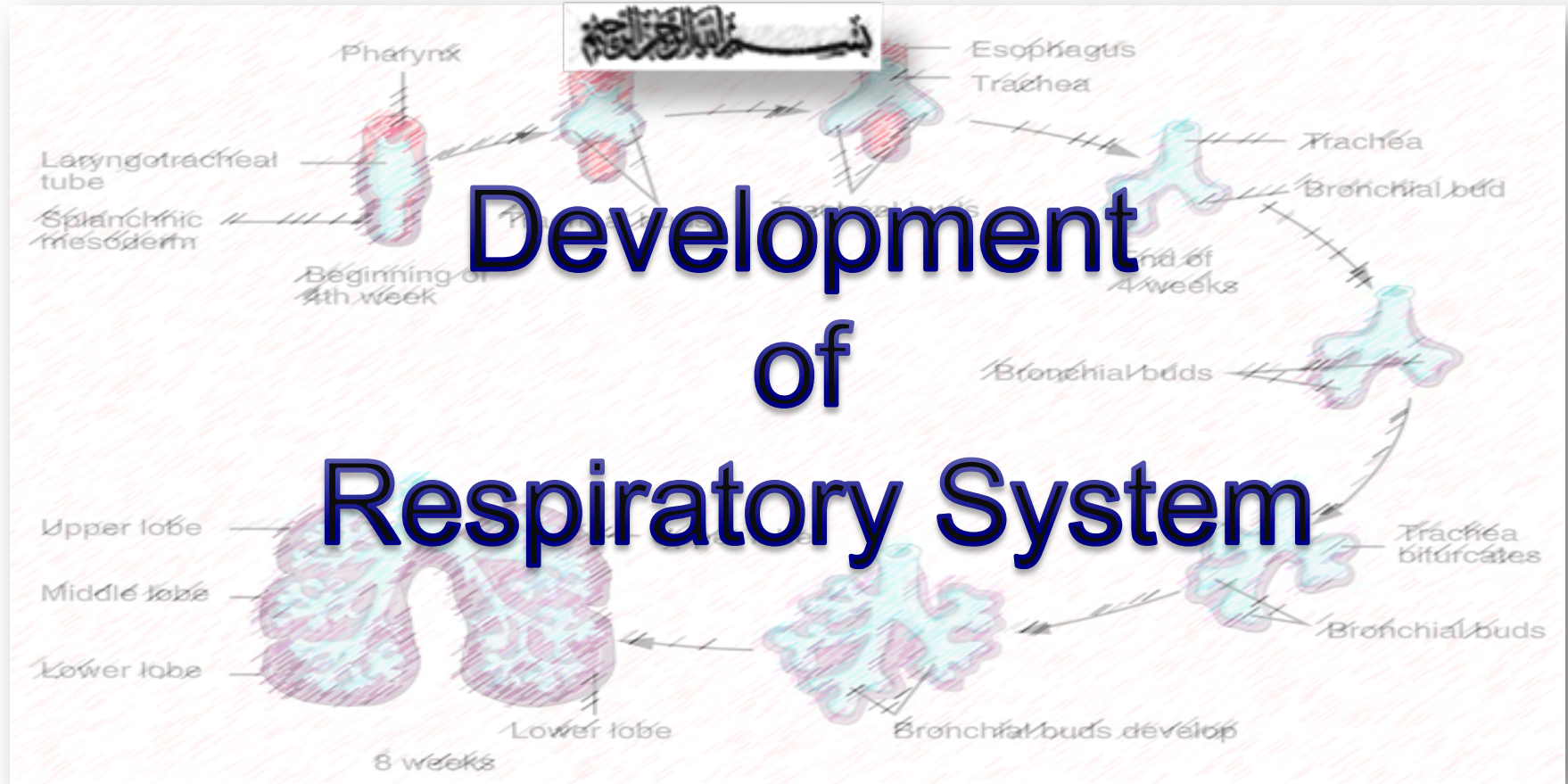


نظام التنفس

Development of Respiratory System



OBJECTIVES

BY THE END OF THIS SESSION WE WILL BE ABLE TO:

- IDENTIFY THE DEVELOPMENT OF:
 - LARYNGEOTRACHEAL (RESPIRATORY) DIVERTICULUM.
 - LARYNX.
 - TRACHEA.
 - BRONCHI & LUNGS.
- DESCRIBE THE PERIODS OF THE MATURATION OF THE LUNG.
- DEFINE THE MOST COMMON CONGENITAL ANOMALY.

Upper respiratory tract:

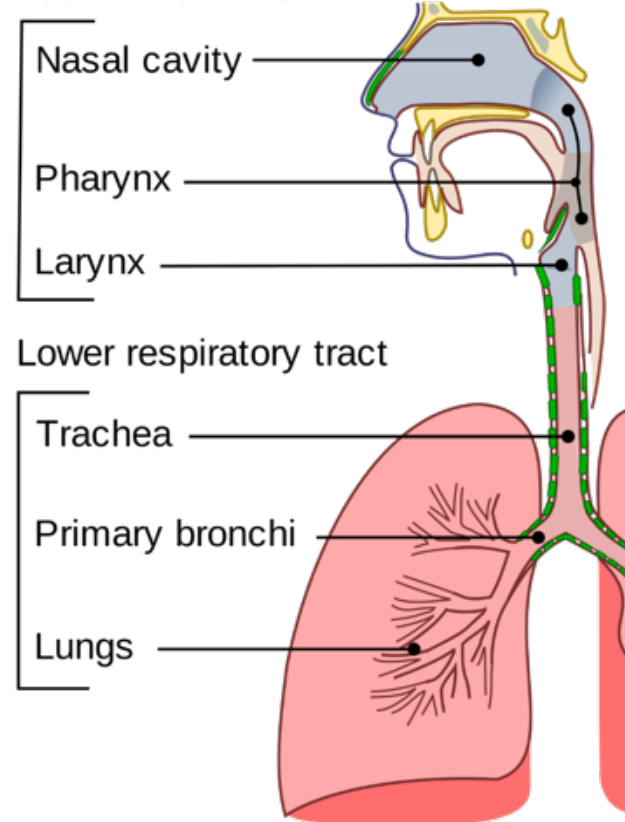
Nose
Nasal cavity & paranasal sinuses
Pharynx (Laryngopharynx).
Larynx

Lower respiratory tract:

Trachea
Bronchi
Lungs

**** In embryology (Moore Persaud) the lower rep tract includes **LAYRNX****

Upper respiratory tract



Respiratory Diverticulum

When begins?

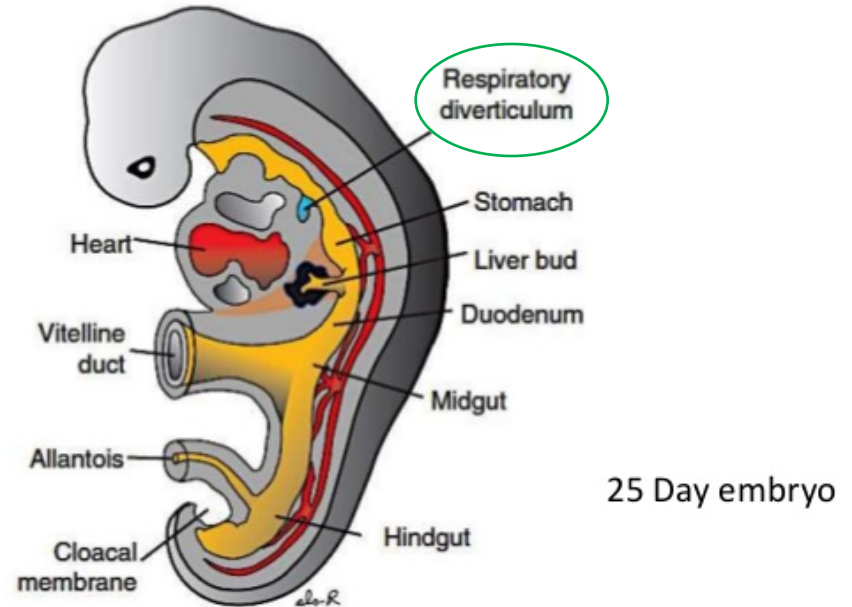
- during the 4th week of development.

How?

- as a median outgrowth (laryngotracheal groove) from the caudal part of the ventral wall of the primitive pharynx (foregut)

Outcome/ course

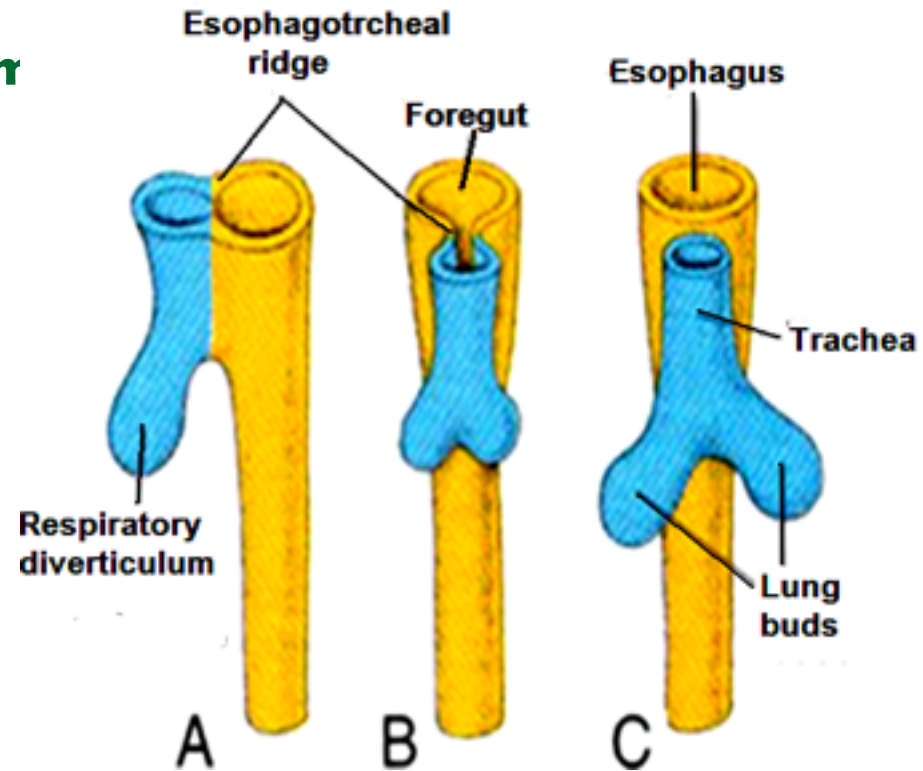
- the groove invaginates and forms the laryngotracheal (respiratory) diverticulum



Tracheo-esophageal Septum

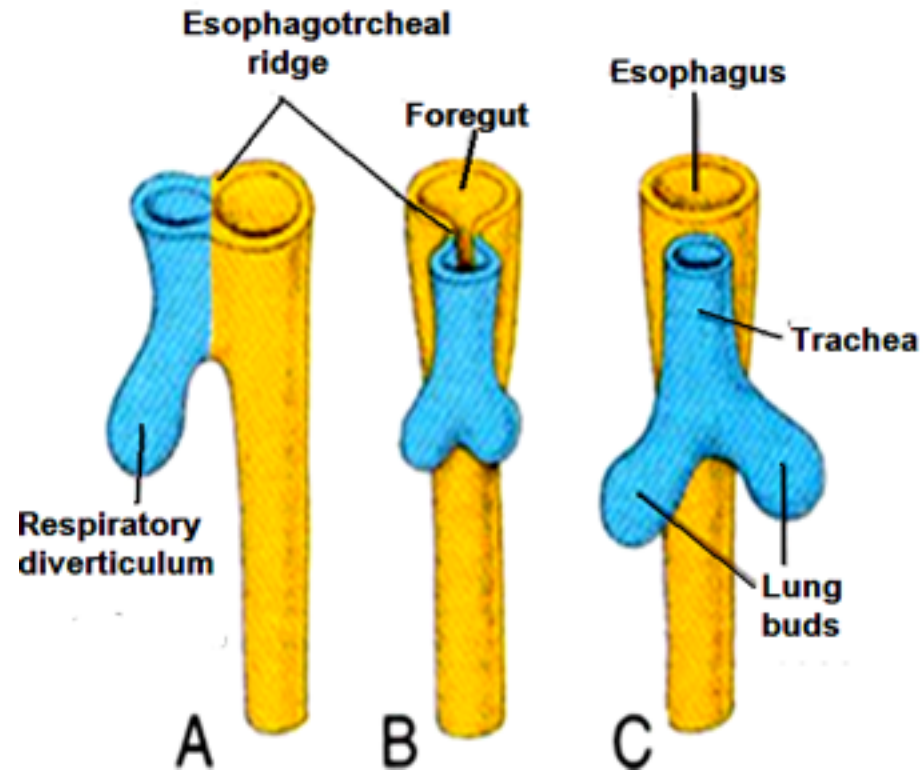
• A longitudinal **tracheo-esophageal septum** develops and divides the diverticulum into a:

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



Respiratory Diverticulum Derivatives

- ▶ **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)**

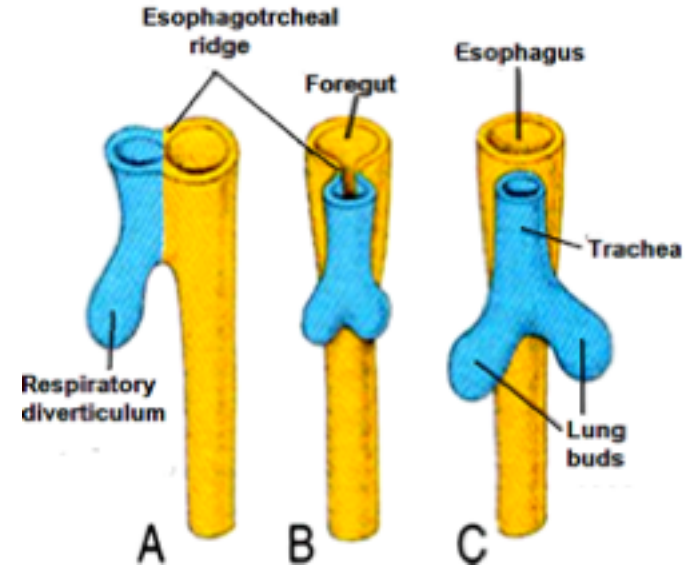


Epithelium, Glands, Connective tissue ,Cartilage, Smooth muscle

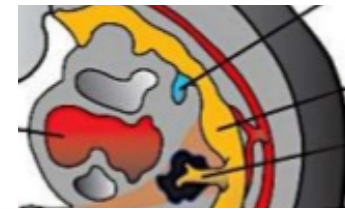
► **Epithelium & glands** of the respiratory tract are derived from **The endoderm lining the respiratory diverticulum**

Whereas;

► **Connective tissue, Cartilage & Smooth muscles** from **the surrounding splanchnic mesoderm**



Larynx



► The Laryngeal orifice.

The opening of the laryngotracheal diverticulum into the primitive foregut becomes the **laryngeal orifice**.

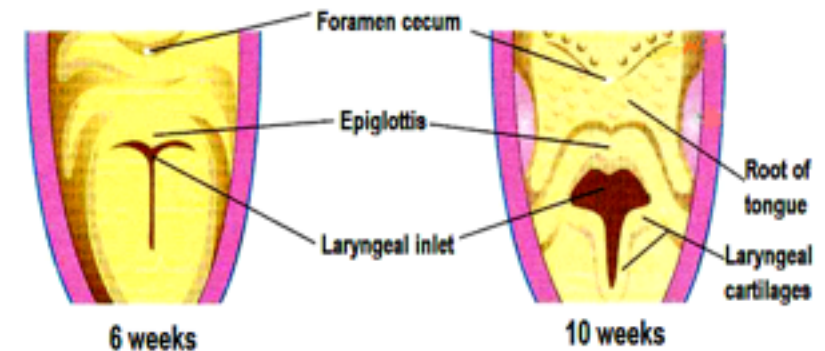
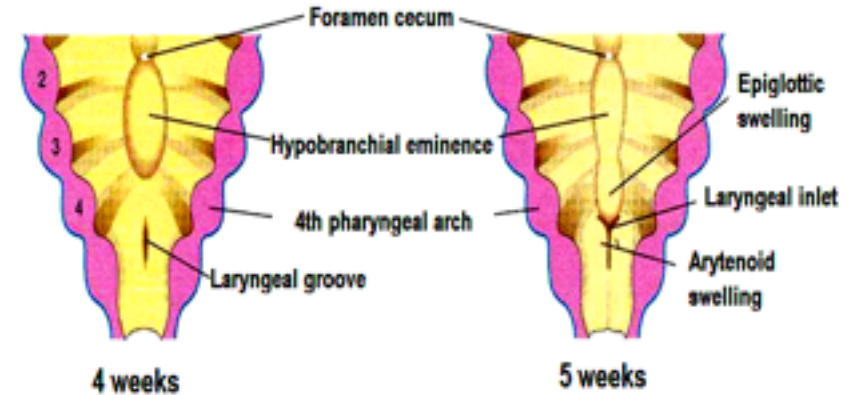
► The Laryngeal epithelium & glands develop from endoderm.

► Laryngeal muscles & the cartilages [except Epiglottis] develop from the mesenchyme of 4th & 6th pharyngeal arches.

From sagittal slit to T shaped??

All laryngeal muscles are innervated by 10th CN (Vagus nerve)

- *The superior laryngeal innervates the 4th Ph. arch derivatives.*
- *The recurrent laryngeal innervates the 6th Ph. arch derivatives*



Larynx

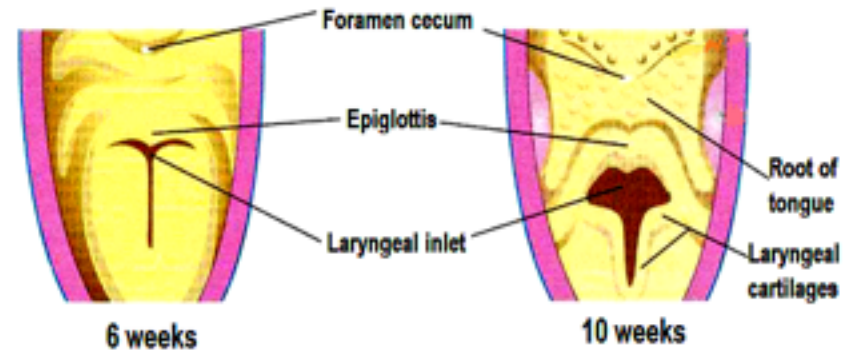
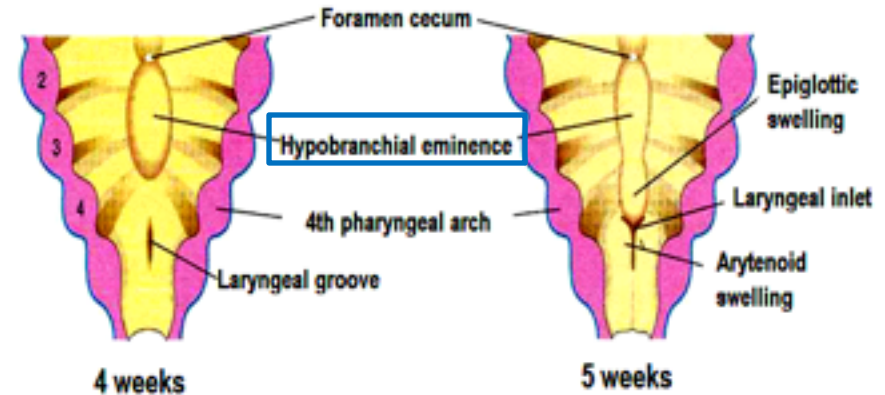
► The Epiglottis:

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

NOTE:

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.

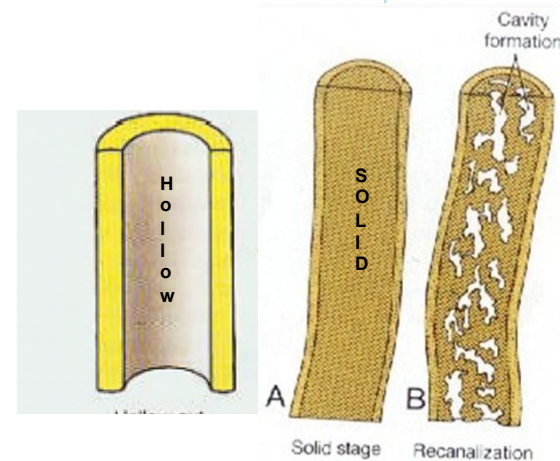
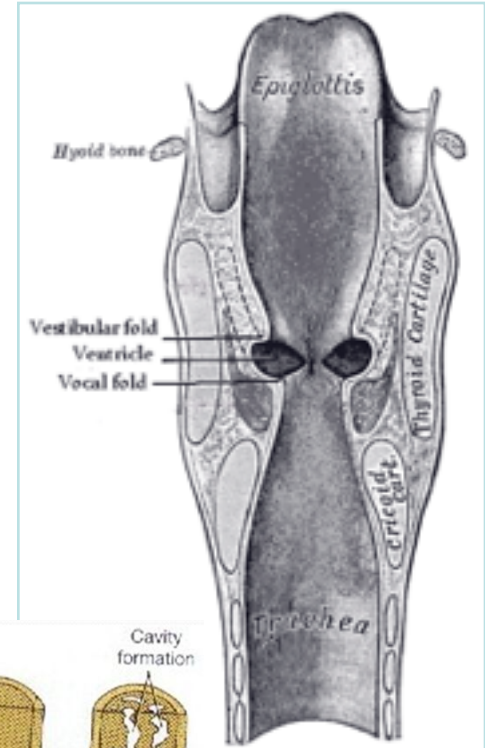
***Recanalization** of larynx normally occurs by the **10th week**.

*During **recanalization**

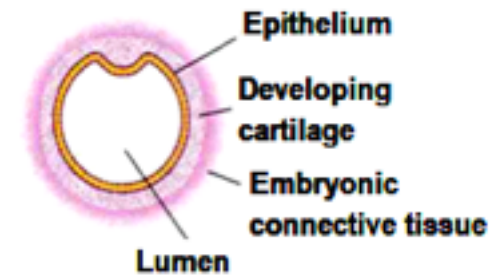
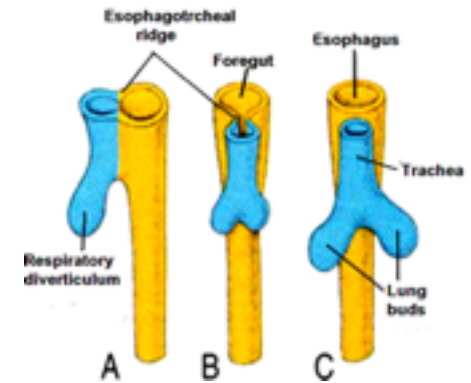
- **Laryngeal ventricles** are formed.

The mucosal folds that bound these recesses become

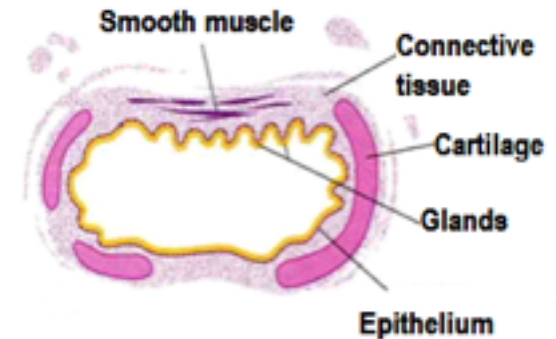
- **vestibular folds (false)**
- and
- **vocal folds (True)**



Trachea



6 weeks



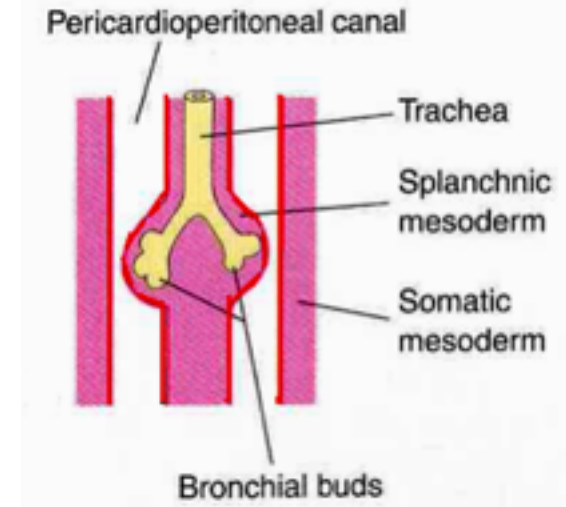
11 weeks

► **The Tracheal epithelium & glands** develop from **endodermal lining of the laryngotracheal tube** distal to the larynx

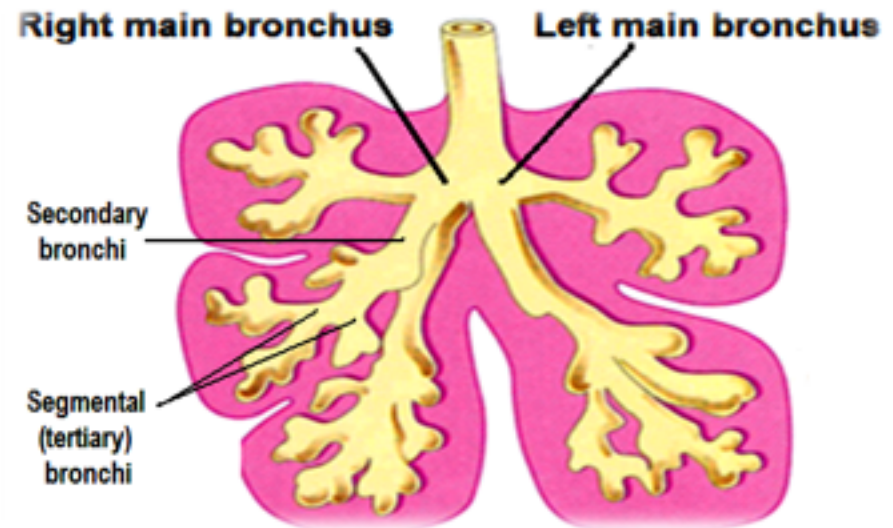
► **Tracheal muscles ,cartilages and CT** develop from the **the surrounding splanchnic mesoderm.**

Bronchi & Lungs

- ▶ **The 2 primary bronchial buds** grow laterally into the **pericardio-peritoneal canals** (part of the intraembryonic celome), the **primordia of pleural cavities**



- ▶ **Bronchial buds** divide and re-divide to give the **bronchial tree**.



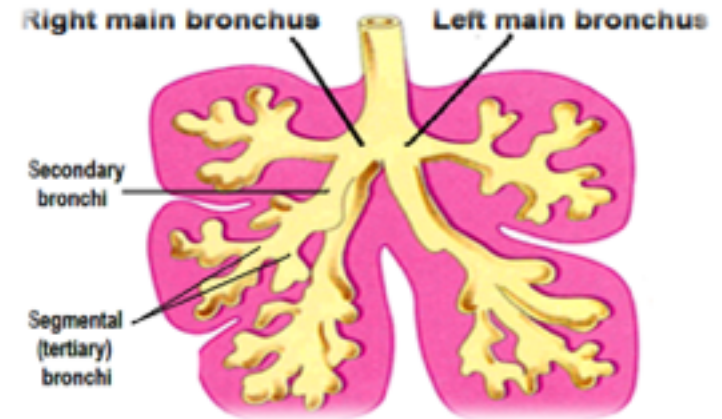
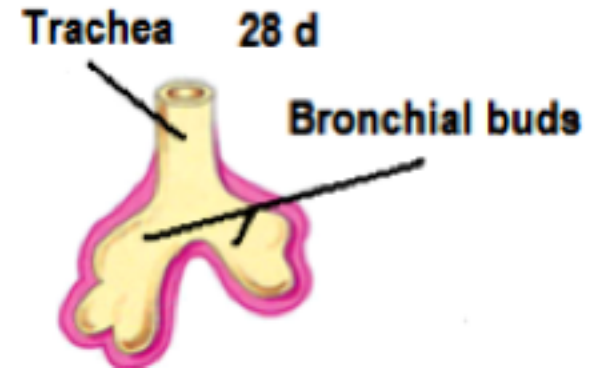
Bronchi & Lungs

The embryonic right main bronchus is slightly **larger (wider)** than the left one & is **oriented more vertically**.

The embryonic relationship persists in the adult.

Foreign body more likely to enter???

The main bronchi subdivide into **secondary** and **tertiary (segmental) bronchi** which give rise to further branches.



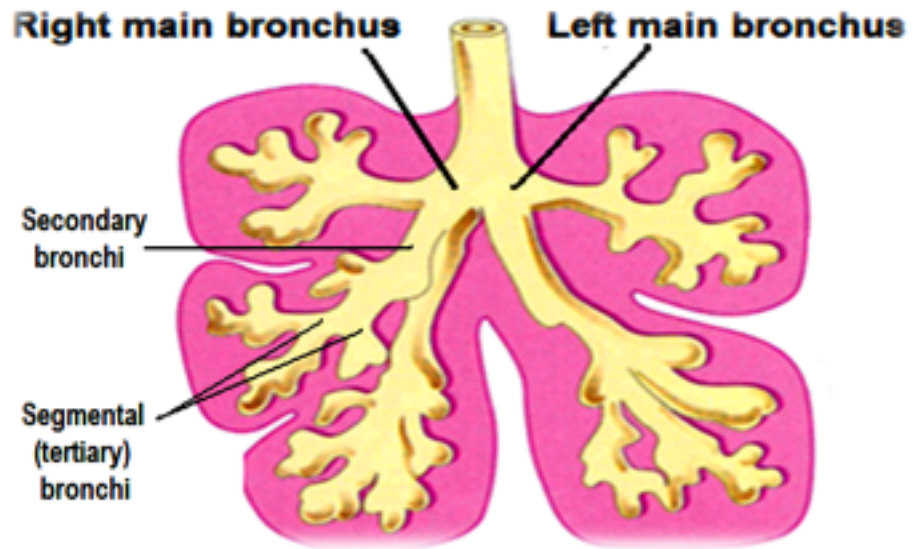
Bronchi & Lungs

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.

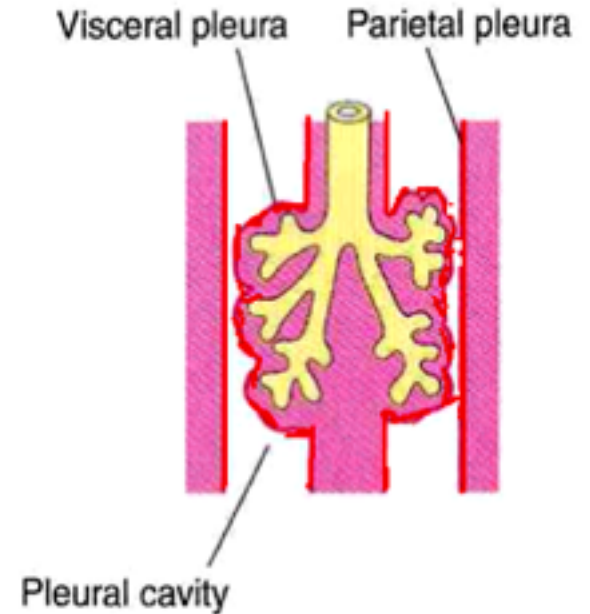
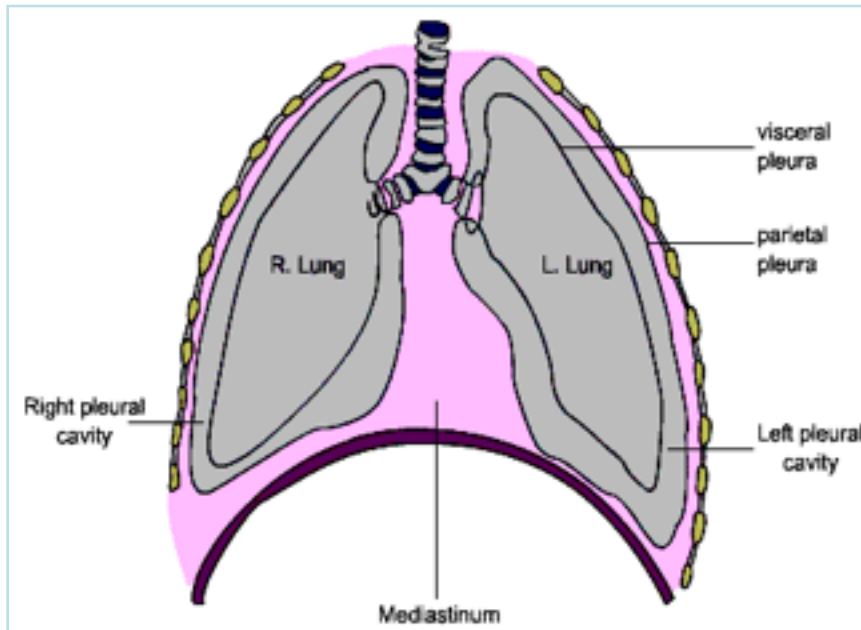
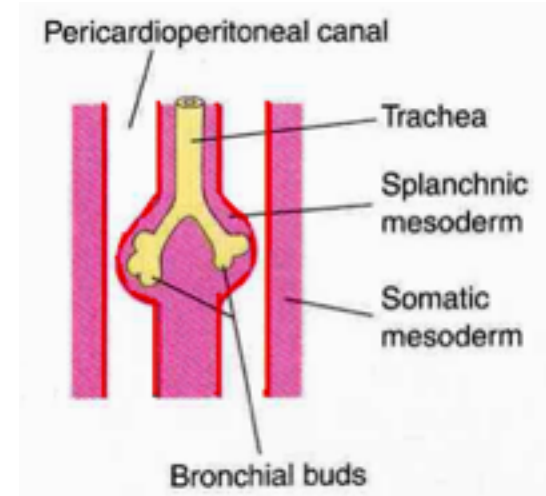
Each segmental bronchus with its surrounding mass of mesenchyme is the primordium of a bronchopulmonary segment.



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**.

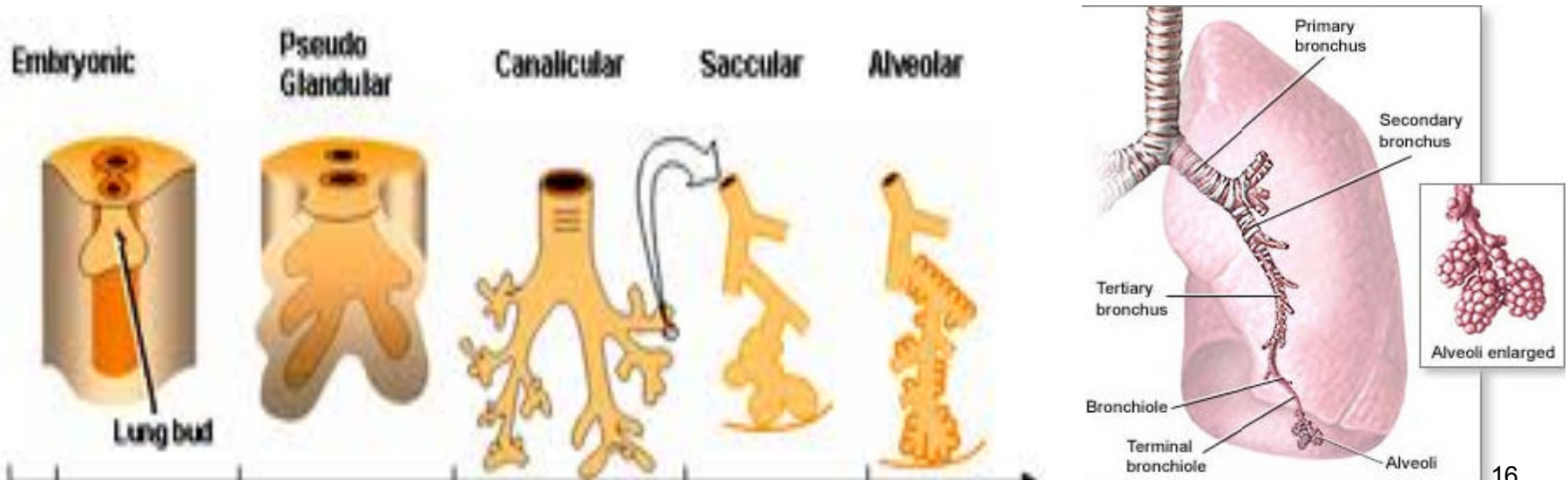


Maturation of the Lungs

Maturation of lung is divided into 4 periods:

| | |
|------------------|--|
| Pseudo-glandular | 5 - 16 weeks |
| Canalicular | 16 - 26 weeks |
| Terminal sac | 26 weeks – birth |
| Alveolar | 8 month to childhood (32 weeks to 8 years) Moore & Persaud |

These periods overlap each other because the cranial segments of the lungs mature faster than the caudal ones.



Maturation of the Lungs

Pseudo-glandular

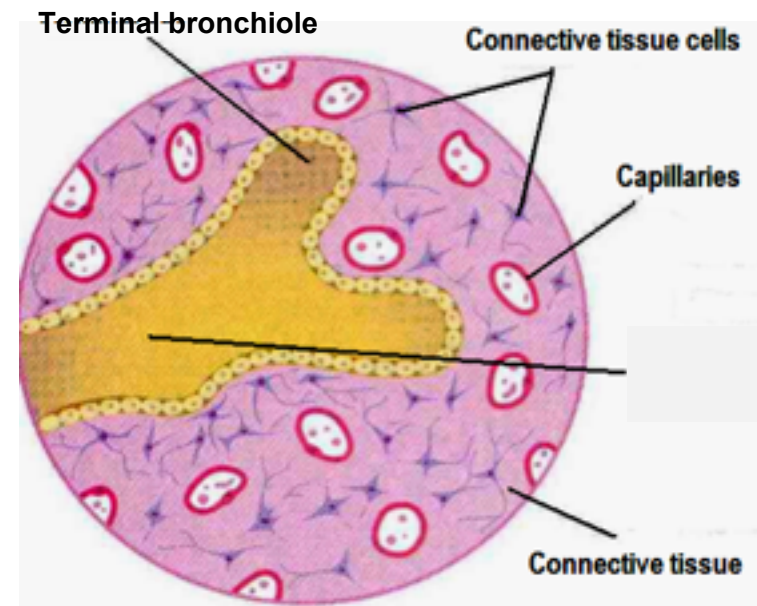
5 - 16 weeks

Developing lungs somewhat resembles an **exocrine gland** during this period.

By **16 weeks** all major elements of the lung have formed **EXCEPT** those involved with gas exchange i.e. **ALVEOLI**.

Respiration is **NOT** possible.

Fetuses born during this period are **unable to survive**.



Maturation of the Lungs

Canalicular Period

16 - 26 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**.

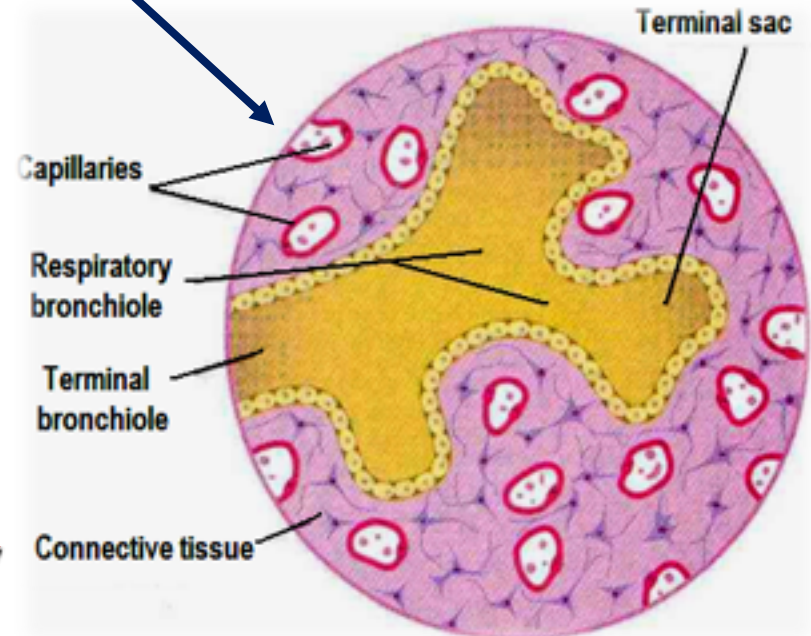
The respiratory bronchioles divide into 3 to 6 tubular passages called **alveolar ducts**.

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)**



Pseudo-glandular
5-16 Weeks

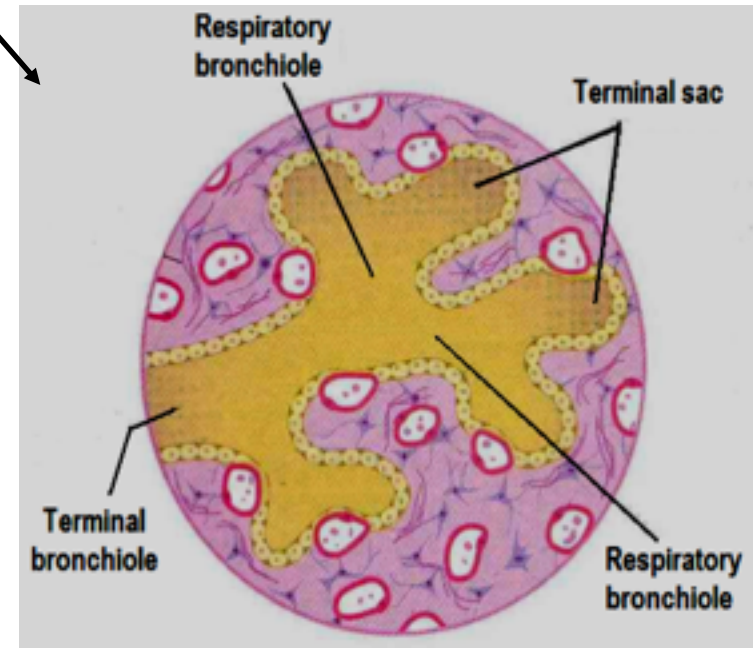
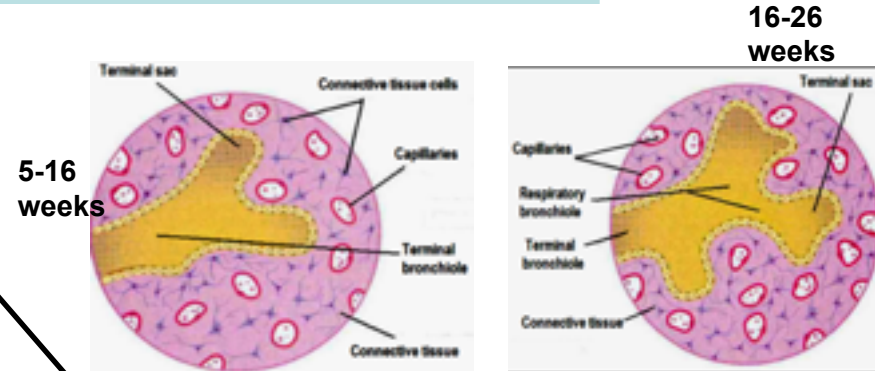


Maturation of the Lungs

Terminal Sac Period

26 weeks to 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
- **By 24 weeks**, the **terminal sacs** are lined by:
 - **Squamous type I alveolar cells** or **pneumocytes** &
 - **Rounded secretory, type II pneumocytes**, that secrete a mixture of phospholipids called **surfactant**.



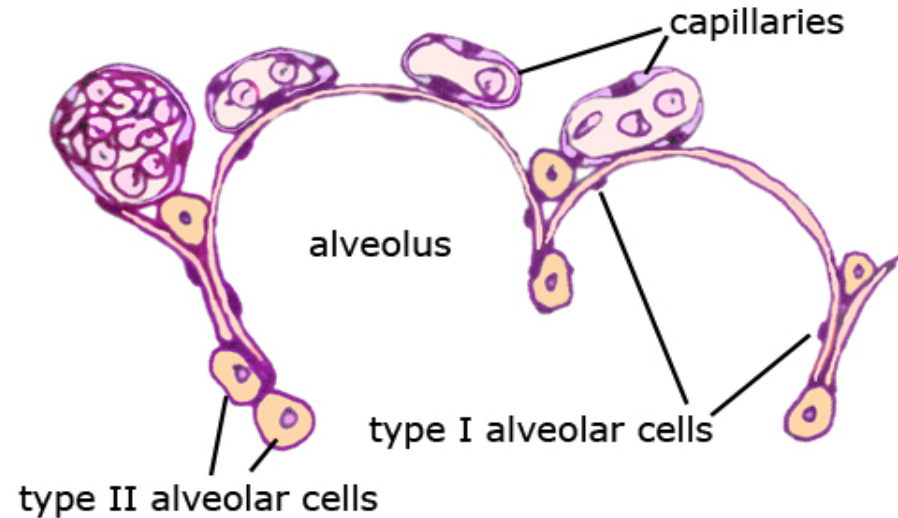
Maturation of the Lungs

Surfactant:

- * production **begins by 24 weeks**.
increases during the terminal stages of pregnancy particularly in **LAST 2 Wks.**
- * **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.**

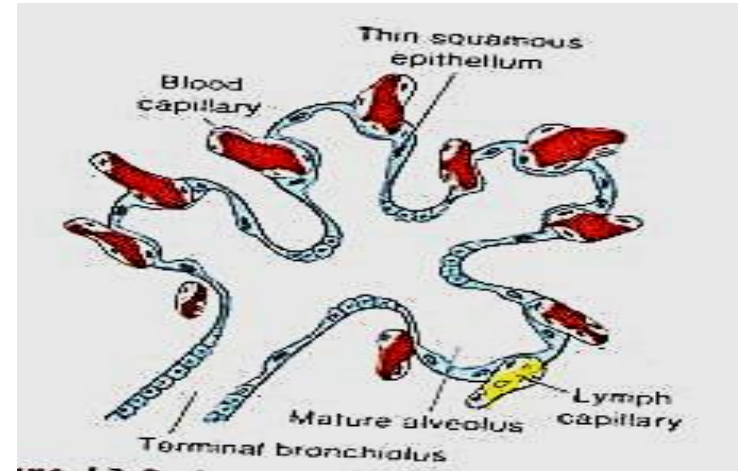


Maturation of the Lungs

Alveolar Period

32 Weeks to 8 Years

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

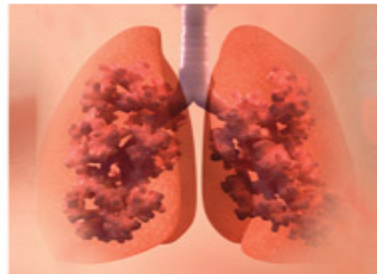


PRETERM LUNGS

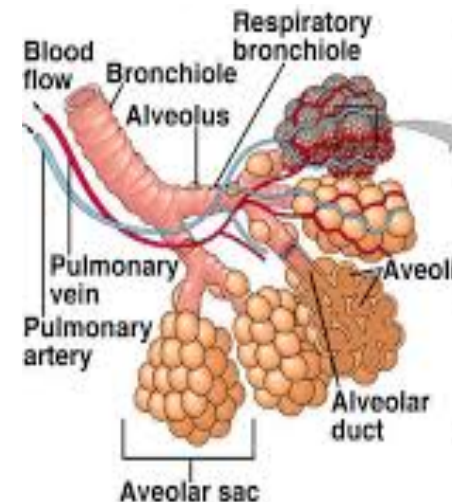


32 WEEKS GESTATIONAL AGE

FULL-TERM LUNGS



40 WEEKS GESTATIONAL AGE

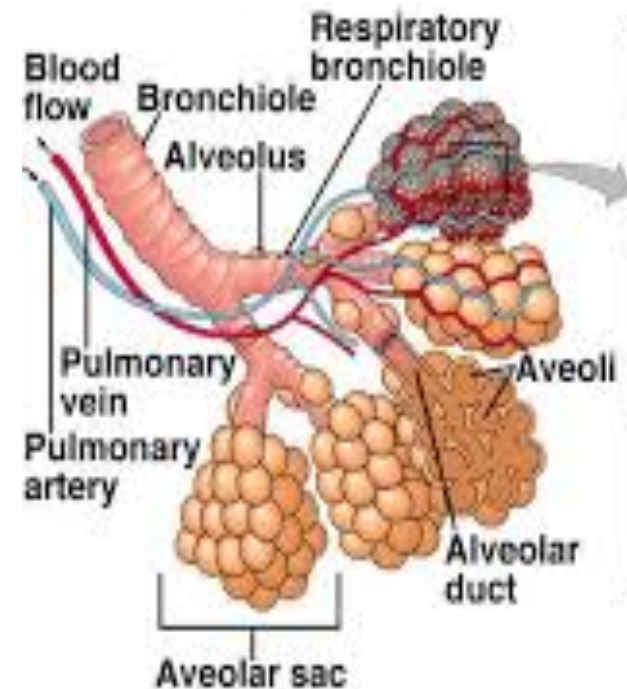


Maturation of the Lungs

Alveolar Period

32 Weeks to 8 Years

- ★ **Characteristic mature alveoli do not form until after birth.**
- ★ **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- Tracheoesophageal Fistula(TEFs)

Fistula ??

An **abnormal passage** between the trachea and esophagus.

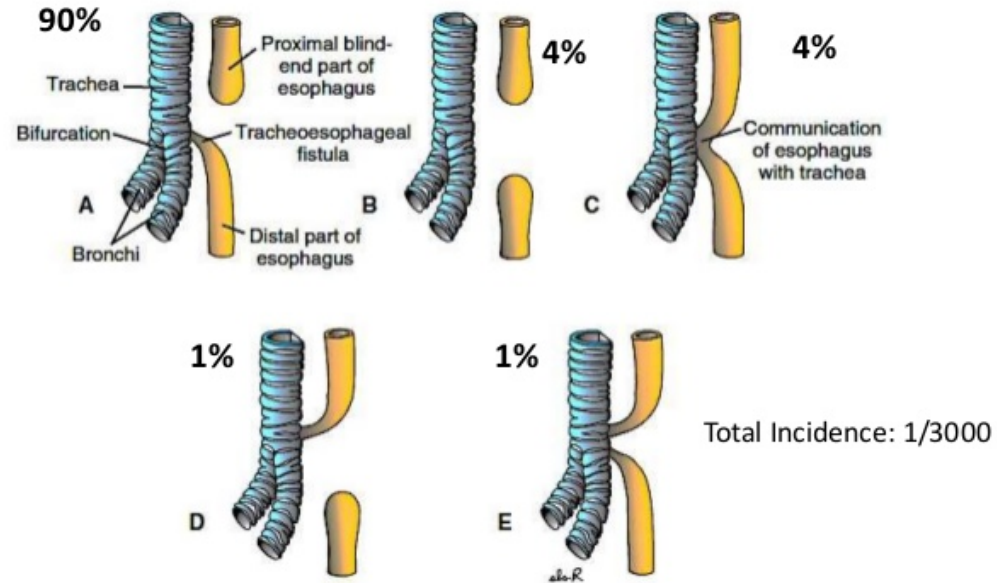
Results from **incomplete division** of the cranial part of the foregut into **respiratory and esophageal parts** by the **tracheo-esophageal septum**.

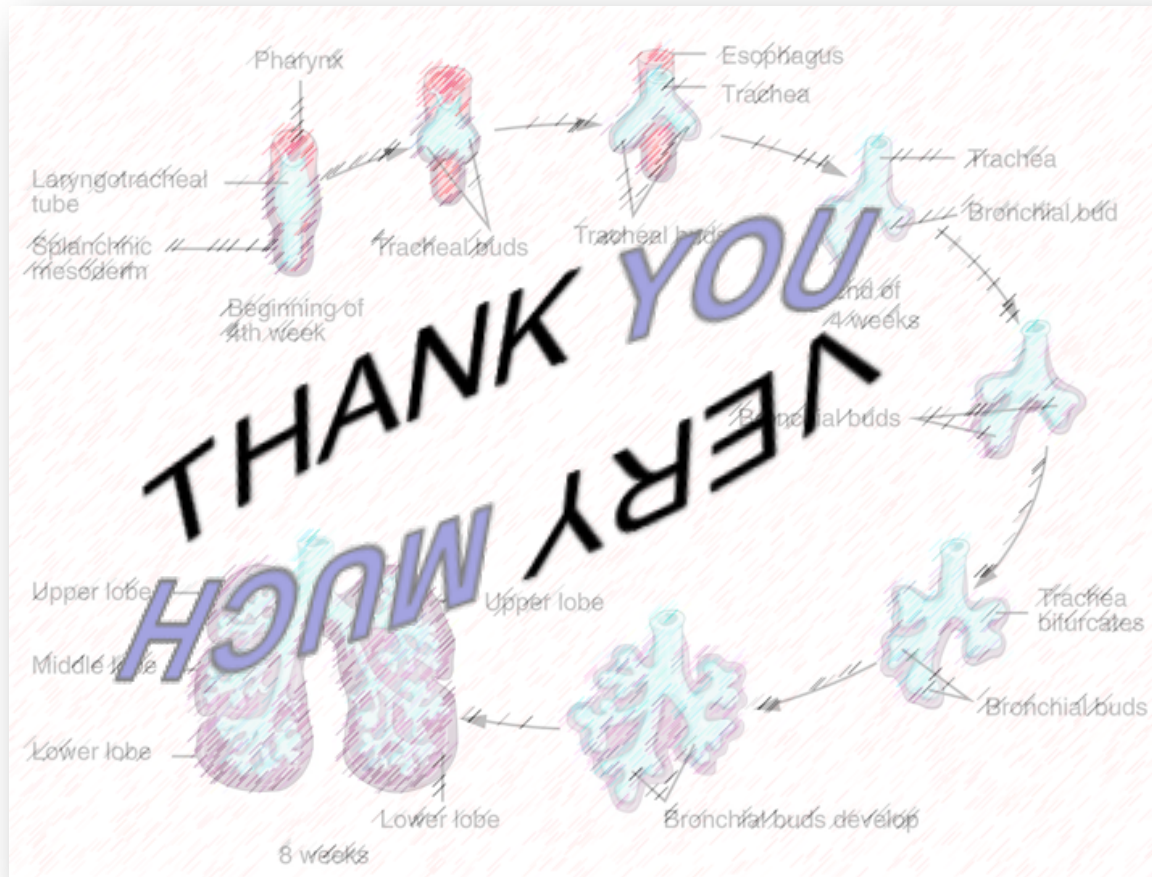
Occurs once in 3000 births.

Most affected infants are **males**.

In more than **90% of cases**, the fistula is associated with **esophageal atresia**

(**Esophagus ends in a blind-ended pouch rather than connecting normally to the stomach**).





<https://youtu.be/Nvo8XGMSCwU>