



Anatomy team
med 438



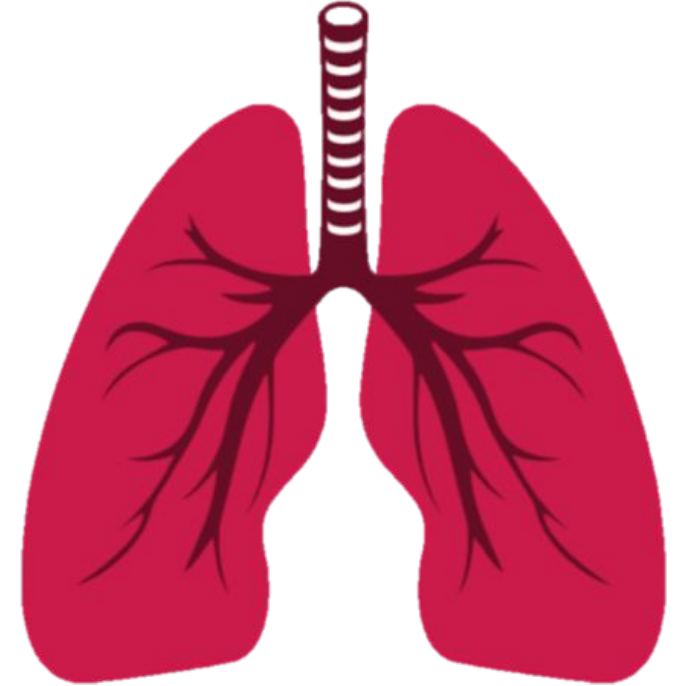
MED 438
KING SAUD UNIVERSITY



Development of respiratory system

Respiratory block-Anatomy-Lecture 5

Editing file



Objectives

- 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

Color guide :

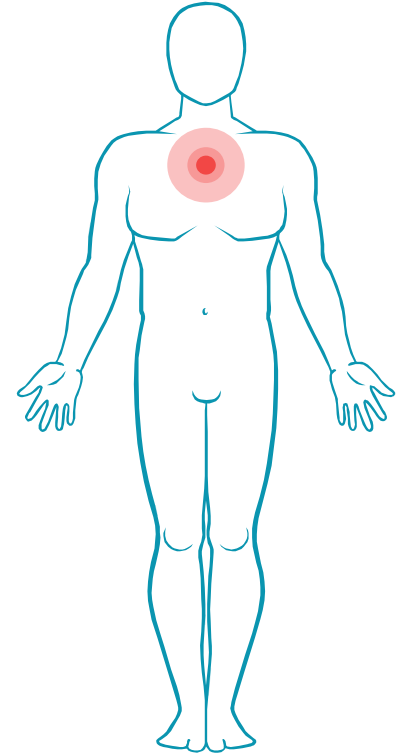
Only in boys slides in **Green**

Only in girls slides in **Purple**

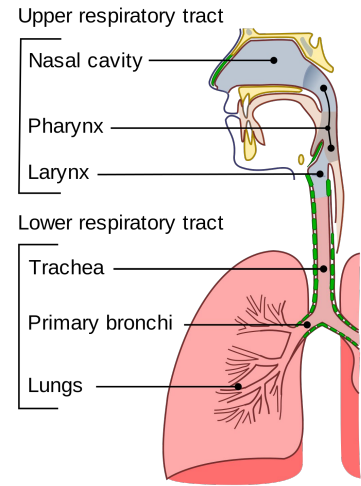
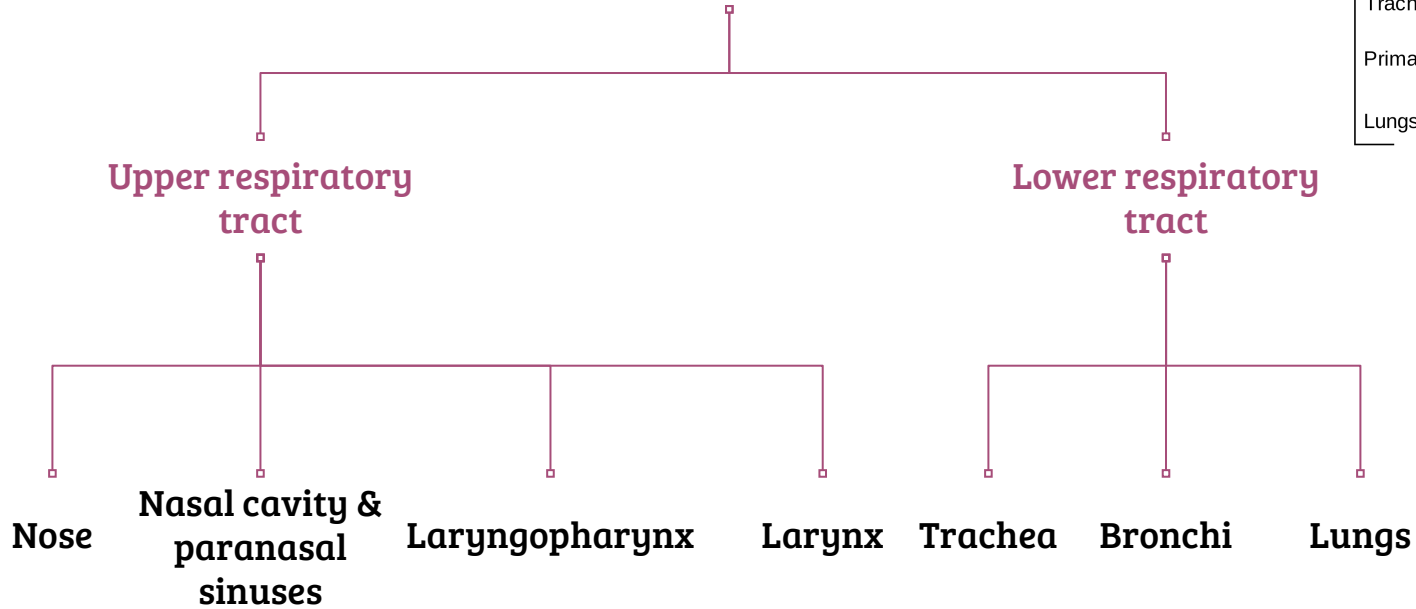
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Extra information in **Grey**



Respiratory system



Development of the respiratory tract

Begins during the 4th week of development

Development of **longitudinal tracheoesophageal septum**

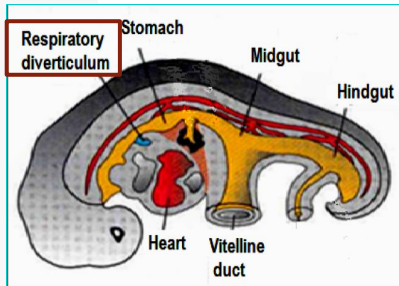
Proximal & distal parts of the respiratory diverticulum

The endoderm & surrounding splanchnic mesoderm

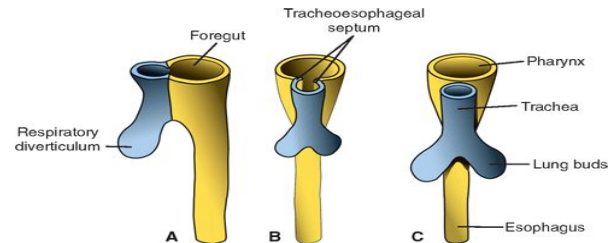
- ▶ **Begins** as a median outgrowth (**laryngotracheal groove**) from the **caudal part** of the **ventral wall** of the primitive pharynx (foregut).
- ▶ The groove **invaginates** (fold within itself) and **forms laryngotracheal (respiratory) diverticulum**.

- ▶ **Divides** the diverticulum into:
 - ▶ **Dorsal portion***: primordium (in the earliest stage of development) of the oropharynx & esophagus.
 - ▶ **Ventral portion***: primordium (=give rise) of larynx, trachea, bronchi & lungs.

* Remember that the larynx, trachea, bronchi & lungs lie anteriorly while the oropharynx & esophagus lie posteriorly. Hence, the ventral and dorsal portions.



- ▶ *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**).

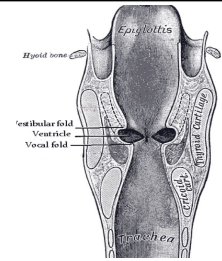
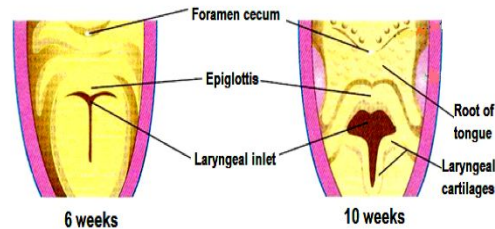
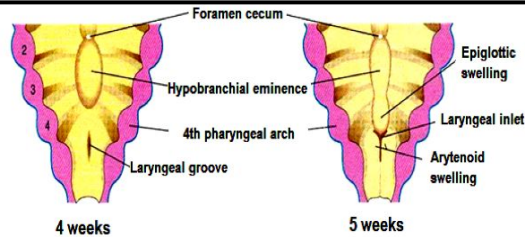


- ▶ The **endoderm** lining the laryngotracheal diverticulum (**respiratory diverticulum**) gives rise to the:
 - ▶ **Epithelium & glands** of the respiratory tract.
- ▶ The **surrounding splanchnic mesoderm** gives rise to the:
 - ▶ **Connective tissue, cartilage & smooth muscles** of the respiratory tract.

Development of the larynx

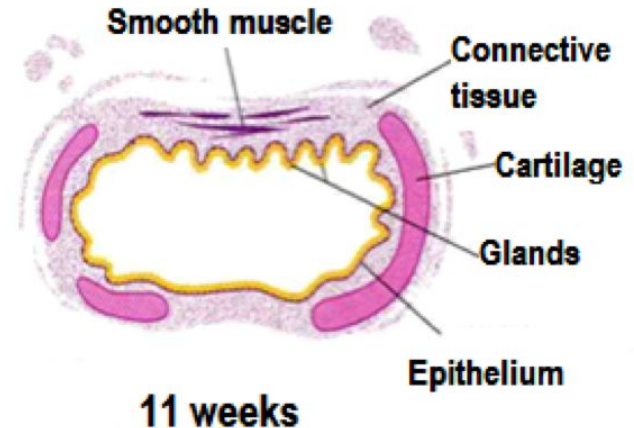
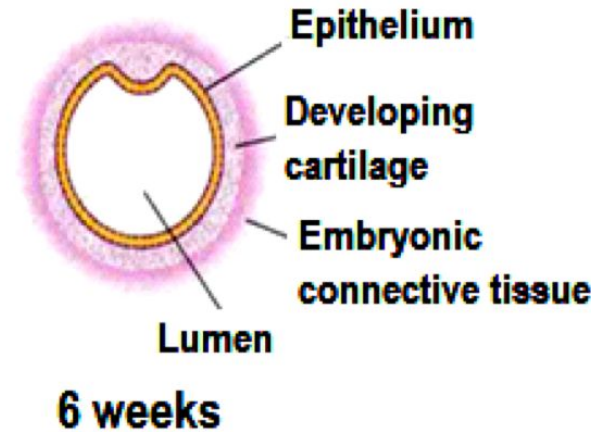
Development of the larynx	Epiglottis	Recanalization of larynx
<p>The opening of the laryngotracheal diverticulum into the primitive foregut becomes the laryngeal orifice (opening).</p> <ul style="list-style-type: none"> - The epithelium & glands are derived from endoderm. - Laryngeal muscles & the cartilages of the larynx (except epiglottis) develop from the mesoderm of 4th & 6th pairs of pharyngeal arches. <p>All laryngeal muscles supplied by (Vagus nerve)</p> <ul style="list-style-type: none"> • The superior laryngeal > 4th Ph. arch derivatives. • The recurrent laryngeal > 6th Ph. arch derivative 	<p>- It develops from the caudal part of the hypopharyngeal eminence, a swelling formed by the proliferation of mesoderm in the floor of the pharynx.</p>	<ul style="list-style-type: none"> - 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.

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.



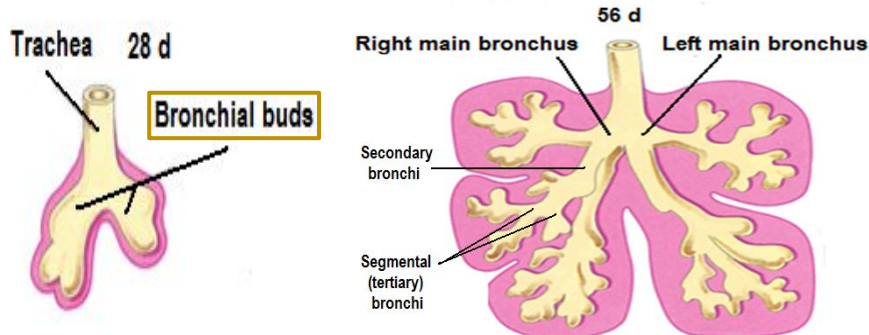
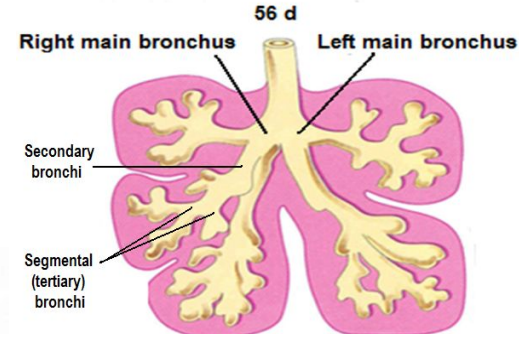
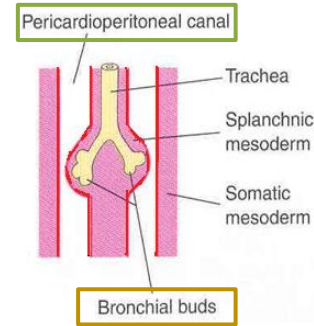
Development of the trachea

- 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

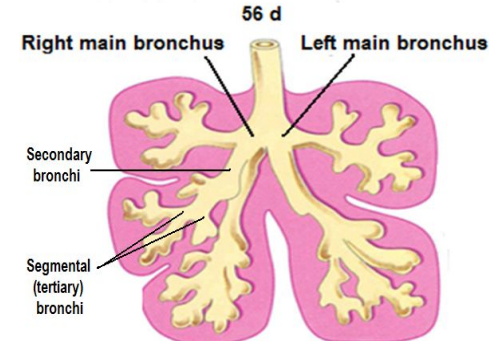
- ▶ The 2 primary **bronchial buds** grow **laterally** into the **pericardio-peritoneal canals** (part of *intra-embryonic celome*), which is the primordia of pleural cavities.
- ▶ Bronchial buds divide and re-divide to give the bronchial tree.



- ▶ The **right** main bronchus is slightly **larger** (wider) than the left one and is **oriented more vertically**.
- ▶ This embryonic relationship **persists** in the adult.
- ▶ The main bronchi subdivide into secondary & tertiary (segmental) bronchi which give rise to further branches.

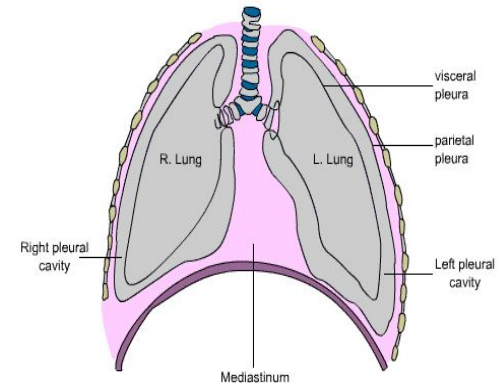
Development of the Bronchi & Lungs

- ▷ The segmental bronchi, 10 in the **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**.



Development of the pleura

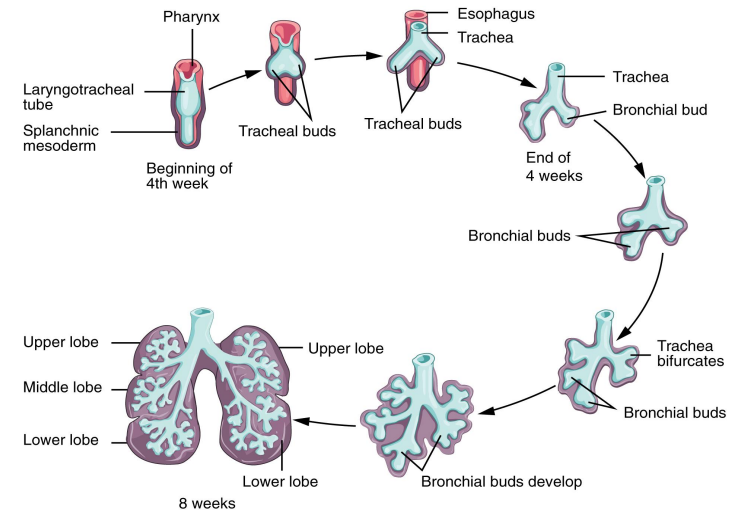
- ▷ As the lungs develop they acquire a layer of **visceral pleura** from the **splanchnic mesenchyme**.
- ▷ The thoracic body wall becomes lined by a layer of **parietal pleura** derived from the **somatic mesoderm**.



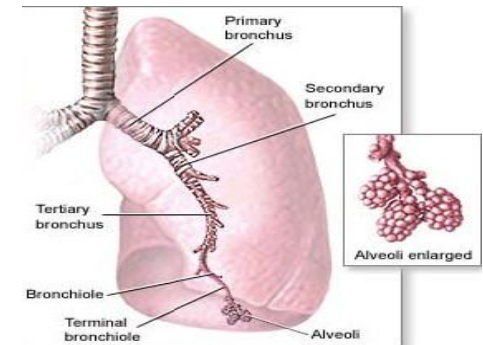
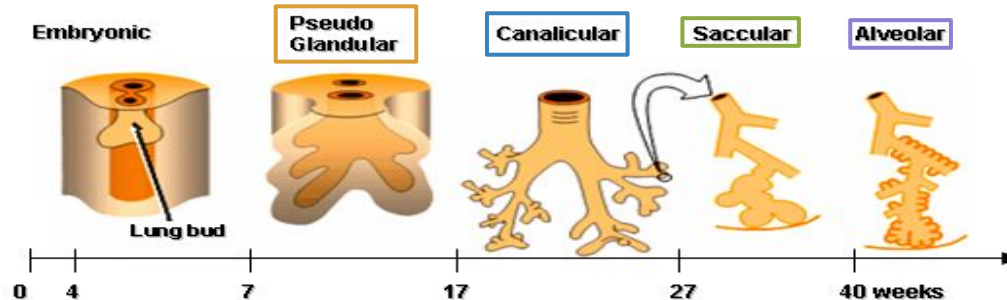
Maturation of the Lungs

Maturation of lung is divided into 4 periods:

- ▶ **Pseudoglandular** (6 - 16 weeks) .
- ▶ **Canalicular** (16 - 26 weeks).
- ▶ **Terminal sac** (26 weeks - birth).
- ▶ **Alveolar** (late fetal period - childhood) (32w to 8y)

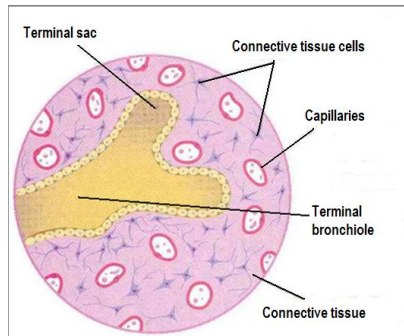


These periods overlap each other because the **cranial** segments of the lungs mature **faster** than the **caudal** ones.



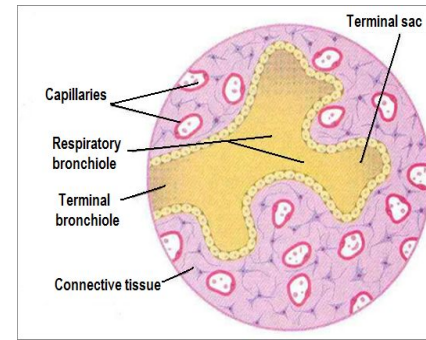
Pseudoglandular Period (5-16 weeks)

- ❑ 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 (alveoli)**.
- ❑ **Respiration is NOT possible.**
- ❑ **Fetuses** born during this period are unable to survive.



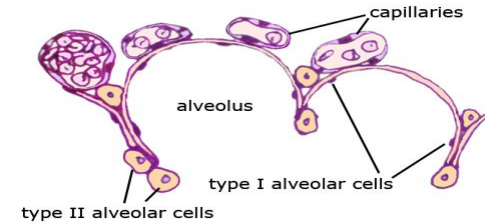
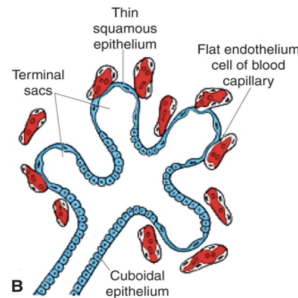
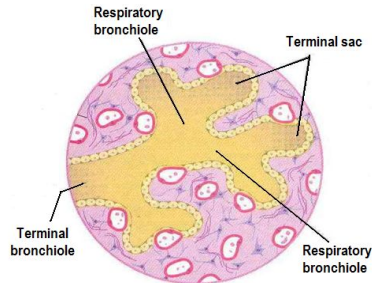
Canalicular Period (16-26 weeks)

- ❖ 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).



Terminal Sac Period (26 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 contact and establish the **blood-air barrier**.
- ▶ Adequate gas exchange can occur which allows the prematurely born fetus to survive.



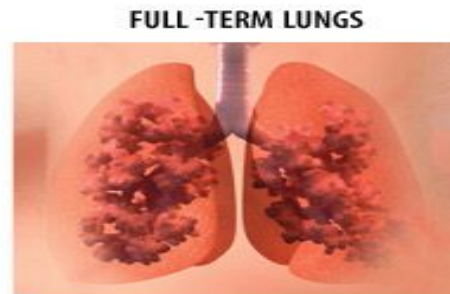
- ▶ By **26 weeks**, the terminal sacs are lined by: squamous **type I pneumocytes** and & rounded secretory **type II pneumocytes**, that secrete a mixture of phospholipids called **surfactant**.
- ▶ **Surfactant** production begins by **20 weeks** and increases during the **terminal** stages of pregnancy.
- ▶ 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.

Alveolar Period (32 weeks – 8 years)

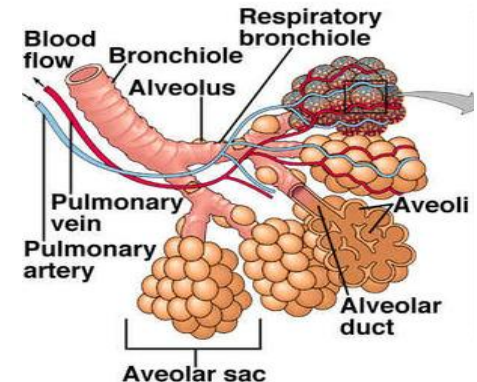
- ▶ At the beginning of the **alveolar period**, each respiratory bronchiole terminates in a cluster of thin-walled **terminal saccules** separated from one another by loose connective tissue.
- ▶ These **terminal saccules** represent future alveolar sacs.
- ▶ Characteristic mature alveoli do not form until **after birth**, so; 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.



32 WEEKS GESTATIONAL AGE

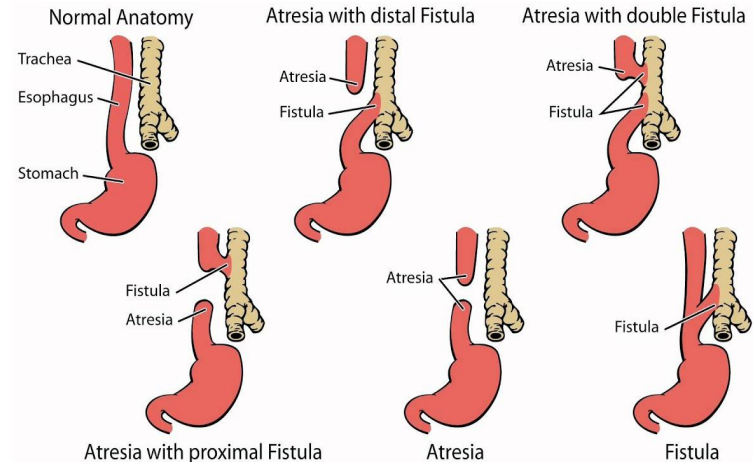
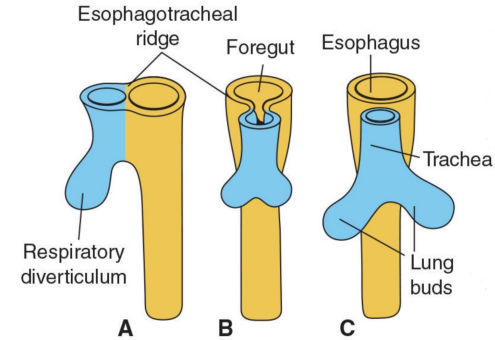


40 WEEKS GESTATIONAL AGE



Developmental anomalies: Tracheo-esophageal 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** (esophagus ends in a blind-ended pouch rather than connecting normally to the stomach).



MCQs

Question 1: The vestibular folds develop during which phase?

- A. recanalization of the larynx
- B. proliferation of the mesoderm in the floor of the pharynx
- C. development of the trachea
- D. differentiation of the endodermal lining of the laryngotracheal tube

Question 2: Which one of the following is derived from the endoderm?

- A. connective tissue of the trachea
- B. glands of the trachea
- C. cartilage of the trachea
- D. laryngeal muscles

Question 3: Which portion of the respiratory diverticulum the larynx arises from?

- A. cranial
- B. caudal
- C. ventral
- D. dorsal

Question 4: At which week does the development of the respiratory tract begins ?

- A. 10th
- B. 4th
- C. 5th
- D. 7th

Question 5: By 17 weeks all major elements of the lung have formed except:

- A. alveoli
- B. bronchioles
- C. trachea
- D. esophagus

Question 6: The parietal pleura is derived from:

- A. thoracic body wall
- B. somatic mesoderm
- C. visceral pleura
- D. splanchnic mesenchyme

Question 7: segments of the lungs mature faster than the ones.

- A. cranial, caudal
- B. caudal, cranial
- C. dorsal, ventral
- D. ventral, dorsal

Question 8: Surfactant production begins by:

- A. 22 weeks
- B. 20 weeks
- C. 18 weeks
- D. 21 weeks

Best wishes



**Don't forget to leave
your feedback:**



Team members

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- Maha Al Nahdi
- Ghaida Al Braithen