The Lung Compartments

- The airways (conducting zones)
- The alveoli (air spaces, respiratory zones)
- The interstitium
LUNG LOBES AND SEGMENTS
LUNG HILUM

- Eparterial bronchus
- Pulmonary artery
- Pulmonary veins

- Hyparterial bronchus
- Pulmonary artery
- Pulmonary veins
Plastic cast of the proximal airways with individual segments distinguished by colour.
Bronchioles are divided into **non-respiratory bronchioles** (all bronchioles proximal to respiratory bronchioles, including terminal bronchioles) and **respiratory bronchioles** (airways with alveoli budding from their walls).
Relationship between airways, pulmonary arteries, pulmonary veins, and lymphatics

- Lung has double arterial supply - pulmonary and bronchial arteries that accompany airways; in general, diameter of airway is similar to that of accompanying pulmonary artery.

- Bronchial arteries provide the lungs with nutrition and oxygenated blood.
Relationship between airways, pulmonary arteries, pulmonary veins, and lymphatics
OVERVIEW OF RESPIRATORY HISTOLOGY
TRACHEA
Tracheal mucosa is closely applied to the anterior cartilaginous portion with scant subepithelial tissue.
TRACHEA
BRONCHUS
BRONCHUS
Bronchioles are generally <3 mm in diameter and lack cartilage and submucosal glands in their walls.
Bronchioles and pulmonary arteries lie alongside each other in the centers of the lung acini, sharing a connective tissue sheath. They lack cartilage, seromucinous glands in their walls.
Bronchioles lack cartilage and seromucinous glands in their walls but have prominent smooth muscle.
EPITHELIUM IN CONDUCTING ZONES
Terminal bronchiole showing non-ciliated Clara cells protruding above the adjacent cilia cuboidal cells.
CLARA CELLS (BRONCHIOLAR EXOCRINE CELLS, CLUB CELLS)

• Produce and secrete glycoaminoglycans (PAS with diastase positive apical surface), lysozymes, tryptase, secretory portion of IgA and surfactant-like substance to protect bronchiolar epithelium and to decrease the surface tension.

• responsible for detoxifying harmful substances inhaled into the lungs (via cytochrome p450 enzymes).

• Reserve cells in bronchioles (proliferate to give rise to both ciliated columnar cells and mucus cells in the bronchioles after injury. In addition, they can proliferate and replenish alveolar epithelial cells-alveolar bronchiolization).
Neuroendocrine (Kultschitsky) cells are found in basal layer of surface epithelium and in the bronchial glands. They are present as single or clusters of cells (neuroepithelial bodies) throughout the airways from main bronchi to terminal bronchioles, especially at bifurcation sites. They have trophic properties with regard to other cells and are involved in:
- growth and development of lungs in utero.
- Regulation of pulmonary regeneration and repair.
- chemoreceptor function (increase in number and degranulate in hypoxic conditions).

Synaptophysin immunostain
NEUROENDOCRINE CELLS

Granules consist of a dense central core separated from an investing membrane by a thin electron-lucent zone. Granules contain: Chromagranin, snaptophysin, calcitonin, human bombesin, neuron specific enolase, leu-encephalin, substance P, ACTH, etc...

Hyperplasia of neuroendocrine cells may be seen in association with pulmonary fibrosis, bronchogenic carcinomas, bronchiectasis, pulmonary arterial disease, infantile bronchopulmonary dysplasia.
The epithelial cells rest on a basement membrane (type IV collagen, laminin, fibronectin): Lamina lucida, lamina densa and lamina reticularis: The latter is thickened (in addition to goblet cell hyperplasia) in asthma and to a lesser extent, a variety of airway diseases.
TRANSITION FROM TERMINAL BRONCHIOLE TO RESPIRATORY BRONCHIOLE
TRANSITION FROM RESPIRATORY BRONCHIOLE TO ALVEOLAR DUCT AND ALVEOLAR SAC
The transition from respiratory columnar epithelium to flattened alveolar lining cells is rather abrupt with a recognized zone of cuboidal non-ciliated cells present, although difficult to identify with consistency in lung sections.
ALVEOLI
Communication between alveoli in adjacent alveolar sacs by the pores of Kohn.
TYPE I ALVEOLAR CELLS

• About 40% of alveolar cells but cover about 95% of alveolar surfaces.

• Organelles of Type 1 alveolar cells clusters around the nuclei such that large areas of cytoplasm virtually free of organelles reducing the thickness of the cell (important for gas exchange).

• They are connected to each other and type II cells by tight junctions, which prevent the leakage of tissue fluid into the alveolar air space.

• Type I alveolar cells are unable to replicate and are susceptible to toxic insults.
TYPE II ALVEOLAR CELLS

- About 60% of alveolar cells but cover only 5% of alveolar surfaces.
- Cuboidal with basally located nucleus as opposed to type I cells.
- Produce and secrete surfactants, which reduce the surface tension in alveoli to permit expansion of the lungs during inspiration and prevents alveolar collapse at low intra-alveolar pressures.
- More resistant to injury compared to type I cells.
- Also called reserve cells as they can proliferate to replace type I and II cells after injury.
- Maintenance of fluid levels by water recapture using active sodium transport (in addition to surfactant) to return excess alveolar surface water to the interstitial fluid.
INTERSTITIUM

• Connective tissue framework of the lung.
• May be divided into three zones for better understanding although they all connect to one another.
  – Central (axial): around the airways and arteries and in the centers of the lobules.
  – Periphery: adjacent to pleura and interlobular septae where it surrounds the veins and lymphatics.
  – Alveolar walls: where these two connective tissue locations are connected by fine ramifications.
INTERSTITIUM
INTERSTITIUM
Pulmonary lobule is bounded by interlobular septa and visceral pleura, which contain pulmonary veins and lymphatics.
ALVEOLAR INTERSTITIUM (WALL)

- dense network of capillaries, each alveolus having approximately 1000 capillary segments.

- On the thin side of alveolar interstitium, there is only endothelial cell cytoplasm, mutual basement membrane and type I cell cytoplasm.

- On the thick side of alveolar interstitium, there are separate basement membranes for alveolar cells and endothelial cells, and all the other intervening elements: collagen and elastin fibers, fibroblasts, myofibroblasts, pericytes, histiocytes, mast cells, scanty nerves and nerve terminals.

- But no lymphatic vessels. Interstitial fluid drains into more abundant connective tissue surrounding the lobules.