Respiratory System Embryology

Germinal Layers

Ectoderm: Gives rise to the outermost layer of the skin (epidermis)

Mesoderm: Gives rise to various structures, such as bones, cartilage, muscles, blood vessels, and the lymphatic system.

Endoderm: Gives rise to the lining of internal organs, such as the gastrointestinal (GI) tract, respiratory system

Development of the nose and Palate

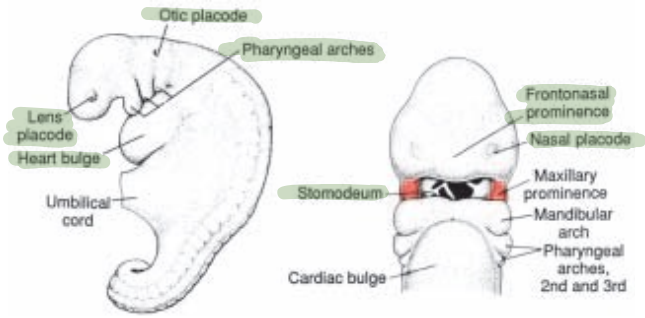
Development of the nose

- At the end of the fourth week, **facial prominences** consisting primarily of neural crest-derived mesenchyme and formed mainly by the first pair of pharyngeal arches appear

- The **frontonasal prominence,** formed by proliferation of mesenchyme ventral to the brain vesicles, constitutes the upper border of the stomodeum

- On both sides of the frontonasal prominence, local thickenings of the surface ectoderm, the **nasal** (**olfactory**) **placodes,** originate under inductive influence of the ventral portion of the forebrain

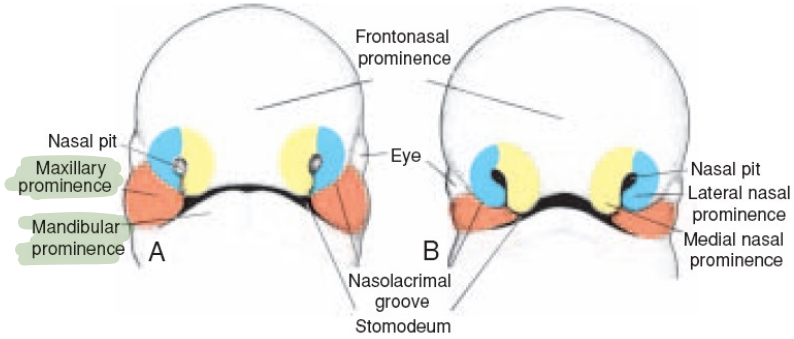
As the name of the Frontonasal prominence suggest it is a bony prominence originating from the frontal bone(constitutes the upper border of the stomodeum) and reaches down to the nose forming the nasal septum



- Otic Placode: Involved in the development of the ear.
- Lens Placode: Involved in the development of the eye.
- Nasal Placode: Involved in the development of the Nose. (makes nostrils)
- Heart bulge: Involved in the development of the heart.
- pharyngeal arches : Involved in the development of the Head and Neck
- Stomodeum : Involved in the development of the oral cavity .

Development of the nose

- During the fifth week, the nasal placodes invaginate to form **nasal pits (nostril) .** then Invagination of cells gives vestibule.
- In so doing, they create a ridge of tissue that surrounds each pit and forms the **nasal prominences.**
- The prominences on the outer edge of the pits are the **lateral nasal prominences;** those on the inner edge are the **medial nasal prominences**



- Maxillary Prominence: Grows internally and is involved in the development of the upper jaw, and the nose.
- Mandibular Prominence: Involved in the development of lower jaw and the nose.

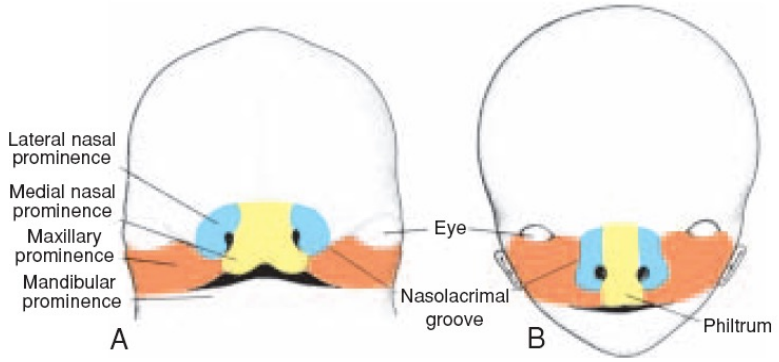
Development of the nose

- During the following 2 weeks, the maxillary prominences continue to increase in size

- Simultaneously, they grow medially, compressing the medial nasal prominences toward the midline

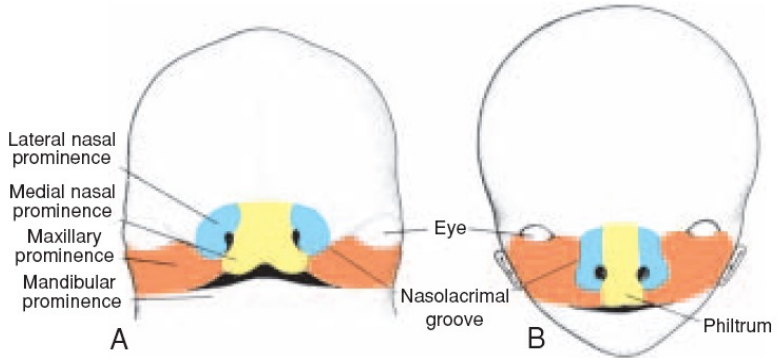
- Subsequently the cleft between the medial nasal prominence and the maxillary prominence is lost, and the two fuse

- If for any reason this fusion fails a developmental anomaly known as Cleft Lip (unilateral or bilateral) arises.



Development of the nose

- The **nose** is formed from five facial prominences
- the frontal prominence gives rise to the bridge; and **nasal septum**
- the merged medial nasal prominences provide the crest and tip;
- the lateral nasal prominences form the sides (alae)
- Olfactory pit forms the nostril and then becomes deeper to form a blind sac (the vestibule)



Development of the nose

TABLE 15.2 Structures Contributing to Formation of the Face

Prominence	Structures Formed
Frontonasal[a]	Forehead, bridge of nose, medial and lateral nasal prominences
Maxillary	Cheeks, lateral portion of upper lip
Medial nasal	Philtrum of upper lip, crest and tip of nose
Lateral nasal	Alae of nose
Mandibular	Lower lip

[a] The frontonasal prominence is a single unpaired structure; the other prominences are paired.

Summary

The nose is formed from five facial prominences.

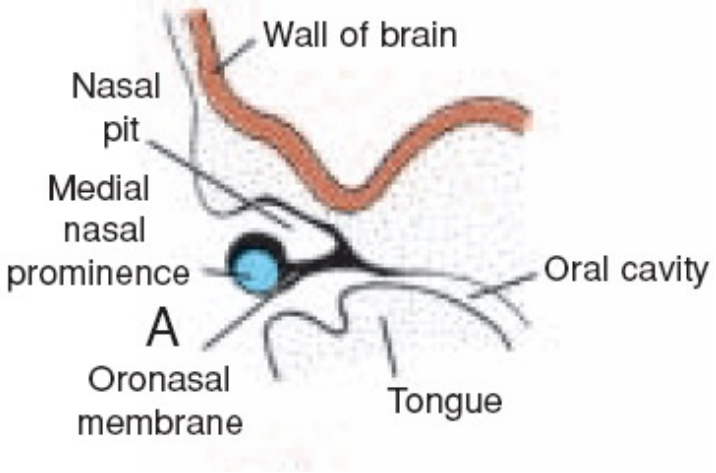
1. Frontonasal Prominence : Gives rise to the Nasal Septum - Forehead - Bridge of the nose - Medial Nasal Prominence - Lateral Nasal Prominence

2&3. Right & left Medial Nasal Prominences : Give rise to the tip of the nose - Nasal Crest - philtrum - Medial portion of the upper lip

4&5. Right & left Lateral Nasal Prominences: Give rise to the Alae of the nose (lateral wall)

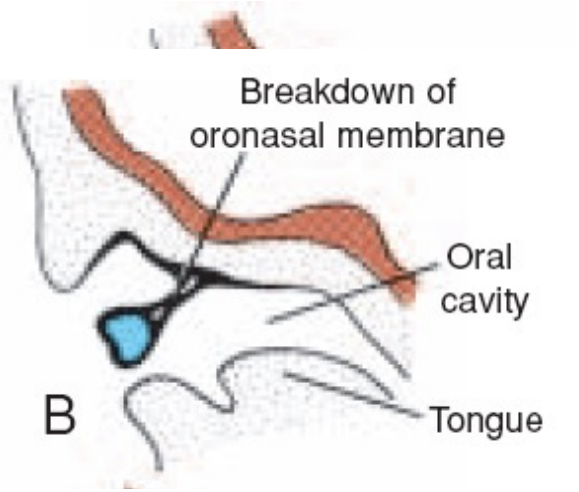
Nasal Cavities

- 1. During the sixth week, the nasal pits deepen considerably, partly because of growth of the surrounding nasal prominences and partly because of their penetration into the underlying mesenchyme



Nasal Cavities

- 2. At first the **oronasal membrane (floor of the nose)** separates the pits from the primitive oral cavity by way of the newly formed foramina, the **primitive choanae**

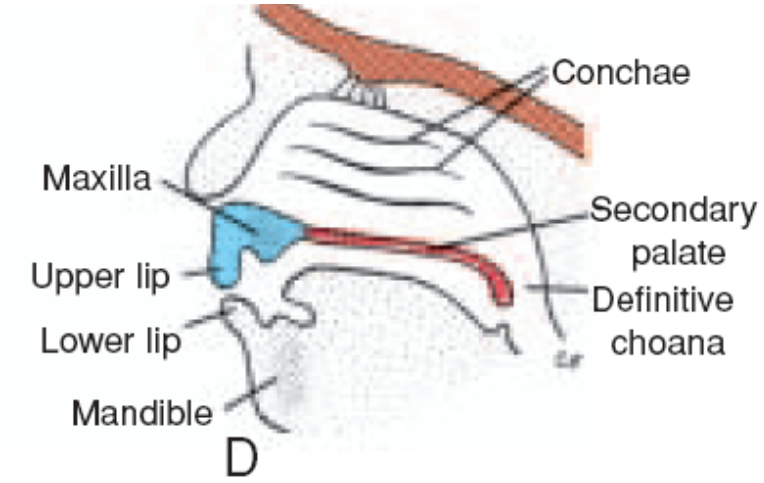


- These choanae lie on each side of the midline and immediately behind the primary palate.

Nasal Cavities

- 3. Later, with formation of the secondary palate and further development of the primitive nasal chambers

- the **definitive choanae will** lie at the junction of the nasal cavity and the pharynx (nasopharynx).



The nasal conchae, are bony structures that project into the nasal cavity from its lateral walls. There are three pairs of nasal conchae: superior, middle, and inferior:

Superior and Middle Nasal Concha: This is an extension of the ethmoid bone.
Inferior Nasal Concha: This is an extension of the maxillary bone.

Paranasal air sinuses

- **Paranasal air sinuses** develop as diverticula of the lateral nasal wall and extend into the maxilla, ethmoid, frontal, and sphenoid bones.

- They reach their maximum size during puberty and contribute to the definitive shape of the face.

Primary palate

- As a result of medial growth of the maxillary prominences, the two medial nasal prominences merge not only at the surface but also at a deeper level.

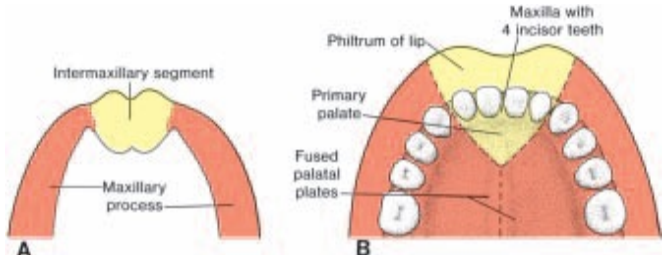
- The structure formed by the two merged prominences is the **intermaxillary segment**

- It is composed of (*a*) a **labial component,** which forms the philtrum of the upper lip;

- (*b*) an **upper jaw component,** which carries the four incisor teeth;

- (*c*) a **palatal component,** which forms the triangular primary palate

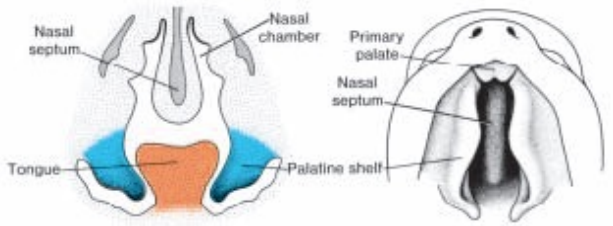
- The intermaxillary segment is continuous with the rostral portion of the **nasal septum,** which is formed by the frontal prominence.



Secondary Palate

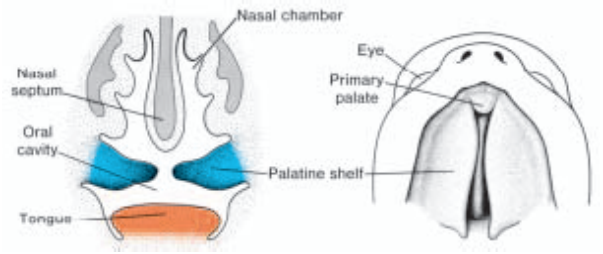
- the main part of the definitive palate is formed by two shelflike outgrowths from the maxillary prominences.

- These outgrowths, the **palatine shelves,** appear in the sixth week of development and are directed obliquely downward on each side of the tongue ((grow medially))



Secondary Palate

- In the seventh week, however, the palatine shelves ascend to attain a horizontal position above the tongue and fuse, forming the **secondary palate**

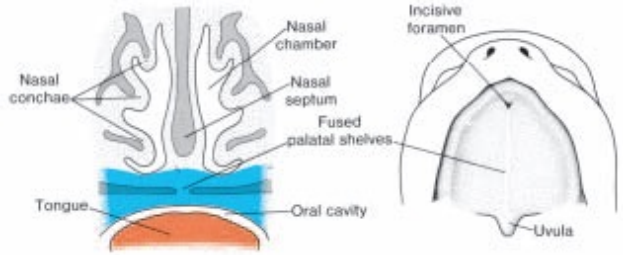


Secondary Palate

- Anteriorly, the shelves fuse with the triangular primary palate, and the **incisive foramen** is the midline landmark between the primary and secondary palates

- At the same time as the palatine shelves fuse, the nasal septum grows down and joins with the cephalic aspect of the newly formed palate

- the two Secondary shelves meet in the midline



Secondary Palate

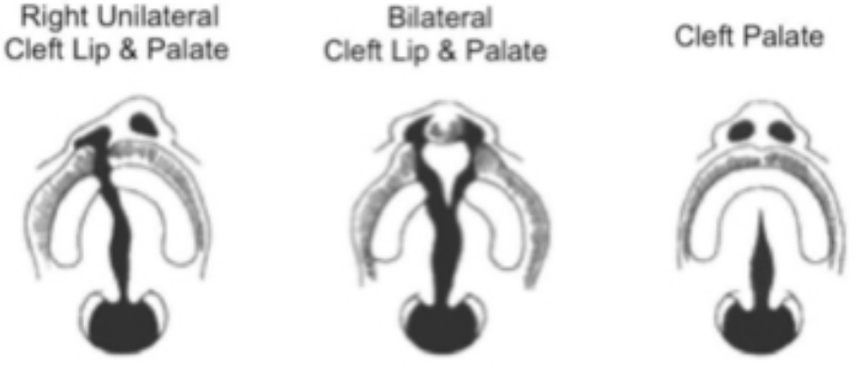
- 2 folds grow posteriorly from the edge of the palatine process to form the soft palate and the uvula.
- The union of the 2 folds of the soft palate occurs during the 8^{th} week
- The 2 parts of the uvula fuse in the midline during the 11^{th} week
- Unilateral cleft lip can extend to the nose

☹ Once again and similar to cleft lip which occurs due to failure of fusion between the Maxillary Prominences and the Medial Nasal Prominences. In the case of the palate, if there is failure of fusion between the primary and secondary palates another developmental anomaly known as Cleft Palate will arise. Cleft Palate has the following characteristics:-

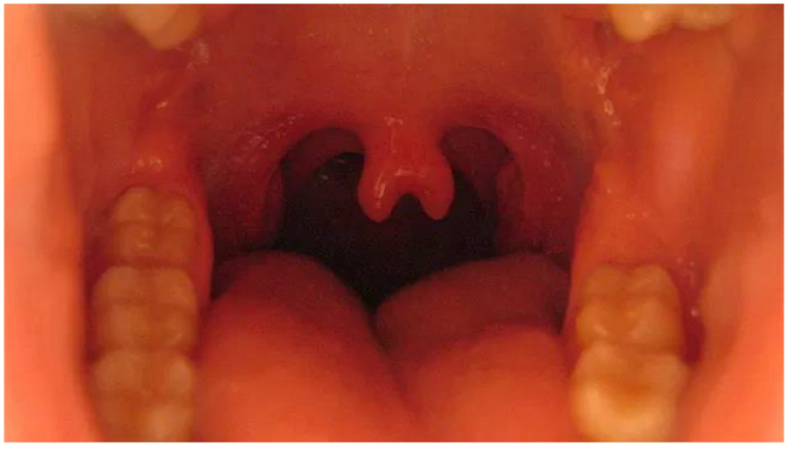
1. It could be unilateral or bilateral.

2. Unilateral cleft lip and palate can extend to the nose and nasal cavity.

3. In cleft soft palate cleft uvula can also occur



Failure of the uvulae to fuse results in a cleft uvula.



Respiratory System

Primitive gut

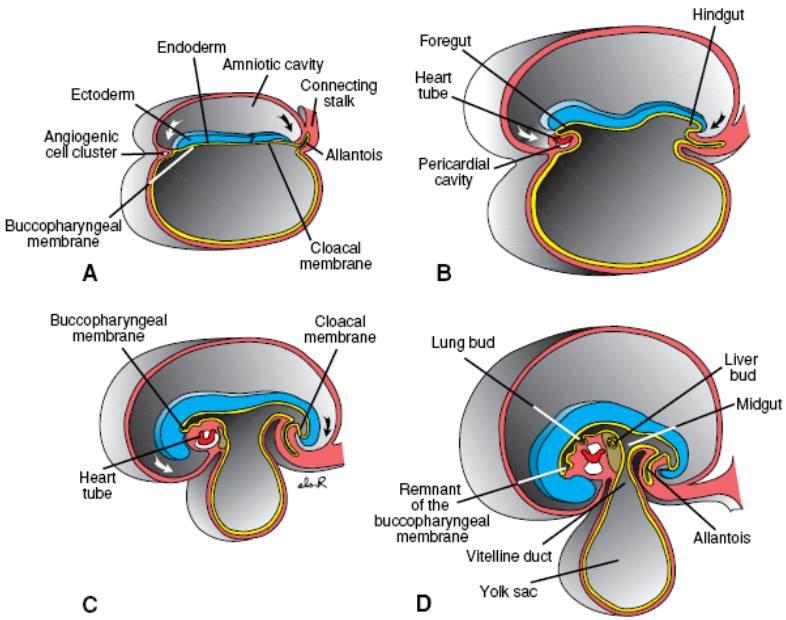
- Development of the primitive gut and its derivatives is in four sections:

- (*a*) The **pharyngeal gut,** or **pharynx,** extends from the buccopharyngeal membrane to the tracheobronchial diverticulum

- (*b*) The **foregut** lies caudal to the pharyngeal tube and extends as far caudally as the liver outgrowth.

- (*c*) The **midgut** begins caudal to the liver bud and extends to the junction of the right two-thirds and left third of the transverse colon in the adult.

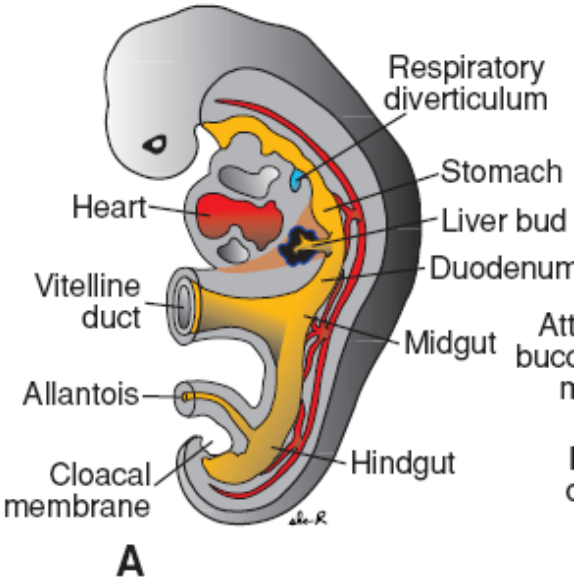
- (*d*) The **hindgut** extends from the left third of the transverse colon to the cloacal membrane



Respiratory diverticulum

- When the embryo is approximately 4 weeks old, the **respiratory diverticulum** (**lung bud**) appears as an outgrowth from the ventral wall of the foregut

- The location of the bud along the guttube is determined by signals from the surrounding mesenchyme, including fibroblast growth factors (FGFs) that instruct the endoderm

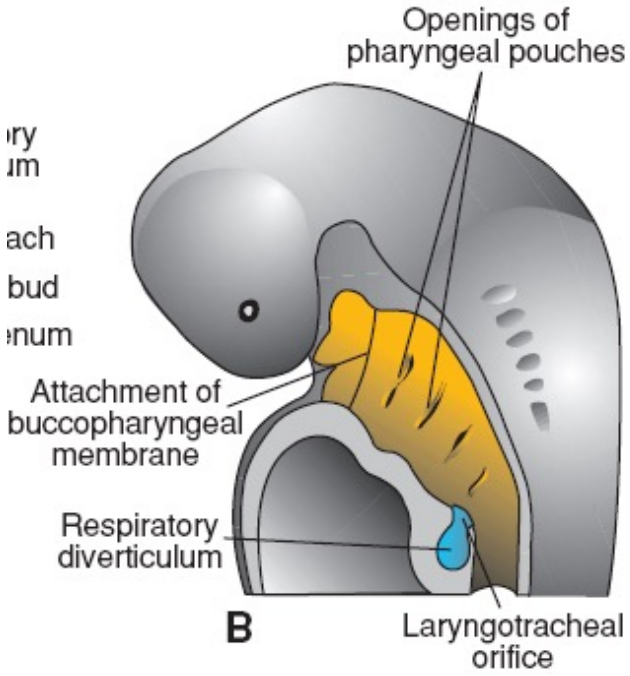


Respiratory diverticulum

- The **epithelium** of the internal lining of the larynx, trachea, and bronchi, as well as that of the lungs, is entirely of **endodermal origin.**

- The **cartilaginous, muscular,** and **connective tissue** components of the trachea and lungs are derived from **splanchnic mesoderm** surrounding the foregut.

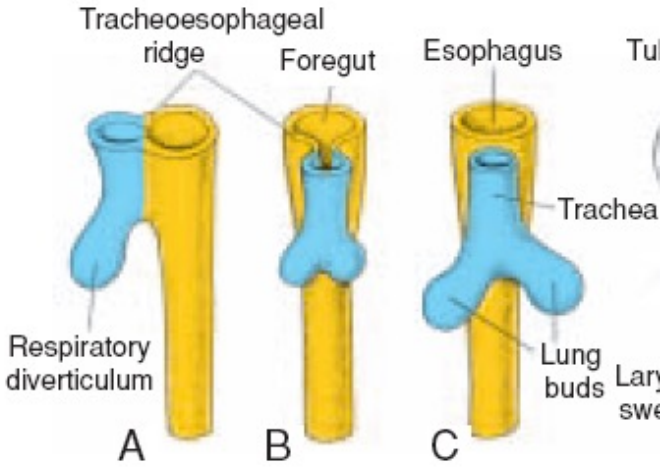
- Initially the lung bud is in open communication with the foregut



Respiratory diverticulum

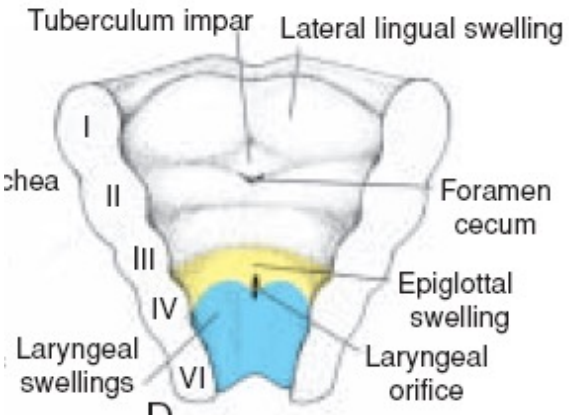
- When the diverticulum expands caudally, two longitudinal ridges, the **tracheoesophageal ridges,** separate it from the foregut

- Subsequently, when these ridges fuse to form the **tracheoesophageal septum,** the foregut is divided into a dorsal portion, the **esophagus,** and a ventral portion, the **trachea** and **lung buds**



Respiratory diverticulum

- The respiratory primordium maintains its communication with the pharynx through the **laryngeal orifice**

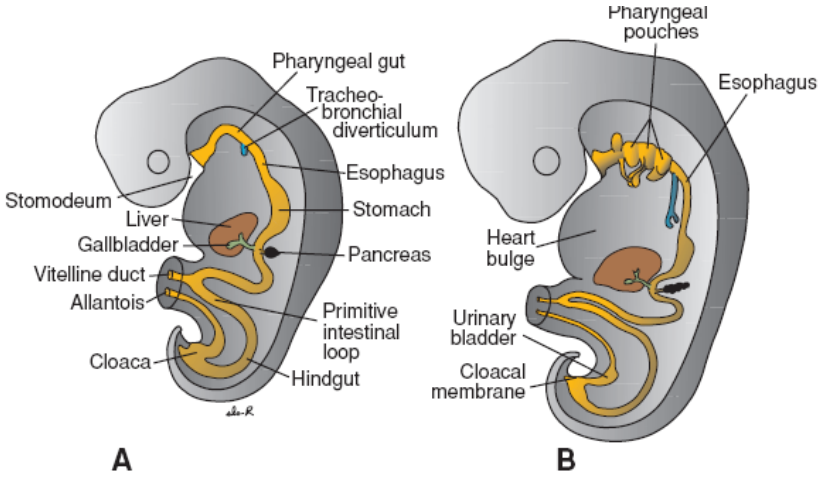


- the respiratory tract maintains some communications with the Laryngopharynx through the Laryngeal orifice (Inlet of the Larynx)

- The Laryngeal Orifice begins as a slit-like opening, then further develops into a T-shape opening, and finally into the laryngeal orifice.

Esophagus

- At first the esophagus is short
- but with descent of the heart and lungs it lengthens rapidly
- The muscular coat, which is formed by surrounding splanchnic mesenchyme, is striated in its upper two-thirds and innervated by the vagus the muscle coat is smooth in the lower third and is innervated by the splanchnic plexus.



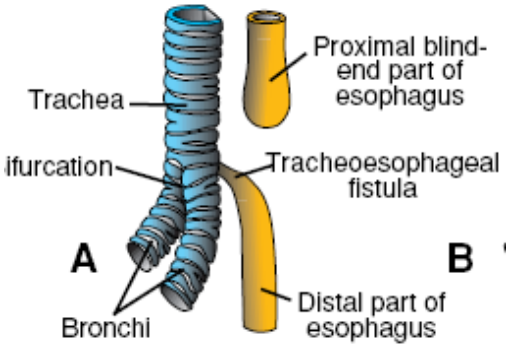
Anomalies of the trachea and esophagus

Tracheoesaphageal fistula (TEF)

- Abnormalities in partitioning of the esophagus and trachea by the tracheoesaphageal septum result in **esophageal atresia** with or without **tracheoesaphageal fistulas**

- These defects occur in approximately in 1/3000 births, and 90% result in the upper portion of the esophagus ending in a blind pouch and the lower segment forming a fistula with the trachea

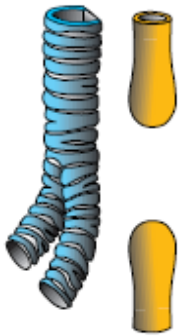
- Predominantly affect male infants



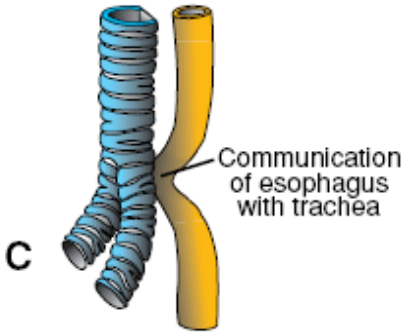
a. Proximal Esophageal Atresia with Tracheoesophageal Fistula (TEF)

Tracheoesaphageal fistula (TEF)

- Isolated esophageal atresia and H-type TEF without esophageal Atresia each account for 4% of these defects.

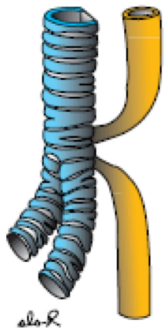


b. DoubleAtresia
: Also known as Isolated Atresia

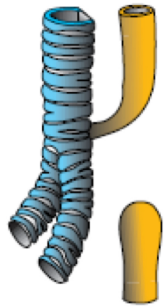


c. H-type Tracheoesophageal Fistula Without Esophageal Atresia

- Other variations each account for approximately 1% of these defects.



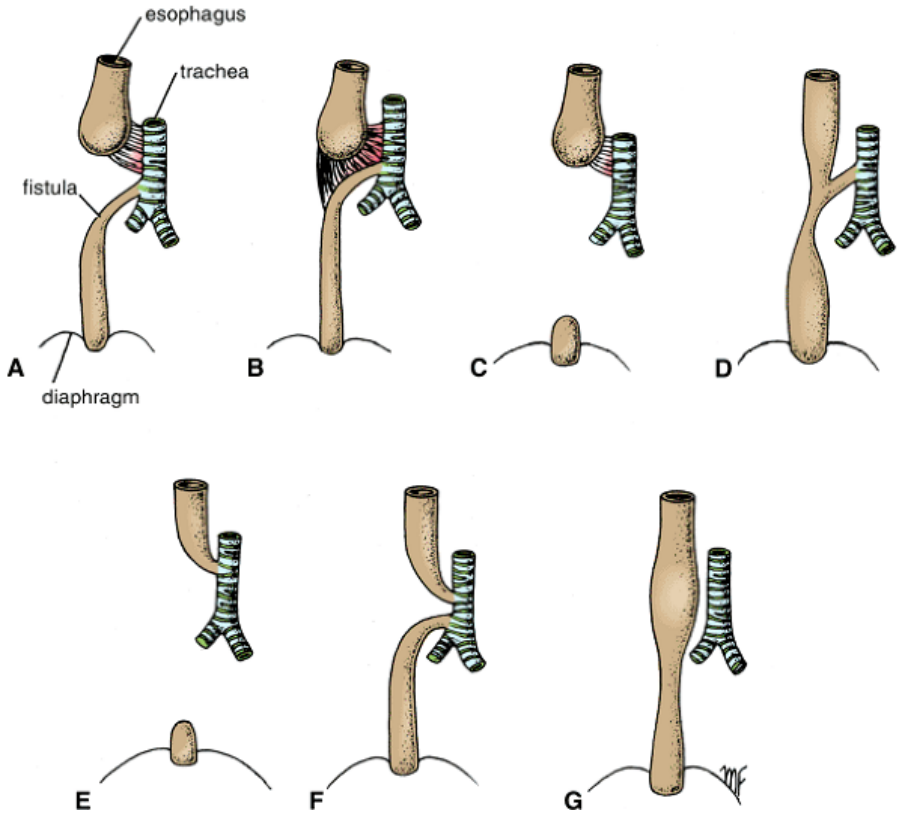
d. Atresia and Double Tracheoesophageal Fistula



e. Distal Esophageal Atresia and Proximal Tracheoesophageal Fistula

Tracheoesaphageal fistula (TEF)

- TEF is the most common anomaly in the lower respiratory tract
- Infants with common type TEF and esophageal atesia cough and choke because of excessive amounts of saliva in the mouth
- When the infant try to swallow milk it rapidly fills the esophageal pouch and is regurgitated
  = ((vomiting))
- A complication of some TEFs is polyhydramnios, since in some types of TEF amniotic fluid does not pass to the stomach and intestines
  - polyhydramnios (extra amniotic fluid before birth) . [oligohydromnos is the opposite world], normally amniotic fluid travel to the oral cavity to GI tract and leave with urine, but fistula impedes this pathway.
- Also, gastric contents and/or amniotic fluid may enter the trachea through a fistula, causing pneumonitis and pneumonia.



- In other cases, air may enter from the lungs into the stomach causing the infant to have a distended abdomen while crying.

Tracheoesaphageal fistula (TEF)

- These abnormalities are associated with other birth defects, including cardiac abnormalities, which occur in 33% of these cases.((The most common Cardiac abnormalities are Atrial Septal defects, Ventricular Septal defects, and Tetralogy of Fallot))

- In this regard TEFs are a component of the **VACTERL** association (**V**ertebral anomalies, **A**nal atresia, **C**ardiac defects, **T**racheoesophageal fistula, **E**sophageal atresia, **R**enal anomalies, and **L**imb defects)

- a collection of defects of unknown causation, but occurring more frequently than predicted by chance alone.

Tracheal atresia and stenosis

- Are uncommon anomalies and usually associated with one of the verities of TEF

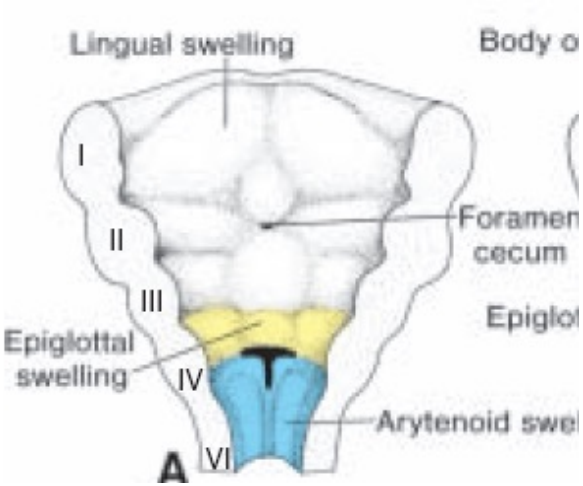
- In some case a web tissue may obstructs the airflow (incomplete tracheal atresia)

Larynx

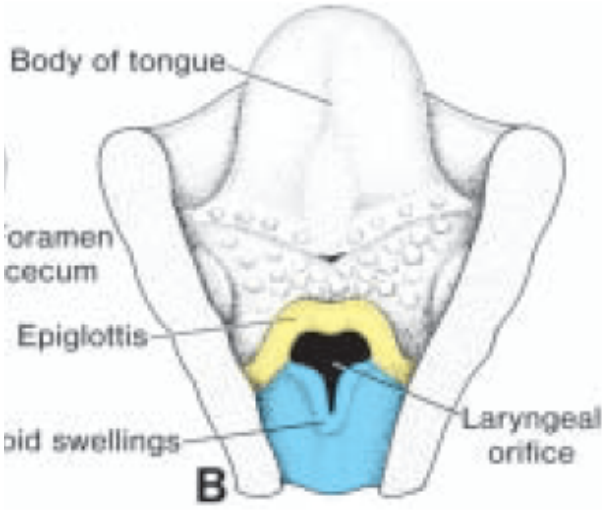
Larynx

- 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



- 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



- At about the time that the cartilages are formed, the laryngeal epithelium also proliferates rapidly resulting in a temporary occlusion of the lumen.

- Subsequently, vacuolization and recanalization produce a pair of lateral recesses, the **laryngeal ventricles** and Saccule

- These recesses are bounded by folds of tissue that differentiate into the **false** and **true vocal cords.**

#Above the ventricle we have the false vocal cord and below it the 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** nerve innervates derivatives of the fourth pharyngeal arch, and the **recurrent laryngeal nerve** innervates derivatives of the sixth pharyngeal arch

- Since all the muscles of the Larynx are derived from the mesenchyme of the fourth and sixth pharyngeal arches (as we stated previously), their innervation is by branches of the tenth cranial nerve, the Vagus Nerve.
- The Superior Laryngeal Nerve (External Laryngeal Nerve) innervates the structures that are derived from the fourth pharyngeal arch and the Recurrent Laryngeal Nerve innervates those derived from the sixth.
- Now we can deduct the reason why all muscles of the Larynx are innervated by the Recurrent Laryngeal Nerve except the Cricothyroid which is innervated by the External Laryngeal Nerve.
- This is due to the fact that the Cricothyroid muscle is derived from the fourth pharyngeal arch and all others are derived from the Sixth.

Anomalies of the larynx

Laryngeal atresia

- Laryngeal atresia is a rare anomaly and cause obstruction of the upper fetal airway
- Also known as **congenital high airway obstruction syndrome (chaos)**
- Distal to the atresia or stenosis the lung are enlarged and capable of producing echoes (echogenic)
- Also the diaphragm is flattened or inverted and fetal ascites and hydrops (accumulation of serous fluid) is present
- Prenatal ultra-sonograpghy permits diagnosis.

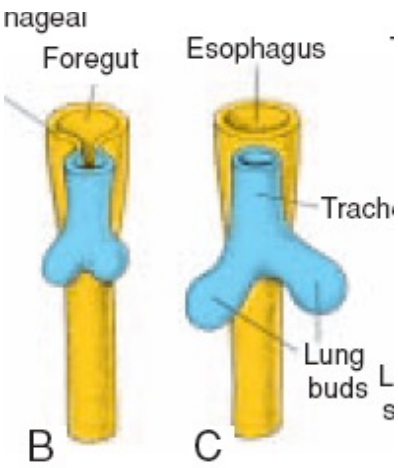
Lungs and Bronchial tree development

Trachea, Bronchi, and Lungs

- During its separation from the foregut, the **lung bud** forms the trachea and two lateral outpocketings, the **bronchial buds**

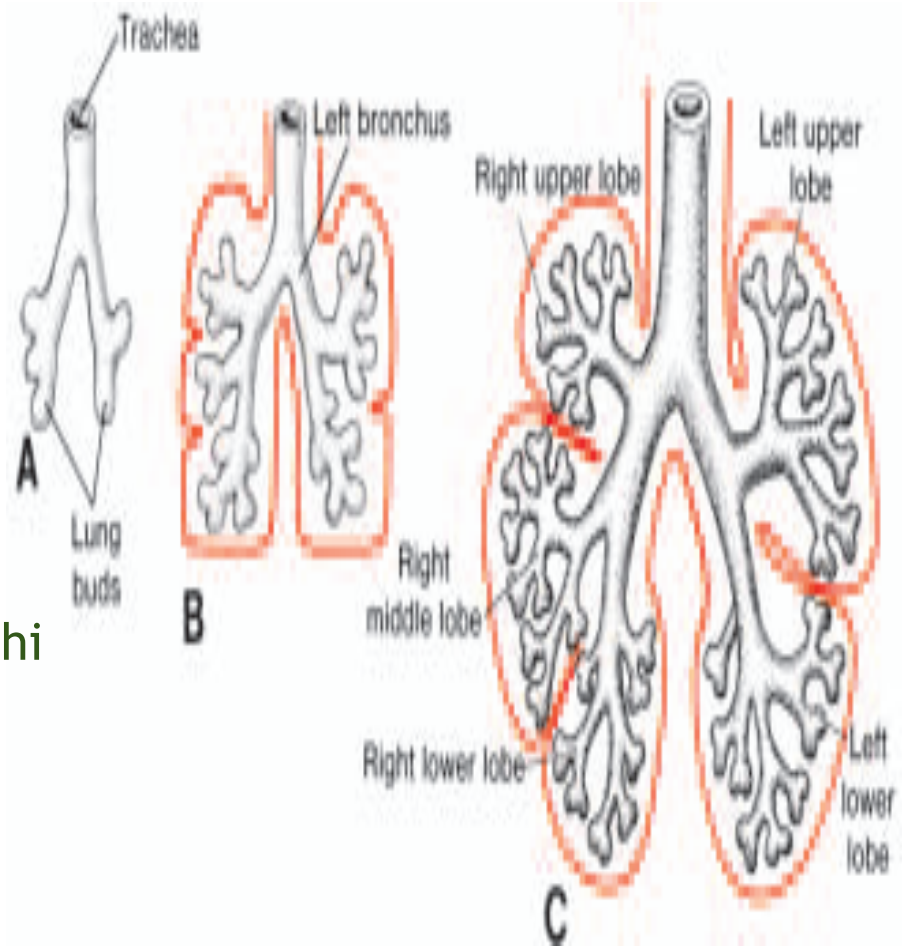
- At the beginning of the fifth week, each of these buds enlarges to form right and left main bronchi

• the lining epithelium is endoderm, the cartilage and muscles come from splanchnic mesenchyme.



Trachea, Bronchi, and Lungs

- The right then forms three secondary bronchi, and the left, two
- thus foreshadowing the three lobes on the right side and two on the left



- They then continue growing into what is known as segmental or tertiary bronchi (10 on the right and 8 on the left).

The bronchial tree
The right and left main bronchi are called the primary bronchi.
The secondary bronchi are called lobar bronchi. So, on the right side there are three lobar bronchi, since the right lung has three lobes (upper, middle and lower lobes), and on the left side there are two lobar bronchi, since the left lung has two lobes (upper and lower lobes).
-The tertiary bronchi are called bronchopulmonary segments. There are 10 bronchopulmonary segments on the right and 10 on the left in posnatal (8 on the left in embryo)

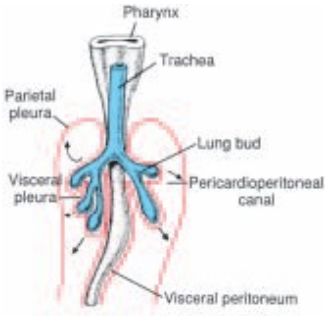
In the right lung:
1-The upper lobe has three bronchopulmonary segments: apical, anterior and posterior.
2-The middle lobe has two segments: medial and lateral.
3-The lower lobe (the base) has five segments: A apicobasal (or apical), medial, lateral, anterior and posterior.

In the left lung in postnatal
1- The upper lobe has 5 bronchopulmonary segments: Apical, anterior, posterior, superior lingual and inferior lingual.
2- The lower lobe (the base) has 5 bronchopulmonary segments; apicobasal (apical), anterior, posterior, medial and lateral.

There is a difference between the number of bronchopulmonary segments in postnatal and in an embryo. The difference is that the embryo has 8 in the left lung instead of 10. After delivery, they become 10 in number. Why is there a difference? In the upper lobe in the embryo, the apical and posterior segments join together as one segment called apicoposterior. After delivery, they are separated to give the apical and posterior segments. In the lower lobe (the base), the anterior segment and the medial segment join together forming one segment, called anteromedial segment. After delivery, they are also separated to give the anterior and medial segments.

Trachea, Bronchi, and Lungs

- With subsequent growth in caudal and lateral directions, the lung buds expand into the body cavity

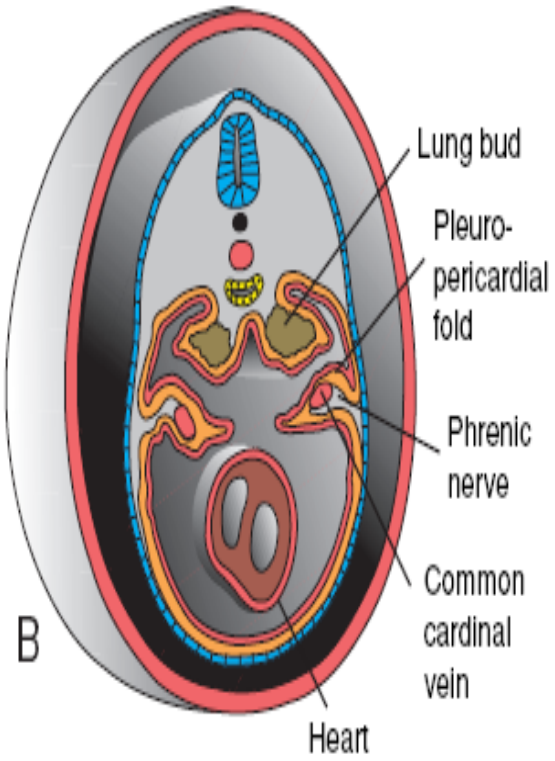


- **The spaces for the lungs, the pericardioperitoneal canals**, are narrow.

- They lie on each side of the foregut

Trachea, Bronchi, and Lungs

- Ultimately the pleuroperitoneal and pleuropericardial folds separate the pericardioperitoneal canals from the peritoneal and pericardial cavities



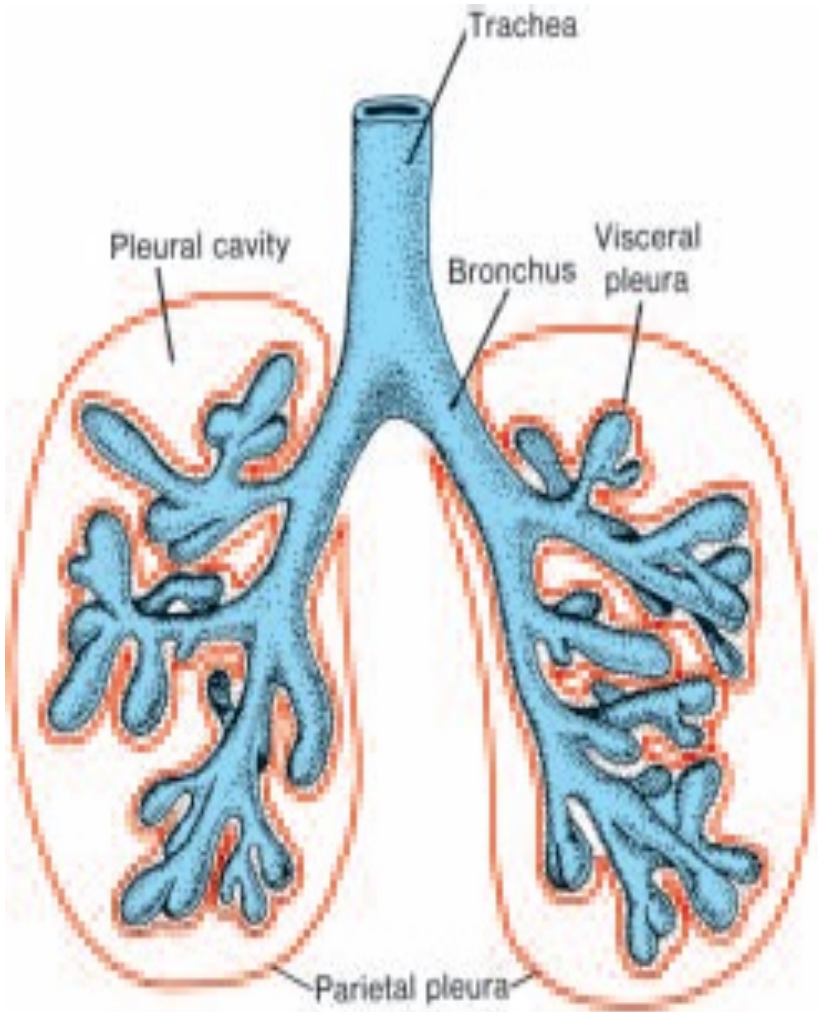
Each one will separate and give :

1. Pericardioperitoneal Cavity:
   - Pericardial Cavity: Surrounds the heart.
   - Peritoneal Cavity: Within the abdominal cavity.

2. Pleuropericardial Cavity
   - Pericardial Cavity:Surrounds the heart.
   - and the remaining space form the prinitive Pleural Cavity: Surrounds each lung within the thoracic cavity.

Trachea, Bronchi, and Lungs

- 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**



Trachea, Bronchi, and Lungs

- During further development, secondary bronchi divide repeatedly in a dichotomous fashion, forming 10 **tertiary (segmental)** bronchi in the right lung and 8 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

- Before the bronchial tree reaches its final shape, however, **an additional 6 divisions form during postnatal life.**

- Thus, as an adult we have a total of 23 generations in the respiratory tract.
- it's essential to note that the development of the respiratory system is largely completed by the age of 10 years old.

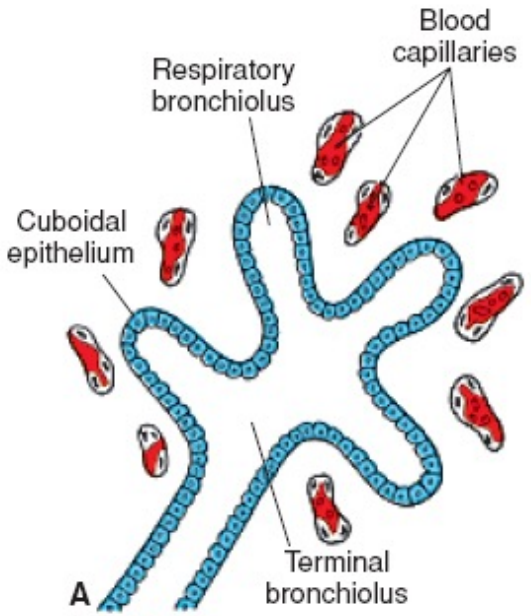
  - Branching is regulated by epithelial-mesenchymal interactions between the endoderm of the lung buds and splanchnic mesoderm that surrounds them

- Signals for branching, which emit fromthe 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

- Up to the seventh prenatal month, the bronchioles divide continuously into more and smaller canals (canalicular phase)
- the vascular supply increases steadily.
- Respiration becomes possible when some of the cells of the cuboidal **respiratory bronchioles** change into thin, flat cells



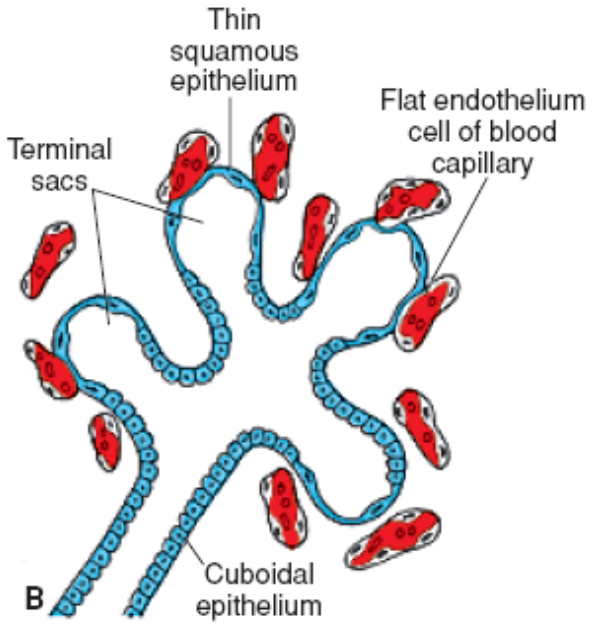
- The epithelium present at this stage is simple cuboidal epithelium.
- may be found clara cells
- The capillaries are far from each other and from the respiratory bronchioles so no formation of respiratory membrane.
- No Respiration in this Stage

Maturation of the Lungs

- These cells are intimately associated with numerous blood and lymph capillaries, and the surrounding spaces are now known as **terminal sacs** or **primitive alveoli**

Alveoli can do gas exchange

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



• This brings us to an important question: Can a baby born at this stage survive?
Yes, because at this stage, simple squamous epithelium would have formed and alveolar capillaries would be present, ((capillaries adhere to these flat cells forming respiratory membrane)) so gas exchange can happen.
Many babies are born at the 7th month of pregnancy, which almost corresponds to this stage of development, and they are able to survive.

Maturation of the Lungs

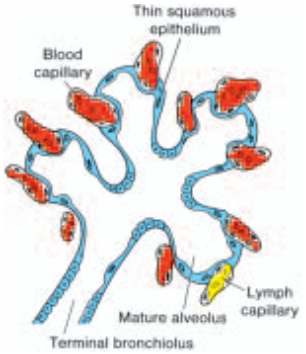
- During the last 2 months of prenatal life and for several years thereafter, the number of terminal sacs increases steadily

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

- 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-.))

At this stage , the alveolar capillaries have established complete contact with the alveoli forming the respiratory membrane "blood-air barrier" with its multiple layers . It is formed by the fusion between the endothelial cells of the capillaries and type I alveolar cells lining the alveolar sacs.



Maturation of the Lungs

TABLE 12.1 Maturation of the Lungs

Pseudoglandular period	5–16 weeks or 6	Branching has continued to form terminal bronchioles. No respiratory bronchioles or alveoli are present. ((But inactive))
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.

Maturation of the Lungs

- In addition to endothelial cells and flat alveolar epithelial cells, another cell type develops 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, and surfactant from the alveolar epithelial cells (type II)

- After birth , the doctor put a tube to suction this fluid from oral cavity and trachea after delivery to clean the airway passage.

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

Maturation of the Lungs

- Fetal **breathing movements** begin before birth and cause aspiration of amniotic fluid
  - Amniotic fluid is important in the stimulation of further lung development
- These movements are important for stimulating lung development and conditioning respiratory muscles
- When respiration begins at birth, most of the lung fluid is rapidly resorbed by the blood and lymph capillaries, and a small amount is probably expelled via the trachea and bronchi during delivery.
- When the fluid is resorbed from alveolar sacs, surfactant remains deposited as a thin phospholipid coat on alveolar cell membranes.
- With air entering alveoli during the first breath, the surfactant coat prevents development of an air-water (blood) interface with high surface tension
- Without the fatty surfactant layer, the alveoli would collapse during expiration (atelectasis).

Maturation of the Lungs

- After birth, the doctor slaps the baby's back or legs to stimulate the skin receptors to send nerve impulses to the respiratory center of the brain → The brain will then respond by sending impulses through the phrenic nerve (motor nerve) to stimulate the diaphragm to contract causing the air to gush through the nose to the lungs → the lungs will now have to inflate to start the inspiration process. At that moment, the baby's first cry is heard.

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

- Although the alveoli increase somewhat in size, growth of the lungs after birth is due primarily to an increase in the number of respiratory bronchioles and alveoli.

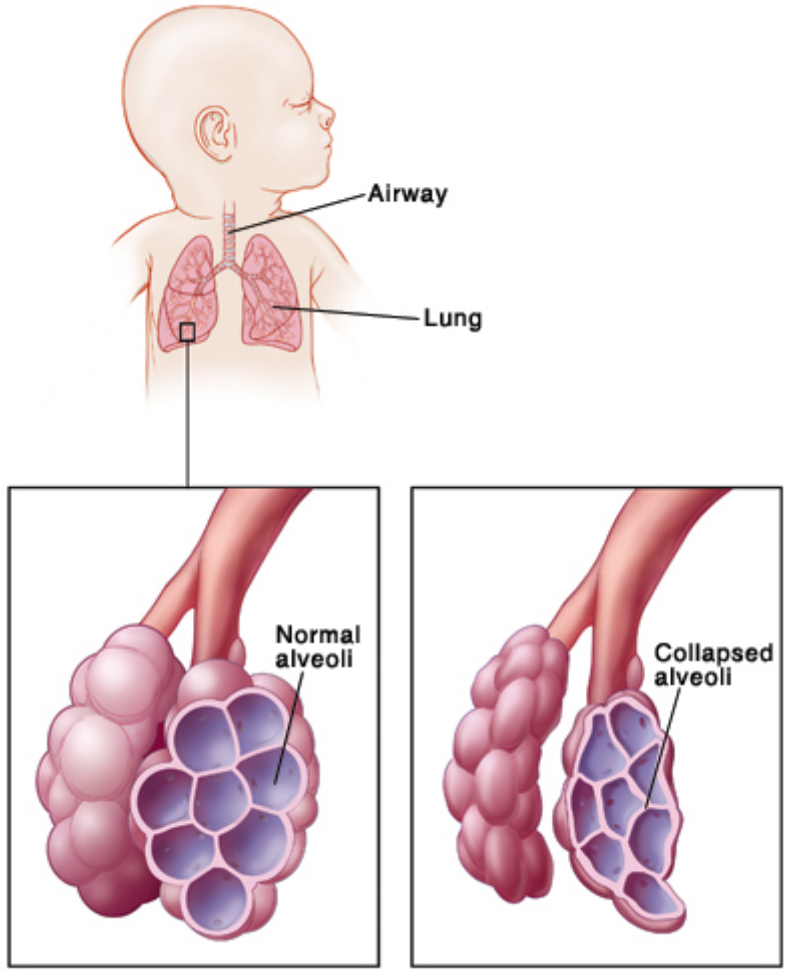
- It is estimated that only one-sixth of the adult number of alveoli are present at birth

- 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

Clinical notes (RDS)

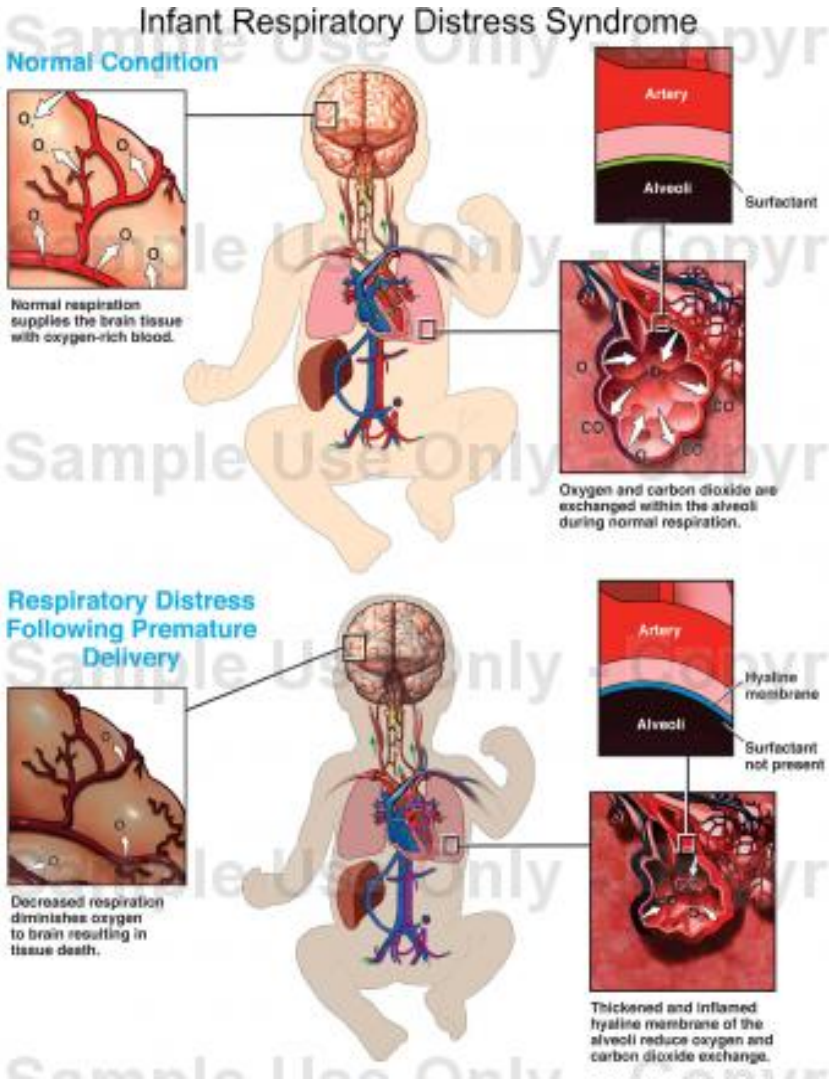
- Surfactant is particularly important for survival of the **premature infant**
- When surfactant is insufficient, the air-water (blood) surface membrane tension becomes high, bringing great risk that alveoli will collapse during expiration.
- As a result, **respiratory distress syndrome** (RDS) develops
- This is a common cause of death in the premature infant (30% of all neonatal diseases)
- In these cases the partially collapsed alveoli contain a fluid with a high protein content, many hyaline membranes, and lamellar bodies, probably derived from the surfactant layer



Clinical notes (RDS)

- 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) to stimulate surfactant production have reduced the mortality associated with RDS
- 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 with the oxygen until the baby can breathe the seventh month).
- Thyroxine is the most important stimulator for surfactants production



Clinical notes (Other Anomalies)

- Although many abnormalities of the lung and bronchial tree have been found (e.g., blind-ending trachea with absence of lungs and agenesis of one lung) most of these gross abnormalities are rare

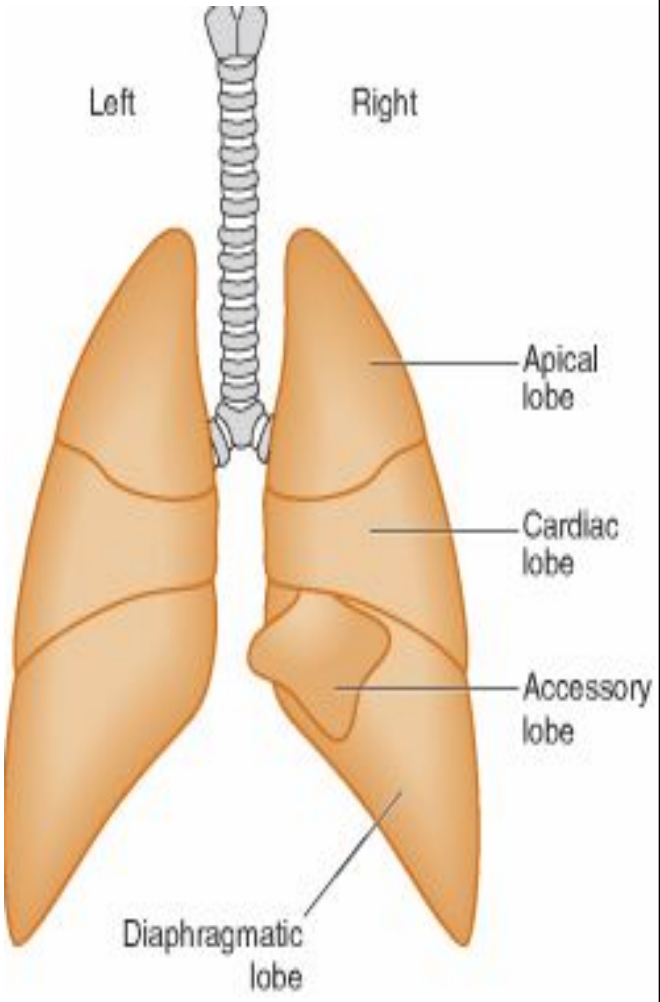
- Abnormal divisions of the bronchial tree are more common; some result in supernumerary lobules.

- These variations of the bronchial tree have little functional significance, but they may cause unexpected difficulties during bronchoscopies.

Clinical notes (Other Anomalies)

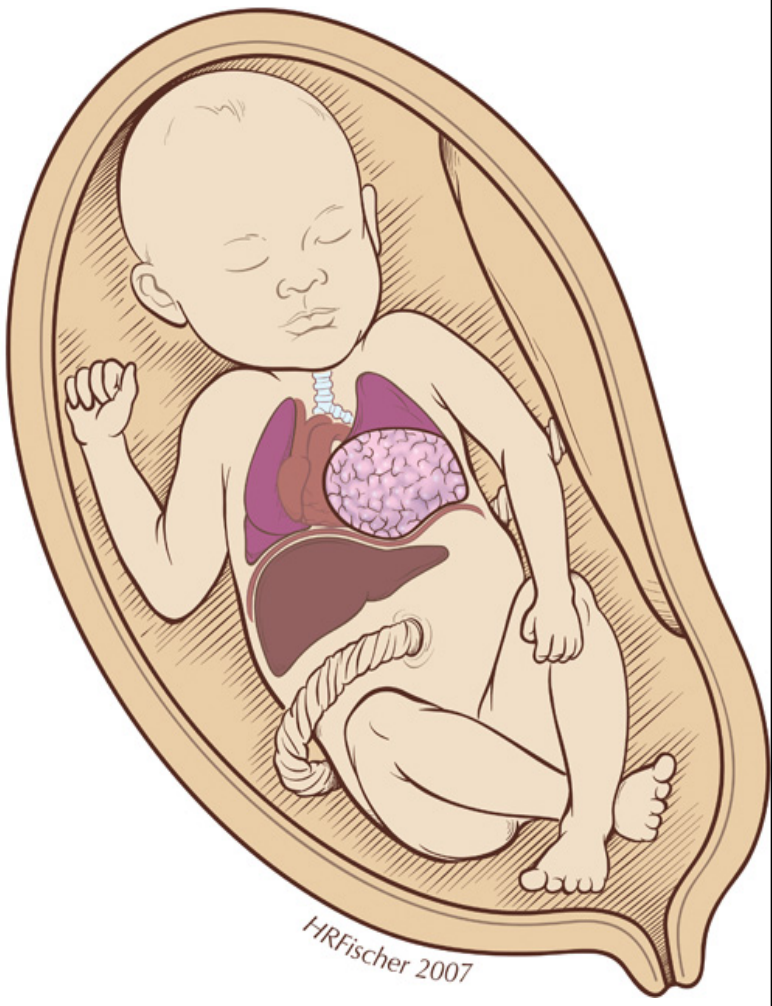
- **ectopic lung lobes** arising from the trachea or esophagus

- It is believed that these lobes are formed fromadditional respiratory buds of the foregut that develop independently of the main respiratory system.



Clinical notes (Other Anomalies)

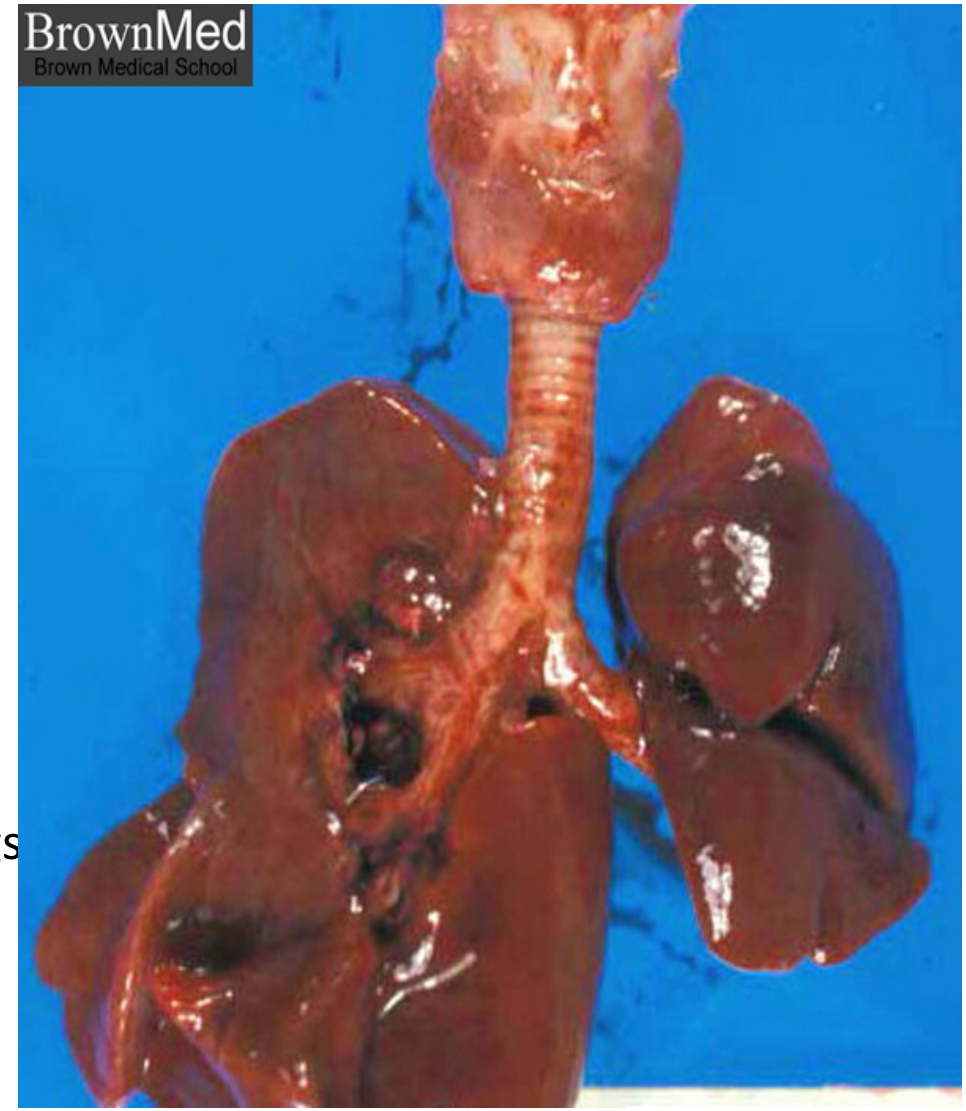
- Most important clinically are **congenital cysts of the lung**
- which are formed by dilation of terminal or larger bronchi
- These cysts may be small and multiple, giving the lung a honeycomb appearance on radiograph
- Or they may be restricted to one or more larger ones
- Cystic structures of the lung usually drain poorly and frequently cause chronic infections



(especially on the left side)

Lung Hypoplasia

- In infants with congenital diaphragmatic hernia (CDH) the lung is unable to develop normally
- Because it is compressed by the abnormally positioned abdominal viscera
- It is characterized by reduced lung volume
- Most infants with CDH die of pulmonary insufficiency as their lungs are too hypoplastic to support life



Oligohydroamnios and lungs

- When oligohydroamnios (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 float in water

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

* Lastly, how can we tell if a newborn died after delivery, or if it was stillborn? We take a sample of the lung tissue and place it in water. If it floats, it means the lungs are healthy and fresh and the baby died after delivery. If it sinks, it means no air was present in the lungs at all and the baby did not take his first breath, so it was stillborn.

Thank you

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