AIDA International freediving

AIDA3 FREEDIVER

INTERMEDIATE FREEDIVER COURSE

Your AIDA Instructor

Name

Age

Background / Profession

AIDA Instructor since

Who are you?

Please introduce yourself to your buddies and to your instructor!

AIDA International

Association **I**nternationale pour le
Développement de l'**A**pnée

Non-profit Organization

Founded 1992

- Education Program
- Safety Standards
- Competitions and World Records

AIDA International freediving

Introducing AIDA3

Learn how to train as a freediver

Introducing free fall

Basic approach:
The "numbers" in freediving are the result of good technique.
They are never the result of pushing beyond your limits.

Prerequisites:
- 18 (16) years old
- AIDA2 Freediver Course completed or
  AIDA Crossover Evaluation passed

AIDA Crossover Evaluation

AIDA2 Freediver Level

- Static (STA): 2+Min
- Dynamic with fins (DYN): 40+m in good technique
- Constant Weight (CWT): 16-20m in good technique
- Free Immersion (FIM) technique demonstration
- Buddying and rescue procedures in all disciplines
- Written AIDA2 Exam >75% pass rate

Evaluation structure

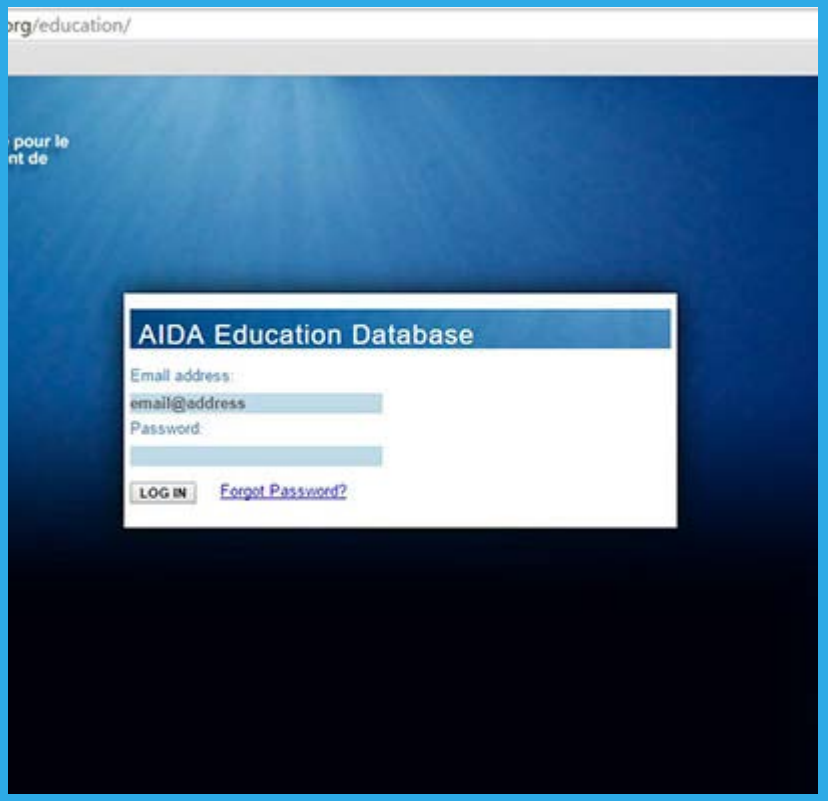
1 Classroom session
1 Pool / confined water session
1 Open water session

Paperwork

Medical statement

Liability release (where applicable)

Registration with EOS



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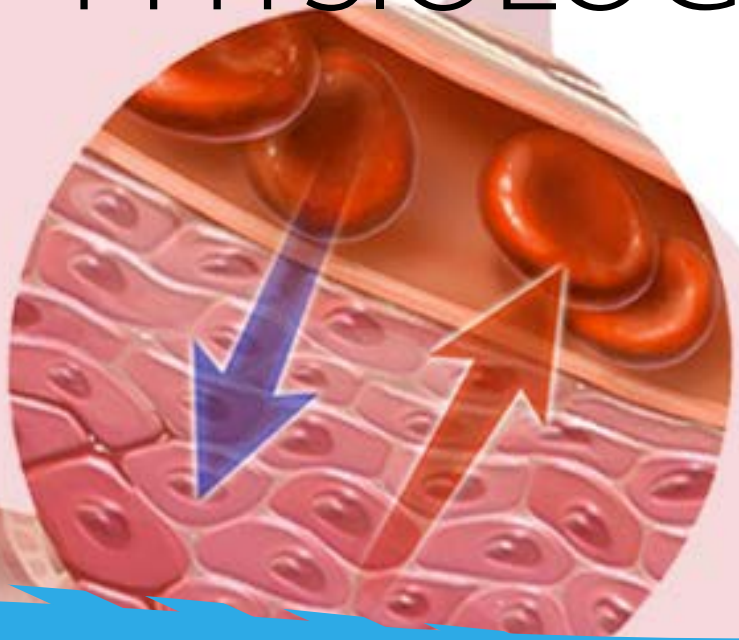
PHYSIOLOGY



Basic Physiology

Blood Composition

Principle of Diffusion

Cardiovascular System

Hyperventilation

Blood Composition

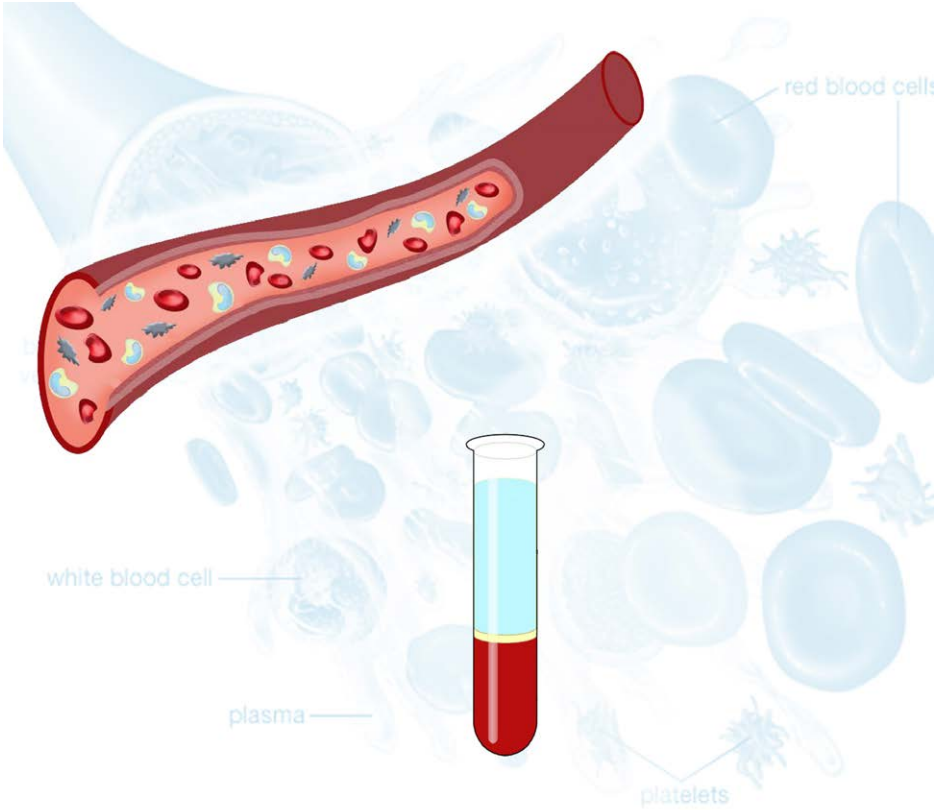
Composition

- 36-54%: Red blood cells
- Blood plasma
- Buffy coat (white blood cells, platelets)

Oxygenated blood: red

Oxygen depleted blood: purple

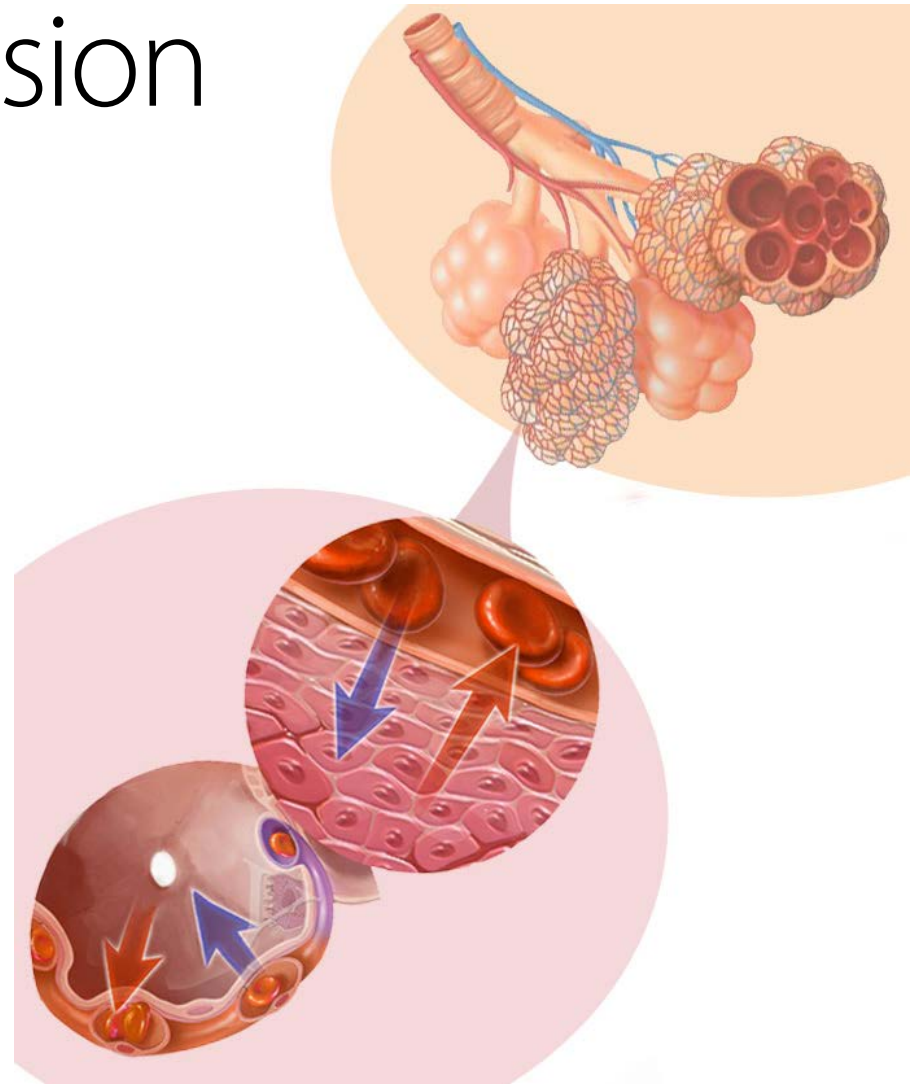
Cyanosis: Blue lips



Principle of Diffusion

Definition

Diffusion is the natural tendency of a gas to move from an area of high concentration to an area of low concentration.



Principle of Diffusion

Gradient

The speed of gas diffusion depends on the steepness of the gradient: The diffusion gradient is the difference of concentration between two areas. The greater the difference, the steeper the gradient, the faster diffusion takes place.

Oxygen & Carbon Dioxide

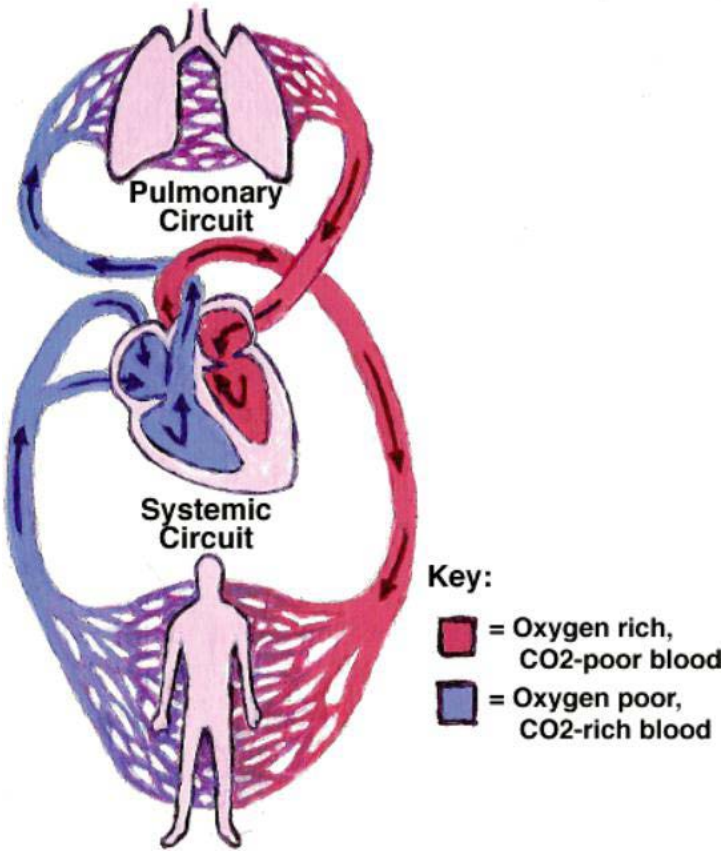
Oxygen (O_2) diffuses from the inhaled air in the alveoli into the alveolar blood and Carbon Dioxide (CO_2) diffuses form the alveolar blood into the air in the alveoli.

Cardiovascular System

Cardiovascular System includes

- Circulatory System
- Respiratory System

Describe the "Journey of O_2 and CO_2 through the body"!



Hyperventilation (Hv)

Definition

Breathing more air than needed to maintain neutral level of CO_2

Effects

- Does not store more O_2
- Delays signals of rising CO_2
- Raises heart rate
- Reduces blood flow to the brain

Bohr effect

Hyperventilation leads to hypercapnia (low CO_2)

Strengthens the bond between haemoglobin and O_2

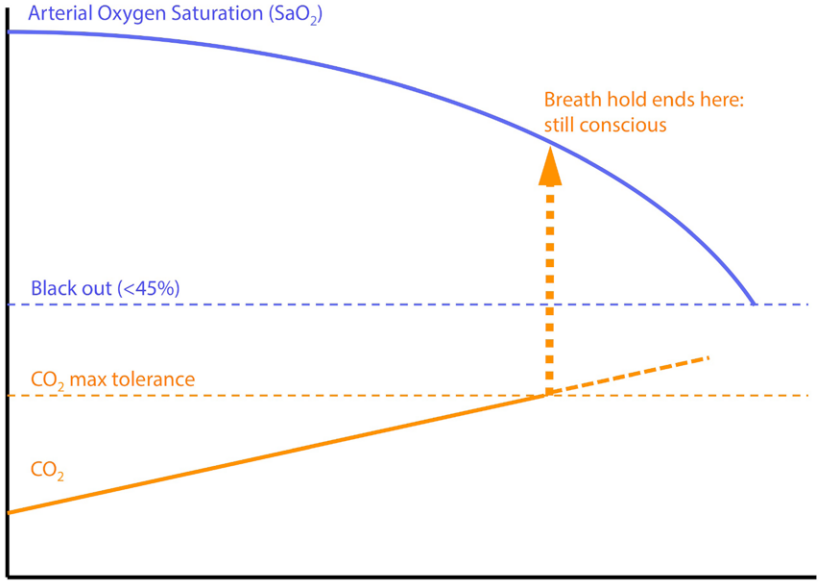
O_2 is thus less likely to be released to tissues

Hyperventilation and Black Out

Static breath hold

- Saturation with Oxygen blue curve: SaO_2
- BO threshold +/- 45% $Sa0_2$ Orange line: CO_2

Black out unlikely, as CO_2 tolerance is reached earlier

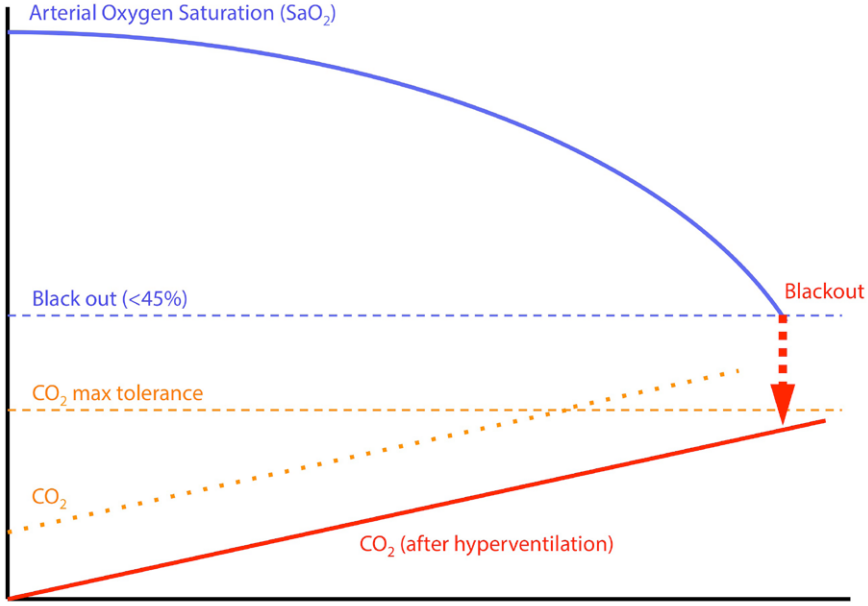


Hyperventilation and Black Out

Hv reduces CO_2 level
(red line)

Symptoms of rising CO_2 delayed

BO-threshold of Oxygen can be reached
Without or reduced signals of rising Carbon Dioxide

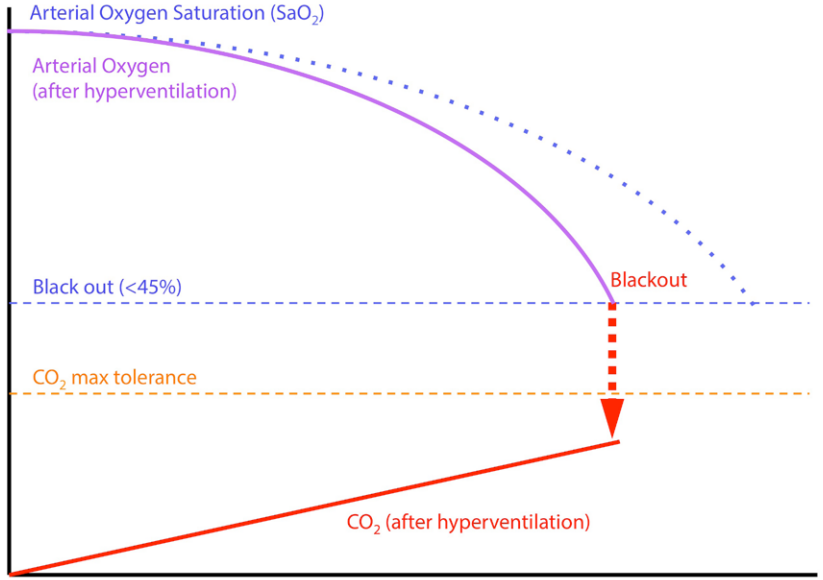


Hyperventilation and Black Out

Low CO_2 delays energy conserving effects:

- Delayed onset of the mammalian dive response (MDR, see later in this presentation)
- Bohr effect

After Hv, a freediver reaches BO-threshold faster



Safely Prolong Dives

Increase tolerance to CO_2

- See chapter "CO_2 tolerance training"

Improve relaxation

- Reduces CO_2 production
- Reduces O_2 consumption

Improve technique to move in water

- Includes all skills learned in AIDA2 : Duck dive, body posture, head position, fin kick, turns, buoyancy, etc.

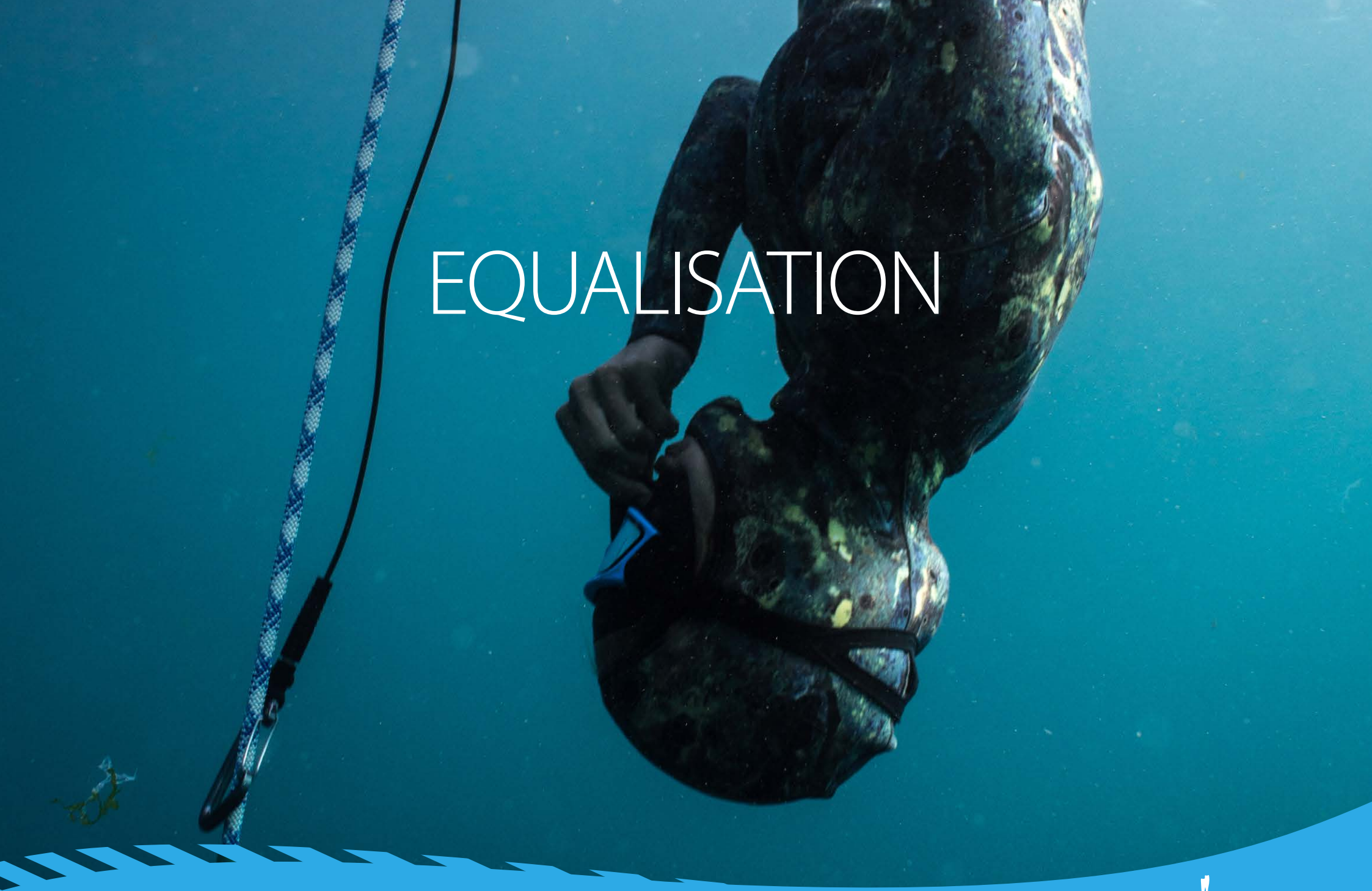
Basic Physiology: Summary

Blood Composition

Principle of Diffusion

Cardiovascular System

Hyperventilation



EQUALISATION

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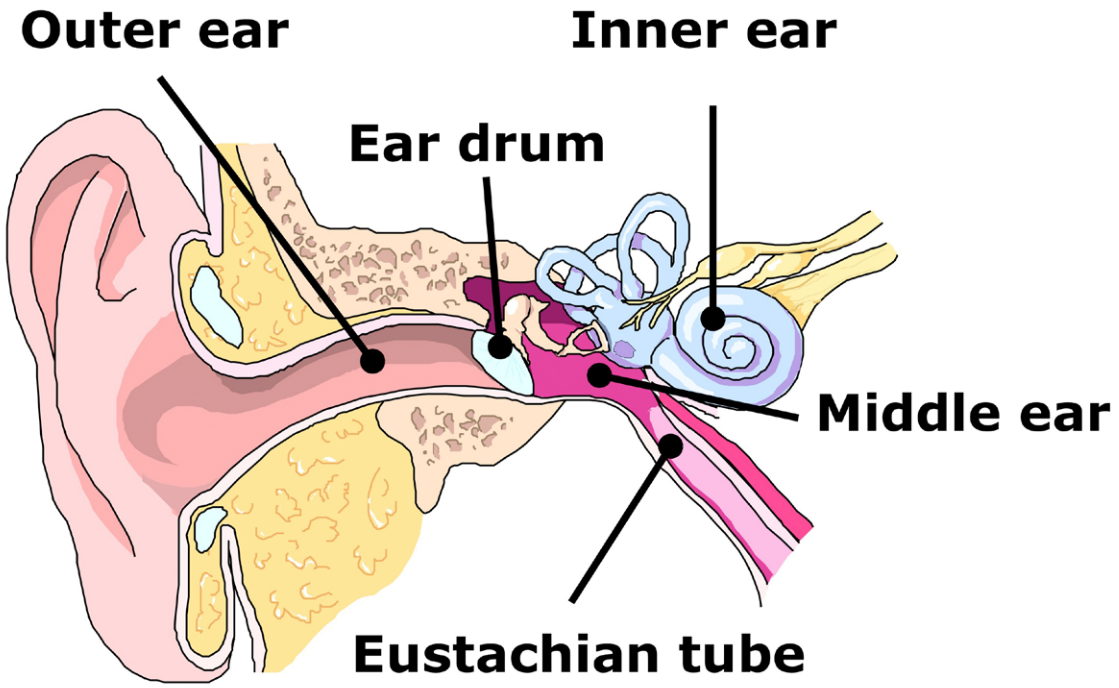
Equalisation

Elements of the Ear

Anatomy of Sinuses

Improving EQ-technique

Elements of the Ear



Anatomy of Sinuses

Hollow spaces

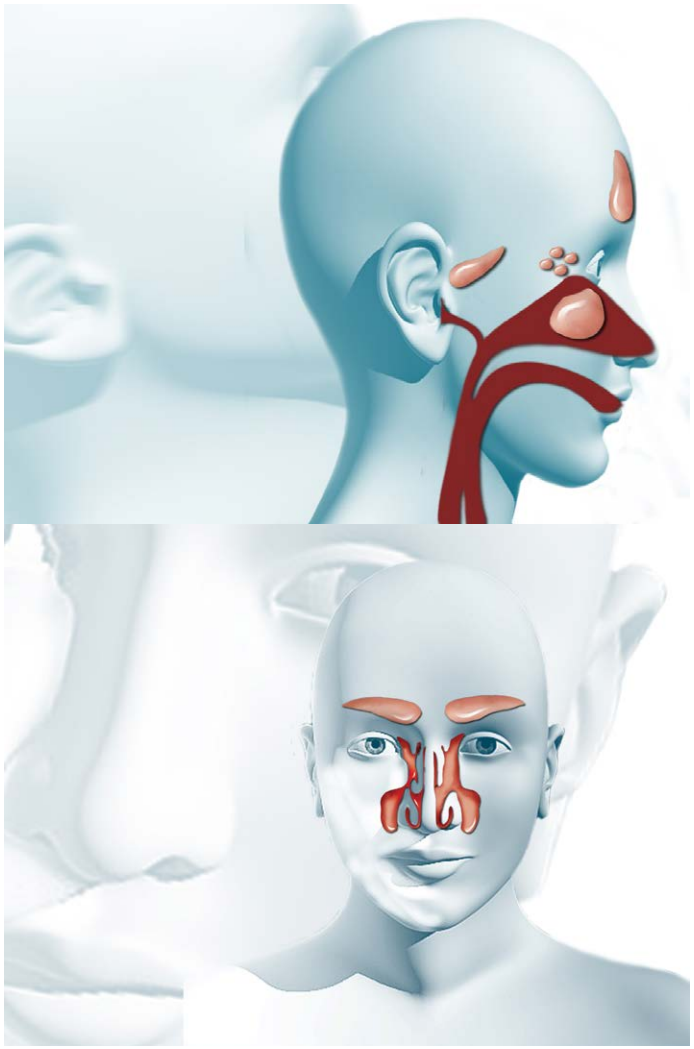
Filled with air

Mucus production

Proper ventilation

Ventilation techniques

- Pranayama



Improving Equalisation

Avoid "Valsalva" beyond beginner level

Learn and apply "Frenzel"

- Breathe calmly through your nose
- Pinch your nose with your fingers
- Pronounce a "T" or a "K"

Equalisation stretching

Ease of equalisation

- Clean technique
- Relax non-active muscles

Equalisation: Summary

Elements of the Ear

Anatomy of Sinuses

Improving EQ-technique

BAROTRAUMA

Barotrauma

Eardrum Perforation and Rupture

Middle Ear Barotrauma

Reverse Block

Hood Squeeze

Sinus Barotrauma

How to avoid blocked Sinuses

Barotrauma

Squeeze = Barotrauma

Failure to equalise

Descending further can lead to one of the injuries described in this chapter

Stay dry until fully healed

Eardrum injury

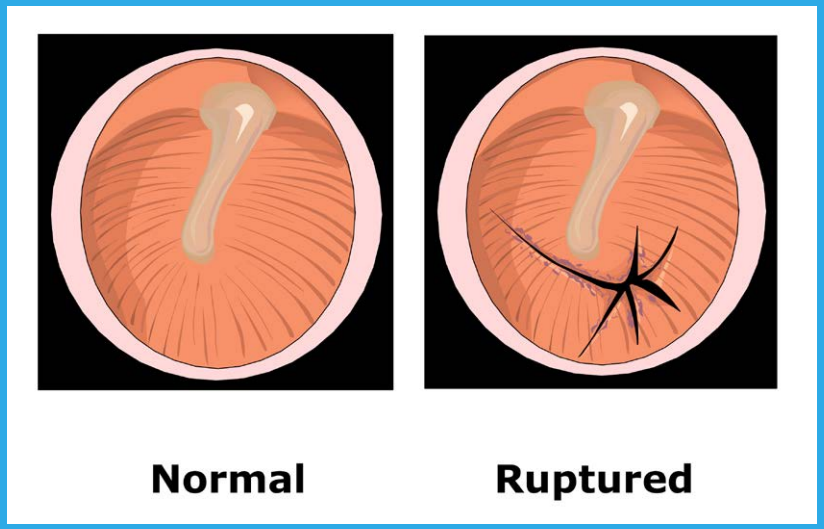
Perforated eardrum: Pinhole

Ruptured eardrum: Large tear

Symptoms

- Sharp pain
- Vertigo / loss of direction
- Temporary / partial loss of hearing
- High risk of infection

Stay dry, see doctor



Middle Ear Barotrauma

Blood forced into middle ear

Symptoms

- Sharp or extreme pain that might persist
- "Full" ear
- Muffled or lost hearing

See doctor

Healing time

- Min. one week
- Up to months
- Risk of middle ear infection

Reverse block

Failure of automatic equalisation on ascent

Sinus or Eustachian tubes blocked

Cause by

- acute or not fully cured infection of the airways
- abuse of decongestant medication

How to react

- Stop ascent
- Do not equalise!
- Stretch the "bad side"
- Ascent slowly using the rope

Hood Squeeze

Well fitting hood

Air trapped in outer ear canal cannot be equalised

Prevention

- Fill ears with water before descent
- Small holes in the hood

Sinus Squeeze

On descent

Blocked sinus(es)
Caused by acute or not fully cured congestion

Stop your descent

Abort the dive

Check for injury
- Blow your nose in your hand
- Check expelled mucus for fresh blood

See doctor
Danger of sinus infection

Avoid blocked Sinuses

Inhale steam

Cleansing Pranayama

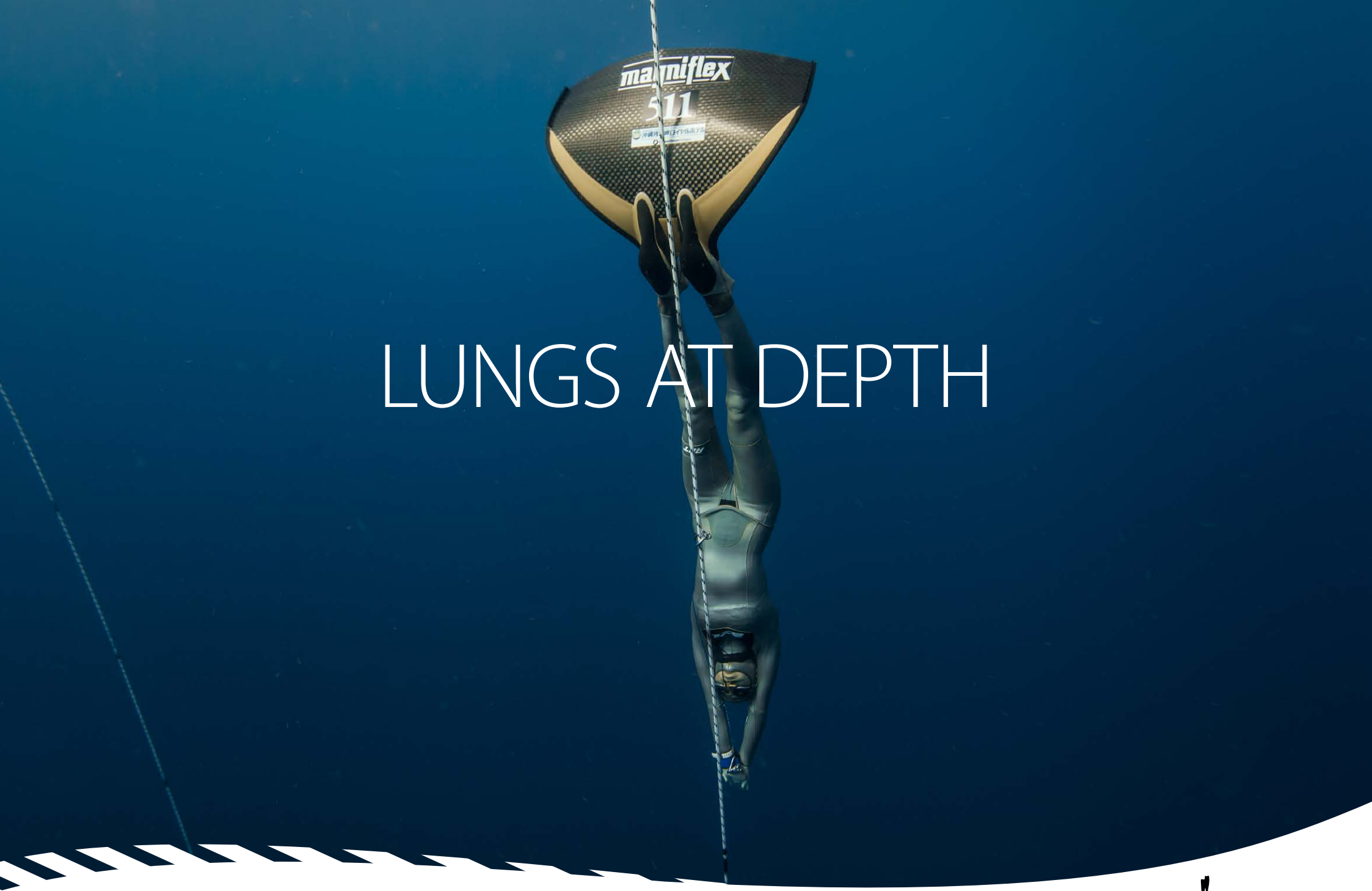
Nasal rinses with Neti pot

Sleep bad side up

SISA (Sudden Interrupt Static Apnea)

Avoid air conditioning

Keep well hydrated



LUNGS AT DEPTH

Lungs at Depth

Lung Measurements

Pressure and Residual Volume (RV)

Lung Barotrauma

Emergency Procedures

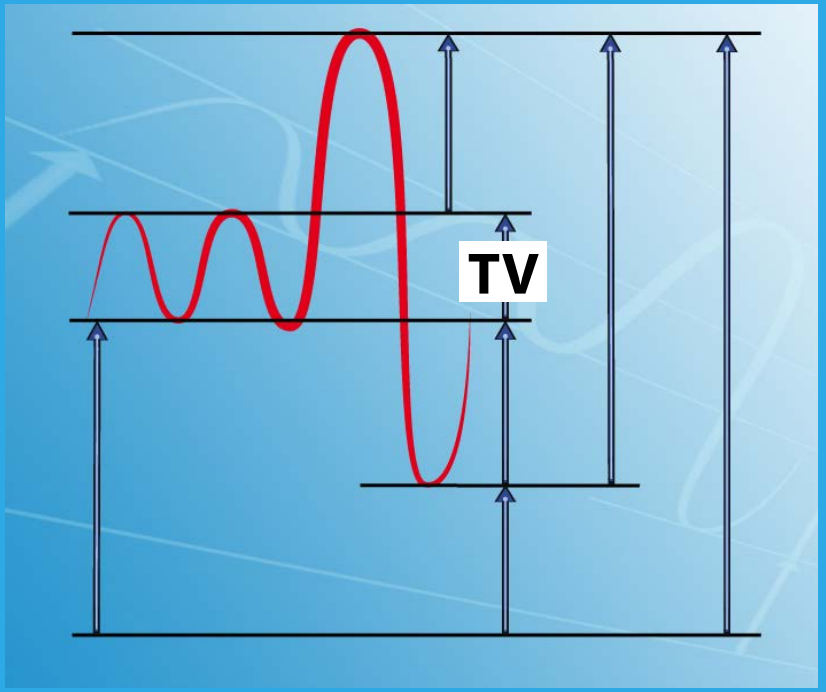
Avoiding Lung Barotrauma

Tidal Volume: TV

Amount of air inhaled and exhaled during normal breathing

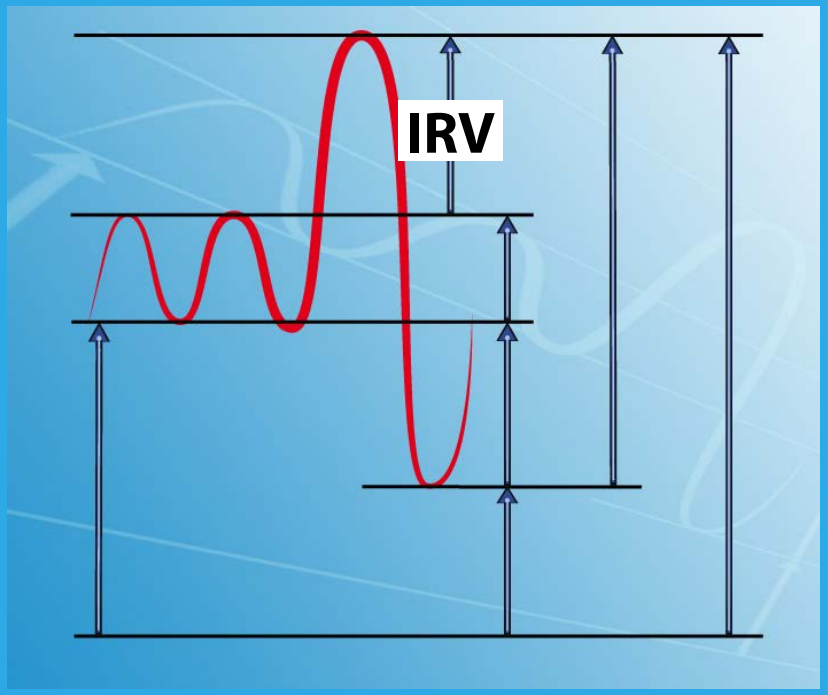
Ca. 500ml, 10-20 times per min

During relaxation phase



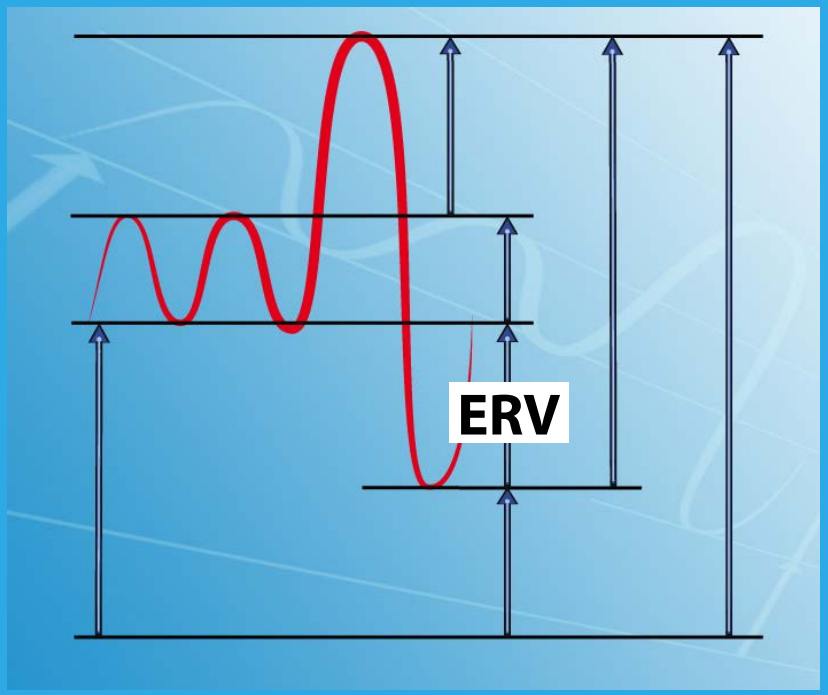
Inspiratory Reserve Volume: IRV

The additional air that can be inhaled after a normal tidal breath in



Expiratory Reserve Volume: ERV

The amount of additional air that can be exhaled after a passive exhale

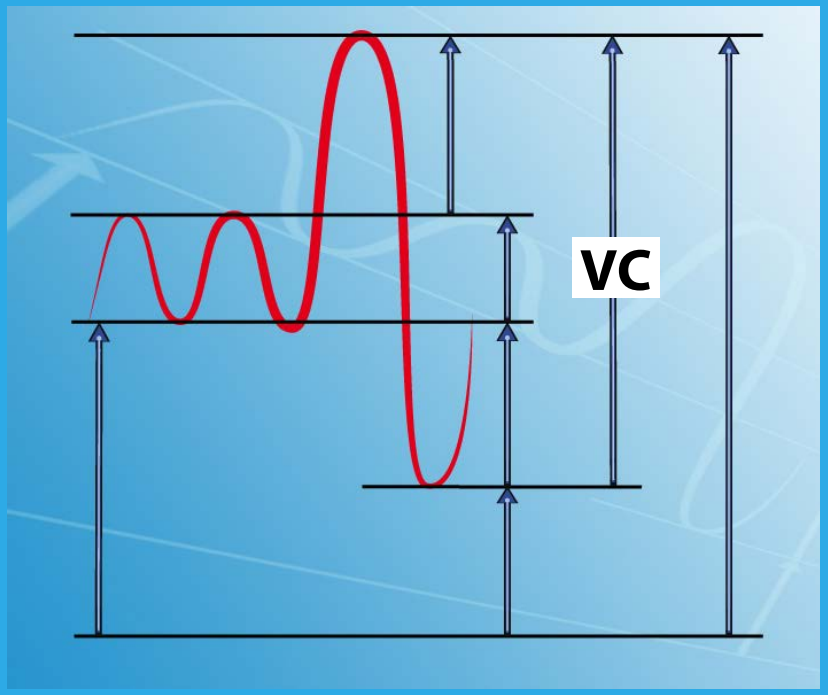


Vital Capacity: VC

The maximum amount of air inhaled after full exhale.

VC = IRV + TV + ERV

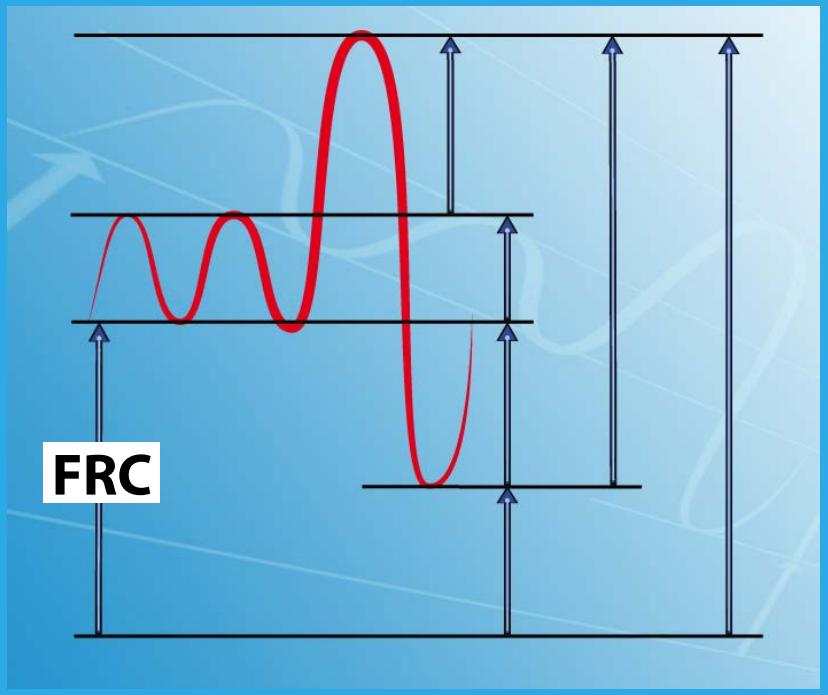
It is on average 3l for women and 4.5l for men



Functional Residual Capacity: FRC

The amount of air remaining in the lungs after a passive exhale

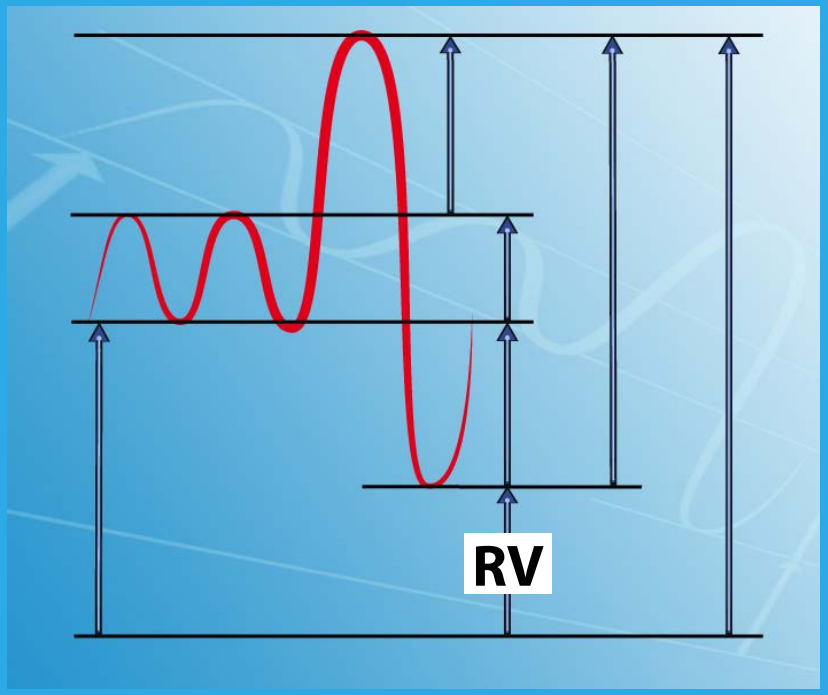
FRC = ERV + RV



Residual Volume: RV

The amount of air remaining in the lungs and the trachea after a maximum exhale

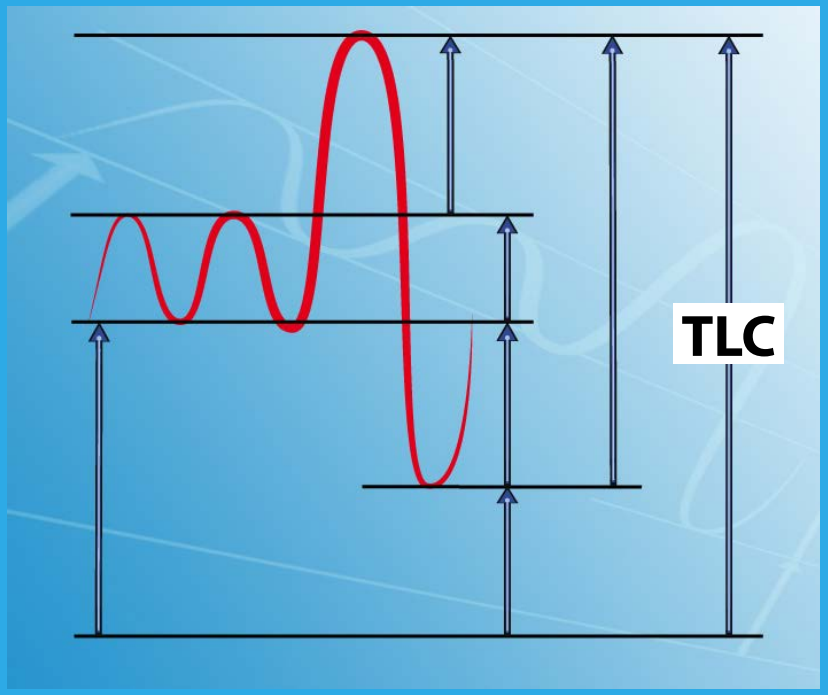
Ca. 25% of TLC (see next slide) in an untrained human



Total Lung Capacity: TLC

The total amount of air the lungs can hold

TLC = VC + RV



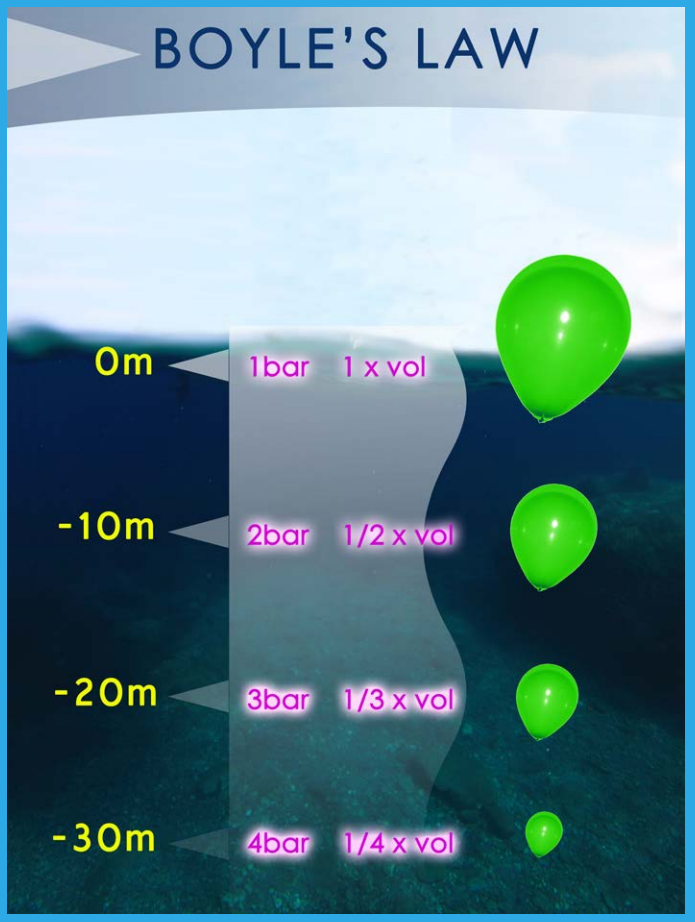
Pressure and RV-Depth

Repetition: Boyle's law

"If the temperature remains constant, the volume of a gas is inversely proportional to the absolute pressure"

Lung: Flexible airspace

Lung compressed according to Boyle's law



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Pressure and RV-Depth

Example: A freediver with TLC of 6L and RV of 1.5L

Depth	Bar	Lung Volume
0 m	1	6 l
10 m	2	3 l
20 m	3	2 l
30 m	4	**1.5 l = RV**
40 m	5	1.2 l

Lung Barotrauma

Pressure related injury

- Freediving below RV without adequate preparation and care

Fluid enters the lungs

Signs and symptoms

- Tightness in the chest
- Wheezing sound while breathing
- Feeling difficult to catch breath
- Urge to cough
- Coughing up pink, foamy liquid
- Fatigue

Emergency Procedures

Stop diving immediately

- Min. 1 week
- Up to months until full recovery

Avoid forced coughing

Breathe gently

Move slowly, allow buddy to tow/help you

Breathe pure Oxygen if available

Seek medical assistance

Avoiding Lung Barotrauma

Self awareness is key

Dive relaxed or do not dive

Stop diving if stressed or cold

Stretching intercostal muscles

Stretching diaphragm: Uddiyana bandha

Correct turns and avoid jerky movements at depth

Slow adaption to depth, inducing blood shift

Summary: Lungs at Depth

Lung Measurements

Pressure and Residual Volume (RV)

Lung Barotrauma

Emergency Procedures

Avoiding Lung Barotrauma

BUOYANCY AND FREE FALL

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Buoyancy and Free Fall

The Archimedic Principle

Neutral Buoyancy

Free Fall Training

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Archimedic Principle

"An object partly or fully immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced by the object."

Neutral Buoyancy (NB)

Your weight = buoyant force

Remain at same depth effortlessly

Set NB according to the dive

- Deeper dive, deeper NB
- Ca. 1/3 of target depth
- min. 10m deep

Shallow NB does not replace lack of technique

Free Fall

Leaving beginner freediving behind

Descend past NB (neutral buoyancy)

Streamlining & relaxation

Ascend against negative buoyancy

Safe Oxygen

Self awareness

Free fall takes some training

Buoyancy and Free Fall: Summary

The Archimedic Principle

Neutral Buoyancy

Free Fall Training

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HYPOXIA AND BLACK OUT

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Hypoxia and Black Out

Hypoxia

Ischemia

Daltons Law

Shallow Water Black Out

Surface Intervals in Freediving

Hypoxia

"..an inadequate supply of Oxygen in the body as a consequence of a low partial pressure of Oxygen in arterial blood"

Cerebral hypoxia

- Enough blood flow to the brain, but the saturation of the blood with Oxygen is decreased
- Consequences: Black out, brain damage and death

Mild cerebral hypoxia: Loss of Motor Control (LMC or Samba)

Ischemia

Shortage of blood supply to an organ

Caused by constriction or blockage

Cerebral ischemia

- Reduced blood flow to the brain
- Same severe consequences of repeated or extended exposure as in hypoxia

Causes for cerebral ischemia

- Standing up too fast
- Tight freedive hood
- Air pocket under the suit

Daltons Law

The total pressure exerted by a mixture of gases is equal to the sum of the partial pressure of each of the different gases making up the mixture – each gas acting as if it alone were present and occupied the total volume.

Normal air consists of:

- 21% or 0.21bar ppO_2
- 79% or 0.79bar ppN_2

Shallow Water Blackout

Pressure related hypoxia on ascent

Ascent reduces diffusion gradient
Gradient of O_2 concentration between the lungs and the alveolar capillaries changes with the outside pressure

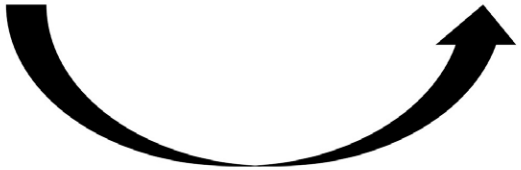
Unconsciousness at an average of 0.1bar ppO_2

The closer to the surface, the greater the relative drop in pressure

Role of safety divers
Meet the diver at a depth of at least -10m

Shallow Water Blackout

0m	0.21	0.08
		0.10 Blackout Zone
10m	0.42	0.16
20m	0.63	0.24
30m	0.84	0.32
40m	1.05	0.40
50m	1.26 $PP0_2$ (bar)	0.48 PPO_2 (bar)



Surface Intervals

Decompression sickness (DCS) can also affect freedivers

Signs and Symptoms of DCS

Rules of Thumb for surface intervals

Dives up to -30m: surface time = 2 * dive time
Dives between -30 and -55m: surface time (min) = depth (m) / 5
Dives deeper than -55m: 1 dive in 24h

Summary: Hypoxia and Black Out

Hypoxia

Ischemia

Daltons Law

Shallow Water Black Out

Surface Intervals in Freediving

TRAINING CONCEPTS

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Training Concepts

Warm-up to Max. Performance

CO_2 Training Tables

Low O_2 Training

Warm-up to Max. Performance

Allow time to switch to "freedive mode"

Physical and mental relaxation

Induce mammalian dive response (MDR, see next chapter)

Visualization and "no warm-up dives"

"Save the legs" – approach

Examples

Warm-up Examples

Warm-up for STA (example 1)

Relaxation	Breath Hold
3.00 Min	first contraction
3.00 Min	first contraction + 30 Sec
3.00 Min	first contraction + 1 Min
6.00 Min	maximum performance

Warm-up for DYN (example 2)

Relaxation	Dry STA or DYN
3.00 Min	Dry STA to first contraction
3.00 Min	Dry STA to first contraction + 20 Sec
3.00 Min	DYN 25m
5.00 Min	Maximum Performance

Warm-up Examples

Warm-up for CWT (example 3)

Relaxation	Pull Downs (FIM)
3.00 Min	Slow FIM to -10m, (or neutral buoyancy), then pull up slowly
3.00 Min	Slow FIM to neutral buoyancy depth, hang 30 Sec, pull up slowly
3.00 Min	Slow FIM to neutral buoyancy depth, hang to first contraction, pull up slowly
5.00 Min	Maximum Performance

CO_2 Training Tables

Tolerance to CO_2

Static or dynamic, wet or dry

No hypoxic conditions

Design Principles

- Breath hold performance is constant
- Approx. 50% of maxSTA to start with
- Eight STA or twenty DYN breath holds

Time based vs. Count based tables

CO_2 Training Tables: Examples

Example 1 (left):
Classic CO_2 table

Breathing	Hold
2.00 Min	2.00 Min
1.45 Min	2.00 Min
1.30 Min	2.00 Min
1.15 Min	2.00 Min
1.00 Min	2.00 Min
0.45 Min	2.00 Min
0.30 Min	2.00 Min
0.15 Min	2.00 Min

Example 2 (right):
Breath count based table

Relaxation	*Hold*
8 Breaths	*2.00 Min*
7 Breaths	*2.00 Min*
6 Breaths	*2.00 Min*
5 Breaths	*2.00 Min*
4 Breaths	*2.00 Min*
3 Breaths	*2.00 Min*
2 Breaths	*2.00 Min*
1 Breath	*2.00 Min*

CO_2 Training Tables: Examples

Example 3:
Classic time-based table for DYN training.

Breathe	*Distance*	*Repetitions*
1:15 Min	*25 M*	*4*
1:00 Min	*25 M*	*4*
0:45 Min	*25 M*	*4*
0:30 Min	*25 M*	*4*
0:15 Min	*25 M*	*4*

Low O_2 Training

Training to high tolerance of CO_2: Possibility to become hypoxic towards the end of the dive

Body and mind can be trained to a certain extent to still function normally under these extreme conditions by hypoxic or low-O_2-tolerance training

Part of competitive / extreme freediving

No gain in exposing yourself to repeated hypoxic states, LMCs or even black outs.

Training Concepts: Summary

Warm-up to Max. Performance

CO_2 Training Tables

Low O_2 Training

THE MAMMALIAN DIVE RESPONSE

Mammalian Dive Response (MDR)

Definition and Effects

Peripheral Vasoconstriction

Bradycardia

Spleen Effect

Blood Shift / Haemo Compensation

Hypo Metabolism

Inducing MDR

Immersion Diuresis

Definition

Series of adaptions

- Peripheral vasoconstriction
- Bradycardia
- Spleen effect
- Blood shift or Haemo compensation
- Hypo metabolism

Series of triggers

- Apnea (elevated CO_2)
- Immersion in water
- Rising pressure (lung volume below RV)
- Low temperature

Effects of MDR

Conservation of Oxygen

- See mainly "Bradycardia" and "hypo metabolism"

Use of Oxygen more efficiently

- Reduced activity of non-vital organs
- See mainly "peripheral vasoconstriction"

Prevention from lung barotrauma

- Enables humans to safely dive below RV
- See mainly "blood shift"

Peripheral Vasoconstriction

Constriction of blood vessels in the extremities

Less Oxygen available in the extremities

More Oxygen available for the brain and vital organs

Side effect: Build up of lactic acid

- Compensation: Extending surface intervals

Bradycardia

Slow-down of the heart rate

- In untrained humans -25% below resting rate
- Up to 50% below resting rate possible in trained freedivers
- The stronger the peripheral vasoconstriction, the stronger the effect of Bradycardia

Trigger: Facial immersion

- Splash cold water on the face
- Used for warm-up procedures before freediving

Spleen Effect

Spleen: Reservoir for red blood cells

- Ready to be released in a case of emergency (e.g. serious bleeding)

Spleen contracts

- Triggered by elevated CO_2 (hypercapnia)

More Oxygen transport capacity available

- More red blood cells allow the body to bond more Oxygen

Blood Shift

Also called "Haemo compensation"

Blood surplus in chest area
Due to peripheral vasoconstriction

Blood vessels of alveoli increase in size

Compensation for volume loss due to pressure

Prevents negative pressure in the lungs

Supports prevention from lung barotrauma

Hypo Metabolism

Metabolism: Chemical transformations within cells

- Most of these transformations take up Oxygen and create body heat
- E.g. digestion

Hypo metabolism: Lowered metabolic rate

- Biomechanical activities below normal level
- E.g. stomach: Digestion stops, undigested food gets expelled and the freediver throws up
- Oxygen uptake is thus reduced

Possible side effect: Hypothermia

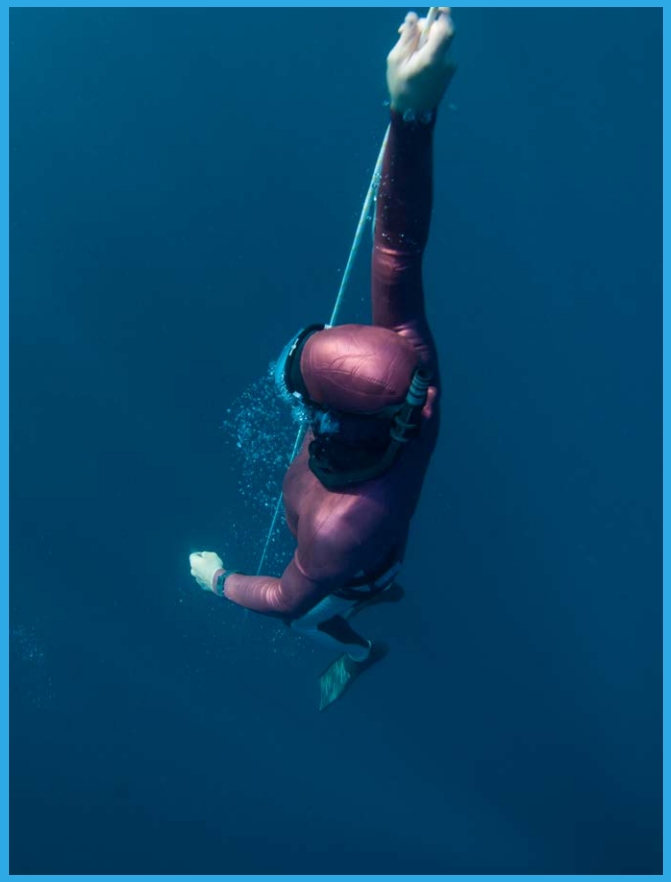
- Due to reduced production of body heat

Inducing the MDR

MDR naturally weak in humans

MDR becomes stronger through training

Triggered by warm-up dives



Immersion Diuresis

Because of peripheral vasocontriction

Surplus of fluid in the torso

Triggers urine production

Danger of dehydration

- Drink during freedive sessions
- After sessions: Drink more than you feel like
- Water, fruit juices and electrolyte drinks

MDR: Summary

Definition and Effects

Peripheral Vasoconstriction

Bradycardia

Spleen Effect

Blood Shift / Haemo Compensation

Hypo Metabolism

Inducing MDR

Immersion Diuresis

Freedive Code of Conduct

Mind your surroundings

Mind your long fins

Mind marine life

Do not remove anything from the sea

Do not leave anything in the sea

Mind the dive site

Be a role model

Thank you for your attention

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