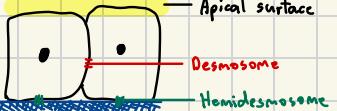
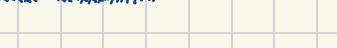
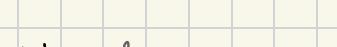
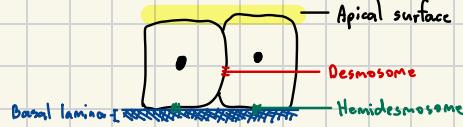


Basic Histology (Seegm's + Junqueira's)

↳ Epithelial Tissue

↳ Characteristics

- ↳ Apical surface:  Apical surface
- ↳ Basal surface:  Basement membrane
- ↳ Basement membrane:  Basal surface



↳ Functions

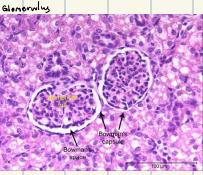
- ↳ Protection (e.g. oral cavity)
- ↳ Secretion (e.g. glands)
- ↳ Absorption (e.g. small intestines)

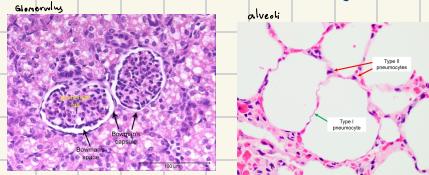
↳ Classification

- ↳ Layers: simple (1), stratified (>1)
- ↳ Shapes: squamous (, e.g. skin), cuboidal (, e.g. kidney), columnar (, e.g. gut)

↳ Covering epithelium

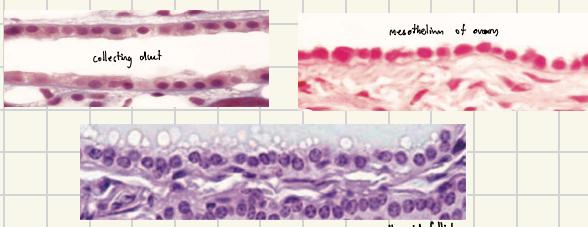
↳ Simple squamous epithelium

- ↳  → diffusion, filtration
- ↳  endothelium, aveoli, Bowman's capsule
- ↳ thin ascending limb, descending limb



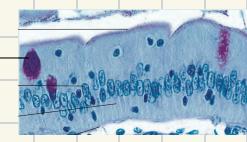
↳ Simple cuboidal epithelium

- ↳ glands, PCT, collecting duct, thick ascending, mesothelium of ovary, thyroid follicles

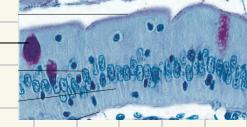


↳ Covering epithelium

↳ Simple columnar epithelium

- ↳  goblet cells: secrete mucus

- ↳ Ciliated: bronchioles, fallopian tubes


- ↳ Microvilli: intestines → absorption


↳ Pseudostratified columnar epithelium

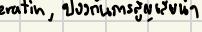
- ↳  goblet cells, cilia

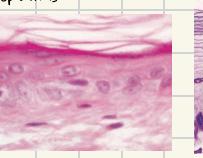
- ↳ trachea, bronchi

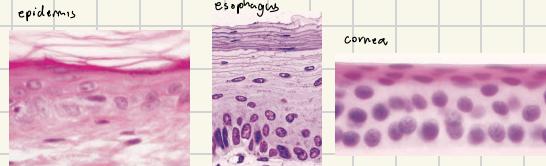


↳ Stratified squamous epithelium

- ↳ keratinized: epidermis

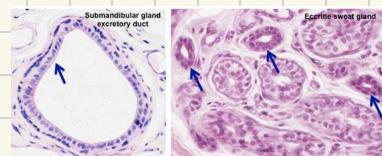
↳ dead cells; cytoplasm with keratin, 

- ↳ nonkeratinized:  pharynx, mouth, vagina, larynx

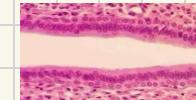


↳ Stratified cuboidal epithelium

- ↳ sweat glands, pancreas, salivary glands

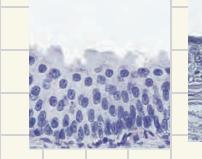


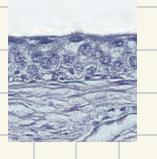
↳ Stratified columnar epithelium: Male's urethra

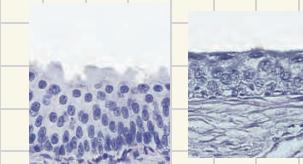


↳ Transitional epithelium

↳ Transitional

- ↳  Stratified cuboidal

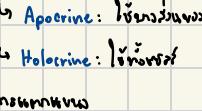
- ↳  Stratified squamous

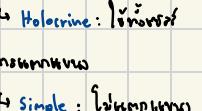


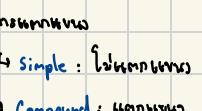
↳ Glands

↳ Exocrine glands:

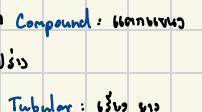
↳ Endocrine

- ↳ Merocrine:  vesicle

- ↳ Apocrine:  vesicle releasing contents into duct

- ↳ Holocrine:  vesicle

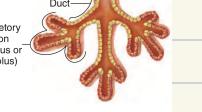
↳ Mucinous

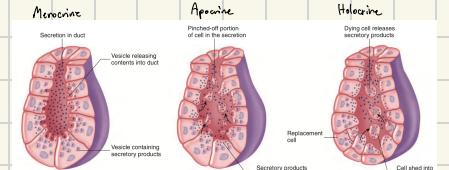
- ↳ Simple: 

- ↳ Compound: 

↳ Serous

- ↳ Tubular: 

- ↳ Acinar: 



SIMPLE Glands (Ducts Do Not Branch)

Class	Simple Tubular	Branched Tubular	Coiled Tubular	Acinic (or Alveolar)	Branched Acinar
Features	Excreted secretory portion, duct usually short or absent	Several long secretory parts joining to drain into 1 duct	Secretory portion is very long and coiled	Rounded, saclike secretory portion	Multiple secretory portions entering the same duct
Examples	Mucous glands of colon; intestinal glands or crypts (of Lieberkuhn)	Glands in the uterus and stomach	Sweat glands along the urethra	Small mucous glands of the skin	Sebaceous glands of the skin
COMPOUND Glands (Ducts from Several Secretory Units Converge into Larger Ducts)	Tubular	Acinar (Alveolar)	Tubuloacinar		
Features	Several elongated coiled secretory units and their ducts converge to form larger ducts	Several saclike secretory units with small ducts converge at a larger duct	Ducts of both tubular and acinar secretory units converge at larger ducts		
Examples	Submucosal mucous glands (of Brunner) in the duodenum	Exocrine pancreas	Salivary glands		

Basic Histology

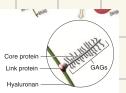
↳ Connective tissue

↳ Components

↳ Ground substance

↳ Glucosaminoglycan (GAG)

↳ Proteoglycan



↳ Glycoproteins

↳ Protein fibers (collagen, elastic fibers)

↳ Resident cells

↳ Adipocytes, Fibroblasts

↳ from mesenchymal cells

↳ Macrophage, Lymphocytes, Mast cells

↳ from hepatic stem cells

↳ Classification

↳ Connective tissue proper

↳ Loose connective tissue

↳ sparse, loose

↳ Ground substance loose

↳ fibers few

↳ organ, dermis layer

↳ Dense connective tissue

↳ dense, tight

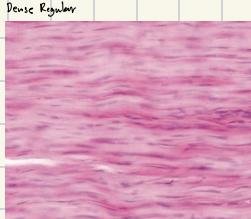
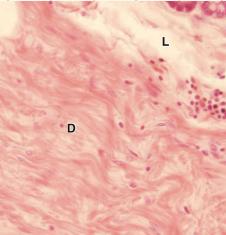
↳ Ground substance less

↳ fibers many

↳ Irregular: fibroblasts scattered

↳ Regular: fibers parallel

Loose (L), Dense irregular (D)



↳ Classification

↳ Specialized Connective Tissue

↳ Adipose tissue

↳ adipocytes: leptin

↳ White adipose tissue

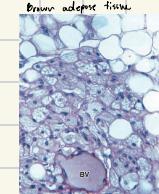
↳ large lipid droplets

↳ Unilocular

↳ Brown adipose tissue

↳ lipid droplets many, small

↳ Multilocular

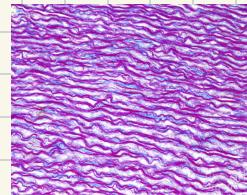


↳ Elastic tissue

↳ elastic fiber

↳ External elastic lamina of Tunica media

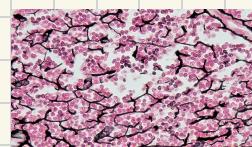
Internal elastic lamina of Tunica intima



↳ Reticular tissue

↳ Reticular fiber: collagen II

↳ many thin, fine fibers



↳ Mucous Tissue

↳ Wharton's Jelly

↳ umbilical cord

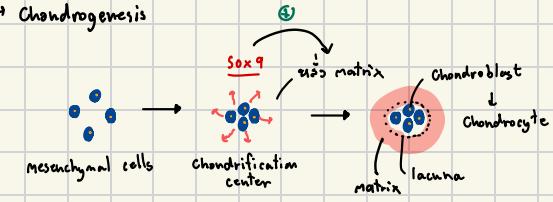


↳ Cartilage

↳ small chondrocytes in lacunae

↳ Perichondrium

↳ Chondrogenesis

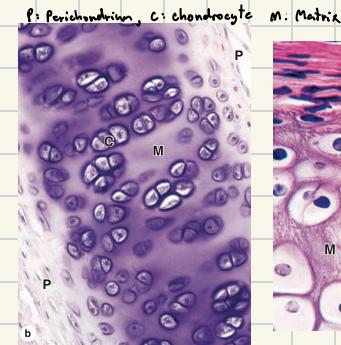


↳ Hyaline Cartilage

↳ ECM type II collagen

↳ 2-4 chondrocytes per lacuna

↳ epiphyseal plate, c-ring, septum cartilagine

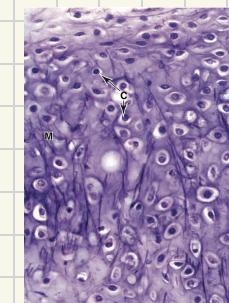


↳ Elastic cartilage

↳ hyaline cartilage

↳ elastin fibers

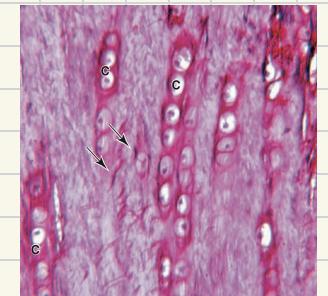
↳ epiglottis, auditory canals, larynx



↳ Fibrocartilage

↳ fibers: collagen III, IV, V

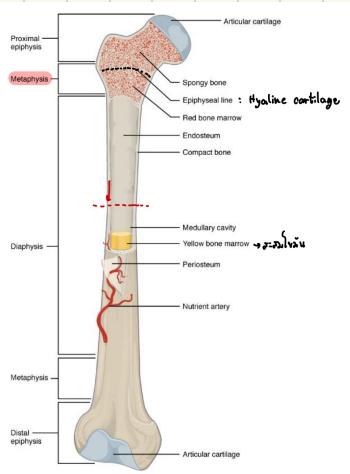
↳ intervertebral disc, pubic symphysis, articular cartilage



Basic Histology

↳ Bone tissue

↳ Anatomy of bones



↳ Structure:

↳ **Periosteum**: CNT, protect compact bone

↳ **Sharpy's / Perforating fibers**

↳ **Collagen fiber**

↳ **Periosteum in compact bone**

↳ **Lamella**

↳ **Haversian system / Osteon**

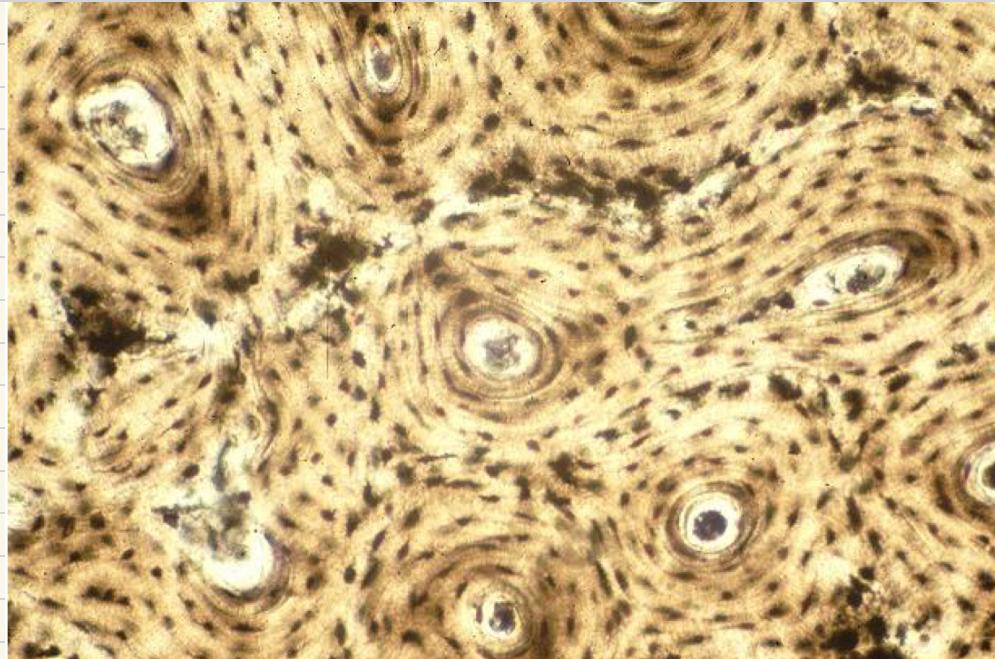
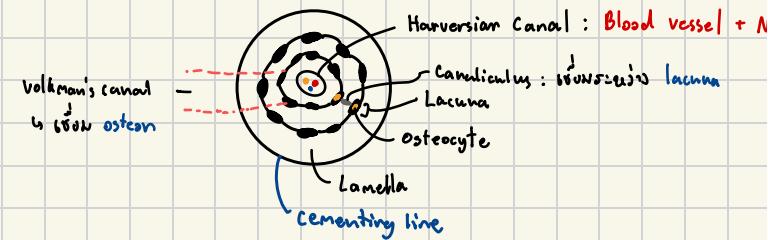
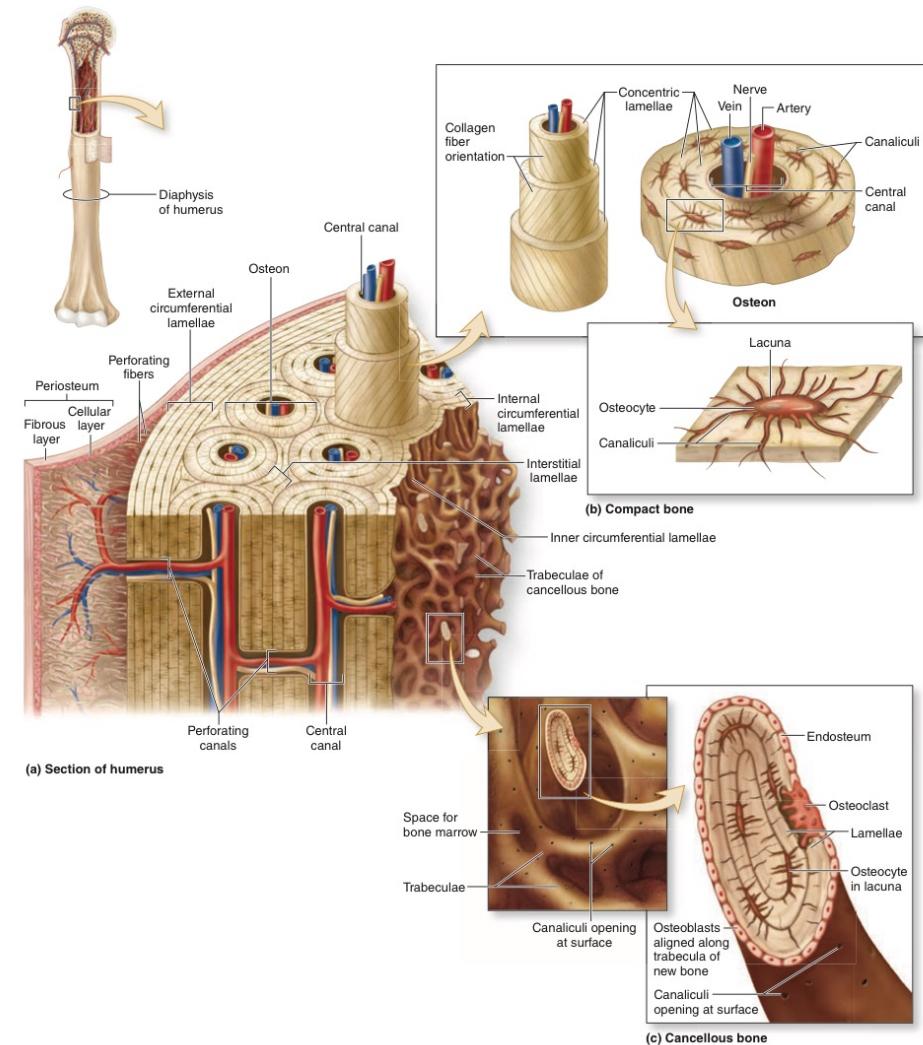


FIGURE 8-1 Components of bone.



Animal Respiration (Raven's + Campbell)

- Simple diffusion animals (O_2 in, CO_2 out)

↳ unicellular organisms

Amphibians, Echinoderms (Papillae)

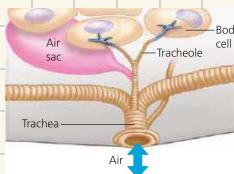
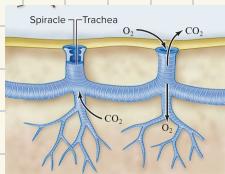
- Tracheal system

↳ insects

↳ spiracles

↳ airways/bronchi Trachea → Tracheole → Body cells

* Air sac: Trachea lung-like organ rich in O_2



- Gills

↳ fish

↳ External gills

↳ larvae, annelids

Amphibians



↳ Gills in crustaceans

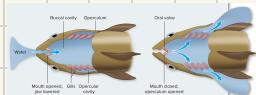
↳ gills in exoskeleton, appendages respiration

↳ brachial gills, exoskeleton = brachial cavity

↳ Gills in bony fishes

↳ operculum

↳ Water flow:



↳ countercurrent exchange

↳ O_2 in > O_2 out

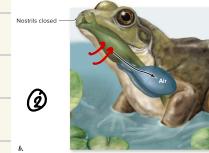
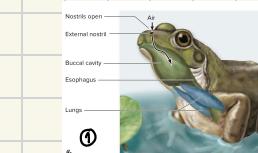
Lungs

↳ Amphibians lungs

↳ positive pressure breathing (convergent evolution)

1. *inhalation* oral cavity into nostril

2. glottis open, *exhalation* → *excretion*



Avian lungs

↳ Air sacs

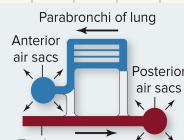


Respiratory cycle:

1. Inhalation

↳ *inhalation* (CO_2 in) into Trachea → Posterior Air sacs

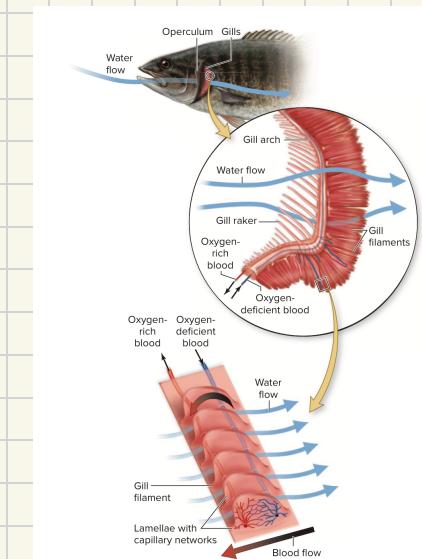
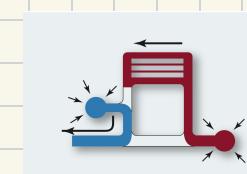
↳ *inhalation* (CO_2 in) → Anterior Air sacs (via Parabronchi)



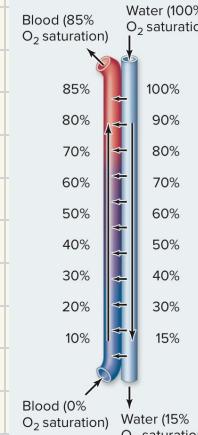
2. Exhalation

↳ *exhalation* Posterior Air sac (CO_2) → *out*

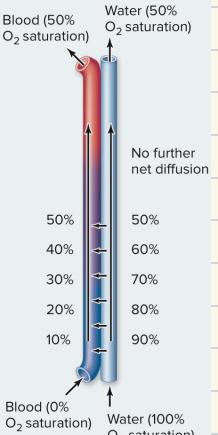
↳ *exhalation* Anterior Air sac (CO_2) → Trachea → *out*



Countercurrent Exchange



Concurrent Exchange



Human Respiration

↳ Anatomy (upper respiratory tract) (seeley's)

↳ Nose

↳ Nares / nostril : external opening

↳ stratified squamous epithelium + coarse hairs



↳ Choanae : opening into pharynx

↳ Nasal cavity : nares → choanae

↳ pseudostratified columnar epithelium

↳ goblet cells → mucus : ထိန်ချုပ်

↳ cilia → move mucus towards pharynx

↳ Olfactory receptor neuron : စုနောက်

↳ Nasal septum : နှုတ်ပုံ L/R

↳ Deviated nasal septum : nasal septum သွေ့ခြားမြတ်ဆုံး

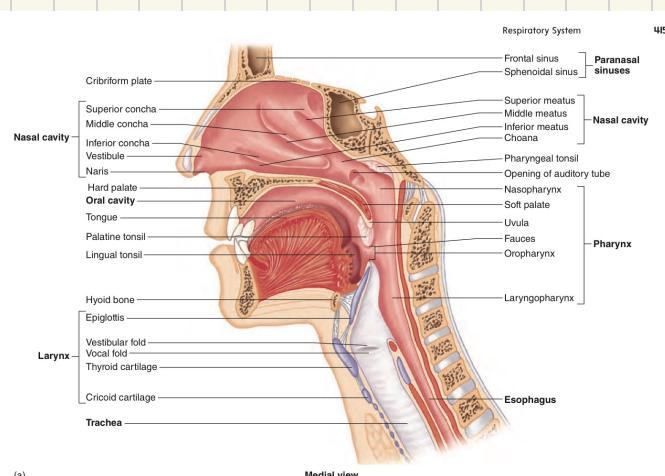
↳ Hard palate : floor of nasal cavity

↳ Conchae : ခါး surface area သူ့ nasal cavity

↳ superior, middle, inferior concha

↳ Paranasal sinuses : ခြားခြားခြား, ခြားခြားခြား

↳ maxillary, frontal, ethmoidal, sphenoidal sinus



↳ Pharynx : အိမ်ချုပ်ချုပ်, ဓမ္မ

↳ Nasopharynx

↳ အိမ်ချုပ် pharynx

↳ pseudostratified columnar epithelium

↳ soft palate

↳ incomplete muscle + connective tissue

↳ အိမ်ချုပ် nasopharynx နဲ့ oropharynx

↳ floor of nasopharynx

↳ ခြားခြားခြားနဲ့ ခြားခြားခြားနဲ့ nasopharynx

↳ Oropharynx : uvula → epiglottis

↳ stratified squamous epithelium

↳ Palatine tonsils

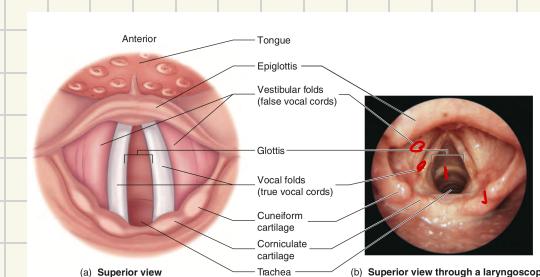
↳ lateral wall between oropharynx, oral cavity

↳ Lingual tonsil

↳ surface သုတေသန

↳ Laryngopharynx : epiglottis → esophagus

↳ stratified squamous + ciliated columnar



↳ Larynx

↳ passage way between pharynx, trachea

↳ 9 cartilages as outer casing (3 unpaired, 2(?) paired)

↳ unpaired cartilages

↳ thyroid cartilage / Adam's apple

↳ longest, hyaline cartilage

↳ အေားအေား hyoid bone

↳ cricoid cartilage (most inferior)

↳ base of larynx

↳ hyaline cartilage

↳ epiglottis

↳ elastic cartilage

↳ ခြားခြားခြား thyroid cartilage

↳ mouth → trachea

↳ paired cartilages : attachment site for vocal chords

↳ cuneiform cartilage (top)

↳ corniculate cartilage (mid)

↳ arytenoid cartilage (bottom)

↳ vestibular fold (false vocal chord)

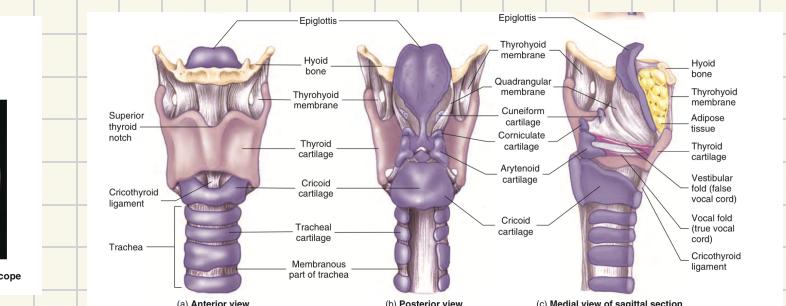
↳ vocal fold (true vocal chord)

(Posterior side)

ligaments on thyroid cartilage



arytenoid cartilage



Human Respiration

↳ Anatomy (seeley '5)

↳ Trachea

↳ connective tissue + smooth muscle

↳ 16-20 C-shaped hyaline cartilages

↳ **pseudostratified columnar epithelium**

↳ cilia + goblet cell

↳ **Left/Right 1° bronchi**

↳ Bronchi

↳ **Trachea** → Main bronchi

↳ right bronchi: more vertical

↳ **pseudostratified columnar epithelium**

↳ **C-shaped cartilages** supporting

↳ **lobar bronchi**: conduct air to each lobe

↳ **segmental bronchi**: air to bronchopulmonary

↳ **segments**

↳ **bronchiole**: smooth muscle only

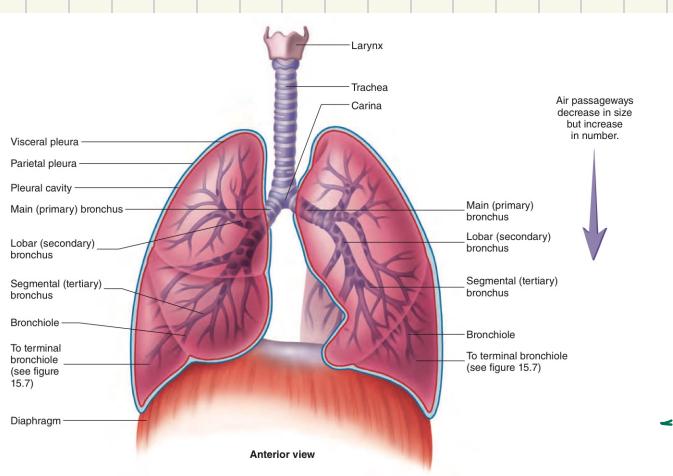
↳ **terminal bronchiole**: ciliated columnar epithelium

↳ **respiratory bronchiole**: cuboidal epithelium

↳ **alveolar ducts**

↳ **alveoli** } **Simple squamous epithelium**

↳ **elastic fibers** → lung recoil



↳ Lungs

↳ **Right lung**: 3 lobes

↳ superior, middle, inferior lobes

↳ **Left lung**: 2 lobes

↳ superior, inferior lobes

↳ **lobes within bronchopulmonary segments**

↳ Respiratory membrane:

1. Alveolar fluid
2. Alveolar epithelium → simple squamous
3. Basement membrane of alveolar epithelium
4. Interstitial space
5. Basement membrane of capillary epithelium
6. Capillary epithelium → simple squamous

↳ Pneumocytes (in alveoli)

↳ **Type I**: gas exchange

↳ **Type II**: secretes surfactant

↳ Pleural Cavities: covering skin, thorax

↳ **pleura (serous membrane)**

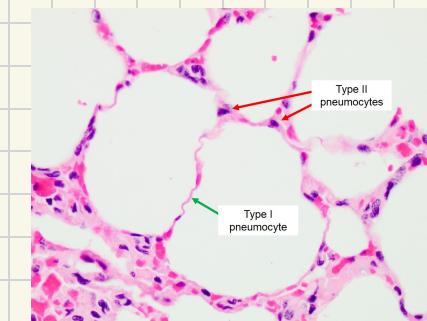
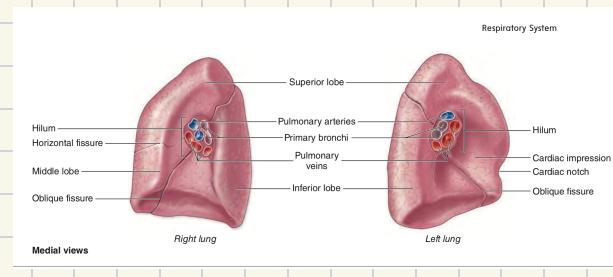
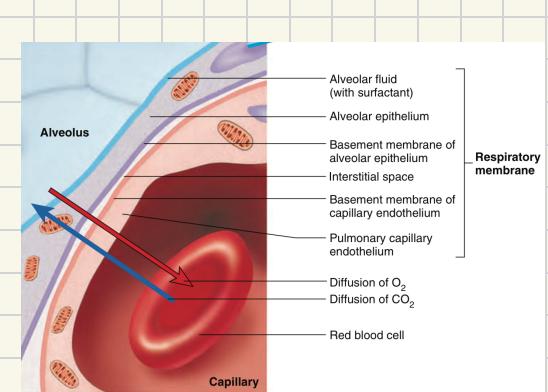
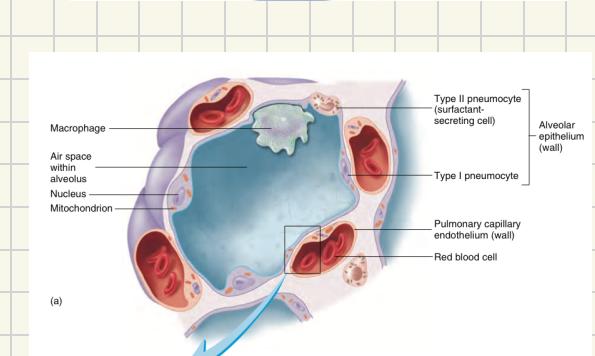
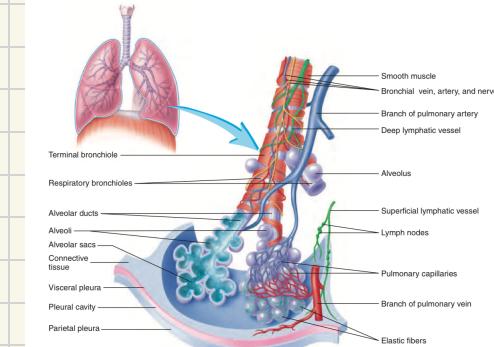
↳ **Parietal pleura**: thorax, diaphragm, mediastinum

↳ **Visceral pleura**: surface of lung

↳ between parietal, visceral pleura

↳ filled w/ **pleural fluid**

↳ lubricant, **on pleural membranes**



Human Respiration

↳ Physiology (seeley's + guyton)

$$P \propto \frac{1}{V}, P_{\text{air}} \rightarrow P_{\text{alv}}$$

↳ Inspiration elevates the rib cage

↳ Muscles of inspiration ↗

- Quiet
 - ↳ External intercostals: lift ribs, sternum
 - ↳ Diaphragm: \downarrow Thoracic volume \uparrow (↓)
 - ↳ Pectoralis Minor
 - ↳ Scalenae
 - ↳ Sternocleidomastoid

↳ $V_{\text{thoracic}} \uparrow, V_{\text{alv}} \uparrow \rightarrow P_{\text{alv}} < P_{\text{atmosphere}}$

↳ air_{atm} → air_{alv}

↳ The end: $P_{\text{alv}} = P_{\text{atmosphere}} \rightarrow \text{air flow stops}$

↳ Expiration depresses the rib cage

↳ Muscles of Expiration ↘ (Forced only)

↳ Abdominal muscles

↳ Internal intercostals

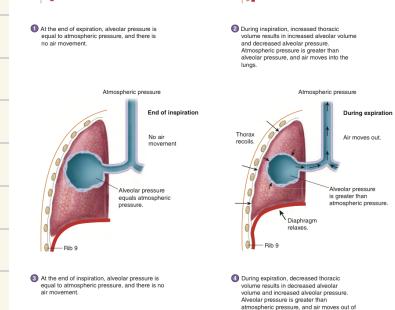
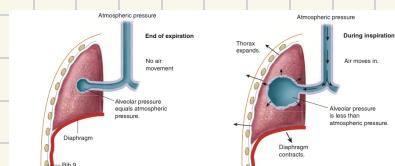
↳ Muscles of Inspiration ↗ (mainly: Diaphragm)

↳ Thoracic volume \downarrow , $V_{\text{alv}} \downarrow$ elastic recoil \rightarrow $P_{\text{alv}} > P_{\text{atmosphere}}$

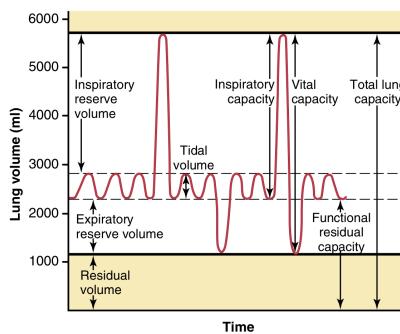
↳ $V_{\text{thoracic}} \downarrow, V_{\text{alv}} \downarrow \rightarrow P_{\text{alv}} > P_{\text{atmosphere}}$

↳ air_{alv} → air_{atm}

↳ The end: $P_{\text{alv}} = P_{\text{atmosphere}} \rightarrow \text{air flow stops}$



↳ Respiratory volume + capacity



Respiratory Volumes (RV)

↳ Tidal Volume: $V_{\text{breath}} \approx 500 \text{ mL}$

↳ Quiet breathing $\approx 500 \text{ mL}$

↳ Inspiratory Reserve Volume: $V_{\text{breath}} \approx 9 \text{ L}$

↳ Expiratory Reserve Volume: $V_{\text{breath}} \approx 1.1 \text{ L}$

↳ Residual Volume: $V_{\text{breath}} \approx 1.2 \text{ L}$

Respiratory Capacities (RV)

↳ Functional residual Capacity (ERV+RV):

↳ $V_{\text{breath}} \approx 2.3 \text{ L}$

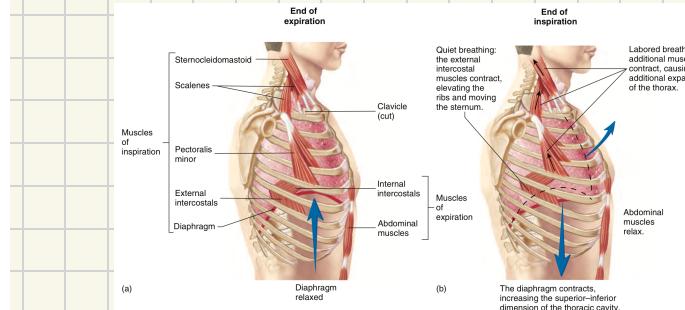
↳ Inspiratory capacity (TV+IRV):

↳ $V_{\text{breath}} \approx 3.5 \text{ L}$

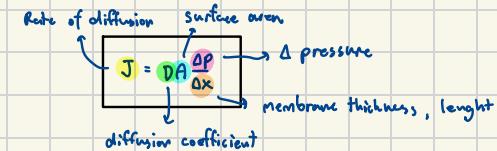
↳ Vital capacity (TV+IRV+ERV):

↳ $V_{\text{breath}} \approx 4.6 \text{ L}$

↳ Total lung capacity (ΣRV): $V_{\text{breath}} \approx 5.8 \text{ L}$



↳ Fick's Law of Diffusion



↳ Dalton's law of partial pressure

$$P_{\text{total}} = P_1 + P_2 + P_3 + \dots$$

$$P_{N_2} = 78\% \cdot P_{\text{air}} = 692.8 \text{ mmHg}$$

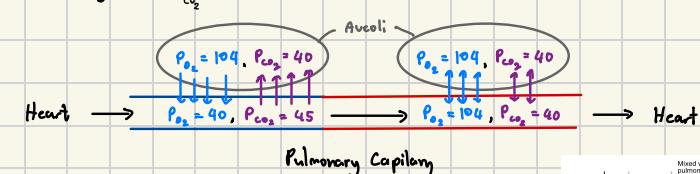
$$P_{O_2} = 21\% \cdot P_{\text{air}} = 169.4 \text{ mmHg}$$

$$P_{CO_2} = 1\% \cdot P_{\text{air}} = 7.6 \text{ mmHg}$$

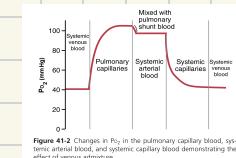
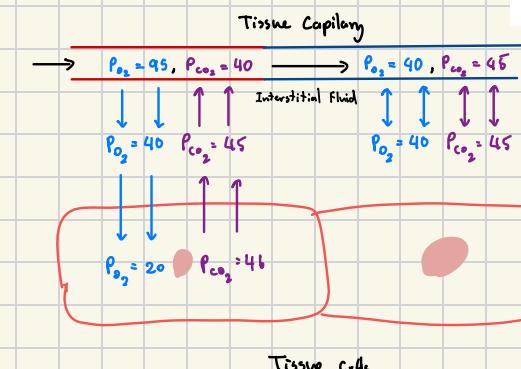
$$\text{ex. } P_{\text{air}} = 760 \text{ mmHg}, P_{\text{air}} = P_{N_2} + P_{O_2} + P_{CO_2} \rightarrow P_{O_2} = 21\% \cdot P_{\text{air}} = 169.4 \text{ mmHg}$$

↳ Gas Exchange

↳ Lungs (Blood $\leftrightarrow_{CO_2}^{O_2}$ Alveoli)



↳ Tissues (Blood $\leftrightarrow_{CO_2}^{O_2}$ Interstitial Fluid \leftrightarrow Tissue Cells)



Tissue Capillary

Human Respiration

↳ Physiology (Guyton + Berne Levy's)

↳ Gas Transport

↳ Hemoglobin

↳ 4 subunits: 2 α , 2 β

↳ Hb + O₂ : **Oxyhemoglobin**

↳ Hb + CO : **Carboxyhemoglobin**

↳ Hb + CO₂ : **Carbaminohemoglobin**

↳ T state (deoxygenated tense)

↳ O₂ affinity ↓↓ CO₂ affinity ↑↑

↳ R state (oxygenated relaxed)

↳ O₂ affinity ↑↑ CO₂ affinity ↓↓

↳ O₂ transport ($\approx 98\%$ in Hb, $\approx 3\%$ in plasma)

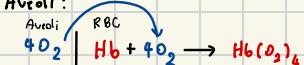
↳ 1 O₂ binds 1 subunit vs Hb:

↳ T-state \rightarrow R-state (conformational shift)

↳ O₂ affinity ↑↑ \rightarrow subunit binds O₂ for delivery

↳ CO is a competitive reversible inhibitor

↳ Arterial:



↳ Tissue:



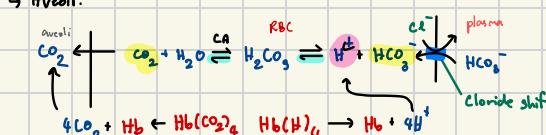
↳ CO₂ Transport

↳ 1 CO₂/H⁺ binds 1 subunit vs Hb

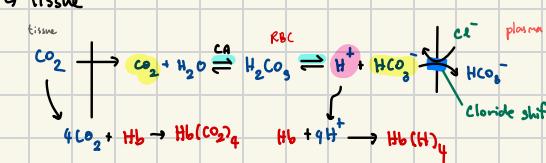
↳ R-state \rightarrow T-state (conformational shift)

↳ CO₂ affinity ↑↑ : subunit binds CO₂ before O₂ binds

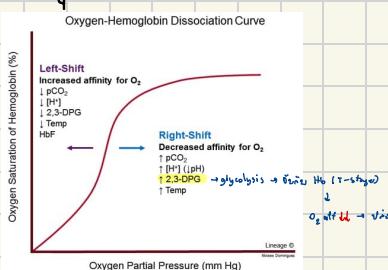
↳ Arterial:



↳ Tissue



↳ Hb(O₂)₄ dissociation curve



↳ Respiratory Regulation \rightarrow Respiratory center

↳ Hering - Breuer inflation reflex

↳ **Apneustic respiration / sighing**

↳ activate \rightarrow Tidal Volume $> 1.5\text{L}$

↳ Mechanism:



↳ Central Chemoreceptors

↳ sit in ventrolateral surface of medulla

↳ sensitive to pH vs extracellular fluid \rightarrow CSF

↳ Cerebrospinal fluid (CSF)

↳ secreted by choroid plexus

↳ absorbed by arachnoid villi

↳ Blood Brain Barrier

↳ Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- ions from blood + CSF

↳ H^+ , HCO_3^- H_2O , CO_2 O_2

↳ Peripheral Chemoreceptors

↳ O_2 H_2O

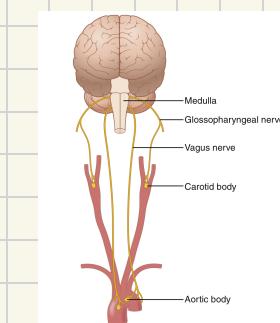
↳ **Central chemoreceptors** \approx **aortic, carotid body**

↳ **Carotid body**: sit in common carotid artery

↳ $\text{CN IX} \xrightarrow{+} \text{DRG}$

↳ **Aortic body**: sit in aorta

↳ $\text{CN X} \xrightarrow{+} \text{DRG}$



↳ Respiratory Regulation

↳ Respiratory center: near neuron inspiratory nucleus

↳ origin Pons + Medulla

↳ Dorsal Respiratory Group: origin dorsal vs medulla

↳ Arousal - sleep - don (Quiet + Forced)

↳ neuron during quiet nucleus of the tractus solitarius

↳ input terminal vs CN IX + CN X

↳ CO_2 receptors:

↳ CO_2 receptors: sit in nucleus of tractus solitarius

↳ **Inspiratory Ramp Signal**

↳ CO_2 receptors: ramp signal

↳ CO_2 receptors: 2S: MOI up \rightarrow inspiration



↳ ramp signal: expiratory: expiratory

↳ expiratory \rightarrow end-expiratory

↳ **Ventral Respiratory Group**

↳ **Asleep** / Forced breathing

↳ CO_2 receptors: DRG 2nd fib.

↳ respiration MOE 2nd fib.

↳ **Pneumotaxic center**

↳ **dorsal** vs nucleus parabrachialis, in upper pons

↳ ⊕ ramp signal vs DRG

↳ strong signal = inspiration

↳ weak signal = expiration