# The Fetal Thorax

## Chapter 61

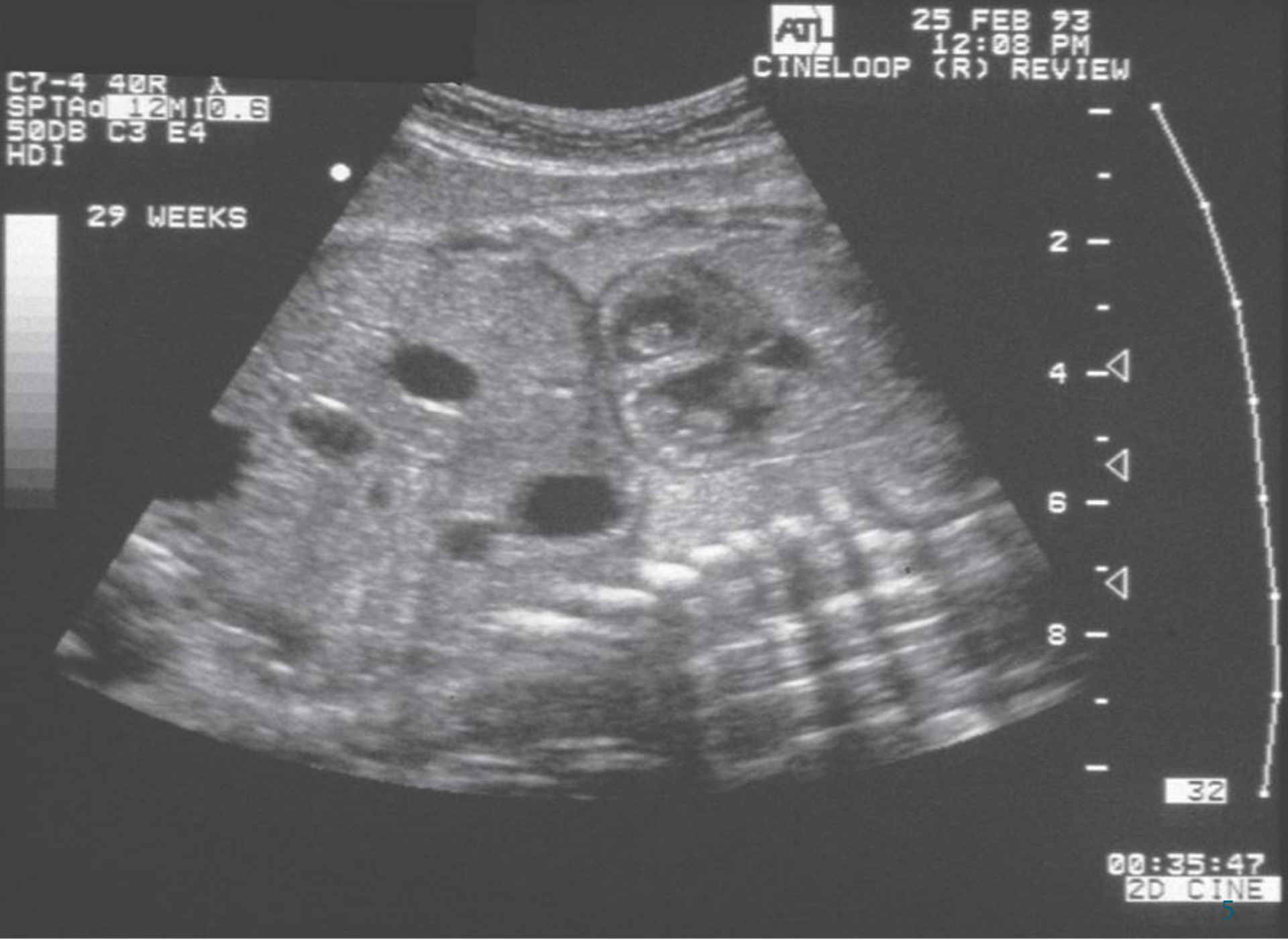
# Embryology

- Pulmonary development
  - Probably single most important determinant for fetal viability
- Pulmonary immaturity
  - Major reason why fetuses younger than 24 weeks' gestation are generally considered nonviable
- Early development
  - Begins as mesenchymal buds from the early trachea form
  - Penetrate the masses destined to be the lungs

- **Breathing movements that occur before birth result aspiration of fluid into the lungs**
- **Lungs at birth are about half filled with fluid derived from the amniotic cavity, tracheal glands, and lungs**
- **Fluid in the lungs at birth is cleared by three routes:**
  1. **Through the mouth and nose**
  2. **Into the pulmonary capillaries**
  3. **Into the lymphatics and pulmonary vessels**

# Fetal Thorax

- Examined in both the transverse and coronal or parasagittal planes
- Normal shape
  - Symmetrically bell shaped
  - Ribs forming the lateral margins
  - Clavicles the upper margins
  - Diaphragm the lower margin
- Diaphragm may be observed as a smooth hypoechoic muscular margin between the fetal liver or spleen and the lungs



# Normal Sonographic Characteristics

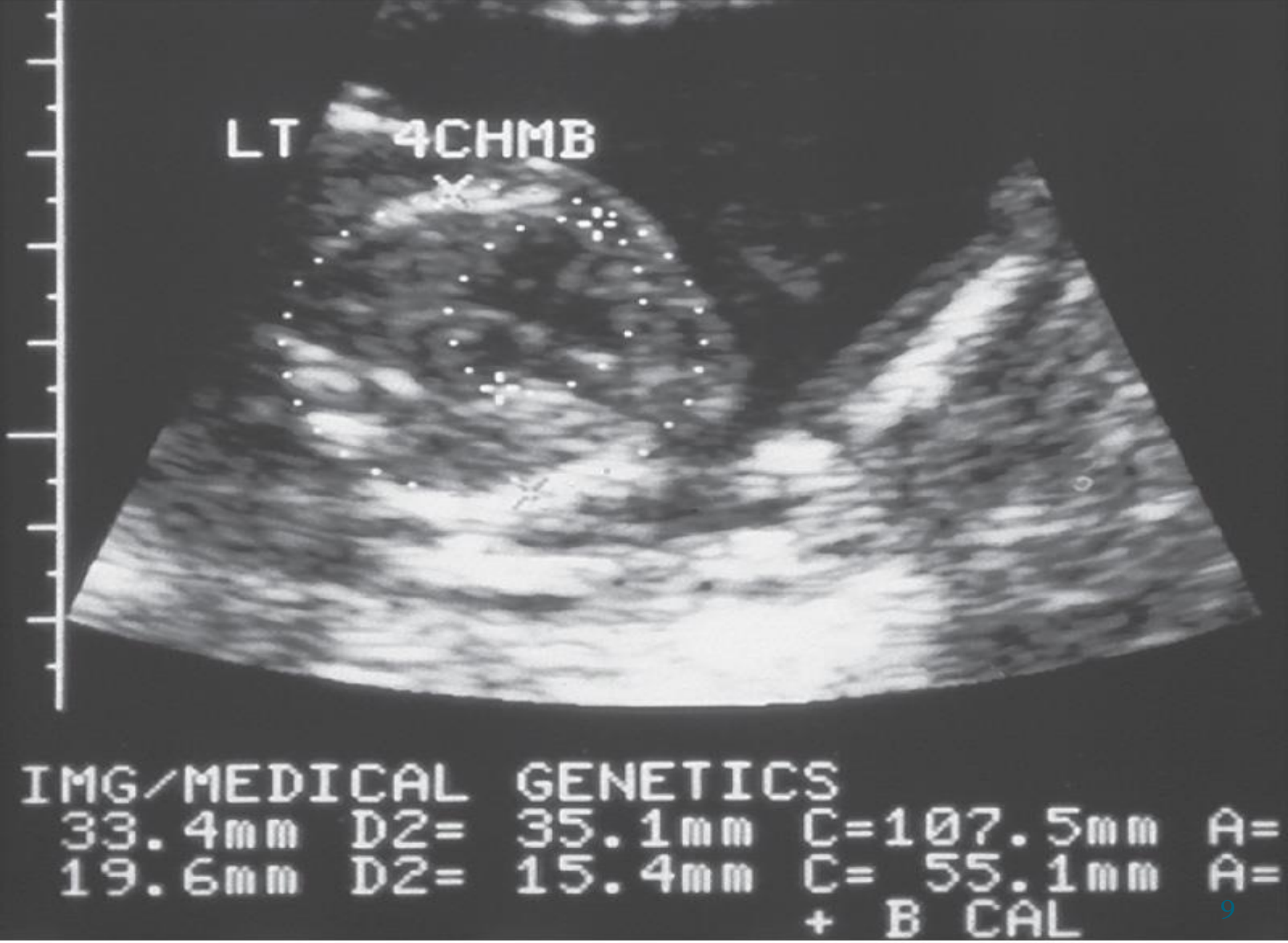
- Transverse, coronal and/or parasagittal
- Evaluate chest: size, shape, symmetry
- Evaluate heart: position, size, rate, pericardial fluid
- Evaluate pulmonary texture
- Centrally positioned mediastinum

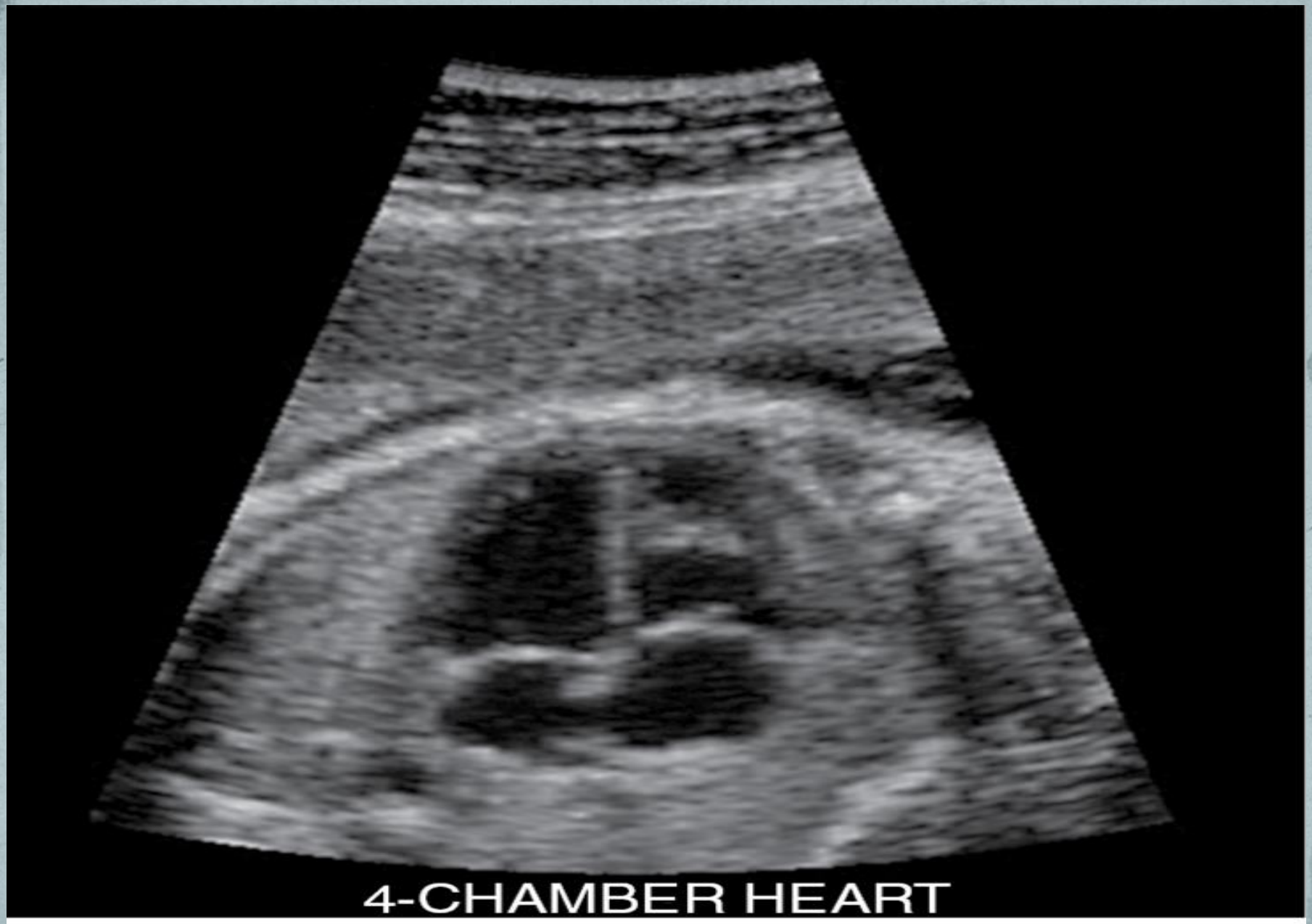
# Size

- Normally slightly smaller than the abdominal cavity
- Ratio
  - Thoracic circumference to abdominal circumference TC/AC
    - Reported to remain constant throughout pregnancy (0.94 ± 0.05)
- Extreme variations in thorax size
  - Look for other anomalies!!!!!!!!!!

# Chest Circumference

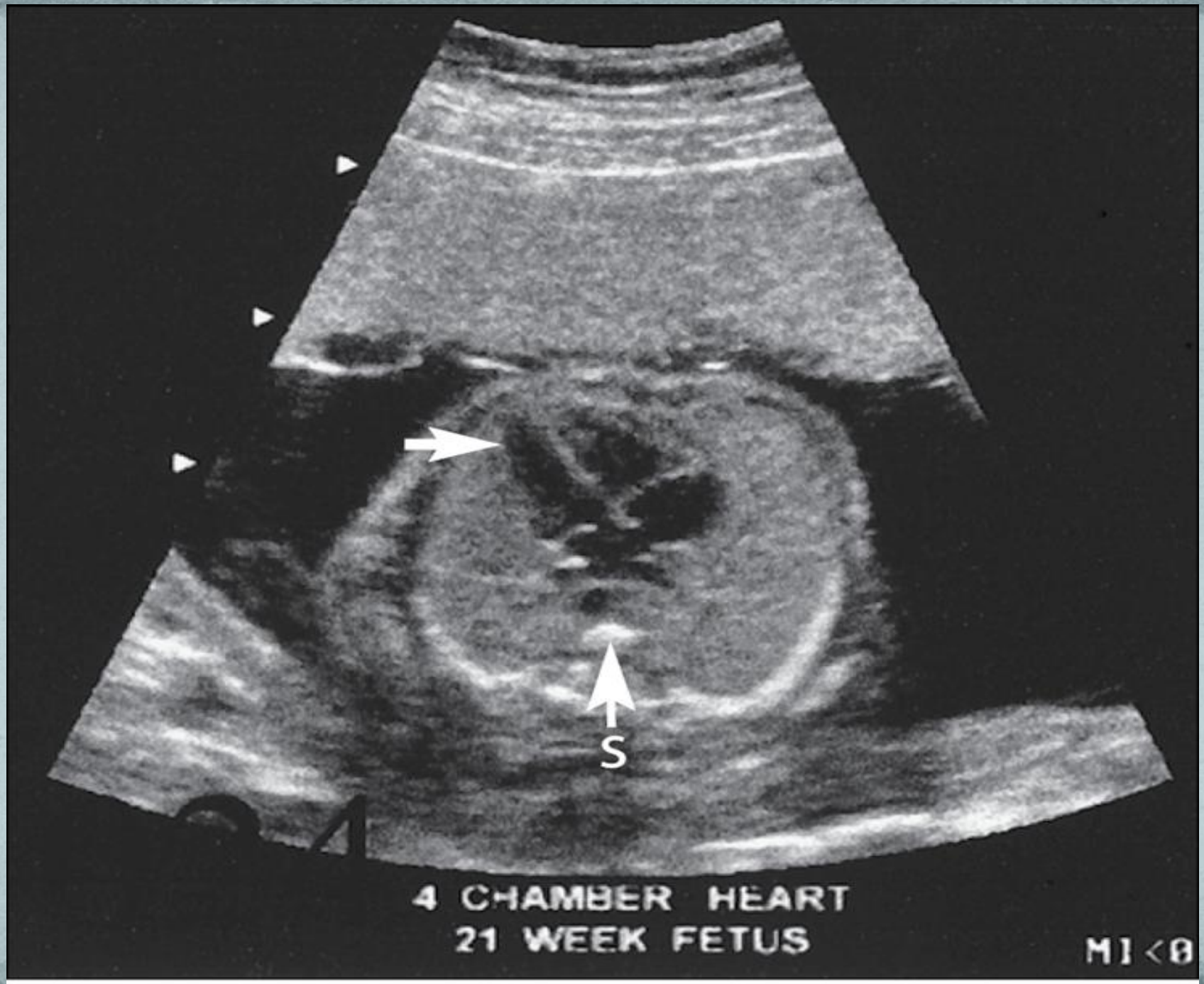
- Measurements are made in transverse
  - At the level of the four-chamber view of the heart
- Number of syndromes may be associated with the finding in a fetus of a significant narrow diameter of the chest
  - Asphyxiating thoracic dystrophy
    - Including thanatophoric dwarfism
- Presence of oligohydramnios
  - Pulmonary hypoplasia may be seen with a reduction in the overall thoracic size





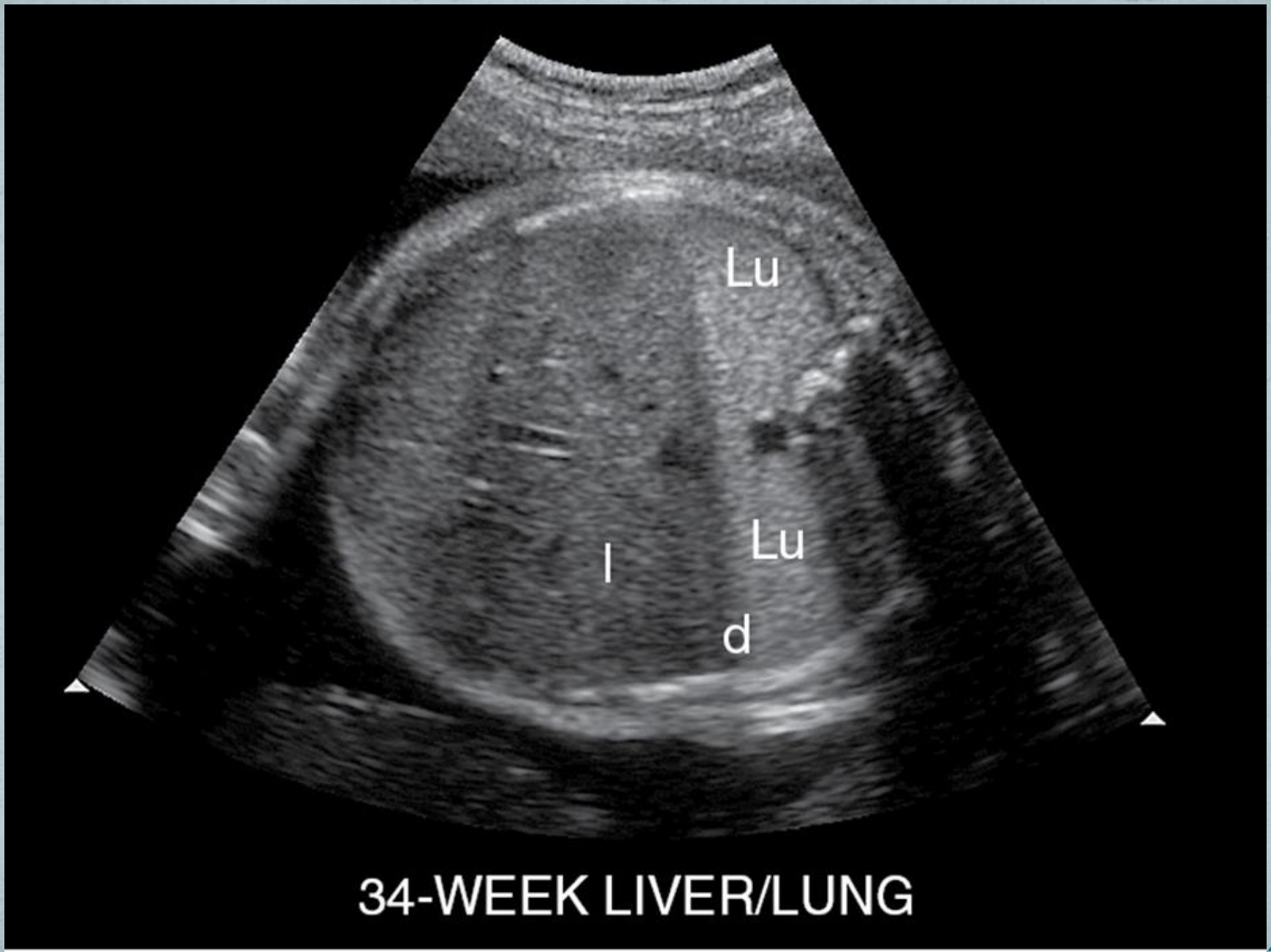
# Position

- Central portion occupied by the mediastinum
  - Majority of the heart midline and left chest
    - Apex should be directed toward the spleen
    - Base lies horizontal to the diaphragm
- Location of heart is important to document
  - The detection of abnormal position may indicate the presence of
    - Chest mass
    - Pleural effusion
    - Cardiac malformation



# Texture

- Lungs appear as homogeneous and moderately echogenic
- Early in gestation
  - Lungs are similar to or slightly less echogenic than the liver
- As gestation progresses
  - There is an increased pulmonary echogenicity relative to the liver




34-WEEK LIVER/LUNG

# Texture

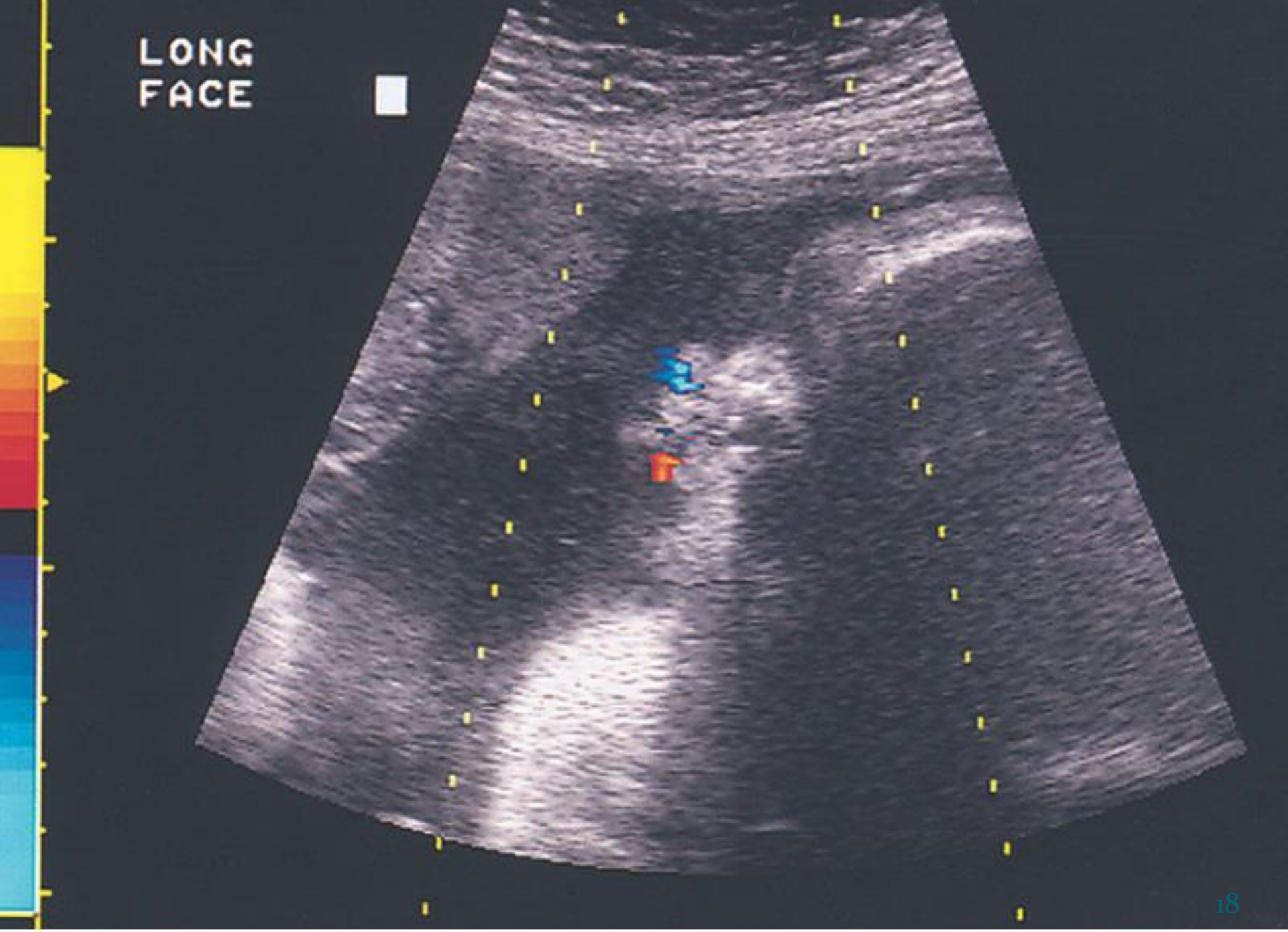
- Two important problems that may complicate the exact determination of echogenicity of the lungs
  - Overlying ribs
  - Acoustic enhancement produced by blood in the heart
- Color Doppler may be used to outline the vascular pattern within the lungs
- Ultrasound cannot assess lung maturity!!!

# Respiration

- Fetal breathing becomes most prominent in the second and third trimesters
- Mature fetus spends almost one third of its time breathing
- Fetal breathing movements were considered to be present if characteristic seesaw movements of the fetal chest or abdomen were sustained for at least 20 seconds

# Respiration

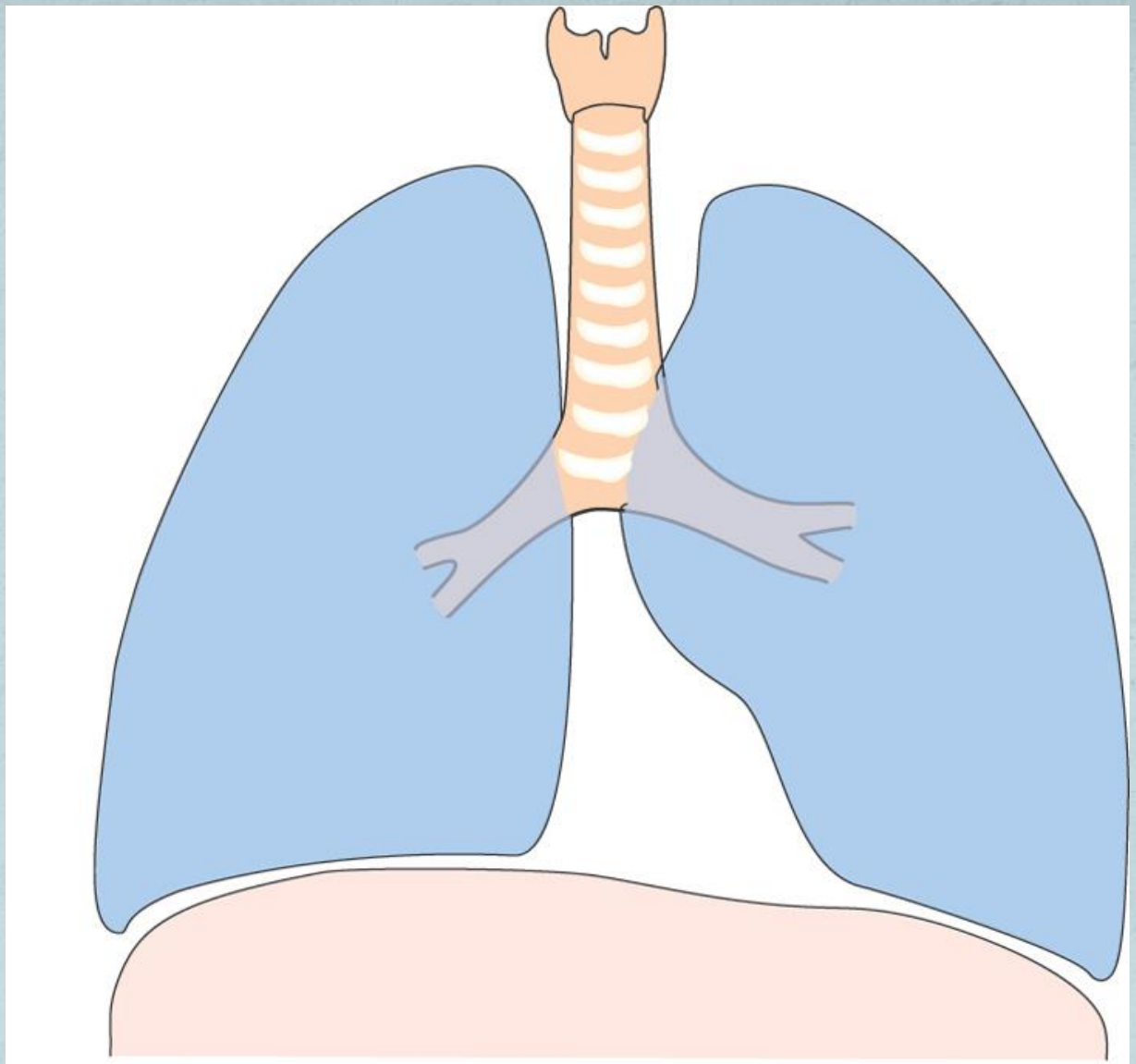
- Fetal breathing movements were considered absent if no such fetal activity was noted during the 20-minute observation period
- Color flow Doppler may be used to detect fetal breathing through the nostrils
  - Facial profile should be obtained with the nose clearly demonstrated
    - As color is turned on, movement may be seen to flow from the nostrils



# Respiration

- Biophysical profile used by many obstetricians to assess fetal well-being uses the respiration pattern as one factor in its scoring
- Fetal respiration may vary in response to maternal activities and substance ingestion
  - It is stimulated by
    - Increased sugar doses
    - Decreased by smoking

# Abnormalities of the Thoracic Cavity



A Normal

# Lungs Abnormalities

- Lung masses are separate from the heart
  - Located above the level of the diaphragm
- Lesions of the lungs may be
  - Cystic
  - Solid
  - Complex
- Fetal echocardiography is beneficial in excluding cardiac involvement
- Evaluation of an intact diaphragm is necessary to exclude diaphragmatic hernia

# Lungs Masses

- Abnormalities that may be present due to compression of venous return and cardiac failure
  - Cardiac rhythm
  - Fetal hydrops
  - Pleural effusions (Commonly seen)
- Masses within the thoracic cavity
  - Have detrimental effects on lung development

# Lungs Abnormalities

- Lungs do not develop properly with a small uterine cavity
  - Results from severe oligohydramnios
    - Chest cavity is abnormally small
    - Fetus unable to practice breathing movement

# Evaluation for Lung Mass

- Check for:
  - Normal heart position and axis
    - Variation from normal – (suspect a mass)
  - Measure the thoracic circumference
- Cardiac axis
  - Evaluated in a four-chamber heart view
  - Estimate the angle at which the intraventricular septum cross-sects the spine at the anterior chest wall
- Normal ranges
  - 22 to 75 degrees (average, 45 degrees)

# Pulmonary Hypoplasia

- Reduction in lung volume
  - Results in small, inadequately developed lungs
- Most commonly occurs from prolonged oligohydramnios
- Prognosis is grave
  - 80% die after birth
- Small percentage of infants have pulmonary hypoplasia without any fetal or uterine problem

# Pulmonary Hypoplasia

- Check by measuring the thoracic circumference (TC) at the level of the four-chamber heart view
  - Exclude
    - Skin
    - Subcutaneous tissues
- TC below fifth percentile
  - Suggests possibility of pulmonary hypoplasia

# Pulmonary Hypoplasia

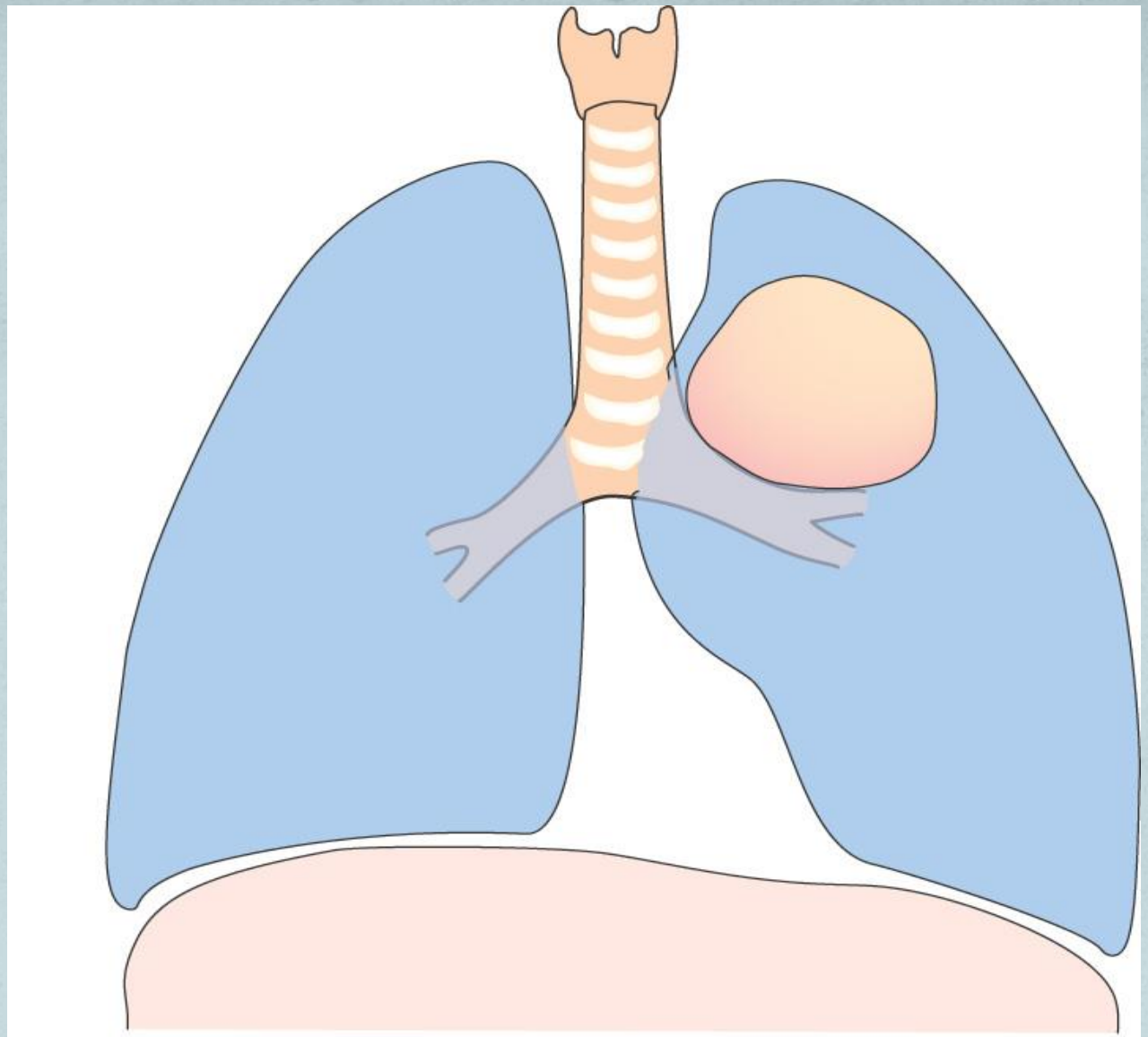
- TC may not be helpful in conditions where
  - Intrathoracic mass compresses lung tissue and yet the TC remains normal
    - Diaphragmatic hernia
    - Pleural effusion
    - Cystic adenomatoid malformations

# Cystic Lung Masses

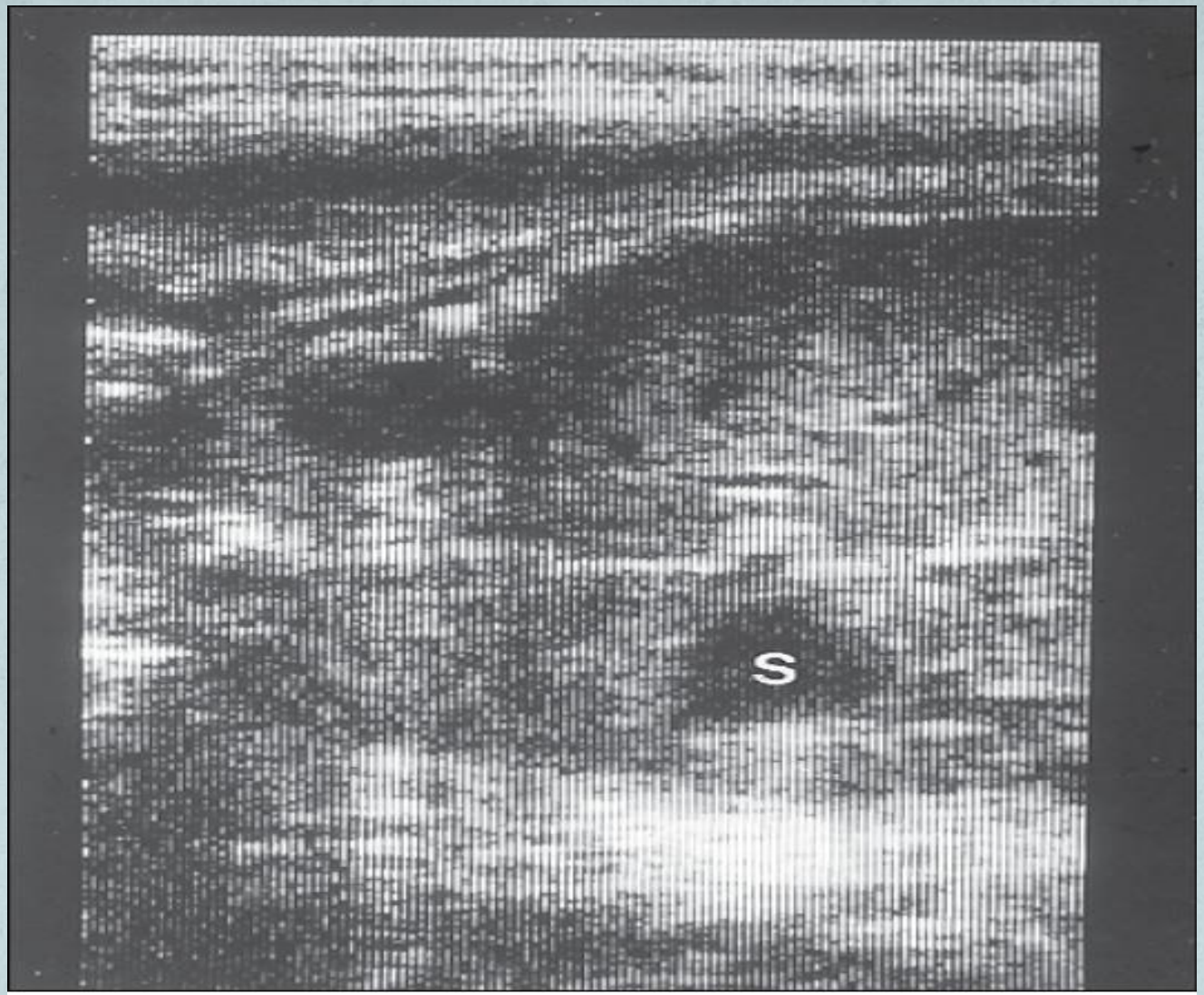
- Echo-free masses that replace normal lung parenchyma
- Vary in size
  - Ranges from small isolated lesions to large cystic masses that cause marked shifts of intrathoracic structures.
- Simple cysts may be surgically excised after delivery

# Bronchogenic Cysts

- Most common lung cyst detected prenatally
- Occur as a result of abnormal budding of the foregut and lack any communication with the trachea or bronchial tree
- Typically occur within the mediastinum or lung
  - Infrequently inferior to the diaphragm
- Sonographically
  - Appear as small circumscribed masses without a mediastinal shift or heart failure
- Amniotic fluid volume within normal range



F Bronchogenic cyst

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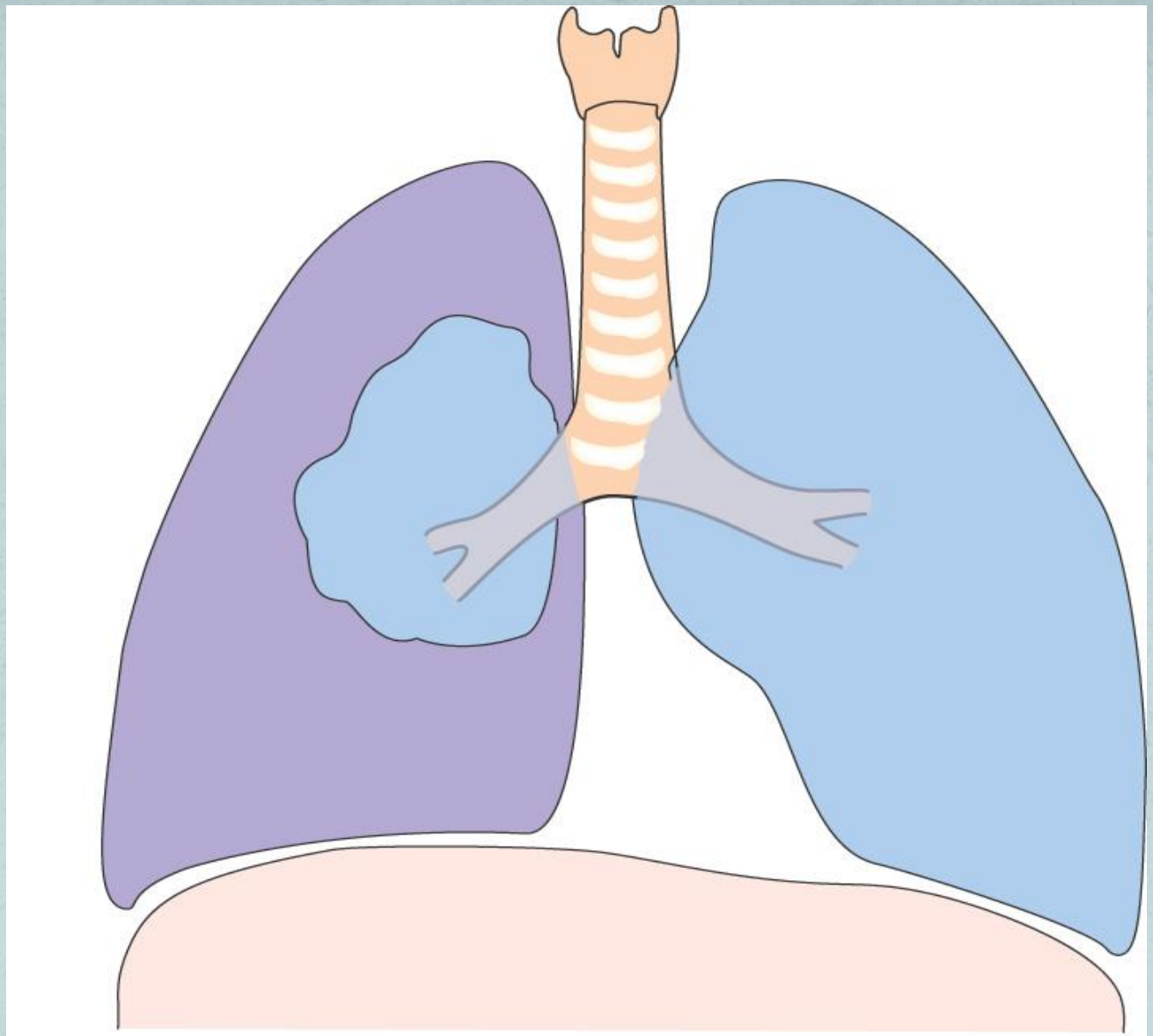
# Pleural Effusions

- "Hydrothorax"
- Accumulations of fluid within the pleural cavity
  - Appear as
    - Isolated lesions or
    - Secondary to multiple fetal anomalies
- Most common reason for fluid
  - Chylothorax
    - Right-sided collection secondary to a malformed thoracic duct



B

Hydrothorax

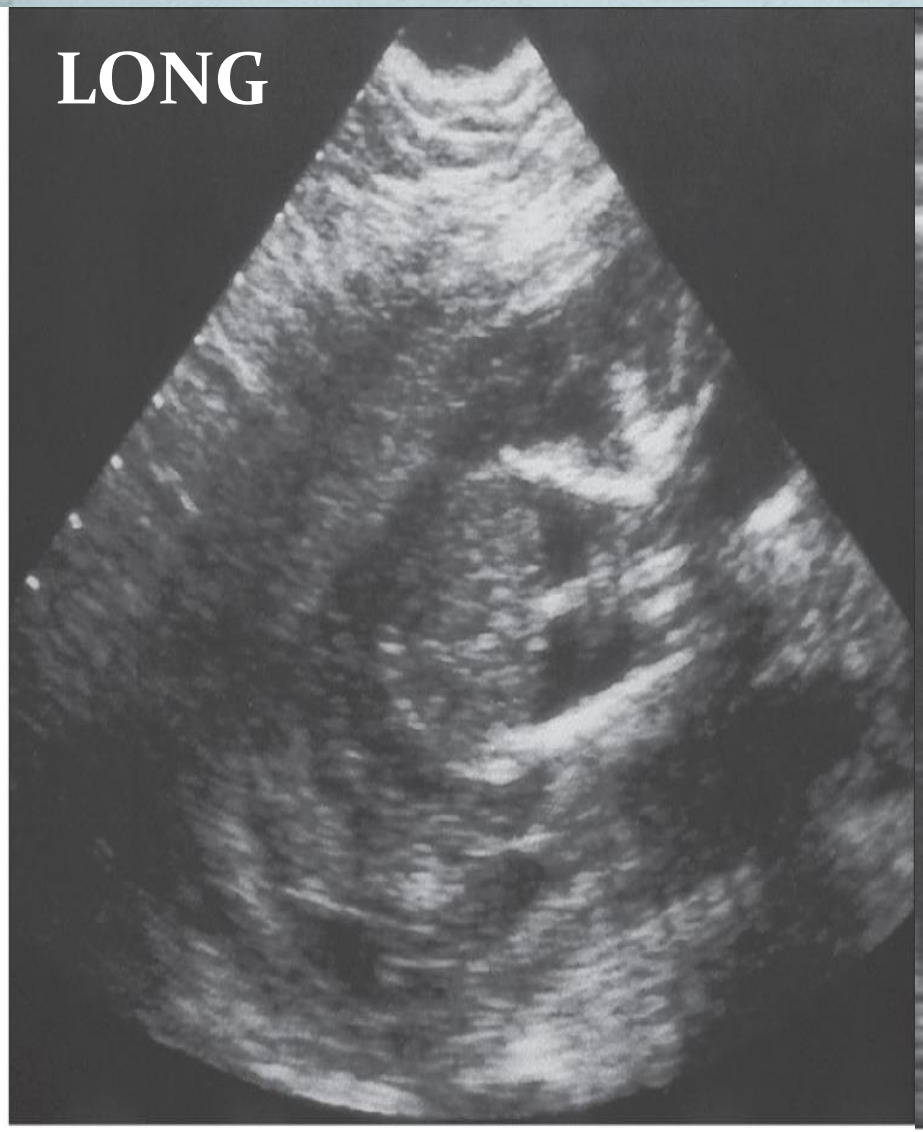
# Pleural Effusions

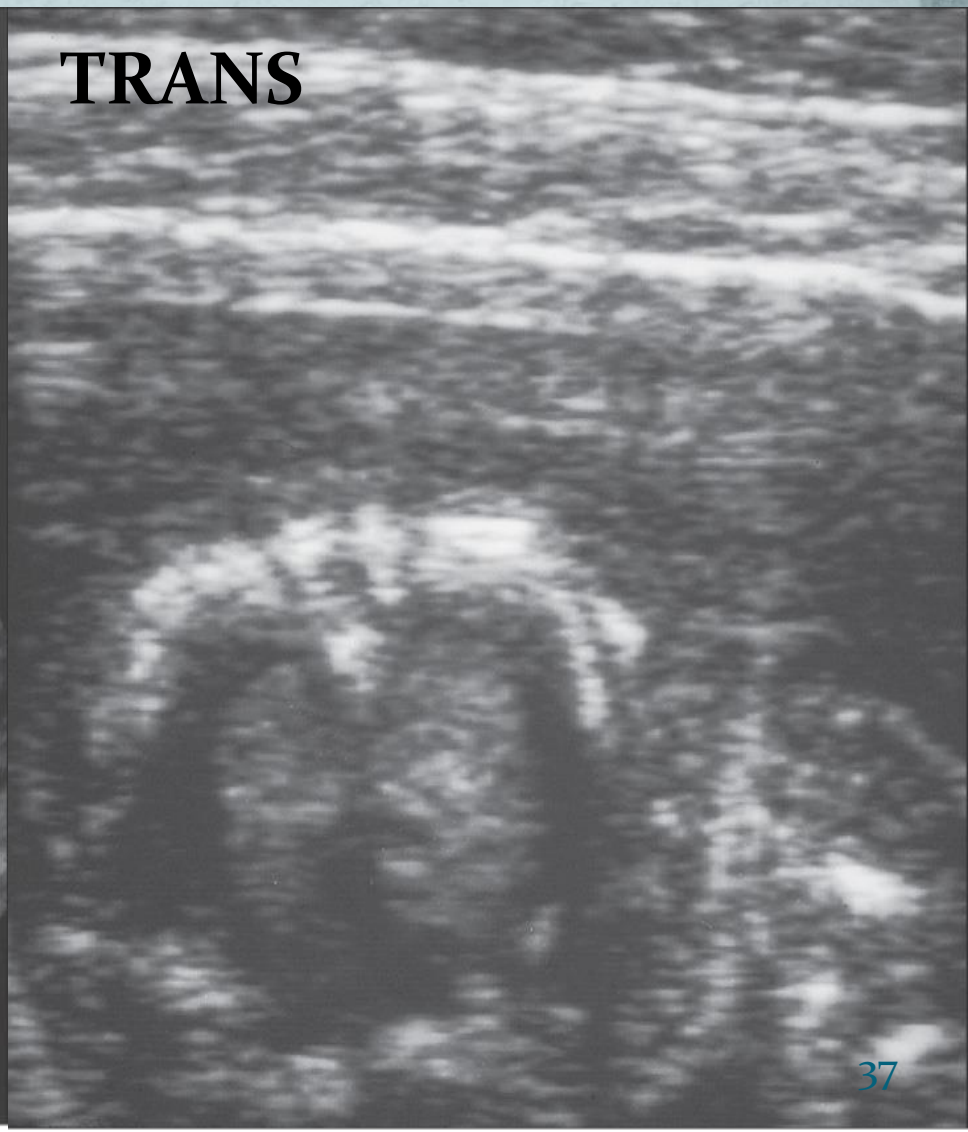
- May result from
  - Immune causes (Rh disease)
  - Nonimmune causes
  - Congestive heart failure (CHF)
  - Chromosomal abnormalities (trisomy 21)
  - Fetus with a cardiac mass
  - Cystic adenomatoid malformations
  - Diaphragmatic hernia
  - Hamartoma
  - Atresia of the pulmonary vein
  - Unknown causes

# Pleural Effusions

- Sonographically
  - Appear as echo-free peripheral masses on one or both sides of the fetal heart
  - Conform to the thoracic cavity and often compress lung tissue
    - Compression may cause pulmonary hypoplasia
  - May cause
    - Shift of mediastinal structures
    - Compression of the heart
    - Inversion of the diaphragm

# Pleural Effusions

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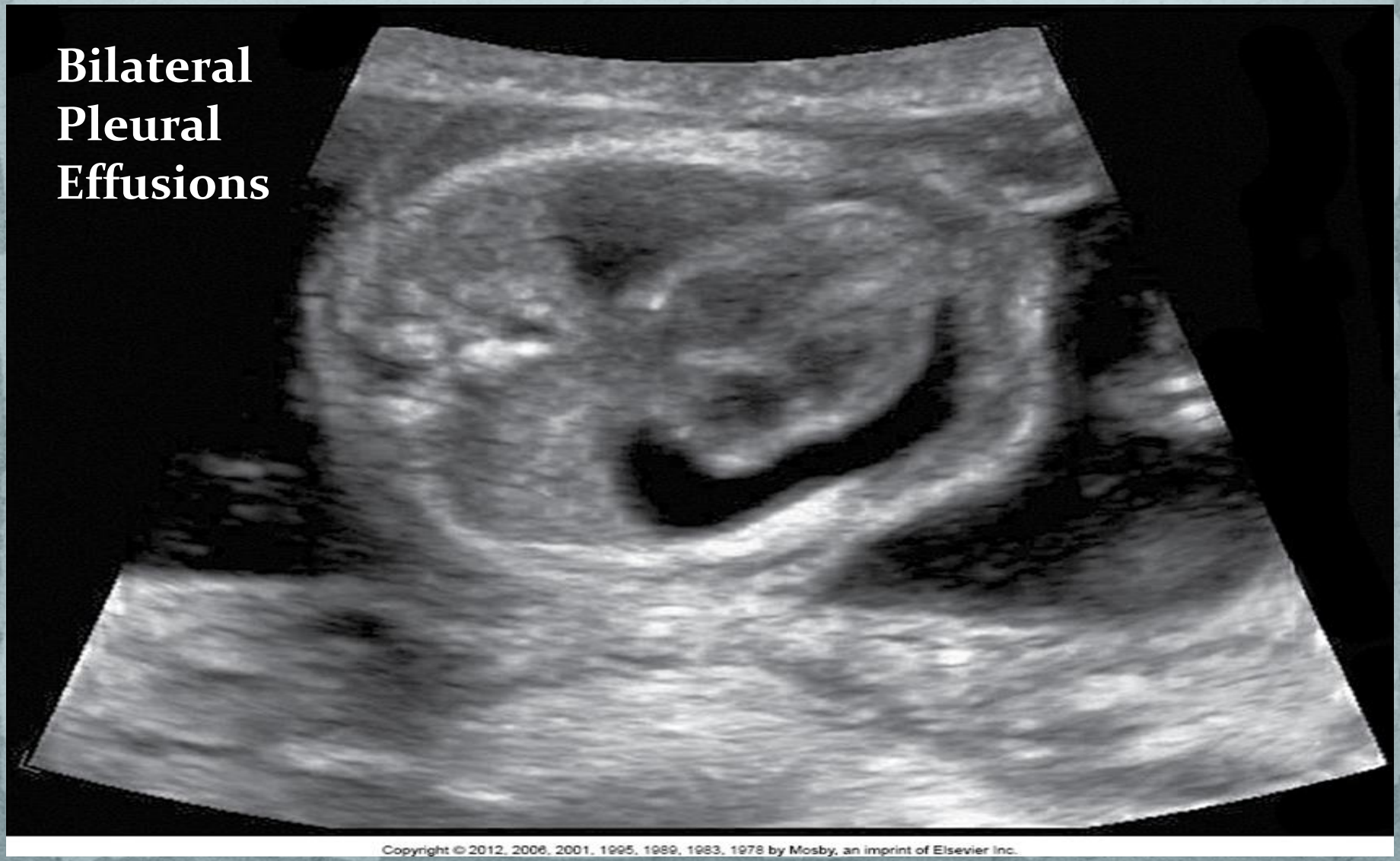
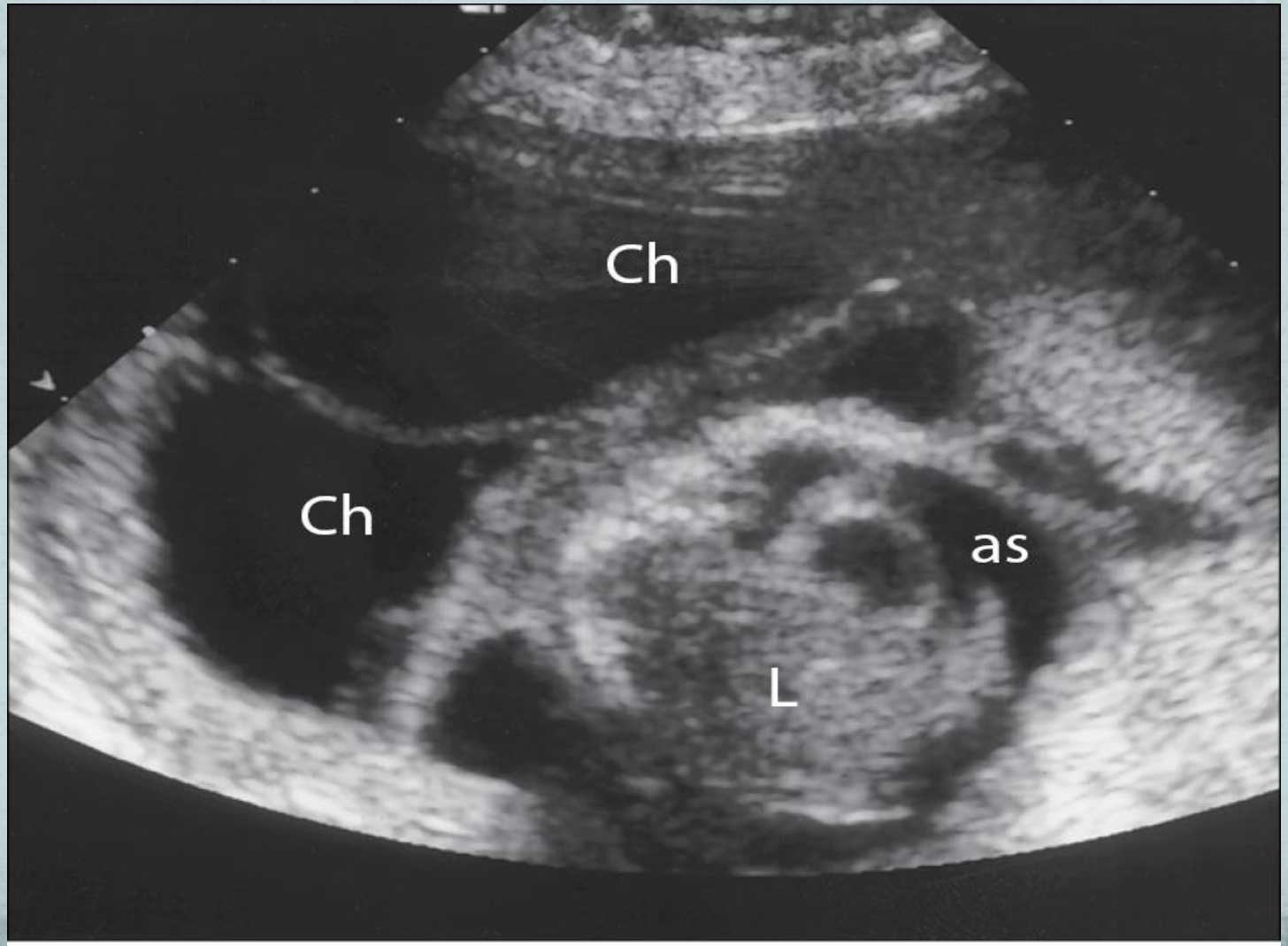
# Pleural Effusions



**Cystic hygroma (Ch), and fetal hydrops. Ascites (as) is seen adjacent to the liver (L). Sonographer should also evaluate for pleural and pericardial effusions.**

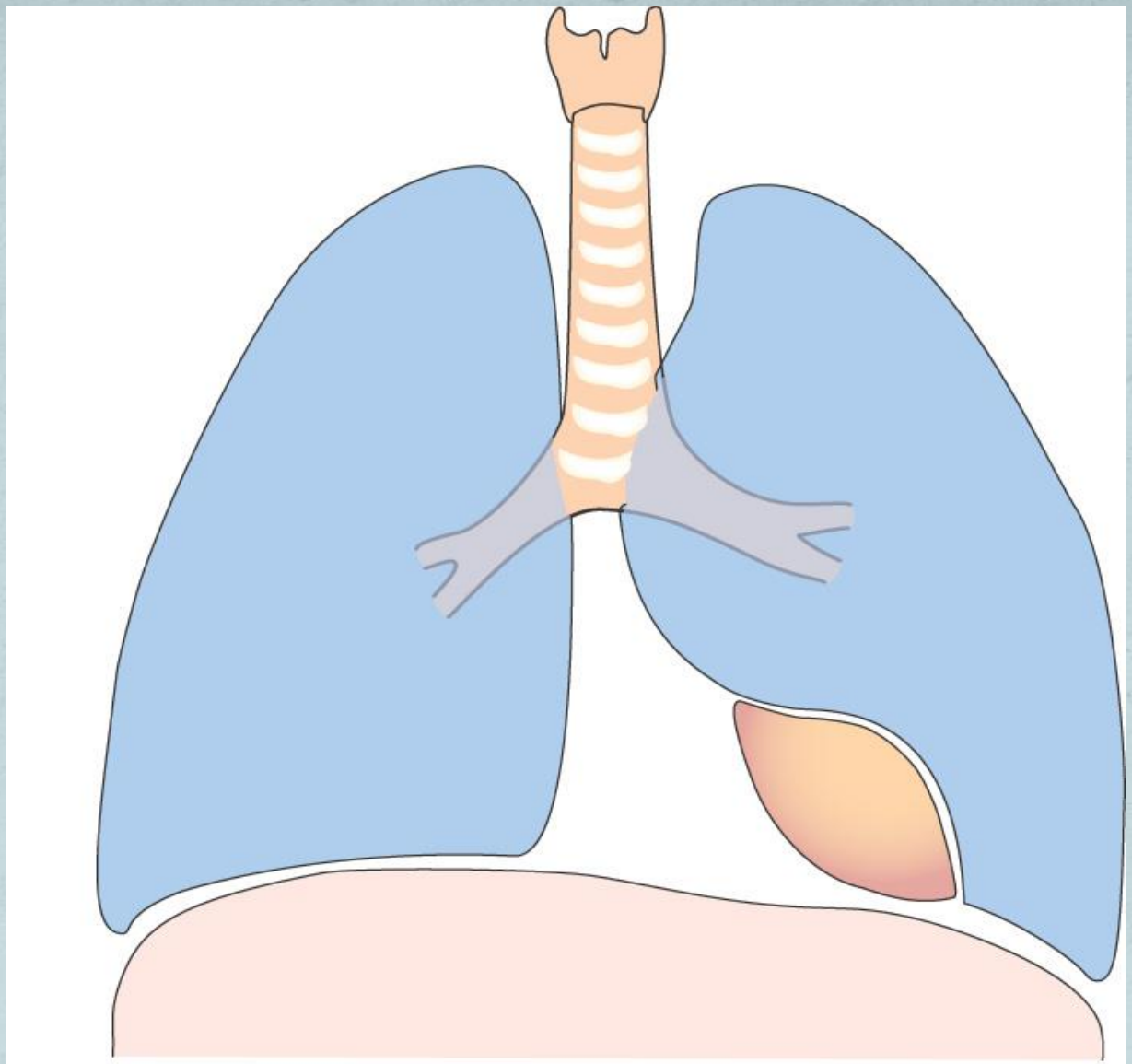


# Solid Lung Masses

- Appear as echo-dense masses in the lung tissue
- Echogenic solid mass resembling lung tissue
- Rarely occurs below diaphragm
- Associated with
  - Hydrops and polyhydramnios
  - Diaphragmatic hernia
  - Gastrointestinal anomalies

# Bronchopulmonary Sequestration

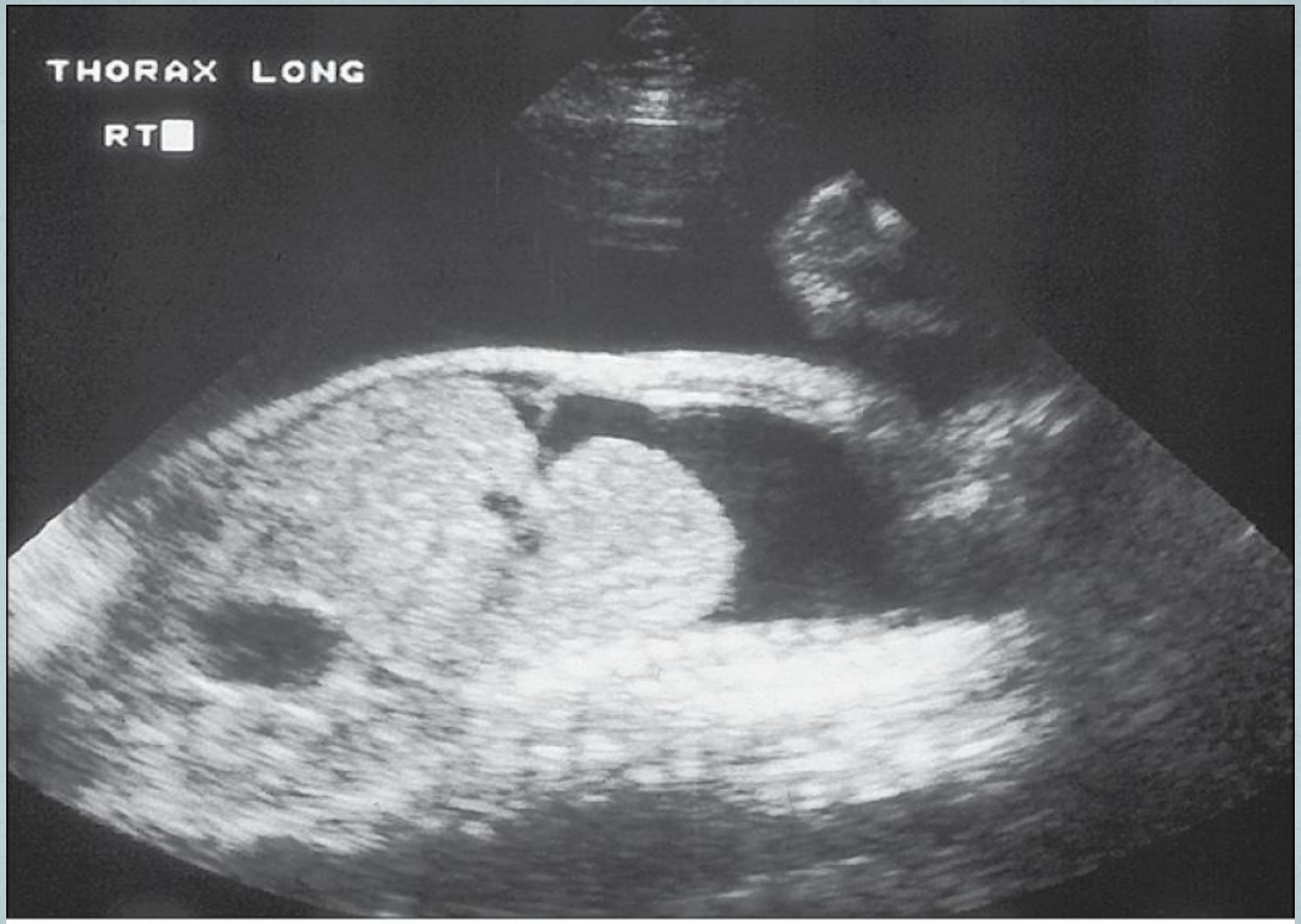
- Extra pulmonary tissue is present either
  - Intralobar
    - Within the pleural lung sac
  - Extralobar
    - Connected to the inferior border of the lung within its own pleural sac



D Extralobar sequestration

# Bronchopulmonary Sequestration

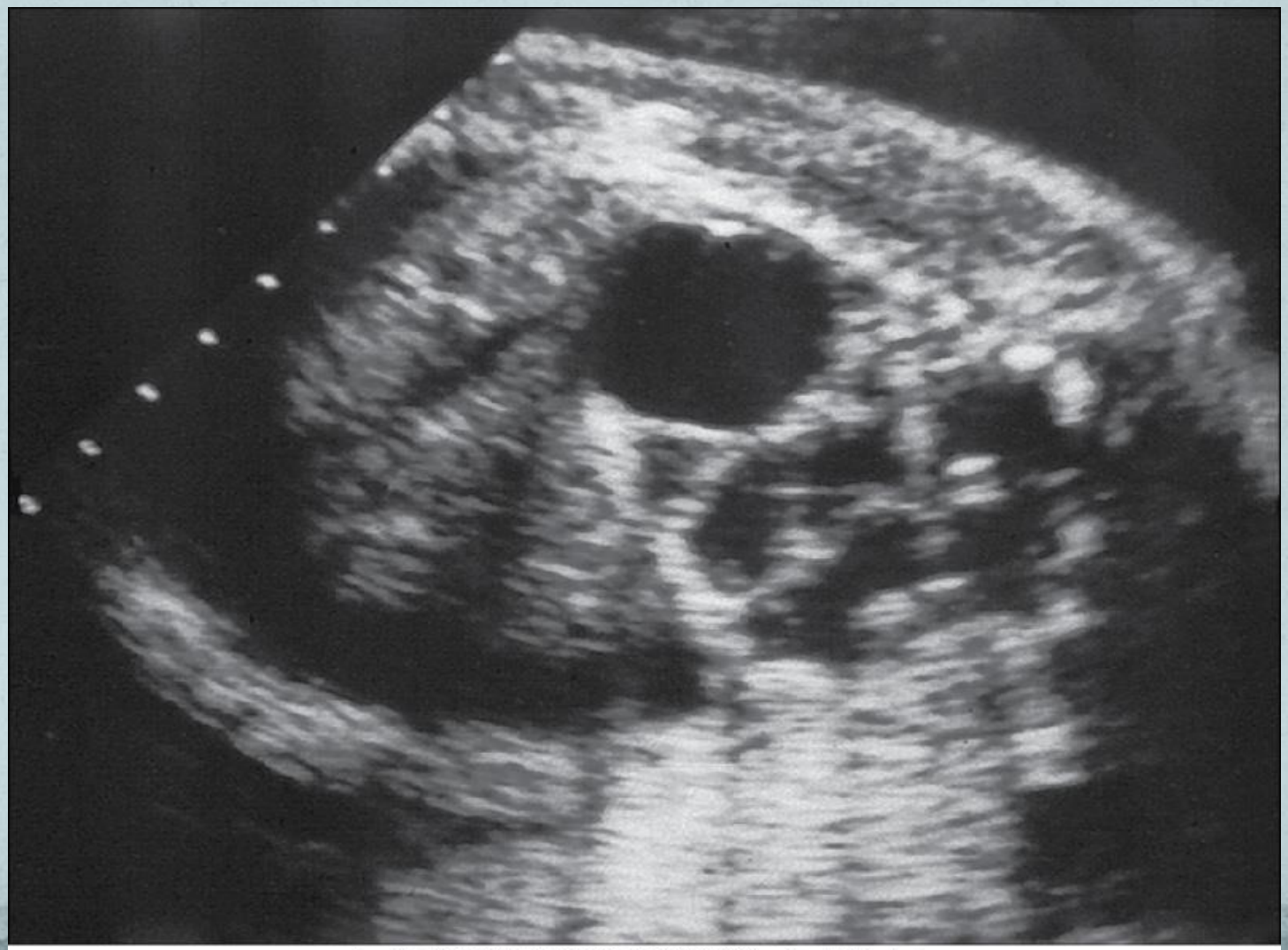
- Sonographically
  - Echo-dense solid mass resembling lung tissue
    - Usually in the lower lobe of the lung
- Majority of extralobar defects occur on the left side and rarely below the diaphragm
  - Appear as a cone- or triangular-shaped mass
- Intralobar lesions are spherical



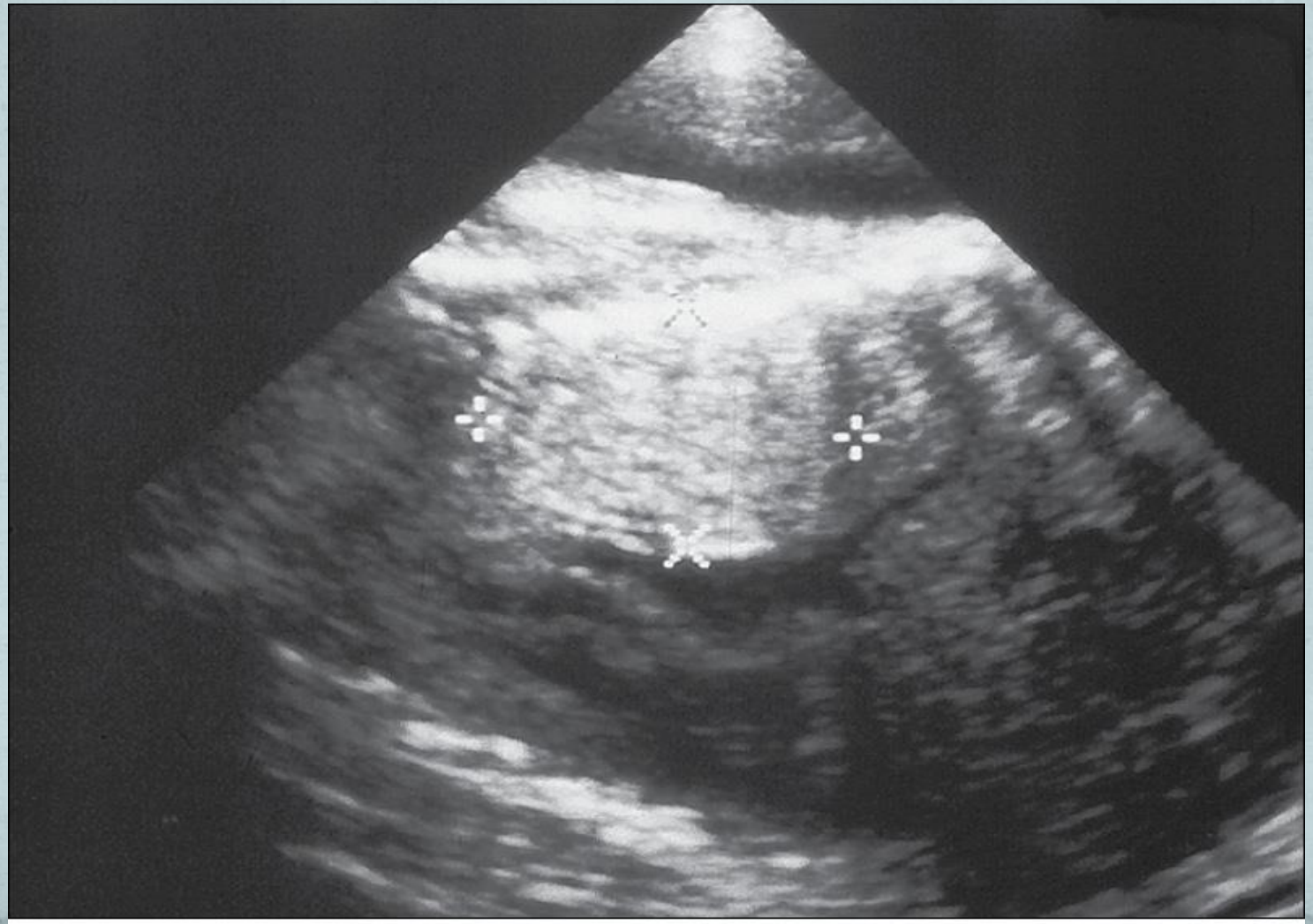
# Congenital Cystic Adenomatoid Malformation

- Abnormality in the formation of the bronchial tree with secondary overgrowth of mesenchymal tissue from arrested bronchial development
- Three forms
  - Type I
    - One or several large cysts replace normal lung tissue (>2 cm)
  - Type II
    - Lesions consist of multiple small cysts (<1 cm)
  - Type III
    - Characterized as bulky, large, noncystic lesions appearing as echo-dense masses of the entire lung lobe

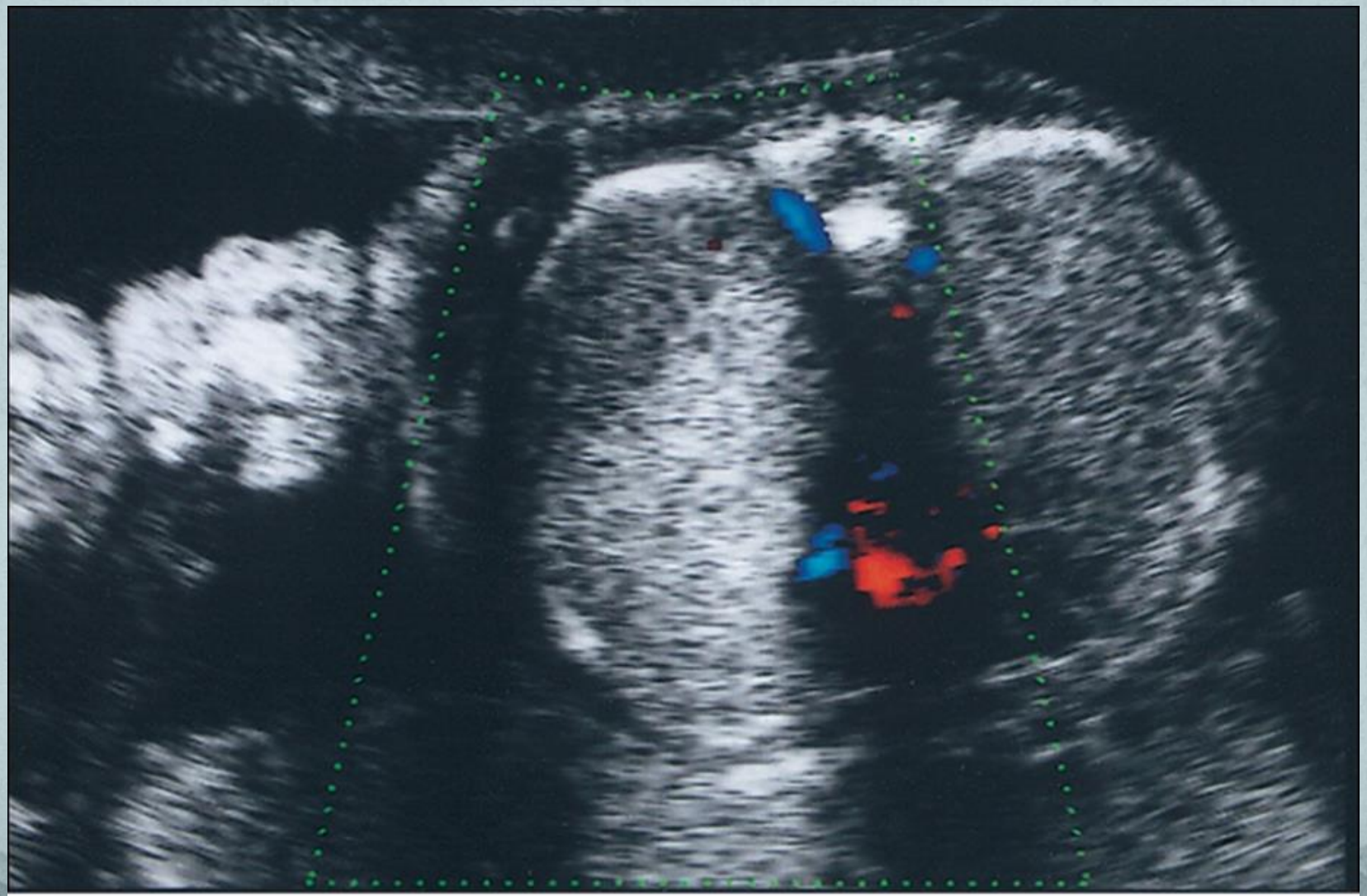
# Type I Congenital Cystic Adenomatoid Malformation

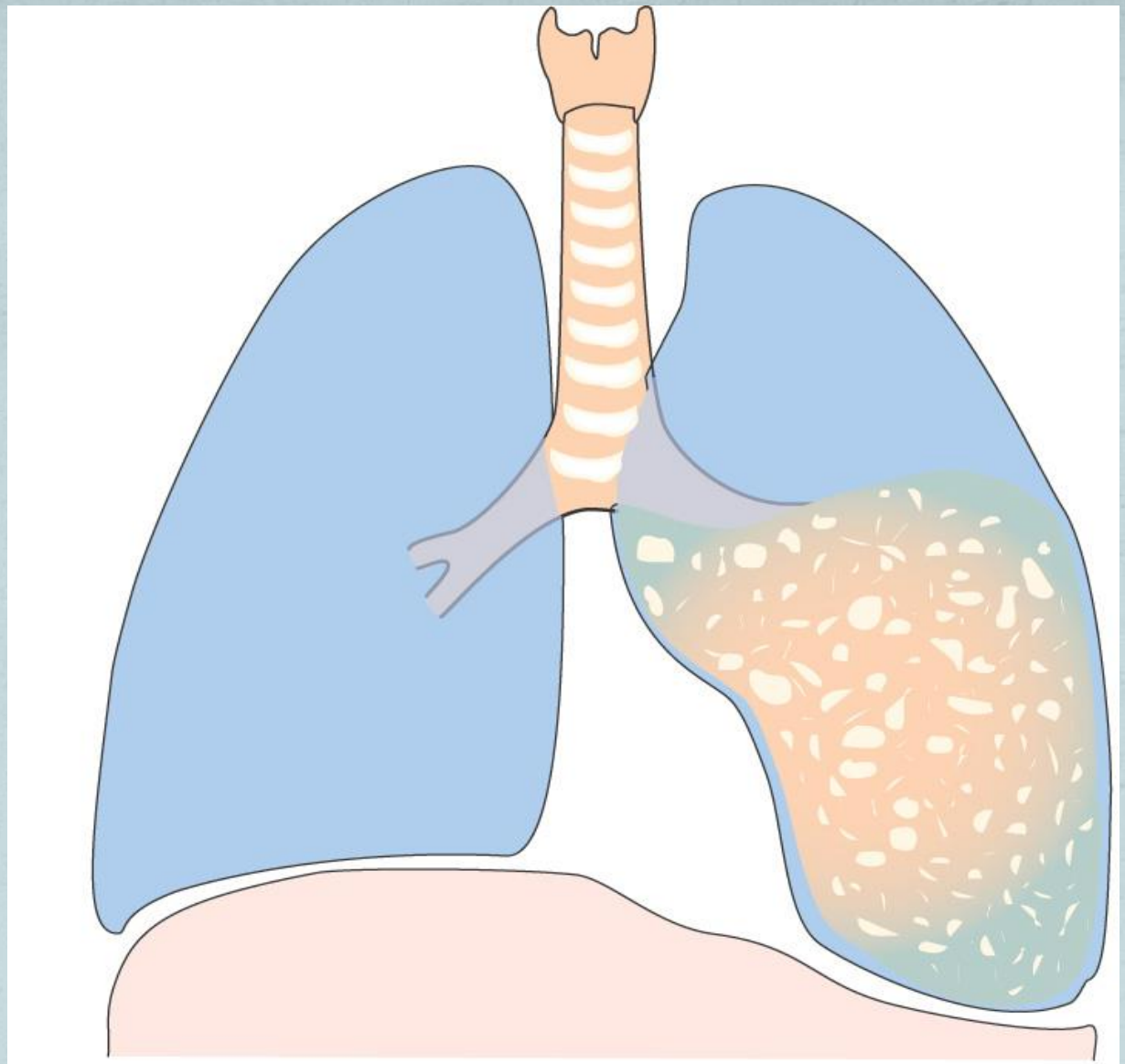


# Type II Congenital Cystic Adenomatoid Malformation



# Type III Congenital Cystic Adenomatoid Malformation





**C** Cystic adenomatoid malformation

# Congenital Cystic Adenomatoid Malformation

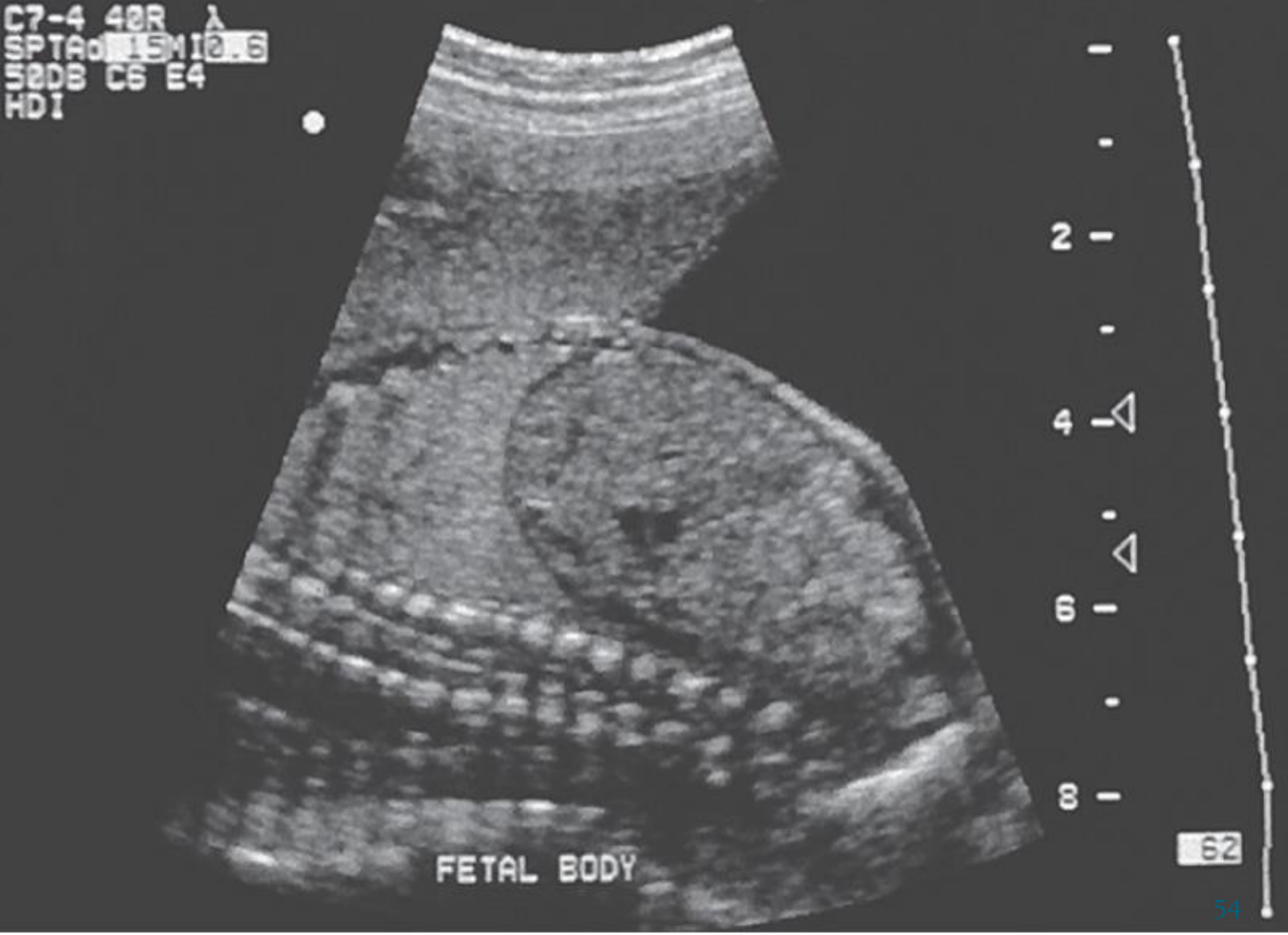
- Attempt to:
  - Determine the number and size(s) of cystic structures
  - Check for presence or absence of a mediastinal shift
  - Identify and assess the size of the lungs
  - Look for fetal hydrops
  - Exclude cardiac masses
  - Search for other fetal anomalies

# Congenital Bronchial Atresia

- Pulmonary anomaly results from focal obliteration of a segment of the bronchial lumen
- Most commonly found in the left upper lobe
- Appears as an echogenic pulmonary mass lesion

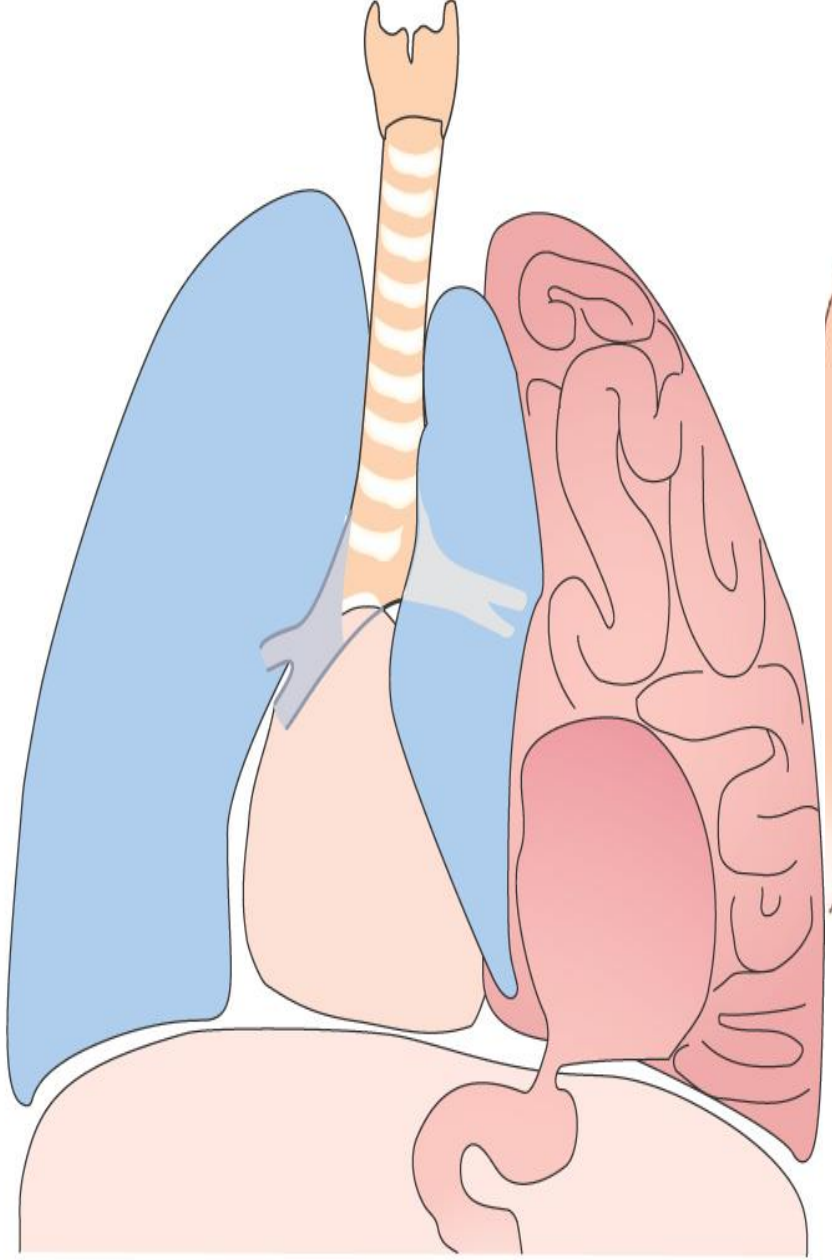
# *Abnormalities of the Diaphragm*

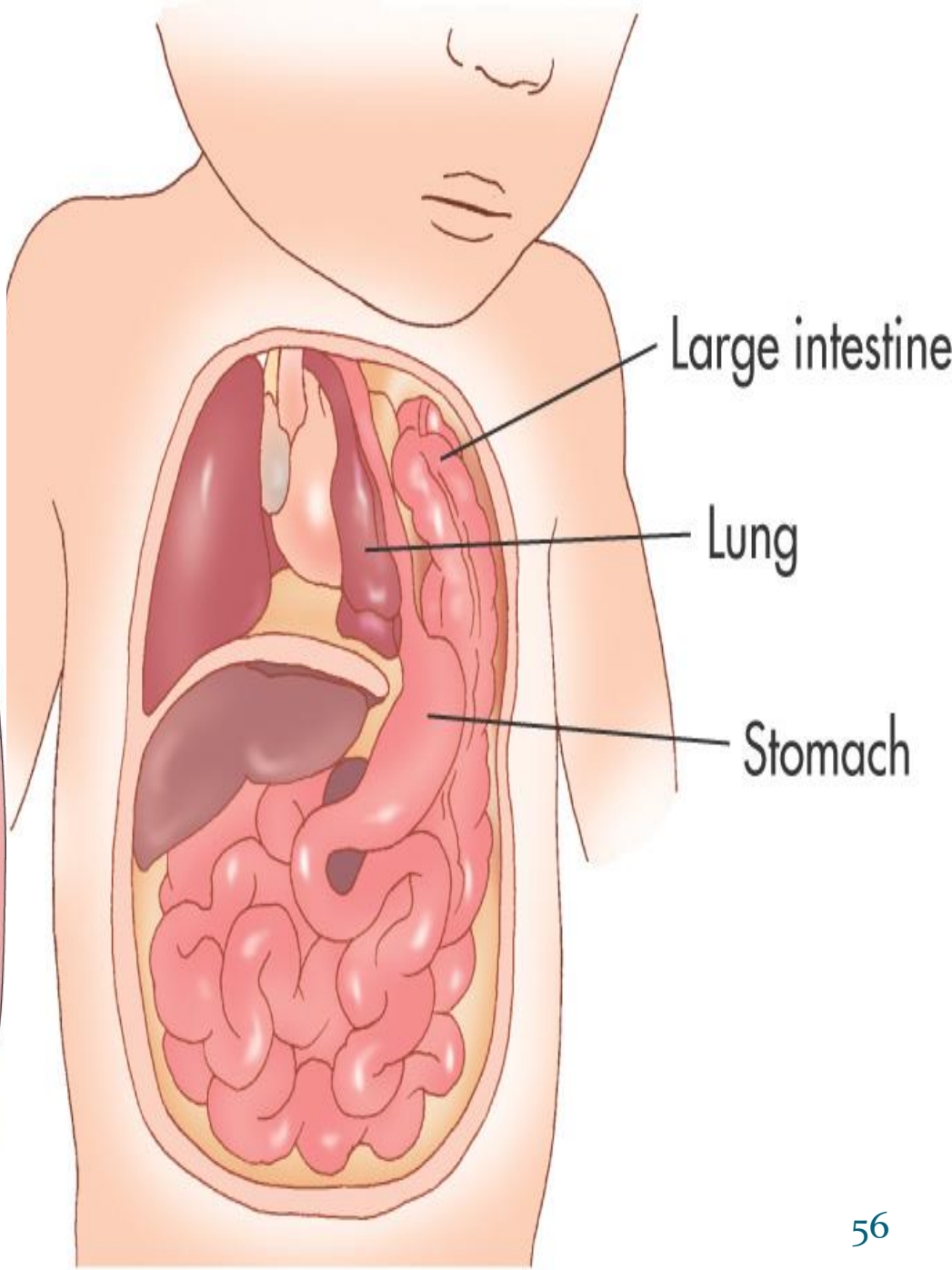
- **Diaphragm**
  - **Important muscle**
  - **Specifically studied in fetuses at risk for congenital defects of the diaphragm or when atypical structures are found in the fetal chest**
- **Normal diaphragm appears as a curvilinear structure coursing anteriorly to posteriorly**
- **Failure to recognize normal relationships should prompt you to search for diaphragmatic defects**



# Diaphragmatic Hernia

- Sporadic defect occurring
  - 1 per 2000 to 1 in 5000 births
- Opening in the pleuroperitoneal membrane
  - (membrane dividing the pleural cavity from the peritoneal cavity)
- Probably develops between the 6th and 10th week
  - Gut is returning from the yolk sac and the diaphragm is developing
- Permits the abdominal organs to enter the fetal chest



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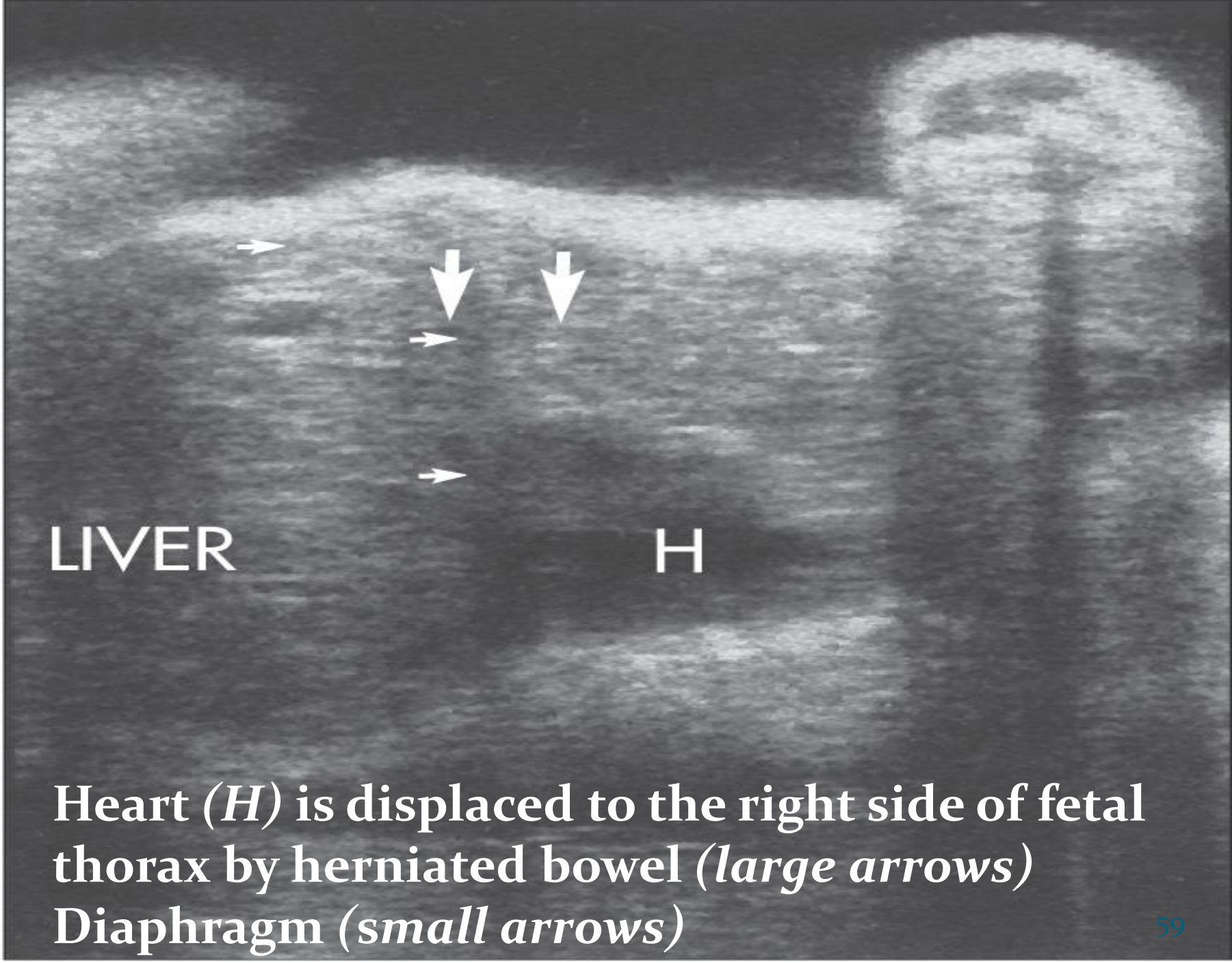
Diaphragmatic hernia

# Diaphragmatic Hernia

- Most common (over 90% of defects)
  - Occurs posteriorly and laterally in the diaphragm (herniation through *foramen of Bochdalek*)
    - Usually are found on the left side of the diaphragm
    - Left-sided organs enter the chest through the opening
      - Stomach
      - Spleen
      - Portions of the liver

# Diaphragmatic Hernia

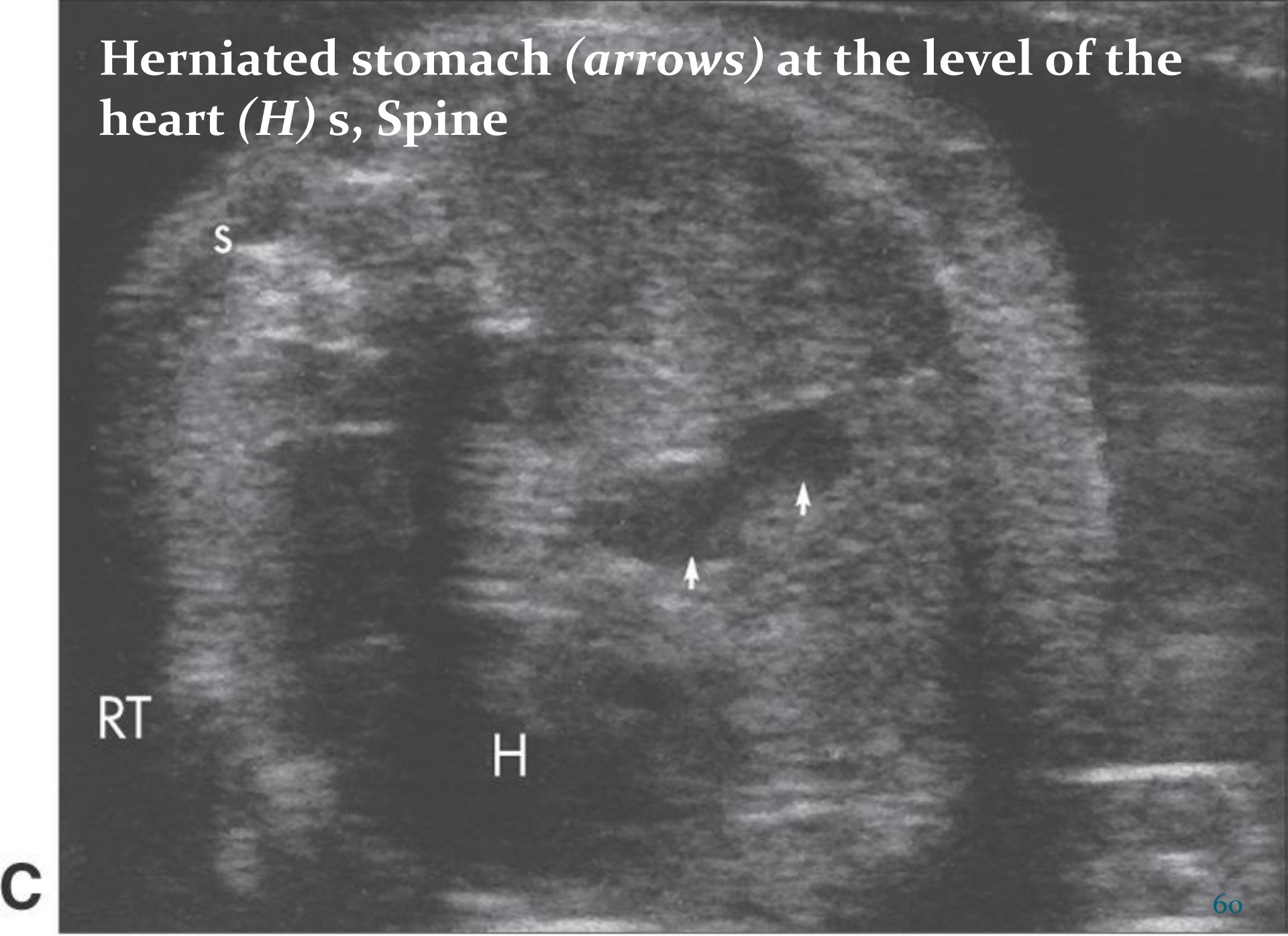
- Abnormally positioned abdominal organs shift the heart and mediastinal structures to the opposite side of the chest
- Consequence of herniated abdominal organs
  - Lungs are compressed and may become hypoplastic

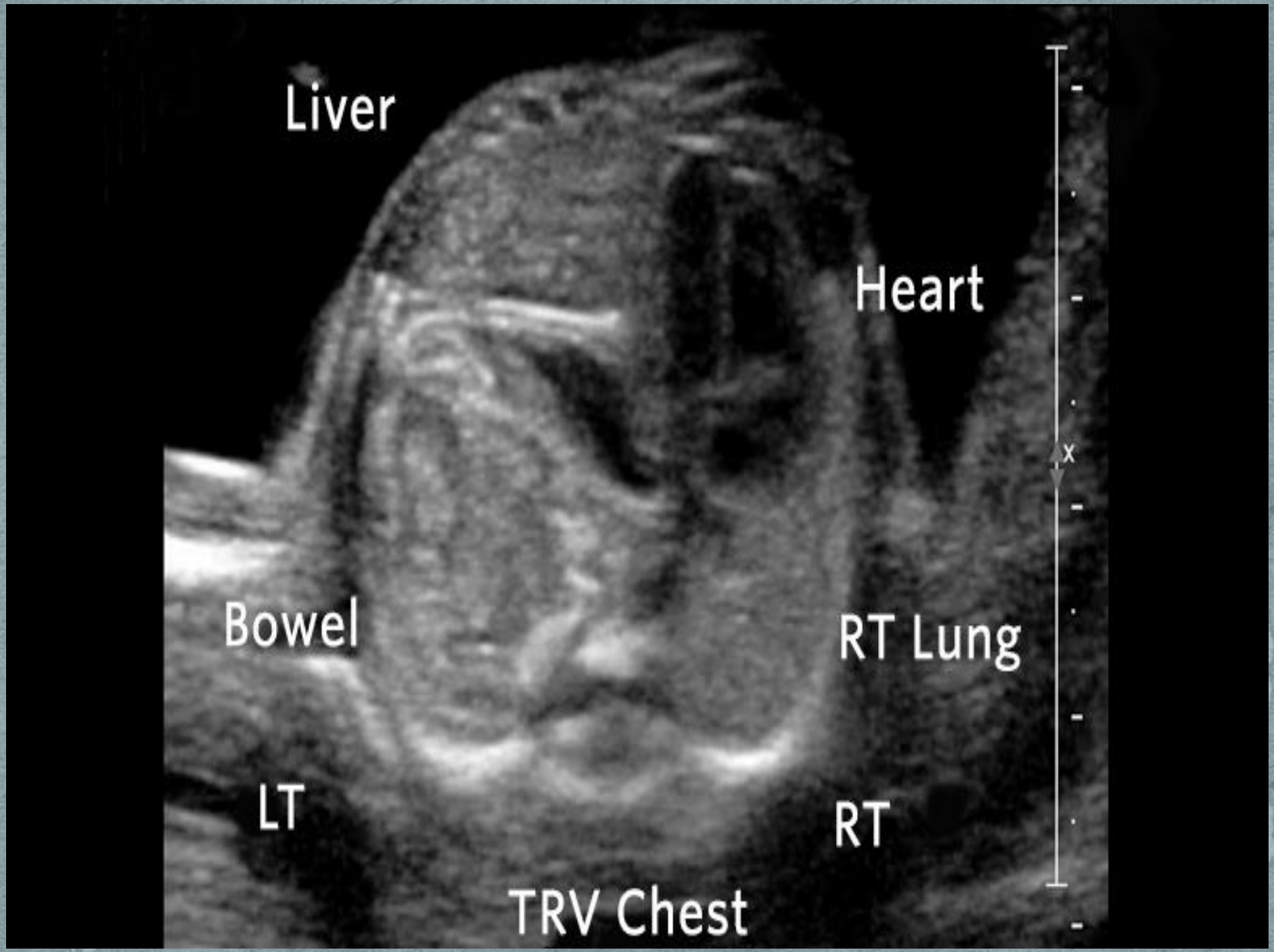


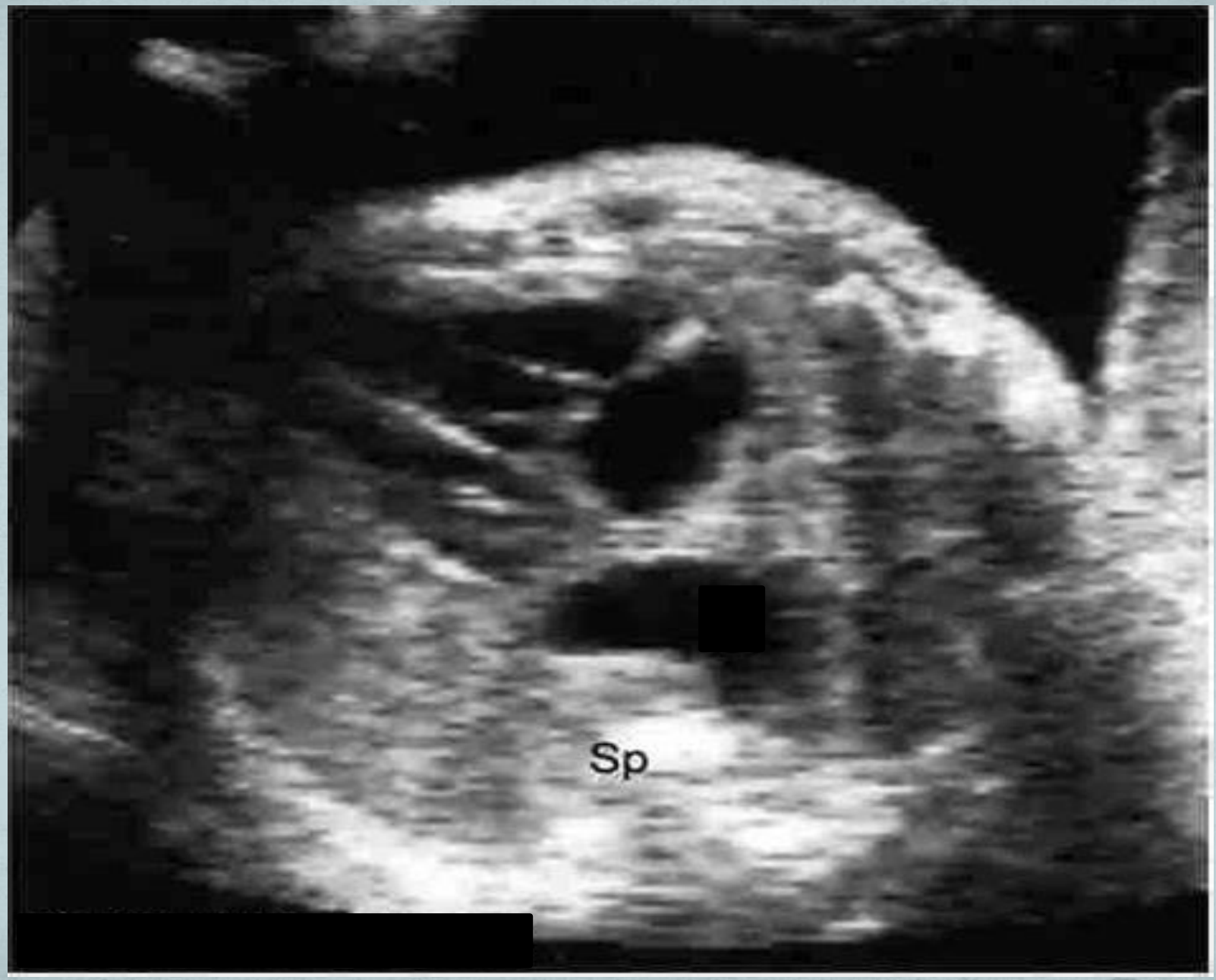

**Heart *(H)* is displaced to the right side of fetal thorax by herniated bowel *(large arrows)* Diaphragm *(small arrows)***

B

# Herniated stomach *(arrows)* at the level of the heart *(H)* s, Spine




Liver
Heart
Bowel
RT Lung
LT
RT
TRV Chest


Sp

# Diaphragmatic Hernia

- May occur anteriorly and medially in the diaphragm (through *foramen of Morgagni*)
  - May communicate with the pericardial sac
  - Heart may be normally positioned and surrounded by pleural fluid
    - Stomach may be located in its normal position in the abdomen

# Diaphragmatic Hernia

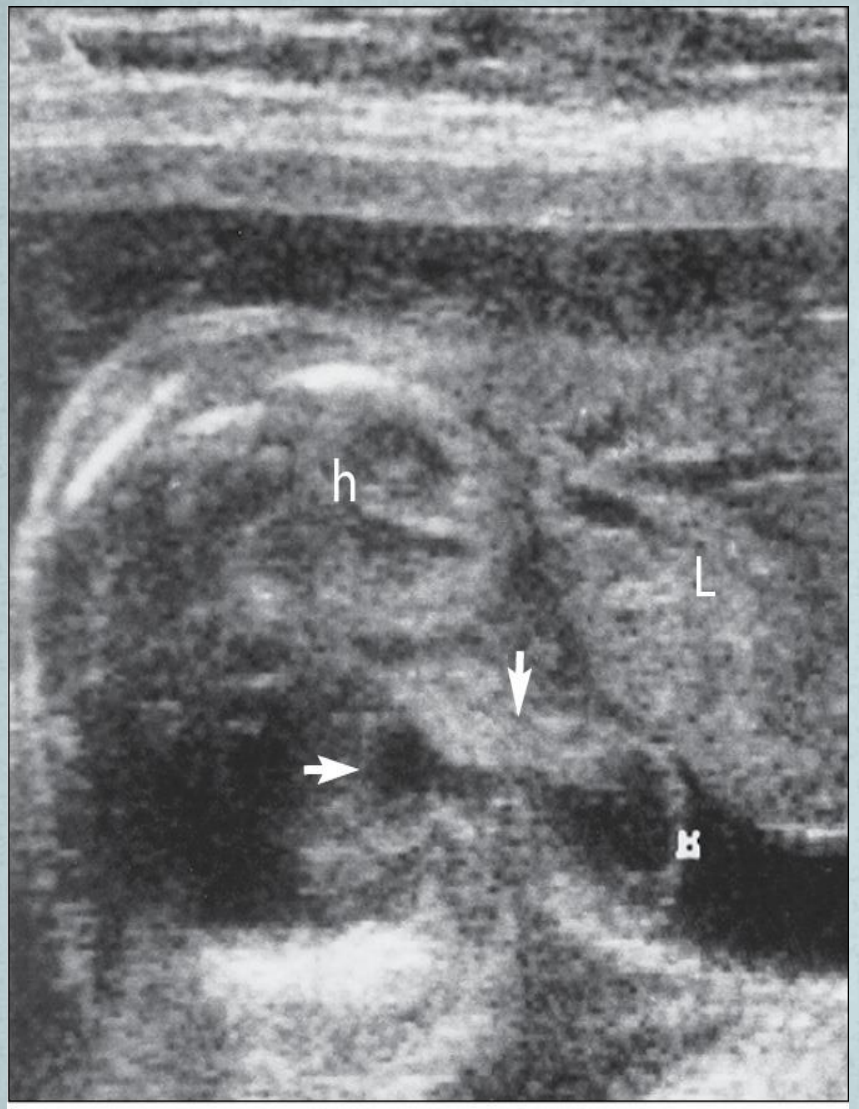
- Prognosis is poor for the fetus if detected before birth if
  - Presence of the stomach is found in the chest, especially if it is dilated
  - Left heart is underdeveloped
  - Congenital heart disease is present
- Primary cause of death is pulmonary hypoplasia
- If diagnosis is made before 25 weeks and polyhydramnios is present
  - Low survival rate

# Diaphragmatic Hernia

- Only clue may be evidence of a solid mass in the chest
- Peristalsis within the herniated intestines confirms the diagnosis
- When unable to demonstrate the stomach bubble in the normal anatomic location after repeated observations
  - Search for a diaphragmatic hernia

# Diaphragmatic Hernia

- Lung and mediastinal masses may be difficult to distinguish from diaphragmatic hernias
- Normally positioned peritoneal organs should aid in differentiating these two conditions
- High mortality rate (75%)
  - Because of the increased frequency of coexisting fatal congenital anomalies

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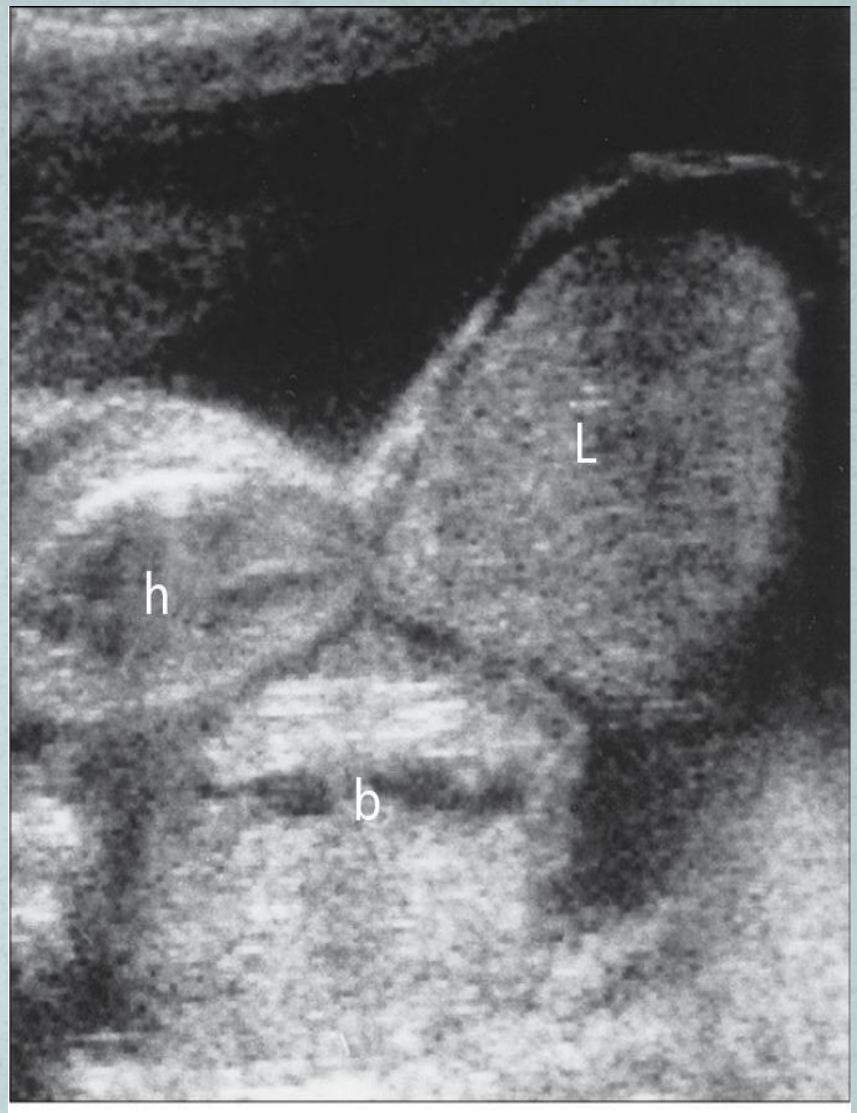


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