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# Newborn Respiratory Disease

## M2 – Respiratory Sequence

Robert Schumacher, M.D.

Fall, 2009

University of Michigan
Medical School

# M2 Respiratory Sequence 2008: Neonatal Lung Disease

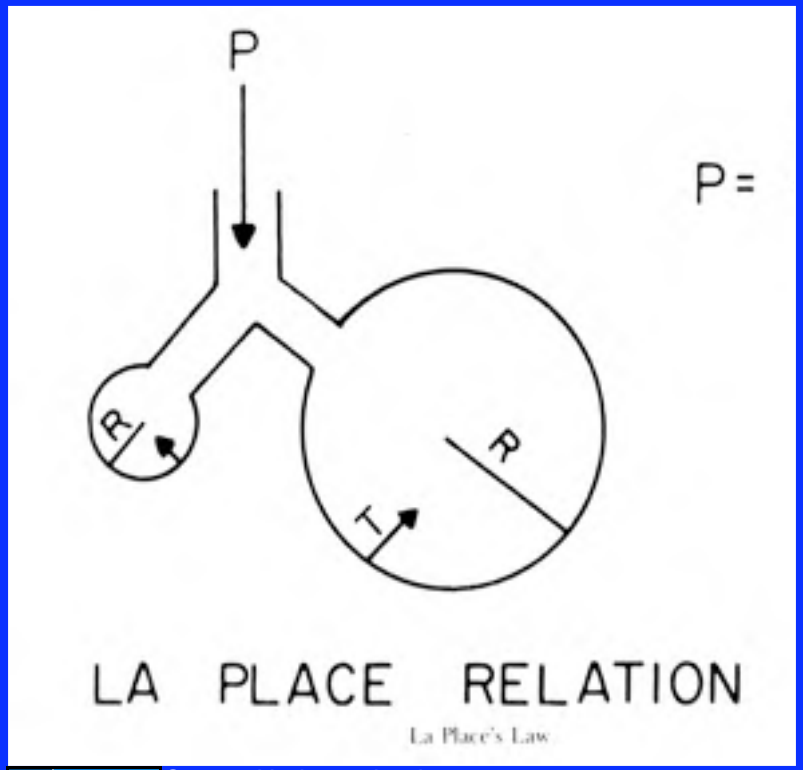
- **Newborn respiratory distress syndrome is characterized by low lung volumes. Contributing factors to the low FRC in such patients include:"**
  - a. decreased lung compliance
  - b. surfactant deficiency
  - c. increased chest wall compliance
  - d. hey, babies are small
  - e. All of the above*

# Review M1

- 2 Dead French Guys
- 1 Dead Swiss Guy

# Laplace Relationship

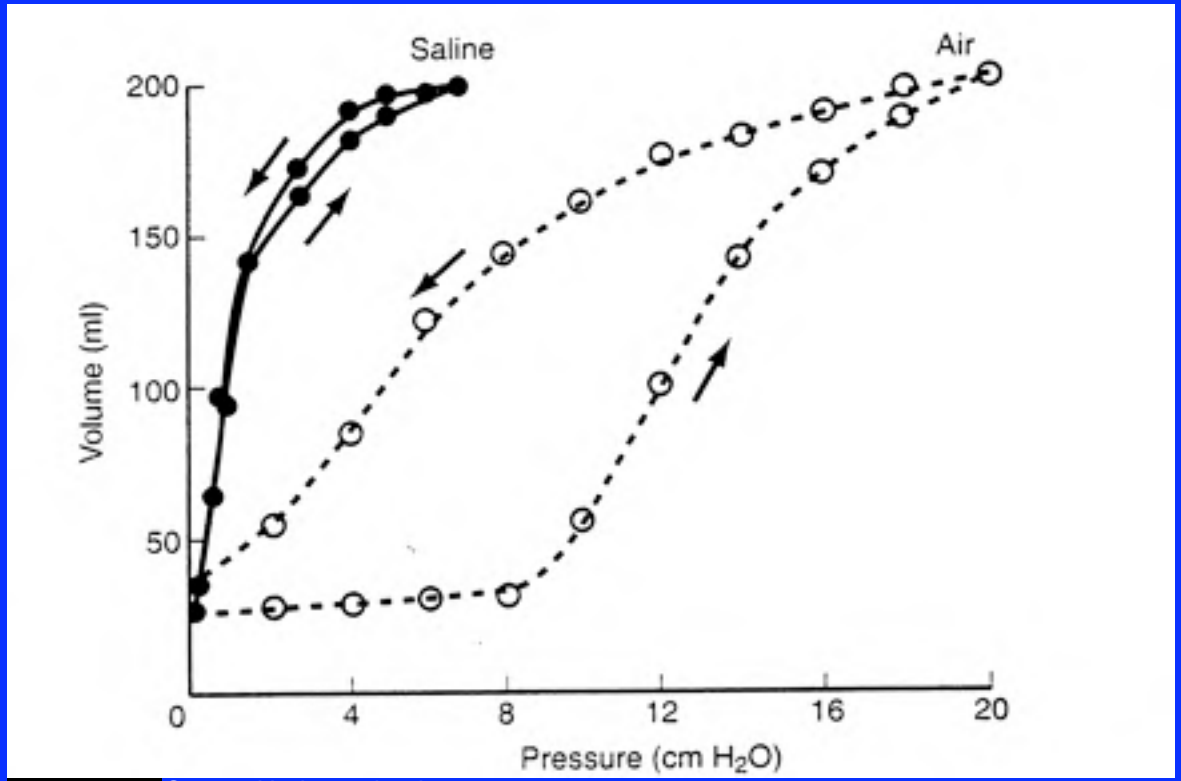
- $\Delta P = 2\gamma/r$
- **Trans-surface pressure = 2(surface tension) / radius of curvature**



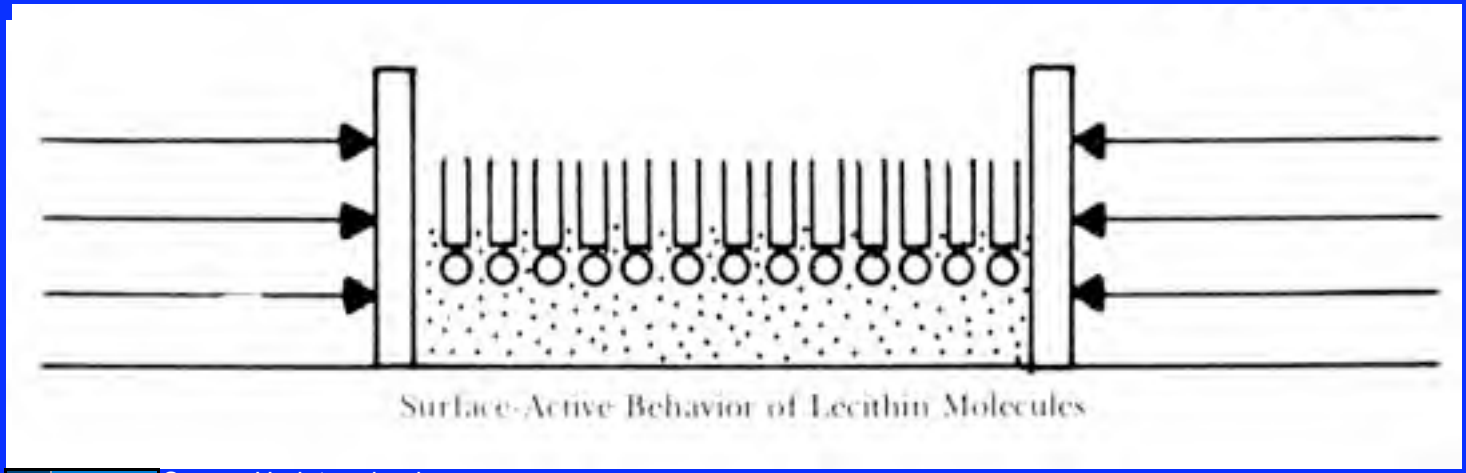

PD-TNCL Source Undetermined

# Von Neergard

- Swiss physicist who demonstrated surface tension forces at work in excised cat lungs. (Air filled v saline filled cat lungs) Laplace relationship holds for alveoli.



- **If this surface film is compressed the phospholipids will be packed more tightly and more water excluded from the surface. This is ideal: the smaller the radius of curvature the more important surface tension forces become (LaPlace), the smaller the radius of curvature the tighter the surfactant molecular pack and the greater the reduction in surface tension forces.**



Surface-Active Behavior of Lecithin Molecules

# Jean L. Poiseuille

PD-EXP Source Undetermined

Poiseuille, Jean Léonard Marie (1799-1869) was a French physiologist who made a key contribution to our knowledge of the circulation of blood in the arteries.

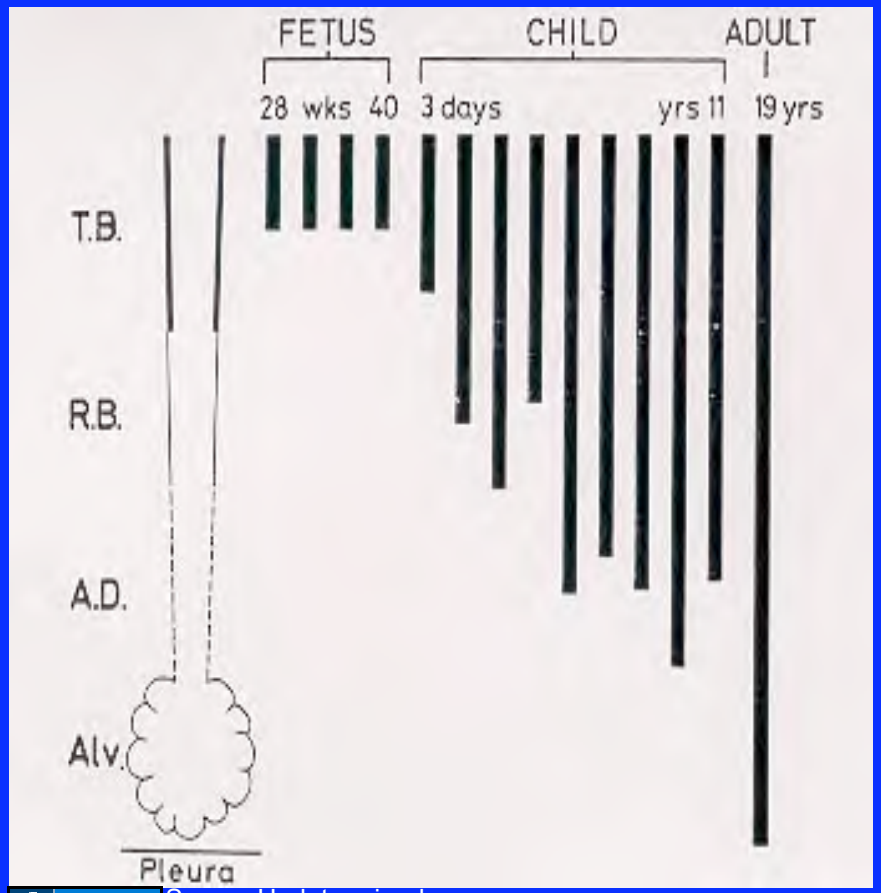
**Poiseuille's Law of The Flow of Liquids Through a Tube:**

**Where:**

*l = the length of the tube in cm*
*r = the radius of the tube in cm*
*p = the difference in pressure of the two ends of the tube in dynes per cm2*
*c = the coefficient of Viscosity in poises (dyne-seconds per cm2)*
*v = volume in cm3 per second*

**Then:**

$$v = r^4 p/8cl$$

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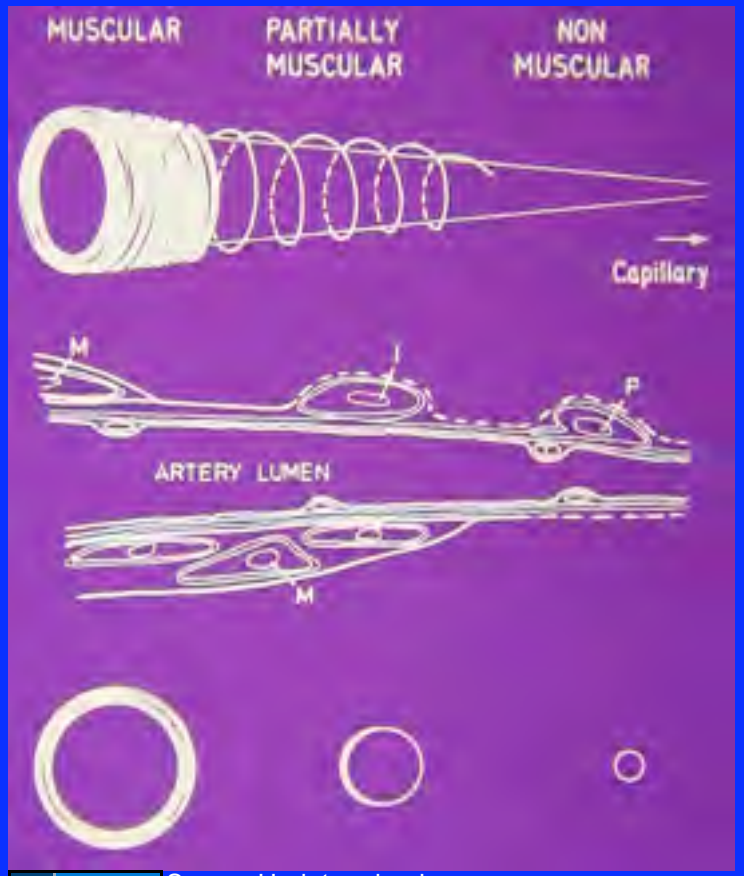


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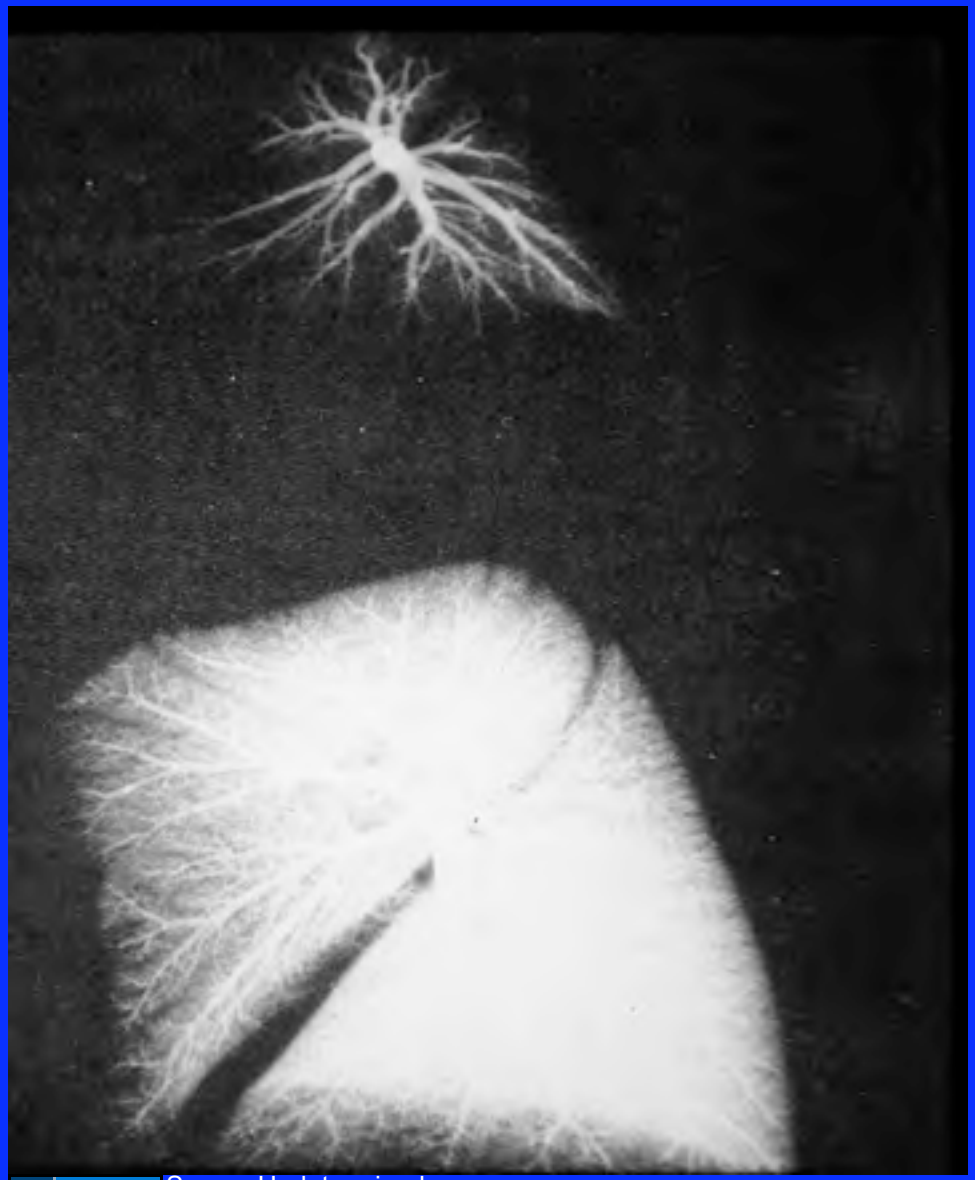
- **Arteriogram:**
  - **Newborn lacks intra-acinar arteries**
  - **Lacks background "haze" seen in the adult lung**
  - **So resistance is high**



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# THE FIRST BREATH:
# Goal #1: Fluid out, Air in.

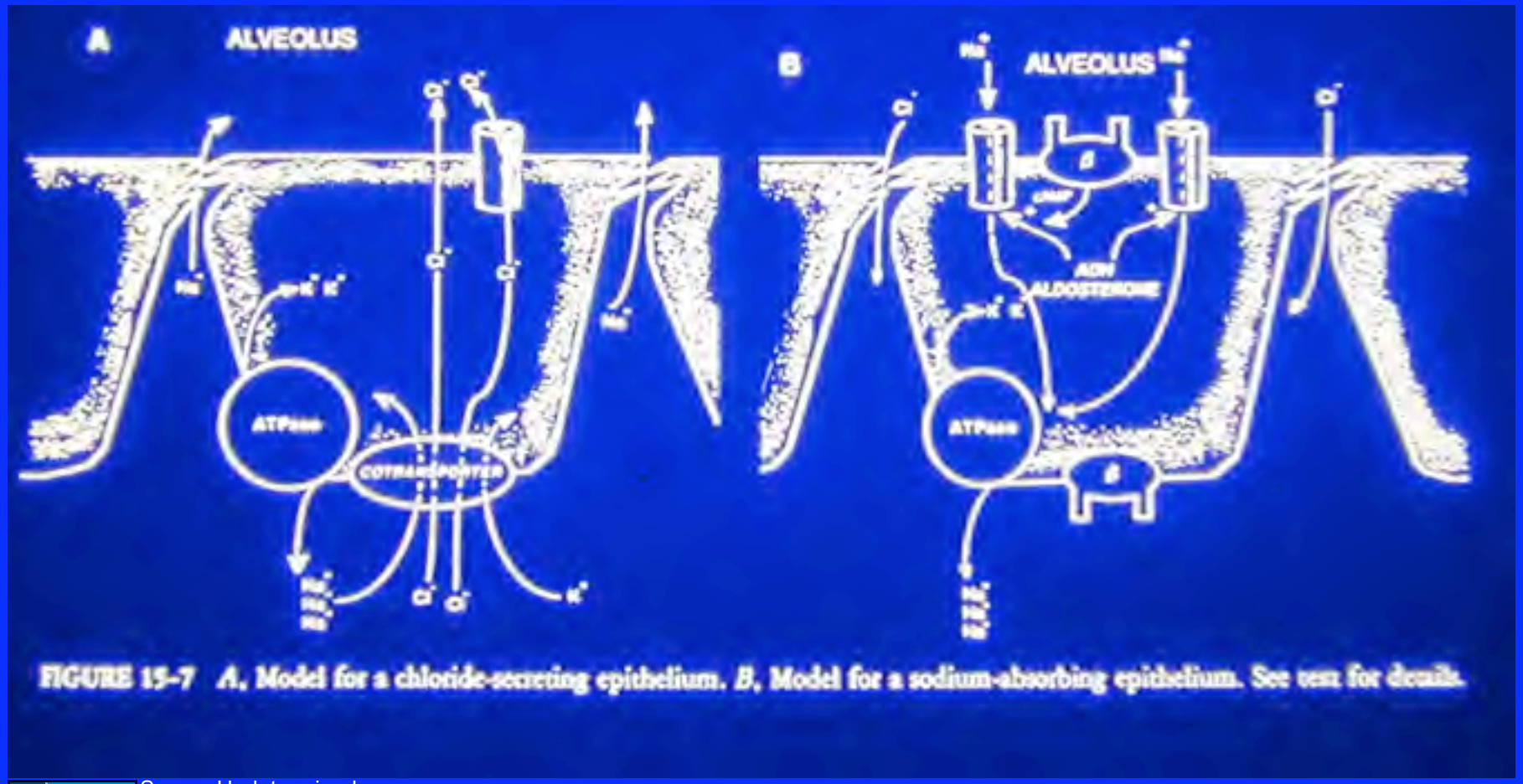



FIGURE 15-7 *A*, Model for a chloride-secreting epithelium. *B*, Model for a sodium-absorbing epithelium. See text for details.

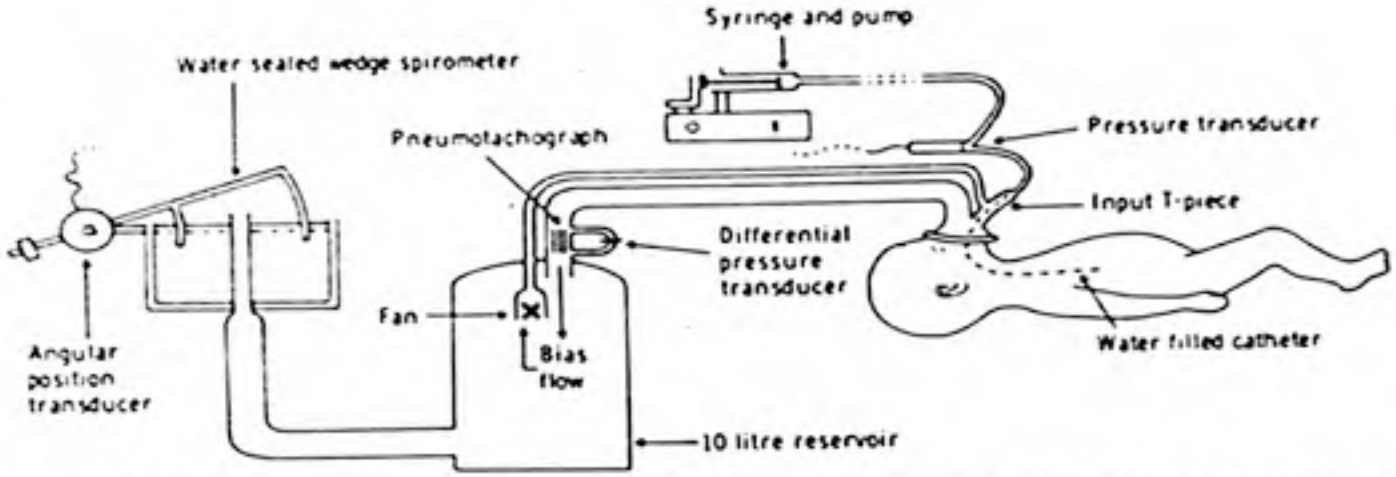
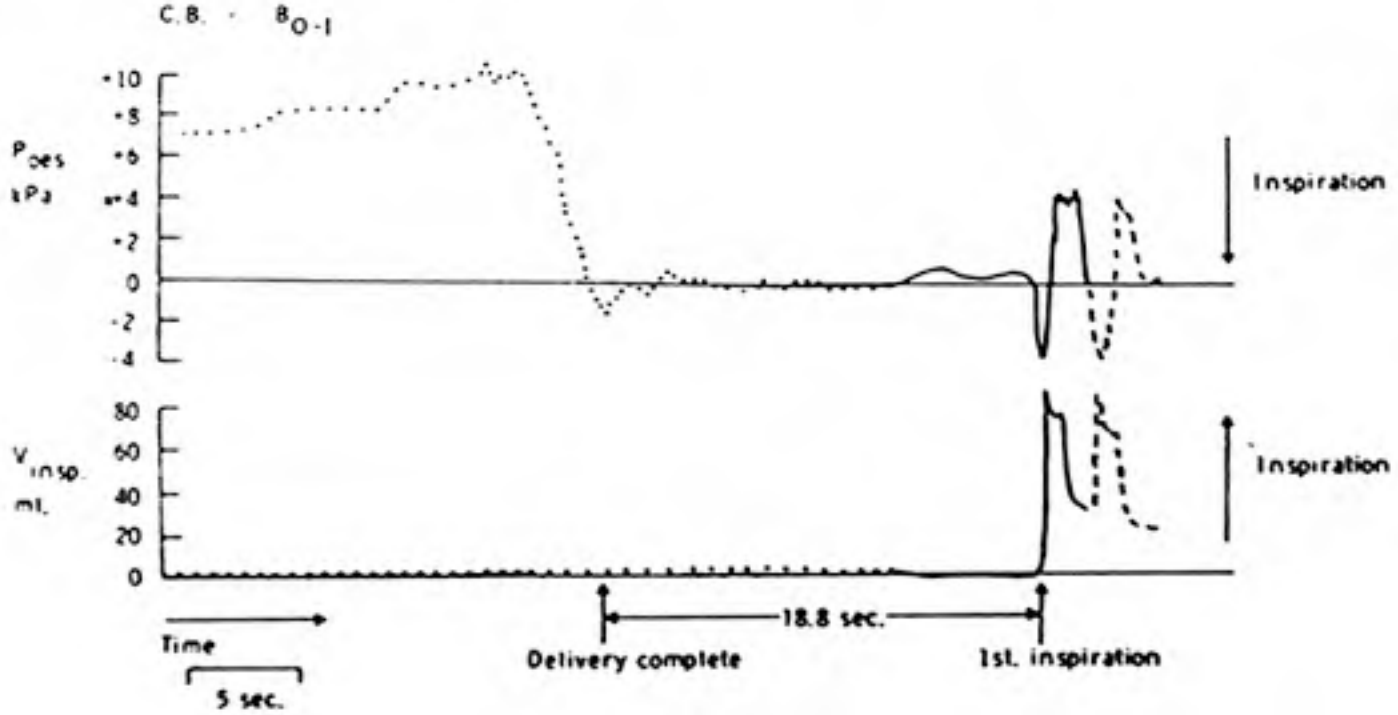
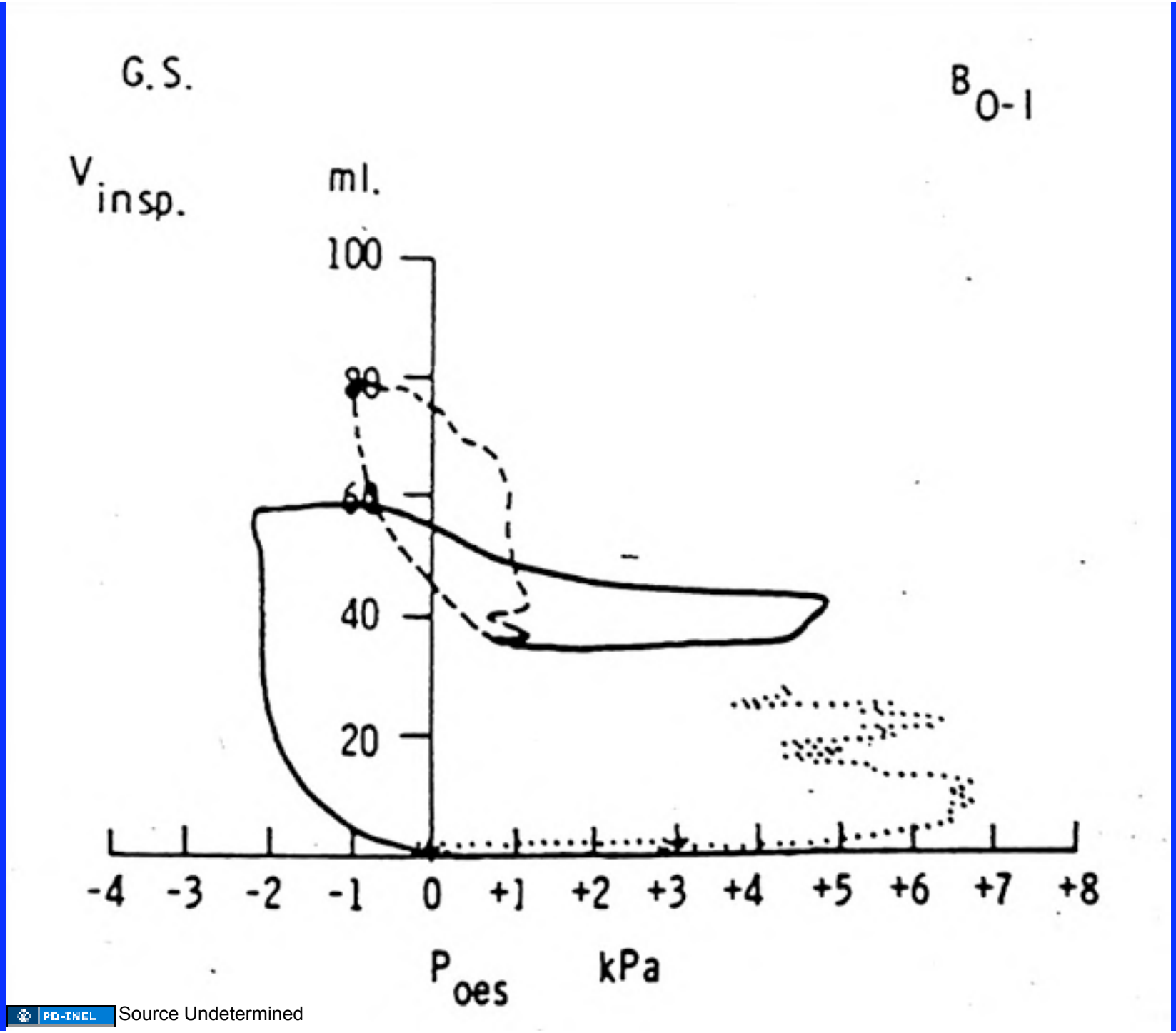
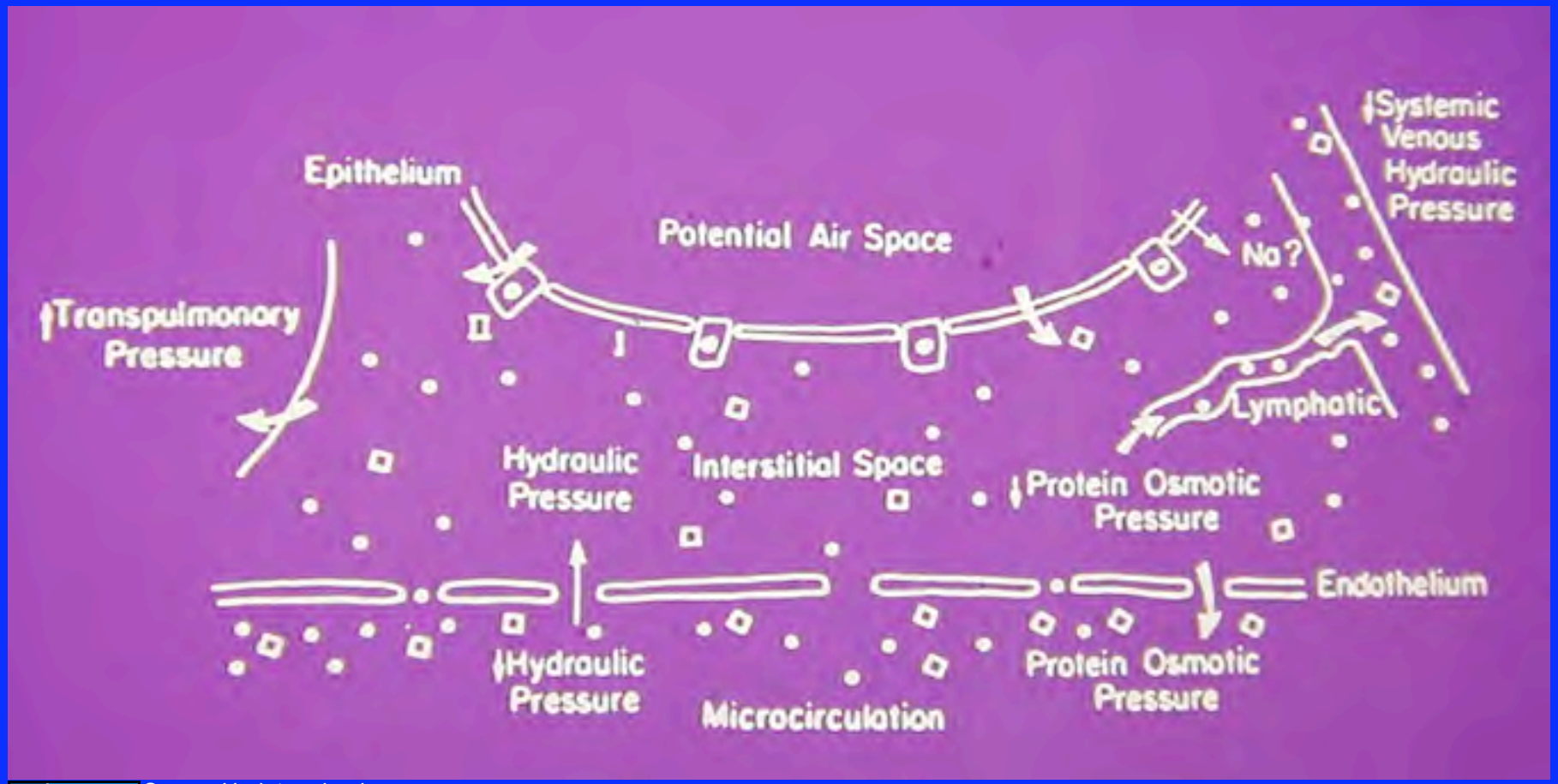


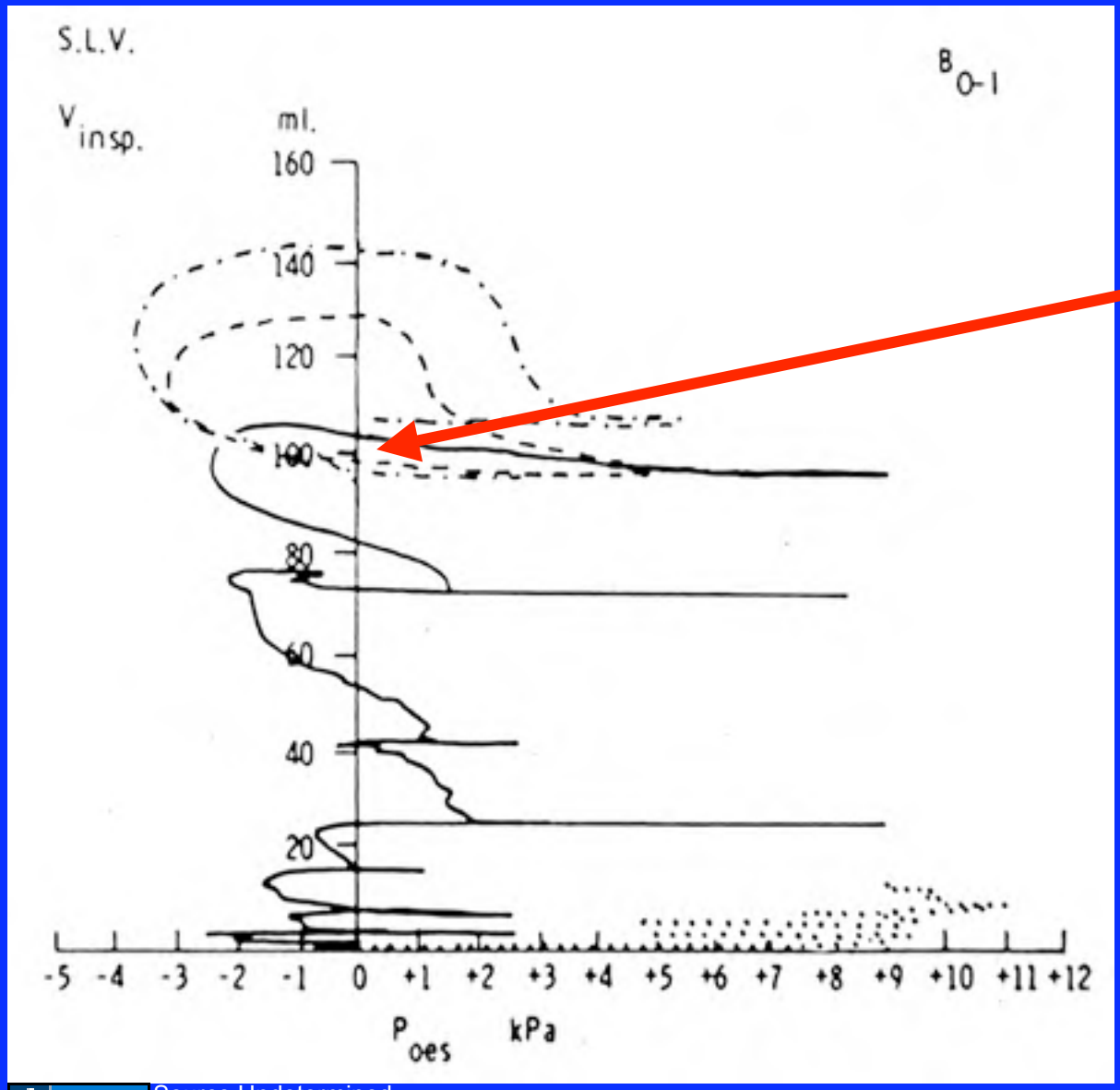

Fig. 1. Diagram of the complete measuring system. Air was circulated through the mask via a 10-liter reservoir and volume fluctuations were measured by the angular displacements of the wedge spirometer.





- **Starling forces at work to clear lung fluid**



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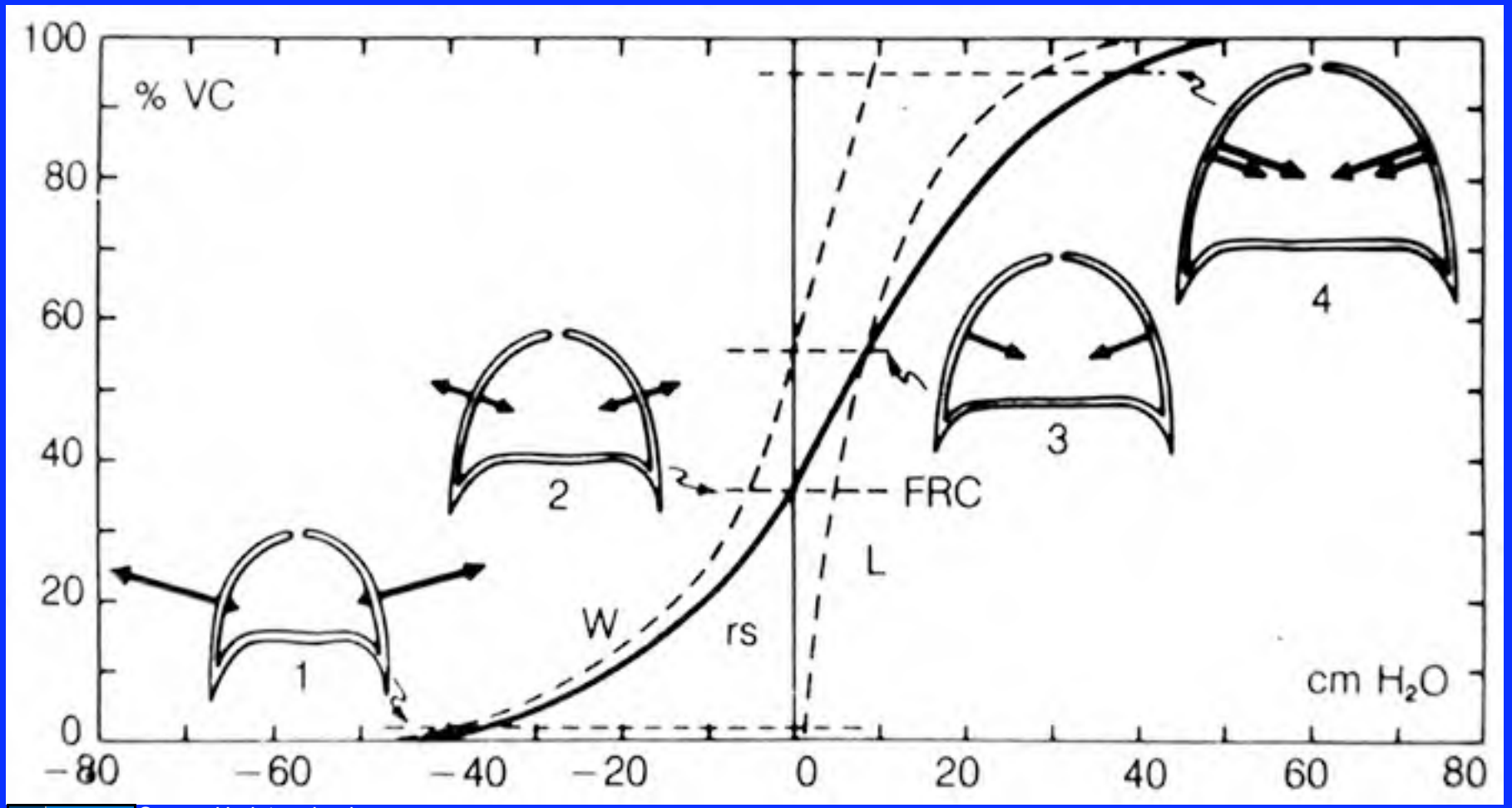
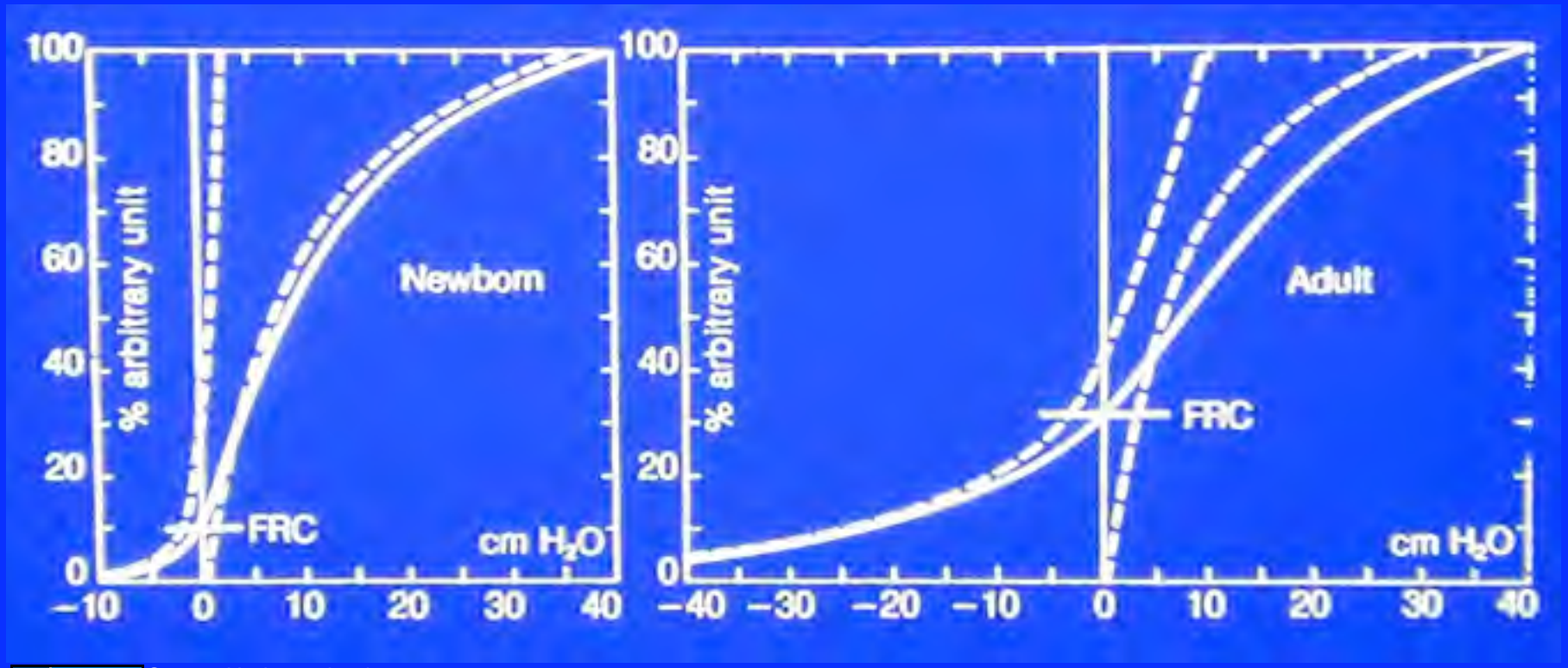
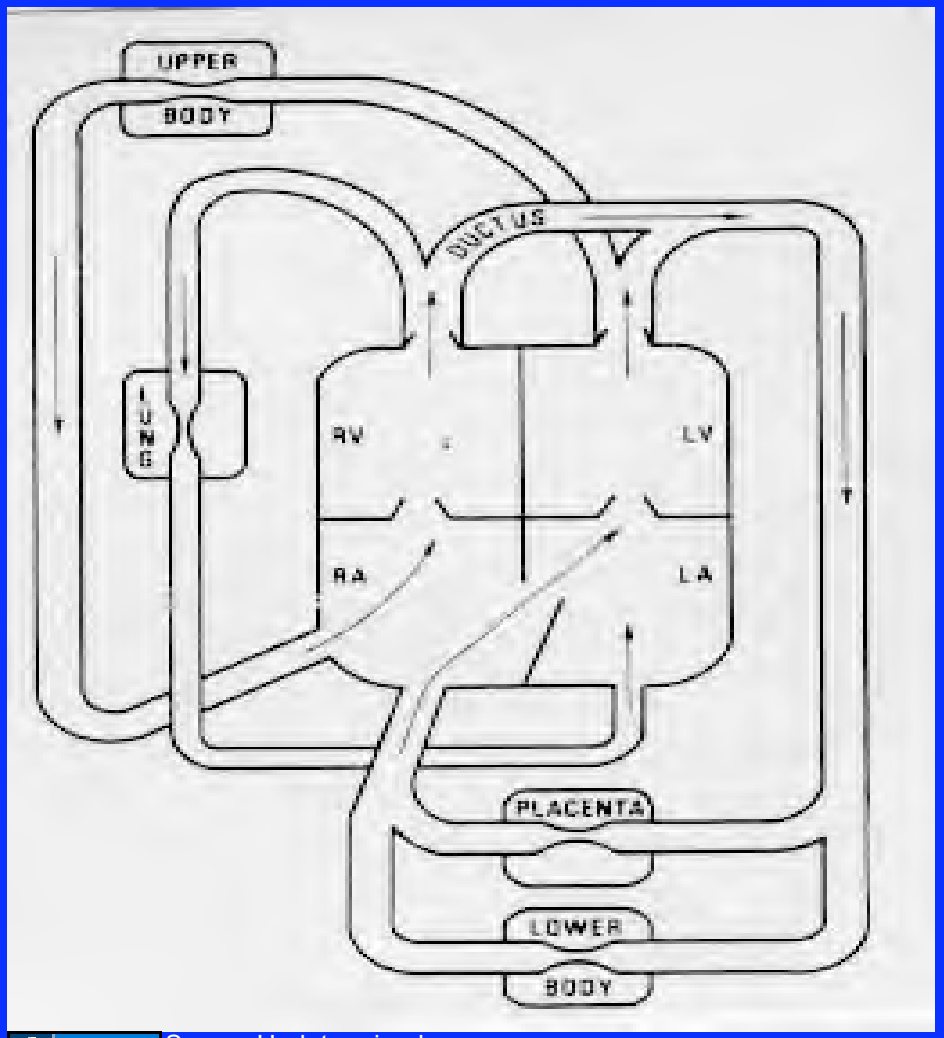
- Functional Residual Capacity is established





# Goal #2. Blood In

- **Fetal circulation:**
  - **"right-to-left shunting" at the level of the atria and the ductus arteriosus.**

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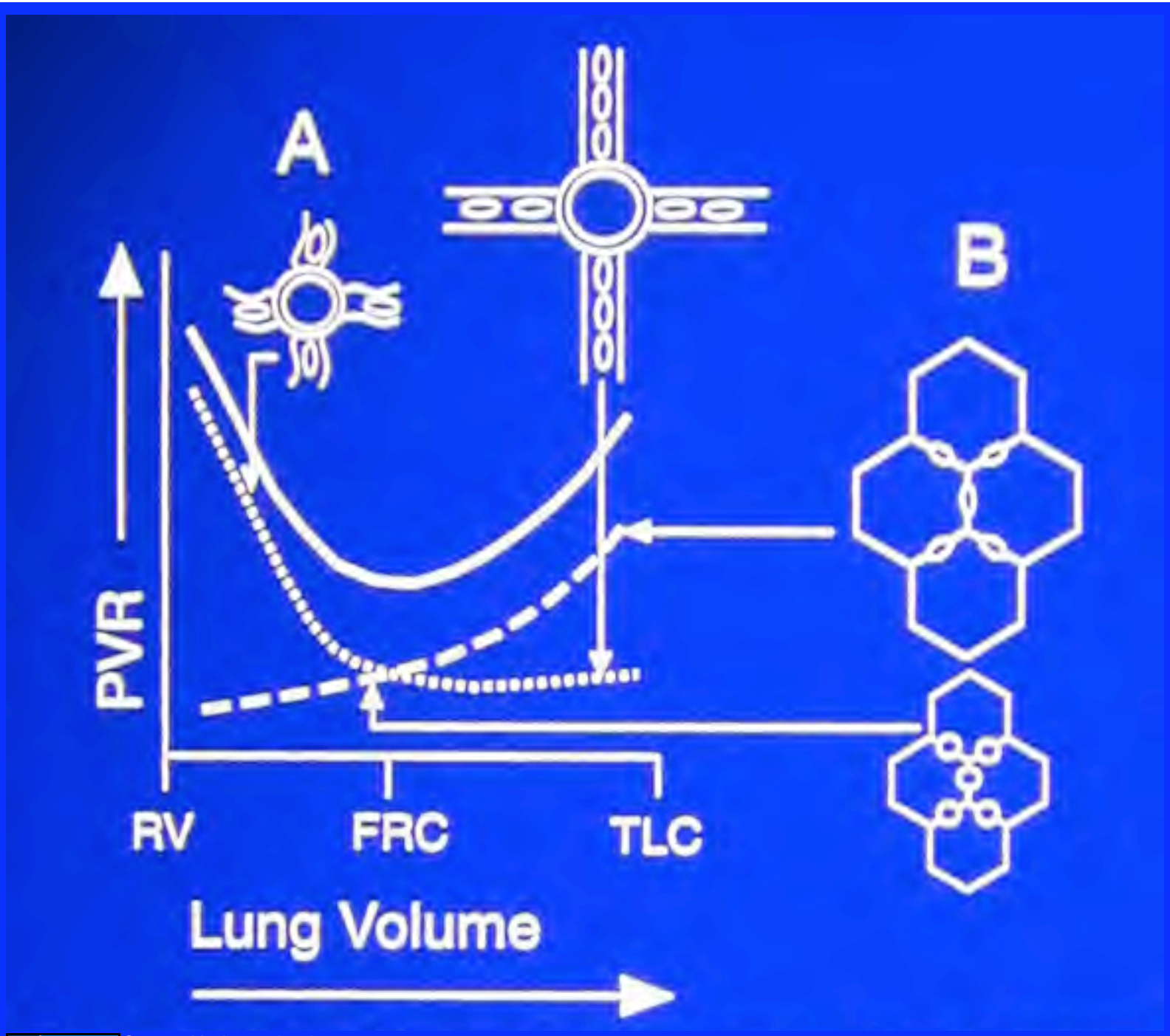
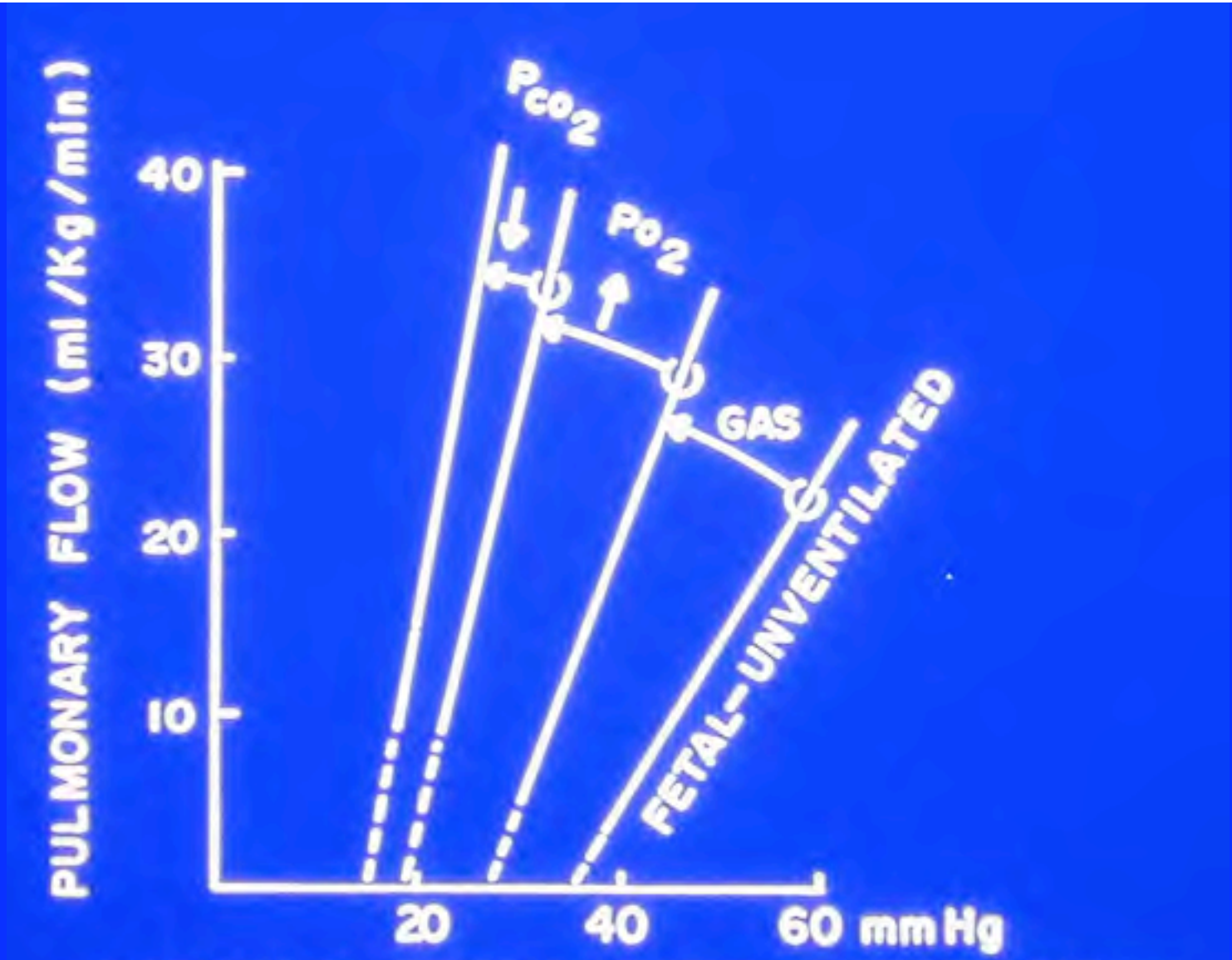





The Postnatal Decline of Pulmonary Vascular Resistance

Figure 4-14. Compare to Figures 3-17, 3-29, and 3-34, and see text. Adapted from Cassin et al. *J Physiol, 171*:61, 1964.

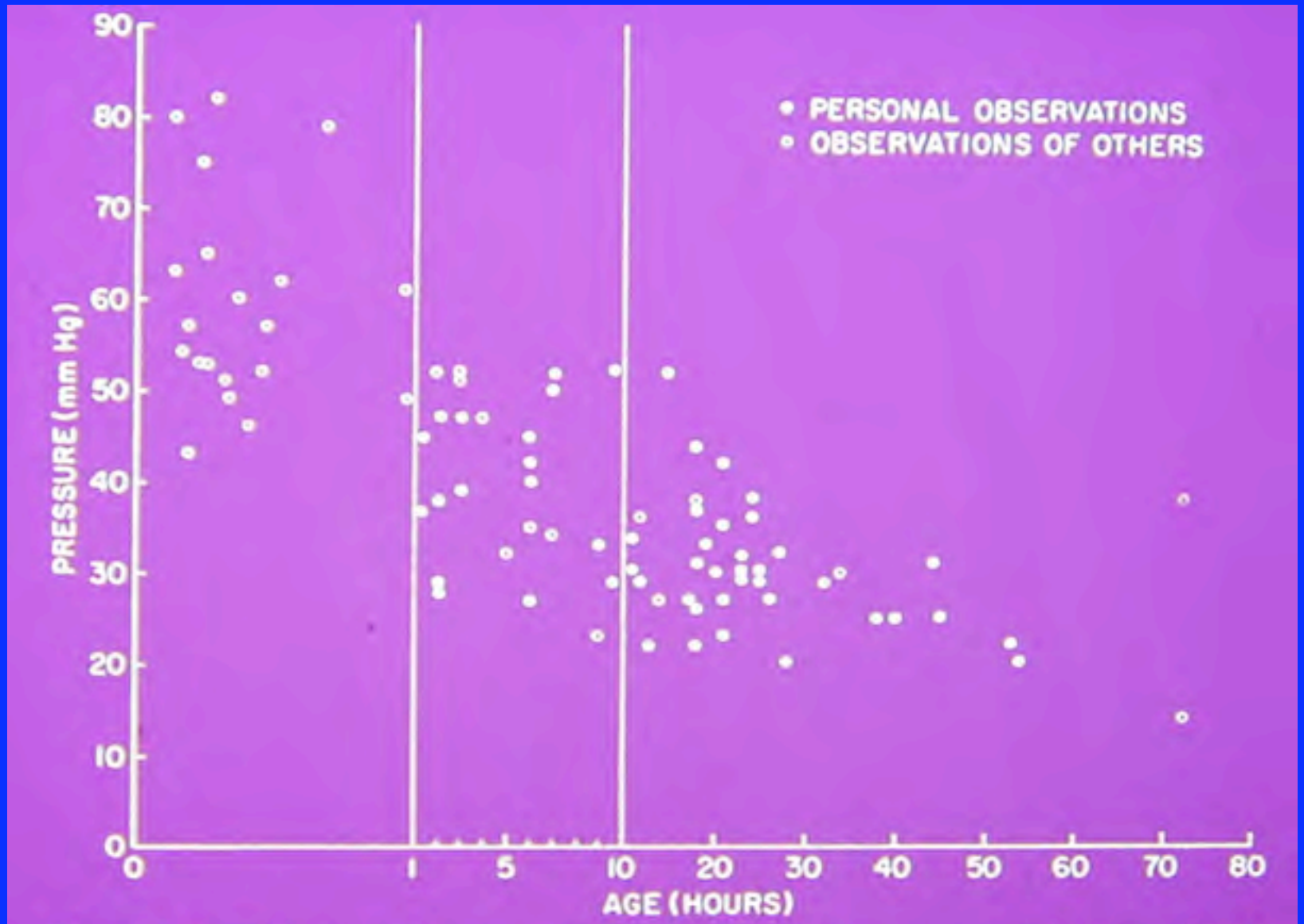
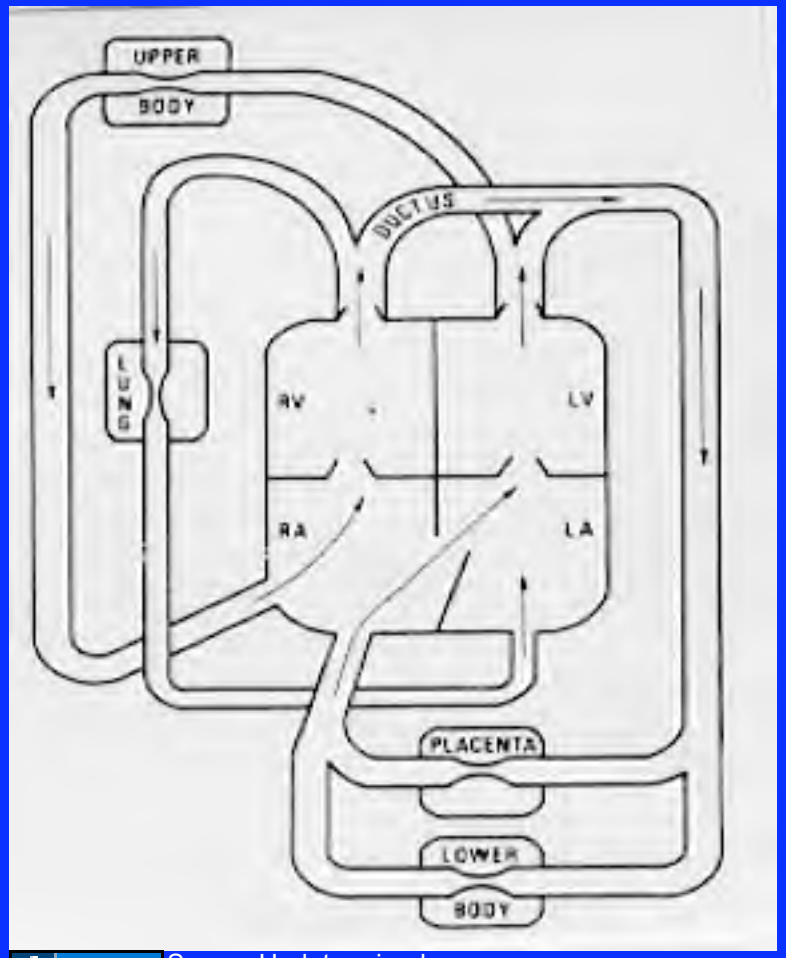



Fig. 3. Correlation of mean pulmonary arterial pressure with age in 85 normal term infants studied during the first three days of life.

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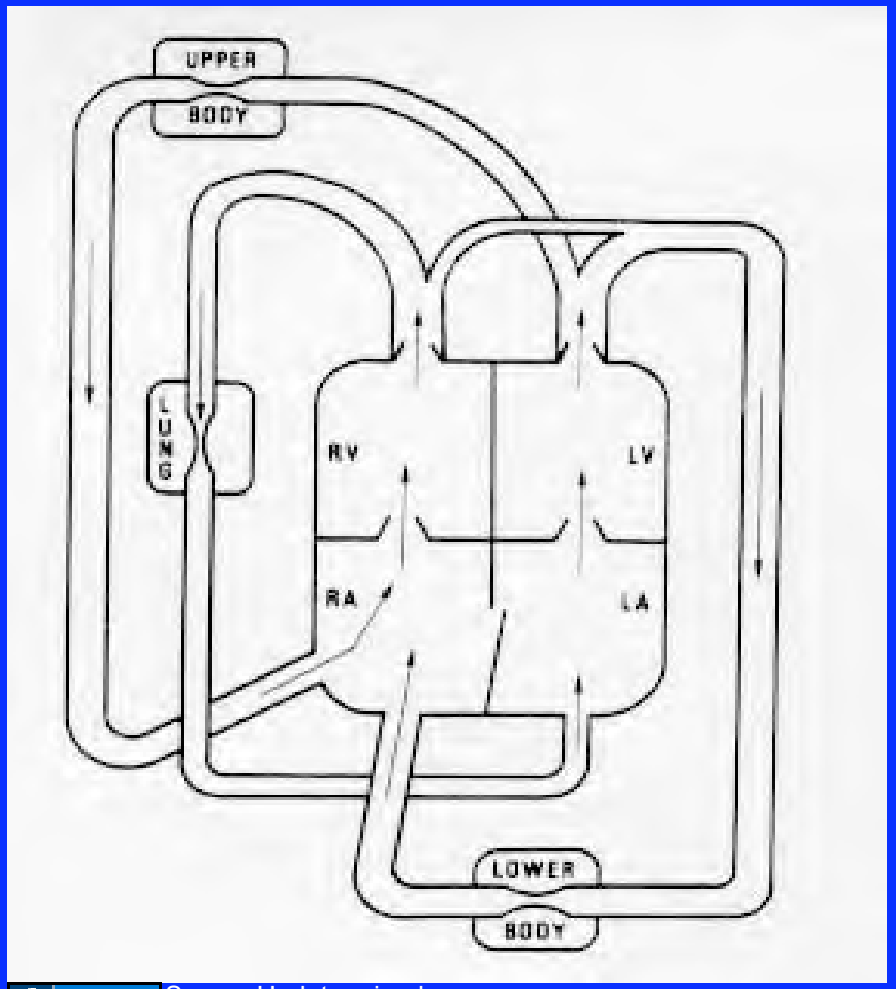



PD-INEL Source Undetermined

# Case: #1

- Because “it’s the Holidays” and her mother-in-law will be in town to “help out”, a scheduled repeat elective cesarean section is performed on a woman at 37 weeks gestational age. When this baby is born he is tachypneic.
- List as many reasons as you can for the lack of clearance of lung fluid.
- How would you treat this problem?

# Transient Tachypnea of the Newborn: (TTNB)

- Also know as “Wet Lung, Retained Fetal Lung Fluid”.
- Occurs as a consequence of delayed or incomplete clearance of fetal lung fluid.
- Predisposing/ causative factors:
  - No labor, c-section, hypoventilation, low colloid oncotic pressure, low pulmonary blood flow

# Transient Tachypnea of the Newborn

- **Lung water content (and weight) is high and an increased respiratory rate is energy efficient.**
- **Signs in infant**
  - **tachypnea**
- **ABGs:**
  - **usually normal**
- **Clinical course:**
  - **usually benign / self limiting.**
- **Treatment (usual) :**
  - **none or O2.**

# Transient Tachypnea of the Newborn

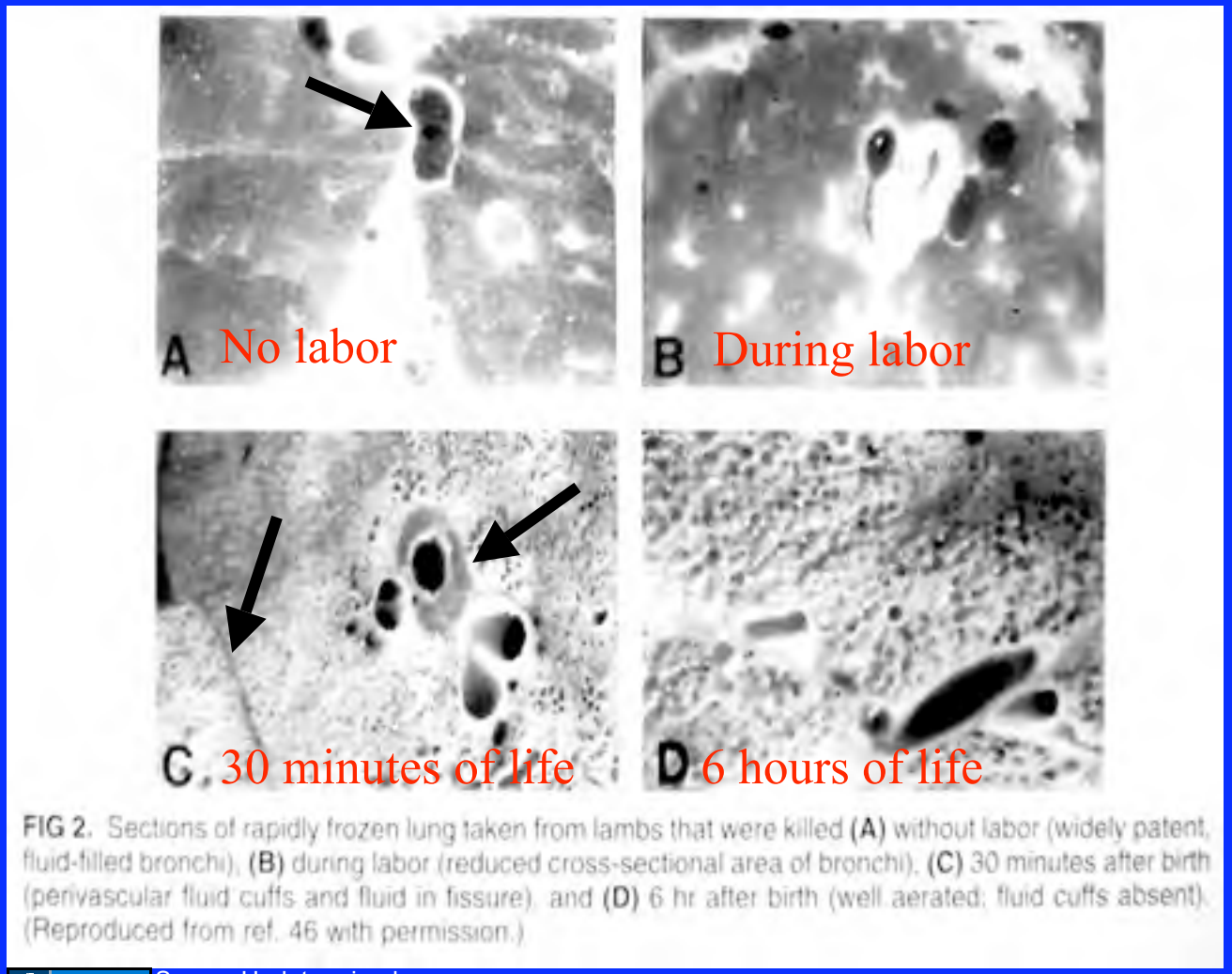
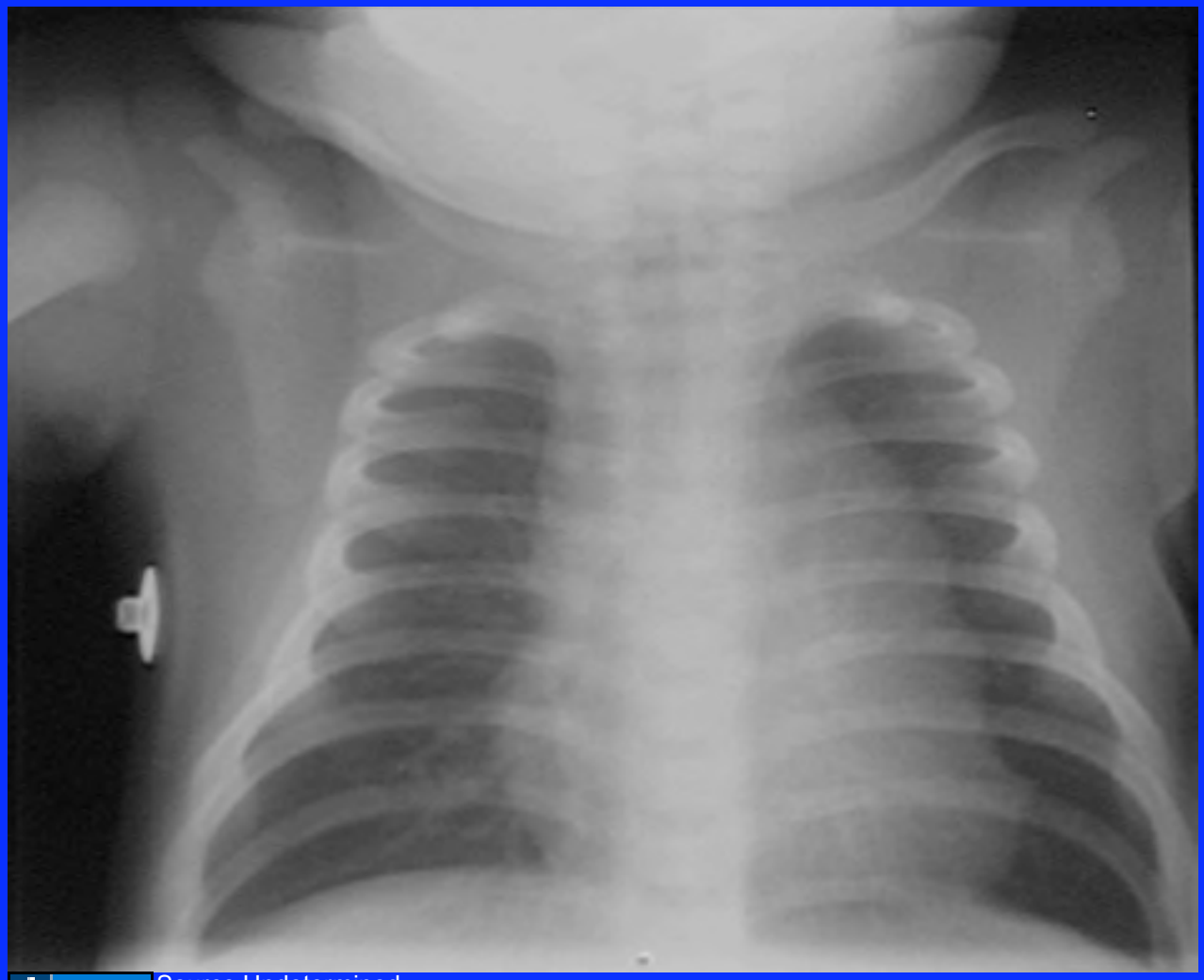



FIG 2. Sections of rapidly frozen lung taken from lambs that were killed (A) without labor (widely patent, fluid-filled bronchi), (B) during labor (reduced cross-sectional area of bronchi), (C) 30 minutes after birth (perivascular fluid cuffs and fluid in fissure), and (D) 6 hr after birth (well aerated; fluid cuffs absent). (Reproduced from ref. 46 with permission.)



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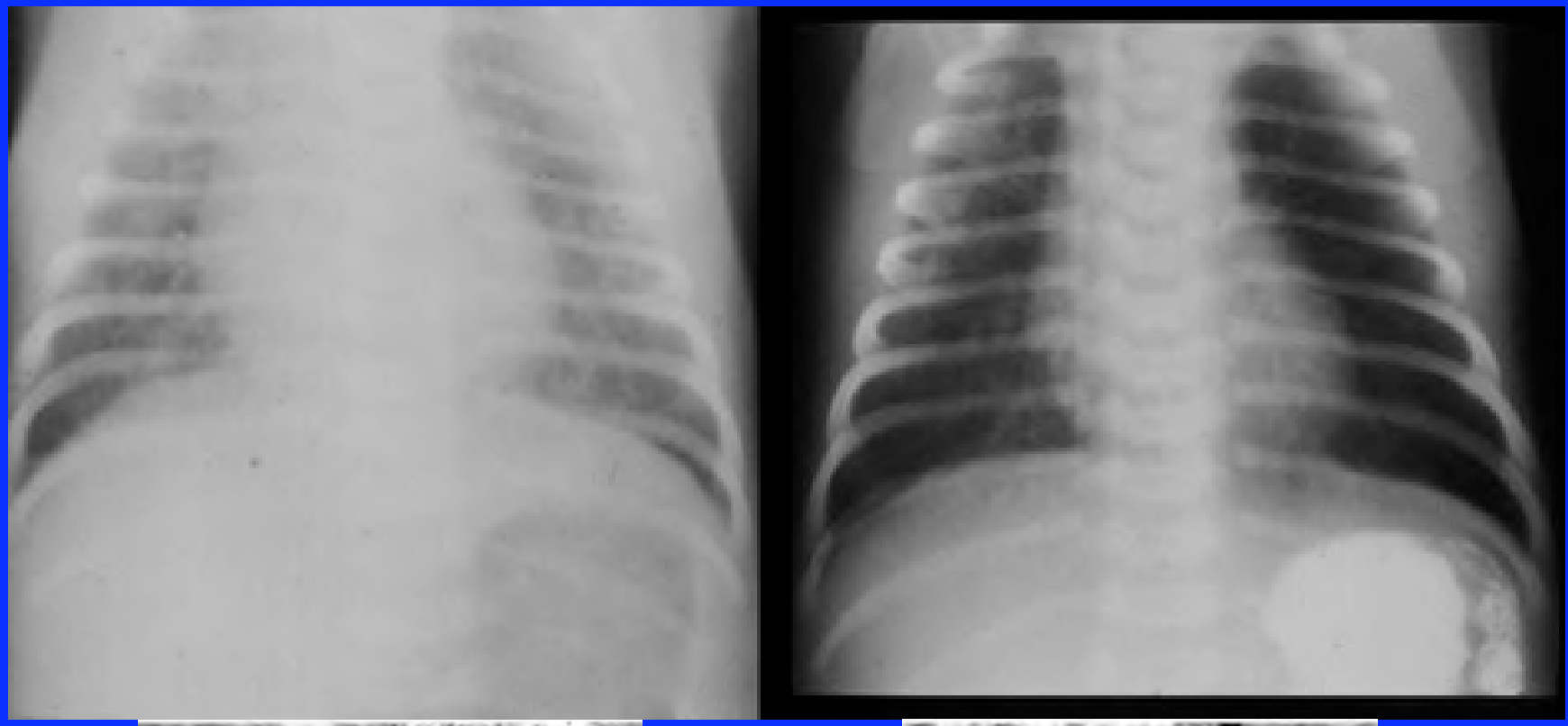
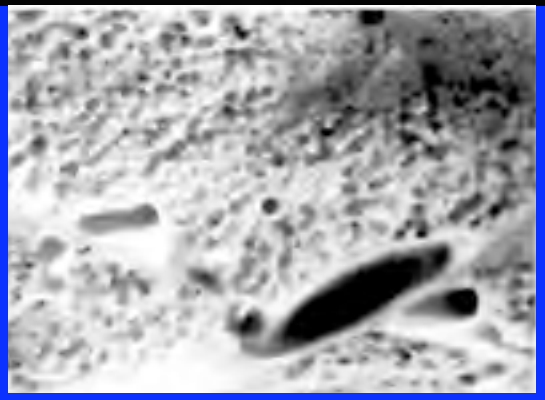
# Transient Tachypnea of the Newborn



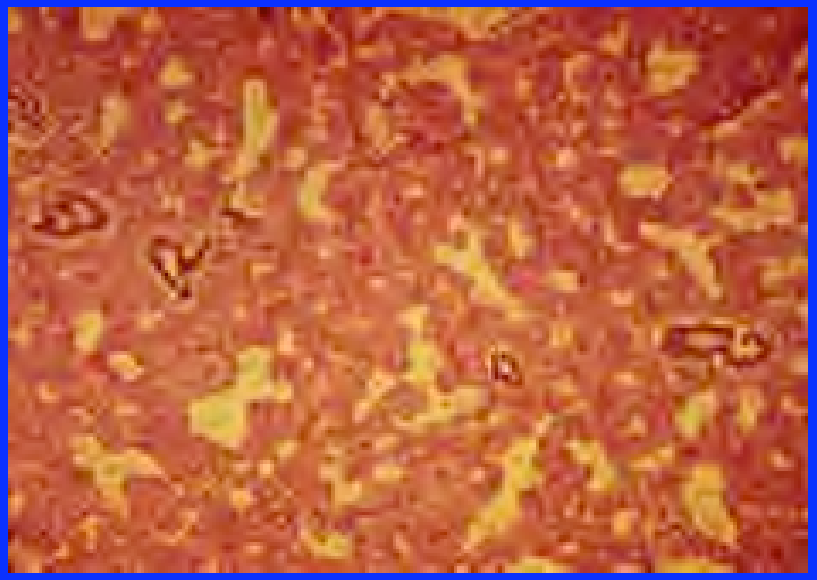


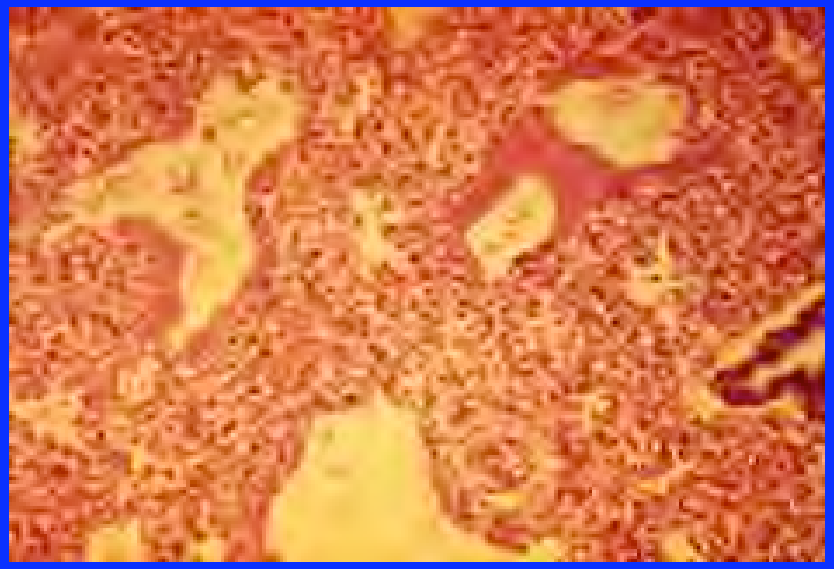
# Case: #2

- A woman delivers premature twins at 25 weeks gestational age. The twins develop respiratory distress.
  - Why is lung volume low in these infants?
    - Small baby
    - Compliant chest wall
    - Non-Compliant lungs (surfactant deficiency)

PD-INCL Source Undetermined

# Hyaline membranes
# Atelectasis





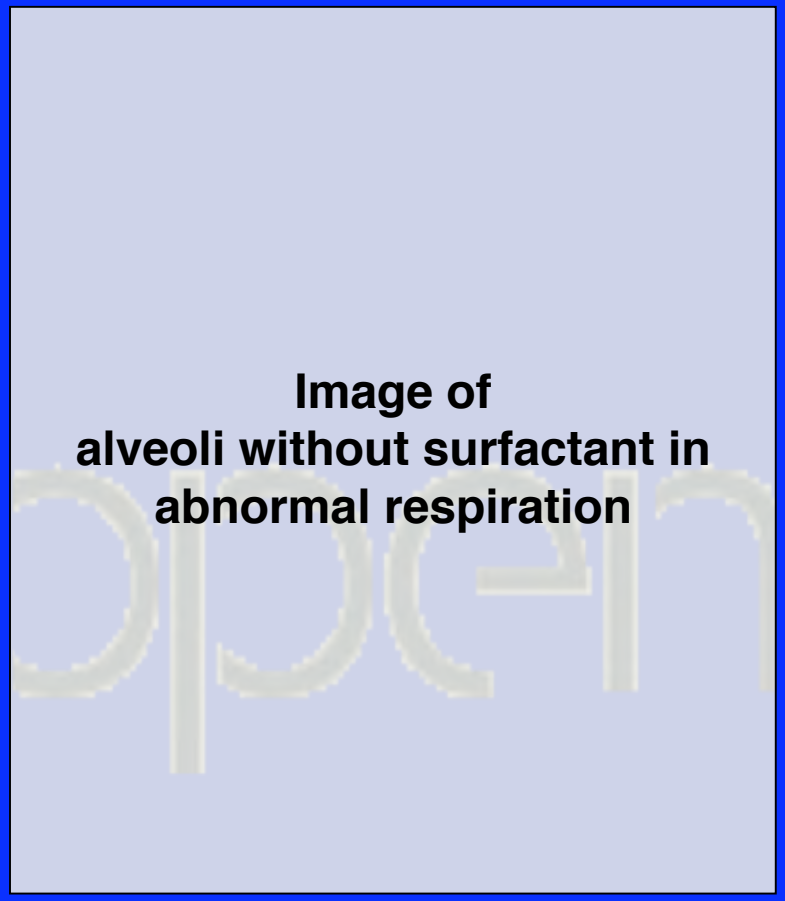
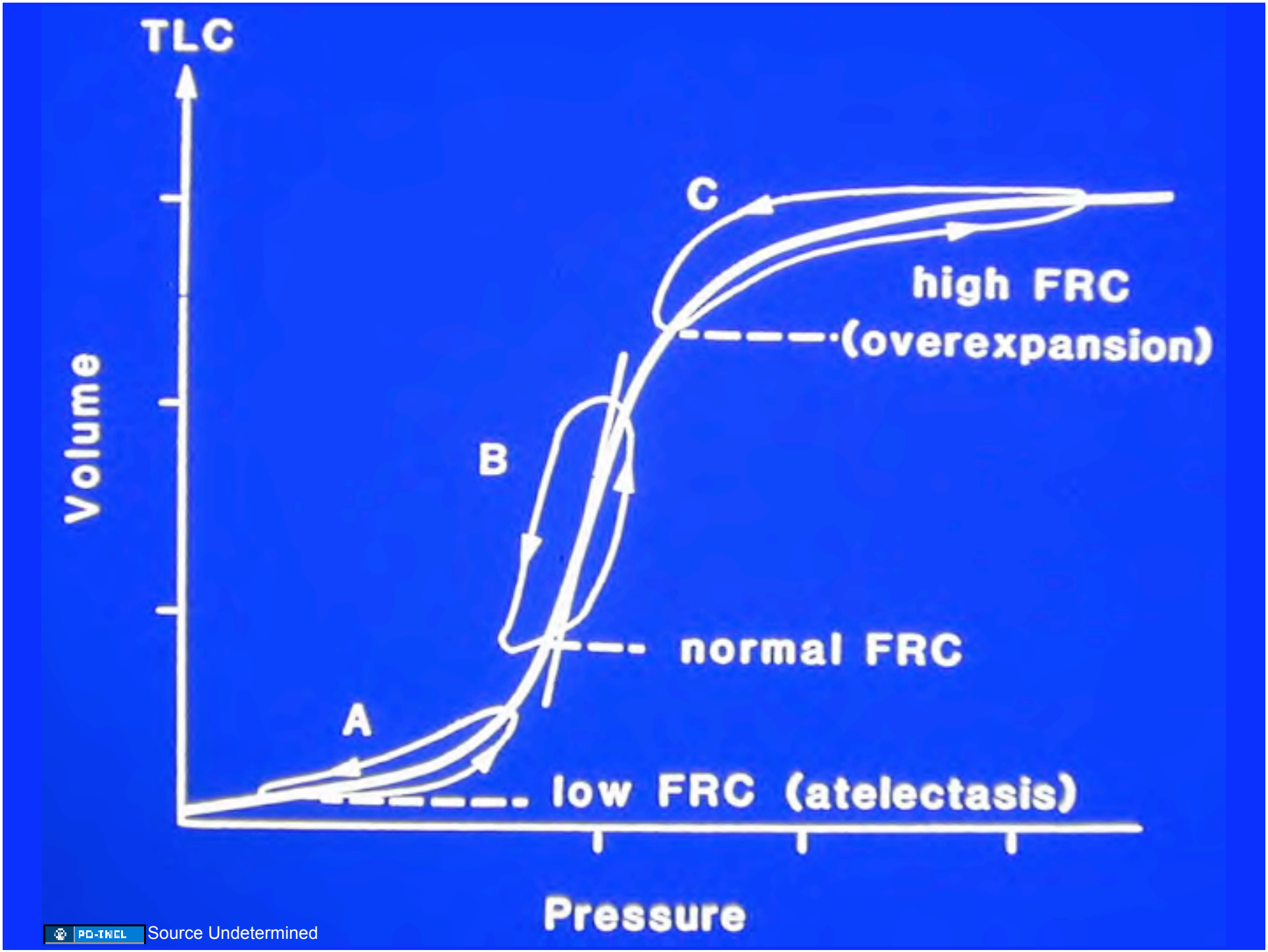


Image of
alveoli without surfactant in
abnormal respiration



# Newborn Respiratory Distress Syndrome (RDS)

- Why does this infant have the following signs:
- Tachypnea ?
  - Minute ventilation is RR x TV. With a compliant chest wall increasing RR is more efficient than taking deeper breaths (increasing TV).
- Grunting ?
  - Exhaling against a partially closed glottis provides positive end expiratory pressure -maintains lung volume (FRC).

## Newborn Respiratory Distress Syndrome (RDS)

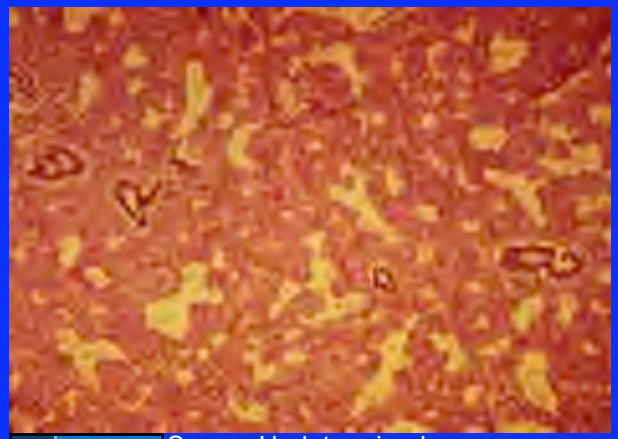
- **Nasal flaring:**
  - **On inspiration alae diameter increases to lower airway resistance.**
- **Paradoxical breathing: (On inspiration the abdomen pops-up, the chest wall sinks)**
  - **Use of diaphragm with compliant chest wall produces negative intra-thoracic pressure, positive abdominal pressure, a costly way to breathe.**
- **Retractions:**
  - **increased use of muscles of respiration = very costly, and hence a "late" sign**

# Newborn Respiratory Distress Syndrome (RDS)

**Low lung volume**

**Air Bronchograms**

**"Ground glass",**
**"Salt and pepper"**
**"reticulogranular lungs**



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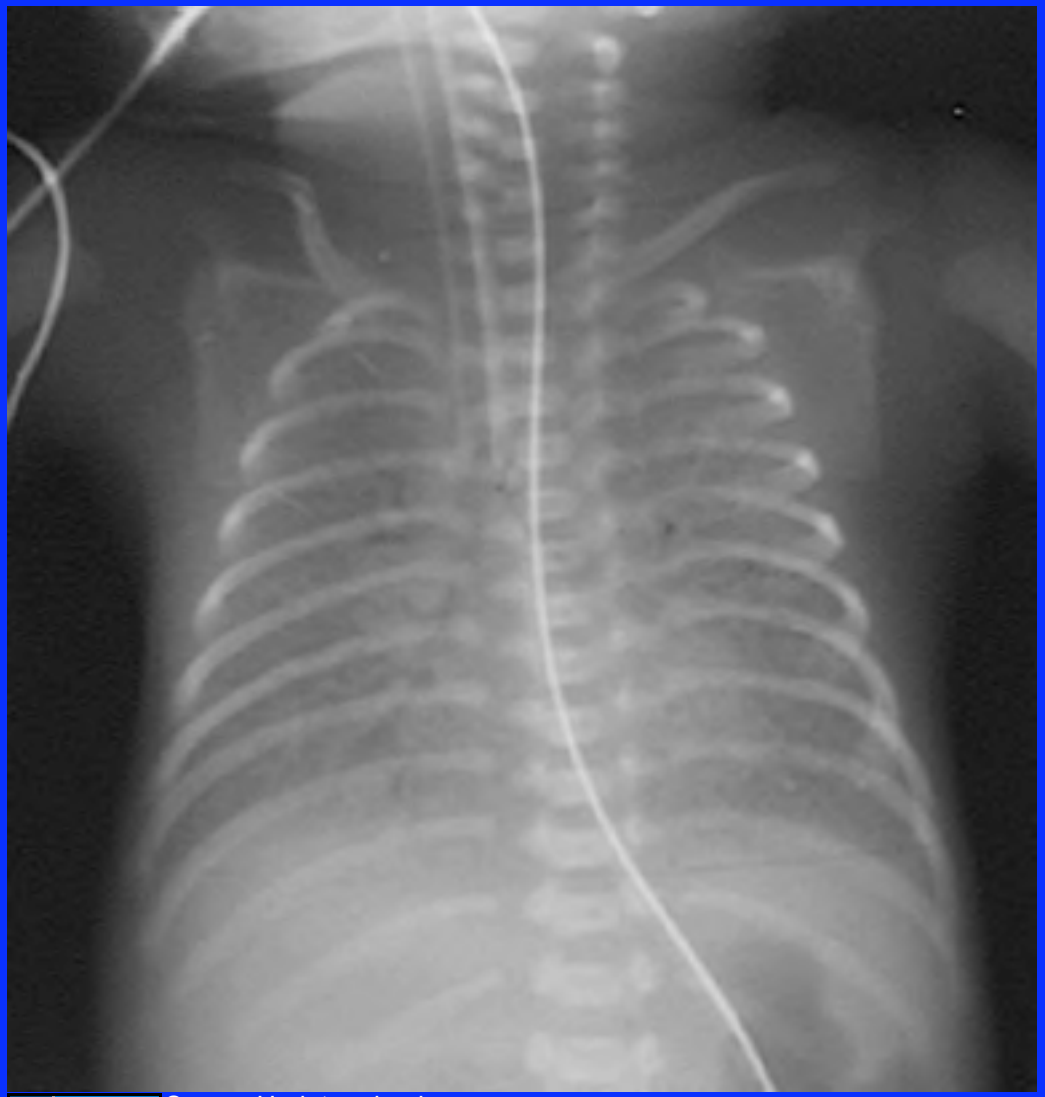

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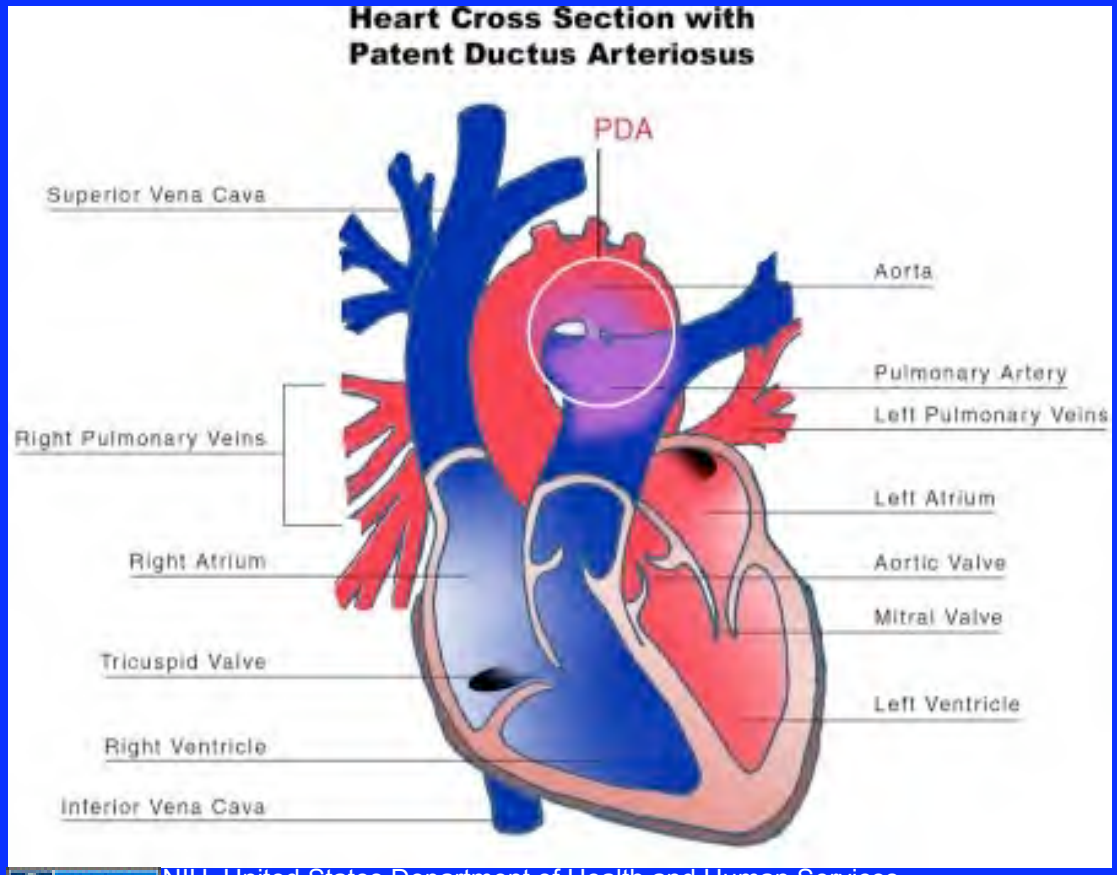
## Newborn Respiratory Distress Syndrome (RDS)

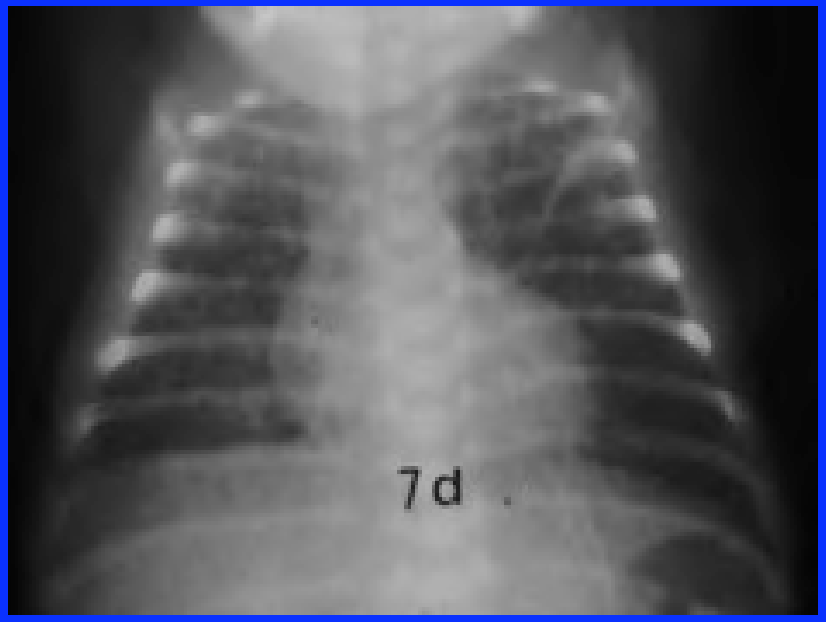
# How would you treat this infant?

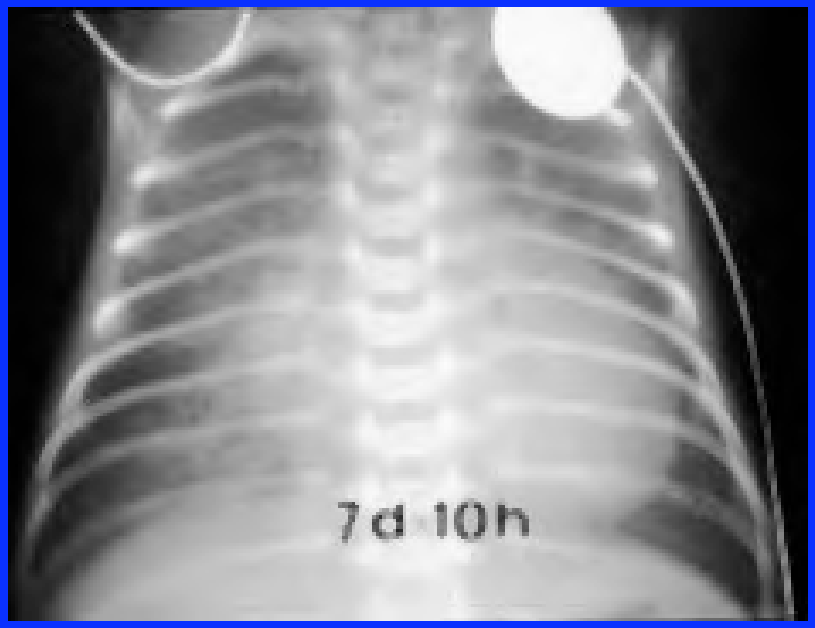
- **Simple things:**
  - Oxygen
- **Maintain FRC:**
  - Positive end expiratory pressure
  - Positive pressure ventilation,
- **Treat the Cause:**
  - Artificial surfactant

- **On day 7 one twin deteriorates. You hear a murmur.**
  - **What is this twin's problem?**



# Patent Ductus arteriosus



# Respiratory Distress Syndrome

- Occurs as a consequence of a structural and functional/biochemical immaturity of a infant's lung including:
  - a relative lack of surfactant production.
  - a compliant chest wall
  - a variable degree of L to R shunting through a patent ductus arteriosus.

# Case #3:

- As a baby shower gift a pregnant woman's friends present her with some crack cocaine. Tired of being pregnant the woman tries to induce labor by using the crack. Subsequent severe abdominal pain prompts her to seek medical attention. An emergency c-section is planned. At rupture of membranes there is blood and thick chunky pea-soup like material seen. The infant is born floppy, pale with no spontaneous respirations.
- Think about why and when this baby may have problems……..

# Case 3# Meconium Aspiration Syndrome.

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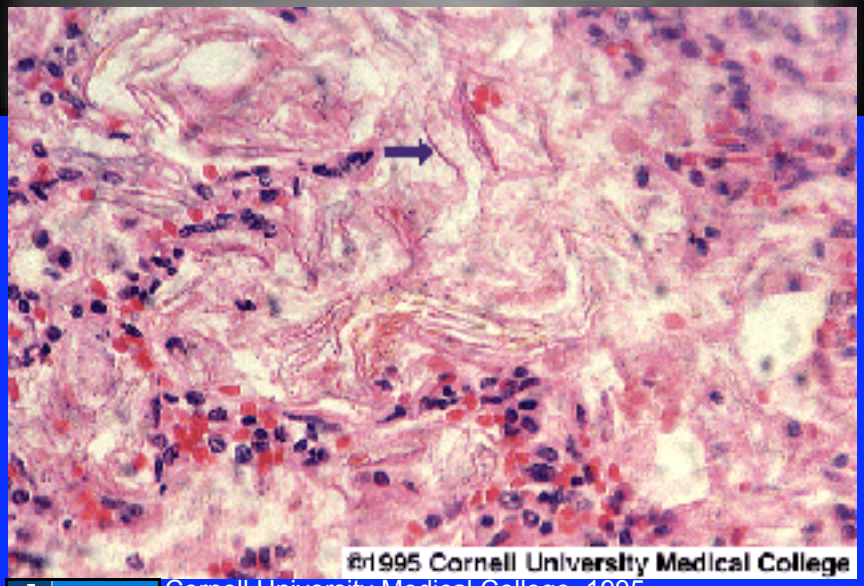
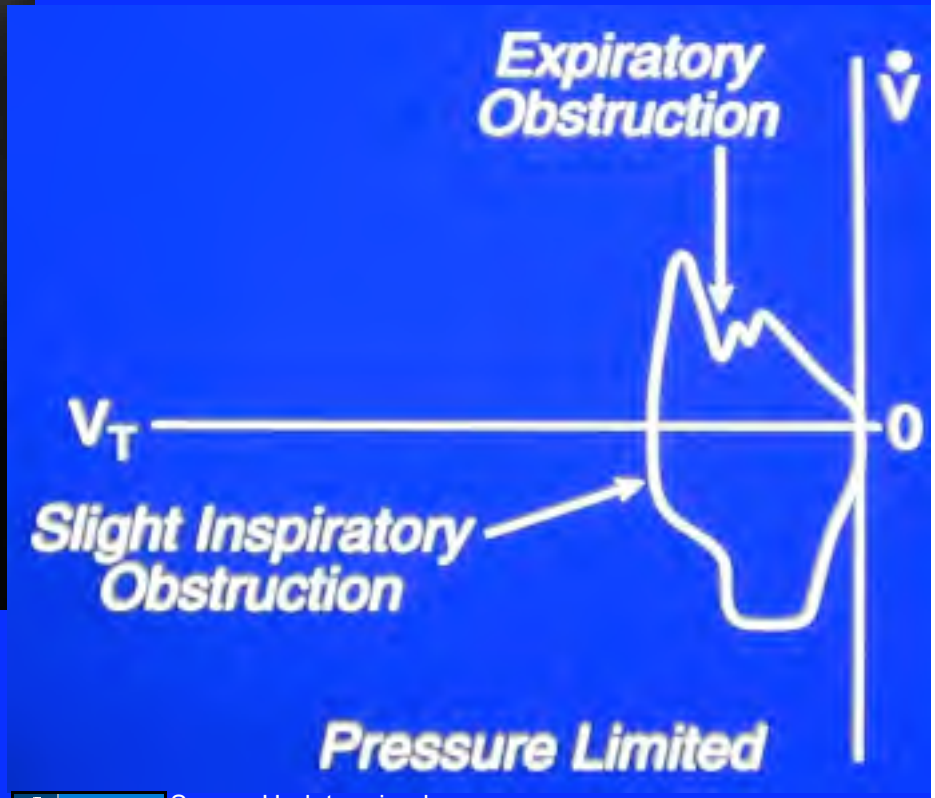



PD-INCL Cornell University Medical College, 1995

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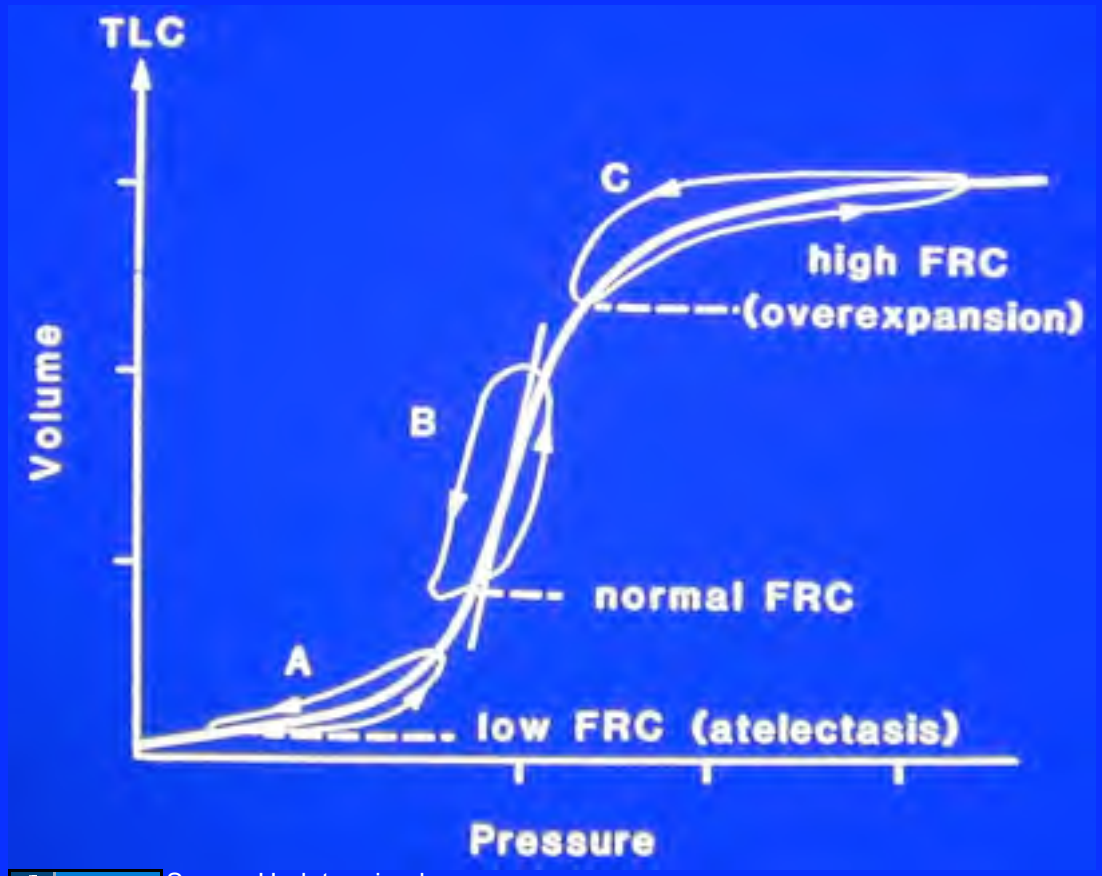
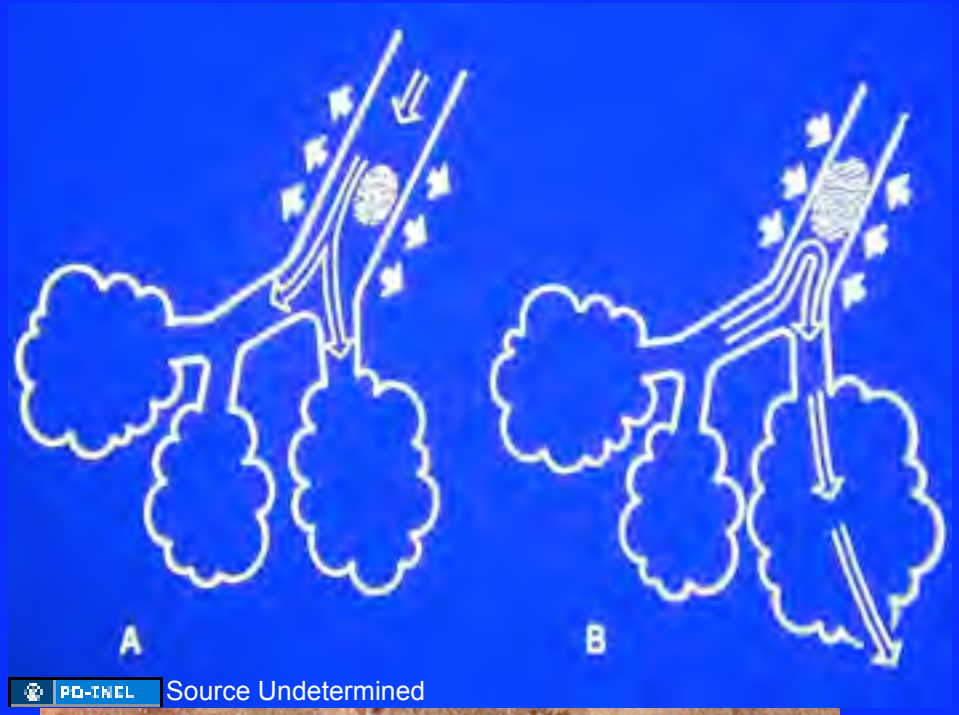
# Meconium Aspiration Syndrome.



# Case #3

- After effective resuscitation, the infant is placed on a ventilator. Shortly thereafter you note decreased breath sounds, a shift of the PMI, hypotension and profound cyanosis.
- What has happened? What should you do?

# Pneumothorax from meconium plug

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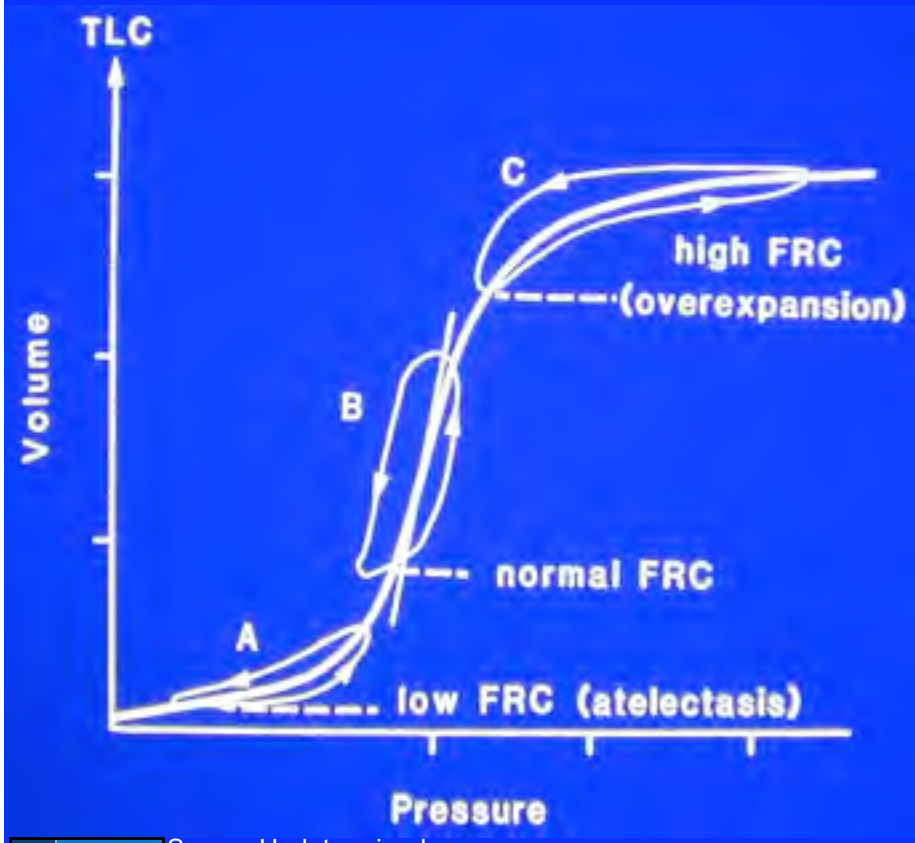
- **Having fixed this problem you note persistent cyanosis. You note curiously that the transcutaneous O2 saturation monitor gives different readings on the hands vs feet.**
- **What is happening? What can you do?**

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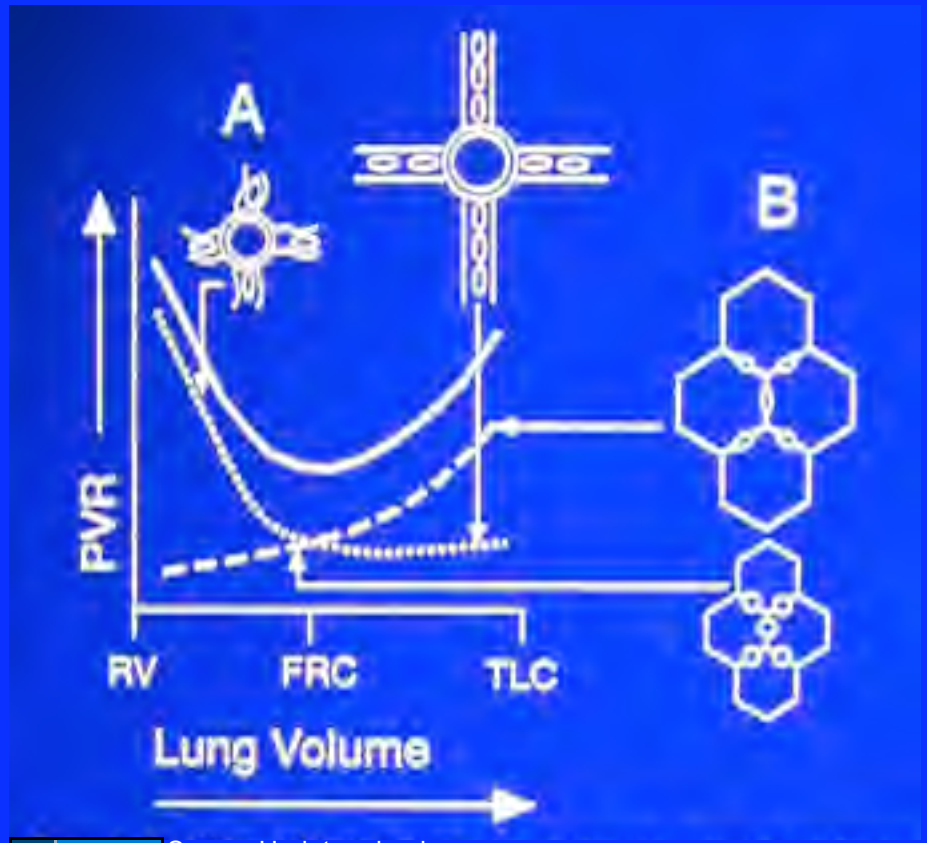


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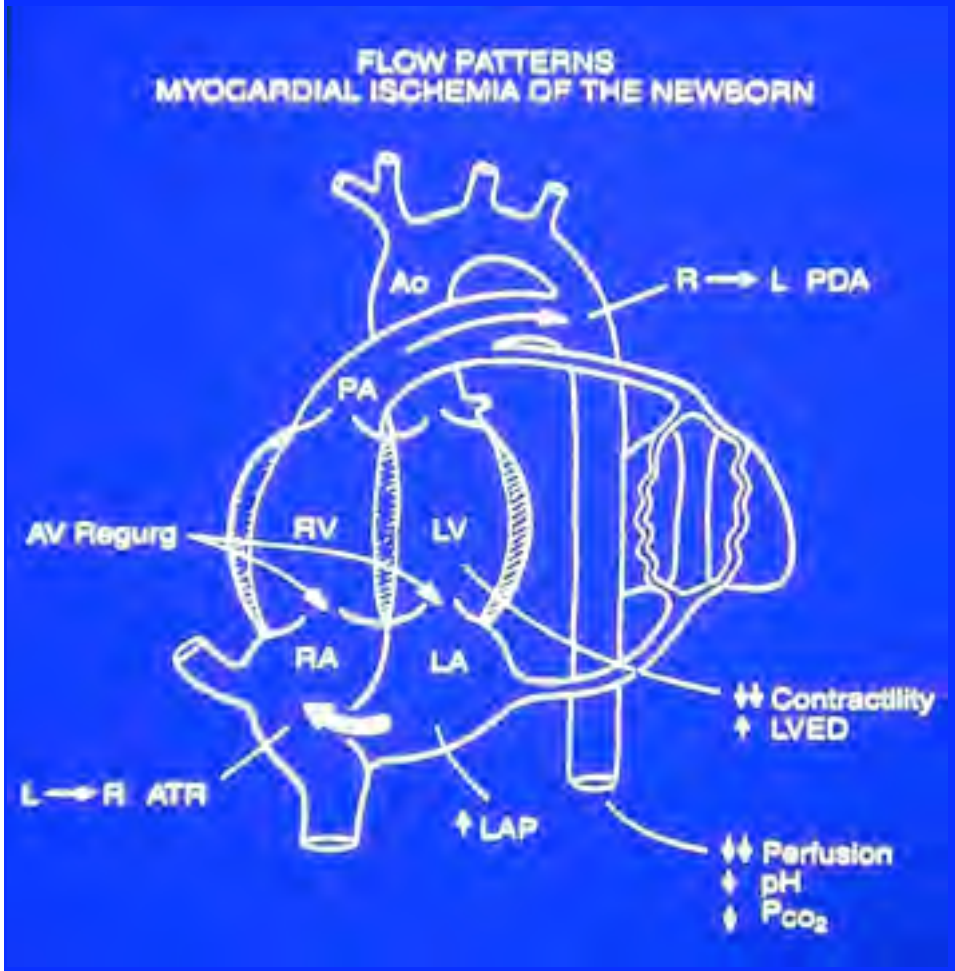


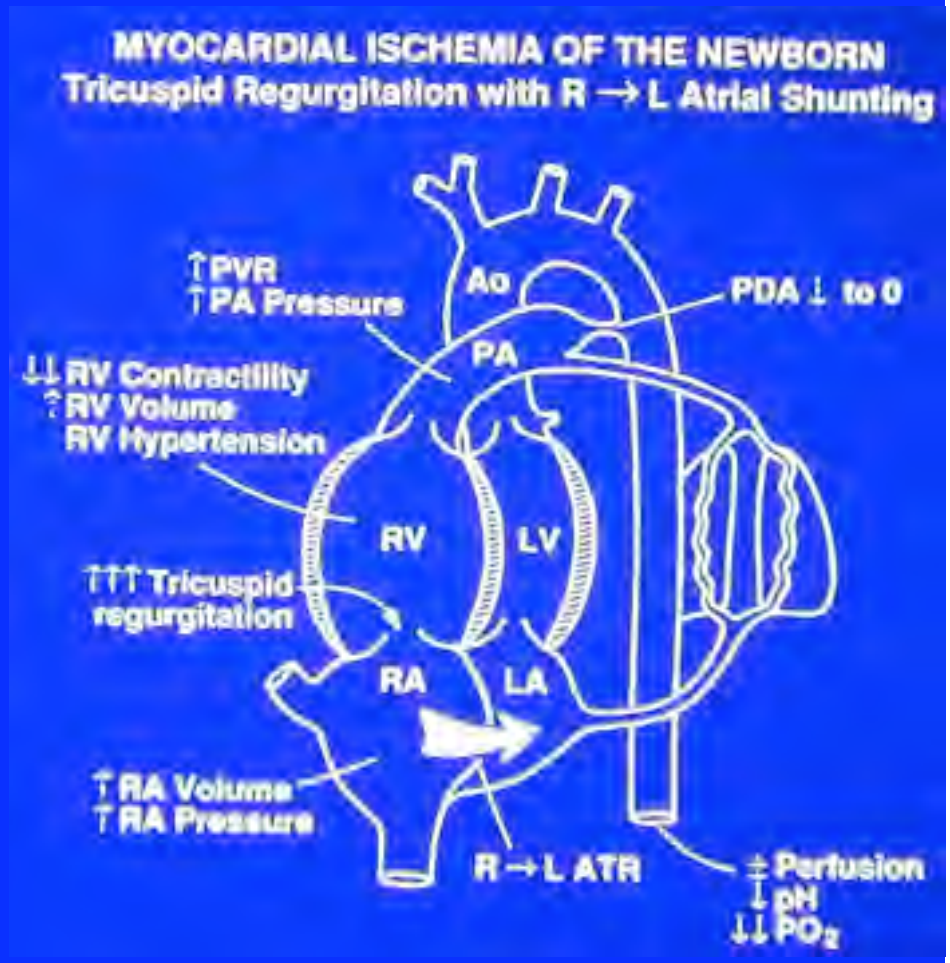

# Persistant Pulmonary Hypertension (PPHN)
# Persistant fetal circulation (PFC)

Persistent pulmonary hypertension of the newborn (PPHN) is the result of elevated pulmonary vascular resistance to the point that venous blood is diverted to some degree through fetal channels (i. e. the ductus arteriosus and foramen ovale) into the systemic circulation and bypassing the lungs, resulting in systemic arterial hypoxemia.

## Persistant Pulmonary Hypertension (PPHN)
## Persistant fetal circulation (PFC)

# Treatment:

- **Fix that which is broken.**
  - **Correct the cause of hypoxia, hypercarbia, acidosis.**
- **If it hurts when you go like that, then don't go like that.**
  - **Avoid over distention of lungs,**
  - **Barotrauma**

## Persistant Pulmonary Hypertension (PPHN)
## Persistant fetal circulation (PFC)

- **Attempt to lower PVR.**
  - **O2, Ventilation, Buffer**
  - **Inhaled Nitric Oxide**
- **Attempt to raise SVR (and output)**
  - **Volume expansion for preload**
  - **Vasoconstrictors?**
  - **Inotropic support**

PD-TNCL Source Undetermined

# Additional Source Information

**for more information see: http://open.umich.edu/wiki/CitationPolicy**

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