Physiology Values

"Respiratory Block"

Important Units:

1 L = 1000 ml

1 meter = 3 feet

10 meters under sea = 1 atm

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Pressure Changes in Lungs During Breathing

Intra-alveolar (intrapulmonary) **pressure**	
Between breathes	0
During inspiration	-1 mmHg
End of inspiration	0
During expiration	+1 mmHg
Intrapleural pressure (IPP)	
End of normal expiration *(between breathes)*	-5 cm H_2O
Resting inspiration	-7.5 cm H_2O
Forced inspiration	-20 *to* -40 cm H_2O
Forced expiration	+30 cm H_2O
Transpulmonary pressure	TPp = Palv – Ppl
Compliance of lung	
Both lungs in adult	200 ml/cm H_2O
Lungs and thorax	110 ml/cm H_2O

Lung Volumes and Capacities

Lung volumes	
Tidal	500 ml
Inspiratory Reserve (IRV)	3000 ml
Expiratory Reserve (ERV)	1100 ml
Residual	1200 ml
Lung capacities	
Inspiratory (IC) *(TV+IRV)*	3500 ml
Functional Residual (FRC) *(ERV+RV)*	2300 ml
Vital (VC) *(TV+IRV+ERV)*	4600 ml
Total Lung (TLC) *(TV+IRV+ERV+RV)*	5800 ml

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FEV_1/FVC Ratio Normal Restrictive *(interstitial pulmonary fibrosis)* Obstructive *(bronchial asthma, emphysema)*	 80% Normal *(80%)* Decreased *(<80%)*
Minute Respiratory Volume (MRV=RR x TV)	6 L/min *usually*
Respiratory Rate Normal Abnormal	 12-18/min 2-4/min
Alveolar Ventilation Dead space *(air in conductive part)* Rate of Alveolar Ventilation *((TV-Dead Space) x RR)*	 150 ml 4.2 L/min

Lung Function in Health and Disease

Decline in FEV_1 after age of 30 Non-Smoker Smoker	 25-30 ml/year 60-70 ml/year

Gas Transfer and Diffusion

Diffusion Coefficient O_2 CO_2 NO_2	 1 20 0.53
Concentration in Alveoli O_2 at rest O_2 during exercise CO_2 normal excretion	 250 ml 1000 ml 200 ml/min

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Partial Pressure (in mmHg)

	Atmosphere (760 mmHg)	Air	Alveoli	Arterial Blood (pulmonary capillaries)	Venous Blood (interstitial space)	Tissues
CO_2	0.04%	0.3	40	40	45	46
O_2	21%	160	104	95	40	20

Due to:
1- Mixing w/old air.
2- O_2 absorbed from alveolar air into pulmonary blood.
3- CO_2 diffused from pulmonary blood into alveoli.
4- -Dry atmospheric air is humidified.

Due to:
1- Physiological Shunt

Hypoxia and Cyanosis

Hypercapnea	PCO_2 above 52 mmHg *(decrease pH)*
Cyanosis	more than 5 g/dl reduced *(deoxygenated Hb)* in blood
Pulmonary blood flow rate	5 L/min
Ventilation-perfusion ratio *(V/Q)*	
Average *(across lung)*	0.8
Apex *(moderate physiological dead space)*	3
Base *(physiological shunt)*	0.6

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Gas Transport

O_2 in 100 ml of Blood	
Blood 100% saturated with O_2	
1 ml of Hb carries	1.34 ml
O_2 Content	20 ml
Blood 97% saturated with O_2	
O_2 Content	19.4 ml
O_2 Released from Hb to Tissue *(per 100 ml of blood)*	
Normal condition	5 ml
O_2 in Venous Blood	14.4 ml
During Strenuous Exercise *(increased by 3 folds)*	15 ml
O_2 in Venous Blood	4.4 ml
At Rest	
O_2 consumed by tissue	250 ml/min
CO_2 produced by tissue	200 ml
O_2 Transport in Blood	
Dissolved in Plasma	3%
Bound to Hb *(oxyhemoglobin)*	97%

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P50 Normal Fetal Hb	 26.5 mmHg 20 mmHg
Utilization Coefficient Rest Exercise	 25% 75%-85%
Dissolved O_2 *(3%)* **per 100 ml blood** Normal Arterial PO_2 *(95 mmHg)* PO_2 Falls *(40 mmHg)* Normally transported to tissue	 0.29 ml 0.12 ml 0.17 ml
CO_2 Transport Forms *(CO_2 from tissue each 100 ml blood)* Dissolved Bicarbonate Ions Carbaminohemoglobin *(with Hb)*	 4 ml/min 7% 70% 23%
Blood pH *(during CO_2 transport)* Arterial Venous Arterial and Venous change	 7.41 7.37 *(higher PCO_2)* 0.04
Respiratory Quotient Normal Diet Carbohydrate Diet Fats Diet	 82% = 0.825 1 0.7

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Diffusion Capacity

	Rest	Exercise *(both increase 20 folds)*	If difference across respiratory membrane is (11 mmHg)	Tissue Consumption
O_2	21 ml/min/mmHg	65 ml/min/mmHg	230 ml/min	250 ml/min
CO_2	400 ml/min/mmHg	1200-1300 ml/min/mmHg		

Exercise Duration and Energy Source

Glycogen Lactic Acid System	1.3 – 1.6 min
Phosphagen System	8 – 10 sec
Aerobic System	Unlimited

O_2 Consumption

	Normal	Untrained average male	Athletically trained average male	Male marathon runner	Max pulmonary ventilation	O_2 DEPT	Max breathing capacity
O_2 Consumed	250 ml/min	3600 ml/min	4000 ml/min	5100 ml/min	100-120 L/min	11.5 L	150-170 L/min

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High/Low Altitudes

Effect of Increased Barometric Pressure *(deep diving)* Every 10 m *(33 ft)* deep At 31 m *(100 ft)* deep	*Surrounding pressure increase by* 1 atmosphere *Surrounding pressure increase by* 4 atmosphere
Effect of Depth on Gas Volume 1 L *(sea level)*	½ L *(at 33 ft)*
Effect of Low O_2 Pressure on Body *(ascend)* Sea Level 10,000 ft 50,000 ft	P_{atm}= 760 mmHg 523 mmHg 87 mmHg
Alveolar PO_2 Sea Level 20,000 ft 50,000 ft	PO_2= 159 mmHg PO_2= 40 mmHg PO_2= 18 mmHg
Effect of Acute Hypoxia Beginning of Hypoxia Beginning of twitching/convulsions Un-acclimatized person into come	12,000 ft 18,000 ft 23,000 ft

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