

EMBRYOLOGY

LECTURE

#1

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 laryngotracheal (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.



THE RESPIRATORY SYSTEM:

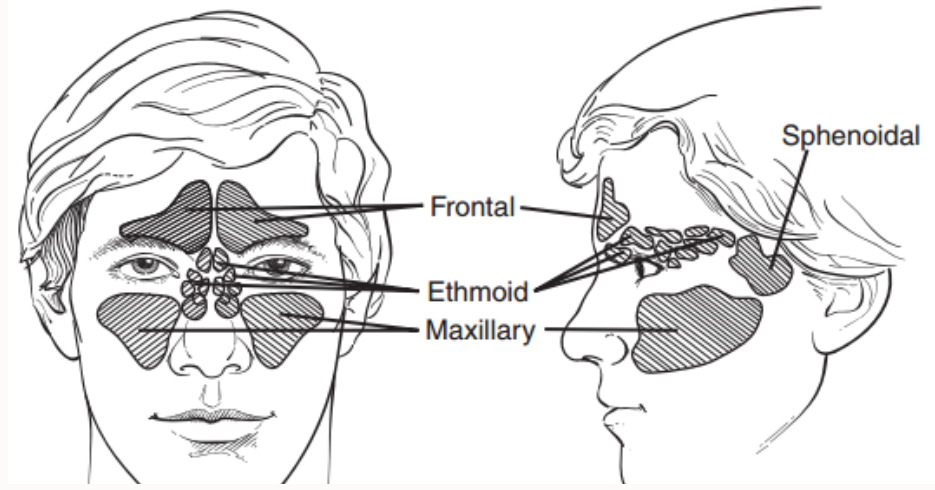
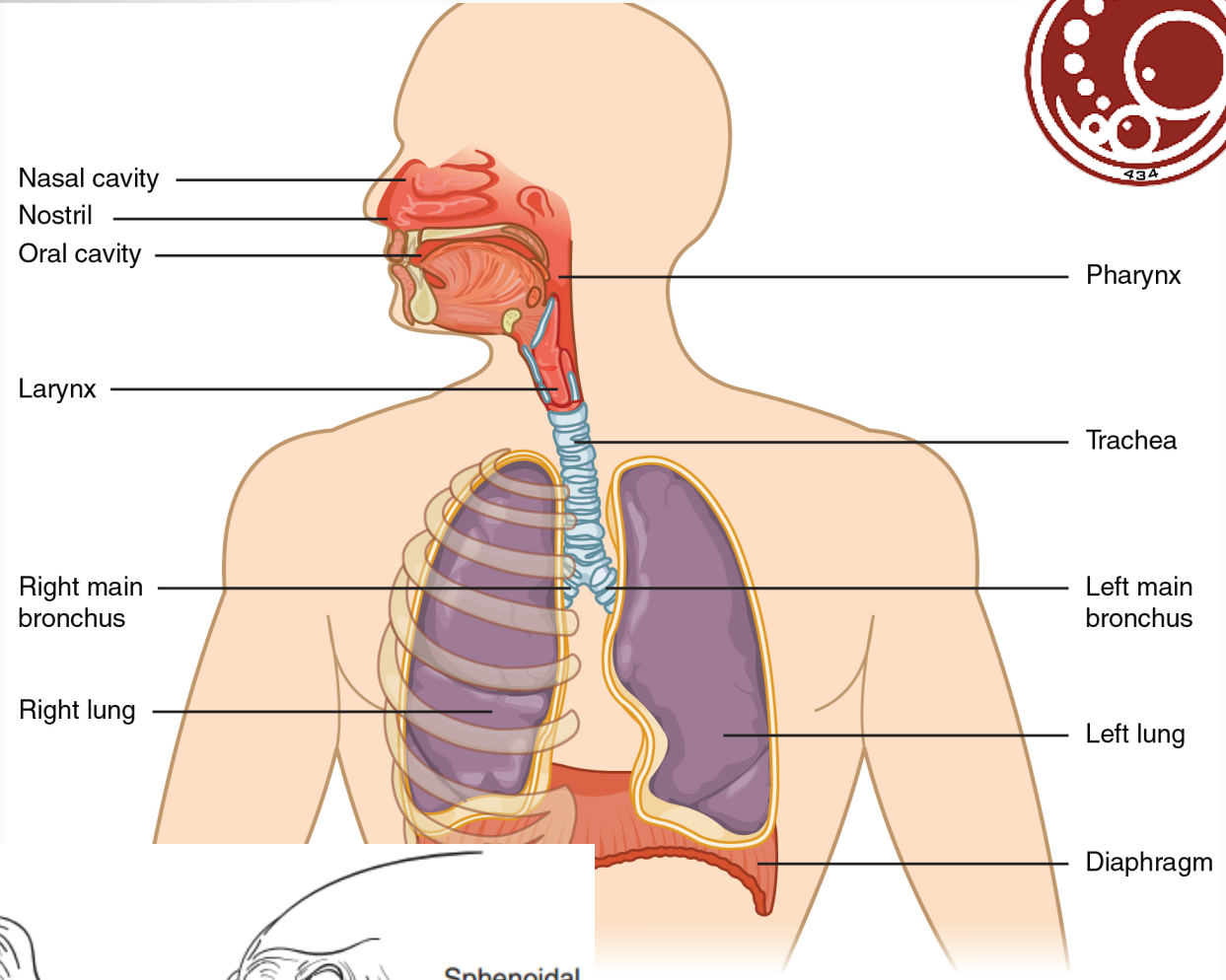
The Respiratory System is divided into:

Upper respiratory tract:

- ★ Nose
- ★ Nasal cavity & paranasal sinuses
- ★ Pharynx

Lower respiratory tract:

- ★ Larynx
- ★ Trachea
- ★ Bronchi
- ★ Lungs



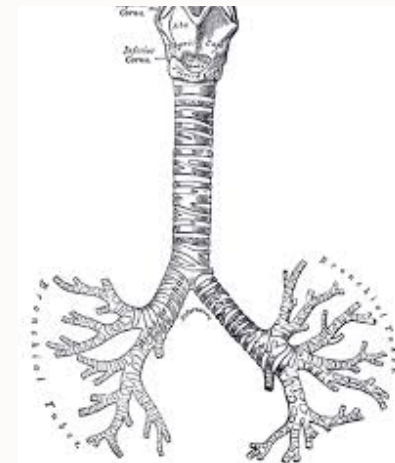
Paranasal Sinuses



THE DEVELOPMENT OF LOWER RESPIRATORY TRACT

It Begins forming in the **4th week** of development.

- 1) It Begins as a **median** outgrowth from the laryngotracheal groove from the caudal part of the ventral wall of the **primitive pharynx**.
- 2) The groove then invaginates (deepens) and forms the **laryngotracheal diverticulum**
- 3) After that, a longitudinal **tracheo-esophageal septum** develops and **divides** the **diverticulum** into:
 - a. **Dorsal portion: primordium* of the oropharynx and esophagus**
 - b. **Ventral portion: primordium (giving rise to) of larynx, trachea, bronchi and lungs**
- 4) **The proximal** part of the respiratory diverticulum remains tubular and forms **larynx & trachea**.
- 5) **The distal end** of the diverticulum dilates to form **lung bud**, which divides to give rise to **2 primary bronchial buds**.
- 6) The endoderm lining the laryngotracheal diverticulum **gives rise to** :
 - a. **Epithelium & Glands of the respiratory tract**
- 7) The surrounding splanchnic mesoderm gives rise to :
 - a. **Connective tissue, Cartilage & Smooth muscles of the respiratory tract.**



*primordium: The earliest stage of tissue or organ.

Development of the Larynx

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

All **Laryngeal muscles & cartilages** develop from the mesoderm of 4th & 6th pairs of pharyngeal arches

except for the Epiglottis.

FYI: Epiglottis develops from caudal part of hypopharyngeal eminence

Recanalization of the larynx:

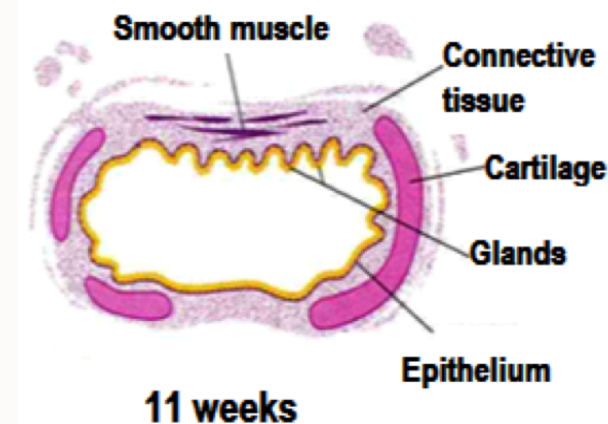
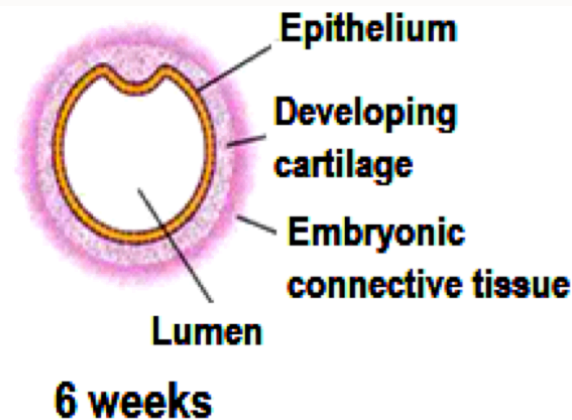
Recanalization of larynx normally occurs by the 10th week

The laryngeal epithelium proliferates rapidly resulting in temporary occlusion of the laryngeal lumen

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:
 - **Epithelium and glands of the trachea**
 - **pulmonary epithelium**
- The cartilage, connective tissue and muscles of the trachea are derived from Mesoderm

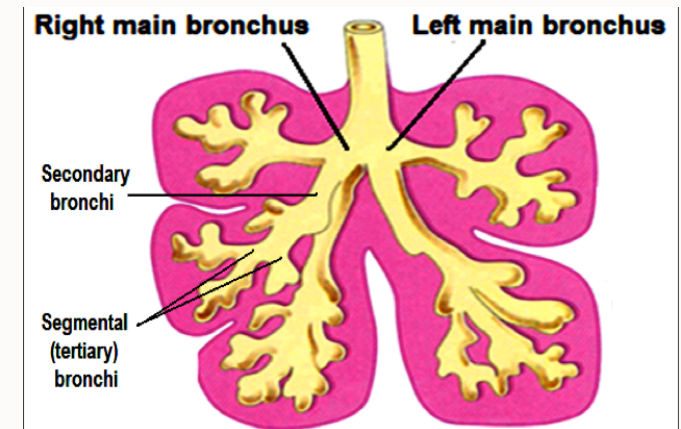




DEVELOPMENT OF THE BRONCHI & LUNGS

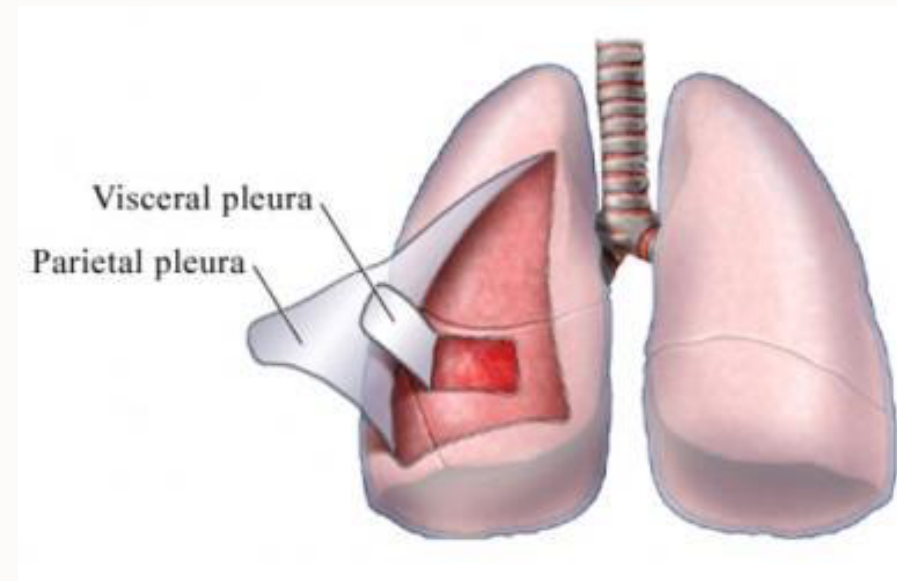
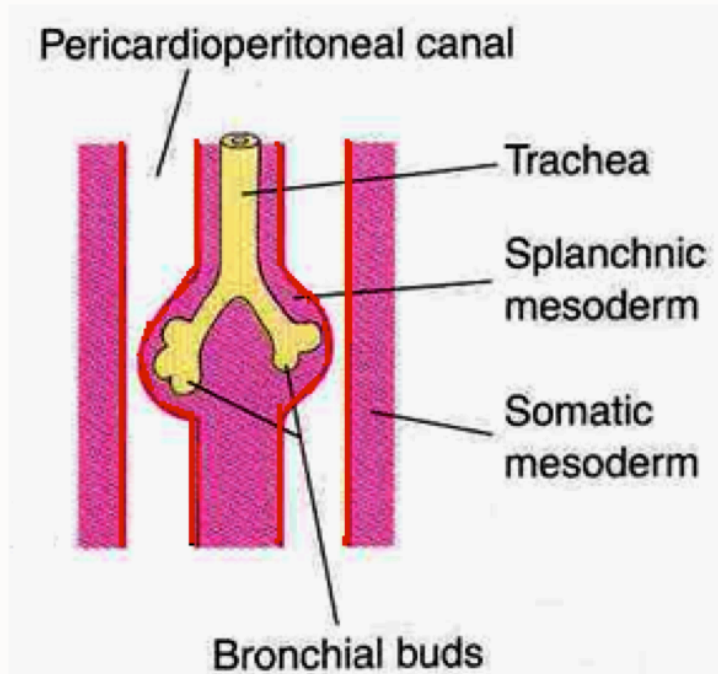
- 1) The 2 primary bronchial buds grow laterally (right and left) **into the pericardio-peritoneal canals** (part of the intraembryonic celome), the primordia of pleural cavities
- 2) Bronchial buds divide and re-divide to give the bronchial tree.
- 3) The main bronchi subdivide into secondary and tertiary (segmental) bronchi which give rise to further branches.
- 4) By the 7th week, the segmental bronchi begin to form:
 - 10 in the right lung
 - 8 or 9 in the left lung.
- 5) each segmental bronchus with its surrounding mass of mesenchyme is the primordium of a bronchopulmonary segment.

The right main bronchus is slightly larger (wider) than the left one and is oriented more vertically "Permanent Feature"



CONC.

- 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** *from **Somatic mesoderm**.





MATURATION OF THE LUNGS

Maturation of lung is divided into 4 periods:

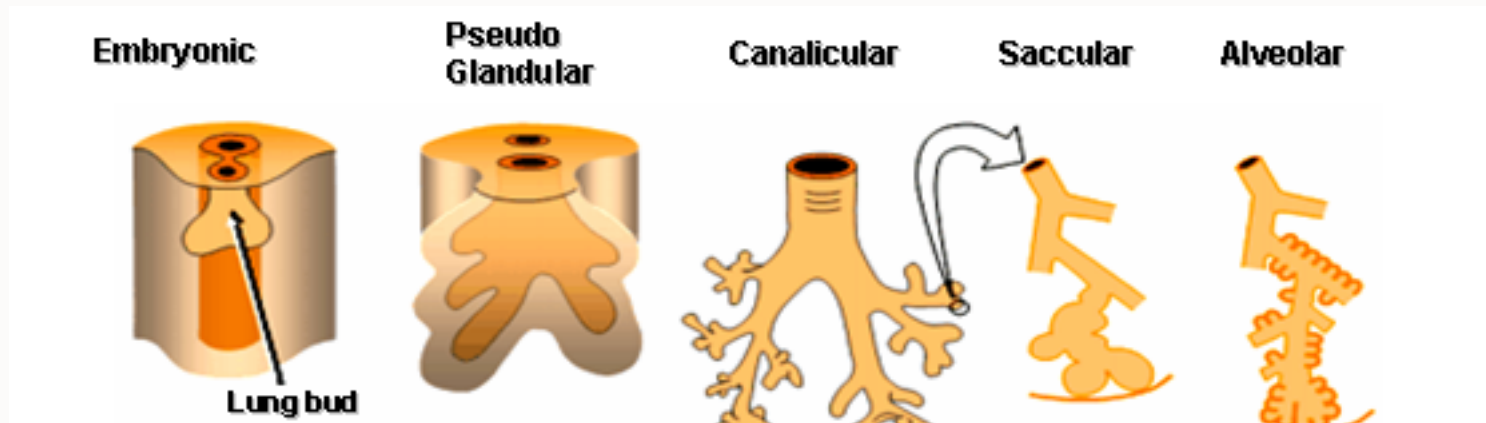
Pseudoglandular
(5 - 17 weeks)

Terminal Sac
(24 weeks - birth)



(16 - 25 weeks)
Canalicular

late fetal period - childhood
Alveolar



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



MATURATION OF THE LUNGS

Pseudoglandular Period

- ✦ 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

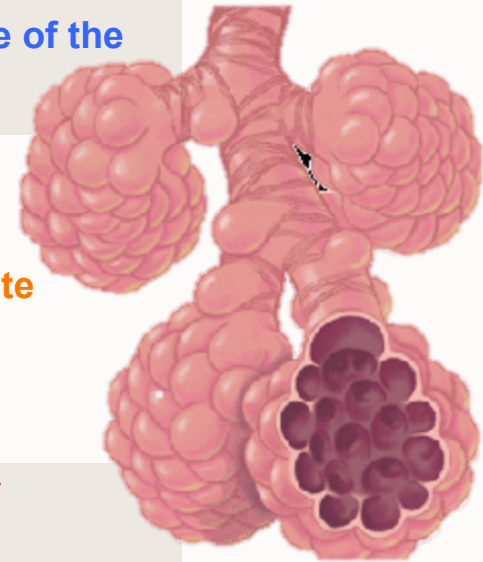
- ✦ **Lung tissue becomes highly vascular.**
- ✦ **Lumina of bronchi and terminal bronchioles become larger.**
- ✦ **By 24 weeks each terminal bronchiole has given rise to two or more respiratory bronchioles.**
- ✦ **The respiratory bronchioles divide into 3 to 6 tubular passages called alveolar ducts. 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 Period

- ✦ **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**

Alveolar Period

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

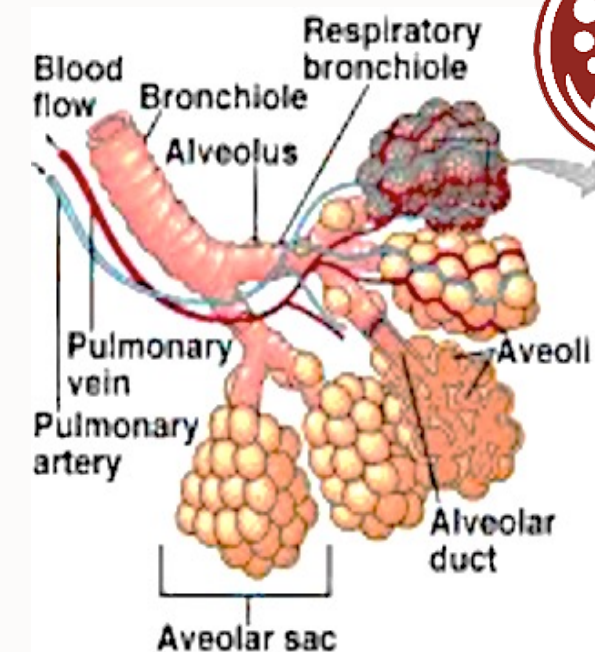




Characteristic mature alveoli:

- 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.



Before birth:

Breathing Movements

- ★ They are not continuous and increase as the time of delivery approaches.
- ★ Help in conditioning the respiratory muscles.
- ★ Stimulate lung development and are essential for normal lung development.

Lungs at birth

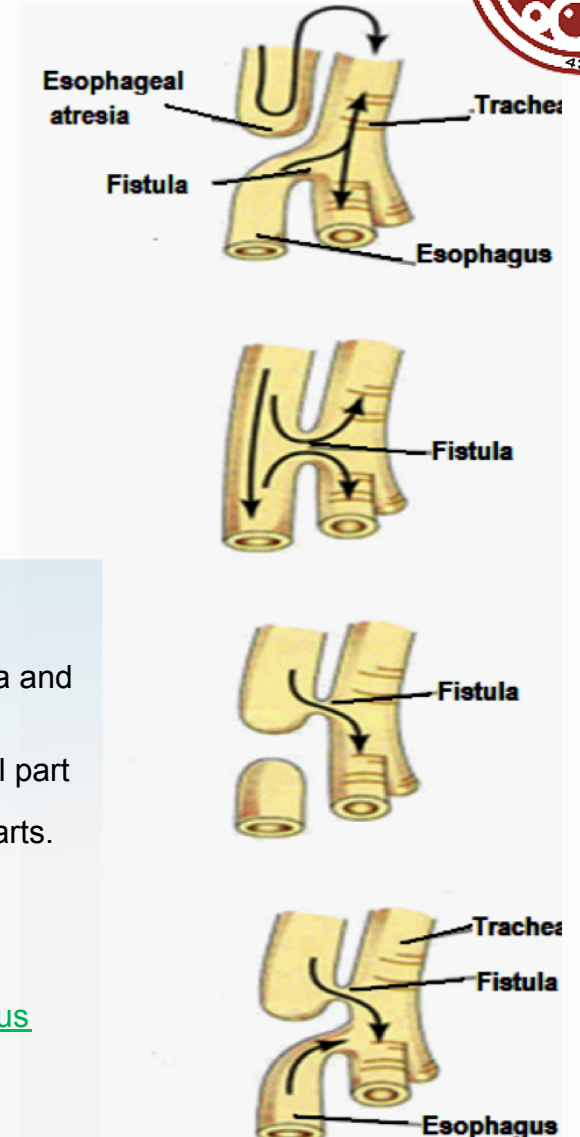
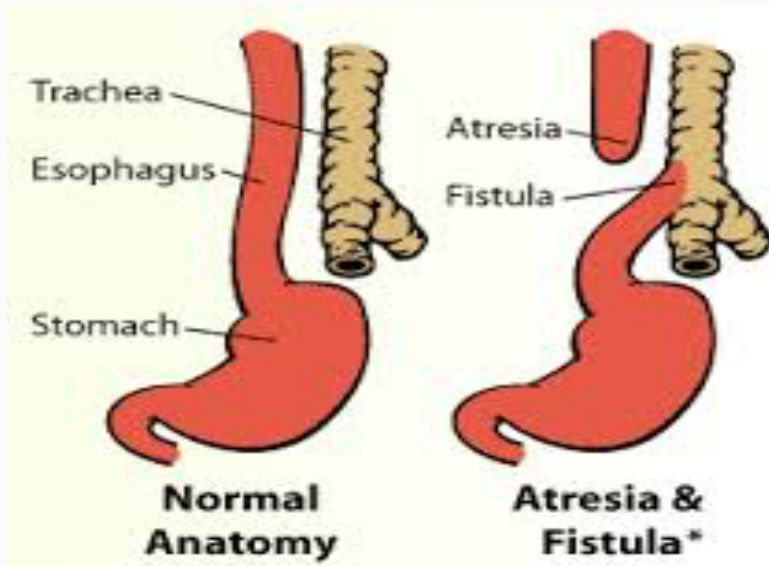
- ★ The lungs are half filled with fluid derived from the amniotic fluid and from the lungs & tracheal glands.
- ★ This fluid in the lungs is cleared at birth: by:
- ★ Pressure on the fetal thorax during delivery.
- ★ Absorption into the pulmonary capillaries and lymphatics.

Factors important for normal lung development

- Adequate thoracic space for lung growth.
- Fetal breathing movements.
- Adequate amniotic fluid volume.

Developmental anomalies

- Laryngeal atresia.
- Tracheoesophageal fistula.
- Tracheal stenosis & atresia.
- Congenital lung cysts.
- Agenesis of lungs.
- Lung hypoplasia.
- Accessory lungs.



Tracheoesophageal Fistula:

- It's an abnormal passage between the trachea and esophagus.
- Results from incomplete division of the cranial part of the foregut into respiratory and esophageal parts.
- 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**).

YouTube Esophageal Atresia

<https://www.youtube.com/watch?v=6KvIPT-1tfM>



MULTIPLE CHOICES QUESTIONS

1. Diverticulum is divided by?

- A) Primitive Pharynx
- B) Tracheo-esophageal septum
- C) Lung bud
- D) Bronchial bud

2. Which rise from endoderm?

- A) Connective tissue
- B) Epithelium and glands
- C) Cartilage
- D) Smooth muscle

3. Recanalization occurs by?

- A) 4th week
- B) 6th week
- C) 8th week
- D) 10th week

4. Which is true for right main bronchus?

- A) Wider & oriented more vertically
- B) Wider & oriented more horizontally
- C) Narrower & oriented more vertically
- D) Narrower & oriented more horizontally

5. Number of segmental bronchi in left lung?

- A) 5
- B) 7
- C) 8
- D) 10

6. Thoracic body wall becomes lined by layer of Parietal Pleura derived from?

- A) Splanchnic mesenchyme
- B) Somatic mesoderm
- C) Endoderm
- D) Segmental Bronchi

Answers:

- 1- B
- 2- B
- 3- D
- 4- A
- 5- C
- 6- B



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-Embryonic Development of the Respiratory System:

<https://www.youtube.com/watch?v=xQiNzxM1s2Y>

-Another detailed animation :

<https://www.youtube.com/watch?v=TbupsZ7LpDs>

