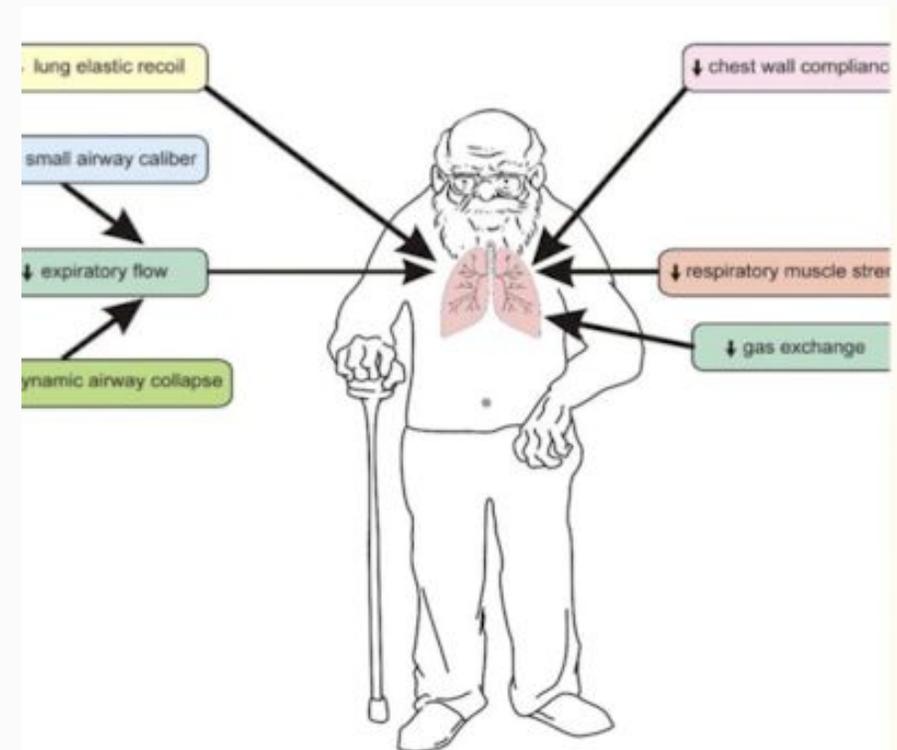
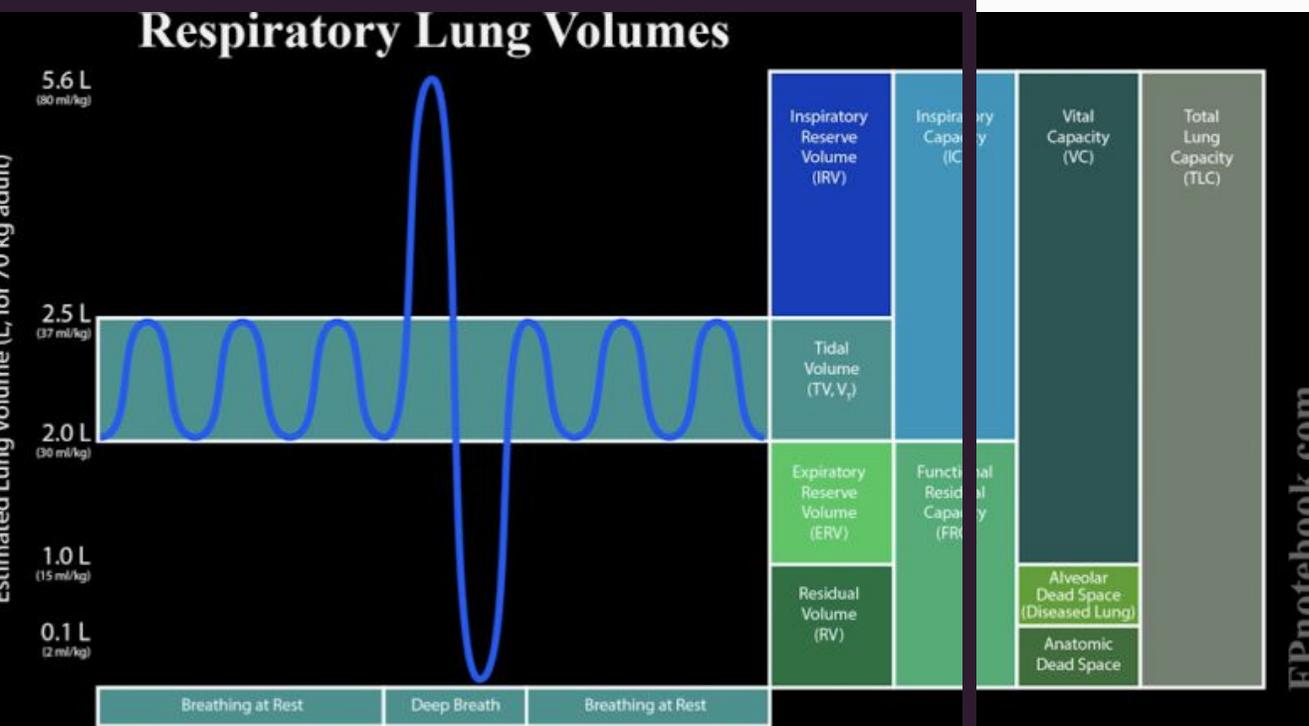


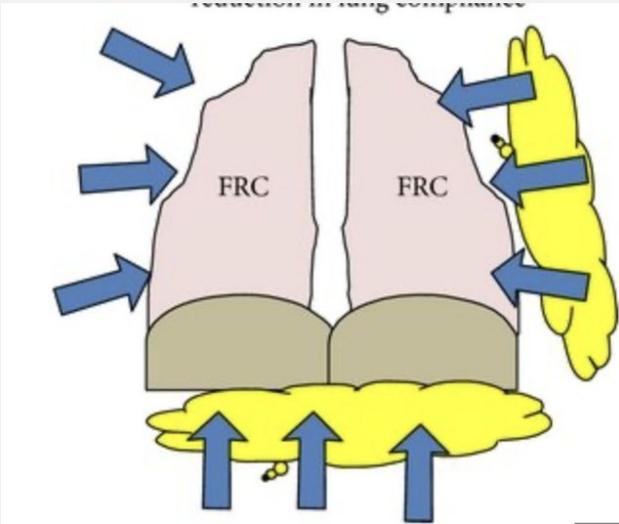


BREATHING IN SPECIAL CIRCUMSTANCES

OLD AGE

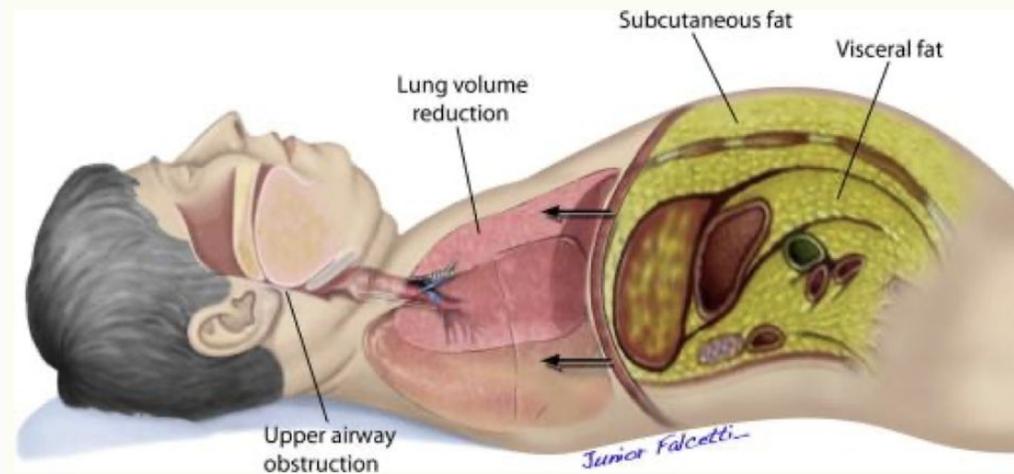
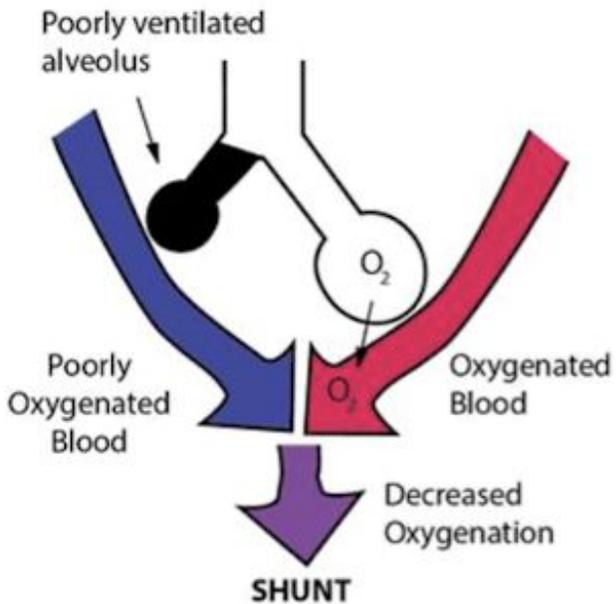
- Decreased Elastic recoil of lung tissue and chest wall compliance
- Respiratory muscle strength decreased
- Residual volume increases
- Decreased Vital capacity and decreased FEV1





Obesity

- Upper airway restriction and lung volume reduction = decreased functional residual capacity (volume in lungs after normal exhalation) – due to excess visceral fat in abdominal cavity
- Increases risk of atelectasis (collapsed alveoli = example of shunting)
- Alveoli have little volume – V/Q mismatching (shunt – alveoli stops gas exchange)



Fear

Effects of adrenaline on organs and tissues in the body

ORGAN	EFFECT	RECEPTOR TYPE
Heart	Increase heart rate	β_1
	Increased contractility	β_1
Blood vessels	Vasoconstriction	α_1
	Vasodilation	β_2
Lungs	Bronchodilation	β_2
Uterus	Relaxation	β_2

- The hypothalamus sends signals once body under stress
- Sympathetic NS stimulates adrenal medulla to secrete adrenaline/noradrenaline – increases alertness, blood flow to muscles, respiration rate and cardiac output (fight or flight)
- Stimulation of corticotrophs (by CRH) causes release of ACTH which stimulates release of cortisol from the adrenal cortex – increasing glucose metabolism and suppressing the immune system

Respiration

Infancy

Initiation of breathing

- **Mechanical** – The compression from the vaginal canal forces any remaining fluid out of

the neonate's lungs

- **Chemical** – Cutting of the umbilical cord results in asphyxia (CO₂ increase, O₂ decrease,

pH decreases = acidosis). This acidotic state is detected by chemoreceptors and

respiratory centres in the medulla initiate breathing

- **Sensory** – Decrease in temperature, stimulation of nerve endings in the skin,

experiencing light and sound in the extrauterine environment all stimulate breathing

Changes during Birth

Normal Ranges for Arterial Blood Gases

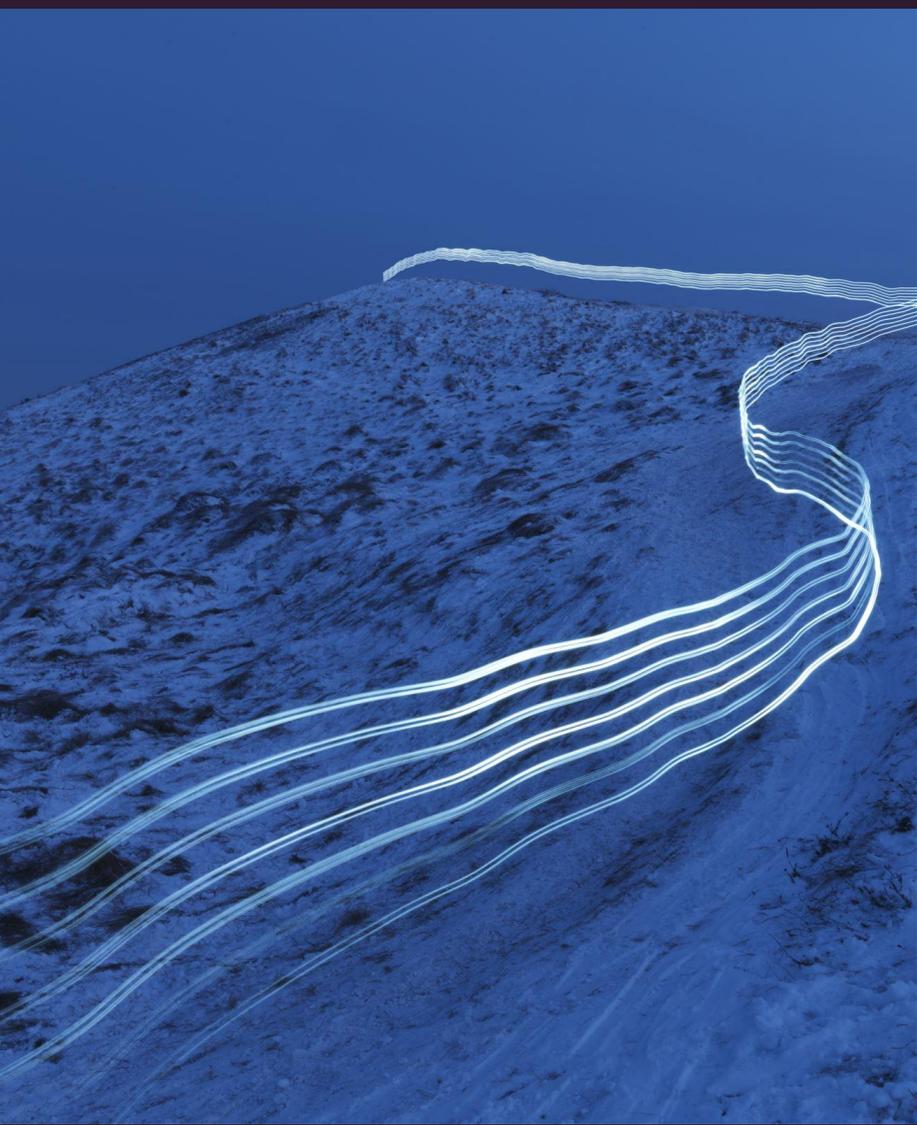
- pH = 7.35-7.45
- pCO₂ = 35-45mmHg
- HCO₃⁻ = 22-26mEQ/L

Diaphragm moves up by 4cm. Ribs flare out = A-P dimension ● Tidal volume (amount of air that moves in and out of lungs) increase by 200ml, resulting in a 5% increase in vital capacity and a 20% decrease in residual volume.

- Respiratory rate does not change
- The end result is an increase in ventilation and a decrease in PaCO₂
- The PaO₂ is essentially unchanged

Pregnancy as a state of compensated resp alkalosis:

- Decrease in PaCO₂ = more bicarbonate = alkalosis
- To compensate for this change, there is a decrease in Bicarbonate ions
- However, this allows the pH to remain unchanged during pregnancy (hence



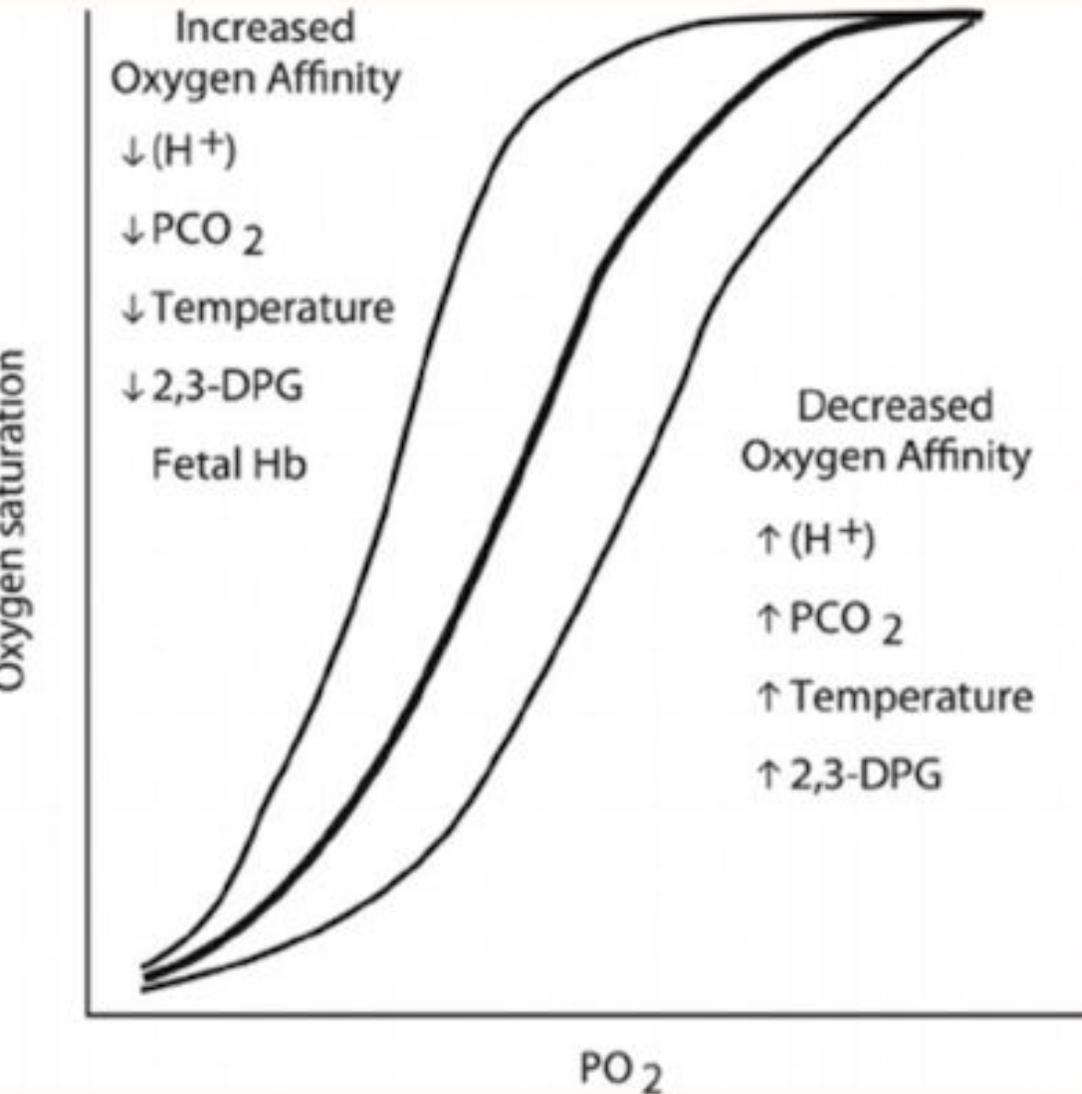
Altitude

- Falling PAO_2 reduces the partial pressure gradient driving O_2 uptake and causes hypoxia
- PP of all constituents of air decreases with altitude

Acute Response

- Hypoxia sensed by peripheral chemoreceptors (in aortic arch) and the respiratory centre responds by increasing ventilatory drive which increases oxygen uptake and carbon dioxide emission
- Respiratory centre also suppresses the cardioinhibitory centre – increasing heart rate/cardiac output and hence increasing oxygen uptake by pulmonary perfusion

Adaptive



The central chemoreceptors adapt slowly allowing ventilation rates to climb to address altitude-induced hypoxia

- This decreases PaCO₂ causing respiratory alkalosis
- Kidneys compensate by decreasing acid secretion and blood pH renormalizes
- Alkalosis also stimulates 2,3-DPG production
- 2,3-DPG decreases Hb's O₂ affinity, causing O₂ Hb dissociation curve to shift to the right and this enhances O₂ unloading to tissues

Acclimation

Takes months to years

- Hypoxia will stimulate erythropoietin to be released from kidneys

increase amount of Hb → increases blood's O₂ carrying capacity by 50%

- Hypoxia stimulates angiogenesis → capillary density and perfusion will

increase



Diving

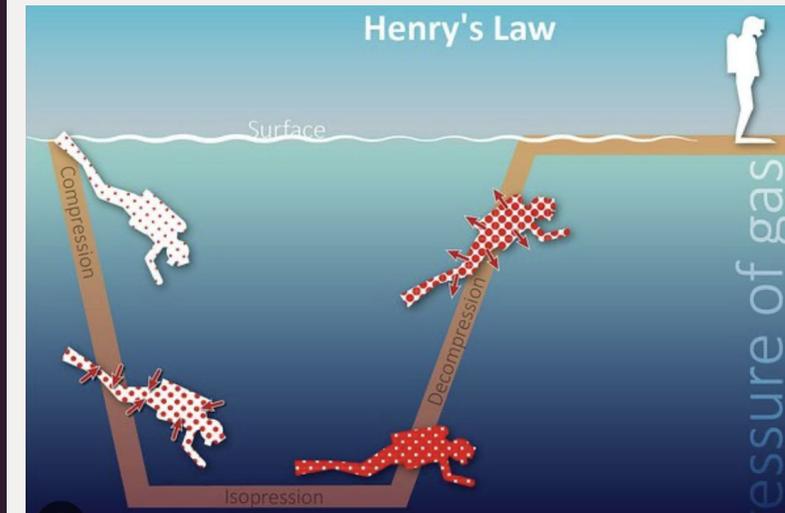
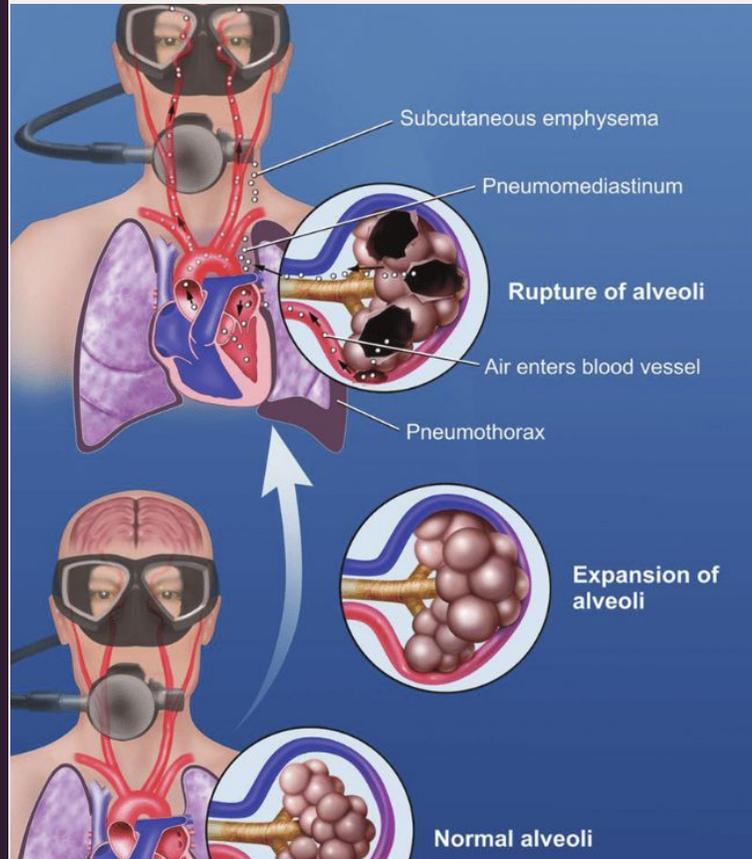
● Increased depth \square compresses gas within alveoli \square increase partial pressure of gases but decreases alveolar volume

● At sea level, only CO₂ and O₂ can dissolve in blood but at depths other gases like N₂ can dissolve in blood

● Pressurising a gas decreases its volume – when a diver resurfaces this can cause severe damage to the tissues that contain the gas

● Nitrogen Narcosis \square N₂ dissolves in blood and disrupts cell membranes ion channels

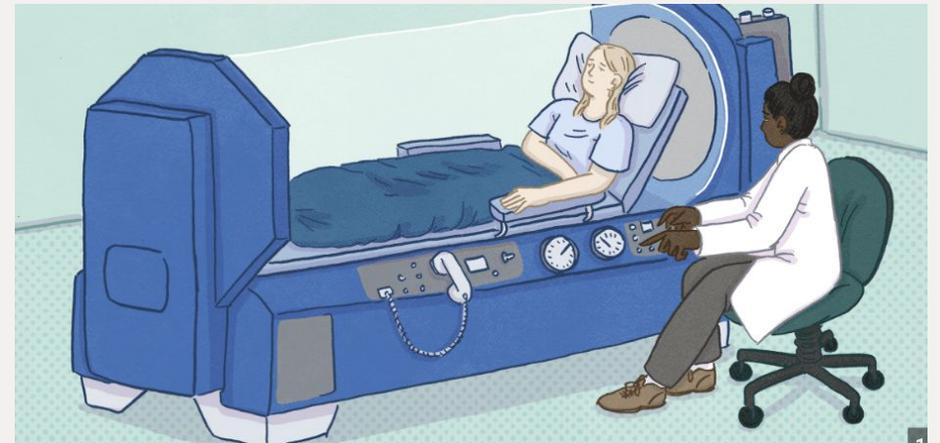
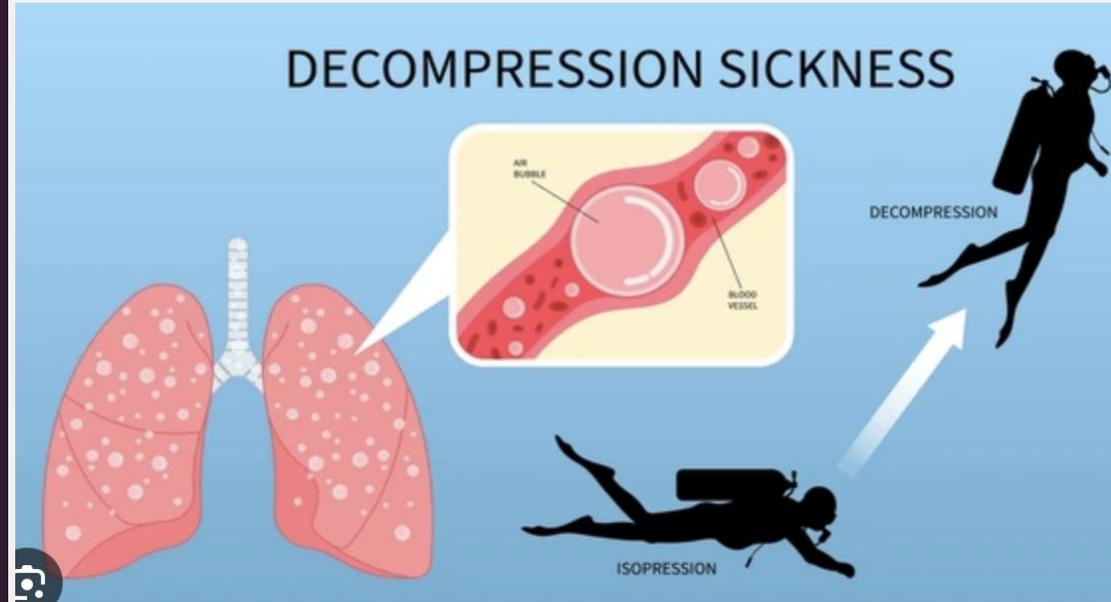
● Oxygen Poisoning \square O₂ can be toxic due to free radicals damaging cells (usually Hb acts as buffer but at depths can be too much for Hb to handle)



Decompression Sickness

With ascension, N₂ comes out and forms bubbles in blood and can form mass in major vessels □ ischaemia

- Can be managed by slow rate of ascent allowing N₂ to dissolve out slowly and be breathed out
- Hyperbaric chamber can be used to treat decompression sickness if ascent was too quick



Breathing in Special Circumstances – Questions

1. With regards to the initiation of breathing; cutting the umbilical cord will result in what?

- a. Acidotic state
- b. Alkalosis
- c. Increased cardiac output
- d. Decrease cardiac output

2. In the adaptive response to altitude change, the alkalosis state of the body will stimulate the production of what?

- a. Erythropoietin**
- b. b. Blood vessels (Angiogenesis)**
- c. c. 2,3-DPG**

ANSWERS:

1)A

2)C

Homeostasis

Lungs Maintaining Acid/Base Balance

- Central chemoreceptors are found in the medulla and they detect changes in H^+ in CSF
- Peripheral chemoreceptors:
 - Carotid chemoreceptors are found at the bifurcation of the common carotid artery and detect change in: PCO_2 , PO_2 and pH

Aortic arch chemoreceptors detect changes in PCO_2 and PO_2

- CO_2 is the most important; it drastically changes H^+ in CSF
- O_2 is only relevant when very/chronically low

Hyperventilation -
decrease in $CO_2 =$
alkalosis

Kidneys: excrete bicarb
to compensate

Hypoventilation -
increase in $CO_2 =$
acidosis

Kidneys: reabsorb Bicarb

Abnormal arterial blood gases



If abnormal consider if its:

- Acidosis/alkalosis? (look at pH/CO₂)

- Respiratory/metabolic? (CO₂ and HCO₃⁻)
 - *Is the imbalance being caused by the lungs or the kidneys*

- Compensated? (is the pH normal = compensated)
 - *Has the body worked to bring the imbalance back to normal*

Normal Ranges for Arterial Blood Gases

- pH = 7.35-7.45
- pCO₂ = 35-45mmHg
- HCO₃⁻ = 22-26mEQ/L

Respiratory or Metabolic?	Acidic or Alkalotic?	pH	P _a CO ₂	HCO ₃ ⁻
Respiratory	Acidosis	Low	High	
Respiratory	Alkalosis	High	Low	
Metabolic	Acidosis	Low		Low
Metabolic	Alkalosis	High		High

Compensated

Respiratory or Metabolic?	Acidic or Alkalotic?	pH	P _a CO ₂	HCO ₃ ⁻
Respiratory	Acidosis	Normal	High	
Respiratory	Alkalosis	Normal	Low	
Metabolic	Acidosis	Normal		Low
Metabolic	Alkalosis	Normal		High

Mrs. Boyle is a 35-year-old female. She reports to the ED in the early morning with shortness of breath. She has cyanosis of the lips. She has had a productive cough for 2 weeks. Her temperature is 102.2, blood pressure 110/76, heart rate 108, respirations 32, rapid and shallow.

•ABG results are:

•pH= 7.43 (7.35 – 7.45)

•PaCO₂= 28 (35-45mmHg)

•HCO₃⁻= 20 (22-26 mEq/L)

a) Uncompensated Respiratory Acidosis

b) Compensated Respiratory Alkalosis

c) Compensated Metabolic Alkalosis

d) Compensated Respiratory Acidosis

Answer

B

A 75 year old gentleman with COPD living in the community is being assessed. His ABG is as follows:

- ABG results are:

- pH= 7.37 (7.35 – 7.45)

- PaCO₂= 52 (35-45mmHg)

- HCO₃⁻= 31 (22-26 mEq/L)

a) Uncompensated Respiratory Acidosis

b) Compensated Respiratory Alkalosis

c) Compensated Metabolic Acidosis

d) Compensated Respiratory Acidosis

D

A 23 year old male comes in following a panic attack and is hyperventilating.

•ABG results are:

•pH= 7.41 (7.35 – 7.45)

•PaCO₂= 26 (35-45mmHg)

•HCO₃⁻= 23 (22-26 mEq/L)

a) Uncompensated Respiratory Acidosis

b) Compensated Respiratory Alkalosis

c) Compensated Metabolic Alkalosis

d) Compensated Respiratory Acidosis

B

Active Vaccines

Administration of an antigen (either a modified infectious agent or a toxin of it) resulting in active adaptive immunity (**long term**)

Passive Vaccines

Administration of an antibody-containing serum (**short term**)

Polysaccharide (PS) Vaccine

Immune response is induced by polysaccharide antigens which are **T-Cell independent** (polysaccharides cannot bind to MHC complexes to be presented to T-Cells). They activate B-Cells directly, but without the T-Cell activation, **no memory B-Cells can be made.**

Conjugate-PS Vaccine

In a conjugate-PS vaccine, there is a carrier protein attached to the PS. Polysaccharides alone cannot be loaded onto the MHC of an APC alone, since MHCs can only bind to proteins. However, in a conjugate-PS, there is now a carrier protein which can bind and activate MHCs on APCs such as T-Cells. This results in T and B Cell activation **memory cells are produced, and long-term immunity is achieved.**

Adjuvant

An adjuvant is a chemical that can be added to any vaccine in order to help the vaccine work better. The adjuvant acts to activate immune cells (e.g. dendritic cells) by binding to **toll-like receptors (TLRs)**, which results in a **stronger immune response**

TYPES OF VACCINATION