

Development of the Respiratory System

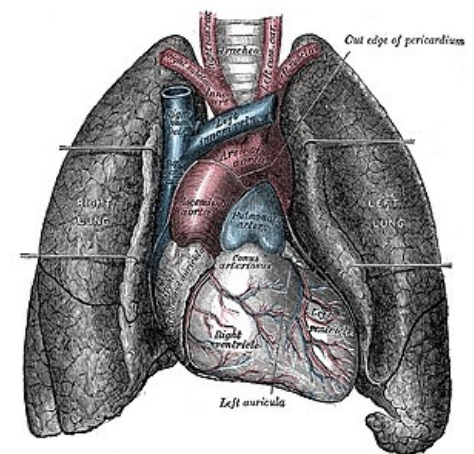
Formation of the lung buds

When the embryo is approximately 4 weeks old, the respiratory diverticulum (lung bud) appears as an outgrowth from the ventral wall of the foregut. An increase in retinoic acid causes upregulation of the transcription factor TBX4 that will induce formation of the bud, growth and differentiation of the lungs. The epithelium of the internal lining of the larynx, trachea, bronchi and lungs is entirely of endodermal origin. The cartilaginous, muscular and connective tissue of trachea and lungs are derived from splanchnic mesoderm.

1. The lung bud is in open communication with the foregut.
2. The diverticulum expands caudally and two tracheoesophageal ridges separate it from the foregut.
3. Tracheoesophageal ridges fuse - tracheoesophageal septum.
4. The foregut is divided into a:
 - dorsal portion - esophagus
 - ventral portion - trachea and lung buds

Larynx

The internal lining of the larynx originates from endoderm, but the cartilages and muscles originate from mesenchyme of the fourth and sixth pharyngeal arches. As a result of rapid proliferation of this mesenchyme, the laryngeal orifice changes in appearance from a sagittal slit to a T-shaped opening. When the mesenchyme of the two arches transforms into the thyroid, cricoid and arytenoid cartilages the adult shape of the laryngeal orifice can be recognized. The laryngeal epithelium proliferates rapidly, resulting in a temporary occlusion of the lumen. Subsequently, vacuolization and recanalization produces a pair of lateral recesses, the laryngeal ventricles that are bounded by folds of tissue that differentiate into the false and true vocal cords. Since musculature of the larynx is derived from mesenchyme of the fourth and sixth pharyngeal arches, all laryngeal muscles are innervated by branches of vagus nerve (the superior laryngeal nerve innervates derivatives of the fourth pharyngeal arch and the recurrent nerve innervates derivatives of the sixth laryngeal arch).



Heart-and-lungs

Trachea, bronchi and lungs

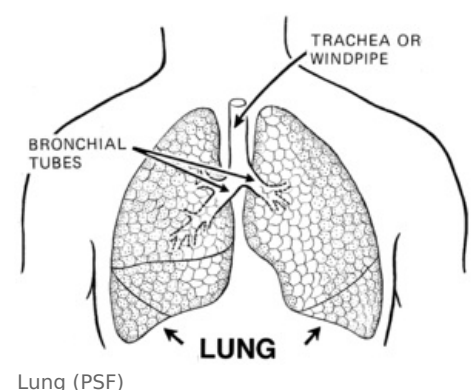
During its separation from the foregut, the lung bud forms the trachea and two bronchial buds. At the beginning of the fifth week, each of these buds enlarges and form right and left main bronchi. The right main bronchi gives rise to three secondary bronchi and the left main bronchi forms two secondary bronchi. During further development, secondary bronchi divide repeatedly, forming ten tertiary (segmental) bronchi in the right lung and eight in the left, creating the bronchopulmonary segments of the adult lung.

With subsequent growth, the lung expands into the pericardioperitoneal canals. Pleuroperitoneal and pleuropericardial folds separate the pericardioperitoneal canals from the peritoneal and pericardial cavities, respectively.

The lung bud forms the trachea and two lateral outpockets - bronchial buds that will form the right and left main bronchi. In the lungs the mesoderm which covers the outside of the lung will give rise to visceral pleura; the somatic mesoderm layer which covers the body wall from the inside will become the parietal pleura. The pleural cavity is the space between the parietal and visceral pleura.

Maturation of the lungs

Periods	time	Features
Pseudoglandular period	5 - 16 week	Branching has continued to form terminal bronchioles. No respiratory bronchioles or alveoli are present.
Canalicular period	16 - 26 week	Each terminal bronchiole divides into 2 or more respiratory bronchioles, which in turn divide into 3-6 alveolar ducts. The cuboidal cells lining the respiratory bronchioles.
Terminal sac period	Up to birth	Cuboidal cells become very thin and flat and intimately associated with blood and lymph capillaries. Terminal sacs (primitive alveoli) form.
Alveolar period	Up to 10	Mature alveoli have well-developed epithelial endothelial (capillary) contacts.



Fetal Breathing movements begin before birth and:

- cause aspiration of amniotic fluid
- stimulate lung development and conditioning of respiratory muscles

At birth Lung fluid is reabsorb but not the surfactant coat. The surfactant prevents the collapse of the alveoli during expiration.

Growth of the lungs after birth is due to an increase in the number of respiratory bronchioles and alveoli and not an increase in size.

Links

Bibliography

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Thoracic anatomy