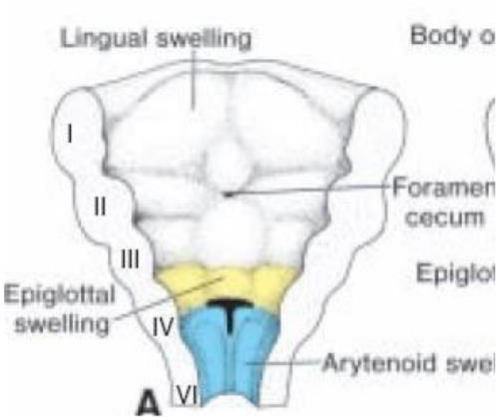
Larynx



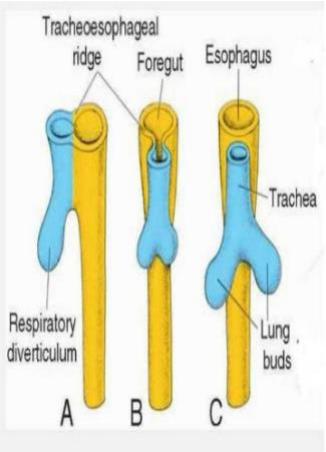
• The internal lining of the larynx originates from endoderm, but the cartilages originate from mesenchyme (blue in the picture) and muscles originate from the fourth and sixth pharyngeal arches.
• As a result of rapid proliferation of this mesenchyme, the laryngeal orifice changes in appearance from a sagittal slit to a T-shaped opening
(at the beginning of larynx formation the shape changes)
• Subsequently, when mesenchyme of the two arches transforms into the thyroid, cricoid, and arytenoid cartilages, the characteristic adult shape of the laryngeal orifice can be recognized.
•After larynx cartilage formation—> proliferation of mesenchymal cells which fill the larynx(occlusion) —> canalization (vacuolization)—> cavity which has ventricles and a saccules
(fold of tissue above this cavity→ false vocal cord, below it→true vocal cord).
• Since musculature of the larynx is derived from mesenchyme of the fourth and sixth pharyngeal arches, all laryngeal muscles are innervated by branches of the tenth cranial nerve, the vagus nerve.
• The superior laryngeal (gives external laryngeal nerve)nerve innervates derivatives of the fourth pharyngeal arch (cricothyroid) , and the recurrent laryngeal nerve innervates derivatives of the sixth pharyngeal arch.

Anomalies of the larynx

❖Laryngeal atresia

•Laryngeal atresia is a rare anomaly that causes obstruction of the upper fetal airway.
• Also known as congenital high airway obstruction syndrome (chaos).
•Distal to atresia or stenosis, the lungs are enlarged, to compensate the obstruction, and capable of producing echoes (echogenic).
•Also the diaphragm (instead of the copula) is flattened or inverted and fetal ascites (fluid in abdominal cavity) and hydrops (accumulation of serous fluid) is present.
• Prenatal ultrasonography permits diagnosis (ecotest).

Trachea, Bronchi, and Lungs development



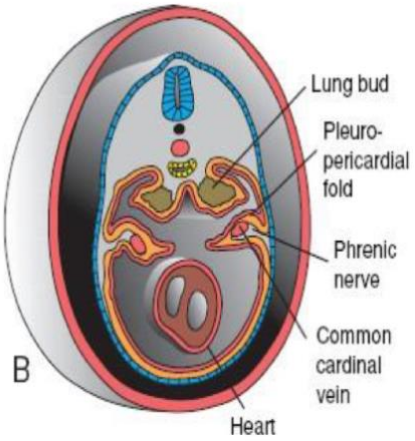
• During its separation from the foregut, the lung bud forms the trachea and two lateral outpocketings known as, the bronchial buds.
•The lining epithelium endoderm, the cartilage and muscles come from splanchnic mesenchyme.
• At the beginning of the fifth week, each of these buds enlarges to form right and left main bronchi.
Remember: the right one is shorter, wider and more vertical.

The right then forms three secondary bronchi (lobar bronchi) then divide into tertiary bronchi:
A-Upper lobe (has 3 segment) Apical, Anterior, Posterior.
B-Middle lobe (has 2 segments) Middle, Lateral.
C- Lower lobe (has 5 segments) apicobasal, Anterior, Posterior, Middle, Lateral.

• The left one forms two secondary (lobar) bronchi then divide into tertiary bronchi:
  A- Upper lobe (has 4 segments): apicoposterior (after birth divides into apical and posterior), anterior, superior and inferior lingular.
  B- Lower lobe (has 4 segments): apical, anteromedial (after birth divides into anterior and medial), posterior, lateral.
• Thus foreshadowing the three lobes on the right side and two on the left.
• As we go distally, the bronchopulmonary segments form the bronchioles> terminal bronchioles> respiratory portion (respiratory bronchioles, alveolar duct> sac> alveoli).

The Development Of Pleura:

-We have two cavities: (Pericardioperitoneal , pleuropericardial).



• Ultimately the pleuroperitoneal and pleuropericardial folds separate the pericardioperitoneal canals from the peritoneal and pericardial cavities.
• Each one will separate and give:
1-Pericardioperitoneal:
—>peritoneum cavity-contains abdominal viscera.
—>pericardium – the heart.
2-pleuropericardial:
—>pericardium cavity.
—> and the remaining spaces form the primitive pleural cavities.
• The mesoderm, which covers the outside of the lung, develops into the visceral pleura.
• The somatic mesoderm layer, covering the body wall from the inside, becomes the parietal pleura.
• The space between the parietal and visceral pleura is the pleural cavity.
• During further development, secondary bronchi divide repeatedly in a dichotomous fashion, forming 10 tertiary (segmental) bronchi in the right lung and 8 –postnatal become 10-in the left, creating the bronchopulmonary segments of the adult lung.
• By the end of the sixth month, approximately 17 generations of subdivisions have formed.
•the start of these divisions from the bronchioles to alveolar ducts to the sac to the alveoli. This division must be repetitive to reach millions of alveoli (the one divided into two>four> eight and so on).
• It still dividing up to ten years after birth.
• Before the bronchial tree reaches its final shape, however, an additional 6 divisions form during postnatal life.
• Branching is regulated by epithelial-mesenchymal interactions between the endoderm of the lung buds and splanchnic
mesoderm that surrounds them.
• Signals for branching, which emit from the mesoderm, involve members of the fibroblast growth factor (FGF) family.
• While all of these new subdivisions are occurring and the bronchial tree is developing, the lungs assume a more caudal position, so that by the time of birth the bifurcation of the trachea is opposite the fourth thoracic vertebra.

Maturation of the Lungs

TABLE 12.1 Maturation of the Lungs

Pseudoglandular period	6–16 weeks	Branching has continued to form terminal bronchioles. No respiratory bronchioles or alveoli are present.
Canalicular period	16–26 weeks	Each terminal bronchiole divides into 2 or more respiratory bronchioles, which in turn divide into 3–6 alveolar ducts.
Terminal sac period	26 weeks to birth	Terminal sacs (primitive alveoli) form, and capillaries establish close contact.
Alveolar period	8 months to childhood	Mature alveoli have well-developed epithelial endothelial (capillary) contacts.

Notes:

1-No respiration at pseudoglandular and canalicular periods, alveoli are present in canalicular period but still inactive.

2-Respiration starts in the terminal sac period and becomes well-developed in the alveolar period.

3-Respiratory membrane is formed in the terminal sac period and becomes well-developed in the alveolar period.

➢ As a rule: if the baby reaches the seventh month can survive,

➢ Primitive alveoli: alveoli can do gas exchange.

2-Canalicular phase:

• The lining epithelium is cuboidal and may be clara cells. The capillaries are far from each other and from the respiratory bronchioles so no formation of respiratory membrane.

3-Terminal sac period(phase):

• Cuboidal cells> simple squamous epithelium.

• Capillaries adhere to these flat cells forming respiratory membrane.

• During the seventh month, sufficient number of capillaries are present to guarantee adequate gas exchange, and the premature infant is able to survive.

Notice that the terminal sac also called primitive alveoli.

4-Alveolar phase:

•More capillaries adhere to the flat cells which result in an increase of respiratory surface area.

• In addition, cells lining the sacs, known as type I alveolar epithelial cells, become thinner, so that surrounding capillaries protrude into the alveolar sacs.

• Type II alveolar epithelial cells and lymph capillaries formed in this phase.

• This intimate contact between epithelial and endothelial cells makes up the blood-air barrier.

• Mature alveoli are not present before birth. maturation happens after birth, the alveoli before birth called primitive alveoli (still developing).

Maturation of the Lungs

-At the end of the sixth month. These cells, type II alveolar epithelial cells, produce surfactant.

-Before birth the lungs are full of fluid that contains:

•a high chloride concentration,

•little protein, some mucus from the bronchial glands,

•surfactant from the alveolar epithelial cells (type II).

..The amount of surfactant in the fluid increases, particularly during the last 2 weeks before birth.

Note:

1-We put a tube to suction this fluid from the oral cavity and trachea after delivery to clean the airway passage.

2-amniotic fluid which is important for maturation of the lungs.

3-respiration begins at birth.

4-Without the fatty surfactant layer, the alveoli would collapse(or may rupture) during expiration (atelectasis).

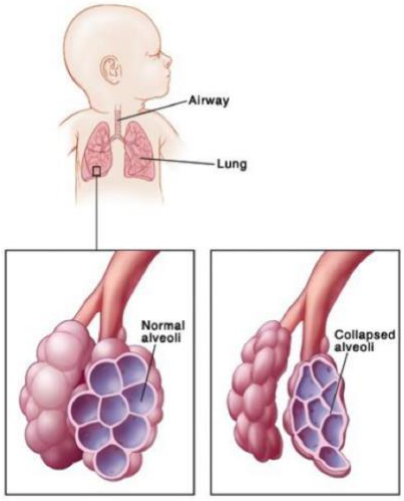
• Respiratory movements after birth bring air into the lungs, which expand and fill the pleural cavity.

• It is estimated that only one-sixth of the adult number of alveoli are present at birth.

• The remaining alveoli are formed during the first 10 years of postnatal life through the continuous formation of new primitive alveoli.

Anomalies of the lung

1-RDS (respiratory distress syndrome)



• The type of surfactant-producing cells is Type II alveolar epithelial cells,

• The Function of surfactant is decreasing the surface tension of alveoli so the ability to expand increased.

• In RDS the baby doesn't have enough surfactant, so the alveoli may rupture and shrink during expiration.

• Surfactant is particularly important for survival of the premature infant.

• RDS, is therefore also known as hyaline membrane disease, accounts for approximately 20% of deaths among newborns.

• Intrauterine Asphyxia may produce irreversible changes in type II cells.

• Recent development of artificial surfactant and treatment of premature babies with glucocorticoids (betamethasone)- before delivery- to stimulate surfactant production have reduced the mortality associated with RDS.

• Thyroxine is the most important stimulator for surfactants production.

…IMPORTANT NOTE

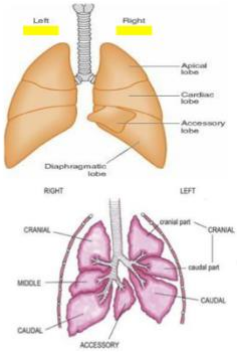
• It Also allowed survival of some babies as young as 5.5 months of gestation, by putting the cute baby in an incubator providing the intrauterine conditions and supplying the oxygen until the baby can breathe (the seventh month).

2- blind-ending trachea (atresia)

3- agenesis of one lung – the baby has one lung; his life depends on the function of this lung to afford him with enough oxygen)

4-ectopic lung- finding the lung in an abnormal location.

5-ectopic lung lobes -arising from the trachea or esophagus,accessory lobes are formed.



6-congenital cysts of the lung, which is the most important clinically in rare anomalies (all without RDS).

•The cyst can be single or multiple.

•These cysts may be small and multiple, giving the lung a honeycomb appearance on radiograph.

•Or they may be restricted to one or more larger ones.

•Cystic structures of the lung usually drain poorly and frequently cause chronic infections.

Lung Hypoplasia

• In infants with congenital diaphragmatic hernia(CDH) –especially on the left side- the lung is unable to develop normally,due to the diaphragm compression on the chest which will lead the hypoplasia of the lung

• Because it is compressed by the abnormally positioned abdominal viscera.

Oligohydroamnios and lungs

•When oligohydroamnios -opposite to polyhydramnios-- (reduced amniotic fluid) is severe lung development is retarded.

• Severe pulmonary hypoplasia results.

Lungs of the newborn infants

• Fresh and healthy lungs contain some air , so pulmonary samples,in forensic medicine, float in water due to the minimal volume of air.

• The lungs of the stillborn infants are firm and sink in water because they contain fluids not air.