

# Development of Respiratory System

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# OBJECTIVES

At the end of the lecture the students should be able to:

- Identify the development of the laryngeotracheal (respiratory) diverticulum.
- Identify the development of the larynx.
- Identify the development of the trachea.
- Identify the development of the bronchi & Lungs.
- Describe the periods of the maturation of the lung.
- Identify the most congenital anomaly.

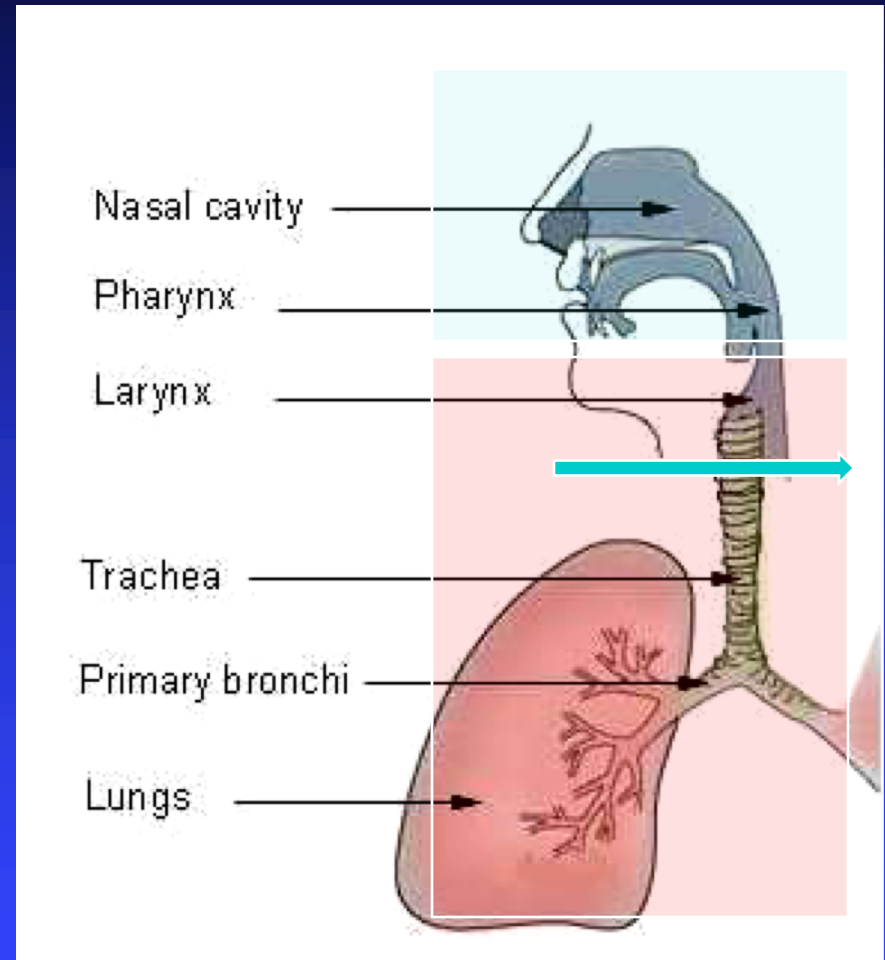
# Respiratory System

## ■ Upper respiratory tract:

- ◆ Nose
- ◆ Nasal cavity & paranasal sinuses
- ◆ Laryngo-pharynx
- ◆ Larynx.

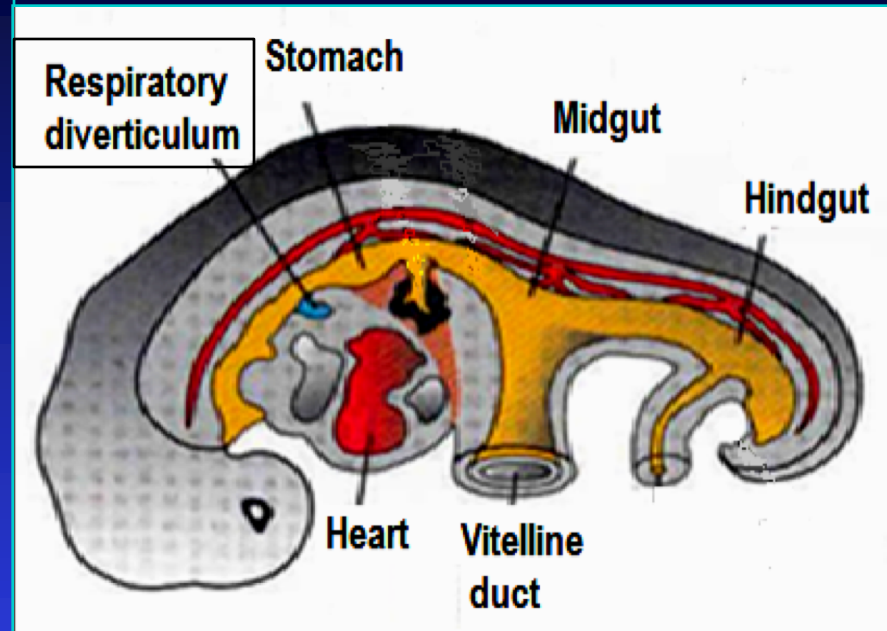
## ■ Lower respiratory tract:

- ◆ Trachea
- ◆ Bronchi
- ◆ Lungs



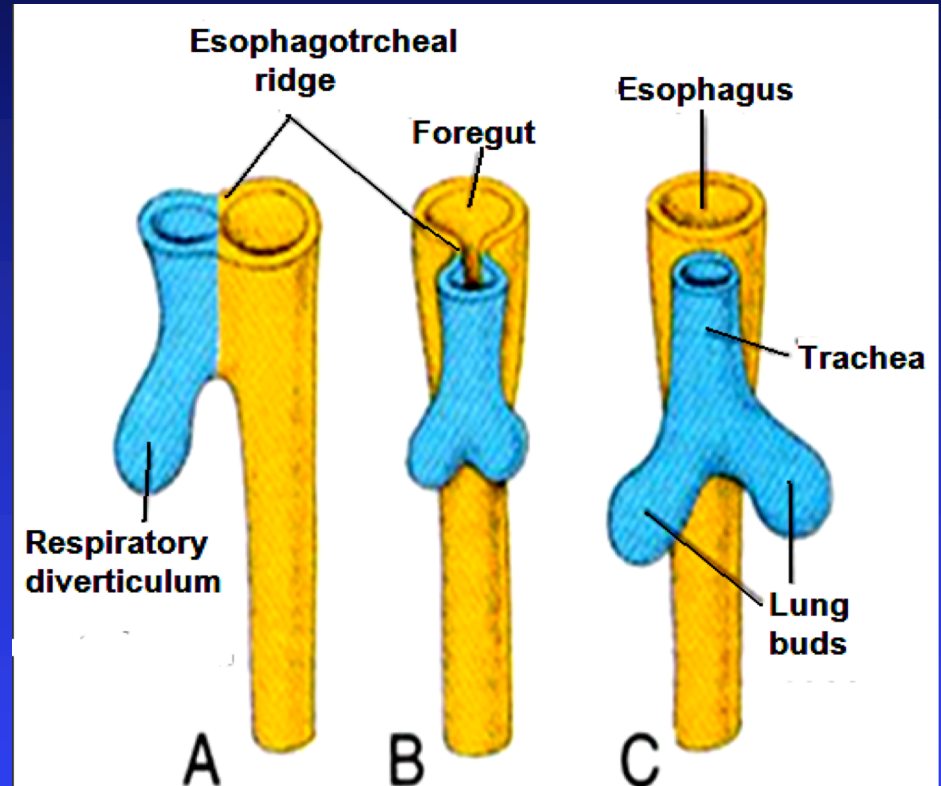
# Development of the Respiratory Tract

- **Begins** during the 4<sup>th</sup> week of development.
- **Begins as** a median outgrowth (**laryngo-tracheal groove**) from the **caudal part** of the **ventral wall** of the **primitive pharynx** (**foregut**)
- The groove **envaginates** and forms the **laryngotracheal (respiratory) diverticulum**.

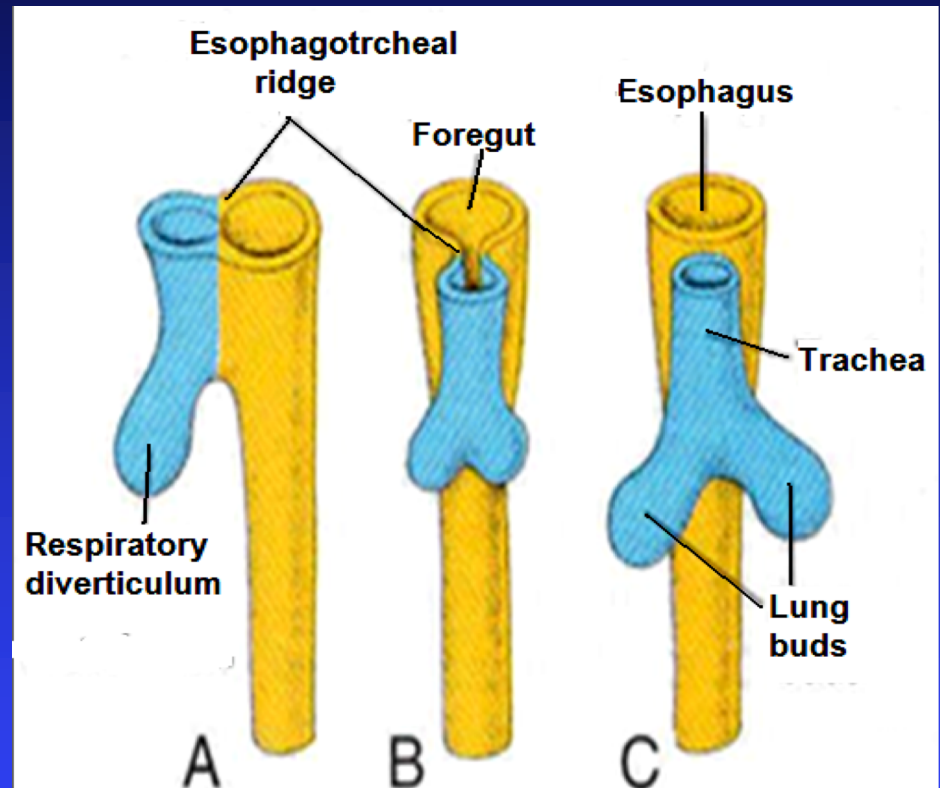


■ A longitudinal **tracheo-esophageal septum** develops and divides the diverticulum into a:

- ◆ **Dorsal portion:** primordium of the oropharynx and esophagus
- ◆ **Ventral portion:** primordium of larynx, trachea, bronchi and lungs



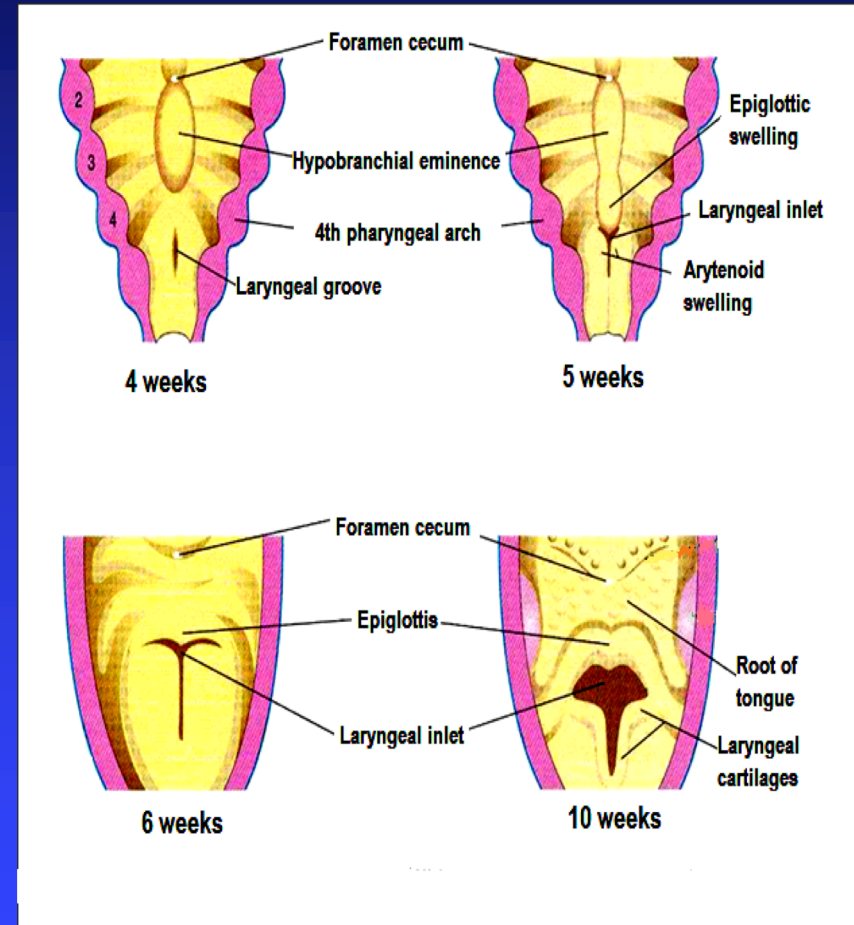
- **The proximal part** of the **respiratory diverticulum** remains tubular and forms **larynx & trachea.**
- **The distal end** of the diverticulum dilates to form **lung bud**, which **divides** to give rise to **2 lung buds (primary bronchial buds)**



- The **endoderm** lining the **laryngotracheal diverticulum (Respiratory diverticulum)**  
gives rise to the:
  - ◆ **Epithelium & Glands** of the respiratory tract.
  
- The **surrounding splanchnic mesoderm**  
gives rise to the:
  - ◆ **Connective tissue, Cartilage & Smooth muscles** of the respiratory tract

# Development of the Larynx

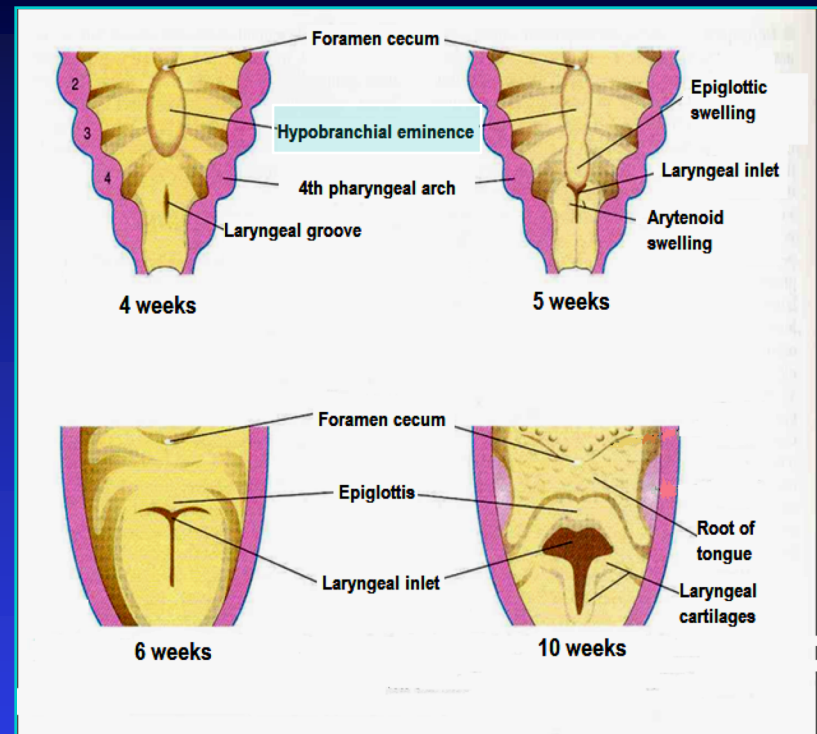
- The opening of the laryngotracheal diverticulum into the primitive foregut becomes the laryngeal orifice.
- The epithelium & glands are derived from endoderm.
- Laryngeal muscles & the cartilages of the larynx except Epiglottis develop from the mesoderm of 4<sup>th</sup> & 6<sup>th</sup> pairs of pharyngeal arches.





# Epiglottis

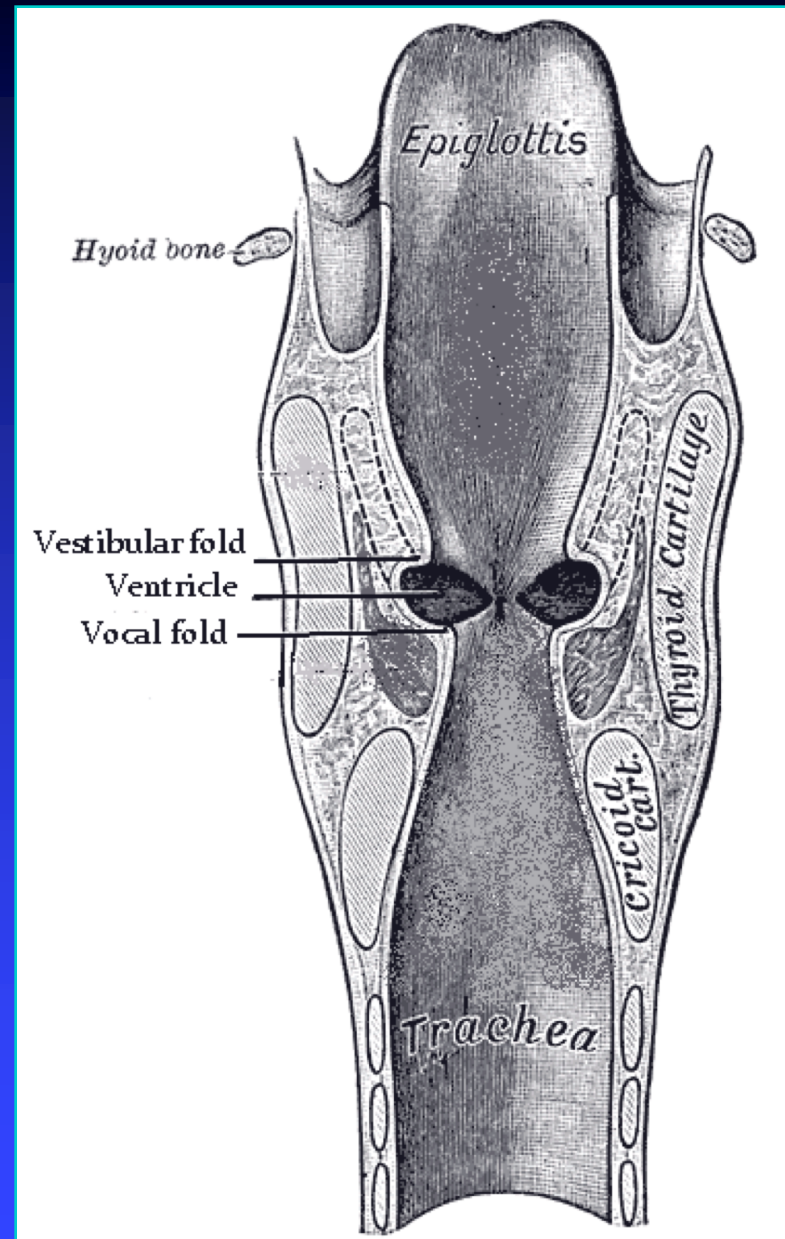
- It develops from the **caudal part** of the **hypopharyngeal eminence**, a swelling formed by the **proliferation of mesoderm in the floor of the pharynx**.



Growth of the **larynx and epiglottis is rapid** during **the first three years** after birth. By this time the epiglottis has reached its adult form.

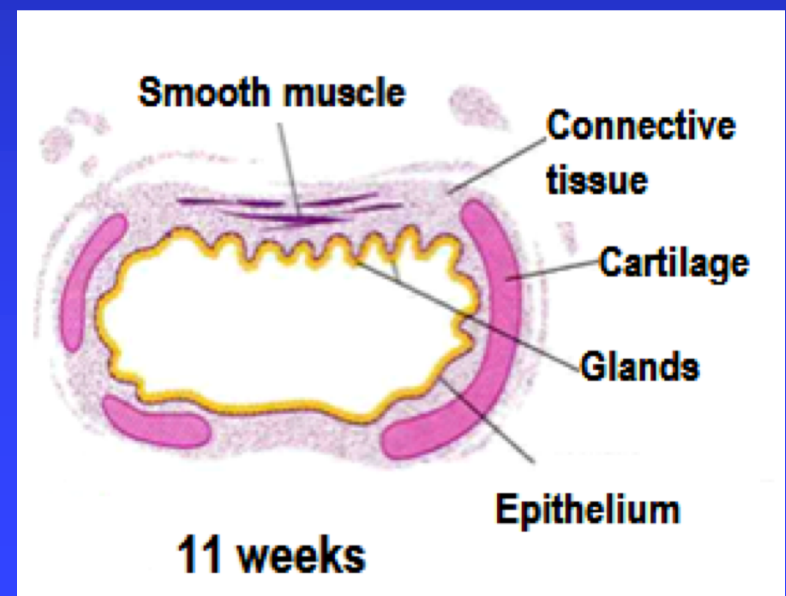
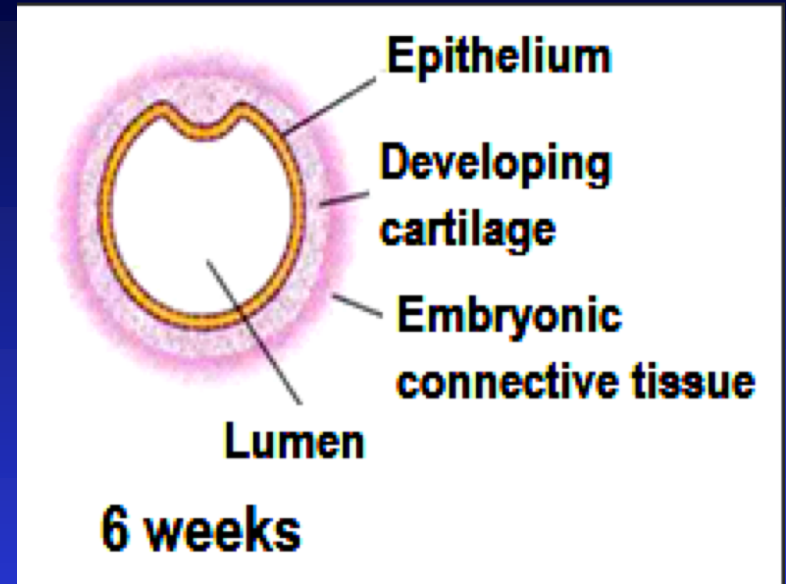
# Recanalization of larynx

- The **laryngeal epithelium** proliferates rapidly resulting in **temporary occlusion** of the laryngeal lumen
- **Recanalization** of larynx normally occurs by the **10<sup>th</sup> week**.
- Laryngeal **ventricles**, **vocal folds** and **vestibular folds** are formed during **recanalization**.



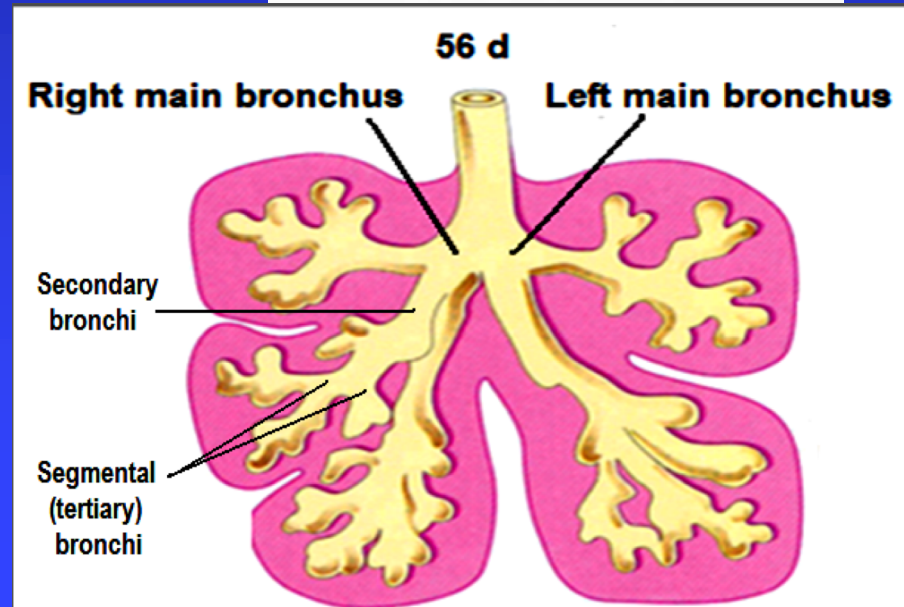
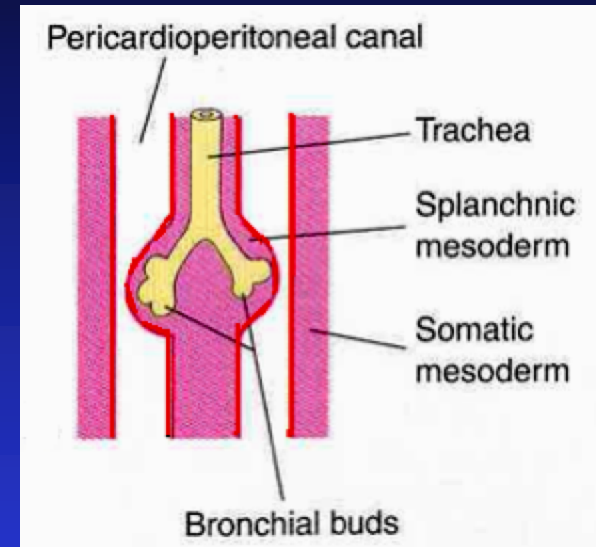
# Development of the Trachea

- The **endodermal lining** of the **laryngotracheal tube distal to the larynx** differentiates into the **epithelium and glands** of the trachea and pulmonary epithelium
- The **cartilages, connective tissue, and muscles** of the trachea are derived from the mesoderm.

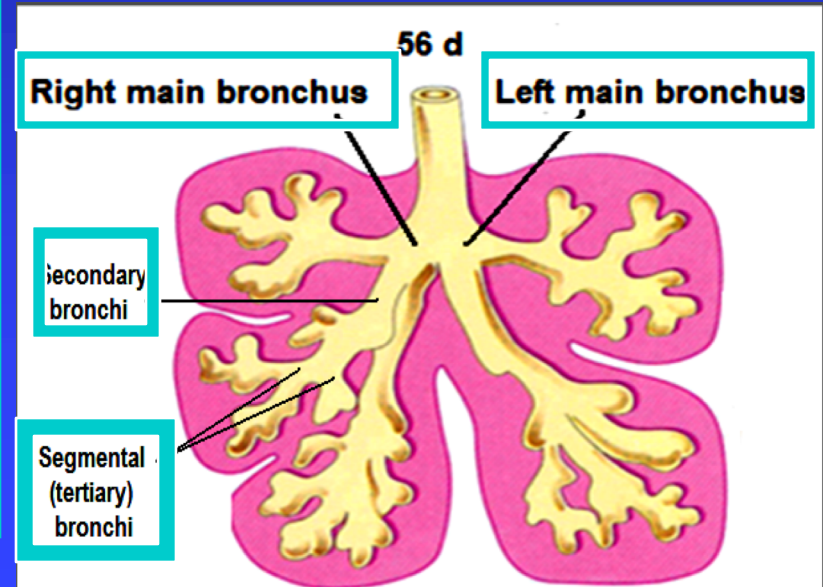
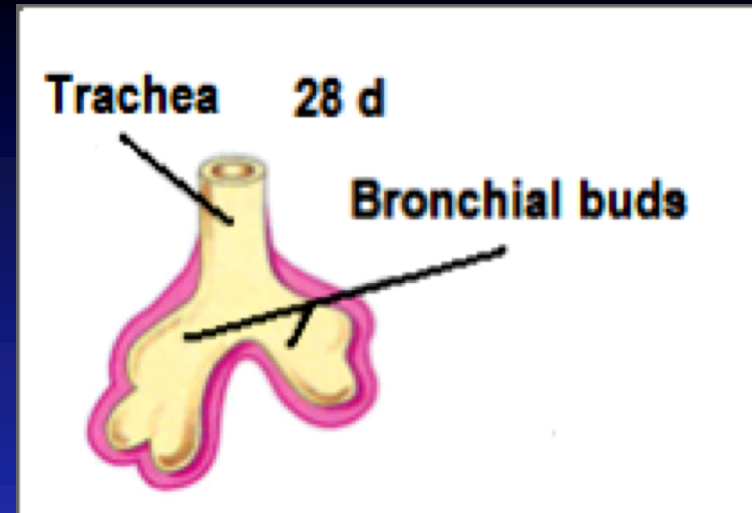


# Development of the Bronchi & Lungs

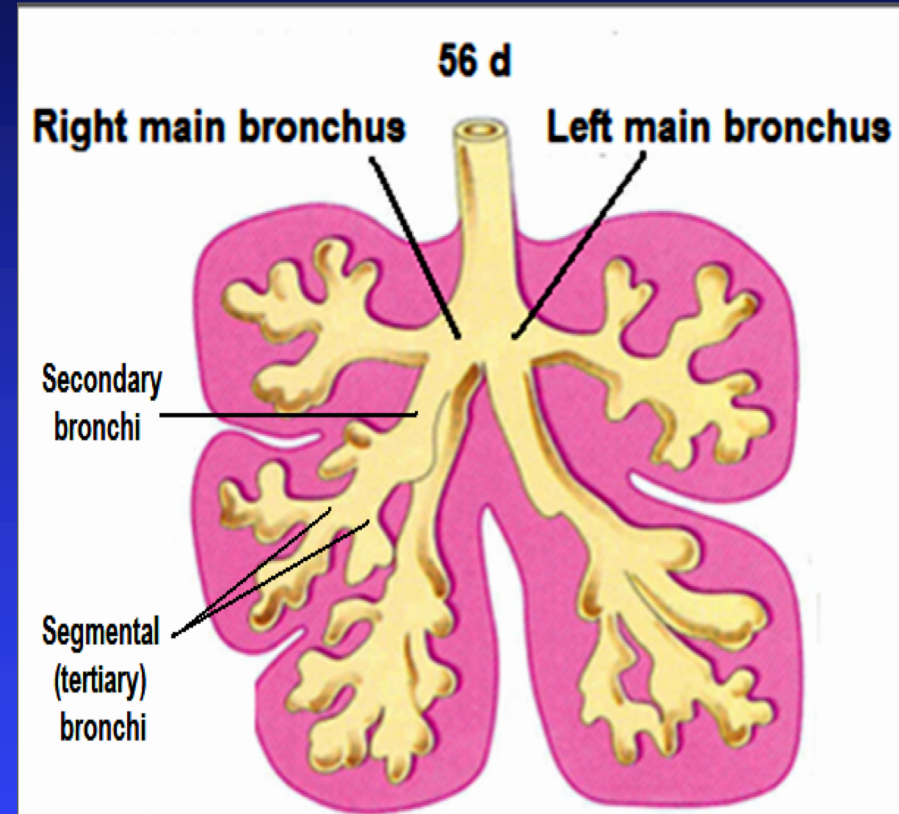
- **The 2 primary bronchial buds** grow laterally into the **pericardio-peritoneal canals** (part of intra-embryonic celome), **which the primordia of pleural cavities**
- **Bronchial buds** divide and re-divide to give the **bronchial tree**.



- **The right main bronchus** is slightly **larger (wider)** than the left one and is **oriented more vertically**
- The embryonic relationship persists in the adult.
- **The main bronchi** subdivide into **secondary** and **tertiary (segmental) bronchi** which give rise to further branches.

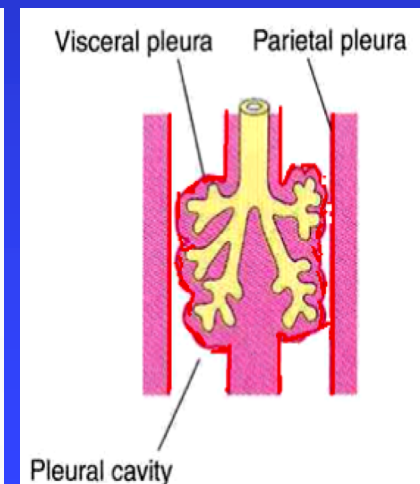
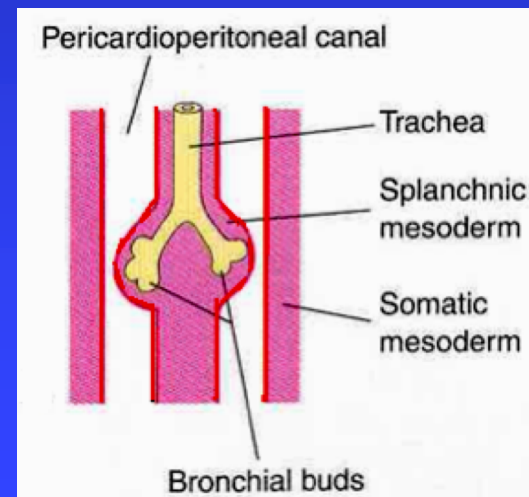
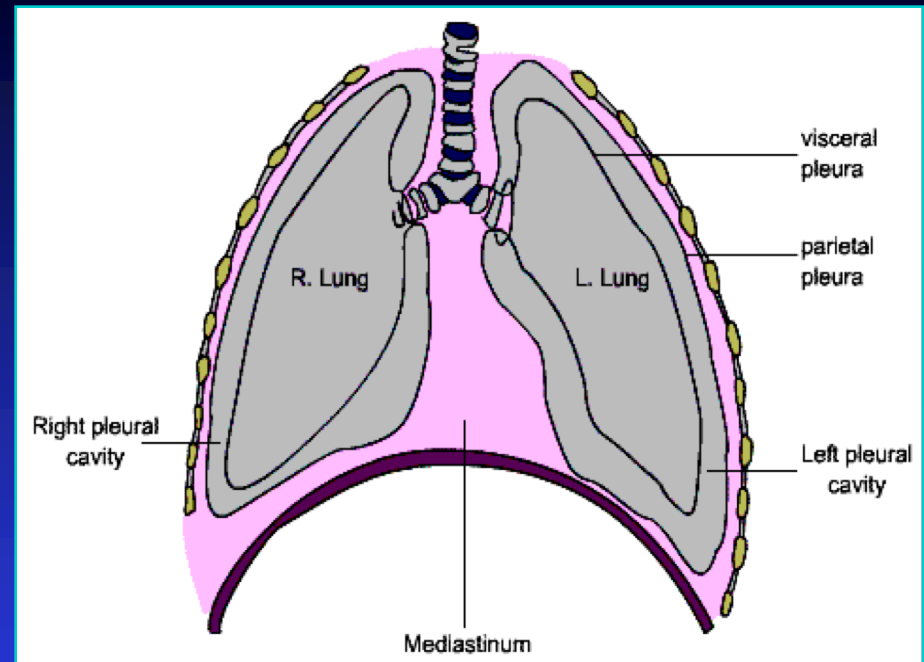


- **The segmental bronchi** 10 in right lung and 8 or 9 in the left lung begin to form by the **7th week**
- The surrounding mesenchyme also divides.
- Each segmental bronchus with its surrounding mass of mesenchyme is the primordium of a **bronchopulmonary segment**.



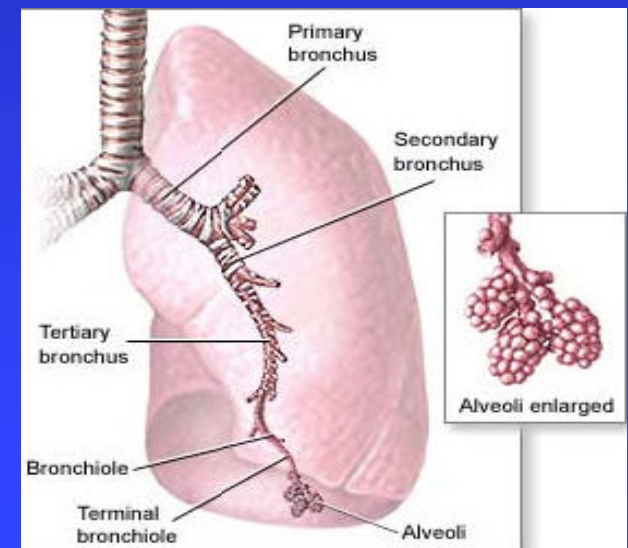
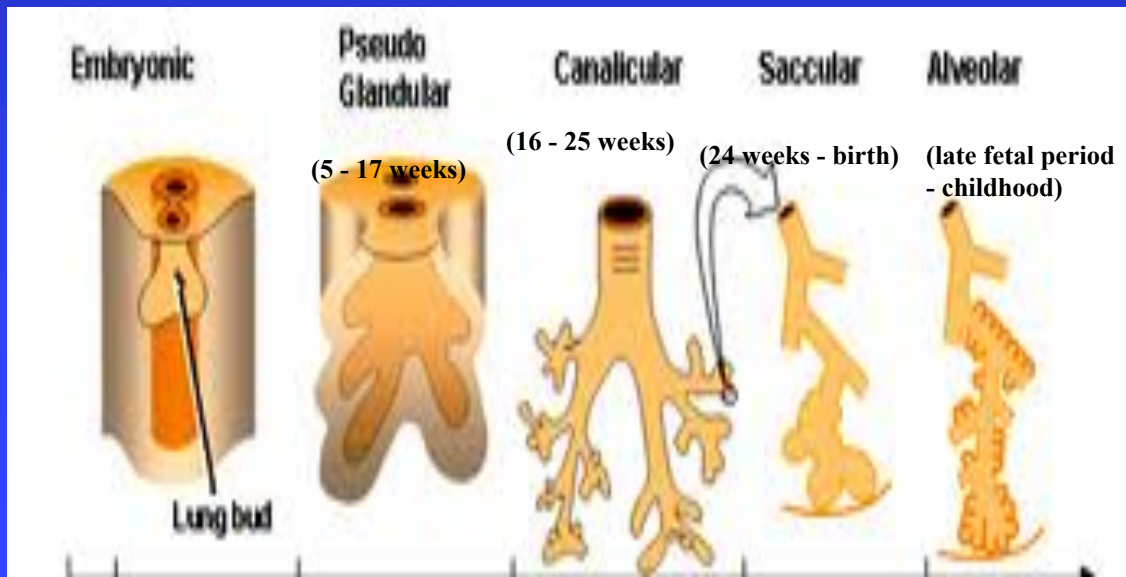
## Development of the pleura

- As the lungs develop they acquire a layer of **visceral pleura from splanchnic mesenchyme.**
- The thoracic body wall becomes lined by a layer of **parietal pleura derived from the somatic mesoderm.**



# Maturation of the Lungs

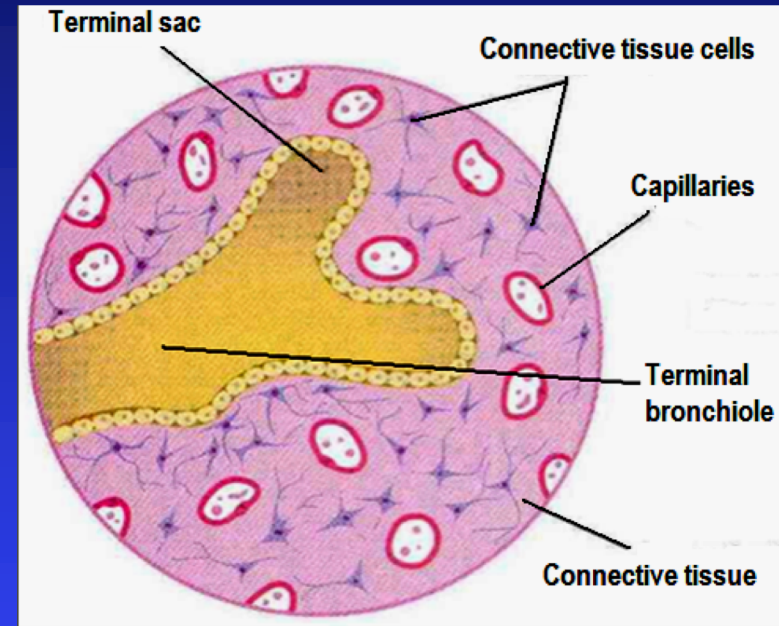
- Maturation of lung is divided into 4 periods:
  - ◆ **Pseudoglandular** (5 - 17 weeks)
  - ◆ **Canalicular** (16 - 25 weeks)
  - ◆ **Terminal sac** (24 weeks - birth)
  - ◆ **Alveolar** (late fetal period - childhood)
- These periods overlap each other because the cranial segments of the lungs mature faster than the caudal ones





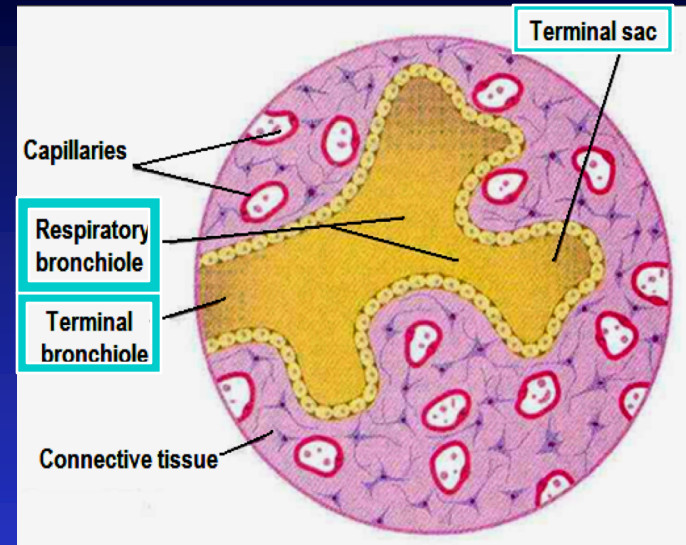
# Pseudoglandular Period (5-17 weeks)

- Developing lungs somewhat resembles an exocrine gland during this period.
- By **17 weeks** all major elements of the lung have formed except those involved with gas exchange (alveoli).
- Respiration is NOT possible.
- **Fetuses** born during this period are **unable to survive**.



# Canalicular Period (16-25 weeks)

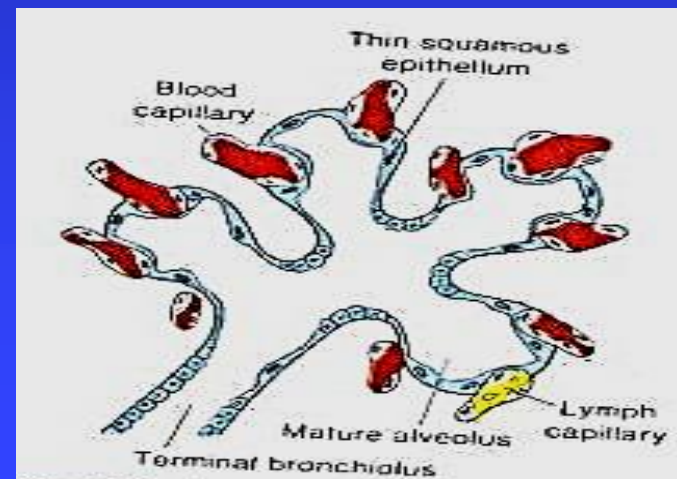
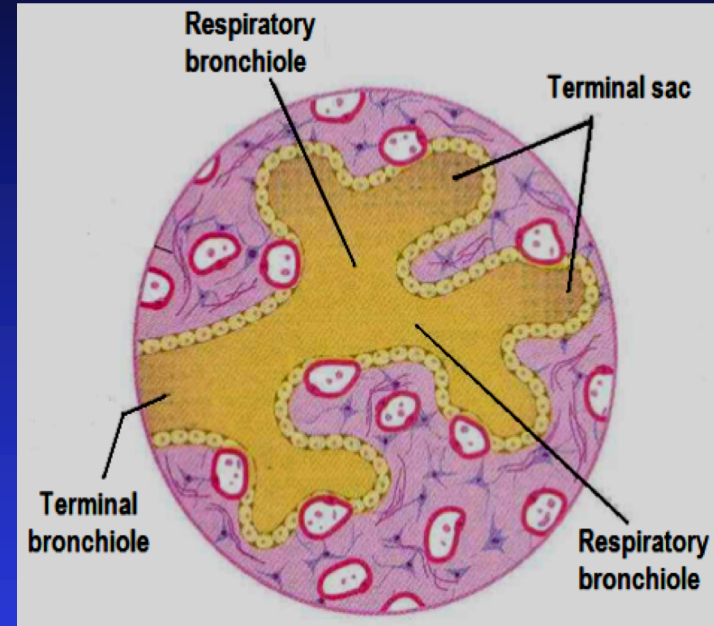
- Lung tissue becomes **highly vascular**.
- Lumina of **bronchi** and **terminal bronchioles** become larger.
- By **24 weeks** each **terminal bronchiole** has given rise to two or more **respiratory bronchioles**.
- The respiratory bronchioles divide into 3 to 6 tubular passages called **alveolar ducts**.
- Some thin-walled **terminal sacs** (**primordial alveoli**) develop at the end of respiratory bronchioles.



- **Respiration is possible at the end of this period.**
- **Fetus born at the end of this period may survive if given intensive care (but usually die because of the immaturity of respiratory as well as other systems)**

# Terminal Sac Period (24 weeks - birth)

- Many more terminal sacs develop.
- Their epithelium becomes very thin.
- Capillaries begin to bulge into developing alveoli.
- The epithelial cells of the **alveoli** and the endothelial cells of the **capillaries** come in intimate contact and establish the blood-air barrier.
- Adequate gas exchange can occur which allows the prematurely born fetus to survive

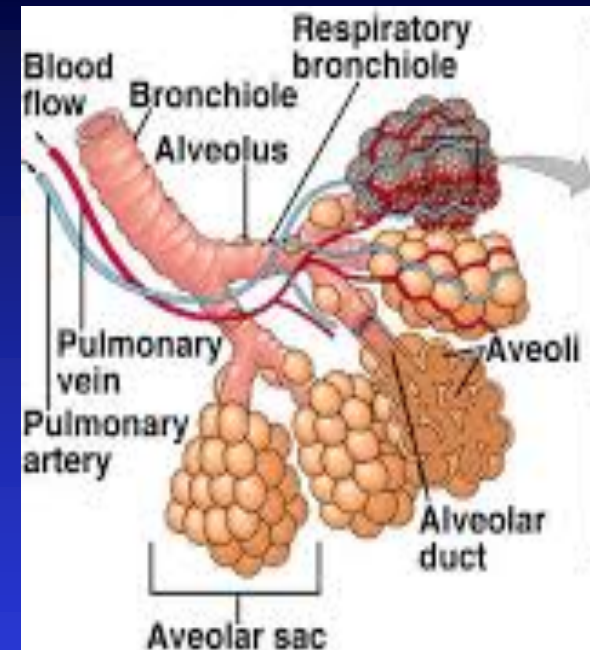




- **Surfactant** production **begins** by **20 weeks** and **increases** during the terminal stages of pregnancy.
- **Sufficient terminal sacs, pulmonary vasculature & surfactant** are present to permit survival of a prematurely born infants
- Fetuses born prematurely at **24-26 weeks** may suffer from respiratory distress due to surfactant deficiency but may survive if given **intensive care**.

# Alveolar Period (32 weeks – 8 years)

- At the beginning of the alveolar period, **each respiratory bronchiole terminates** in a cluster of thin-walled **terminal saccules** separated from one another by loose connective tissue.
- **These terminal saccules** represent **future alveolar sacs.**



PRETERM LUNGS



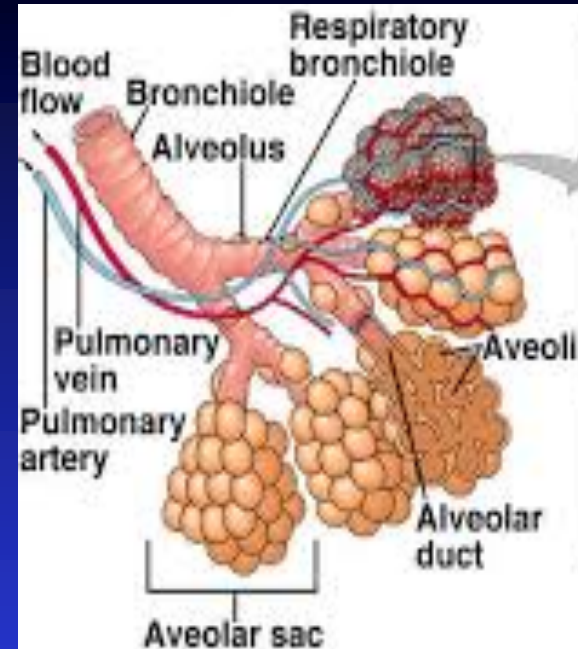
32 WEEKS GESTATIONAL AGE

FULL-TERM LUNGS



40 WEEKS GESTATIONAL AGE

- Characteristic mature alveoli do not form until after birth, so; 95% of alveoli develop postnatally.
- About 50 million alveoli, one sixth of the adult number are present in the lungs of a full-term newborn infant.

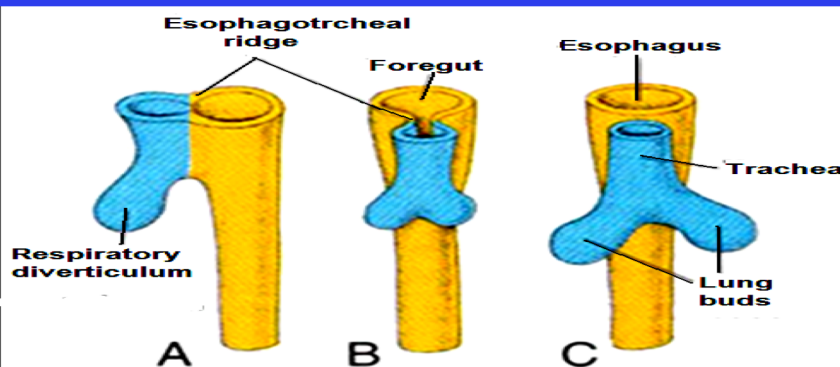
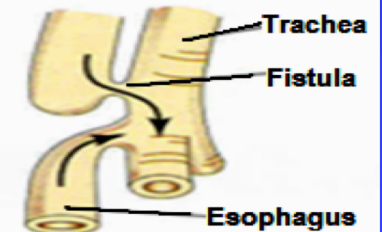
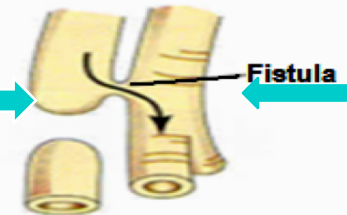
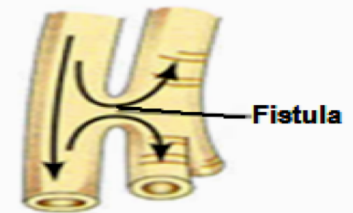
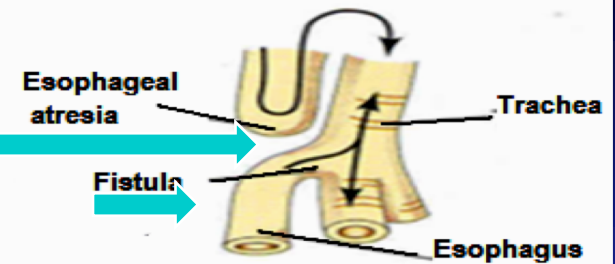


- From 3-8 year or so, **the number of alveoli continues to increase**, forming additional primordial alveoli.
- **By about the eighth year**, the **adult complement of 300 million alveoli is present**.

# Developmental anomalies

## Tracheo-esophageal Fistula

- An **abnormal passage** between the trachea and esophagus.
- **Results from incomplete division** of the cranial part of the foregut into **respiratory** and **esophageal parts** by the **tracheo-esophageal septum**.
- Occurs once in 3000 to 4500 live births.
- Most affected infants are **males**.
- In more than **85% of cases**, the fistula is **associated with esophageal atresia** (esophagus ends in a blind-ended pouch rather than connecting normally to the stomach).



**Thank You**