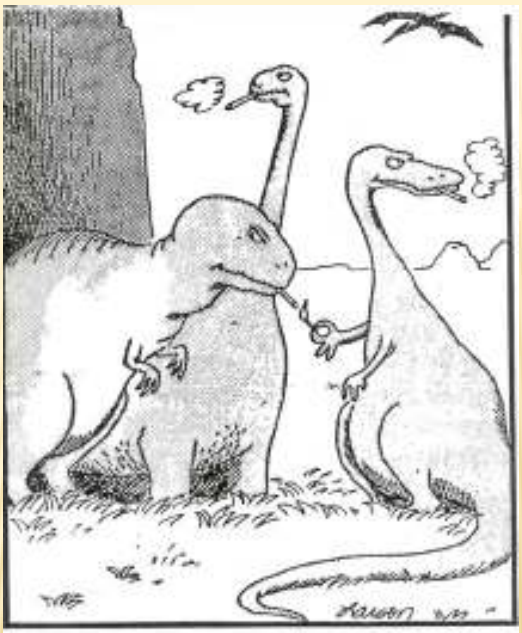
Unit 9

Respiratory System



The real reason dinosaurs became extinct.

HUMAN RESPIRATION

- Works together with the circulatory system
- Exchange of gases between atmosphere, blood, and cells
- If respiratory system and/or circulatory system fails, death will occur
- Cells need O_2 for work; release CO_2 as a waste product
- Accumulation of excess CO_2 is toxic to cells and MUST be removed

HUMAN RESPIRATION

Respiratory System

- Intakes oxygen
- Releases carbon dioxide waste

Circulatory system

- Transports gases in blood between lungs and cells

RESPIRATORY STRUCTURES AND ORGANS

- Nose – made of cartilage and bone and is designed to warm, moisten, and filter air as it comes into the system
- Pharynx – (throat) conducts food and air; exchanges air with Eustachian tube to equalize pressure

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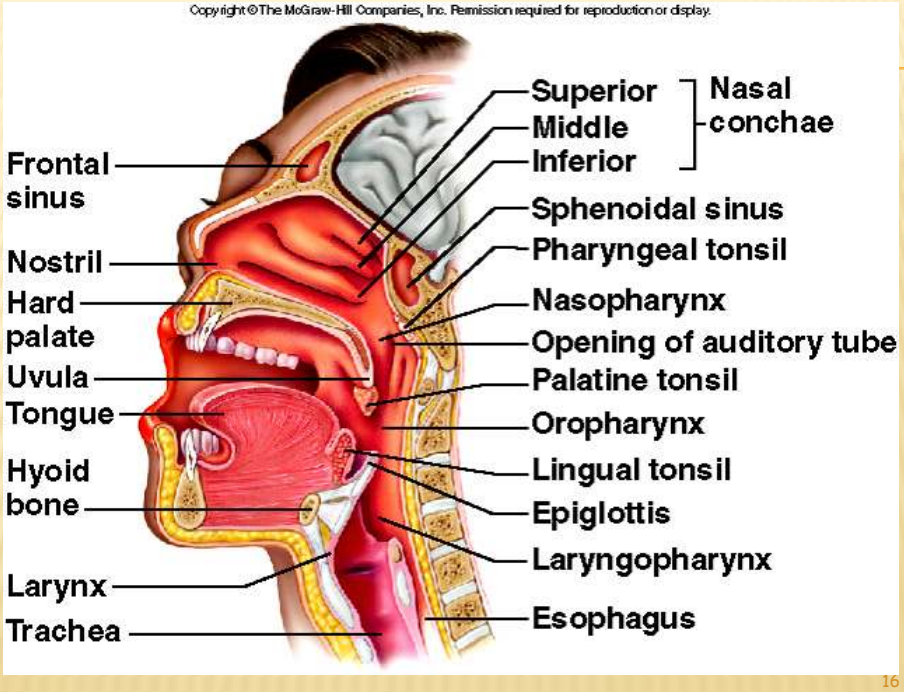

RESPIRATORY STRUCTURES AND ORGANS

- Larynx – (voice box) connects the pharynx and the trachea; made of cartilage; contains vocal cords
- Epiglottis – flap of tissue that covers trachea; ensures food travels down the esophagus

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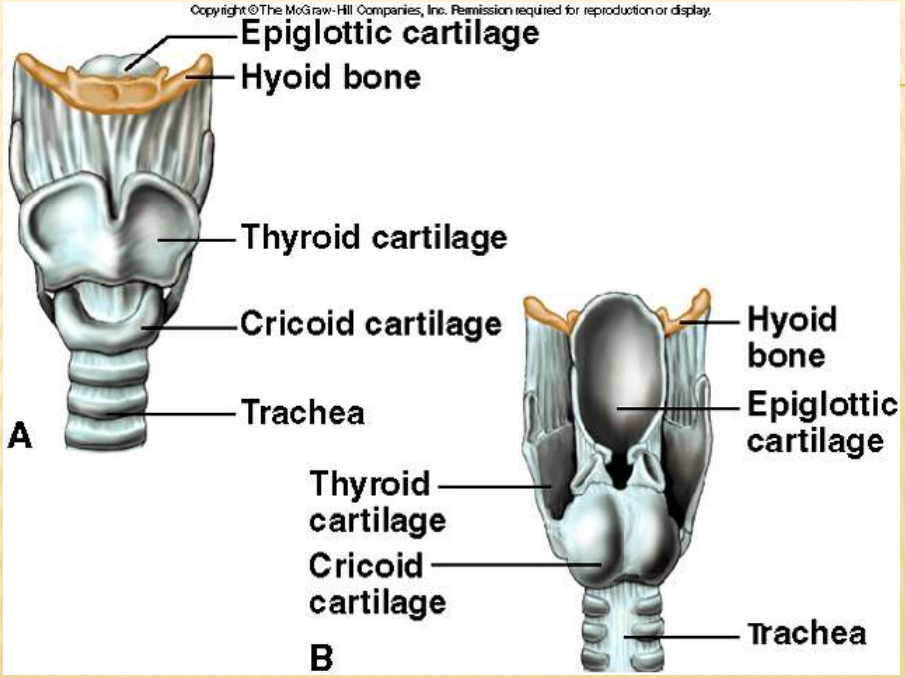


FIG. 16.05A

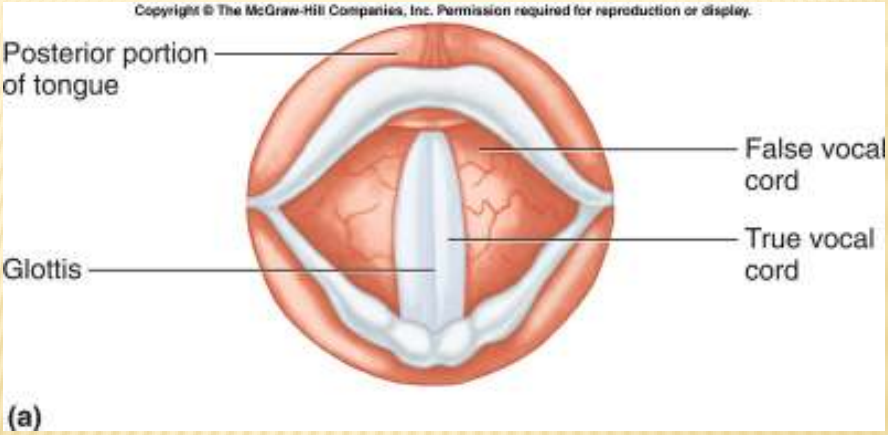
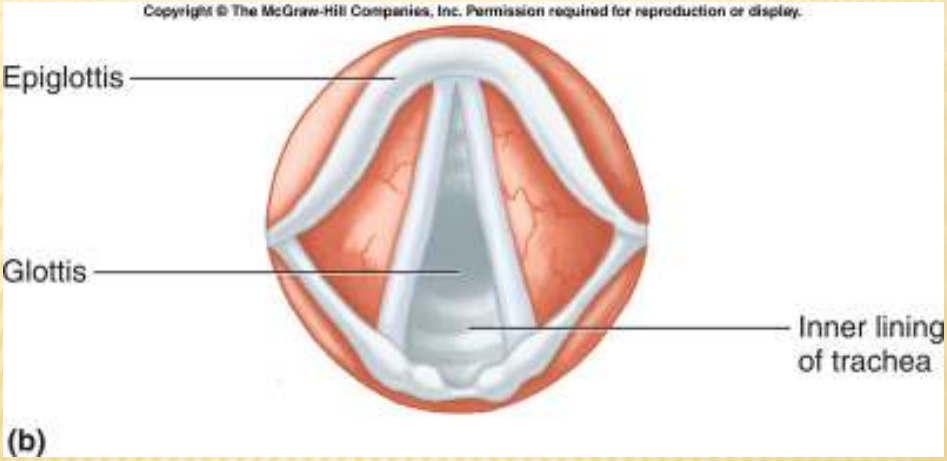


FIG. 16.05B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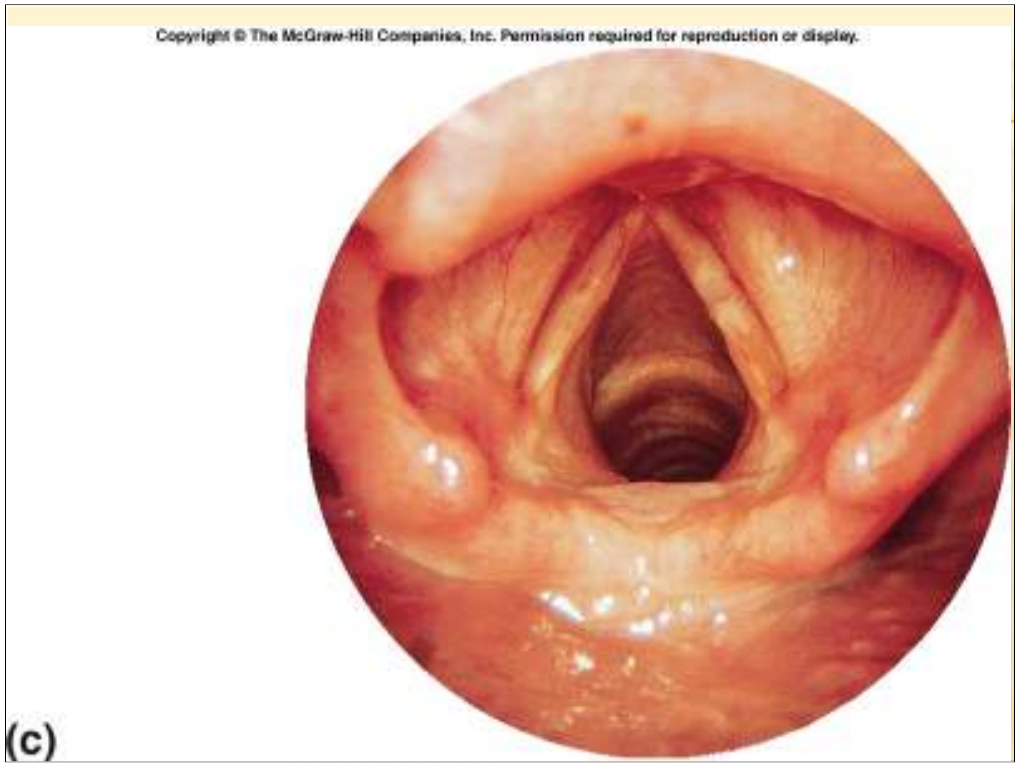
Epiglottis
Glottis
Inner lining of trachea
(b)



(c)

RESPIRATORY STRUCTURES AND ORGANS

- Trachea – (windpipe) tubular passage way for air; carries air to the lungs, C-shaped cartilage rings, divides at end
- Bronchi – pair of tubes that branch from trachea and enter lungs; have cartilage plates; lining is ciliated & secretes mucus

RESPIRATORY STRUCTURES AND ORGANS

- Bronchioles – tiny tubes lacking cartilage and cilia; possess smooth muscle
  - **Autonomic nervous system regulates diameter of bronchioles**
  - **Sympathetic division dilates bronchioles**
  - **Parasympathetic division constricts bronchioles**

RESPIRATORY STRUCTURES AND ORGANS

- Alveoli – cup shaped structures at the end of the bronchioles that resemble bunches of grapes; are in direct contact with capillaries (gas exchange); covered with SURFACTANT that keep them from collapsing.

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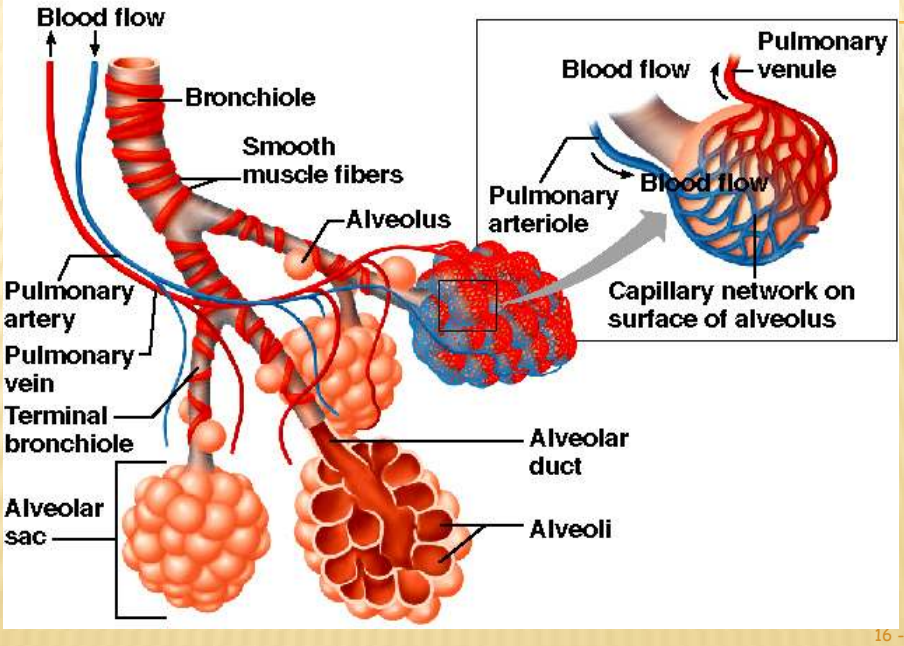
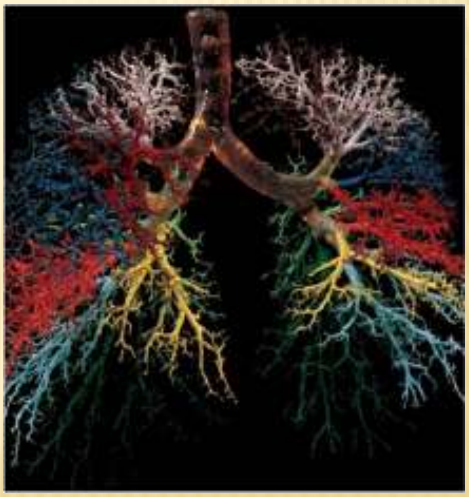


Branches of the Bronchial Tree

- The successive divisions of the branches from the trachea to the alveoli are:

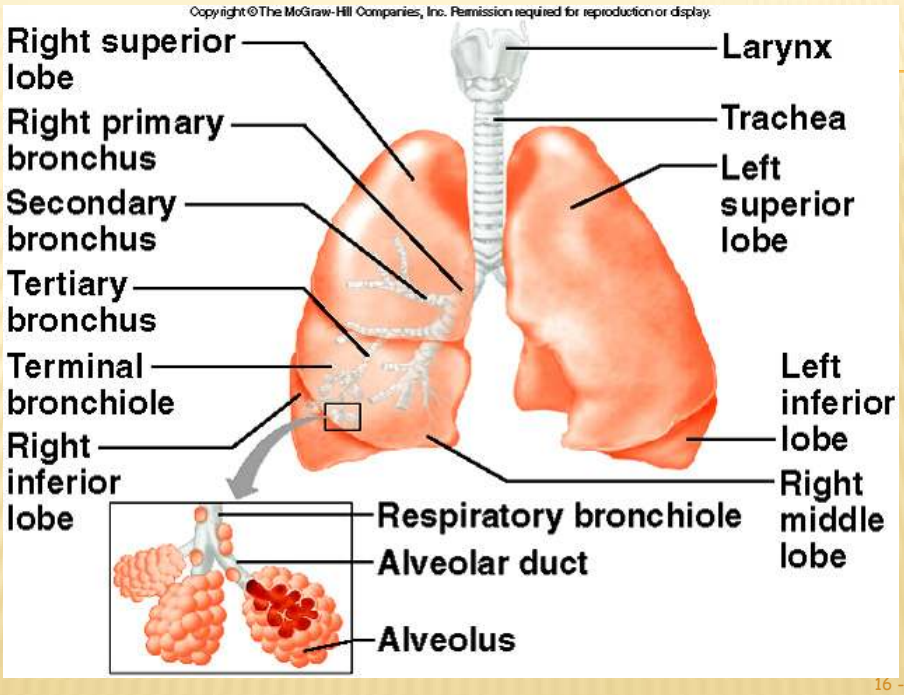
1. Right and left primary bronchi
2. Secondary or lobar bronchi
3. Tertiary or segmental bronchi
4. Intralobular bronchioles (12-14 generations)
5. Terminal bronchioles
6. Respiratory bronchioles
7. Alveolar ducts
8. Alveolar sacs
9. Alveoli



16

THE LUNGS

- Lungs – paired, cone-shaped organs that are surrounded by a pleural membrane, made of elastic tissue, and divided into lobes

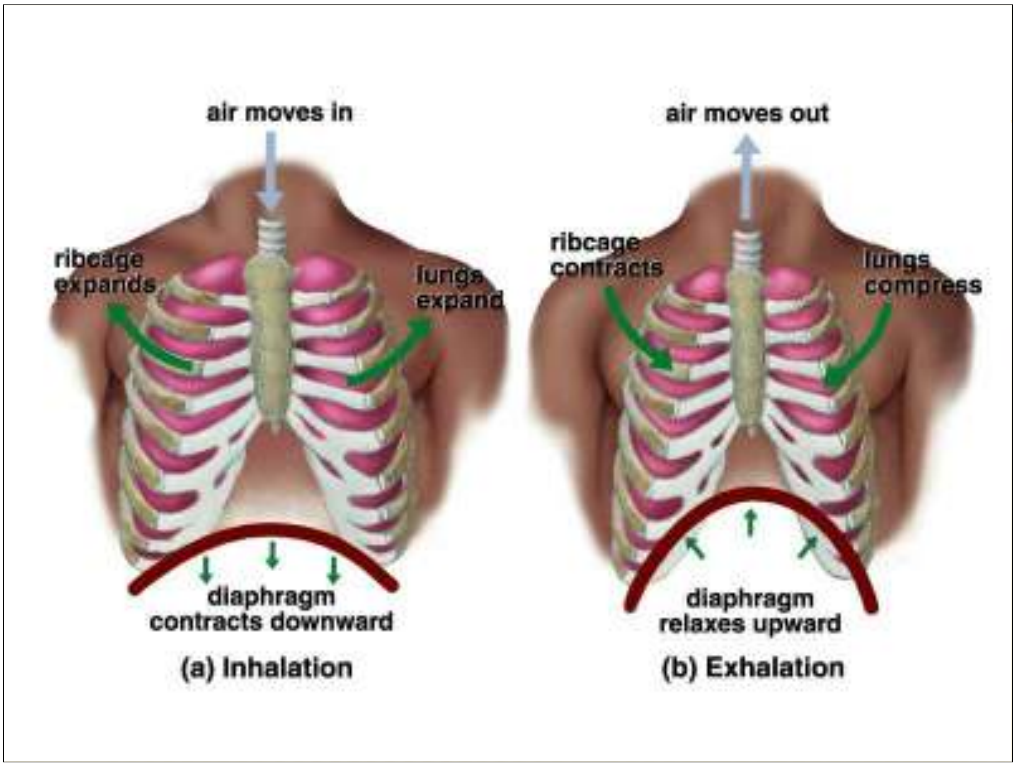


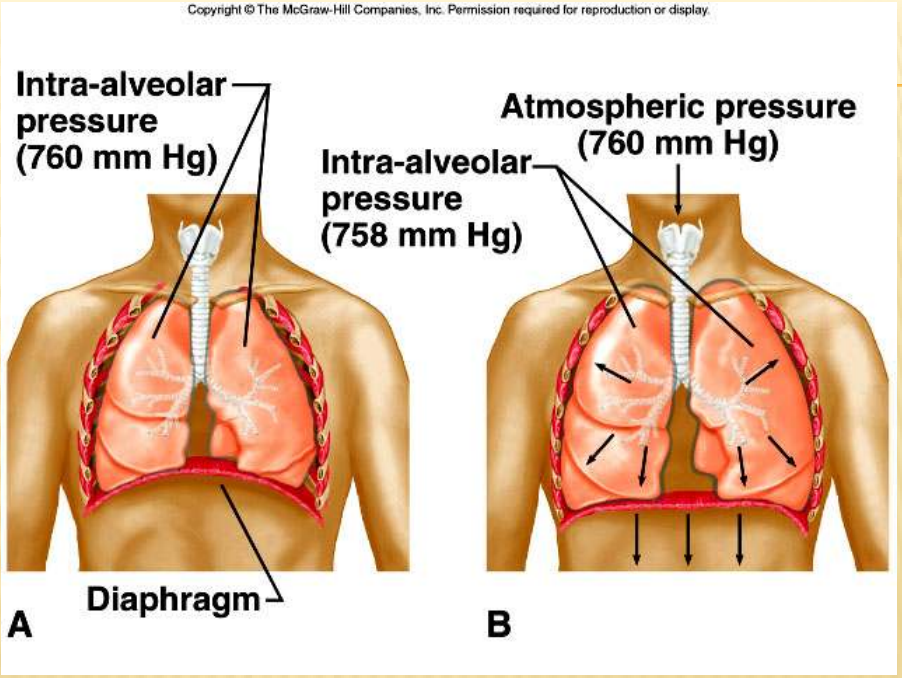
MECHANICS OF BREATHING

- Inhaling (active process) – Air moves in. Why??
  - Gases move from an area of high pressure to low pressure
  - During inspiration – diaphragm pulls down and lungs expand
  - When lungs expand, it INCREASES the VOLUME, which DECREASES the PRESSURE inside lungs
  - Lung pressure is lower than outside pressure, so air moves in

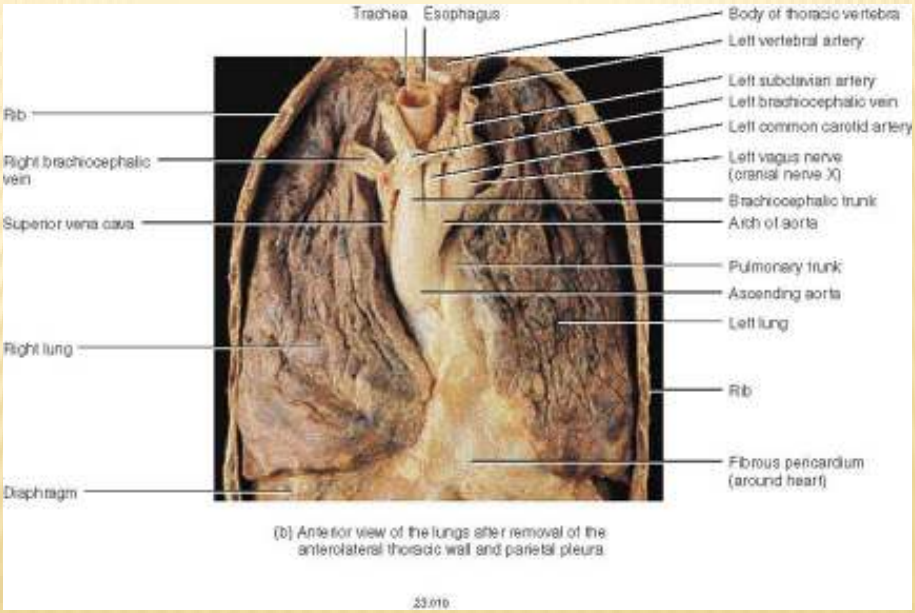
MECHANICS OF BREATHING

- Exhaling (passive process) – breathing out
  - Diaphragm and muscles relax
  - Volume in lungs and chest cavity decreases, so now pressure inside increases
  - Air moves out because pressure inside is HIGHER than OUTSIDE atmosphere


air moves in
ribcage expands
lungs expand
diaphragm contracts downward
(a) Inhalation
air moves out
ribcage contracts
lungs compress
diaphragm relaxes upward
(b) Exhalation

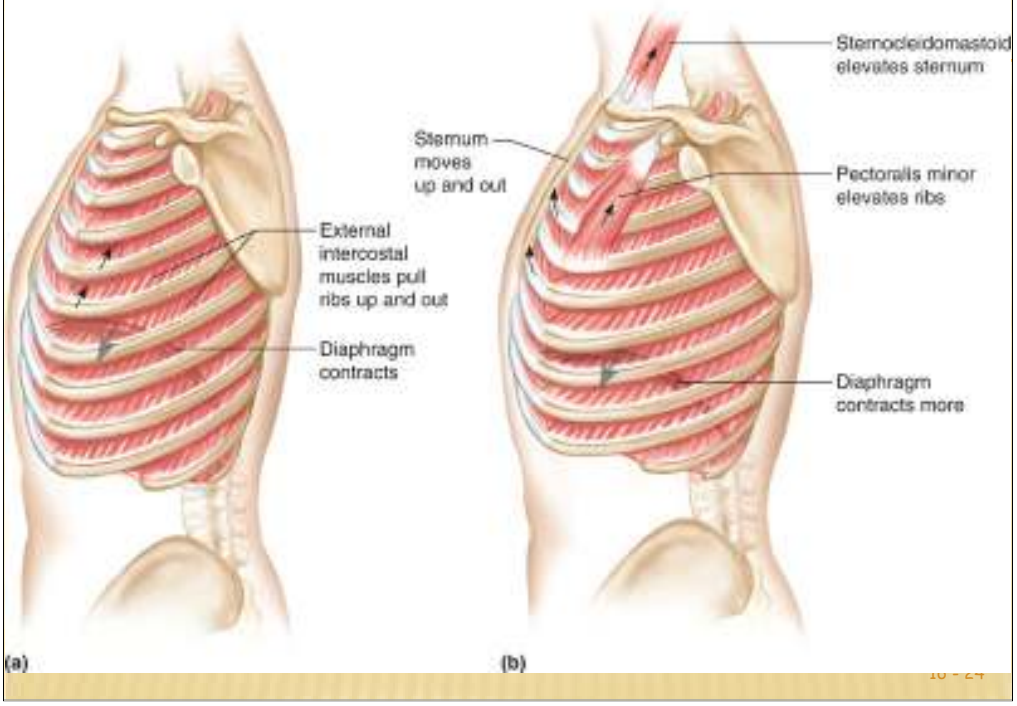


Respiratory Structures



(b) Anterior view of the lungs after removal of the anterolateral thoracic wall and parietal pleura

23.01b

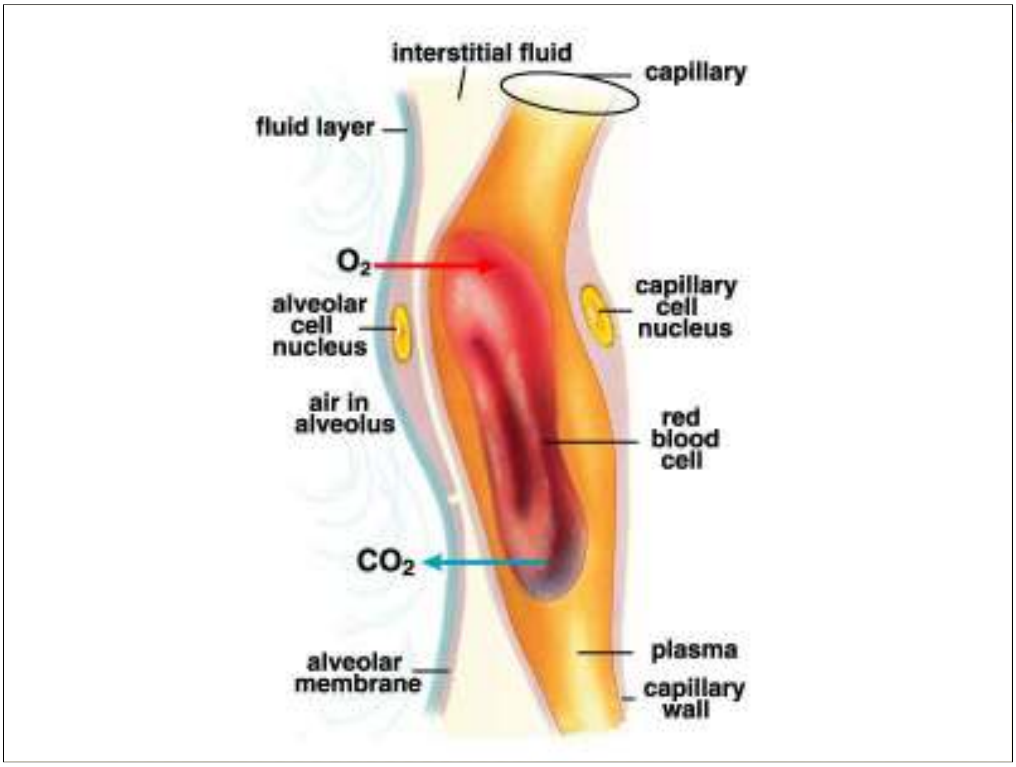


RESPIRATION

- What is respiration?
  - External respiration – exchange of O_2 and CO_2 between respiratory surfaces and the blood (breathing)
  - Internal respiration – exchange of O_2 and CO_2 between the blood and cells
  - Cellular respiration – process by which cells use O_2 to produce ATP

EXTERNAL RESPIRATION

- Exchange of O_2 and CO_2 between alveoli and blood
- Partial pressure of O_2 higher in alveoli than blood so O_2 diffuses into blood
- Partial pressure of CO_2 higher in blood than alveoli, so CO_2 moves into alveoli in opposite direction and gets exhaled out


interstitial fluid
capillary
fluid layer
O_2
alveolar cell nucleus
capillary cell nucleus
air in alveolus
red blood cell
CO_2
plasma
alveolar membrane
capillary wall

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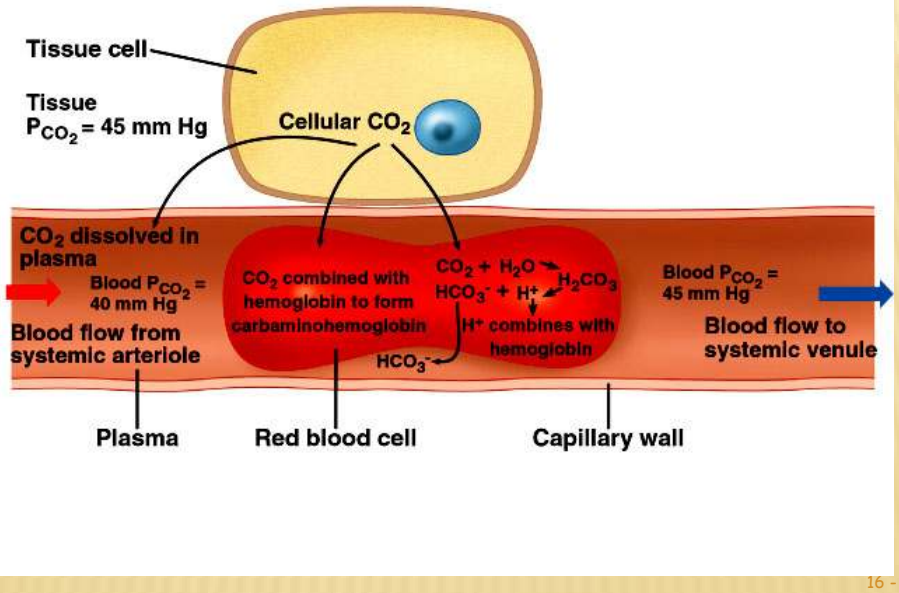


INTERNAL RESPIRATION

- Exchange of O_2 and CO_2 between blood and tissues
- Pressure of O_2 higher in blood than tissues so O_2 gets release into tissues.
- Pressure of CO_2 higher in tissue than in blood so CO_2 diffused in opposite direction into blood.
- CO_2 Is a waste product
- O_2 Is used in cellular respiration

GAS EXCHANGE

- Earth's atmosphere is about 78% Nitrogen and about 21% O_2
- What happens to the air when we inhale?

GAS	INHALED	EXHALED
O_2	20.71%	14.6%
CO_2	.004%	4.0%
H_2O	1.25%	5.9%

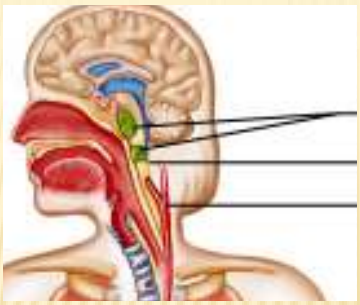
- 300 million alveoli in a healthy lung
- Hemoglobin can hold four O_2 molecules

GAS TRANSPORT IN BLOOD

- Carbon dioxide
  - 70% as bicarbonate ion (HCO_3^-) dissolved in plasma
  - 23% bound to hemoglobin
  - 7% as CO_2 dissolved in plasma
- Oxygen
  - 99% bound to hemoglobin
  - 1% as O_2 dissolved in plasma
- Carbon monoxide poisoning occurs because CO binds to hemoglobin more readily than O_2

CONTROL OF BREATHING

- Breathing is regulated by the rhythmicity center in the medulla of brain



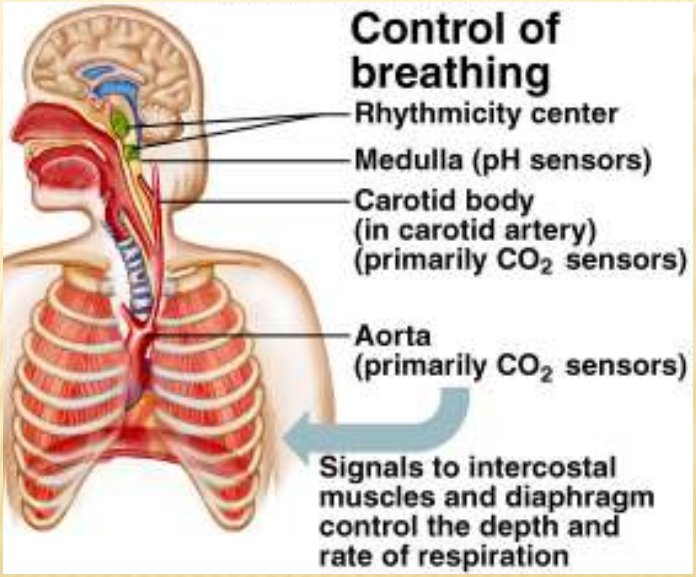
rhytmicity center

- Medulla stimulates inspiratory muscles (diaphragm & external intercostal muscles)

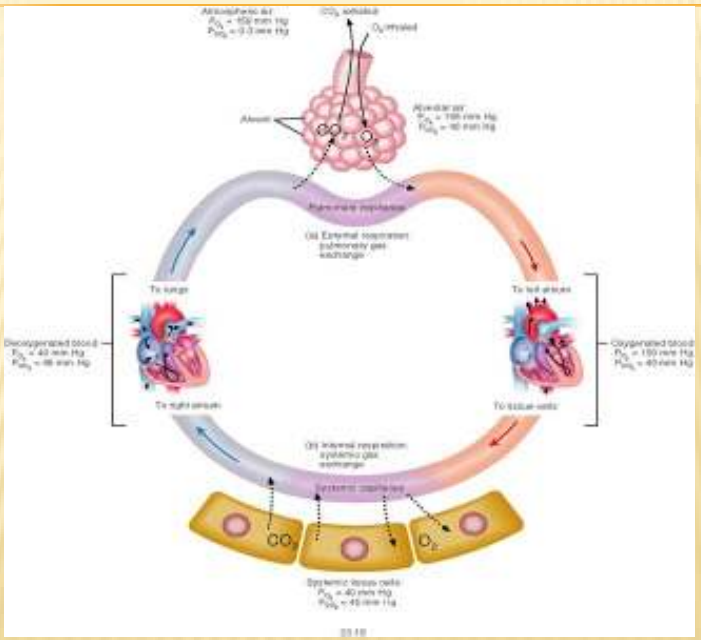
CONTROL OF BREATHING

- The most important factor affecting the rhythmicity center is CO_2
- ↑ in arterial CO_2 causes ↑ in acidity of cerebrospinal fluid (CSF)
- ↑ in CSF acidity is detected by pH sensors in medulla
- medulla ↑ rate and depth of breathing

CONTROL OF BREATHING



Physiology of Respiration



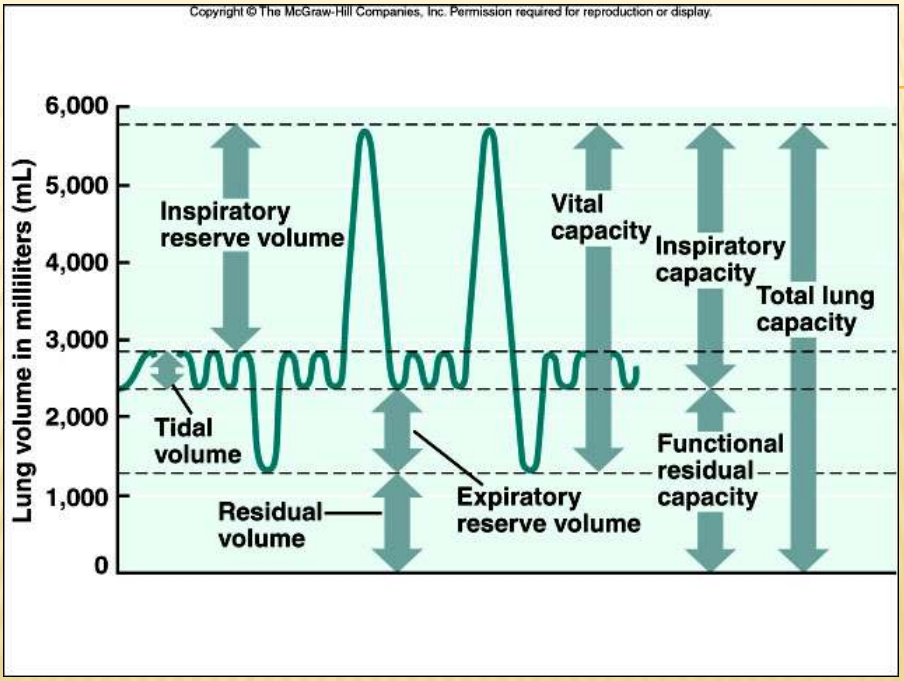
RESPIRATORY VOLUMES – IMPORTANT!

TABLE 16.2 RESPIRATORY AIR VOLUMES AND CAPACITIES

NAME	VOLUME*	DESCRIPTION
Tidal volume (TV)	500 mL	Volume moved in or out of lungs during respiratory cycle
Inspiratory reserve volume (IRV)	3,000 mL	Volume that can be inhaled during forced breathing in addition to tidal volume
Expiratory reserve volume (ERV)	1,100 mL	Volume that can be exhaled during forced breathing in addition to tidal volume
Residual volume (RV)	1,200 mL	Volume that remains in lungs even after maximal expiration
Inspiratory capacity (IC)	3,500 mL	Maximum volume of air that can be inhaled following exhalation of tidal volume: IC = TV + IRV
Functional residual capacity (FRC)	2,300 mL	Volume of air that remains in the lungs following exhalation of tidal volume: FRC = ERV + RV
Vital capacity (VC)	4,600 mL	Maximum volume of air that can be exhaled after taking the deepest breath possible: VC = TV + IRV + ERV
Total lung capacity (TLC)	5,800 mL	Total volume of air that the lungs can hold: TLC = VC + RV

*Values are typical for a tall, young adult.

This is found on Page 754 in your book!
Know it! Know it! Know it!



RESPIRATORY VOLUMES – IMPORTANT!

- Example:
  - A male that is 40 years old and is 180 cm tall, has:

    TV = 547 ml
    IRV = 3300 ml
    ERV = 1300 ml
    RV = 1280 ml

  Calculate:

IC = TV+IRV	547 + 3300 = 3847 ml
FRC = ERV + RV	1300 + 1280 = 2580 ml
VC = TV + IRV +ERV	547 + 3300 + 1300 = 5147 ml
TLC = VC + RV	5147 + 1280 = 6427 ml

Normal VC = 4175 ml and normal TLC = 5800 ml.
Does this person have good lungs?

RESPIRATORY DISORDERS AND HOMEOSTATIC IMBALANCES

Bronchiogenic Carcinoma (Lung Cancer)

- Most fatal cancer in the U.S.
- Highly metastatic
- Usually linked with cigarette smoking
- Starts in the walls of the bronchi due to irritation of the bronchiole epithelium
- Common irritants include smoking, pollution, dust particles
- 20 times more prevalent in smokers than non- smokers

THE AWESOME SMOKERS LUNG!

Emphysema

- “Blown up or full of air”
- A condition where the alveolar walls lose their elasticity and remain filled with air during expiration
- Alveoli become damaged and eventually merge together to form large air sacs with reduced overall volume
- Patients often develop a barrel chest
- Generally caused by cigarettes, pollution, industrial dust particles

Influenza

- Caused by one of many viruses
  - Antibiotics cannot help
  - Medications used to treat the symptoms
    - + sneezing
    - + congestion
    - - coughing
    - - rhinorrhea
  - May result in rhinitis: inflammation of the nasal mucosa
  - Commonly known as the flu

Pneumonia

- Acute infection or inflammation of the alveoli of the lungs
- Most common infectious cause of death in the U.S.
- Alveolar sacs fill with fluid and dead white blood cells reducing the amount of functional surface area of the lungs
- Most commonly caused by bacterium
  - *Streptococcus pneumoniae*
- Affects those in poor health or compromised immune system

Sudden Infant Death Syndrome (SIDS)

- 10,000 infant deaths per year in the U.S.
- Cause is not known but thought to be caused by an infectious agent or compressed carotid artery
- Most deaths occur in the fall or winter
- Over 50% of SIDS death children had an upper respiratory infection within the past two weeks
- May also be caused by improper positioning for sleeping in the crib

Tuberculosis (Tb)

- Caused by a bacterium
  - *Mycobacterium tuberculosis*
- An infectious communicable disease that destroys the lung tissue and pleura
- Replaced by fibrous connective tissue called tubercles
- Disease is spread by inhalation of the bacterium