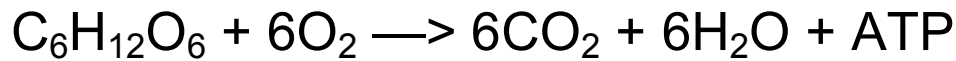


# RESPIRATORY SYSTEM

## Respiration

1. cellular respiration:



2. breathing - transportation of gases

a. inhaled air into blood into tissue

b. tissue into blood into exhaled air

3. diffusion of gasses requires:

a. thin walled structures

b. moist surfaces

c. rich blood supply

**Upper respiratory tract** - outside the thorax:

a. nose & nasal cavity

b. nasal & paranasal sinuses

c. larynx & pharynx

**Lower respiratory tract** - within the thorax:

a. trachea

b. bronchi, bronchial tree

c. lungs, pleural cavity

## Nose / Nasal cavity

1. Anterior opening - nostril (bone: external nares)
2. Alar cartilages support nostril (vestibule)
3. Nasal septum
  - a. divides nasal cavity into R&L halves
  - b. anterior septum formed by hyaline cartilage
  - c. posterior septum = vomer, ethmoid bones
4. Lateral walls have 3 pairs of turbinate bones
  - a. superior, middle, & inferior conchae
  - b. air-space beneath each concha = meatus
  - c. superior, middle, and inferior meati
  - d. meati exit through internal nares to nasopharynx
5. Lateral walls have 2 openings:
  - a. nasolacrimal ducts: carry tears from lacrimal sacs
  - b. paranasal sinuses drain via paranasal ducts
  - c. both ducts lined with a mucous membrane
6. Warms & humidifies incoming air

## **Epithelia of the nasal cavity**

1. nasal vestibules lined with
  - a. sebaceous and sweat glands - lubrication
  - b. coarse hairs help filter inspired air
2. middle/upper conchae covered with olfactory epithelium
3. inferior conchae covered with respiratory epithelium

## **Respiratory epithelium?**

1. mucous membrane (mucous cells, vascular)
2. pseudostratified **ciliated** columnar epithelium
3. cilia sweep particles (trapped in mucous) to throat

## **Pharynx** - common passage for resp./dig. systems

### **1. Nasopharynx** -

- a. space above soft palate, posterior to nasal cavity
- b. auditory tubes connect nasopharynx with middle ear
- c. pharyngeal tonsil (adenoids) on posterior wall
- d. soft palate = "valve" between nasal cavity & pharynx

### **2. Oropharynx** -

- a. space below soft palate, above hyoid
- b. palatine tonsils located in lateral walls
- c. lingual tonsils located at base of tongue

### **3. Laryngopharynx** - (voice box)

- a. space between hyoid and glottis

## **Larynx** (voice box)

1. large cylinder - reinforced with cartilage
2. suspended below Hyoid bone
3. surrounds and protects the glottis + trachea
4. vocal folds (cords) vibrate to produce sound
5. epiglottis - (see below)

**Laryngitis:** infection/inflammation of the larynx

## **Laryngeal cartilages** (modified tracheal rings)

1. thyroid (Adam's apple) - large, shield-shaped
2. cricoid - medium-sized, ring-shaped
3. arytenoid (2) - post. anchor for vocal ligaments (cords)
4. corniculate (2) - post. anchor for vestibular ligaments
5. cuneiform (2) - stabilize epiglottis from below
6. epiglottal cartilage...

## **Epiglottis**

1. plate-like sheet of elastic cartilage (rigid)
2. hinged: folds over to cover the glottis
3. "valve" that diverts food to esophagus (protect airway)

**Laryngeal ligaments:** two of note:

1. vestibular lig.s + vestibular folds = "false vocal cords"
2. vocal lig.s + vocal folds = "vocal cords"
  - a. space btw. vocal folds = glottis (entrance to airway)
  - b. male cords = 15mm; female cords = 10mm
  - c. tension & spacing of cords = sound pitch & volume

## **Trachea** (windpipe)

1. tough, flexible tube, connecting larynx to lungs
2. reinforced by 18-20 tracheal cartilages
  - a. 'C'-shaped hyaline cartilages
  - b. connected in series by annular ligaments
  - c. trachealis muscle spans 'gap' along back of trachea
3. trachea is lined with respiratory mucosa
4. trachea divides to form R&L primary bronchi
  - a. bifurcation @ T<sub>5</sub>
  - b. last tracheal cartilage has a unique shape
  - c. carina: interior 'keel' @ last ring - ridge btw. bronchi

**Bronchitis:** infection/inflammation of the bronchi/bronchioles

**Tracheotomy:** cutting an opening into the tracheal wall

**Tracheostomy:**

- surgical opening in trachea to allow passage of air

## Morphological changes along bronchial tree

1. tracheal rings break into 'plates' @ 2° bronchi
2. epithelium: pseudostratified > squamous
3. ciliated epithelium changes to non-ciliated epithelium  
i.e. = macrophages (not cilia) must remove debris
4. smooth muscle increasingly common > 2° bronchi
  - a. bronchodilation (increase dia.) - Sym. ANS
  - b. bronchoconstriction (decrease dia.) - Psym. ANS

## Bronchial tree

1. trachea divides into R&L primary bronchi
  - a. R+L 1° bronchi pass into R+L lungs
  - b. Right bronchus is longer, better aligned with trachea
2. primary bronchi split to form secondary (lobar) bronchi  
- right side has 3 bronchi, Left side has 2 bronchi
3. 2° bronchi split to form tertiary (3° = segmental) bronchi  
- located within their own *bronchopulmonary segment*
4. 3° bronchi split into bronchioles
  - a. bronchioles branch into respiratory bronchioles
  - b. respiratory bronchioles terminate in several alveoli
5. alveolus - site of gas exchange
  - a. blind pocket, lined with simple squamous epithelium
  - b. alveolar wall is very thin = *respiratory membrane*
  - c. vascular, to facilitate O<sub>2</sub> pickup & dump CO<sub>2</sub>
  - d. elastic fibers in alveolus push air out of segment
  - e. septal cells (in alveolus) produce surfactant  
- reduces surface tension - keeps alveoli 'open'

## **Infant respiratory distress syndrome**

- a. premature babies don't produce enough surfactant
- b. alveolar walls stick together = alveolar collapse
- c. insufficient respiratory surface > blue baby

## **Emphysema: destruction of alveoli**

- loss of SA for gas exchange - shortness of breath

## **Pulmonary embolism: blood clot in lungs**

- clot blocks pulmonary blood vessels... necrosis?

## **Lungs**

1. cone-shaped
2. base rests on the diaphragm
3. apex extends above clavicles
4. root:
  - a. primary bronchus
  - b. pulmonary blood vessels and nerves
  - c. bound by CT as they leave mediastinum
5. hilus: point of entry for the root into the lung tissue
6. lobes:
  - a. right lung: superior, middle & inferior lobes
  - b. left lung: superior & inferior lobes

## **Pleural cavities**

1. = subdivisions of thoracic cavity
2. mediastinum (central partition)
  - a. heart, aorta, vena cavae
  - b. trachea, root of lung
  - c. esophagus, thymus gland
  - d. phrenic and vagus nerves
3. visceral pleura - serous membrane covering lung
4. parietal pleura - serous membrane lining pleural cavity
5. pleural cavity:
  - a. "potential space"
  - b. contents = serous fluid
6. serous fluid "holds" visceral & parietal pleurae together

## **Pneumothorax: "air in the thorax"**

1. air enters pleural cavity
2. serous fluid fails to maintain pleural contact
3. lungs collapse
4. "**Sucking wounds**": elastic nature of tissue turns lung into a dense lump that draws air thru open wound.

## **Pleural adhesions**

1. damage to either visceral & parietal pleurae  
(pneumonia, viruses, tumors, broken ribs, etc.)
2. tissue healing process confuses visc. & par. layers
3. pleural adhesions form between visc. & par. layers
4. painful during deep breaths, body movements

## Major events in inspiration

1. diaphragm contracts (phrenic nerve)
  - a. flattens = increases volume of the thorax
  - b. compresses abdominal contents (guts)
2. forced inspiration? several muscles raise rib cage:  
*external intercostal, sternocleidomastoid, serratus anterior, pectoralis minor*
3. pressure decreases in lungs (vacuum)
4. air is pulled into lungs

## Major events in expiration

1. normal expiration is passive
  - a. elasticity of thoracic wall
  - b. elasticity of alveoli & bronchial tree
  - c. rebound of abdominal contents lifts diaphragm
2. forced expiration
  - a. abdominal wall muscles compress gut...
  - b. Internal intercostal muscles compress rib cage
  - c. decreased thoracic volume = air is forced out of lungs

## Control of breathing

1. respiratory centers in pons + medulla oblongata
2. mechanoreceptors: lung volume + blood pressure
3. chemoreceptors: CO<sub>2</sub> & O<sub>2</sub> & blood pH
4. protective reflexes:  
cough: response to injury to respiratory tract