Radiographic Manifestations of Tuberculosis

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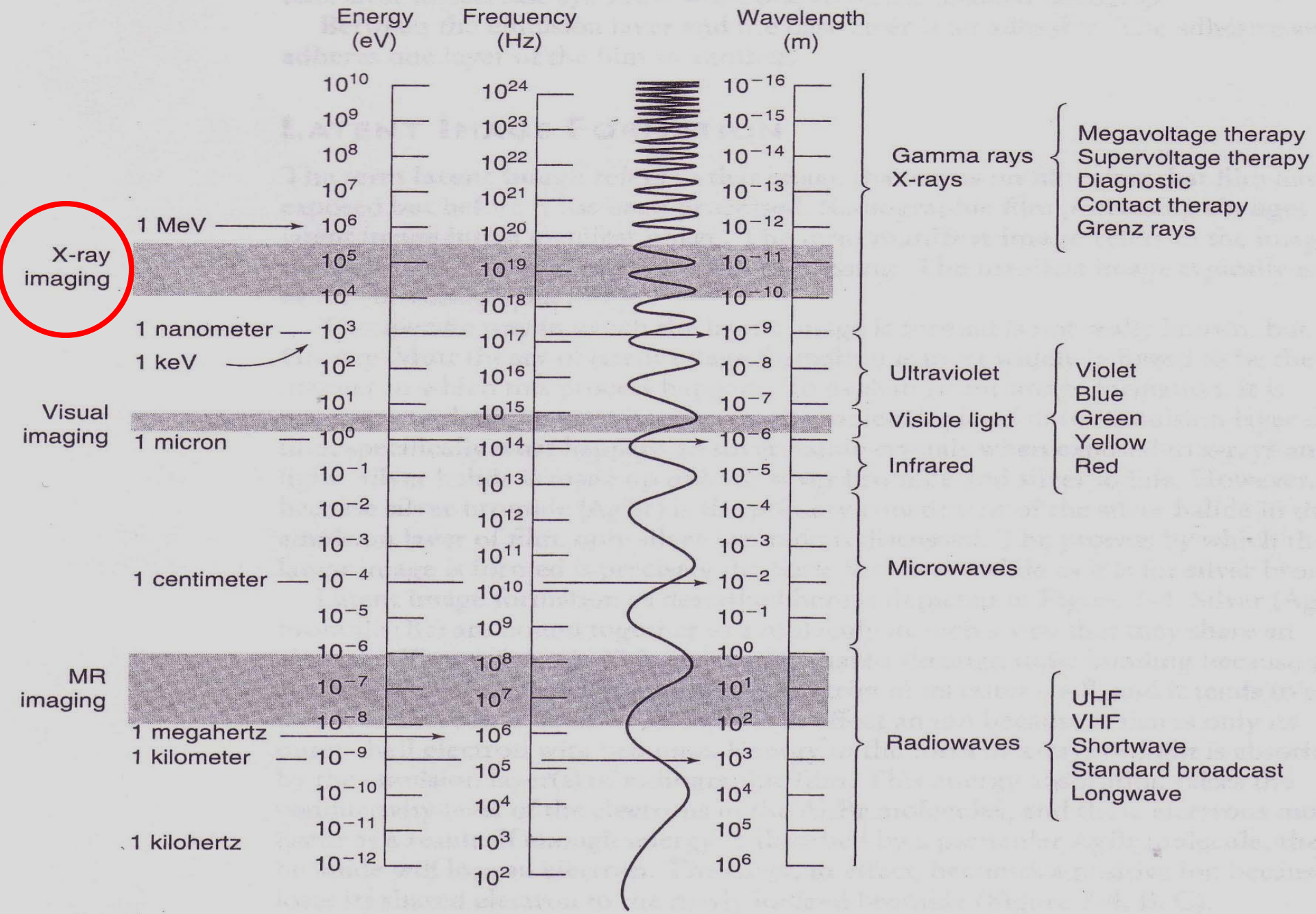
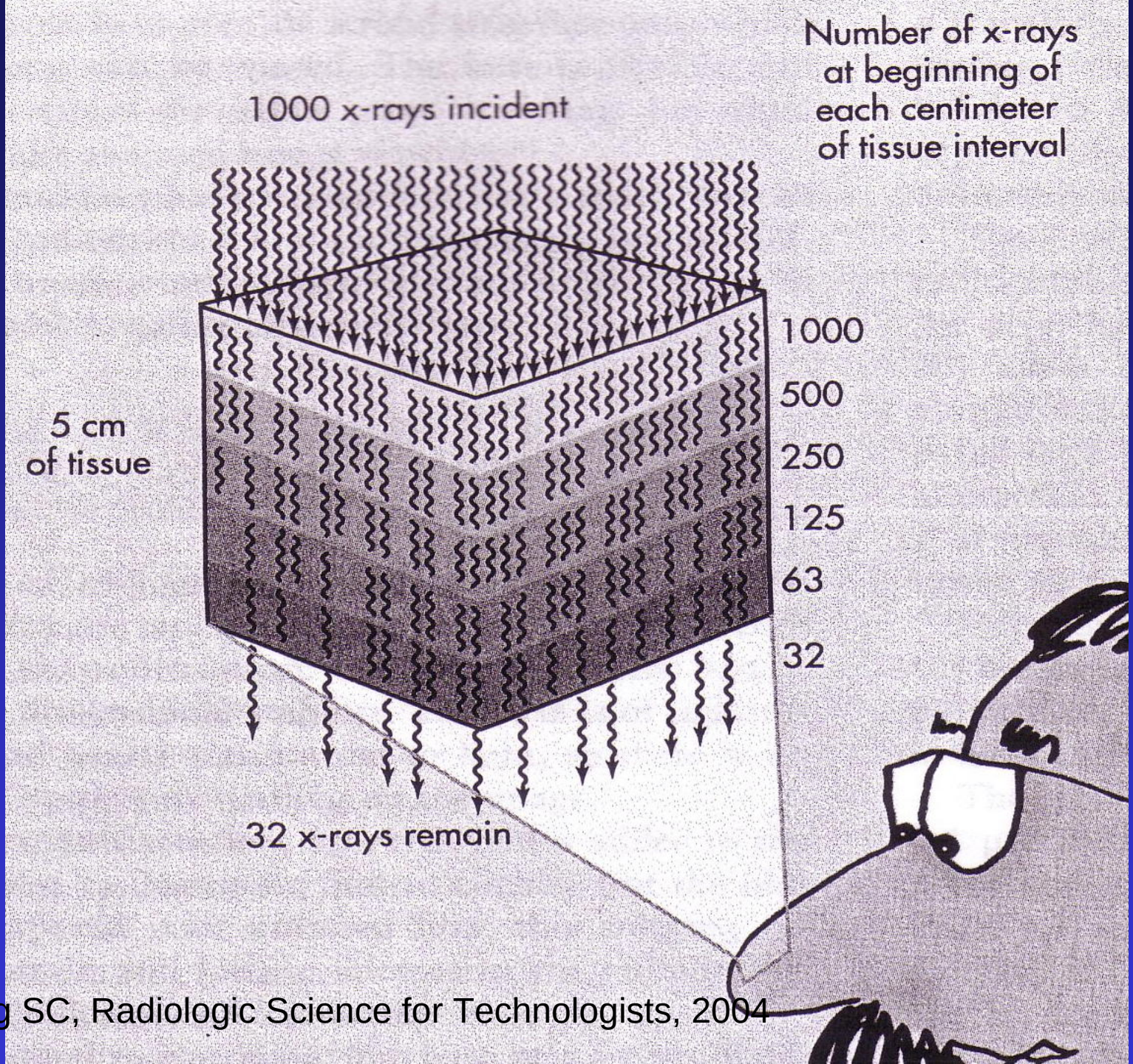
Virginia Nurse Training

Today's Objectives

- Learn how Radiation is produced and how much an individual receives during a CXR
- Learn the ABCDE method of reading the CXR
- Learn the major landmarks of the CXR
- Learn to distinguish infiltrates, cavities and pleural effusions on the CXR
- Learn some of the X-ray manifestations of Pulmonary Tuberculosis

THE ELECTROMAGNETIC SPECTRUM



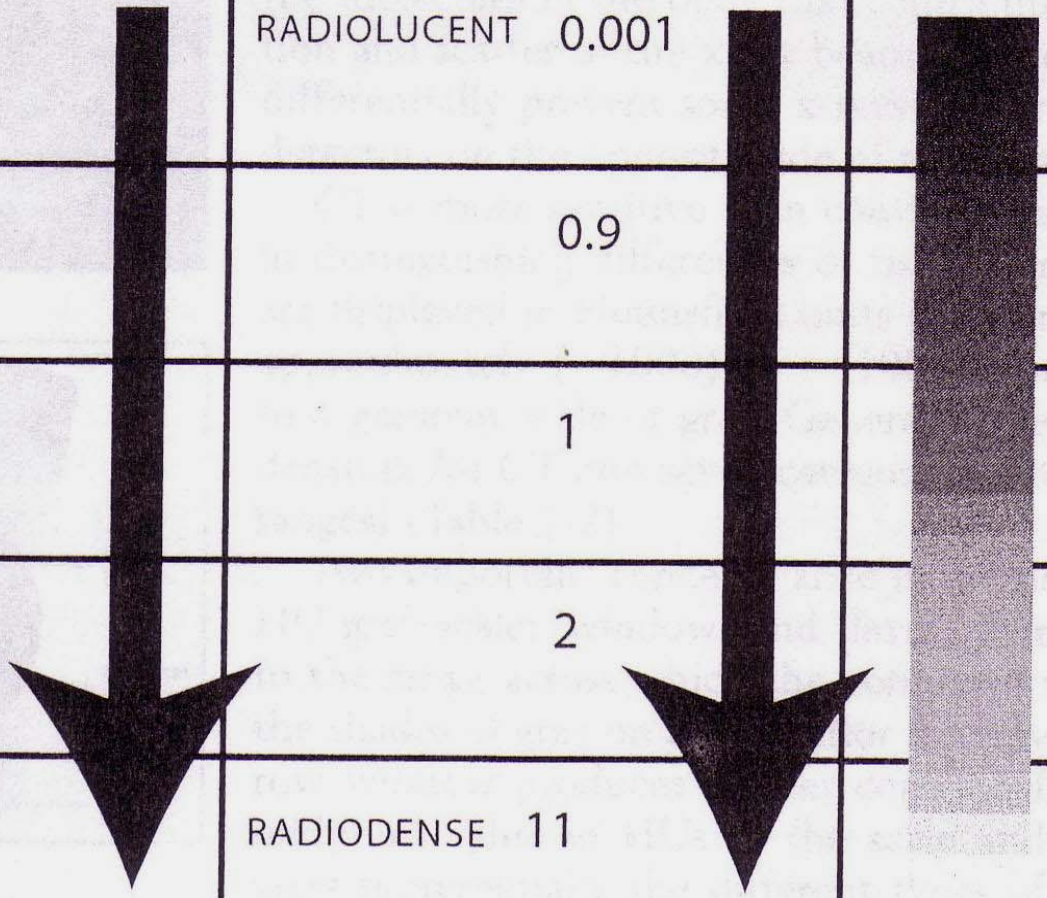


Bushong SC, Radiologic Science for Technologists, 2004

TABLE 1-1

The Five Main Radiodensities on a Standard Radiograph

Material	Effective Atomic Number	Density (g/cm³)	Color on Film
Air	7.6	RADIOLUCENT 0.001	
Fat	5.9	0.9	
Water (Organ tissue, muscle skin, blood	7.4	1	
Bone	14.0	2	
Metal	82.0	RADIODENSE 11	



Fauber TL, Radiographic Imaging and Exposure,2004

Diagnostic Examination	Effective Dose (mSv)
X-rays	
Chest (PA film)	0.02
Head	0.07
Cervical spine	0.3
Thoracic spine	1.4
Lumbar spine	1.8
Abdomen	0.53
Pelvis/hip	0.83
Limbs/joints	0.06
Upper GI	3.6
Lower GI	6.4
Screening mammogram	0.13
CT	
Head	2.0
Abdomen	10.0
Chest	20-40
Pulmonary angiography	20-40
PET - CT	25

Semelka RC, Medscape 2006

Radiation risk for X-ray examinations to an average adult

Examination	*Typical effective dose (mSv)*	*Risk**
Chest	0.02	1 in 1000 000
Mammography	0.06	1 in 300 000
Abdomen	0.7	1 in 30 000
Lumbar spine	1.3	1 in 15 000
CT head	2	1 in 10 000
Barium enema	7.2	1 in 2800
CT body	9	1 in 2200

* Additional lifetime risk of fatal cancer.

Table 5.3 **Effective total body dose in radiological examinations**

Examination of organs/ body regions	Typical effective total body dose (mSv)	Equivalent number of chest radiographs	Equivalent period of natural background radiation
Radiography			
Limbs and joints	0.01	0.5	1.5 days
Chest PA	0.02	1	3 days
Skull	0.1	5	2 weeks
Cervical spine	0.1	5	2 weeks
Thoracic spine	1.0	50	6 months
Lumbar spine	2.4	120	14 months
Hip	0.3	15	2 months
Pelvis	1.0	50	6 months
Abdomen	1.5	75	9 months
Barium swallow	2.0	100	1 year
Barium follow-through	5.0	250	2.5 years
Small-bowel barium enema	6.0	300	3 years
Large-bowel barium enema	9.0	450	4.5 years
Mammography	0.5	25	10 weeks
Computed tomography			
Head	2.0	100	1 year
Chest, abdomen	8.0	400	4 years
Scintigraphy			
Bone	5.0	250	2–5 years
Thyroid	1.0	50	6 months
Heart (thallium)	18	900	9 years

Eastman GW, Getting Started in Clinical Radiology, 2006

TABLE 1. Estimated fetal radiation exposure from selected procedures

Procedure	Fetal radiation exposure (rad)
Skull films	0.004
Dental films	0.0001
Chest radiograph, two views with shielding	0.00002–0.00007
Abdominal film, single	0.1
Hip film	0.2
Intravenous pyelogram	1.0–1.4
Upper gasterointestinal series	0.056
Barium enema or small bowel series	2.0–4.0
Computerized tomography (CT) scan of head or chest	<1
CT scan of abdomen and lumbar spine	2.6–3.5
Upper or lower extremity	0.001
Technetium lung scan	0.12–0.15
Technetium renal scan	0.1–0.33
Technetium bone scan	0.18–0.45
Technetium bleeding scan	0.2–0.47
Hepatobiliary HIDA scan	0.15
Ventilation-perfusion scan	0.215
Perfusion portion	0.175
Ventilation portion	0.040
Iodine (^{131}I), at fetal thyroid	590.0

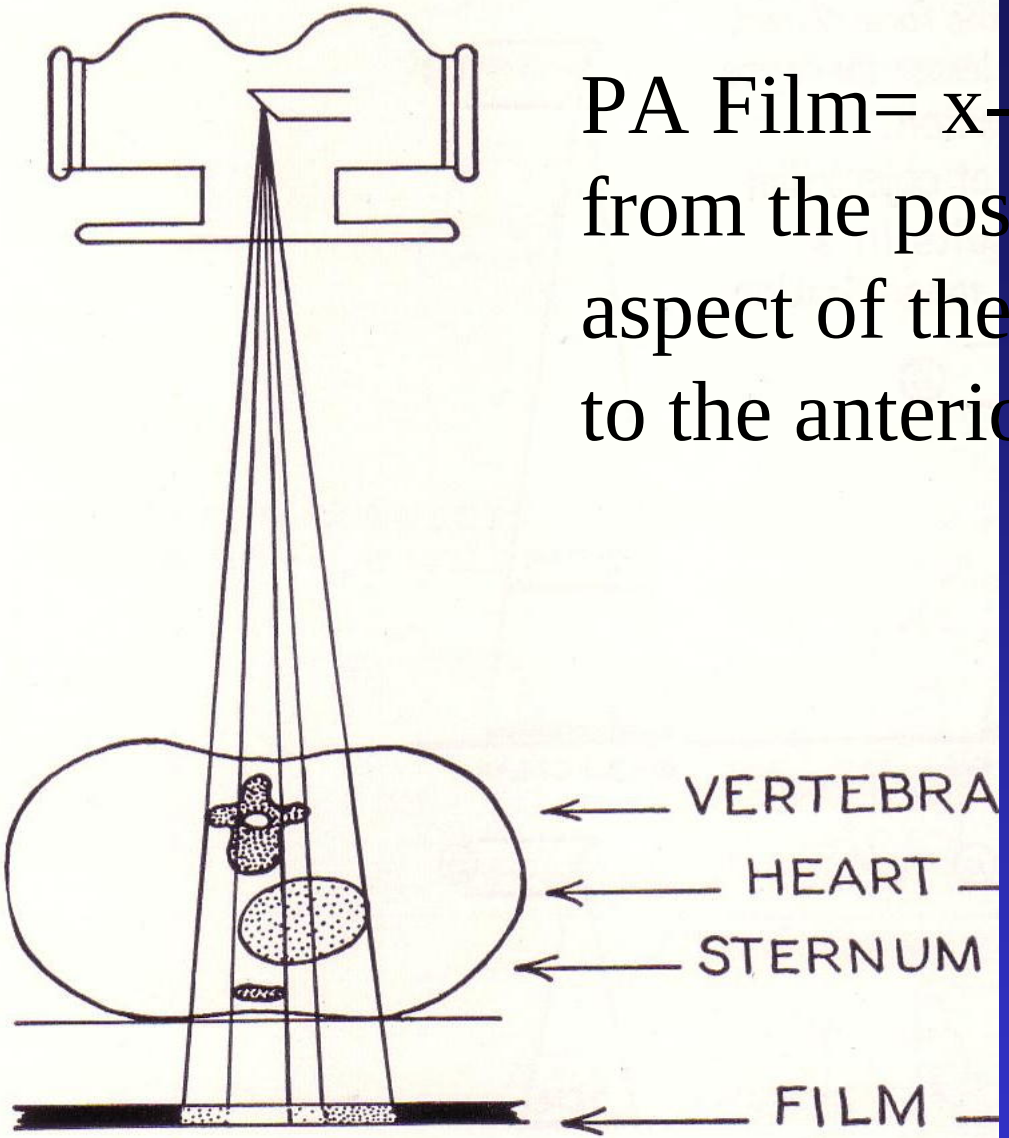
MMWR 2004; 53 (RR-15), 86

Film/Screen

X-Ray generator

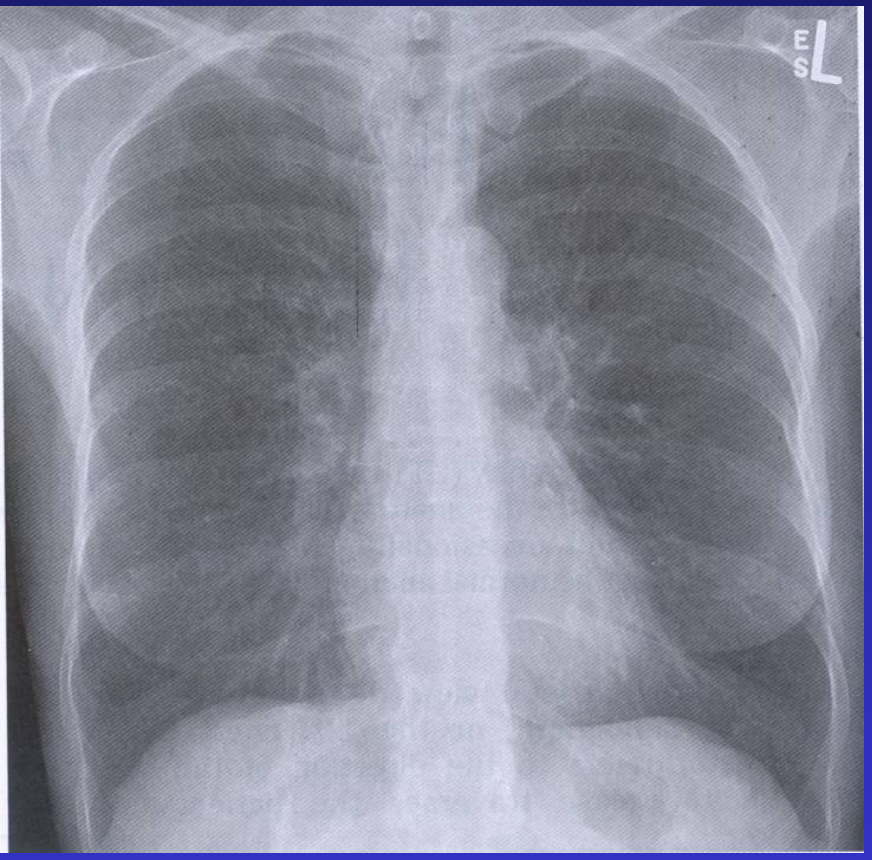
Dept. Radiology, U.VA

PA Film= x-rays go from the posterior aspect of the patient to the anterior

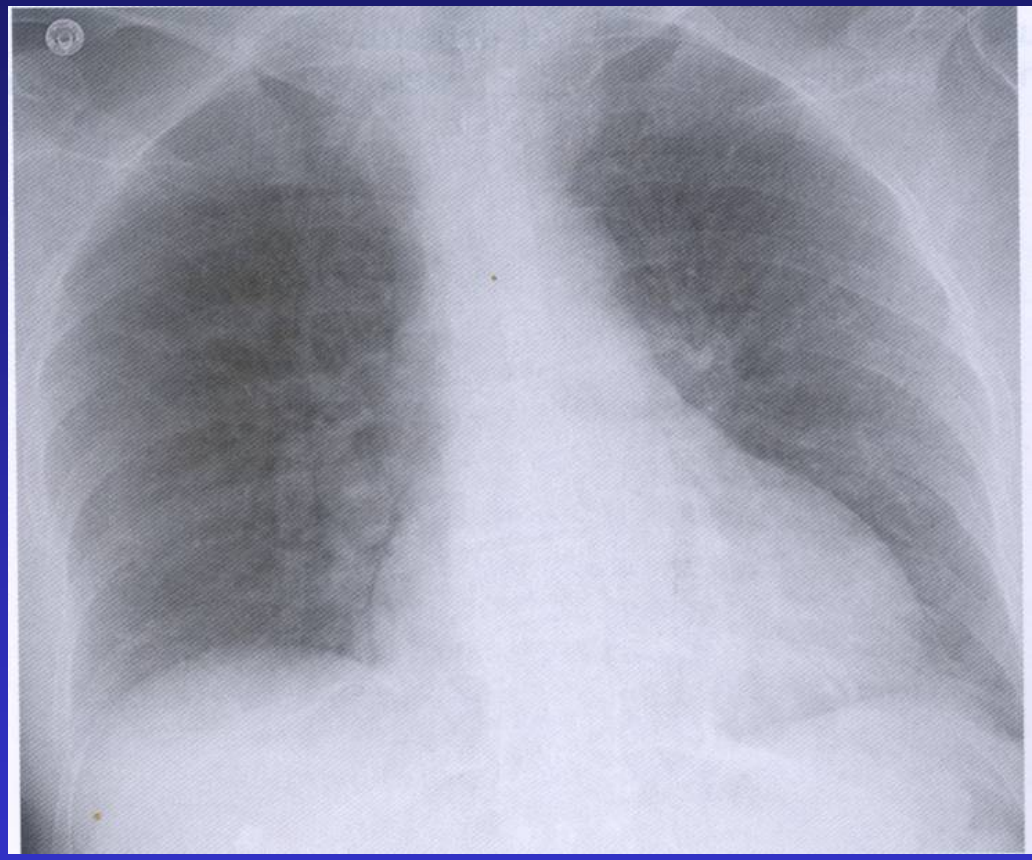


SUPERIMPOSITION OF STRUCTURES LYING ONE ABOVE THE OTHER

PA & AP Chest X-rays



PA View



AP View

“Reading” the Chest X-ray

Air: Central airways and lung parenchyma

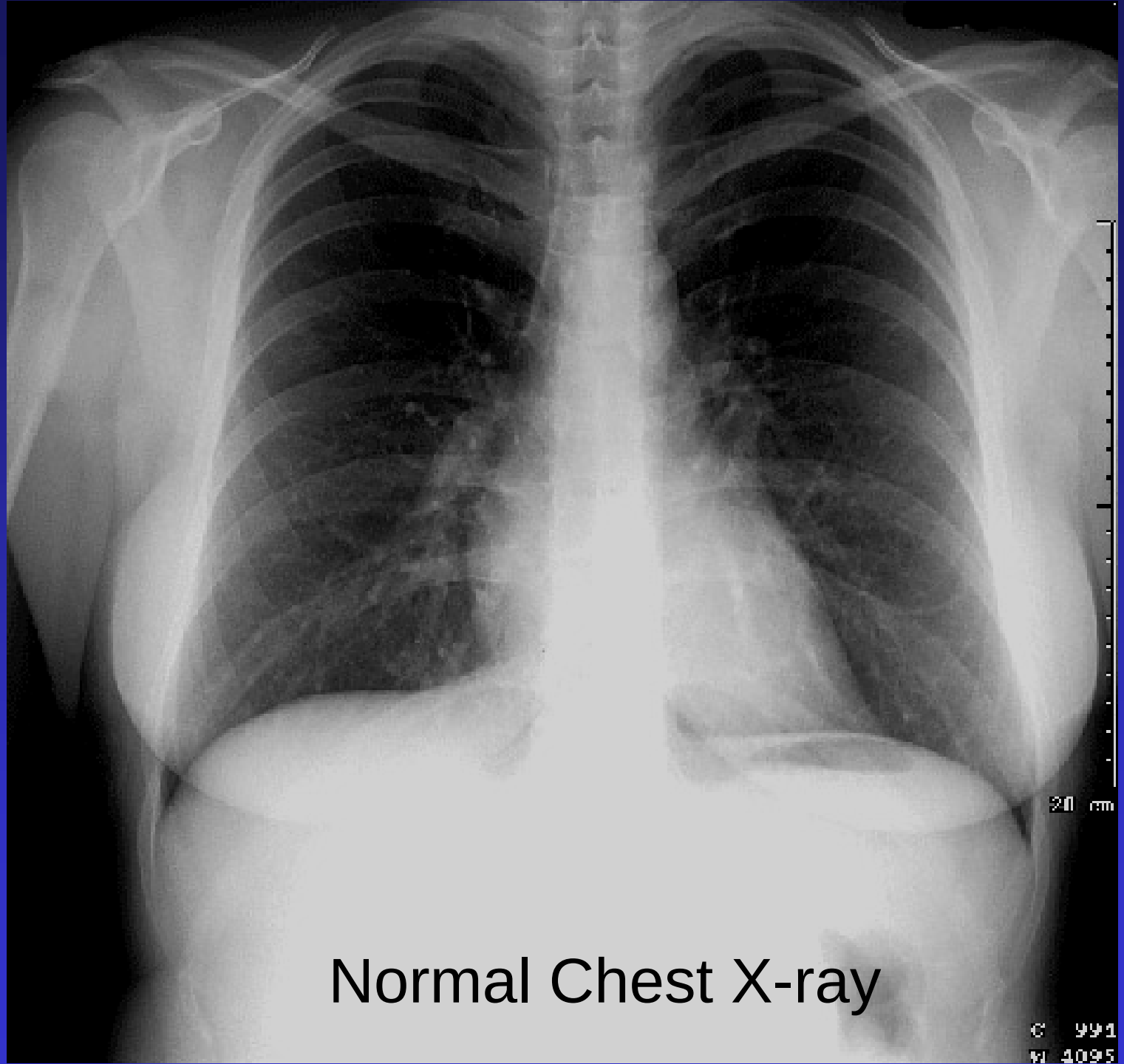
Bones: Ribs, clavicles, spine, shoulders, scapulae

Cardiac: Heart, blood vessels and mediastinum

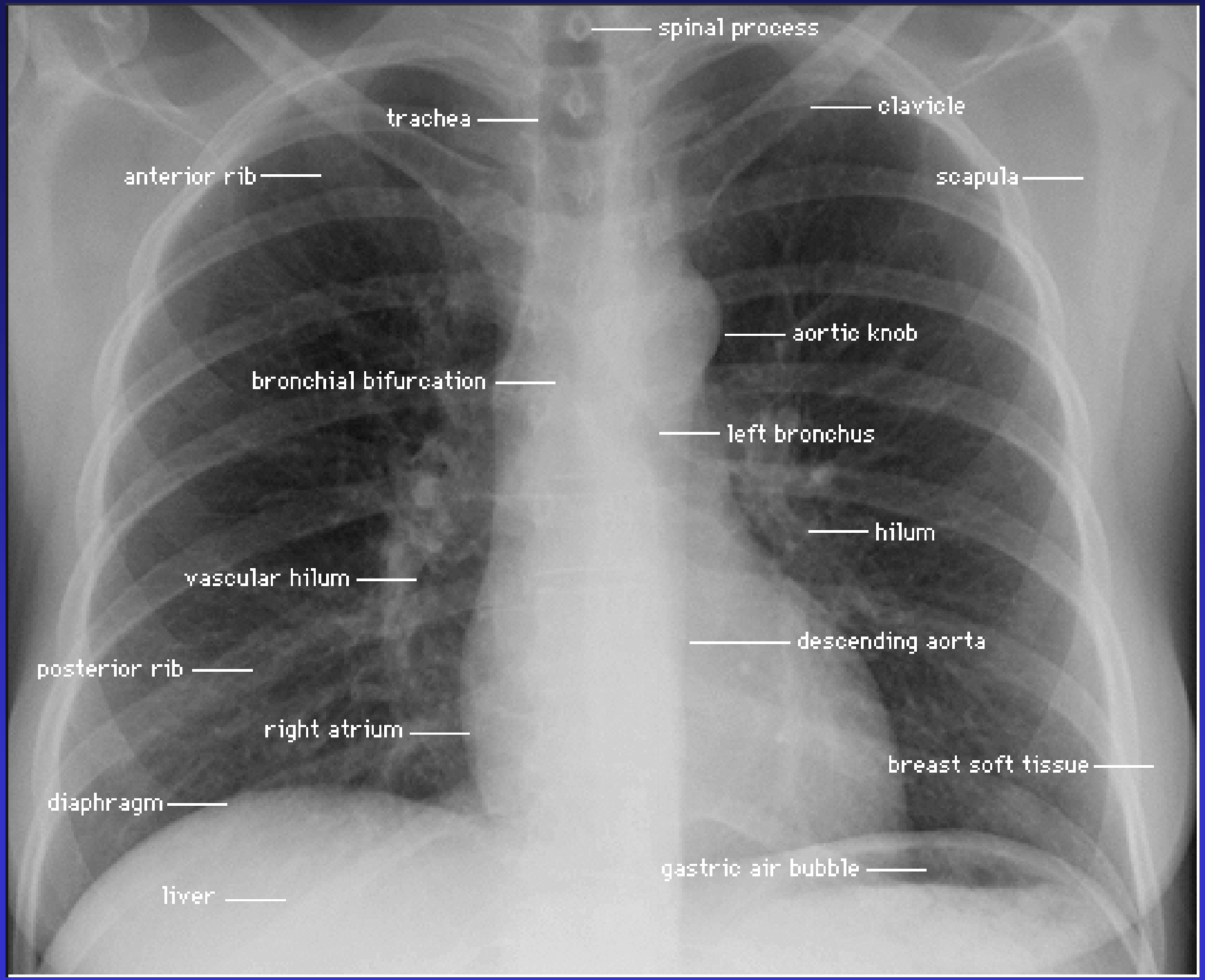
Diaphragm and pleura

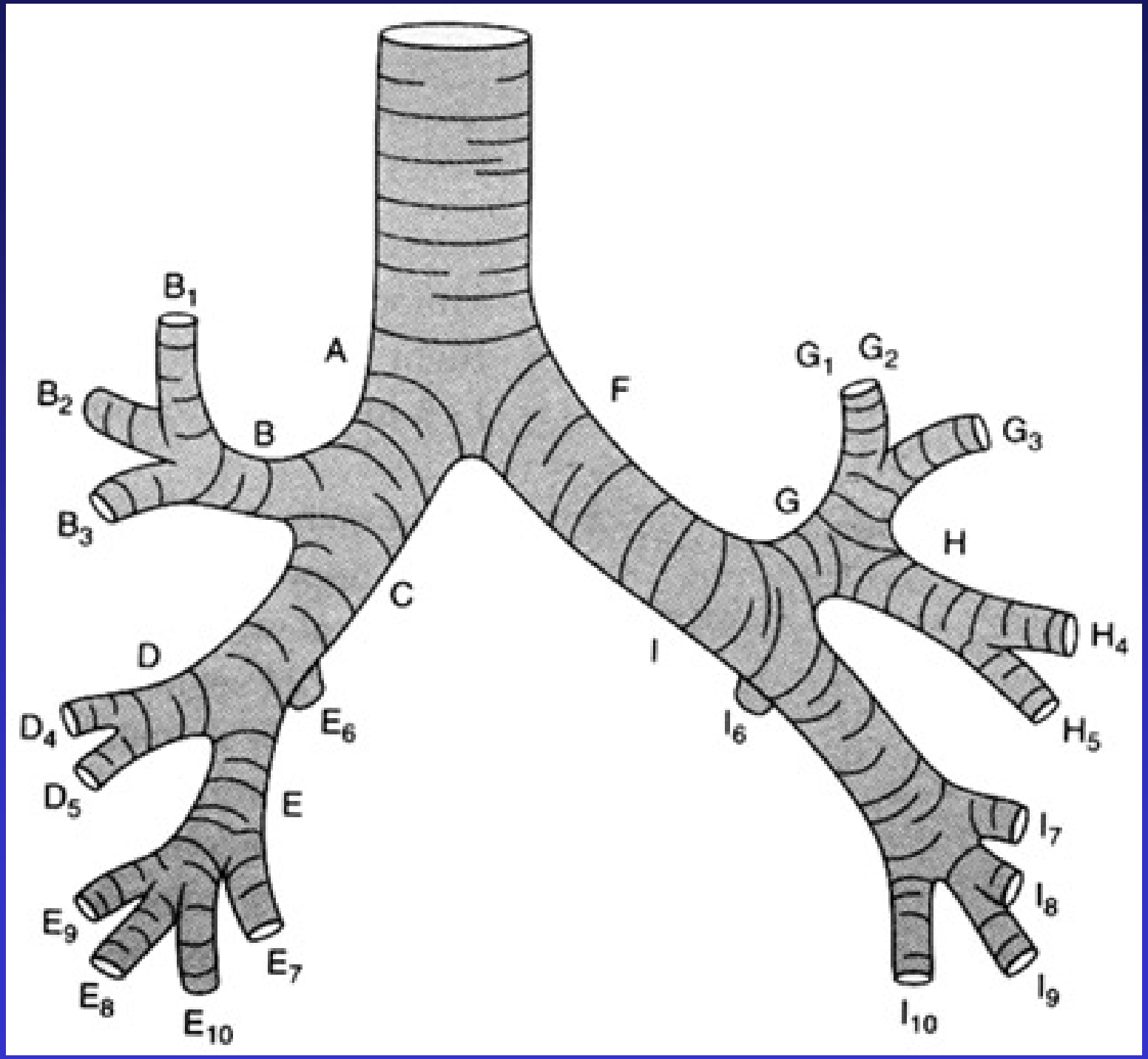
Everything else: soft tissues of the neck, chest wall

Uzelac & Davis, Blueprints Radiology, 2nd Ed 2006



Normal Chest X-ray


spinal process
trachea
clavicle
anterior rib
scapula
aortic knob
bronchial bifurcation
left bronchus
hilum
vascular hilum
descending aorta
posterior rib
right atrium
breast soft tissue
diaphragm
gastric air bubble
liver


B1
B2
B3
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C
D
D4
D5
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E
E9
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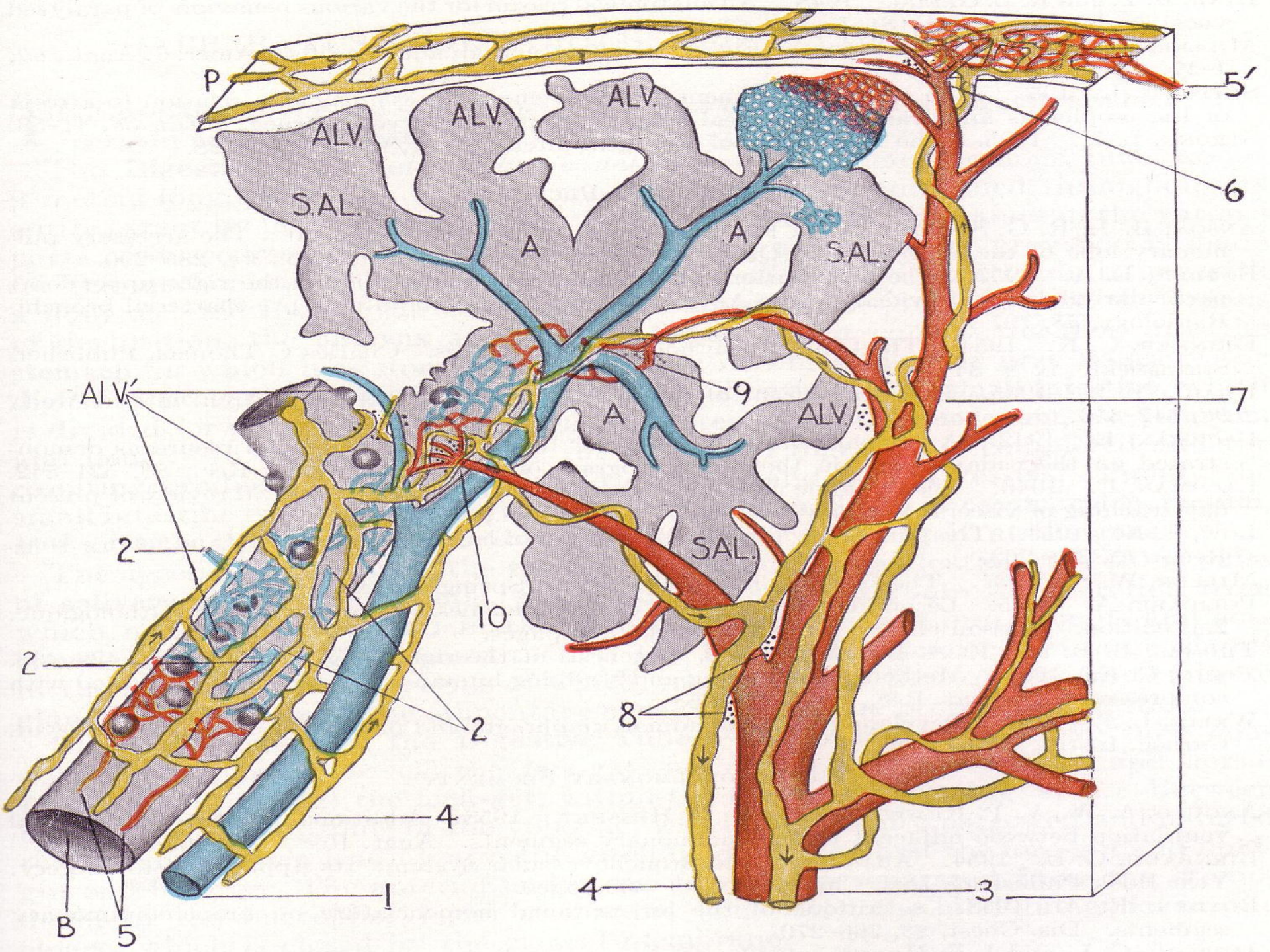
P
ALV.
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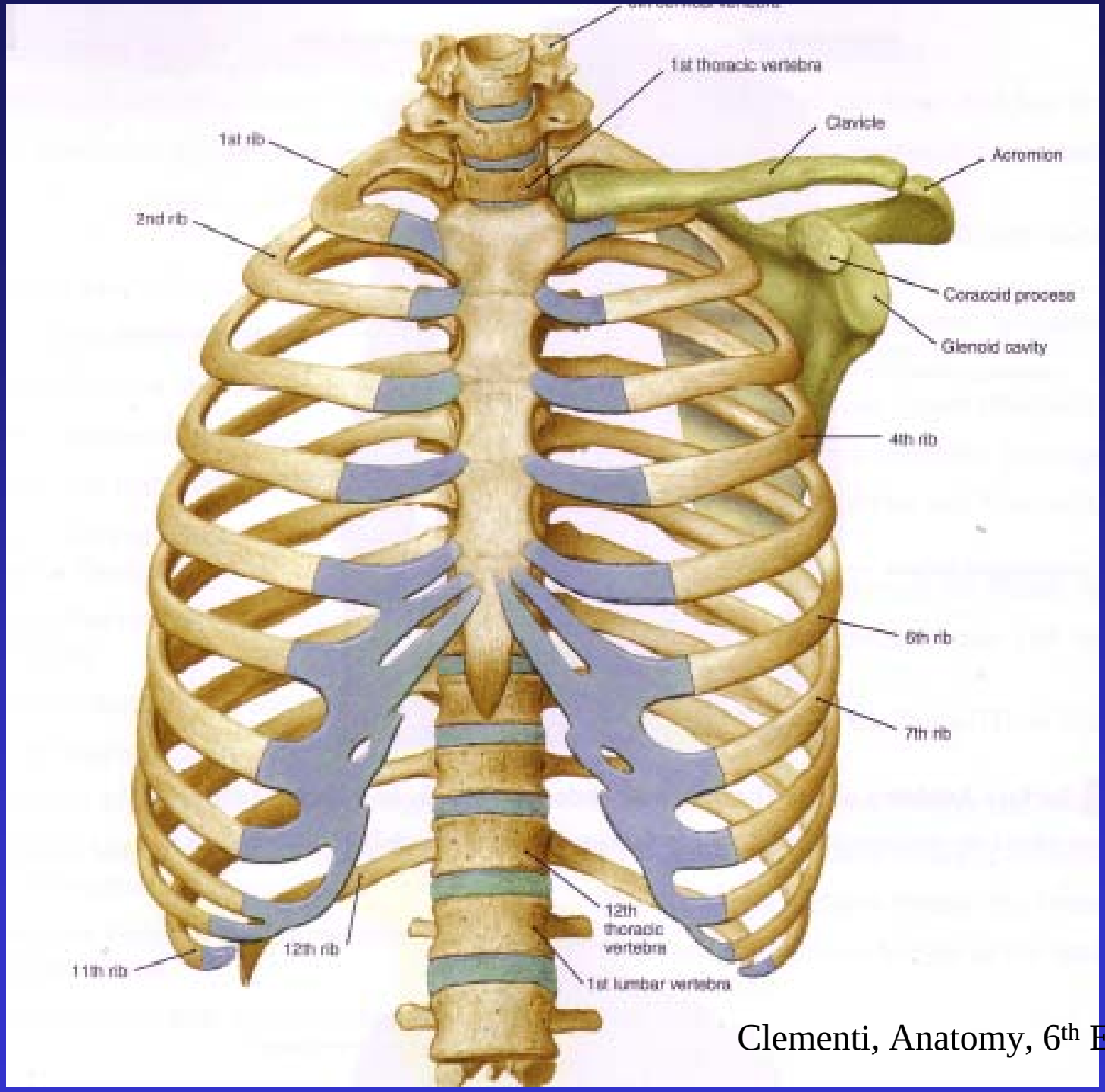
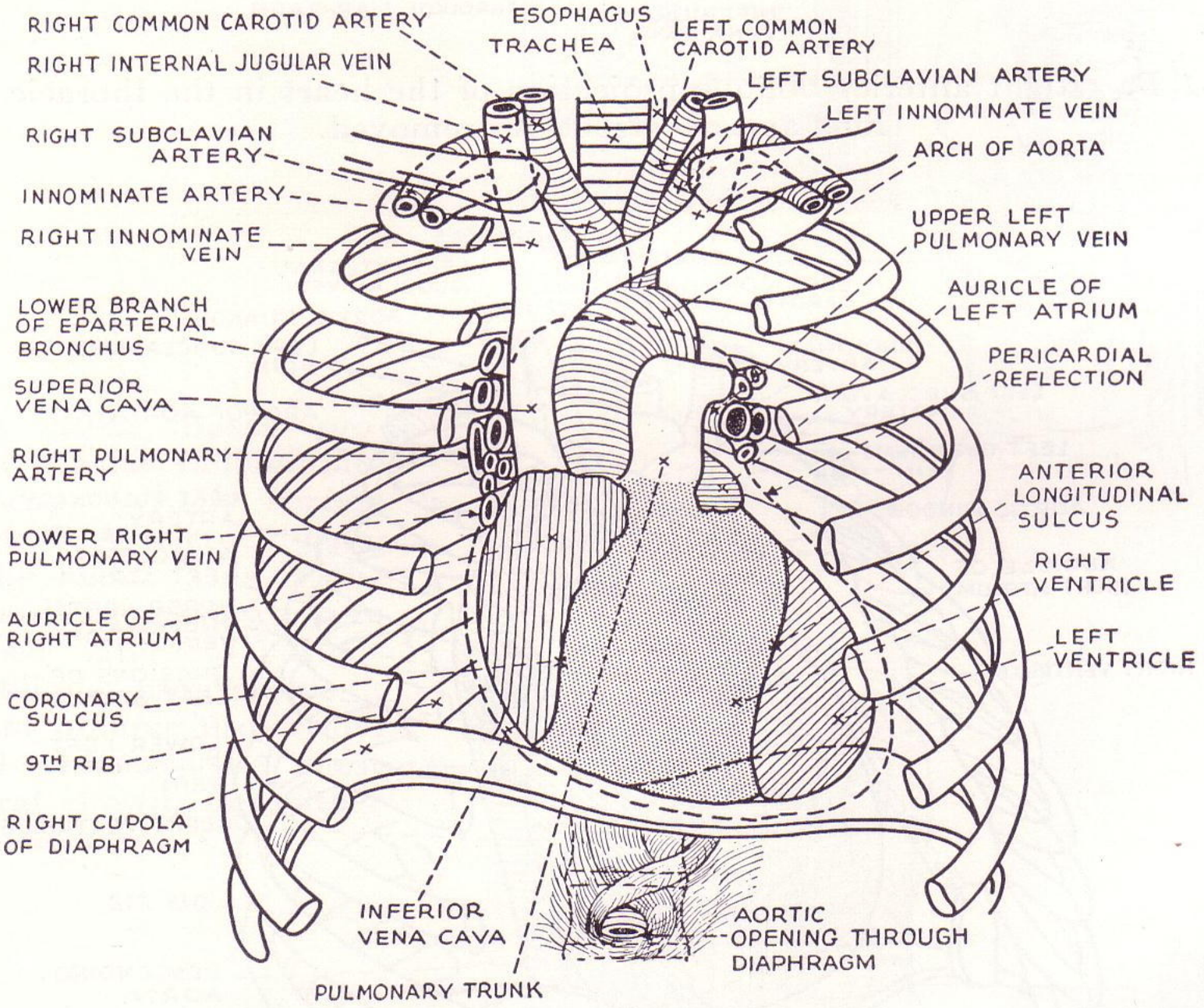
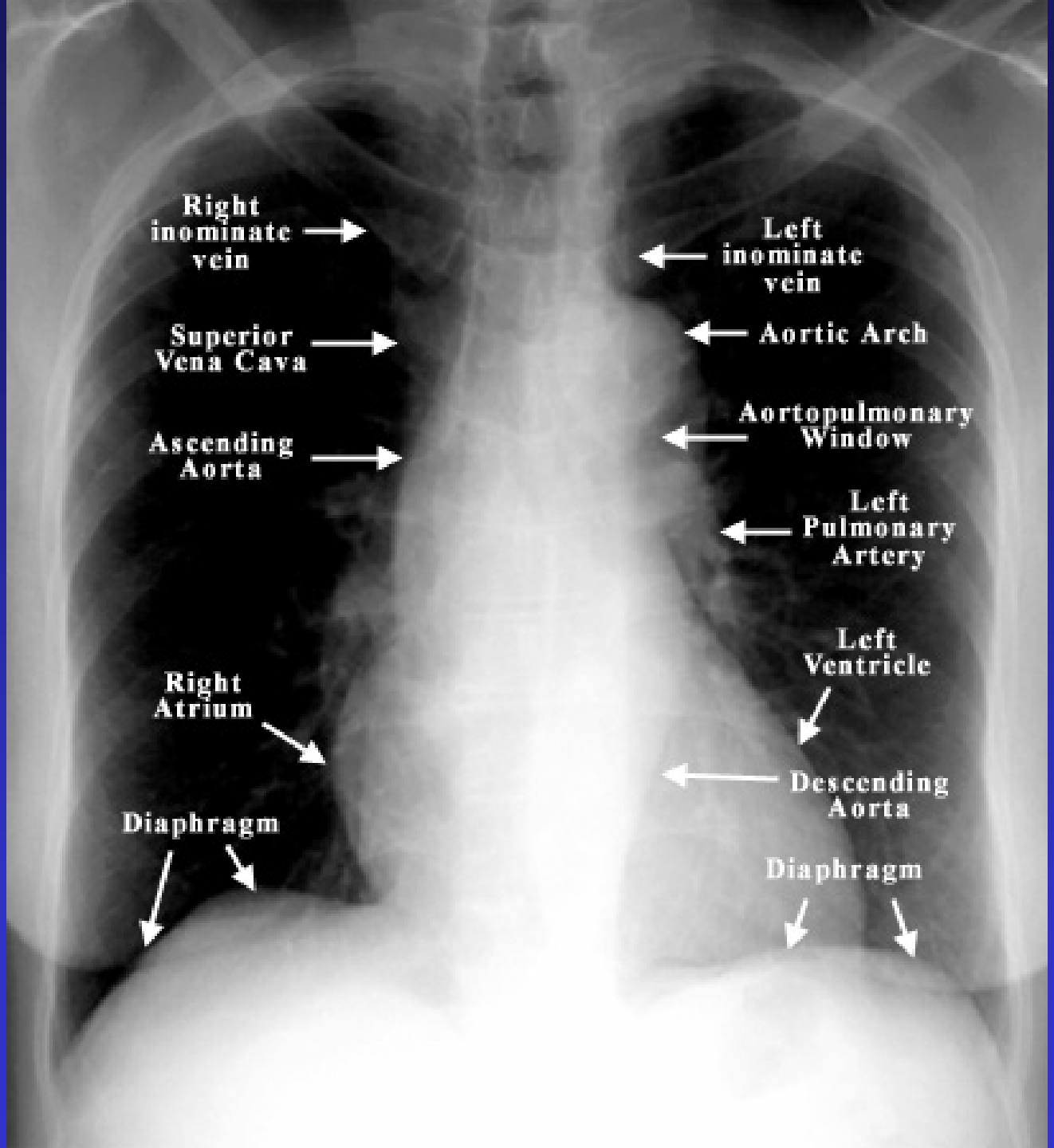
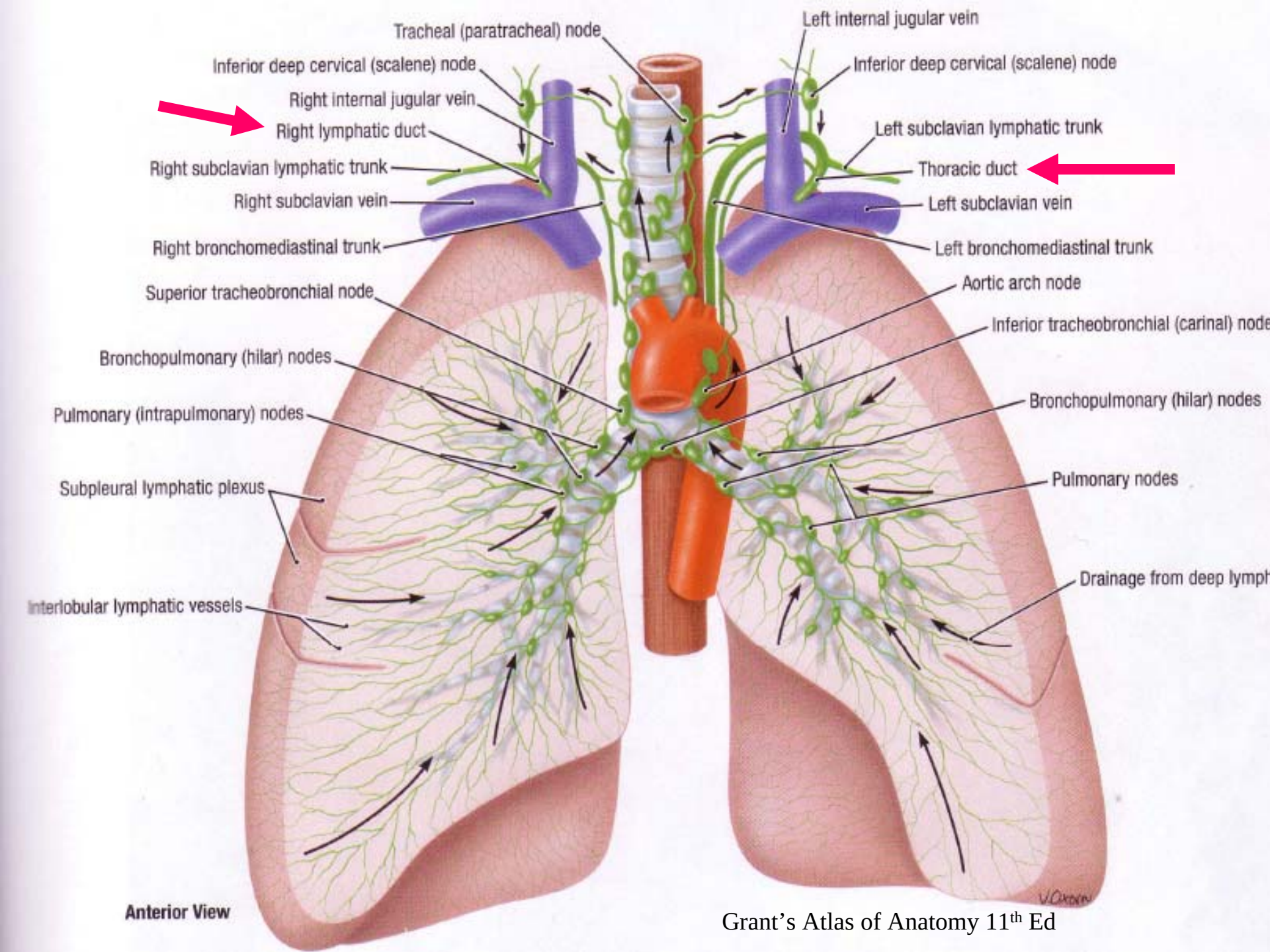


Clementi, Anatomy, 6th Ed, 2011

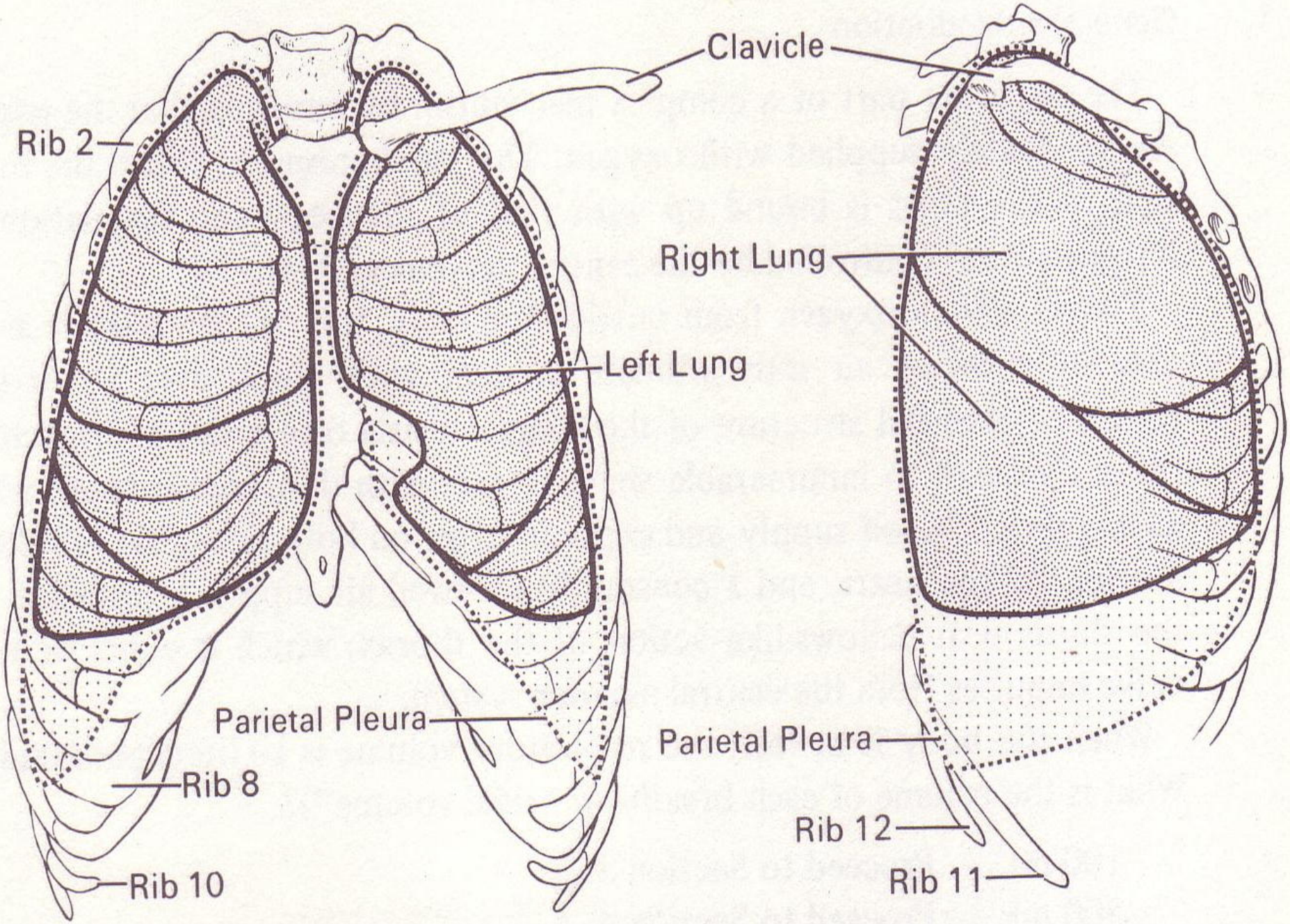
BASIC ANATOMY IN THE FRONTAL PROJECTION

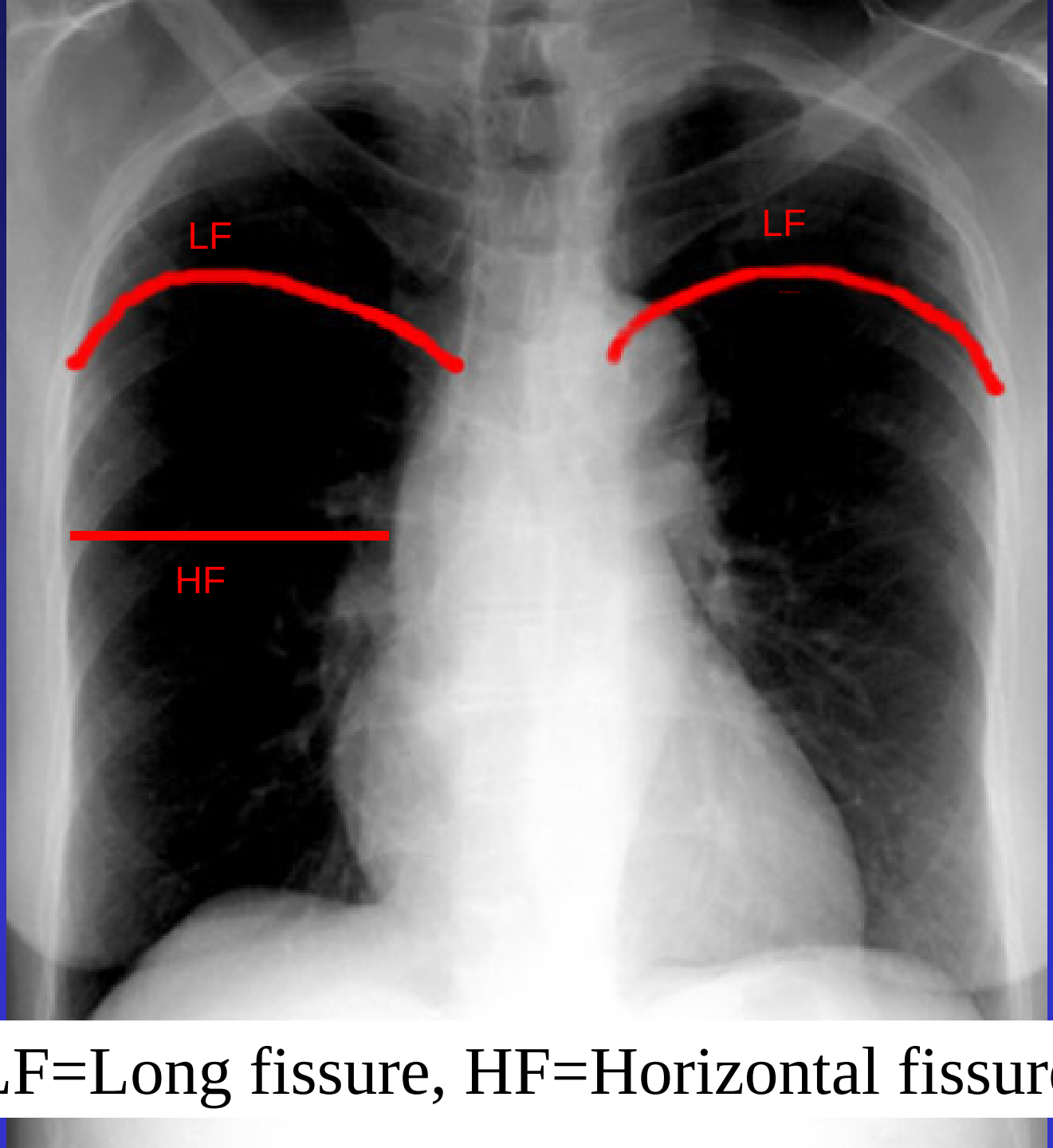



Right inominate vein
Superior Vena Cava
Ascending Aorta
Right Atrium
Diaphragm
Left inominate vein
Aortic Arch
Aortopulmonary Window
Left Pulmonary Artery
Left Ventricle
Descending Aorta
Diaphragm

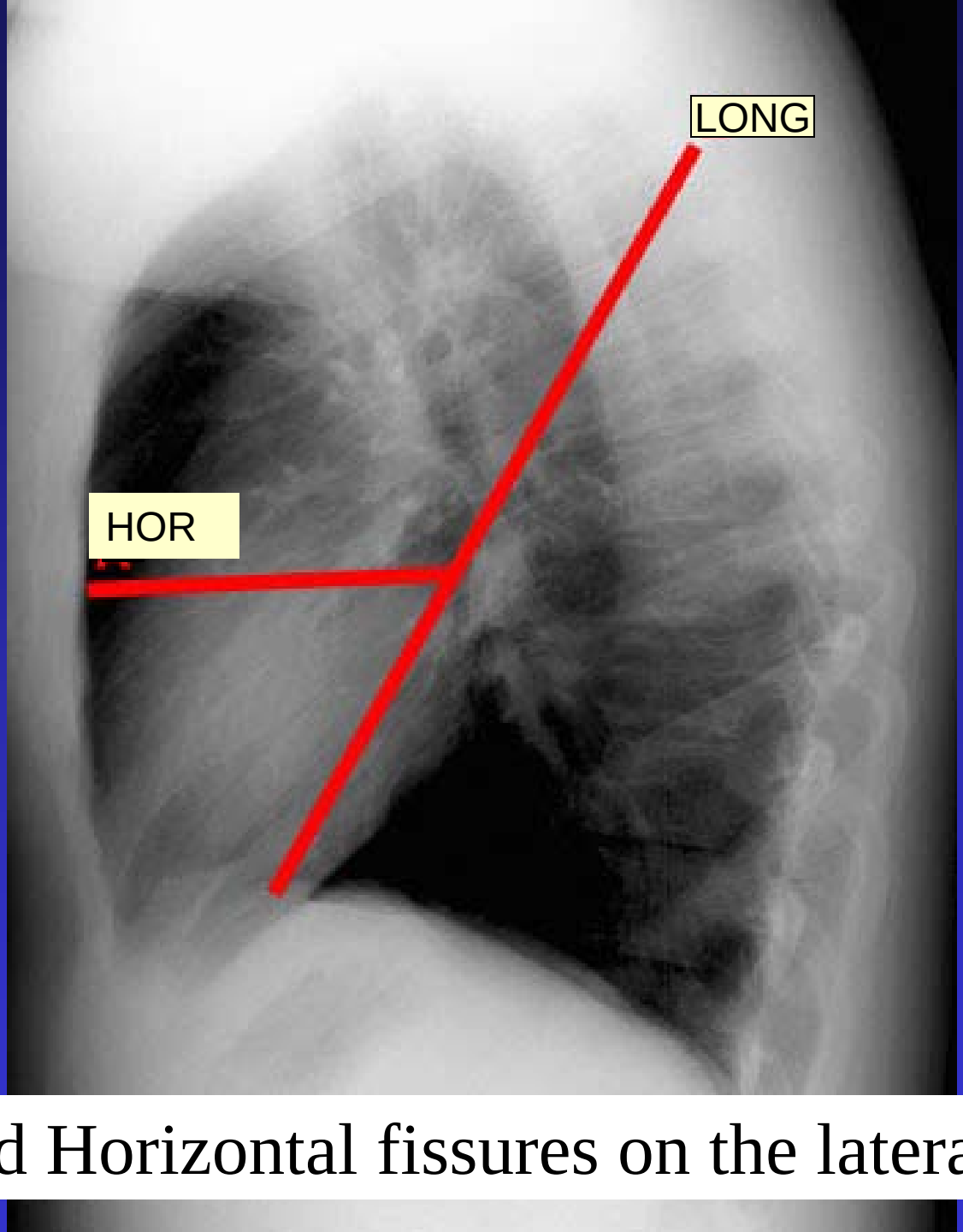


Grant's Atlas of Anatomy 11th Ed


Clavicle
Rib 2
Right Lung
Left Lung
Parietal Pleura
Parietal Pleura
Rib 8
Rib 12
Rib 10
Rib 11



LF=Long fissure, HF=Horizontal fissure



Long and Horizontal fissures on the lateral x-ray

“Reading” the Chest X-ray

Air: Central airways and lung parenchyma

Bones: Ribs, clavicles, spine, shoulders, scapulae

Cardiac: Heart, blood vessels and mediastinum

Diaphragm and pleura

Everything else: soft tissues of the neck, chest wall

Red Flag terms on the CXR report

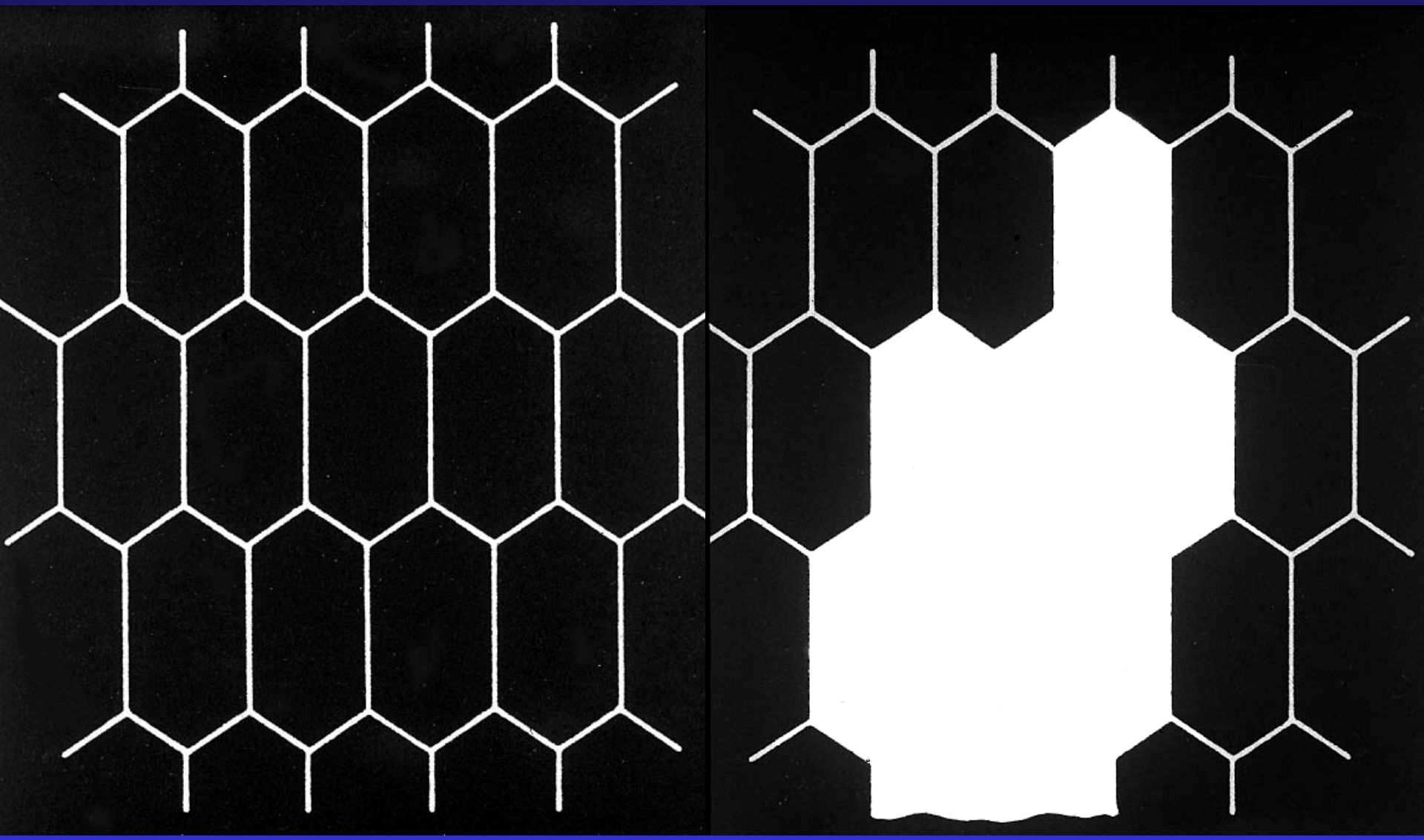
- Air space disease, parenchymal infiltrate, pneumonic process
- Cavitary lesion
- Nodular densities
- Mass lesions
- Interstitial infiltrate/s
- Hilar or perihilar lymphadenopathy
- Pleural effusion or blunting of the costophrenic angle

Infiltrates

- Also known as air space disease (ASD), alveolar filling disease, acinar disease or parenchymal disease
- Appearance and findings
  - Increased opacity
  - Ill defined, hazy, patchy, fluffy, or cloud-like
  - Air bronchograms
  - Lobar or segmental distribution

Normal

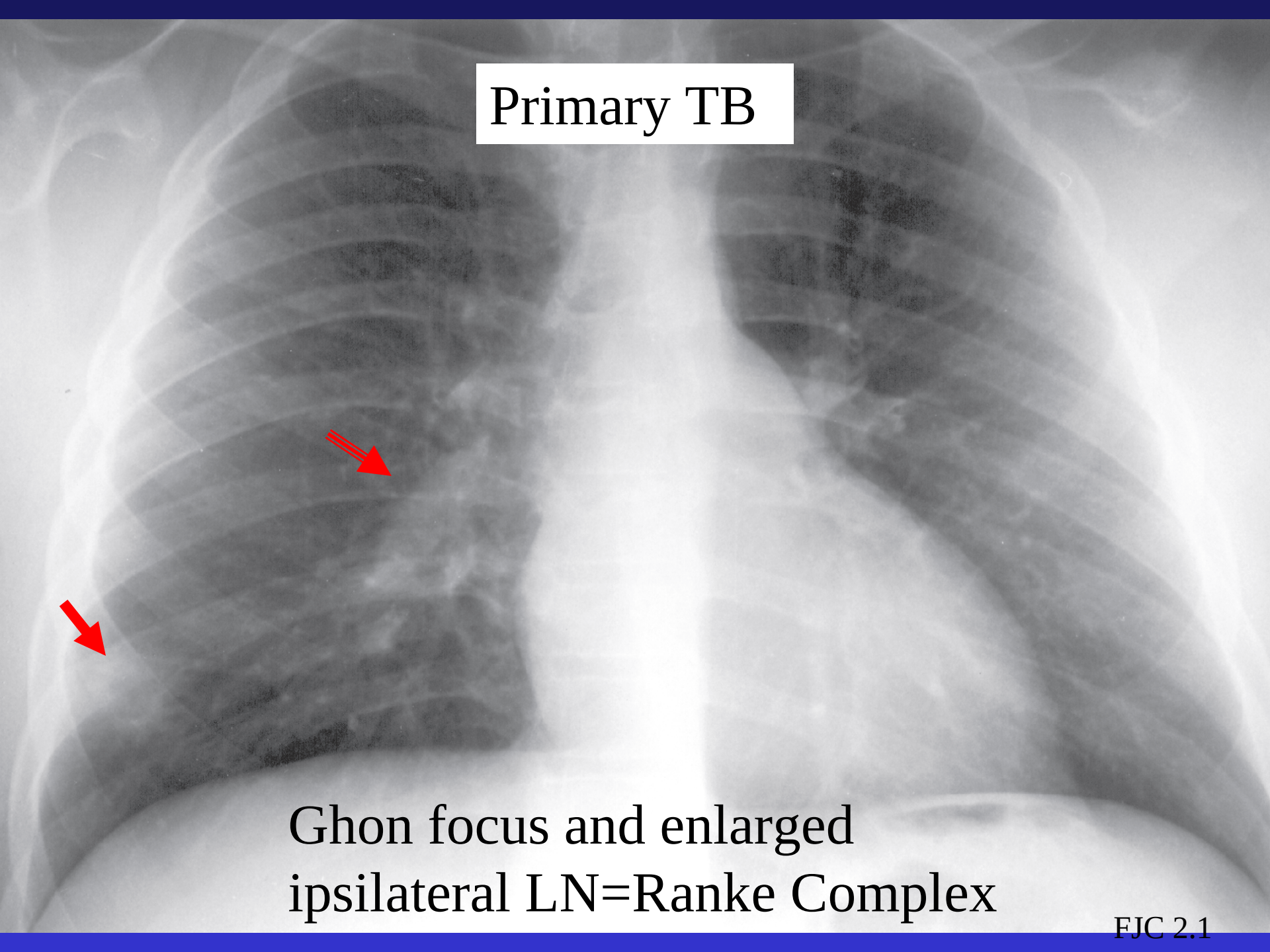
Consolidation



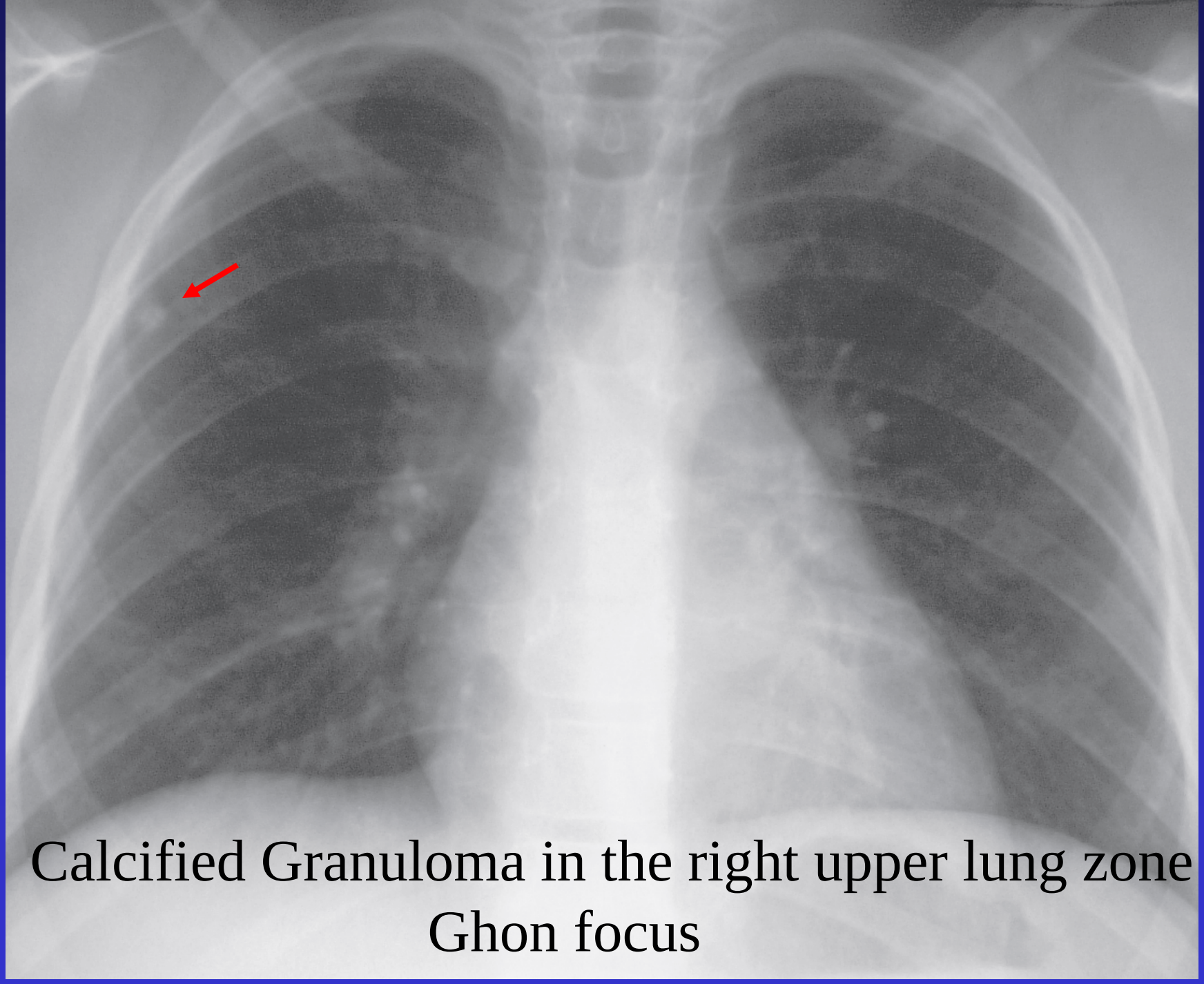
Primary Tuberculosis

- First infection with M. tuberculosis
- Most commonly by way of inhaled air
- Primary or Ghon focus
- Lymphatic spread
- Hematogenous spread
- Development of Delayed Hypersensitivity and Cell Mediated Immunity in 8 weeks

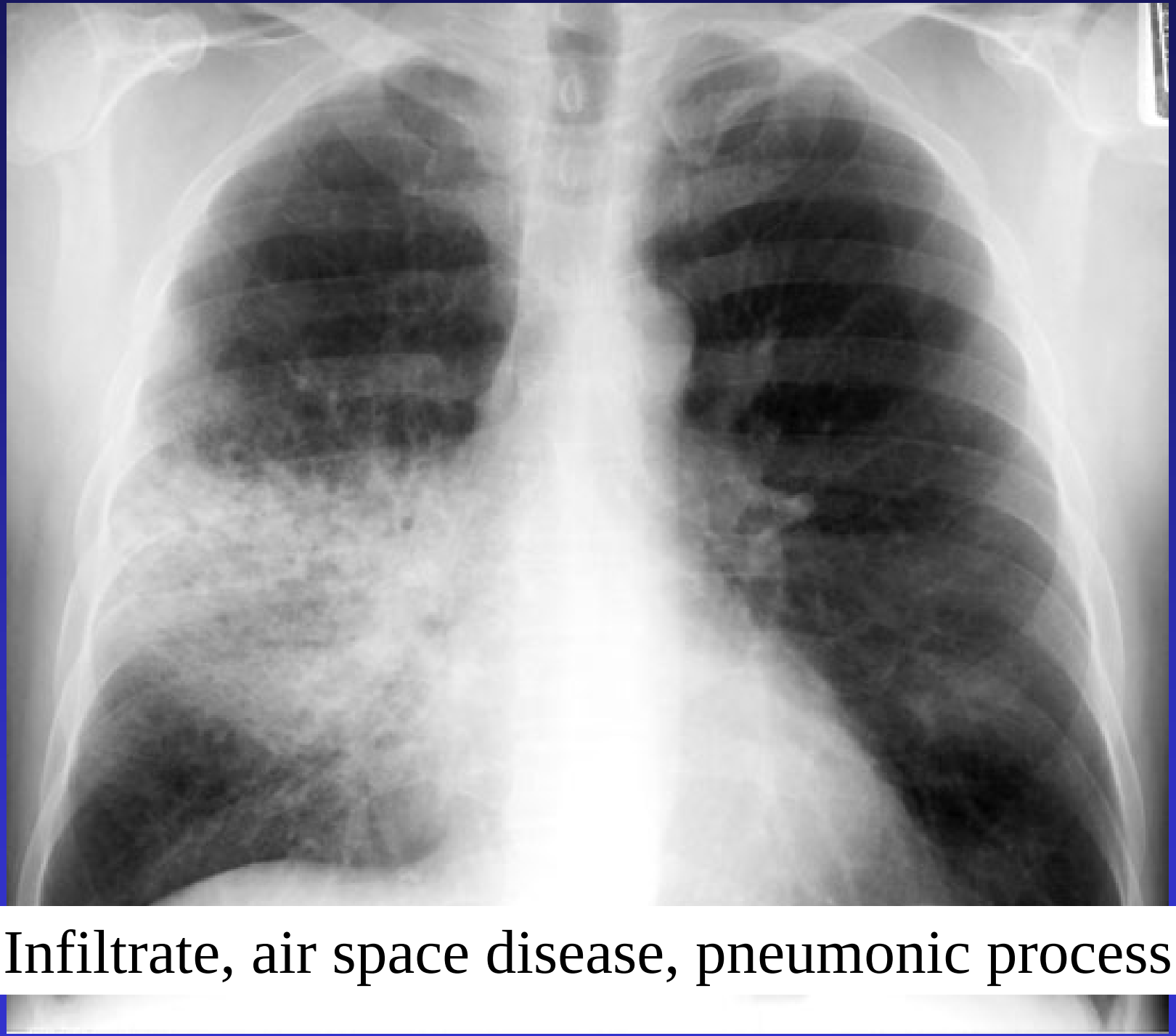
Primary TB



Ghon focus and enlarged ipsilateral LN=Ranke Complex

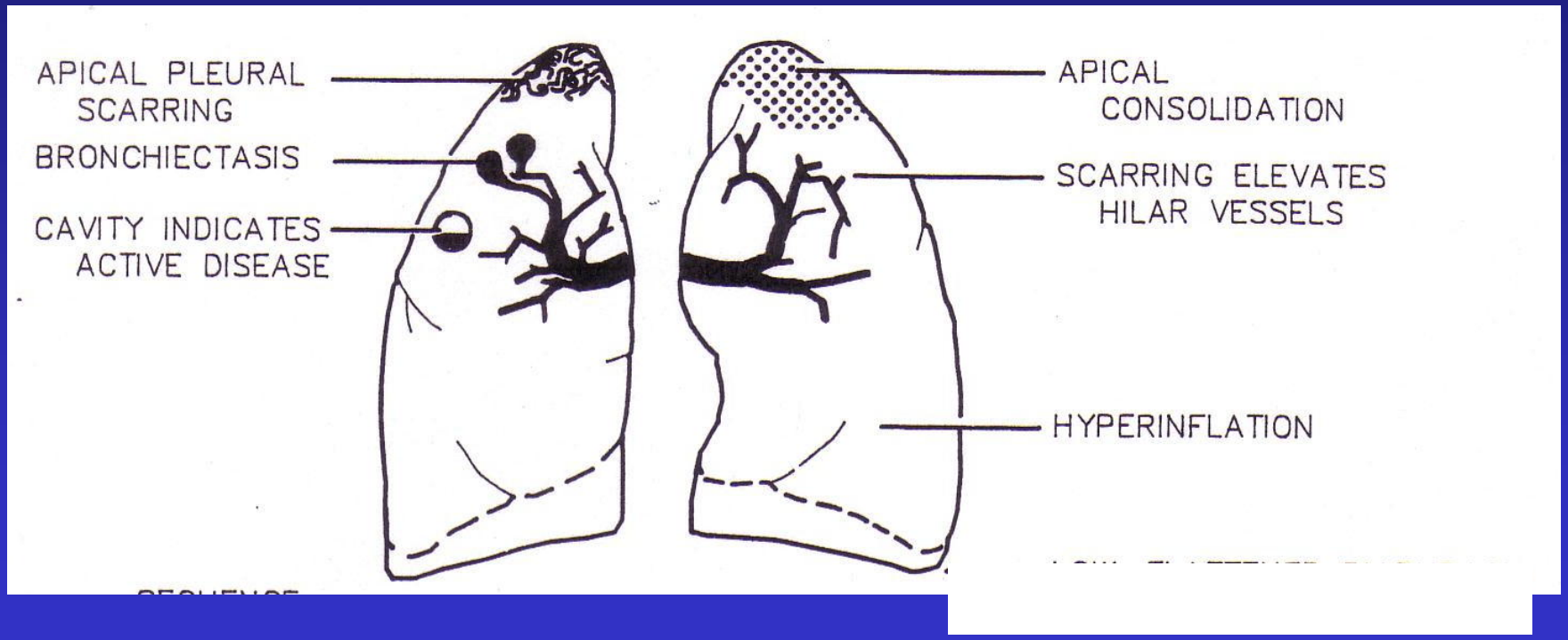


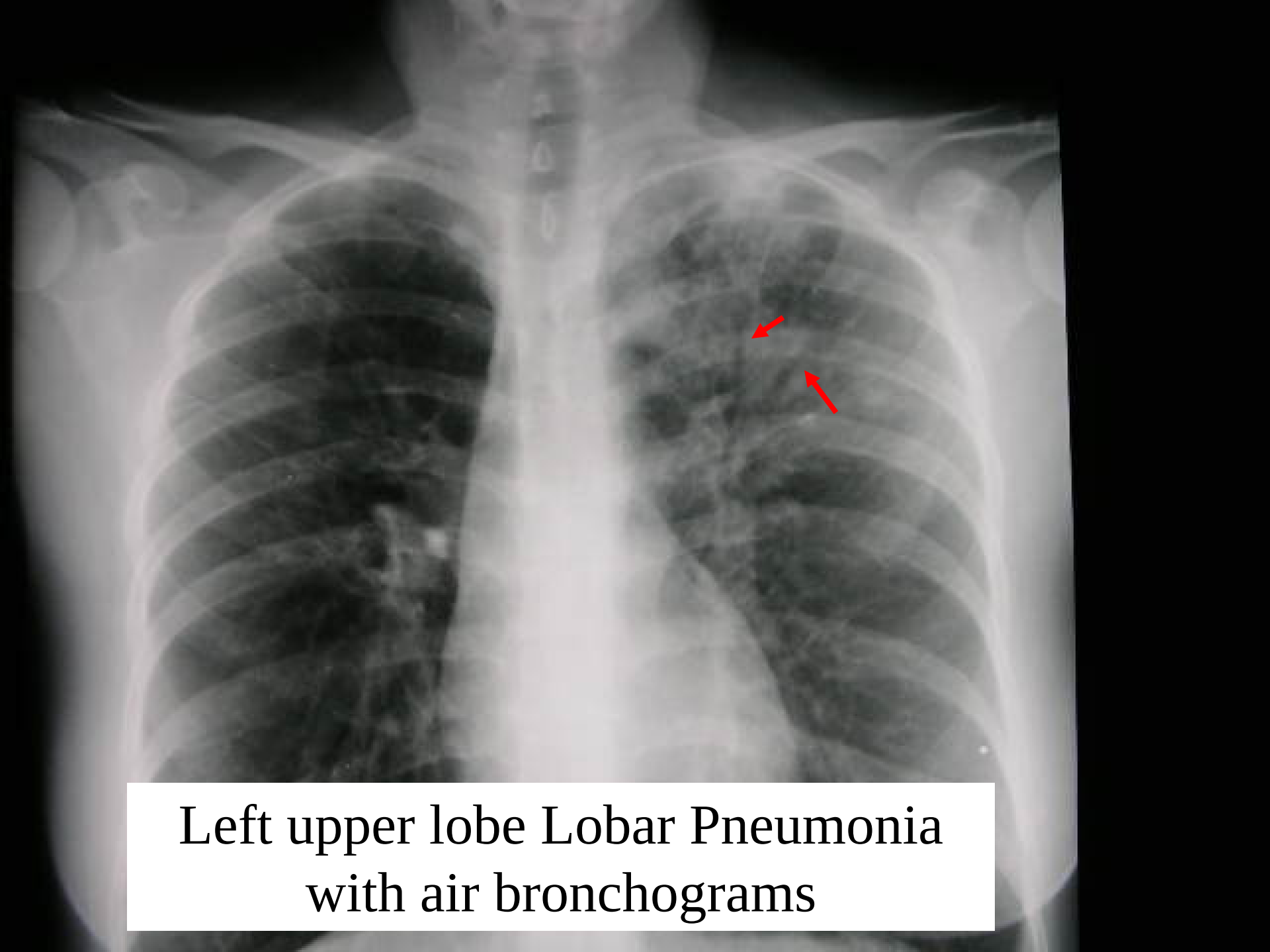
Calcified Granuloma in the right upper lung zone
Ghon focus



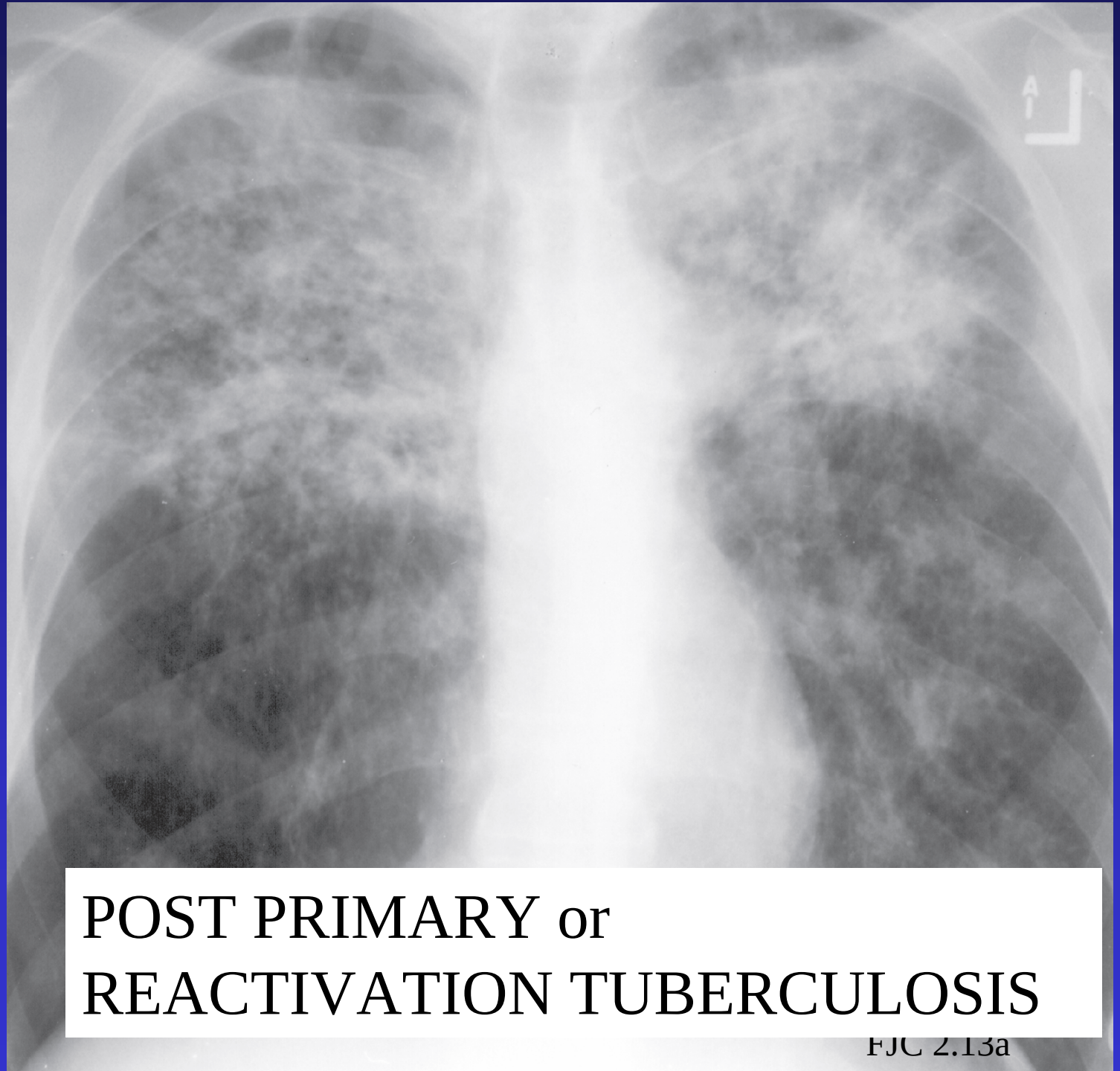
Infiltrate, air space disease, pneumonic process

Post Primary Tuberculosis
Reactivation TB





Left upper lobe Lobar Pneumonia with air bronchograms

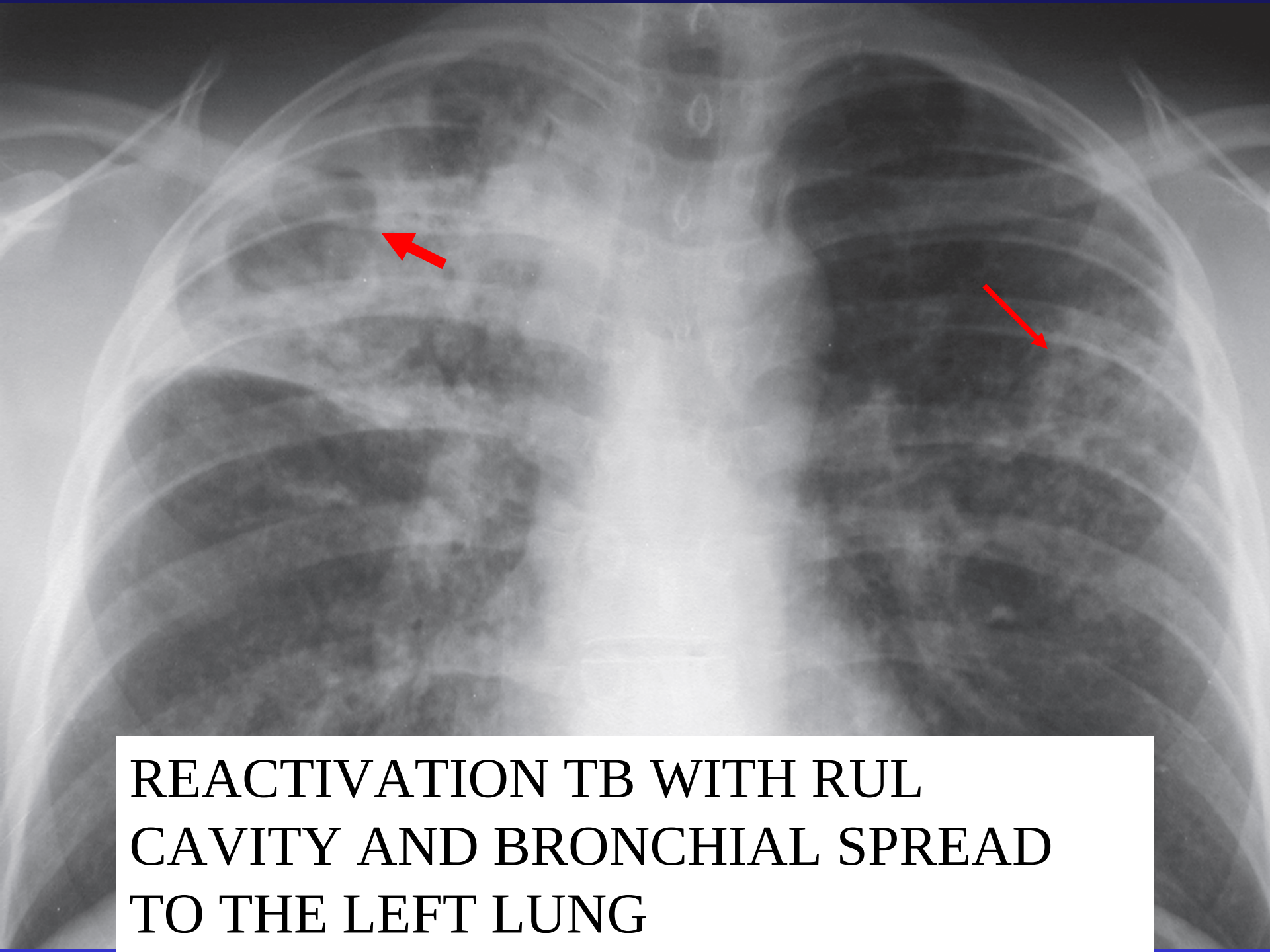


POST PRIMARY or
REACTIVATION TUBERCULOSIS

FJC 2.13a

Cavitary Disease

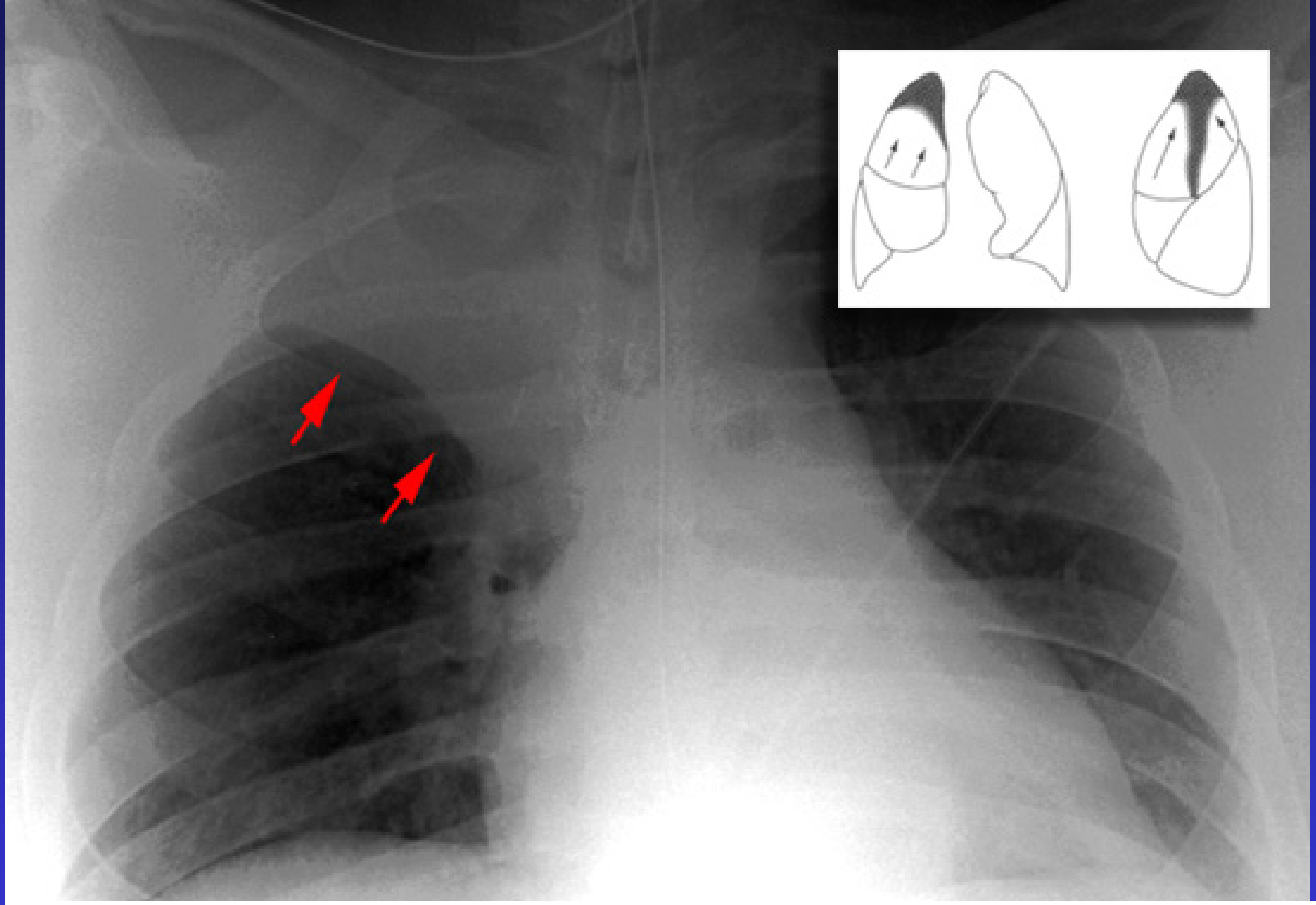
An air filled area, usually circular, within a parenchymal infiltrate which represents an area of the lung tissue which has been destroyed. The cavity contains air as it is open to a bronchial tube. The wall of the cavity can be thick or thin and the inner margin may be smooth or irregular



REACTIVATION TB WITH RUL CAVITY AND BRONCHIAL SPREAD TO THE LEFT LUNG

Atelectasis

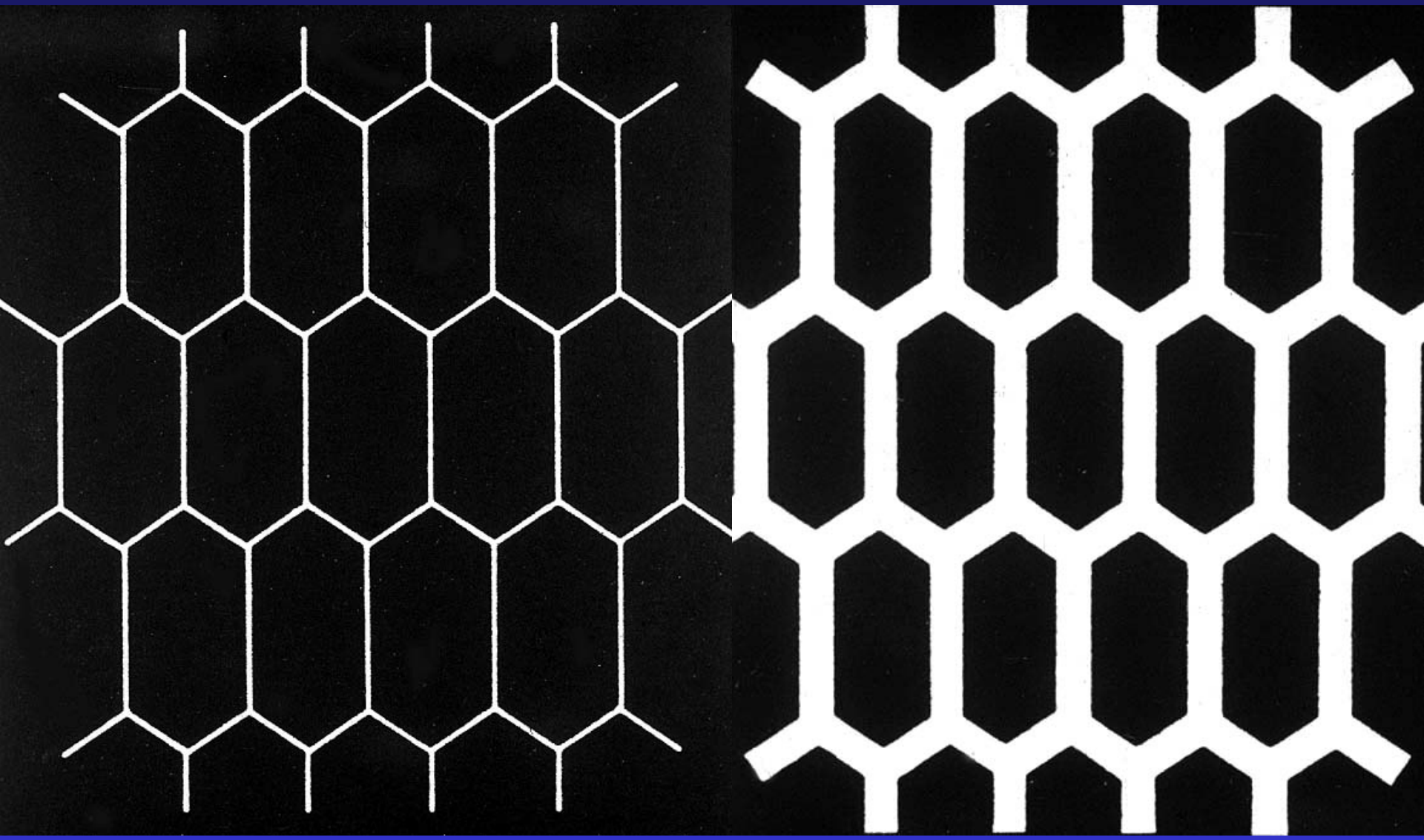
- Diminished air within the lung associated with loss of volume
  - Can be due to obstruction of the bronchus to the area
  - Can be due to scarring and retraction of the injured lung tissue

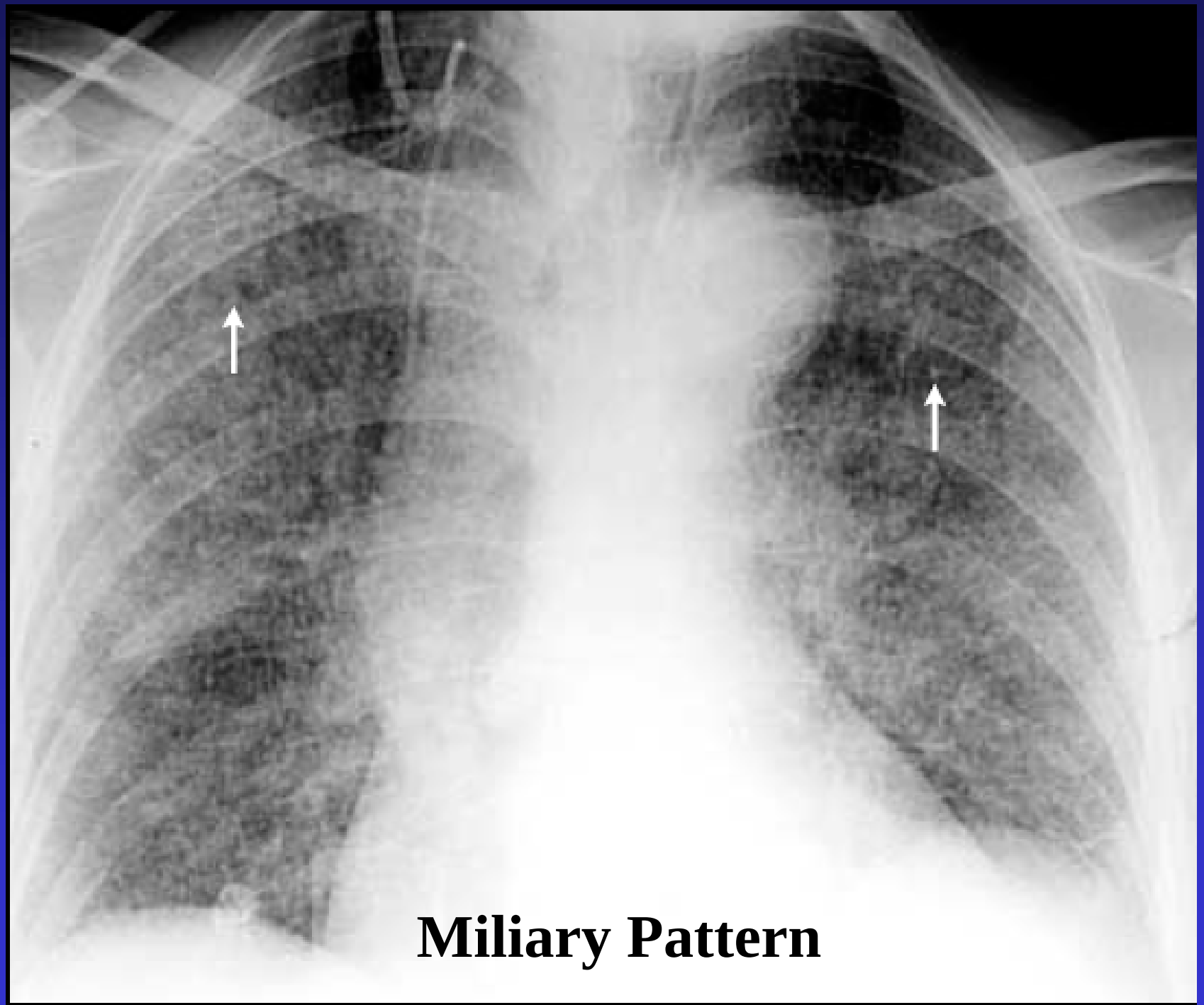


Collapse or Atelectasis of the Right upper lobe
Note elevation of the Horizontal fissure

Normal

Interstitial disease





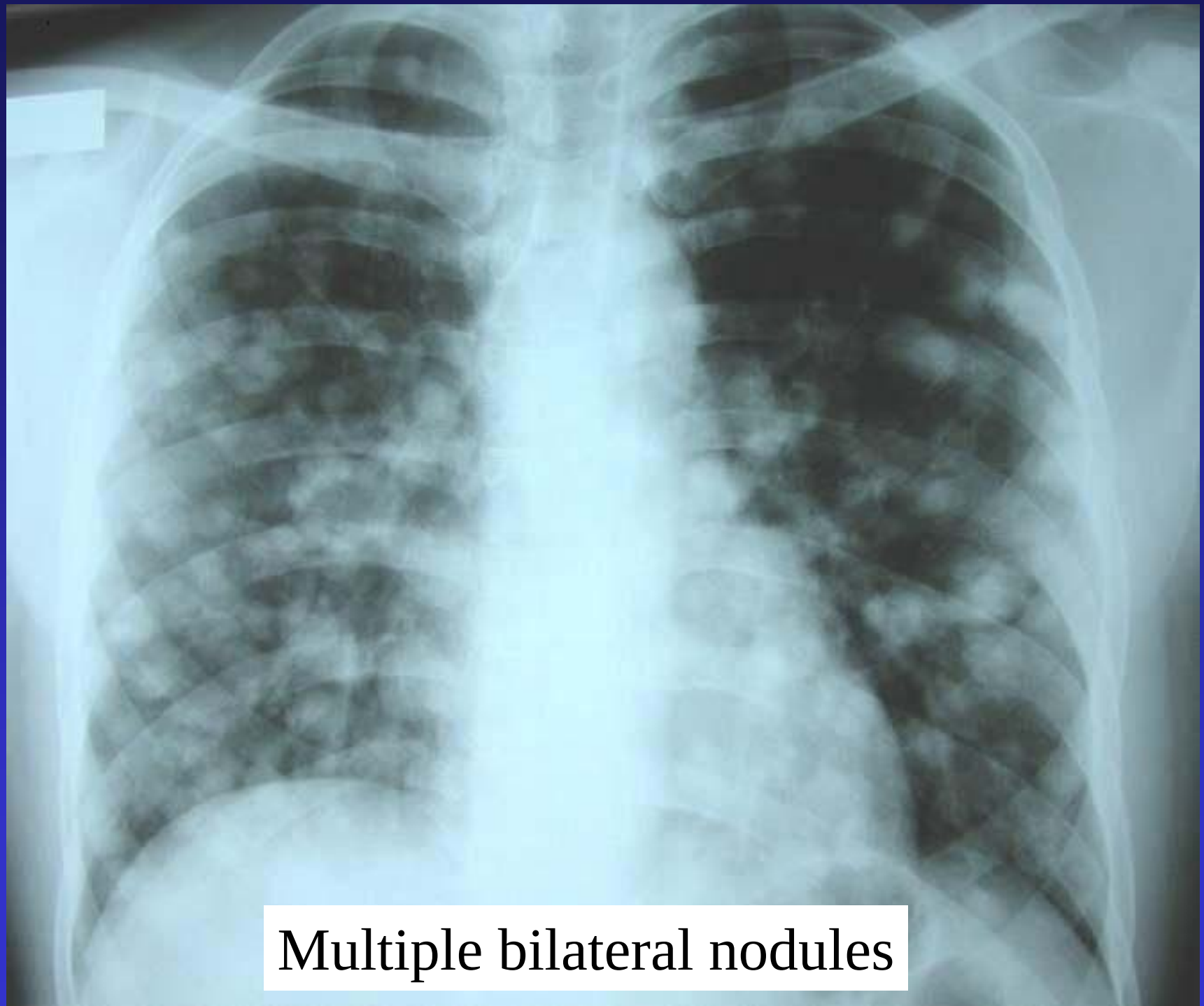
Miliary Pattern

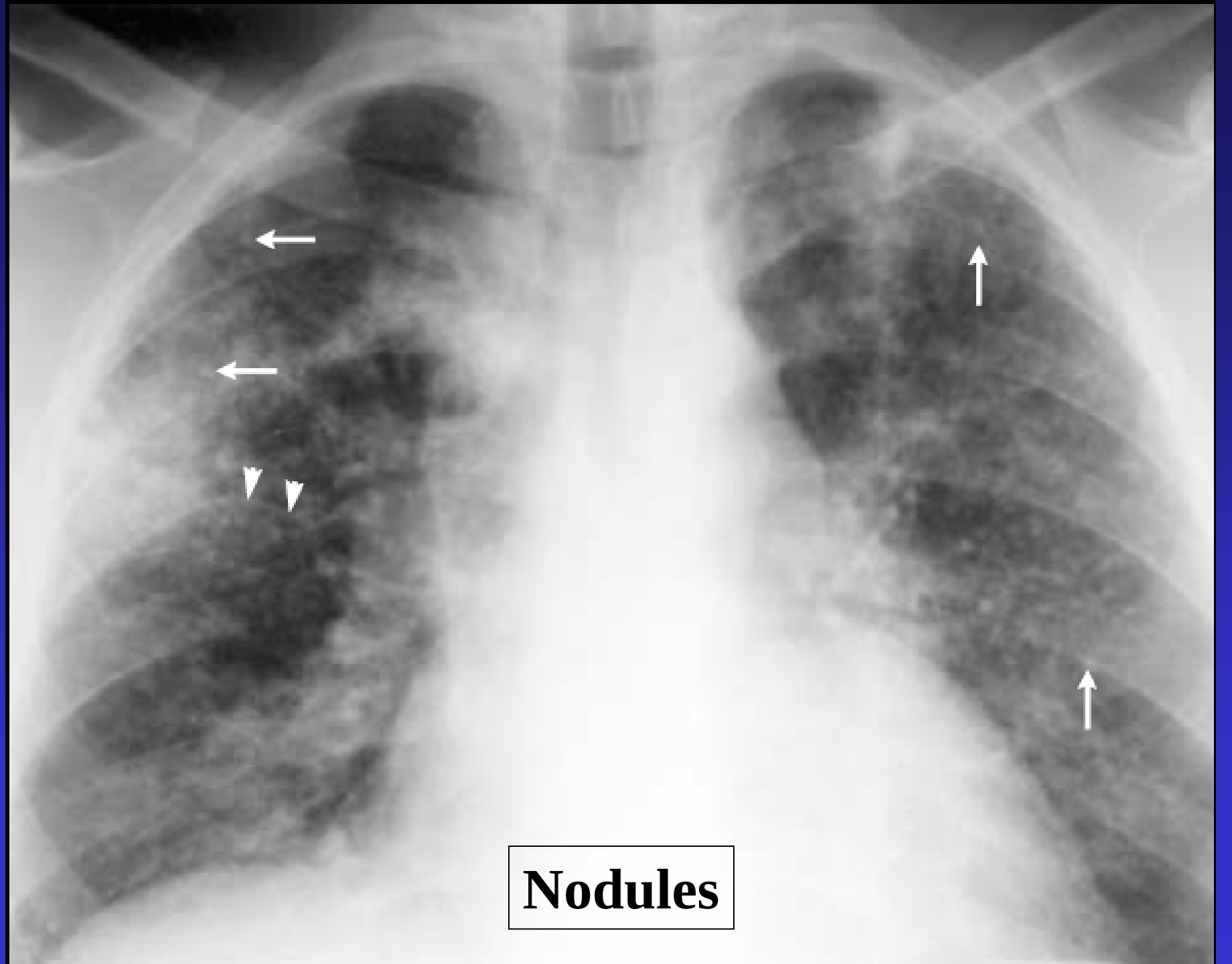
Miliary TB

Millet seeds

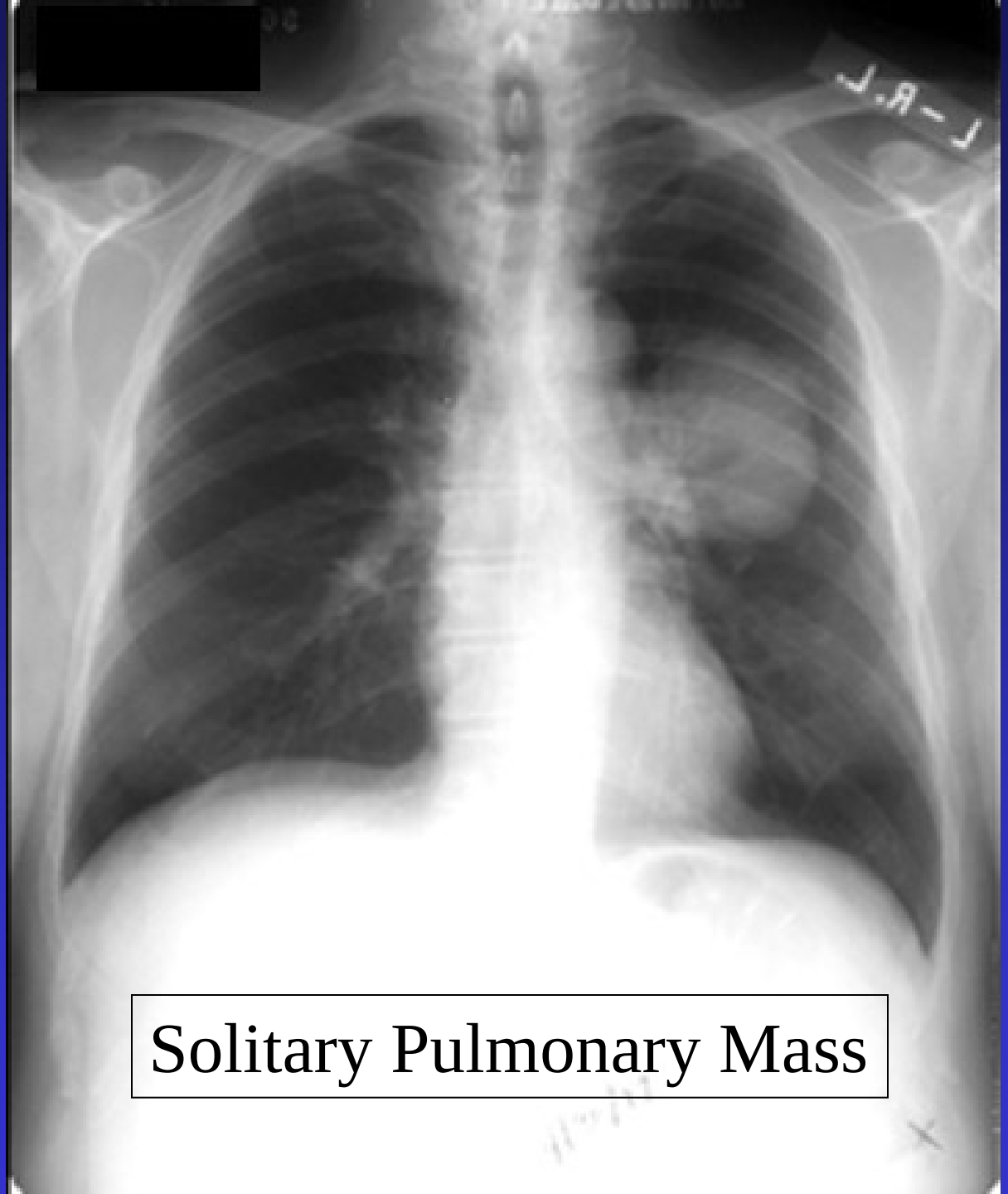
Nodules/Masses

- Nodules and masses are discrete areas of increased lung opacity whose borders do not conform to anatomic divisions (such as a fissure)
- Masses are similar to nodules except that they are larger, measuring greater than 30mm in diameter
- Nodules and masses should be described by noting their size, the sharpness of their borders, their number, their location and the presence or absence of calcification


Multiple bilateral nodules



Nodules



Solitary Pulmonary Mass

“Reading” the Chest X-ray

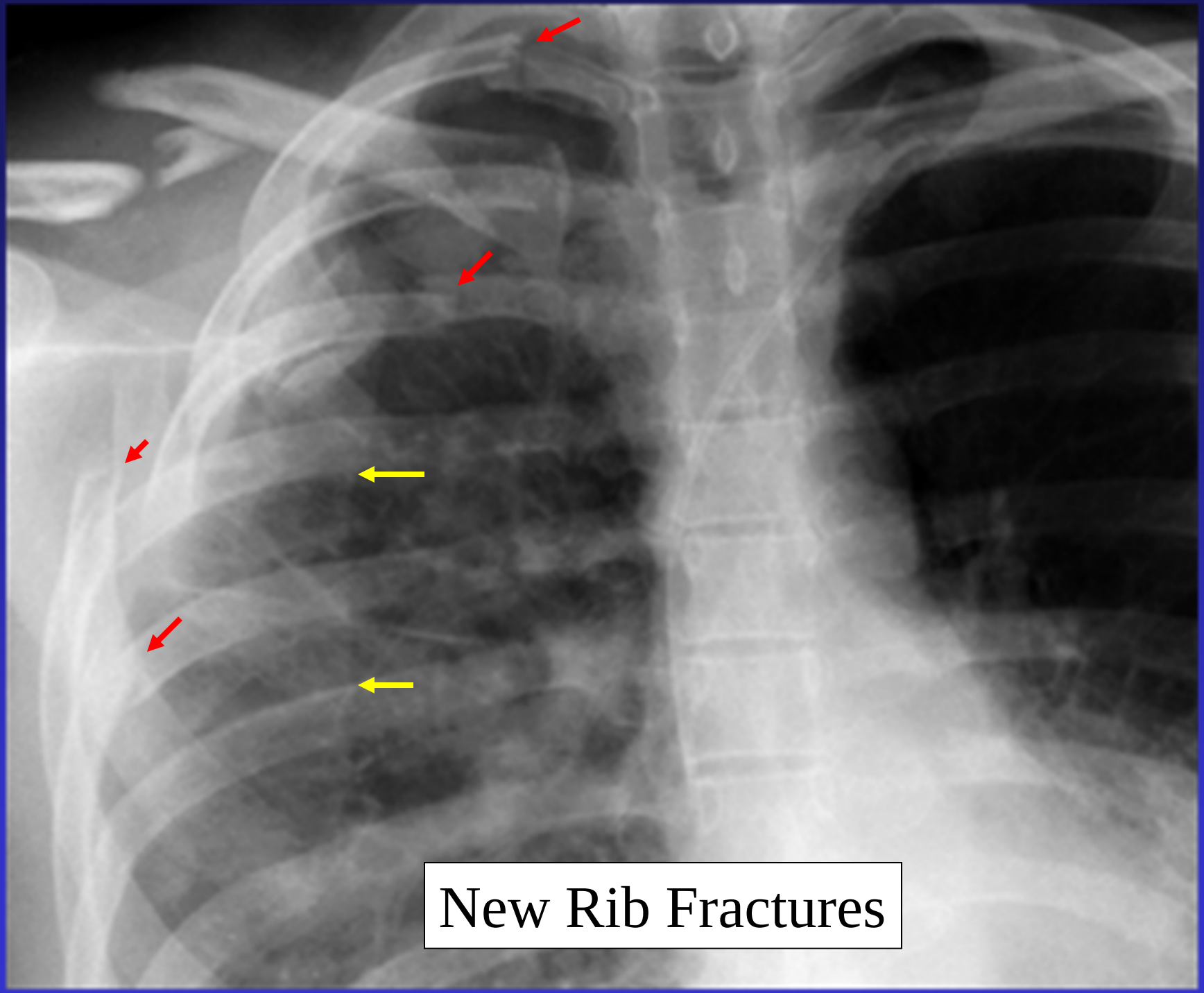
A*ir: Central airways and lung parenchyma*

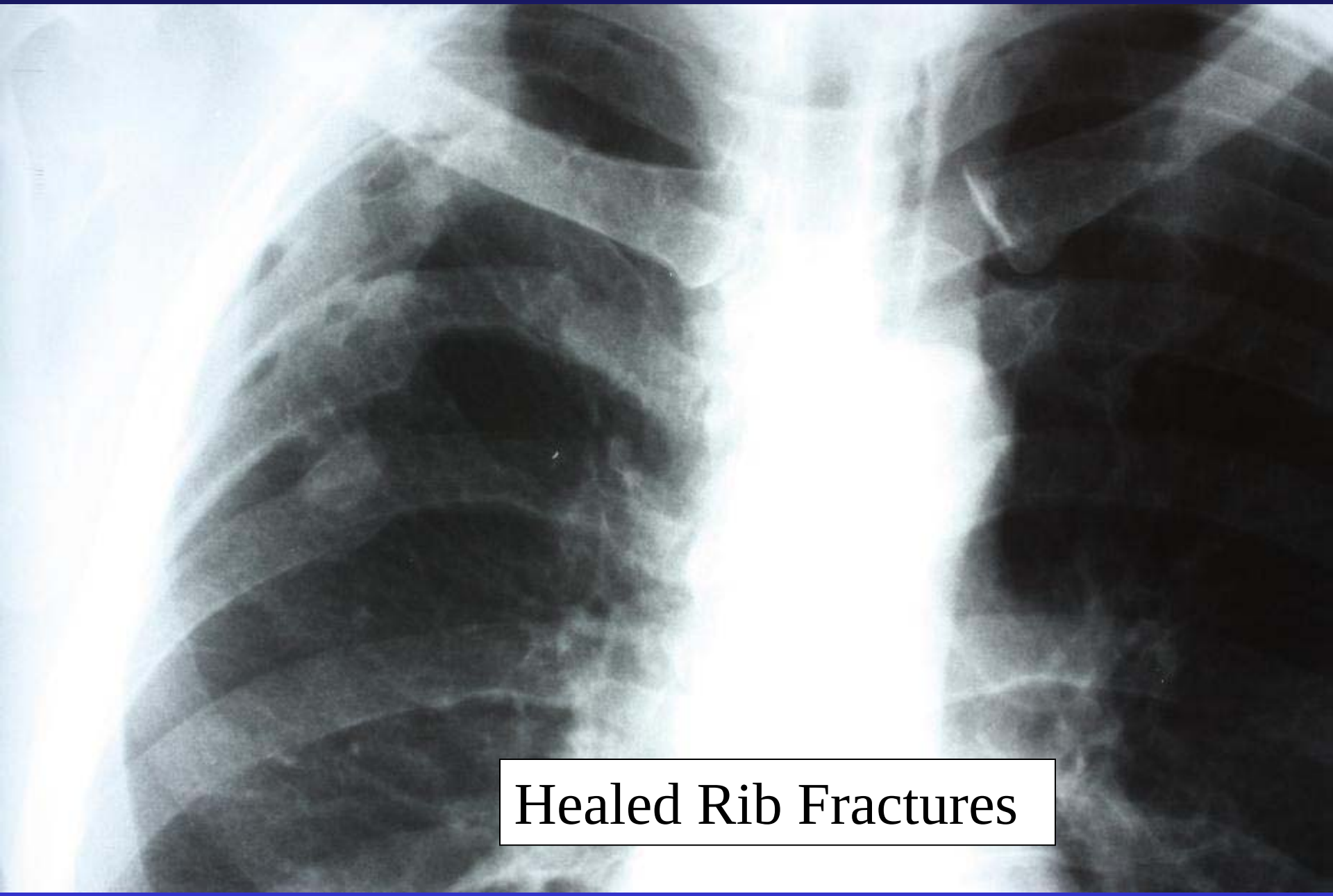
B**ones: Ribs, clavicles, spine, shoulders, scapulae**

C*ardiac: Heart, blood vessels and mediastinum*

D*iaphragm and pleura*

E*verything else: soft tissues of the neck, chest wall*


New Rib Fractures


Healed Rib Fractures

“Reading” the Chest X-ray

***A**ir: Central airways and lung parenchyma*

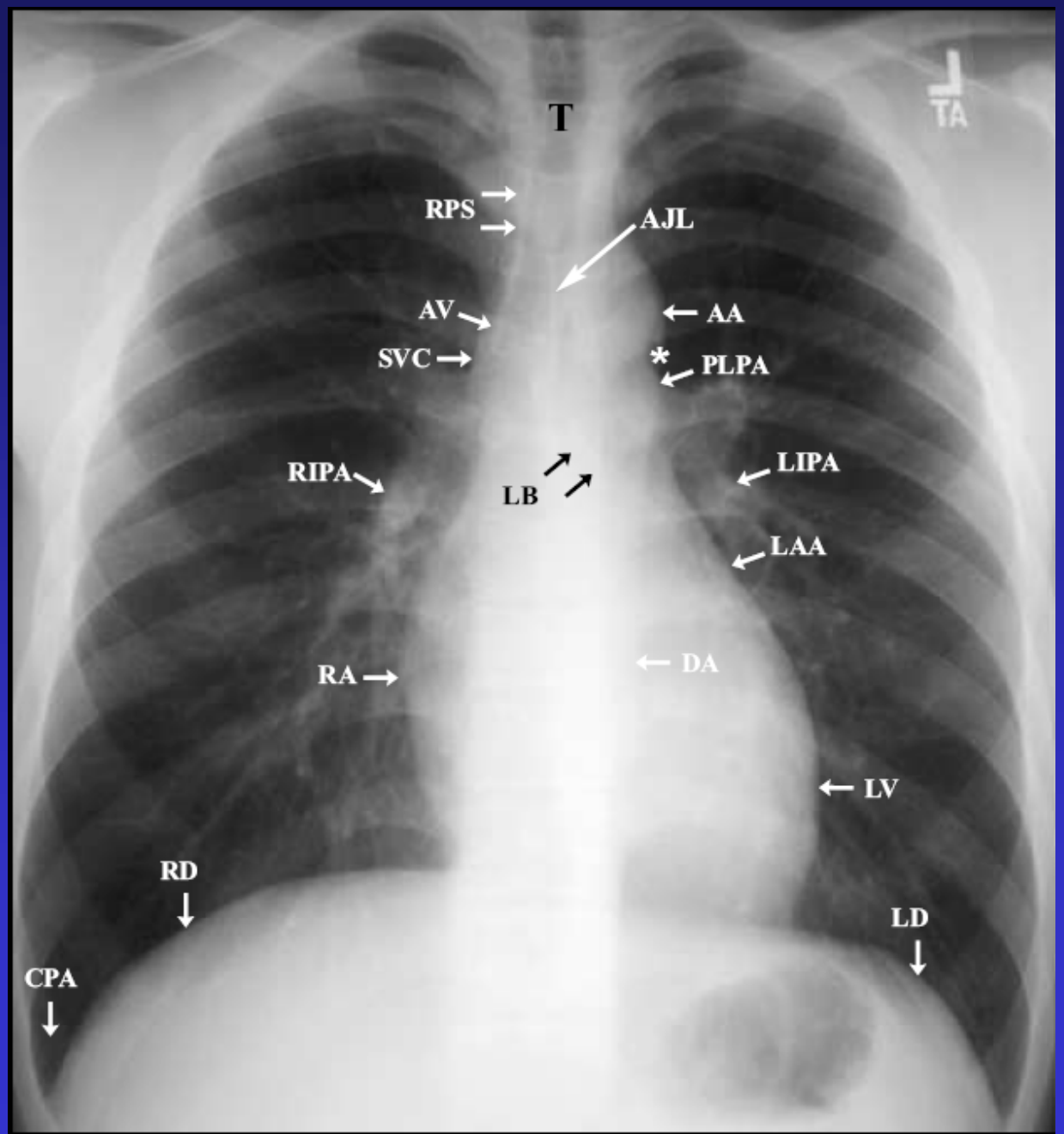
***B**ones: Ribs, clavicles, spine, shoulders, scapulae*

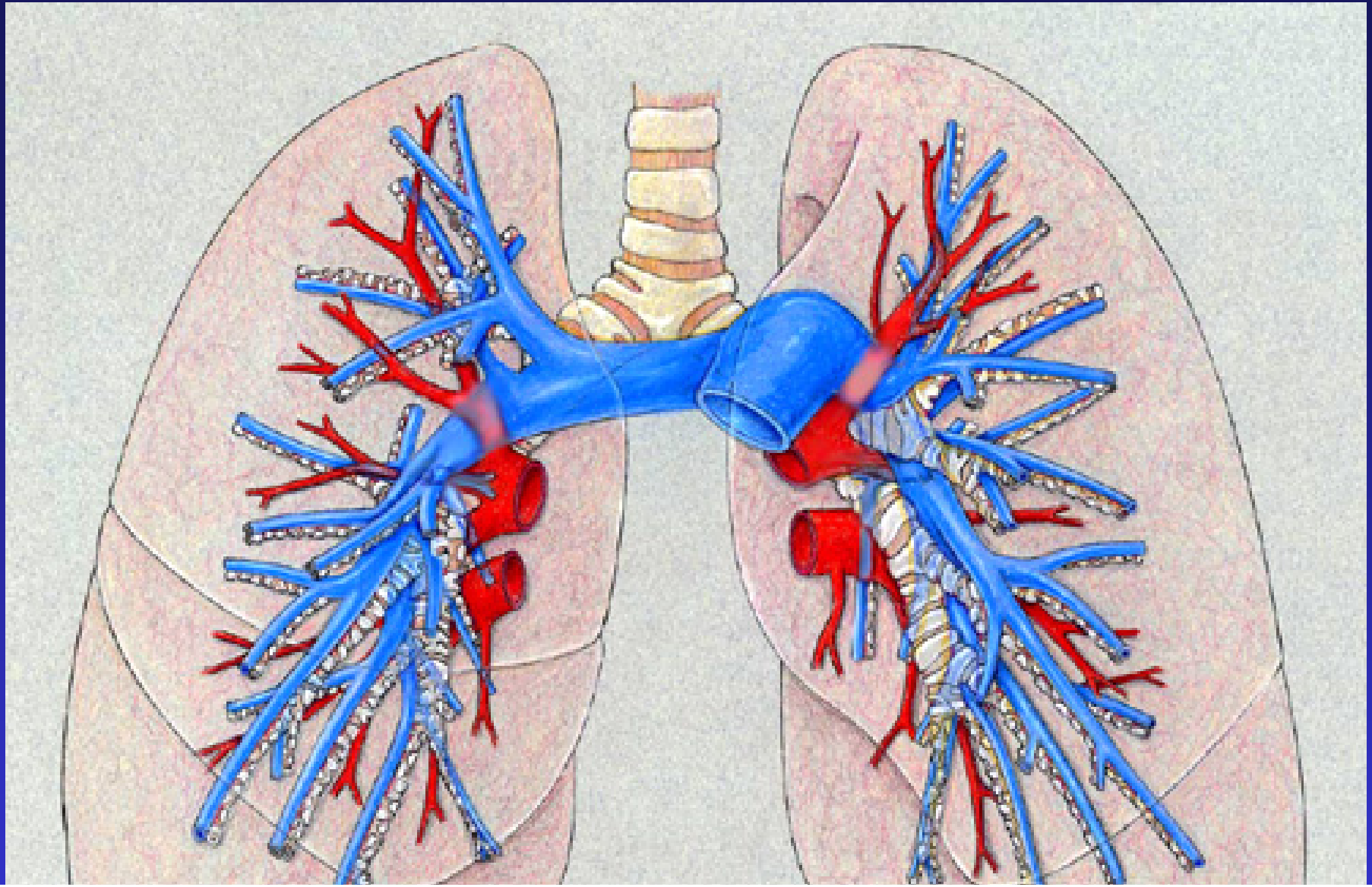
Cardiac: Heart, blood vessels and mediastinum

***D**iaphragm and pleura*

***E**verything else: soft tissues of the neck, chest wall*

Normal Frontal (PA) Chest Radiograph





Blue=Pulmonary Artery with low oxygenated blood

Red=Pulmonary Veins with fully oxygenated blood

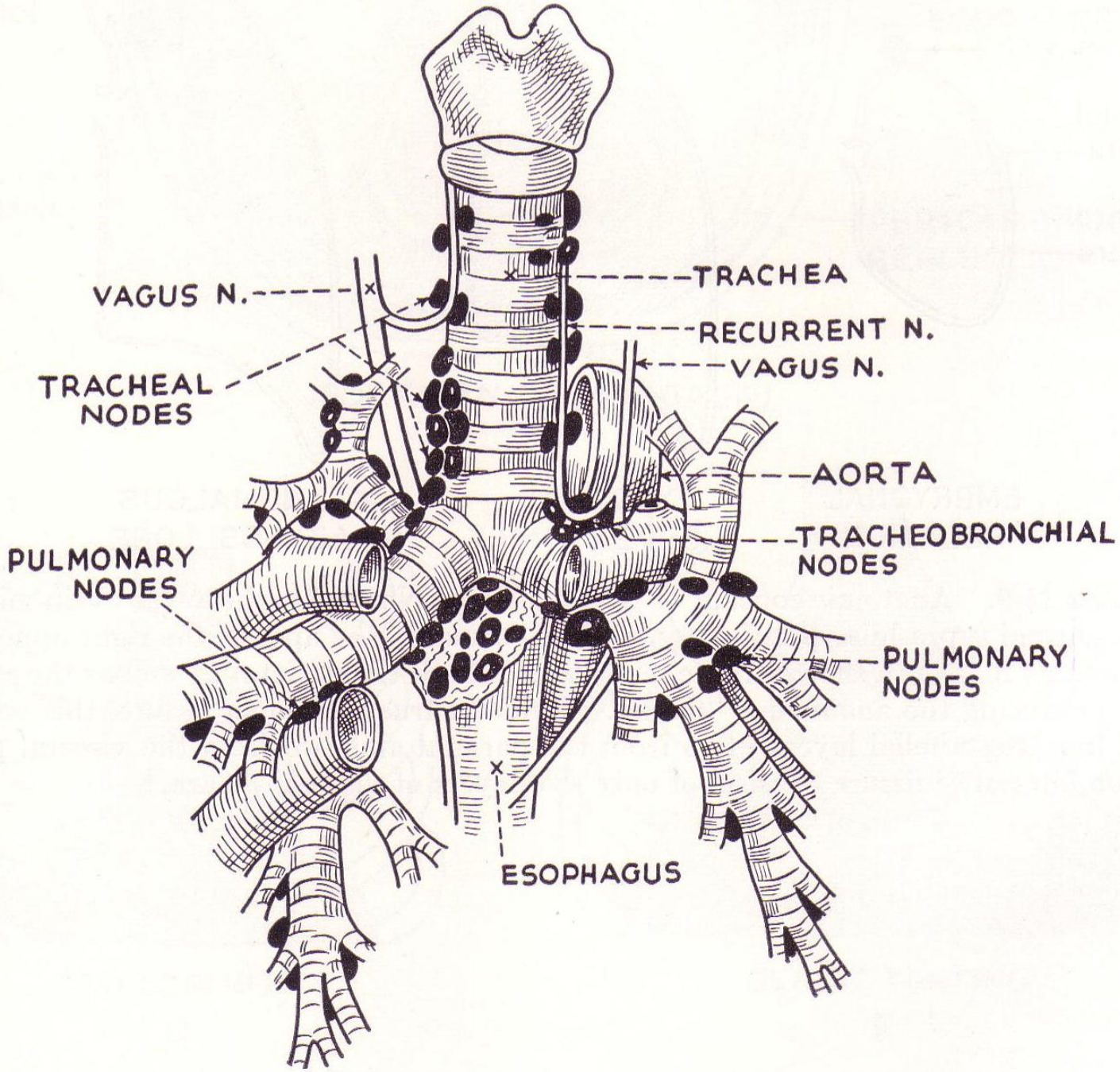
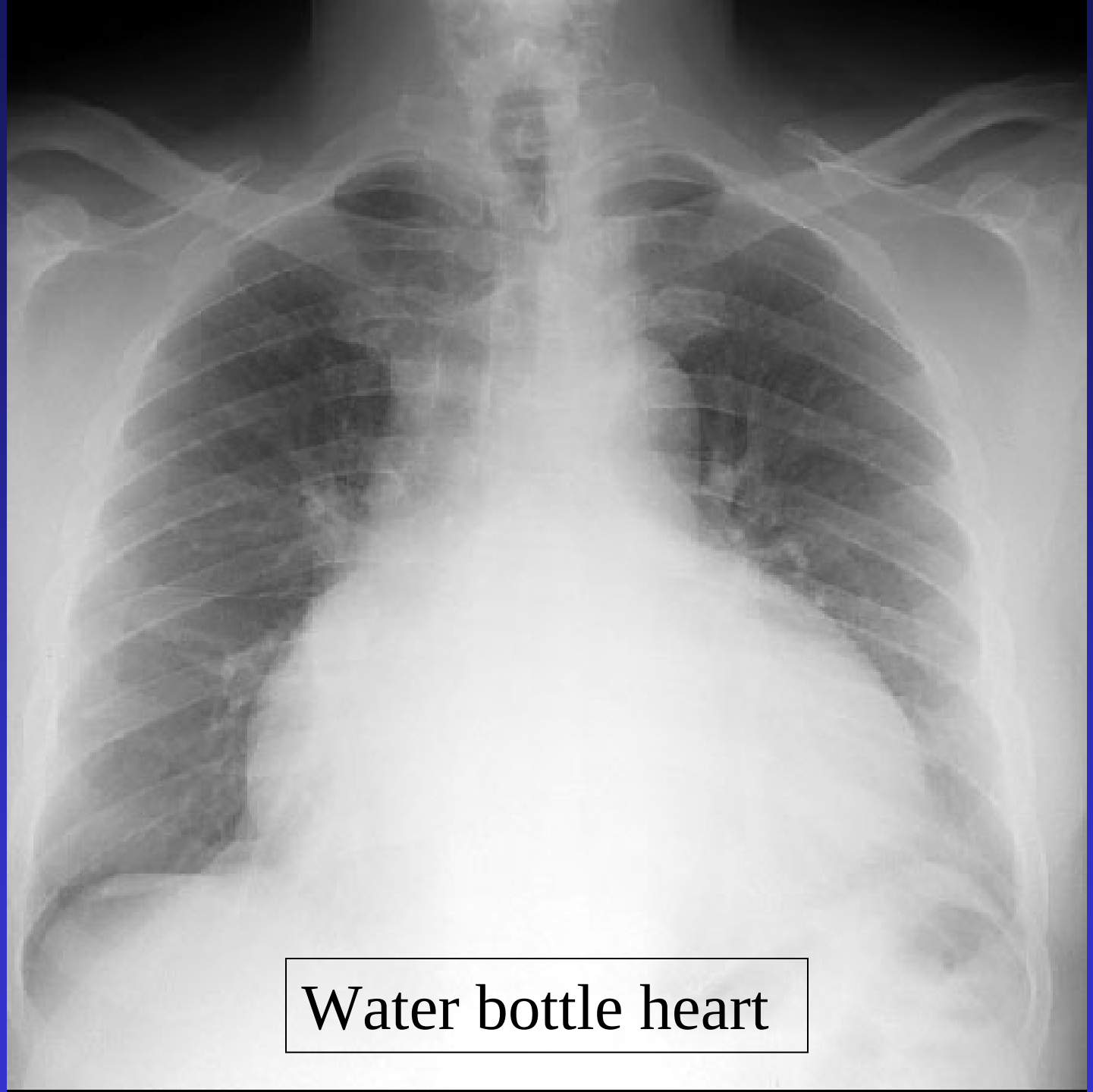


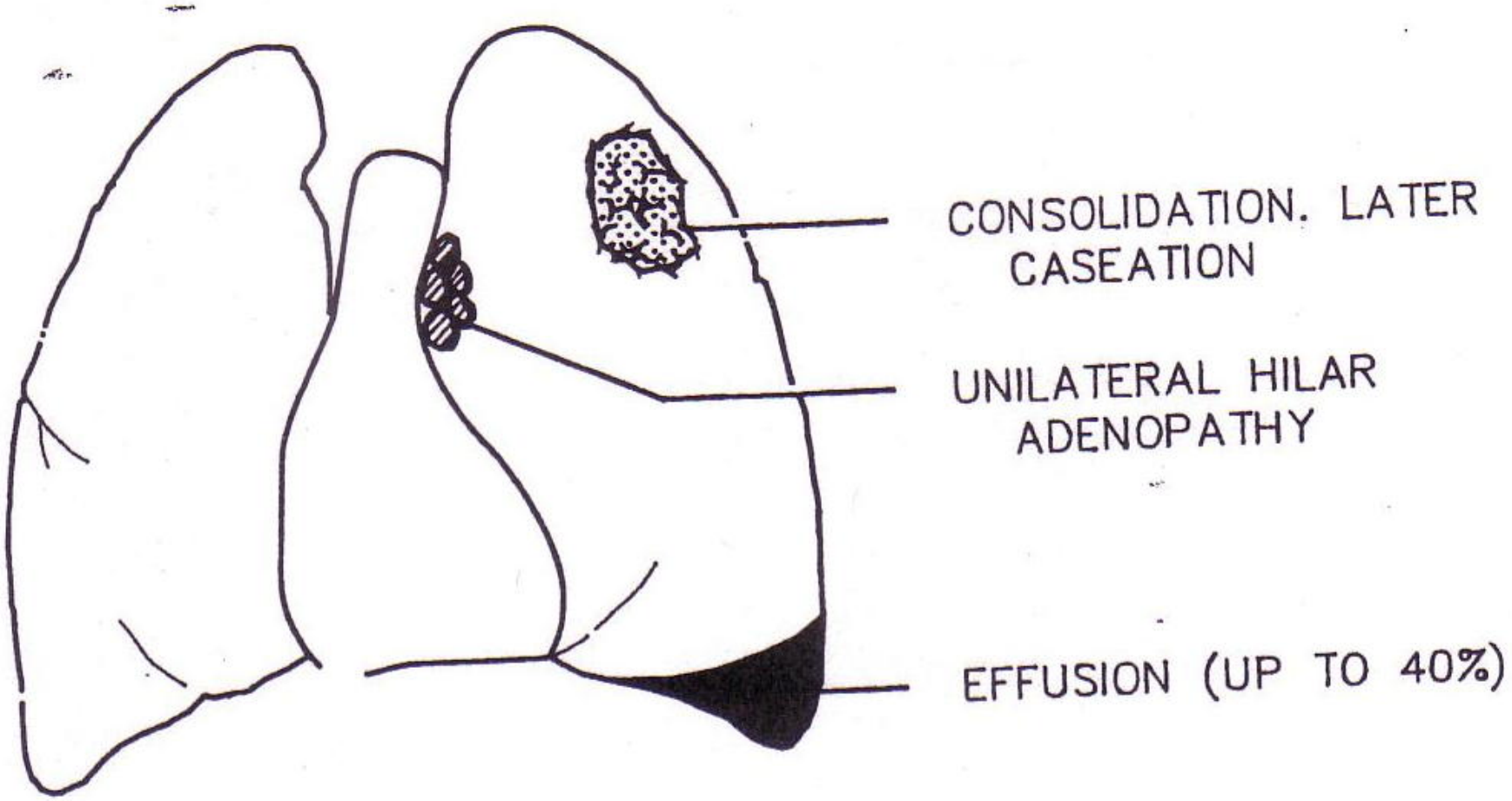
Figure 14-7. Lymph nodes of the tracheobronchial tree. (After Sukienikow.)

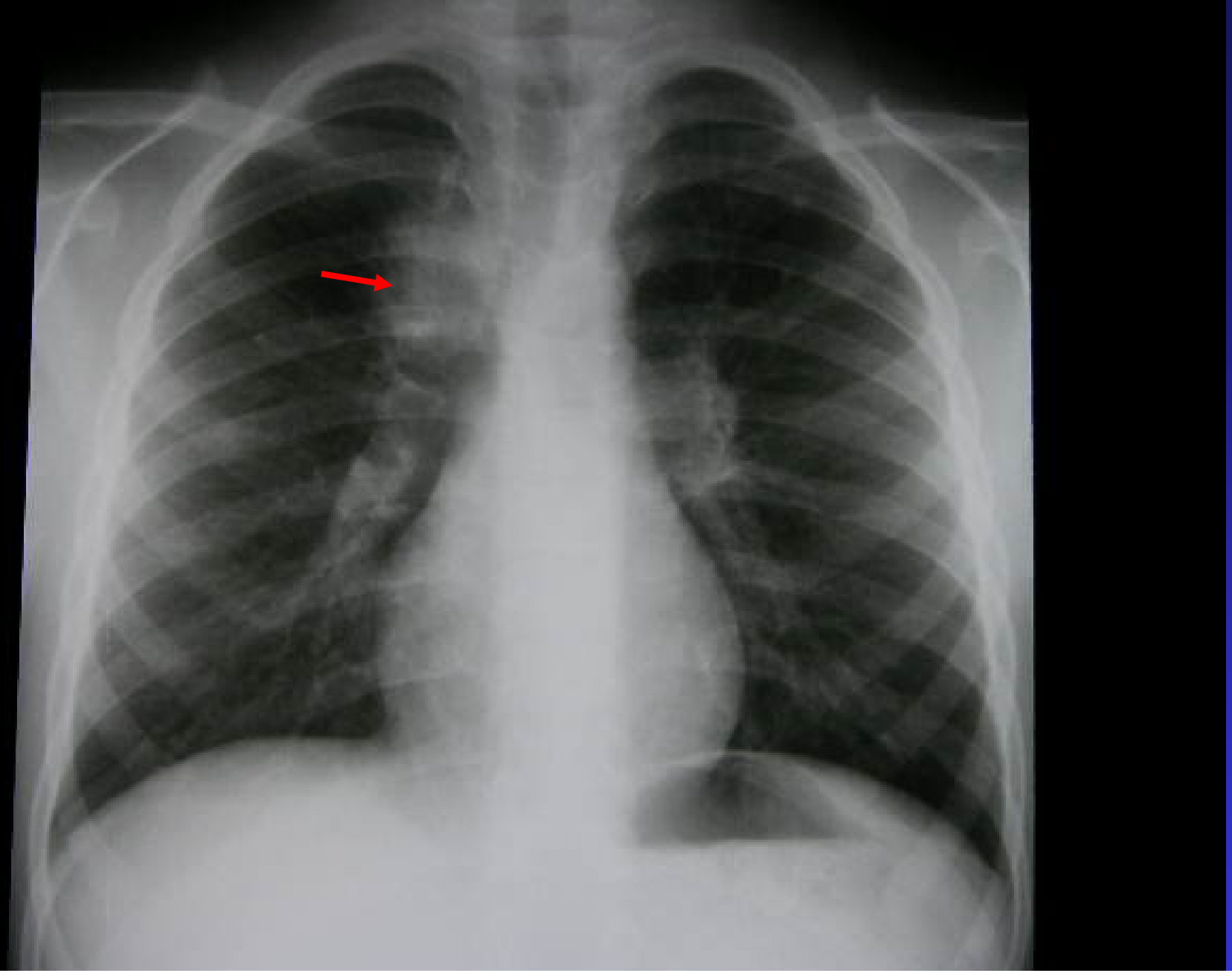

Water bottle heart

Lymphadenopathy

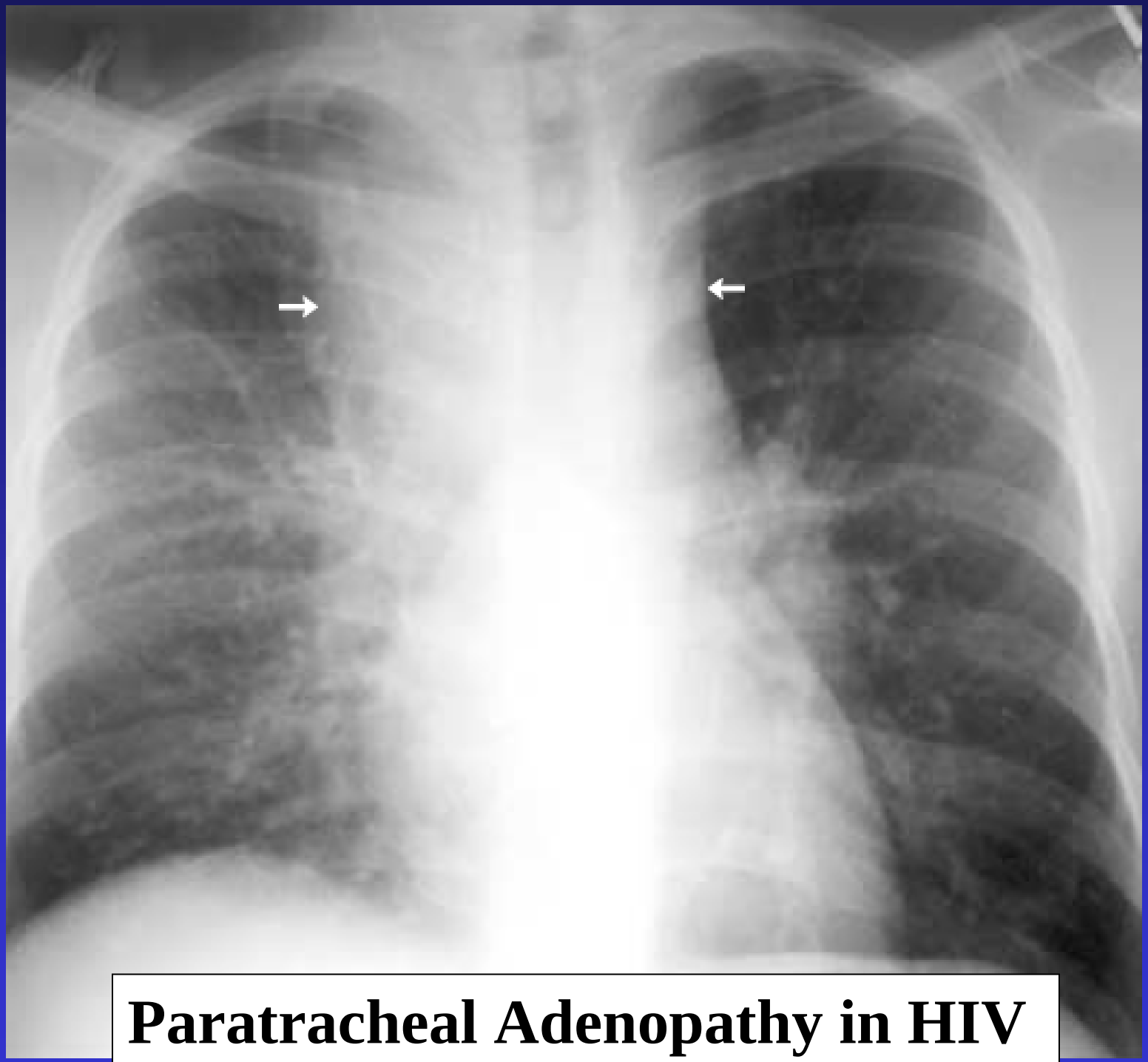
- Enlarged lymph nodes appear on the chest radiograph as soft tissue densities in characteristic locations, including:
  - Right paratracheal area
  - Hila
  - Aorta-pulmonary window
  - Subcarinal mediastinum
  - Supraclavicular area
  - Paraspinous region
  - Retrosternal area on the lateral radiograph
- One or more regions may be involved, and in certain conditions, nodes may calcify

Primary Tuberculosis (First Infection TB)

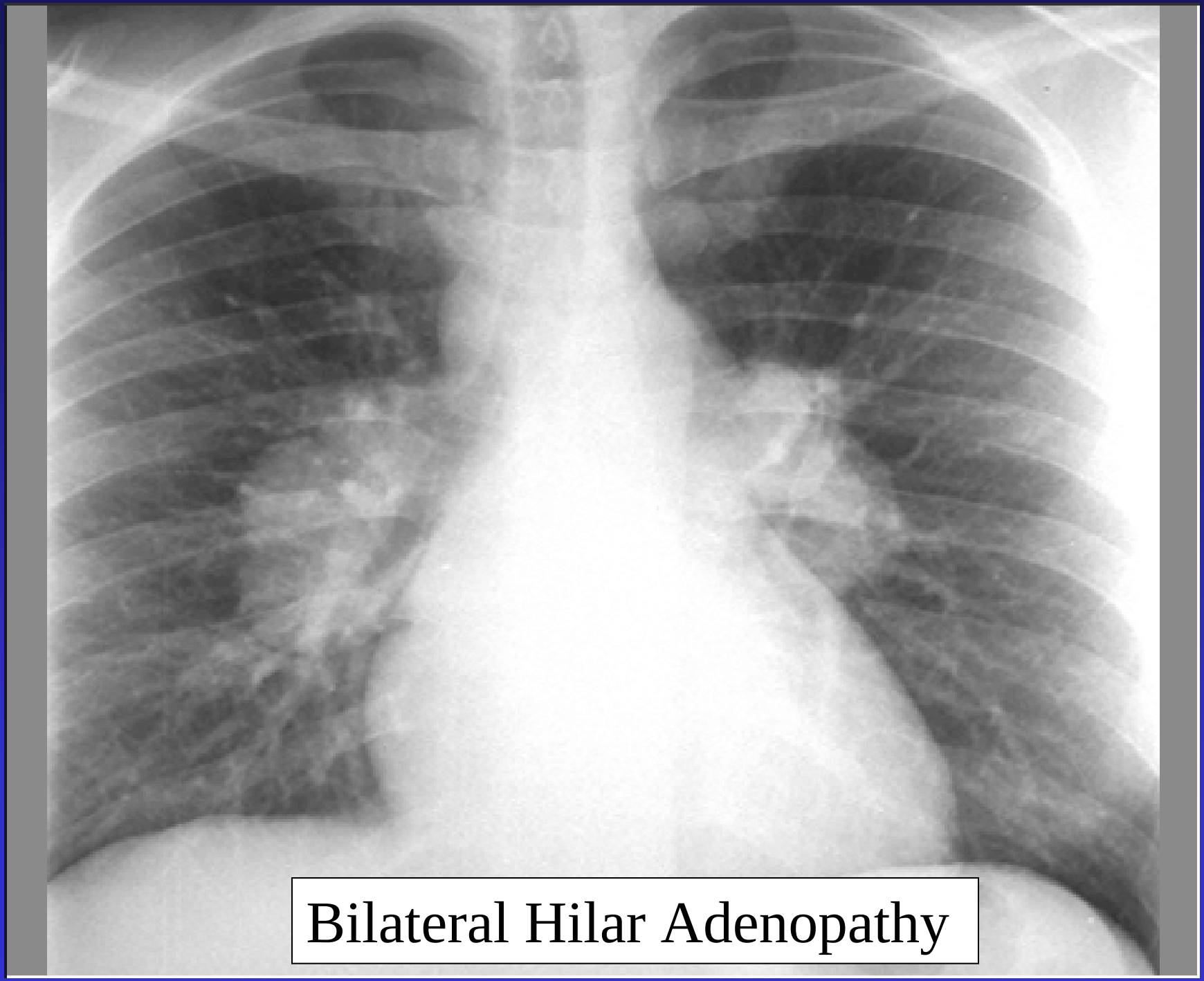




Right Azygous Lymph Node enlargement



Paratracheal Adenopathy in HIV


Bilateral Hilar Adenopathy

“Reading” the Chest X-ray

Air: Central airways and lung parenchyma

Bones: Ribs, clavicles, spine, shoulders, scapulae

Cardiac: Heart, blood vessels and mediastinum

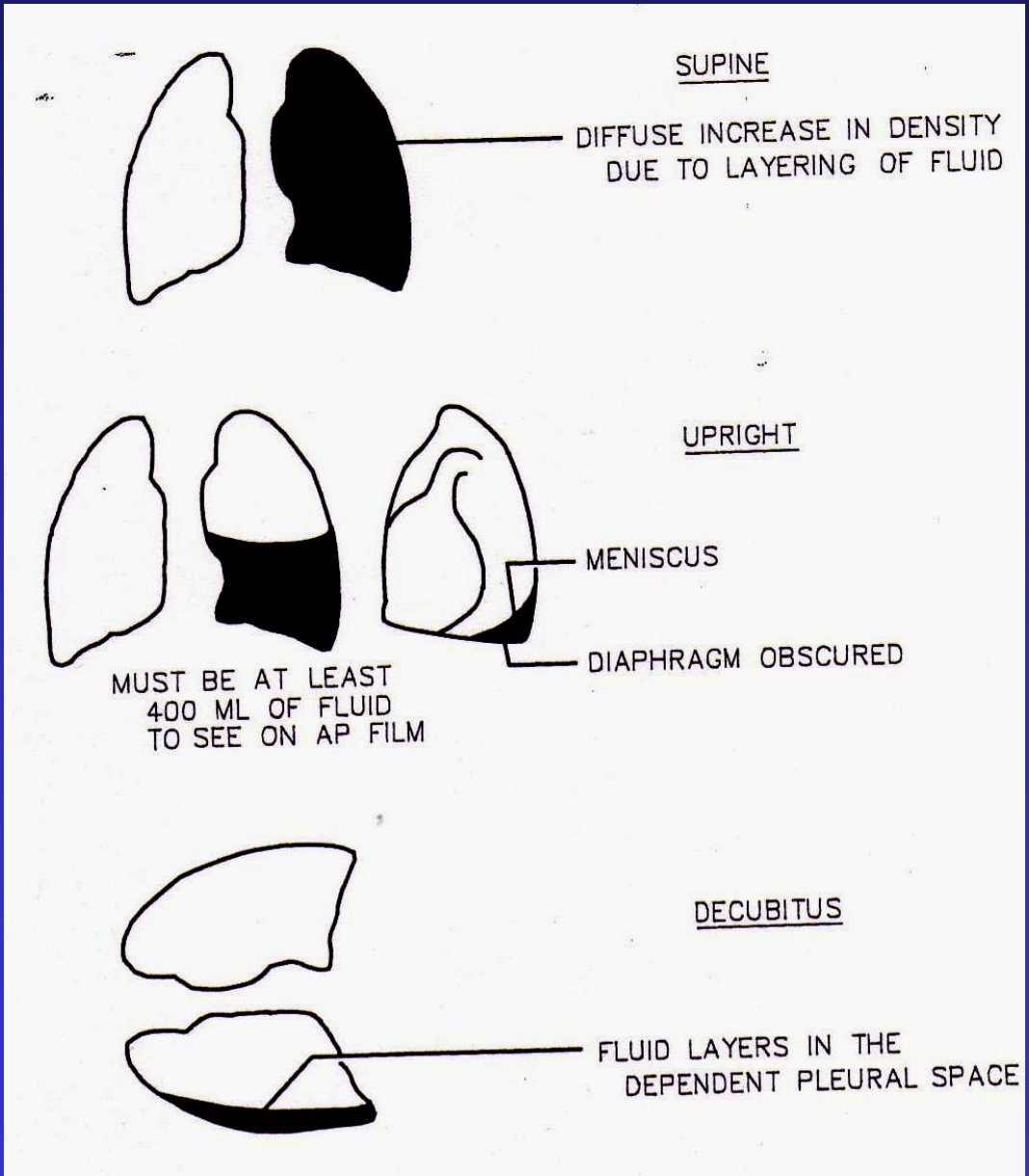
Diaphragm and pleura

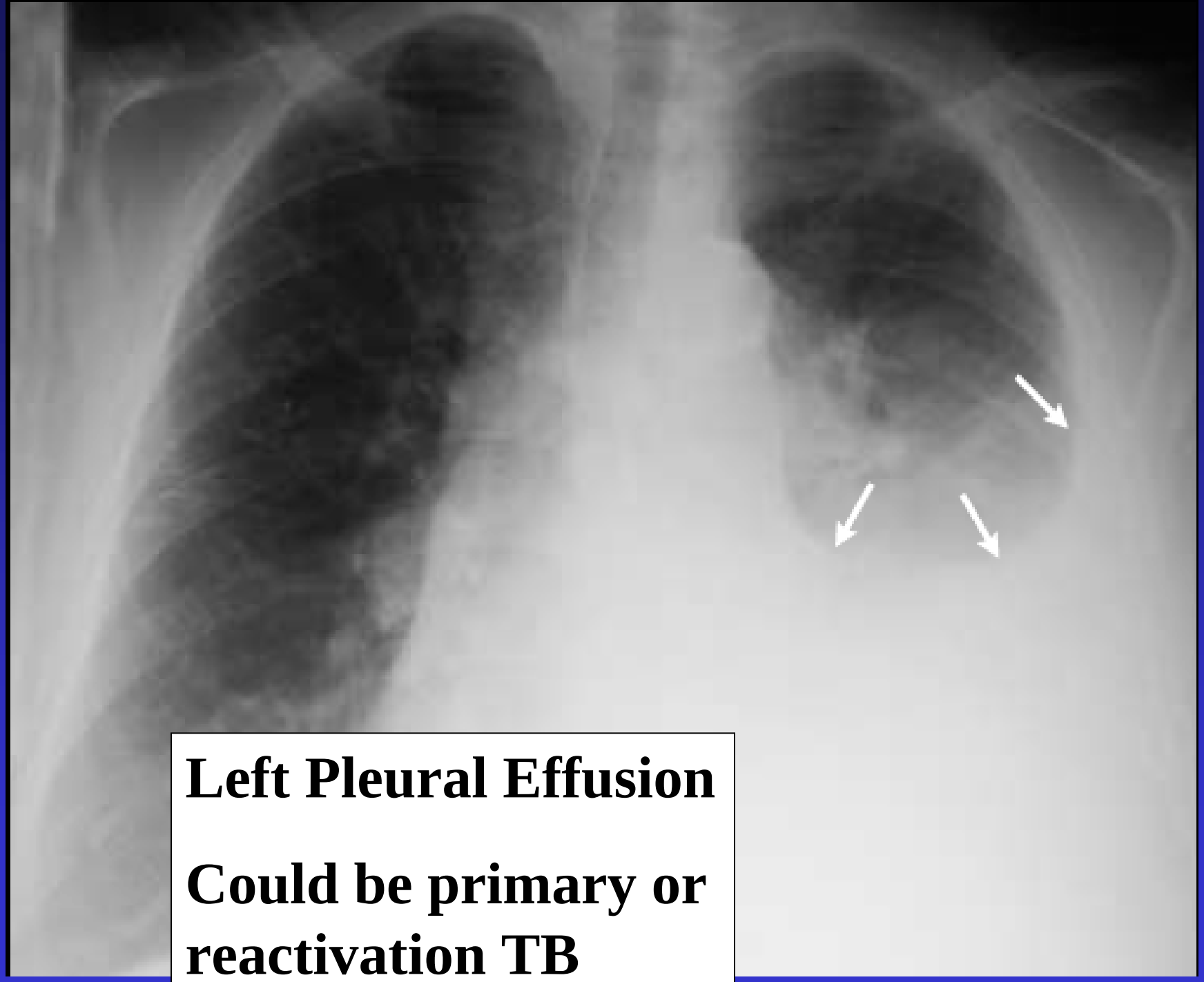
Everything else: soft tissues of the neck, chest wall

Pleural Disease

- Because pleural abnormalities are, by definition, outside the lung parenchyma, an air bronchogram cannot be seen
- Pleural abnormalities are usually homogeneous opacities
- In the upright patient, a pleural effusion will form a curvilinear interface with aerated lung that resembles a meniscus. This occurs because the pleural fluid settles dependently by gravity within the pleural space
- In the supine patient, a pleural effusion may layer posteriorly in a dependent fashion, creating a hazy opacity over the entire hemithorax

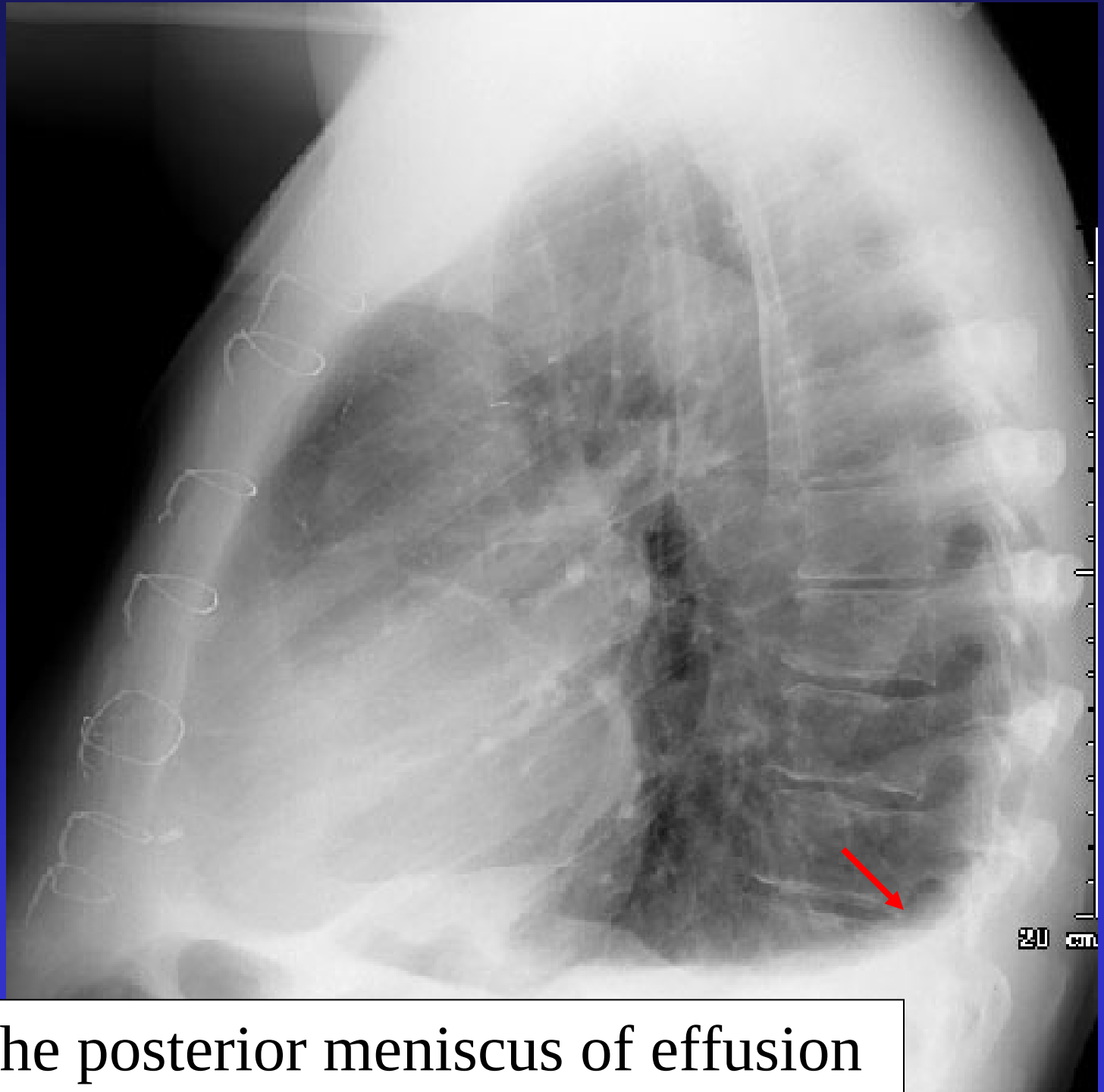
Pleural Effusion





Left Pleural Effusion

Could be primary or reactivation TB



Note the posterior meniscus of effusion

“Reading” the Chest X-ray

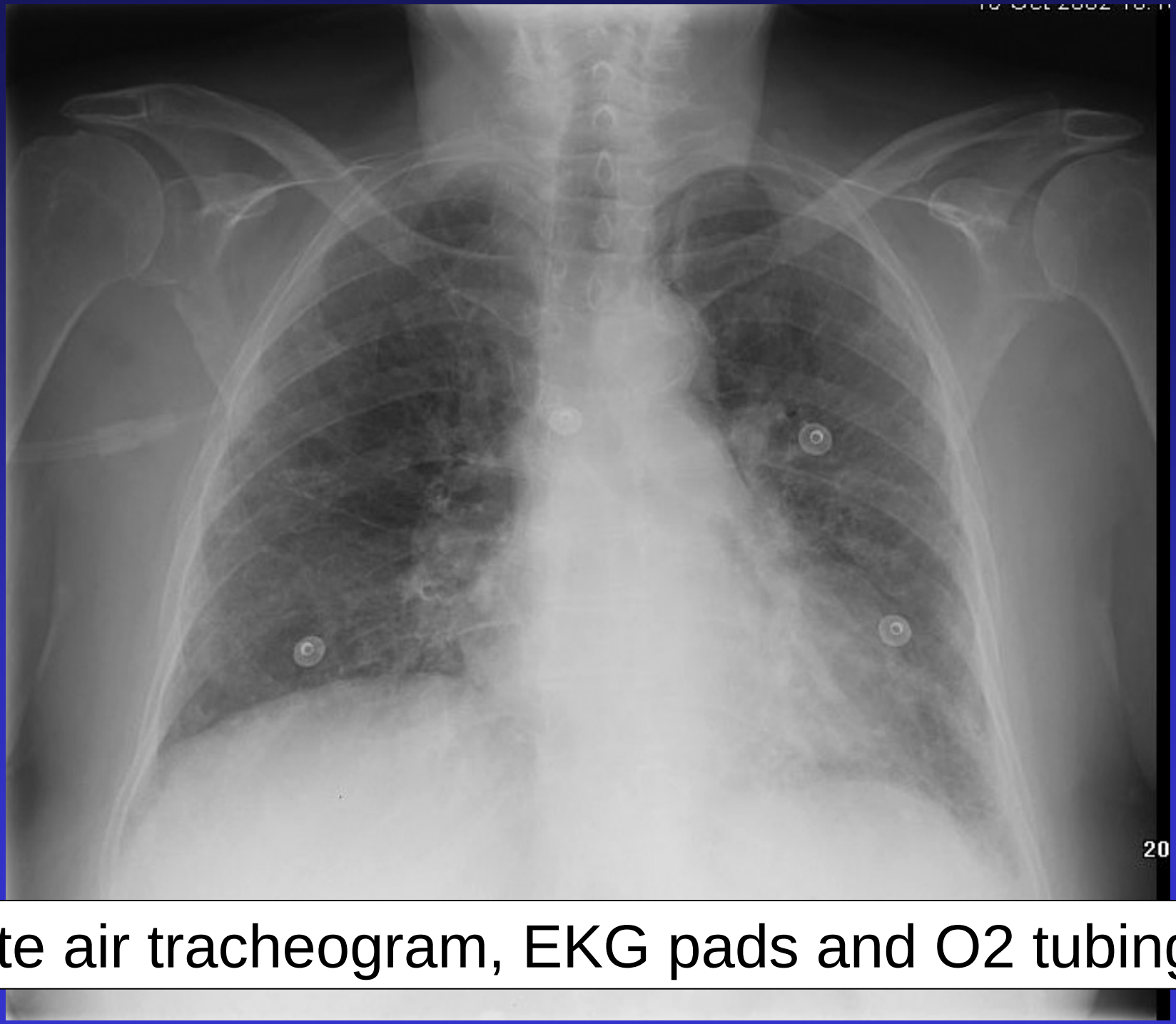
***A**ir: Central airways and lung parenchyma*

***B**ones: Ribs, clavicles, spine, shoulders, scapulae*

***C**ardiac: Heart, blood vessels and mediastinum*

***D**iaphragm and pleura*

Everything else: soft tissues of the neck, chest wall



Note air tracheogram, EKG pads and O2 tubing

What we have accomplished

- Learned how Radiation is produced and how much an individual receives during a CXR
- Learned the ABCDE method of reading the CXR
- Learned the major landmarks of the CXR
- Learned to distinguish infiltrates, cavities and pleural effusions on the CXR
- Learned some of the X-ray manifestations of Pulmonary Tuberculosis

Acknowledgements

- Reynard J. McDonald, MD, Medical Director, NJMS Global Tuberculosis Institute

References

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