Review of Histology/Histopathology and Airway Diseases (Obstructive)

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• Overview
  – Two lectures will follow the structure/function section of the syllabus:
    • Lecture 1 - Histology/histopathology review and Airways disease.
    • Lecture 2 - Interstitial and parenchymal disease, and vascular disease.
Pulmonary Diseases: Structure-Function Correlation I

Goals:
- To review microanatomy/histology of normal lung and compare to pathologic alterations within those elements
- To observe the relationship between structural/morphologic manifestation of diseases to measurable functional parameters using prototypical diseases of the airways
- To describe the pathology, Gross and microscopic, of these pulmonary diseases.
Pulmonary Diseases: Structure-Function Correlation I

- **Cast of Characters**
  - Airways
    - Conducting
    - Respiratory
  - Vessels
    - Arteries, arterioles - pulmonary and bronchial
    - Capillaries
    - Veins/Venules and Lymphatics
  - Pleura - visceral and parietal

- **Airways Conducting Zone**
  - Trachea
  - Bronchi - ciliated and goblet cells, elastic tissue, smooth muscle, glands, cartilage
  - Bronchioles - (1 mm) - No cartilage or bronchial glands, ciliated lining, no goblet cells, smooth muscle

- **Cell types**
  - **CILIATED CELL** - beating of cilia contribute to mucociliary elevator
  - **GOBLET CELL** - Mucus secretion
  - **BASAL CELL** - reserve cell
  - **KULCHITSKY CELL** - neuroendocrine cells.
Squamous metaplasia
Pulmonary Diseases: Structure-Function
Correlation 1

- Airways Respiratory Zone
  - Respiratory bronchiole - lined by ciliated cells and **CLARA CELLS**
  - Alveolar ducts/sacs
    - **Type I cells**
      90% of alveolar surface
    - **Type II cells**

- Cell types
  - **CLARA CELLS** - produce a component of surfactant and are the bronchiolar reserve cell
  - **TYPE I CELLS** - thin lining cell for gas exchange
  - **TYPE II CELLS** - surfactant and alveolar reserve cell
**Pulmonary Diseases: Structure-Function Correlation I**

- **Vessels - Pulmonary**
  - Arteries/arterioles - travel and divide with bronchi and bronchioles
  - Produce capillary bed in alveoli for gas exchange
  - Venules collect capillary blood into lobular septa, forming veins and joining at the hilum.

- **Vessels - Bronchial**
  - Artery from aorta
  - Supplies bronchial tree up to respiratory bronchiole
  - Venous drainage to azygous/hemiazygous
Pulmonary Diseases: Structure-Function
Correlation I

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Pulmonary Diseases: Structure-Function
Correlation 1

• Disease of the acini and interstitium
  1) Replacement of air with fluid, inflammatory cells or cellular debris
  2) Thickening of alveolar walls and interstitium
  3) Destruction of acinar walls
• Disease of the conducting airways
• Disease of the pulmonary vasculature
Pulmonary Diseases: Structure-Function Correlation I

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Pulmonary Diseases: Structure-Function Correlation I

• Disease of the conducting airways
  – Asthma
  – Chronic bronchitis
  – Bronchiectasis
Disease of the conducting airways - Bronchiectasis

- Dilatation of bronchi and bronchioles, usually due to necrosis of wall and obstruction
  - Foreign body
  - Mucoid impaction
  - Cystic fibrosis
  - Immotile cilia
  - Chronic bronchitis and infection

- Gross Pathol. - Dilated bronchi, filled with mucus or pus, lower lobes.

- Microscopic -
  - Can have acute and chronic inflammation
  - Varying degrees of fibrosis
Figure 11.59: Normal cilia (nasal mucosa). Outer and inner dense areas (arrow) are apparent in these cilia. The inner arms are usually blunter and less distinct than outer arms. (× 730,000)
Pulmonary Diseases: Structure-Function Correlation I

• Disease of the conducting airways
  – Asthma
  – Chronic bronchitis
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Disease of the conducting airways - ASTHMA

• Bronchospasm, usually reversible, due to allergic or non-allergic stimuli.
• Anatomic targets - bronchial epithelium and smooth muscle.
• Inflammation
• Obstructive disease

• Gross pathology
  – hyperinflation, severe if status asthmaticus
  – Mucus plugging
• Microscopic
  – Smooth muscle hypertrophy
  – Inflammation, eosinophils
  – Basement membrane thickening
  – edema
Disease of the conducting airways -
ASTHMA

- Gross pathology
  - hyperinflation
  - Mucus plugging
- Microscopic
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Functional significance
- Total lung capacity - increased during attack
- Work of breathing increased due to airway resistance
- Airway resistance increased, on expiration more than inspiration

Pulmonary Diseases: Structure-Function Correlation I

- Disease of the conducting airways
  - Asthma
  - Chronic bronchitis
  - Bronchiectasis
Disease of the conducting airways - 
**Chronic bronchitis**

- Persistent cough with sputum production for 3 months in two 2 consecutive years.
- Smoking
- Repeated infections

- **Gross Pathology:** Brown discolored, mucus filled bronchi.
- **Microscopic:**
  - Bronchial gland hyperplasia
  - Goblet cell metaplasia
  - Chronic inflammation
  - Fibrosis of bronchioles
  - Loss of cilia
**Disease of the conducting airways - Chronic bronchitis**

- **Gross Pathology:** Brown discolored, mucus filled bronchi.
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- **Functional Significance:**
  - Airway resistance, due to mucus, edema and narrowing. **Obstructive disease**
  - Degree of obstruction determines extent of V/Q mismatch
  - Lung capacity normal
  - Right heart failure and pulmonary hypertension can occur
Pulmonary Diseases: Structure-Function Correlation I

• Disease of the acini and interstitium
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From NEJM 2000;343:270
Destruction of acinar walls - Emphysema

- Obstructive disease
- Involves the airway distal to the terminal conducting bronchiole
- Airway wall is damaged, and fibrosis can be present.
- Is classified by pattern/ location of damage within the respiratory acinus

- Centriacinar (Centrilobular)
  - Smoking
  - Damage is to the respiratory bronchiole. When severe disease develops, whole acinus involved.
  - Upper lobes, especially apical portions most affected
- Panacinar (Panlobular)
  - Damage is to the entire acinar unit from respiratory bronchiole to alveolar sac
  - More severe at bases, but is more diffuse than CLE
  - Alpha -1 antitrypsin deficiency
Destruction of acinar walls - Emphysema

• Pathogenesis
  – Protease/Antiprotease hypothesis
    • Imbalance between neutrophil derived elastase and deficiency in anti-elastase activity from alpha-1-antitrypsin
    • Neutrophil elastase is unchecked, causing tissue destruction
    • Smoking causes more rapid evolution of panacinar emphysema.

• Pathogenesis
  – Protease/Antiprotease hypothesis
    • In panacinar emphysema, deficiency in alpha 1 anti-trypsin is a genetic defect
    • In centrilobular emphysema, the interplay of cigarette smoke, acquired deactivation of A1AT activity and activation of a perhaps broader spectrum of proteases may be significant. These may include proteinase 3, cathepsins and metalloproteinases (1,2,9,12)
    • Other inhibitors of protease activity may also play a role – e.g. TIMPs
## Destruction of acinar walls - Emphysema

**CENTRILOBULAR** VS. **PANACINAR**

**CENTRILOBULAR**
- Gross pathology
  - Upper lobe, irregularly dilated airspaces
  - Thin walled and grossly apparent
- Microscopic
  - Dilated spaces, alongside normal alveoli
  - Anthracotic pigment

**PANACINAR**
- Gross Pathology
  - Lower lobe, more uniformly dilated spaces
  - Voluminous lungs
- Microscopic
  - Dilated spaces, uniformly dilated.
Destruction of acinar walls - Emphysema

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**Destruction of acinar walls - Emphysema**

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<th>STRUCTURAL</th>
<th>VS.</th>
<th>FUNCTIONAL</th>
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| - Gross pathology  
  - Upper lobe, irregularly dilated airspaces  
  - Thin walled and grossly apparent  
- Microscopic  
  - Dilated spaces, alongside normal alveoli  
  - Anthracotic pigment | | - Total lung capacity increase  
- Lung compliance increased  
   (elastin destruction)  
- V/Q mismatch mild - airway and capillary destruction  
- Recoil decreased; lose radial traction on airways  
  **Obstructive**; worsens on forced expiration |