
Embryology

Development of the respiratory system

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Development of the lower respiratory system

Begins to form during the **4th week** as a median outgrowth called (**laryngotracheal groove**). This groove evaginates (**تفرع جانبي**) forming the respiratory diverticulum.

* A longitudinal tracheoesophageal septum divides the diverticulum:

* **Dorsal portion**: primordium of the **Oropharynx** and **Esophagus**.

* **Ventral portion**: primordium of the **Larynx**, **Trachea**, **Bronchi** and **Lungs**.

* The **proximal part** remains tubular and forms the trachea.

* The **distal part** divides give rise to two lung buds (primary bronchial buds).

* The **endodermal lining** gives rise to **epithelium and glands** of the respiratory tract.

* The **splanchnic mesoderm** gives rise to the **connective tissue, cartilage and smooth muscles** of the respiratory tract.

Development of the larynx:

* The epithelial lining of the larynx develops from the endoderm of the cranial end of laryngotracheal tube.

* The laryngeal epithelium proliferates rapidly resulting in temporary occlusion (**سد مؤقت**) of the laryngeal lumen. *Recanalization* (**إعادة فتح السد**) of larynx normally occurs by the **10th week**.

* Laryngeal ventricles, vocal folds and vestibular folds are formed during re-canalization.

Development of the epiglottis :

* Develops from the caudal part of the hypopharyngeal eminence (**بروز**) formed by the proliferation of mesoderm in the floor of the pharynx. Development of epiglottis and larynx is rapid during **the first three years** after birth.

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 :

*The two primary bronchial buds grow laterally into the pericardioperitoneal canals (part of the intraembryonic coelom), the primordia of pleural cavities.

*Bronchial buds divide and re-divide to give rise to the bronchial tree.

*The right main bronchus is *slightly larger* than the left one and is oriented more *vertically*.

*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 also divides.

***Segmental bronchus + surrounding mass of mesenchyme** = primordium of a **bronchopulmonary segment**.

*By the **24th** week, about 17 orders of branches have formed and respiratory bronchioles have developed. Additional 7 orders of airways develop after birth.

Maturation of the lungs :

*During development lungs acquire a layer of **visceral pleura** from **splanchnic mesenchyme**.

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

*Maturation of lung is divided into **4** periods:

*Pseudoglandular (5 - 17 weeks)

• The conducting (airway) system through the terminal bronchioles develops. By the 17th week, all major elements of the lung have formed except those involved with gas exchange. **Respiration is not possible**. Fetuses born during this period are **unable to survive**.

*Canalicular (16 - 25 weeks)

• Lung tissue becomes highly vascular. Luminal diameter of the conducting system increases, and respiratory bronchioles, alveolar ducts, and terminal sacs begin to appear. **Respiration is possible** at the end of this period. Fetus born at the end of this period **may survive** if given intensive care.

*Terminal sac (24 weeks - birth)

• More terminal sacs form, and alveolar type I cells and surfactant producing alveolar type II cells develop. Blood-air barrier is established. By the **24th week**, the terminal sacs are lined by type I pneumocytes and type II pneumocytes that secrete surfactant. **Adequate gas exchange can occur** allowing the prematurely born fetus to **survive**.

*Alveolar (late fetal period - childhood)

• Respiratory bronchioles, terminal sacs, alveolar ducts, and alveoli increase in number.

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

*Surfactant production begins by **20 weeks** and increases during the terminal stages of pregnancy.

***Sufficient terminal sacs, pulmonary vasculature** and **surfactant** are present to permit survival of 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.

Factors of maturation of the lungs :

A) Adequate thoracic space for lung growth. B) Fetal breathing movements. C) Adequate amniotic fluid volume.

Developmental anomalies :

- *Laryngeal atresia (congenital lack of the normal opening into the larynx)
- *Tracheoesophageal fistula (An abnormal passage between the trachea and the esophagus . Commonly a birth defect, with the trachea connected to the esophagus resulting from incomplete division of the cranial part of the foregut into respiratory and esophageal parts)
- *Tracheal stenosis (Narrowing of the trachea)
- *Tracheal atresia (Extremely rare anomaly. Refers to a congenital absence of the trachea)
- *Agenesis of lungs (Absence or incomplete development of the lungs)
- *Lung hypoplasia (Deficiency or underdevelopment of a tissue or body structure)
- *Accessory lungs (Lung tissue in other locations)
- *Congenital lung cysts.

Breathing movements: Occur before birth, not continuous, increase as delivery approaches. Help condition respiratory muscles. Stimulate lung development(essential).

Lungs at birth: • 1/2 filled with amniotic fluids.

- Fluids cleared by: Pressure on fetal thorax during delivery and absorption into pulmonary capillaries & lymphatics.

4th week : the lower respiratory tract begins to develop.

10th week : recanalization of the larynx.

17th week : all major elements of the lung have formed except those involved with gas exchange.

24th week : about 17 orders of branches have formed and respiratory bronchioles have developed

each terminal bronchiole has given rise to two or more respiratory bronchioles

Squamous type I pneumocytes and rounded secretory, type II pneumocytes,

1. **Recanalization of larynx is developed :**
 - a. At 6th week after fertilization.
 - b. At 10th week after fertilization.**
 - c. During the embryonic period.
 - d. Immediately after birth.
2. **In the developing lower respiratory tract, which one of the following structures is endodermal in origin?**
 - a. Tracheal cartilages.
 - b. Epiglottis.
 - c. Epithelium**
 - d. Laryngeal muscles.
3. **The stage of lung maturation that continues after birth is:**
 - a. The pseudoglandular period.
 - b. The terminal saccular period.
 - c. The alveolar period.**
 - d. The canalicular period.
4. **In the alveolar period, regarding maturation of the lung :**
 - a. It begins early during the embryonic period.
 - b. The lungs are not capable of respiration.
 - d. Type I pneumocytes secrete surfactant.
 - c. Most mature alveoli are developed postnatally.**
5. **Respiratory bronchioles begin to develop at :**
 - a. Pseudoglandular period.
 - b. Canalicular period.**
 - c. Terminal sac period.
 - d. Alveolar period.
6. **In Pseudoglandular period of maturation of the lung :**
 - a. It extends from 16 to 24 weeks.
 - b. The fetuses born can survive.
 - c. It has mature alveoli.
 - d. The Fetuses born are unable to survive.**
7. **In the developing lung, the terminal saccular period extends from:**
 - a. 6-16 weeks.
 - b. 10-20 weeks.
 - c. 24 weeks – birth.**
 - d. From birth till 8 years.

8. **In the terminal saccular period, regarding maturation of the lung :**
- a. It extends from 16 to 26 weeks.
 - b. The blood-air barrier has established.**
 - c. It has type I alveolar epithelial cells producing pulmonary surfactant.
 - d. It has many mature alveoli.
9. **Regarding the development of the respiratory system :**
- a. The epithelial lining of the bronchial tree is ectodermal in origin.
 - b. The tracheal cartilages develop from the endoderm.
 - c. The Recanalization of the larynx is developed at 6th week.
 - d. Most of the laryngeal cartilages develop from 4th and 6th pharyngeal arches.**
10. **Regarding the developing lung :**
- a. Fetus born at 7th month can not survive.
 - b. The parietal pleura develops from the splanchnic mesoderm.
 - c. At birth the lungs are completely filled with fluid.
 - d. Surfactant production begins by 20 weeks.**
11. **Epiglottis is developed from :**
- a. 4th pharyngeal arch.
 - b. 6th pharyngeal arch.
 - c. Ectoderm.
 - d. Hypopharyngeal eminence.**

Thank you