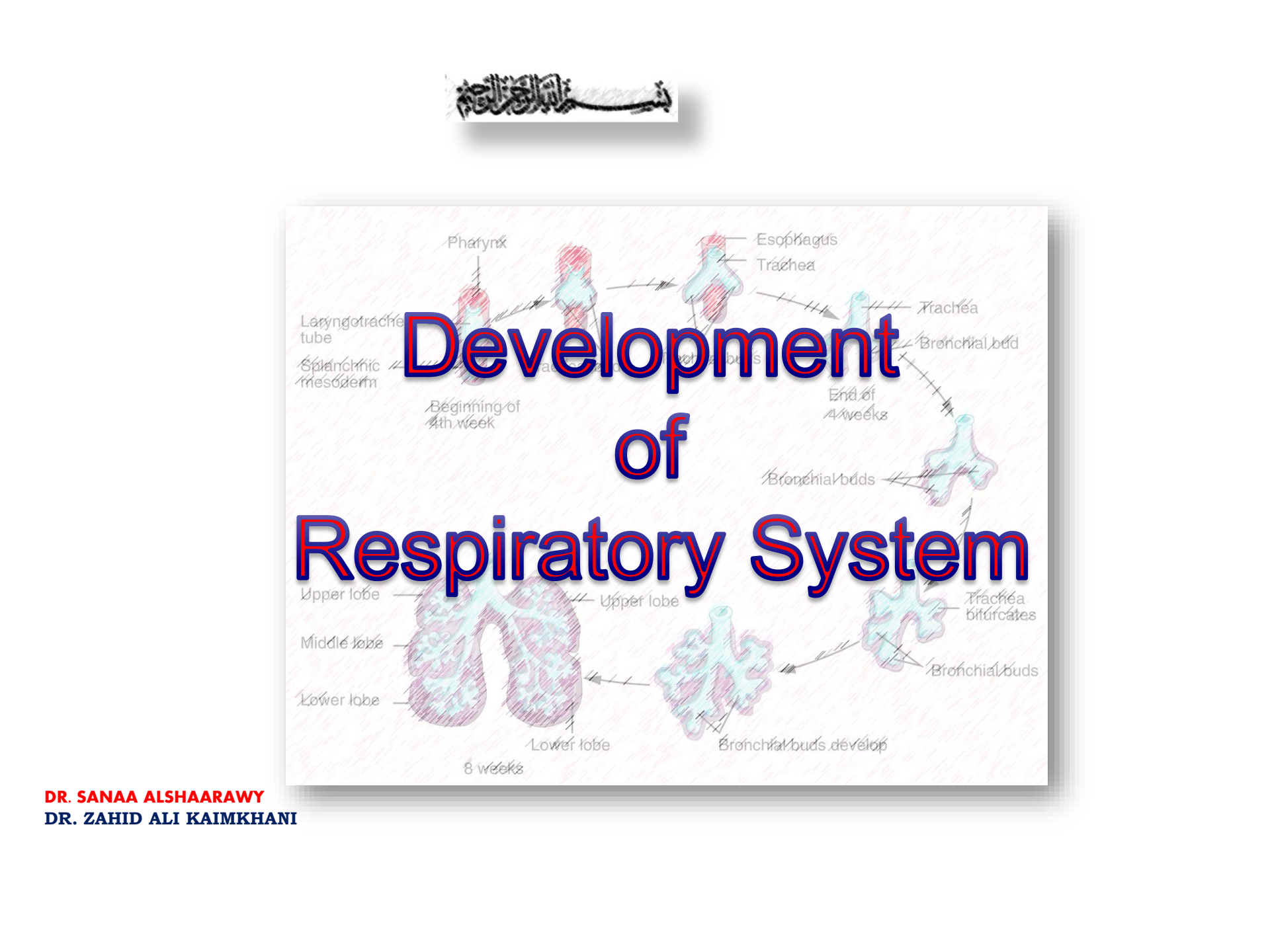


Development of Respiratory System

DR. SANAA ALSHAARAWY
DR. ZAHID ALI KAIMKHANI

OBJECTIVES

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

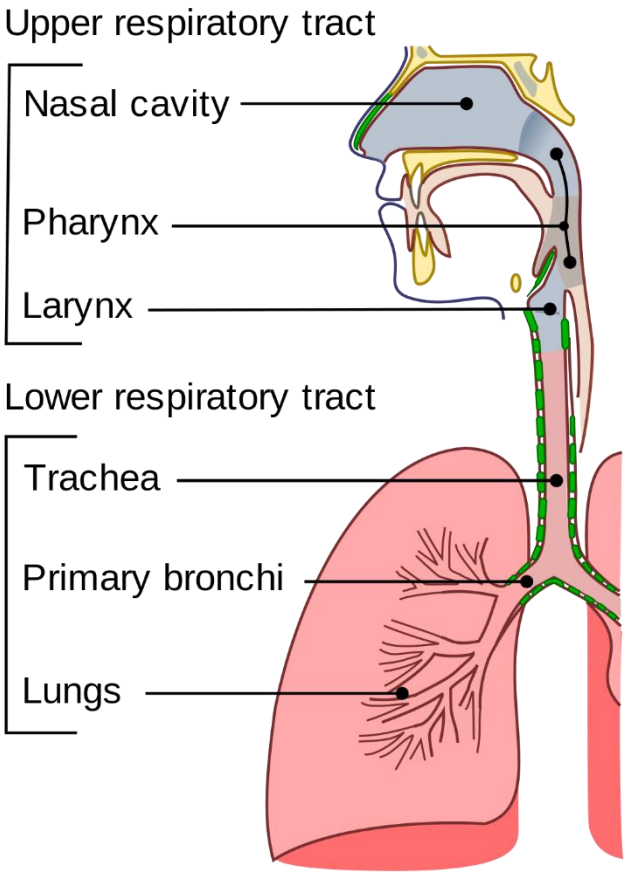
- DESCRIBE THE DEVELOPMENT OF THE:
  - LARYNGEOTRACHEAL (RESPIRATORY) DIVERTICULUM.
  - LARYNX.
  - TRACHEA.
  - BRONCHI & LUNGS.
- DESCRIBE THE PERIODS OF THE MATURATION OF THE LUNG.
- DEFINE THE MOST COMMON CONGENITAL ANOMALY.

Upper respiratory tract:

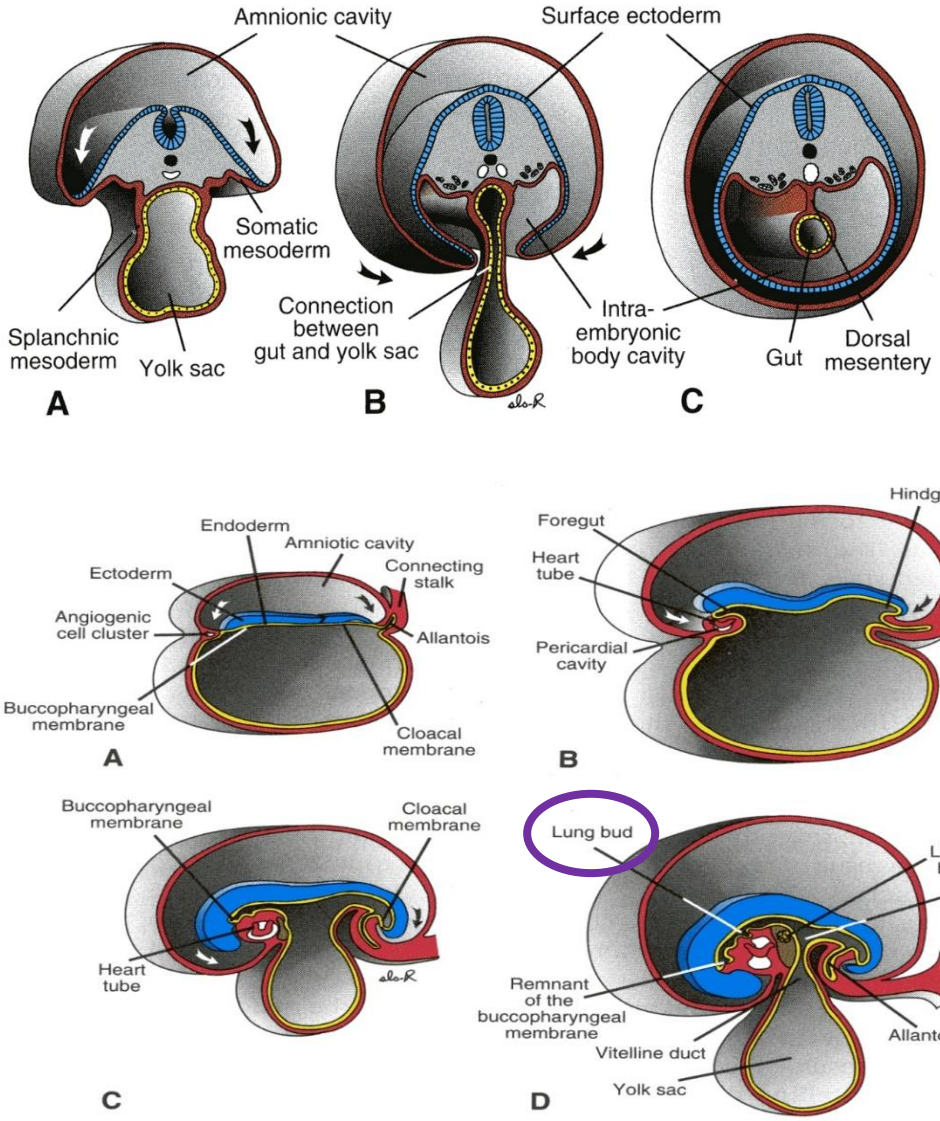
- **Nose**
- **Nasal cavity & paranasal sinuses**
- **Pharynx (Laryngopharynx).**
- **Larynx ???**

Lower respiratory tract:

- **Trachea**
- **Bronchi**
- **Lungs**



Development of Respiratory System



Respiratory Diverticulum

When begins?

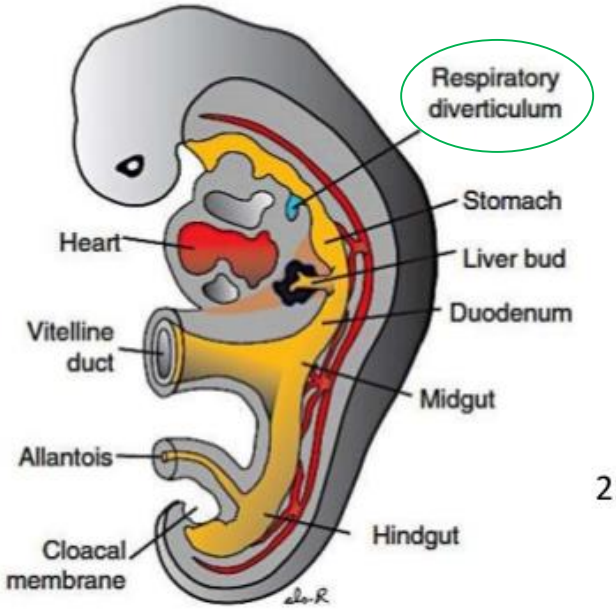
•during the 4th week of development.

How?

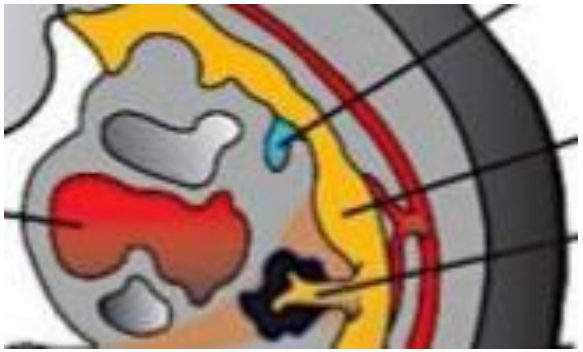
•as a median outgrowth (laryngotracheal groove) from the caudal part of the ventral wall of the primitive pharynx (foregut)

Outcome/ course

• the groove envaginates and forms the laryngotracheal (respiratory) diverticulum



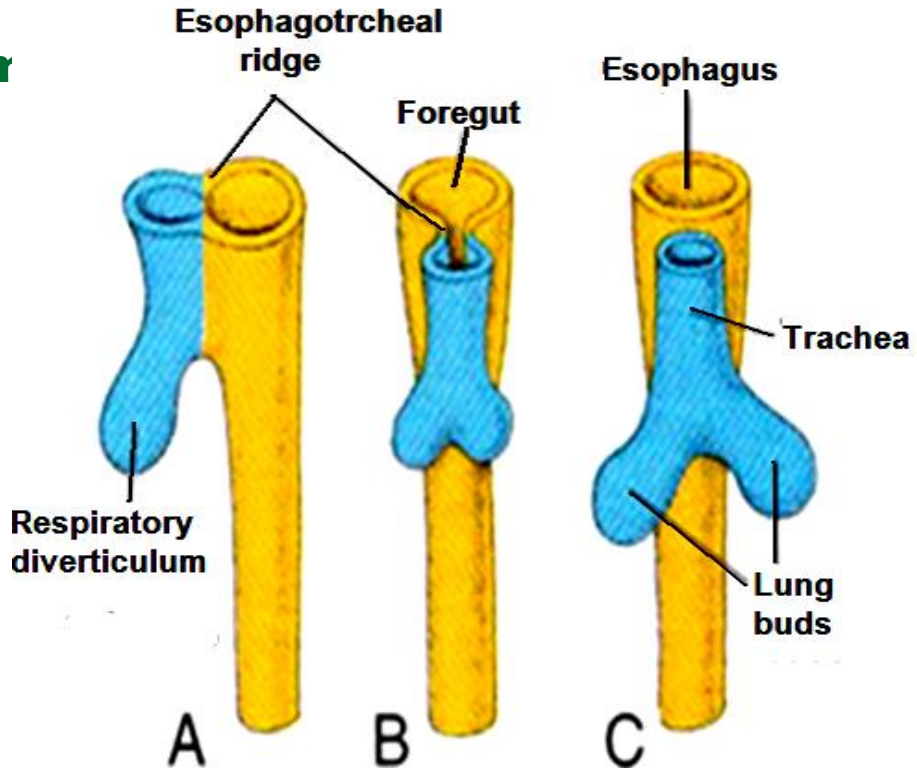
25 Day embryo



Tracheo-esophageal Septum

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

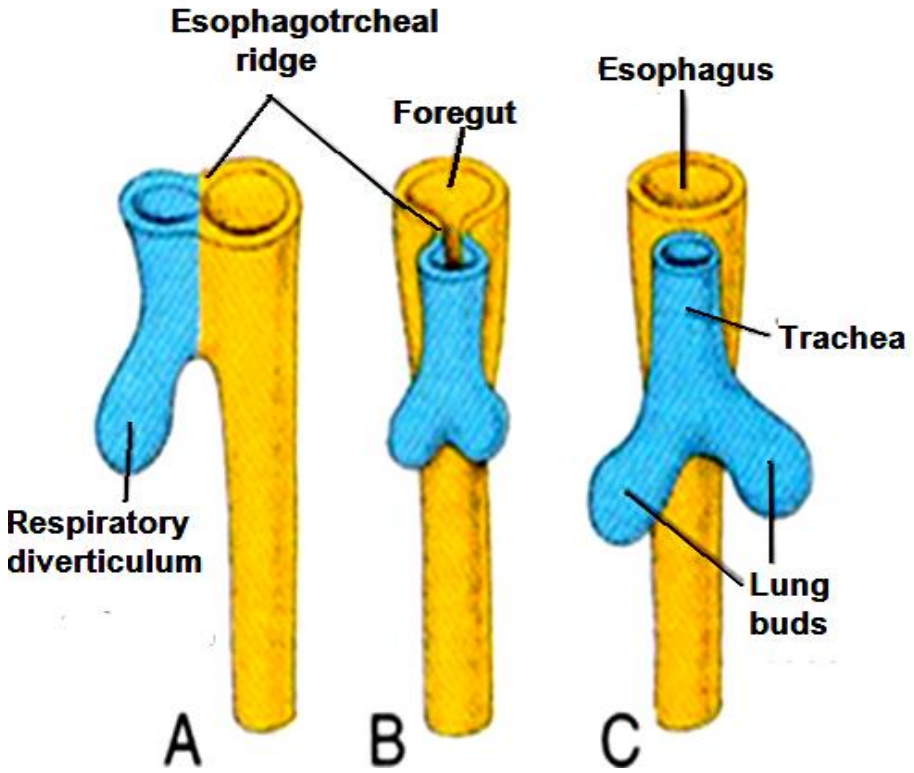
- **Dorsal portion:** primordium of the oropharynx and esophagus
- **Ventral portion:** primordium of
  - larynx,
  - trachea,
  - bronchi &
  - lungs



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)**

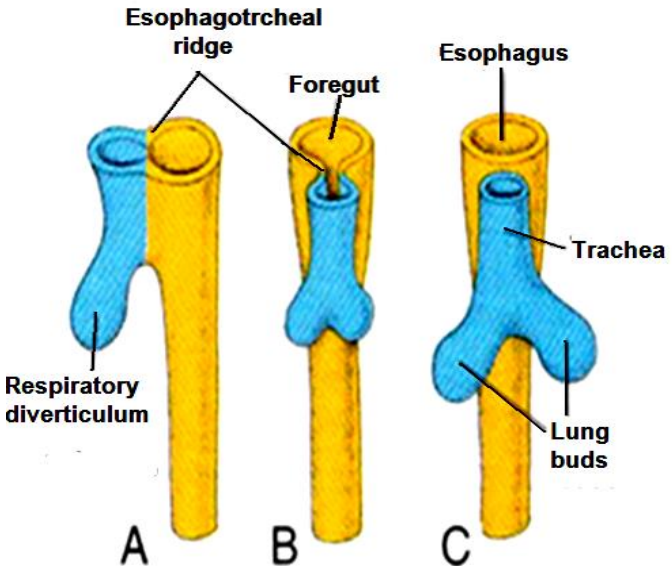


Epithelium, Glands, Connective tissue ,Cartilage, Smooth muscle

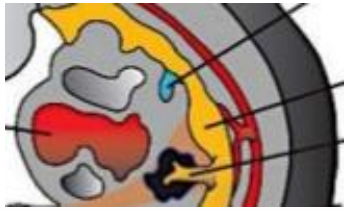
►**Epithelium & glands** of the respiratory tract are derived from **The endoderm lining** the **respiratory diverticulum**

Whereas;

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

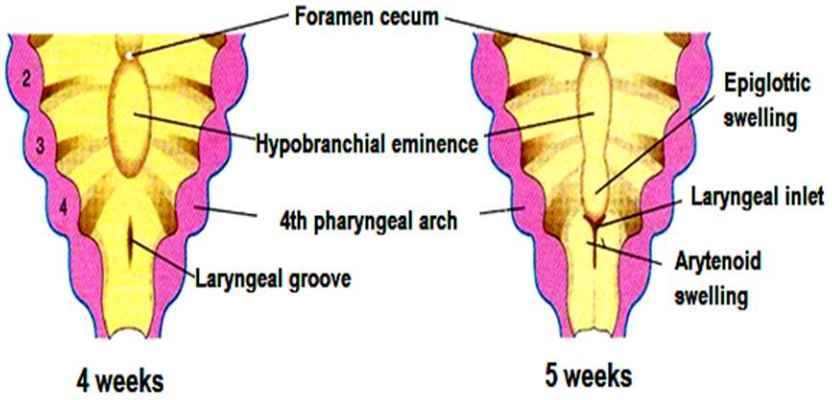


Larynx



►The Laryngeal orifice.

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



► The Laryngeal epithelium & glands

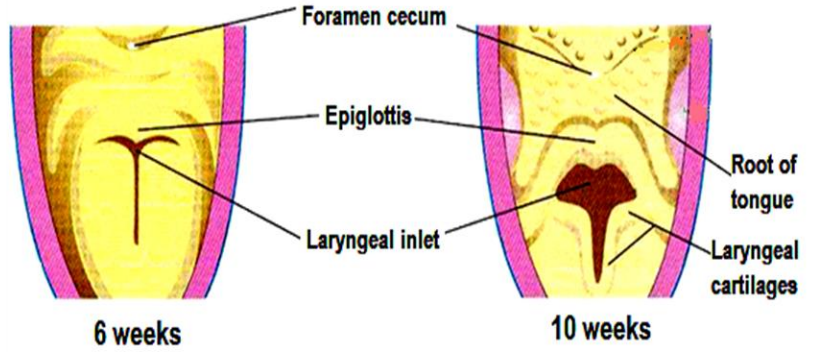
develop from **endoderm**.

► 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)

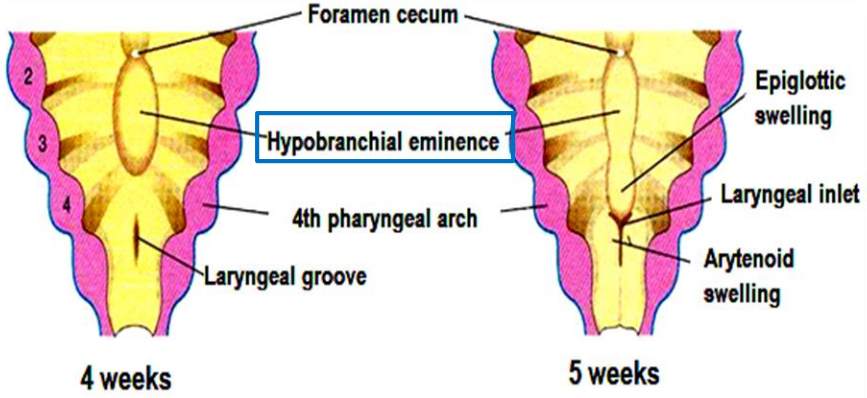
- ***The superior laryngeal innervates the 4th Ph. arch derivatives.***
- ***The recurrent laryngeal innervates the 6th Ph. arch derivatives***

Larynx

►The Epiglottis:

develops from the **caudal part of the hypopharyngeal eminence,**

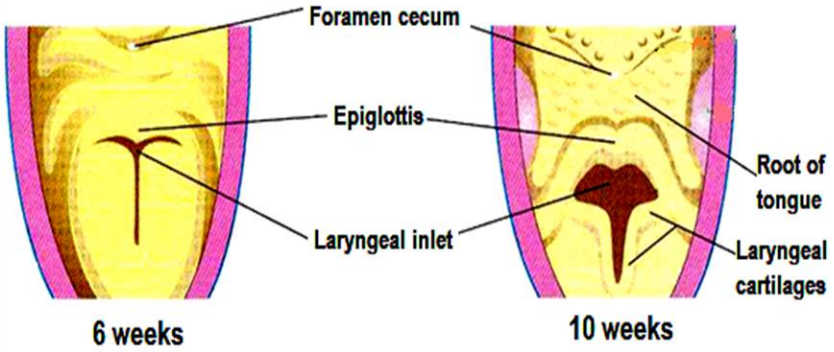
[**a swelling formed by the proliferation of mesoderm** in the floor of the pharynx].



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

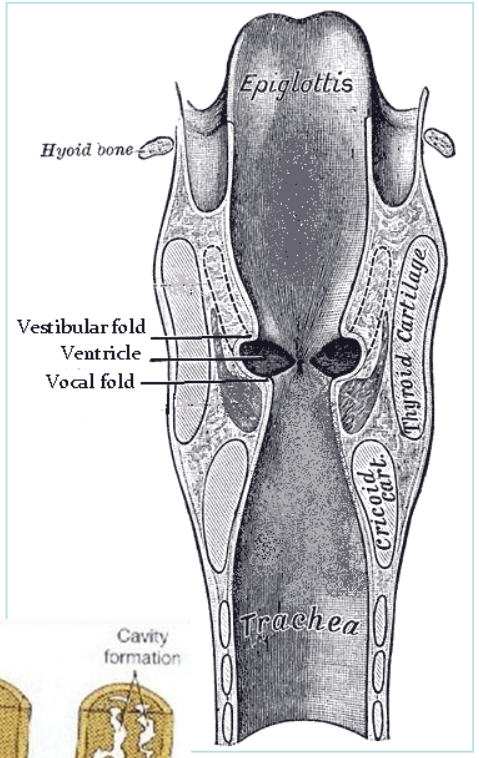
- Laryngeal ventricles are formed.

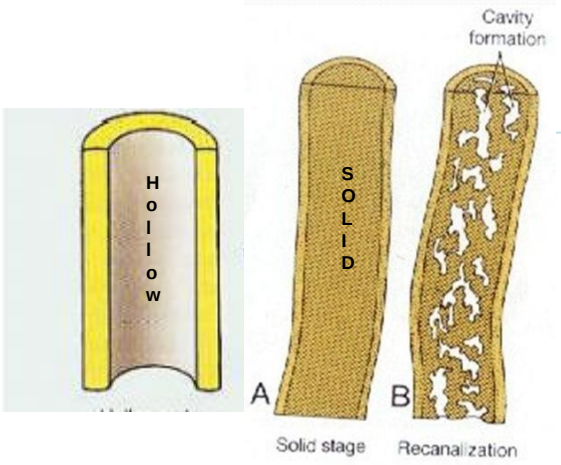
The mucosal folds that bound these recesses become

- vestibular folds (false)

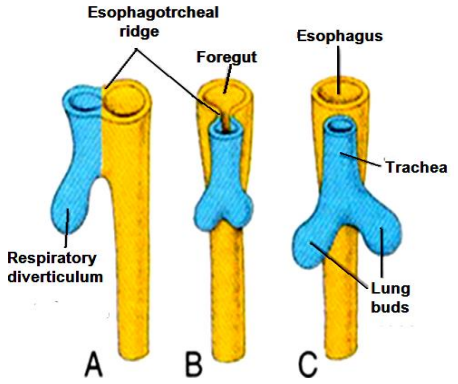
and

- vocal folds (True)



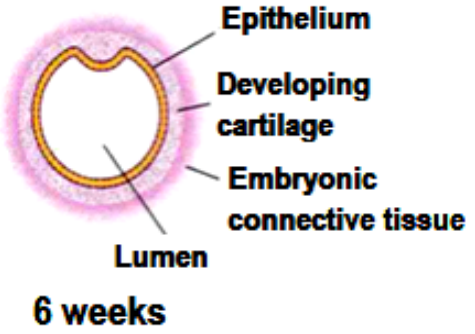


Trachea



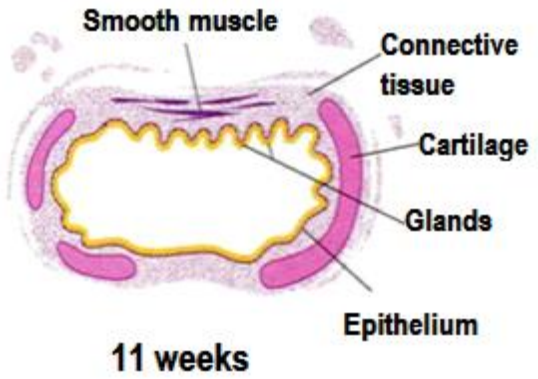
► **The Tracheal epithelium & glands**

develop from **endodermal lining of the laryngotracheal tube** distal to the larynx



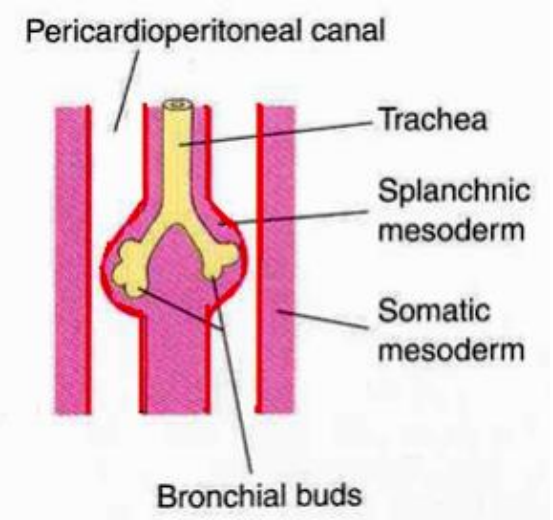
► **Tracheal muscles ,cartilages and CT**

develop from the **the surrounding splanchnic mesoderm**.

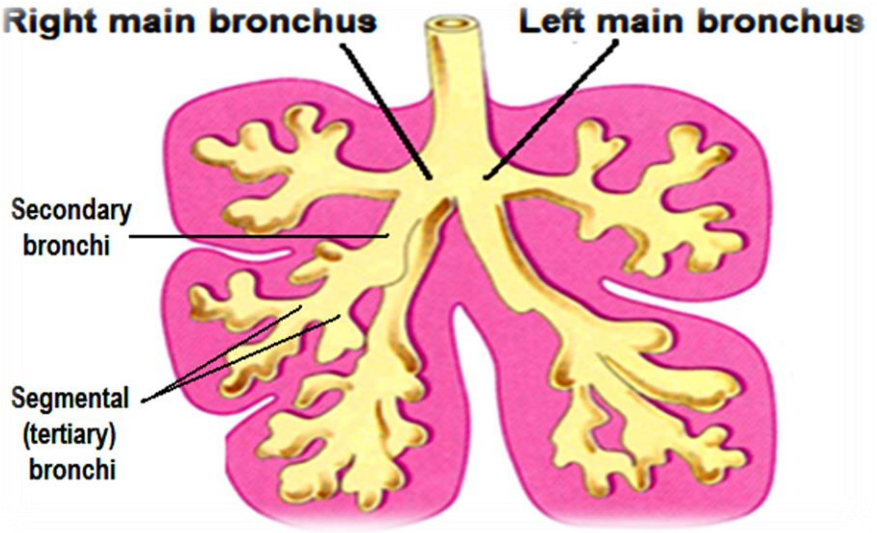


Bronchi & Lungs

- **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.**



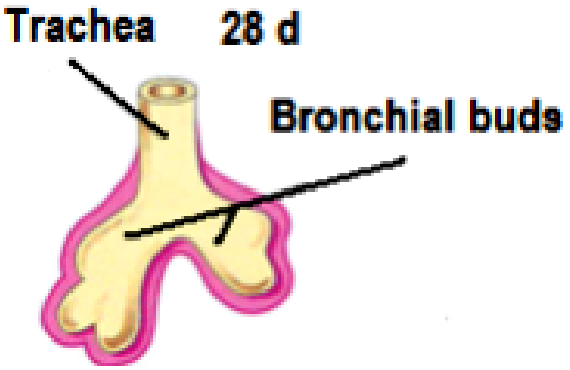
Bronchi & Lungs

The embryonic right main bronchus

is slightly larger (wider) than the left one

&

is oriented more vertically.

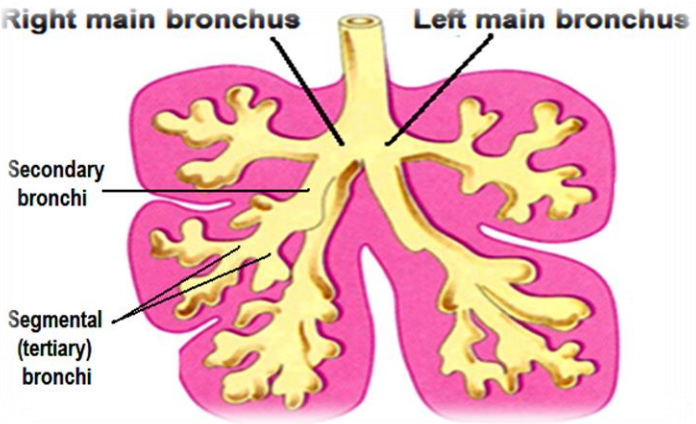


The embryonic relationship persists in the adult.

Foreign body more likely to enter???

The main bronchi

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



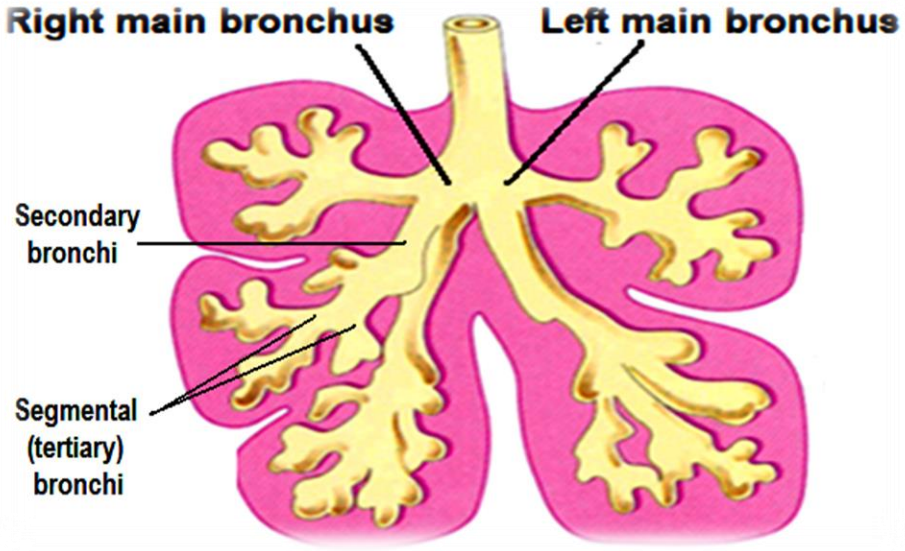
Bronchi & Lungs

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.

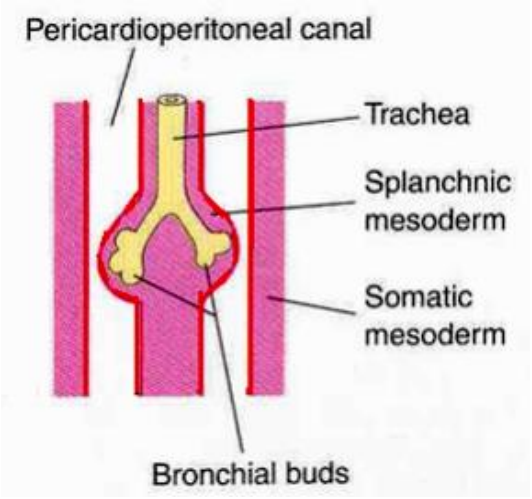
Each segmental bronchus with its surrounding mass of mesenchyme is the primordium of a bronchopulmonary segment.

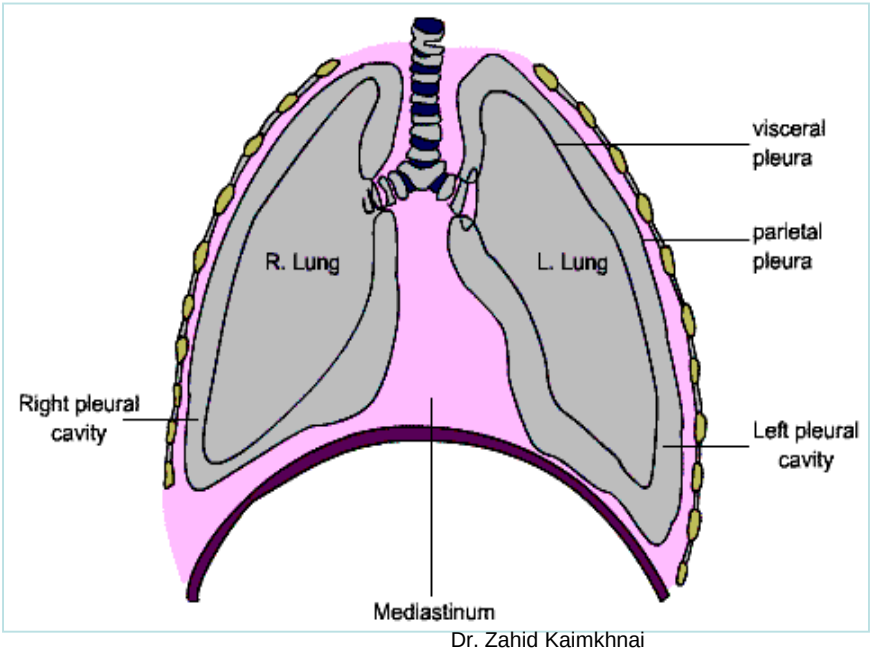


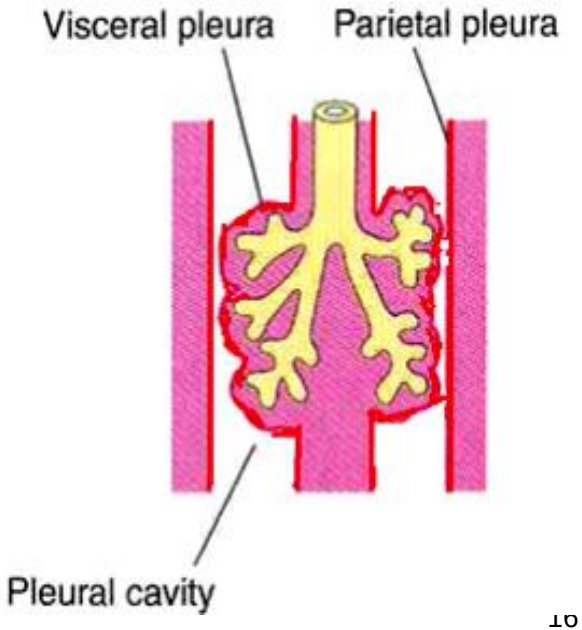
Pleura

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.





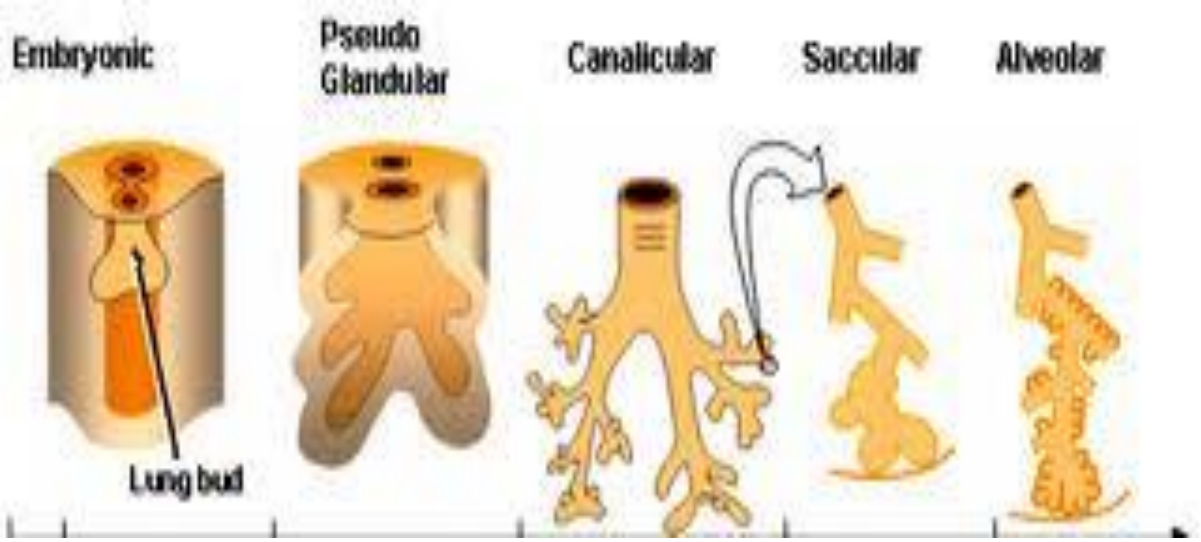


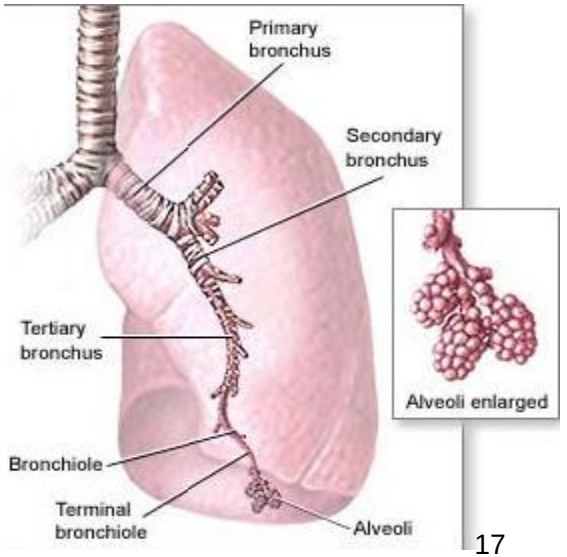
Maturation of the Lungs

Maturation of lung is divided into 4 periods:

Pseudo-glandular	5 - 16 weeks
Canalicular	16 - 26 weeks
Terminal sac	26 weeks – birth
Alveolar	8 mo 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

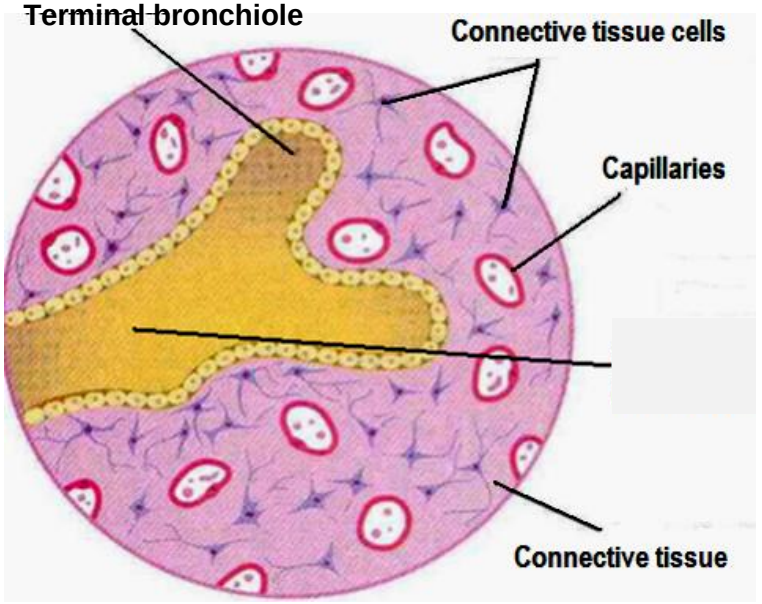
Pseudo-glandular	5 - 16 weeks

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..

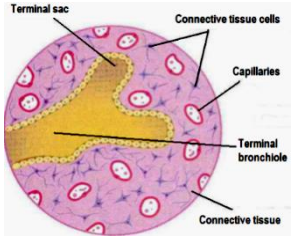
Lumina of bronchi and terminal bronchioles become larger.

By 24 weeks each terminal bronchiole has given rise to two or more respiratory bronchioles.

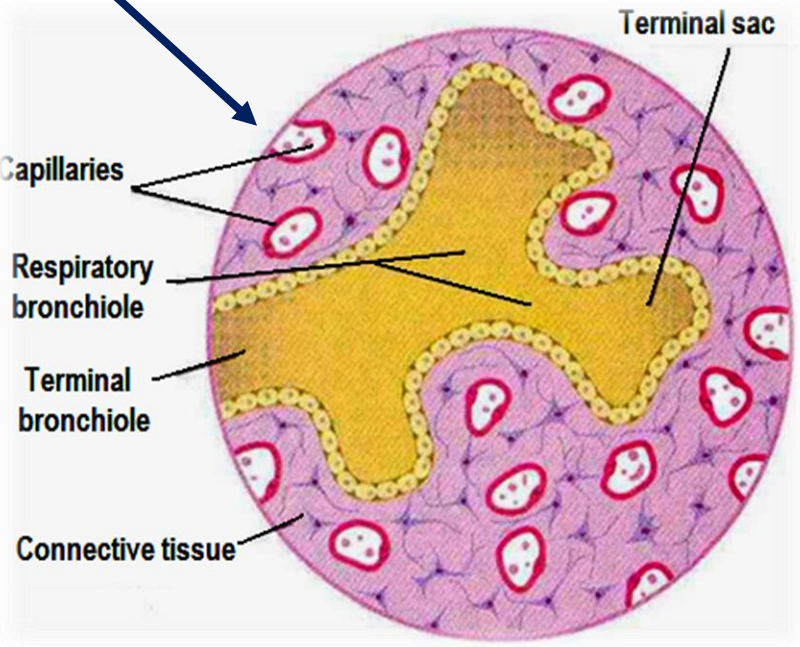
The respiratory bronchioles divide into 3 to 6 tubular passages called alveolar ducts.

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)



Psudo-glandular
5-16 Weeks

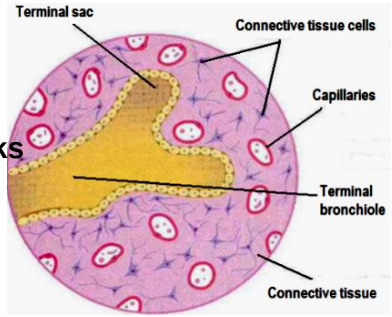


Maturation of the Lungs

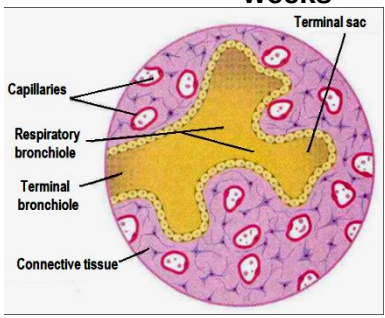
Terminal Sac Period	26 weeks to birth

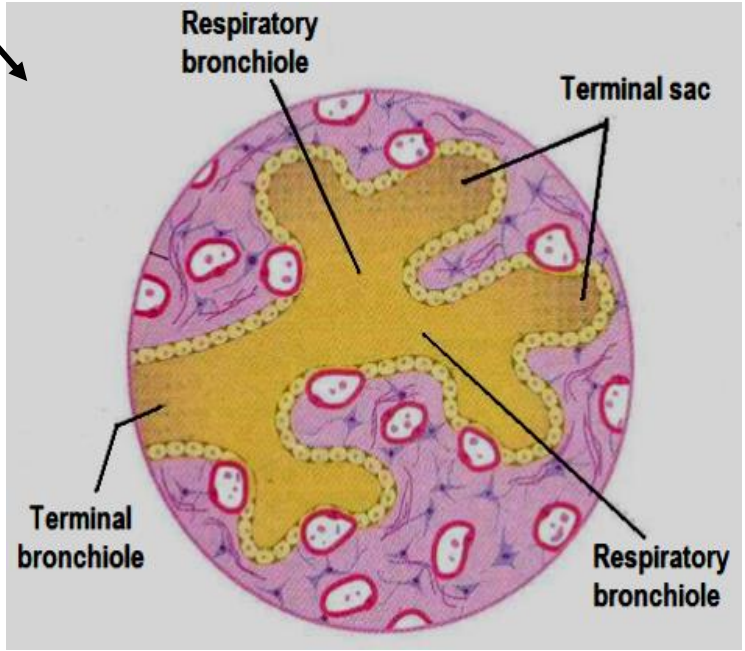
- Many more terminal sacs develop.
- Their epithelium becomes very thin.
- Capillaries begin to bulge into developing alveoli.
- .
- The epithelial cells of the alveoli and the endothelial cells of the capillaries come in intimate contact and establish the blood-air barrier.
- Adequate gas exchange can occur which allows the prematurely born fetus to survive
- By 26 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.

5-16 weeks



16-26 weeks





Maturation of the Lungs

Surfactant:

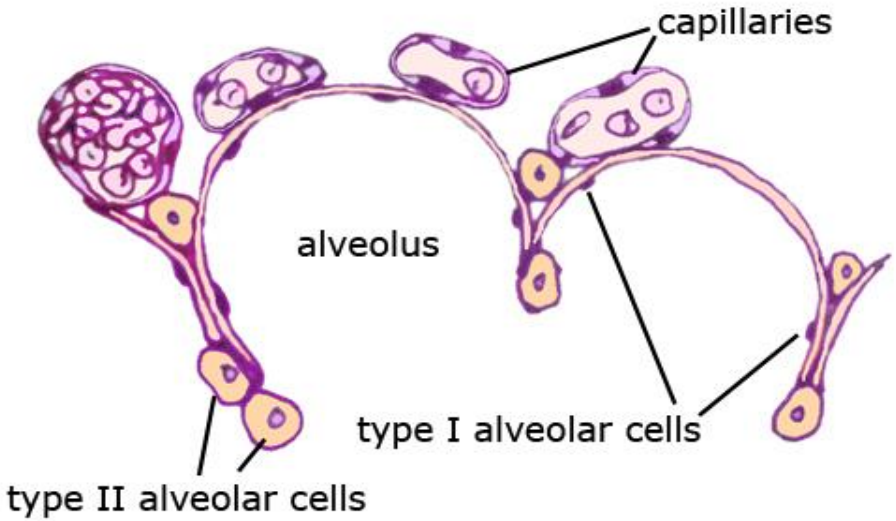
* production **begins by 20 weeks.**
  increases during the terminal stages of pregnancy particularly in LAST 2 Wks.

* **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**

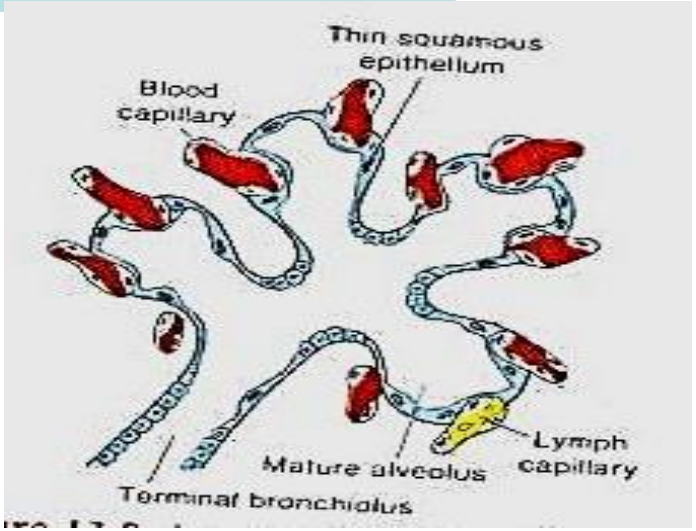
But

* **may survive if given intensive care.**



Maturation of the Lungs

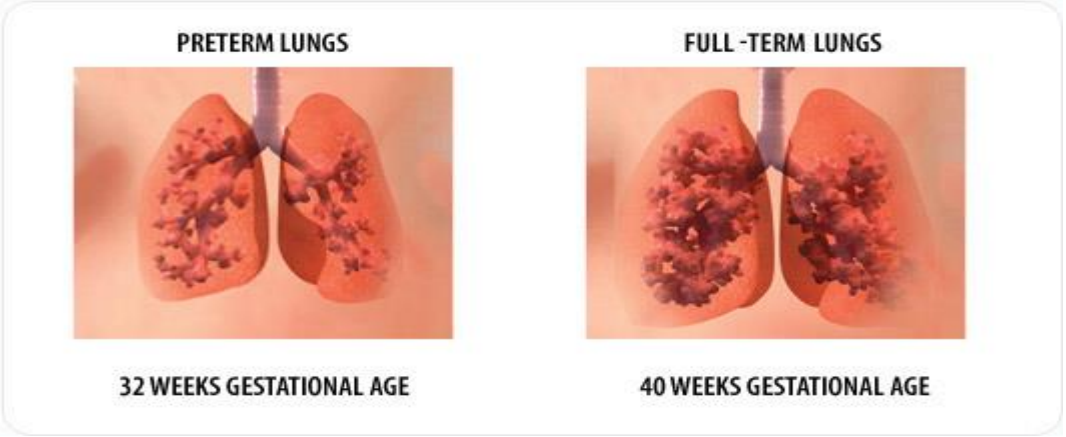
Alveolar Period	32 Weeks to 8 Years

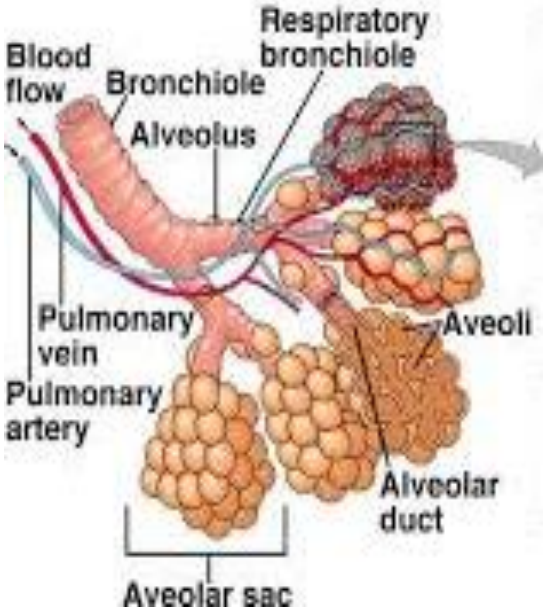


* At the beginning of the alveolar period, each respiratory bronchiole terminates in a cluster of thin-walled terminal saccules.

* Terminal saccules are separated from one another by loose connective tissue.

* These terminal saccules represent future alveolar ducts

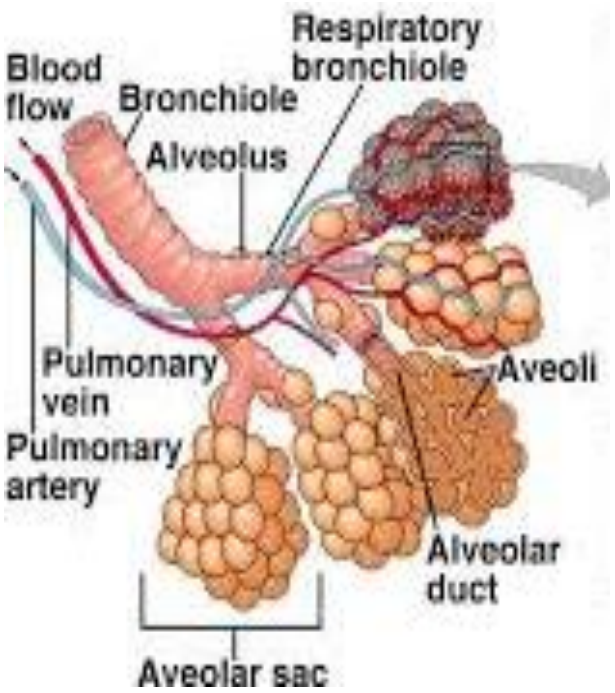




Maturation of the Lungs

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.**

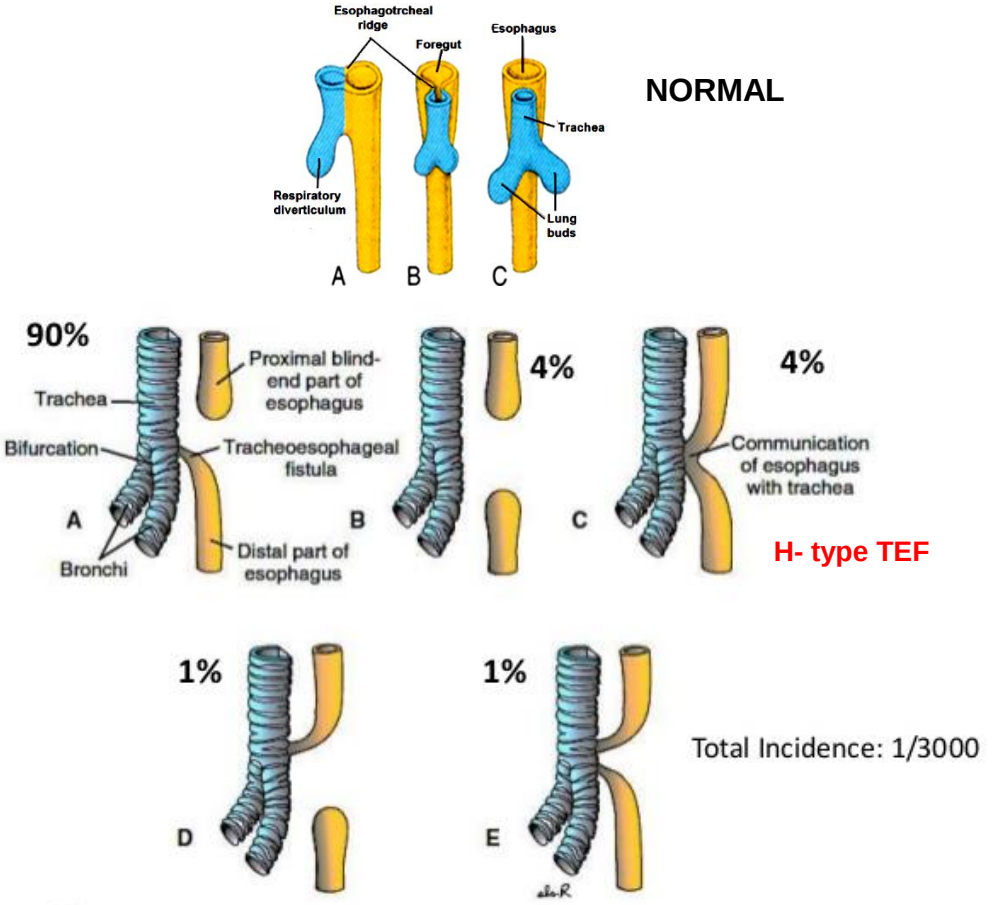


- **From 3-8 year or so, the number of alveoli continues to increase, forming additional primordial alveoli.**
- **By about the eighth year, the adult complement of 300 million alveoli is present.**

Developmental anomalies- Tracheoesophageal Fistula(TEFs)

Fistula ??

- An **abnormal passage** between the trachea and esophagus.
- **Results from abnormal partitioning** 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).**
- **Other defects –VACTERAL?**




Pharynx
Esophagus
Trachea
Laryngotracheal tube
Splanchnic mesoderm
Tracheal buds
Beginning of 4th week
Trachea
Bronchial bud
4 weeks
Bronchial buds
Upper lobe
Middle lobe
Lower lobe
Lower lobe
8 weeks
Upper lobe
Bronchial buds develop
Trachea bifurcates
Bronchial buds
THANK YOU VERY MUCH