Lecture Outline: Respiratory System
Hole's HAP [Chapter 19]

I. Introduction

Respiration is the process of exchanging gases between the atmosphere and body cells.

Respiration consists of:

Ventilation –

External Respiration –

Transport –

Internal Respiration –

Cellular Respiration –

II. Organization

1. Conducting division

2. Respiratory division

III. Functions

1. Gas exchange
2. Conducting passageway
3. Protection of respiratory surfaces
4. Sound production
5. Sense of olfaction

IV. Components

1. Upper respiratory system
   - nose, nasal cavity, paranasal sinuses, pharynx

2. Lower respiratory system
   - larynx, trachea, primary bronchi, lungs

   A. Nose and nasal cavity
      Nose –

      External nares –

      Vestibule – space within flexible area, coarse hairs

      Nasal septum – perpendicular plate of ethmoid and vomer

      Nasal conchae – superior, middle, inferior
         meatuses –

      Hard palate –

      Soft palate –

      Olfactory region – extends from superior nasal conchae

      Internal nares – nasal cavity opens into nasopharynx

   B. Sinuses

   C. Pharynx
      1. Nasopharynx –

      2. Oropharynx –

      3. Laryngopharynx –

D. Larynx –

Cartilages

1. Thyroid – shield, hyaline cartilage

2. Cricoid – hyaline cartilage

3. Epiglottis –

4. Three pairs of smaller cartilages:
   - arytenoid
   -
   - cuneiform

Vocal cords

Vestibular folds
- false vocal cords

-

Vocal folds
- true vocal cords

-

-

E. Trachea

Length is about 11 cm, open tube

Histology

Mucosa –

Submucosa –

Cartilages –

Heimlich maneuver – abdominal thrusts

Tracheostomy –

F. Bronchi

Trachea bifurcates into 2 primary bronchi

Primary bronchi

Right primary bronchus – larger in diameter, more vertical

Left primary bronchus

Branching

Primary bronchi → (intrapulmonary bronchi) secondary

bronchi → _____ → bronchioles →

_____

G. Alveoli

Approximately 300 million total

Sacs composed of 2 cell types:

- Simple squamous epithelium (_____)
- Septal cells (_____) →

Macrophages

Capillaries surrounding alveoli:

RV → pulmonary arteries → capillaries

→ _____ → LA

H. Lungs –

1. Location:

2. Characteristics:

Apex – superior end

Base – concave inferior end, rests on diaphragm

Hilus –

Cardiac notch – indentation on left lung

3. Lobes – supplied by lobar bronchi

   Right lung –

   Left lung –

4. Pleural membranes (serous)

   Parietal pleura

   Visceral pleura

      Pleurisy –

      Pneumothorax –

      Hemothroax –

V. Respiratory Mucosa

1. Respiratory epithelium
   PSCCE with Goblet cells –

   Stratified Squamous –

   PSCCE –

   Cuboidal cells with cilia –

2. Lamina propria –

3. Respiratory defense system
   - mucus escalator – cilia beat upward

   - filtration – traps particles in mucus

   - alveolar macrophages –

VI. Breathing Mechanism

Breathing is the movement of air from outside the body into the bronchial tree and alveoli

- air movements of inspiration and expiration

- changes in the size of the thoracic cavity due to _____

Lungs at rest have an internal pressure equal to the outside pressure of the thorax

1. Inspiration
   - intra-alveolar pressure decreases to about _____ as the thoracic cavity enlarges

   - atmospheric pressure forces air in the airways

   - shape of thorax changes by contraction of sternocleidomastoid and pectoralis minor muscles

2. Expiration
   - due to elastic recoil of the lung tissues and abdominal organs

   - maximal expiration is due to contraction of abdominal muscles and intercostal muscles

3. Boyle's law

   Inverse relationship between _____ and _____

   Pressure and airflow – air flows from high to low pressure

   Diaphragm flattens as it contracts

   During inhalation:

   → increase volume of thoracic cavity

   →

Pressure changes

Atmospheric pressure (1 atm) = 760 mmHg

	Inhalation	Exhalation
Intra-alveolar pressure		
Intra pleural pressure		

4. Respiratory Cycle
   = inhalation + exhalation

   Tidal Volume – amount of air inhaled or exhaled

   _____ ml at rest

   Eupnea –

5. Respiratory muscles
   Inspiration – diaphragm, external intercostals

   Expiration – passive process

   Hyperpnea –

   Inspiration – scalenes + same as above

   Expiration – internal intercostals and abdominal muscles

6. Respiratory rate
   Adults

   Children

7. Respiratory Volumes
   A. Resting tidal volume =

   B. Expiratory reserve volume =

   C. Residual volume =

   D. Inspiratory reserve volume

   E. Vital capacity

8. Alveolar ventilation
   Minute ventilation – tidal volume multiplied by breathing rate

   -

   Alveolar ventilation rate – major factor affecting concentrations of oxygen and carbon dioxide in the alveoli

   -

   - tidal volume minus physiologic dead space then multiplied by breathing rate

9. Nonrespiratory air movements
   Coughing

   Sneezing

   Laughing

   Crying

   Hiccuping

   Yawning

   Speech

VII. Control of Respiration

1. Respiratory centers in medulla oblongata

   - respiratory rhythmicity center = controls basic rhythm of respiration

2. Pontine respiratory group – formally called _____ and

   _____ centers in Pons

   Apneustic center – lower pons
   - increases inspiration =

   Pneumotaxic center – superior pons
   - coordinates transition between inspiration and expiration

   -

3. Respiratory reflexes –

   A. Chemoreceptors – sensitive to _____, _____, and _____ in blood

   - stimulate respiratory centers →

   Central chemoreceptors – located in medulla oblongata

   - sensitive to _____ and _____ changes in CSF

   Peripheral chemoreceptors in carotid and aortic bodies

   B. Baroreceptors
   - carotid and aortic sinus detect stretching in vessel walls and blood pressure is adjusted

   -

   Hering-Breuer reflex
   - stretch receptors in lungs prevent over-inflation

   -

   - inhibitory impulses to respiratory center in medulla oblongata →

Factors affecting breathing

- decreased blood oxygen concentration stimulates peripheral chemoreceptors in the carotid and aortic bodies

- motor impulses travel from the respiratory center to the diaphragm and external intercostal muscles

-
-

- inhibitory impulses from receptors to respiratory center prevent over-inflation of lungs

VIII. Alveoli

- gas exchanges between the air and blood occur within the alveoli

Alveolar pores =

1. Respiratory membrane
   2 cell layer thickness

   Simple squamous epithelium –

   Endothelium –

   RDS – Respiratory Distress syndrome = not enough surfactant produced

2. Diffusion through respiratory membrane
   - gases are exchanged because of differences in _____

   A. Dalton's law and partial pressure
      - pressure exerted by a particular gas in a mixture of gases is directly related to the concentration of that gas in the mixture and to the total pressure of the mixture

Atmospheric pressure –

760 mmHg =

Partial pressure of individual gas = % of that gas in atmosphere times total pressure of system

Ex. pO_2

B. External respiration

- pCO_2 is greater in capillary surrounding alveoli than in alveoli

-

- CO_2 diffuses from blood →

- O_2 diffuses from alveoli →

C. Internal Respiration

- pCO_2 is greater in tissues & tissue fluid than in capillaries → CO_2 diffuses to blood

- O_2 diffuses into tissues

3. Oxygen Transport

- Most oxygen binds to hemoglobin to form oxyhemoglobin

- Oxyhemoglobin releases oxygen in the regions of body cells

- Much oxygen is still bound to hemoglobin in the venous blood

A. Oxygen

Hemoglobin (Hb) bound = 98.5%

Oxygen dissolved in plasma = 1.5%

B. Oxygen Release

Amount of oxygen released from oxyhemoglobin increases as:

- partial pressure of carbon dioxide increases
- the blood pH decreases
- blood temperature increases

Each Hb can carry 4 molecules of O2

If all Hb carry 4 molecules, then _____ saturated.

If Hb average 2 molecules, then _____ saturated.

Factors that affect oxygen dissociation curve:

1) pO_2

2) pH - ____acid environment (____pH)
   → O_2 dissociates more readily from Hb

3) Temperature - ____temperature → ____ O_2 released from Hb

4) fetal Hb - binds more O_2 than adult Hb

4. Carbon Dioxide Transport

- dissolved in plasma

- combined with hemoglobin

- in the form of bicarbonate ions

A. Dissolved in plasma: _____

B. Combines with globin part of Hb: _____

- called carbaminohemoglobin

$CO_2 + Hb \leftrightarrow Hb\ CO_2$

C. Most transported as bicarbonate ions: _____

$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H+ + HCO_3^-$

5. Chloride Shift
   - bicarbonate ions diffuse out of RBCs

   -

   -

   When blood reaches lungs, all reactions are reversed:

   Cl^- moves out of RBC;

   HCO_3^- moves into RBC;

   H_2CO_3 forms $\leftrightarrow$ $CO_2 + H_2O$

   CO_2 diffuses into alveoli

Life-Span Changes

Clinical Applications