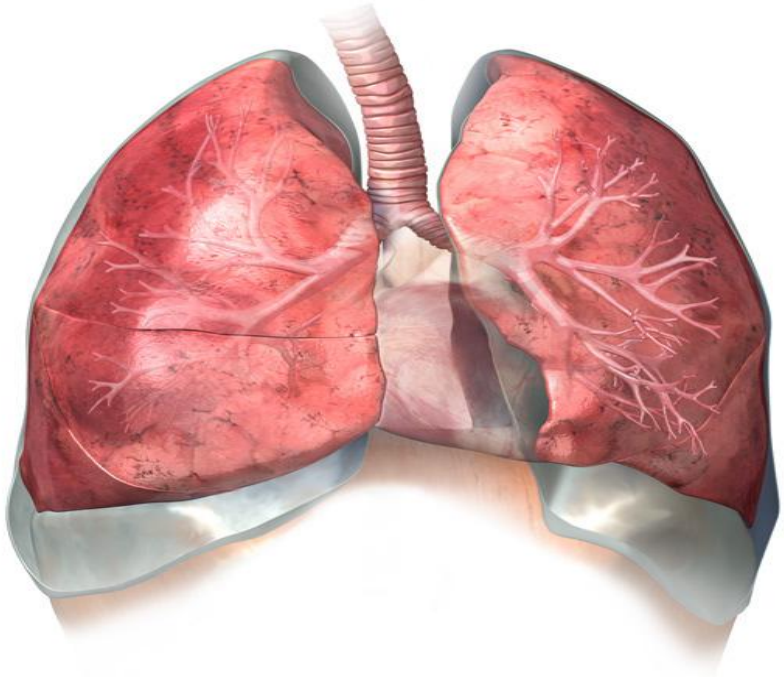
# Embryology

# Respiratory Block




**Lecture1 [Development of Respiratory System]**

*EMBRYOLOGY TEAM 433

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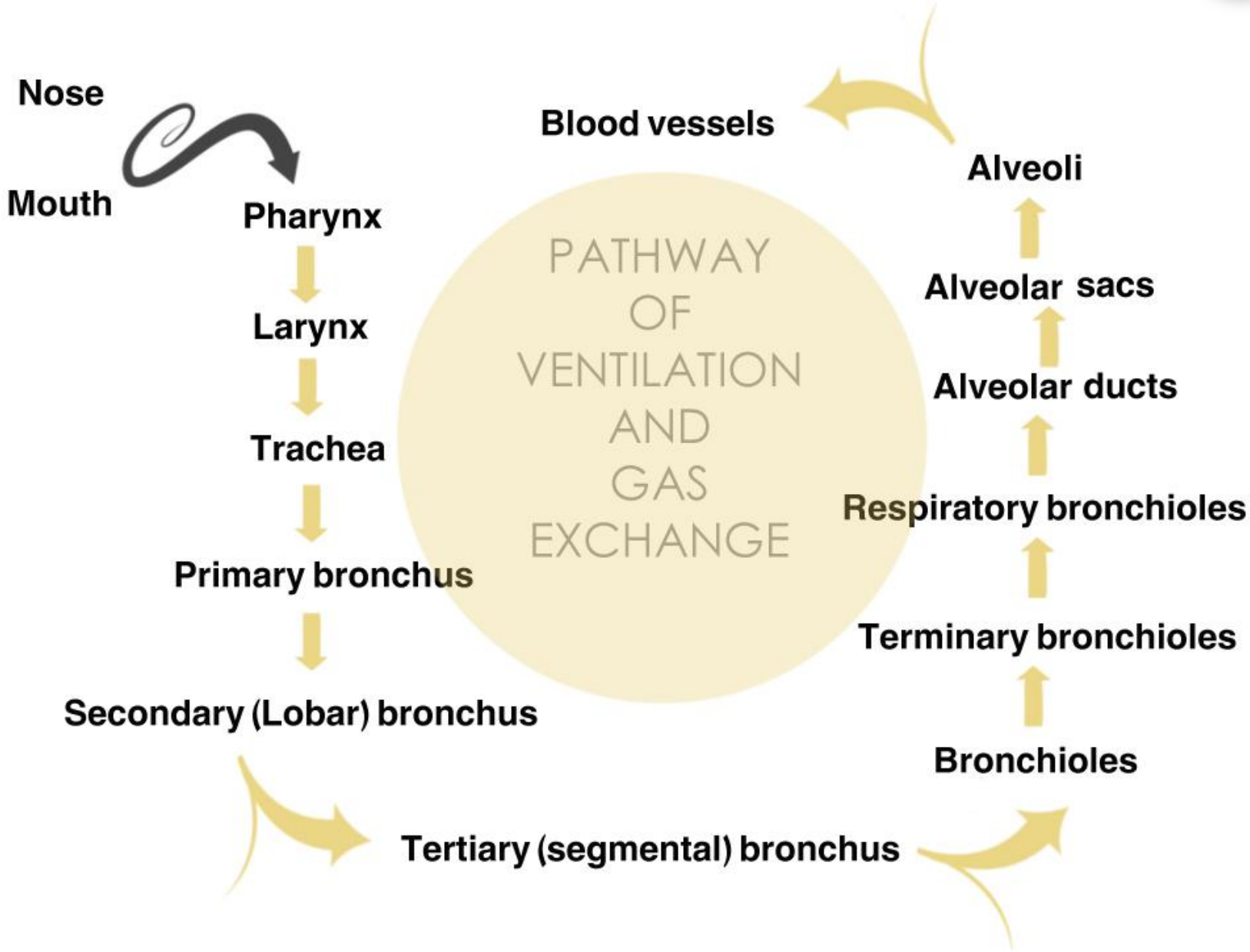
# OBJECTIVES

At the end of the lecture, the student should able to:

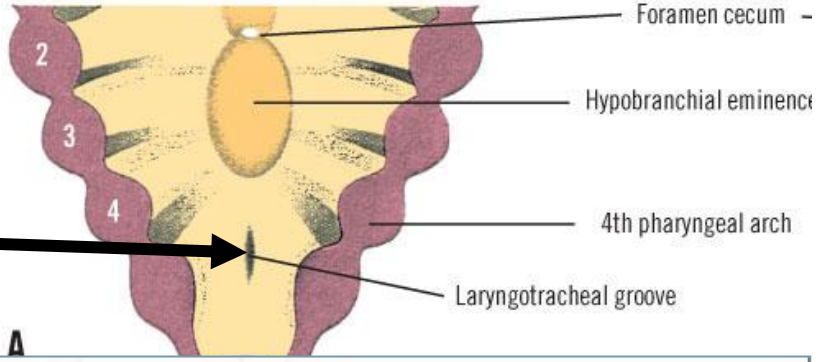
- Identify the development of the laryngeotracheal (respiratory) diverticulum.
- Identify the development of the larynx.
- Identify the development of the trachea.
- Describe the periods of the maturation of the lung.
- Identify the most congenital anomaly.

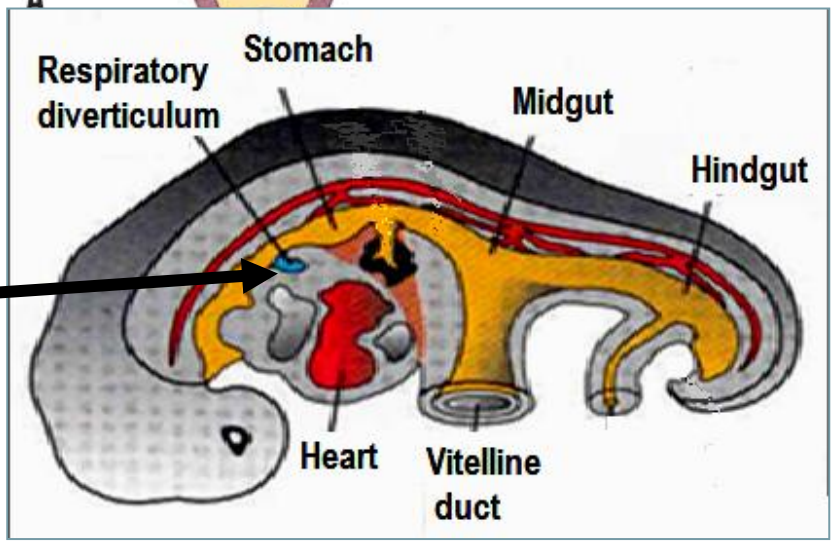
Smile >>  then >> Start


Nose
Mouth
Pharynx
Larynx
Trachea
Primary bronchus
Secondary (Lobar) bronchus
Tertiary (segmental) bronchus
Bronchioles
Terminary bronchioles
Respiratory bronchioles
Alveolar ducts
Alveolar sacs
Alveoli
Blood vessels
PATHWAY OF VENTILATION AND GAS EXCHANGE

# INTRODUCTION

- It starts at the **4th week** of development.
- Begins as a median outgrowth (laryngotracheal **groove**) from the caudal (inferior) part of the ventral (anterior) wall of the primitive* pharynx.
- The groove gives rise and forms **laryngotracheal**
- **(Respiratory) diverticulum.**
- *primitive: eariest (original) stage of pharynx البلعوم البدائي.



- **Tracheosophageal septum** develops and divides the diverticulum *1 into :

**1. Dorsal portion:**

**Primordium *2** of the oropharynx*3 and esophagus.

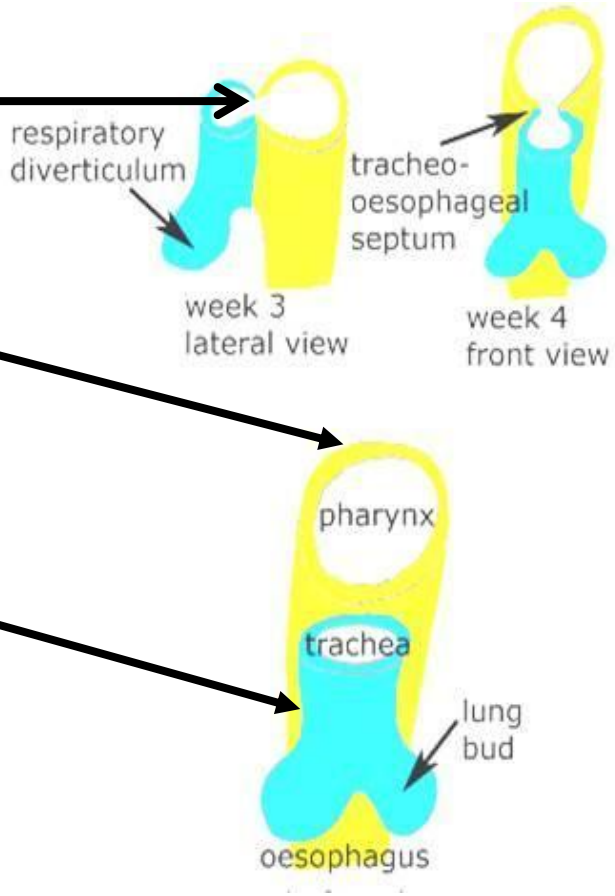
**2. Ventral portion:**

**primordium** of larynx, trachea, bronchi and lungs.

*1 diverticulum: small tube.

*2 primordium : earliest (original) stage. المرحلة البدائية

3* oropharynx: a cavity formed at the back of the mouth ( between the soft palate and epiglottis )



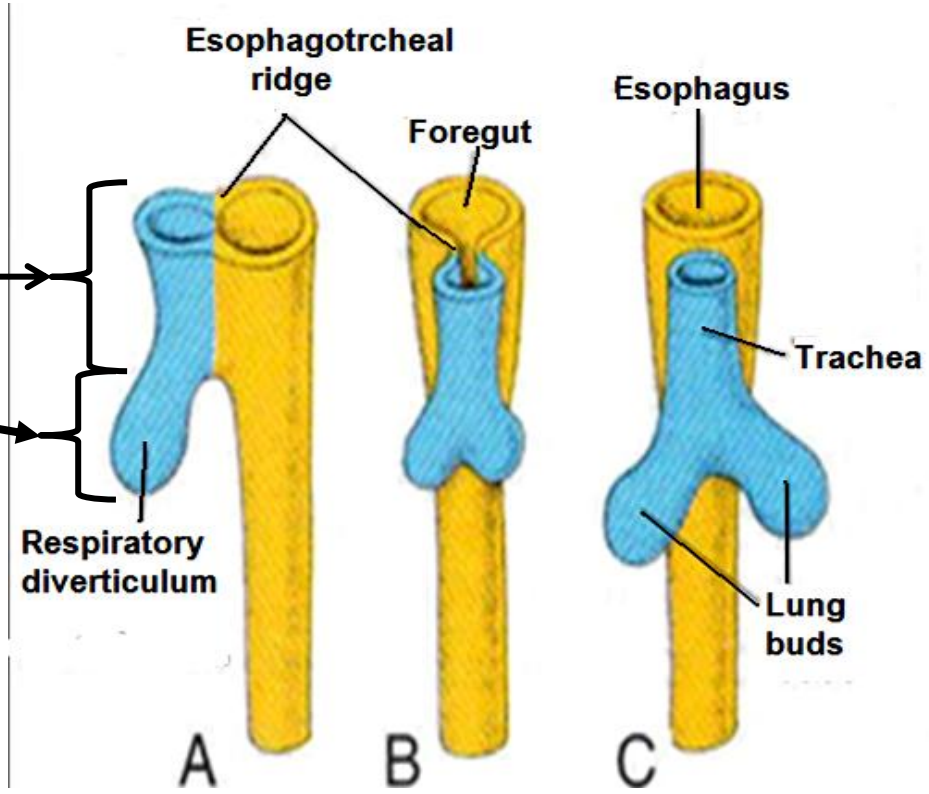
- **The proximal part**

Of the respiratory diverticulum remains tubular and forms **larynx** and **trachea**.

- **The distal end**

Of the diverticulum dilates (يتوسع) to form **lung bud***, which divides to give rise to **2 lung buds** (primary bronchi buds).

*bud: any small part of the embryo. (برعم)



# The origin of the parts

| endoderm lining the laryngotracheal diverticulum | surrounding splanchnic (visseral ) mesoderm |
|---|---|
| Epithelium & Glands of the respiratory tract. | Connective tissue, Cartilage & Smooth muscles of the respiratory tract. |

## Recanalization of larynx: (10th week)

The laryngeal epithelium proliferates rapidly resulting in temporary occlusion (closing) of the laryngeal lumen; Recanalization of larynx normally occurs by the 10th week, Laryngeal ventricles, vocal folds and vestibular folds are formed during recanalization.

NB: abnormal development in this stage or level will develop anomalies* like Tracheoesophageal fistula .

*Anomaly: abnormal development.

# THE DEVELOPMWNT OF..

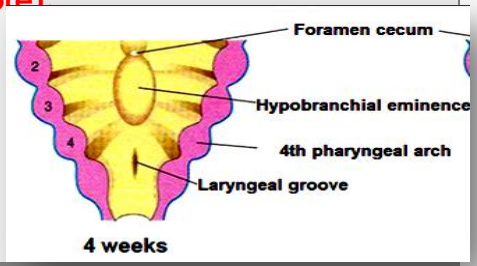
## Larynx

**1.** The opening of the laryngotracheal diverticulum into the primitive foregut becomes the laryngeal orifice. ( فوهة أو ثقب)

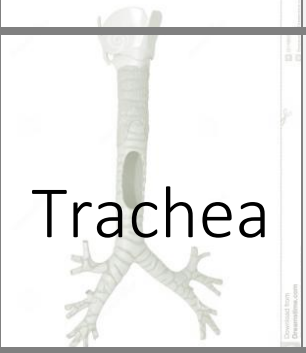
**2.** The epithelium & glands are derived from **endoderm**. **(AS mentioned before)**

**3.**Laryngeal muscles & the cartilages of the larynx except Epiglottis,

Develop from the mesoderm of 4th & 6th pairs of pharyngeal arches.



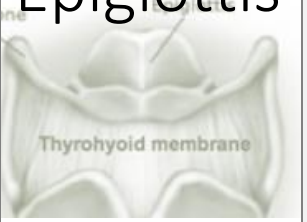

## Trachea



**1.** The endodermis lining of the laryngotracheal tube distal to the larynx* differentiates into the epithelium and glands of the trachea and pulmonary epithelium. ( *تحت الحنجرة )

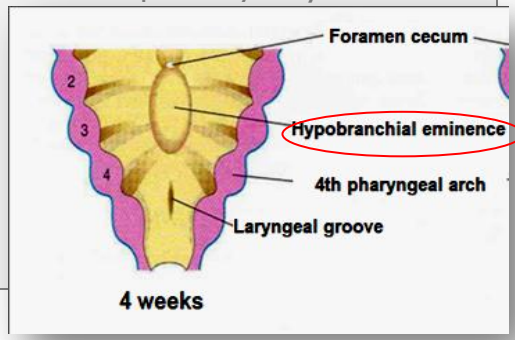
**2.**The cartilages, connective tissue, and muscles of the trachea are derived from the mesoderm (AS mentioned before )

## Epiglottis

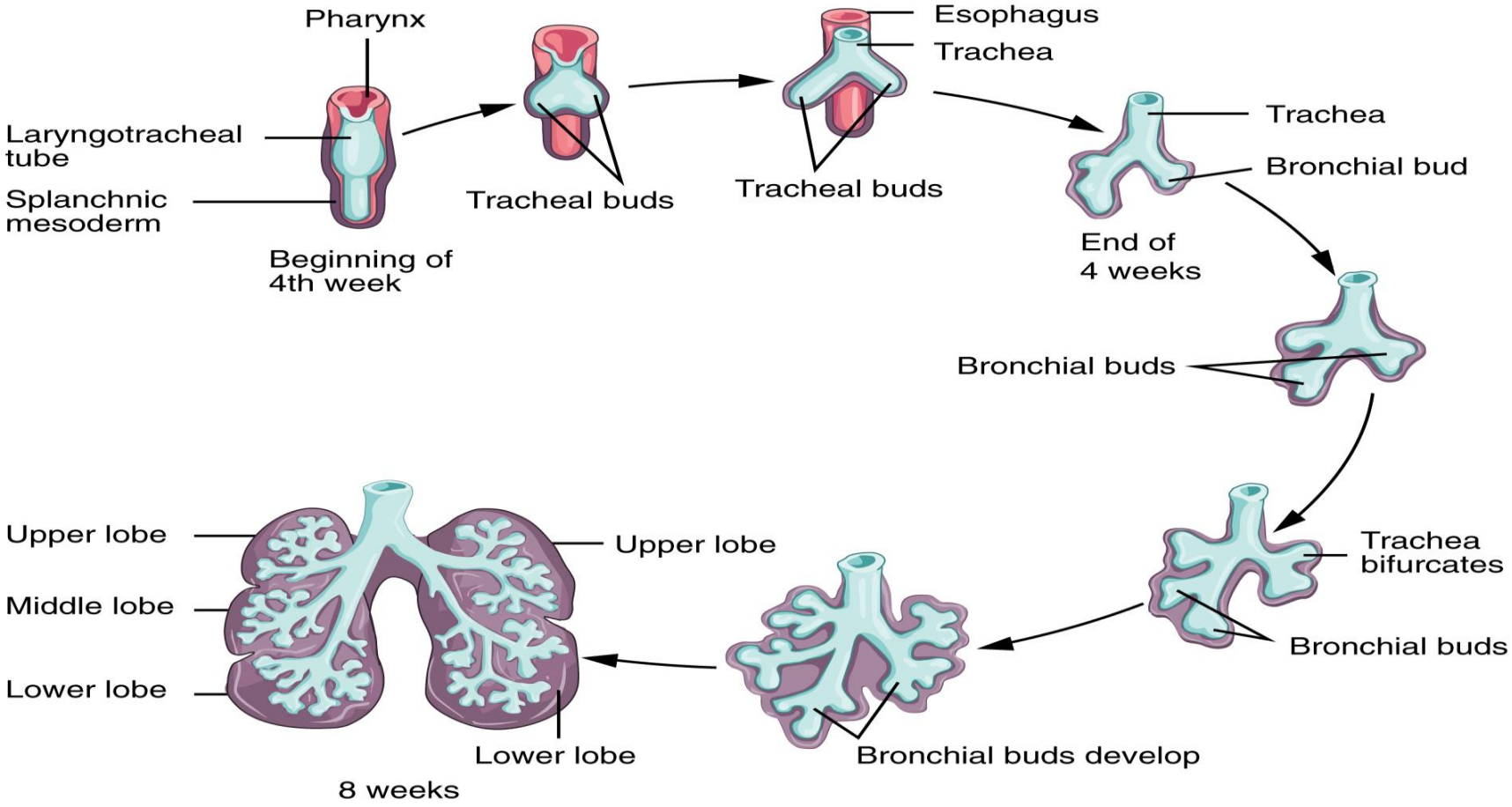



It develops from the caudal part of the hypopharyngeal eminence which is (a swelling formed by the proliferation of mesoderm in the floor of the pharynx).

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.

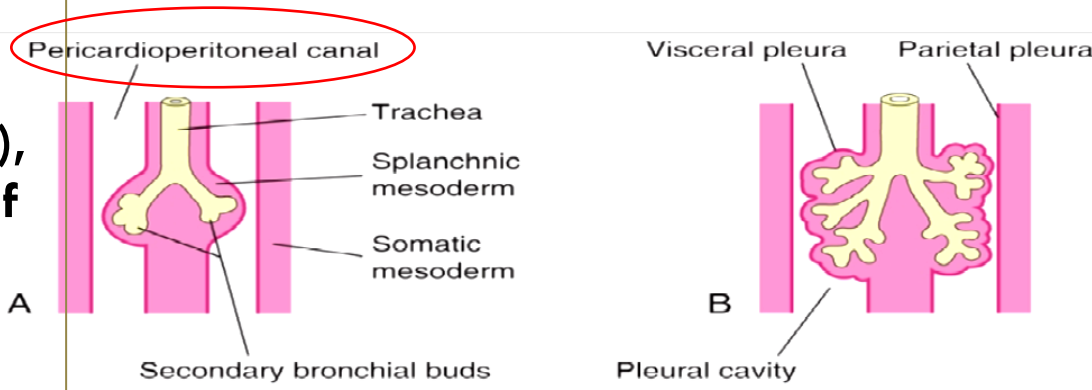


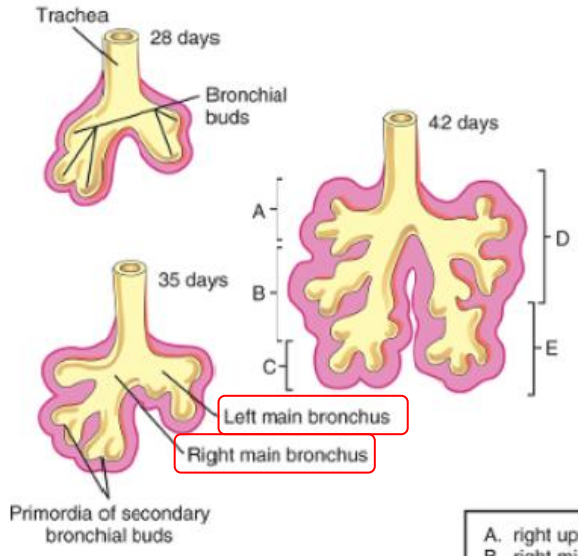
# Development of the Bronchi & Lungs



# Development of the Bronchi & Lungs

# The 2 primary bronchial buds grow laterally into the pericardio-peritoneal canals* (part of the intraembryonic celome),
# At the beginning of the 5th week, each of these buds enlarges to form right and left main bronchi.
# Bronchial buds divide and re-divide to give the bronchial tree.



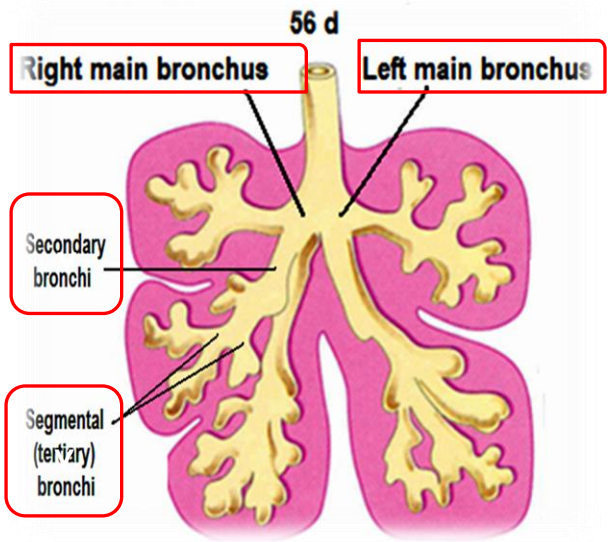




# The right main bronchus is slightly larger than the left one and is oriented more vertically.
# The embryonic relationship persists in the adult.

* **the pericardio-peritoneal canals**: later on this canal will represent the pleural cavities.

# Development of the Bronchi & Lungs

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




# 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 *1 also divides.

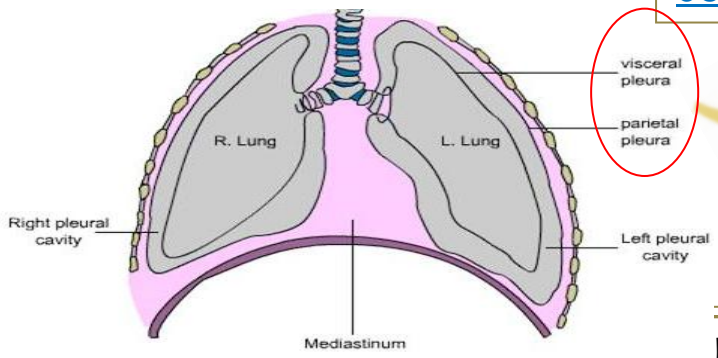
# Each segmental bronchus with its surrounding mass of mesenchyme is the primordium *2 of a bronchopulmonary segment.

*1 mesenchyme : part of mesoderm .

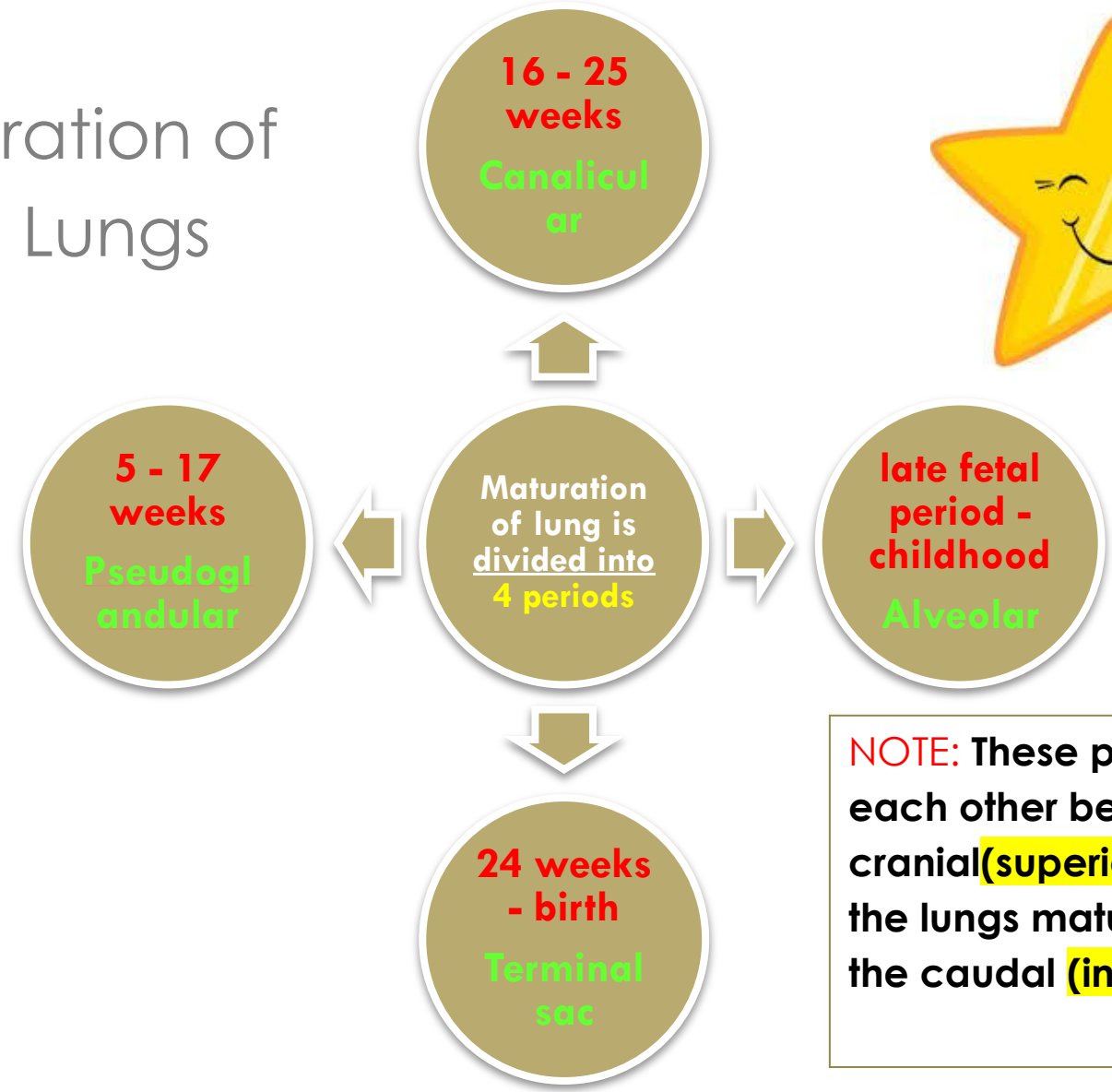
*2 primordium :earliesr sign of organ during devilopment .

# 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




NOTE: **These periods overlap each other because the cranial(superior) segments of the lungs mature faster than the caudal (inferior) ones.**

# EXPLANATION FOR EACH PERIOD

| # Pseudoglandular Period (5-17 weeks) | # Canalicular Period (16-25 weeks) |
|---|---|
| • Developing lungs somewhat إلى حد ما resembles يشبه an exocrine gland during this period.<br><br>• By 17 weeks all major elements of the lung have formed except those involved with gas exchange (alveoli).<br><br>• Respiration is NOT possible.<br>• Fetuses born during this period are unable to survive. | • Lung tissue becomes highly vascular.<br>• Lumina of bronchi and terminal bronchioles become larger.<br>• By 24 weeks each terminal bronchiole has given rise to two or more respiratory bronchioles.<br>• The respiratory bronchioles divide into 3 to 6 tubular passages called alveolar ducts.<br>• Some thin-walled terminal sacs (primordial alveoli) develop at the end of respiratory bronchioles.<br>• Respiration is possible at the end of this period.<br>• 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 Sac Period (24 weeks - 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 (close) 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 pneumocytes and
- Rounded secretory, type II pneumocytes, that secrete a mixture of phospholipids called surfactant.

## # Alveolar Period (32 weeks – 8 years)

- At the beginning of the alveolar period, each respiratory bronchiole terminates in a cluster of thin-walled terminal saccules, separated from one another by loose connective tissue.
- These terminal saccules represent future alveolar sacs.
- The epithelial lining of the terminal sacs attenuates to an extremely thin squamous epithelial layer.

# ABOUT MATURE ALVEOLI

- They do not form until after birth. 95% of alveoli develop postnatally( بعد الولادة )

-The number of alveoli in adult is 50 million alveoli.

-One sixth of them are present in the lungs of a full-term( فترة حمل كاملة) newborn infant.

-Most increase in the size of the lungs results from:

-An increase in the number of respiratory bronchioles ( الشعيبات الهوائية)

- Increase in the number of primordial alveoli( الحويصلات الهوائية البدائية)

Note:
Increase in the size of the lungs doesn't result from increase in the size of the alveoli.

-From 3-8 year or so, the number of immature alveoli continues to increase, forming additional primordial alveoli.

By about the eighth year, the adult complement of 300 million alveoli is present.

# Breathing Movements

-Occur before birth, not continuous and increase as the time of delivery approaches

يزيد مع اقتراب وقت الولادة

-Help in conditioning the respiratory muscles.

-Stimulate lung development and are essential for normal lung development.

# Lungs at birth

-The lungs are ½ filled with fluid derived from the amniotic fluid , lungs & tracheal glands.

-Fluids cleared by: Pressure on fetal thorax (chest) during delivery and absorption into pulmonary capillaries & lymphatic's.

# Lungs of a Newborn

-Fresh healthy lung always contains some air (lungs float in water).

-Diseased lung may contain some fluid and may not float (may sink).

-Lungs of a stillborn infant are firm, contain fluid and may sink in water.

## Important Factors for Normal lung development

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

**Laryngeal atresia.**

**Tracheoesophageal fistula.**

**Tracheal stenosis & atresia.**

**Congenital lung cysts.**

**Agenesis of lungs.**

**Lung hypoplasia.**

**Accessory lungs.**

# Developmental anomalies

## Tracheoesophageal Fistula

**It is abnormal passage between the trachea and esophagus.**

**Fistula 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 closed sac rather than connecting normally to stomach)**

| | |
|---|---|
| 4th Week | Begine to form Lower Respiratory Tract |
| 5th Week | Each bud enlarges to form right and left main bronchi |
| 7th Week | Begin to form the segmental bronchi (10 in right lung and 8 or 9 in the left lung ) |
| 10th Week | Recanalization of larynx |
| 17th Week | By this week all major elements of the lung have formed except those involved with gas exchange (alveoli). |
| 24th Week | By this week each terminal bronchiole has given rise to two or more respiratory bronchioles |
| Pseudoglandular (5th – 17th weeks) | resembles an exocrine gland and like what we said at 17 week |
| Canalicular1( 6th - 25th weeks) | • Lung tissue becomes highly vascular and like what we said at 24 week<br>• Lumina of bronchi and terminal bronchioles become larger<br>• Develop of some terminal sacs<br>• respiratory bronchioles divide into 3 to 6 tubular passage (alveolar ducts) |
| Terminal sac(24th weeks – birth) | • Developing of terminal sacs<br>• Capillaries begin to bulge into developing alveoli<br>• establish the blood-air barrier |
| Alveolar(32 weeks – 8 | • each respiratory bronchiole terminates in a cluster of thin-walled terminal saccules( represent future alveolar sacs.) , separated from one another<br>• epithelial lining of the terminal sacs attenuates to an extremely thin squamous epithelial layer. |
| 3rd - 8th | Immature alveoli increase formina additional primordial alveoli |
| 8th year | Adult complement of 300 million alveoli present . |

# Summary



- Development of the lower respiratory track begins to form **during** the 4th week .
- Tracheo-esophageal septum divides the diverticulum into **tow** portions .
- **Endoderm** of laryngotracheal diverticulum gives rise to **epithelium** and **glands** of respiratory track .
- **Splanchnic mesoderm** gives rise **to connective tissue** , **smooth muscle** and **cartilages** of respiratory track .
- The opening of laryngotracheal diverticulum becomes a laryngeal opening .
- All **muscles** and **cartilages** of laryngeal except **epiglottis** develop from the **mesoderm** of 4th and 6th pairs of pharyngeal arches .
    - **Epiglottis** develops from caudal part of **hypopharyngeal eminence** .
- Growth of **larynx** and **epiglottis** is rapid during first **3** years after birth .
- Ventricle , vocal folds and vestibular folds are formed during recanalization of larynx and its normal occur by the 10th week .
- **Bronchial buds** divide and re-divide to give the **bronchial tree** .
- **Right** main bronchial is **larger** and more **vertical** .
- **Segmental bronchi** is **10** in right lung and **8-9** in left lung and it begin to form by the **7th** week .
- **Viscera pleura** is develop from **splanchnic mesenchyme** and **parietal pleura** is develop from **somatic mesoderm**
- Maturation of lung is divided into **4** period .
- **Cranial segments** of the lungs mature **faster** than the **caudal** ones .
- In the **pseudoglandular period** all elements of lung are formed **except** those involved in gas exchange and in this stage fetuses **cannot** survive .
- In the **canalicular period** , lung becomes highly vascular .
- Lungs are **half filled** with fluid and it is **cleared** at birth by some reasons .
- **Fresh lung** contain some **air** but **diseased lung** contain some **fluid** .
- **Tracheo-esophageal fistula** is an example of abnormality of development in the respiratory track .
- **Tracheo-esophageal fistula** occur in **male** more than female and in **85%** of cases its associate with **esophageal atresia .**
- In the periods of maturation of lung , fetus **cannot survive** in the **first stage** , **some of fetus died** in **second stage** and in the **third and 4th stages all** of fetus survive .

# MCQs

Lower Respiratory Tract Begins to form during_____ of development:
6th week
3rd week
10th week
4th week*

The endoderm lining the laryngotracheal diverticulum gives rise to the:
Connective tissue
Cartilage
gland and Epithelium*
Smooth muscles and Epithelium

Recanalization of larynx normally occurs by the
5th week
10th week.*
after birth
15th week

The segmental bronchi, 10 in right lung and 8 or 9 in the left lung begin to form
7th week*
3rd week
9th week

Terminal sac takes place in which period:
(24 weeks - birth)*
(late fetal period - childhood)
(16 - 25 weeks)

Alveolar takes place in which period:
(late fetal period - childhood) *
(24 weeks - birth)
(5 - 17 weeks)

Respiration is possible at the end of this period:
Pseudoglandular
Canalicular*
Terminal sac
Alveolar

The lungs are half filled with fluid derived from the ..... and from the lungs & tracheal glands:
yolk sac
amniotic fluid*
endoderm
splanchnic mesoderm

because the caudal segments of the lungs mature faster than the cranial ones(f)

The laryngeal epithelium proliferates rapidly resulting in temporary occlusion of the laryngeal lumen(t).

## Done by :

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Abdul lateef Alhassan

Hamad Alkhunaifer

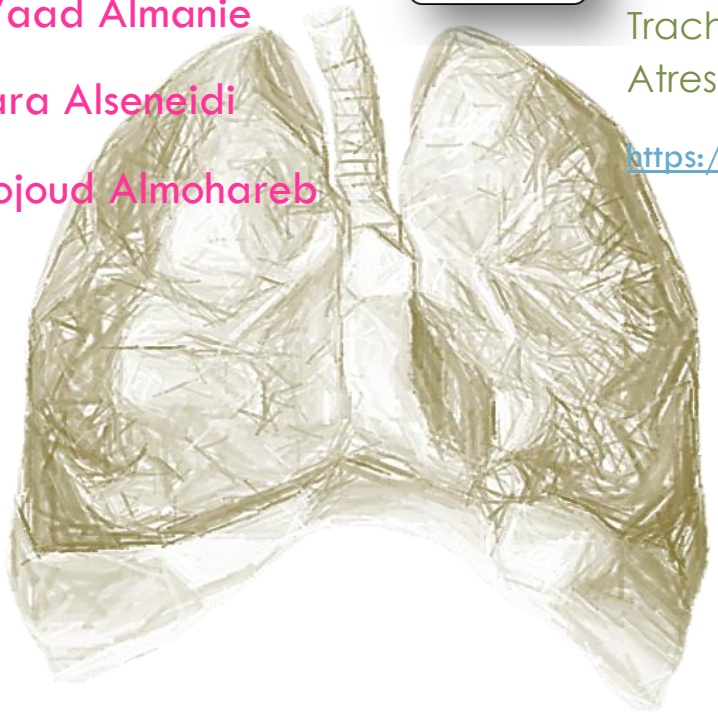
Saad Altuiraqi

Rawan Alotaibi

Waad Almanie

Sara Alseneidi

Nojoud Almohareb



The embryonic development of respiratory system :

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

Tracheoesophageal Fistula (Esophageal Atresia):

https://www.youtube.com/watch?v=6KvlPT-1tfM