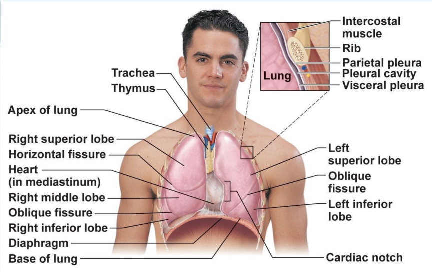
Respiratory System Cheat Sheet

by zpms1207 via cheatography.com/147948/cs/32198/

Lung Anatomy

Occupy all of the thoracic cavity *except* mediastinum	
Root	site of vascular, bronchial attachments
Costal surface	anterior, lateral, posterior surfaces

Structures of the Lungs



Upper Respiratory Tract

conduction, filtration, humidification and warming of inhaled air	
Nasal Cavity	Nasal conchae, nasal vestibule, nostril
Paranasal Sinuses	Maxillary, frontal, sphenoidal and ethmoidal sinuses
Pharynx	Nasopharynx, oropharynx, laryngopharynx
Larynx (superior)	Vocal cords, epiglottis, vestibular fold, thyroid cartilage, vocal fold, cricoid cartilage, thyroid gland

Lower Respiratory Tract

conduction, gas exchange	
Trachea	cervical, thoracic
Bronchi	left primary bronchus, right primary bronchus
Bronchioles	respiratory bronchiole, terminally bronchiole, alveoli
Lungs	left lung, right lung (larger)

Functional Anatomy

Respiratory zone: site of gas exchange	Microscopic structures: respiratory bronchioles, alveolar, ducts, alveoli
Alveoli	~300 million alveoli account for most of the lungs' volume, ***main site for gas exchange***
	Surrounded by fine elastic fibres

Functional Anatomy (cont)

	Contain open pores that connect adjacent alveoli, allow air pressure throughout lung to be equalised
	House alveolar macrophages that keep alveolar surfaces sterile
Conducting zone	Conduits to gas exchange sites
	Includes all other respiratory structures
Trachea	Windpipe: from larynx into mediastinum
	Wall composed of 3 layers: mucosa, submucosa, adventitia
	Carina: Last tracheal cartilage, point where trachea branches into two bronchi
Conducting zone structures	Trachea → right and left primary bronchi
	Primary bronchus → secondary bronchi → 3rd, 4th etc.
	Bronchioles: < 1mm diameter
	Terminal bronchioles: < 0.5mm diameter
Respiratory muscles	Diaphragm and other muscles that promote ventilation

Respiratory Volumes

Adult Male average	Adult Female average
Tidal volume (TV)	
500mL	500mL
amount of air inhaled/exhaled each breath at rest	
Inspiratory reserve volume (IRV)	
3100mL	1900mL
amount of air during forceful inhalation after normal TV	
Expiratory reserve volume (ERV)	
1200mL	700mL
amount of air during forceful exhalation after normal TV exhalation	
Residual volume (RV)	
1200mL	1100mL
amount of air remaining in lungs after forced exhalation	

Respiratory Capacities

Adult Male average	Adult Female average
Total lung capacity (TLC)	
6000mL	4200mL
max amount of air contained in lungs after max inspiratory effort: TLC = TV+IRV+ERV+RV	
Vital capacity (VC)	
4800mL	3100mL
max amount of air that can be expired after max inspiratory effort: VC = TV+IRV+ERV	
Inspiratory capacity (IC)	
3600mL	2400mL
max amount of air that can be inspired after normal expiration: IC = TV+IRV	
Functional residual capacity (FRC)	
2400mL	1800mL
volume of air remaining in lungs after normal TV expiration: FRC = ERV+RV	

Pulmonary Function Tests

Spirometer	
instrument used to measure respiratory volumes/capacities	
Can distinguish between	Obstructive pulmonary disease: increased airway resistance e.g. bronchitis, asthma
	Restrictive disorders: reduction in TLC due to structural/functional lung changes e.g. fibrosis, tuberculosis (TB)
Minute ventilation	Total amount of gas flow into/out of respiratory tract in 1 minute
Forced vital capacity (FVC)	Gas forcibly expelled after taking a deep breath
Forced expiratory volume (FEV)	Amount of gas expelled during specific time intervals of FVC

Partial Pressure Gradient

Dalton's Law of Partial Pressures	Total pressure exerted by mixture of gases is the sum of pressures exerted by each
	Partial pressure of each gas is directly proportional to its percentage in the mixture

Partial Pressure Gradient (cont)

Example:	Atmospheric pressure is 760mmHg at sea level
	Oxygen constitutes ~21% of the atmosphere
	21% x 760 = 159mmHg

Mechanisms of Breathing: Pulmonary Ventilation

Inspiration and expiration	Inspiration: gases flow into lungs
	Expiration: gases exit the lungs
Mechanical processes dependant on volume changes in thoracic cavity	Volume changes → pressure changes
	Pressure changes → gases flow to equalise pressure
Boyle's Law	Relationship between pressure and volume of a gas

Mechanics of Breathing: Inspiration

Inspiration	Expiration
Sequence of events	
1. Inspiratory muscles contract → diaphragm descends, rib cage rises	1. Inspiratory muscles relax → diaphragm rises, rib cage descends due to costal cartilage recoil
2. Thoracic cavity volume increases	2. Thoracic cavity volume decreases
3. Lungs are stretched → intrapulmonary volume increases	3. Elastic lungs recoil passively → intrapulmonary volume decreases
4. Intrapulmonary pressure drops → -1mmHg	4. Intrapulmonary pressure rises → +1mmHg
5. Air flows into lungs down its pressure gradient until intrapulmonary volume = 0 *(equal to atmospheric pressure)*	5. Air flows out of lungs down its pressure gradient until intrapulmonary pressure is 0

Internal Respiration

Capillary gas exchange in body tissues	
Partial pressures and diffusion gradients are reversed compared to external respiration	pO2 in tissue is always lower than in systemic arterial blood
	pO2 of venous blood in 40mmHg
	pCO2 is 45mmHg

External Respiration

Exchange of O2 and CO2 across the respiratory membrane	
Influenced by:	Partial pressure gradients
	Gas solubilities
	Ventilation-perfusion (V/Q) coupling
	Structural characteristics of the respiratory membrane

Control of Respiration

Medullary Respiratory Centres	Pontine Respiratory Centres	Chemical Factors
Involves neurons in the reticular formation of the medulla and pons	Influence and modify activity of the VRG	**Influence of pO2**
1. Dorsal respiratory group (DRG)	Smooth out tradition between inspiration/expiration and vice versa	▸ Peripheral chemoreceptors in the aortic and carotid bodies are O2 sensors
▸ Near the root of cranial nerve IX		*(when excited, they cause respiratory centres to increase ventilation)*
▸ Integrates input from peripheral stretch and chemoreceptors		▸ Substantial drops in arterial pO2 (to 60mmHg) must occur in order to stimulate increased ventilation
2. Ventral respiratory group (VRG)		**Influence of arterial pH**

Control of Respiration (cont)

▸ Rhythm-generating and integrative centre	▸ Can modify respiratory rate/rhythm even if CO2 and O2 levels are normal
▸ Sets eupnea (12-15 breaths/min)	▸ Decreased pH may reflect CO2 retention, accumulation of lactic acids, excess ketone bodies in diabetic Pts
▸ Inspiratory neurone excite the inspiratory muscles via the phrenic and intercostal nerves	▸ Respiratory system controls will attempt to raise the pH by increasing respiratory rate and depth
▸ Expiratory neurone inhibit the inspiratory neurone	

Oxygen Transport

Molecular O2 is carried in the blood	1.5% dissolved in plasma
	98.5% loosely bound to each Fe of haemoglobin (Hb) in RBCs
	4x bound O2 per Hb
O2 and Hemoglobin	Oxyhemoglobin (HBO2): hemoglobin-O2 combination
	Reduced hemoglobin (HSB): haemoglobin that has released O2
Influence of pO2 on Hemoglobin Saturation	Oxygen-hemoglobin dissociation curve
	Shows how binding and release of O2 is influenced by the pO2
Hemoglobin Saturation Influencing Factors	
Increases in temperature, H+, pCO2, and 2,3-biphosphoglycerate (BPG)	Modify Hb structure decreasing affinity for O2
	Occur in systemic capillaries

Oxygen Transport (cont)

Increases O_2 unloading

Shifts HbO_2 dissociation curve to the right

Decreases in these factors shift the curve to the left by decreasing O_2 unloading

Carbon Dioxide Transport

CO_2 is transported in the blood in three forms	7-10% dissolved in plasma
	20% bound to globin of Hb *(carbaminohemoglobin)*
	70% transported as bicarbonate ions *(HCO_3^-)* in plasma
CO_2 combines with water to form carbonic acid (H_2CO_3), which quickly dissociates	$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$
In systemic capillaries	HCO_3^- quickly diffuses from RBCs into plasma
	Chloride shift occurs when outrush of HCO_3^- from the RBCs is balanced as Cl^- moves in from plasma
In pulmonary capillaries	HCO_3^- moves into RBCs, binds with H^+ to form H_2CO_3
	H_2CO_3 is split by carbonic anhydrase into CO_2 and H_2O
	CO_2 diffuses into the alveoli