RESPIRATORY SYSTEM

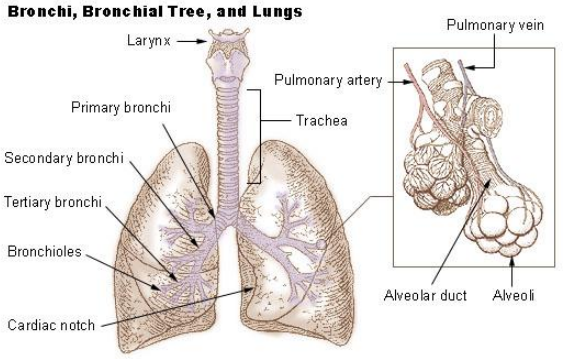
Lec-1

Dr. Muhammad Tariq Javed

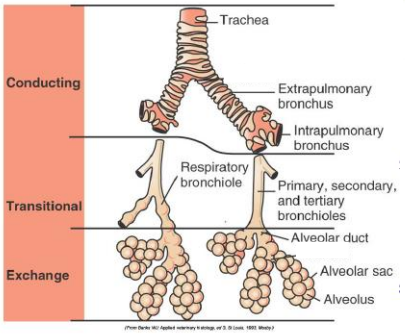
Professor
Department of Pathology,
University of Agriculture, Faisalabad.
Email: mtjaved@uaf.edu.pk
Web: http://www.geocities.ws/mtjaved

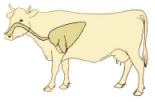
1

HISTO-PHYSIOLOGY



HISTO-PHYSIOLOGY



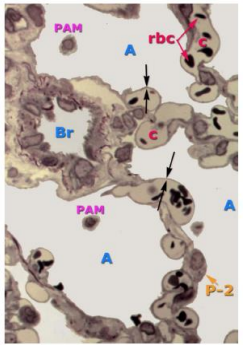


- **Conducting System:** Nasal Cavity, sinuses, larynx, trachea and Bronhi. Lined by Ciliated epithelium and goblet cells
- **Transitional System:** Bronchioles lined by non-ciliated cells, Clara cells and a few ciliated cells.
- **Exchange System:** Alveoli lined by Type 1 (membranous) and Type 2 Pneumocytes

HISTO-PHYSIOLOGY

- Alter the **pH** of blood by facilitating elimination of CO_2 and H_2O
- Filter out small **blood clots** formed in veins
- Filter out gas **micro-bubbles** occurring in the venous blood
- Influence concentration of some biologic substances and **drugs**
- **Convert angiotensin I** to angiotensin **II** by the action of angiotensin-converting enzyme
- May serve as a layer of soft, **shock-absorbent** protection for the heart,
- **Immunoglobulin-A** is secreted in the bronchial secretion
- Maintain sterility by producing **mucus** containing antimicrobial compounds.
- **Ciliary** escalator

HISTO-PHYSIOLOGY



Lung: Plastic Embedded section 1u Thick
(Br) terminary Broncheole is round, some Cells lining are **clara** cells

(A) Alveolus: Most of Alveolar Surface is lined by Type 1 pneumocytes,
Few clumps of Surfactant producing **Type 2** pneumocytes And some pulmonary alveolar Macrophages
(PAM) --- Dust cells

Alveolar walls are thin (black arrows)

Blood Air Barrier: endothelium, basement Membrane and type 1 pneumocytes
(C) capillaries; **(rbc)** red blood cells

5

HISTO-PHYSIOLOGY

- **Type 1 pneumocytes** (membranous pneumocytes)
  - gas exchange
  - squamous epithelial cells; large, thin, scale-like cells
  - cover 95% of the alveolar surface
  - Only half as numerous as Type 2 pneumocytes

6

HISTO-PHYSIOLOGY

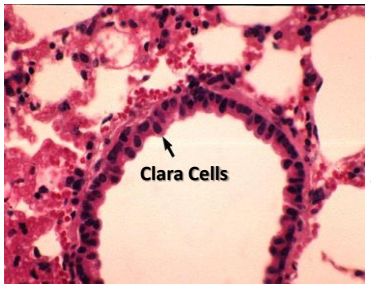
- **Type 2 pneumocytes**
  - can proliferate and differentiate into type 1 pneumocytes
  - secrete **pulmonary surfactant (PS),**
    - consists 80-90% of **phospholipids**
      - Phosphatidyl choline (PC),
      - Phosphatidyl glycerol (PG),
      - Phosphadityl inositol (PI)
    - 5-10% of surfactant proteins
      - (SP-**A**, SP-**B**, SP-**C**, SP-**D**).
  - PS reduce alveolar surface tension.

7

- A third cell type, the **brush cell**, rarely found in alveoli of various species of animals, its function is unknown

8

HISTO-PHYSIOLOGY



Clara cells: dome-shaped cells with short microvilli found in bronchioles. may secrete glycosaminoglycans to protect the bronchiole lining.

9

HISTO-PHYSIOLOGY

- Removal of agents/particles.
  - Particles of 1-2 µm mostly deposit at the broncho-alveolar junction.
  - Bigger particles are trapped in the upper respiratory passages.
- Warms and humidifies the air.

10

DEFENSE MECHANISM OF RESPIRATORY SYSTEM

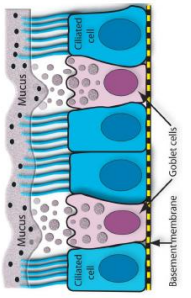
Non-Specific
- Air Turbulence
- Mucus Trapping
- Mucociliary Clearance
- Phagocytosis
- Coughing
- Sneezing

Specific
- Antibodies
- Cell Mediated Immunity
- Secretions
- Phagocytosis

Under Normal Conditions,
- Toxicants are detoxified,
- Toxins are Neutralized,
- Particles are trapped and removed
- Microorganisms are trapped, destroyed and removed

11

- **Clearing Mechanism/Spreading Factor**
  - Mucociliary transport
    - Ciliary movement – 1000 beats / min
    - Propel mucus at the rate of 10 mm / min
  - Swallowing
    - Tuberculosis spread in the body
    - Helminthes eggs and larvae also spread
  - Ig A, E and G
    - Virus neutralization
    - Aggregation of macromolecules / antigens
    - Inhibition of bacterial colonization
    - IgG acts as opsonin



12

- **Clearing Mechanism/Spreading Factor**
  - Interferon, lysozyme and lactoferrin
    - **Interferon** – antiviral
    - **lysozyme** and **lactoferrin** – antibacterial
    - Lactoferrin, lysozyme, **complement** and **SOD** is high in alveolar liquid
    - SOD – prevents free radical injury
    - ROS: bactericidal
  - Systemic cellular and humoral response – inflammation
  - Sneezing, coughing, bronchoconstriction

13

- **Clearing Mechanism/Spreading Factor**
  - Alveolar macrophages
    - Inactivate and sequester pathogens / substances
    - Macrophages move towards the bronchioles and onto the mucociliary blanket
    - They also move to the regional lymph nodes
  - Particles reach the interstitium by endocytosis across the alveolar type 1 epithelial cells
  - Particles move in lymph and phagocytosed by interstitial macrophages – local lymph nodes

14

Breaches in Defence

Viruses inhibit the pulmonary Defense Mechanisms and predispose lungs to Secondary Bacterial Pneumonia

Other Factors Impair Pulmonary Defense

- Stress
- Dehydration
- Uremia
- Lung Oedema
- Immunodeficiency
- Ammonia, etc.

15

ROUTES OF RESPIRATORY INSULTS

- Aerogenous Insults
  - Nasal passages and upper air ways
    - irritants (large),
    - highly soluble gasses
    - Infectious agents
  - Distal airways
    - Fine particles
    - Weakly soluble gasses
    - Infectious agents

16

ROUTES OF RESPIRATORY INSULTS

- **Haematogenous Insults**
  - Alveolar septa and pulmonary interstitium
  - Toxins / infectious agents
- **Traumatic**
  - Mechanical

17

ALVEOLAR RESPONSE TO INJURY

- Necrosis of type 1 cells and sloughing — Exudative phase (inflammation)
- Within **24 hours** type 2 cells begins to proliferate
  - Small clusters of alveolar cells — **in 2 or 3 days**
  - By **6 days – may** be complete lining of alveoli by type 2 cells
  - During this phase it is usual to see atypical cells with increased nuclear and cytoplasmic volumes, abnormal shape and increased basophilia
- Proliferation of type 2 cells — exudative to proliferative stage of pneumonia
  - alveolar exudate composed of macrophages and other mononuclear cells
- Transformation of cells from type 2 to type 1 takes place

18

ALVEOLAR RESPONSE TO INJURY

- The character of alveolar exudate
  - **Serous fluid** containing various quantities of fibrin,
  - **Neutrophil** phase – predominates in most bacterial infections
  - Accumulation of alveolar **macrophages**
- Amount of **fibrin** in alveolar exudates – amount of damage to alveolar capillary
- Prominence of fibrin in acute alveolar injury in cattle
  - High fibrinogen content of bovine blood
  - Low plasminogen (a precursor of a major fibrinolytic enzyme)
  - High plasmin inhibitor in pulmonary tissue
- Alveolar macrophages — from the interstitial compartment in inflammation — from blood monocytes

19

ALVEOLAR RESPONSE TO INJURY

- Once the inflammatory process supervene — **macrophages**
  - are important chemo-attractant and stimulate **neutrophils** and **lymphocytes**
  - they have enhanced phagocytic and bactericidal activity
  - release lysosomal hydrolases and enhance **firbinolysis** by activation of **plasminogen**
  - but are also involved in **pulmonary fibrosis**
- In acute inflammation – inflammatory fluid and leukocytes accumulate
  - in the interstitium and alveoli

20