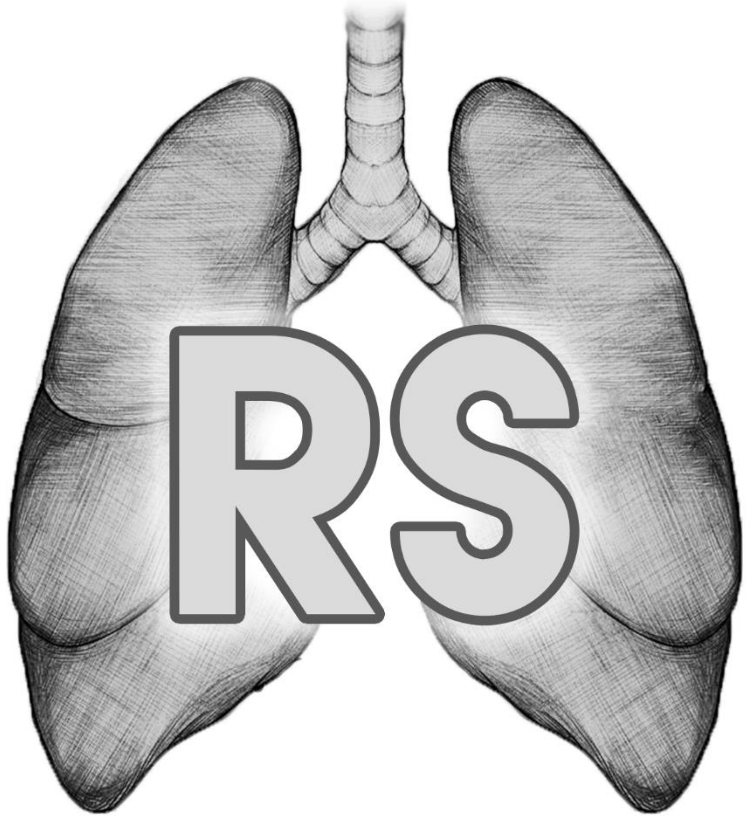


PBL

○ Sheet ☑ Slide *-Edited* ○ Handout

Number

2

Subject

Clinical Overview

Done By

Omar Saffar

Corrected by

Doctor

Eman Badran

Date: 25/12/2016

Price:

Respiratory distress syndrome

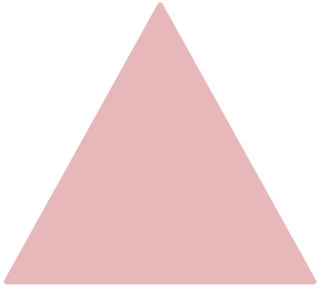
Eman Farouk Badran
MD. MRCPCH
Professor of Pediatrics
Head division of Neonatology
At Jordan University Hospital

Third year medical students

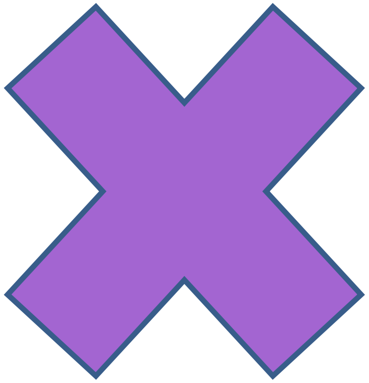
12 / December/2016

Priority levels

Important!



Read it quickly



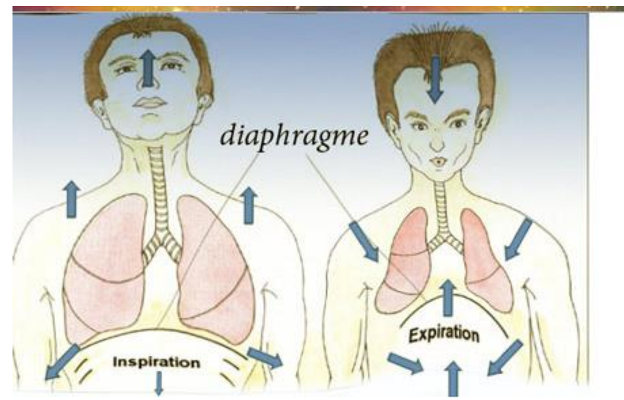
Not Important

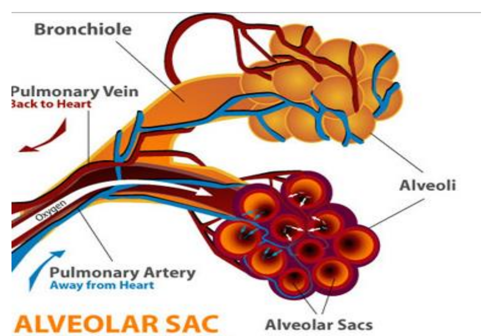
Outlines

- Definition
- Physiology
  - Respiration
  - Surface tension
  - Lung compliance
  - Lung volume
  - surfactant
- Respiratory distress syndrome
  - Pathophysiology
  - Incidence
  - Presentation
  - management

Respiration = the series of **exchanges** that leads to the uptake of oxygen by the cells, and the release of carbon dioxide to the lungs

- Step 1 = ventilation
  - **Inspiration & expiration**
- Step 2 = **exchange between alveoli** (lungs) and pulmonary capillaries (blood)
  - Referred to as *External Respiration*
- Step 3 = **transport of gases** in blood
- Step 4 = **exchange between blood and cells**
  - Referred to as *Internal Respiration*

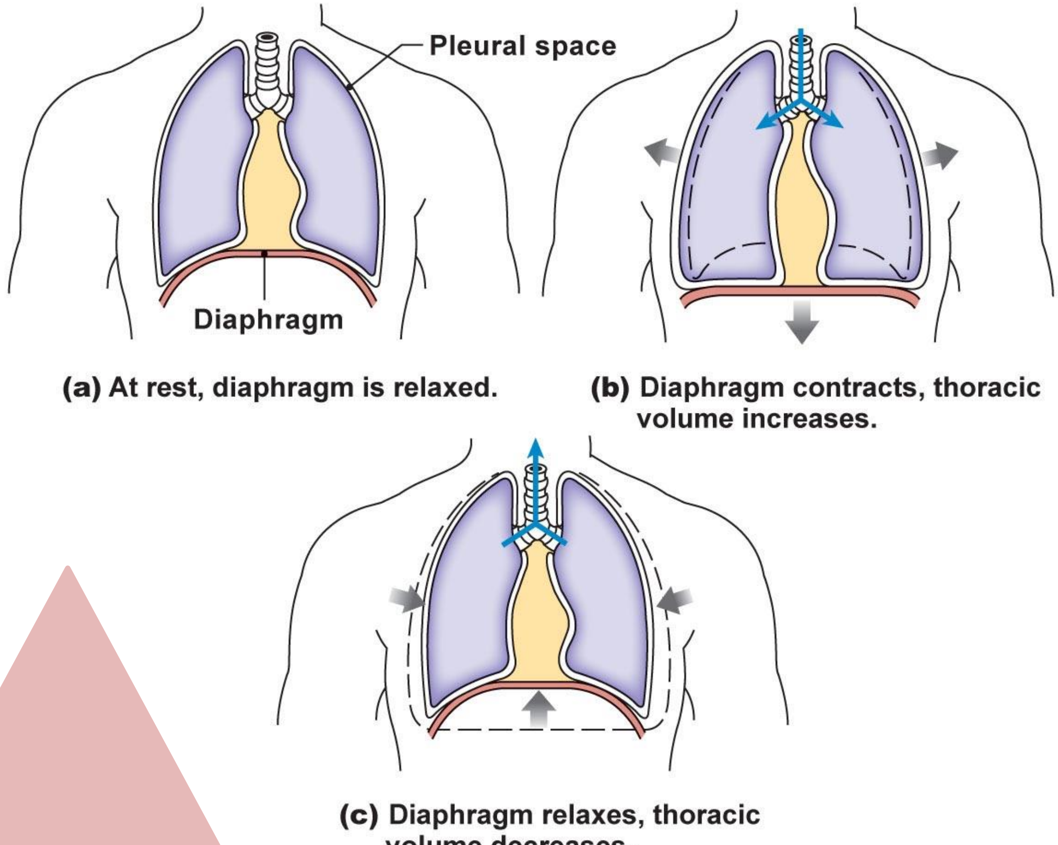




Ventilation = (inspiration + expiration) responsible muscles

- **The diaphragm (only creates about 60-75% of the volume change during inspiration)**

- **The muscles of inspiration (external intercostals muscles) & muscles of expiration (internal intercostals muscles**

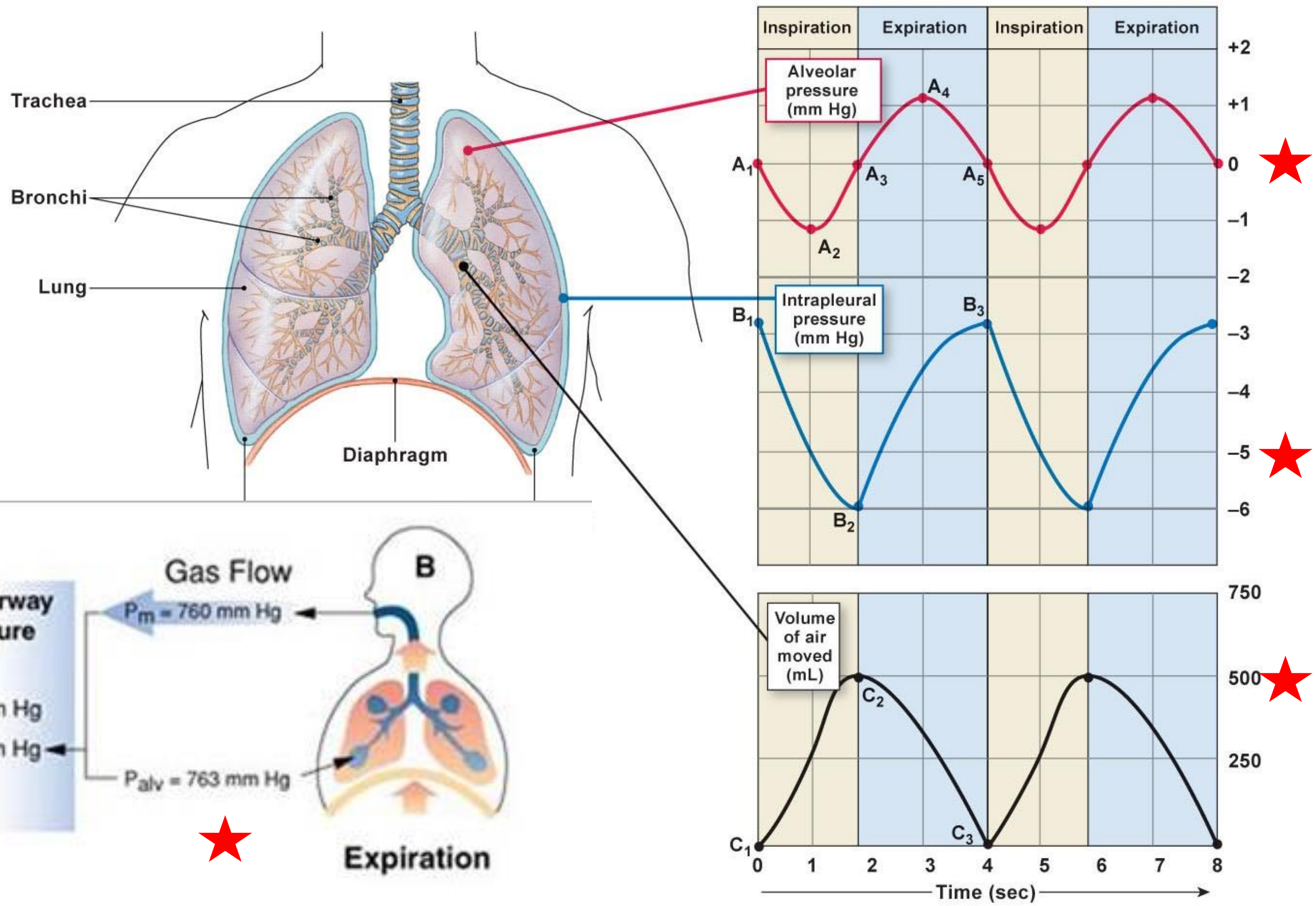


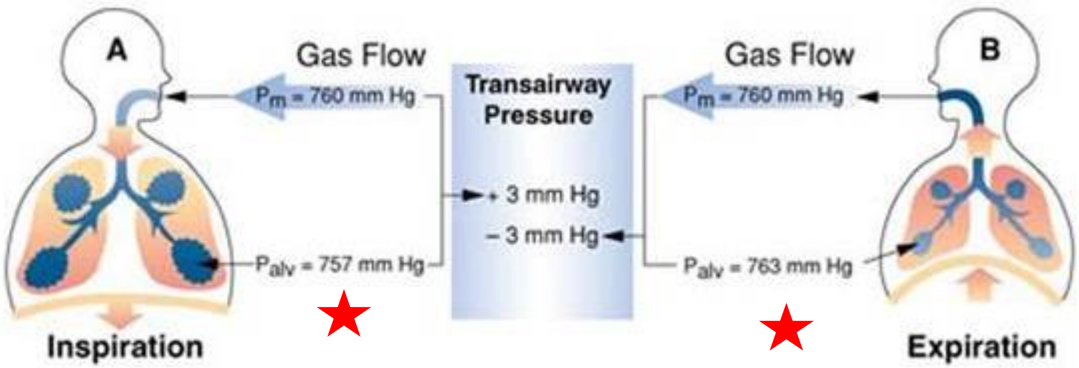
(a) At rest, diaphragm is relaxed.

(b) Diaphragm contracts, thoracic volume increases.

(c) Diaphragm relaxes, thoracic volume decreases.

Ventilation





Tidal volume in new born = 4 –6ml / kg

If baby weigh=3kg

TV =12 -18 ml

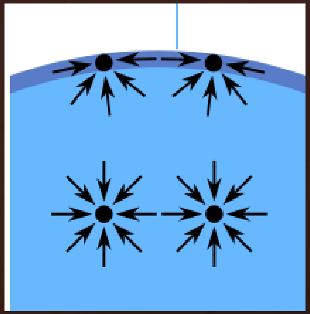
Minute ventilation

Minute volume = Tidal Volume x Frequency

Minute ventilation = Tidal volume * RR
= 500 ml/b * 20 b/min = 10000 ml/min

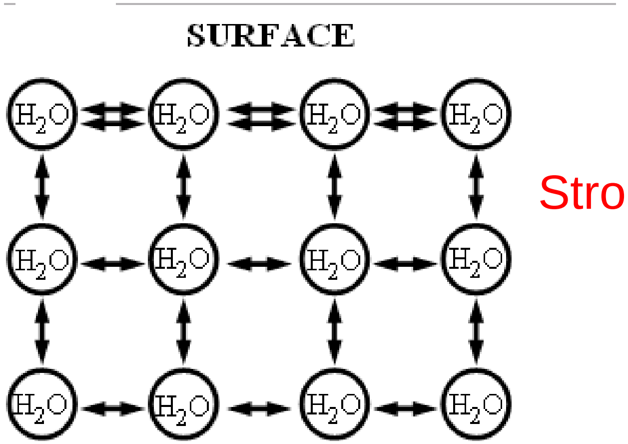
But if for some reason tidal volume decreased to let's say 250ml, RR should increase to 40 to compensate, so:
250 * 40 = 10000 ml/min → Tachypnea

Surface tension

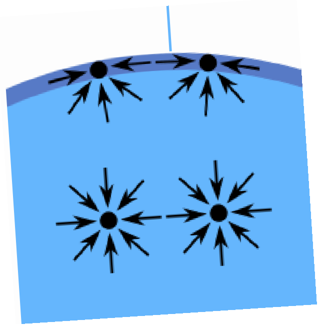


An air-filled sphere coated with water has a tendency to collapse (reach a minimum volume) due to the pulling force of water surface tension

Stronger



Surface tension—molecules at the surface form stronger bonds

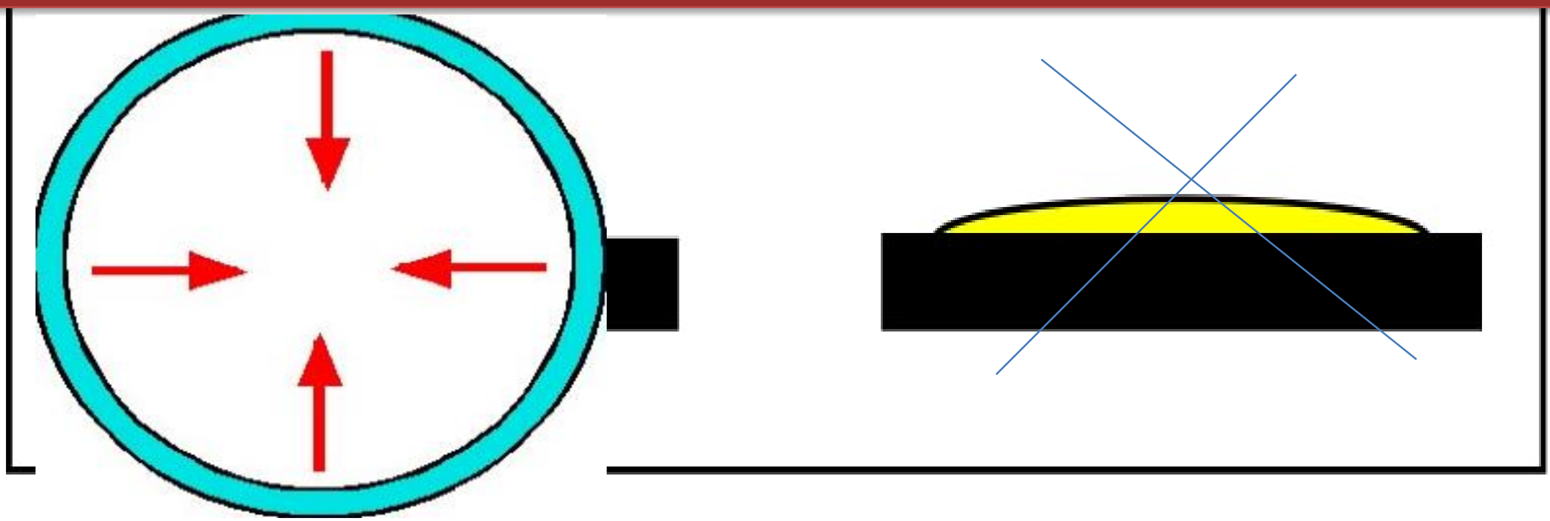


Surface Tension

Water has a VERY HIGH surface tension

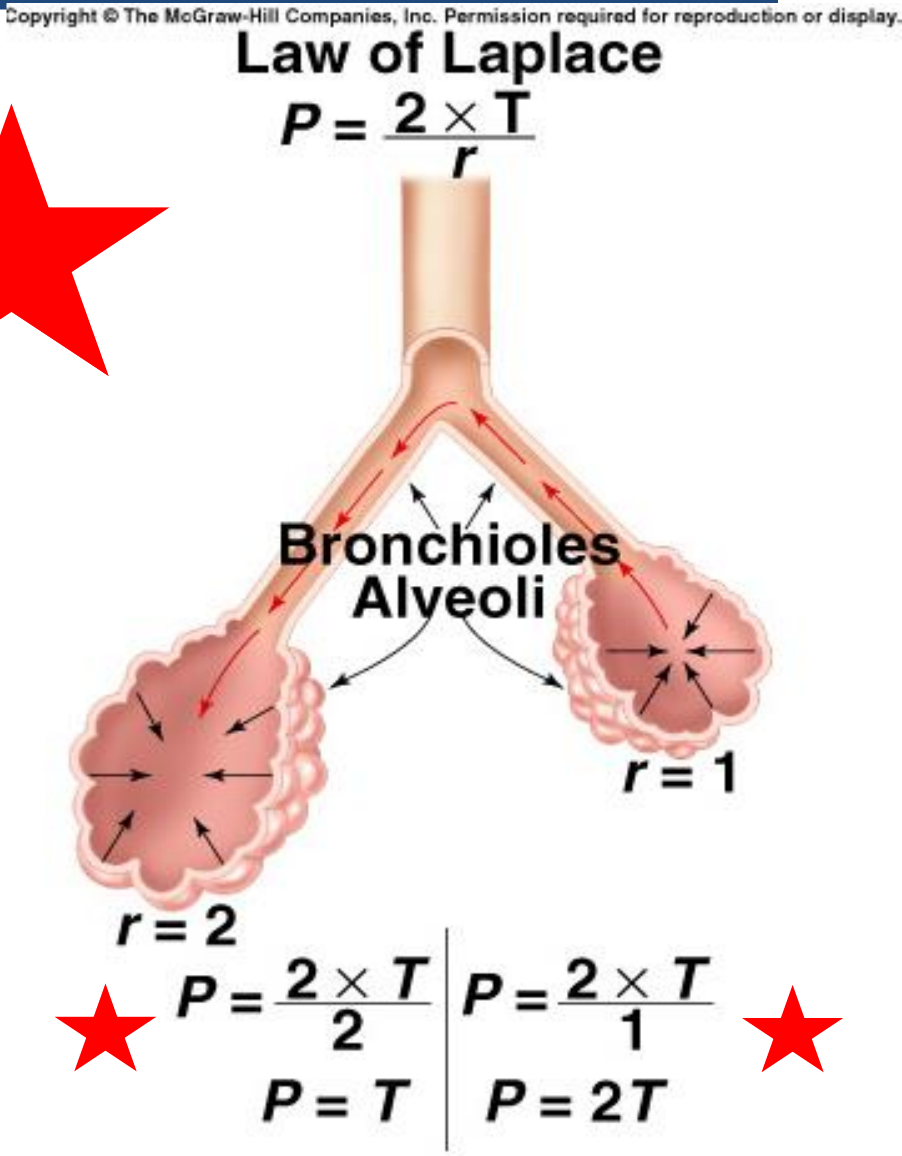
Water will attempt to minimize its surface area in contact with air

Surface tension : Attractive forces between molecule at air water interface



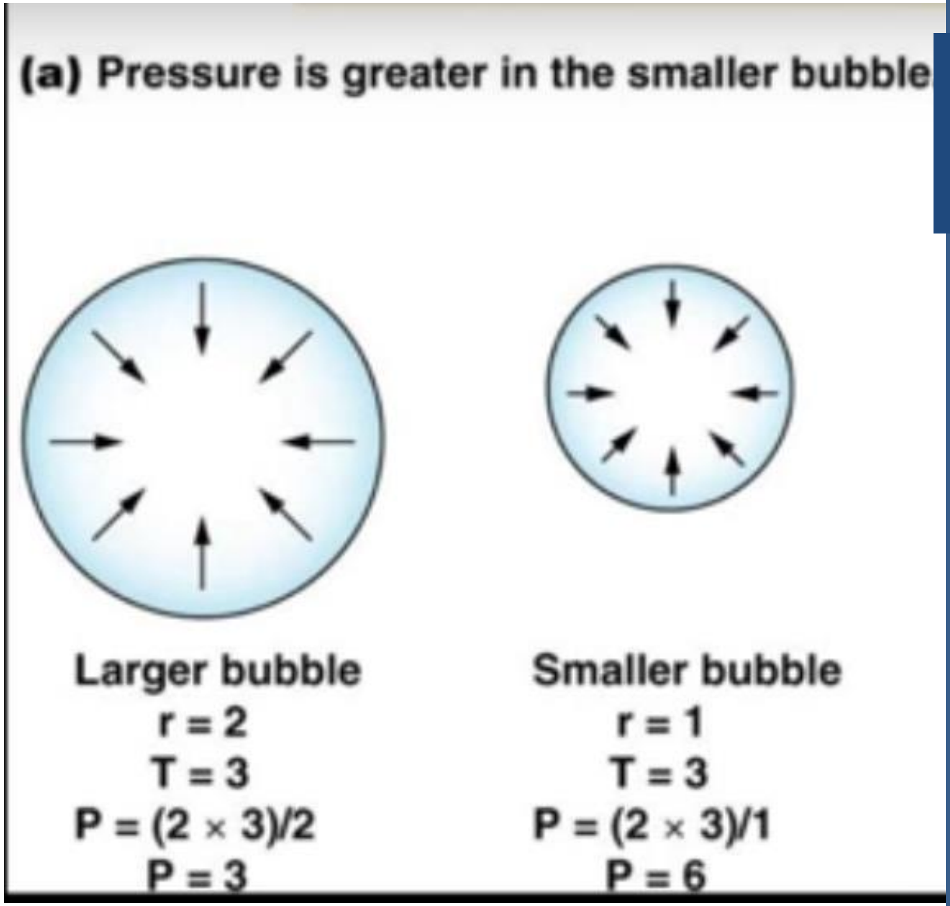
Law of Laplace

- Collapsing Pressure in alveoli is :
  - directly proportional to surface tension
  - and inversely proportional to radius of alveoli
- The smaller the sphere the more surface tension
  - Pressure in smaller alveolus greater

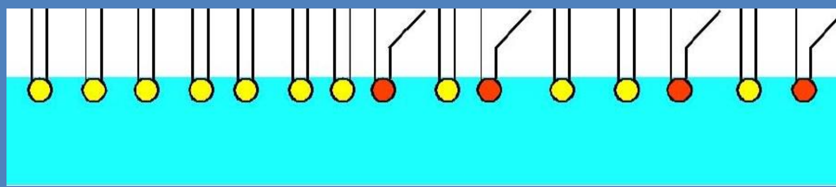


Surface tension

$$P \text{ (collapsing Pressure)} = \frac{2 \times T}{r}$$



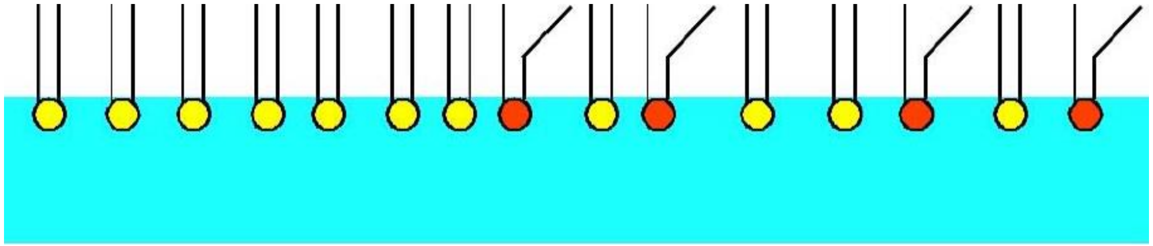
Lipids form a monolayer at the air-water interface



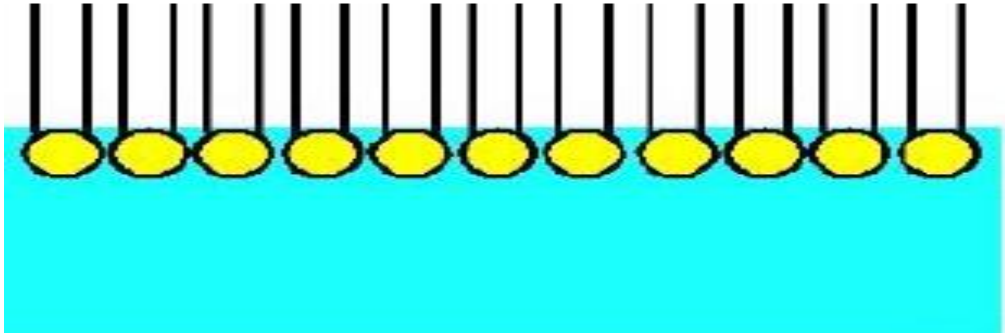
Surfactant

Will be discussed later on

Lipids form a monolayer at the air-water interface

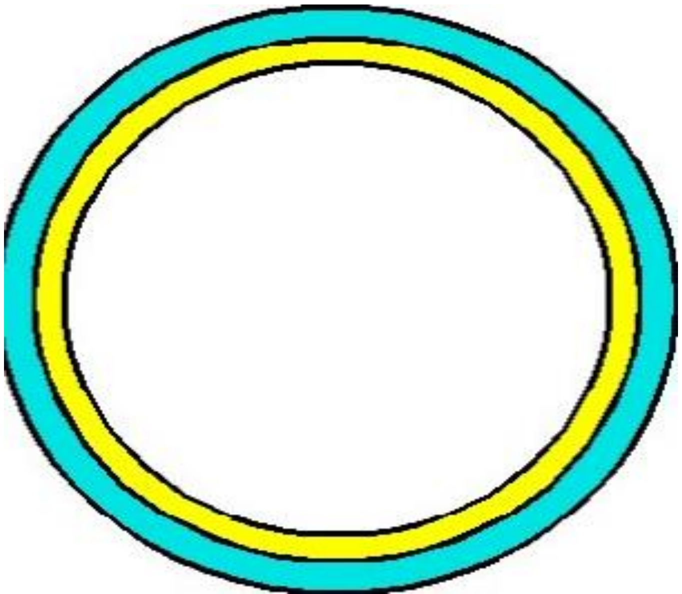


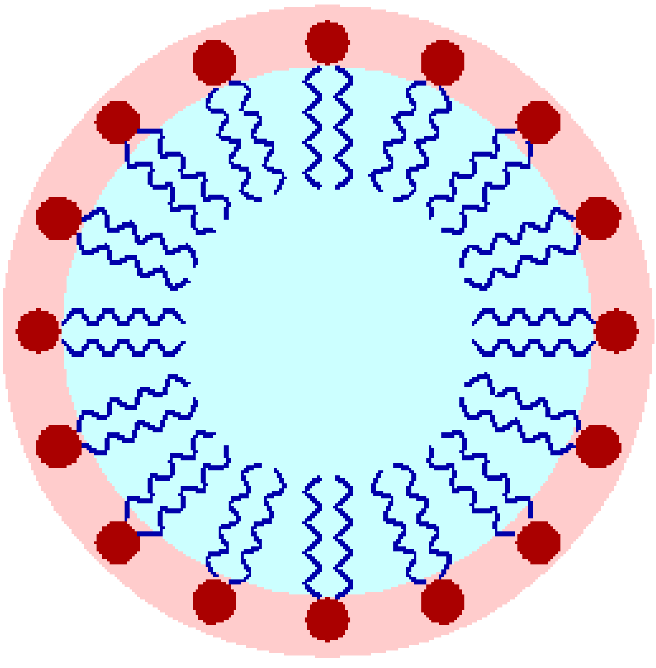
Surface tension decreases as lipid monolayer is compressed



1. Alveoli are coated with lung surfactant in order to reduce the surface tension of water through:
    a) It scatters among the fluid molecule decreasing the attraction between them.
    b) It also spreads over the fluid preventing air-fluid interface.

thus preventing collapse (atelectasis) upon exhalation and decreasing the force necessary to expand the alveoli upon inhalation

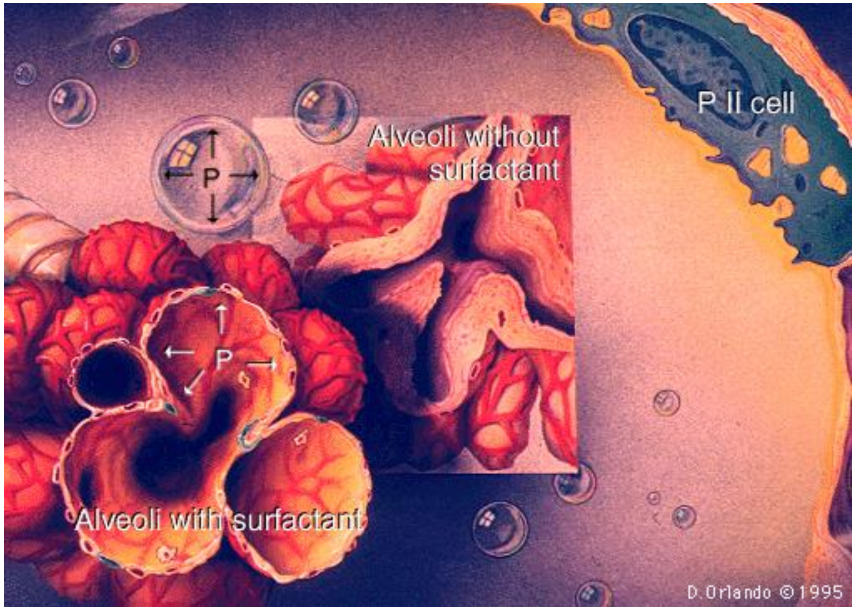




Lung Function in respiratory distress syndrome (RDS)

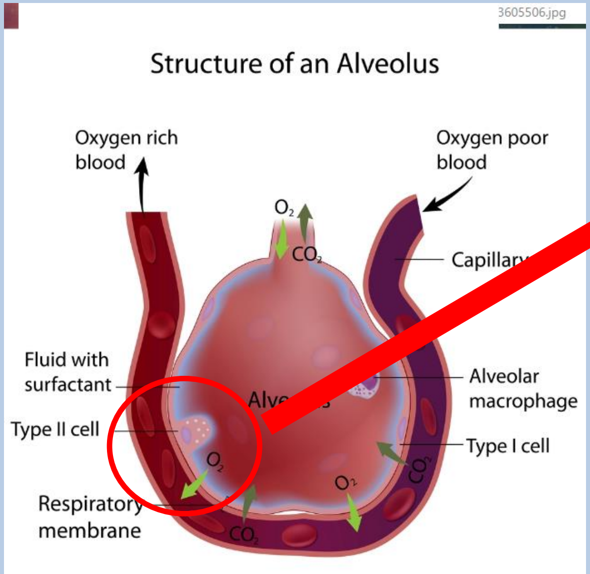
★Syndrome indicates lack of surfactant!

- Reduction in FRC from 30 ml/kg, to as low as 4-5 ml/kg



Surfactant

- produced by alveolar type II cells



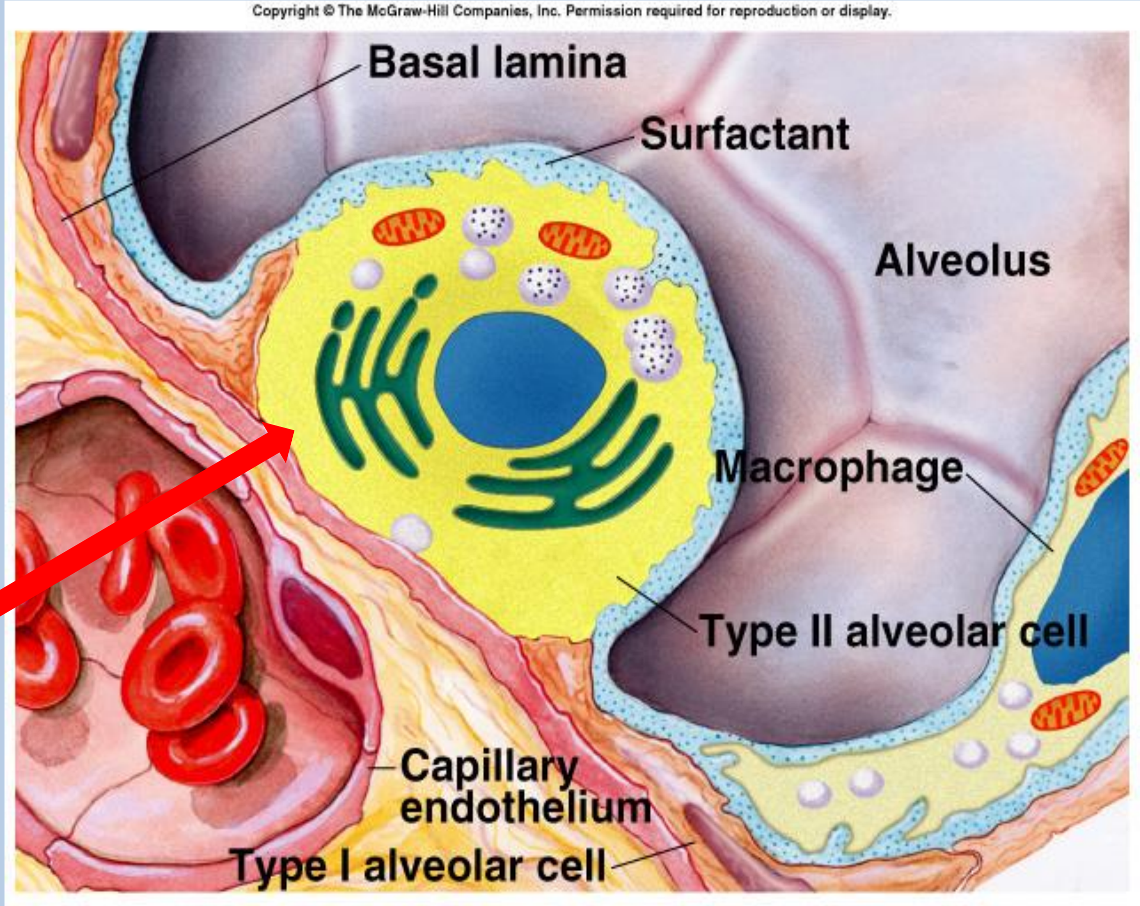
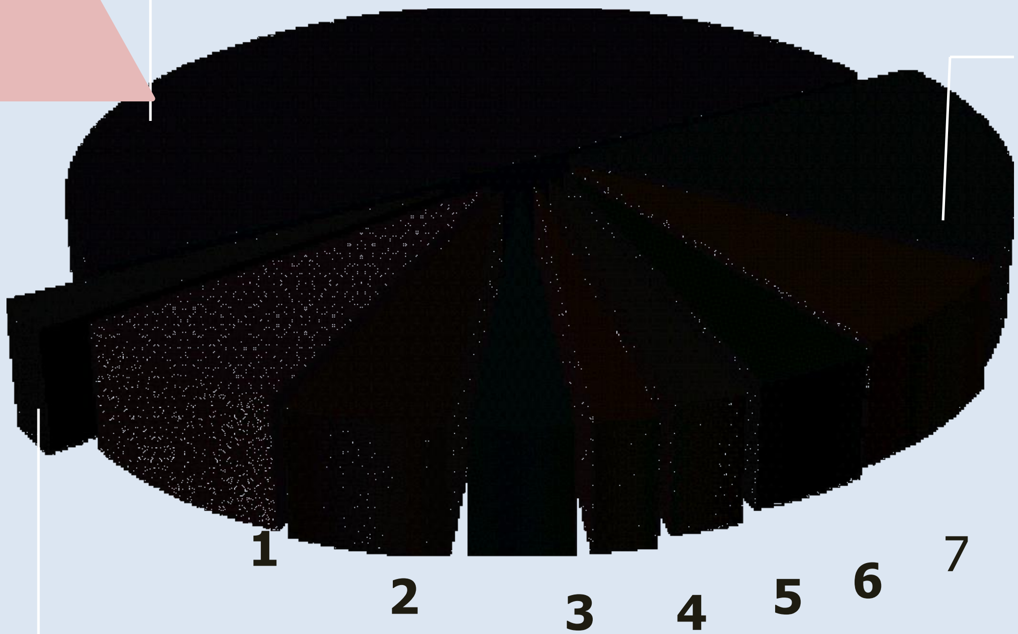


Figure 16.12

Endogenous Surfactant composition and functions

- **Major Lipids (~90%)**
  - Saturated Phosphatidylcholine **DPPC** (**Lecithin**) 60-80% ★
  - Unsaturated Phosphospholipids ✖
  - Phosphatidylglycerol (**PG**) ~10%
- **Proteins (~10%)**
  - SP-A **Immune Function* ★
    Hydrophilic, Host defense
    Surfactant homeostasis
  - SP-B *Spreading of Lipid layer* ★
    - Hydrophobic, Spreading, ↓ surface tension
  - SP-C *Spreading of Lipid layer* ★
    - Hydrophobic , Adsorption
  - SP-D: ? Phagocytic function

Surfactant Composition



DPPC - dipalmitoylphosphatidylcholine 60%*

- *Reduces alveolar surface tension*

PG - phosphatidylglycerol 7%*

- *Promotes the spreading of surfactant throughout the lungs*

1. **Serum proteins 10%**
2. **2. Other lipids 5%***
3. **Other phospholipids 3%***
4. **Phosphatidylinositol 2%***
5. **Sphingomyelin 2%***
6. **Phosphatidylethanolamine 4%***
7. **Unsaturated Phosphatidylcholine 17%***

*** By molecular weight**

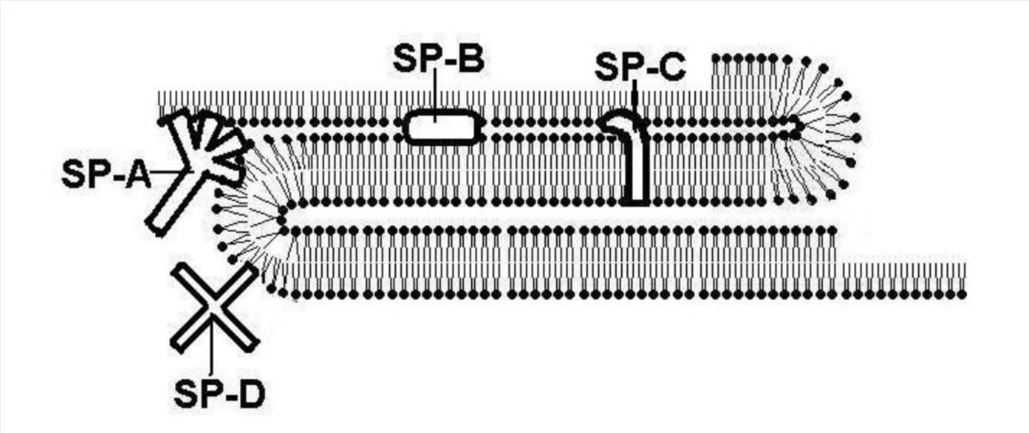
Prenatal diagnosis ★

- Lecithin and sphingomyelin ratio in the amniotic fluid, if ratio is more than 2 indicates adequate lung maturity

Surfactant proteins

Surfactant proteins are divided into 2 groups:

- **Large and water-soluble SP-A and SP-D proteins** ★
- **small, hydrophobic SP-B and SP-C proteins.** ★

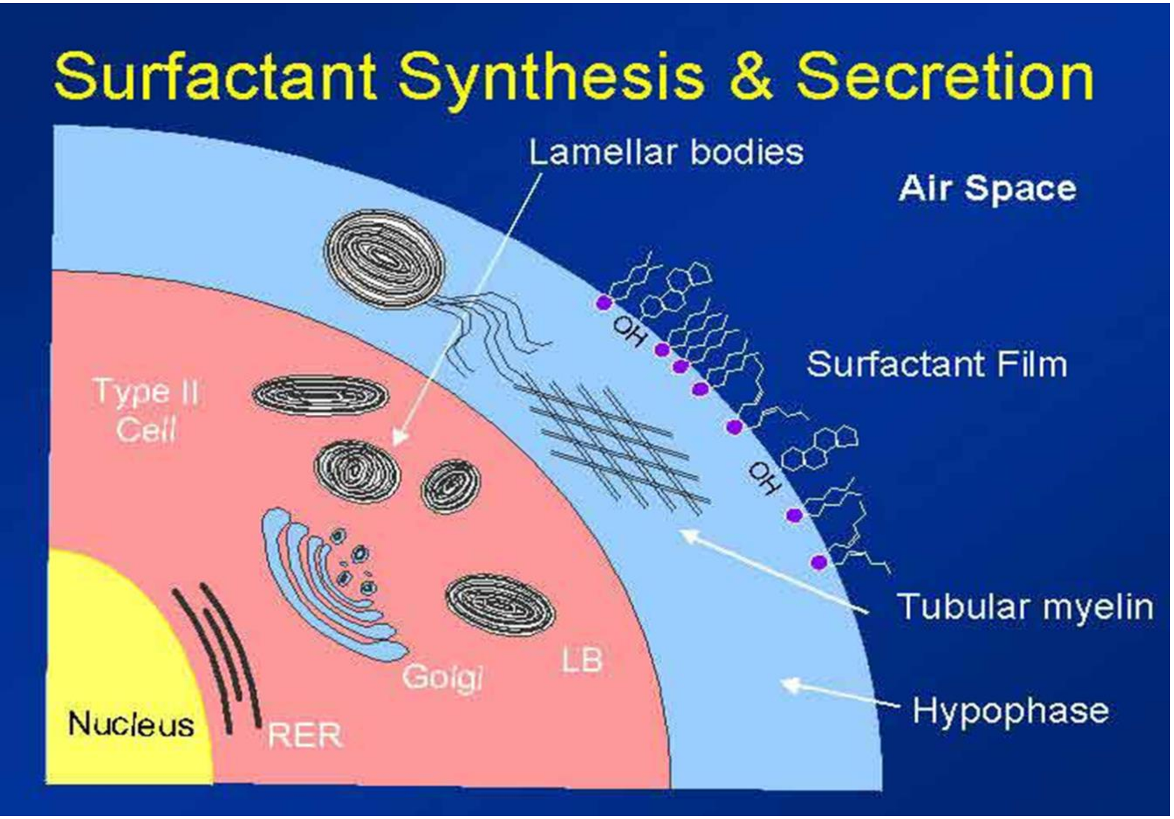


Are of great importance to immune defense mechanisms of the lung

-ability to bind to bacteria, viruses and other pathogens ………………(**Mainly protein A)**

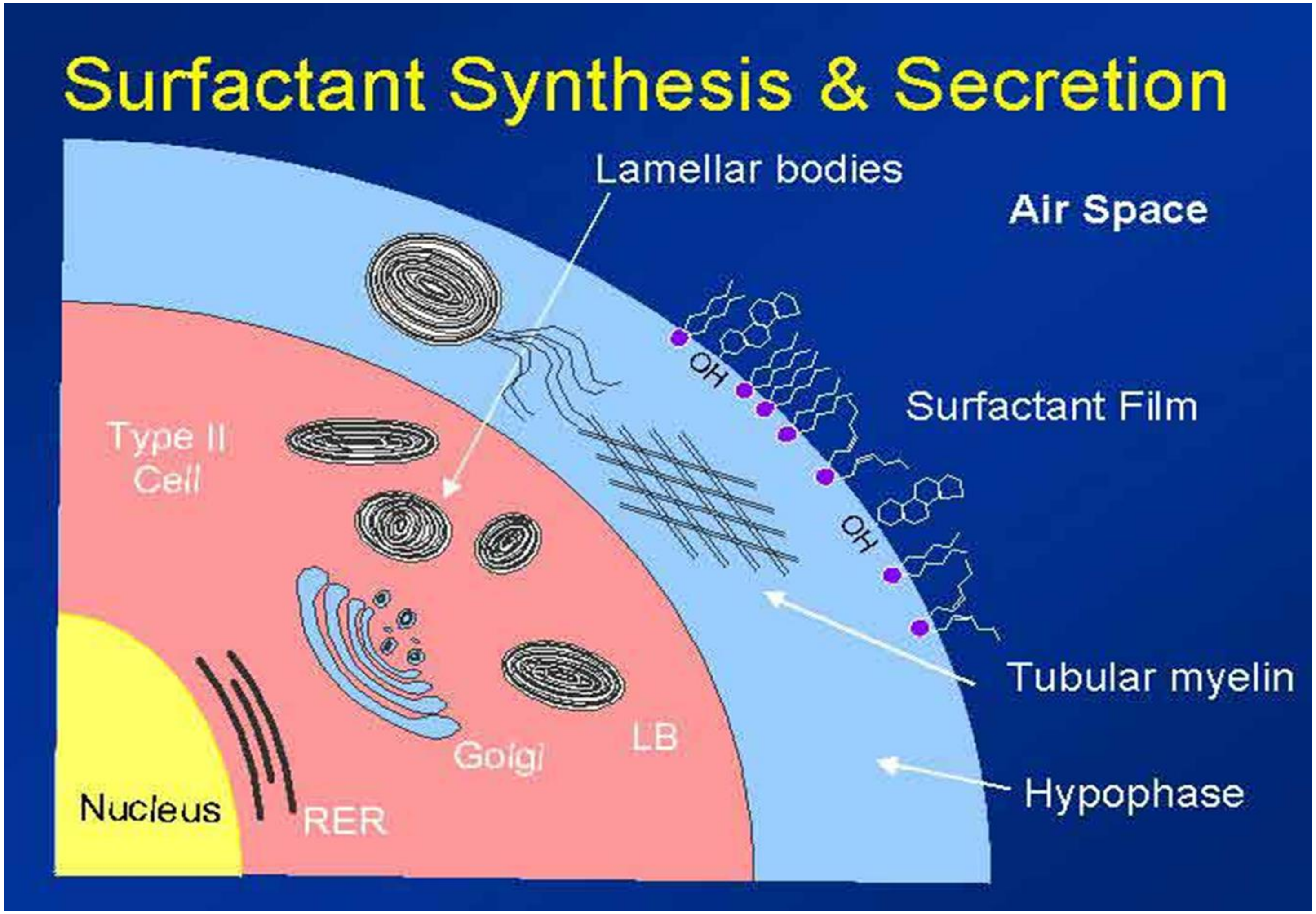
- well as to activate alveolar macrophages

Component



1-Lipid

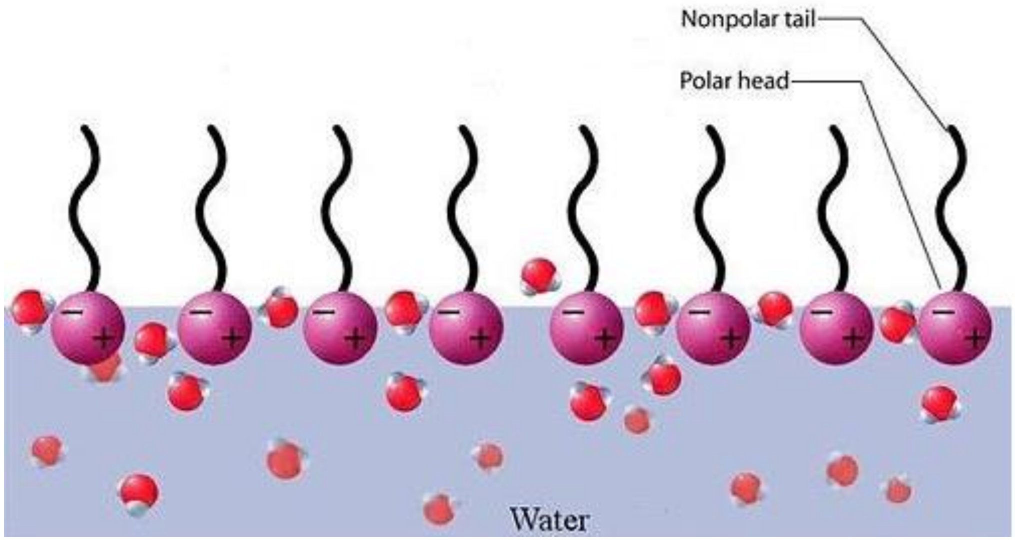
- Synthesized in the smooth endoplasmic reticulum moved to Golgi apparatus



- **Surfactant** is synthesized by ***type II alveolar cells*** from fatty acids that either reach the lung from blood or formed (de novo) inside it. It is stored in organelles know as ***"lamellar bodies"***.

Component

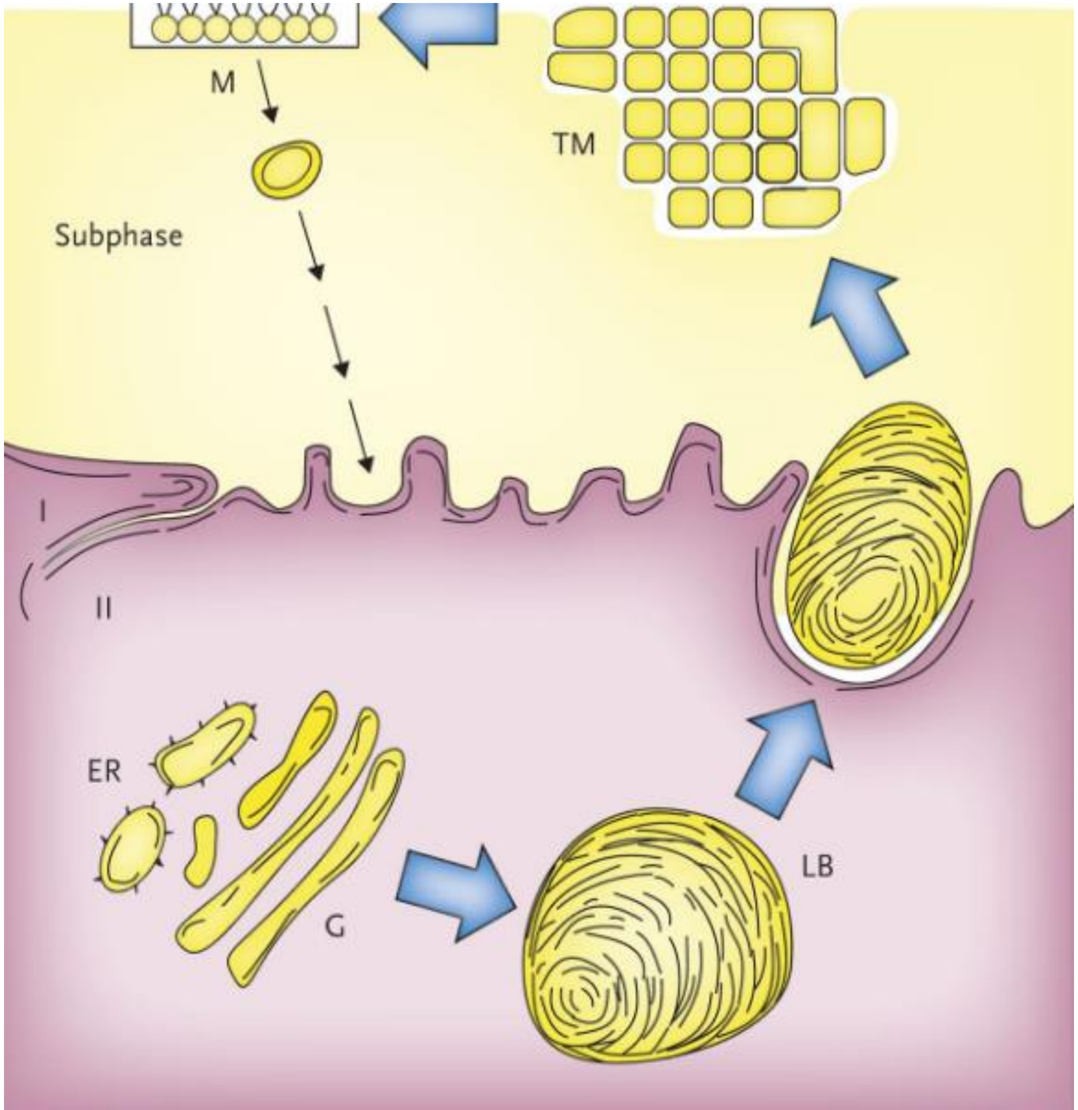
Lipid



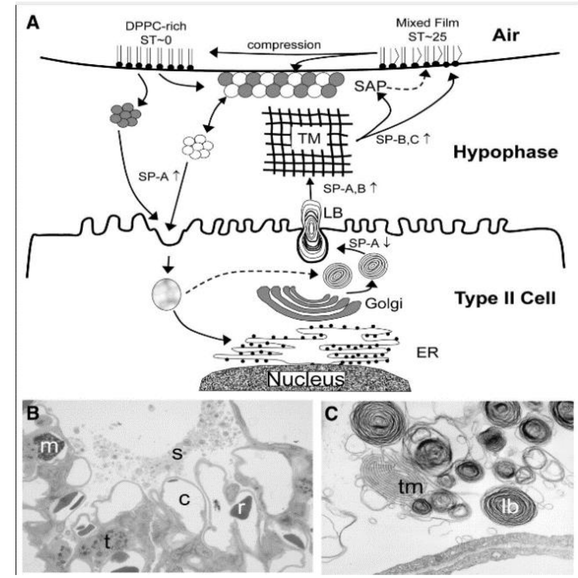
- **The main constituent of the monolayer is dipalmitoylphosphatidylcholine (DPPC), which is a bipolar lipid (it has a hydrophilic ‘head’ and a lipophilic ‘tail’)**

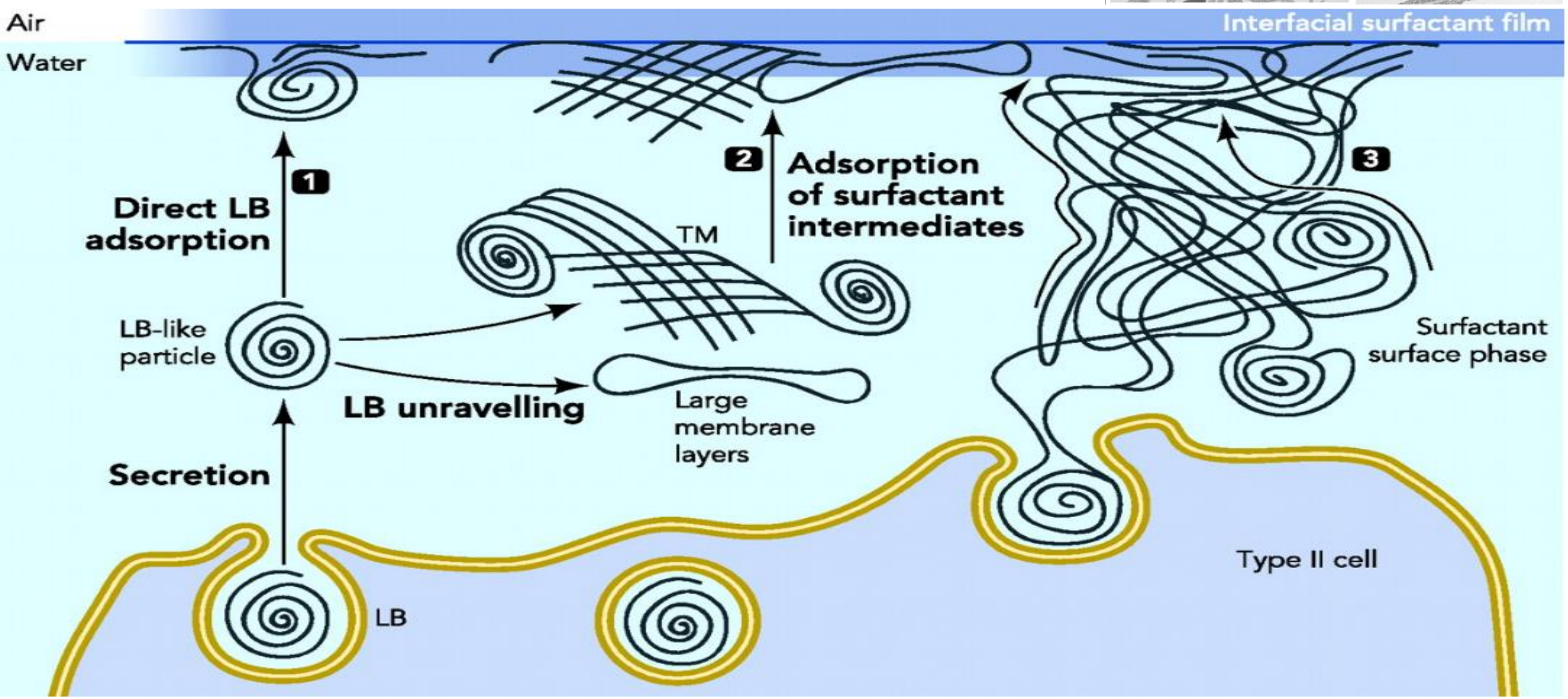
Surfactant synthesis

monomolecular surfactant



- Surfactant **Lipoprotein complex** that lowered the surface tension synthesized by Type II pnuemocyte





Functions of surfactant:

1-Decrease surface tension:

Roles of Lung surfactant

surfactant decreases surface tension

- ↑ pulmonary compliance
- ↓ alveolar collapse
- Respiratory distress syndrome (RDS)

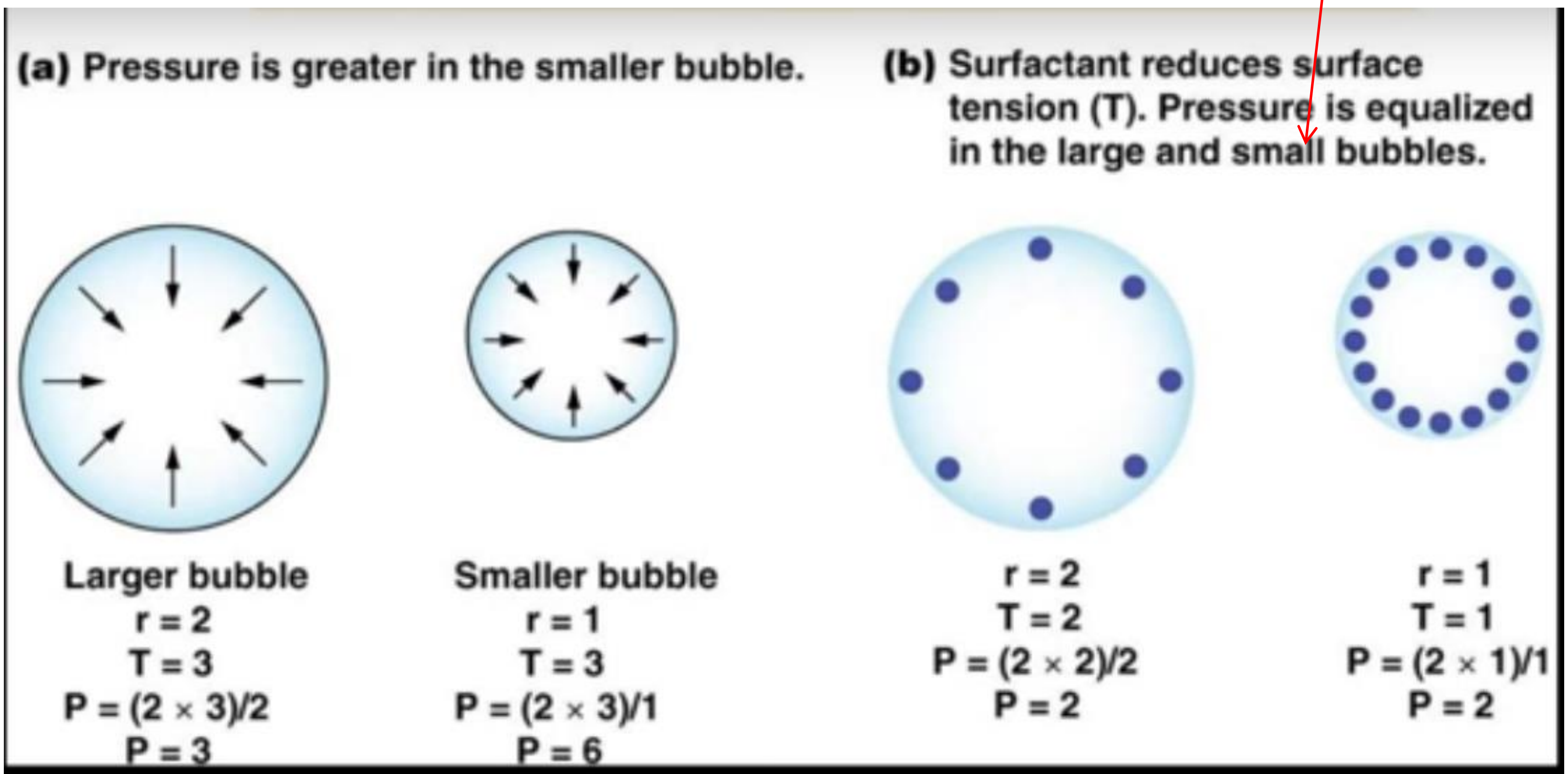
Fetal lung maturity

- L/S ratio → Lecithin & sphingomyelin
- phosphatidylglycerol
- foam stability or shake test

L/S < 1.5	immature
L/S 1.5-1.9	intermediate
L/S ≥ 2	lung maturity

Ventilation in the presence of surfactant

- Disrupts the surface tension & cohesion of water molecules
- Impact?
  - prevents alveoli from sticking together during expiration



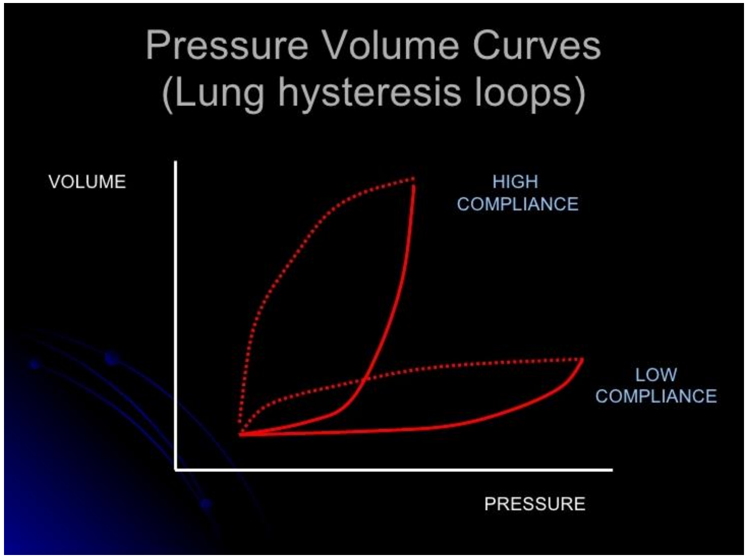
Functions of surfactant:

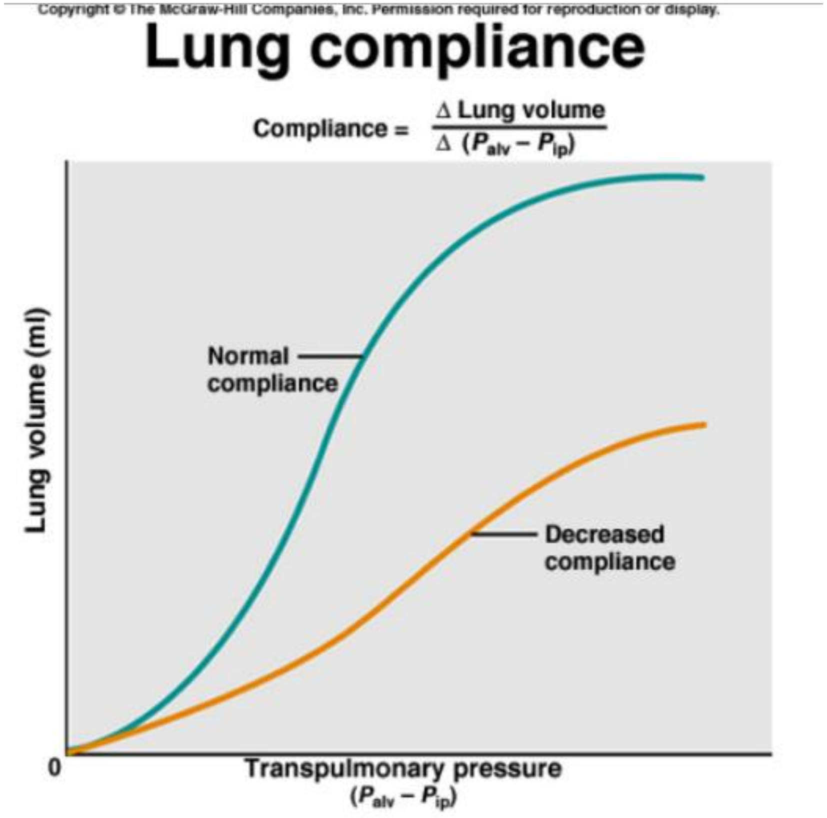
This decreased surface tension:

- **Increase the lung compliance**
  - **Helps lung expansion during inspiration**
  - **stabilize the alveoli :**

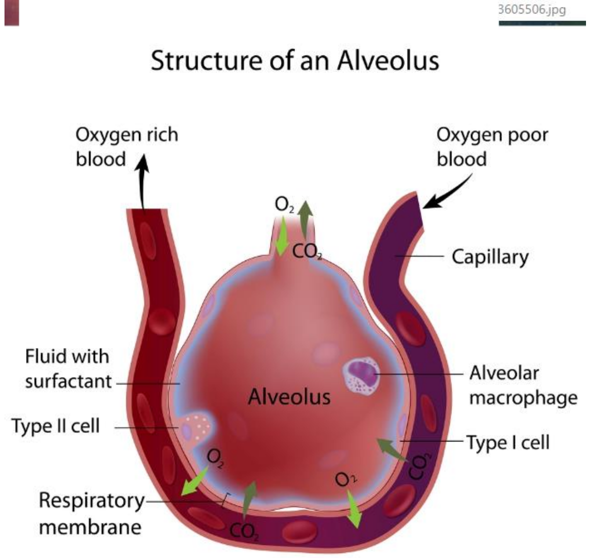
This protects the alveoli from

- ❑ Collapse during expiration
- ❑ over distention during inspiration
- ❑ Prevent collapse during expiration (atalactasis)





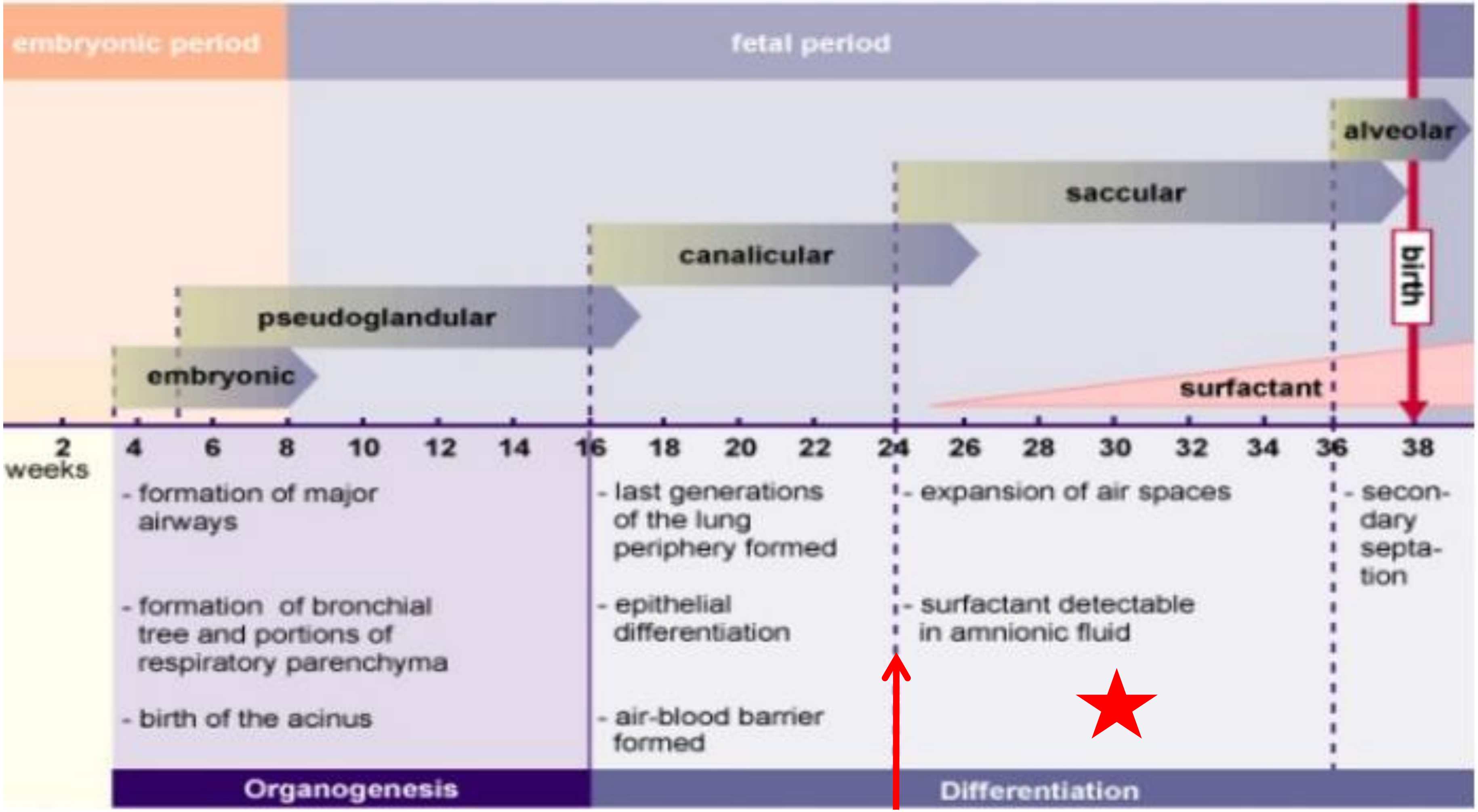
Functions of surfactant:

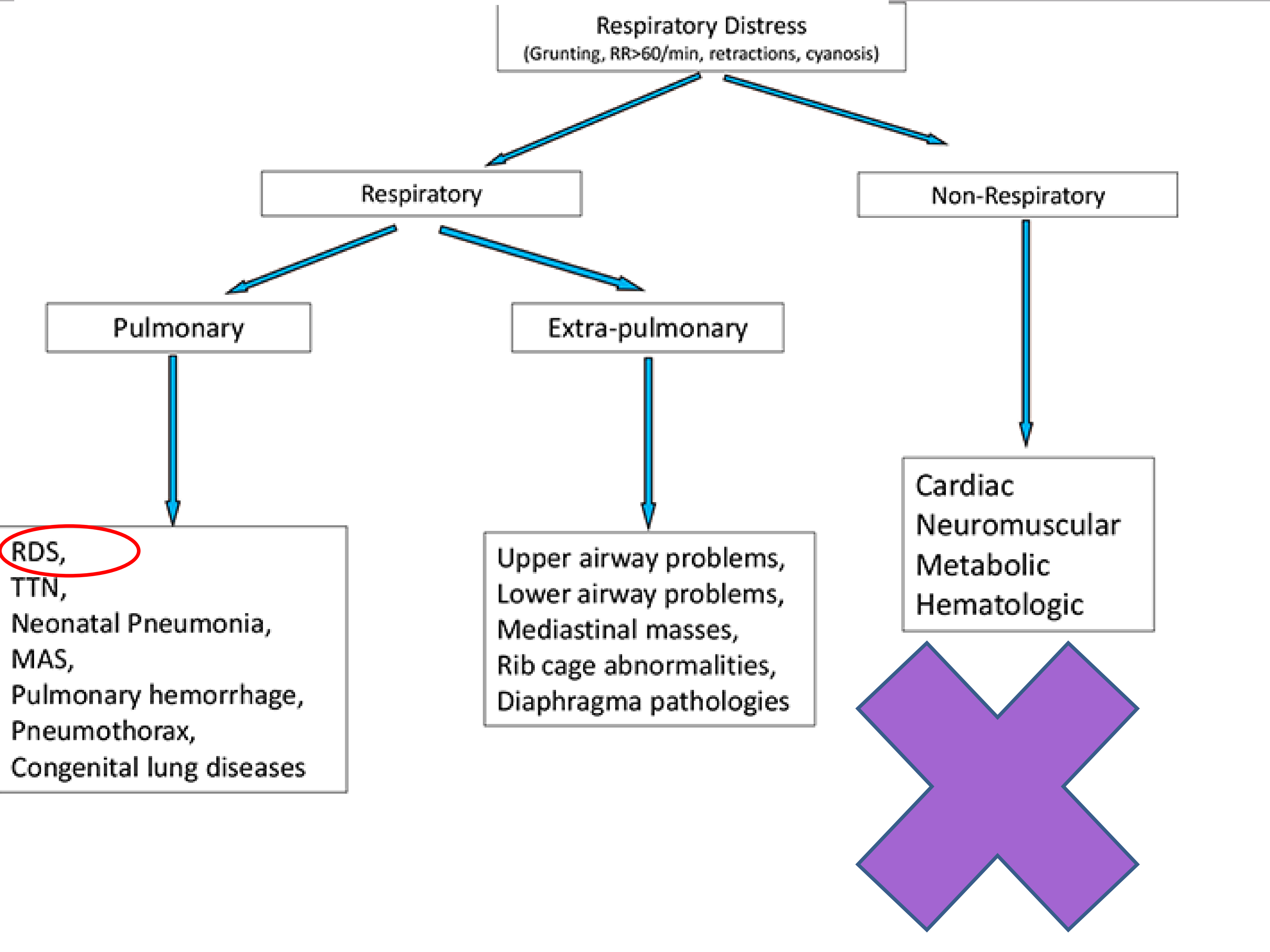


This decreased surface tension:

- **Protects against pulmonary edema as it decreases the filtration forces for the fluid from pulmonary capillaries into alveoli.**

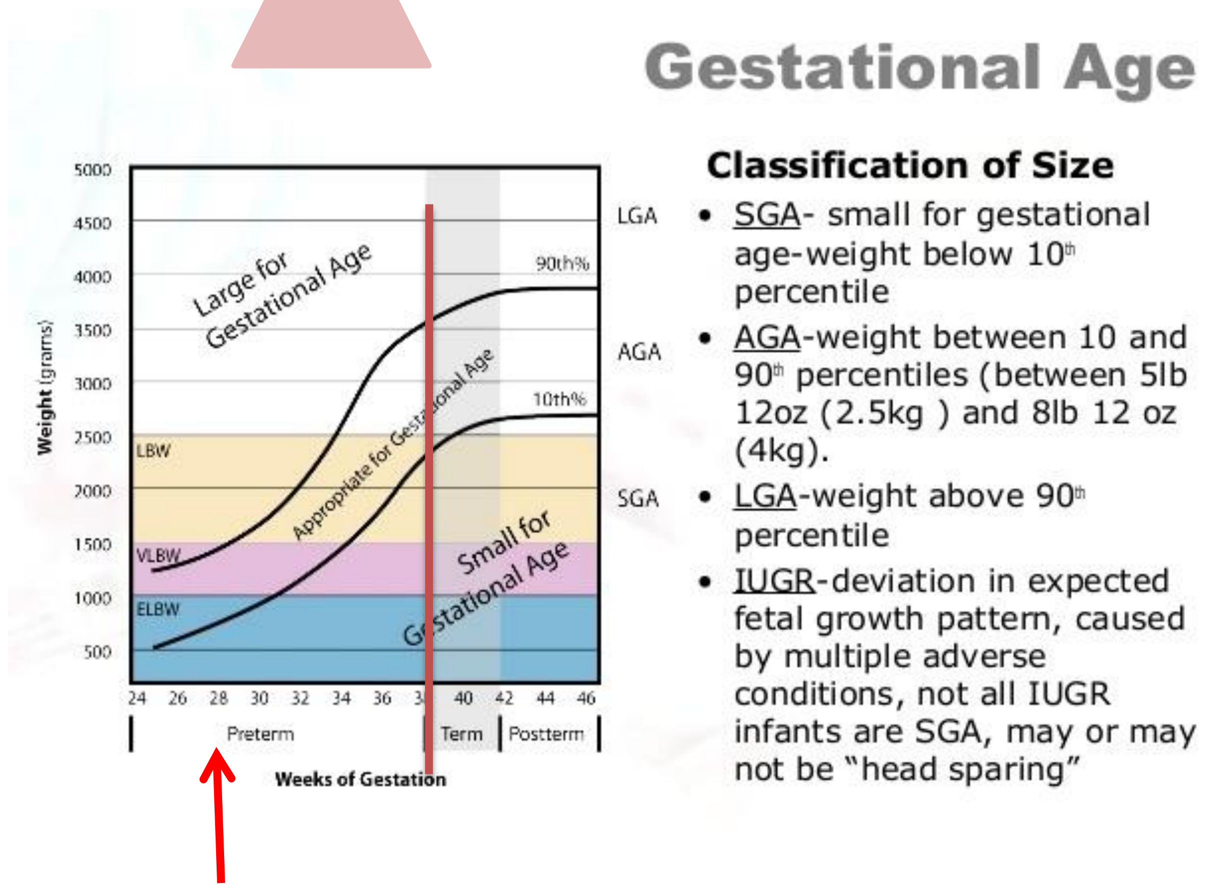
Phases of Lung Development




Respiratory Distress
(Grunting, RR>60/min, retractions, cyanosis)
Respiratory
Non-Respiratory
Pulmonary
Extra-pulmonary
RDS,
TTN,
Neonatal Pneumonia,
MAS,
Pulmonary hemorrhage,
Pneumothorax,
Congenital lung diseases
Upper airway problems,
Lower airway problems,
Mediastinal masses,
Rib cage abnormalities,
Diaphragma pathologies
Cardiac
Neuromuscular
Metabolic
Hematologic

Case

- Baby born preterm at 28 week



Respiratory distress syndrome (RDS)

Preterm baby
Excepted to
have RDS

CLINICAL MANIFESTATION

- Tachypnea
- Nasal flaring → Flow = 1/radius → so nares are lifted upward to increase their radius for better flow
- Intercostal, sternal recession
- Grunting; closure of glottis during expiration
- Cyanosis

These manifestations happen with all respiratory diseases

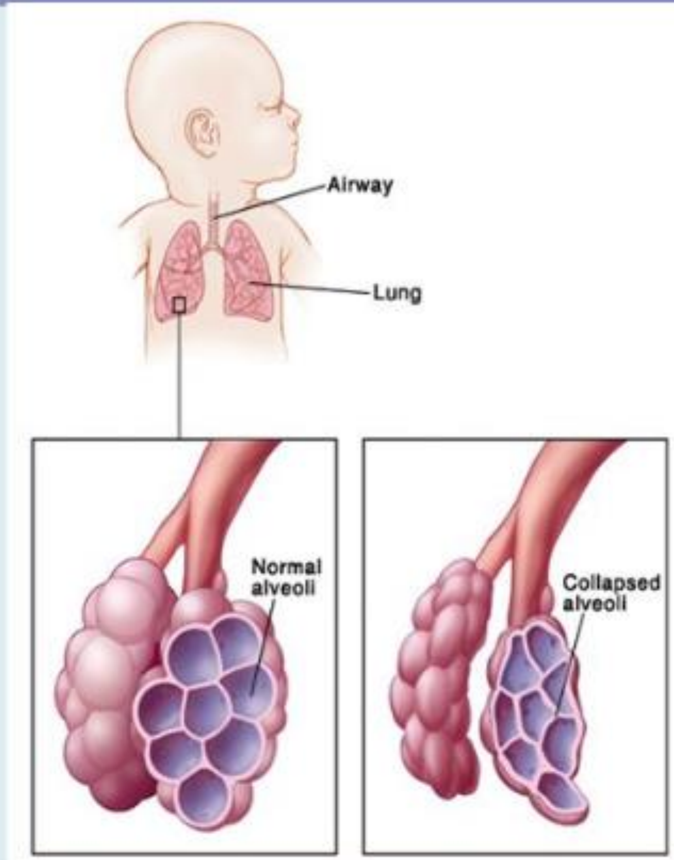
DEFINITION

- Acute lung disease of the newborn

Respiratory Distress Syndrome (RDS)

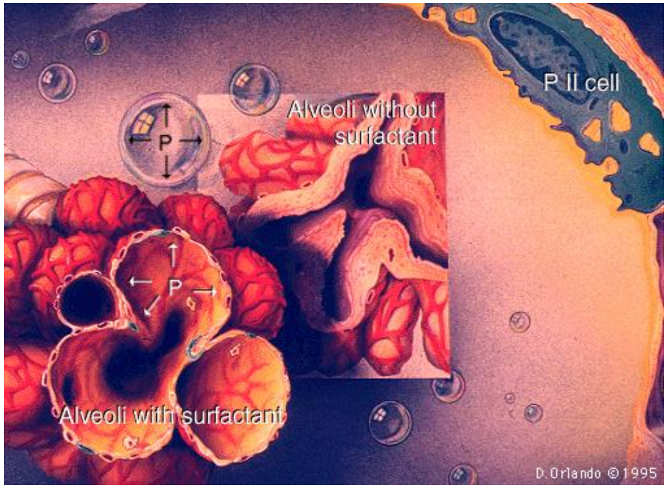
- Also called hyaline membrane disease.
- Most common cause of respiratory distress in preterm infants.
- Due to structural and functional immaturity of lungs.
  - Underdeveloped parenchyma
  - Surfactant deficiency
    - Type II pneumatocytes
- Results in decreased lung compliance, unstable alveoli

"Atelectasis"



pathophysiology

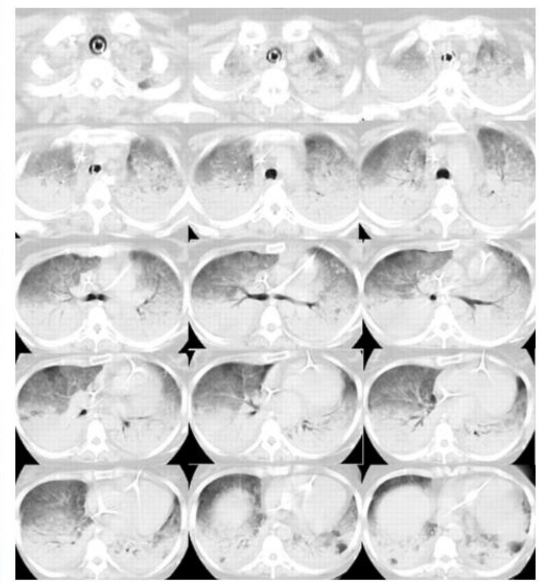
- Instability of terminal airspaces (difficult to expand during inspiration and atelectasis at expiration) due to elevated surface forces at liquid-gas interfaces (elevated surface tension)

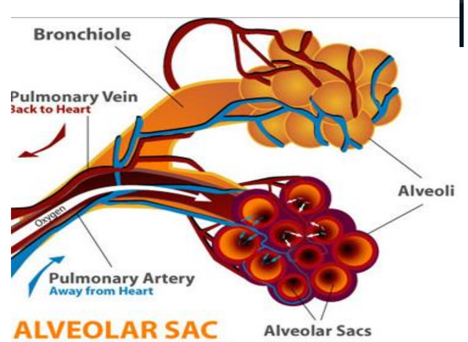


Diminished surfactant :

- ★ Progressive Atelectasis
- ★ Loss of functional residual capacity
  - Small lungs and small tidal volume
- ★ Alterations in ventilation perfusion ratios
- ★ Uneven distribution of ventilation

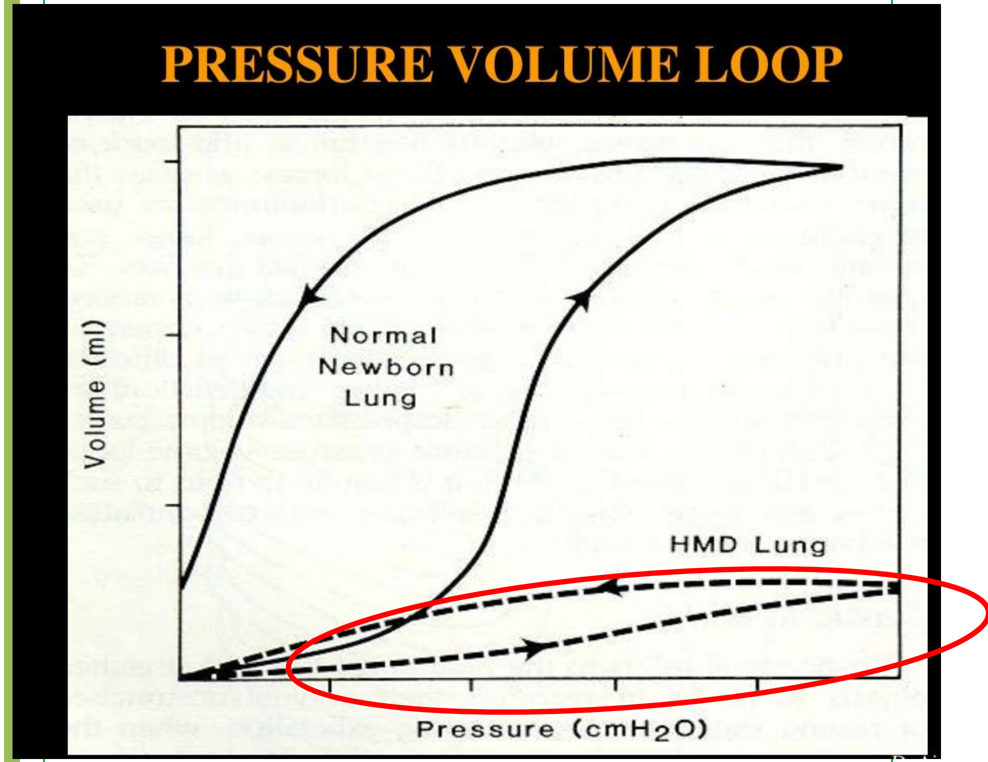
"V/Q mismatch due to collapsed alveoli"





Lung compliance in RDS

- Lung Compliance is also reduced: from 1-2 to 0.2 - 0.5 ml/cmH_2O/kg

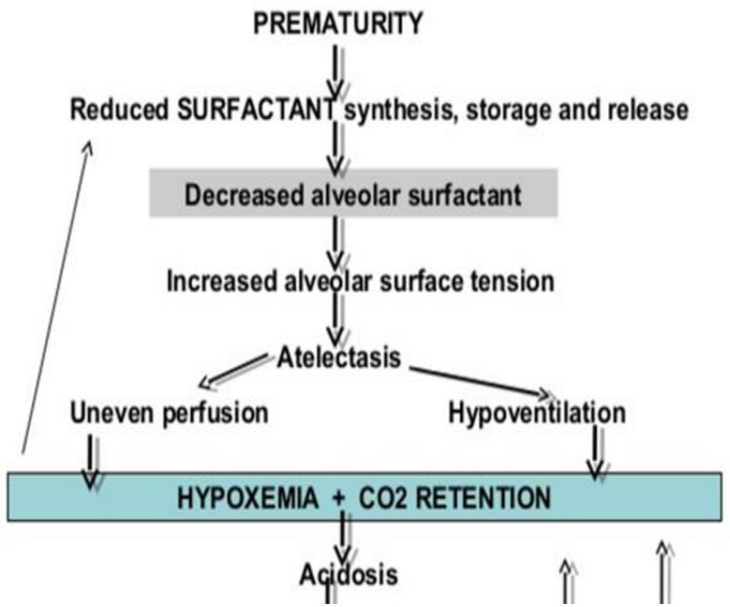


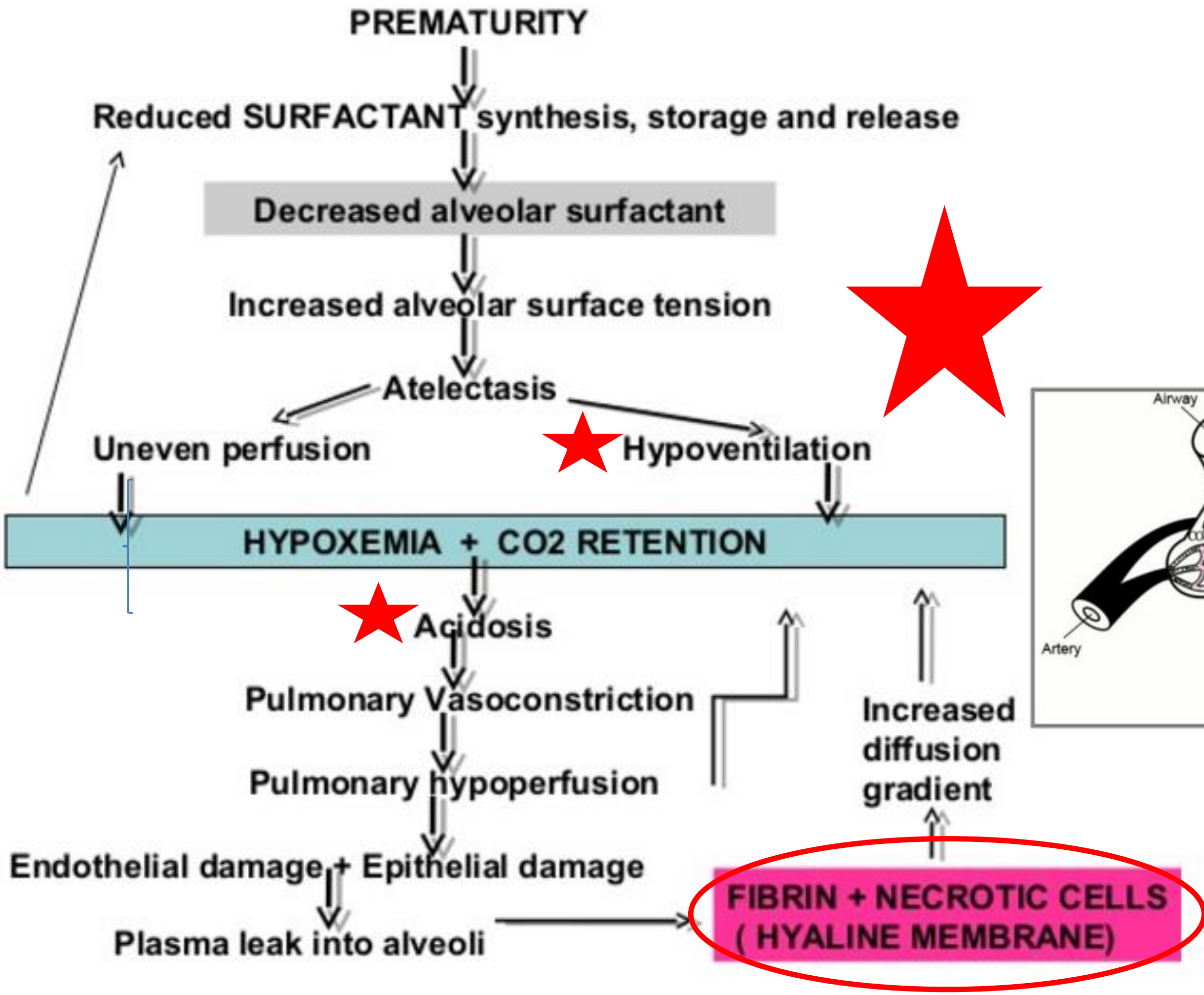
RDS: clinical picture

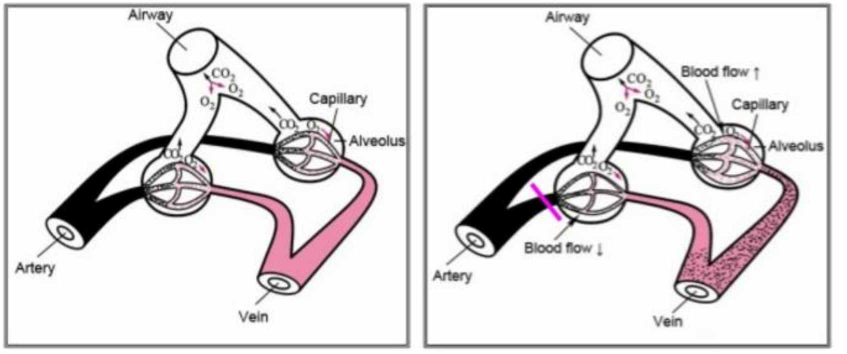
- At admission of the baby he has
  - Cyanosis
  - ↓ Pulse Oximeter 75% (normal > 95%) For Saturation: O2 attached to hemoglobin

Blood gas:

- ↓ PaO2 = 45% mmHg (normal 80-108) → O2 content in the serum
- ↓ Ph= 7.2 (normal 7.35-7.45) → Acidosis
- ↑ CO2 = 65 mmHg (normal 35-45)

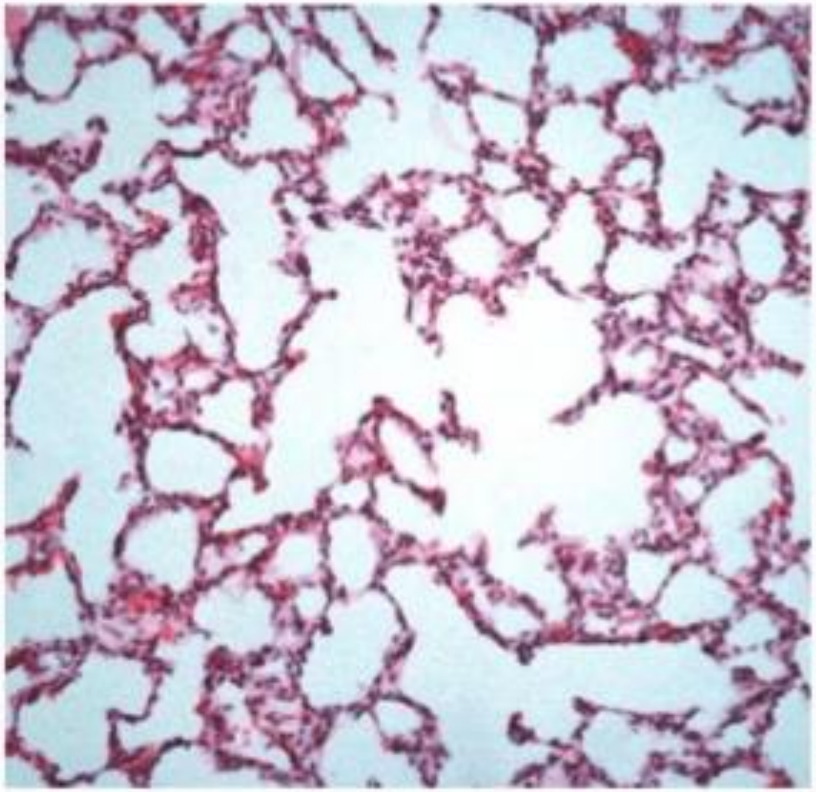


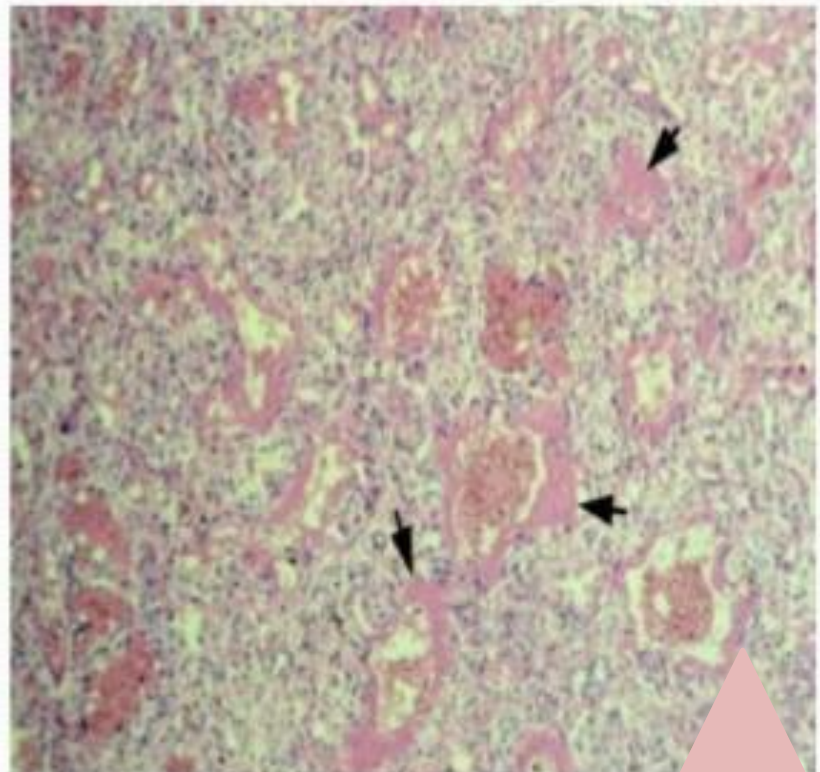




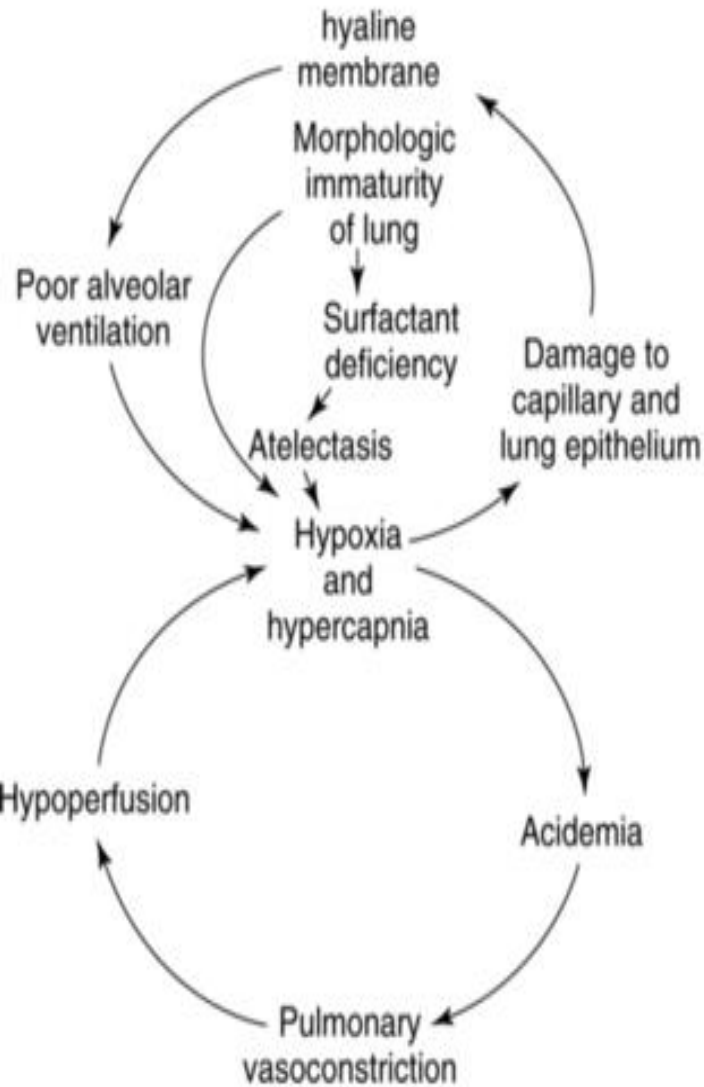
Lung hypo-perfusion
V/Q mismatch

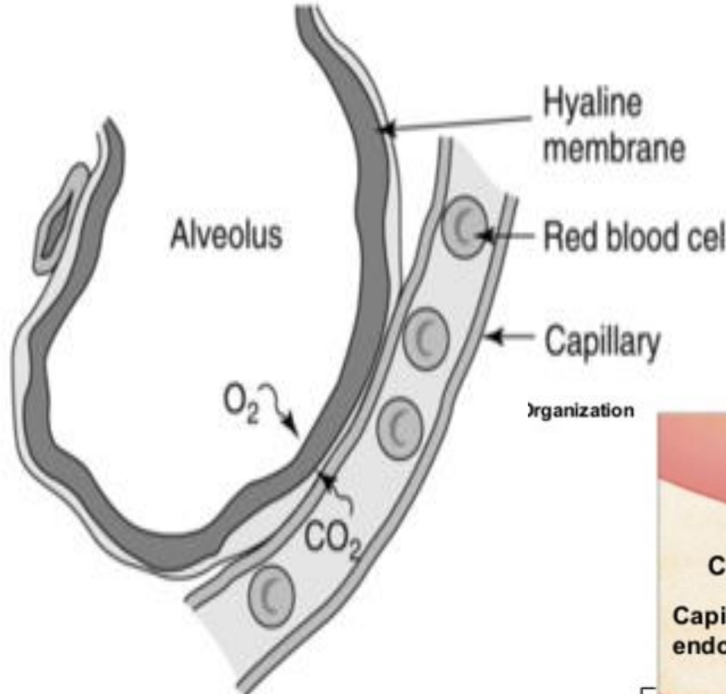
Normal Lung　　Hyaline Membranes

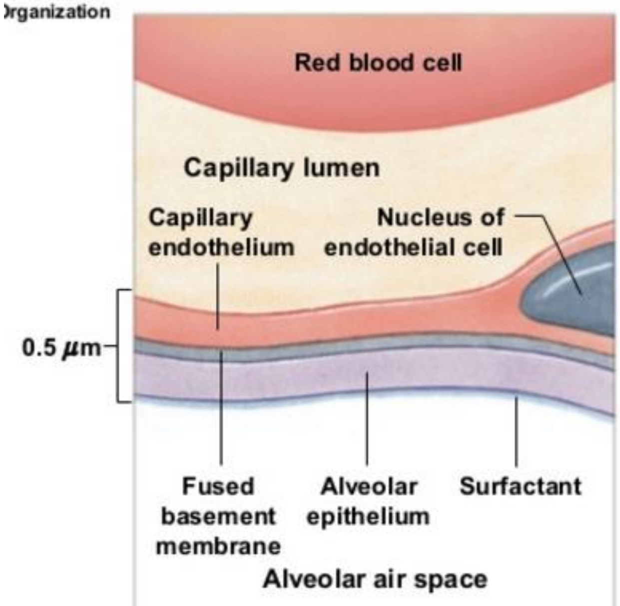




- Hyaline membrane- combination of sloughed epithelium, protein & edema.

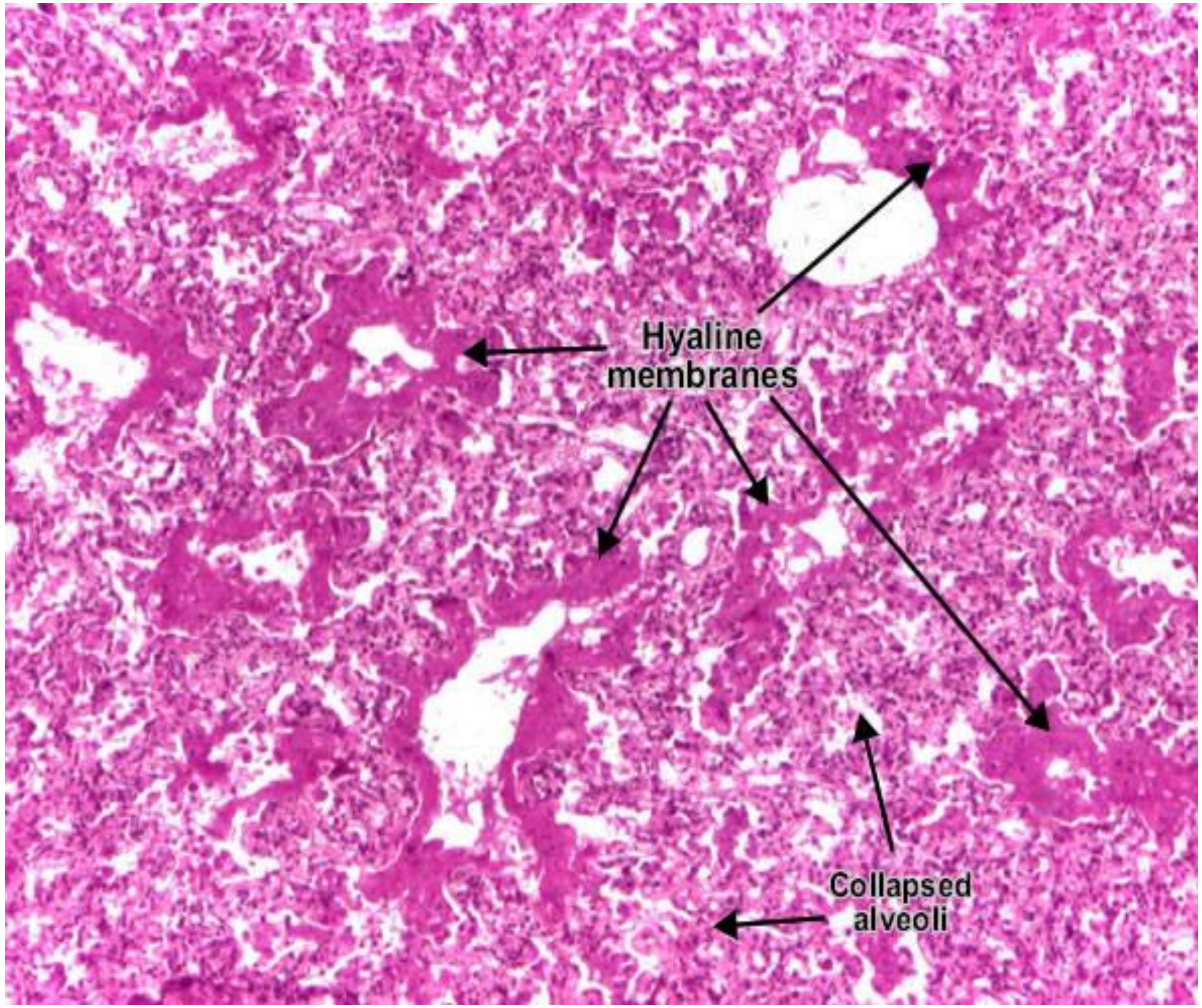






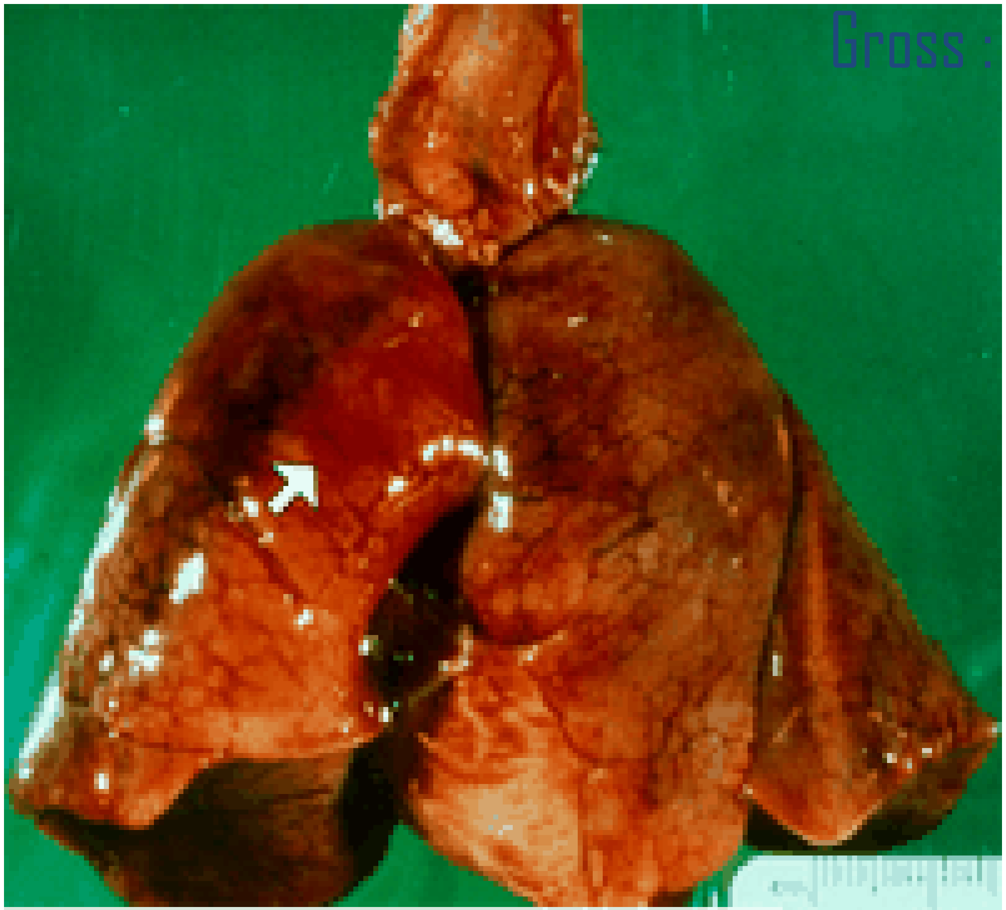
c The respiratory membrane, which consists of an alveolar epithelial cell, a capillary endothelial cell, and their fused basement membranes.

- Hyaline membrane- combination of sloughed epithelium, protein & edema.



- Hyaline membrane- combination of sloughed epithelium, protein & edema.

Gross : Lung firm, red, liverlike



- Photograph of an autopsy specimen demonstrates small atelectatic lungs with focal hemorrhage (arrow) visible on the pleural surface.

Incidence

Respiratory Distress Syndrome (RDS)

- Also known as **Hyaline Membrane Disease (HMD)**
- Commonest cause of preterm neonatal mortality
- RDS occurs primarily in premature infants; its incidence is inversely related to gestational age and birth weight

Gestational age	Percentages
Less than 28 wks	60-80%
32-36 wks	15-30%
37-39 wk	5%
Term	Rare

Nelson Textbook of Pediatrics, 18th Ed.

The more the baby is preterm the more risk of RDS there is

Risk Factors

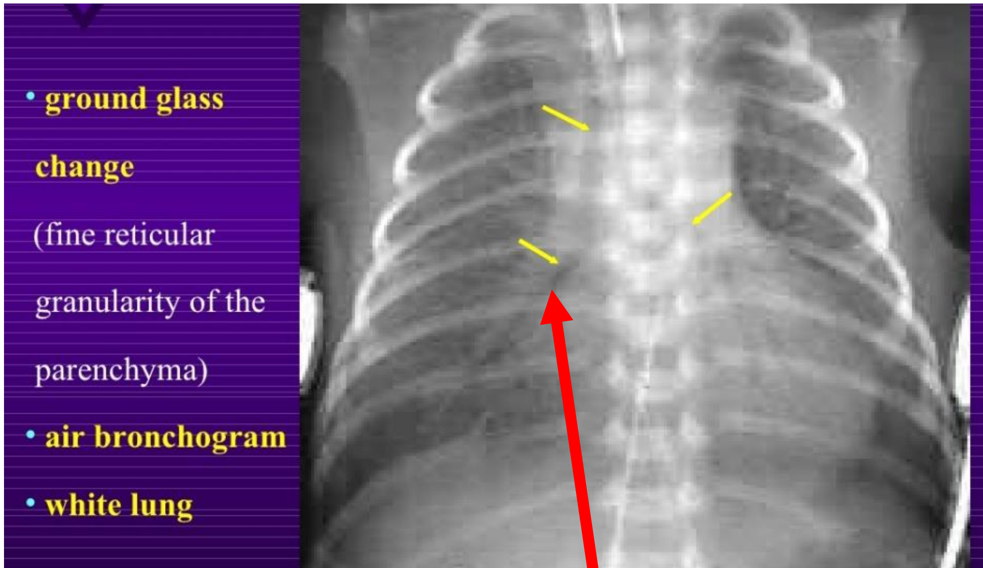
Increased Risk	Decreased Risk
• Maternal diabetes • multiple births • cesarean section delivery • perinatal asphyxia • cold stress • history of previously affected infants	• Chronic or pregnancy-associated hypertension • maternal heroin use • prolonged rupture of membranes • antenatal corticosteroid prophylaxis

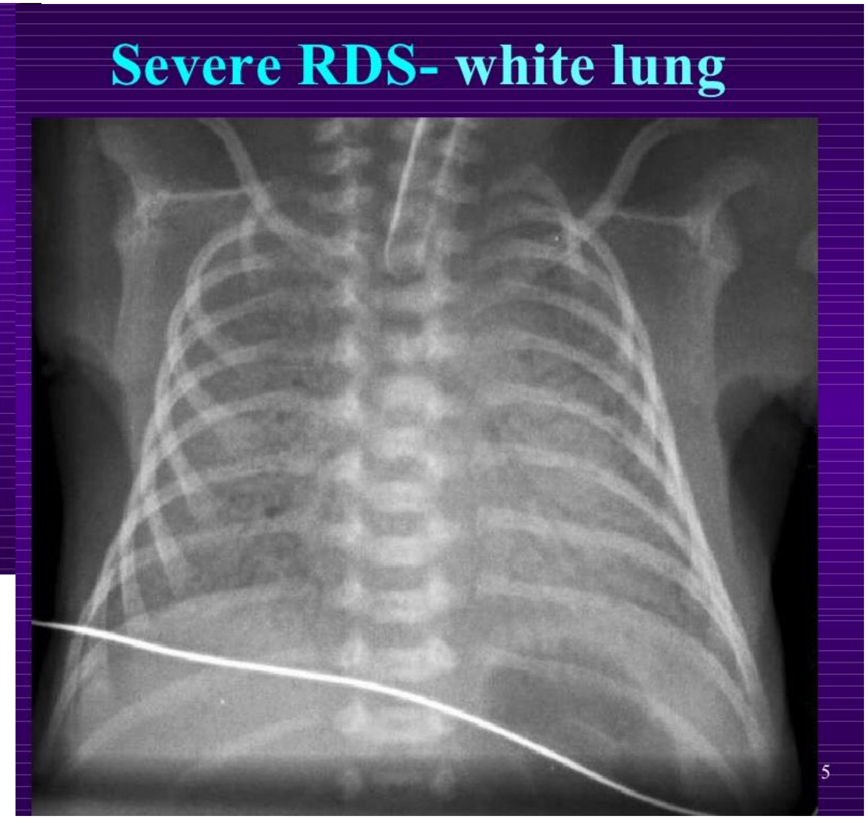
All of these are related to increased cortisol level in the fetus

Just know that there is susceptibility Details are not important!, only highlited things. ***Saffar***

- Susceptibility to RDS is interaction between genetic, environmental and constitutional factors
- ***<u>Very preterm infants</u>***
  - – Common allels predicts RDS: **SP- A** 642, Sp-B121, Sp-C 186 ASN.
- Term Infants: Loss of function mutation of **SP-B, SP-C**, phospholipids transporter ABCA3

Chest X-Ray





Due to closed alveoli

➢Chest radiograph: air bronchogram, reticular/ ground-glass appearance after 6-12 hrs to full opacity later on.

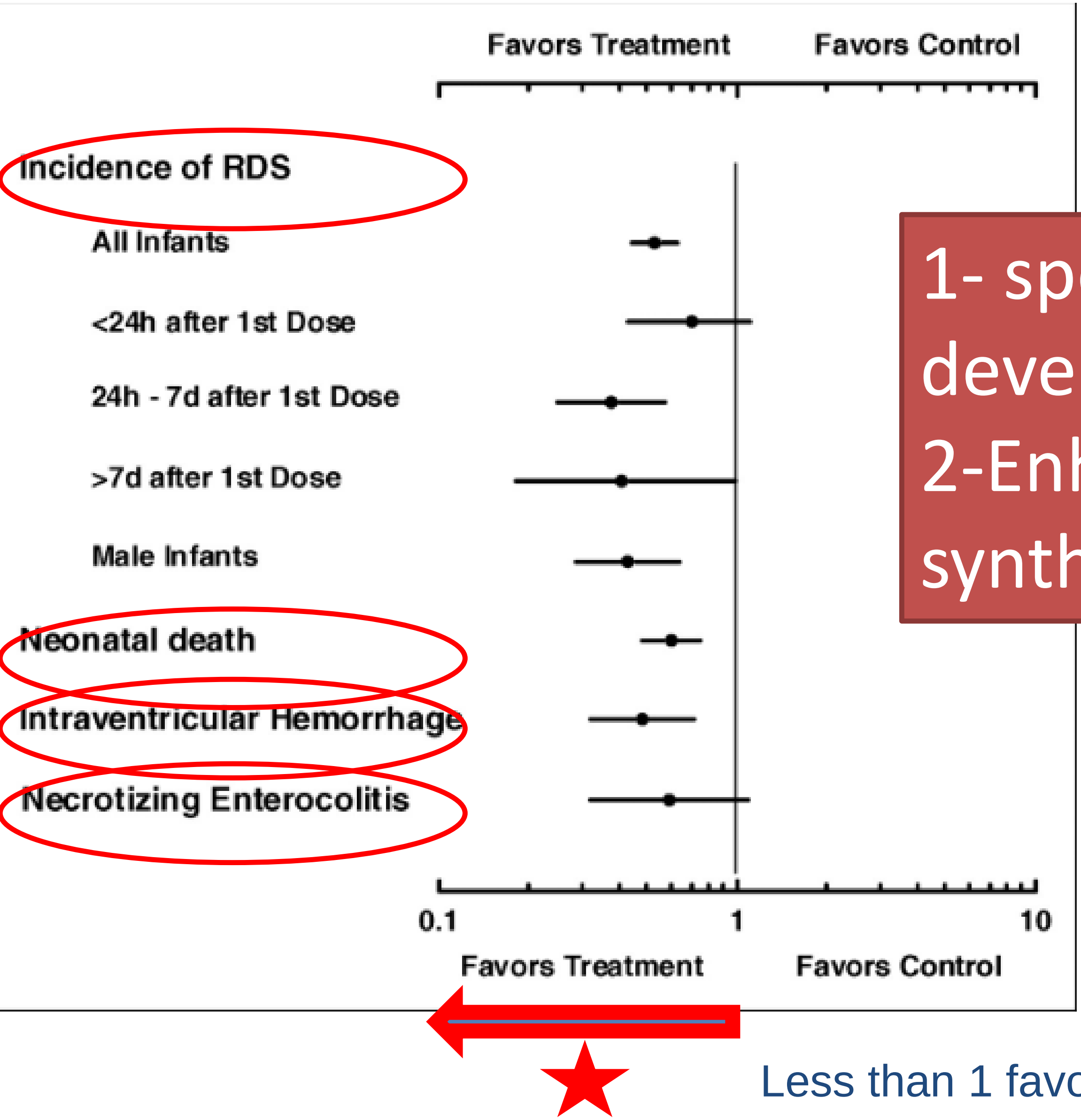
Prevention

- ★ Prevention of prematurity
- Antenatal corticosteroid therapy

  Dexamethasone or betamethasone

  ↓RDS mobidity and mortality
- PS prophylatic therapy

Antenatal Corticosteroid Effects



1- speed up lung development

2-Enhance surfactant synthesis

Less than 1 favors treatment

Specific

RDS - Treatment

- Oxygen
- CPAP
- Mechanical ventilation
- Surfactant replacement
- Supportive Care

CPAP in RDS: How does it work ?

- Diminishing atelectasis
- Improving Functional residual capacity
- Correcting ventilation-perfusion abnormalities
- Decreasing pulmonary edema
- Reducing intrapulmonary shunting

Antenatal steroid and Surfactant goes hand in hand

Le Fin.

"je pense donc je suis"

Descartes

Omar Saffar