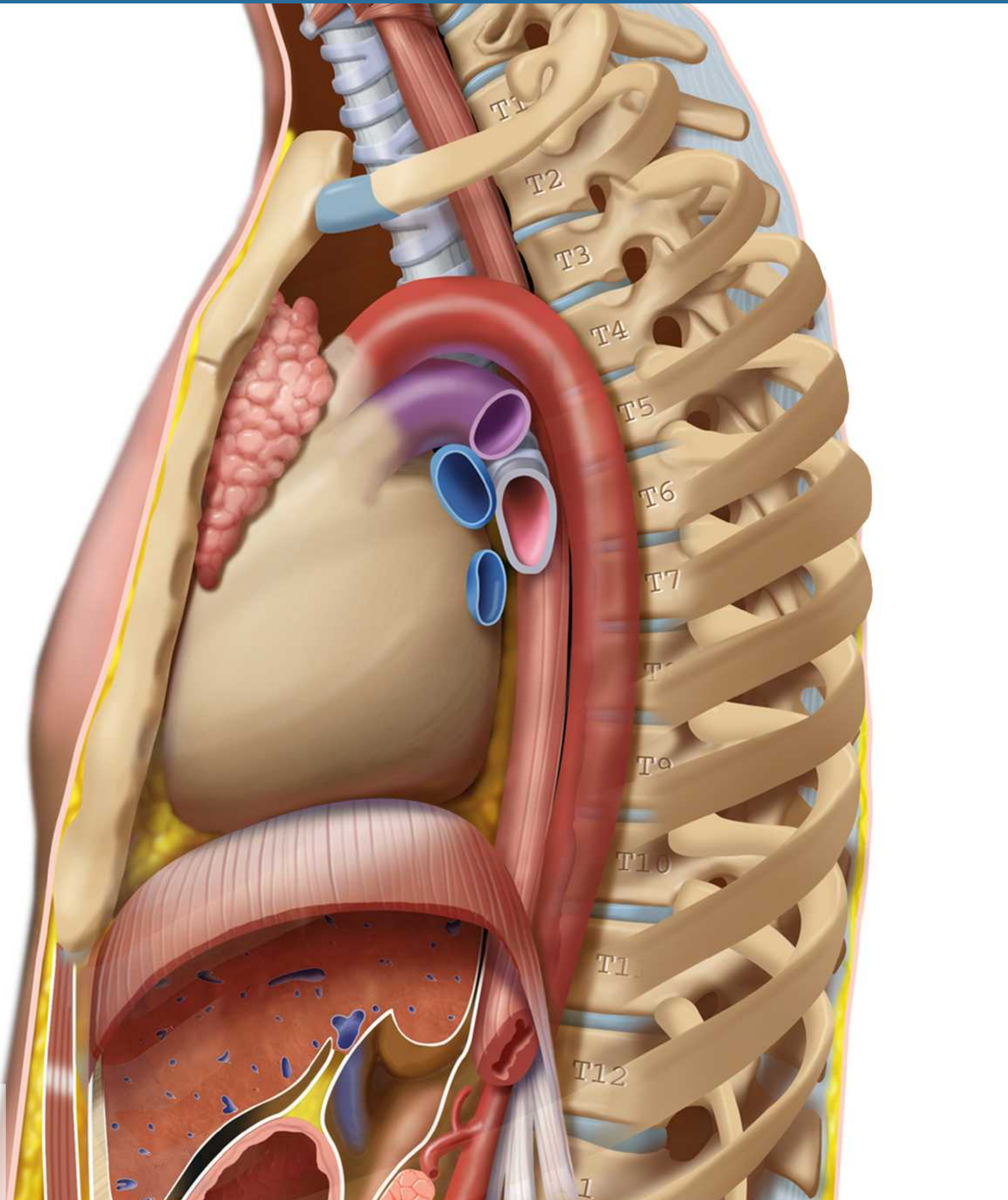
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Dedications

To Ric Harnsberger, whose vision, enthusiasm, charisma, and hard work created and sustained this entire enterprise. Your legacy will endure long after all of our names are forgotten.

MPF

To my family, especially my husband, Paul, and my daughters, Jennifer and Heather, whose love, encouragement, and support have seen me through this project. To my dear friend and coauthor, Dr. Brett Carter, from whom I continue to learn every day.

MRDC

To my wife, Janani Venkateswaran, whose support throughout my career has helped sustain me and drive me forward.

SPR

I dedicate this project to my parents, Ralph and Joy Carter, without whom this effort would not have been possible.

BWC

To Miguel Flores.
The stalwart patriarch of the Flores/z clan, whose staunch work ethic remains an inspiration to me. You started in this world with so little and have done so much. Thank you not only for your example but also for your hijo.

PJW

To my parents, I truly owe you everything.
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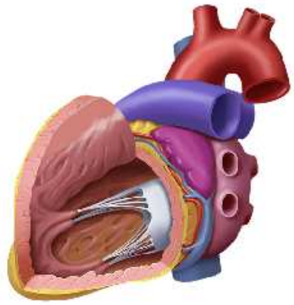
AMS



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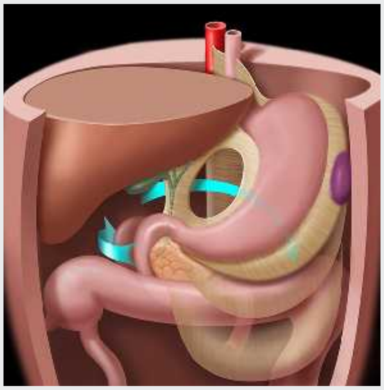

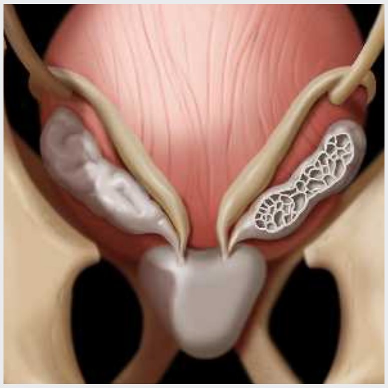

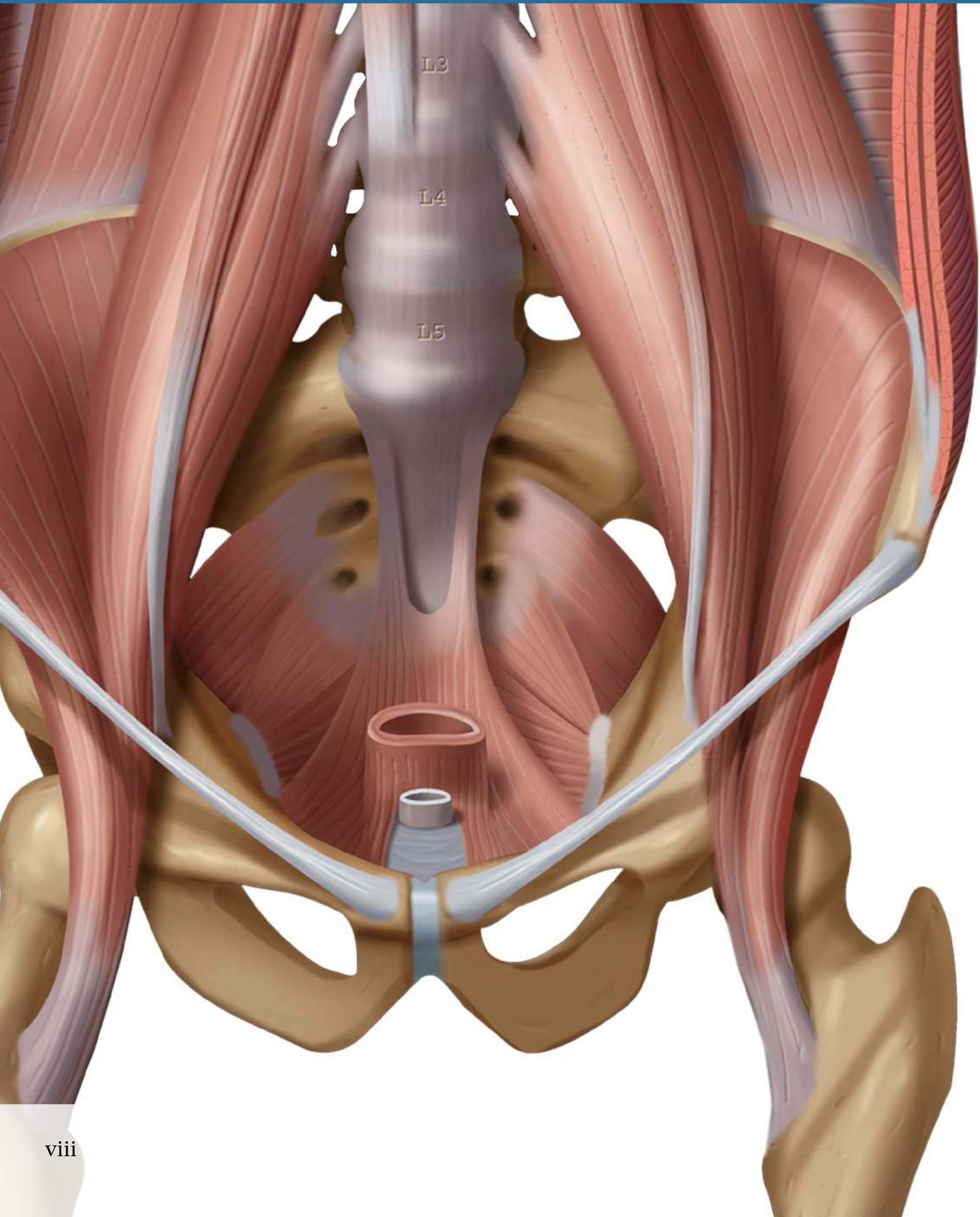
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Preface

In his elegant foreword to the first edition of this book, Professor Morton Meyers related the evolution of our understanding of human anatomy, from Vesalius' Fabrica through the many contributions of surgeons, such as Harvey Cushing, who wrote that "...from the publication of the Fabrica almost to the present day the intimate pursuit of...anatomy has constituted the high road for entry into the practice of surgery." Meyers went on to write, "Today it is the radiologist who is most facile with highly detailed anatomy, and who...demonstrates this in vivo. Dissectional anatomy has been superseded by cross-sectional anatomy."

In the decade since the publication of the first edition of this book, our ability to define normal and abnormal anatomy of the chest, abdomen, and pelvis has continued to advance. An example is the major improvement in MR evaluation of the pelvis, depicting in multiple planes with unprecedented detail the pertinent anatomical alterations that may result in pelvic floor laxity, urinary and fecal incontinence, and perianal fistulas. Similar advances have been made in the multimodality depiction of anatomic structures throughout the body, and these have been incorporated into this second edition of Imaging Anatomy.

As with the first edition, we feature what Meyers deemed "exquisite, museum-quality illustrations," paired with the imaging modalities most relevant to the understanding of human anatomy in health and disease.

We hope that the efforts of our radiologist authors and talented medical illustrators will make the anatomy of the chest, abdomen, and pelvis "come alive" for our readers.

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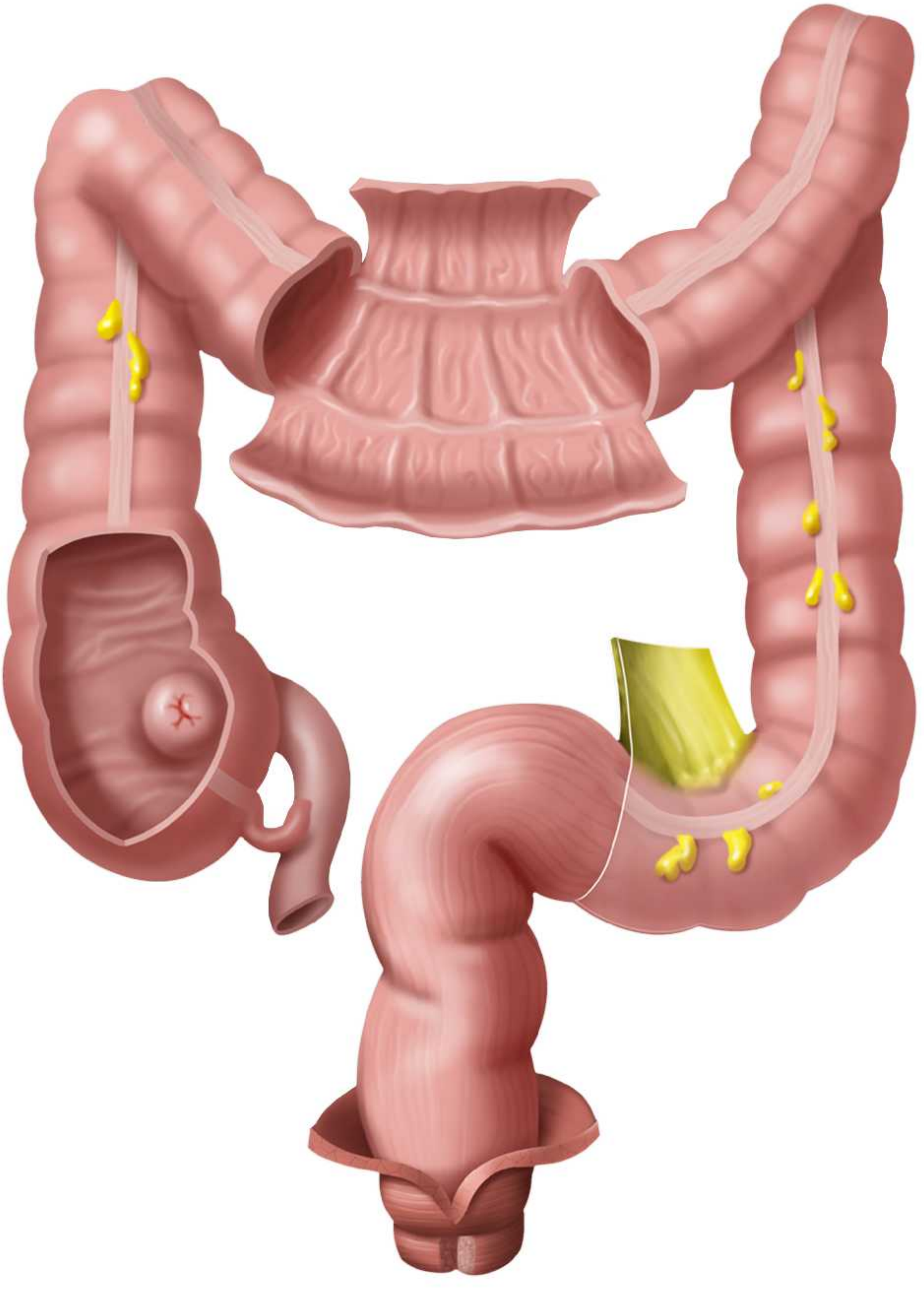

Sections

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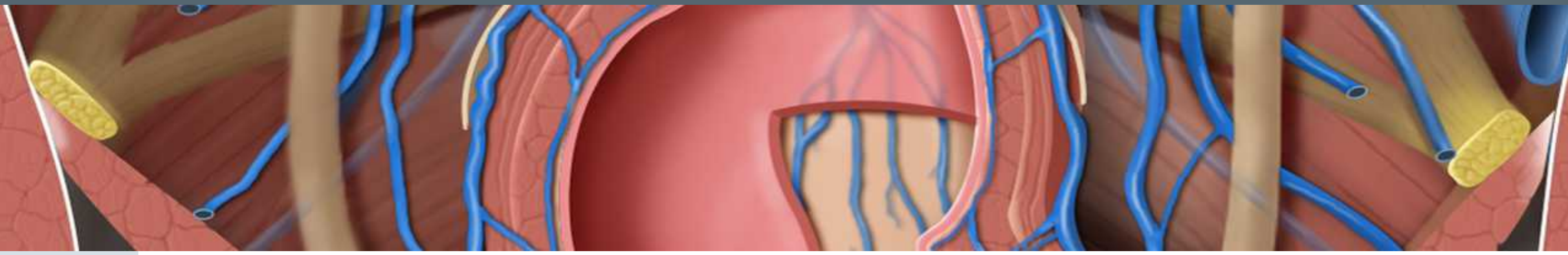

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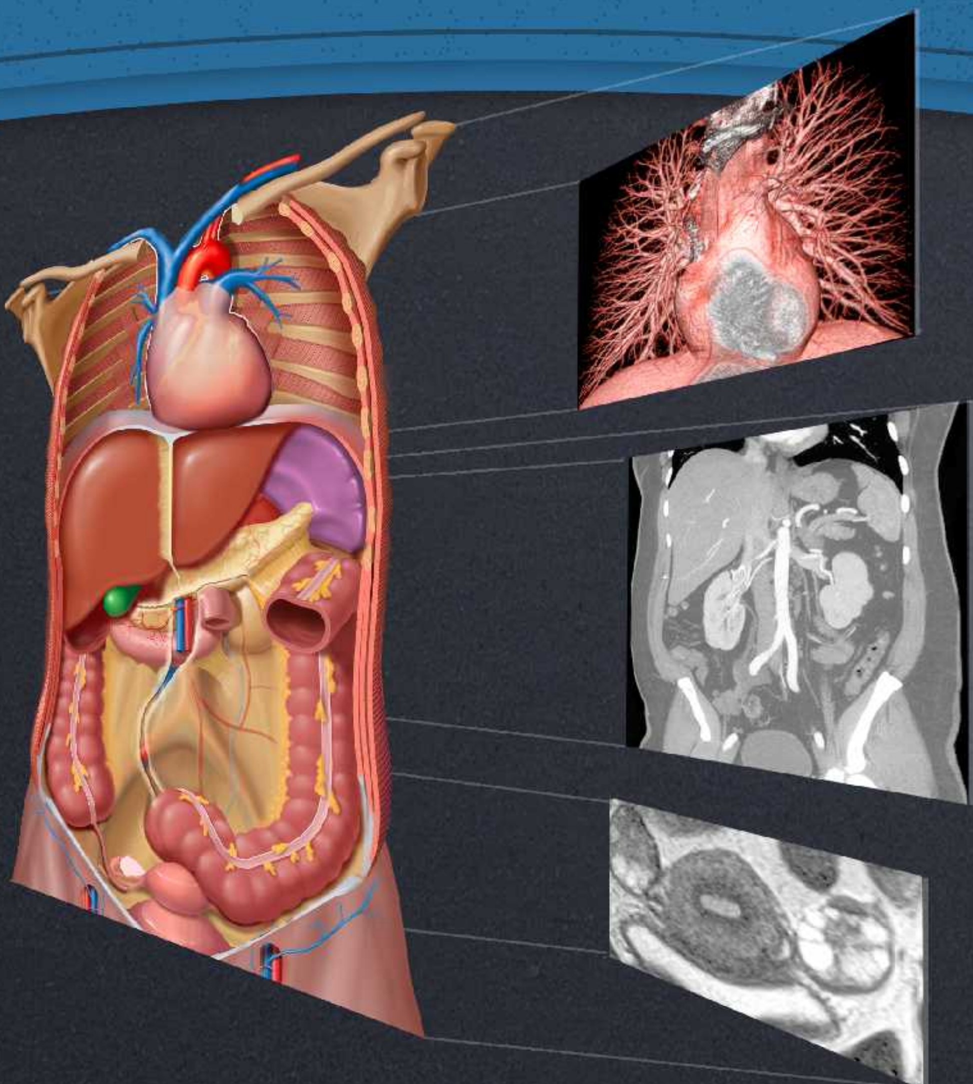

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SECTION 1

Chest

GENERAL ANATOMY AND FUNCTION

Chest Wall

- Anatomy
  - Spine
  - Sternum
  - Ribs
  - Clavicles
  - Scapulae
  - Skeletal muscles
  - Chest wall nerves and vessels
  - Skin and subcutaneous fat
- Function
  - Protects lungs, cardiovascular structures, and intrathoracic organs
  - Participates in bellows-like process of respiration

Pleura

- Anatomy
  - Thin, continuous membrane
  - Parietal pleura: Lines nonpulmonary surfaces
  - Visceral pleura: Lines pulmonary surfaces
  - Pleural space: Potential space between pleural surfaces
- Function
  - Production and absorption of normal pleural fluid
    - Lubrication of pleural surfaces
    - Facilitation of lung motion during respiration
  - Clearance of abnormal pleural fluid

Airways

- Anatomy
  - Trachea
  - Mainstem bronchi
  - Lobar bronchi
  - Segmental/subsegmental bronchi
  - Bronchioles
  - Distal airways and alveoli
- Function
  - Gas exchange during respiration
  - Protective mechanisms against foreign particles
    - Mucociliary escalator
    - Cough reflex
  - Gas exchange to and from alveolar-capillary interface

Heart and Great Vessels

- Anatomy
  - Venae cavae
  - Right atrium
  - Right ventricle
  - Pulmonary arteries
  - Capillary network
  - Pulmonary veins
  - Left atrium
  - Left ventricle
  - Thoracic aorta and branches
- Function
  - Pump action for systemic and pulmonary circulations
  - Transport of deoxygenated blood to capillary-alveolar interface
  - Transport of oxygenated blood to tissues

CHEST RADIOGRAPHY

Standard Chest Radiography

- Imaging study of choice for initial assessment of cardiopulmonary disease
- PA and lateral chest radiographs
  - Orthogonal views (at right angles to each other)
  - Analysis of orthogonal views for precise anatomic localization of imaging abnormalities

Standard Radiographic Positioning

- Upright patient
- Full inspiration and breath hold near total lung capacity
- No rotation or motion
- Attempt to minimize overlying osseous structures
- Area of interest closest to image receptor (IR)
- Radiographic technique
  - Source-to-image receptor distance (SID): 72 inches to minimize magnification
  - Central x-ray beam centered on thorax
  - Beam collimation to include outer chest wall

Radiographic Projections

- **Posteroanterior (PA) chest radiography**
  - Term PA: Describes PA direction of x-ray beam traversing chest toward IR
  - Anterior chest against IR
  - Head vertically positioned and chin on top of grid device
  - Dorsal wrists on hips, and elbows rotated anteriorly to move scapulae laterally
  - Shoulders moved caudally and squarely against IR to bring clavicles below apices
- **Left lateral chest radiography**
  - Term **left lateral**: Denotes that left lateral chest wall is against IR
  - X-ray beam traverses chest from right to left toward IR
  - Arms above head to move upper extremities away from lungs and mediastinum
- **Anteroposterior (AP) chest radiography**
  - Term AP: Describes anteroposterior direction of x-ray beam traversing chest toward IR
  - Supine and bedside (portable) radiography and imaging of sitting and semiupright patients
    - Neonates, infants, and young children
    - Debilitated and unstable patients
    - Critically ill and bed-ridden patients
  - Distinctive features
    - Magnification of anterior structures (heart and mediastinum) farthest from IR; shorter SID
    - Clavicles course horizontally and partially obscure apices
    - Ribs assume horizontal course
- **Lateral decubitus chest radiography**
  - Recumbent position with right or left side down
  - Elevation of chest on radiolucent support
  - Frontal radiograph (AP or PA) with horizontal x-ray beam
  - Indications
    - Evaluation of pleural fluid in dependent pleural space (x-ray beam tangential to fluid-lung interface)
    - Evaluation of air in nondependent pleural space (x-ray beam tangential to visceral pleura-air interface)

- **Apical lordotic** (AP or PA axial) **chest radiography**
  - Superior angulation of x-ray beam from horizontal plane of 15-20°
  - Distinctive features
    - Clavicles and first anterior ribs project above apices
    - Ribs course horizontally
    - Magnification (foreshortening) of mediastinum
  - Indications
    - Radiographic visualization of apex, superior mediastinum and thoracic inlet
    - Enhanced visualization of minor fissure in suspected middle lobe atelectasis
- Expiratory radiography
  - Evaluation of air-trapping
  - Evaluation of pneumothorax (limited value)
    - No clear difference in sensitivity or specificity for diagnosis

Radiographic Interpretation

- Assessment of patient's identity and location of right/left markers
- Assessment of entire thorax
  - **Frontal radiography**
    - Inclusion of all thoracic structures from larynx to lung bases
    - Full inspiration
      - Diaphragm below posterior 9th-10th ribs or at 5th-7th anterior ribs at mid clavicular line
  - **Lateral radiography**
    - Inclusion of anteroposterior extent of chest wall
    - Inclusion of apical lung and posterior costodiaphragmatic sulci
- Assessment of **appropriate radiographic positioning**
  - No rotation
    - Spinous process of T3 (posterior structure) centered between medial clavicles (anterior structures) on frontal radiography
    - Superimposition of right and left ribs posterior to thoracic vertebrae on lateral radiography
  - Medial aspects of scapulae lateral to lungs on frontal radiography
  - Arms above thorax without superimposition on lung and mediastinum on lateral radiography
- **Appropriately exposed radiograph**
  - Assessment of peripheral pulmonary vasculature
  - Visualization of pulmonary vessels through heart and diaphragm on frontal radiography
  - Visualization of vertebrae through heart on frontal radiography
- Systematic evaluation
  - Assessment of multiple superimposed structures and tissues
  - Assessment of all visible structures including portions of neck, shoulders, and upper abdomen
  - Anatomic localization of abnormalities
  - Assessment of associated findings
  - Comparison to prior studies
- Challenges
  - Evaluation of retrocardiac lung
  - Evaluation of retrodiaphragmatic lung
  - Evaluation of apical lung

Radiographic Densities

- 5 radiographic densities
  - **Air**
  - **Water** (fluid, blood, and soft tissue)
  - **Fat**
  - **Bone**
  - **Metal** (contrast, metallic portions of medical devices, metallic foreign bodies)
- **Silhouette sign**
  - Intrathoracic process (mass, consolidation, pleural fluid) that touches mediastinum or diaphragm obscures visualization of their borders on radiography
  - Critical for radiographic diagnosis of
    - **Atelectasis**
    - **Consolidation**
    - **Pleural effusion**

COMPUTED TOMOGRAPHY

General Concepts

- Imaging based on x-ray absorption by tissues with differing atomic numbers
- Display of differences in x-ray absorption in cross-sectional format
- Excellent **spatial resolution**
- Enhanced visualization of structures of different tissue density based on display of wide range of Hounsfield unit (HU) measurements
  - **Window width** refers to number of HU displayed
  - **Window level** refers to median (center) HU
  - Window width and level for assessment of thoracic CT
    - **Lung window** (width of 1,500 HU; level of -650 HU)
      - Evaluation of lungs, airways, and air-containing portions of gastrointestinal tract
      - Identification of pneumomediastinum, pneumoperitoneum, and soft tissue gas
    - **Soft tissue (mediastinal) window** (width of 400 HU; level of 40 HU)
      - Evaluation of vascular structures and soft tissues of mediastinum and chest wall
    - **Bone window** (width of 2,000 HU; level of 400 HU)
      - Evaluation of skeletal and calcified structures
      - Evaluation of metallic objects and medical devices
    - **Liver window** (width of 150 HU; level of 50 HU without contrast and 100 HU with contrast)
      - Evaluation of upper abdomen: Liver, kidney
      - Evaluation of pleural effusions for solid pleural nodules

Conventional CT

- Evaluation, localization, and characterization of abnormalities detected on radiography
- Localization of lesions in preparation for CT-guided biopsy/drainage

Contrast-Enhanced CT

- Administration of intravenous contrast
  - Evaluation of vascular structures
  - Evaluation of vascular abnormalities
  - Distinction of vascular structures from adjacent soft tissues (e.g., lymph nodes)

- Determination of lesion/tissue enhancement
- Administration of enteric contrast
  - Evaluation of gastrointestinal perforations/leaks

CT Angiography

- Vascular imaging
  - Timing of contrast bolus
  - Imaging of specific vascular structures
    - CT pulmonary angiography for evaluation of pulmonary thromboembolic disease
    - CT aortography for evaluation of traumatic aortic injury or aneurysm
    - CT aortography for evaluation of acute aortic syndrome
      - Baseline unenhanced images required prior to contrast administration to document intramural hematoma

High-Resolution CT

- Technique
  - Thin sections to minimize partial volume effects
  - High-resolution reconstruction algorithm
- Indications
  - Evaluation of diffuse infiltrative lung disease
  - Evaluation of patients with unexplained dyspnea and normal radiographs
- Special techniques
  - Prone imaging for evaluation of peripheral basilar lung disease
  - Expiratory imaging for evaluation of small airways disease

Postprocessing Techniques

- Multiplanar reformations
  - Multiplanar evaluation of axially oriented structures and abnormalities
  - Evaluation of anatomic location of lung lesions in relation to interlobar fissures
  - Evaluation of chest wall and mediastinal involvement by adjacent pulmonary lesions
  - Coronal and sagittal lesion measurements
- Maximum-intensity projection (MIP)
  - Evaluation of vascular structures
  - Increased conspicuity of pulmonary nodules
- Minimum-intensity projection (minIP)
  - Evaluation of central airways and air-trapping
- Surface-rendered displays
- Volume-rendered techniques for problem solving and education
  - Virtual bronchoscopy

MAGNETIC RESONANCE IMAGING

General Concepts

- Application of radiofrequency to excite protons within magnetic field
- Detection of signal emitted by nuclei as they relax to their original alignment with generation of image depicting their spatial distribution
- Advantages of MR
  - Excellent contrast resolution
  - Multiplanar imaging
  - Intrinsic vascular "contrast"
  - Increased soft tissue contrast

Technique

- Spin-echo sequences typically used in chest imaging
  - T1-weighted images
  - T2-weighted images
- Bright blood sequences

Indications

- Imaging of heart and great vessels
- Distinction of vascular structures from adjacent soft tissues without use of contrast
- Evaluation of mediastinum and hila
- Diagnostic imaging of thymus
- Assessment of chest wall and diaphragm

ANGIOGRAPHY

Pulmonary Angiography

- Venous catheterization
- Cannulation of pulmonary arterial system
- Indications
  - Evaluation of congenital and acquired pulmonary vascular abnormalities
  - Management of selected cases of thromboembolic disease

Aortography

- Arterial catheterization
- Cannulation of proximal aorta
- Indications
  - Evaluation of traumatic aortic and great vessel injury
  - Assessment of congenital arterial vascular anomalies
  - Evaluation of caliber and integrity of aortic and great vessel lumina

Bronchial Artery and Intercostal Arteriography

- Arterial catheterization
- Selective cannulation of bronchial/intercostal arteries
- Indications
  - Diagnosis and treatment of hemoptysis

OTHER CHEST IMAGING MODALITIES

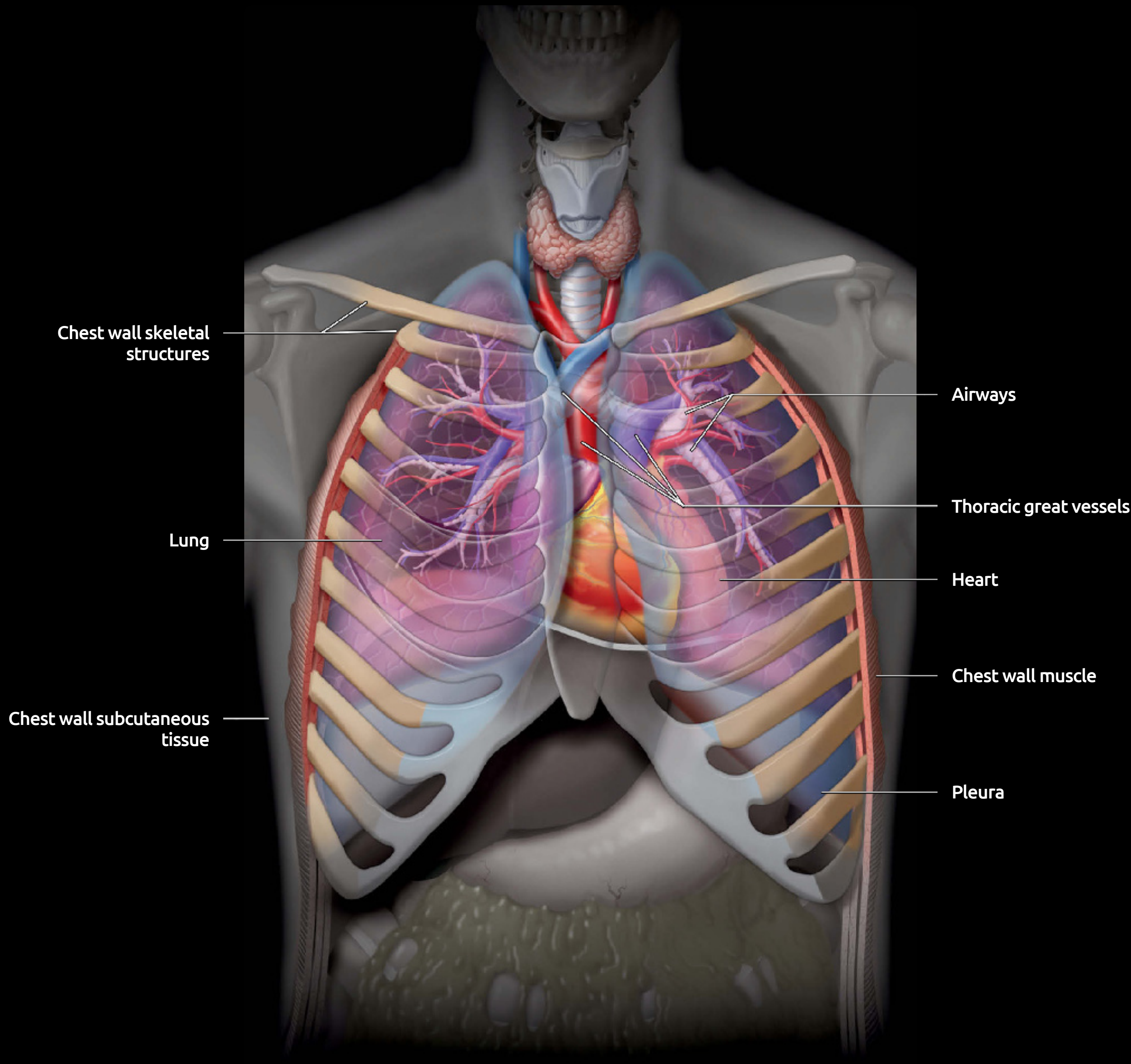
Scintigraphy

- **Positron-emission tomography**
  - Determination of metabolic activity of lesions
  - Staging of malignant neoplasms
  - Use of integrated **PET/CT imaging**
- **Ventilation-perfusion imaging**
  - Evaluation of thromboembolic disease
    - Study of choice in pregnant subjects
  - Evaluation of pre- and postoperative lung function

Ultrasound

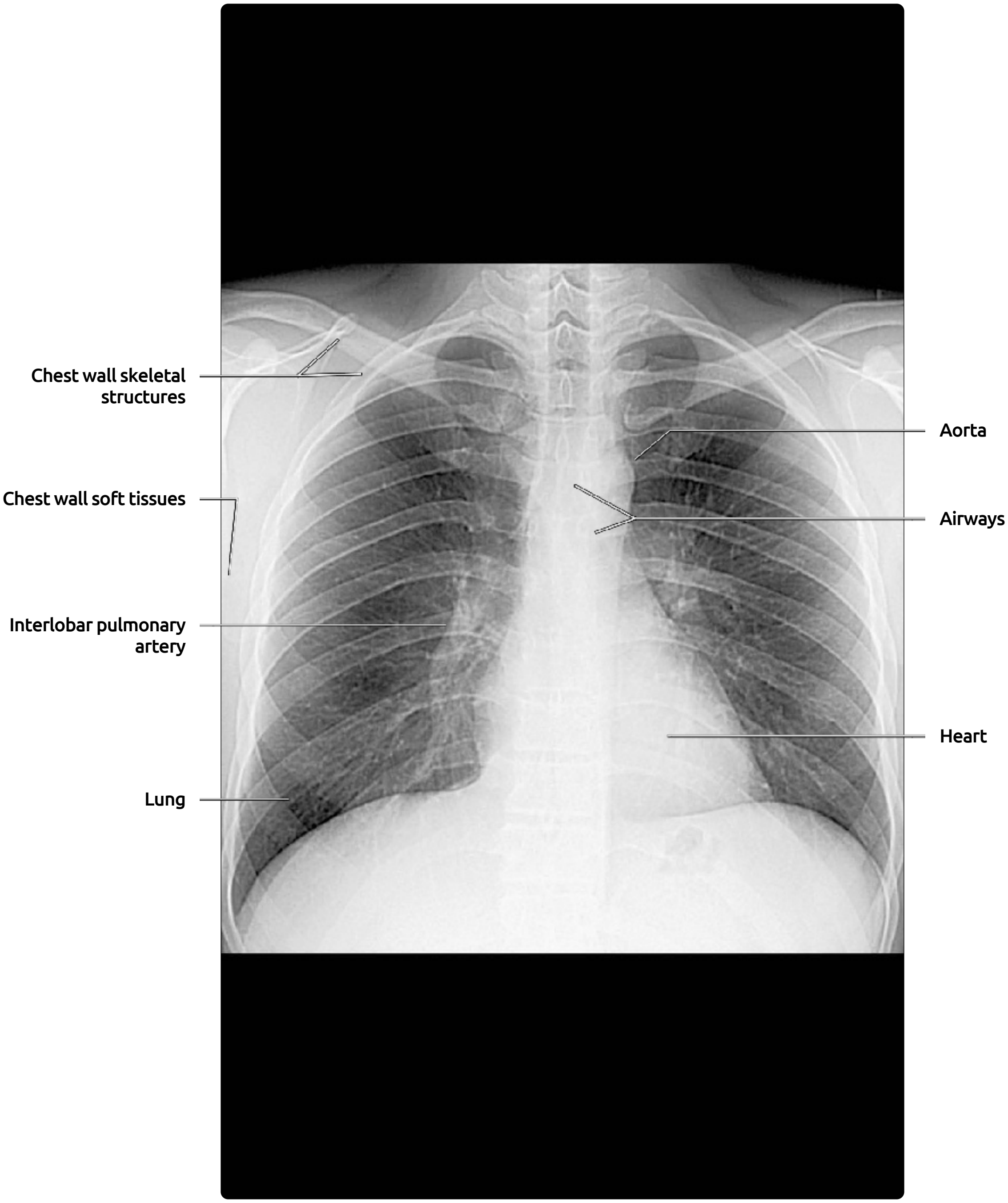
- Evaluation of **pleural effusion**
  - Free vs. loculated
  - Thoracentesis/biopsy planning and thoracostomy tube placement
- Evaluation of diaphragmatic motion in cases of suspected paralysis

CHEST OVERVIEW



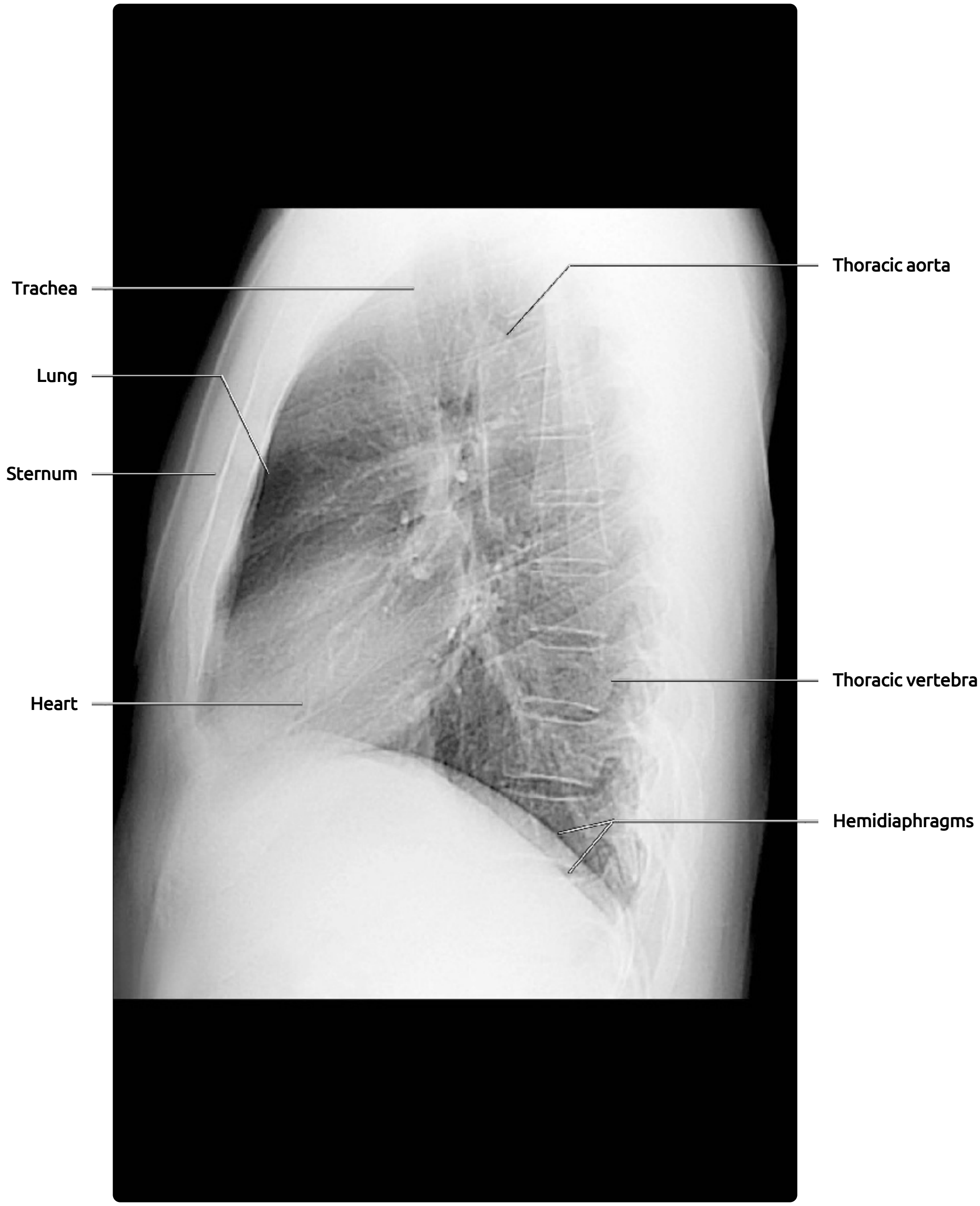
Graphic shows the complex and diverse structures and organs of the thorax. The chest wall skeletal and soft tissue structures surround and protect the primary organs of respiration, the thoracic cardiovascular system, and the proximal gastrointestinal tract. The apposed pleural surfaces create a potential space that normally contains a small amount of fluid, which lubricates the pleural surfaces and reduces friction during respiratory motion. The airways deliver oxygen to the alveolar-capillary interface and carry carbon dioxide out to the environment. The heart and vessels deliver deoxygenated blood to the capillary-alveolar interface and oxygenated blood to the peripheral organs and tissues.

PA CHEST RADIOGRAPHY



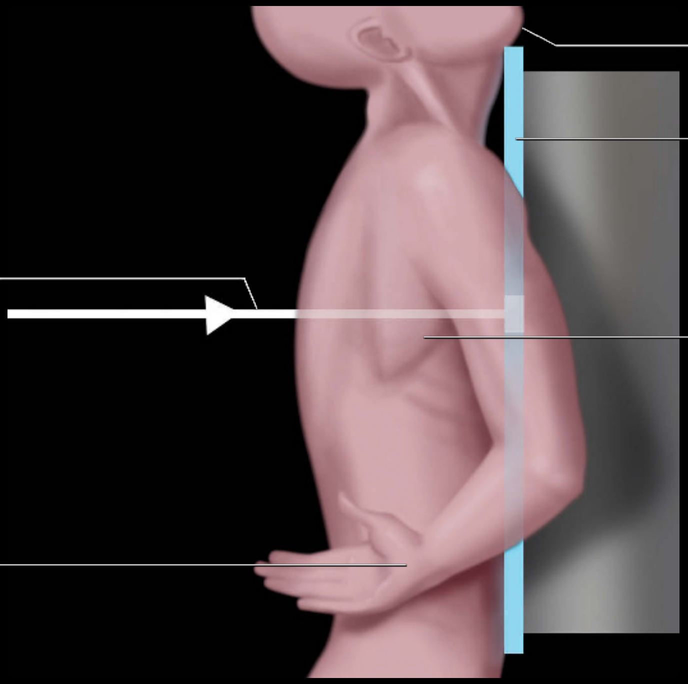
Normal posteroanterior (PA) chest radiograph helps illustrate inherent challenges regarding interpretation of radiographs of the thorax. Chest radiography displays a wide range of structures and tissue types with significant superimposition of structures of different radiographic densities. Portions of the lung may be obscured by overlying mediastinal soft tissues and skeletal structures. Attention to radiographic image quality is of paramount importance for accurate diagnosis of subtle abnormalities.

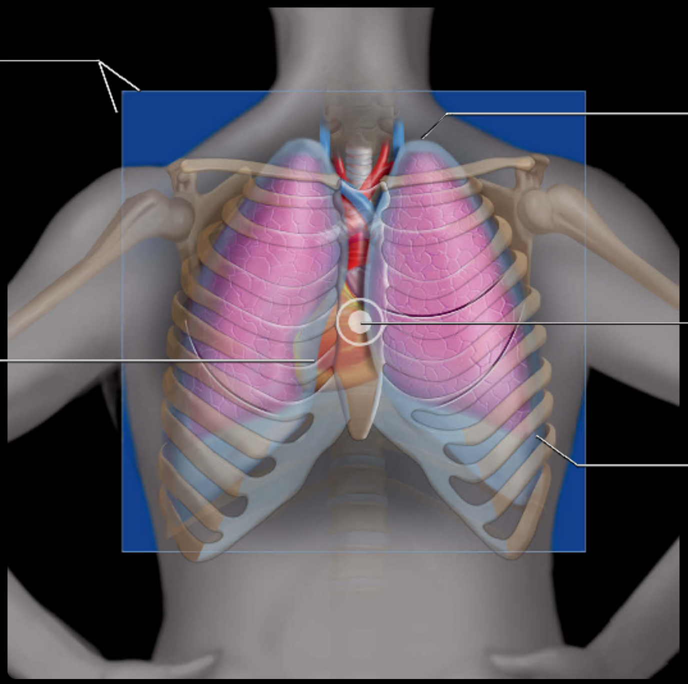
LATERAL CHEST RADIOGRAPHY



Lateral chest radiography is orthogonal (at 90°) to PA chest radiography. The lateral chest radiograph is a complementary radiographic projection that allows visualization of the retrocardiac left lower lobe and the retrodiaphragmatic lung bases, and it allows evaluation of the thoracic vertebrae. As on the PA chest radiograph, multiple structures of various densities are superimposed and must be evaluated in a systematic manner. Evaluation of both PA and lateral chest radiographs allows anatomic localization and characterization of thoracic abnormalities and the formulation of an appropriate differential diagnosis.

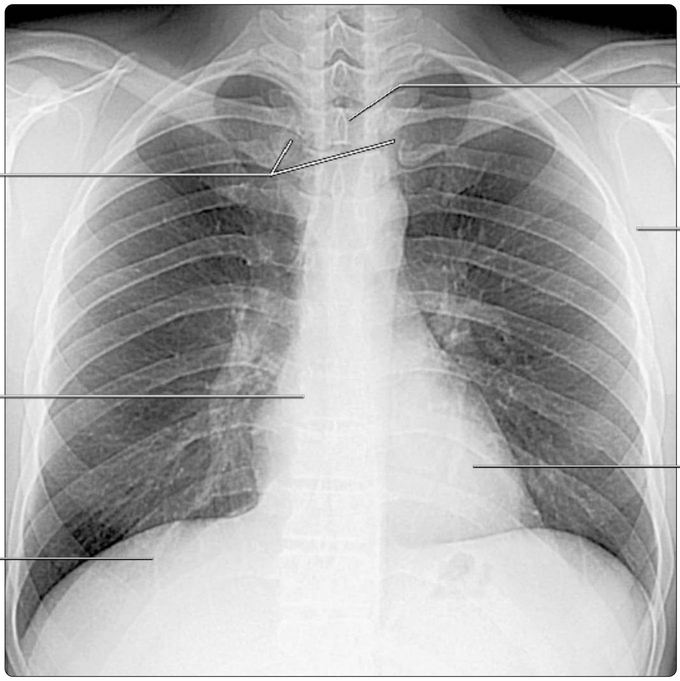
PA CHEST RADIOGRAPHY, POSITIONING AND COLLIMATION

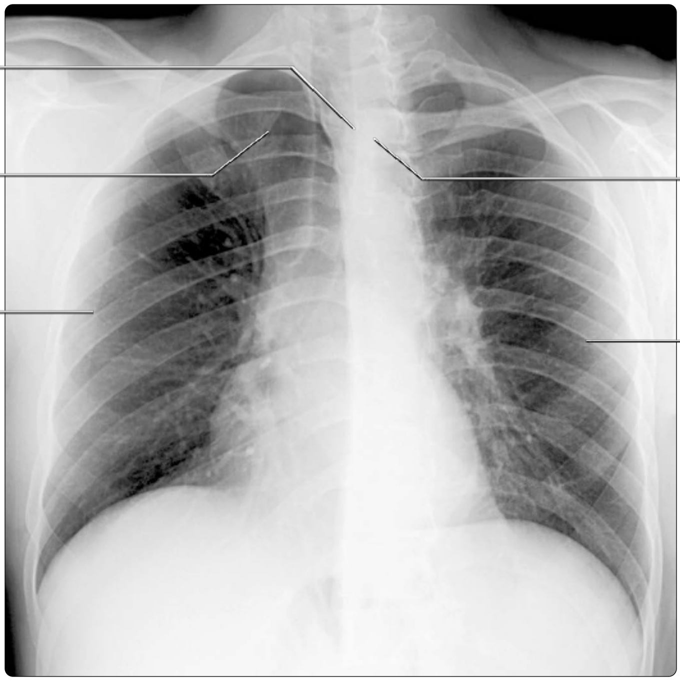




(Top) *Graphic shows proper positioning for PA chest radiography. The patient is upright with the anterior chest against the vertical image receptor, the chin over the top of the device, the arms flexed with the backs of the hands on the hips, and the shoulders internally rotated to move the scapulae off the lungs. The x-ray beam travels through the patient in a posteroanterior direction.* **(Bottom)** *Graphic shows proper PA chest radiographic collimation for imaging the lungs and mediastinum. The white target sign shows the centering of the x-ray beam. The blue overlay represents the collimated x-ray beam that extends from the cervical airway superiorly to below the costophrenic angles inferiorly and includes the left and right skin surfaces. The anterior structures of the chest (shown in color) are closest to the image receptor and experience the least magnification.*

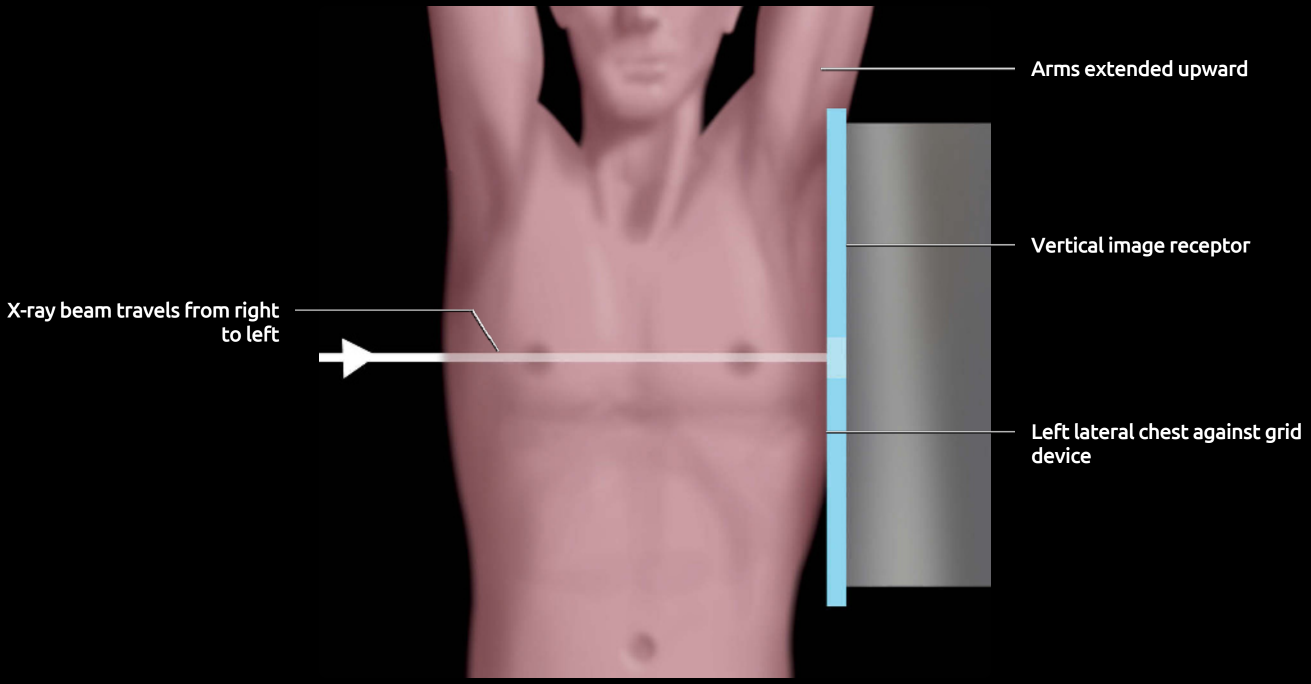
PA CHEST RADIOGRAPHY

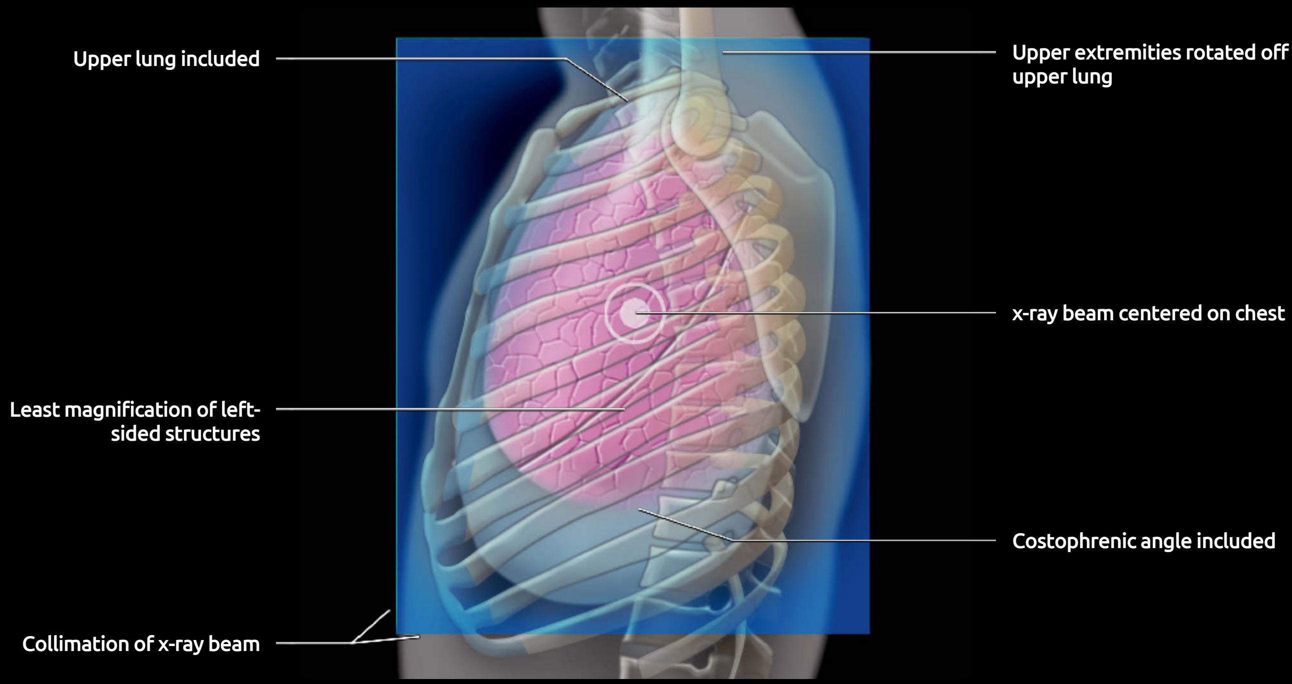




(Top) *Well-positioned normal PA chest radiograph shows that the scapulae are rotated off the lungs and the spinous process of T3 is located equidistant from the medial clavicles. Proper collimation spans from the cervical trachea superiorly to below the costophrenic angles inferiorly and includes the lateral aspects of the chest wall. Optimal exposure allows visualization of the peripheral pulmonary vessels, the vertebral bodies (visible through the mediastinum), and the retrocardiac and retrodiaphragmatic pulmonary vessels.* **(Bottom)** *Poorly positioned PA chest radiograph shows marked rotation to the right. The left medial clavicle overlies the spinous process of T3, and the right medial clavicle is displaced to the right of midline. Increased density of the left hemithorax results from x-ray penetration of a greater thickness of left-sided chest wall soft tissues, when compared to the right, due to rotation.*

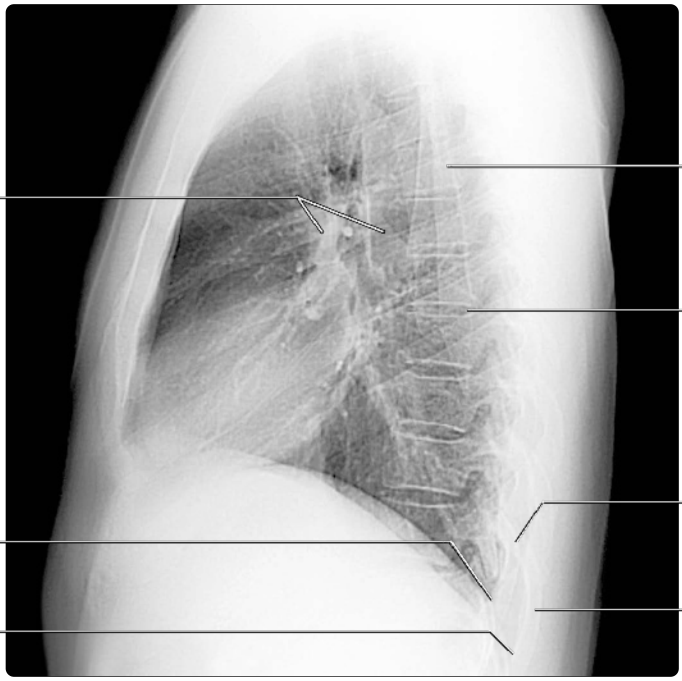
LEFT LATERAL CHEST RADIOGRAPHY, POSITIONING AND COLLIMATION

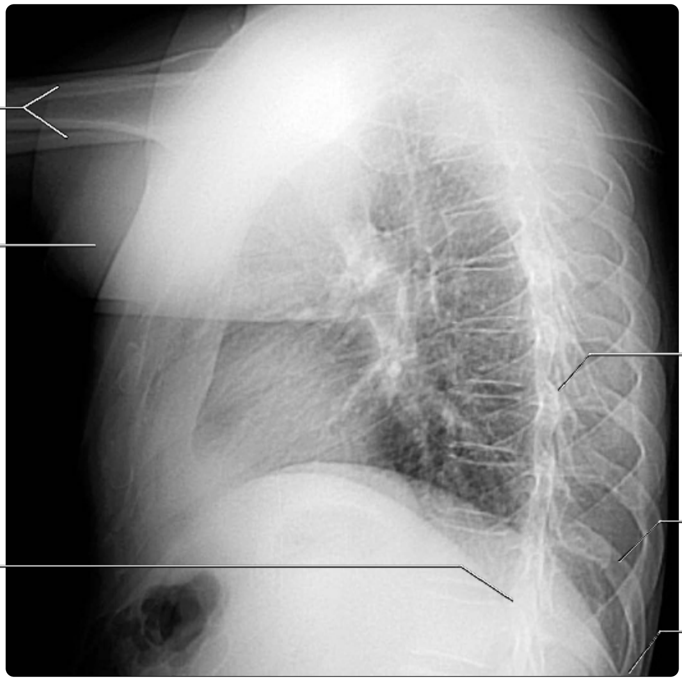




(Top) *Graphic shows proper positioning for left lateral chest radiography. The patient is upright with the left lateral chest against the vertical image receptor and the arms extended upward for unobstructed visualization of the upper lungs. The x-ray beam travels through the patient from right to left for a left lateral chest radiograph.* **(Bottom)** *Graphic shows proper left lateral chest radiographic collimation for imaging the lungs and mediastinum. The white target sign shows the centering of the x-ray beam. The blue overlay represents the collimated x-ray beam that extends from the cervical airway superiorly to below the costophrenic angles inferiorly and includes the anterior and posterior skin surfaces. The structures of the left chest (shown in color) are closest to the image receptor and experience the least magnification.*

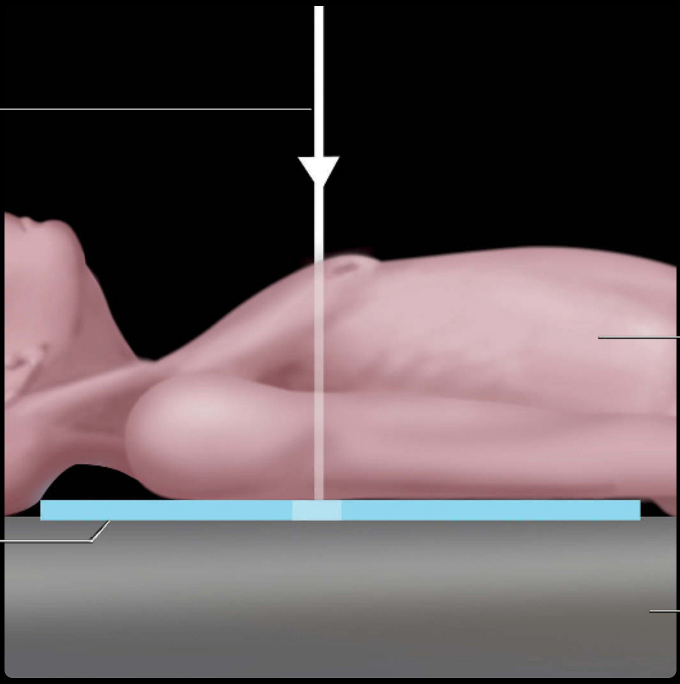
LEFT LATERAL CHEST RADIOGRAPHY

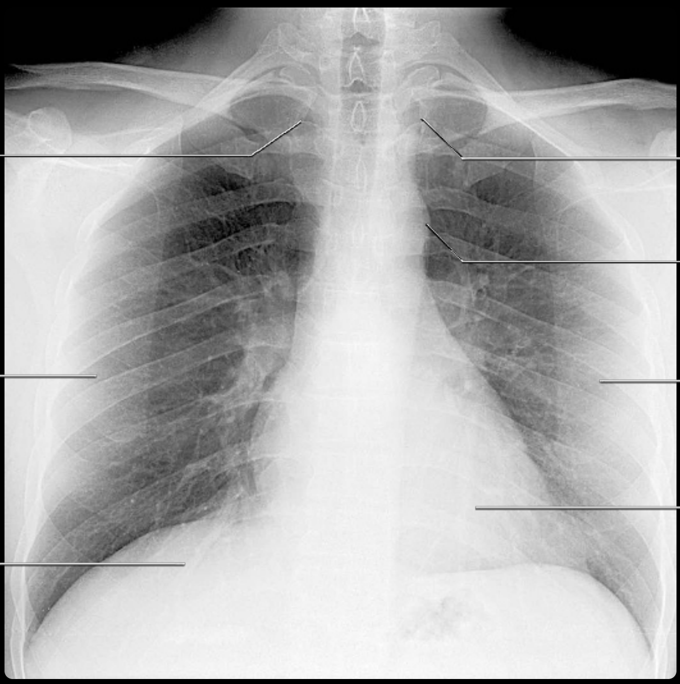




(Top) *Well-positioned normal left lateral chest radiograph shows that the upper extremities are not visible. The hila are centrally located. The thoracic intervertebral disks are visible. The posterior ribs are superimposed and project behind the vertebrae. There is minimal magnification of the left posterior ribs, which appear sharper and smaller than the right posterior ribs. Proper collimation allows inclusion of the lung apices, the posterior costophrenic angles, and the anterior and posterior skin surfaces.* **(Bottom)** *Poorly positioned left lateral chest radiograph shows that the skeletal and soft tissue structures of the upper extremities obscure the anterior lungs and mediastinum. Rotation precludes superimposition of the posterior ribs. The right posterior ribs appear larger and project behind the left posterior ribs. The right costophrenic angle projects posterior to the left.*

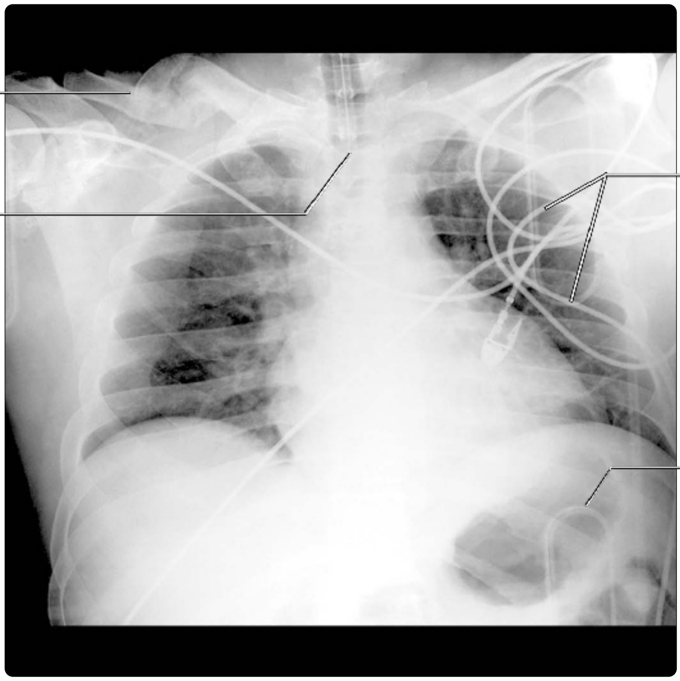
AP CHEST RADIOGRAPHY, POSITIONING AND COLLIMATION

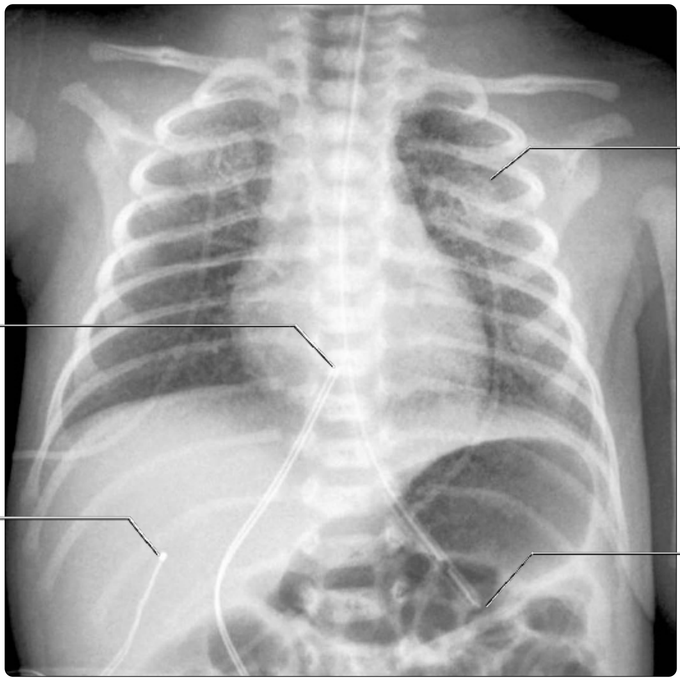




(Top) *Graphic shows proper positioning for supine AP chest radiography. The patient's back is against the radiographic cassette, and the upper extremities are by the patient's sides. Internal rotation of the shoulders will minimize the degree of superimposition of the scapulae on the lateral upper lungs. The x-ray beam travels through the patient in an anteroposterior direction. The heart and anterior chest structures are farthest from the cassette and experience some magnification.* **(Bottom)** *Normal AP chest radiograph shows that the heart and great vessels appear mildly magnified. The clavicles show a horizontal course and their medial portions obscure the lung apices. The medial scapulae project over the lateral aspects of the lungs. Note that exposure factors and collimation are optimal with visualization of retrocardiac and retrodiaphragmatic skeletal and vascular structures.*

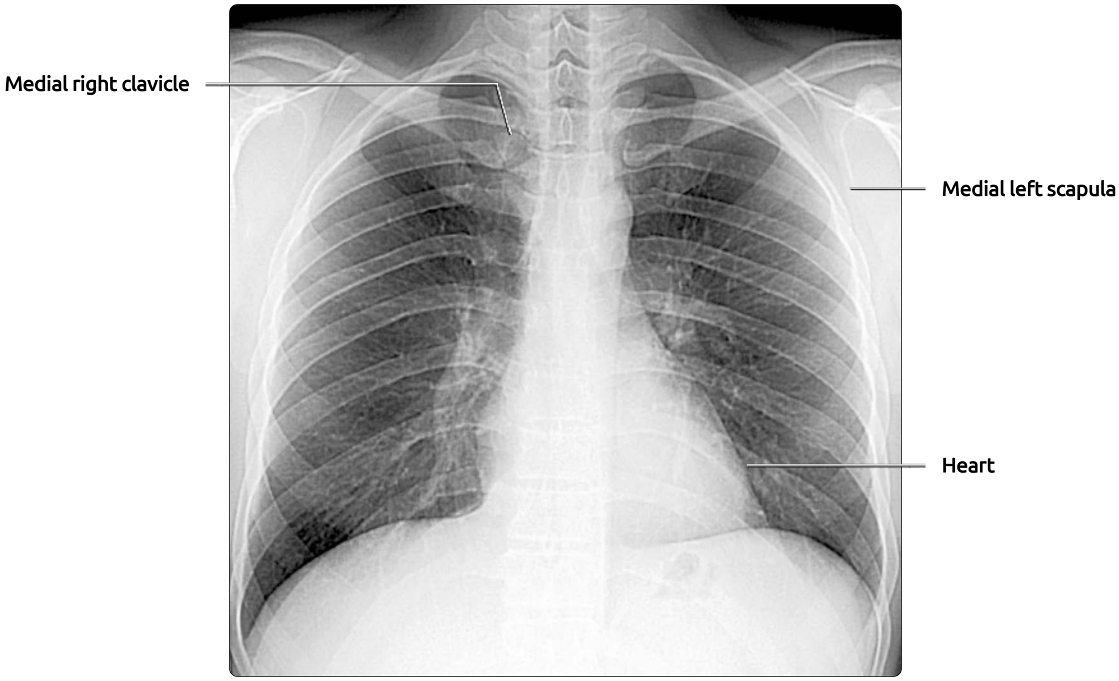
PORTABLE AP CHEST RADIOGRAPHY, TRAUMA AND INTENSIVE CARE

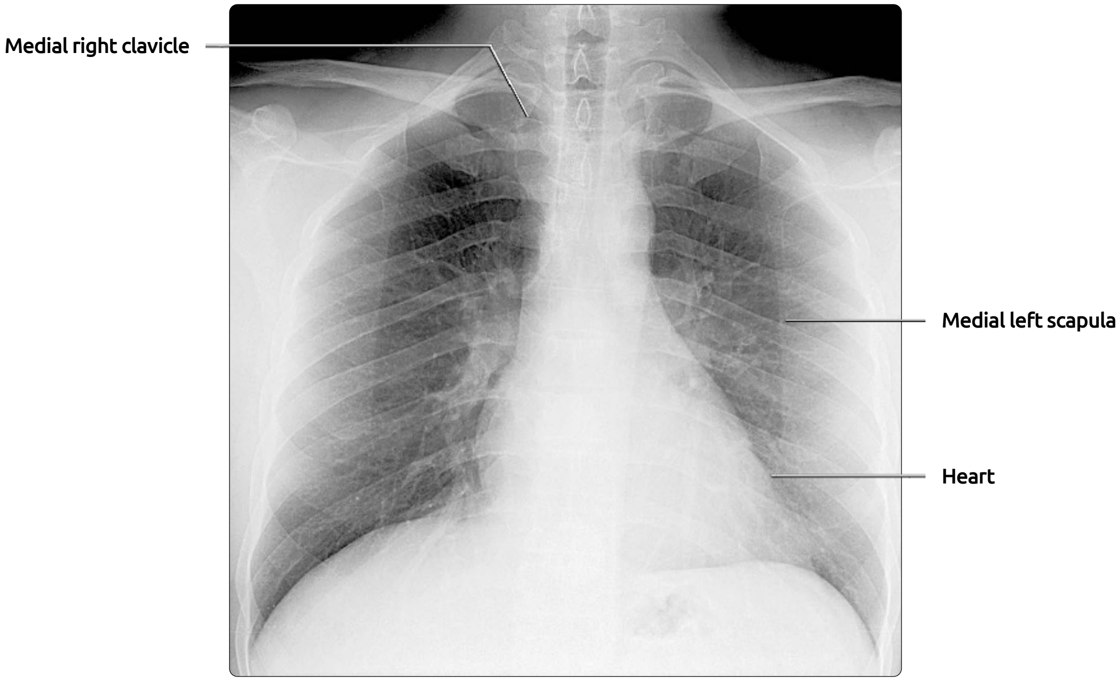




(Top) *Supine bedside (portable) AP chest radiograph shows a patient involved in a motor vehicle collision. Portable radiographs are used for imaging debilitated, seriously ill, and traumatized patients. AP chest radiographs in the setting of trauma are often compromised by technical factors related to overlying radioopaque monitoring and stabilizing devices. However, they provide a quick assessment of the integrity of the thoracic structures and the position of life support devices.* **(Bottom)** *Supine AP chest radiograph shows a 1-day-old infant born at 31 weeks of gestation with mild respiratory distress syndrome. Portable radiography is optimal for imaging neonates and infants, particularly those who are seriously ill due to congenital abnormalities &/or prematurity. Portable chest radiography allows rapid assessment of life support devices, cardiothymic silhouette, pleural spaces, skeletal structures, and upper abdomen.*

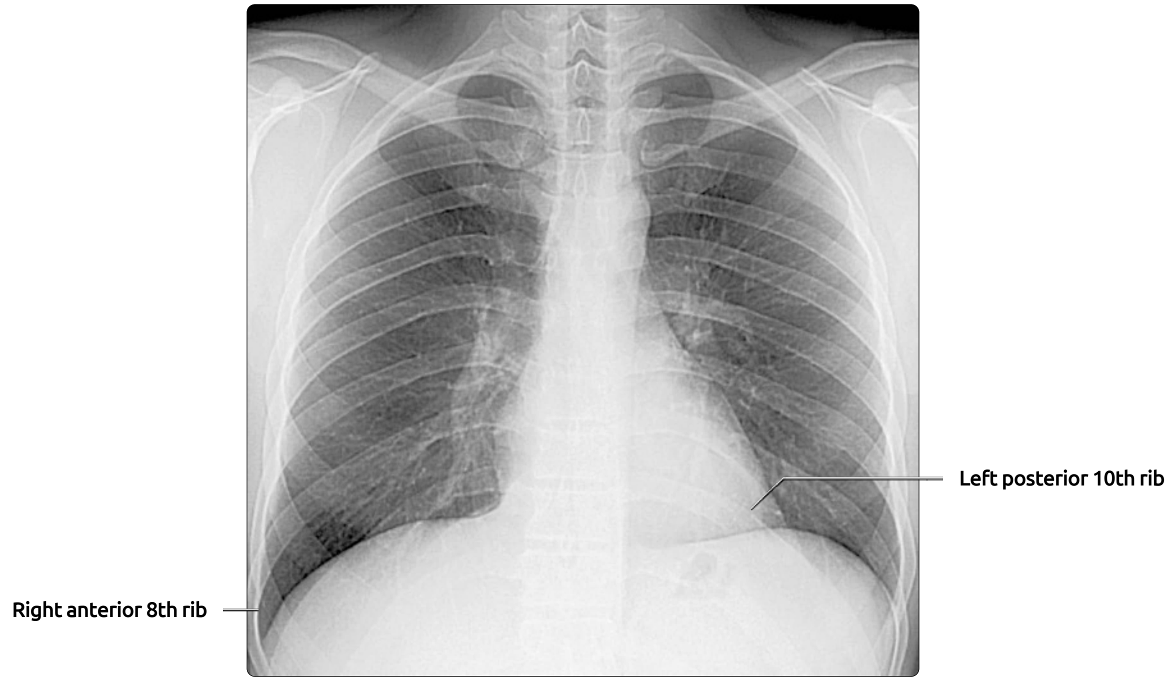
PA AND AP CHEST RADIOGRAPHY

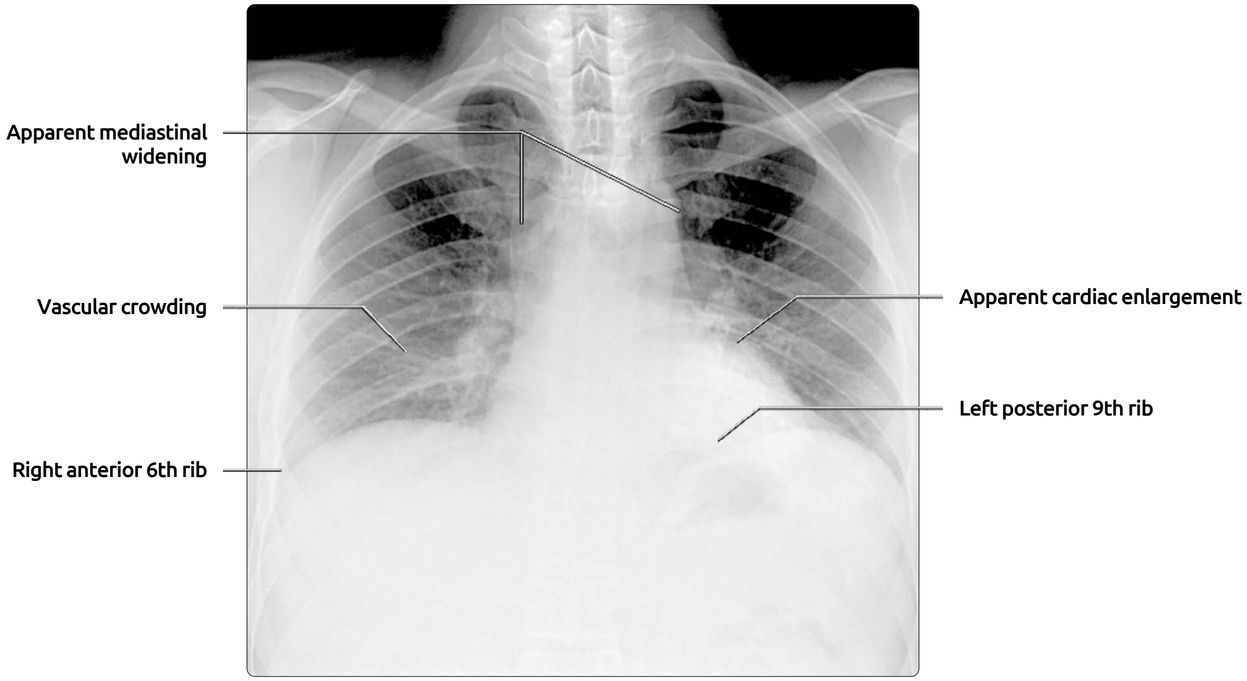




(Top) *First of 4 normal chest radiographs of the same patient is shown. PA chest radiograph shows that the heart and mediastinum, which are closest to the image receptor, undergo the least magnification. The medial clavicles curve inferiorly and do not obscure the lung apices. The scapulae are rotated laterally and do not obscure the lateral aspects of the lungs.* **(Bottom)** *AP chest radiograph of the same patient shows that the heart and mediastinum appear slightly larger as they are farthest from the image receptor and undergo some magnification. The clavicles exhibit a horizontal course and their medial aspects obscure the lung apices. The medial portions of the scapulae overlie the lateral aspects of the lungs.*

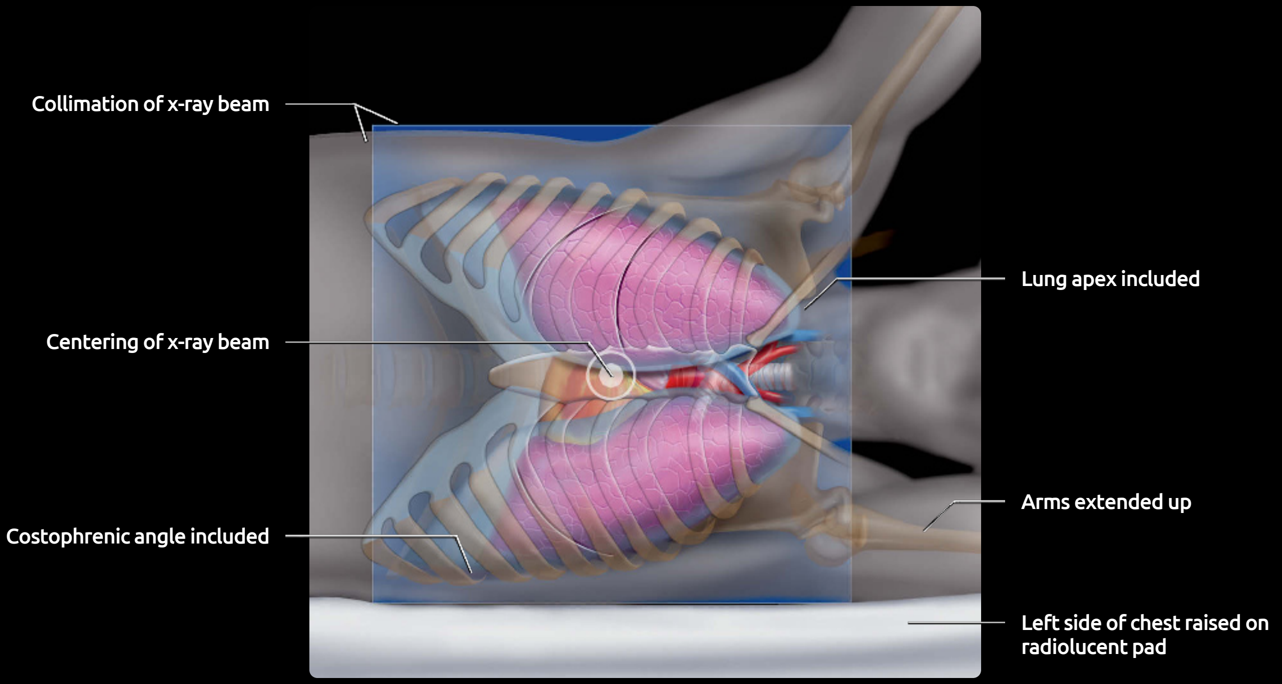
INSPIRATORY AND EXPIRATORY CHEST RADIOGRAPHY

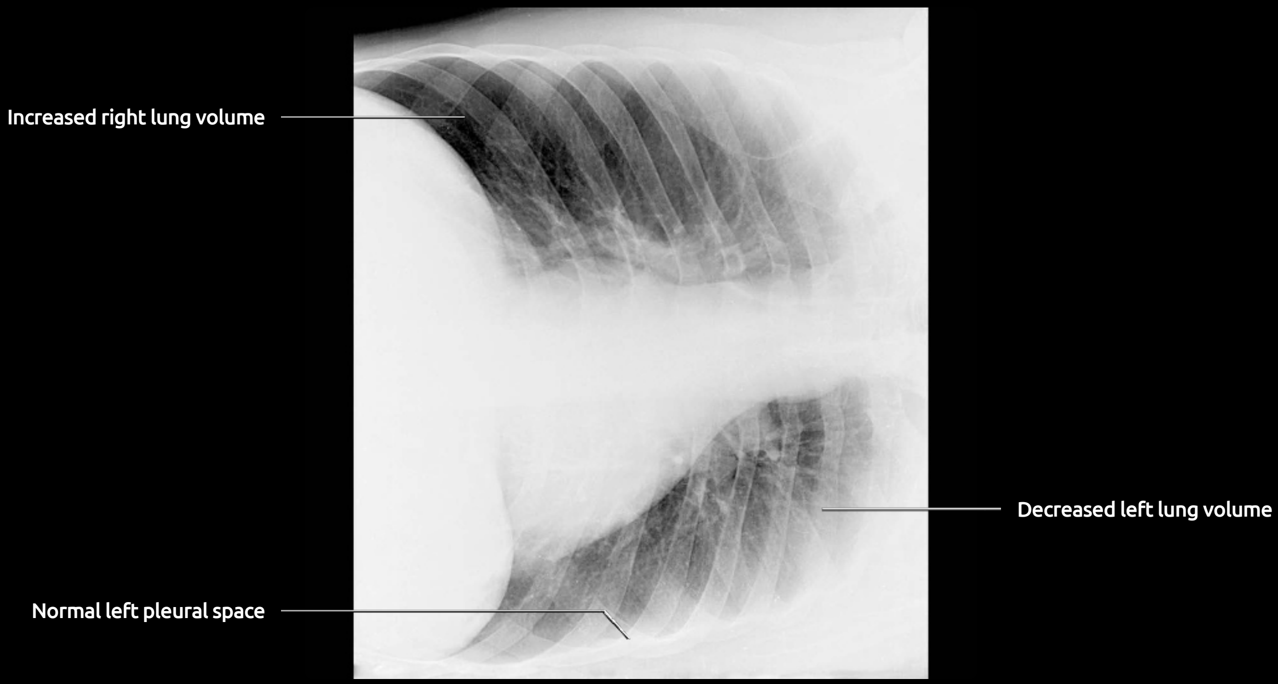




(Top) *PA chest radiograph obtained at full inspiration shows optimal visualization of the lung bases and the retrocardiac and retrodiaphragmatic lung. A portion of the 8th anterior right rib is visible through the lung and projects above the hemidiaphragm. A portion of the 10th posterior left rib is visible through the lung and projects above the hemidiaphragm.* **(Bottom)** *PA chest radiograph obtained at end expiration shows low lung volumes. The lung bases are partially obscured with increased basilar density and vascular crowding and resultant poor visualization of the retrodiaphragmatic lung. A portion of the right 6th anterior rib is visible through the lung and projects above the hemidiaphragm. A portion of the left 9th posterior rib is visible through the lung and projects above the hemidiaphragm.*

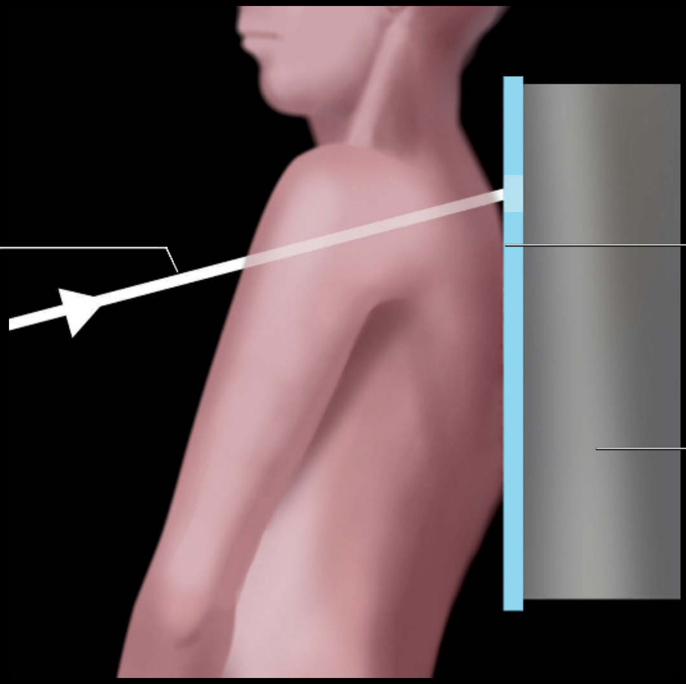
LATERAL DECUBITUS CHEST RADIOGRAPHY, POSITIONING AND COLLIMATION





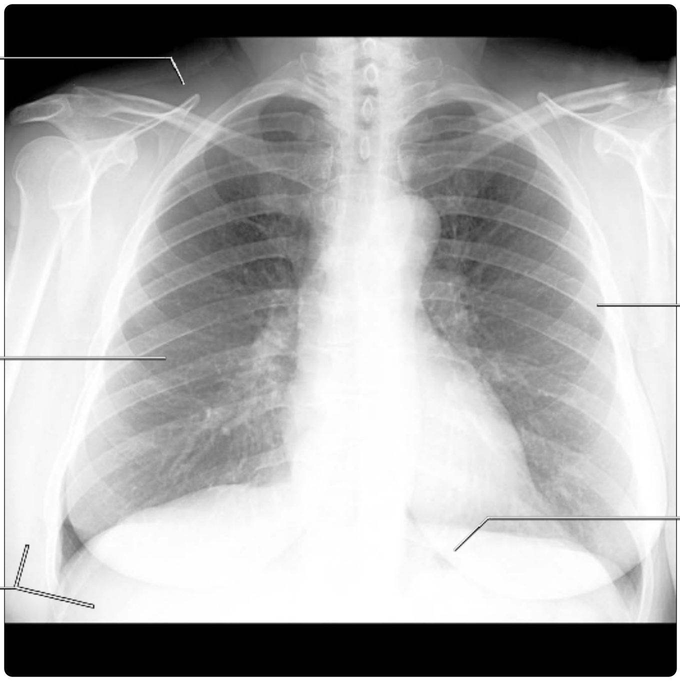
(Top) *Graphic shows proper lateral decubitus PA radiographic collimation for imaging the lungs and mediastinum. The white target sign shows the centering of the x-ray beam. The blue overlay represents the collimated x-ray beam that extends from the cervical airway superiorly to below the costophrenic angles inferiorly and includes the left and right skin surfaces. The thorax is elevated on a radiolucent pad to ensure inclusion of the dependent pleural surface and chest wall. The anterior structures of the chest (shown in color) are closest to the image receptor and experience the least magnification.* **(Bottom)** *Normal left lateral decubitus radiograph shows a larger lung volume in the nondependent right lung and volume loss manifesting as increased density in the dependent left lung. There is no pleural thickening or fluid.*

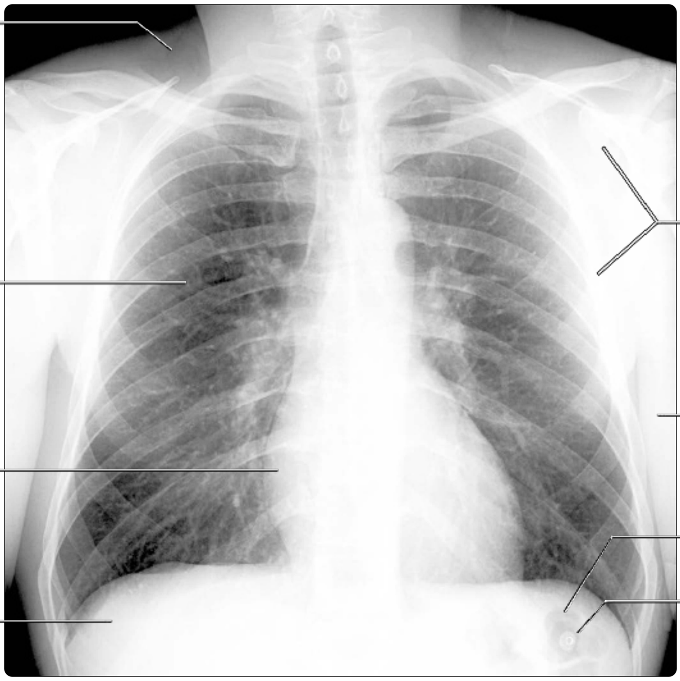
APICAL LORDOTIC CHEST RADIOGRAPHY, POSITIONING



(Top) *Graphic shows proper positioning for AP apical lordotic chest radiography. The patient is upright with the posterior shoulders against the vertical image receptor, and the arms are internally rotated to move the scapulae away from the lungs. The x-ray beam travels through the patient from anterior to posterior and is centered at the sternal manubrium and oriented superiorly at a 20° angle from the horizontal plane.* **(Bottom)** *Normal apical lordotic chest radiograph projects the medial aspects of the clavicles above the lung apices. Note that the apex is partly obscured by the anterior aspects of the 1st ribs and their costochondral articulations in this case. The mediastinum is foreshortened and mildly magnified. The scapulae overlie a significant portion of the bilateral lateral lungs.*

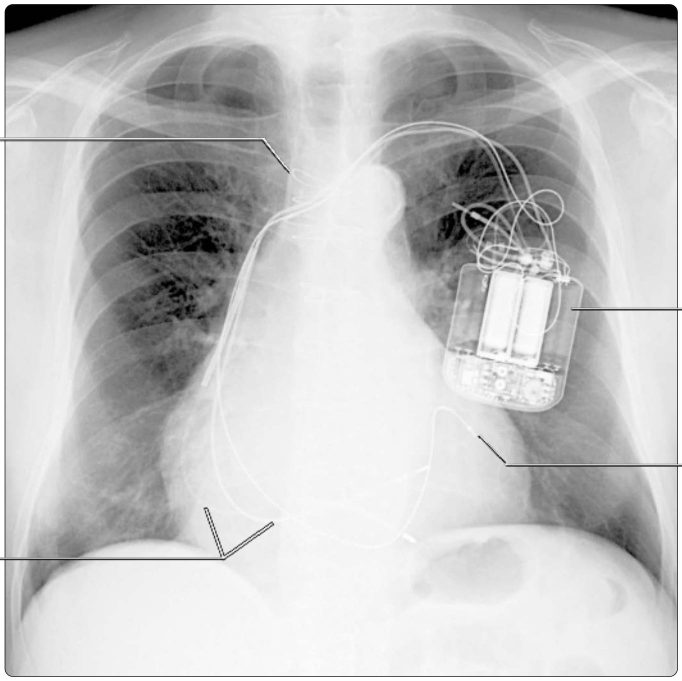
RADIOGRAPHIC DENSITIES

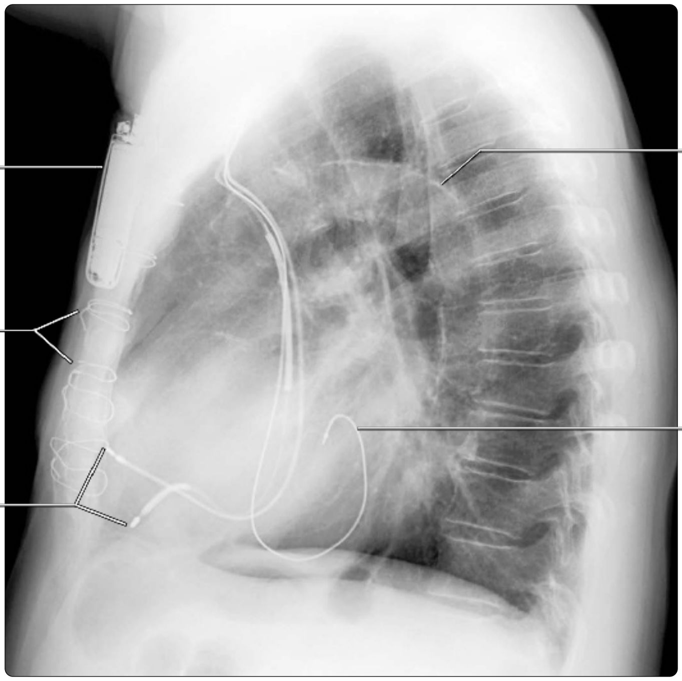




(Top) *PA chest radiograph shows the 4 radiographic densities. Air is present in the lungs bilaterally and within the gastric air bubble. Water (or soft tissue) density is seen in the mediastinum, abdomen, and subcutaneous tissues. Fat density is visible in the supraclavicular regions. Calcium density is noted in the skeletal structures.* **(Bottom)** *PA chest radiograph shows the 4 radiographic densities. Air density is present in the lungs and in the bowel gas. Water (soft tissue) density is seen in the mediastinum, abdomen, and subcutaneous soft tissues. Fat is more difficult to demonstrate in this thin patient but is present in the normal supraclavicular regions. Calcium is represented by the skeletal structures. Metal is represented by a metallic snap on the patient's gown.*

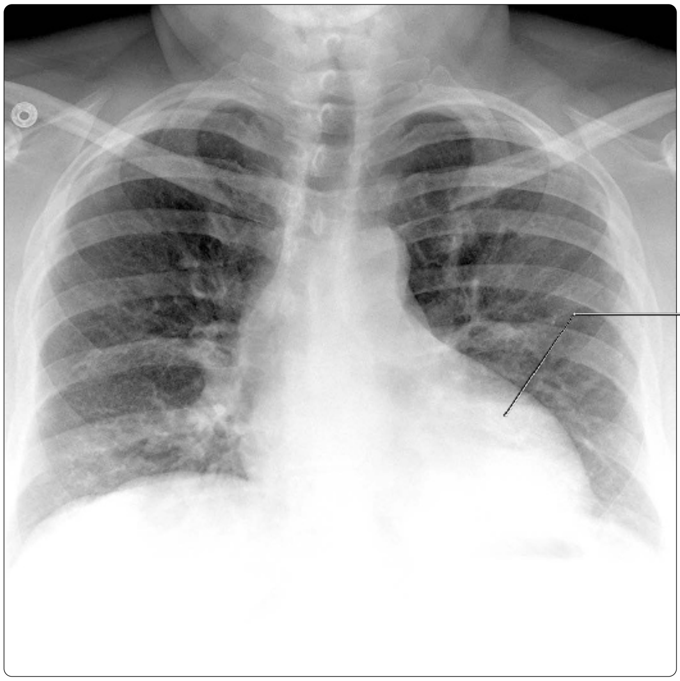
RADIOGRAPHIC DENSITIES, MEDICAL DEVICES

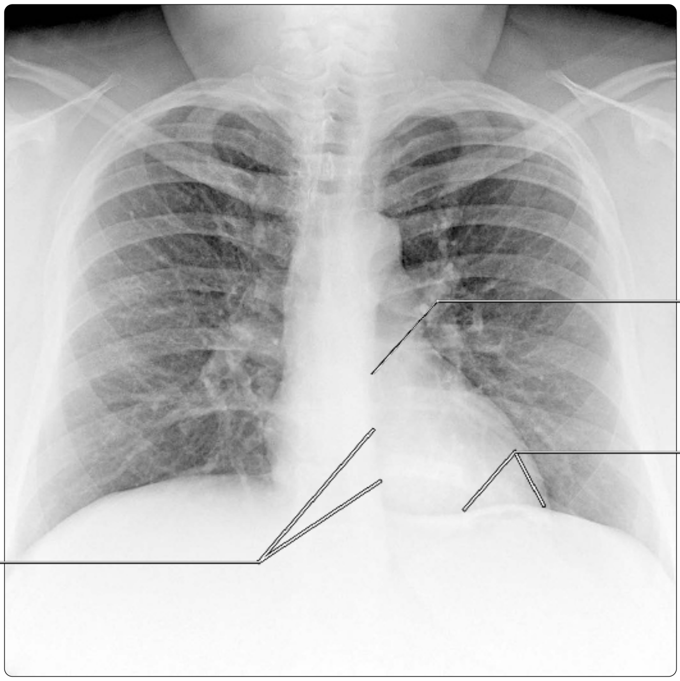




(Top) *First of 2 chest radiographs of a patient with a biventricular pacemaker and implantable cardioverter defibrillator is shown. Orthogonal radiographs allow accurate assessment of the integrity and position of medical devices. PA chest radiograph shows 2 pacer leads in the right ventricle and 1 in a tributary of the coronary sinus. The metallic portions of the pulse generator obscure visualization of the left mid lung. Note cardiomegaly and atherosclerotic calcification of the thoracic aorta. The lungs are clear. Metallic sternal wires are present.* **(Bottom)** *Lateral chest radiograph shows 2 right ventricular leads and a 3rd lead in a tributary of the coronary sinus. The left lung behind the pulse generator is now visible, although superimposed, on the contralateral right lung. Cardiomegaly, calcified aortic atherosclerosis, and sternal wires are again noted.*

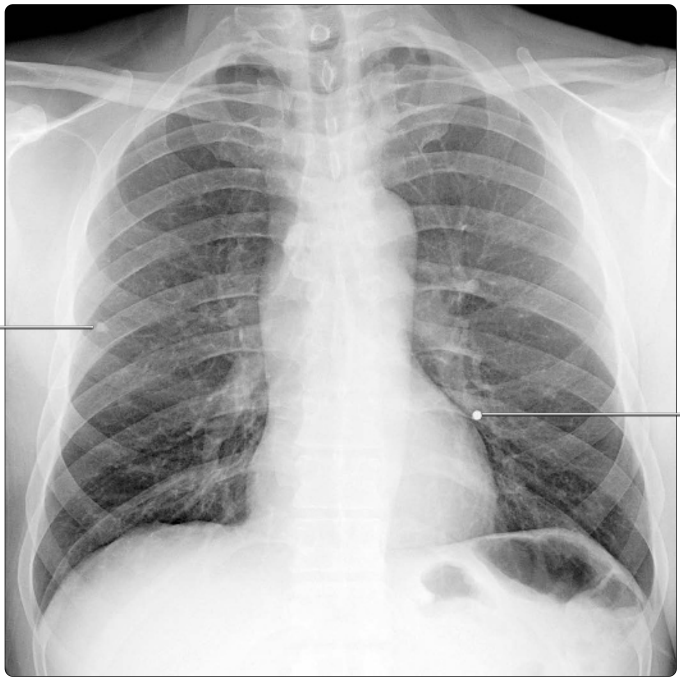
SILHOUETTE SIGN





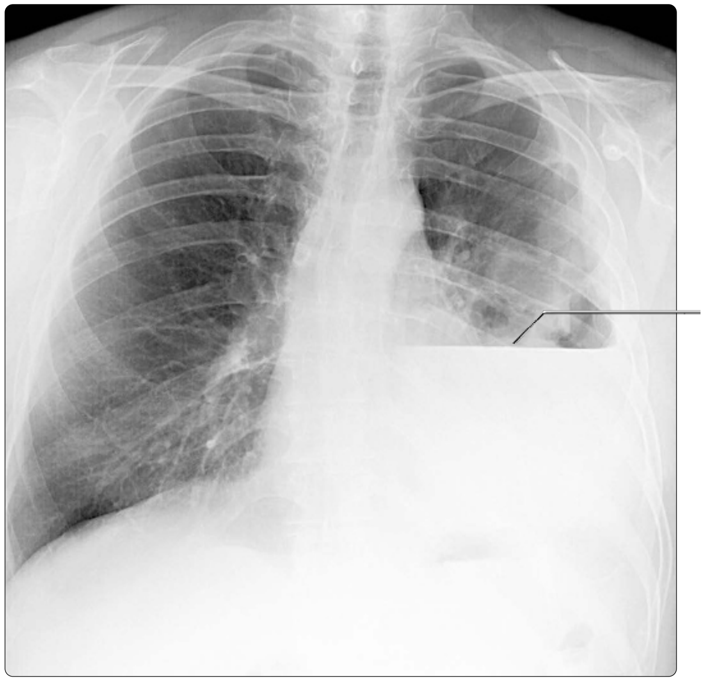
(Top) *First of 2 chest radiographs of a 43-year-old woman who presented with cough and fever is shown. PA chest radiograph shows low lung volume and left retrocardiac airspace disease with obscuration of the left hemidiaphragm, the left paraaortic interface, and the left paravertebral stripe consistent with left lower lobe pneumonia.* **(Bottom)** *PA chest radiograph obtained 2 years earlier shows a normal appearance of the left lower lobe with visualization of the medial left hemidiaphragm, the left paraaortic interface, and the left paravertebral stripe. This case illustrates the value of the silhouette sign and the importance of comparison with prior studies in the diagnosis of subtle radiographic abnormalities.*

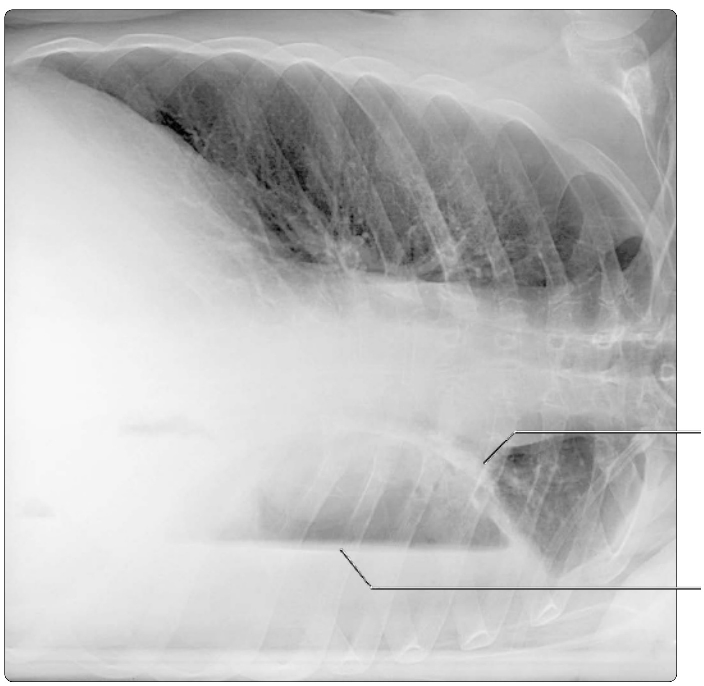
ANATOMIC LOCALIZATION WITH ORTHOGONAL RADIOGRAPHY



(Top) *First of 2 chest radiographs of an asymptomatic 57-year-old man is shown. PA chest radiograph shows a BB pellet projecting over the left lower lung zone adjacent to the left cardiac border. Note the difference in radiographic density between the metallic BB pellet and the calcified right mid lung zone granuloma.* **(Bottom)** *Lateral chest radiograph (orthogonal to the PA chest radiograph) shows the BB pellet projecting over the lower sternal body and anterior to the lung. The radiographs allow accurate anatomic localization of the BB pellet in the soft tissues of the left anterior chest wall. In the same manner, PA and lateral chest radiography allows initial characterization and anatomic localization of imaging abnormalities.*

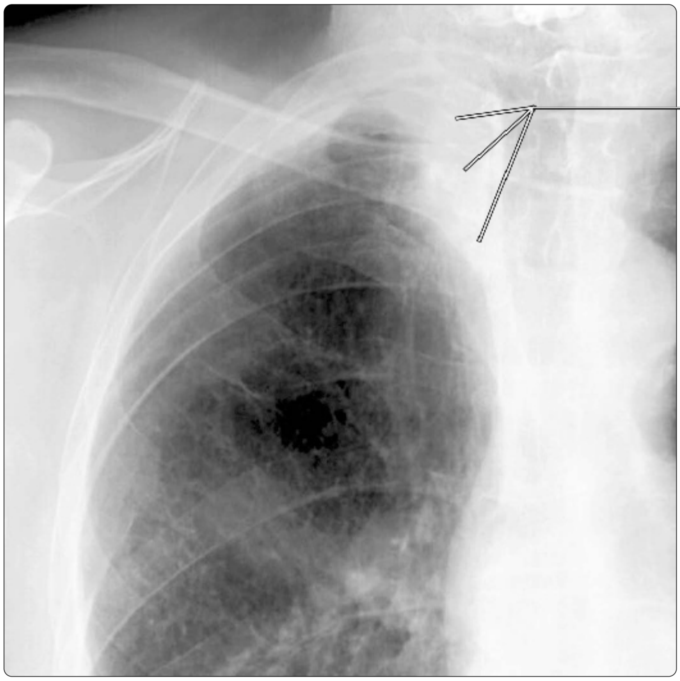
DECUBITUS RADIOGRAPHY FOR EVALUATION OF COMPLEX PLEURAL DISEASE

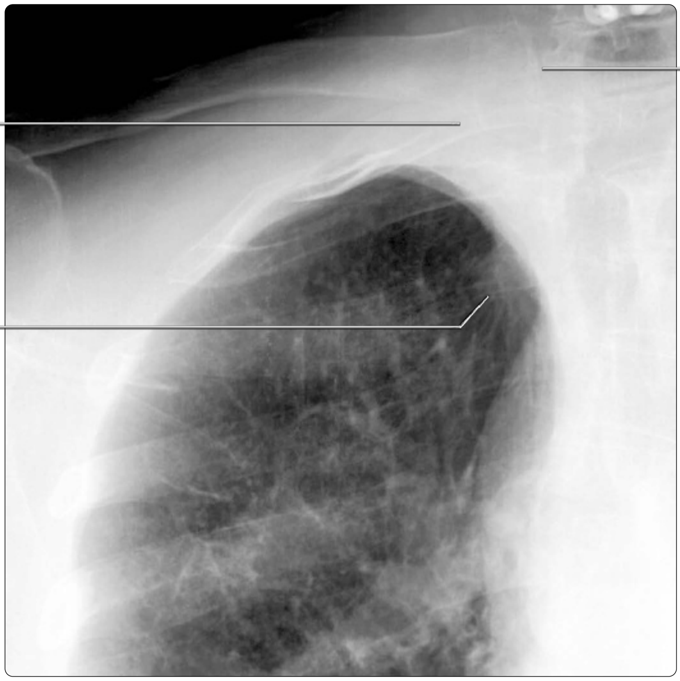




(Top) *First of 2 chest radiographs of a patient with a left empyema and a bronchopleural fistula is shown. PA chest radiograph shows a large air-fluid level that spans the width of the left hemithorax.* **(Bottom)** *Left lateral decubitus chest radiograph shows a discrepant length of the air-fluid level, which appears longer than on the PA chest radiograph, indicating that the air and fluid collection has an elongated shape. Note the thick medial wall of the air and fluid collection. The findings are characteristic of a loculated pleural effusion. The presence of air indicates a communication with the tracheobronchial tree (bronchopleural fistula), and the findings are diagnostic of a complicated empyema. In this case, the lateral decubitus radiograph allows localization of the abnormality to the pleural space and distinction from parenchymal disease.*

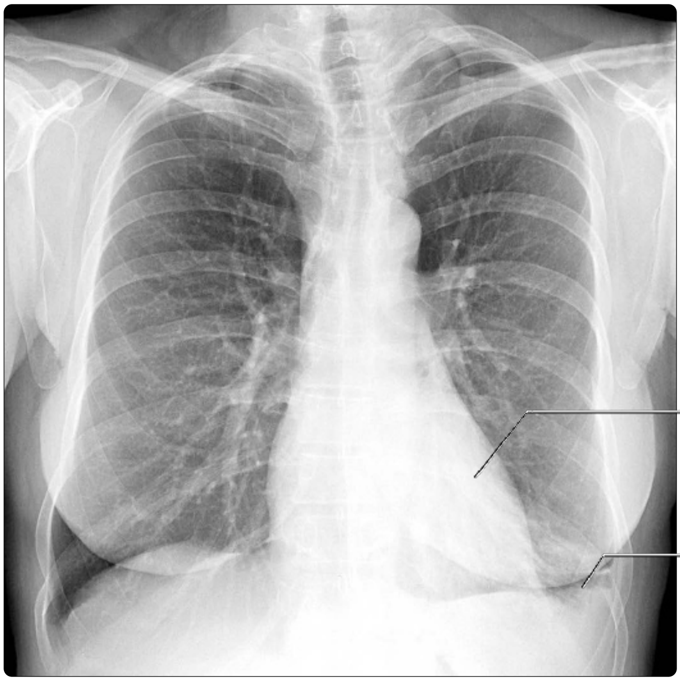
LORDOTIC CHEST RADIOGRAPHY FOR EVALUATION OF APICAL LESION

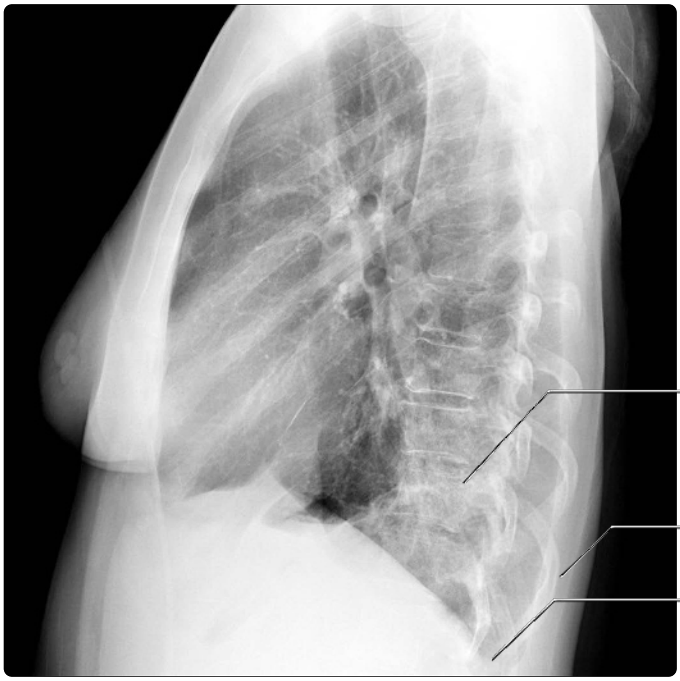




(Top) *First of 2 chest radiographs of a patient with a right apical mass is shown. PA chest radiograph coned down to the right apex demonstrates an abnormal irregular apical mass and thickening of the medial aspect of the right apical pleura.* **(Bottom)** *AP apical lordotic radiograph coned down to the right upper lobe allows visualization of the medial aspect of the right apical lung by projecting the right medial clavicle and right 1st anterior rib above the lung apex. The spiculated lateral border of this right apical lung cancer is now visible.*

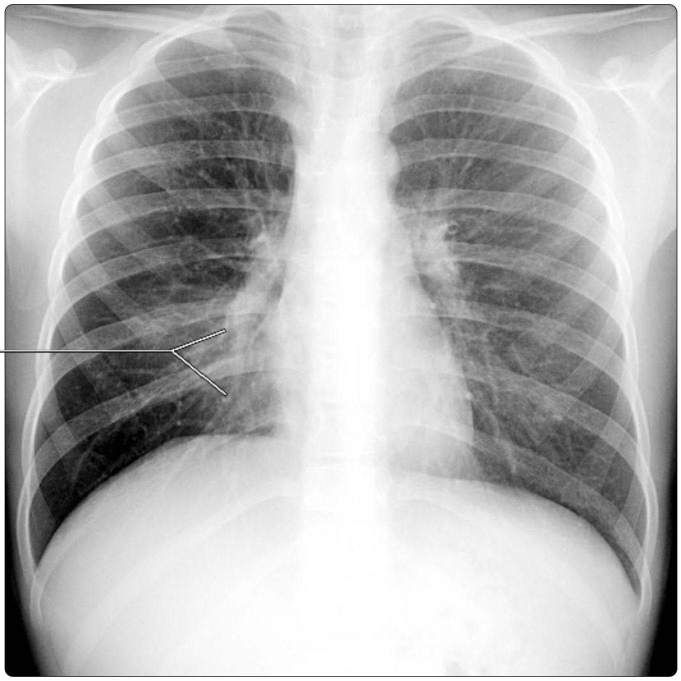
SILHOUETTE SIGN, LEFT LOWER LOBE AIRSPACE DISEASE

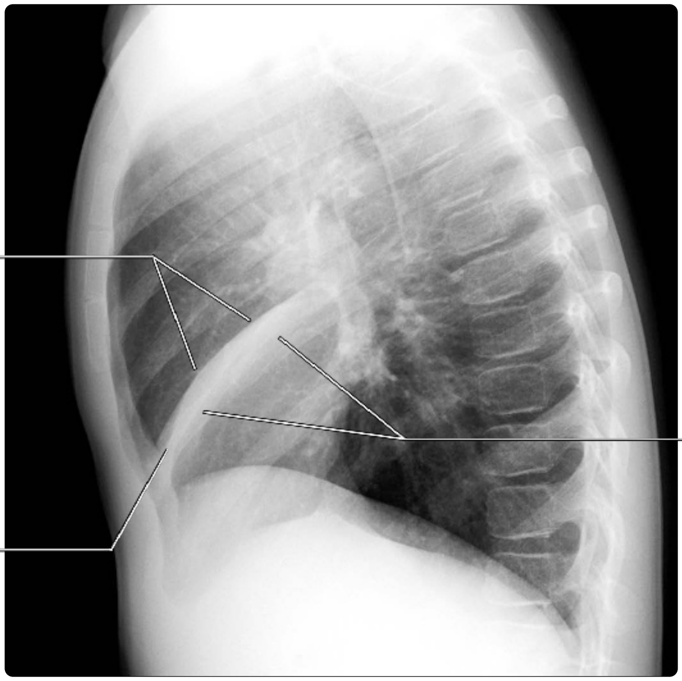




(Top) *First of 2 chest radiographs of a 45-year-old woman with left lower lobe pneumonia is shown. PA chest radiograph shows a subtle retrocardiac left basilar air space opacity that obscures the lateral aspect of the left hemidiaphragm. The alveolar air in the left lower lobe has been replaced by an inflammatory process producing the silhouette sign.* **(Bottom)** *Lateral chest radiograph shows that the consolidation is located in the posterior basilar segment of the left lower lobe, produces the spine sign (increasing opacity over the lower thoracic spine), and obscures the posterior left hemidiaphragm. The right hemidiaphragm is visualized in its entirety as there is no right lower lobe airspace disease. The left lateral chest radiograph facilitates identification of the right ribs (and the normal ipsilateral right hemidiaphragm) by virtue of their magnification, as they are farthest from the image receptor.*

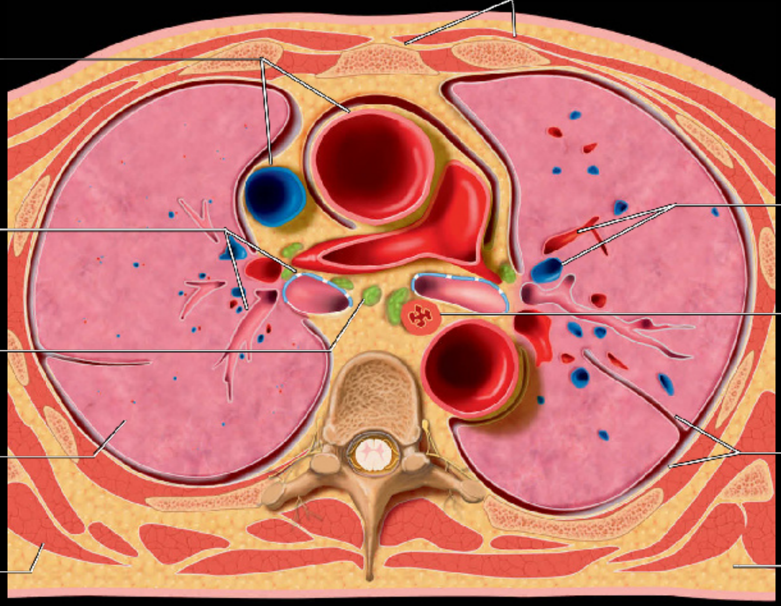
SILHOUETTE SIGN, MIDDLE LOBE AIRSPACE DISEASE





(Top) *First of 2 chest radiographs of a 10-year-old asthmatic boy with middle lobe atelectasis is shown. PA chest radiograph shows airspace opacity in the medial aspect of the right lower lung zone, which obscures the right cardiac border. The location of the process can be inferred by obscuration of the right cardiac border while the right hemidiaphragm is well visualized. Atelectasis has resulted in evacuation of alveolar air from the middle lobe producing the silhouette sign.* **(Bottom)** *Lateral chest radiograph shows a band-like opacity that projects over the heart and represents the atelectatic middle lobe. Posteroinferior displacement of the minor fissure and anterosuperior displacement of the inferior aspect of the right major fissure are typical of middle lobe volume loss and help distinguish atelectasis from consolidation.*

CROSS-SECTIONAL ANATOMY



Graphic shows the cross-sectional appearance of the mid thorax and illustrates the manner of visualization and assessment of various organs and tissues in cross section. Cross-sectional imaging allows assessment of the organs, structures, and tissues of the chest. The soft tissues of the chest wall consist of skin, subcutaneous fat, and chest wall muscles. Together with the skeletal structures, the soft tissues of the chest wall surround and protect the thoracic cavity and its internal organs and tissues. The apposed pleural surfaces form the potential pleural space. The pulmonary arteries and veins course through the lungs. The mediastinal fat, mediastinal vascular structures, esophagus, central tracheobronchial tree, and lymph nodes are also depicted.