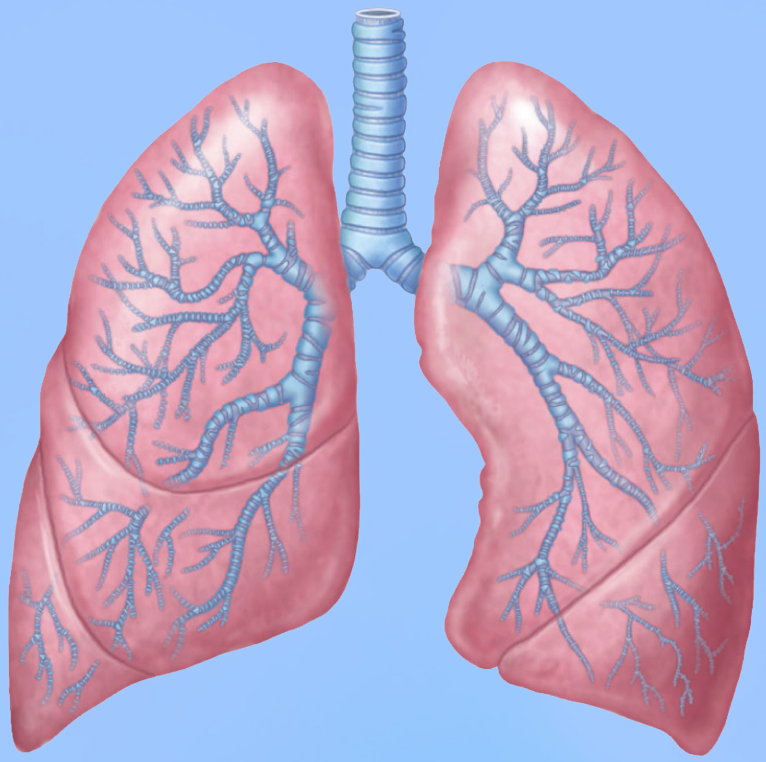
9 EFFECTS OF LOW AND HIGH GAS PRESSURE ON THE BODY

Physiology Team 433



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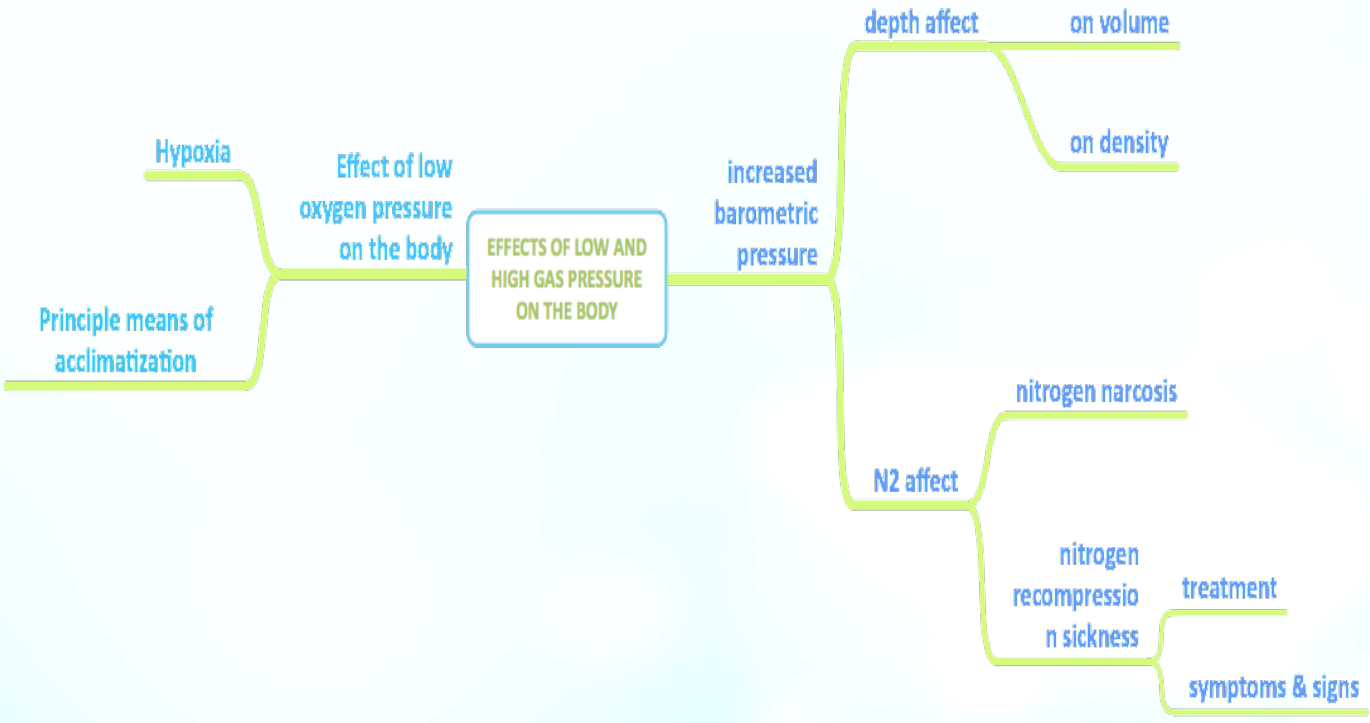
Respiratory Block

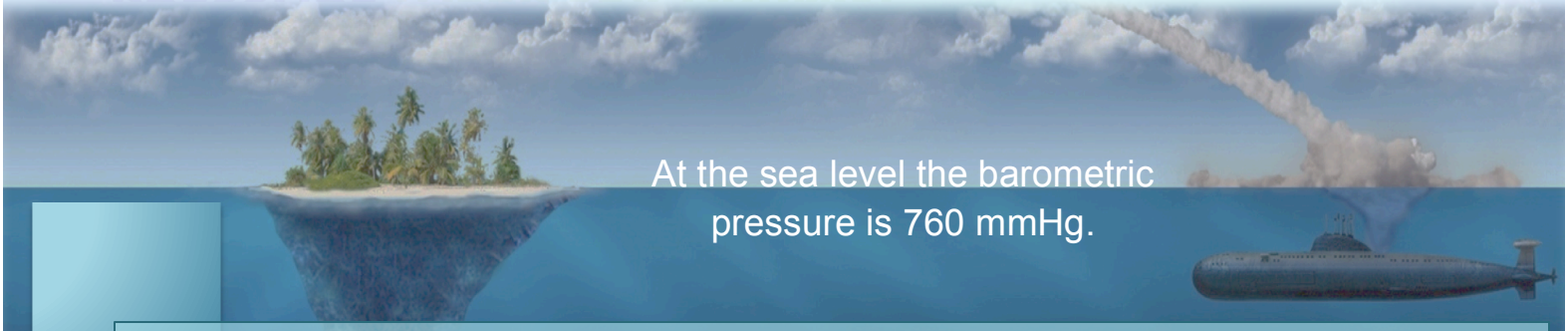
Objectives

- Describe the effect of exposure to how and high barometric pressure on the body.
- Describe the body acclimatization to how barometric pressure.
- Define decompression sickness and explain how it can be avoided.
- Understand the effect of high nitrogen pressure, and nitrogen narcosis.

Mind Map:



FIRST: EFFECT OF INCREASED BAROMETRIC PRESSURE (DEEP SEA DIVING)



At the sea level the barometric pressure is 760 mmHg.

When human descend **below the sea**, the pressure around them **increased**.

To prevent the lungs from collapse, air must be supplied also under high pressure.

Blood be will expose to extremely high alveolar gas pressure (HYPERBARISM)

Under certain limits these high pressures cause tremendous alterations in the physiology of the body.

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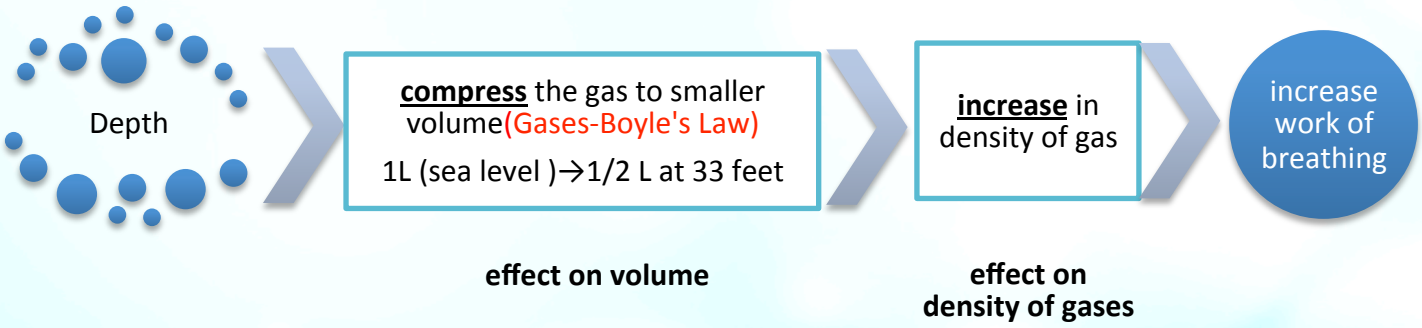
- for every **10 meter** (33 feet) of depth in sea water → surrounding pressure increases by **1 atmosphere**
- at a depth of **31 meter** (100 feet) in the ocean →diver is exposed to a pressure of **4 atmospheres** (the surrounding pressure is 3 + 1 atmospheric pressure)

These problems confront **SCUBA** (self contained under water breathing apparatus).



FIRST: EFFECT OF INCREASED BAROMETRIC PRESSURE (DEEP SEA DIVING)

↑ NITROGEN EFFECT AT HIGH NITROGEN PRESSURE

It has 2 effects:

1-Nitrogen narcosis (Anesthetic effect)

2- Decompression sickness (Cassion's disease)

1

Facts about N_2	**1. Anesthetic gases.** **2. Dissolve freely in the fats of the body (including the membranes and other lipid structures of the neurons) alcohol intoxication.**

Because of it dissolves in fats that leads to :

Alteration of the electrical conductance of the membranes→ reduces their excitability → narcosis develops.

Valuse	At 120 feet	The diver loses many of his cares.
	At 150 feet	There is a feeling of euphoria and drowsiness and impaired performance
	At higher pressure	Loss of coordination and finally coma might develop

2

What is it ? **Syndrome caused by a decrease in the ambient pressure, which occur in animal and men when the tissues of the body contain an excess of physically inert gas.**

during descent: the high partial pressure of nitrogen forces into solution in body tissue particularly in fat

on ascending: the inert gas comes out of physical solution forming a gaseous phase (bubbles), leading to symptoms and signs.

During slow ascent: N_2 is slowly removed from the tissues since the partial pressure there is higher than that in the arterial blood and alveolar gas.

If decompression is rapid: bubbles of gaseous nitrogen are released, in tissues and blood, causing the symptoms of decompression sickness

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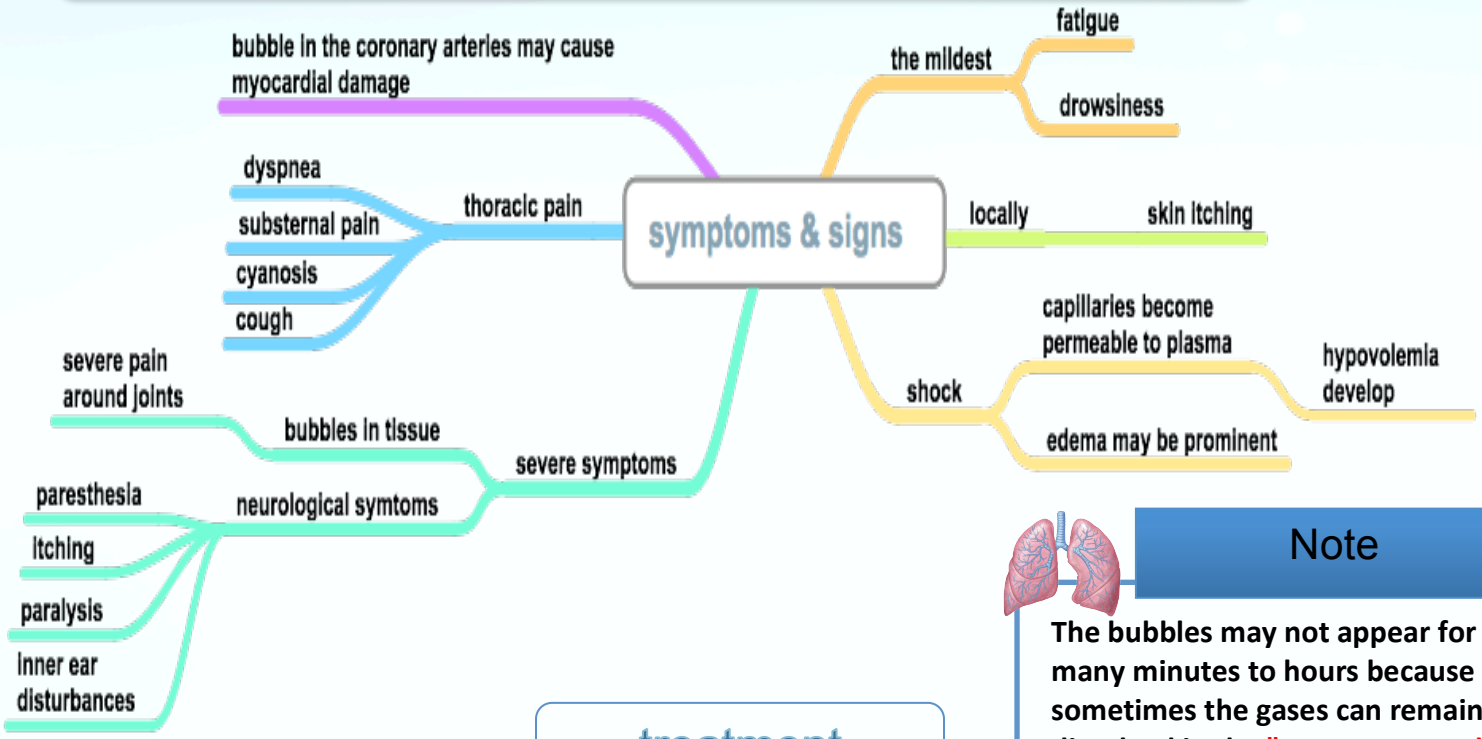
FIRST: EFFECT OF INCREASED BAROMETRIC PRESSURE (DEEP SEA DIVING)

↑ NITROGEN EFFECT AT HIGH NITROGEN PRESSURE

2- Decompression sickness (Cassion's disease)



Note

The bubbles may not appear for many minutes to hours because sometimes the gases can remain dissolved in the "supersaturated" state for hours before bubbling.

treatment

In a very deep dive, the risk of decompression sickness can be reduced if a helium-O2 mixture is breathed during the dive.

- ✓ Rapid **recompression** in a pressure chamber.
- ✓ Followed by **slower decompression.**
- ✓ This reduces the volume of the bubbles and forces them back into solution.

by using this time schedule:
10 minutes at 50 feet depth
17 minutes at 40 feet depth
19 minutes at 30 feet depth
50 minutes at 20 feet depth
84 minutes at 10 feet depth

Features of helium	
	✓ 1⁄4-1/5thenarcoticeffectofnitrogenonCNS ✓ 1/7 the molecular weight of nitrogen. ✓ low density→ ↓ airway resistant ✓ High diffusion through tissues.(so it can leaves the tissue easly) ✓ 1/2 as soluble as nitrogen in body fluids→↓ the quantity of bubble that can form in tissue when decompressed.

SECONED: EFFECT OF LOW OXYGEN PRESSURE ON THE BODY (AVIATION- ASCEND TO HIFG ALTITUDE)

Decrease in barometric pressure is the basic cause of all the hypoxia problems in high altitude

level	Symptoms
12,000 feet (where hypoxia begins)	Drowsiness, lassitude, mental and muscle fatigue, sometimes headache, occasionally nausea and sometimes euphoria.
Above 18,000.	Twitching or convulsions
Above 23,000	un acclimatized person can enter into coma.

hight	barometric pressure	PO2
At sea level	760 mmHg.	159 mmHg(97% saturated)
At 10,000 feet-20,000 feet	523 mmHg	40 mmHg(90%-less than 70% saturated)
At 50,000 feet	87 mmHg.	18 mmHg

- ✓ As the barometric pressure decreases, the oxygen partial pressure decreases proportionally, remaining less than 21 % of the total barometric pressure.
- ✓ at high altitude CO2 is continuously excreted from the pulmonary blood into the alveoli. Also, water vaporizes into the inspired air from the respiratory surfaces.
- ✓ These two gases dilute the oxygen in the alveoli, thus reducing the oxygen concentration and therefore hypoxia develops.

- ✓ A person remaining at high altitudes for days, weeks or years becomes more and more acclimatized to low PO2
- ✓ So that it causes fewer deleterious effects on the body and it becomes possible for the person to work harder without hypoxic effects or to ascend to still higher altitude

SECONED: EFFECT OF LOW OXYGEN PRESSURE ON THE BODY (AVIATION- ASCEND TO HIFG ALTITUDE)

PRINCIPLE MEANS OF ACCLIMATIZATION

Increase in pulmonary ventilation. (Hyperventilation). **About 1.65 times.**

Increase red blood cells [1].

Hemoglobin 15 g/dl to about 20 g/dl
Haematocrit 40-45 an average of about 60

Increased diffusing capacity of the lungs (by opening all the pulmonary capillaries and alveoli).

Increase vascularity of the tissues.
-increased cardiac output
-increased numbers of systemic circulatory capillaries

Increased ability of the cells to utilize oxygen despite the low PO2.

Note

(1) kidney secret erythropoietin→bone marrow→increase RBC formation

HOW OUR BODIES ACCLIMATIZE AT HIGH ALTITUDE

1- immediate: peripheral chemoreceptors will respond to the low P_{CO_2} (Carotid bodies) → Hyperventilation → ↓ PCO_2 of arterial blood → ↑ fresh air to alveoli → respiratory alkalosis (↑PH) → ↑ affinity of hemoglobin to oxygen → better O_2 loading in lung

2- days: ↑ 2,3-DFG in RDC → ↓ affinity between Hg & O_2 → ↑ O_2 unloading to tissue

3- days to weeks: kidney → ↑ erythropoietin → bone marrow → ↑ RDC & Hg → ↑ O_2 content of blood

Q1: risk of decompression sickness can be reduced by using which of the folloing mixtures:

A- O_2-He

B-O_2-N_2

C-O_2-H

Q2: As we decent beneath the sea, volumes of gases will become smaller and smaller due to compression of gases, which of the following physics principles described what happen?

A-Bernoulli's principle

B- Dalton's law

C- Boyle's law

Q3: at high pressures nitrogen can cause varying degrees of:

A-narcosis

B-necrosis

C-death

Q4-which of the following is NOT a principle of acclimatization:

A-Increase in Red Blood Cells and Haemoglobin Concentration

B- increase in pulmonary ventilation

C- decreases vascularity of the tissues.

D-increased diffusing capacity of the lungs

Q5:What will happen to the barometric pressure and PO2 at high altitude?

A- ↑ the barometric pressure proportionally ↓ (Po2)

B- ↓ the barometric pressure proportionally ↓ (Po2)

C-Nothing will change

Q6: Breathing air under high pressure for a long period of time can increase which of the following in the body fluid:

A- Sodium

B- nitrogen

C- chloride

Q7: Which of the following is NOT correct about the helium?

A- Higher density than nitrogen

B- High diffusion through tissue

c- it has less narcotic affect than nitrogen

Q8: Effects of hypoxia beginning at which of the following levels (approximately)

A- 12,000 feet.

B- 21,000 feet.

C- 20,000 feet.

Answers: 1-A, 2-C, 3- A, 4-C, 5-B, 6-B, 7-A, 8- A

Summary

Describe the effects of exposure to low and high barometric pressures on the body.

Deep sea diving :When human descend below the sea, the pressure around them increased.

high altitude :As the barometric pressure decreases, the oxygen partial pressure decreases proportionally

Describe the body acclimatization to low barometric pressure.

1-Increase in pulmonary ventilation.

2- Increased red blood cells.

3-Increased diffusing capacity of the lungs.

4- Increased vascularity of the tissues.

5-Increased ability of the cells to utilize oxygen despite the low PO2.

Definedecompression sickness and explain how it can be avoided.

It is a syndrome caused by a decrease in the ambient pressure

1-Rapid recompression in a pressure chamber followed by slower decompression.

In a very deep dives, the risk of decompression sickness can be reduced if a helium-O2 mixture is breathed during the dive..

Understand the effects of high nitrogen pressure, and nitrogen narcosis.

Nitrogen like most other anesthetic gases, dissolve freely in the fats of the body including the membranes and other lipid structures of the neurons.

eads to alteration of the electrical conductance of the membranes, reduces their excitability and subsequent narcosis develops.

ALTITUDE ADAPTATION OF CENTRAL CHEMORECEPTORS (10:06)

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