Development of the Respiratory System: From Embryo to Birth

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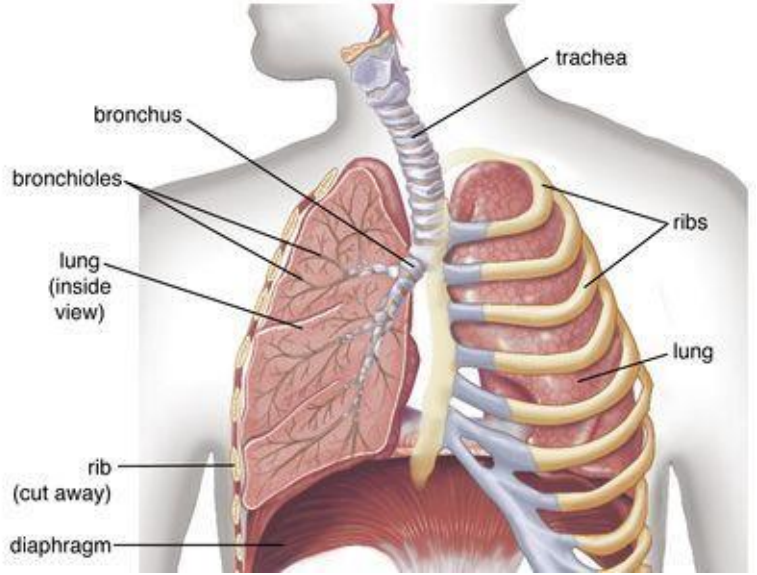
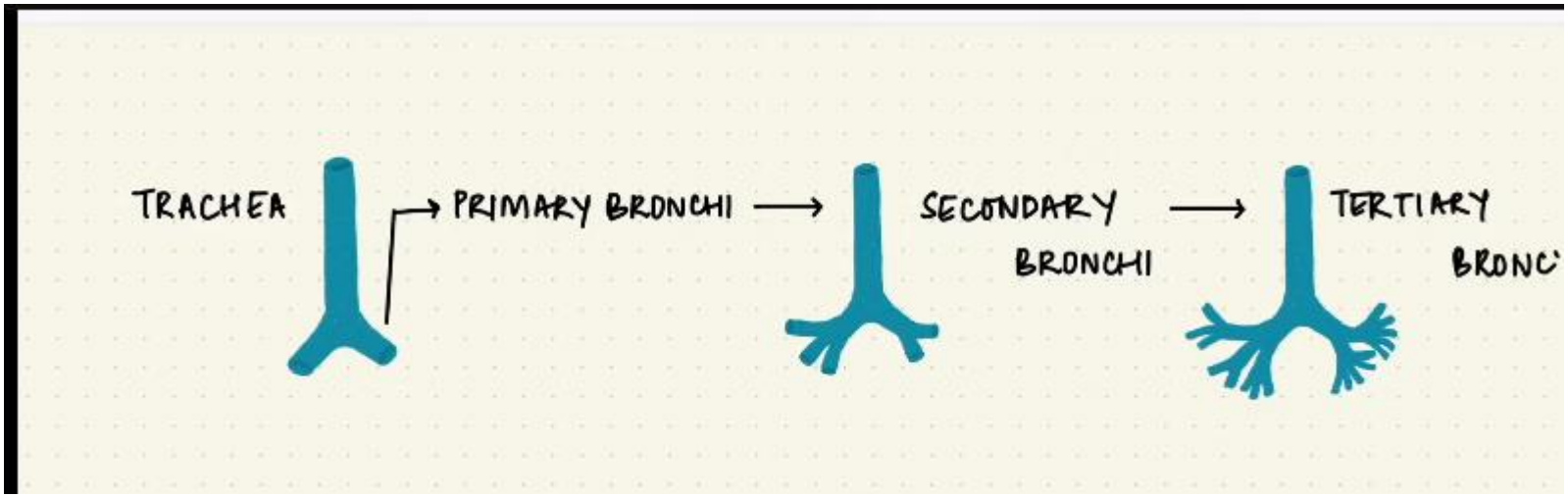
Introduction: The Final Picture

We'll explore the development of:

- Airways (respiratory tree)
- Lungs
- Pleural cavities
- Focus on lower airways: from trachea downwards
- What structures will we see in the end?

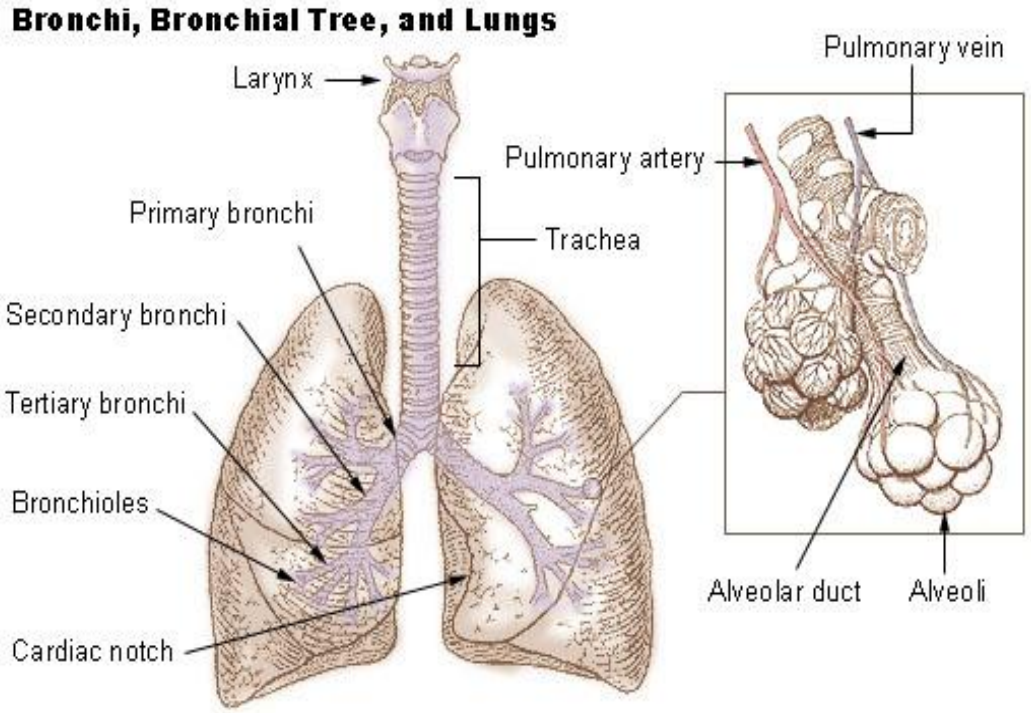




Trachea divides into:

- right and left main primary bronchi
- Secondary bronchi
- and tertiary bronchi

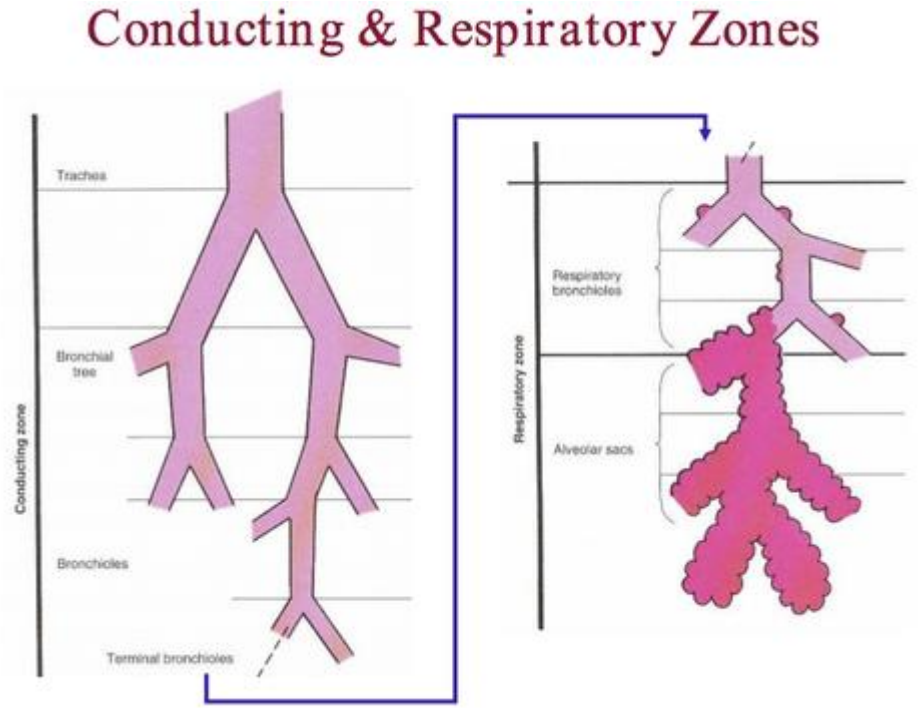
The Respiratory Tree



- Bronchioles lead to terminal bronchioles
- Respiratory bronchioles connect to alveolar ducts and sacs

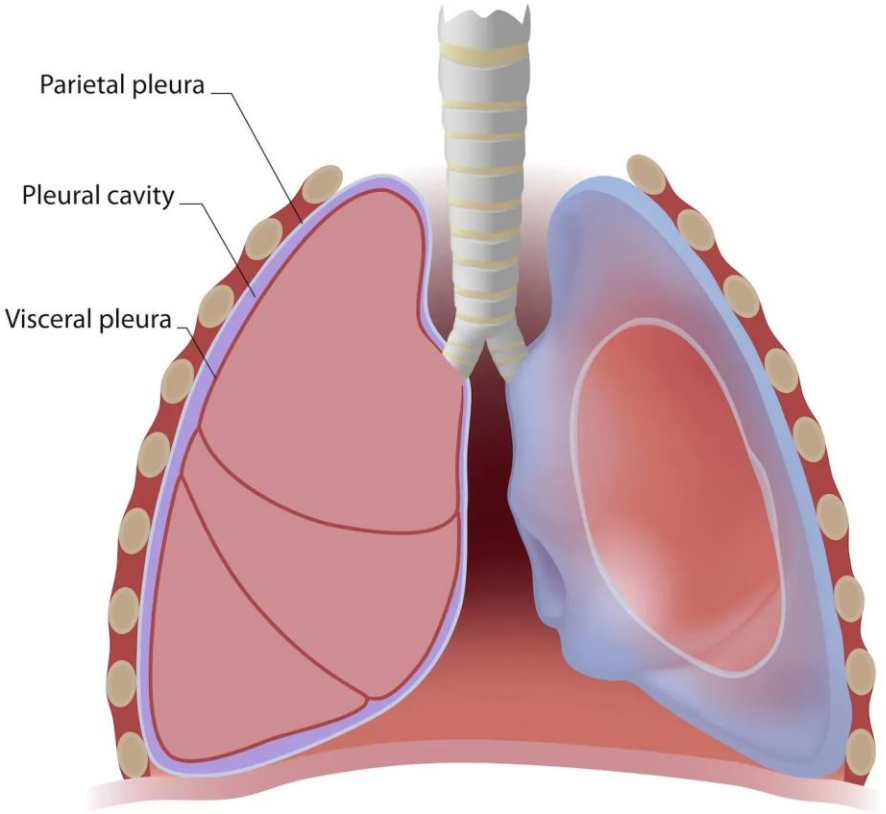
What's the difference between the conducting zone and respiratory zone?

The **conducting zone** moves air into and out of the lungs.
The **respiratory zone** moves oxygen and carbon dioxide in and out of the blood. This process is referred to as respiration or gas exchange.



Lungs and Pleural Cavities

- Lungs are inside pleural cavities
- Two layers of pleura:
- Visceral pleura (attached to lung)
- Parietal pleura (lines chest wall)
- Pleura is mesodermal in origin

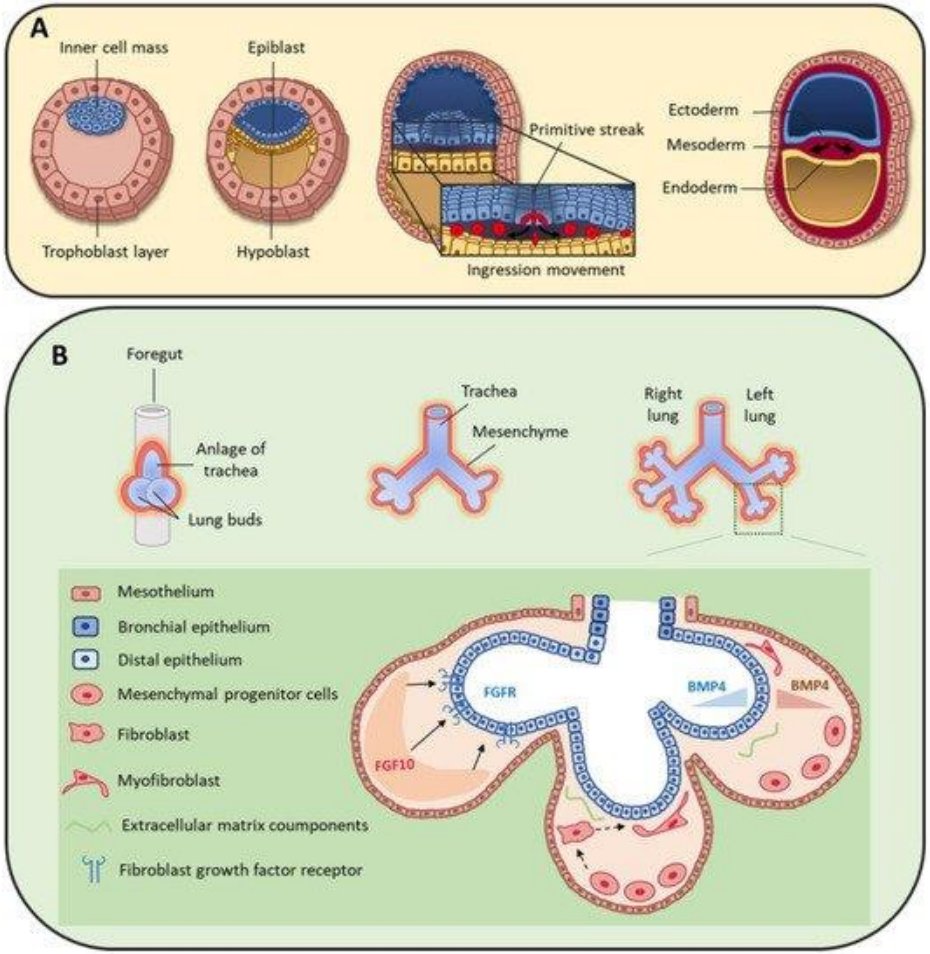


Can you explain why the pleura is important for lung function?

Pleura it cushion the lungs and makes breathing easier.

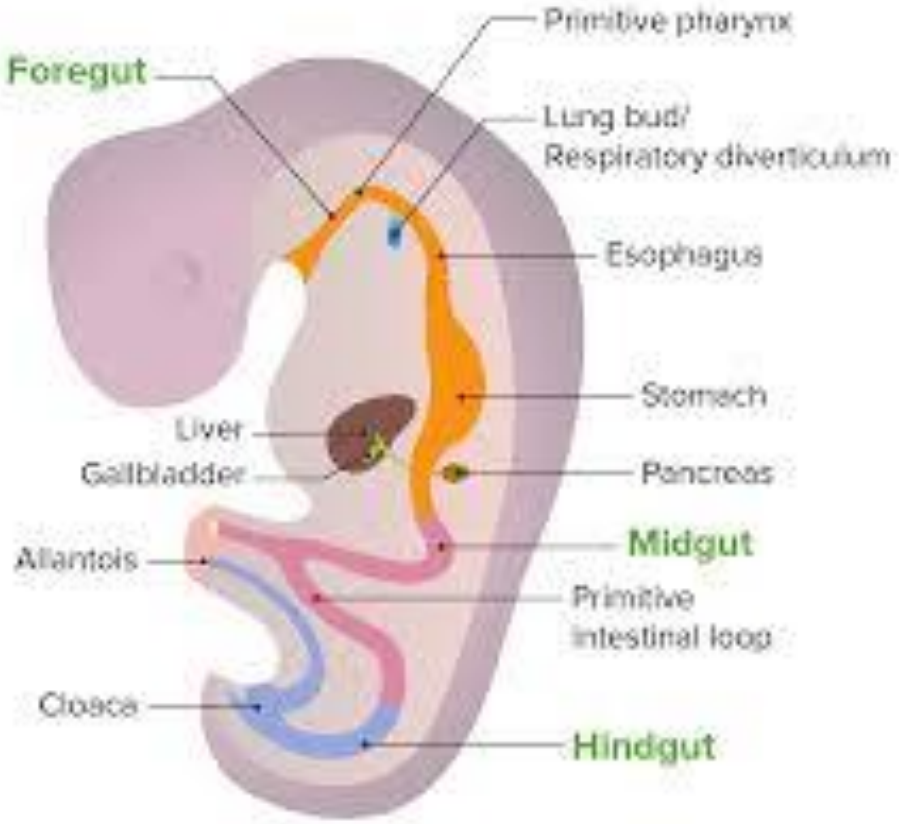
Embryological Origins

- Three germ layers: ectoderm, mesoderm, endoderm
- Airway wall components:
- Epithelial lining (endoderm)
- Smooth muscle, cartilage, connective tissue (mesoderm)

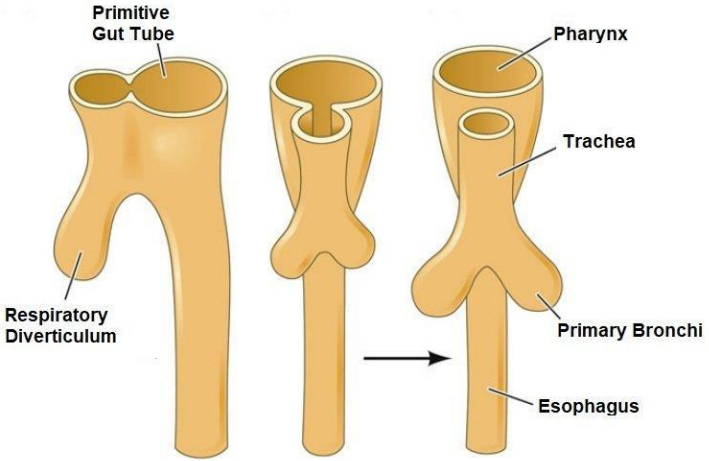


Why is it important to understand the embryological origins of tissues?

- It has potential for insights into important clinical issues, as well as fundamental insights into human biology, such as early pregnancy loss.
- origins of congenital anomalies
- developmental origins of adult disease.


Primitive pharynx
Foregut
Lung bud/
Respiratory diverticulum
Esophagus
Stomach
Liver
Gallbladder
Pancreas
Midgut
Allantois
Primitive
intestinal loop
Cloaca
Hindgut

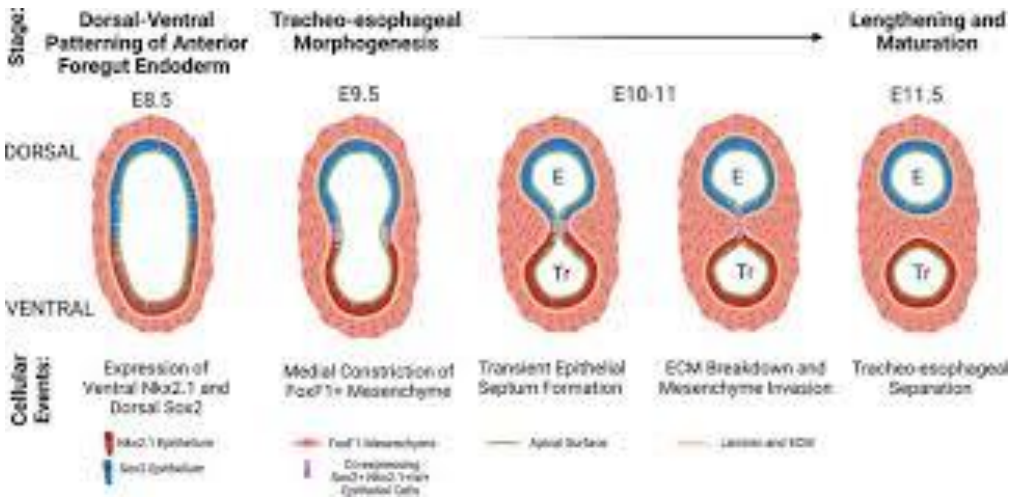
Week 4: The Beginning

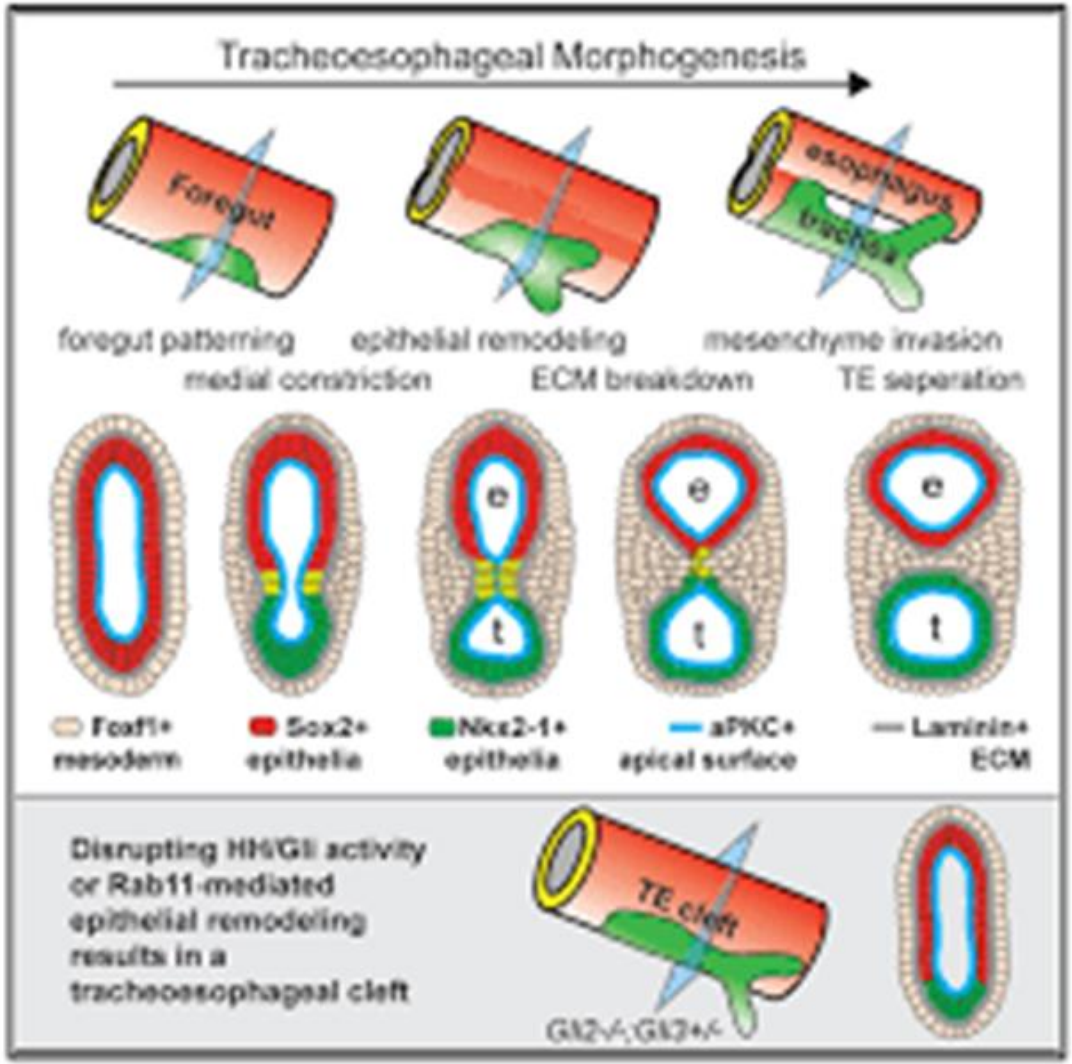


- Primitive gut tube
- Respiratory diverticulum forms as an outgrowth
- Lower portion becomes the lung bud
- Surrounded by splanchnic mesenchyme

Tracheoesophageal Separation

- Tracheoesophageal folds form longitudinally
- Folds fuse to create tracheoesophageal septum
- Separates ventral trachea from dorsal oesophagus




Tracheoesophageal Morphogenesis
Foregut
esophagus
trachea
foregut patterning
medial constriction
epithelial remodeling
ECM breakdown
mesenchyme invasion
TE separation
e
t
Foxf1+
mesoderm
Sox2+
epithelia
Nkx2-1+
epithelia
aPKC+
apical surface
Laminin+
ECM
Disrupting Hh/Gli activity
or Rab11-mediated
epithelial remodeling
results in a
tracheoesophageal cleft
TE cleft
Gli2-/-;Gli3+/-

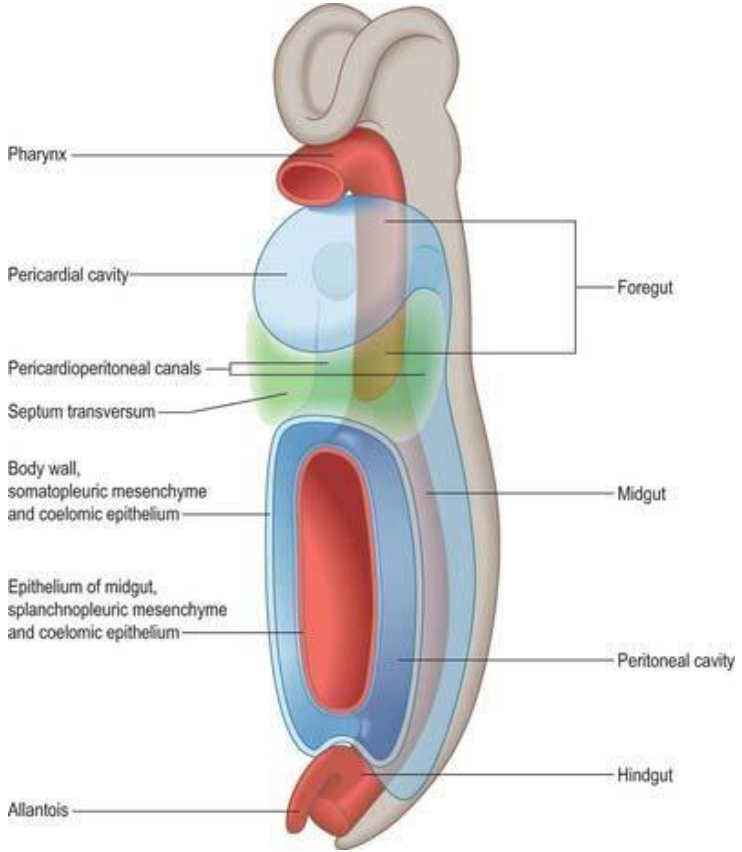
What could happen if this process goes wrong?

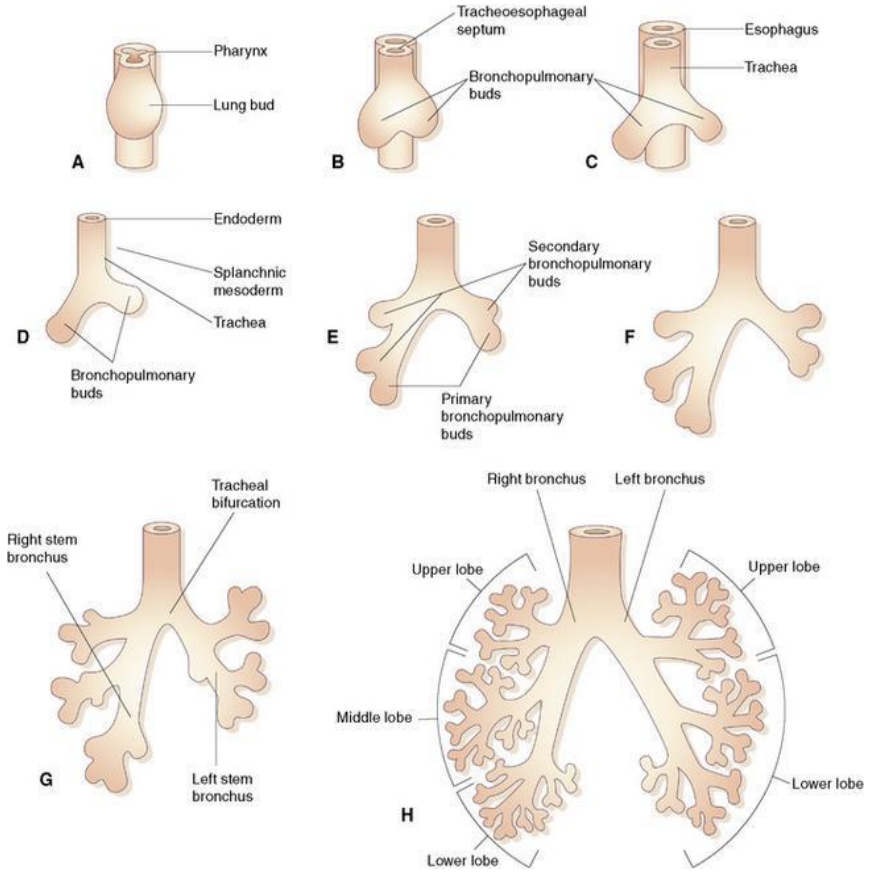
Esophageal atresia: Results from the failure of the foregut to recanalize

tracheoesophageal fistulas: Results from the failure of the lung bud to separate completely.

Formation of Pleural Cavities

- Bronchial buds grow into pericardioperitoneal canals
- Canals become pleural cavities
- Membranes form to separate cavities:
- Pleuropericardial membrane
- Pleuroperitoneal membrane





Bronchial Development

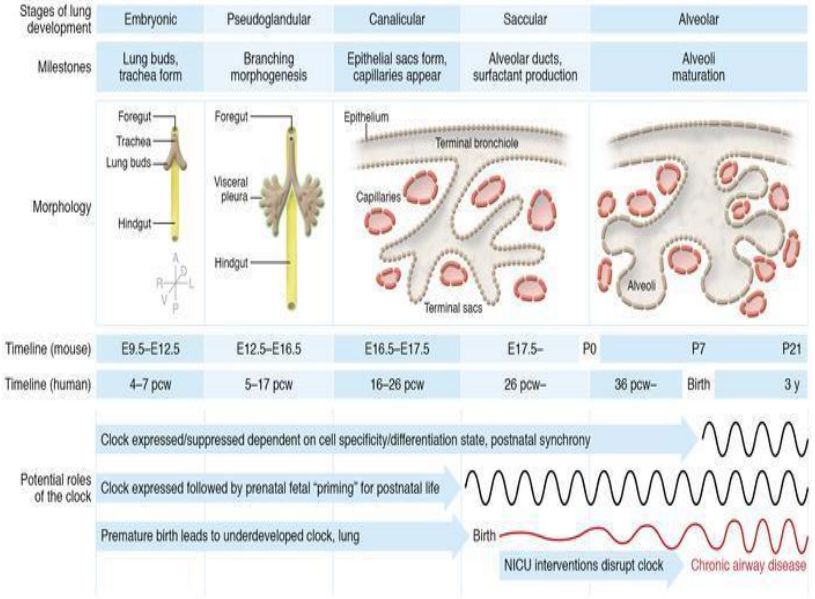
- Primary bronchi form from lung buds
- Secondary (lobar) bronchi:
- 3 on right, 2 on left
- Tertiary (segmental) bronchi:
- 10 on each side (may fuse on left)

Stages of Lung Development

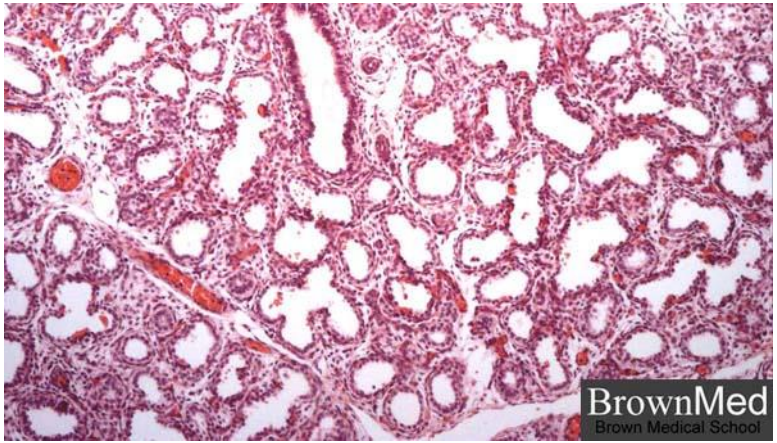
- Embryonic stage (up to 6 weeks)
- Pseudo-glandular stage (6-16 weeks)
- Canalicular stage (13-25 weeks)
- Saccular stage (24 weeks to birth)
- Alveolar stage (birth to 8 years)

Pseudo-glandular Stage (6-16 weeks)

- Lung resembles a gland
- Formation of:
- Bronchi
- Bronchioles
- Terminal bronchioles
- Surrounding mesenchyme forms connective tissue and capillaries



Canalicular Stage (13-25 weeks)



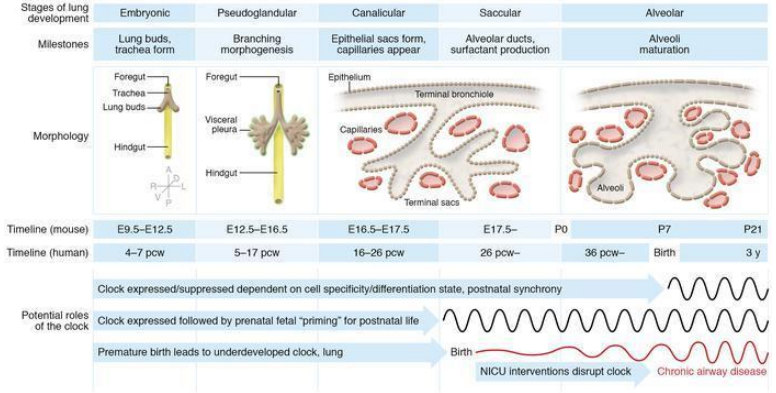
- Formation of respiratory bronchioles and alveolar ducts
- Widening of existing airways
- Increase in capillary development
- Why is this stage called "canalicular"?

Saccular Stage (24 weeks to birth)

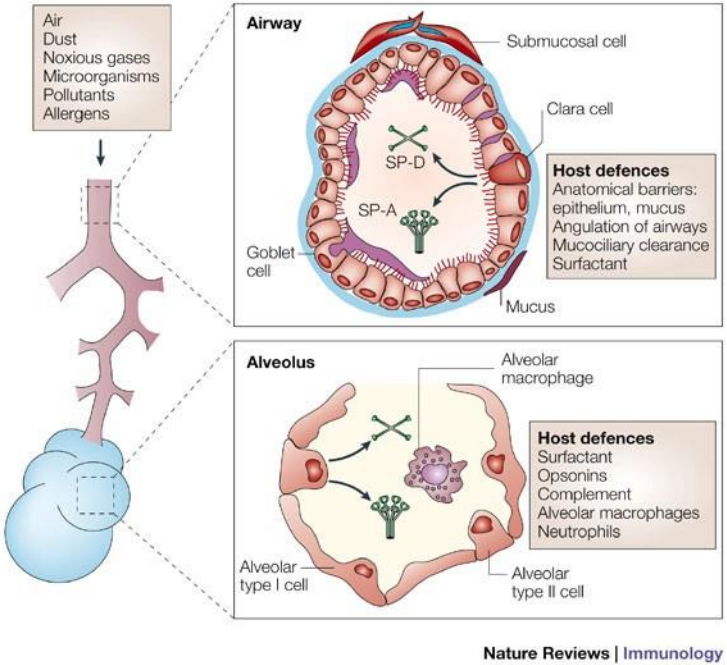
- Formation of alveolar sacs
- Development of primitive alveoli
- Flattening of alveolar lining cells (Type I cells)
- Appearance of Type II cells producing surfactant
- What is the significance of surfactant production?

Alveolar Stage (birth to 8 years)

- Maturation and proliferation of alveoli
- Millions of alveoli at birth, but more needed
- Continued development of gas exchange surfaces



Surfactant: A Crucial Component



- Produced by Type II alveolar cells
- Phospholipid that lines alveoli
- Reduces surface tension
- Prevents alveolar collapse
- How does surfactant relate to premature births?

Foetal Circulation and the Lungs

- Lungs filled with fluid in utero
- High pulmonary vascular resistance
- Cardiac shunts bypass lungs:
- Ductus arteriosus
- Foramen ovale
- Oxygenation occurs via placenta
- How does this differ from post-natal circulation?

Transition at Birth

- First breath fills lungs with air
- Lung fluid resorption
- Drop in pulmonary vascular resistance
- Closure of cardiac shunts
- Initiation of pulmonary gas exchange

Clinical Implications

- Premature birth can affect lung development
- Respiratory distress syndrome due to surfactant deficiency
- Potential for long-term respiratory issues

Summary: Key Stages of Respiratory System Development

- Embryonic: Formation of lung buds and primary structures
- Pseudoglandular: Development of conducting airways
- Canalicular: Formation of gas exchange structures
- Saccular: Development of primitive alveoli
- Alveolar: Maturation and proliferation of alveoli
- What aspect of respiratory system development do you find most fascinating?

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Question **1**

Not yet answered

Marked out of 1.00

A newborn male presents with excessive drooling, coughing, and cyanosis during feeding. A nasogastric tube is inserted but cannot be advanced into the stomach. Chest X-ray shows the tube coiled in the upper mediastinum. What is the most likely diagnosis?

- a. Diaphragmatic hernia
- b. Esophageal atresia with tracheoesophageal fistula
- c. Hyaline membrane disease
- d. Laryngomalacia
- e. Pulmonary hypoplasia

drooling occurs when excess saliva flows out of your mouth involuntarily.

Cyanosis refers to a bluish-purple color of the skin

Correct Answer

Esophageal atresia with tracheoesophageal fistula

Explanation:

Esophageal atresia with tracheoesophageal fistula (TEF): results from a failure of proper separation of the trachea and esophagus during embryological development (week 4).