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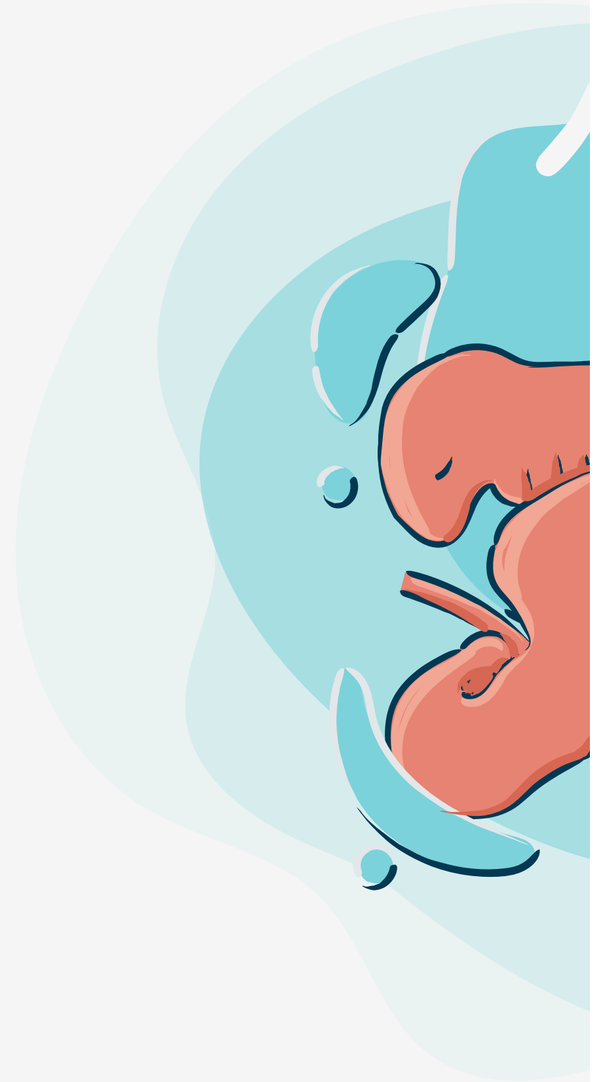
Embryology of the respiratory system

Editing file

Color Index:
Main text -Important -Notes -Male Slides -Female Slides -Extra

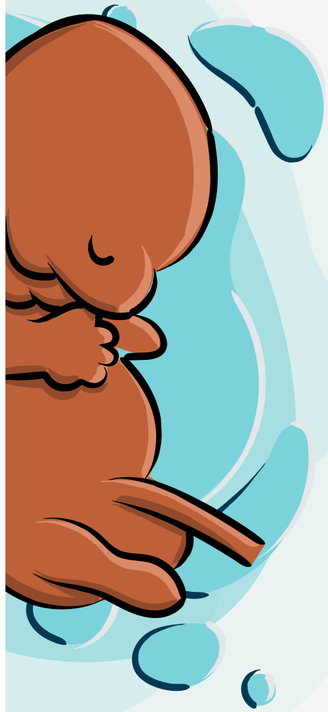
Objectives

- **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.**



Before you start studying this lecture, we highly recommend that you watch this video first!

Respiratory system

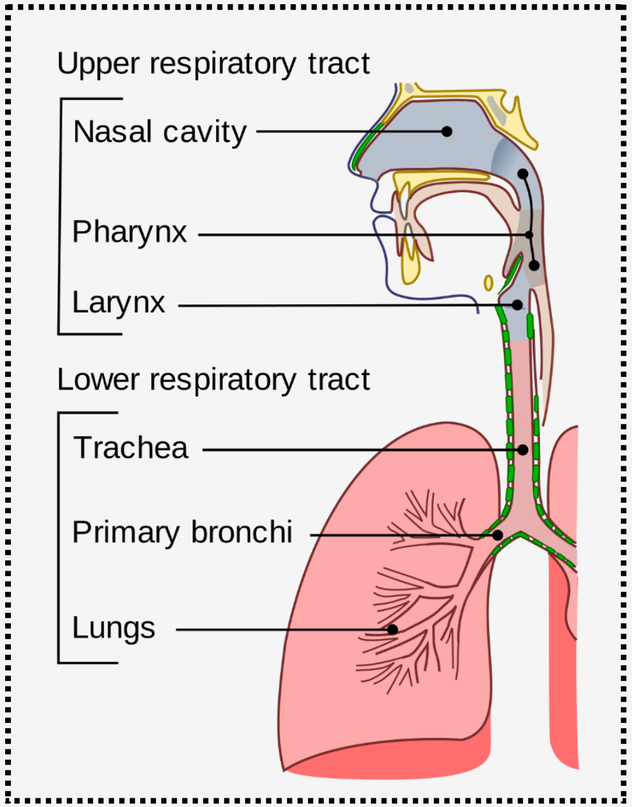


Upper respiratory tract:

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

Lower respiratory tract:

- Trachea
- Bronchi
- Lungs



In embryology(Moore persaud)the lower respiratory tract includes **Larynx

Moore Persaud is the reference textbook

Development of the respiratory tract

Respiratory Diverticulum

When it begins?

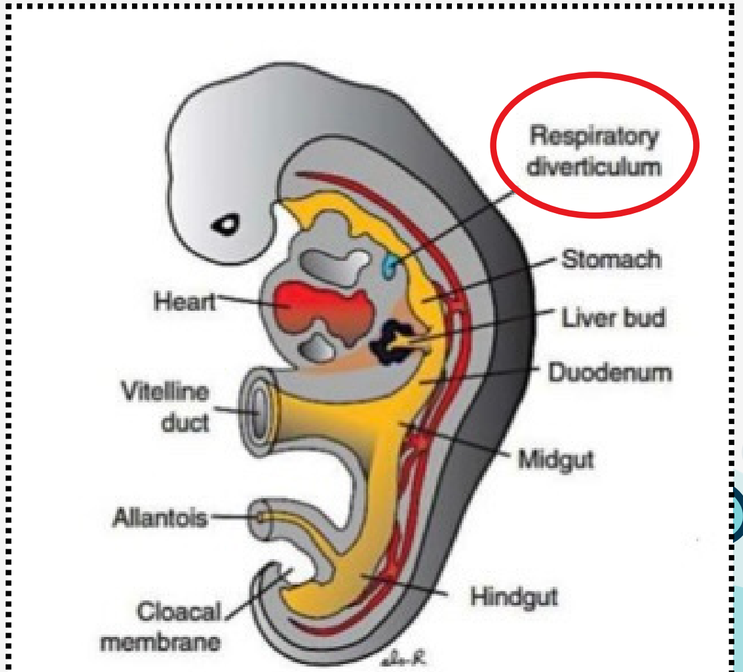
During the middle of the **4th** week of development.

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 laryngo-tracheal or Respiratory diverticulum.



Tracheo -esophageal septum

A longitudinal **tracheo-esophageal** Septum develops and divides the primitive foregut / diverticulum into a:

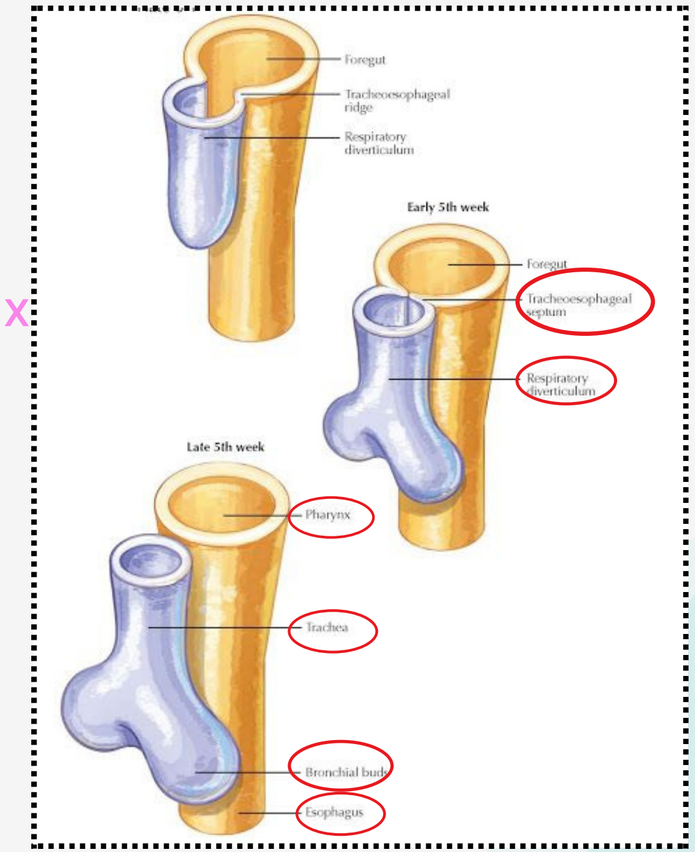
- **Dorsal portion:**

primordium (means giving rise to)of the oropharynx and esophagus(digestive)

- **Ventral portion:**

primordium of Respiratory Diverticulum

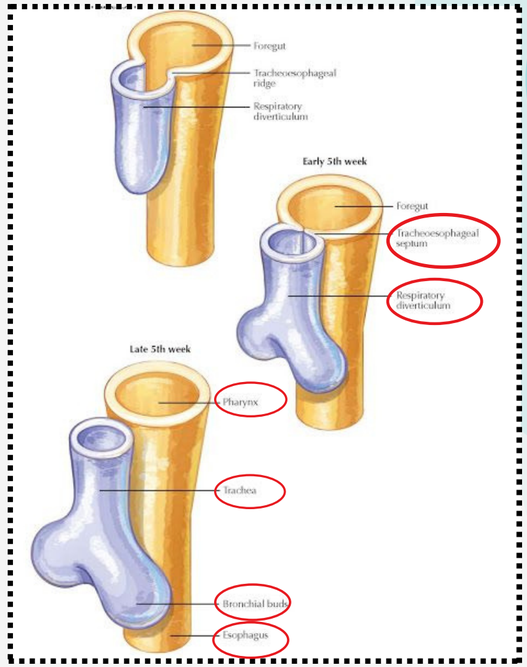
1. larynx
2. trachea
3. bronchi and lungs



Respiratory diverticulum derivatives

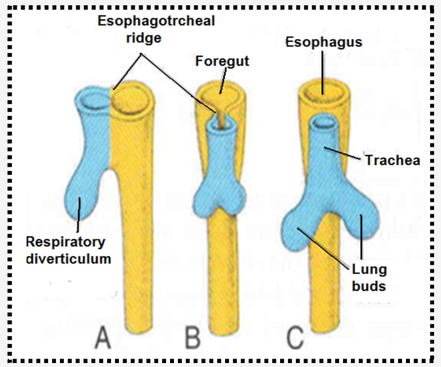
The Proximal part : of the respiratory diverticulum remains tubular and forms Larynx &Trachea.

The Distal end : of the diverticulum dilates to form lung bud, which divides to give rise to two lung buds (primary bronchial buds).



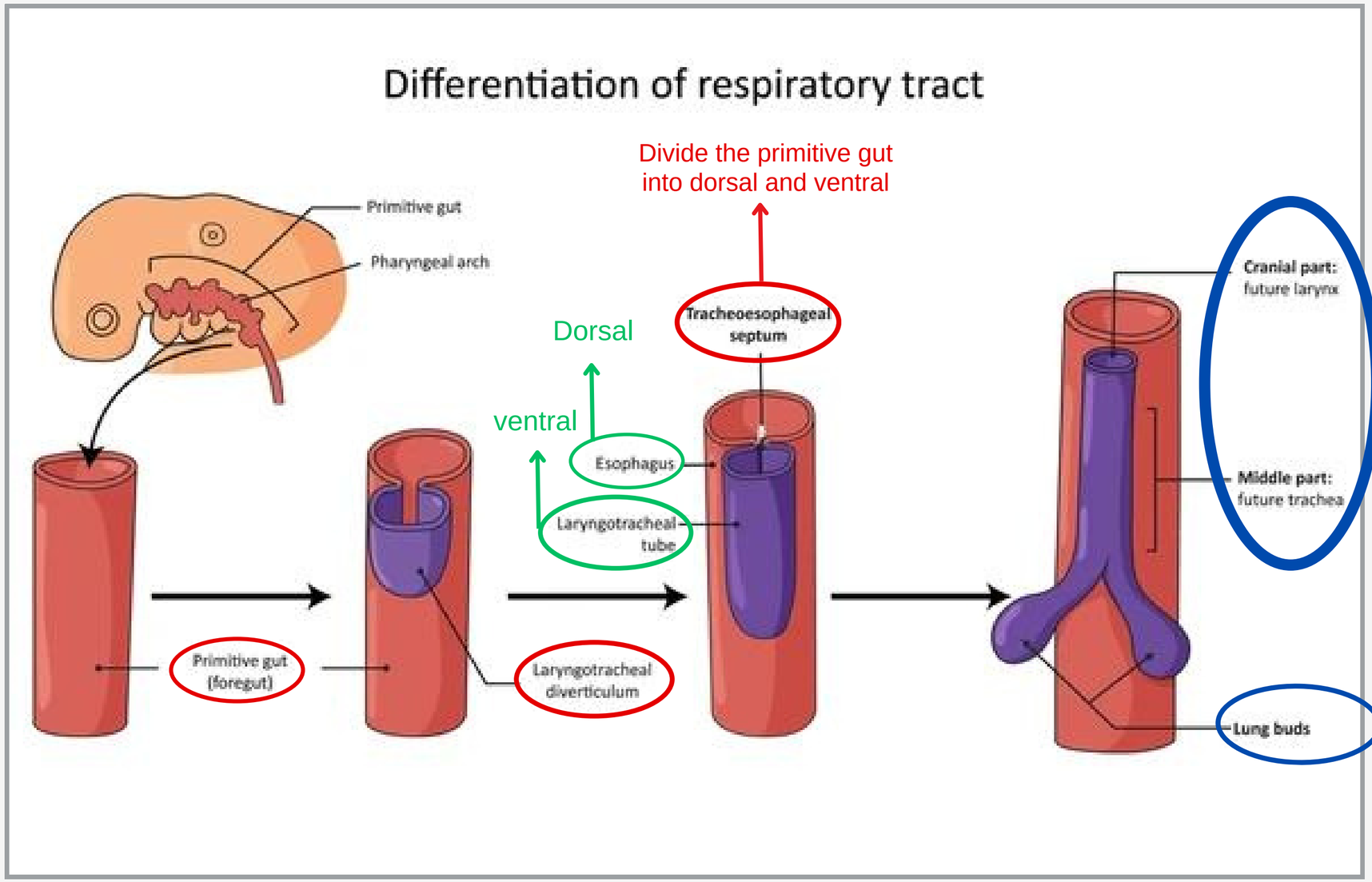
The endoderm lining the laryngotracheal diverticulum (Respiratory diverticulum)
Gives rise to the:
Epithelium & Glands of the respiratory tract.
(the endoderm giving rise to epithelium and glands in any parts of respiratory)

The surrounding splanchnic mesoderm
Gives rise to the:
Connective tissue , Cartilage & Smooth muscle of the respiratory tract



Note: In general in all respiratory system, there are endoderm and mesoderm.

Extra helpful slide



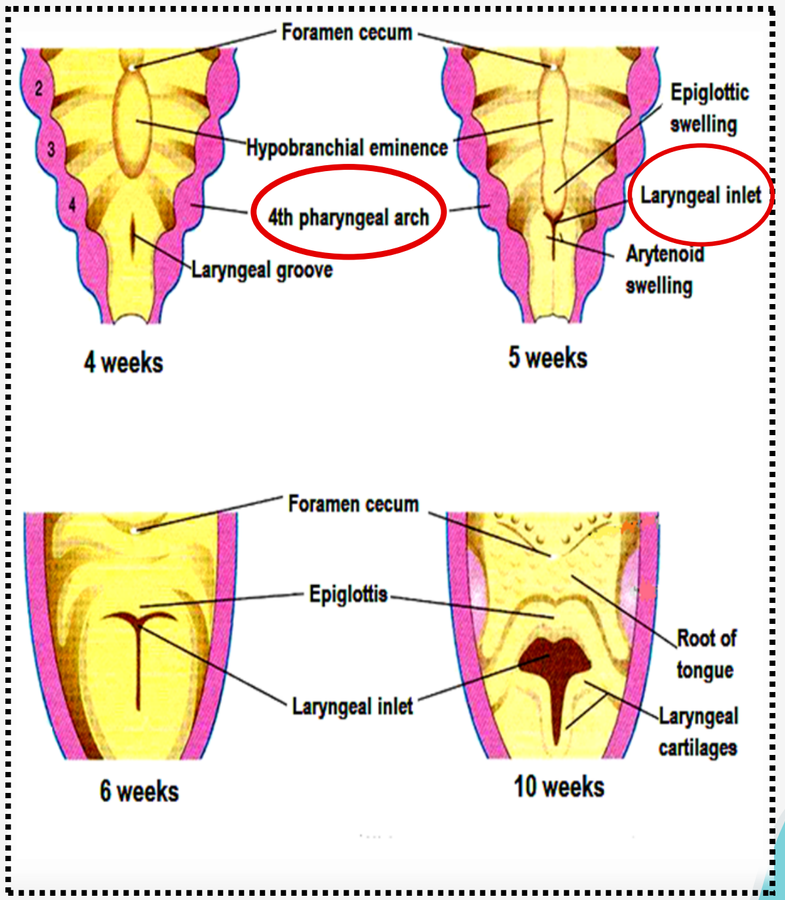
Development of the larynx

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

Laryngeal muscle & the cartilage of the larynx **(Except Epiglottis)**
Develop from the mesenchyme / mesoderm of **4th &6th** Pairs of pharyngeal arches

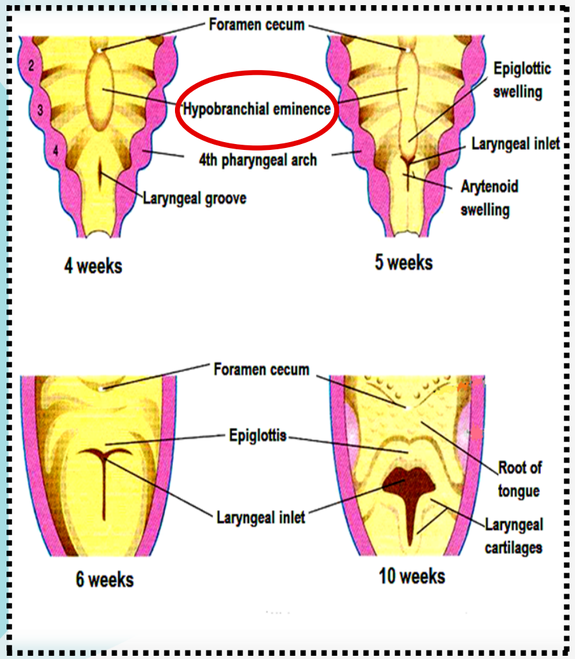
The laryngeal
Epithelium & glands
Develop from endoderm of respiratory diverticulum

The 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



Epiglottis

The epiglottis develops from the caudal part of the **hypopharyngeal eminence**, which is a swelling formed by the proliferation of the mesoderm in the floor of the pharynx .

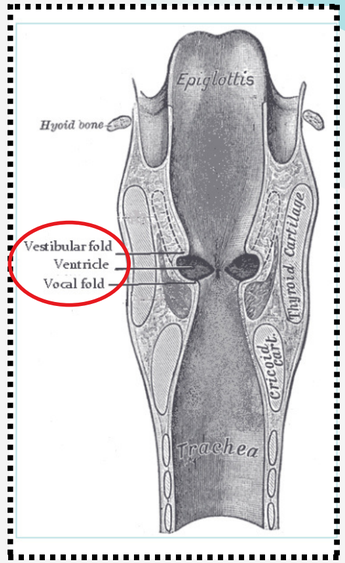


Note:
Growth of the larynx and epiglottis is rapid during the first 3 years after birth. By this time the epiglottis has reached its adult form

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**

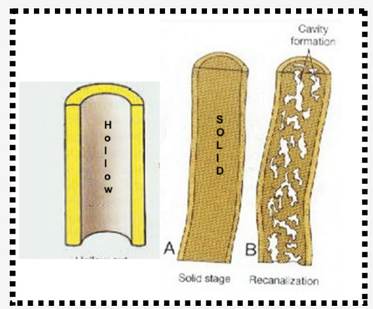
-at 4th week respiratory system will start to develope including the larynx
-during the development period there will be rapid increase in laryngeal epithelium causing occultation
-at 10th week there will be recanalization of the occultion and it will open



- **During recanalization:**

-Laryngeal ventricles are formed

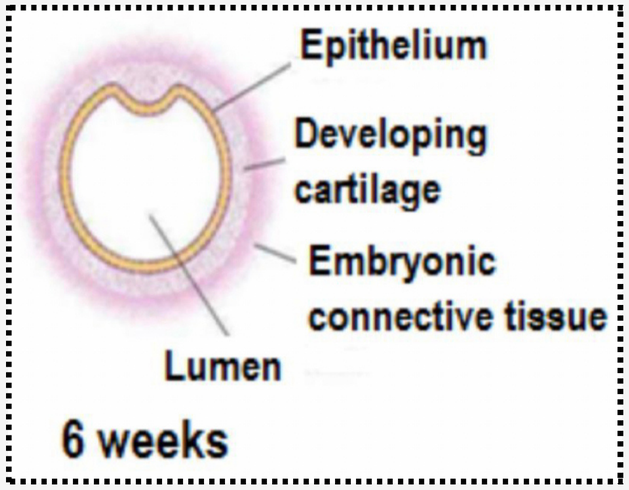
-The mucosal folds that bound these recesses become :
i.Vestibular folds (False vocal cords)
ii.Vocal folds (True vocal cords)

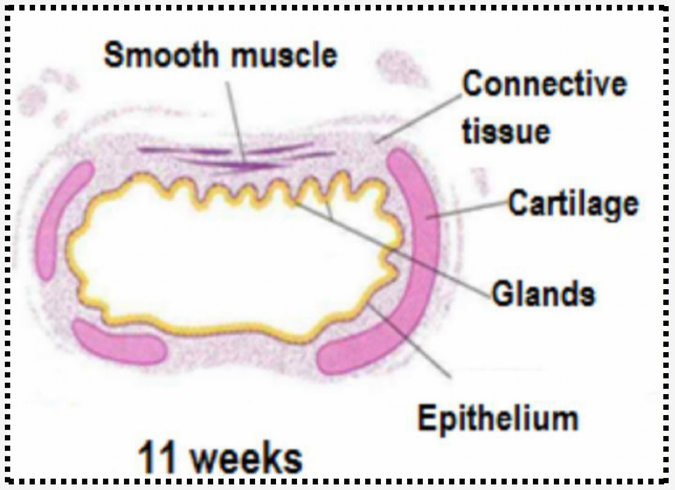


Development of the Trachea

- **Distal to the larynx** : the endodermal lining of the laryngotracheal tube 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 (the surrounding splanchnic mesoderm)





Bronchi and Lungs

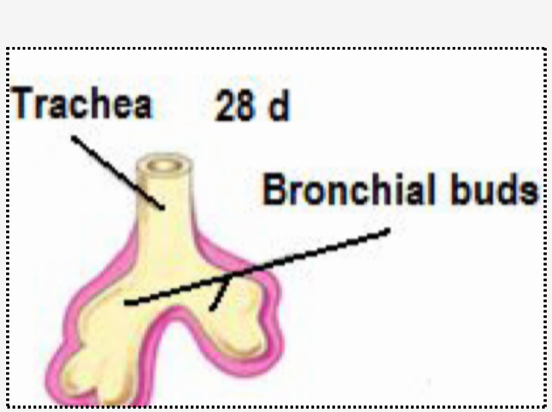
1- The two primary bronchial (lung) buds grow laterally into the pericardio-peritoneal canals (part of the intraembryonic celome), the primordia of pleural cavities.
-Bronchial buds divide and re-divide to give the bronchial tree

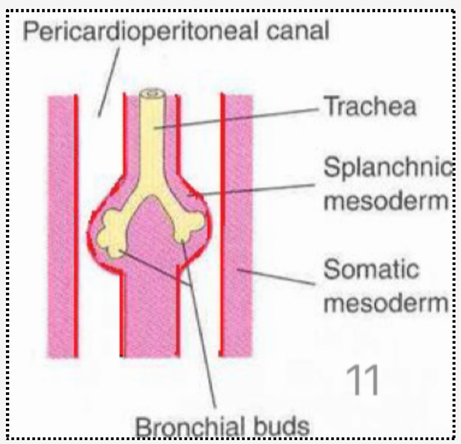
2- The embryonic right main bronchus is slightly larger / shorter (wider) than the left one and is oriented more vertically.
(The embryonic relationship persists in the adult)

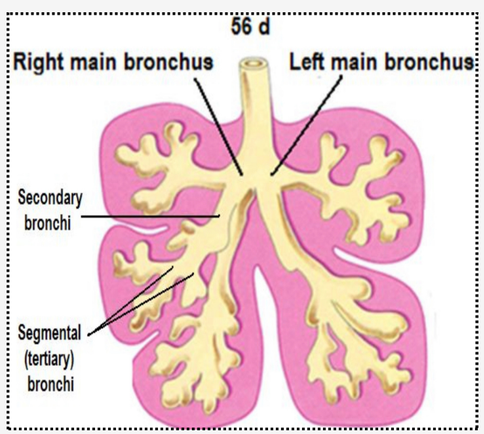
3- The main bronchi subdivide into secondary and tertiary (segmental) bronchis which give rise to further branches.

4- 10 segmental bronchi in the right lung and 8 or 9 in the left lung begin to form by the 7th week. The surrounding mesenchyme also divides.

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







Lung maturation

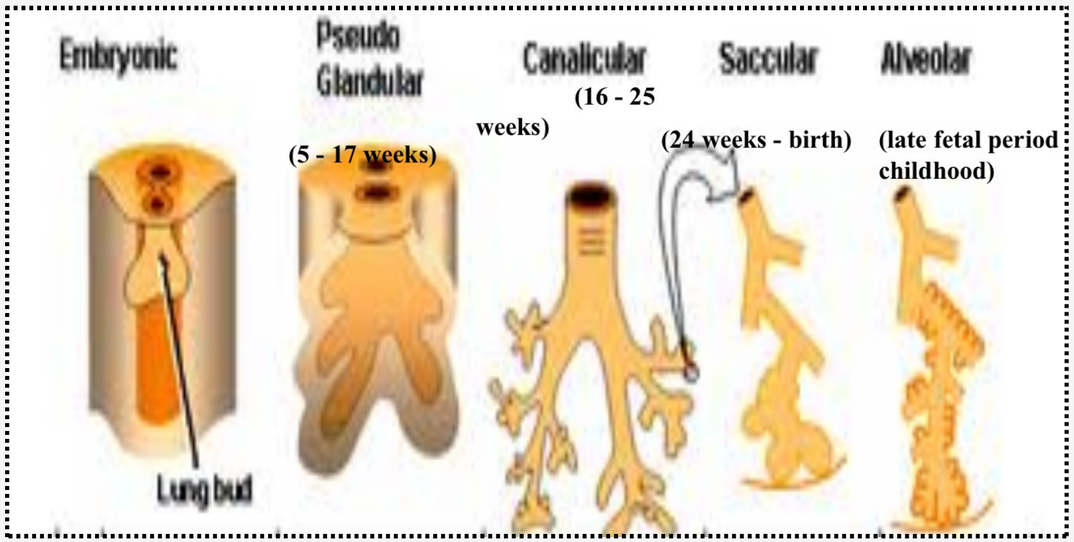
Dr Note : periods are important!!

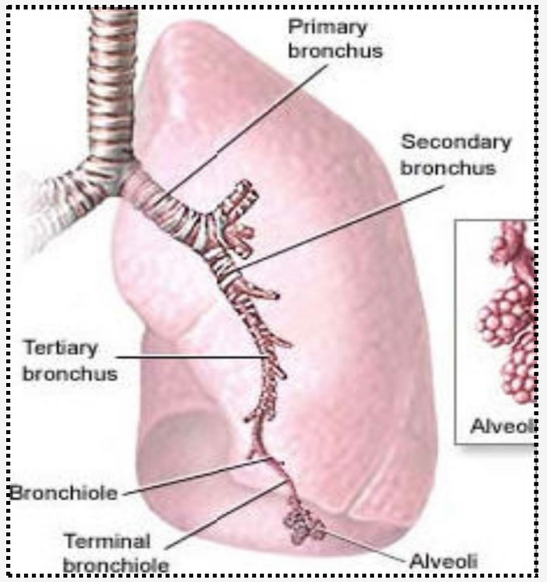
Highly recommended video

- Maturation of lung is divided into 4 periods:

1-Pseudoglandular	2- Canalicular	3- Terminal sac	4- Alveolar
5- (16 /17) weeks	16 - (25/26) weeks	(24/26) weeks to birth	32 weeks to 8 years (8 months to childhood) Late fetal period childhood

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





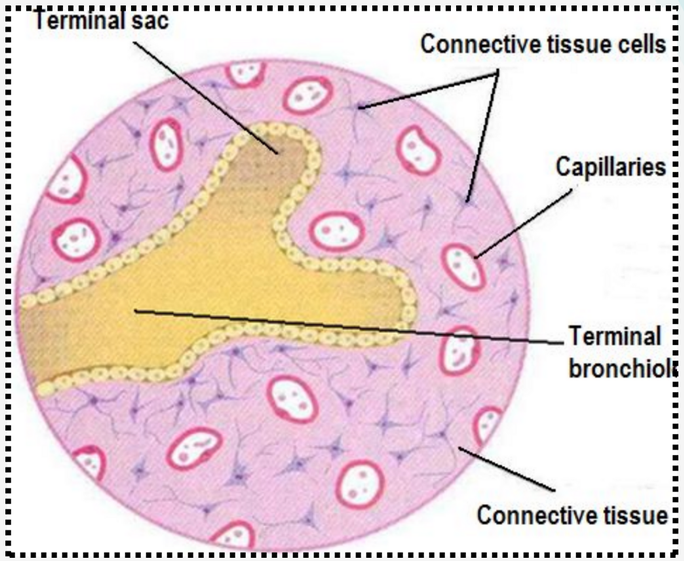
1- Pseudo-glandular

Developing lungs somewhat resembles an exocrine gland during this period.

Respiration is NOT possible.

By 16/17 weeks all major elements of the lung have formed except those involved with gas exchange i.e. **ALVEOLI**.

Fetuses born during this period are unable to survive.



2- Canalicular

Lung tissue becomes highly vascular.

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

Some thin-walled terminal sacs (primordial alveoli) develop at the end of respiratory bronchioles.

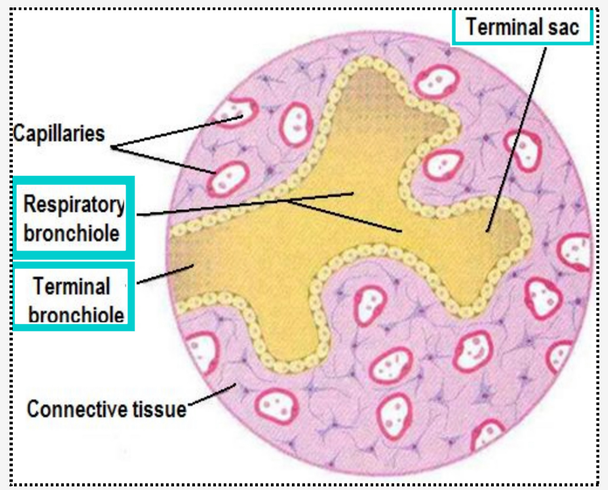
Fetus born at the end of this period may survive if given intensive care

But usually die because of the immaturity of respiratory as well as other systems

Lumina of bronchi and terminal bronchioles become larger.

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

Respiration is possible at the end of this period.



3-Terminal Sac Period

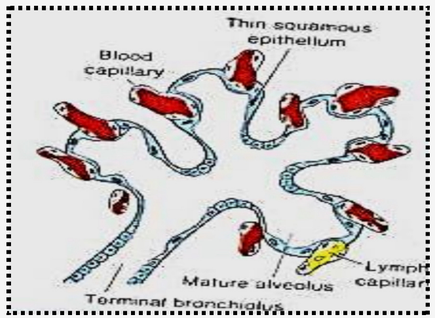
Many more terminal sacs develop.

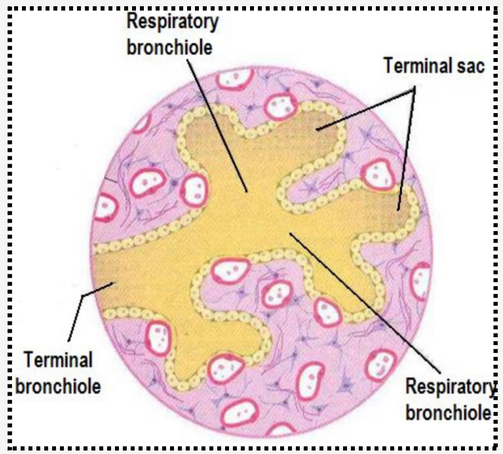
Their epithelium becomes very thin forming the developing alveoli..

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

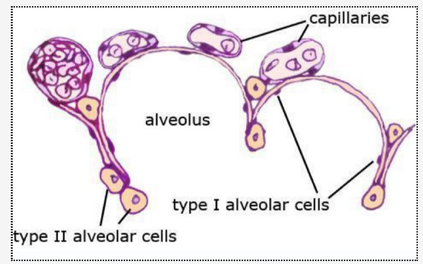




Surfactant production:

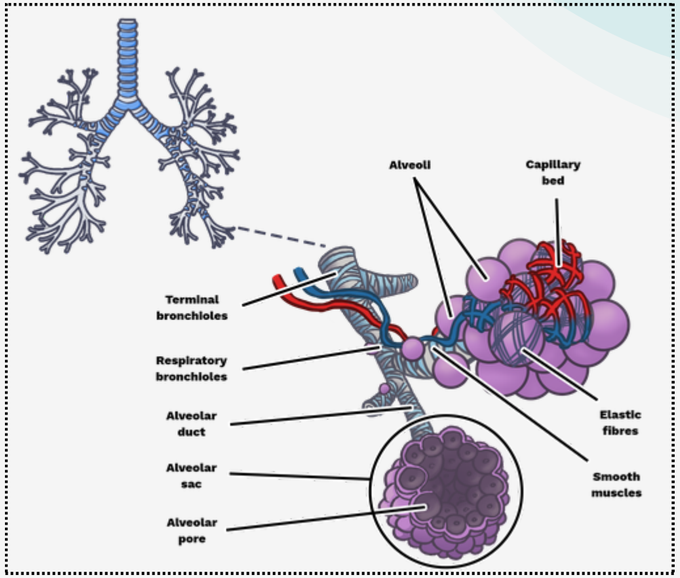
By 24 weeks, the terminal sacs are lined by:

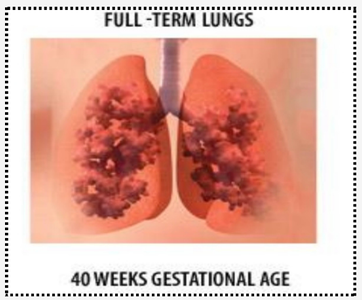
- Squamous type I alveolar cells or pneumocytes and rounded secretory type II pneumocytes, that secrete a mixture of phospholipids called surfactant.
- **Surfactant production begins by 24 weeks** and increase during the terminal stages of pregnancy particularly in last 2 weeks
- Sufficient terminal sacs, pulmonary vasculature and 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.
- RDS (Hyaline membrane disease)



4- Alveolar (32 Weeks to 8 Years)

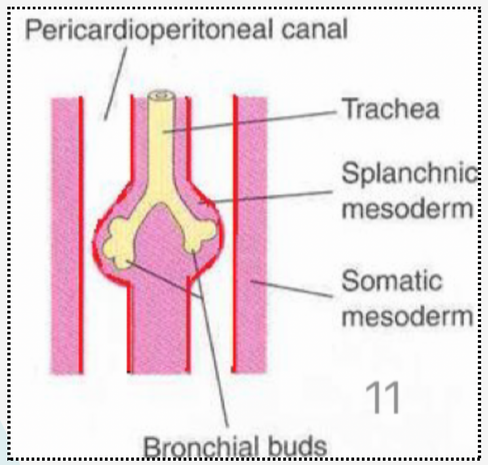
- At the beginning of the alveolar period, each respiratory bronchiole terminates in a cluster of thin-walled terminal saccules (future alveoli)
- Terminal saccules are separated from one another by loose connective tissue.
- These terminal saccules or alveoli represent future alveolar sacs
- Characteristic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

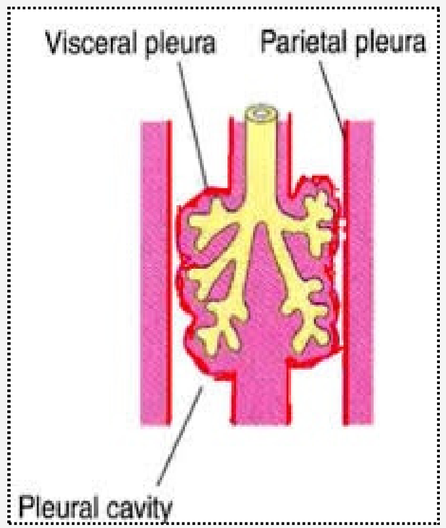


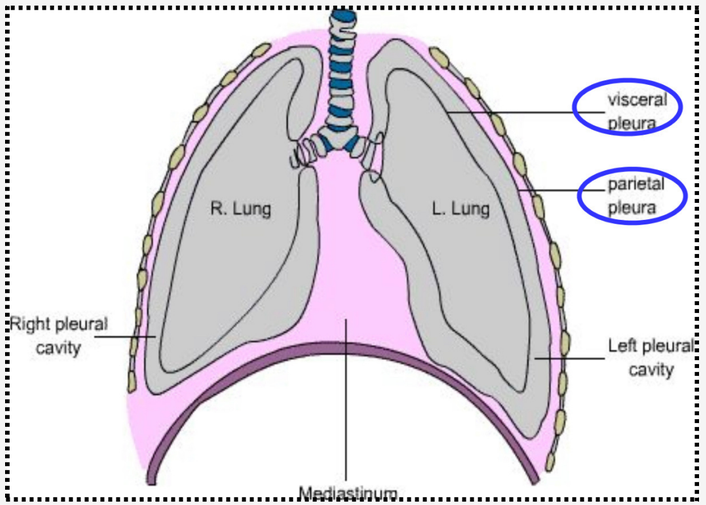


Development of the pleura

- 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.







Developmental anomalies - Tracheoesophageal Fistula(TEFs)

- Fistula is an abnormal passage between the trachea and esophagus

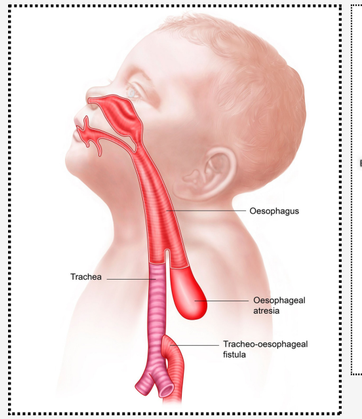
- Results from incomplete division of the cranial part of the foregut into respiratory and esophageal parts by the tracheo-esophageal septum.

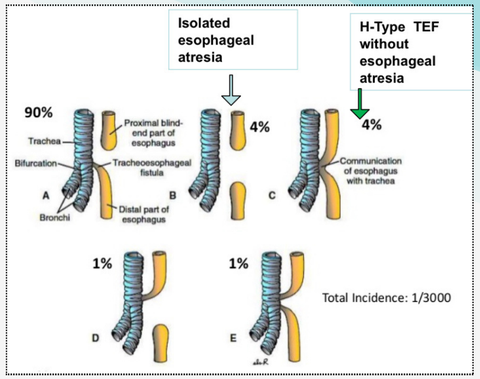
- Occurs once in 3000 - 4500 live births.

- Most affected infants are males.

- In more than 85% - 90%of cases, the fistula is associated with esophageal atresia (upper end of the esophagus ending in to lind pouch and lower segment forming fistula with trachea)[it comes along with the Tracheoesophageal Fistula(TEFs)]

- esophagus ends in a blind-ended pouch rather than connecting normally to the stomach VACTERAL association





it can come as a case scenario

A baby had coughing & choking while taking a bottle,vomiting and difficulty breathing while feeding [symptoms of Tracheoesophageal Fistula(TEFs)]

Case from Dr:

- A newborn baby boy came to ER who is noted to have excessive salivation and episode of coughing and vomiting ,which are exacerbated when feeding is attempted ,what is the diagnosis?
  -Tracheoesophageal Fistula(TEFs)

MCQs

1- The proximal part of the Respiratory Diverticulum gives rise to ?

A-Trachea

B-Primary bronchial buds

C-Esophagus

D-Cartilage

2- Which of the following structures doesn't arise from the mesoderm?

A-Smooth muscles

B-C.T

C- Glands & Epithelium

D- Cartilage

3- Recanalization of larynx occur at the:

A- 4th week

B- 6th week

C- 11th week

D- 10th week

4- Which of the following develops from the mesoderm of the 4th & 6th pairs of pharyngeal arch?

A-Epiglottis

B-Laryngeal muscles & cartilage

C-Trachea & larynx

D-C.T

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

MCQs

from Dr **5- Blood-air barrier established in which period ?**

A-Pseudoglandular | B-Terminal sac | C-Canalicular | D-Alveolar

6- In wich period the respiration is not posssible?

A-Pseudoglandular | B-Canalicular | C-Terminal sac | D-Alveolar

7- Surfactant production starts at ?

A- Week 10 | B- Week 21 | C- Week 24 | D-Week20

8- The thoracic body wall becomes lined by a layer of …….. pleura derived from the……..

A-parietal - splanchnic mesenchyme. | B-visceral - splanchnic mesenchyme. | C-parietal - somatic mesoderm. | D- visceral - somatic mesoderm.

5-B
6-A
7- C
8-C

Team Leaders

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