

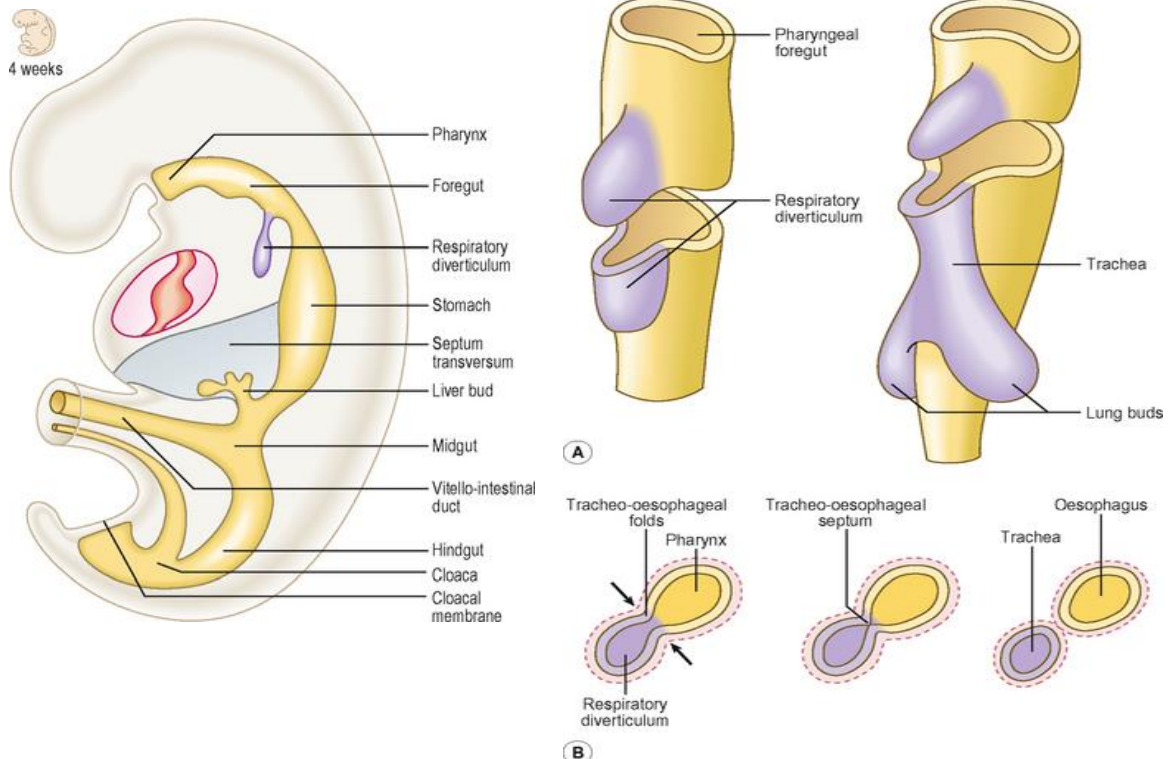
[Type text]

Development of the Respiratory System

* The development of respiratory system starts in the **4th week** from :

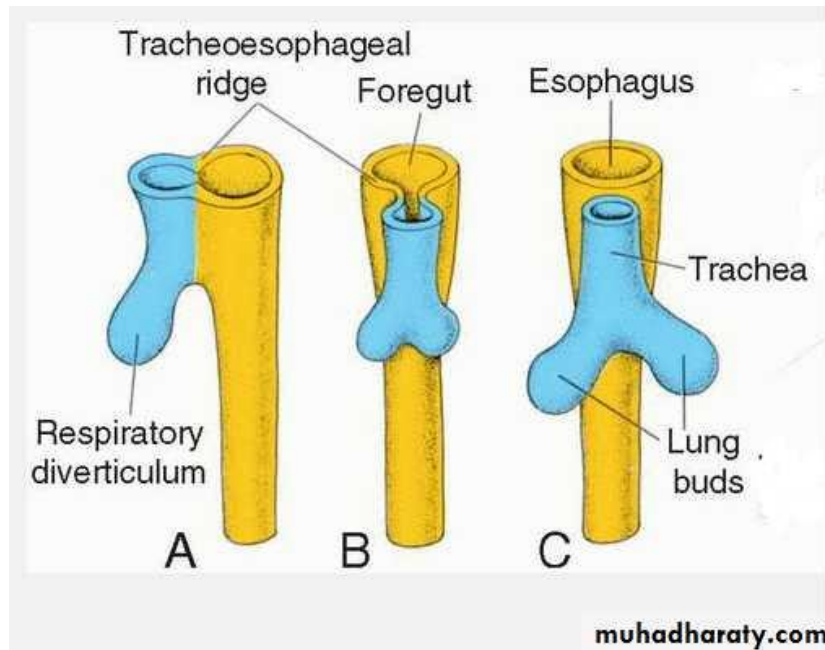
I) The epithelium develops from the **endoderm of the floor of the pharyngeal part of the foregut:**

- A **respiratory diverticulum (lung bud)**, appears as an outgrowth from the ventral wall of foregut .
- Two longitudinal ridges (**tracheoesophageal ridges**) develop on both sides .
- Then these ridges fuse to form **tracheoesophageal septum** dividing the foregut from caudal to cranial into:
 - Dorsal part forms the future **esophagus**.
 - Ventral part forms the **laryngo-tracheal tube**.

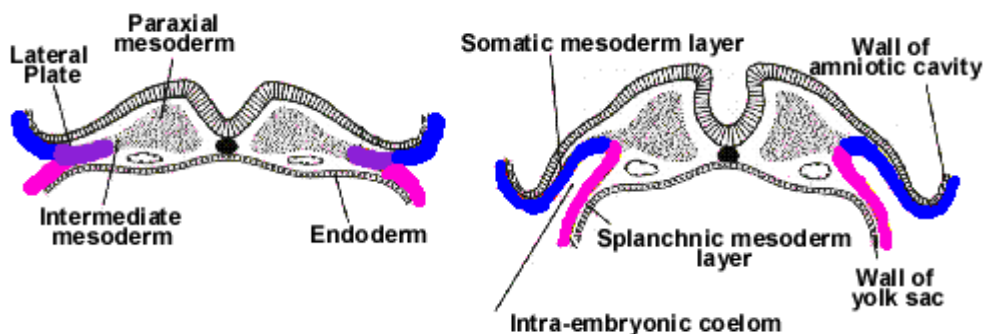


[Type text]

- **The laryngo-tracheal tube** grows caudally:
 - **Its upper part** forms the larynx and maintain its communication with the pharyngeal part of foregut through laryngeal inlet (orifice) .
 - **The next part** forms trachea.
 - **Its lower part** divides into 2 lateral out pouching called **bronchial buds**.



II) The other components of the respiratory system (muscles, cartilages, connective tissue, vessels) develop from the surrounding **splanchnic mesoderm**.



THE LARYNX

* **Cartilages :**

- **Epiglottis:** develops from the mesoderm of the caudal part of the hypobranchial eminence (part of 4th pharyngeal arch).
- **Other cartilages:** develops from the mesoderm of 4th and 6th arches.

* **Muscles :**

- **Cricothyroid muscle:** develops from the 4th arch (supplied by external laryngeal nerve which is branch from superior laryngeal nerve).
- **Other muscles:** develop from the 6th arch (supplied by the recurrent laryngeal nerve).

* **Mucous membrane :**

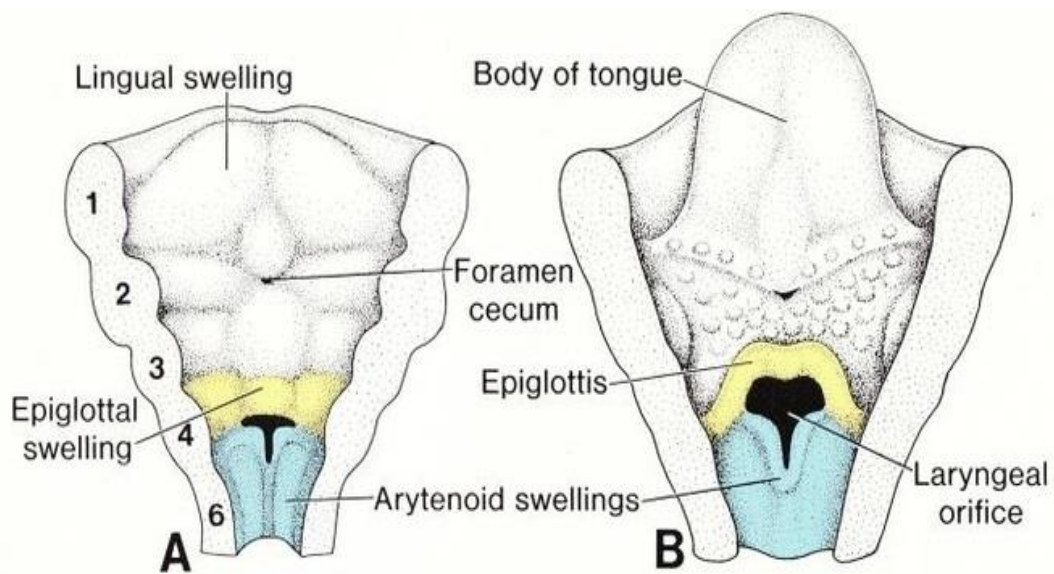
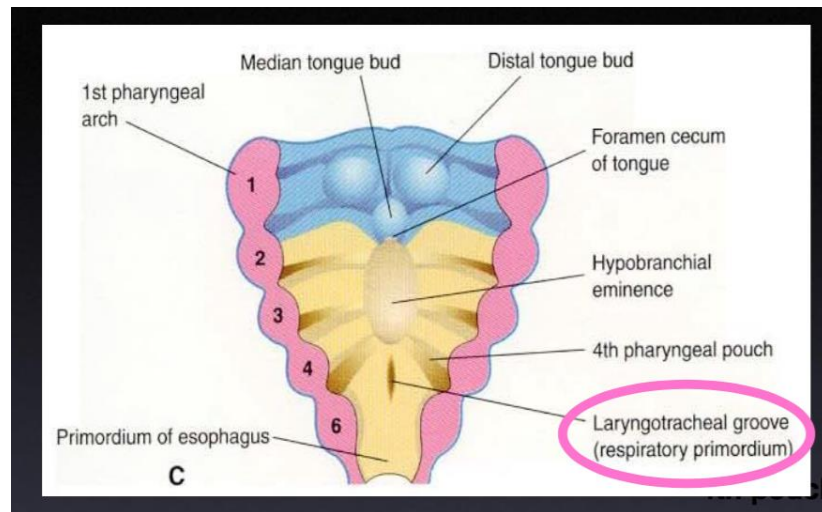
- **Supraglottic area:** derived from 4th arch (supplied by internal laryngeal nerve which is a branch of superior laryngeal nerve).
- **Infraglottic area:** derived from 6th arch (supplied by the recurrent laryngeal nerve).

* **Inlet of larynx :**

- The respiratory diverticulum communicates with pharyngeal part of the gut by the laryngeal inlet .
- In the 4th week of gestation , the inlet of larynx appears as sagittal groove called **laryngotracheal groove** in the floor of the pharyngeal part of the foregut between the 4th and 6th arch .
- From the 4th arch develop a single **epiglottic swelling** cranial to the the laryngotracheal groove , and from the 6th arch **2 arytenoid**

[Type text]

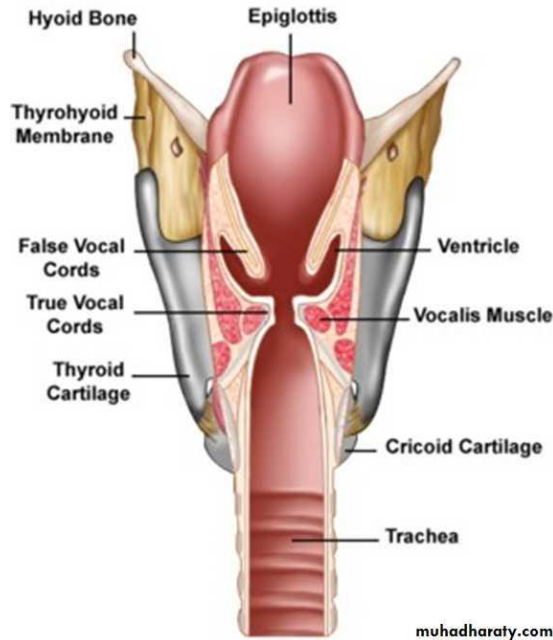
swellings develop caudal to this groove with formation of a **T shaped laryngeal inlet** .



* **Lumen of larynx :**

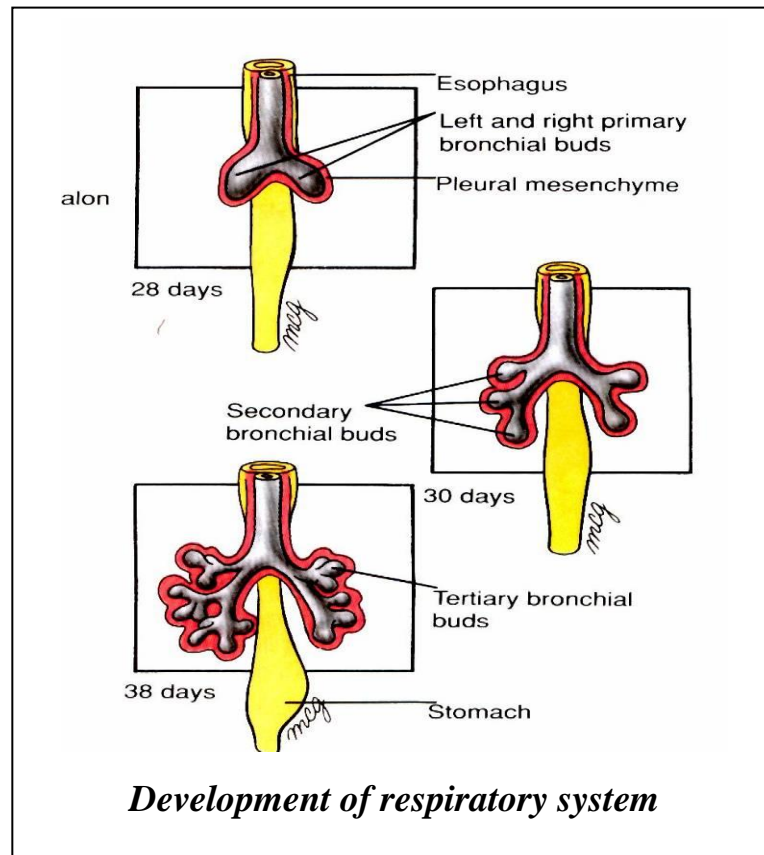
- **Early** , due to rapid proliferation of laryngeal epithelium , temporary occlusion of the lumen occurs .
- **Subsequently** , **recanalization** of the lumen occurs with **formation of** vocal folds , vestibular folds and 2 lateral recesses (ventricles of larynx).

[Type text]



Trachea , Bronchi and lungs

- During separation of respiratory diverticulum from the foregut, the laryngo-tracheal tube forms the trachea and two bronchial buds.



[Type text]

- These 2 buds grow laterally to form **right and left main bronchi**.
- The **right** bud then branches into **three** secondary lobar bronchi, while the **left** bud forms **two secondary lobar bronchi**.
- With further development, the secondary bronchi **divide** repeatedly forming **10 right tertiary (segmental)** bronchi in the right lung and **8-10 left tertiary (segmental)** bronchi with division of the surrounding splanchnic mesoderm creating the **bronchopulmonary segments** of the adult .
- 17 generations of subdivisions occur before birth & 7 more generations are formed after birth.

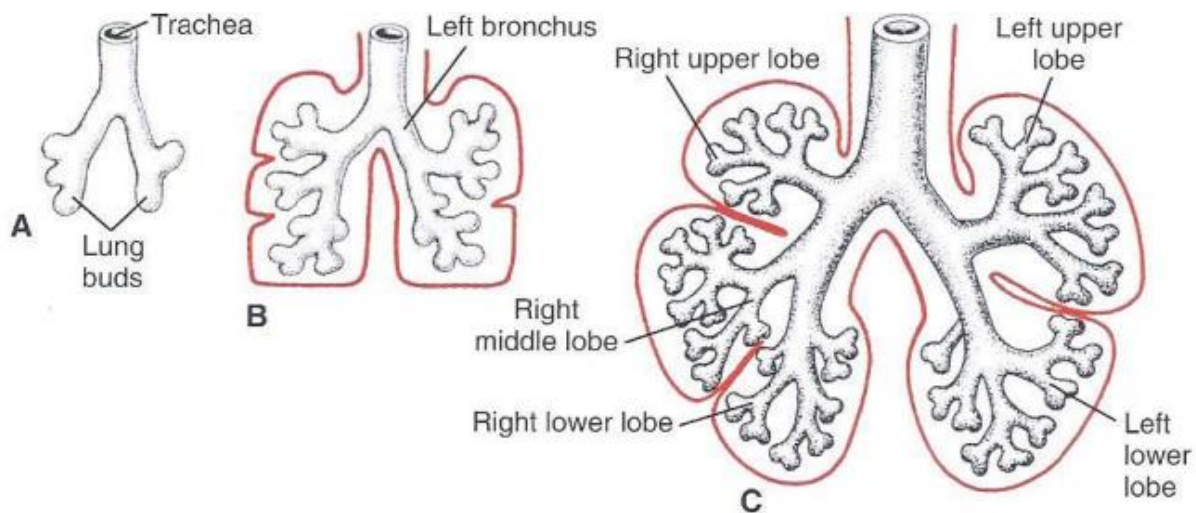


Figure 14.5 Stages in development of the trachea and lungs. **A.** 5 weeks. **B.** 6 weeks. **C.** 8 weeks.

- **Maturation of the lungs** is divided into 4 periods :
 - 1- Pseudoglandular period** : (5-17 weeks)
 - The lungs resemble **exocrine glands** .
 - At the end of this period , **all elements** of lungs are formed

except alveoli .

- Respiration is **not** possible .

2) Canalicular period :(16-25 weeks)

- The lungs becomes **highly vascular** and each bronchiole divide into **3-6 alveolar ducts** .
- **At the end** of this period , some thin wall **terminal sacs** develop at the end of alveolar duct → respiration is **possible** and if the fetus is born , may survive in **intensive care**.

3) Saccular period : (24 - birth)

- Many **terminal sacs** (future alveoli) , develop at the end of the alveolar ducts , with their **epithelium** becomes very **thin** and comes in close contact with the **endothelium** of the capillaries to form **blood-air barrier** .
- **Gas exchange** can occur allowing premature fetus to survive .
- Secretion of **surfactant** (which allow postnatal distension of the alveoli) starts from 24 weeks of gestations.

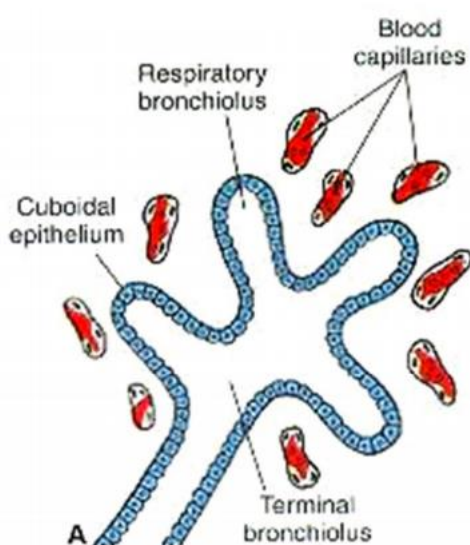
4) Alveolar period : (32 weeks – 8 years)

- Each respiratory bronchioles terminates into a clusters of thin wall **mature alveoli** with formation of **alveolo-capillary membrane** allowing **gas exchange** .
- 95% of mature alveoli develop **postnatally** .
- These **periods overlap** each others because the **cranial** segments of the lungs mature **faster** than the caudal segments .
- **Before birth** , respiratory movements allow suction of amniotic fluid in the airway which help expansion & development of the lungs , the

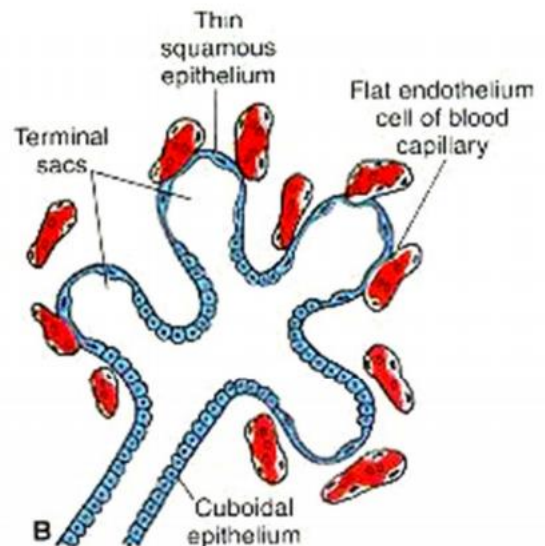
[Type text]

respiratory passage help in secretion of amniotic fluid and training of respiratory muscles .

- **After birth** , the lungs half filled with amniotic **fluid** which is **cleared** through the nose & mouth due to **compression** of the thorax during labour and **absorption** of this fluid through veins , capillaries and lymphatics . With the first inspiration , air enters the lungs , the lungs are inflated , starting of gas exchange with establishment of pulmonary circulation.
 - **Clinical importance** : The lung of **stillbirth** sinks in water while if the **baby die after birth** his lung float in water (contain air)
- As the lungs develop , they acquire a layer of **visceral pleura** derived from **splanchnic** mesoderm and the thoracic wall is lined by a layer of **parietal pleura** derived from the **somatic** mesoderm . The space in between forms the **pleural cavity** .

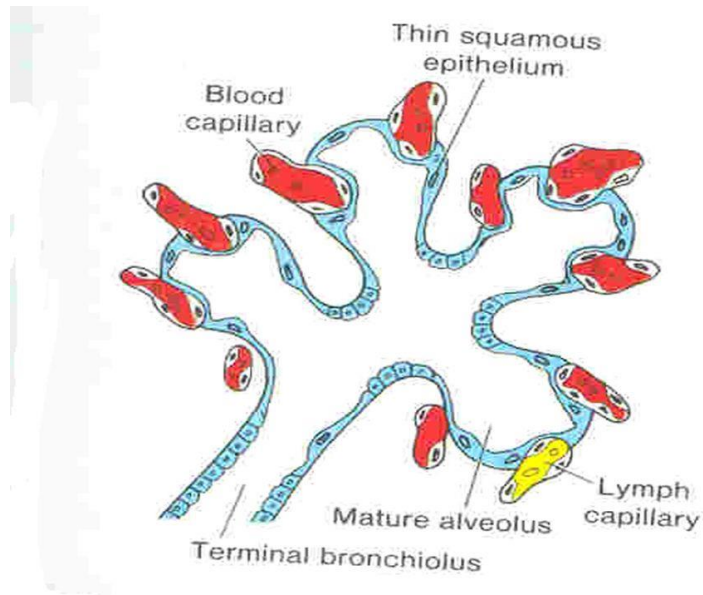


Canalicular period

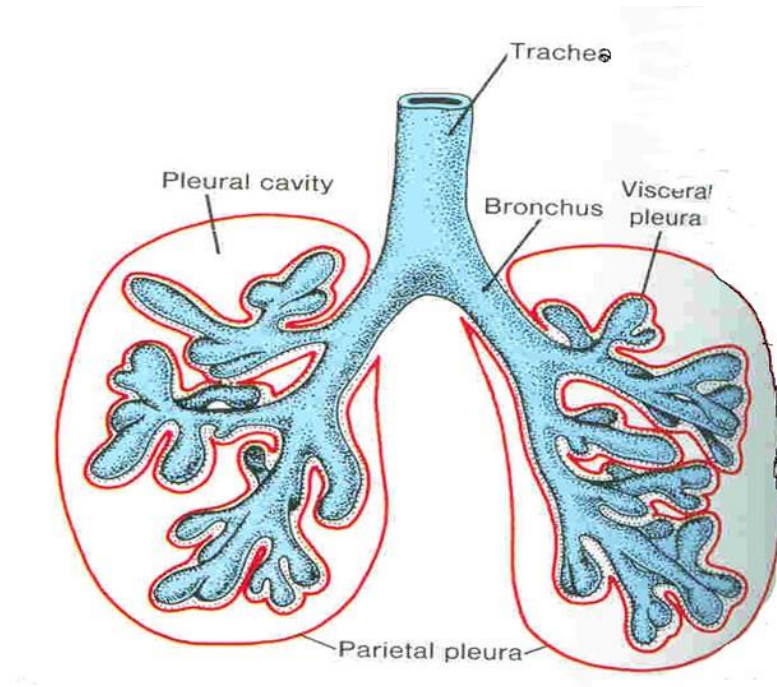


Saccular period

[Type text]



Alveolar period



Development of pleura

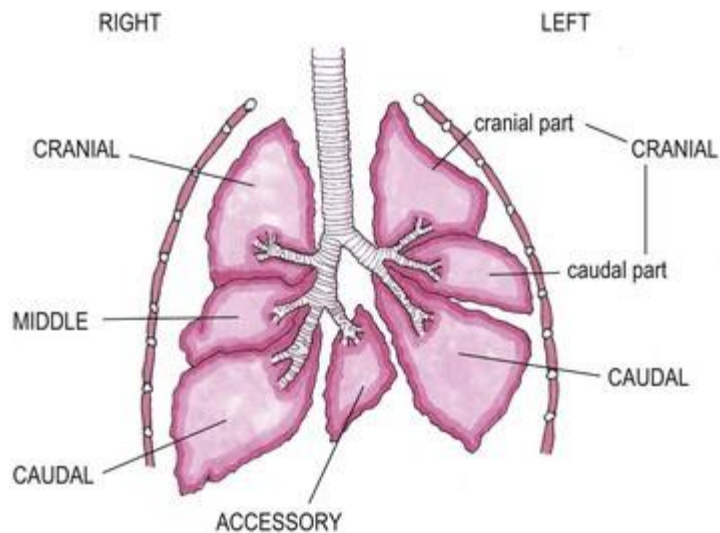
- * Please watch the following excellent video:
<https://www.youtube.com/watch?v=Nvo8XGMSCwU>

* **CONGENITAL ANOMALIES :**

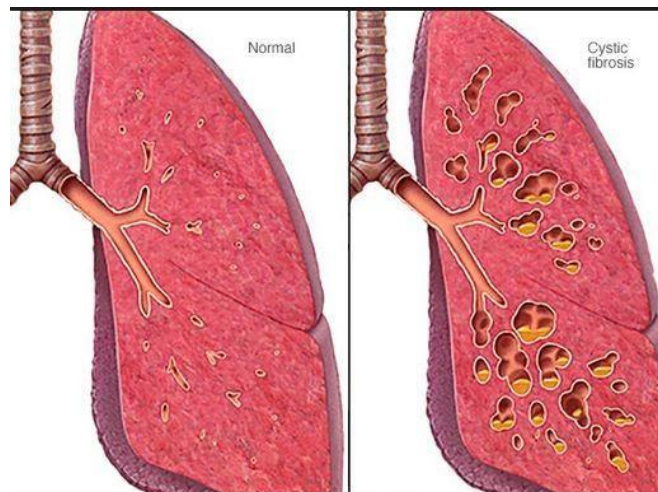
1- Anomalies of the lungs

- **Respiratory distress syndrome:** failure of the alveoli to inflate due to absence of the surfactant (which lowering surface tension).
- Agenesia of the lungs .
- Hypoplasia of the lungs
- **Ectopic lung lobes** arising from the trachea or esophagus.
- **Congenital cysts of the lung:** which are formed by dilation of terminal or larger bronchi.

Ectopic lung lobes



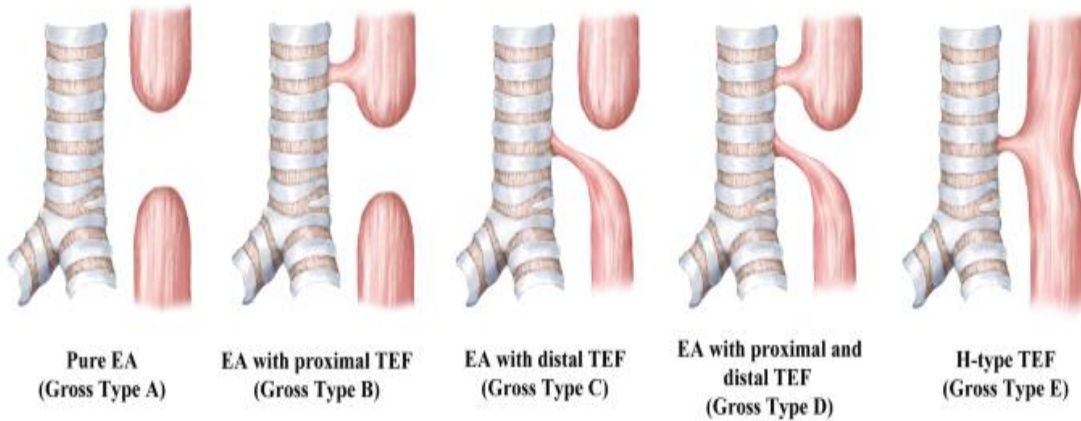
Congenital cysts of the lung



[Type text]

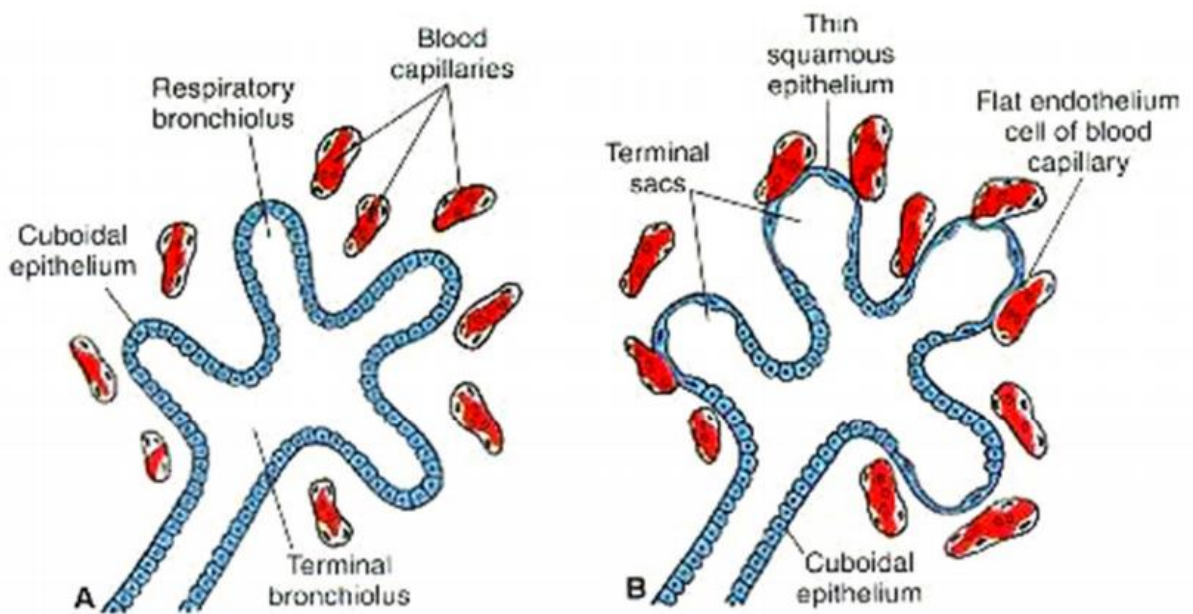
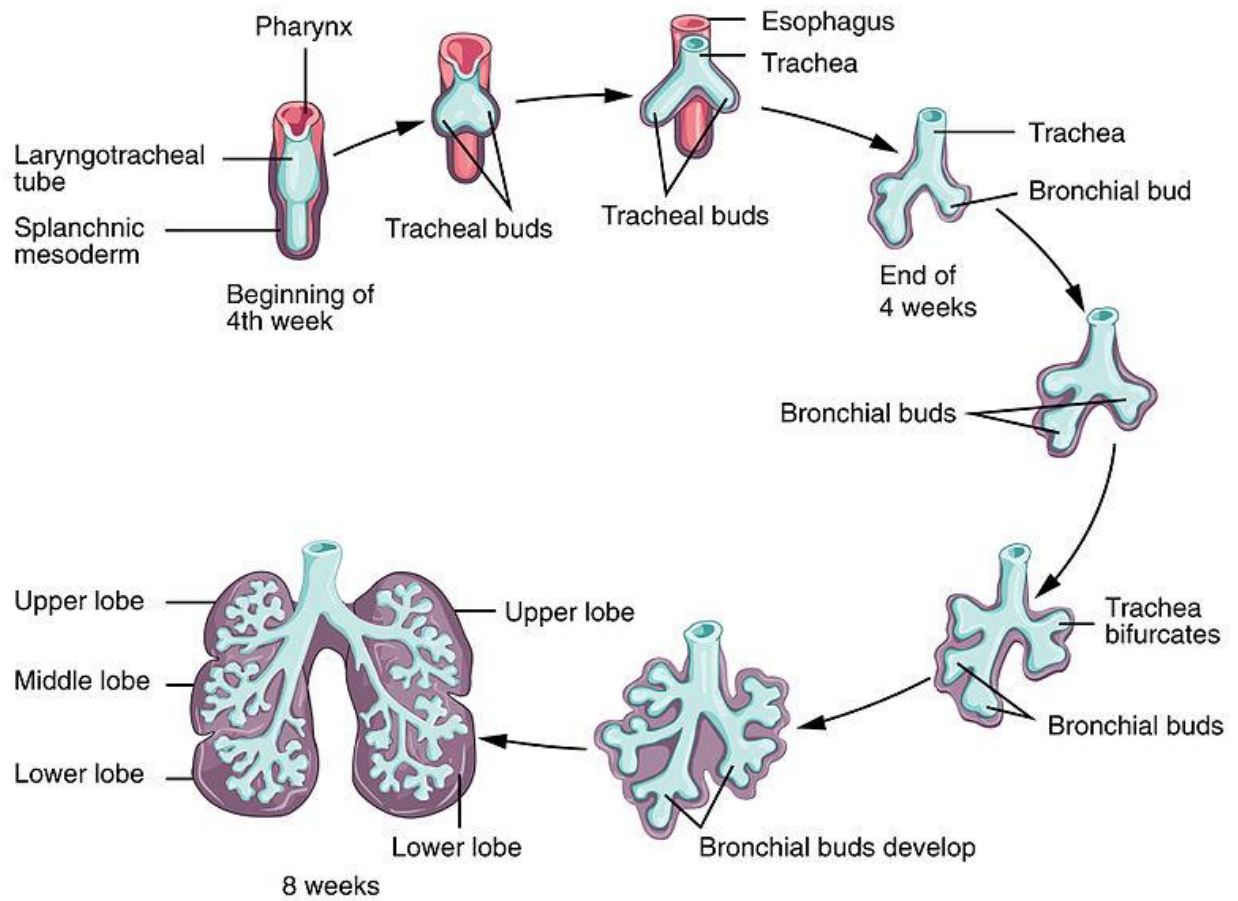
2- Esophageal atresia with or without tracheo-esophageal fistula

- It is due to failure of proper development of **trachea-esophageal septum** .



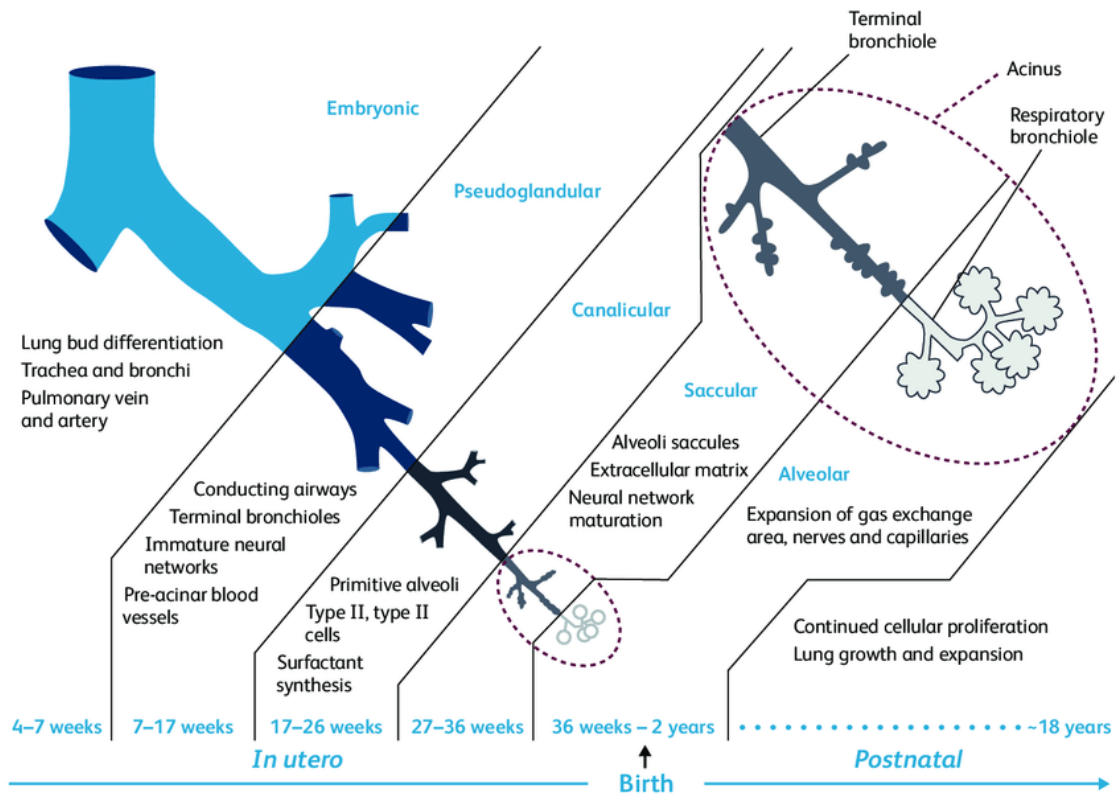
[Type text]

[Type text]



[Type text]

[Type text]



[Type text]