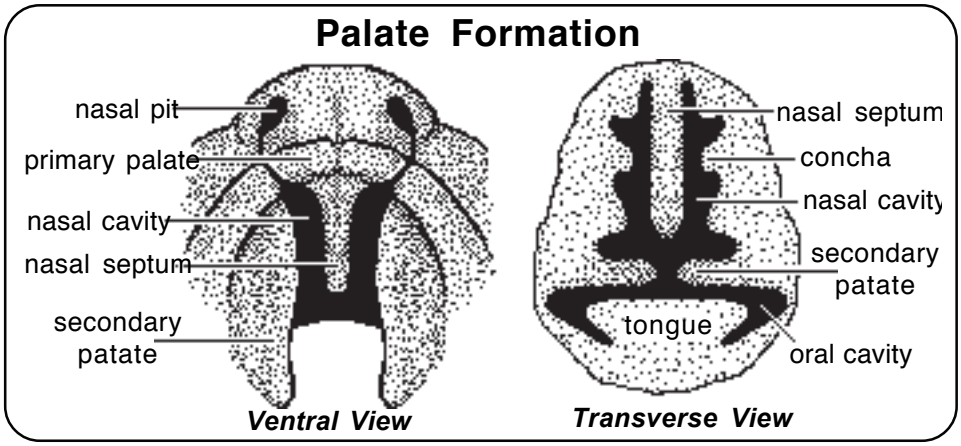
Development of Respiratory System

Mohammad Saiful Islam
Phd (Japan) Postdoc (Australia)
Dept. of Anatomy, Histology & Physiology
Sher-e-Bangla Agricultural University, Dhaka

Epithelium lining the nasal cavity is derived from *ectoderm*; that lining of the rest of the respiratory system comes from *endoderm*.

Summary of Nasal Cavity Development:

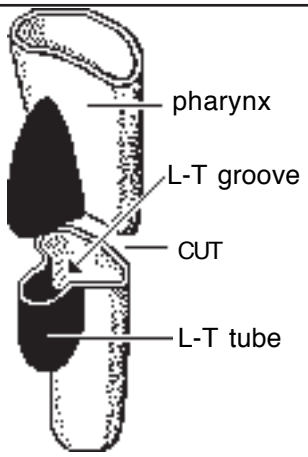
- initially, bilateral *nasal placodes* appear (ectodermal thickenings at the tip of the frontonasal prominence)
- placodes become *nasal pits* by outward growth of the surrounding *medial* and *lateral nasal processes;* continued outgrowth transforms the pits into a *nasal cavity*
- right & left medial nasal processes fuse to form a *primary palate* (incisive bone & upper lip) and a *nasal septum*; lateral nasal processes become nose cartilage and nasal & lacrimal bones
- formation of the *secondary palate* divides the common naso-oral space into three separated cavities (right & left sides of the nasal cavities and the oral cavity); also, the secondary palate divides the pharynx into three compartments (nasopharynx, oropharynx, & laryngopharynx)



- *conchae* (scrolls of thin bone covered by mucosa) arise as cartilaginous ridges from bones of the nasal cavity wall
- *paranasal sinuses* (diverticula of the nasal cavity) develop postnatally.

Larynx, Trachea and Lungs:

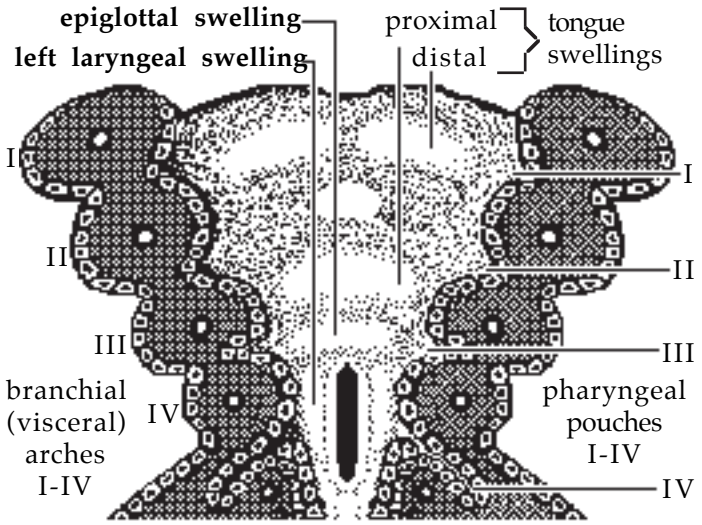
- originate as an evagination of endoderm along the floor of the pharynx, named *laryngotracheal groove*.
- a *tracheoesophageal septum* grows from lateral walls of the laryngotracheal groove and fuses along the midline
- the septum creates a *laryngotracheal tube* (future ***trachea*** & *lung buds*) as a separate entity from the esophagus
- the ***larynx*** develops rostrally, where the lumen of the groove retains communication with the pharynx.



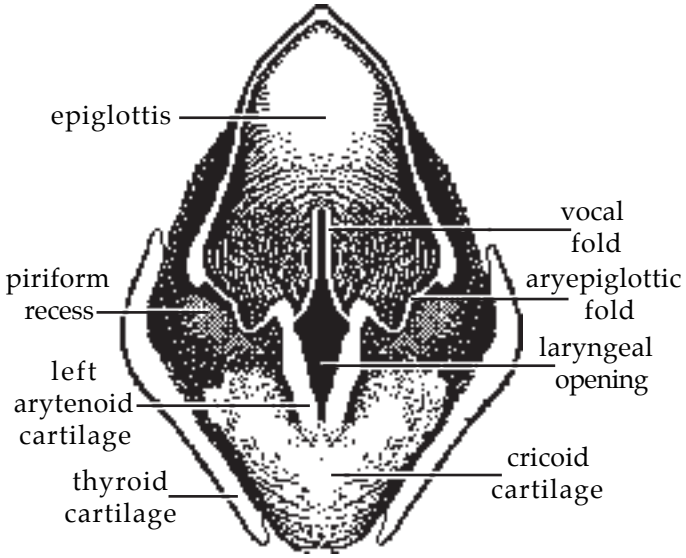
Laryngo-Tracheal Groove (ventral view)

Larynx:

- pharyngeal arch *splanchnic mesoderm* forms bilateral *laryngeal swellings* and a rostral *epiglottal swelling*
- the swellings border the *laryngeal opening* (between the laryngotracheal groove and pharynx)
- growth of the laryngeal swellings that give rise to ***cartilages of the larynx***
- a diverticulum of the lateral laryngeal wall produces a ***lateral ventricle*** & ***vocal fold***, bilaterally (except in cats & cattle which lack these)
- laryngeal muscles are formed from somite myotomes that migrate into pharyngeal arches:
  IV (cricothyroideus m. innervated by the vagus n. cranial branch) and
  VI (other muscles innervated by the vagal recurrent laryngeal n.)



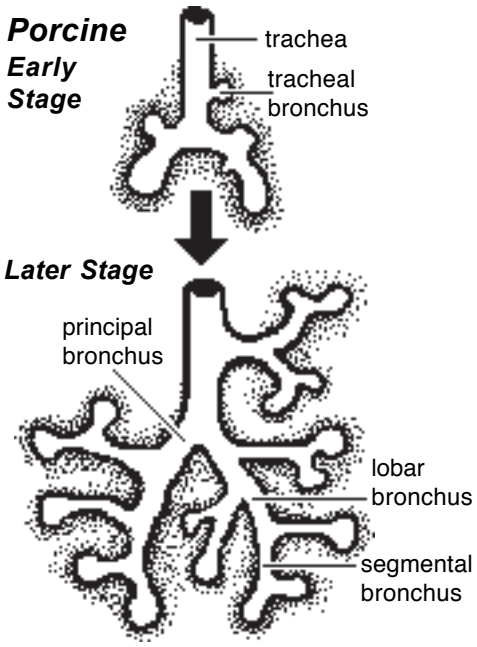
Dorsal View of Floor of Pharynx (roof removed)



Dorsal View of Larynx

Trachea and bronchi:

- the *laryngotracheal tube* grows caudally; elongation shifts bronchi caudally into thoracic splanchnic mesoderm
- splanchnic mesoderm contributes cartilage and connective tissue to the trachea and lungs
- endoderm contributes respiratory epithelium to the trachea and lungs
- the blind, caudal end of the tube develops bi-lobed bronchial buds which grows to form the future ***principal bronchi***
- outgrowths of each principal bronchus form future ***lobar bronchi***, each of which gives rise to outgrowths that become future ***segmental bronchi***, each of which gives rise to more than a dozen additional bronchial branches. The smallest branches are ***bronchioles***. They give rise to lung terminal sacs and ***alveoli***.
- bronchial branchings continue to occur throughout the fetal period and into the postnatal period.



Bronchial Development
(Dorsal View)

NOTE: ***Generally in domestic mammals, the right principal bronchus divides into four lobar bronchi (to cranial, middle, caudal & accessory lobes), while the left gives rise to two lobar bronchi (to cranial & caudal lobes).***

There are right side exceptions: the horse lacks a middle lobe; (humans lack an accessory lobe;) in ruminants and swine the right cranial lobe is supplied by a tracheal bronchus.

Lungs:

• The endoderm-lined bronchial tree grows into splanchnic mesoderm which forms the cartilage, fascia, smooth muscle, and vessels of the lung.

• Continued branching of the bronchial tree results in lung tissue, coated by visceral pleura, occupying more and more of the pleural cavity.

• Initially, as they grow into splanchnic mesoderm, the bronchiole-lung branches are solid cores of cells (growth is like exocrine gland growth into mesoderm). Eventually, terminal branches become hollow, dilated, and sac-like with endoderm becomes a thin epithelium (*terminal sacs*).

• ***Alveoli*** are created by the formation of septae that partition the terminal sacs.

• Some endodermal alveolar cells become cuboidal rather than flat and produce a phospholipid surfactant that reduces surface tension and thus facilitates alveolar expansion (as opposed to alveolar collapse). Fetal lungs contain fluid that facilitates the breathing movements that take place *in utero* to prepare for postnatal respiration. At birth, lung fluid drains or is absorbed as air is breathed.

NOTE: Species differ in degree of lung maturity at birth. Also, within a single lung, distal regions are less mature than proximal ones. Formation of new alveoli occurs post-natally to a considerable extent in all mammals. Subsequently, lung growth is due to hypertrophy (increased size) of alveoli and air passageways.

Alveolar Formation

