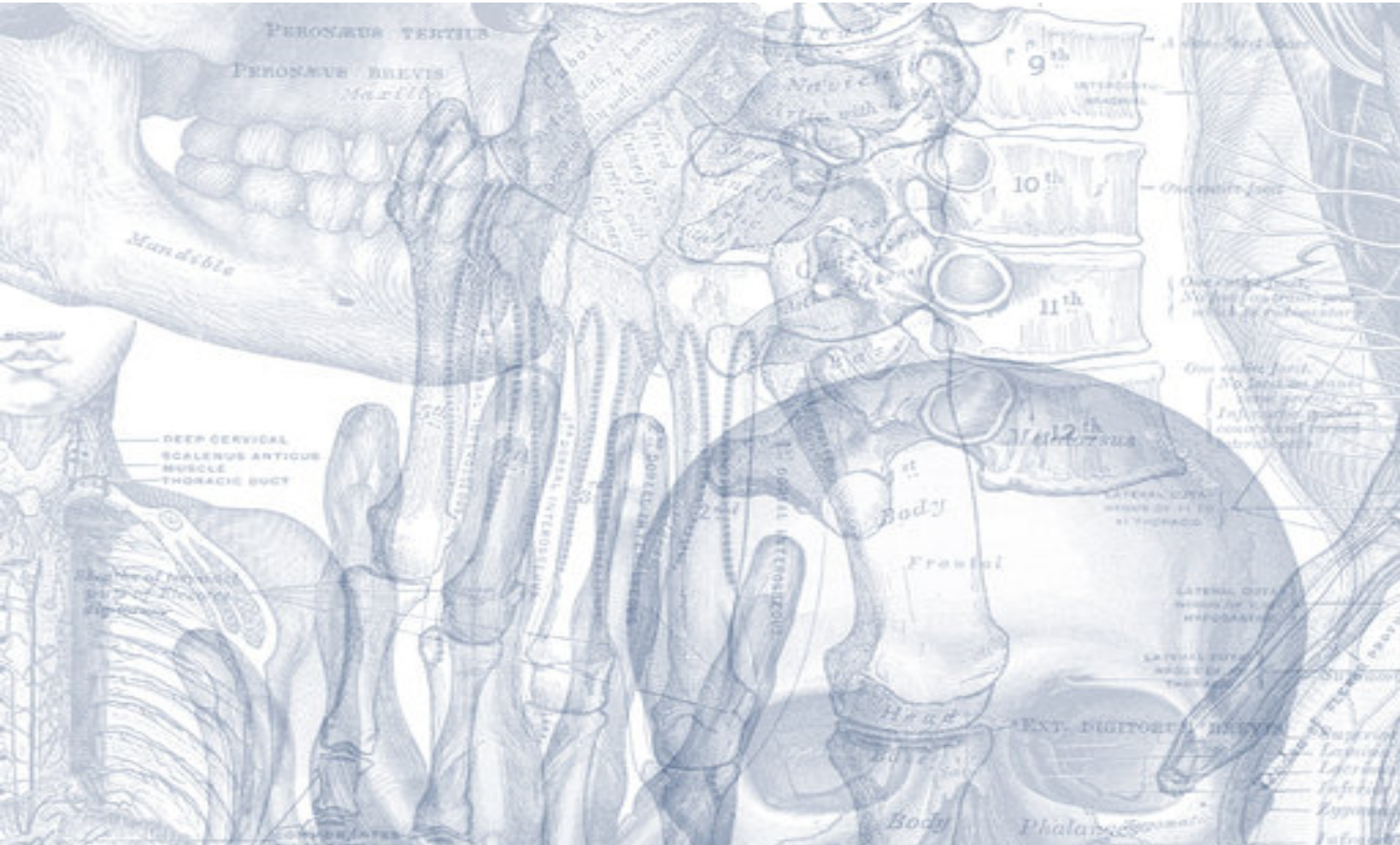


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MEDICINE
KING SAUD UNIVERSITY



Embryology Of Respiratory System

Please view our [Editing File](#) before studying this lecture to check for any changes.

Color Code

- Important
- Doctors Notes
- Notes/Extra explanation

Objectives

At the end of the lecture the students should be able to:

- ✓ Identify the development of the laryngeotracheal (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.

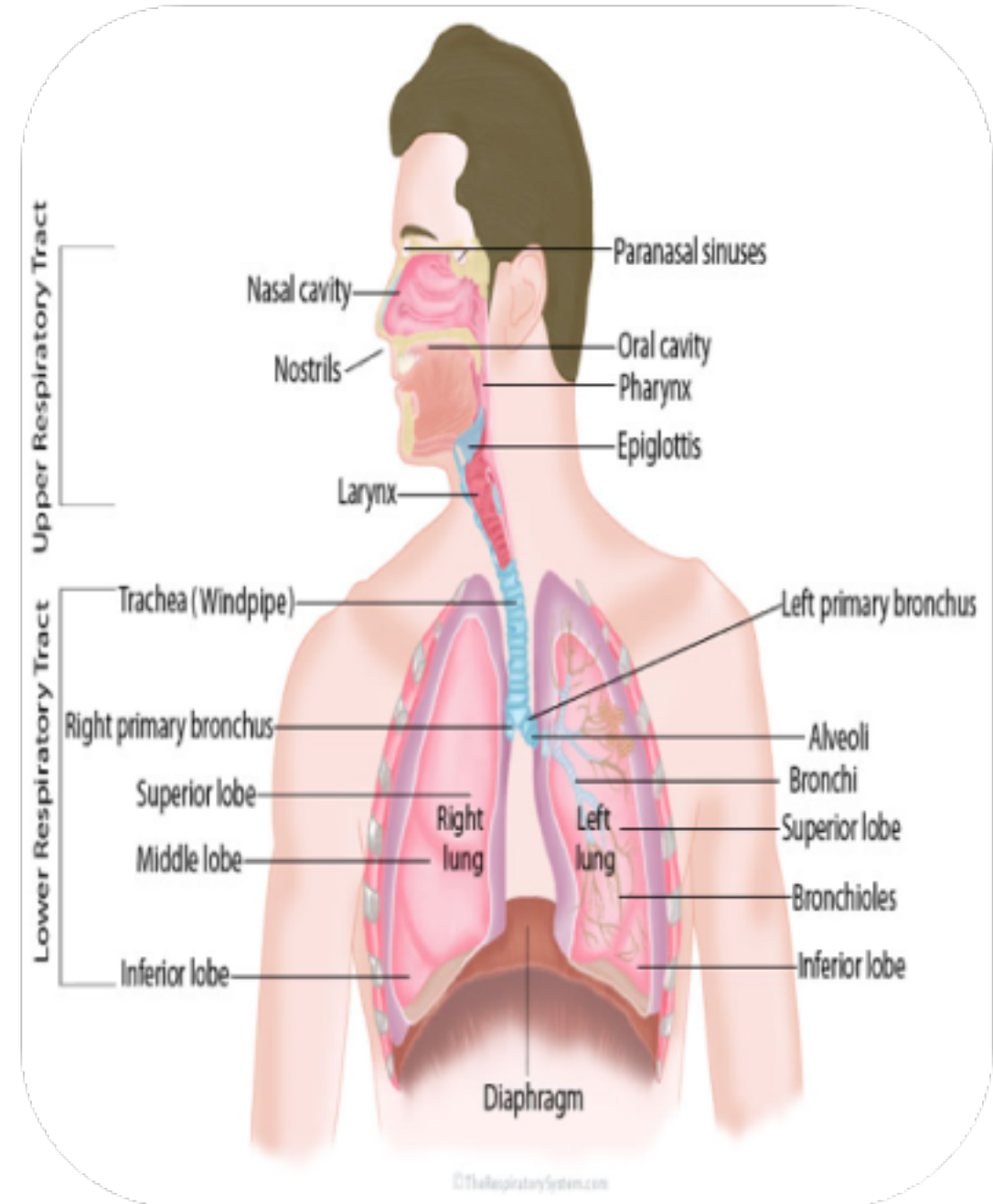
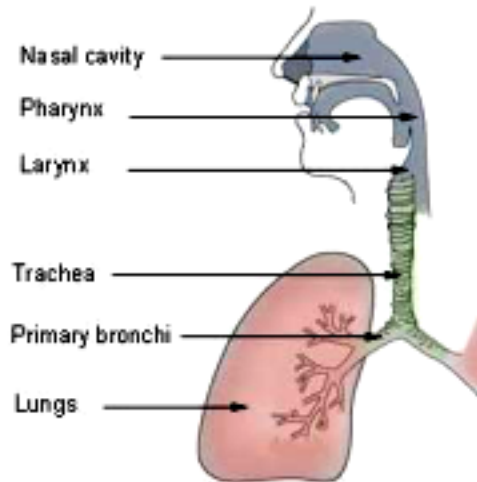
Respiratory System:

Upper respiratory tract:

- Nose
- Nasal cavity & paranasal sinuses
- Pharynx

Lower respiratory tract:

- Larynx
- Trachea
- Bronchi
- Lungs





فيديو يحتوي على موسيقى

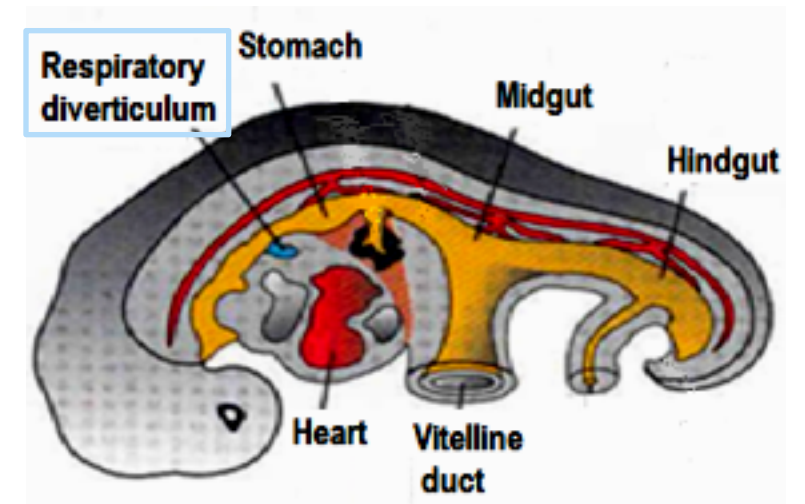
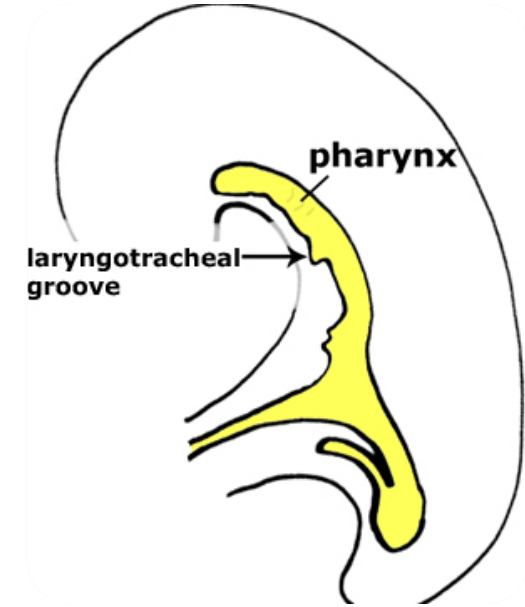
Development Of The Lower Respiratory Tract

Begins to form during the 4th week of development.

- Begins as a median outgrowth (laryngotracheal groove) from the caudal¹ part of the ventral² wall of the primitive pharynx (foregut)

1:inferior
2:anterior

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



Team 435

يبدأ نمو الجهاز التنفسي السفلي أثناء الاسبوع الرابع بظهور نمو في الجزء السفلي من جدار البلعوم الأمامي يطلق عليه وصف تجويف أو شق groove ومن ثم يغلق هذا الشق فيصبح كالأنبوب له فوهة diverticulum

Development Of The Lower Respiratory Tract

A longitudinal tracheo-esophageal septum (esophagotracheal) develops and divides the diverticulum into a:

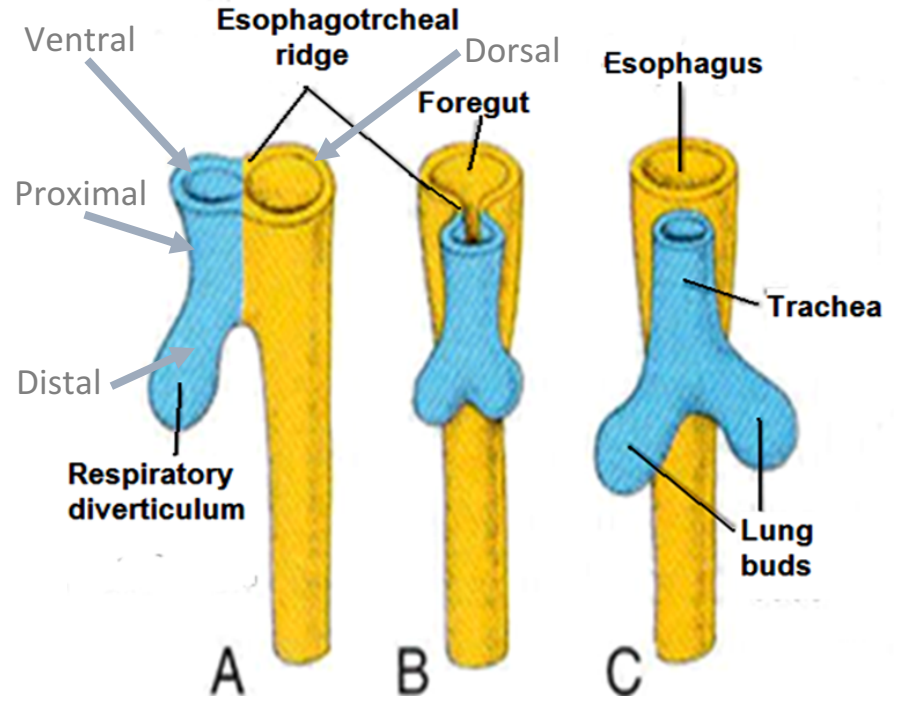
Ventral portion:
primordium* of

- Bronchi
- Lungs

The distal end of the diverticulum dilates to form **lung bud**, which divides to give rise to **2 lung buds (primary bronchial buds)**

- Larynx
- trachea

The proximal part of the respiratory diverticulum remains tubular and forms larynx & trachea.



Dorsal portion:
primordium* of

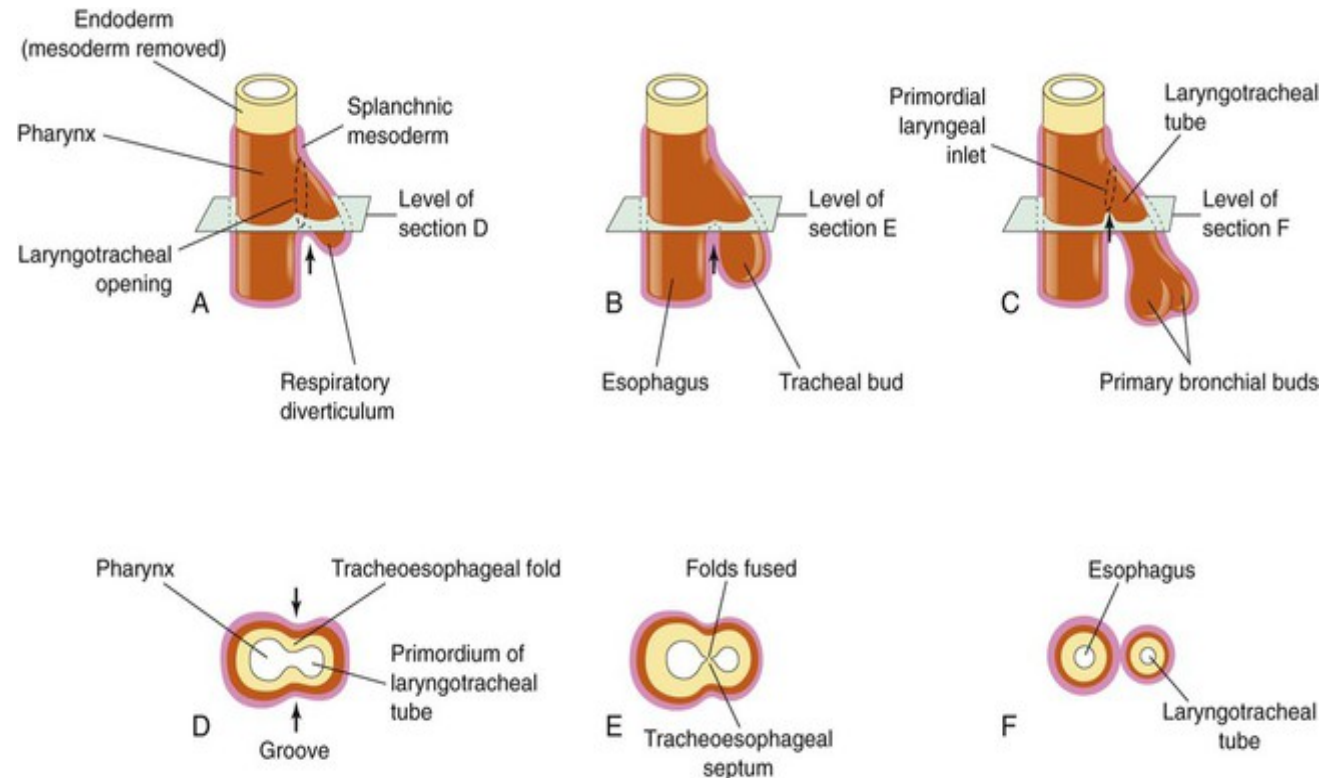
- Oropharynx
- esophagus

* Primordium: an organ, structure, or tissue in the earliest stage of development

Laryngotracheal Diverticulum

The **endoderm** lining the laryngotracheal diverticulum gives rise to the: **Epithelium & Glands** of the respiratory tract

The surrounding **splanchnic mesoderm** gives rise to the: **Connective tissue, Cartilage & Smooth muscles** of the respiratory tract

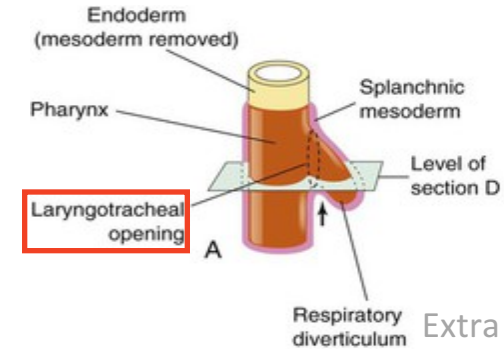


Extra

Development Of The Larynx

- The **opening of the laryngotracheal diverticulum** into the primitive foregut **becomes the laryngeal orifice***.
- The **epithelium & glands** are derived from **endoderm**.
- Laryngeal muscles & the cartilages of the larynx (**except Epiglottis**) develop from the **mesoderm** of **4th & 6th** pairs of pharyngeal arches.

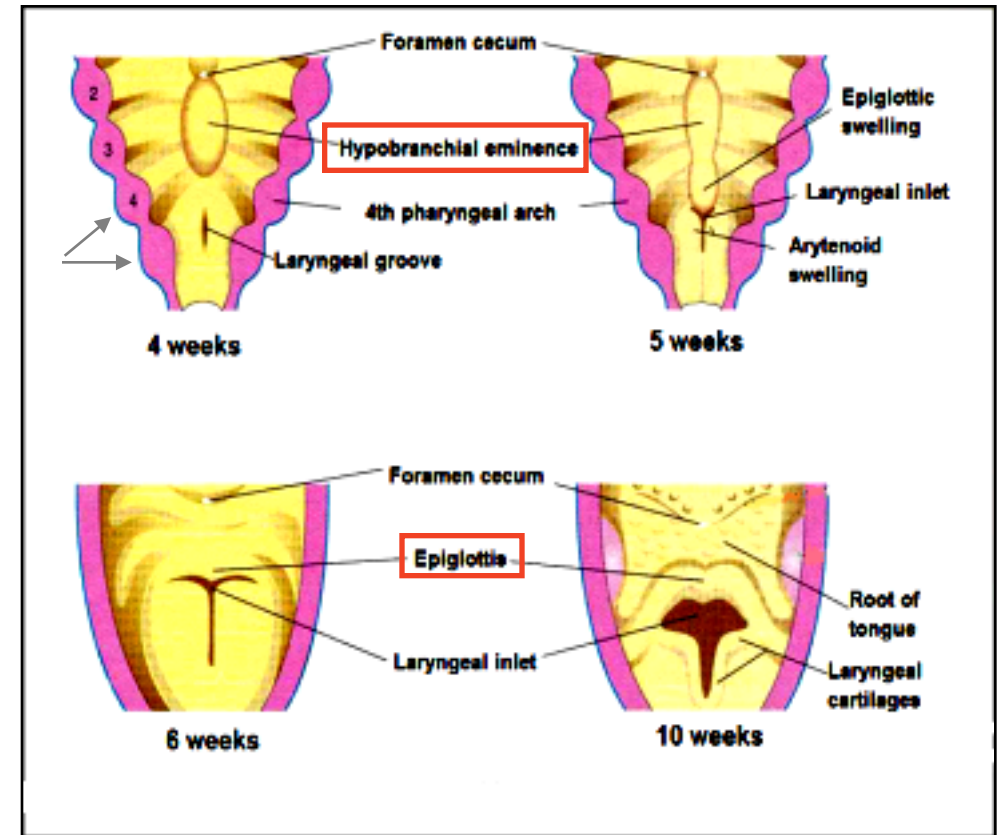
*orifice: opening



Epiglottis

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

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.



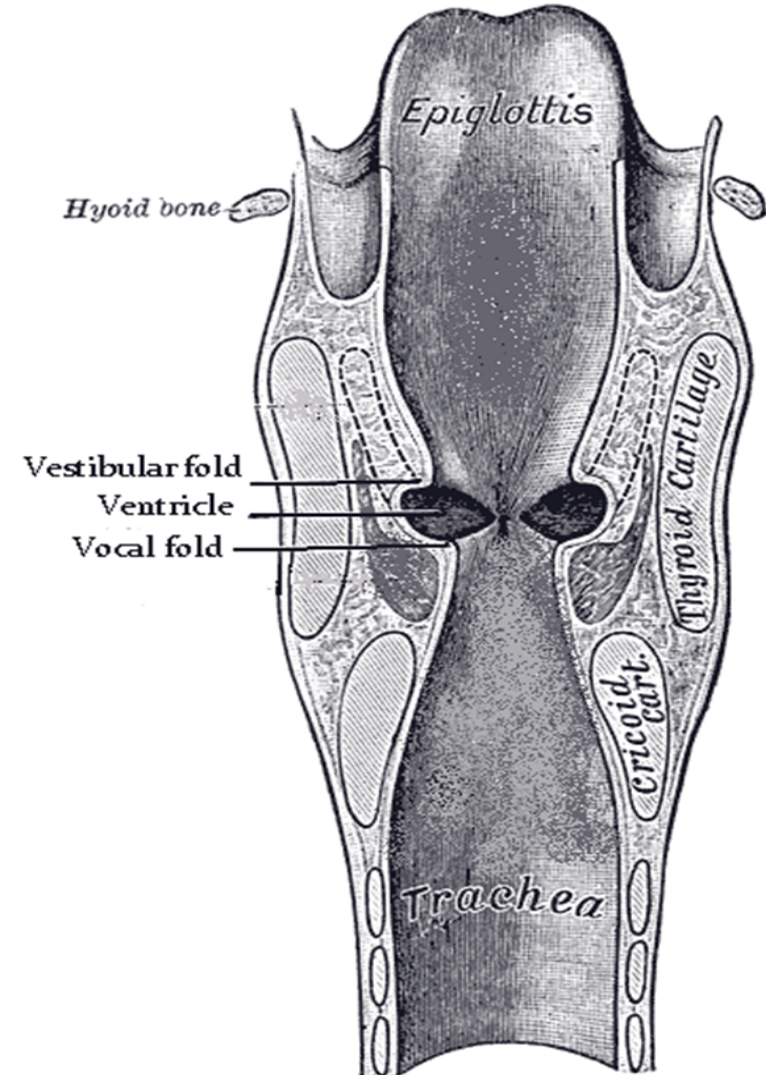
Recanalization Of Larynx

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

Team 435

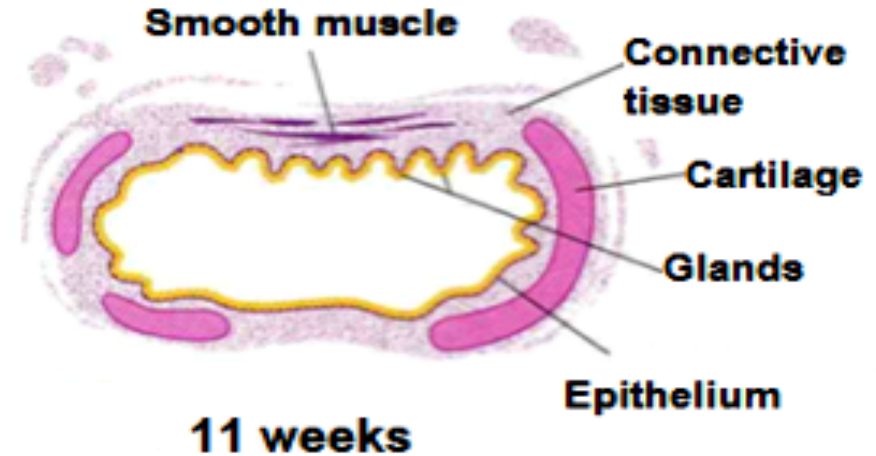
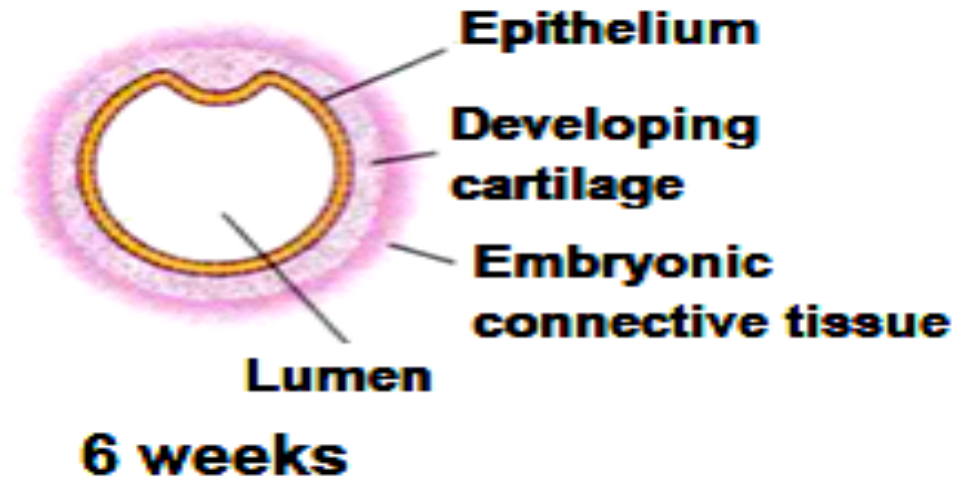
الغشاء السطحي للحنجره يتكاثر بسرعة وينتج عنه انسداد مؤقت في جوفها - في الأسبوع العاشر يحدث إعادة صنع للقنوات وينتج عنه التالي:

- 1- vocal cords
- 2- vestibular folds
- 3- laryngeal ventricles



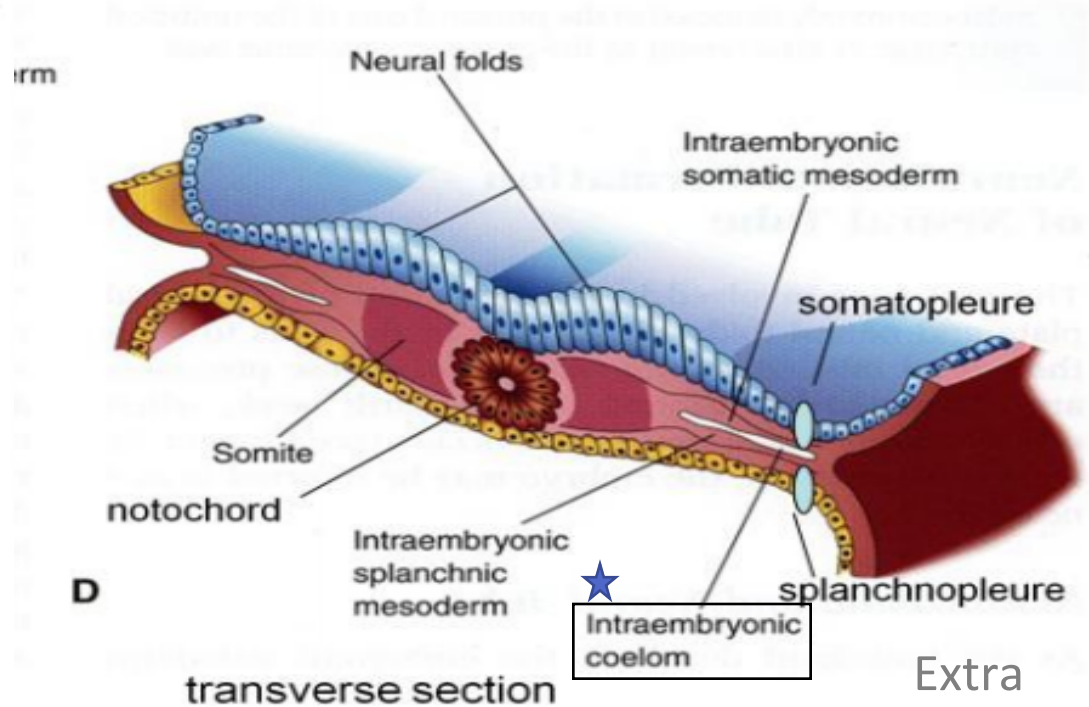
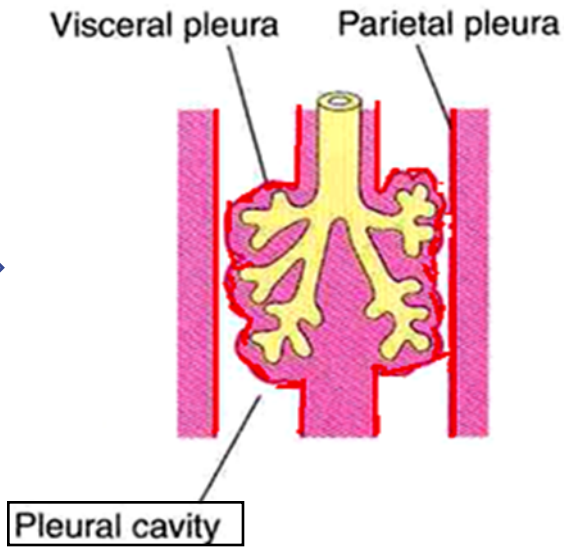
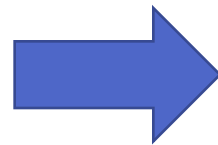
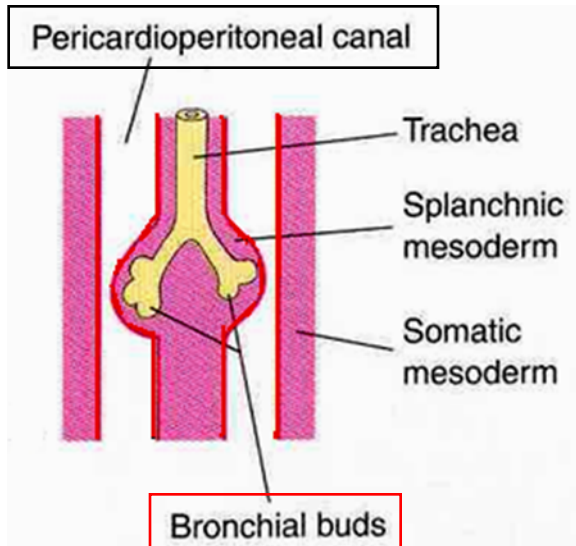
Development Of The Trachea

- The endodermal lining of the laryngotracheal tube **distal** to the larynx **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**.



Development Of The Bronchi & Lungs

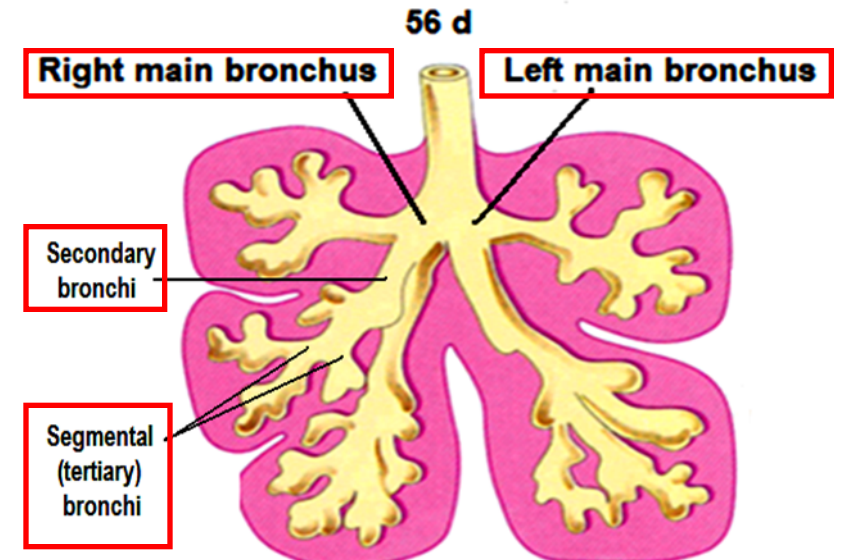
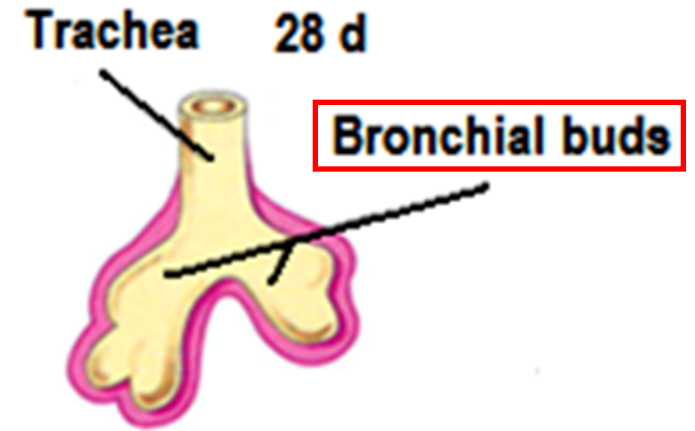
- The **2 primary bronchial buds** grow laterally into the **pericardio-peritoneal canals** (part of the **intraembryonic celome**)*, which is the primordia (early form) of pleural cavities.
- Bronchial buds **divide and re-divide** to give rise to the bronchial tree.



- Celome: cavity lined by epithelium coming from the mesoderm.
- Intraembryonic celome: forms in the lateral mesoderm, giving rise to somatic & splanchnic mesoderm
- Primordium: an organ or tissue in the earliest stage of development

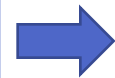
Bronchi

- The **right** main bronchus is:
 1. **slightly larger (wider)** than the **left** one.
 2. is oriented **more vertically**.
 - The embryonic relationship (between the right and left bronchus) persists in the adult.
 - The **main bronchi** subdivide into → **secondary bronchi** then into → **tertiary (segmental) bronchi** which give rise to further branches.
- The main bronchus goes to the lung.
 - The secondary (lobar) bronchi go to the lobes.
 - The tertiary (segmental) bronchi go to the bronchopulmonary segments.

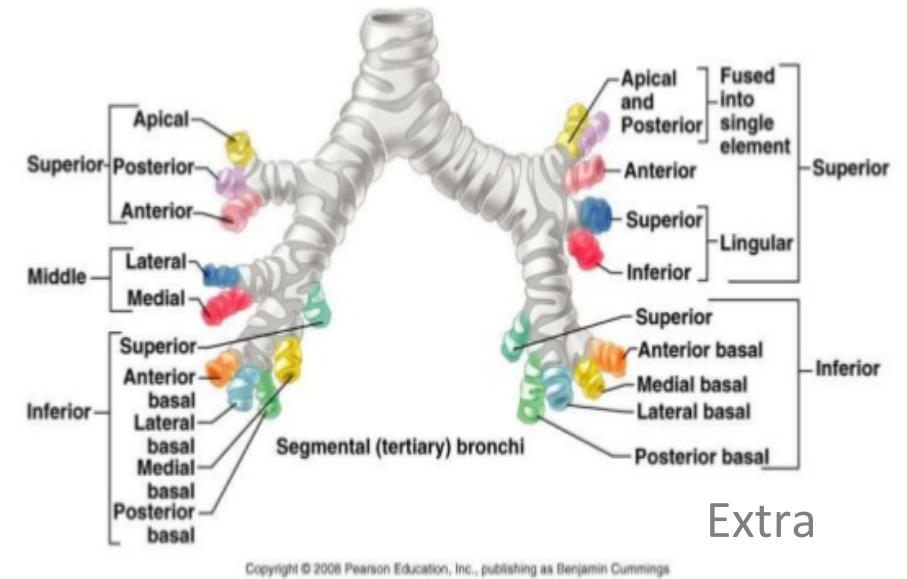


Tertiary (Segmental) Bronchi

- The segmental bronchi:
 - 10 in right lung
 - and 8 or 9 in the left lung
- begin to form by **the 7th week** (note: the number in the left lung can be different than the one mentioned in the anatomy lecture)
- The surrounding mesenchyme also divides.



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

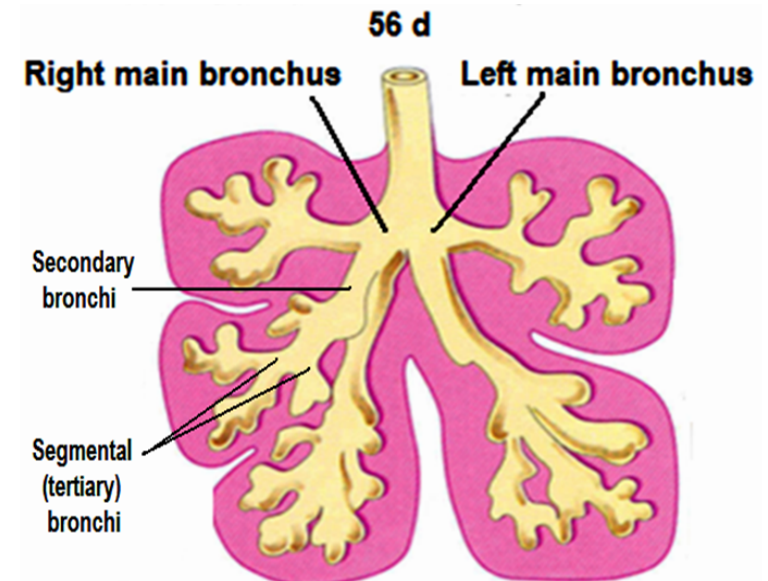


A bronchopulmonary segment is considered as a:

- Surgical unit: can be removed without disturbing the other segments.
- Anatomical unit: has own blood (arterial) supply, venous drainage, nerve supply and lymph vessels.
- Physiological (functional) unit: full function of a complete lung (كأنه وحدة أساسية في الرئة)

Mesenchyme: a type of tissue (most originate from the mesoderm) that forms most of the connective tissue such as bone and cartilage

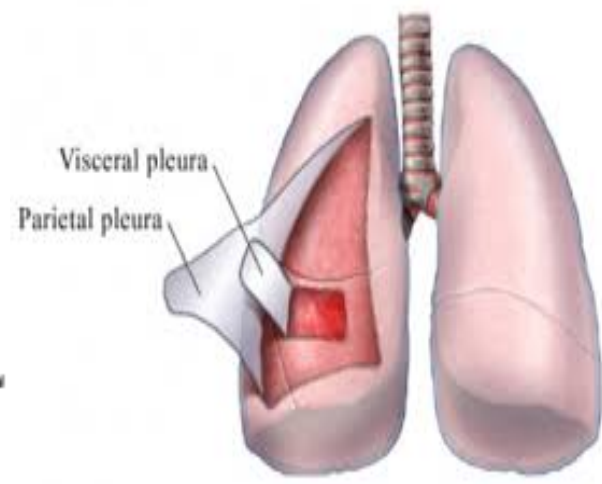
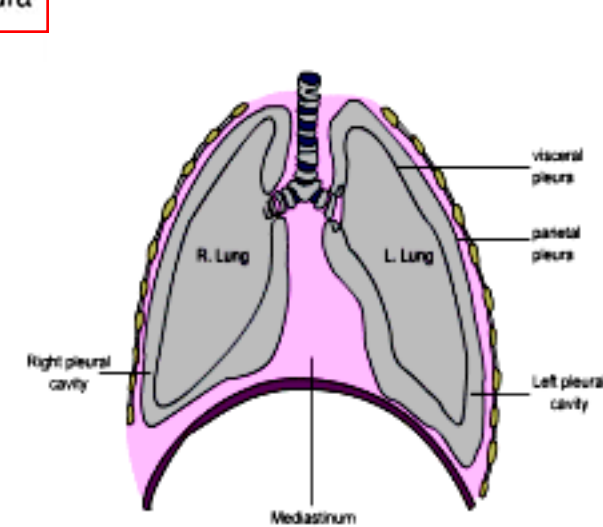
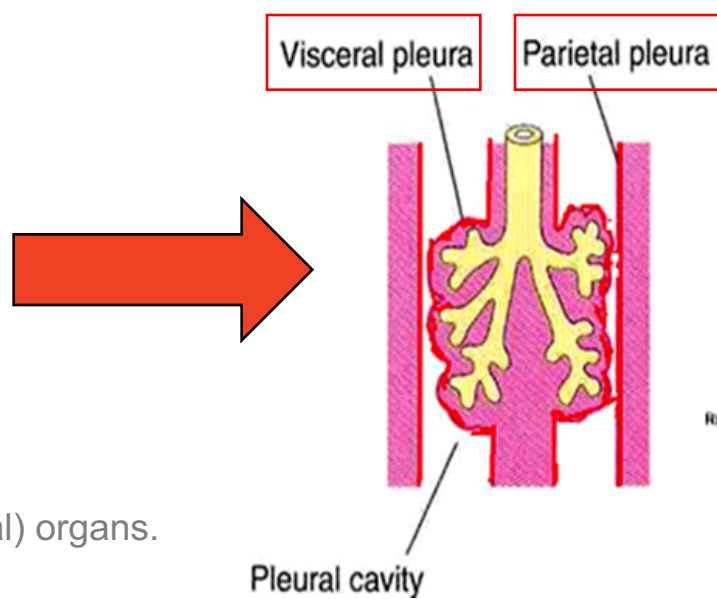
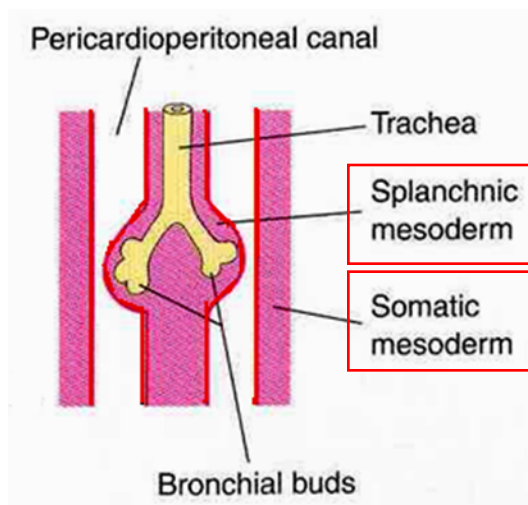
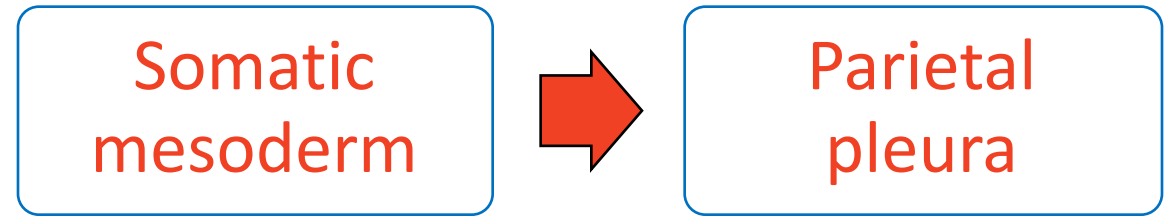
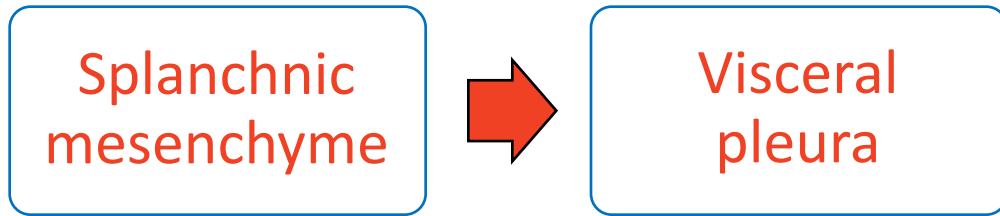
Segment: portion.



Development of the pleura

- As the lungs develop they acquire a layer of **visceral pleura** from **splanchnic mesenchyme** (splanchnic (visceral) mesoderm).

- The thoracic body wall becomes lined by a layer of **parietal pleura** derived from the **somatic mesoderm**.



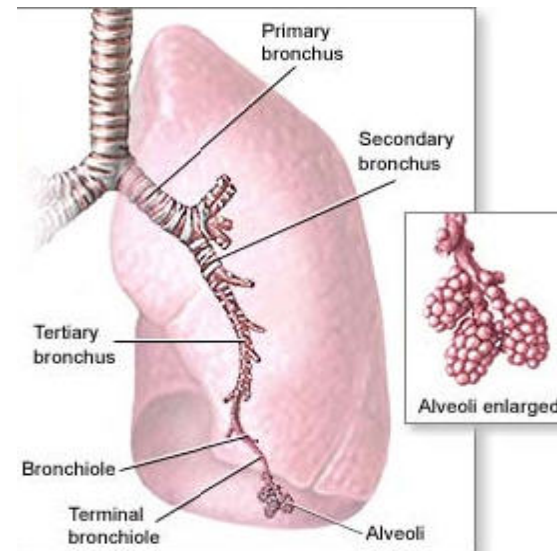
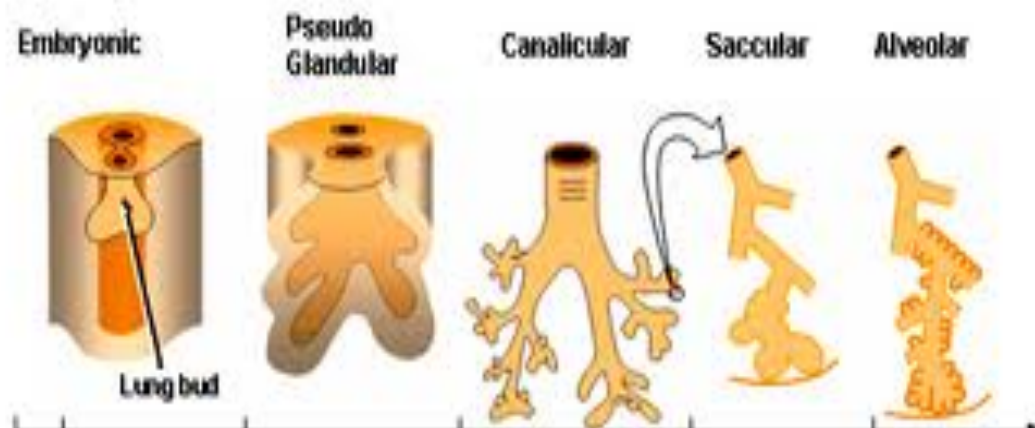
Splanchnic: relating to visceral (internal) organs.
Somatic: relating to body.

Maturation Of The Lungs

Maturation of lung is divided into 4 periods:

- Pseudoglandular (5 - 17 weeks)
- Canalicular (16 - 25 weeks)
- Terminal sac (24 weeks - birth)
- Alveolar (late fetal period - childhood)

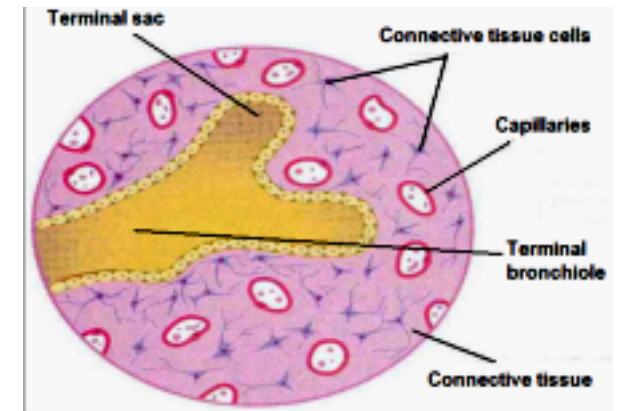
**These periods overlap each other because the cranial segments of the lungs mature faster than the caudal ones*



Maturation Of The Lungs

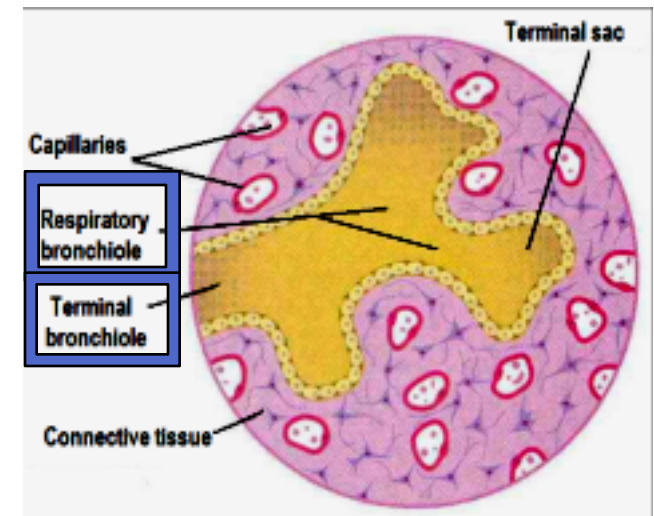
Pseudoglandular Period (5-17 weeks)

- Developing lungs somewhat resembles an exocrine gland (الغدد الإفرازية) 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 (16-25 weeks)

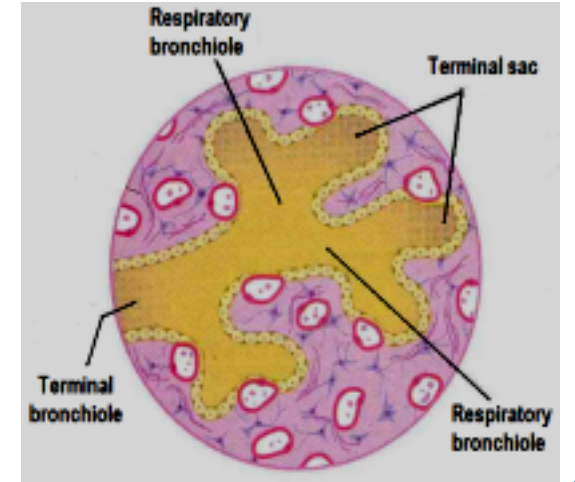
- Lung tissue becomes **highly vascular**.
- Lumina of bronchi and terminal bronchioles become larger.
- By **24 weeks** each terminal bronchiole has given rise to two or more **respiratory bronchioles**.
- The respiratory bronchioles divide into 3 to 6 tubular passages called **alveolar ducts**.
- Some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



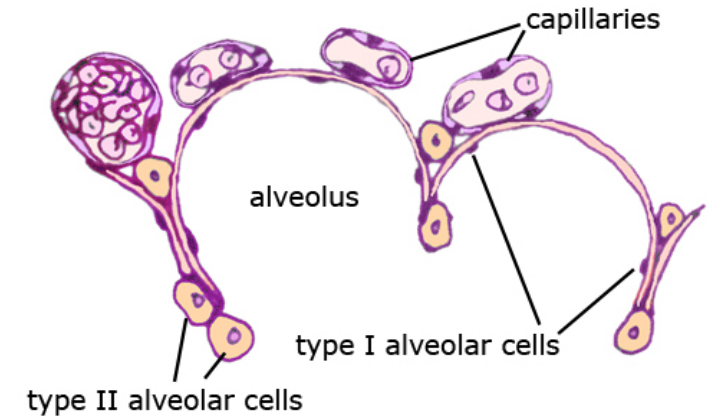
Maturation Of The Lungs

Terminal Sac Period (24 weeks - birth)

- Many more terminal sacs develop.
- Their epithelium becomes **very thin**.
- Capillaries begin to bulge (تبرز) 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.



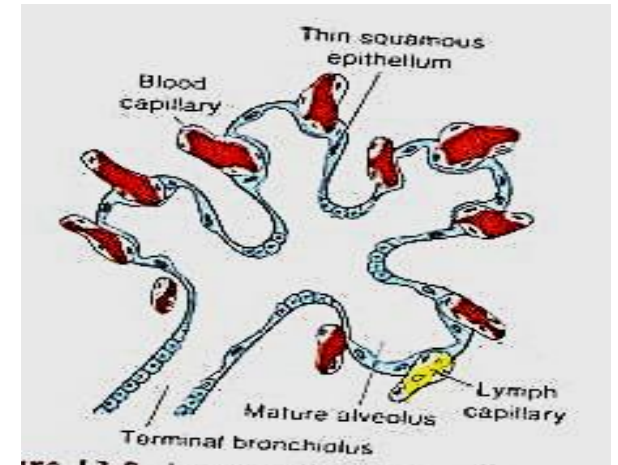
- By **24 weeks**, the **terminal sacs** are lined by:
 - Squamous **type I pneumocytes** and
 - Rounded secretory, **type II pneumocytes**, that secrete a mixture of phospholipids called **surfactant**.
- **Surfactant** production begins by **20 weeks** and increases during the terminal stages of pregnancy.
- **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 – 8 years)

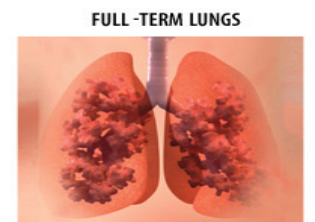
- At the beginning of the alveolar period, each respiratory bronchiole terminates in a cluster of thin-walled terminal saccules separated from one another by loose connective tissue.
- These **terminal saccules** represent future **alveolar sacs**.
- Embryonic life → Terminal saccules.
- Adult Life → Alveolar sacs.



- Characteristics of 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.
- That's why a kid under the age of 8 cant compete in running with an adult but a kid older than that can win a running contest easily against an adult.



32 WEEKS GESTATIONAL AGE



40 WEEKS GESTATIONAL AGE

Breathing Movements:

- Occur **before birth**, 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.

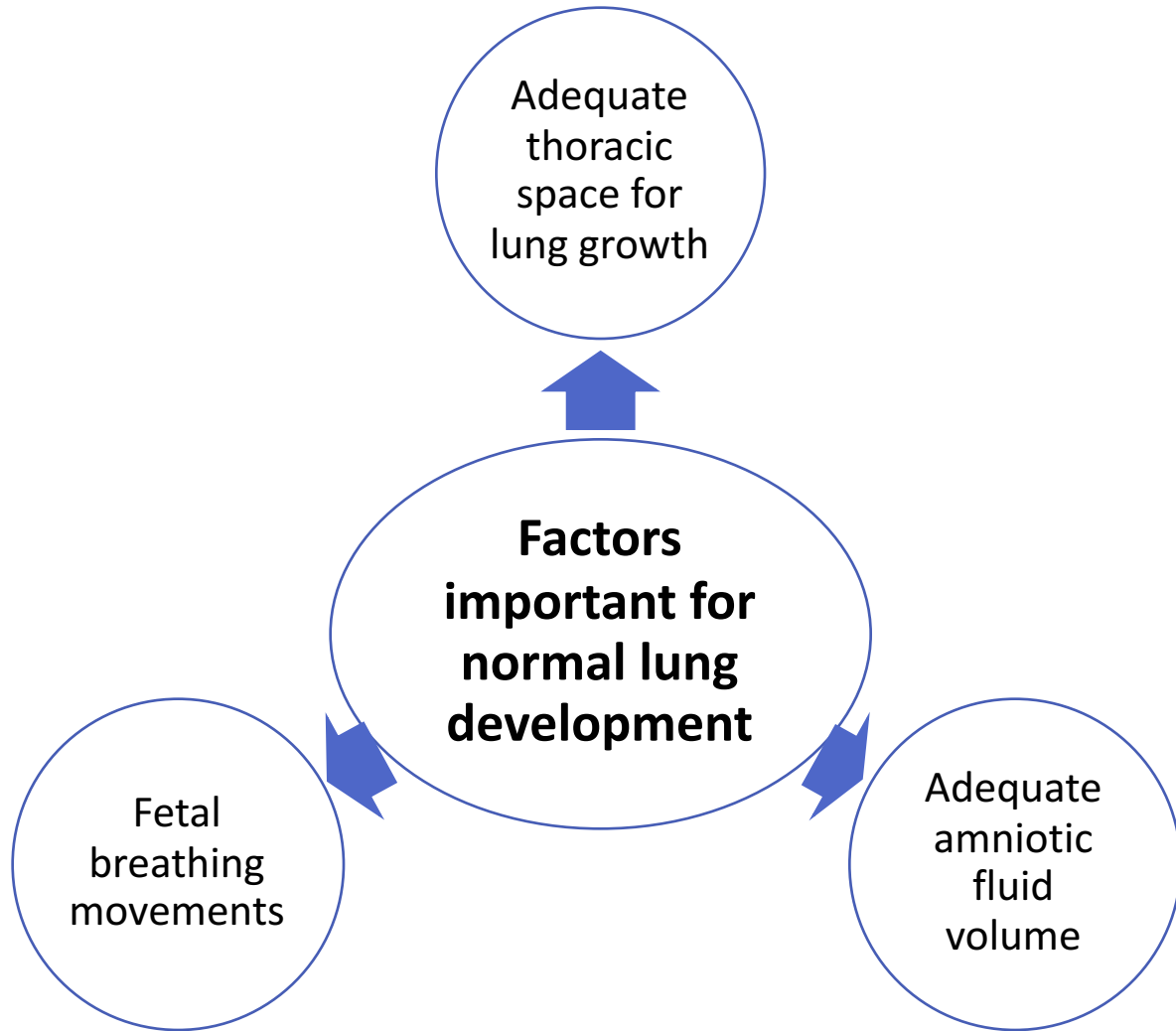
Lungs of a newborn

- **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.

Lungs At Birth:

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

*stillborn: babies who are born dead (die in the womb)



Development anomalies

Laryngeal atresia.

Tracheoesophageal fistula.**

Tracheal stenosis & atresia.

Congenital lung cysts.

Agenesis of lungs.

Lung hypoplasia.

Accessory lungs.

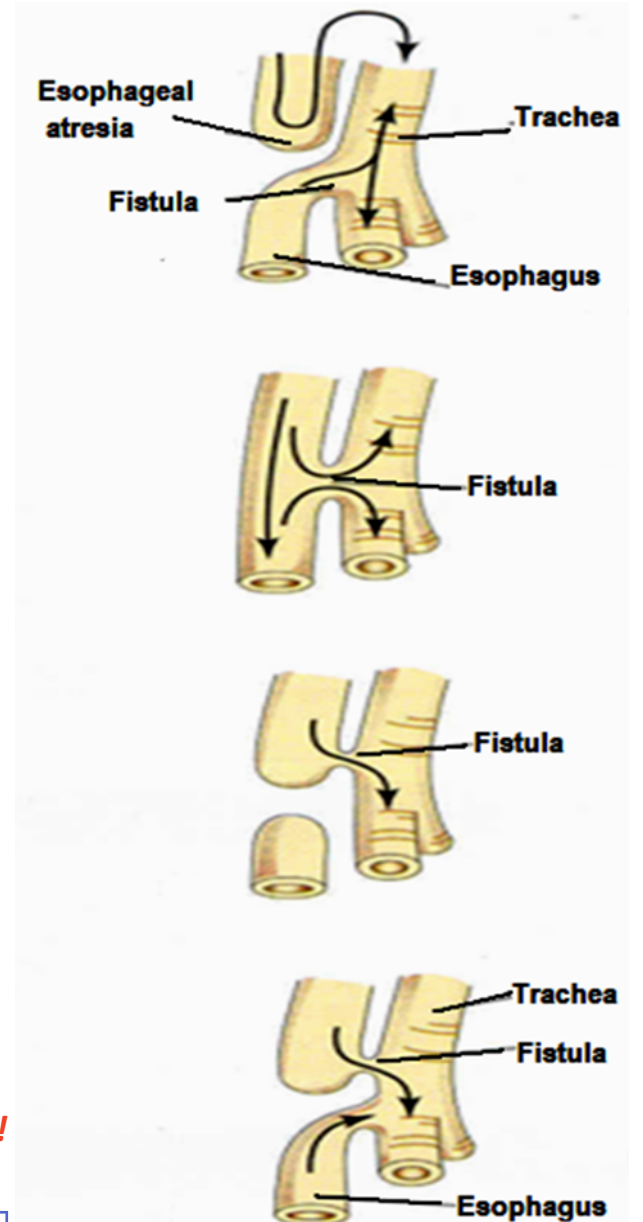
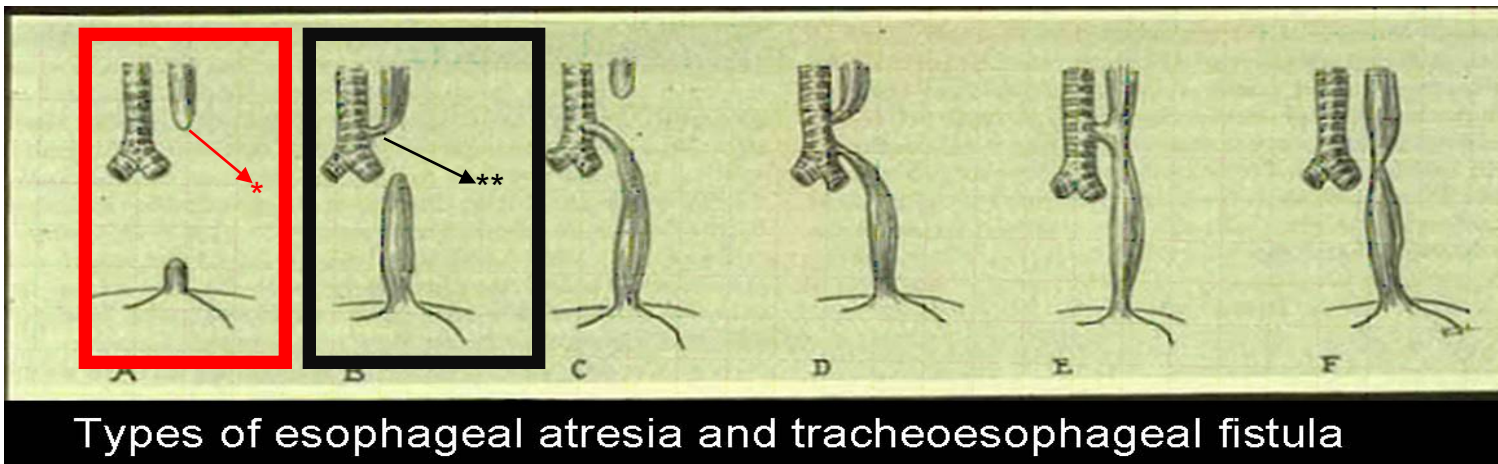
Tracheoesophageal Fistula**

- 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 to 4500 live births.
- Most affected infants are **males**.
- In more than **85% of cases**, the fistula is associated with **esophageal atresia***
- **Esophageal Atresia**: esophagus ends in a blind-ended pouch “close end” rather than connecting normally to the stomach.

Recall what we took in foundation:

A **fistula** is an abnormal pathway between 2 anatomic spaces.

A **sinus tract** is an abnormal channel that originates or ends in one opening.

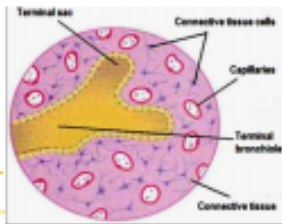
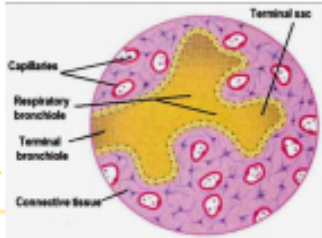
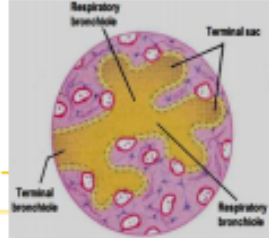
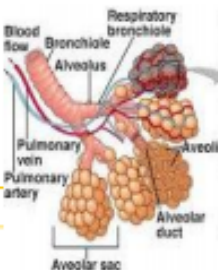


WATCH !!!

[GOOD VIDEO TO UNDERSTAND](#)

Summary

Team 435

	Pseudoglandular Period	Canalicular Period	Terminal Period	Alveolar Period
Alveoli forming	No	Yes "some" : By 24 weeks terminal bronchiole has given rise to respiratory bronchioles.	Yes :developing of many alveoli	Yes
Respiratory survive	No	Yes at the <u>end</u> May survive "usually die"	Yes "Adequate"	Yes
Capillaries begin to bulge	No	No	yes	-
Pictures				



Summary

Team 435

4 th weak	Begin to form lower respiratory tract
10 th weak	Recanalization of the larynx
5-17 weak	Pseudoglandular
17 weak	All major elements of the lung formed except alveoli
16-25 weak	Canalicular
24 weak	Each terminal bronchiole has given rise to two or more respiratory bronchioles
24weak –birth	Terminal sac
Late fetal period 32 weeks – childhood 8 years	Alveolar
3-8 years	Immature alveoli increase forming additional primordial alveoli.
8 years	Adult complement of 300 million alveoli present

MCQs

Q1-The lower respiratory development begins ?

- A- 4th week
- B- 7th week
- C-10th week
- D- 6th week

Answer: A

Q2-Which of the following lines the laryngotracheal diverticulum gives rise to the epithelium & glands ?

- A-The endoderm
- B-The splanchnic
- C-both A&B
- D-None of A&B

Answer: A

Q3-The bronchopulmonary segment is

- A-an anatomical segment
- B-A surgical segment
- C-A functional segment
- D-All of the above

Answer: D

Q4-At which period of maturation of the lung does the lung tissue become highly vascular ?

- A-Pseudoglandular
- B- Alveolar
- C- Canalicular
- D-Terminal Sac

Answer: C

Q5- Which one of the following statements is true about the Terminal Sac period ?

- A-The alveolar ducts will start forming at this period .
- B- prematurely born fetus are unable to survive.
- C-The epithelium of the terminal sacs will become very thick.
- D-Capillaries begin to bulge at this period .

Answer: D

Q6-The cartilages, connective tissue and muscles of the trachea are derived from ?

- A-the epithelium and glands of the trachea
- B-the mesoderm
- C-the endoderm
- D-the mesoderm of 4th and 6th pair of pharyngeal arches

Answer: B

SAQs

Q1-What is the origin of the following pleura:

Visceral pleura: splanchnic mesenchyme.

Parietal pleura: somatic mesoderm

Q2-A 28 year old women delivered a baby boy at the 26th week of pregnancy , the baby was taken to the intensive care unit .

1) what is the period of maturation of the lung is this baby in ?

Ans : Terminal Sac Period

2) Is there a chance for the baby to survive , explain why ?

Ans : Yes, since that he was born in 26th week (in the terminal sac period) , the blood-air barrier has been formed and an Adequate gas exchange can occur .

Q3-When the Recanalization occurs ? Mention the organs formed during recanalization ?

Ans : at the 10th week,,,2 ventricles, vocal folds and vestibular folds



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