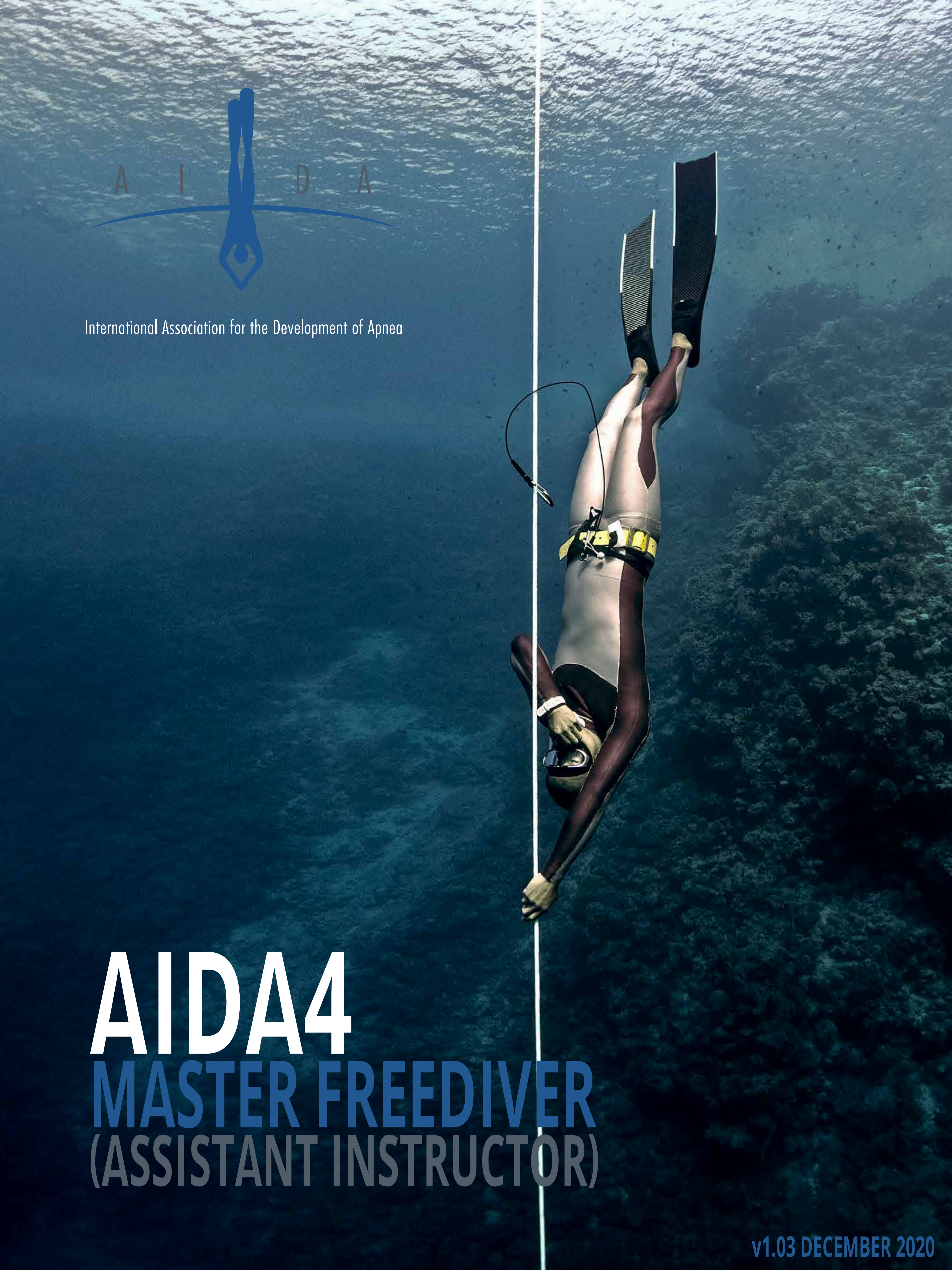


AIDA

International Association for the Development of Apnea

AIDA4
MASTER FREEDIVER
(ASSISTANT INSTRUCTOR)

v1.03 DECEMBER 2020

CONTENTS

CHAPTER 01

INTRODUCTION TO AIDA4

The AIDA1 and AIDA2 Courses are the recognised standards that give beginners a detailed introduction to modern freediving. Both of these courses focus on safety by learning and applying sound freediving techniques. The AIDA3 Course takes you a step further; you learn how to train as a freediver and take your freediving to the next level. This enables you to systematically and safely expand your abilities as a freediver.

In the AIDA4 Course you will learn the latest techniques and essential knowledge in order to extend your capabilities to safely reach the limits of recreational freediving, which AIDA sets at a depth of 38 meters. Of course freediving doesn't end there. After successfully finishing the AIDA4 course you will be prepared to enter the world of competitive freediving and go beyond the limits of recreational freediving safely should you choose to do so.

A successful AIDA4 student can also act as an assistant instructor on all AIDA freediving courses. The last chapter of this manual discusses your role as an AIDA Assistant Instructor.

Prerequisites

To enrol in the AIDA4 Master Freediver Course you must:

- **Be at least 18 years of age,**
- **Have completed the AIDA3 Advanced Freediver Course or have passed the AIDA3 Crossover Evaluation (see below),**
- **Have completed the AIDA Medical Form (see below),**
- **Have completed the Liability Release (see below),**
- **Have a qualification in First Aid including CPR, passed within the last two years.**

Course Structure

This course consists of:

- **Minimum 3 theory sessions or 1 knowledge review session,**
- **Minimum 1 warm-up and stretching session,**
- **Minimum 2 confined water sessions,**
- **Minimum 4 open water dive sessions.**

The content of this manual covers the three theory lessons that may be conducted by your AIDA Master Instructor. You have two ways to acquire the knowledge necessary to successfully pass the AIDA4 Course:

1) **Reading this manual, or**
2) **Sitting with your AIDA Master Instructor for the theory sessions, where they will use the AIDA4 course slides to complete the theory.**

In case you choose the first, the manual does not entirely replace the face-to-face theory lessons. Your AIDA Master Instructor will assess your understanding of freedive theory by going through the Knowledge Reviews, found at the end of every chapter, with you.

You must also pass the written AIDA4 exam.

Your AIDA Master Instructor will review your answers on both the Knowledge Reviews and the final exam and will ensure you understand any questions you have answered incorrectly.

Whether you choose to learn through self-study or traditional theory sessions, both will enable you to successfully understand all requirements of the AIDA4.

1.1 Paperwork

If you have already successfully passed any other AIDA Course, you will be familiar with the paperwork mentioned below. This must be given to your instructor before the course starts. By following this procedure, AIDA makes sure that you are both fit for and aware of the risks of freediving.

AIDA Crossover Evaluation

If you already have an intermediate or advanced certification from a freedive organisation other than AIDA you may qualify to enter the AIDA4 Course after successfully passing the AIDA3 Crossover Evaluation. Your AIDA Instructor will evaluate your knowledge of theory and skills in confined water and open water, allowing them to appropriately identify your level of freediving.

To enrol in the AIDA4 Course, you will need to demonstrate the same skills required for the AIDA3 certification, as outlined in the AIDA3 Course Completion Form:

- **Static (STA): 2:45+Min,**
- **Dynamic with fins (DYN): 55+m,**
- **Good conduct of body posture and fin-kicking technique in DYN,**
- **DYN-CO_2 table: Design a table for yourself and perform it,**
- **Demonstrate neutral buoyancy-test for DYN and open water,**
- **Constant Weight (CWT): Dive comfortably to 24-30m, including freefall,**
- **Free Immersion (FIM) technique demonstration,**
- **Use of lanyard for CWT and FIM,**
- **Demonstrate self-rescue skills: arms-only ascent (-15m), loss of mask (-10m),**
- **Demonstrate a tow of an injured freediver at the surface for 50+m,**
- **Controlled turn at 10m (CWT) without use of the rope, and**
- **Buddying and Rescue Technique in open water (depth 10m+ and surface rescue), STA and DYN.rferferferfegrerger55544**

These skills must be demonstrated properly to show you have a good command of all these techniques. For example, it is not good enough to simply do a CWT dive to -24m somehow. You must be able to demonstrate dives with a good command of the relaxation technique and one full breath, an efficient duck dive, good line orientation, efficient body posture, good finning and equalization techniques, freefall, a safe bottom turn, efficient use of buoyancy on the ascent and good recovery breathing upon surfacing.

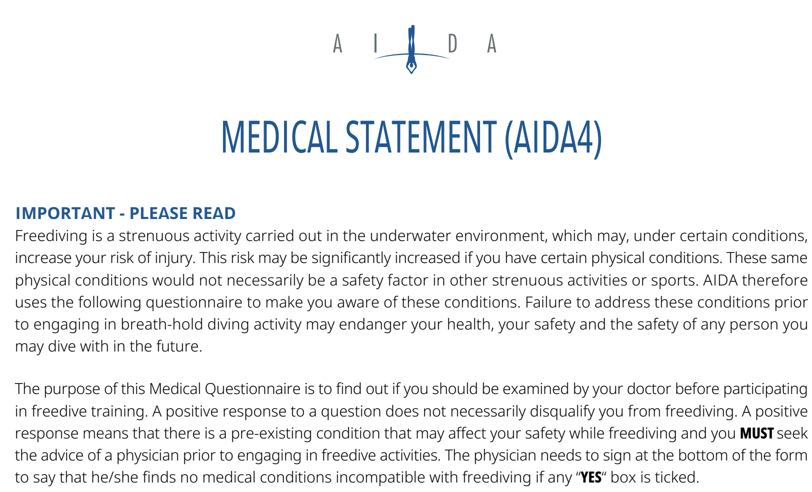
Your AIDA Instructor will assess your skills and knowledge during a minimum of:

- **1 Classroom session,**
- **1 Pool / confined water session,**
- **1 Open water session.**

Once you have sufficiently mastered all the required skills taught in the AIDA3 Course, you are allowed to enrol in the AIDA4 Course. If you are not able to pass this evaluation comfortably, your AIDA Instructor may offer you extra training sessions. You should note that extra training sessions may not be part of the AIDA3 Crossover Evaluation or the AIDA4 Course.

AIDA Medical Statement

The Medical Statement is there for your safety. It covers potential health issues that may prevent you from being able to freedive safely. All questions that you answer 'NO' to mean you are ready to continue your freedive journey. If you answer YES to any question, you will need to get medical clearance before starting your course. If this is necessary, please ask your doctor to complete the designated part of the form.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MEDICAL STATEMENT (AIDA4)

IMPORTANT - PLEASE READ
Freediving is a strenuous activity carried out in the underwater environment, which may, under certain conditions, increase your risk of injury. This risk may be significantly increased if you have certain physical conditions. These same physical conditions would not necessarily be a safety factor in other strenuous activities or sports. AIDA therefore uses the following questionnaire to make you aware of these conditions. Failure to address these conditions prior to engaging in breath-hold diving activity may endanger your health, your safety and the safety of any person you may dive with in the future.

The purpose of this Medical Questionnaire is to find out if you should be examined by your doctor before participating in freedive training. A positive response to a question does not necessarily disqualify you from freediving. A positive response means that there is a pre-existing condition that may affect your safety while freediving and you **MUST** seek the advice of a physician prior to engaging in freedive activities. The physician needs to sign at the bottom of the form to say that he/she finds no medical conditions incompatible with freediving if any "**YES**" box is ticked.

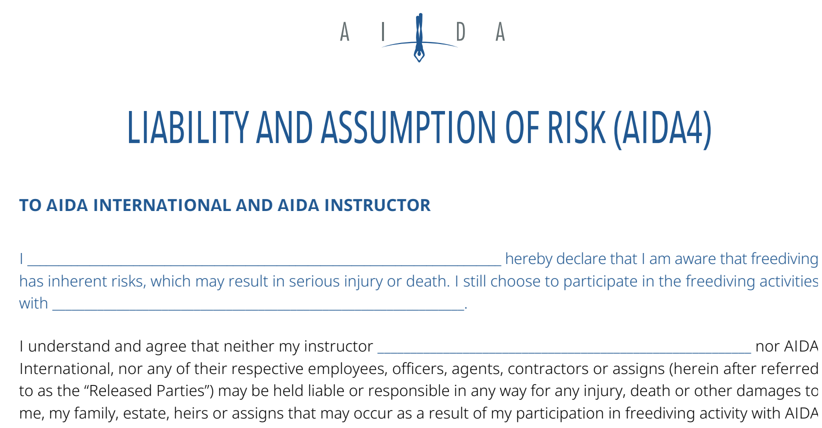
Figure 1.1
AIDA Medical Statement.

Be honest about your medical condition! Please mention any conditions in addition to those stated in the document. You must also reference any previous minor surgeries or mild cases of asthma. Your examining doctor needs to have a holistic picture of your condition to ensure you can freedive safely. If you are travelling to a remote destination for your AIDA Course, please make sure that you have all necessary paperwork BEFORE you leave home.

The medical statement must be filled in, signed and handed in to your AIDA Master Instructor at the beginning of the course. Full version is available at the end of this manual (See **Appendix A**).

AIDA Liability Release (where applicable)

This form emphasises that freediving is an absolutely safe activity as long as you follow the rules indicated and taught by your instructors. AIDA Education maintains an impeccable safety record. We would like to keep it that way. This waiver says that you have understood that you are the most important part of freediving safety. Full version is available at the end of this manual (See **Appendix B**).



LIABILITY AND ASSUMPTION OF RISK (AIDA4)

TO AIDA INTERNATIONAL AND AIDA INSTRUCTOR

I ________________________ hereby declare that I am aware that freediving has inherent risks, which may result in serious injury or death. I still choose to participate in the freediving activities with ________________________.

I understand and agree that neither my instructor ________________________ nor AIDA International, nor any of their respective employees, officers, agents, contractors or assigns (herein after referred to as the "Released Parties") may be held liable or responsible in any way for any injury, death or other damages to me, my family, estate, heirs or assigns that may occur as a result of my participation in freediving activity with AIDA

Figure 1.2
AIDA Liability Release.

First Aid / CPR Certification

Successful AIDA4 students must also have training in basic First Aid and Cardio Pulmonary Resuscitation. To become certified as AIDA4 Master Freediver, your last training or training-update must not be more than two years ago. Your AIDA Master Instructor and / or National AIDA should be able to advise on which courses are acceptable.

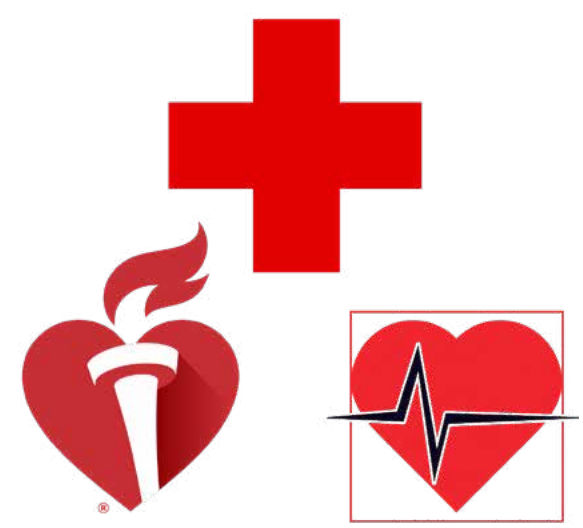


Figure 1.3
First Aid and CPR training agencies (not limited).

CHAPTER 02

FAILURE DEPTH

2.1 Introduction

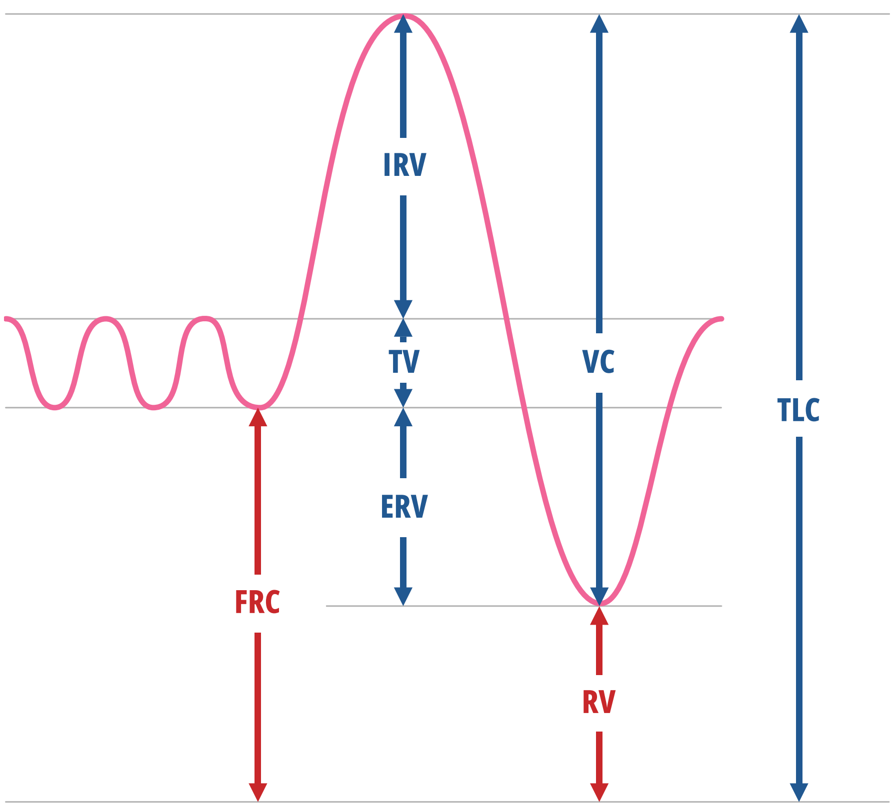
Reaching Residual Volume

Residual Volume (RV) at the surface is the volume of air that remains in the lungs after a maximum forceful expiration. During a dive, RV is the minimal size your lungs can be compressed to by the rising hydrostatic pressure during your descent. Descending further creates negative pressure in your lungs and makes it nearly impossible to perform an equalization manoeuvre as it makes it very difficult to extract air from the lungs to push up into your middle ear, sinuses, or mask.

The potential negative pressure in your lungs can also cause a lung barotrauma if you do not stop your descent at that point.

Equalization Fails

Failure depth is the depth where normal equalization does not work anymore and you need to stop your descent immediately to avoid any injury. At this depth your lungs have reached their residual volume (RV, **see illustration** below and also see the AIDA3 manual for an explanation of lung measurements).



Description

IRV	Inspiratory Reserve Volume
TV	Tidal Volume
ERV	Expiratory Reserve Volume
VC	Vital Capacity
TLC	Total Lung Capacity
RV	Residual Volume
FRC	Functional Residual Capacity

Figure 2.1
Figure of Respiratory Volumes and Capacities, Reaching Residual Volume (RV) indicates your failure depth.

Calculation: Failure Depth (bar) = TLC / RV

Failure depth is defined as the relation between your total lung capacity (TLC) and residual volume (RV):

Failure Depth (bar) = TLC (litres) / RV (litres)

The average RV in an untrained freediver is about 25% of the TLC. It takes 4 bars of pressure to reach RV, which is achieved at a depth of 30m.

Failure depth does not depend on the lung-size of a freediver (TLC), but on the relaxation of the freediver, the flexibility of the muscles connected with breathing and the elastic characteristics of lung tissue.

TLC is mostly genetically defined and can only be altered by a flawless breathing technique to reach the maximum potential during the One Full Breath. Trying to expand TLC is only possible by using a technique called packing which has a limited benefit and comes with a list of potential dangers (see **chapter 4.3**). Instead of packing, a more effective, and safer method is for you to decrease your residual volume (RV). This would change the equation that defines failure depth; the smaller RV is in relation to TLC, the deeper your failure depth.

If properly trained over an extended period of time (years), reducing RV in relation to TLC displays an impressive potential. Top freedivers have shifted their failure depth to 100+ metres! Think about that before you start applying other techniques like packing or mouthfill (a different technique also explained in this manual, see **chapter 3**).

2.2 How to Decrease the Residual Volume (RV)

There are several ways to work on the reduction of RV, which can be combined into a meaningful training regime. Some of the techniques you learn in this chapter are performed dry and can be part of a daily workout at times where you do not have access to deep water for training. Other techniques need a freediving setup in order to be properly applied.

Safe way to Increase Failure Depth

The safest way to increase failure depth is to reduce RV in relation to TLC. Whichever combination of techniques you choose, be prepared to invest regular training and a lot of time. Reduction of the RV is a physical adaption and as such it does not happen overnight. Be patient! Taking short-cuts could lead to injuries, these are not to be understated, and can possibly lead to the end of your freediving career and in the worst case a fatal injury. Please also re-read the chapter about Barotrauma in the AIDA3 manual for an overview of possible injuries, and more importantly, how to prevent them.

Small Steps, High Self-Awareness

Approaching RV and going beyond it needs maximum self-awareness. You may have already experienced the feeling of approaching RV. Do you remember the "elephant that slowly steps on your chest" while you were going deeper than previously during your AIDA3 Course? This is your body getting compressed, or more precisely, muscles and other tissues getting stretched to their momentary limits by the rising hydrostatic pressure. Take this sensation seriously and approach it step by step. These tissues need time and repetition to adapt to the new situation.

Uddiyana Bandha

Uddiyana Bandha is a technique from pranayama, which in turn is an essential part of yoga. Freedivers have adopted this technique to work towards reducing the residual volume (RV) of their lungs. With this technique you can effectively stretch your diaphragm and has a similar effect to diving close to or beyond RV. One major advantage of the technique is that it is done dry, no pool or depth is needed, and you can thus incorporate it into your daily training program.

In broad strokes, Uddiyana Bandha is done in the following manner:

1. Warm up your breathing muscles through your choice of gymnastics, sun salutations (a popular yoga sequence) and / or breathing exercises (bhastrika, full yogic breathing, etc.).


Figure 2.2

2. Stand with your feet more than shoulder width apart, lean forward and rest your hands on your thighs or knees.


Figure 2.3

3. Exhale completely and lock your throat.


Figure 2.4

4. Pull your navel in towards the spine and then up towards your thorax. Your chest is expanding while the diaphragm gets sucked upwards.


Figure 2.5

5. Hold your breath for as long as you are able to comfortably. Keep your head straight and do not look up while doing so.


Figure 2.6


Figure 2.7

6. Release all muscles before opening your airway.
7. Open your airway and let the air flow in gently. Restart your breathing.
8. Repeat from step 3 onwards.

As a variation you can do this sequence while seated instead of in the leaning forward stance.

Reverse Packing

Reverse packing is a technique that can be used to simulate the effect of rising hydrostatic pressure on a deep freedive. It is safe as long as it is applied in a reasonable and controlled manner.

Caution: You should practice and master reverse packing within your range of normal breathing (Vital Capacity). **Only** if you have mastered the technique can you go carefully below RV. Start with only one reverse pack. Your body needs time to adapt and progressing too quickly can lead to injury.

How to reverse pack:


Figure 2.8


Figure 2.9

1. Sit or kneel with your spine straight.
2. Pinch your nose closed (use fingers or a nose clip) and relax your abdomen completely.


Figure 2.10

3. Suck air up from your lungs into your mouth (without any activity in the abdomen).


Figure 2.11

4. Expel the air from your cheeks through your mouth.


Figure 2.12

5. Repeat 3 and 4 until your abdomen gets pulled in. Do not go below RV until you master the technique.


Figure 2.13

6. Open your airway and let the air flow in gently. Inhale normally for a few breaths, then repeat the whole process.

Reverse packing allows you to exhale in a step-by-step manner. Once you have mastered this technique you can take it one step further.

Reverse packing combined with Uddiyana Bhanda to stretch the diaphragm:

1. Apply Uddiyana Bhanda on a full exhale.
2. Release and inhale.
3. Fully exhale to RV.
4. Do one reverse pack and expel the air from your mouth.
5. Apply Uddiyana Bhanda.
6. Repeat from step 2.

Start very carefully with only one reverse pack and repeat this over several days until you are comfortable with it. Then move on to do the same exercise with two reverse packs. Again, it will take days (or weeks) to become comfortable with the decreased amount of air in your lungs.

Over time (several weeks) you can move on to replace the reverse packs used in this exercise with a mouthfill (see **chapter 3**) before applying Uddiyana Bhanda. In the context of this exercise, a mouthfill is essentially doing the same as a few reverse-packs, this is moving a large amount of air from your lungs to your mouth after you have actively fully exhaled. Keep proceeding very carefully when moving to this stage.

2.3 How to Increase the Vital Capacity (VC)

Strong Word of Caution

Research has proved that it is not possible to increase your Total Lung Capacity beyond its physical limits. A great number of breathing exercises have been published in the past that claim to do exactly this, they all have several things in common; they do not change your TLC, they are dangerous and they do not serve the purpose of a freediver.

However, through training it is possible to

a. comfortably access the full VC,
b. extend the VITAL capacity (VC, not the TLC),

by gaining full control of, and to a certain degree, strengthening and stretching the intercostal muscles, diaphragm and abdominal muscles.

Full Lung Stretches

After a warm-up, it is possible to start with gentle movements and stretches on a full inhale. Repeated gentle stretches on a full inhale can make you more comfortable while relaxing with full lungs, which is beneficial for every discipline in freediving.

This is an easy full lung stretch:

1. **Sit or kneel with your spine straight.**
2. **Take a “One Full Breath”.**
3. **Raise both arms to the sky.**
4. **Relax with full lungs and your arms pointing parallel up to the sky.**
5. **Gently lengthen your left arm towards the sky.**
6. **Relax with both arms up.**

7. Gently lengthen your right arm towards the sky.
8. Repeat steps 3-6 as long as you can comfortably hold your breath.
9. Release your arms down first, then release the air from your lungs.
10. Take a few relaxed breaths.
11. Repeat from step 2.

Be very careful when stretching with full lungs. There is the possibility you may get dizzy or even faint!

A well-executed "One Full Breath" allows you to access your total lung capacity. As the lungs expand, the main artery to your brain can be exposed to a small, but significant, mechanical pressure, which can reduce the blood flow to the brain. This is why a full inhale alone can lead to dizziness. If you combine this with a gentle stretch, blood flow to the brain can be further reduced to the point of not enough blood reaching your brain for it to function normally.

If you experience the first signs of dizziness, immediately release the air from your lungs, release your posture, bend forward and / or crouch down. The blood flow will stabilize itself immediately.

Full breath exercises should always be executed in a sitting or kneeling position to protect yourself from a fall in case you faint.

DO NOT APPLY PACKING FOR STRETCHING EXERCISES.
DO NOT BEND BACKWARDS ON FULL LUNGS.

There are no pain receptors in the lungs and injuries can occur without notice. Excessive packing is known to cause such injuries so it is good advice not to add packing to stretching exercises. Also, packing in combination with stretching is suspected to have long-term negative effects on lung tissue. As these "packing-stretch techniques" are not required for recreational freediving, AIDA discourages you from using them.

Full-Breath Cycle to Increase VC

Combining a Full-Breath-Cycle with Uddiyana Bandha and eventually Reverse Packing is an effective way of reducing your residual volume, accessing the total lung capacity and learning to control your breath.

As in all breath control exercises, find a position where you can sit comfortably with your spine straight. If you are very flexible you can sit on the floor cross-legged (or even in the lotus position). Most of us are not flexible enough for this so it is much better to kneel on a cushion or even sit on a chair – a straight spine is more important than a spectacular yogic sitting position.

This is the sequence:

1. **Sit or kneel with your spine straight.**
2. **Take a "One Full Breath".**
3. **Raise both arms to the sky.**
4. **Relax with full lungs and your arms pointing parallel up to the sky.**
5. **Gently lengthen your left arm towards the sky.**
6. **Relax with both arms up.**
7. **Gently lengthen your right arm towards the sky.**
8. **Repeat steps 3-6 as long as you can comfortably hold your breath.**
9. **Release your arms and the air from your lungs (passive exhale).**
10. **Completely exhale to RV while bending forward.**
11. **Release and relax while holding your breath on RV.**
12. **Straighten your spine while still relaxing your abdomen,**
    a. **Option 1: add one reverse pack;**
    b. **Option 2: add two to three reverse packs after extended time of practice;**
    c. **Option 3: instead of three reverse packs, add a mouthfill.**
13. **Apply Uddiyana Bandha and hold as long as you are able to comfortably.**
14. **Release all muscles.**
15. **Allow the air to flow back to your lungs.**
16. **Repeat from step 2.**

2.4 FRC-Diving

Definition: Functional Residual Capacity (FRC)

In your AIDA3 Course, you learned about common lung measurements which play a role in freediving. The lung-measurement used in this chapter is the Functional Residual Capacity (FRC) – basically the amount of air that is left in your lungs after a passive exhale. You achieve a passive exhale by completely relaxing your torso while opening your airways. Most likely some air will flow out from your lungs. Once the air-flow has stopped you have reached FRC.

FRC is about 50% of your Total Lung Capacity (TLC). However, if you do a passive exhale during an open water session while floating, this percentage might be somewhat lower due to the fact that your torso is mostly submerged and therefore the lungs are already exposed to minimal water pressure.

This is not a problem. What is important in FRC training is to refrain from active or forced exhaling before the dive. Let the air flow out from your lungs while your body and all breathing muscles are completely relaxed. It does not matter if the amount of air in your lungs after the passive exhale varies a bit due to the chosen relaxation position, waves that might interfere with that or any other factors. What matters when diving on FRC is to do so with full body awareness, not “by numbers”. Make your own judgment when to stop your descent exclusively on what you feel!

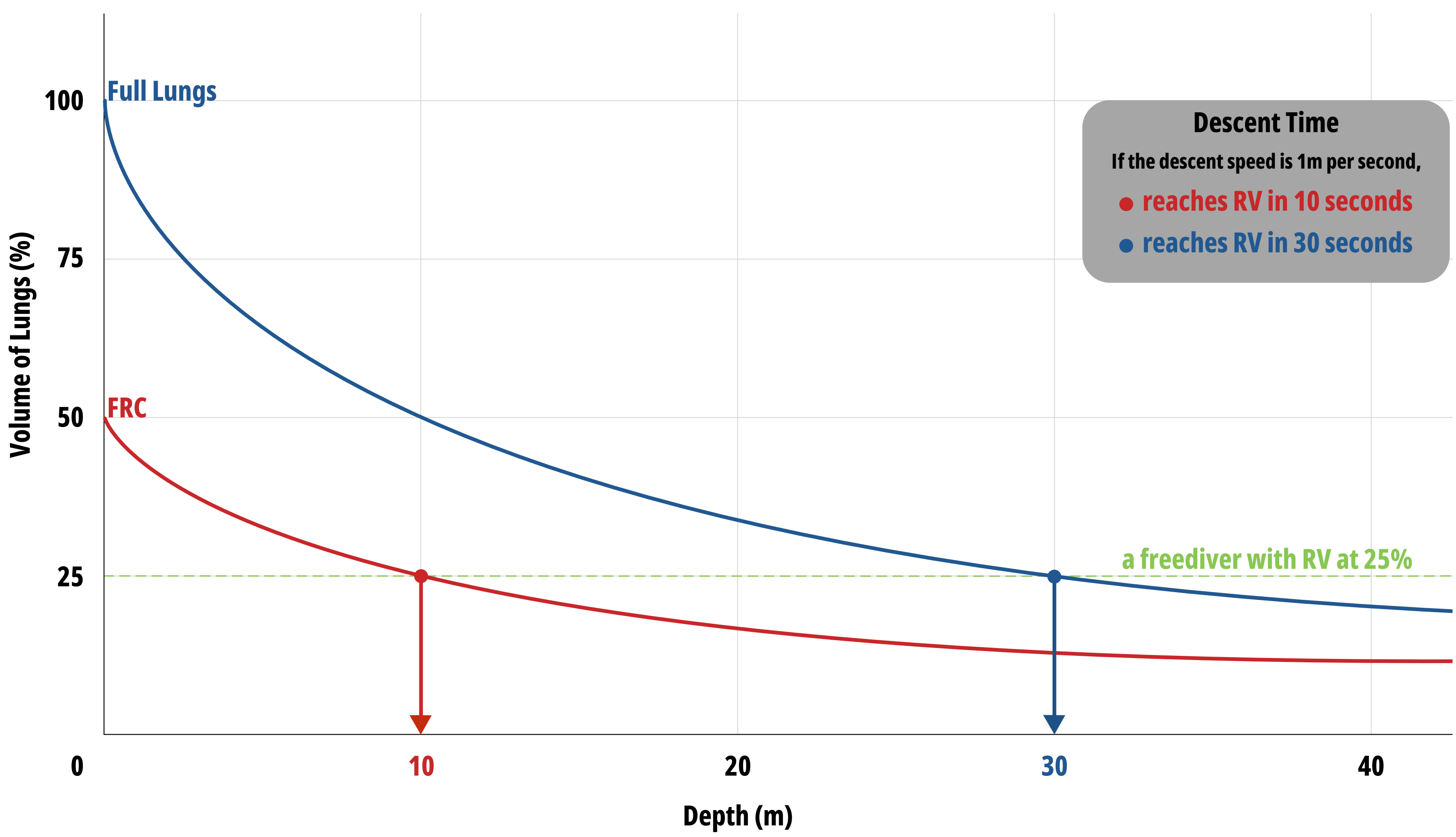


Figure 2.14
The Effects of FRC-Diving: Shallower depth and shorter descent-time to reach RV.

Simulated Pressure of a Deep Dive at Shallow Depth

Diving on FRC instead of full lungs has a dramatic effect on the lungs as you descend along the dive line. Assuming you start with an FRC (45-50% of TLC), you will reach your failure depth at a depth of 10m.

If you start your dive with slightly less than 45-50%, due to your torso being submerged as discussed, you will reach RV and thus failure depth even earlier.

This makes FRC dives a great way to train your equalization technique while approaching RV.

Quick Approach to Failure Depth

This dramatically quick approach to failure depth must be taken into account when starting with FRC by increasing depth only in small steps and approaching failure depth very carefully. Therefore it is vital that you always do FRC dives with full self-awareness and by means of Free Immersion (FIM), to maintain full control of the descent speed at all times and to be able to stop your descent whenever necessary.

Less Buoyancy – Early Freefall

On FRC you have less air in your lungs and hence less buoyancy. Freefall may set in at a very shallow depth, perhaps after just a few metres. Use the rope to control your descent from the beginning and never let go of it during an FRC dive. You may also remove weights from your weight belt to compensate for the reduced buoyancy.

As you reach negative buoyancy quite early, it is advisable to use a lanyard at all times on FRC dives. The characteristics of FRC dives are quite different from a dive with full lungs. As the maximum depth is less, the dive time is shorter and there is close to no buoyancy to help during the ascent. It is very important to inform your buddy before attempting an FRC dive to avoid surprises.

Less Air = Less Oxygen

As the lungs are not full from the start, there are fewer Oxygen reserves available for the body during a dive, resulting in an elevated risk of blacking out. Therefore you should keep your FRC dives short and they should not be combined with hangs.

Head and body position

As the lungs are not full from the start, you can reach residual volume at around 10m, for this reason you should keep your chin tucked in towards your chest and relax your chest.

FRC ≠ Empty Lung or Exhale Dive

An FRC dive is not an empty lung dive. Typically there is around 50% of air still in the lungs before starting the dive. “Empty lung dives” (or “RV-dives”) are a different concept, one that is not discussed here and is not recommended by AIDA.

Performed as Warm-Up Dive

As FRC dives simulate a dive to greater depth they are not only an excellent tool to improve adaption to depth, but also a great option for training when depth is not available, or for warm-up dives.

With one (or more) FRC dive(s) you can prepare your body for a following target dive without the potential downside of full-lung warm-up dives. As FRC dives are short you may be able to use a thinner neoprene suit in a given water temperature; as your exposure to the water will be shorter compared to executing a set of full-lung warm-up dives.

Be aware that with FRC dives you will reach your RV in a shorter time. Diving at a constant speed, it takes you roughly 30-45s to reach 30m on TLC and reach your RV. It would take you only about 10-15s to reach RV on FRC, as this is hit at 10m (see the grey box in figure 2.14). You should slow your descent on FRC and focus fully on any sensation in your chest, approach your limit very carefully and allow your body time to adapt.

Chapter 02 Knowledge Review

What is the failure depth of someone who has a residual volume of 18%?

Name three precautions you should take when diving on FRC.

How can you make your failure depth deeper?

Stretch on inhale increases ____________.

Stretching on exhale increases the flexibility of ____________.

Functional residual capacity is typically what percentage of the Total Lung Volume?

Why is it good to warm up using FRC dives prior to a deep dive?

What happens to your buoyancy when you practice FRC dives?

CHAPTER 03

MOUTHFILL EQUALIZATION

3.1 Introduction

To Enable Equalization Below RV

Mouthfill is an advanced equalization technique used to equalize ears, sinuses and mask at depths below RV, when the Frenzel manoeuvre (and also of course Valsalva) is no longer possible or becomes dangerous. To perform a mouthfill, freedivers take air into their mouth before reaching RV, then store it in the mouth and throat to use it to equalize.

When lungs of a diver are compressed to (or below) the size of RV, the diver cannot take any more air from the lungs without putting extra stress on lung tissue. Trying to take more air can be dangerous and lead to lung injury.

Risk of Lung Injury

The mouthfill is a relatively safe and effective technique, but only if done properly and with cautious depth-progression. That is why this technique should only be taught and supervised by professional instructors who can explain all the important details of the technique to you.

Done correctly, mouthfill equalization does not put any extra stress through muscle activity on lung tissue. Therefore this can be a good alternative equalization technique to be used when diving below RV.

You may ask why mouthfill can lead to lung injury, and at the same time prevent it?

The first reason is, that when you learn how to do the mouthfill technique, you may be able to reach a greater depth immediately (adding 10m, 20m, 30m or even more). Easy equalization below RV may encourage you to extend your depth quickly. Achieving a new depth is very rewarding and exciting, but to do it safely you need to consider other factors, like lung adaptation to pressure or Oxygen limits, and increasing your depth slowly giving your body time to adapt.

Another reason of increased risk of lung injury is a mistake with the mouthfill manoeuvre itself. If taken too deep or "re-charging after losing it" close to or below your RV can cause lung barotrauma.

Small Progressions & Body Awareness

Body and mind awareness are always the main keys to safety in freediving. Feeling and understanding your body signals during the dive are the best prevention to any damage. Being able to rely on your sensations allows you to use your full potential, but also greatly reduces the risk of injury. Acquiring body and mind awareness requires months or years of freediving training and can be developed with the help of, for example, mindfulness or meditation practice.

If you follow the two above, you should be able to recognize when:

- **you have lost your mouthfill;**
- **you cannot equalize anymore;**
- **contractions (on the way down) create too much pressure on the chest;**
- **there is too much pressure on the chest due to hydrostatic pressure or lack of relaxation.**

If you notice any of the above, you should STOP YOUR DESCENT immediately, make a controlled turn and return to the surface. There is no depth worth risking an injury!

The Mouthfill in the AIDA4 Course

During the AIDA4 Course you should learn and be able to correctly demonstrate the mouthfill technique both on FRC dives and moderately deep dives. You can also use the mouthfill technique on your deep dives (max. 38m), but if you can reach these target depths without mouthfill, you are not required to use it.

3.2 How to Do a Mouthfill

The procedure of a mouthfill may sound simple; inflate your cheeks and use this air to equalize! But many freedivers do not find it easy at all to master this skill, and achieving a good mouthfill can present a challenge to even the most experienced freedivers.

Step 1: Filling the Mouth with Air (Charging)

Every mouthfill starts with the act of filling the mouth and throat with a maximum amount of air. Before you start your dive, you need to decide at which depth you will perform the filling (or "charge"). For training purposes do a dive on full lungs and plan to fill at 10m. While practicing this skill, the easiest way is to dive Free Immersion as you want to focus on equalization and don't want to descend too fast.

At 10m you stop and grab the line, still in a head-down position. Take a few seconds to focus and to completely relax. Then:

1. Pinch your nose and keep it pinched.
2. Contract abdominal and intercostal muscles to increase intra thoracic pressure and push air from your lungs into your mouth. Do it slowly, do not push hard and do not stress the muscles.
3. While charging (pushing up air), create a sound like pronouncing the letter "M" (also called "grouper call").
4. While charging, make sure you also lower your jaw to create a larger airspace.
5. When the cheeks are fully inflated, tuck your chin in, lock the glottis and keep your nose pinched.
6. Relax your abdomen completely.

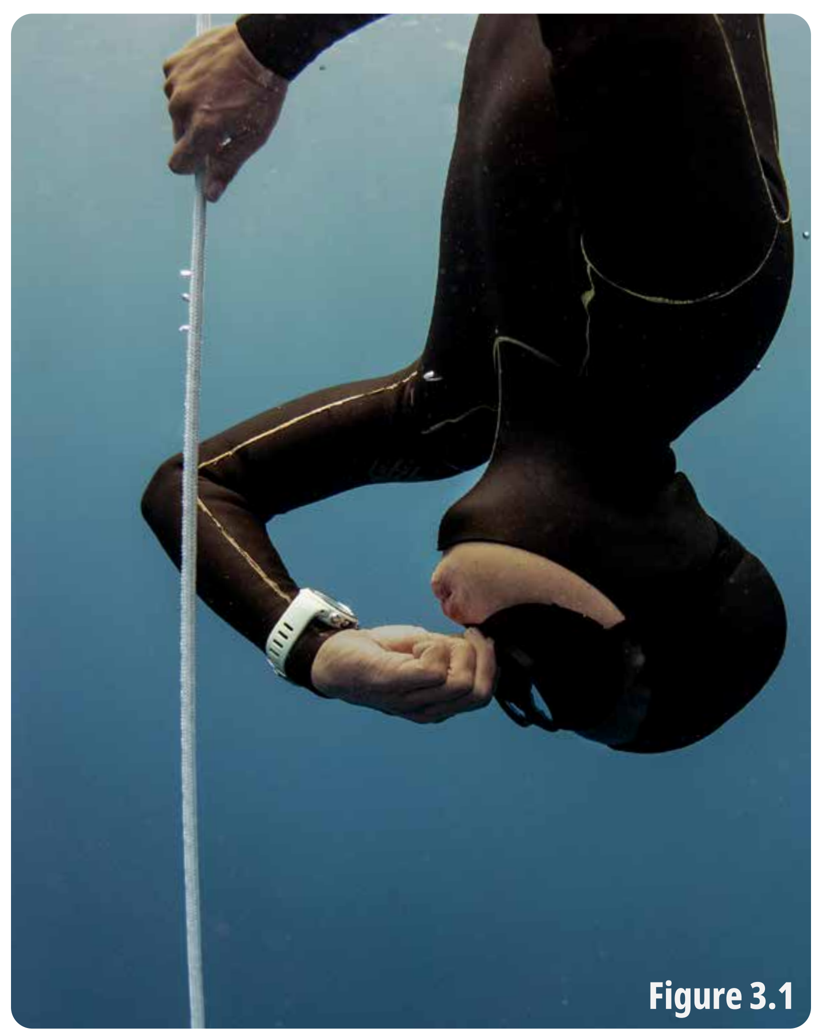


Figure 3.1

It is very important to pinch your nose before inflating your cheeks. If you fill without pinching your nose or let go of it at a later stage, the collected air will immediately rush out from your nose into the mask.

While pushing air from your lungs into your mouth, you should create a sound. That sound will cause a contraction of muscular systems around the vocal chords which will give you greater control over the airflow from lungs to mouth, especially in a "head-first" position.

If charging is done correctly, you should feel both ears equalize while you inflate your cheeks.

The act of filling or "charging", is basically identical to the Valsalva manoeuvre where you contract muscular systems around the thoracic area to achieve an increase in pressure in the lungs, which results in an equalization of the middle ears and sinuses. The difference now is that you do this and inflate your cheeks, lower your jaw and once the filling is complete, you lock the glottis for the rest of the descent.

Step 2: Equalization – Use of Facial Muscles

So now the charging is done. You are still stationary at 10m depth. Now that the cheeks are fully inflated, abdomen relaxed, glottis locked, soft palate relaxed and both ears fully equalized, you can slowly continue your descent and start "managing" the mouthfill. Remember to keep your nose pinched, and pull the line with your free hand.

At this early stage of the mouthfill, equalization should be the easiest. There is a positive pressure in your mouth cavity, so the achieved equalization during the filling process should remain for a few metres, depending how full your mouth is.


Figure 3.2

As soon as you feel a build-up of pressure in your ears, it's time to equalize again. At this stage, you use mainly your cheeks to pressurize the air in the mouth. With a mouth full of air, jaw wide open and cheeks inflated you will not be able to use your tongue as a piston as you do in the Frenzel.

As you descend further, the amount of air in your mouth is slowly decreasing. As the amount of air decreases, you can slowly close your jaw - basically gradually close your mouth, which will also help to keep the pressure of the air in your mouth constant.

The mouthfill allows you to choose between two equalization strategies:

a) Equalizing whenever you feel a slight build-up of pressure on your eardrums;

b) Equalizing constantly, keeping a constant slight contraction of facial muscles (as if you were smiling), which keeps your Eustachian tubes open at all time. You should not feel any build-up of pressure on your eardrums.

Both strategies work well and use up an equal amount of air from your mouth. Most deep freedivers prefer the "constant pressure" as it results in less movement in the mouth. This helps to hold and control the mouthfill.

Step 3: Switching to the Frenzel Technique

As you continue your descent, the air in your mouth is getting less. At some point you will not be able to create sufficient pressure for equalization anymore by using your cheeks or bringing up your jaw. At this point, you have reached a neutral stage, where your cheeks are in their normal position and your mouth is closed. Now is the time to switch to Frenzel equalization while still using the stored air.

The transition from the first part of the mouthfill where you equalize using your cheeks to the second part where you perform the Frenzel should be smooth. If you switch too suddenly between techniques this can cause air to escape from your mouth into your lungs.

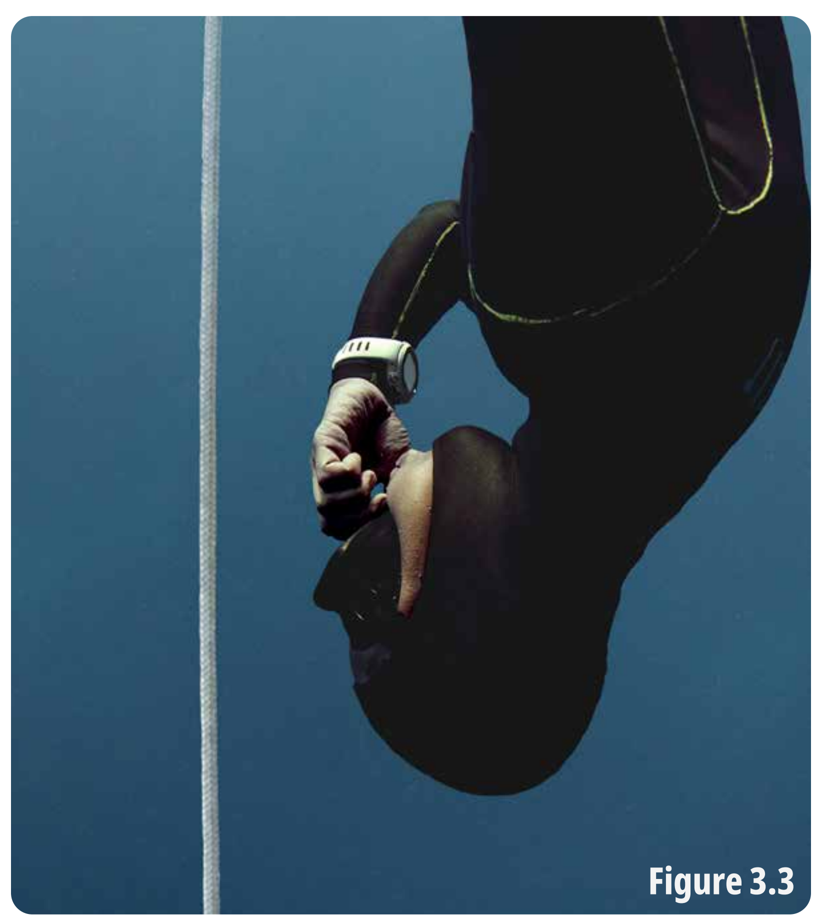


Figure 3.3

So as your cheeks start to get smaller, you slowly position your tongue to get ready to pressurize the remaining amount of air with the help of the rear part of your tongue.

Begin with your tongue in a "T- lock" position. This means you are applying the Frenzel manoeuvre with the tip of your tongue placed behind your upper teeth as if you were about to pronounce the letter "T". As the air volume drops further, keep the "T-lock" and gradually raise your tongue to the top of your mouth until all of the air trapped between the tongue and the roof of the mouth has been used (see **figure 3.8**).

It is important that any remaining air is always kept in the back of the mouth, as this is where you need it, especially while performing the Frenzel technique. Air that stays in the front part of the mouth cavity (in other words: below the tongue) cannot be used for equalization.

Step 4: Final Part: Tuck Chin and Smile

You are still equalizing with the Frenzel technique and approaching the end of your mouthfill. As hydrostatic pressure increases at a slower rate during the deep part of a dive, changes in air volume in the mouth will become more and more subtle.

To achieve equalization with even very little air left in your mouth you do the following:

1. Tuck your chin in and pull it slightly backwards, compressing the air in the back part of your mouth.
2. Contract the muscles around your lips, as if you were smiling, to bring any remaining air from the front of the mouth cavity towards the back.

Figure 3.4

In this position, you should be able to achieve a few more equalizations. You should always be very aware of the pressure sensation on your eardrums.

“Riding” the ears, which means pushing your depth without sufficient equalization can result in serious injury of your ears like middle ear barotrauma or eardrum rupture. In addition, this might result in a subconscious attempt to bring up air from your lungs, which can result in lung or trachea barotrauma.

It is recommended that you calculate the mouthfill ratio to reach the target depth with a little bit of “air to spare”, to make for a comfortable turn at the end of the rope. Any remaining air in your mouth after the turning point should be put back into your lungs.

How to Equalize the Mask during Mouthfill

Equalize your mask before taking mouthfill. While you descend further using the air in your mouth, remember to keep equalizing the mask from time to time. Do it carefully by releasing the fingers on your nose just a little bit to let a small portion of air get into your mask.

Lock Positions for General Equalization

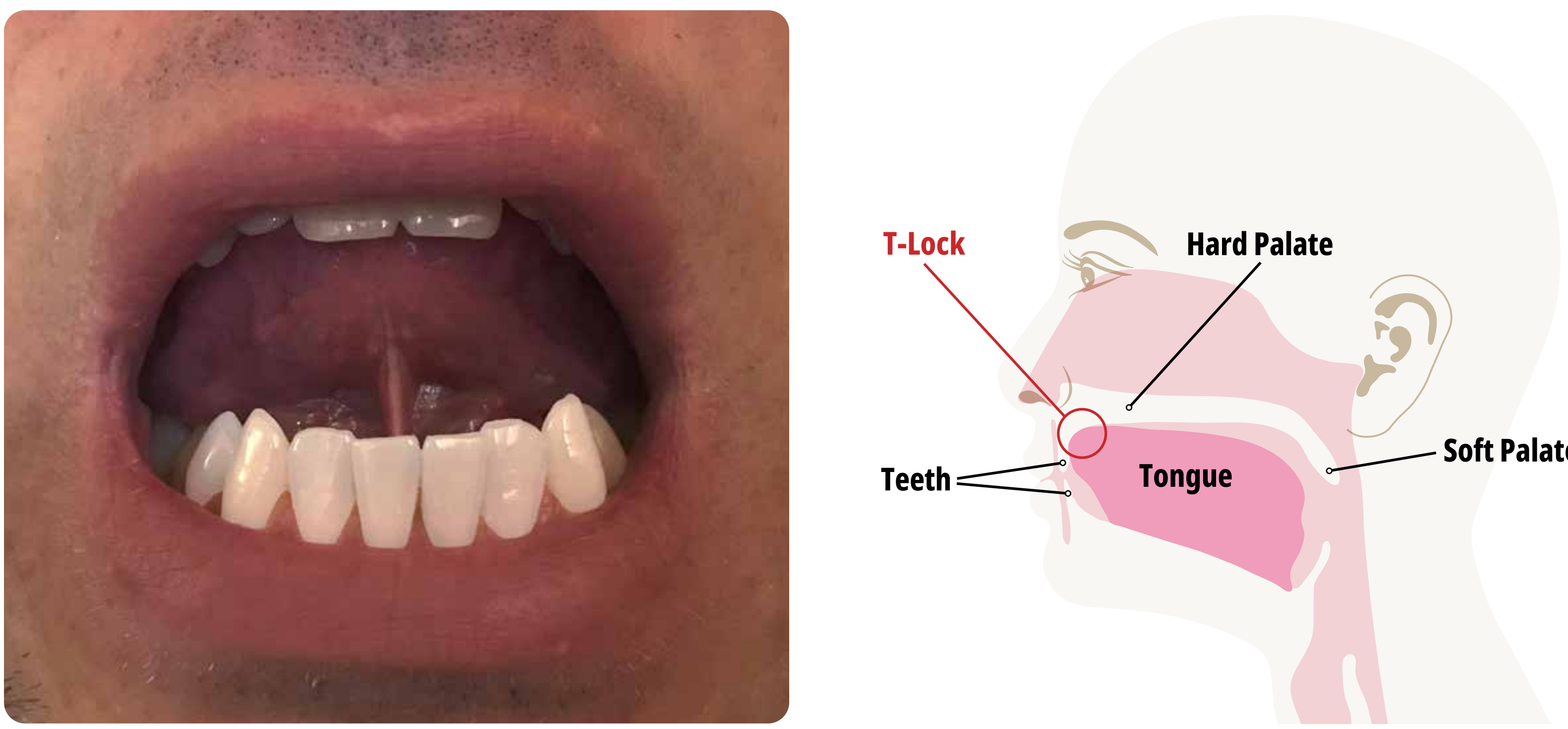


Figure 3.5
Tongue position for T-Lock.

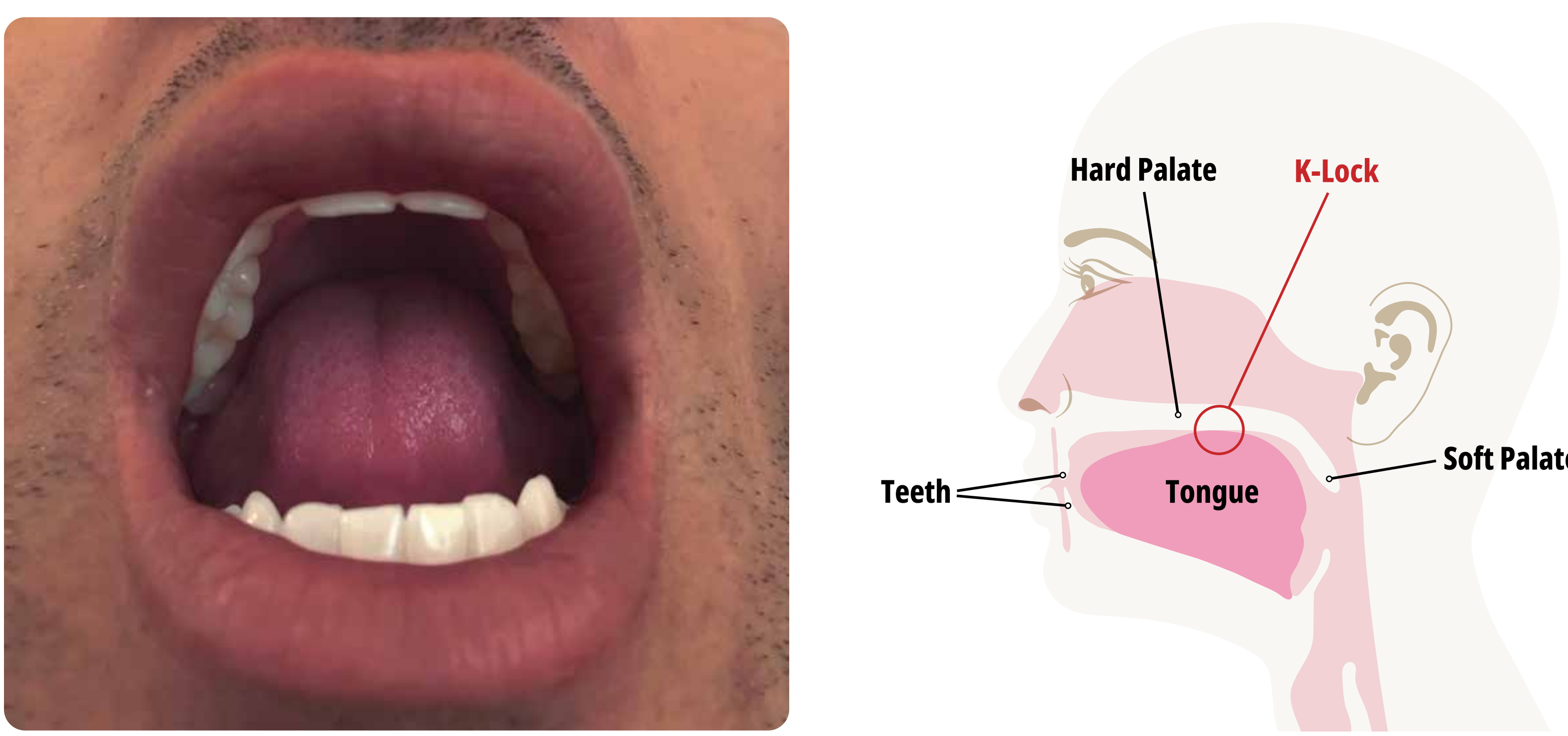


Figure 3.6
Tongue position for K-Lock.

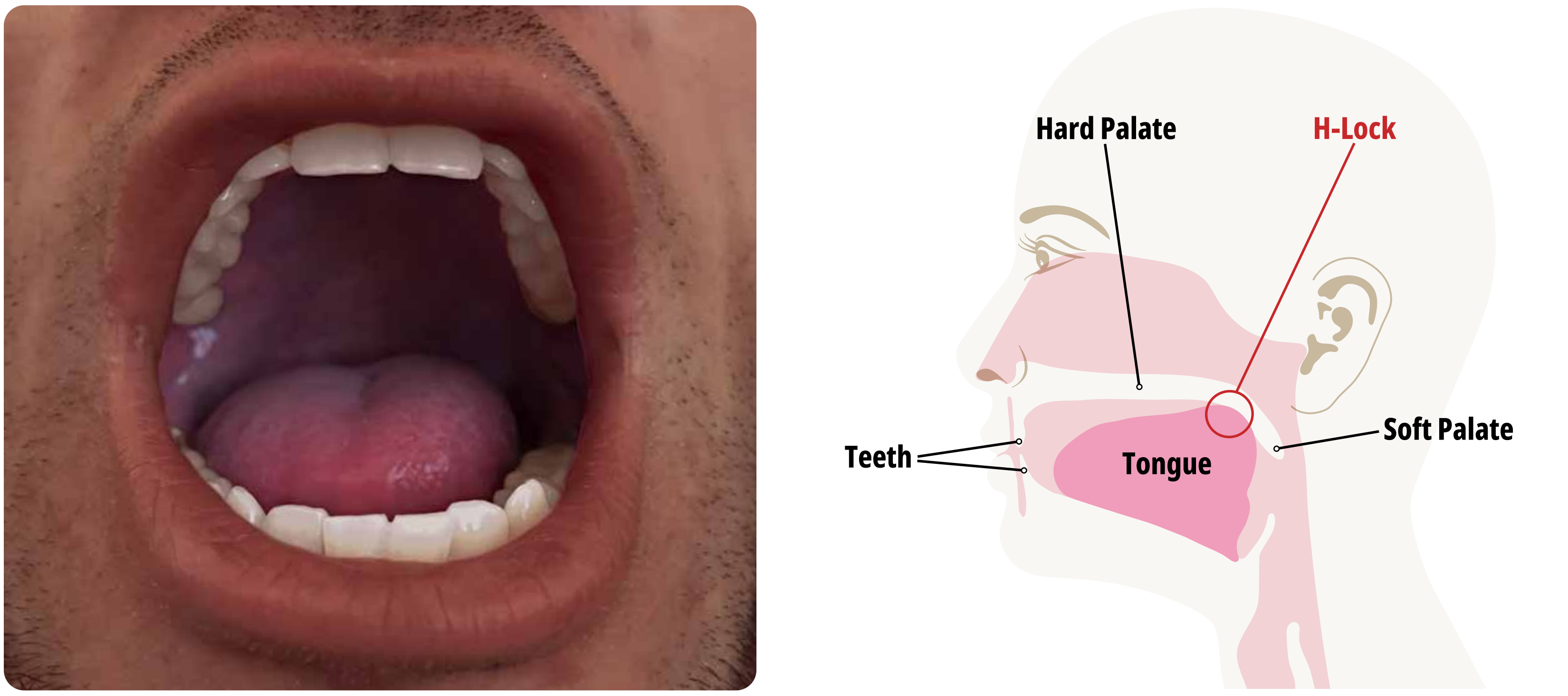


Figure 3.7
Tongue Position for H-Lock.

How to gradually raise your tongue to the top of your mouth

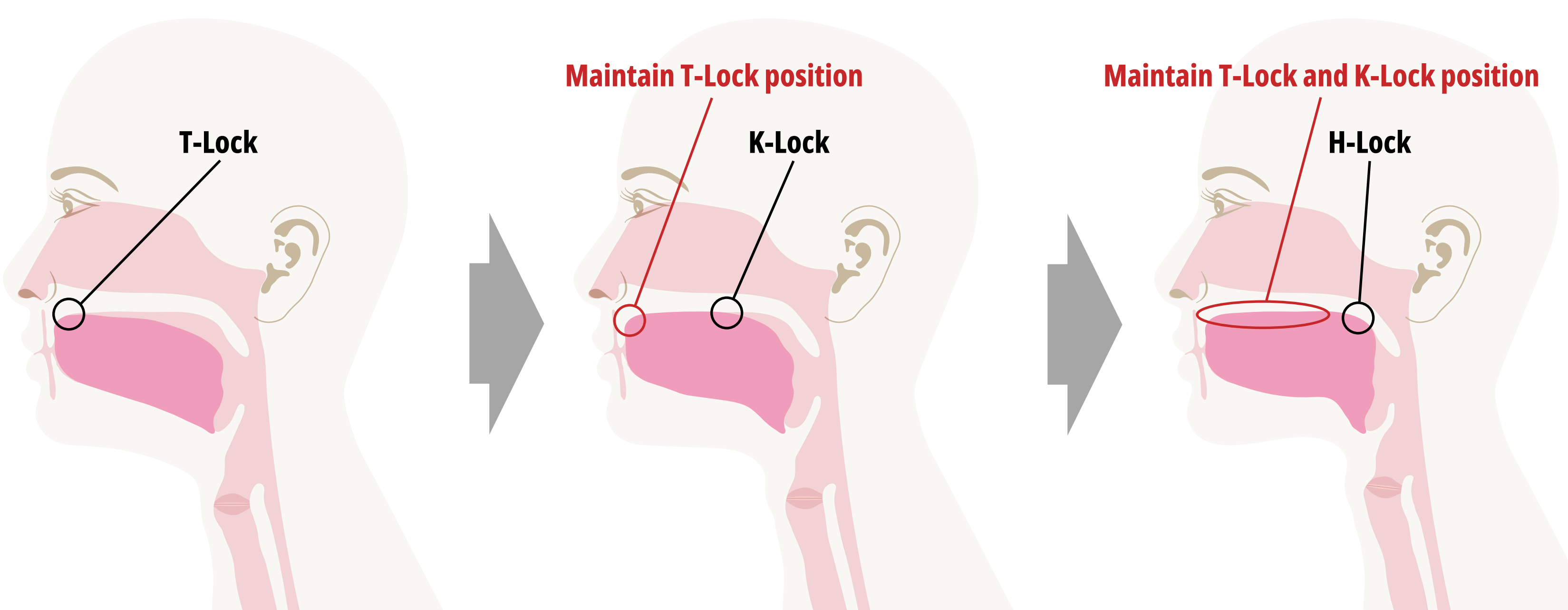


Figure 3.8
Figures show how to position your tongue while you are doing Mouthfill at depth. They also show the movement of Adam's apple.

3.3 Mouthfill Efficiency

You can calculate the efficiency of your mouthfill by taking note of where you fill your mouth (charge) and as you descend compare this to where you are not able to equalize anymore.

Surface Mouthfill

Take a mouthfill at the surface (1 bar) and use only the air in your mouth to equalize as described in the previous chapter. See how deep this takes you, and record the depth where you are not able to equalize anymore.

It is important for the exercise that you only use the air in your mouth. You should feel the volume of air in your mouth decrease quite quickly due to the rapid increase in hydrostatic pressure close to the surface.

MF Ratio = Pressure reached / Pressure charged

Let's say you were able to dive to 15 metres (2.5 bar) by equalizing with your surface mouthfill. Divide the pressure of the depth you were able to reach (2.5 bar) with the pressure where you took the mouthfill (1 bar), and you will find that you were able to equalize to a depth of 2.5 times more than where you took the mouthfill. This is your mouthfill ratio.

Pressure possible to reach = Pressure charged x MF Ratio

If you are able to take the same mouthfill (2.5) at, for example 20 metres (3 bar), you can calculate by multiplying the pressure where charged (3) and multiply by your ratio (2.5), which is 7.5 (see **Figure 3.9**). It means you might be able to equalize down to 65 metres.

To find your ratio, it can be useful to take the mouthfill at different depths and compare the results you get. If they differ too much, there might be other influencing factors such as leaking air, refilling air from the lungs (especially if you do shallow mouthfills with full lungs). Diving with mouthfill on FRC might increase the chances of getting accurate numbers, but be careful when using this combination of techniques.

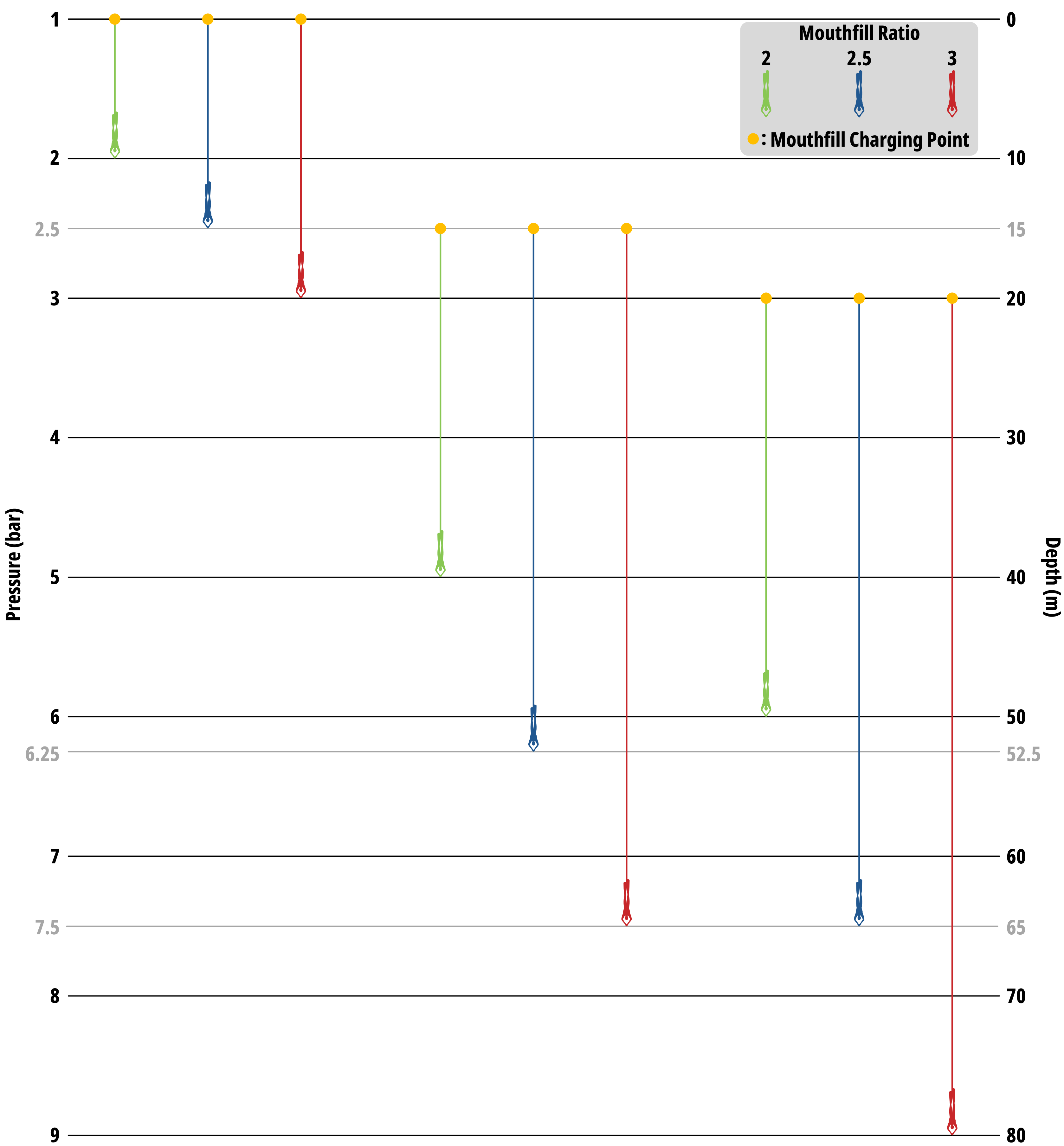


Figure 3.9
A Mouthfill Ratio chart for specific pressure (depth) calculation.

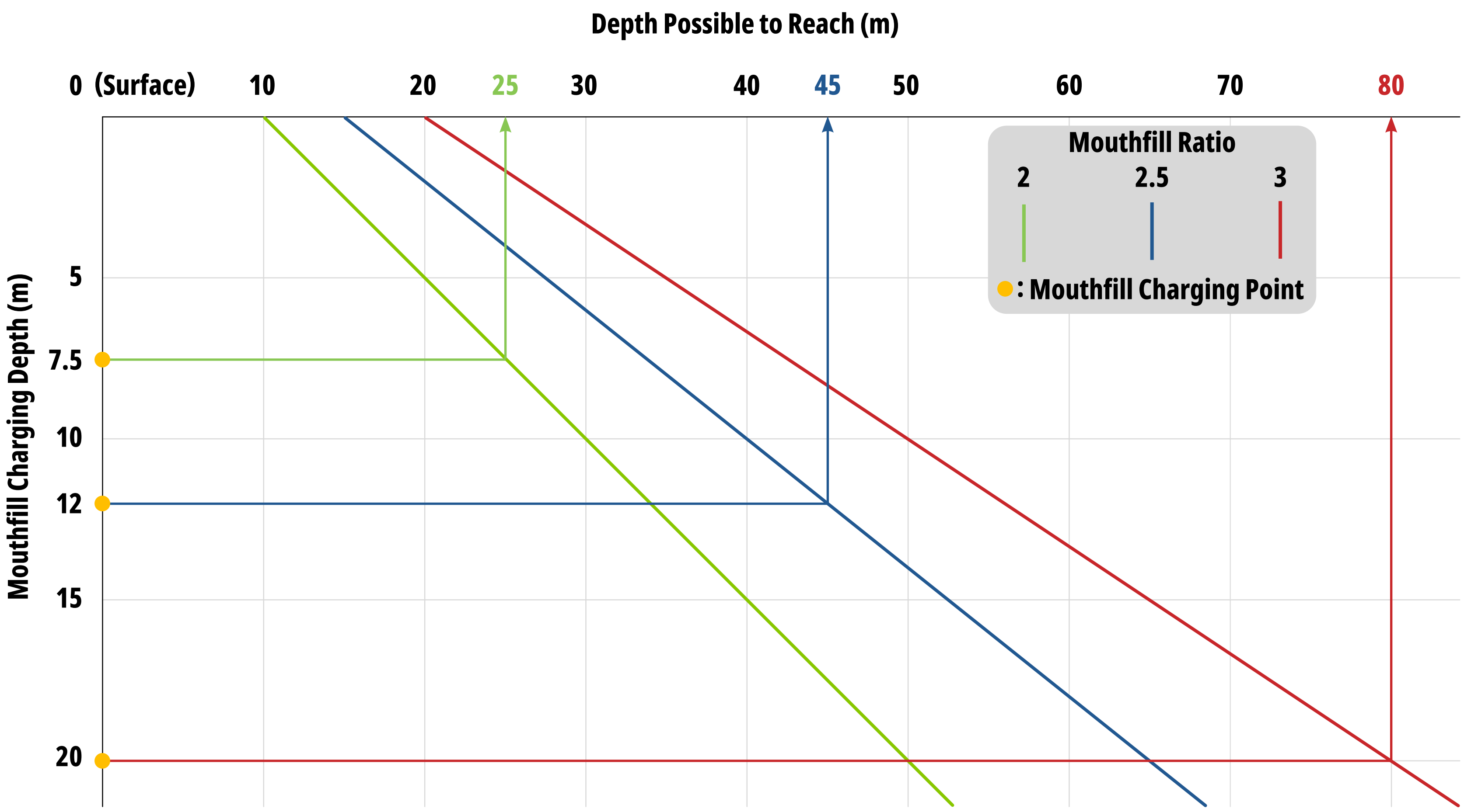


Figure 3.10
A Mouthfill Ratio chart for overall depth in metre calculation.

As you can see, increasing the MF ratio can significantly increase the depth of how deep you are able to use the mouthfill for equalization. With training you can both increase the volume you charge your mouthfill with, and improve your ability to manage the air in your mouth to equalize.

Tip

- **(pressure (bar) - 1) x 10 = Depth (m)**
  ex) (3.5 - 1) x 10 = 25m
- **(Depth (m) + 10) / 10 = Pressure (bar)**
  ex) (80 + 10) / 10 = 9bar

Timing of the Mouthfill: Start Charging Shallow!

To start your work with this technique, it is recommended you charge the mouthfill at quite a shallow depth of 10m. The second challenge of the mouthfill technique is to manage it, which means to use the air in your mouth efficiently until it runs out. As you improve charging and managing the mouthfill from this shallow depth you can then slowly increase the depth where you charge.

As you have learned in this chapter, if your goal is to comfortably reach the limits of recreational freediving of -38m, charging your mouthfill at -10m is in most cases already deep enough.

There is no benefit in trying to charge your mouthfill as deep as possible before being very proficient and relaxed in using the air in your mouth until it runs out.

Figure 3.11
A freediver practices Mouthfill with a Nose Clip.

Chapter 03 Knowledge Review

If you can reach 15m using mouthfill from the surface, what depth would you be able to reach if you could perform the same mouthfill at 30m?

Name three ways to move the air from the mouth to the nasal cavity whilst using mouthfill.

Why should you continue to train to increase VC after you have learnt mouthfill?

Why is it good practice to make a sound when filling the cheeks?

Why should you continuously hold your nose after mouthfill?

Why is constant pressure mouthfill more popular?

Why do we smile whilst we are performing equalization with Mouthfill?

At what depth should you take mouthfill when you first start to practice?

CHAPTER 04

LUNG PACKING

4.1 Introduction

Pumping Air to the Lungs with the Mouth

Lung packing, also known as carpa, buccal pumping or glossopharyngeal insufflation, is a technique of inhaling (pushing) air to the lungs by action of the mouth, the lips, the cheeks and the tongue. Reported for the first time in 1951, in patients with respiratory muscles paralysis, this technique has been used to assist when normal breathing is failing.

Lung packing has also been adapted for freediving and used to increase pressure in the lungs above normal. Lung packing allows a freediver to inhale more air beyond Total Lung Capacity (TLC). Packing enables freedivers, to a certain extent, to achieve greater depths, distances and time. Recent events over the last several years have, however, indicated that this technique is not without risk.

Possible to Extend One Full Breath beyond TLC

Packing is sometimes falsely believed to be a common way to take the One Full Breath before a freedive. The correct way of how to perform the One Full Breath is described in the AIDA2 Course. The One Full Breath is good enough for any recreational freediving including all performances required on AIDA4 Course and actually for greater performances as well.

Packing is just one of many tools which can be used to go beyond recreational freediving. As an AIDA4 Master Freediver you should have a wide knowledge about these. In this chapter you will learn how to pack, why freedivers do it, and the advantages and disadvantages of the technique as well as all risks involved.

However AIDA does not recommend packing for STA or DYN dives, nor for dives to depths less than - 60m, which is way beyond the scope of recreational freediving.

Considerable Risks and Limited Effect

Packing is a technique that comes with considerable risks, ranging from being uncomfortable over surface blackouts to short and long-term injuries of the lung tissue (see chapter 4.3). Lung packing should therefore never be used by untrained freedivers and even then only with the utmost care.

In addition, the positive effects of lung packing on your freedive performance are quite limited and must always be seen in context of the possible risks and dangers.

Lung Packing in the AIDA4 Course

On the AIDA4 Course you will not use packing for any of your dives (confined or open water). You will be taught how to pack in the classroom and to get used to the technique only within the VC volume of your lungs. Before you try packing, carefully read the whole chapter, in particular the section about risks of packing and how to avoid them.

There are many other ways which are safer and more efficient to improve your dives (depth, distance or time), the most important of which is of course: Relaxation. A few others are introduced to you in this manual: Mouthfill, Reduction of RV, Fitness for Freediving, etc.

You should always train patiently, progress slowly and master all other available skills and techniques before you make a decision to use packing for your dives.

4.2 Effects of Packing

Effect on Failure Depth

Packing increases the amount of air inside your lungs. That means if a freediver is performing packing after a full breath, he / she is diving with an amount of air beyond TLC. Let's assume a freediver with 6L TLC is able to pack 1L on top of it. His RV is defined as 25%. Let's have a look what will happen by diving deep:

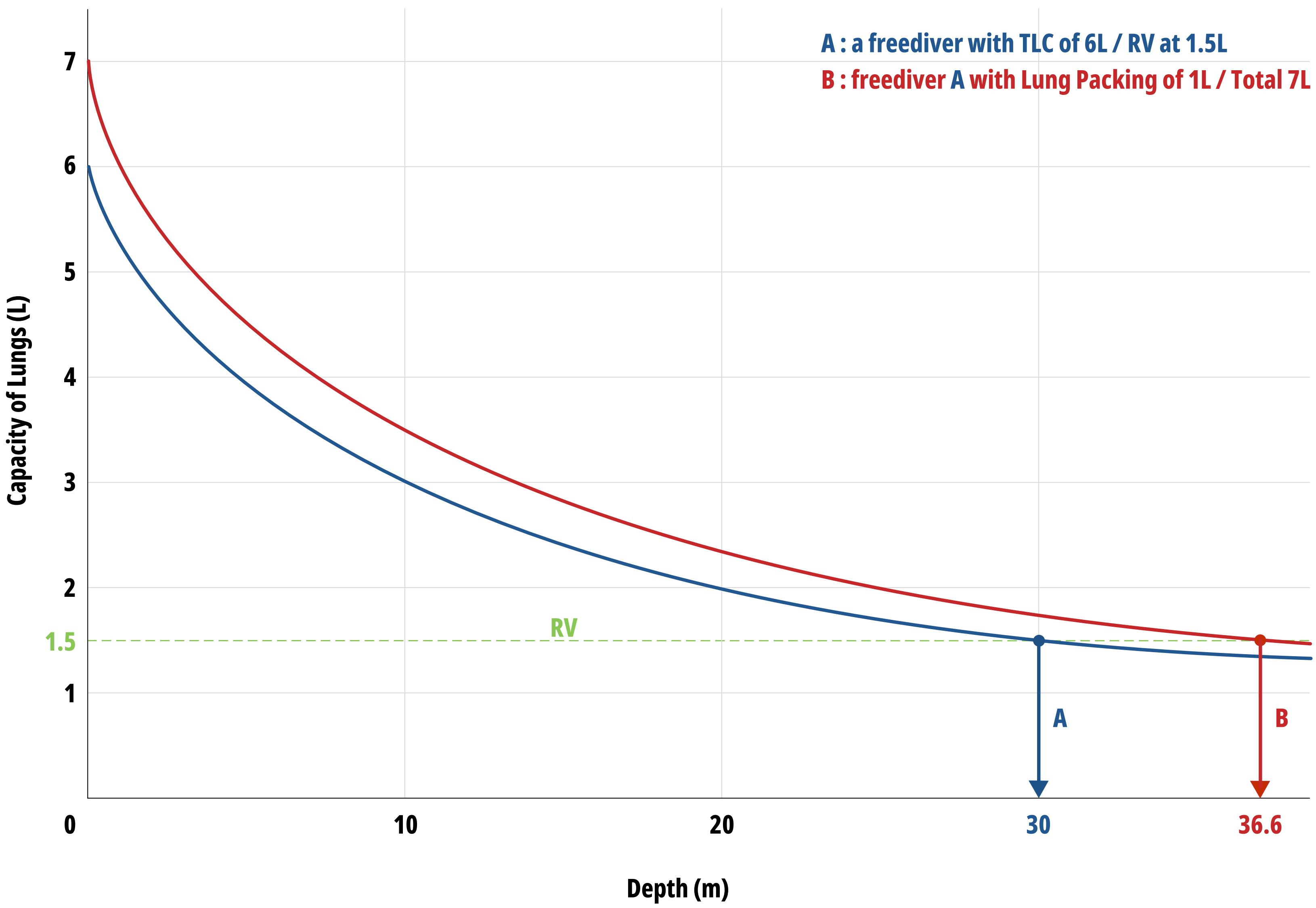


Figure 4.1
Effects of Packing.

Without packing (**A**), the diver reaches failure depth at -30m (4bar) with 1.5L volume. With 1L additional air from packing (**B**), he reaches the RV of 1.5L at a depth of around 36.6m (4.66bar).

Ease of Equalization

In the example above you can see that the diver is reaching failure depth at a deeper level with packing. This can help him to equalize deeper using the Frenzel technique, but it may also help him to charge the mouthfill deeper.

It is important to mention, that the RV has not changed, but the depth where the diver is reaching the RV has been set down for about 7m due to the additional air from packing. As described in **chapter 2.2**, the residual volume can be reduced with training. To compare the benefits of reduced RV versus packing, let us assume a freediver with a TLC of 4L, has reduced her RV to 20% (**B**) with appropriate training methods:

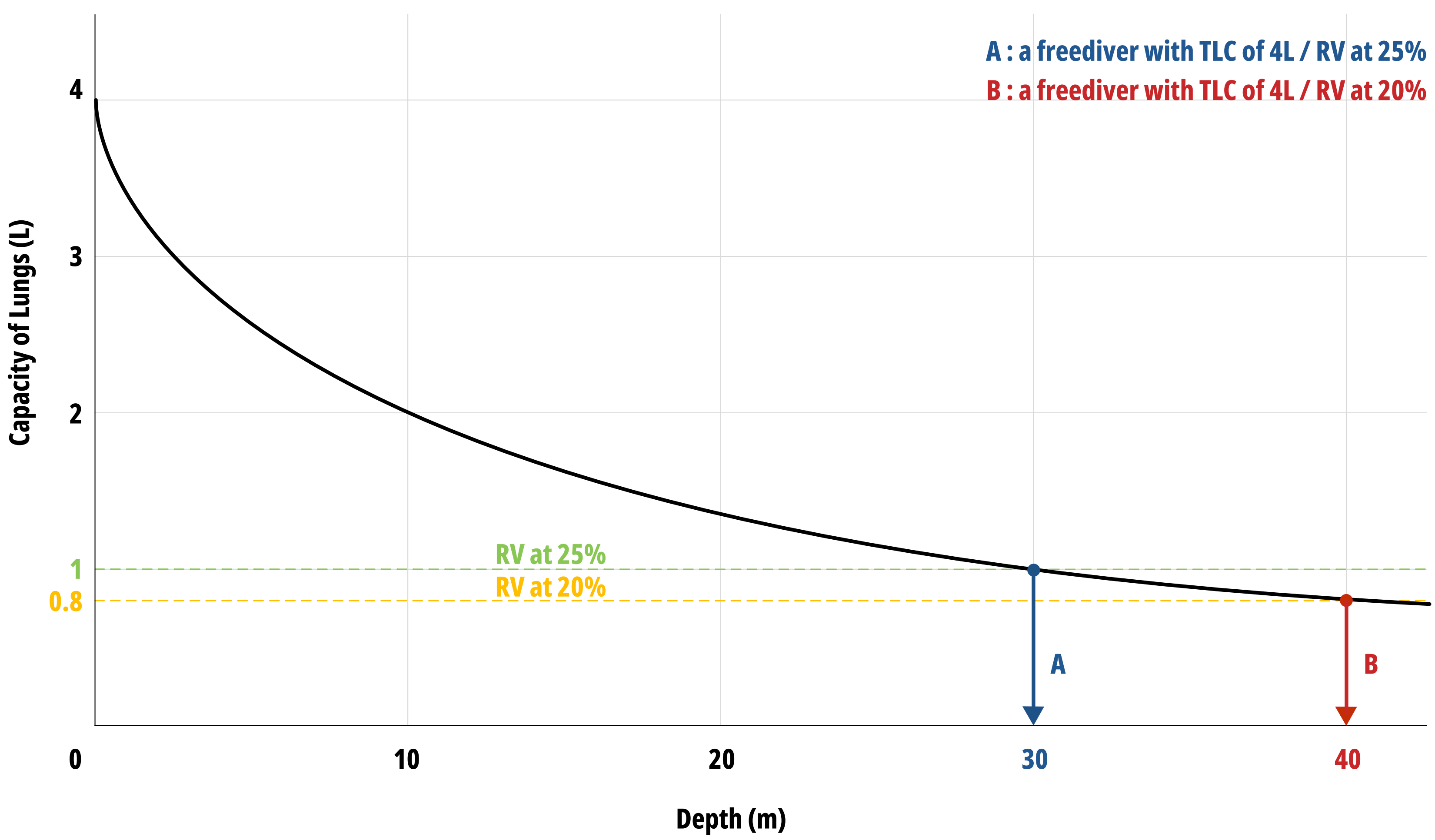


Figure 4.2
Effects of reduced RV.

The failure depth of the diver with trained RV is 40m – and this is without the use of any packing. Compared to the diver with 6L TLC + packing, she can reach deeper depths thanks to her trained flexibility.

Extra Oxygen

Packing increases the amount of air inside the lungs and therefore also the amount of Oxygen available to the freediver. It also increases the limit of hypoxia with each pack. Indeed, in competitive freediving beyond the limits of recreational freediving, this can play a role.

However, there are other factors, which influence the usage of Oxygen to a great extent, namely your freediving technique or ability to relax. It is recommended you work on these factors first to reduce Oxygen consumption before introducing packing to your diving.

It is especially the case if hypoxia is not part of your problems beyond recreational freediving, that packing will not be beneficial for you.

Support the One Full Breath

You may have already noticed that it is not easy to take a 100% full breath under all circumstances. At the end of your inspiratory reserve volume the muscles may get tense and you need quite a bit of energy to fill the lungs completely. Also wetsuits can be tight around the chest and you may feel pressure from the outside, especially when in a vertical position in the water, where parts of your lungs are already submerged and are therefore exposed to a little bit of water pressure.

In addition, your relaxation can suffer from taking a full breath. This is why some freedivers do a 90-95% breath and then use a few packs to fill their lungs completely. To do so, try to fill your lungs as much as you can without losing relaxation and gently add 3-4 small packs.

When and Why NOT to Use Packing?

There is now clear evidence that packing can be harmful for the lungs (see chapter 4.3). This is why AIDA strongly recommends that packing should always be the last tool you use for improving your freediving.

For improving your pool performance - static time or dynamic distance - you should work on relaxation, CO_2 tolerance and greater efficiency of technique. These are also indispensable tools for deep dives.

For equalization, proper technique and flexibility are the true keys for reaching depths. Depths to 60m or even deeper can easily be reached without the use of any packing. If you start to use packing, AIDA recommends you do so in very small increments. When reaching certain goals in depths with the usage of packing you may want to reach those goals as well without any packing, before increasing depths or increasing the amount of packing.

We strongly indicate you read the following chapter before adding packing to your training.

4.3 Warning and Disadvantages

Increased Buoyancy

Your lungs are the largest airspace of the body. When fully inhaled the lungs are also the airspace that creates the most amount of positive buoyancy, according to Archimedes' Law. The technique of packing adds air on top of your already fully inflated lungs, which causes an increase of size / volume of the lungs, which in turn causes an increased amount of displaced water when you submerge. As the additional air you gain from packing has no weight under normal atmospheric ambient pressure, it means that you also gain buoyancy.

Adding more weights to your weight belt can of course compensate the increased buoyancy. However according to Boyle's Law, you will know that, your lungs will compress with increasing depth, which means that as you descend deeper you constantly lose buoyancy. If you use additional weight to compensate for packing, the problem is that the lead-weight you carry keeps a constant negative buoyancy throughout the dive: More weight means more work on ascent!

Discomfort in the Chest

The amount of air you can inhale during your One Full Breath is limited by muscles and bone structures surrounding your lungs. Packing does not engage any of the muscles that you normally use for breathing, which allows these muscles to stretch and your lungs to expand beyond the full inhale achieved using the diaphragm and intercostal muscles. However, adding air in this manner usually causes discomfort and an uncomfortable sensation of positive pressure around the chest, as you are now stretching the thorax beyond its natural range. This feeling might even intensify when you engage the upper body in movement, like doing a duck dive, enduring contractions in STA or doing a turn at the end of a lane in DYN.

Risk of Surface Blackout

A blackout in freediving can have various reasons or triggers. We know that a blackout at the end of a breath hold that is too long is caused by low partial pressure of Oxygen in arterial blood to the point where the brain shuts down partially to conserve the remaining Oxygen.

One of the risks of excessive packing includes the so-called packing blackout: The full or partial loss of consciousness during or shortly after packing. We already mentioned that the technique of packing stretches the thorax and expands the lungs beyond their natural range. The pressure that your packed lungs exert on the heart and arteries going to the brain can restrict the blood flow and lead to an insufficient blood supply to the brain. This is a form of cerebral ischemia (see AIDA3 manual), signs and symptoms are identical to the LMC or blackout, only now it happens on the surface while packing or shortly after during the initial part of the descent.

When providing buddying a diver who uses the technique of packing is advised to watch the diver closely while packing and during the start of the dive, and to be ready to stop the diver from descending if you see signs of LMC or blackout.

If a diver experiences such an event – as with any type of LMC or blackout – he or she should stop diving for the rest of the day.

Risk of Lung Injury Pre-Dive

Excessive packing before the dive might stretch thorax and lungs to their limit. The most serious issue this can cause is an over-expansion and damage of the lung tissue, which in turn can cause air / gas bubbles to enter the blood stream and cause potentially lethal blockages ("Arterial Gas Embolism" – AGE, see Chapter 5.2).

There is also the risk of a lung collapse, especially when combining packing with stretching. This might be the case in "dry training", but also during the first movements to start a dive: A strong duck dive in CWT, a long grab in FIM, or a wide arm-pull in DNF/CNF.

Risk of Injury during Ascent: (Blood shift) Embolism

It is important to remember that freedives will trigger the blood shift: Blood travels to the blood vessels surrounding the lungs, which helps in further compression at depths below RV (see AIDA3 manual). However the effect of the Blood Shift doesn't simply disappear when we ascend. An additional amount of blood will still be accumulated around the lungs and might limit the capability of the lungs to expand back to their full extent during ascent. It might be even more of an issue to accommodate all the extra air added through packing pre-dive!

The problem now is that the space in our chest is decreased due to the Blood Shift. If we have packed the lungs pre-dive, the volume of air expanding on the ascent might go beyond the limit of our chest flexibility - in the worst case – can cause a gas embolism as mentioned above.

4.4 How To Do Packing

To properly apply the packing technique, you need good control and awareness of the following muscles:

- **muscles of the lips, mouth and cheeks**
- **tongue**
- **larynx (especially glottis - vocal cords)**
- **pharynx**
- **Soft Palate**

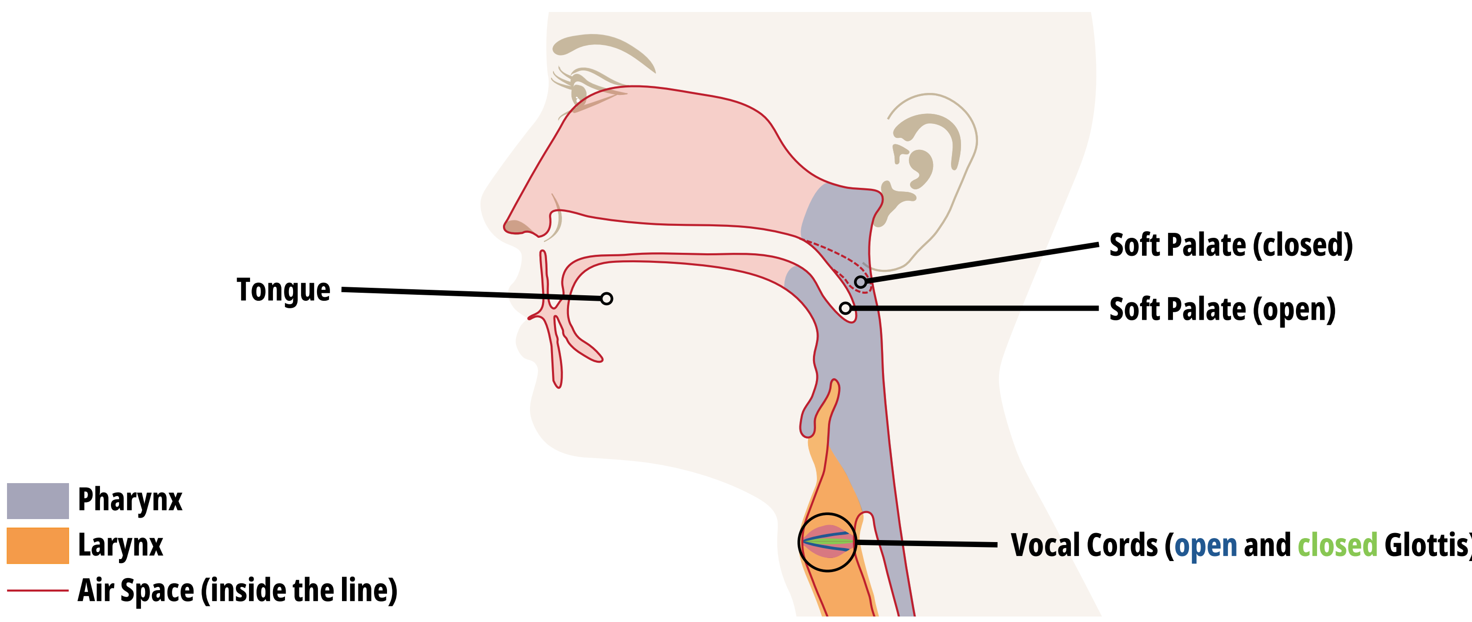


Figure 4.3
Muscles related to Packing.

The following step-by-step instructions explain how to take one single pack. To pack your lungs more, you need to repeat all steps several times.

For most people it is easier to pack if you keep the nose pinched during packing. Therefore it is recommended to pinch your nose, if you cannot control your glottis and soft palate.

Step 1: Close Glottis and Soft Palate


Figure 4.4

Close your glottis and the soft palate (to develop these muscles, see **chapter 7.4**), so that the space in your mouth is separated from your lungs. Keep your tongue down and relaxed on the floor of the mouth cavity. The tip of your tongue should be behind your teeth.

Step 2: Suck Air into your Mouth

Figure 4.5

Open your lips slightly and shape them like you want to suck water through a straw. Suck the air into your mouth by moving down your jaw and the floor of your mouth.

Step 3: Close Lips and open Glottis

Figure 4.6

Close your lips and open your glottis (See **Figure 4.3**).

Step 4: Move Air from your Mouth to your Lungs

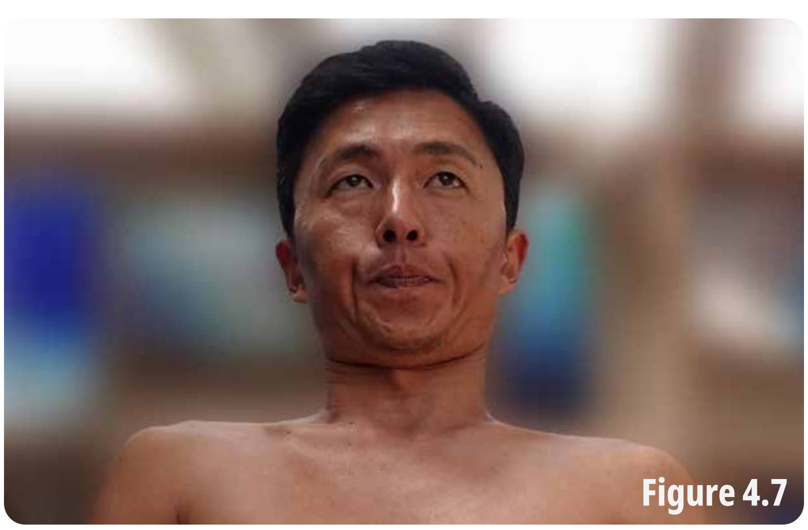


Figure 4.7

Move the air that you sucked into your mouth to the back of your throat and then into your lungs by raising your jaw and moving your tongue up towards the roof of your mouth. Close the glottis immediately when the air gets to your lungs.

Repeat from Step 1

Exercise Packing within VC!

The safest way to exercise packing is to practice within your vital capacity (VC):

Start packing at RV (or FRC) and increase the volume of air in your lung, pack by pack, until you get close to TLC - but not beyond! Staying within VC allows you to practice the technique as much as you like, without creating any excessive pressure in your lungs and risking an injury.

Slow Progression

Remember! When you start learning this technique, do not go beyond your TLC and increase lung packing volumes in small steps compared with previous volumes.

Chapter 04 Knowledge Review

What are three disadvantages of packing?

Typically past what depth may freedivers need to use packing?

Why do you progress slowly with the amount of air you pack?

Can Packing give you extra oxygen for the performance?

What happens to your failure depth when you pack?

Which will benefit your dive more, relaxation or packing?

CHAPTER 05

DECOMPRESSION ILLNESS (DCI)

Unlike scuba divers, freedivers do not breathe compressed air while diving. But this does not free us of the risk of the influence of Nitrogen, in particular its high partial pressure at great depths.

The belief that Nitrogen does not affect freedivers was common in the past. But several cases of decompression sickness reported by spear-fishermen, commercial freedivers (Korean Haenyeo or Japanese Ama) and deep freedivers proved this assumption wrong: The deeper a freediver dives, the longer or the higher the number of consecutive dives become, the greater the risk of Decompression Illness (DCI).

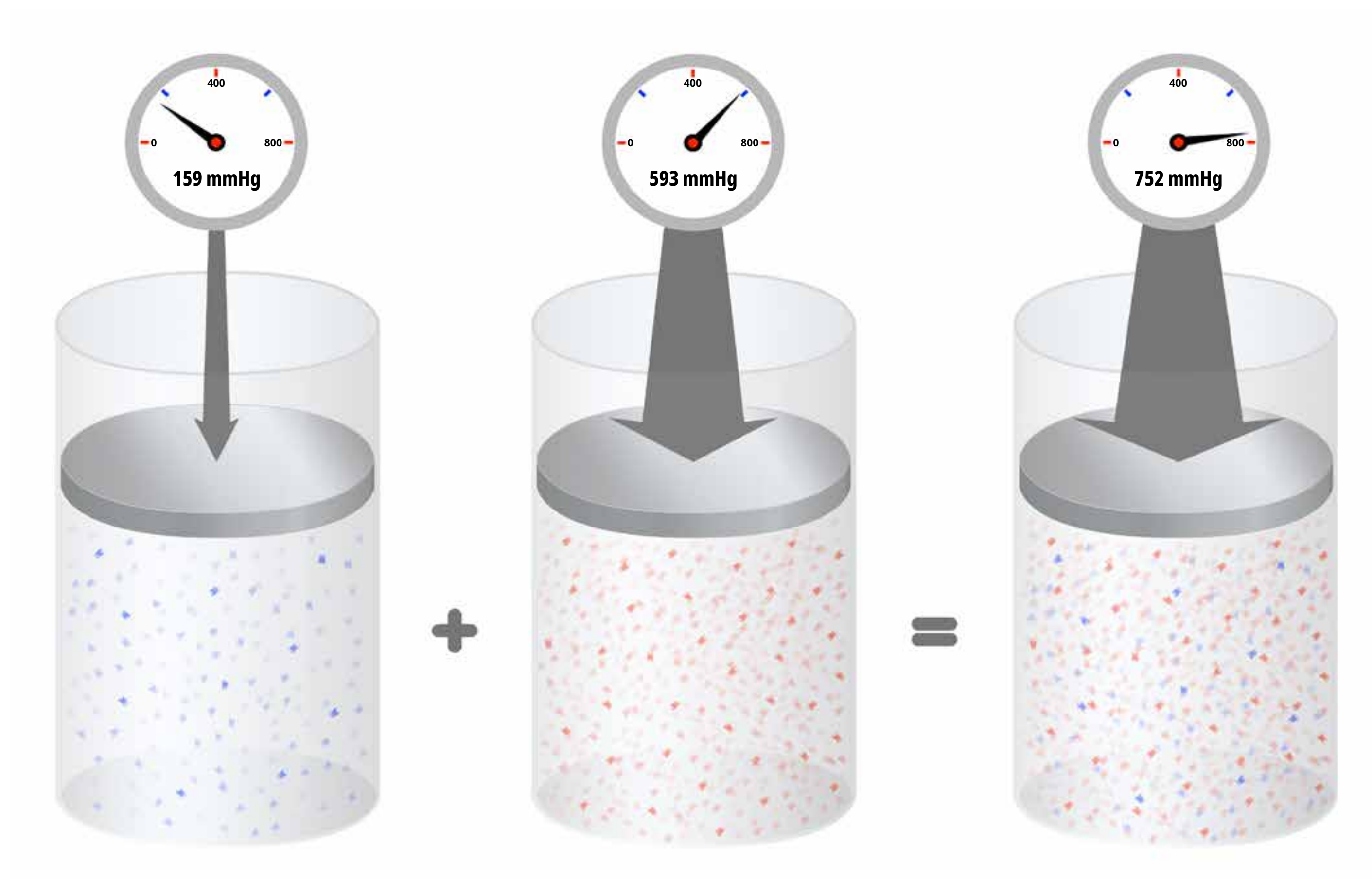
To understand this phenomenon and to be able to minimise any associated risks you need to understand two physical laws: Dalton's Law (see also AIDA3 Manual) and Henry's Law.

Note: This manual does not include Nitrogen Narcosis or CO_2 Narcosis, as these are effects observable only when diving to depths way beyond recreational freediving.

5.1 Introduction

Definition: Dalton's Law

The AIDA3 Manual already introduced you to the basics of Dalton's Law, or the "law of partial pressures", as a vital component in understanding the phenomenon called "Shallow Water Blackout".



Total pressure of a mixture of gases is equal to the sum of the partial pressures of the component gases.

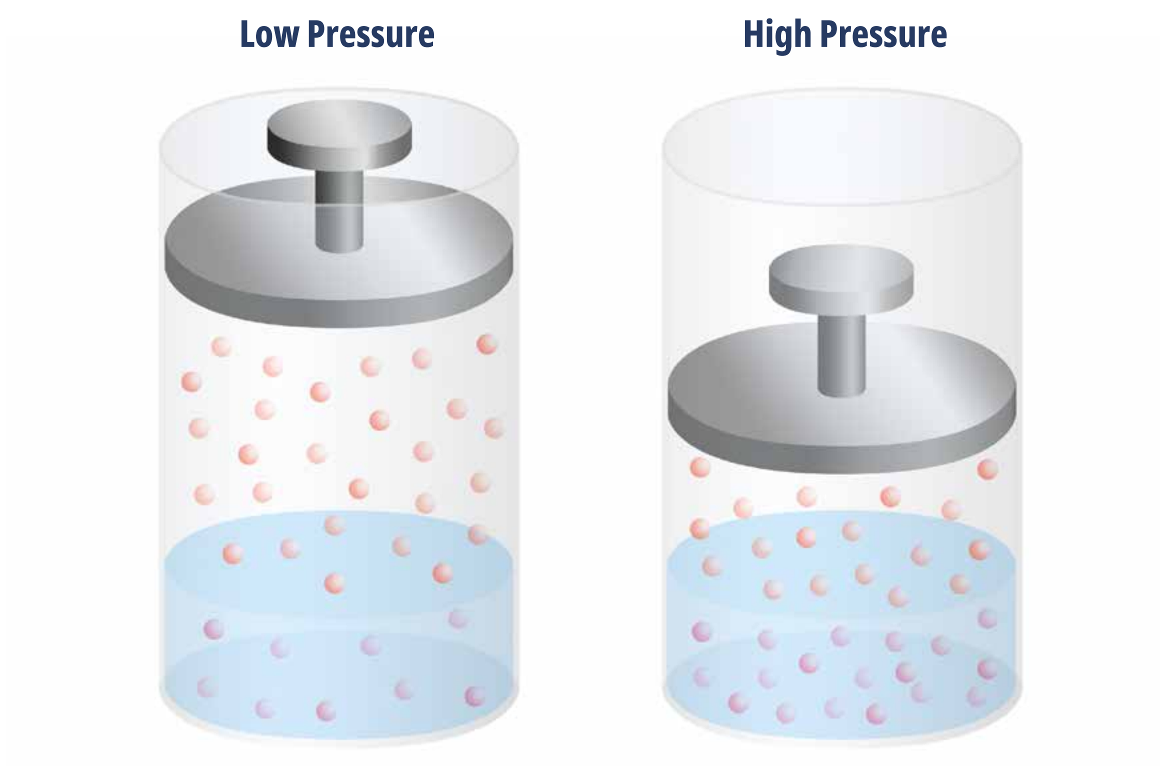
Figure 5.1
Dalton's Law.

To understand the effects of changing partial pressures on the human body, it is vital to understand the effects of Dalton's Law. Chemical activities in our bodies and some of the physical properties, e.g. solubility of the gases in liquids depend on the partial pressure of a gas. When the partial pressure of the gas changes, our body responds to it and the strength of the response depends on the partial pressure of the gas.

In our further examination, we mainly look at the individual effect of the three gasses Nitrogen, Oxygen and Carbon Dioxide - each gas can cause a different reactions of the human body when exposed to changing partial pressures.

Definition: Henry’s Law

The solubility of the gas in liquids – for example Nitrogen in blood - depends on a few factors like temperature, the nature of the liquid, the nature of the gas and, as explained in the chapter above, the partial pressure of the gas.



The concentration of a gas that is dissolved in a liquid is proportional to the partial pressure of that gas in contact with the liquid.

Figure 5.2
Henry’s Law.

If we increase the partial pressure of the gas that is in the contact with the liquid we increase the concentration of the molecules of the gas. As a result, there will be more collisions of the molecules of the gas with the surface of the liquid and gas molecules will dissolve in that liquid. The higher the pressure, the more molecules dissolve. If we decrease the pressure the dissolved gas will gradually escape from the solution.

This is what happens if you carefully open a well-shaken bottle of carbonated drink – the gas escapes from the solution slowly. By carefully opening the bottle you created a gradual pressure change. However, if you open the same bottle in one quick move, the pressure change happens abruptly and the gas comes out of solution in an explosive way – and the soda might overflow.

You will also find when you leave an open carbonated drink for a while, without the elevated pressure being trapped, the beverage will become “flat” when most of the gas has gone out of solution.

5.2 Forms of DCI

Nitrogen Related Symptoms

The air in our lungs consists of Nitrogen, Oxygen, Carbon Dioxide and traces of other gasses, but the only gas we focus on in context of DCI is Nitrogen.

At Sea Level – Constant Level of Dissolved Nitrogen

Nitrogen is a "neutral gas" - research has shown so far that it is not used during breathing under normal atmospheric pressure. At sea level, the dissolved gases in the blood and tissues are in proportion to the partial pressure of the gases in the lungs. There is always a constant level of Nitrogen (about 1 litre) dissolved in our blood and tissues.

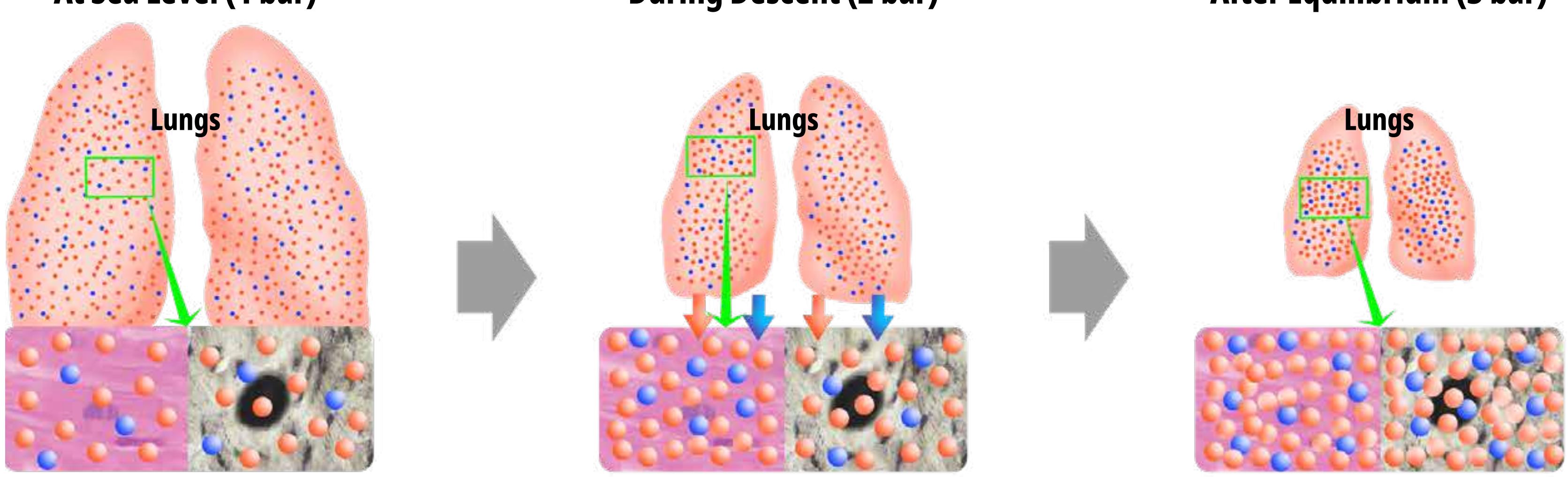


Figure 5.3

Henry's Law: This is just an ideal concept of gas saturation in human's body while diving. The second illustration shows the different speed of gas saturation per unit area in between Fast and Slow tissues.

During Descent: Absorption of Nitrogen to Tissues

As a freediver descends, the hydrostatic pressure increases, the lungs of a freediver get compressed and therefore the partial pressure (pp) of the gas inside the lungs increases proportionally. The partial pressure of the gases in the lungs are now greater than the partial pressure of these gases dissolved in the blood and tissues. Therefore, to maintain the balance, gases will move from the lungs into the blood and then from the blood to tissues – this is what Henry's Law describes.

The difference between the partial pressure of the gasses in the lungs and the surrounding tissues is called gradient. The greater the difference in pressure the steeper the gradient. The speed and amount of the gas dissolved in the blood and tissues depends on the steepness of the gradient.

Not all tissues absorb Nitrogen at the same speed. We can divide bodily tissues into “fast” and “slow” tissues: “Fast” tissues are those with a dense net of blood vessels and therefore large blood supplies, for example the lungs or the brain. These tissues absorb (and release) Nitrogen rapidly. On the other hand, slow tissues are those with a less dense net of capillaries and poor blood supply, e.g. bones or fat. These tissues absorb (and release) Nitrogen more slowly.

It is worth mentioning that the brain is not only a fast tissue, but also supplied with even more blood than normal during the dive due to effects summed up as the Mammalian Dive Response (see AIDA3 Manual): Peripheral vasoconstriction (reduced blood flow to the extremities) and cerebral vasodilation (enhanced blood flow to the brain) caused by elevated CO_2 levels. Hence the absorption of gas in the brain during freediving is especially heightened.

On Ascent - Release of Nitrogen from Tissues

During the ascent of the freediver, the process reverses. When the hydrostatic pressure is relieved, the partial pressure of Nitrogen in the lungs decreases and tissues release excess amounts of Nitrogen to adjust to the dropping partial pressure. Nitrogen comes out of the solution in tissues and the blood back to the gas state in the lungs.

Decompression Illness: Insufficient Elimination of Dissolved Nitrogen on Ascent

Unfortunately there is a difference between the efficiency of the two processes called saturation and desaturation when the hydrostatic pressure changes. The human body can adjust relatively quickly to the rising pressure during the descent (saturation), but the opposite process of adjusting to the dropping pressure during ascent (desaturation) is less quick, which can lead to problems.

To remove the excess Nitrogen from the body requires time. Even though breath-hold dive times are short (compared to scuba diving) and freedivers do not breathe compressed air, there is still the relatively fast ascent speed of freedivers of up to 120m per minute that can affect the slower process of desaturation.

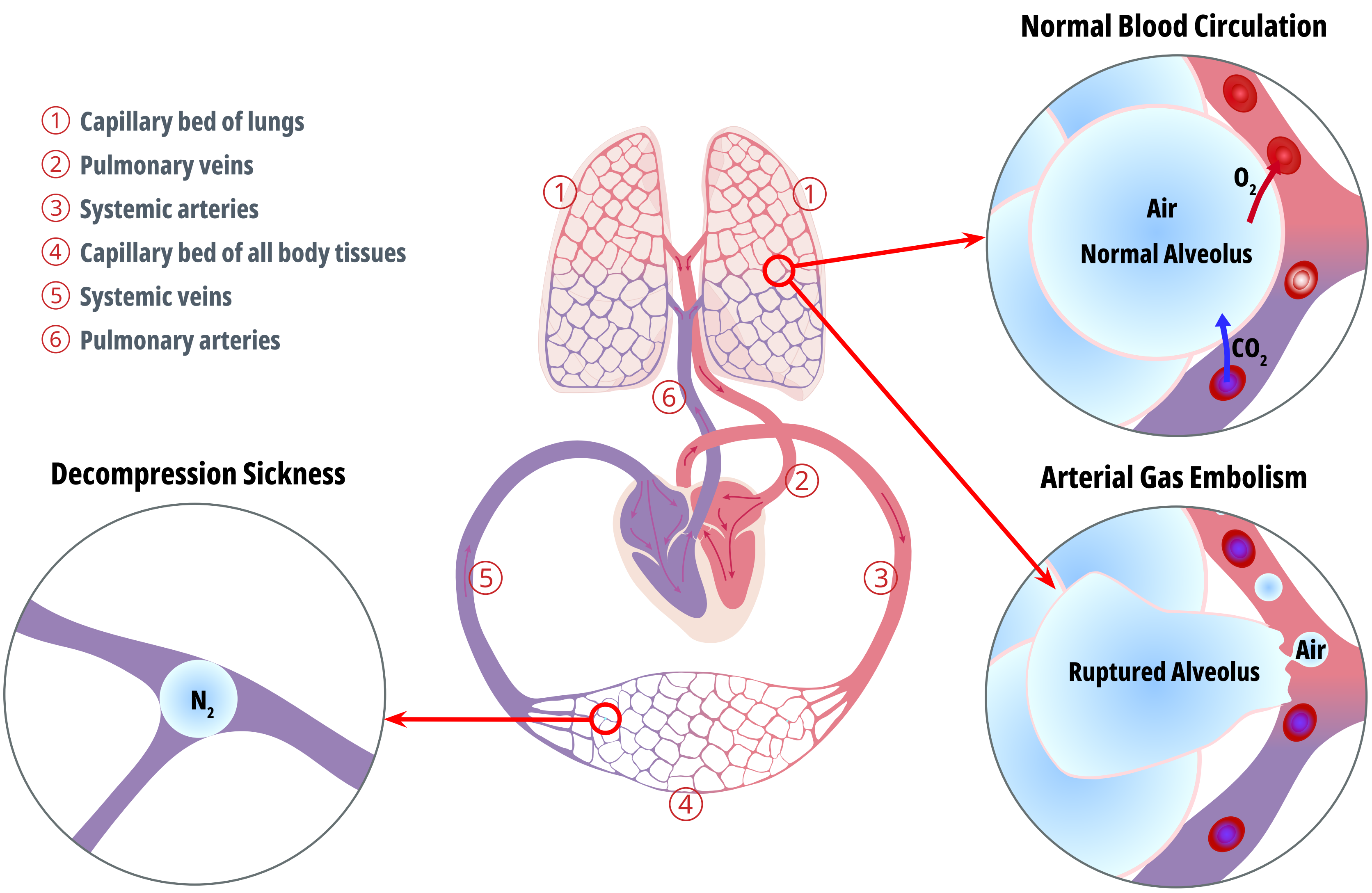


Figure 5.4

Bubbles form locally in Bloodstream and tissues (DCS - Left), Normal Blood Circulation (Upper Right), Air or Gas enters the Systemic Arterial blood stream (AGE by ruptured lungs - Lower Right).

DCS: Tissues affected

When a diver ascends too quickly, the Nitrogen dissolved in the tissues comes out of solution too rapidly and forms bubbles in the bloodstream and tissues. If the bubbles block the blood flow to tissues, they can create damage known as DCI.

The first type of decompression illness is known as Decompression Sickness (DCS). DCS happens when Nitrogen comes out of solution in the tissues causing local damage.

AGE: Blood Flow affected

The second type of DCI is called Arterial Gas Embolism (AGE). Nitrogen bubbles enter the arteries of the systemic circulation and are transported through the body causing local blockages in the blood flow that may lead to damage of organs.

These two types of decompression illness can develop after both scuba and freediving, but freedivers are more likely to suffer from the second type – AGE.

An AGE (arterial gas embolism) is located in arterial blood and is far more dangerous than a VGE (venous gas embolism), because the former can get into the brain with the arterial blood and cause damage there. How can bubbles appear in arterial blood? They can form from excess Nitrogen accumulation during the ascent of the freediver, but this is less likely than in venous blood. The more likely scenario is that bubbles that formed somewhere else (e.g. in venous blood) enter the arterial circulation.

How can that happen?

The most recognized reason is a cardiac defect such as a Patent Foramen Ovale (PFO) that allows the bubbles in the heart to pass from venous to systemic arterial blood. It has nothing to do with freediving, and the only way to reduce the risk of it is a specific medical check-up before you decide to freedive.

Reduced blood flow to the limbs and skin due to vasoconstriction protects tissues from excess Nitrogen uptake, but the cerebral blood supply maintains normal or even increased because of the hypercapnic conditions (elevated level of CO_2) during the dive – mainly towards the end of a dive. If bubbles enter the arterial blood, it is more likely they will get to the brain and interrupt circulation by blocking small arteries. This is also the reason why freedivers who suffer from DCI have to deal mainly with neurological symptoms.

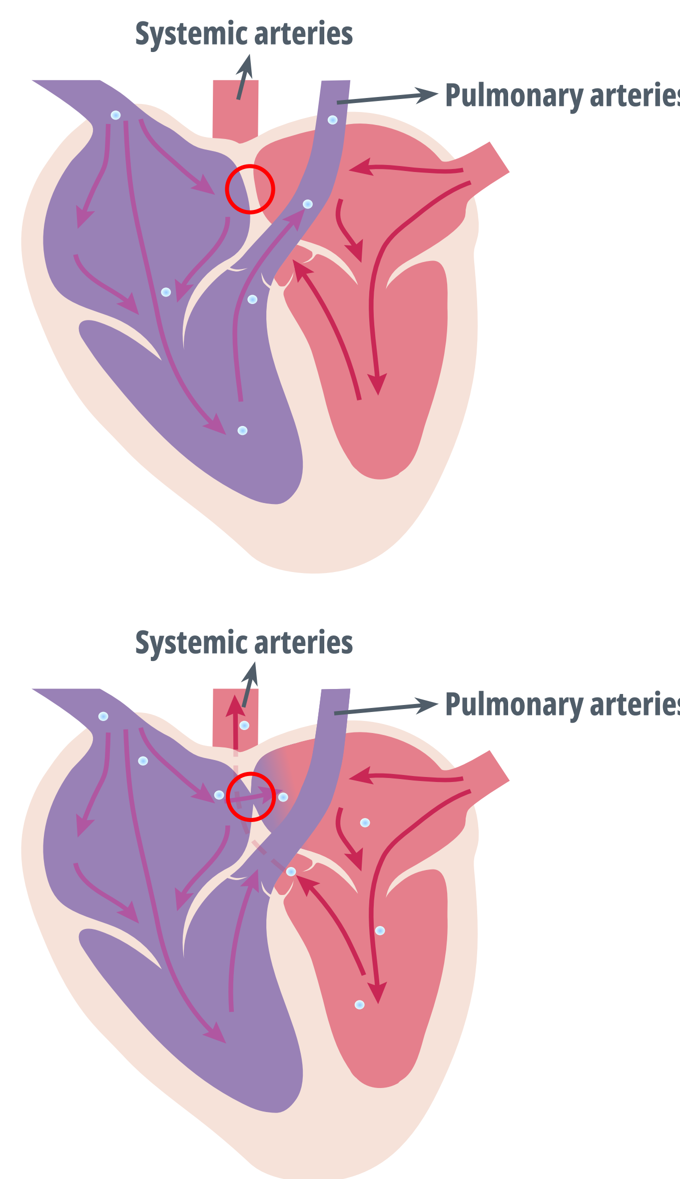


Figure 5.5
A normal heart (upper) and a heart with a PFO (lower).

Specific Freediving-Related Dangers

A freediver is at great danger when he or she suffers from a lung barotrauma (lung squeeze), which damages the barrier between alveoli and blood vessels. As a result, bubbles may pass through the barrier and enter the arterial blood flow.

Latest research also indicates that consecutive freedives may compress the already created bubbles to the size that allows them to bypass the pulmonary filter and get into the arterial side. This is why AIDA works with conservative rules for surface intervals as you have learned in the AIDA3 Course.

It is worth noting that even conservative surface intervals are not long enough to eliminate all excess Nitrogen, but they are long enough to reduce the level of Nitrogen to a safe level to freedive to moderate depths again.

This does not work for freediving beyond recreational depths anymore, hence the especially important rule of “only one freedive to 55m or deeper in 24h”.

5.3 Various Scenarios Leading to DCI

There are three main scenarios that can lead to decompression illness in freediving.

Scenario 1: Repetitive Freediving

During each dive a freediver absorbs a small amount of Nitrogen. The longer and deeper the dives, the more Nitrogen is dissolved in the body. If the surface intervals in between dives are not long enough to remove the vast majority of excess Nitrogen from the body, a great number of moderately deep dives as 20-30m might be enough to cause issues related to the dissolved Nitrogen.

In such a scenario, the accumulation of Nitrogen will progress with each consecutive dive, increasing the risk of forming bubbles and blockage.

Haenyeo or Ama divers are an example of generations of people who suffered from this type of DCI. Freedive instructors must be careful to respect the recommended minimum surface intervals to stay out of harm’s way.

Scenario 2: Deep Freediving

Deep freediving creates more complicated conditions that can enhance the risk of decompression illness. The same as for repetitive freedives, one dive will accumulate some Nitrogen in the blood and tissues. The longer and the deeper the dive is, the more the body will be saturated with Nitrogen.

The ascent speed of a freediver is rather quick – with a Monofin it can be more than 2m per second (120m per minute), which is very fast compared to scuba diving, where the “safe” ascent speed is 10m per 1 minute.

The rapid change of the hydrostatic pressure will lead to the growth of bubbles.

Scenario 3: Freediving after Scuba Diving

Freediving after scuba diving is very likely to cause serious problems!

After scuba diving your body needs several hours to de-saturate completely. If you freedive before this is the case, bubbles produced while scuba diving can be compressed by the freedive and migrate easier to a more problematic area. Physical activity after scuba (in this case freediving) can also increase the risk of bubbles passing over to the arterial circulation (so called "shunting").

Signs and Symptoms of DCI

As explained earlier, it is likely that DCI in freediving affects the brain, so the symptoms will be seen in the central nervous system more often than in a case of decompression illness caused by scuba diving. The symptoms may appear within few minutes to a few hours after diving.

Symptoms felt by the victim:

- **Extreme tiredness and fatigue**
- **Muscular weakness**
- **Paraesthesia (numbness or tingling sensations)**
- **Partial paralysis**
- **Vertigo and balance problems**
- **Dizziness**
- **Burning in the lungs**
- **Difficulty breathing**
- **Inability to control bladder**
- **Nausea**
- **Impaired concentration**
- **Hearing difficulties**

Signs you can see as a buddy:

- **Unsteady manner of walking**
- **Vomiting**
- **Unconsciousness**
- **Lethargy**
- **Behavioural changes**
- **Speech disturbance**

Symptoms more commonly associated with scuba diving:

- **Muscle pain**
- **Joint pain**
- **Skin rash or itching**

Immediate Response to Signs and Symptoms

If you suspect your buddy may be suffering from severe symptoms of DCI or the mild symptoms persist, you should follow the procedure:

1. Administer 100% Oxygen – immediately.
2. Have the patient drink at least 1 litre of water if possible. Do not give any food.
3. The victim should reduce his or her activity. It is most advisable to lie down and rest.

Figure 5.6
Administer 100% Oxygen to a freediver who suffers from DCI.

If symptoms disappear within 30 minutes – keep the patient under observation and consult a diving doctor.

If you suspect your buddy may be suffering from more severe symptoms or the mild symptoms persist longer than for one hour, contact emergency services and arrange evacuation to a hyperbaric facility ('recompression chamber'). Continue administering Oxygen and fluids en route, one litre of water per hour.

It is advisable to report the accident to DAN (Divers Alert Network). This organization collects accident data for future analysis and in-depth research that will help us to gain a better understanding of DCI in freediving.

Freediving Factors Increasing the risk of DCI

- **Greater depth.**
- **Long bottom time or dive time – hanging at depth, long and slow dives, free immersion (deep FIM dives are longer for most freedivers than CWT).**
- **Greater number of dives – spearfishing (up to 8 hours with short breaks).**
- **Repeated freedives (deep or large number) on consecutive days.**
- **Greater speed of the ascent – the highest risk here is while using a lift**

bag on ascent in No Limits freediving. But also constant weight dives can be fast enough, especially with a Monofin.

- **Increased physical effort during the dive - Valsalva manoeuvre, or any kind of hard work will lead to faster saturation of the tissues due to elevated heart beat and blood pressure.**
- **Lung barotrauma during a dive.**
- **Elevated level of CO_2 will expand cerebral blood vessels letting more Nitrogen to dissolve.**

General Factors Increasing the Risk of DCI

- **Dehydration.**
- **Presence of alcohol in the blood – similar vasodilating effect as CO_2.**
- **Low temperature and hypothermia – impaired blood circulation may lead to delayed recompression and / or desaturation of tissues.**
- **Low general fitness.**
- **Gender - women can get DCI easier.**
- **Age - higher risk after 45 years old.**

Diving Insurance

AIDA strongly recommends (this is compulsory for instructors and assistant instructors) you to carry valid professional Insurance or Liability Insurance, which covers freediving activity. The most recognized is DAN, but each part of the world has its own insurers. Contact your national AIDA for additional information.

5.4 DCI Prevention

The risk of decompression illness is probably very low for most recreational freedivers. Nevertheless it is important to know that the risk exists and how to reduce them.

This is how you can decrease the risk of decompression illness.

Surface Intervals for Freediving

The first precaution to make our dives safer to avoid DCI is a choice of safe surface intervals. Long enough time on the surface between dives will allow your body to remove excess Nitrogen and reduce the risk of bubble creation.

Other than for scuba diving, decompression tables have not been developed so far for freediving, since there has been very little research on the matter. AIDA recommends two simple ways of calculating surface intervals in between dives. These rules are based on experience to provide a wide enough safety margin to keep every recreational freediver on the safe side.

Calculate Surface Intervals using time

Calculating surface time by measuring the dive time. The surface interval equals at least double the dive time.

Examples:

- **Dive time 30 sec: 1 min surface interval**
- **Dive time 2 min: 4 min surface interval**

Calculate Surface Intervals using depth

Calculating surface time by measuring the diving depth is normally more conservative.

The depth in metres divided by 5 equals the surface time in minutes.

For example:

- **depth 30m: 6 min surface interval**
- **depth 40m: 8 min surface interval**
- **depth 50m: 10 min surface interval**

Whichever calculation, using depth or time, gives you **the greatest** surface interval will ensure that you have the correct surface interval.

WARNING: THESE RULES APPLY TO ALL DIVES.

FOR EXAMPLE, AFTER A 30M and 4 MINUTES LONG DIVE, THE FREEDIVER SHOULD WAIT 8 MINUTES INSTEAD OF 6 MINUTES BEFORE BUDDYING ANOTHER FREEDIVER.

Calculate Surface Intervals for Freediving deeper than 55m:

Dives deeper than 55m should not be followed by any other freedives. The rule here is very simple – **ONLY ONE deep dive in 24h**. Also be careful with warm-up dives before the deepest one. If possible try to reduce the number, the depth and the time of warm-up dives.

Surface Intervals between Scuba and Freediving

As mentioned earlier, freediving after scuba diving creates the highest risk for DCI if there is not enough time allowed in between to completely de-saturate the body after scuba diving (see also your AIDA2 Manual).

Freediving after scuba diving

After a scuba dive the body will need several hours to de-saturate completely. The safest way is to wait for the dive computer to clear the "No-fly" sign (see **figure 5.7**), which means the body had enough time to completely recover.

If you did not wear a dive computer during scuba diving, it is strongly recommended not to freedive until 12 hours after one scuba dive and 24 hours after repetitive scuba dives or decompression dives.

Figure 5.7
No-fly sign.

Scuba diving after freediving

At the moment there are no conclusive studies on how much time it is safe to allow for scuba diving after freediving. Care should be taken to scuba dive conservatively and consider the following points:

- **Use a more conservative decompression model for your scuba dive, e.g. use the repetitive dive tables or add a deep stop.**
- **Decrease the bottom time during scuba diving.**
- **Use Oxygen enriched mixture (nitrox) on your scuba dive.**
- **Never freedive before a scuba dive that requires decompression stops.**
- **Never scuba dive after a freedive greater the 55m.**

Hydration

Hydration is one of the most important precautions to take. Remember to drink enough water both before and after your training. Some freedivers also drink water during a training session. Do not let your body dehydrate at any time, because the consequences can be harsh. A freediver can repeat the same freedive session pattern many times without any incident, but then all of a sudden develop DCI just because of dehydration.

Dehydration is the common reason for many issues freedivers deal with, like cramps, fatigue, early contractions, blocked sinuses and DCI.

You should be well hydrated at all times. Pay extra attention to your hydration levels at least 12 hours before a freedive session.

Break between multiple Freedive Sessions

If you do more than one session or you are in the sea for the whole day (e.g. spear-fishing or on a freediving / snorkelling trip) be sure you have a proper break in between sessions:

- **If you plan to do several sessions in one day, make a break of at least 30 minutes every hour.**
- **If it’s a break in between 2 freedive sessions, make it longer. Two hours or more is a safe interval.**
- **No second session on the same day if your first one included a freedive deeper than 55m.**

During the break don’t snorkel or safety dive. Rest well - drink a lot and if you have more time eat something easy to digest. Other than that – simply relax!

No Warm-up Dive

Each freedive leads to the accumulation of some Nitrogen in the body of the freediver. The longer or deeper the dive, the more gas dissolves in your tissues. Try to reduce the number and the duration of your warm-up dives. More and more top-level athletes do not perform any warm-up dives at all. This is a practice, which you have to carefully build up and adapt to, so it is fairly uncommon in recreational freediving.

Warm-up Dives

If you do warm-up dives, your warm-up dives should:

- **Not be deeper than 15-20m.**
- **Not be very long (maximum 2 minutes is recommended).**
- **Include FRC dives to be shallower.**

Reduce Dive Time

The shorter the dive time, the less Nitrogen dissolves in your body. Work on your technique. Efficient and easy equalization, streamline position, efficient finning, arm or leg strokes, and arm pull downs in free immersion all contribute to shorten your dive time. Spending only a short time at the targeted depth or bottom plate is highly recommended. Do not stop here to admire the ocean and big blue around you.

Reduce final Ascent Speed

If possible, slow down the final stage of your ascent (last 20-10m depending on the dive depth). It will support the safe release of excess Nitrogen.

Oxygen Decompression

Oxygen decompression is a procedure used only in competitive freediving after deep dives (below 60m). Breathing pure Oxygen (or enriched air) at depth comes with its own set of risks, which outweigh the potential benefits for recreational freediving. It should only be done under supervision by a qualified and experienced person, and it is strongly recommended that competitive freedivers should attain a scuba certification beforehand.

It is more efficient to do decompression at depth, but to do that you need to be trained in scuba diving, preferably with the addition of diving with Oxygen enriched gases (nitrox).

Flying after Freediving

After shallow recreational freediving there should be no problem with flying. But you might consider waiting 24 hours before getting onto the plane, if you are / were:

- **Deep (55+ metres).**
- **Freediving intensely a few days in a row.**
- **Freediving extensively in one day (e.g. spearfishing for many hours straight).**

Figure 5.8
A freediver is breathing pure Oxygen under the supervision of a qualified person after a deep dive.

Chapter 05 Knowledge Review

Name three symptoms of Decompression sickness (DCS).

Using time what is the rule for calculating surface interval?

Using depth what is the rule for calculating surface interval?

What should you do if your buddy is exhibiting signs or symptoms of DCS?

After what depth should you take oxygen after the dive to reduce the risk of developing decompression sickness?

What is the Partial Pressure of oxygen at 20m?

Why is it better to breathe oxygen at a depth of 5m after a deep dive (60m+)?

Why does dehydration increase your susceptibility to DCS?

CHAPTER 06

ADVANCED EQUIPMENT

6.1 Nose Clip

There are two general types of nose clips. Those which pinch the nose just slightly to prevent water from entering the freedivers airways, and those which can exercise a considerable amount of force on the nose to allow the freediver to do an equalization manoeuvre against it.

Figure 6.1
Nose Clip.

Pinch the Nose Airtight

It is most important that a nose clip pinch the nose absolutely airtight. Every nose is different in size and shape, so if you try to achieve that with a nose clip that doesn't fit you very well, you might have to squeeze the nose clip so hard to the point it becomes painful. You will have to check which ones are airtight for you whilst exerting the least amount of pressure and hence find the most comfortable ones.

Ratcheted or Friction

The design of nose clips is basically the same. One "wing" is fixed, while the other wing slides on a cross bar. The differences are in the details. Some crossbars are ratcheted and the moving wing locks in stepwise, while other crossbars are smooth and the floating wing is held in place by friction. All nose clips can best be released by pulling the small part of the floating wing towards the open end of the crossbar.

Various Materials: Aluminium, Plastics, etc.

Most nose clips are made out of a suitably stiff and durable form of plastic. However there are nose clips made of many other materials, such as aluminium or even hard wood. What they all have in common is that the parts that come in contact with your nose need to be padded and replaceable as abrasion is to be expected – the materials of these nose pads again vary from silicone to thin neoprene or plastic.

Relaxation Position

A nose clip caters for all comfortable relaxation positions, such as laying on your back, holding on the float or face-down with a snorkel.

6.2 Hektometre Goggles

No need to flood with water

The goggles remained filled with air, so your vision is not affected by water. Although the lens aperture is fairly small.

Goggles with a flexible membrane

Inside what look like normal goggles is a rubber membrane that allows water to enter the goggles in between the membrane and the eyepiece to take account of the reduction in volume as you dive down.

Figure 6.2
Hektometre Goggles for Deep Freediving.

6.3 Fluid Goggles

Combined with Nose Clip

Most freedivers using Fluid goggles will combine this competition tool with a well fitting nose clip for equalization or, in pool disciplines, to keep water from entering the airways.

Tunnel vision

The construction of a fluid goggle allows a freediver to see a relatively sharp picture straight ahead, in other words, only in the area covered by the lenses. As the lenses cover only a relatively small area of the total field of vision, the sharp area feels quite like tunnel vision with a clear picture at the centre, while peripheral vision will be mostly blurred.

Figure 6.3
Fluid Goggles for Deep Freediving.

Goggles filled with Seawater or Saline Solution

Fluid goggles look very similar to common swimming goggles. But fluid goggles are very different because they are either fully filled with sea water or saline solution, or there are other models that have small holes or perforations to allow sea water to enter the space between the eyes and the lens.

As the air in fluid goggles is replaced by water, there is no need to equalize them as the pressure changes upon descending in the water column.

Frontal Lens with ca. 200 Dioptries

The freedivers eyes are in contact with water, which leads to a considerably blurred vision. To compensate for that, fluid goggles are fitted with a strong lens directly in front of each eye of the freediver. These lenses are roughly rated at 200 dioptres.

The freediver wearing a fluid goggle literally sees through water first, before the breaking index of the water gets compensated by the lens, fitted to the front of the goggle.

Relaxation on the Back or with Snorkel

Fluid goggles allow for all common relaxation positions. Face up on the back, face down with a snorkel or upright while holding on the float or the dive line.

6.4 Dive Computer

Figure 6.4
Dive Computers with Freedive Mode.

Safety device for surface intervals

One of the main purposes of a dive computer with freedive mode is to indicate the following measurements for each dive, these are essential to stick to a safe minimum surface interval; Maximum depth, total dive time and time spent at the surface since the dive.

Some freedive computers already calculate a safe surface interval, based on these measurements, and indicate to the freediver with an audible beep when it is safe to dive again. Recent developments point towards integrating descent and ascent speeds to a more complex model to calculate shorter safe surface intervals.

Depth Alarms

Modern dive computers allow you to set multiple depth alarms. This can be very helpful for the correct timing of crucial moments in a deep freedive, such as onset of freefall, charging the mouthfill or a warning just before reaching target depth.

However, many dive computers are quite limited in the volume with which they announce a certain depth (usually with a short beep). It might therefore be necessary to wear this type of dive computer under your hood, rather than on the wrist where it might be too far away from your ears to clearly hear the alarms.

Dive Analysis

Figure 6.5
Graph of a Dive.

Many dive computers record a reading of all measurements every second (or even more frequently). These recordings can be transferred to a computer after the dive session and used to analyse the dives by means of specialized software. This has become an essential tool to optimize many factors of a successful deep freedives, such as onset-depth of the freefall, changes of descent / ascent speeds, etc.

Integrated Heart Rate Monitor

Many of the newer dive computers come with the option of adding a heart rate monitor. You can then analyse the dive along with your heart rate at the same time to ensure that you start the dive with a low heart rate and that this reduces even further during the dive. Heart rate monitors cannot be used in competition.

6.5 Neck Weight

Figure 6.6
Self Made Neck weight (Left) and Factory Made Neck weight (Right).

Improve trim (weight distribution)

While using a weight belt is enough to set neutral buoyancy for all purposes, it also imposes a problem. The weight will all be around the hips, while most of the buoyancy in the human body is around the lungs. This leads to a rotating momentum, pulling the body in an upright position.

By moving the weight above the lungs, this rolling momentum can be balanced and the so-called "trim" of the body optimized - this is normally done by using a neck weight of an appropriate mass.

However it is not recommended to use heavy neck weights for an extended time as this can lead to discomfort or even injury of the neck. This can especially be the case in long DYN / DNF training sessions. It is better to distribute the weight needed between the weight belt and the neck weight to a reasonable level and try to minimise the mass of the neck weight for open water diving by setting neutral buoyancy to one third of the target depth.

Quick Release

As with every means of carrying weights as a diver, a neck weight needs to have a quick release. In case of an emergency, the buckle of the neck weight must be able to be opened one-handed by the rescuer. Many self-made neck weights are made with a plastic buckle (as used in backpacks or climbing gear), which fulfils this important safety requirement.

Takes some Fine Tuning

The neck weight, just like the weights on the belt, must be adjusted to any given freediving situation. The colder the water, the thicker the wetsuit, the more weight you will need to achieve a given depth of neutral buoyancy.

Of course buoyancy in salt water is greater than in fresh water. For competitive freediving, the various salinity and other qualities of the water will change the buoyancy of a freediver, so that athletes sometimes adjust the mass of their neck weight in grams rather than kilos!

Commercial Solutions

Neck weights were mostly "do it yourself" solutions, made of a bicycle inner tube, lead shot and a buckle. It is very important that you secure your neck weight from breaking and leaking (by means of double layering the tube, wrapping the final product with electric tape, or another appropriate solution), as this can lead to an expensive pool cleaning bill or, even worse, contamination by lost lead in open water.

Recently, commercial solutions have appeared on the market for pool training and we can expect to see the same commercial solutions for open water training soon.

6.6 Doc's Proplugs

Vented ear plug

By placing this in your ear just before you go in the water will restrict the amount of water flushing next to your ears.

Figure 6.7
Doc's Proplugs.

Cold water use

If used in cold water, the ear plugs hold the same water next to the ear until removed. After a few minutes the water next to the ear will warm to close to body temperature. This will mean that the eardrum is not getting cold water placed on it, this will keep the tissue more flexible and should allow for easier equalization in cold water.

Preventing ear infections

If you are particularly prone to ear infections, then this can be a really useful tool. Place your head on one side and fill your ear canal with fresh clean water ideally at body temperature. Then place the vented ear plug into your ear. The ear plug then holds the fresh water next to the ear and reduces the chances of developing an ear infection.

6.7 EQ Tool

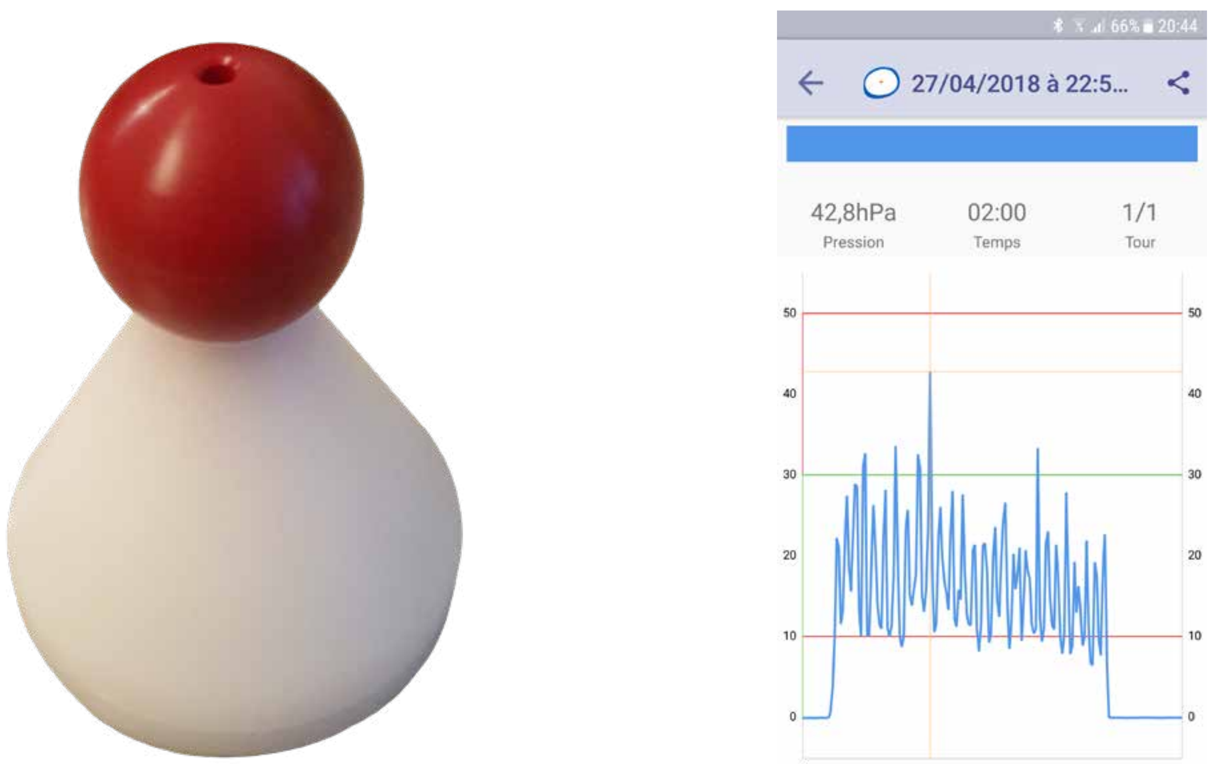


Figure 6.8
Digital EQ Tool (Left) and Digital reading of Nasal force on a mobile phone.

Digital reading of Nasal force

Measures the amount of pressure that is required to equalize.

Can be integrated to your mobile phone

The system connects directly to an Android or IOS system.

Minimal Pressure to equalize

Train to ensure that you are using the minimal amount of pressure for your equalization.

6.8 Spirometer

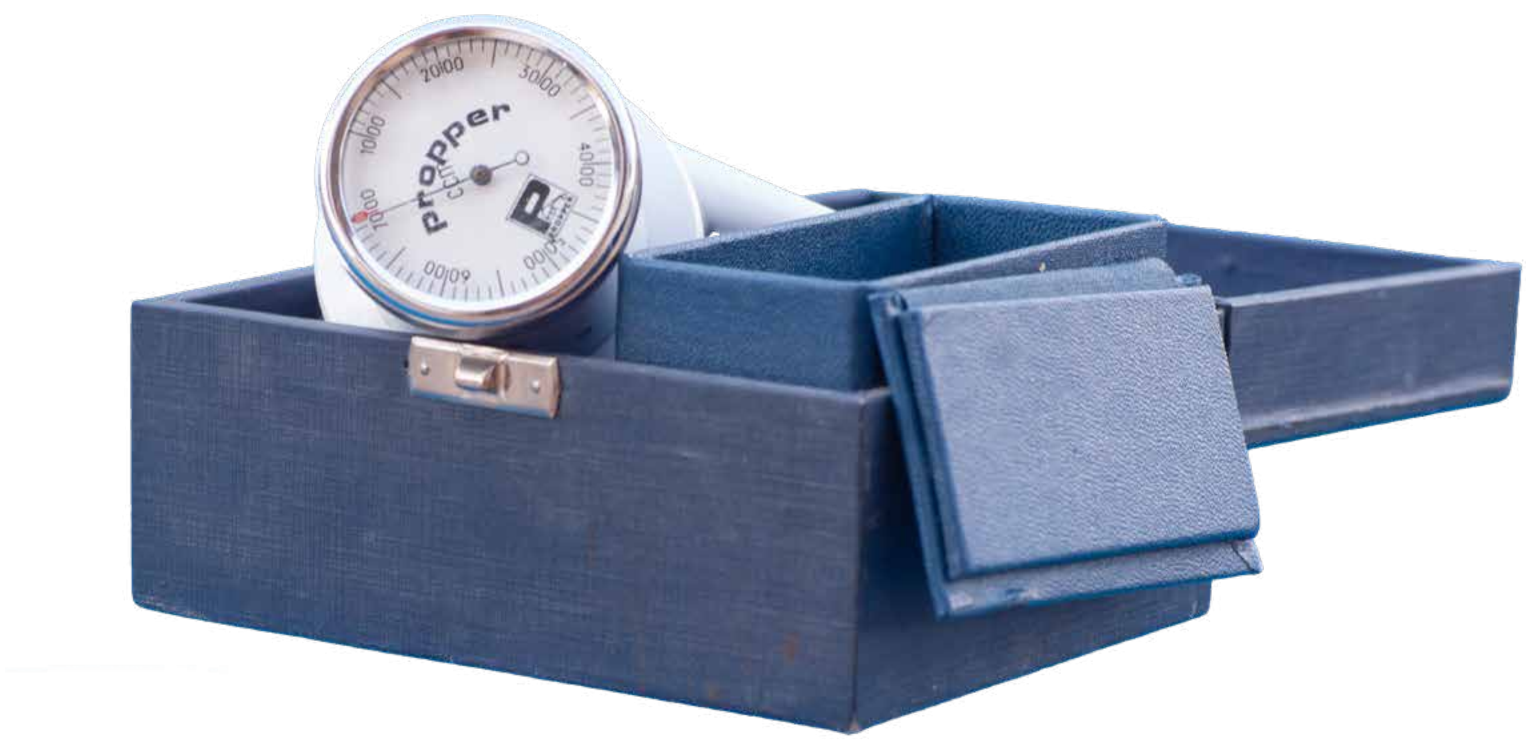


Figure 6.9
Spirometer.

Used to measure Vital Capacity

A relatively low cost way that you can track your Vital Capacity. As you start your lung and diaphragm stretches, you should see your vital capacity increasing.

Can be used to measure packing ability

By performing three packs and then making an expiration onto the spirometer, you can determine the amount of air that you are able to pack in three packs. A very useful determination as when some people who pack tried this their Vital Capacity did not actually increase.

Can be used to track Vital Capacity after stretching

By measuring your Vital Capacity you should see an increase over a period of time to ensure that the stretching exercises that you are performing are making a difference.

6.9 Pulse Oximeter

Figure 6.10
Pulse Oximeter.

Measures the saturation of oxygen in the blood stream

The gauge gives a real time reading of the percentage of oxygen in the bloodstream.

Measures Heart Rate

The gauge also gives a real time reading of your heart rate, the unit is not usually waterproof, but can be used whilst doing dry statics.

Figure 6.11

Chapter 06 Knowledge Review

What other piece of equipment should be combined with fluid goggles?

Neck weights are generally filled with what material?

Are all neck weights quick release?

What three things could you use a dive alarm for?

A spirometer measures what part of the lungs?

Can a nose clip be used with Hectometre goggles?

Name two disadvantages of fluid goggles.

An EQ tool measures what?

CHAPTER 07

FITNESS FOR FREEDIVING

7.1 Introduction

Fitness refers to capabilities of all systems of the body: The cardiovascular system, the respiratory system, the central nervous system and the musculoskeletal system.

Aerobic / Anaerobic

A freedive is a combination of aerobic and anaerobic activity. During the first part of a descent the freediver works aerobically, because the air in their lungs and tissues is fresh and new. During the ascent from a deep dive the freediver works anaerobically, not because most of the O_2 has been burnt, but mainly due to vasoconstriction and blood shift taking blood (and O_2) away from legs and arms.

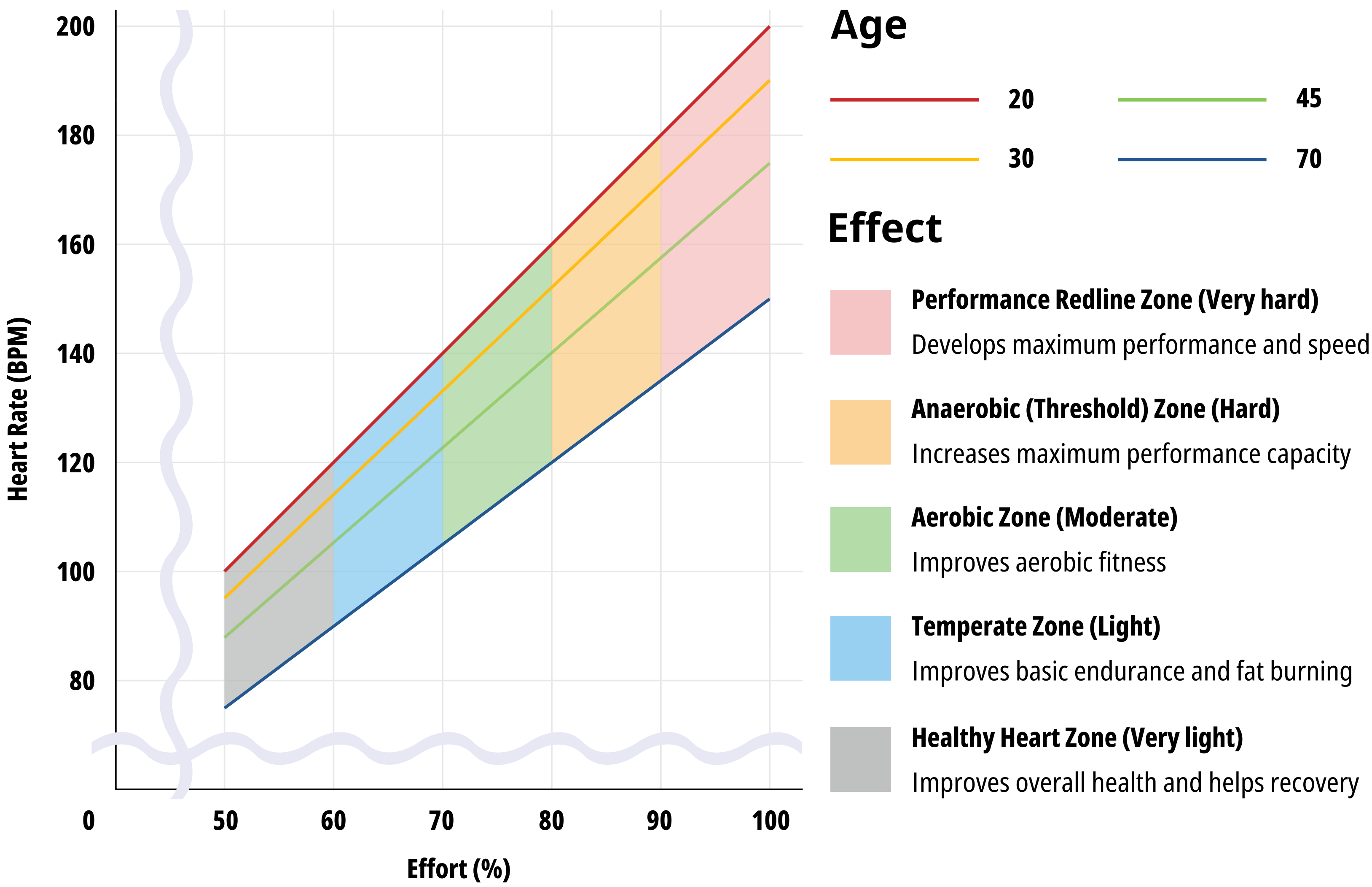


Figure 7.1
The relation between age, HR and effort in physical performance.

Aerobic Fitness

Aerobic means 'with oxygen'. During aerobic work, the body is working at a level where the demands for O_2 can be met by the O_2 intake. The only waste products formed are CO_2 and water. A sound basis of aerobic endurance is fundamental for any kind of sport. The key reasons for aerobic endurance training are to enable the body to perform at a greater pace with a minimal amount of lactic acid – to raise the aerobic capacity.

This can be done, for example, by long steady runs / swims or cycling. Aerobic training increases the Cardiovascular fitness, making the heart stronger and improving the maximum O_2 uptake (VO_2MAX).

During an aerobic workout the heart rate should be between 50% and 80% of its maximum capacity. These activities are effective if protracted for long intervals, especially if working with a lower heart rate:

60-70% of maximum heart rate for 30+ min develops basic endurance and aerobic capacity, and is also ideal for losing weight.

70-80% is particularly beneficial for developing the Cardiovascular system.

Anaerobic Fitness

General Anaerobic means 'without oxygen'. It is considered very important by many, because it recreates the condition of a deep dive or a maximum dynamic. An anaerobic workout takes place between 80% and 100% of your maximum heart rate. During an anaerobic workout, the body is working so hard that the demand for O_2 exceeds the rate of O_2 supply and the muscles have to rely on a different source of energy. This is glycogen (sugar stored in muscle cells), which is used, instead of O_2, to produce the energy needed.

Age	Max. Heart Rate*
20	200
30	190
40	180
50	170
60	160
70	150
80	140

***Maximum Heart Rate = 220 - Age**

Table 7.1
How to calculate your Maximum Heart Rate.

This process can create lactic acid, which can accumulate in the muscles until it provokes fatigue and sore muscles, and the athlete cannot perform any longer. This is called the anaerobic threshold. Raising anaerobic endurance is done by improving Lactic Acid Tolerance. The aim is to saturate the muscles with lactic acid which educates the body to deal with it more effectively. That is why AIDA recommend that a typical DYN training table includes at least 20 performances, to try and create lactic acid tolerance training.

Good ways to train anaerobically out of the water are: gym training and interval training. Interval training is performed using the same disciplines for aerobic training, but with a different concept: e.g.: Run at maximum speed for 30" and rest for 1', and repeat the cycle 10 times. Gym training makes it possible to work specifically on single muscles, or muscle groups, to strengthen only the muscles needed for the specific freediving discipline.

Muscle strengthening can also be achieved without the use of a gym: body weight exercises. Body weight exercises could include: push-ups, sit-ups, squats, lunges etc. They are normally completed without the support of weights or machines.

Yoga can increase strength without increasing size as much as weight-lifting. The use of yoga for freediving is good for many different reasons:

- **Muscle strengthening is achieved by holding yoga postures.**
- **Stretching is vital for any sport (as we will see later) and it's an important part of yoga.**

- **Breathing is one of the main concerns for freedivers, and it's one important branch of a yoga called 'Pranayama'**

Remember that yoga is a training tool as are many others: you don't have to do yoga to be a good freediver.

Pilates is also becoming a popular way to train for freediving.

General Fitness: Strength, Flexibility, Endurance, Body Composition

General fitness refers to general capabilities – strength, flexibility, endurance (cardiovascular and Muscular) and body composition – that can be used for many activities.

General fitness (e.g. aerobic function and cardiovascular capability) allows an athlete to engage in more intense and specific training. General fitness also allows an athlete to recover faster and can help to enhance recovery from an injury.

Fitness has additional value for sports in extreme environments – such as freediving, mountaineering and rock climbing – where failure can mean more than losing a match. The ability of an athlete to avoid injury, or even survive, may depend on the athlete's fitness!

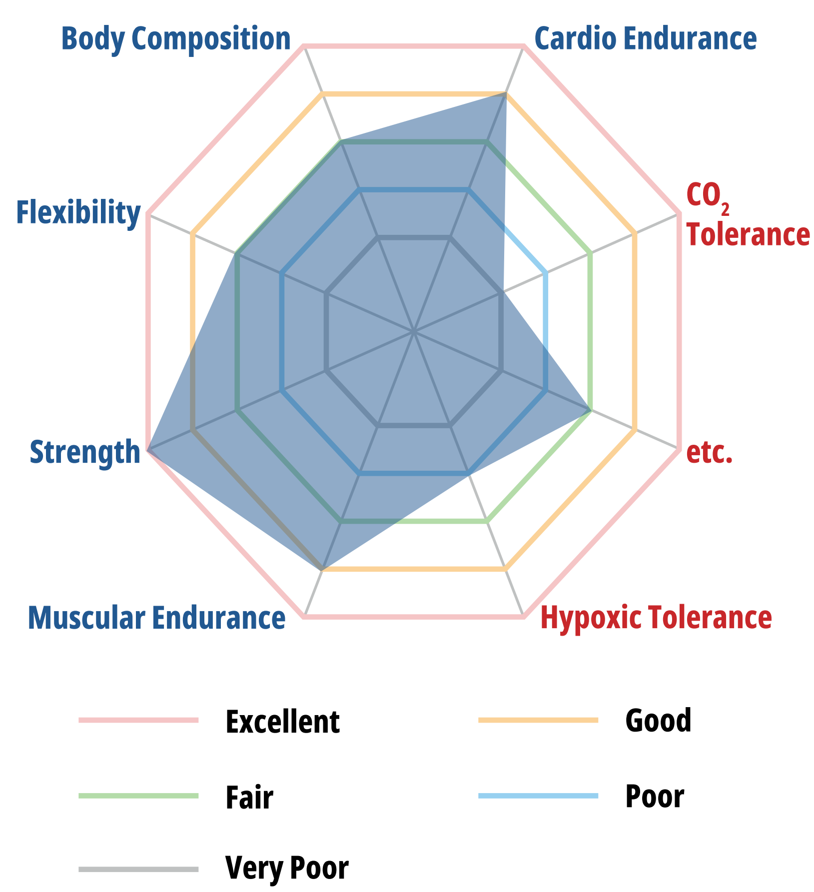


Figure 7.2

A chart of General (texts in blue) and Specific (texts in red) Fitness level for freediving. This person should improve his/her CO_2 and Hypoxic Tolerance to be a good freediver.

Specific Fitness: Capability for a Certain Event

Specific fitness refers to the capability to develop physiological qualities for a specific sport or event. While some qualities e.g. CO_2 tolerance, anaerobic capacity, hypoxic tolerance, etc. are shared physiological qualities for all forms of freediving, fitness for STA is quite different to fitness for CWT, and both are different to fitness for CNF.

Personal Training Design

The purpose of this chapter is not to present an ideal training plan suitable for all freedivers – this is not possible! The purpose is to introduce you to key concepts in athletic training that can be applied to freediving. If you choose to you can learn more about these concepts and use them to develop a training program to increase your freediving capabilities. Freediving is a sport, and as such, increased fitness is closely correlated to increased performance.

Growing Body of Knowledge

Unlike swimming, cycling, and running where large numbers of athletes, coaches and scientific studies have accumulated a wealth of knowledge and experience, freediving is in an early stage. Success can be reached in many different ways. Each athlete chooses his / her training as an artist chooses colours. For example, CWT world records have been set by athletes doing intensive pool training, by athletes doing intensive dry training and no pool training, and by athletes doing little pool or dry training (with emphasis on breathing, relaxation and yoga).

The goal of this chapter is to show you methods you can use to increase your fitness for freediving. Freediving is a sport, and as such, can be trained for with techniques developed for other sports.

Fitness does not equal Health

Fitness is not the same as health. A person can be healthy but not fit or fit but not healthy. This distinction is important, but both health and fitness are critical to a successful athlete. You may have read about high-level athletes who died suddenly during practice or competition (often attributed to heart problems); in European football (“soccer”), in American football, in triathlons and in marathons. Those athletes were extraordinarily fit, but with the wisdom of hindsight, not healthy. Do not sacrifice health for fitness.

7.2 The Importance of Recovery

Training is Work plus Recovery

Training is the combination of work and recovery. Without adequate recovery, performance may not improve and may even degrade due to injury and overtraining.

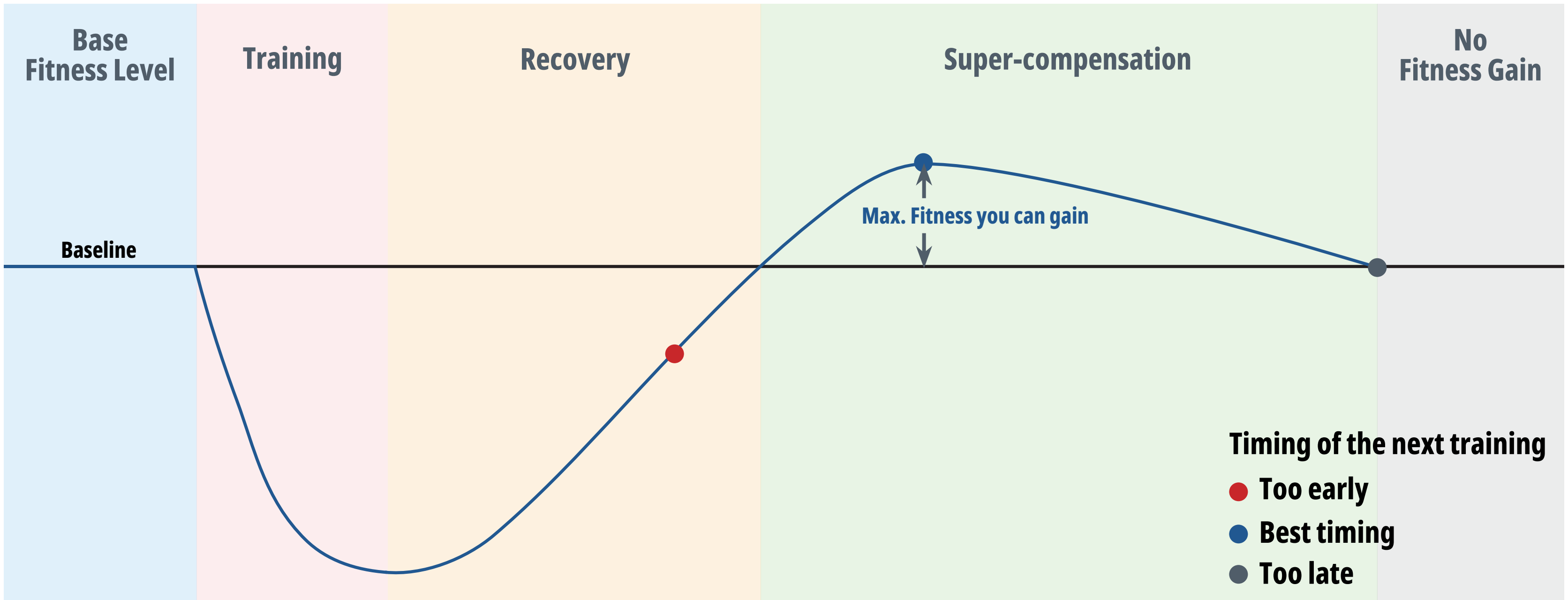


Figure 7.3
Training and recovery cycle.

Active: 40-55% Maximum Heart Rate, 20-60min

Active recovery includes any light physical activity undertaken at a low level of intensity for a limited duration. Walking, swimming, cycling (e.g. on an exercise bike) are typical active recovery tools. Active recovery sessions are similar to aerobic training, but HR is maintained at a lower level (e.g. 40-55% of maximum) and sessions are limited to 20-60 minutes. Active recovery increases circulation to recover the damaged muscles, improves the removal of lactic acid, increases production of hormones used for recovery and helps the neurological system recover from intense efforts. Certain forms of Yoga (e.g. Yin) are another means of active recovery with great results.

Passive: Sleep, Rest, etc.

Passive recovery includes sleep, rest, and other non-physical activities such as socializing or reading. Passive recovery gives the body and mind time to rest and recover from training.

Active vs. Passive Recovery

Any period without additional stress on the body and mind should lead to recovery. Some forms of recovery, however, are more effective than others. Drinking a beer while watching television is a form of inefficient recovery. Light physical effort is called active recovery and leads to faster and fuller recovery than mere rest, which is referred to as passive recovery. For best results, it is recommended to combine passive and active forms of recovery.

Therapy as a form of recovery

Therapy can be a good way to recover from an intense workout or from a series of training days. The best therapy is massage. Different massages are available but the best one for recovery would be a sports massage. It can help to improve circulation, increase your range of motion and help to shorten recovery time.

Myofascial Release: Massage, Rolling

Muscles recovering from intense training may benefit from “myofascial release”, by means of certain types of massages or rolling (e.g. with foam roller). Such techniques increase the removal of waste products from muscles to avoid cramps and release adhesions in connective tissue that can lead to muscle tightness and scar tissue.

7.3 Overtraining

Training vs. Overtraining

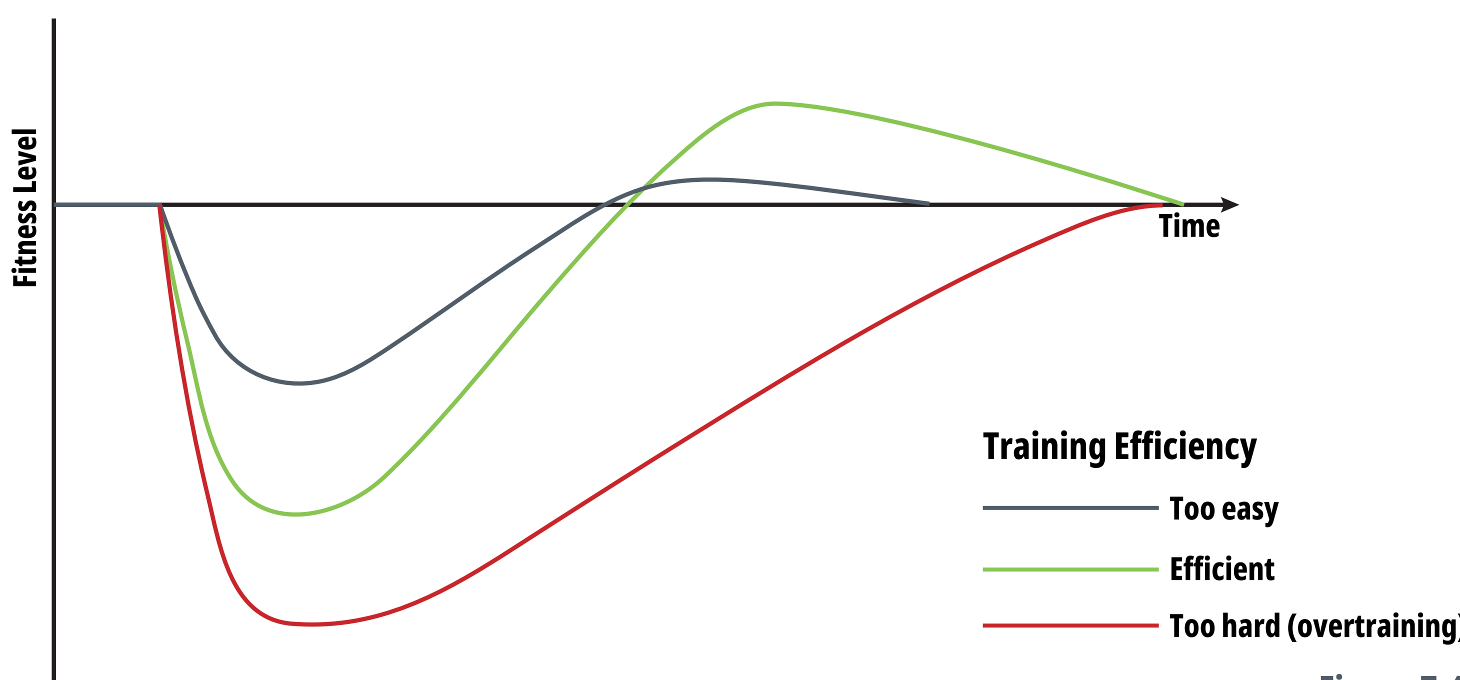


Figure 7.4
Training and Overtraining

Training stresses the systems of an athlete (e.g. muscular or cardiovascular), but with adequate load (also known as “physical overreach”) combined with enough recovery, this leads to so-called super-compensation; a series of adaptations that improve the functionality of the heart, increases the capillary system and increases metabolism and strength of muscles.

However, without adequate recovery, too high a load, inadequate nutrition, or wrong periodisation, etc., adaptation will be limited, or worse, health and performance will degrade and can lead to Overtraining.

Physiological Signs and Symptoms of Overtraining

- **Decreased performance (e.g. VO_2max)**
- **Decreased energy levels**
- **Decreased aerobic and anaerobic threshold**
- **Decreased appetite**
- **Elevated resting heart rate and blood pressure**
- **Increased susceptibility to illness and injury**
- **Increased muscle tension**
- **Prolonged fatigue**

Psychological Signs and Symptoms of Overtraining

- **Irritability, uncontrolled emotions and moodiness**
- **Anxiety**
- **Decreased vigour**
- **Decline in feelings of self-worth**
- **Insecurity**
- **Oversensitive to criticism**
- **Insomnia**
- **Depression**

Recovery from Overtraining

If the symptoms are recognised early, several days of rest may be enough to treat overtraining. An over-trained athlete should stop all training. Low level aerobic activity, however (e.g. at HR 40-55% of maximum, for more than 45 minutes), may aid recovery. Restorative activities such as meditation and low-intensity yoga may also aid recovery. If symptoms are not recognized early, a prolonged period of rest along with medical supervision may be required.

If you over train, recovery with guidance from a coach, a trainer or a medical professional is recommended. In addition, you should review your training log and identify the likely cause before you continue training, otherwise you may march again down the same path.

7.4 Technical and Mental Training

Until now, we have addressed athletic (i.e. physical) training. In general, non-athletic training addresses various needs for freedivers, like rehearsing sequences of actions (including equalization), increasing tolerance to CO_2, and increasing chest flexibility, while minimising risk of injury, overtraining and DCI.

Visualisation / Mental Training

Visualisation allows an athlete to mentally rehearse a performance; by mentally repeating the performance systematically, an athlete can “hardwire”, or program a complex sequence of actions with the goal to perform them correctly in real life. A primary benefit of visualisation is the number of times an athlete can “rehearse” without the physical or logistical cost of the actual performance. Visualisation also allows an athlete to address the weak points of a dive and prepare for the case of difficulties. In freediving this might include having a plan if: the first contraction sets in unusually early on a deep dive, the mouthfill is lost, fear of depth or being surprised by a thermocline occurs, to name only a few possible situations.

Many athletes also find that visualisation helps them to calm down for a performance by establishing a relaxation routine. Visualisation is a valuable tool for freedivers. You cannot underestimate the benefits of calming the mind before a dive. In addition, the ability to rehearse a dive may be more valuable than in other sports, for two reasons. Firstly, visualisation avoids additional training loads, in which in breath hold dives, especially in the depth disciplines, carry substantial risk of overtraining. Secondly, the risk of DCI limits athletes to one deep dive per day, while visualised dives add no DCI risk!

Dry Equalization Training

Athletes use a great deal of dry equalization training. As with visualisation, this technique allows practice of a skill used at depth without risk of overtraining or DCI. Dry equalization training includes practicing to control the various parts of the equalization technique, such as tongue action, blocks, control of the soft palate and the glottis.

Dry EQ-training can also be combined with practicing mouthfill (see **chapter 3**), and decreasing residual volume (see **chapter 2.2**).

Equalization Exercise examples

Tongue Exercises

Figure 7.5
Exercise 2 (Left) and Exercise 4 (Right).

1. Try to touch your nose with your tongue
2. Try to touch your chin with your tongue
3. Bring your tongue into your mouth keeping it applied to the roof of your mouth
4. Bring your tongue into your mouth keeping it applied to the floor of your mouth

Jaw Exercises

Figure 7.6
Exercise 2 (Left) and Exercise 3 (Right).

1. Repeatedly open and close the jaw
2. Extend your jaw forward
3. Move the jaw from side to side
4. Extend your jaw forward and back in circular motion - clockwise and then anti-clockwise

Breathing exercises

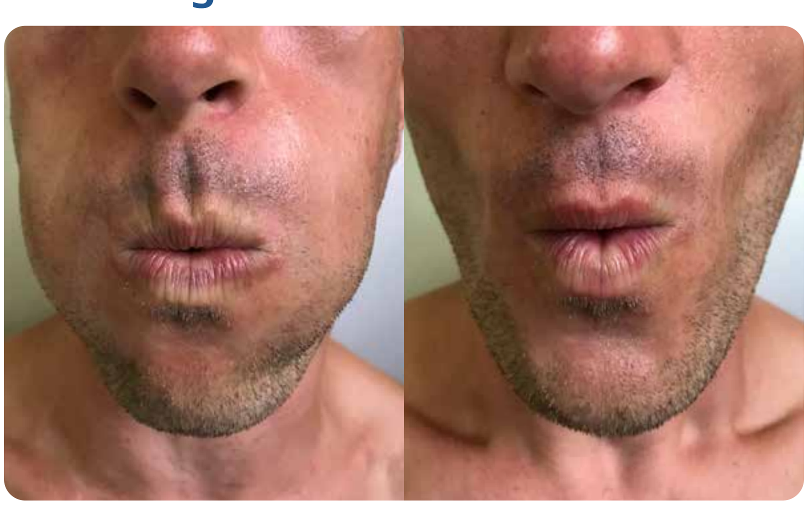


Figure 7.7
Exercise 2 (Left) and Exercise 3 (Right).

1. Blow up balloons
2. Try to blow out through pursed lips
3. Try to breathe in though pursed lips

Tongue – Soft Palate Exercises

Figure 7.8
Exercise 3 up (Left) and down (Right).

1. Press your tongue against your hard palate and apply a vacuum and click
2. Try to compress your soft palate with your tongue
3. Bob your Adam's apple

Tongue – Jaw – Soft palate Exercises

Figure 7.9
Exercise 2.

1. Yawn with a 3-5 second apnea with an open mouth
2. Stifle a yawn (as if in an interesting meeting) keeping your lips closed

Swallowing

Figure 7.10
Exercise 1.

1. Take a sip of water into the mouth, pinch your nose shut and swallow the water whilst lowering your chin towards your chest
2. Repeat exercise with your liquid of choice (non-alcoholic)

Soft Palate Exercises

1. Pronounce -AH- three times quickly and powerfully
2. Repeat the above exercise with the following sounds
3. EE-EH-OH-EEK-EET-AK-OK-OOK-OOT

CO_2 Tables

Athletes use breathing tables to increase psychological and physiological tolerance to rising CO_2 levels. Breathing tables in water should only be done a full supervision from a qualified buddy. They can be done dry by yourself, on a bed or sofa. Although anaerobic training, e.g. sustained, high-intensity cardiovascular training also increases tolerance to rising CO_2 levels, it's a significant source of stress, and must be used in limited amounts, with significant recovery. See your AIDA3 Manual for an introduction to CO_2 tolerance training.

Reduction of RV

Finally, reduction of residual volume (as outlined in this manual in **chapter 2.2** and in AIDA3) is an effective way to train the body for compression at depth, without risk of overtraining or DCI.

Types of Yoga

Freediving and yoga have been connected since the 1980's, when Jacques Mayol's character, in the film The Big Blue, practices yoga before a competition dive. Since then, many elite freedivers have been active yoga practitioners or instructors. Yoga isn't required for freediving, but many divers benefit from it.

An important part of yoga is pranayama, which literally translated means "extension of the life force". It includes, amongst others, exercises to cleanse, strengthen and control the breathing apparatus. Another reason to practice yoga is mindfulness – presence in the moment, free from past and future – which is the basis of yoga and as useful for freediving. Finally, most forms of yoga increase, if regularly practiced, overall flexibility, which can benefit freedivers.

Freedivers can choose from many forms of yoga. Among them, Iyengar, Ashtanga, Kundalini, Yin or Bikram. Instruction on any form of yoga is beyond the scope of this course. If you are interested in starting practicing yoga, find a local instructor or studio. Freedivers in your area may be able to point you in the right direction.

7.5 Warming up for Training

Any chapter on training should address pre- and post-training activity "Warming up" and "cooling down". This chapter covers this essential topic first for training and then for target dives.

Diaphragm Stretching

Due to the importance of decreasing Residual Volume to help to avoid thoracic squeeze, diaphragm flexibility is critical for freedivers. Increasing flexibility of the diaphragm takes time. If you start stretching your diaphragm today, there will be little change tomorrow, but there should be a significantly increase in flexibility over the following months. As with other forms of training, consistency is the key, e.g. several minutes per session, several times per week.

Active Warm-up: Joint Mobilisation

All training should start with a warm up. Joint mobilisation and a gradual increase in HR prepare your body for the training to come.

Gradually Increase of Effort

Cardiovascular training, both aerobic and anaerobic, may benefit from a tailored warm up. In addition to joint mobilisation (e.g. with dynamic stretching), the warm up should gradually raise HR from resting rate (e.g. 60 bpm) to training rate (e.g. 140 bpm). When the body is at rest, approximately half its blood flows to organs, rather than to muscles. These organs perform critical functions, including digesting food and producing hormones and enzymes. A proper warm up over 15 to 20 minutes allows the body to gradually reduce blood flow to organs and increase it to muscles. This minimises stress on the body. Starting training without a proper warm up forces the body to suddenly cut blood flow to organs which can cause significant stress on the body. Adding this stress to the stress of training is not productive. Either the intensity of training must be reduced to avoid injury and overtraining, or the combination of sudden-start stress and training stress may lead to injury or overtraining.

Active Cool down: Warm-up in Reverse

An active cool down is like a warm up in reverse. It allows the body to slowly return to a resting state, allowing it to wash out lactic acid out of fatigued muscles. Rather than stopping quickly, a gradual decrease in effort, combined with warm-up like dynamic stretches, provides a proper cool down.

7.6 Warming Up for Target Dives

Active Warm-up: Focus on Areas to be used

Chapter 9.3 introduces you to the general principles of creating and carrying out a warm-up. However, techniques used for warming up for training can also be tailored for target dives. Joint mobilisation as described in the previous chapter is useful, focusing on muscle groups to be used during the target dive, which would be hips and legs for CWT, shoulders for FIM and both for CNF.

Unlike for training, raising HR is generally not a goal for pre-dive warm ups.

Mental Preparation: Visualisation

Elite athletes also visualise dives during pre-dive warm up, for example during a boat transfer or on the platform just before the dive. Visualising a dive before leaving for the dive site has the added benefit of acting as a checklist of equipment needed for the dive.

Figure 7.11
A freediver visualise dives during pre-dive warm-up.

Engaging the MDR

Many freedivers warm up by engaging their MDR, often by one or more breath holds, short hangs (e.g. at neutral buoyancy) or FRC dives. Breath holds increase CO_2, decreasing blood pH, lowering HR, and releasing red blood cells from the spleen. Hangs and FRC dives do the same, and may engage peripheral vasoconstriction. FRC dives can also be used to rehearse equalization.

Stretching the Diaphragm: Pre-dive

Stretching the diaphragm before diving can make the difference between a comfortable dive and a lung barotrauma. Divers can stretch their diaphragms during their pre-dive warm up on shore, or on the boat.

FRC-Dives for Warm-up

For depth disciplines, a common solution is a single FRC dive, rather than hang(s). FRC dives are brief, rarely long enough to chill an athlete and a single dive can engage the MDR without risking hypothermia.

Warming up vs. Hypothermia

In cold water warm ups could cause excessive heat loss. The usual solution for this is more neoprene (and with it, more weight). Neither benefits performance!

For STA, heat loss isn’t an issue as athletes float at the surface and can wear as much neoprene as they require without need for weight.

For DYN and DNF, some freedivers do dry warm ups, for example by a series of breath holds, thus avoiding the need for excessive neoprene. Even among athletes choosing to wear a wetsuit to optimize buoyancy and trim, few if any use in-water warm ups.

For depth disciplines, in cold water, the least number of warm up dives can allow the freediver to wear a minimal amount of neoprene, thereby reducing the amount of weight required for the dive.

Warm up Progression with in-water Training

At the start of a depth training sequence you may begin your first few training sessions with larger warm-ups, e.g. one or two hangs at neutral buoyancy depth, followed by two FRC dives. As you become more accustomed to depth you may decrease your warm-up and a single hang plus one FRC (or two FRC dives) might be enough at this stage. As depth training progresses (or the competition approaches) you may switch to a warm up with only a single FRC dive, and, in some cases, even forgo completely the warm-up dives. The preparation for such a no-warm-up-dive you do entirely by means of dry warm-up and visualisation.

Warm ups are different for each individual. You should use as much of a warm up as you need to prepare for your dive but be mindful not to do more than that.

Figure 7.12
A warm-up dive in FIM.

Chapter 07 Knowledge Review

How many days would you freedive before planning a rest day?

Is the decent on Constant Weight Aerobic or Anaerobic exercise?

What is the ideal heart rate range to workout aerobically?

Do you have to go to the gym to train for freediving?

Name three physiological symptoms of over training.

Name three Psychological symptoms of overtraining.

Why is it good to exercise your tongue?

What therapy might help in recovery from training?

CHAPTER 08

NUTRITION FOR FREEDIVING

8.1 Introduction: Aerobic & Anaerobic Systems

Nutrition: The Sum of all Inputs

Nutrition is the sum of inputs that fuel the systems of the body: carbohydrates, fats, proteins and other nutrients – vitamins, electrolytes, antioxidants, etc. – plus water.

Essential for Basic Operation of the Human Body

Nutrition is essential for basic operation of the human body. Without nutrients, a body will cease to function; without water, a body will decrease to function sooner. Proper nutrition is useful to recreational athletes and required for those competing at higher levels. Proper nutrition, along with physical and mental training, allows elite athletes to perform at extraordinary levels. Proper nutrition allows recreational athletes to perform to the peak of their abilities.

Aerobic and Anaerobic Energy Systems

The body has two independent energy systems: aerobic and anaerobic. These systems differ significantly with respect to fuel, capacity and output. As their names imply, these systems also differ in respect for the need for Oxygen, this is significant for freediving.

Both Systems in use at all Times

Before examining functions and fuels for the aerobic and anaerobic systems, it is important to note that both systems operate in combination. Specifically, skeletal muscle systems can function both aerobically and anaerobically, and use both energy systems simultaneously: varying the percentage of energy derived from each based upon energy demand, fuel supply, fitness and (importantly) training.

Freediving: An Unusually Anaerobic Sport

Freediving is an unusual sport. The athlete does not breathe during the performance. However, the anaerobic and aerobic systems are both important. Freediving includes a range of intensities and durations. Longer sessions – such as spearfishing and recreational diving, which may last several hours – are almost entirely aerobic. Shorter performances – such as a single target dive – may require significant energy from the anaerobic system.

8.2 Eating Before Freediving

Digestion Times for Various Food Groups

Foods digest at different rates. Fruits digest quickly, providing energy in the form of simple carbohydrates in less than one hour. Grains (such as oats or rice) digest at an intermediate rate of two to three hours, but provide significant energy in the form of simple and complex carbohydrates.

Blended fruit and vegetable “shakes” may combine the best of fruits and grains- rapid digestion, plus a rich mix of carbohydrates - and, if desired, fats.

Proteins (meats, fish, and eggs) digest relatively slowly in one to five hours, and are best consumed after diving.

Last but not least, fats take the longest

Foods and Digestion Time

Water	0-10 min
Fruits	30-60 min
Egg	1 hr
Vegetables	1-2 hr
Grains, Beans, Nuts	2-3 hr
Cheese	3-4.5 hr
Meat	3-5 hr
Fat	40 hr
Fatty Meal	72 hr

Table 8.1
Various foods and digestion time.

digestion time. While most fats are digested within 40 hours, a fatty meal can take up to 72 hours!

Various Disciplines Require Various Foods

What to eat before freediving depends in part on personal preference, and in a larger part on activity. Static apnea requires minimal fuel. A constant weight dive requires fuel for a short aerobic and anaerobic performance (e.g. 2-4 minutes). A longer apnea session like recreational diving or spearfishing requires fuel for extended performance, both aerobic and anaerobic.

Static Apnea: Minimal Solid Food

Static apnea requires minimal effort, and therefore minimal fuel. For static performances (training and competition) early in the day, many freedivers prefer to avoid solid food entirely, staying hydrated and maintaining blood sugar levels with fruit juice (often mixed with water), coconut water and / or sports drink (discussed in the section on **"Hydration"** below). For static performances late in the day, freedivers consuming solid foods look for fast digesting options, grains (such as oats), hours before the performance, and faster digesting fruits.

Short Performances: Light Meal Hours Before

Target dives in constant weight, free immersion or dynamic apnea require fuel for a short aerobic and anaerobic performance, typically, one or more warm up dives, and a single longer or deeper dive. Every diver is different and understanding your body's energy needs and how to supply them is important for every diver. Some divers prefer a light meal (e.g. oats with honey) hours before the performance, allowing it to fully digest. Other divers prefer a carbohydrate-rich meal the night before, with only a small amount of fruit and / or sports drink to maintain hydration and blood sugar levels. Sports gels digest quickly and can be used as an energy source for target dives 30-60 minutes before performance.

Longer Performances: Preparation Starts the Day Before

Longer performances, for example an extended day for a freedive instructor with back-to-back teaching sessions, require fuel for extensive aerobic effort, with significant anaerobic effort. Effective fuelling for such performances starts the day before, with healthy fats and carbohydrates that can be stored as fatty acids and glycogen, and continues with a light meal (e.g. oats with honey, nuts and fruit) before activity, giving it time to fully digest (this may mean an early alarm). Blended fruit and vegetable "shakes" are energy-rich and digest rapidly, and can be a useful option before longer activities. Sports drinks and gels can be consumed during these activities to maintain energy.

No Digestion While Diving

A body at rest uses most of its blood-flow for internal organs (e.g. digestion). Athletic performance and apnea rapidly shift blood-flow away from those organs. Rapidly reducing blood-flow to the digestive system (especially the stomach) can be disruptive, with unpleasant consequences. For that reason, freedivers prefer to allow enough time for the stomach to fully digest solid food prior to commencing athletic or breath hold activity.

8.3 Foods to Avoid Before Freediving

Figure 8.1
Foods to avoid before Freediving.

Certain foods can promote mucus production in some people.

Freedivers who suffer from congestion in their sinuses and equalization problems when diving may find that cutting down their intake of the following foods reduces the amount of mucus in their airways. You may need to experiment with which food affects you personally by eliminating one of the food groups below for a week to see if the amount of mucus you produce reduces. When you freedive you may need to stop this intake for up to a week before your freedive sessions, to help improve your equalization.

- **Dairy products – cow's milk and cheese in particular**
- **Acidic fruit and fruit juice – such as oranges and other citrus fruit**
- **Wheat**
- **Sugar**

Protein

Because of their longer digestion time, many freedivers avoid protein in any form before freediving. In general, this means avoiding proteins the morning before freediving. Some competitive divers avoid large amounts of protein the night before deeper target dives.

Caffeine and other Stimulants

For many people, caffeine and other stimulants increase the activity of the sympathetic nervous system, including raising the resting heart rate, which can increase Oxygen consumption and thus shorten breath hold time. For this reason, many freedivers avoid caffeine in any form before freediving, and other freedivers even avoid caffeine for a significant period (e.g. 30 days) prior to competition.

8.4 Hydration

Hydration is Essential

Proper hydration is essential for all sports, but can be critical for freediving. Small decreases in hydration can result in large decreases in performance. Proper hydration is especially important for freediving. Reduced hydration can lead to a thicker bloodstream causing the heart to work harder, which we do not want in freediving. A thicker bloodstream can also lead to the retention of Nitrogen in the system, which in turn increases our susceptibility to decompression sickness. Dehydration can exacerbate congestion, making equalization more difficult.

Dehydration: Immersion Diuresis, Mouth-Breathing, Sweating, Overheating

Many factors can cause dehydration for freedivers. Sweating (the body's cooling mechanism) can quickly dehydrate an athlete unless fluids are rapidly replaced. For freedivers, this often occurs after putting on a wetsuit, and before entering the water. Mouth breathing can also cause dehydration, especially in dry climates. Immersion diuresis is a significant cause of dehydration for freedivers. Hydrostatic pressure from immersion causes the kidneys to remove additional water, regardless of temperature. Compared to pool sessions this effect is stronger in depth freediving and can be lessened by using FRC dives.

Pre-Hydration Starts the Day Before

Effective hydration starts the day before diving and continues on the morning before diving. For longer sessions, hydrating while diving is recommended (e.g. bring a bottle of isotonic drink in your training float). For multi-day events, remaining continuously hydrated can be challenging (especially in dry and / or hot climates). In such situations drinking just a lot of water might not be enough and it is advisable to use isotonic drinks or rehydration salts to avoid a low level of salt (mainly sodium) in the body.

Indicator for Hydration: Colour of Urine

Relatively clear urine can indicate proper hydration; coloured or darker urine can indicate severe dehydration.

Caffeine and Alcohol

Caffeine and alcohol can be diuretics and cause dehydration. If you feel these act as a diuretic for you but you still choose to drink either of them the day before diving, you will need to hydrate accordingly.

Water Alone may be Insufficient

Water alone can be insufficient for hydration. Adding electrolyte tablets (sodium, potassium, magnesium) to water can address this issue, and even table salt can

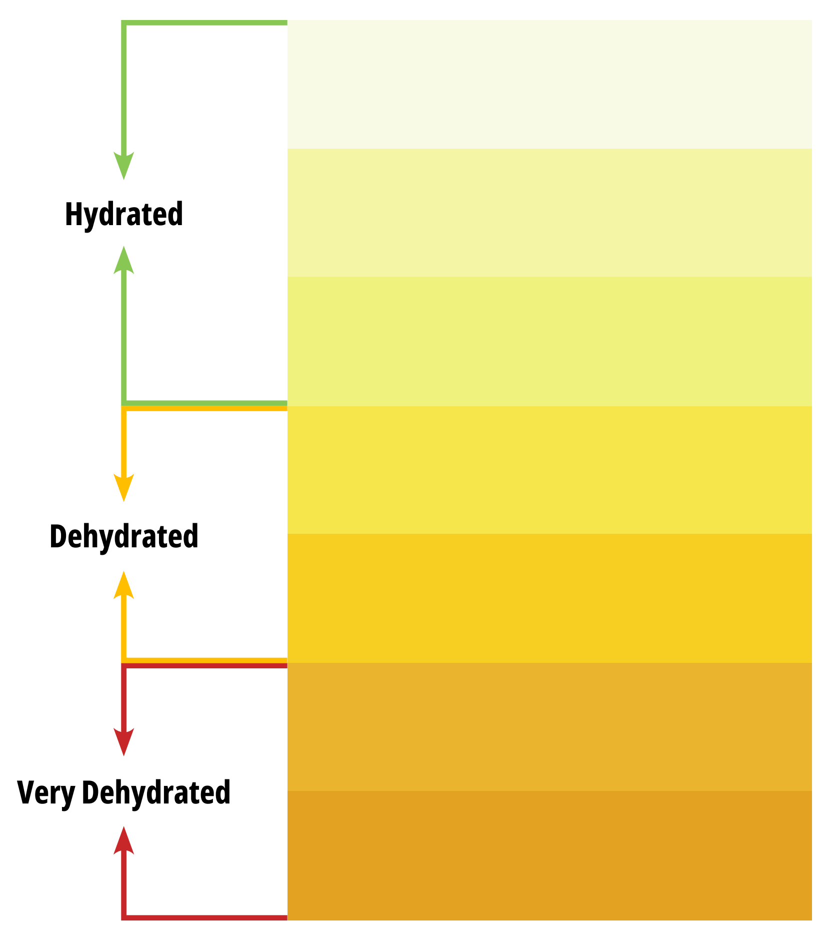


Figure 8.2
A simple urine color hydration chart.

replace lost sodium. Fruit juice, typically diluted with water, can provide simple sugars. Coconut water is an excellent option, it contains both electrolytes and sugars.

Many athletes prefer isotonic sports drinks, which provide carbohydrates and minerals (and may absorb faster than water). An Isotonic sports drink is one that's approximately the same concentration of salt and sugar as the human body (e.g. 4-8% sugar).

Figure 8.3
Homemade sports drink.

You can make sports drink with bottled or filtered water, sea salt, lemon or lime juice, and honey (or raw sugar); many athletes consider this a significant improvement over pre-packaged sports drinks. As a rule, drinks with less sugar (e.g. 3-5%) may be better for hydration, and drinks with more sugar (e.g. 6-8%) may be better for maintaining blood sugar while exercising.

8.5 Post-Performance Recovery

Post dive recovery

It is important to start your Nutritional recovery after a dive as soon as physically possible, if not immediately, at the maximum of one hour after exiting the water.

Re-Hydrate as Soon as Possible

If you're dehydrated, begin hydration as soon as possible, if you're not sure, assume you're dehydrated. Sports drinks, fruit juice, coconut water, herbal teas and mineral water are common choices.

Replenish Carbohydrates

The next step is to replenish fuel that you've used. This means carbs for the anaerobic system, fats for the aerobic system, plus proteins.

To replenish carbohydrates, post-performance is one of the few times you can use sugars in almost any form. Best is a mix of simple and complex carbs: fruits, honey and whole grains. Healthy fats are useful after longer efforts, to refuel the aerobic system. Some athletes prefer "recovery shakes": blended mixes of fruit, vegetables, grains and non-dairy milk or "ice cream" that are digested quickly, and refuel both systems.

Replenish Protein

Finally, replace proteins that were metabolised, and provide material to repair muscles that were damaged during training. Healthy proteins include eggs, fish, lean meat, and vegetable sources (e.g. beans and whole grain rice). Protein supplements (also available for vegetarians) can be useful, but they are not a replacement for natural protein sources.

Anti-Oxidants: Countermeasure to Free Radicals

Anti-oxidants minimise damage from "free radicals". Free radicals are atoms or molecules with an unpaired electron. They are produced all the time in our bodies because of normal metabolism. In large numbers, they are believed to cause harm to the body and are held responsible for many health problems, including heart disease, some cancers and much of the ageing process.

When you hold your breath repeatedly for an extended time, your cells start to spontaneously break down sugars to release Oxygen and excrete cellular wastes into the blood stream. This leads to increased levels of free radicals post-freediving, which can result in muscle soreness, discomfort, fluid retention and fatigue.

Antioxidants are enzymes and nutrients in the blood that "disarm" free radicals and render them harmless by donating

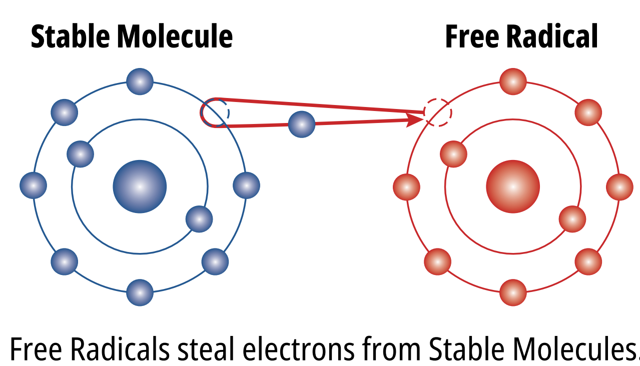


Figure 8.4
Free Radical without Anti-Oxidant.

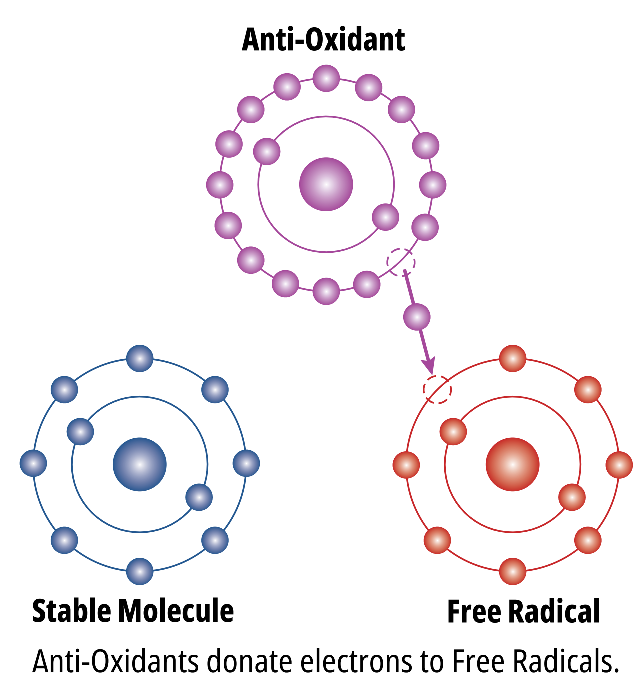


Figure 8.5
Free Radical with Anti-Oxidant.

one of their own electrons to neutralize the free radical.

To make sure your diet is high in antioxidants, check/monitor if you eat enough vitamin A, C, E. Include fresh fruit, vegetables, bell peppers, avocados and nuts and seeds regularly in your diet. Also, a daily glass of red wine might help.

Latest scientific results suggest that the desired training effect might be reduced if anti-oxidants are taken before a performance. However, intake of anti-oxidants after training is safe and will help to better recovery time.

BCAAs

Branch chain amino acids (BCAAs--leucine, isoleucine and valine) provide the body with essential amino acids to speed up recovery. Because the body can't produce BCAAs itself, a supplement can be useful after long or strenuous exercise.

BCAA rich food includes meat, poultry and fish, beans and lentils, milk, tofu and tempeh, cheese, eggs, pumpkin seeds, quinoa and nuts.

Chapter 08 Knowledge Review

Name three good sources of protein.

Name three foods that are carbohydrates.

Name three sources of good fat.

Give two examples of antioxidants.

How long does it take Grains to digest?

How quickly after a freedive session should you start to replenish the energy that your system has just used?

Name three sources of good rehydration.

Why is it important to pre-hydrate before freediving?

CHAPTER 09

THE ROLE OF ASSISTANT INSTRUCTOR

Another purpose of this course is to prepare you for the role as "Assistant Instructor". This is a role that will allow you to gain experience and confidence in supervising freedive students, organising training sessions and handling all gear involved in the safest manner.

9.1 Student Supervision

After you have successfully finished your AIDA4 Course and have been certified by your AIDA Master Instructor you are qualified to supervise students at all course levels in open water, confined water and classroom situations.

Note: To act as an assistant instructor or to supervise students you need to carry your own Professional Liability insurance and current First Aid including CPR.

Supervising: Provide Safety

As an Assistant Instructor you can work with an AIDA Instructor as a team. The instructor will introduce a new skill, after that you can supervise how the students are practicing that specific skill.

Example: Duck Dive. First, the AIDA Instructor introduces the Duck Dive to the students. After having demonstrated (or have you as the assistant demonstrate) the skill, the instructor will determine how the students are now going to exercise the Duck Dive – one-by-one, or all together, in what area, etc. After making sure all students have understood the skill-practice, you, as the assistant can take over and supervise the students.

You can and should give feedback in a constructive way to the students after every attempt. Make sure you are not going beyond what the instructor has already introduced. Also, the given skill “Duck Dive” can be done in many various ways – it is your task to make sure that the students stick to the technique as introduced by the instructor.

Supervising is not Teaching!

Teaching is defined as introducing a new skill. This is where the line is drawn between you as the AIDA4 Assistant Instructor and the AIDA Instructor. You are allowed to supervise a skill practice that has been already introduced by the instructor, but you cannot teach a new skill yourself!

Warning: An AIDA4 Assistant Instructor cannot teach!

Signing off skills

Skills need to be signed off by the appropriate level instructor for that course. Any AIDA skill such as line orientation, duck dive or freefall, needs to be witnessed by the instructor and not by the assistant. It is the instructor who is responsible for ensuring that all skills are of an adequate level for that course, as it is their name on the course completion form and them that will be certifying the student.

In Confined Water

In Confined Water or Pool sessions, you can supervise training sessions without the presence of the instructor, where students repeat already learned skills. This can also include a training session with CO_2 tables, which have been discussed with and approved by the instructor in charge. In all cases, you will need to carry your own Professional Liability insurance and current First Aid certificate including CPR.

In Open Water

With you as an assistant present, the AIDA Instructor can raise the maximum number of students from 4 to 6. This usually results in a 2-float setup with three students on each float. In this situation, the instructor introduces a new skill to the students on Float A, while you are with the students on Float B. When the students on Float A are ready to exercise that skill, the instructor will swap position with you. You take over the supervision of the skill exercise of the students on Float A, while the instructor introduces the same skill on Float B.

An AIDA4 Assistant Instructor is not allowed to supervise students in open water without the presence of the instructor.

9.2 Setup Handling

As a successfully certified AIDA4 freediver, you can manage and setup independently all equipment involved in freediving, especially all gear involved in an open water session.

Essential Knots

There are only two essential knots which you need to be able perform on an open water setup. First, the Water Bowline allows you to attach the bottom weight safely to the dive-line (if a carabiner is not used) and also comes in handy in every other situation where you need to attach a rope with a safe knot that does not tighten itself under tension. Secondly, the Clove Hitch is there to set the dive-line to a chosen depth.

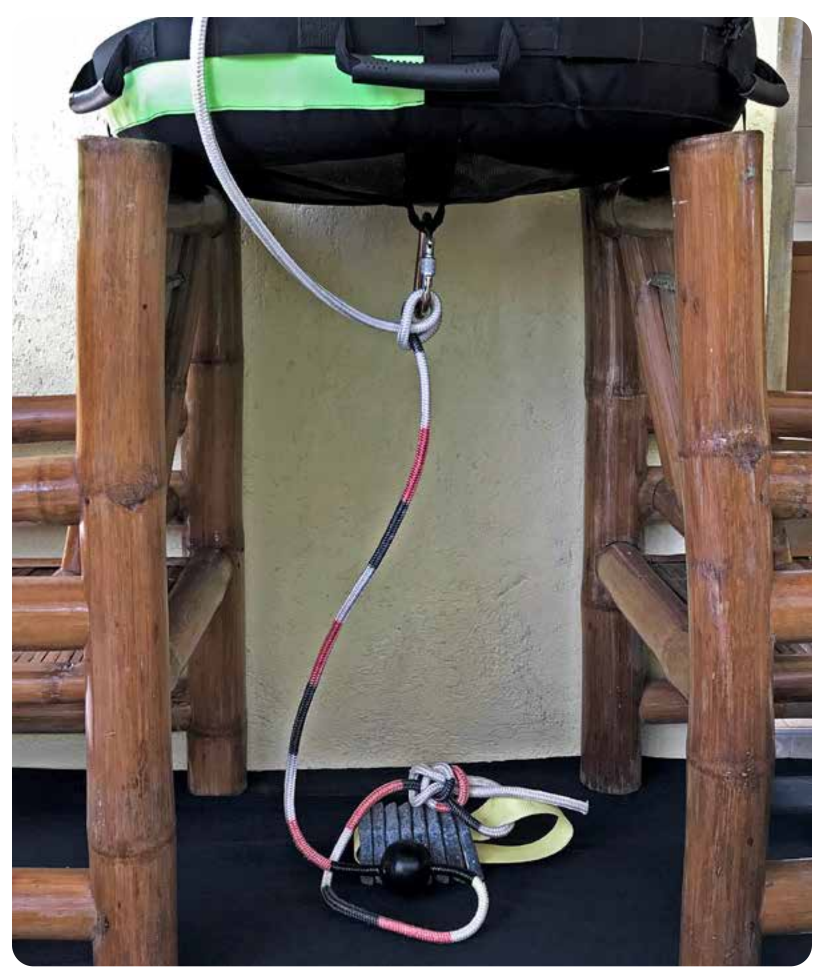


Figure 9.1
Essential freediving setup.

Water Bowline

The water bowline is a bowline with an added half hitch on the tail end. When under tension the half hitch grabs onto the tail making the knot more secure. Bowlines are great in general, easy to tie and untie even if the knot was heavily loaded. The water bowline is ideal for example to attach a bottom weight to the dive-line.

Figure 9.2
How to do Water Bowline.

Clove Hitch

The clove hitch is easy to tie, easy to untie, strong and just bites tighter the more it gets loaded.

Figure 9.3
How to do Clove Hitch.

Braiding Technique

In freediving we can be operating with quite long ropes, a usual teaching rope is 40m metres long (one metre to attach it to the float, one metre for bottom weight and lanyard stopper and 38 metres diving depth for the AIDA4 Course). It is essential to stow long ropes in a meaningful way to avoid knots and entanglement. Two common ways to stow a long rope are:

Single Daisy Braiding

In this very popular method, the rope is repeatedly looped through itself.

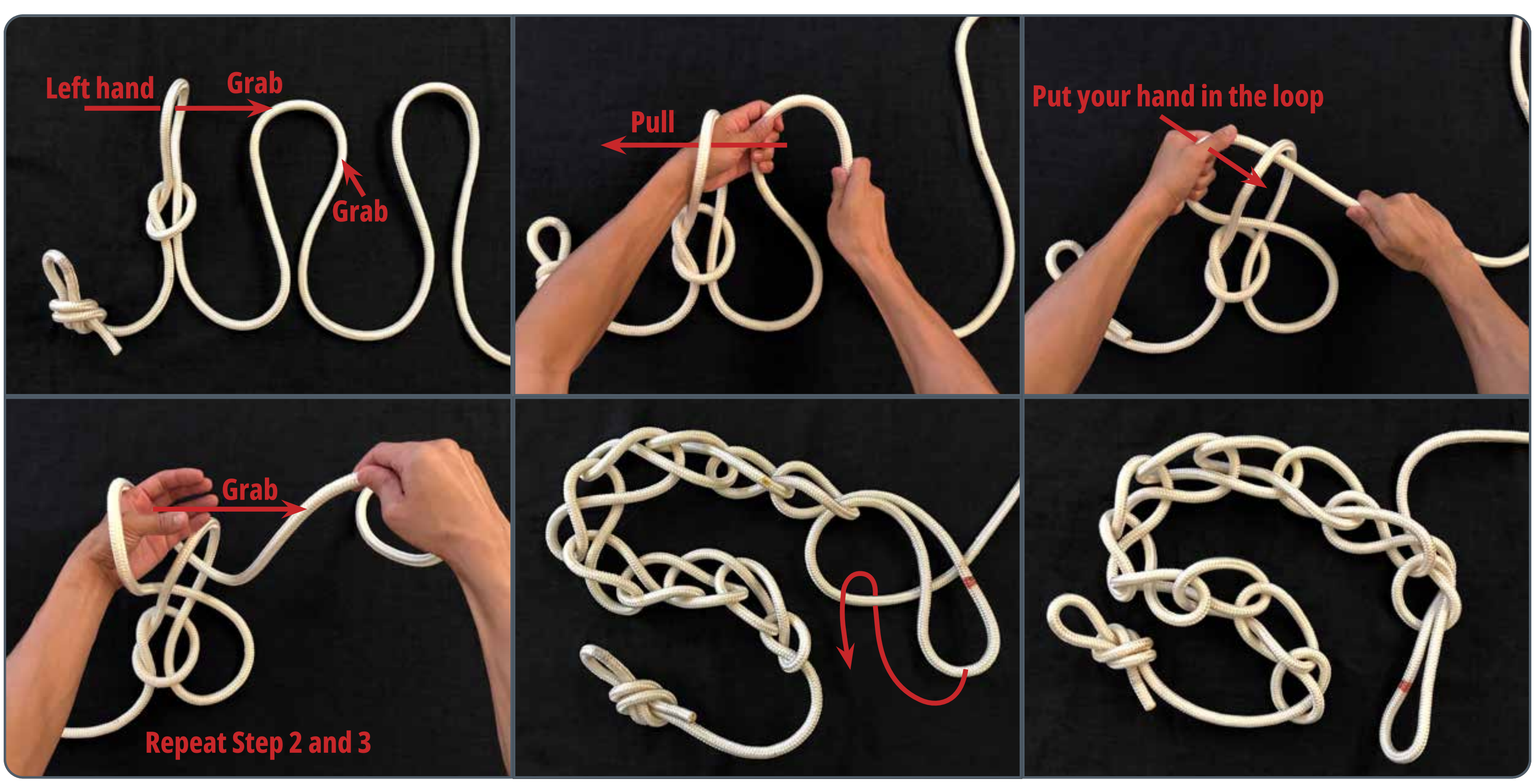


Figure 9.4
How to do Single Daisy Braiding.

Double Daisy Braiding

This very elegant method is very secure against tangling or knots, also the double braided rope can be more compact and easier to handle.

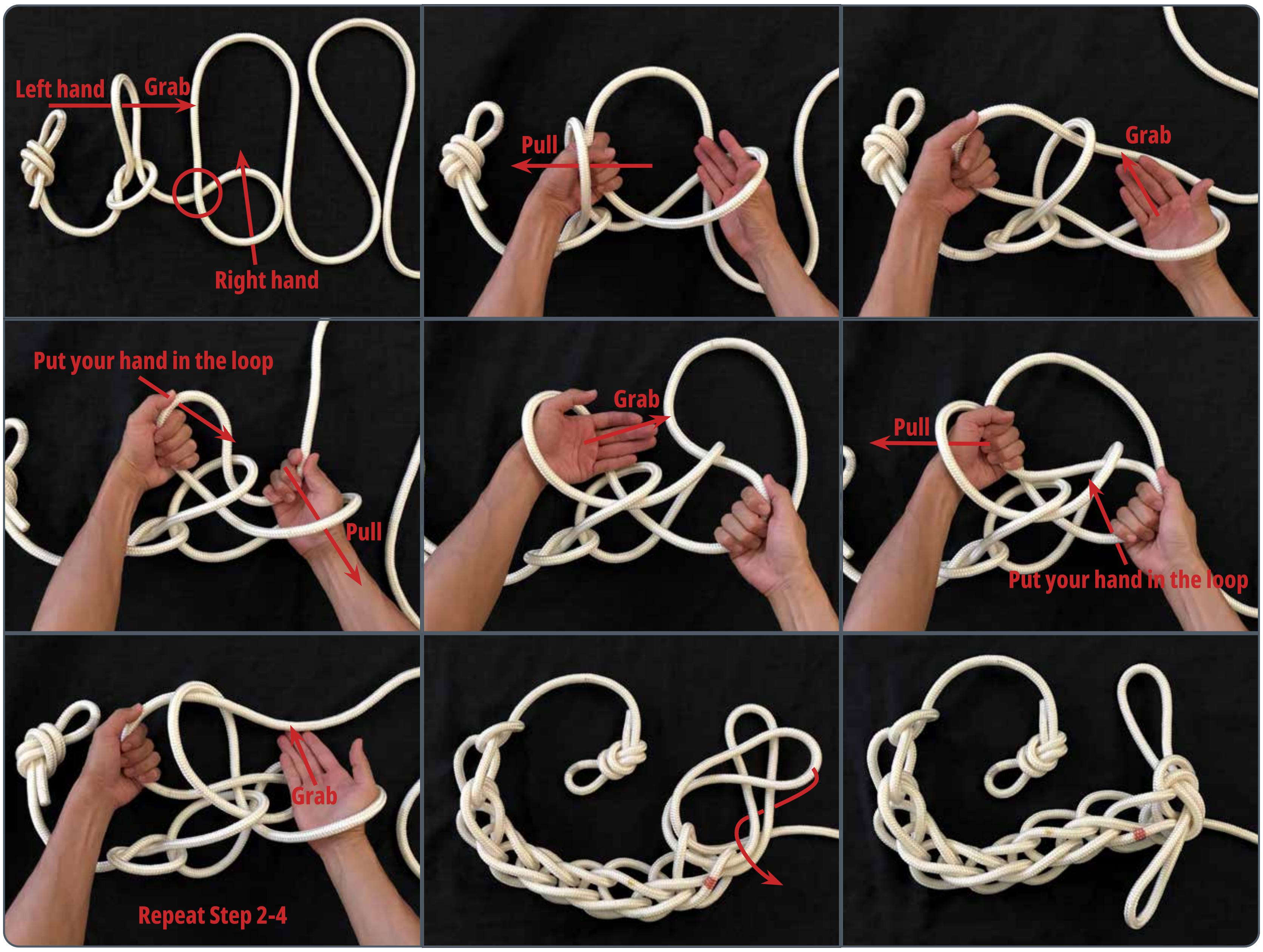


Figure 9.5
How to do Double Daisy Braiding.

Set Target Depth of the Rope

With a rope that is marked every five metres it is quite convenient to set the bottom weight to a given target depth. The first step is to extract the correct amount of rope from the buoy and secure the rope with a clove hitch (see figure 9.3) to a carabineer below the float. The next step is to then release the bottom weight and allow the rope to slowly reach the desired depth.

If the target depth is not exactly on a five-metre mark, let's say 27m, you can add two metres to the 25m marking on the rope, attach the rope with a clove hitch to the float, then dive to the first marking and check with your dive computer if it is really at 2m depth.

You should always check if there is enough depth available and drop the rope very carefully also making sure the bottom weight is not touching the ground. In addition, when diving in currents, there should be a minimum of 10m available below the bottom weight to avoid getting caught in rocks or corals.

Care should also be taken if the rope is being lowered in areas frequented by scuba divers. The rope should be dropped slowly and with more caution.

9.3 Lead Warm-up and Stretching

The purpose of this chapter is to introduce you to how to perform and guide a full body warm-up and stretching session, and how to perform and guide specific stretches for the breathing muscles. It is recommended conducting such a session in a calm environment, with enough space for all students to do extended movements and stretches and the option of sitting and / or lying down.

Low Impact Physical Activity

Choose exercises and movements, which do not rely on great flexibility or strength. Active movements of joints and muscles are better than static stretches to warm them up and activate their full range of movement. Try to come up with a sequence that you are very comfortable with in terms of knowing what you are doing, for what purpose each exercise is done and how you can correct fellow freedivers exercising incorrectly to prevent them from getting injured.

Mobilisation of Major Muscle Groups

It is better to try and lead the stretching in a structured flow for example from head to toe. Choose a series of exercises which activates all major muscle groups of the body, but does not exceedingly challenge your flexibility or that of your fellow freediver you are guiding through the sequence.

Specific for the Planned Freedive Session

Adapt your sequence according to the upcoming freedive session you are warming-up for. For example, before an open water session it is recommended to include the hip-flexors by doing repeated gentle high lunges or low lunges. This exercise would not be very helpful before a static session – here you can, for example, focus on general warm-up and on activating the breathing muscles of the torso.

The stretching session to improve general bodily flexibility must include:

1. Check for Injuries and Adapt

Before beginning your warm-up session you have to ask all participants if they have an injury of any kind. If any of these injuries can potentially interfere with your planned sequence, you will need to adapt the respective exercises accordingly for the injured person.

2. Gentle stretching movements on full lungs in sitting or kneeling position

Exercises that include stretches while inhaling are safer to be done in a kneeling position, for example a seated body twist on inhale. If this stretch is done excessively with the head as well as the chest then this can lead to fainting, particularly in well-built freedivers. Emphasis should be given that this is a stretch for the intercostal muscles and not for the head or neck.

3. Stick to a Set Time

A warm-up sequence should take between ten to twenty minutes. Stick to an agreed time, especially if several groups of freedivers are involved, or a boat is waiting, or the reserved pool-time is about to begin.

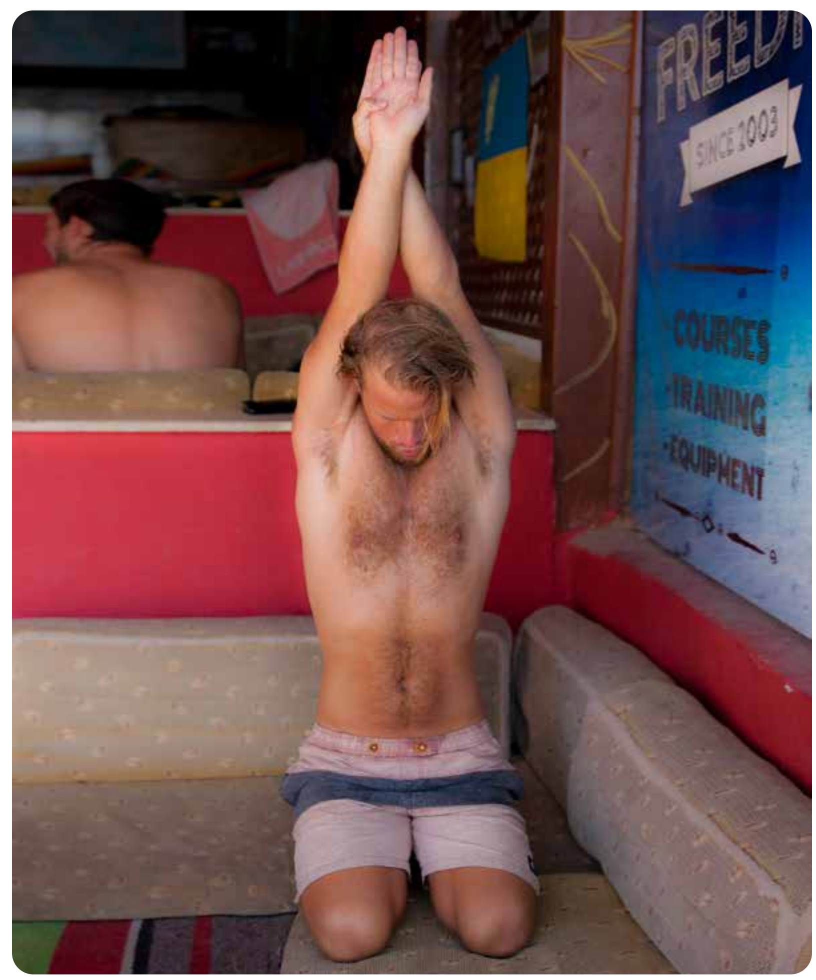


Figure 9.6
Full lungs stretching in kneeling position.

9.4 General Instructor Assistance

In addition, "off-session", you as an AIDA4 Assistant Instructor can be of great support for an instructor, even more so during a busy freedive course with a large group of students. This chapter introduces a few of these side activities.

Be Approachable for Students

As an assistant you can act as a bridge between a group of students and the instructor. Students might subjectively perceive you as more approachable than a seasoned instructor, so you can help them with their specific problems and – if necessary – relay them to the instructor so they can address them.

It is often easier for you as an assistant to empathise with students and their small or large issues, as it might be not so long ago since you dealt with similar issues yourself. Make this empathy your strength!

Equipment Selection and Handling

Before the first session, the students need help to select the best fitting gear available for them. After the session, show students how to properly rinse the gear and how to store it for drying.

- **Wetsuit: Select a well-fitting wetsuit for the student, especially if the water is cold. Water flush – water that enters the suit – is what will eventually affect the body temperature of a student most. A suit that is a good fit will reduce water flush. However, if it's too tight it could affect the ability of the student to move or even breathe freely.**
- **Mask: To ensure you have given the student the correct mask, the student should place it on their face without the strap behind the head and breathe in gently through the nose. If the mask remains in place without the strap behind the head then this can help ensure that the mask will not leak when the student gets in the water. You may also want to introduce the student to the concept of spitting in the mask before the session to stop it fogging.**
- **Fins: Help students to select a pair of fins that fit snugly without hurting. Ideally there should be minimal gaps between the rim of the foot pocket and the foot to avoid friction, which can lead to blisters. You can adjust the fit by using or changing the thickness of socks or neoprene socks.**
- **Weight belt and weights: Make a first estimation how much weight the student will need. This of course varies greatly on the nature of the session: DYN takes a lot more weight than open water. The correct weight will then be checked by the instructor, as soon as they enter the water. Introduce students on how to handle a weight belt correctly, by always holding it up on the open end, and how to place and tighten a flexible weight belt correctly on the hip bones.**

Group Management

You can support a smooth course by gathering the group in time and leading them to the next session – this may mean showing the way to the classroom, to the gear room or the boat that takes you to open water.

Ask the students if they have any needs at this stage, e.g. only you know that there are no toilets at the harbour you are headed to, or show them how they can carry their own gear with one hand while they need the other hand to hold on while the boat is moving.

Administration Support

Running and managing a course with a large group of students also comes with some administrative tasks where you can be of great support to the instructor. Be it printing paperwork or supervising students filling it in; cleaning the whiteboard before a classroom session, supervising students sitting an exam or taking photos of students for the registration on EOS – the more you can anticipate the needs of the group and the instructor, the more support you can provide!

Chapter 09 Knowledge Review

Apart from your AIDA4 qualification what else do you need to assist on AIDA courses?

Who is responsible for signing off skills?

Which two knots are useful for setting up the line?

Show the instructor a clove hitch.

How do you check that the mask fits the students face?

What should you look out for when dropping the line?

How many students can an instructor teach in open water with you as an assistant?

CHAPTER 10

ONE OCEAN

The ocean is a fundamental component of the global ecosystem.

It is heavily affected by human activities such as pollution, overfishing and tourism. Even though freediving is a gentle way to approach the ocean and marine life, our behaviour still has an impact.

In this chapter we will build on our understanding of the marine environment in addition to the Rules of Behaviour from AIDA1 and AIDA2, and knowledge from AIDA3.

Please consider that your local water-environment may have specific environmental concerns, which you should familiarise with.

The information presented here are not meant just for the classroom. We are asking you to implement your knowledge and environmental awareness into your diving, training and living, so that we all take responsibility for the ocean's health.

AIDA Green encourages all freedivers to be ambassadors for the ocean.

Please note, that when the word "Ocean" is used in this material, it encompasses the entire Earth's water systems such as sea, rivers and lakes.

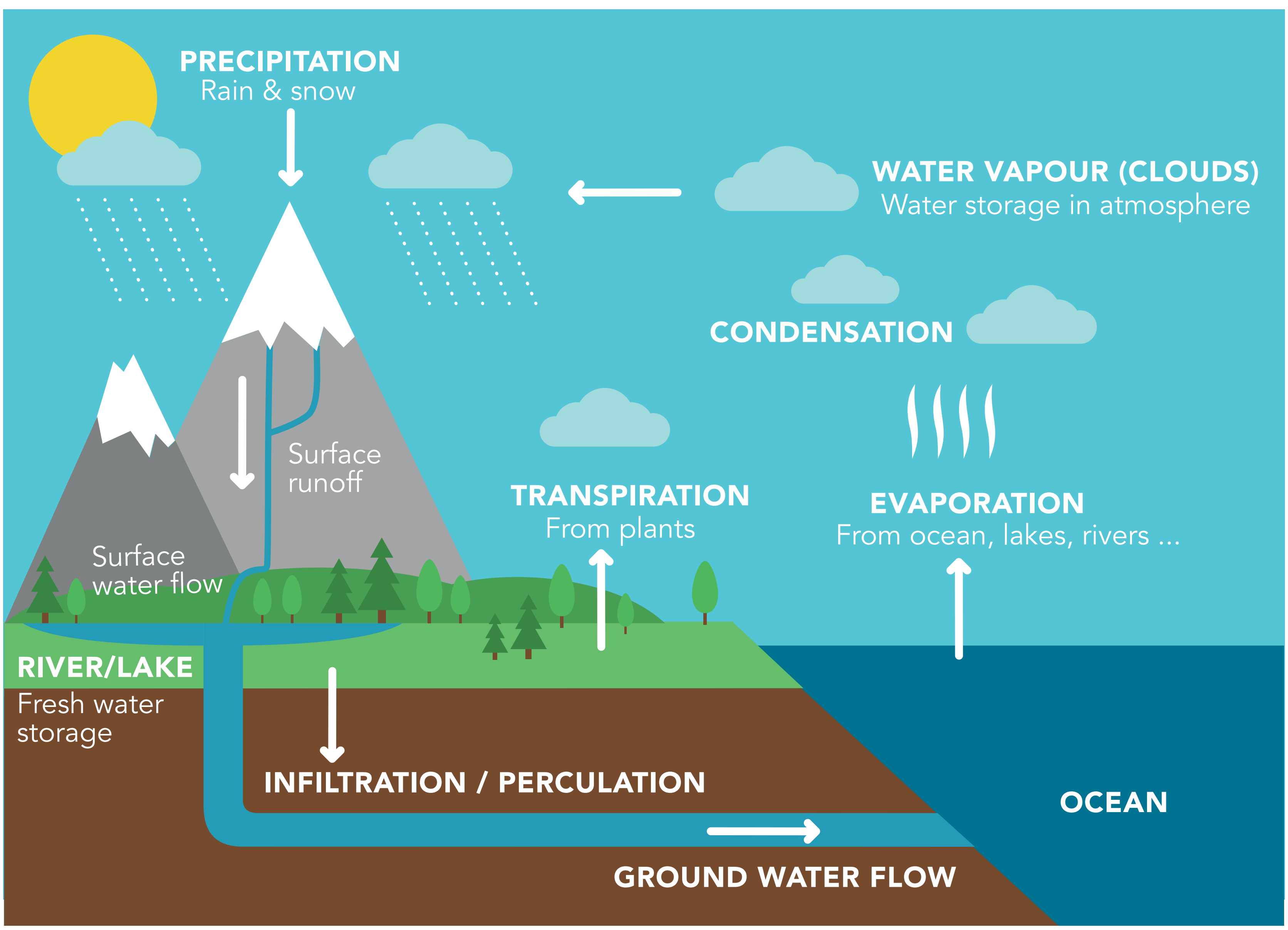
10.1 The Importance Of The Ocean

The ocean is crucial for life on the planet: it regulates the climate, it produces oxygen and it influences the weather.

Climate Control

Between the ocean and the atmosphere there is a continuous exchange of heat, water and energy. This interaction influences the energy and water cycles that drive the planet's climate system.

WATER-CLIMATE-CYCLE



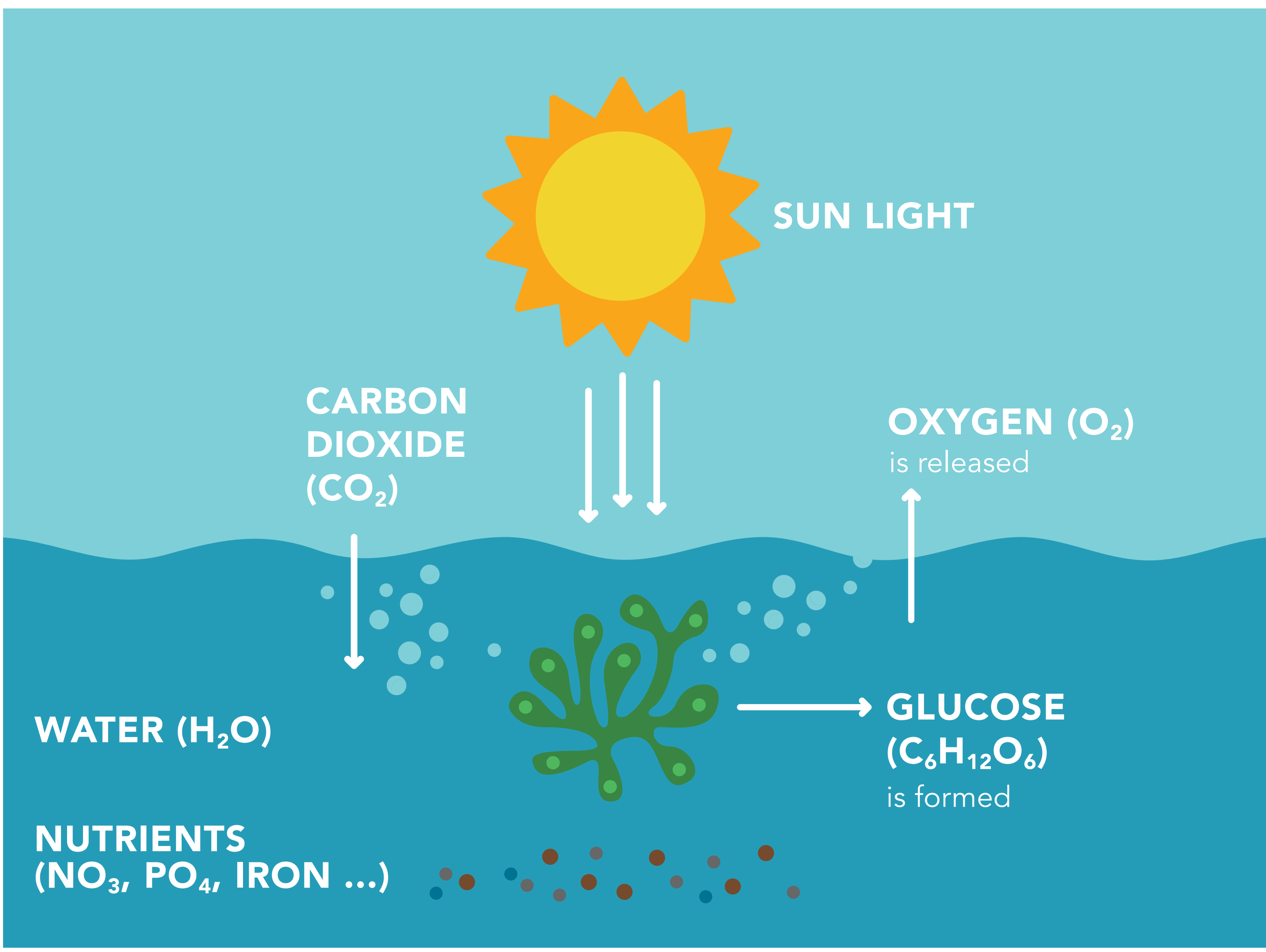
The ocean regulates the weather and the climate by absorbing most of the solar radiation that reaches the Earth.

Water evaporates from the ocean producing clouds that eventually bring rain over land areas sustaining every form of life, including human life. The ocean is therefore our main source of freshwater.

Changes in the ocean-atmospheric system results in changes in the climate that, in return, causes further changes to the ocean and the atmosphere. These reciprocal interactions have tremendous physical, chemical, biological, economic and social repercussions. For example, both draught and floods drastically modify the composition and fertility of the soil. As a consequence the yield of crops and agricultural produce is greatly affected by climate change, with potentially devastating effects on people and economy.

Oxygen

PHOTOSYNTHESIS



$$CO_2 + H_2O \xrightarrow{\text{LIGHT ENERGY}} C_6H_{12}O_6 + O_2$$

The ocean produces most of the oxygen available on the planet. Just like rainforests, marine organisms like phytoplankton, algae, kelp, marine plants and corals use sunlight as a source of energy to convert water and carbon dioxide into sugar through photosynthesis, producing oxygen as by-product.

Most of the oxygen currently available in the atmosphere has been produced by photosynthetic organisms in the ocean throughout billions of years. The consequent accumulation of oxygen in the atmosphere enabled the development of life on our planet.

In terms of proportion, the oxygen currently produced by terrestrial plants constitutes around 20-26 % of the total (rain forests alone, such as the Amazon, give an input of around 12-20%), while the remaining 74-80 % is produced by marine organisms (phytoplankton alone is estimated to produce over 50% of the total).

HUMANS And The OCEAN

The ocean provides food, medicines, mineral and energy resources. It supports jobs and national economies as well as serving as a highway for transportation of goods and people.

The ocean is a source of inspiration, fascination, recreation, rejuvenation and discovery. It is also an important part of the heritage of many cultures.

10.2 The Status Of The Ocean

Global Warming And Climate Change

Global warming is defined as the long-term temperature rise in the world's climate system. The earth's atmosphere naturally traps heat. This creates a natural 'greenhouse effect' that keeps the Earth's surface warm.

Normally greenhouse gases in the atmosphere are absorbed by plants, trees, plankton and further photosynthetic organisms.

However the amount of greenhouse gases produced by human activities are currently exceeding the amount that nature can naturally absorb, so their concentration in the atmosphere keeps increasing, alongside with the average temperatures of the planet.

The main human activities that are responsible for the ongoing global warming and climate change are fossil fuels combustion, animal farming, destruction of the forests and of the marine ecosystems.

Even if all human activities should suddenly cease, and so the connected emissions, the current amount of greenhouse gases accumulated in the atmosphere would require hundreds of years to be absorbed by natural processes. Despite scientists recommendations, many countries keep pursuing the myth of limitless economic growth burning fossil fuels in higher and higher amounts, causing a continuous rise of greenhouse gases concentration in the atmosphere (**https://www.esrl.noaa.gov/gmd/ccgg/trends/**).

Global warming consequences include drastic changes in climate patterns, the reduction of ecosystem biodiversity, an increase of uncontrolled wildfires, the rise of the ocean temperatures. These effects have a direct impact on all ecosystems as well as on water, energy, wildlife, agriculture and human health:

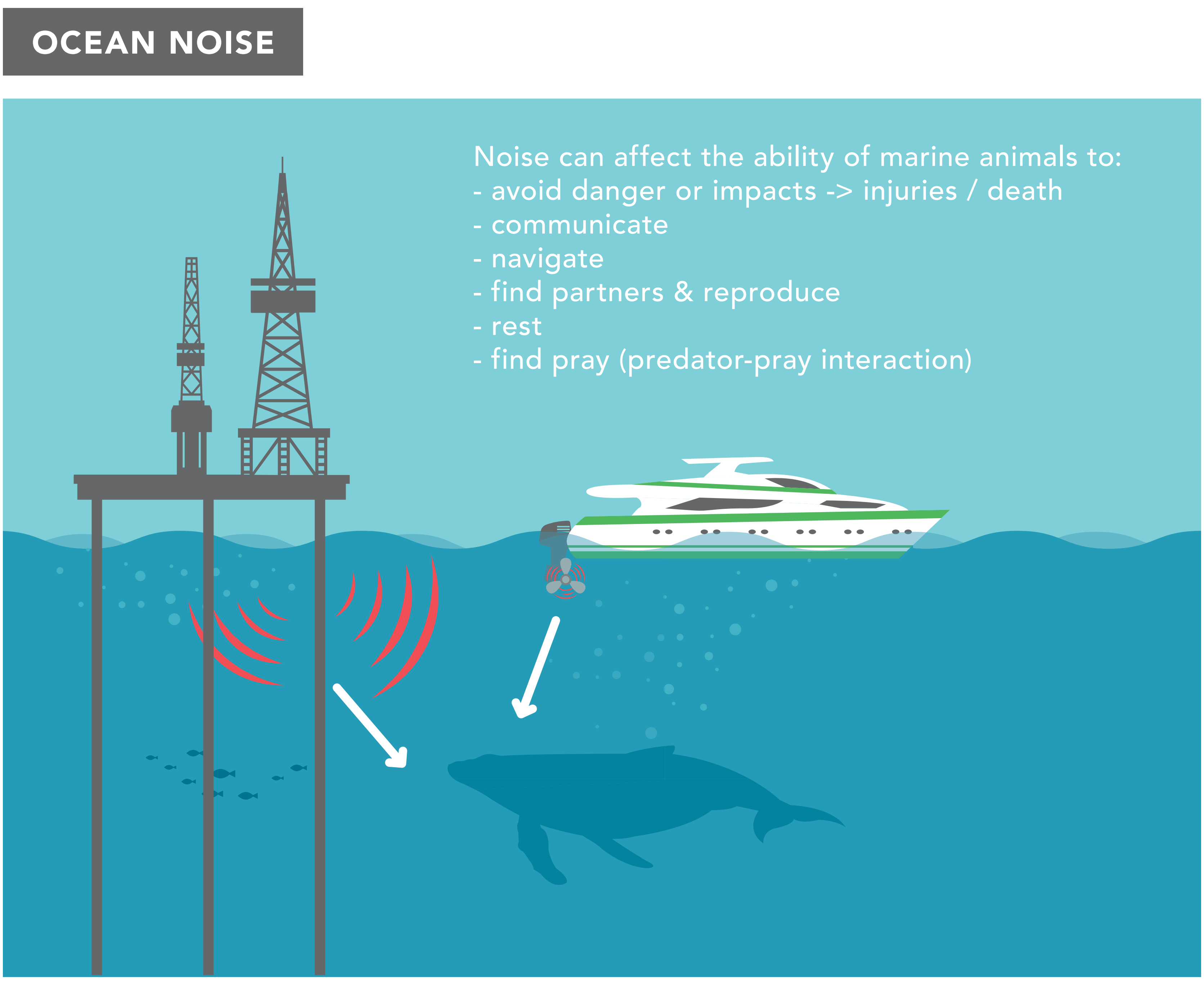
- **Water:** ice and glaciers are melting at the poles and at high altitudes. Sea levels are rising, lakes and reservoirs are suffering from drought and less snow is accumulating.
- **Weather:** Higher temperatures cause more extreme weather-associated events such as storms, heat waves, floods, fires and droughts. Increased desertification and costal erosion are also consequences of global warming.
- **Ecosystems:**
    - Habitat modifications, often leading to irreversible changes.
    - Disturbance of season-dependant biological cycles, such as pollination and spawning
    - Changes in reproductive and migratory cycles
- **Agriculture and food supplies** are affected by scarcity and poor quality of water sources. Diseases caused by waterborne bacteria are becoming more frequent.
- **Human health:** exposure to extreme temperatures and poor air quality increases the occurrence of airborne disease and viruses.

Temperature changes are not uniform across the globe. The increasing average global temperature induces extreme weather events, including exceptional snowfall and frosts in certain areas of the planet. As a consequences, crops suffer severe damages, causing food shortages and changes in the migrations patterns of several animal species, which are obliged to relocate to more suitable areas.

Offshore Drilling

Oil and gas industry activities release enormous amounts of toxic by-products and greenhouse gases, and they cause hundreds of oil spills in the water, all of which have long-lasting impacts. Even the most advanced clean-up operations remove just a fraction of the oil spilled. Some of the cleaning methods include the use of hazardous chemicals.

Ocean Noise



Sound travels faster in water than in the air - approximately 1,550 metres (5,085 feet) per second in seawater, which is 4.3 times faster than in air.

Cetaceans such as dolphins and whales depend on sound for communication, for hunting, for orientation, for navigation and to communicate with each other.

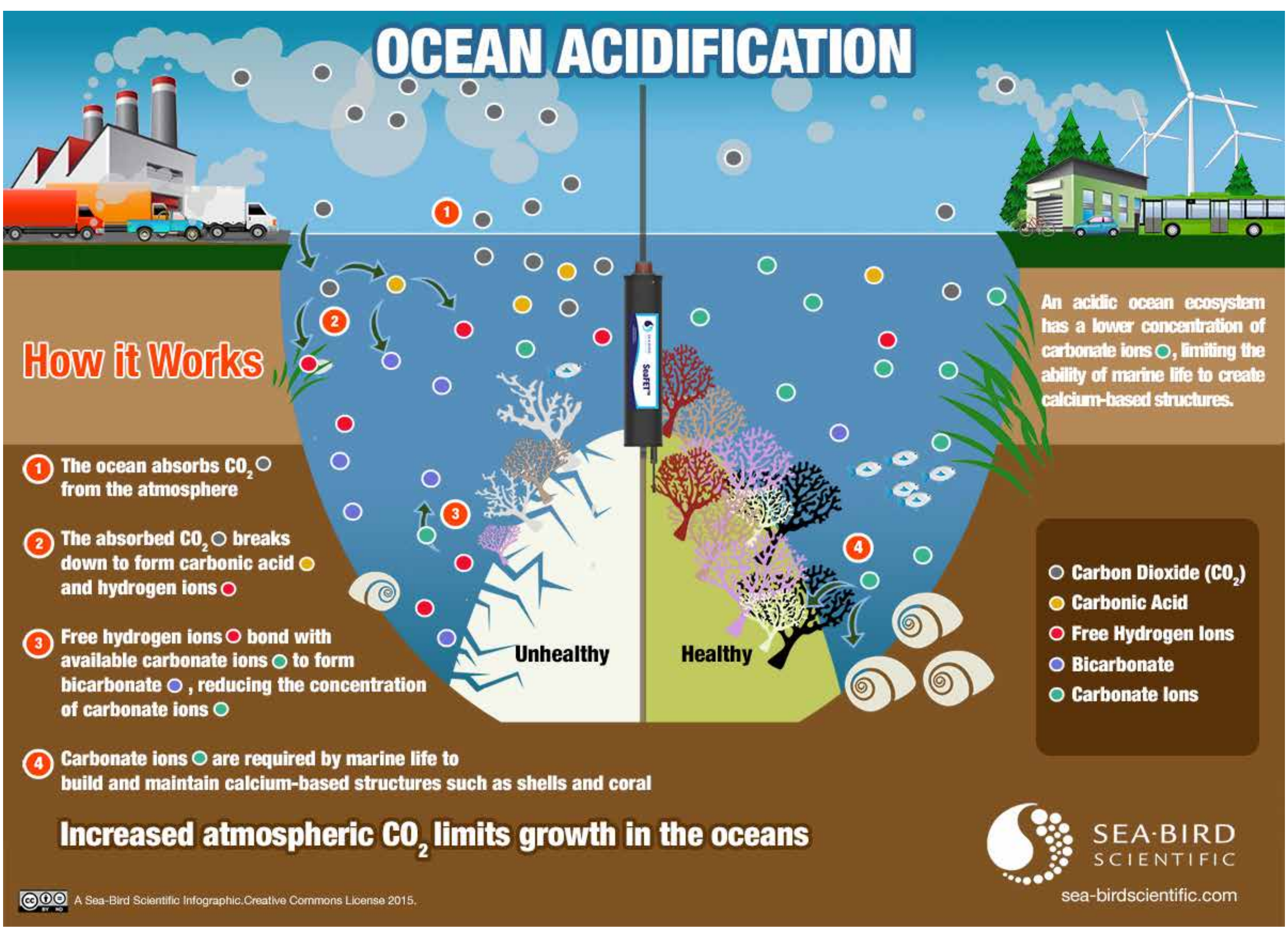
Human generated noise deriving from fracking, drilling and large ships engines are increasing, modifying the underwater acoustic landscape. The search for new oil fields is done using air-gun seismic tests, which produce a series of underwater blasts that are 100,000 times louder than a jet engine. The impact on cetaceans and other marine animals such as sea turtles and fishes is tremendous and it includes deafness, lack of orientation, disruption of hunting and mating patterns, stranding and death.

Ocean Noise videos:

- https://www.youtube.com/watch?v=t0DHEldqfIc
- https://www.youtube.com/watch?v=GFPTpbSFr74

10.3 Acidification

What Is Ocean Acidification?



Ocean acidification is the ongoing reduction of the ocean pH. The pH indicates the level of acidity of a water-based solution: the lower it is, the more acidic the solution. The ocean pH is controlled by one main factor: the concentration of CO_2 in the atmosphere. The ocean in fact is not only our main oxygen source, it is also one of the main carbon sinks of the planet: the more CO_2 we introduce into the atmosphere, the more of it gets absorbed by the ocean. Once there, the CO_2 reacts with the water producing carbonic acid, causing its acidification. The more CO_2 is absorbed by the ocean, the more acidic it becomes. It is exacly the same process happening in our blood when we hold our breath. If CO_2 emissions continue with the current trend, by 2100 ocean acidity will have risen 150%.

Consequences

Increased carbonic acid concentration in the ocean rises its hydrogen ions concentration. The hydrogen ions bond with the carbonate ions dissolved in the ocean to form bicarbonate ions (hydrogen ions + carbonate ions ↔ bicarbonate ions). This process increases the concentration of bicarbonate ions but reduces that of carbonate ions. Calcifying organisms such as corals, molluscs, coralline algae and many species of plankton need the carbonate ions and calcium ions to produce their skeletons and shells of calcium carbonate (calcium ions + carbonate ions ↔ calcium carbonate, also called limestone). The reduced availability of carbonate ions caused by ocean acidification therefore compromises their capacity to build and maintain their shells and skeletons. Their growth and fertility rate are negatively affected, and their limestone skeletons and shells are progressively dissolved. The growth of coral reefs is compromised by the same mechanism, and the delicate balance of their ecosystems is jeopardised.

Ocean acidification also lowers the immune response of most marine animals, including corals, plankton and fishes, exposing them to lethal diseases. Reproductive failure and higher death rates occur as a result of an increased exposure to pathogens.

A higher CO_2 concentrations in the ocean also favours the growth of algae and seagrasses, as it increases their photosynthetic activity, making it easier for them to compete for space with corals and other reef building organisms. This induces algae to overgrow corals, accelerating the progressive disappearance of coral reefs.

The dissolution of shells and skeletons of calcifying organisms caused by acidification rises even more the concentration of bicarbonate ions in the ocean (hydrogen ions + calcium carbonate ↔ calcium ions + bicarbonate ions), leading towards its progressive saturation. However, bicarbonate is also a product of the dissolution of CO_2 in the water (CO_2 + water ↔ carbonic acid ↔ bicarbonate + hydrogen ions). If the ocean gets saturated with bicarbonate ions, its capacity of absorbing further CO_2 from the atmosphere therefore is greatly reduced. This leads to a steeper rise of CO_2 concentration in the atmosphere and more severe greenhouse effect with more serious consequences on the climate. The whole cause-effect sequence can be resumed as:

Rise of CO_2 in the atmosphere → rise of CO_2 in the ocean → ocean acidification → dissolution of limestone rocks, shells and skeletons → ocean saturation with bicarbonate ions → ocean reduced capacity of absorbing further CO_2 from the atmosphere → steeper rise of CO_2 in the atmosphere → uncontrolled greenhouse effect causing drastic changes to the climate and to all ecosystems.

10.4 Coral Reefs

Importance And Fragility Of Coral Reef Ecosystems

Coral reefs cover less than 1% of the ocean, but they host 25% of all marine species. This means that coral reefs support more species per unit area than any other marine environment, including over 4,000 species of fishes, 800 types of hard corals and hundreds of other marine species.

Coral reefs provide shelter, food and a substrate for marine organisms to grow. Their structure is built by calcifying organisms such as corals, molluscs, sponges, calcareous algae, bryozoans, foraminifera etc. that combine the calcium ions with the carbonate ions to produce their skeletons and shells of calcium carbonate (limestone). Throughout this work, coral reefs sequestrate enormous amount of carbon from the water and they store it into the substrate. Due to this efficient carbon sequestration work as well as to their high biodiversity, coral reefs are referred to as the rainforests of the ocean.

Coral reefs are complex ecosystems where all species are interconnected and interdependent, exchanging nutrients in a very efficient recycling system. Each species, as essential component of such system, performs a specific task to maintain its delicate balance. This enables coral reefs to thrive in waters which are poor of nutrients. However if just few species are eliminated from the reef, the whole ecosystem can collapse in a domino effect.

Many coastal communities depends economically on coral reefs. The commercial value of coral reefs is estimated to be several hundred million euros per year.

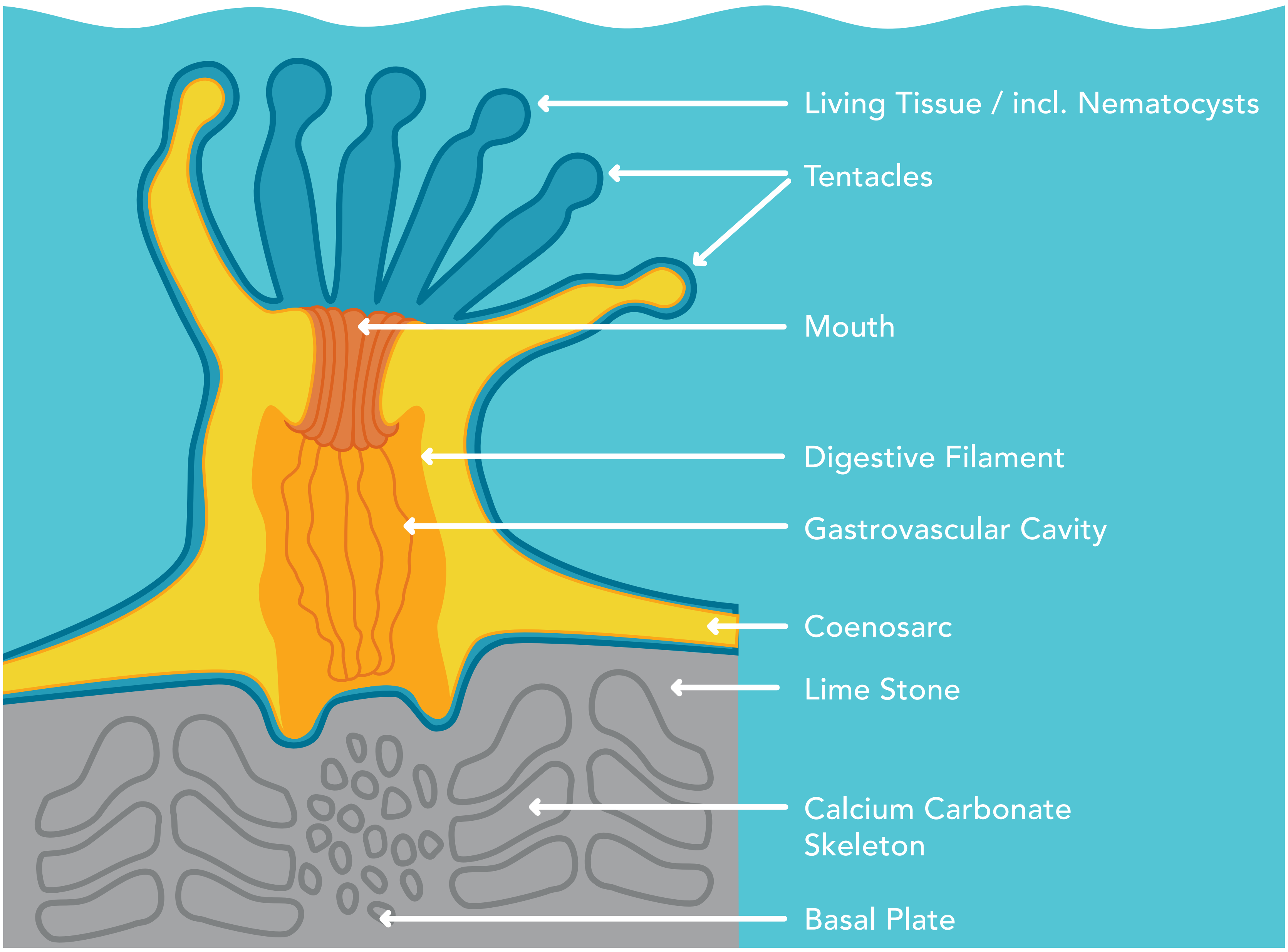
Coral reefs protect coastal areas from wave action preventing erosion, property damage and loss of life. Globally, around half a billion people live within 100km of coral reefs and benefit from their production and protection.

What Are Corals?

Corals are colonial organisms composed by thousands of tiny animals (0.5 – 20 mm) similar to upside down jellyfishes, called polyps. Their "head" is in the bottom and it contains a stomach with an opening on the top, which functions as both mouth and exit, used for eating zooplankton and to clear away debris. Surrounding the opening there is a circle of tentacles that the polyp uses for hunting plankton, for self-defence and for waste products removal.

Within the same coral colony, all polyps are interconnected and genetically identical (clones). They are all descendants of the single polyp that funded the colony and then it reproduced itself sequentially through binary divisions (asexual reproduction). One night per year, all polyps of all corals in the same area also reproduce sexually by spawning eggs and sperms simultaneously in the water. From their fertilization, a tiny little larva called planula is generated. The planula lives in the water column for a few days/weeks and then it settles down on a solid substrate, such as a rock or a dead coral, where it metamorphoses into a new polyp, the founder of a new coral colony.

ANATOMY OF A CORAL POLYP



Polyps are among the very few animals that build the substrate on which they grow. In the specific case of hard corals, this substrate is made of calcium carbonate (limestone) that polyps produce combining the dissolved calcium ions with the dissolved carbonate ions, like all the other calcifying organisms. Most of the coral reef structure is made of limestone produced by hard corals. A great help in this building work is provided by a very special guest: some microscopic algae, called zooxanthellae, that live inside the body of the polyps. Polyps and zooxanthellae have a mutualistic relationship (endo-symbiosis) in which each receive important benefits from the other. The polyps transfer the algae inorganic nutrients such as nitrogen and phosphorus and provide them a safe place to live and to make photosynthesis, sheltered from their predators. The algae in return supply oxygen, carbohydrates, amino acids and fats produced by photosynthesis to the polyps, contributing to 60% of their overall nutritional requirements (the remaining 40% comes from eating plankton).

The photosynthetic activity of the zooxanthellae, and in particular the absorption of dissolved CO_2, greatly helps the polyps in building their limestone skeletons, facilitating the formation of calcium carbonate. Thanks to such help, reef-building corals can grow from 1 to 6 cm per year depending on the species.

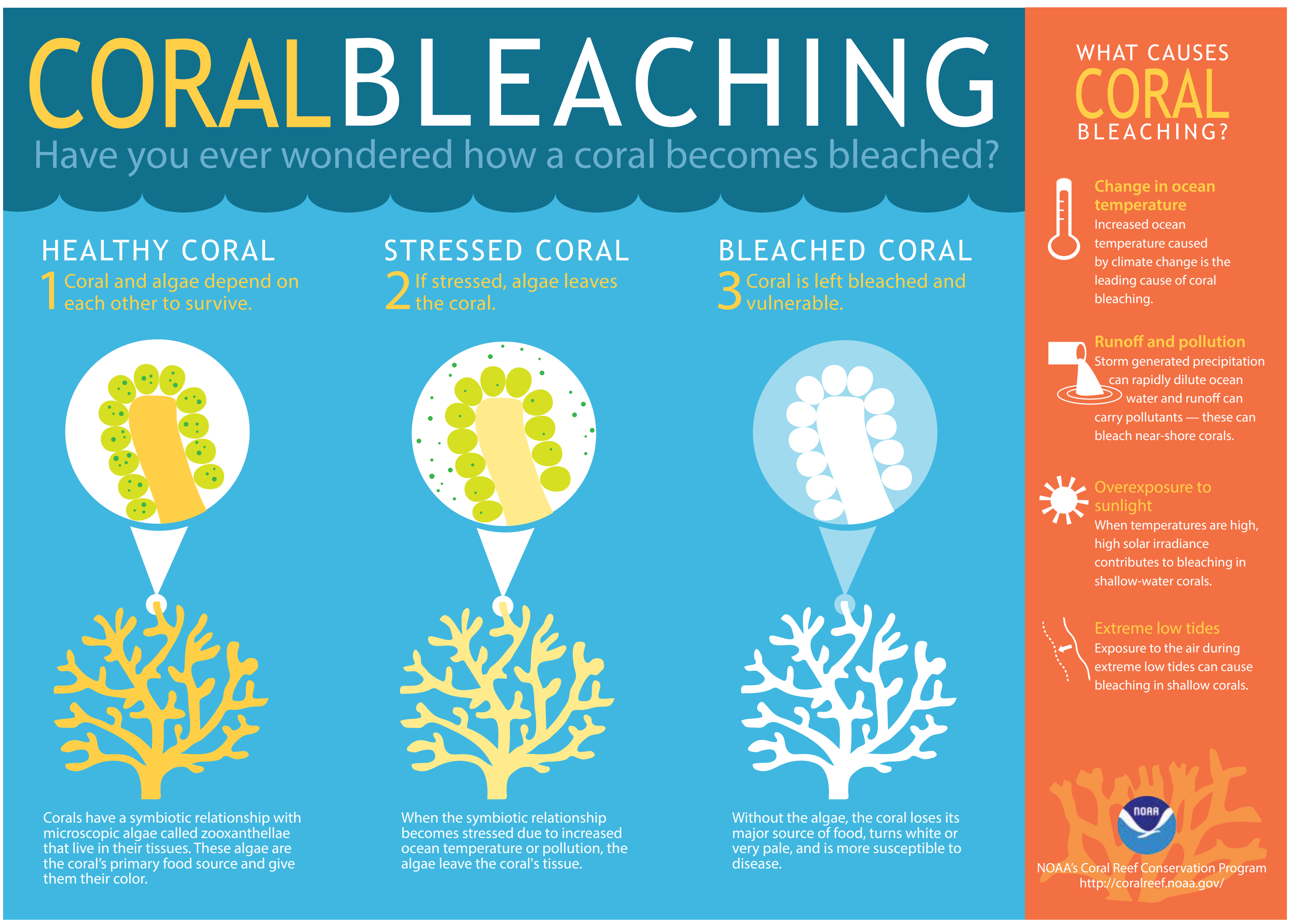
Moreover, the photosynthetic pigments of the zooxanthellae are responsible for the colours of the corals, as the polyps themselves are completely transparent. As discussed in the next paragraph, when the corals are affected by some environmental stressor, the polyps expel their zooxanthellae, in this way they lose their coloration so that the underneath skeleton, made of white limestone, becomes visible.

What Are Coral Reefs?

Coral reefs are made by a large variety of calcifying and non-calcifying organisms living together. As the name suggests, the main constituents of coral reefs are corals. Other important components are sponges, molluscs, coralline algae, worms, hydrozoans, bryozoans, foraminifera and further marine organisms. All these species have been growing together throughout hundreds of millions of years, and through their incessant deposition of layers of limestone they created colossal structures such as coralline islands, atolls and thousands of kilometres of fringing and barrier reefs.

Over 3,000 species of corals are currently known, and within each species there is a great variety of shapes and colours. Some of them can be easily confused with rocks, due to their globular shape and dull colours, so many unaware tourists often stand on them to take rest while swimming over the reefs, killing hundreds of polyps in one time. On the other hand, branching corals are extremely fragile, and they can be easily destroyed by just a mild touch, vanishing the construction work done by the coral colony throughout several decades. In many popular tourism destinations, masses of unaware tourists stepping all over the reef, in just few years led to the destruction of entire portions of coral reefs, which took hundreds of years to be formed.

Threats To Coral / Coral Bleaching



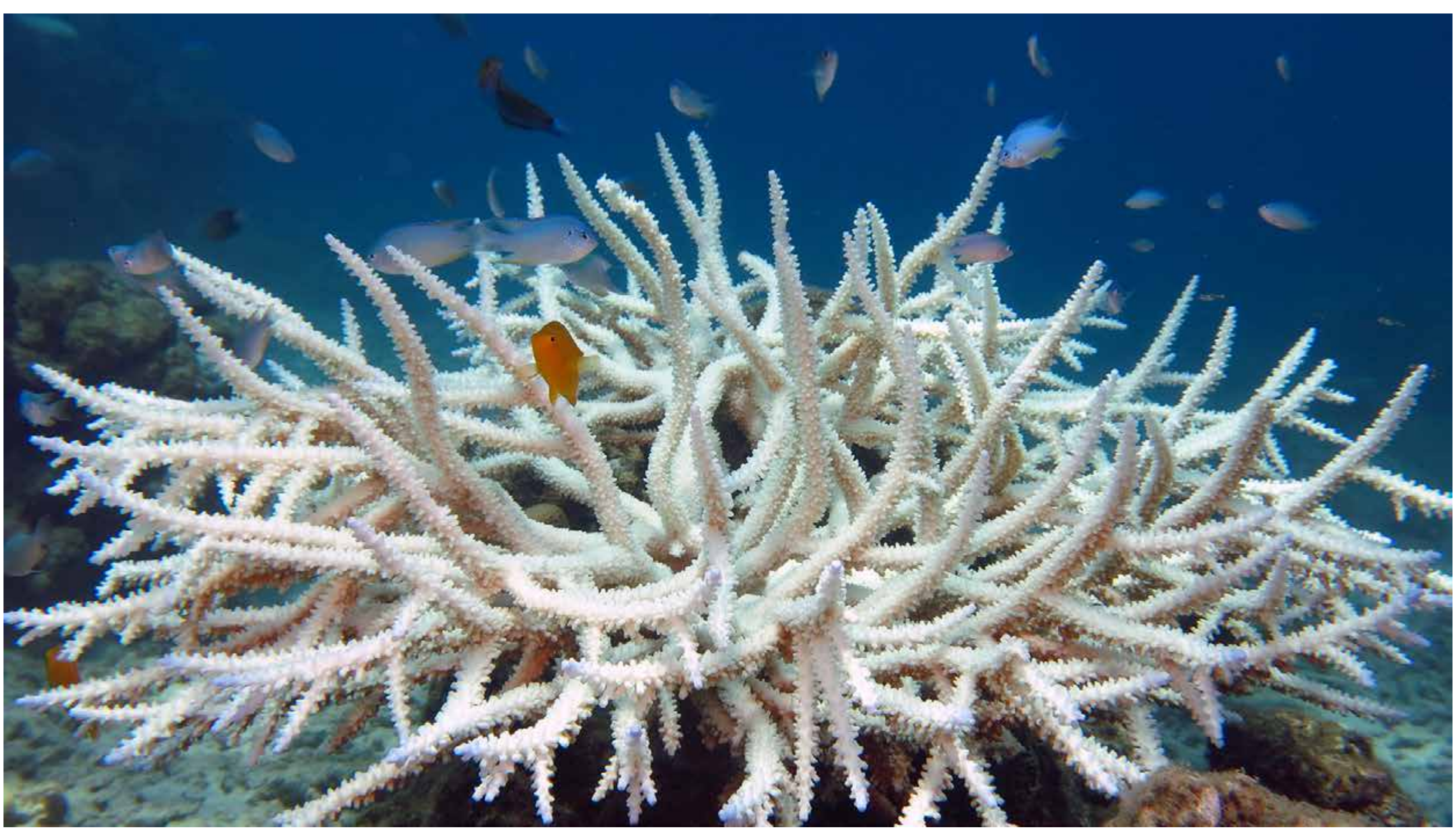
Coral reefs are among the most fragile ecosystems of the planet. Their state of health is greatly affected by both environmental and anthropogenic threats. Corals can live only within specific environmental conditions, and when these condition changes, corals suffer from different levels of stress. The main environmental stressors are:

- **Changes in temperature.**
- **Changes in light intensity.**
- **Changes in nutrients availability (too many or too few)**

- **Changes in water clearness (turbidity has a negative impact)**
- **Presence of human pollutants (micro-plastics, heavy metals, pesticides etc.)**
- **Acidification**

When corals are stressed, they expel the symbiotic algae from their tissues, losing their coloration. Since the polyps are completely transparent, it is then possible to see the white limestone skeleton beneath them. This response of the corals to environmental stress is therefore known as “coral bleaching”.

By losing the zooxanthellae, the corals lose their primary source of nutrients (60% of the total), so they have to rely only on the few nutrients obtained from the digestion of the plankton. This allows them to survive for a limited amount of time, from a couple of weeks to a couple of months depending on the species. If the environmental stressor regresses within this timeframe, the polyps accept back the zooxanthellae, recovering its original colour and its primary source of nutrients. If instead the stressor persists, the coral colony starves to death, and its living tissues are decomposed by microorganisms.



*Severe bleaching on branching coral (Bleached coral, Acoropora sp. by Vardhan Patankar, **Wikimedia Commons**)*

Anthropogenic (Human) Threats

Beyond the environmental stressors, which are indirectly caused by humans, other threats to coral reefs are directly caused by human activities, such as:

- **Water pollution** caused by industrial discharges, oil spills, animal farming discharges, agrochemicals runoffs, human sewage.
- **Land reclamation** is one of the most destructive practice performed especially on small islands, where coral reefs are literally buried under constructive materials to gain more dry space on land. Even the nearby reefs get severely affected and often suffocated by the amount of sediments stirred up by the dredging operations.
- **Overfishing.** Fishes are critical components of the reef ecosystem and their numeric reduction compromises the delicate balance of the whole food web of the reef.
- **Ghost nets** and other abandoned fishing gears entangle and suffocate corals, trapping and killing many other marine animals that live within the reef ecosystem, such as fishes, turtles, dolphins etc.
- **Destructive fishing** such as dynamite, cyanide and trawling nets fishing.
- **Collection of living species** for the aquarium market.
- **Coral mining** for construction material.
- **Unsustainable tourism** as mass of unaware tourists stand on corals, feed fishes, chase marine animals, pick up shells and other marine organisms for souvenirs, consume high amounts of seafood at restaurants etc. provoking the disappearance of entire reefs within just few years, as it happened in many popular tourist destinations.
- **Sunscreen residuals** as the majority of sunscreens are highly toxic to corals, except the ones based on titanium dioxide and non-nano zinc oxide,.
- **Plastic,** as plastic bags and other objects entangle corals suffocating them, while micro-plastics are ingested by the polyps, poisoning them.

The decline of coral reefs worldwide is well documented and mass bleaching events are becoming more frequent. Entire coastlines are polluted to the point of non recovery, leading to the imbalance of ocean food webs, the extinction of marine species and the increased occurrence of coral diseases, causing irreversible changes in reefs delicate ecosystems.

Progressive decay of a coral colony due to coral disease.

10.5 Seagrasses

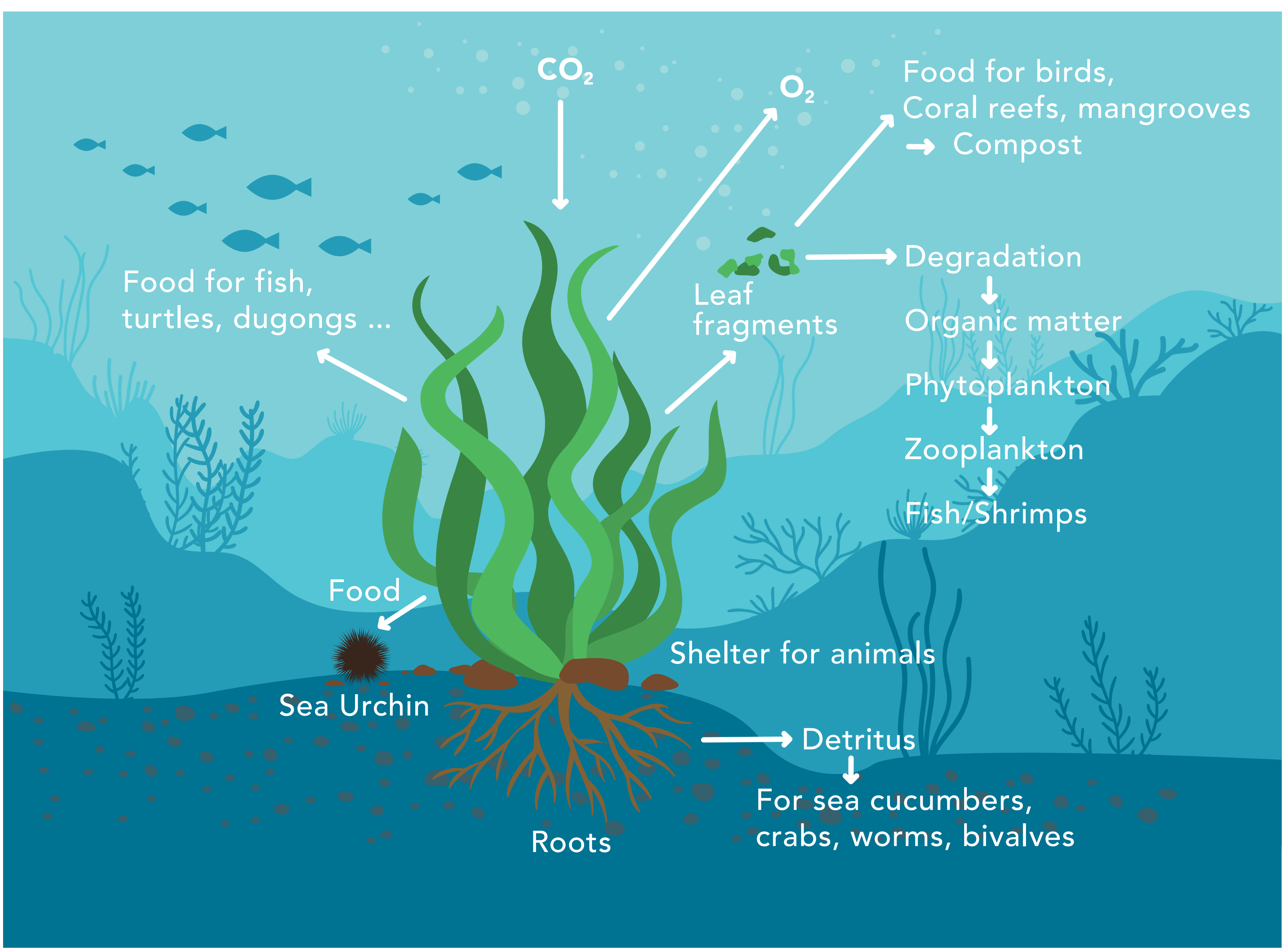
Seagrasses provides food, shelter and nursery grounds for many marine organisms such as fishes, molluscs, crustaceans, sea urchins and sea turtles. They filters nutrients and chemicals in the marine environment, producing oxygen and stabilising coastal sediment, helping to protect the coastline from erosion.

What Are Seagrasses?

Terrestrial plants, such as trees, vegetables and common grass, evolved from some primordial algae that colonized the dry lands hundreds of millions of years ago. Sea-grasses are instead the successive evolution of some terrestrial plants that, around 100 million years ago, adapted back to marine life. For such reason seagrasses have different biological and morphological features from the macro-algae (also known as see-weeds), and they are more similar to terrestrial plants: they have roots capable of absorbing nutrients, of propagating and of producing buds; their leaves can do photosynthesis but cannot absorb nutrients; they can reproduce sexually through pollination, producing flowers and seeds.

There are 72 known species of seagrass throughout the world's coastlines. Their leaves range in size from small paddles (1cm / 0.39in) to long blades (5m / 196in) and their complex root systems provide a strong anchorage to the seafloor.

SEAGRASS



The majority of seagrass species are fully submerged and live in shallow waters covering large areas, forming giant underwater meadows called seagrass beds. Some are intertidal and others can grow up to a depth of 40 m / 130 ft.

Seagrasses absorbs large amounts of CO_2 through photosynthesis and they transfer it into their roots where it can be stored for thousands of years. For this reason, similarly to coral reefs, seagrasses offer a valuable contribution in reducing the impact of greenhouse emissions and global warming.

Seagrasses filters the water, cleaning it and creating healthy ecosystems where many other marine species can thrive. Several species of fishes, crustaceans and other marine animals lay their eggs among seagrasses, so after hatching the larvae and juvenile individuals can find shelter from predators between their leaves. The presence of seagrasses is therefore important for ensuring replenishment of fish stocks and other marine animals by ensuring successful reproductive cycles.

Current Situation

Unfortunately, seagrass is one of the most rapidly declining ecosystems on earth. Coastal development, destructive fishing practices, anchor damage and sewage pollution have contributed to the progressive disappearance of many seagrass meadows.

Estimates suggest that 20-25% of seagrass has been lost in the last 50 years. The current rate of decline is 7% per year.

This loss causes the reduction in the absorption and storage of CO_2, a decline in fishing grounds, a decrease in water clarity and an increase in coastal erosion.

What You Can Do To Help Protect Seagrass And Corals

All general recommendations described in the environmental awareness chapters of the previous courses are very important, please be sure you are still familiar with them. Beyond them, behaviours that are critically important for the protection of corals and seagrasses include:

- **Do not touch, step, walk, kick or stir sediment with your fins on the seagrass and corals.**
- **Do not pollute or litter the ocean, discourage others from doing so.**
- **Use a reef safe sunscreen (titanium dioxide and non-nano zinc oxide only) and biodegradable soap (double check the ingredients as most brands contain harmful substances).**

- **Make a proper anchorage for boats: do not anchor on seagrass or coral reefs, try to find sand patches and designated areas (specified in marine charts).**
- **Encourage others to stop overharvesting marine life. Do not use destructive or illegal fishing practices and discourage others from engaging in these activities.**
- **Urge individuals to stop destroying habitats on land and in the ocean.**
- **Support the establishment of marine protected areas or marine sanctuaries.**
- **Advocate for and support coastal zoning initiatives, mapping and identification of seagrass beds and coral reef areas.**
- **Support marine conservation organisations.**

Simple Daily Actions To Help The Health Status Of The Ocean

The race to save the oceans is still in place, and we are all competing in it. Despite the most effective actions should be taken on a global scale, such as a global ban of single use plastics and a tax system applied to all environmental polluting activities, we as single individuals can still provide an important contribution to help winning the race. Simple actions you can do on a daily base include:

- **Reduce water pollution and runoff at home. Rinse your equipment either while you shower or in a bucket.**
- **Put your suit on in the water whenever it is possible, so to avoid the use**

of soaps.

- Use only biodegradable soaps and shampoos.
- Mindfulness of plastic use, follow the “Rs” rules: refuse, reduce, reuse and recycle.
- Use only coral reef friendly sunscreens (titanium dioxide or non-nano zinc oxide based)
- Avoid burning fuels as much as possible. Chose environmental friendly ways of transportation.
- Eat local and seasonal. Reduce the consumption of fish, meat and other animal-based products, chose plant-based alternatives.
- Choose brands that offer eco-friendly products or suggest to your favourite brand or sponsor to start making products that are environment friendly.
- Be a wise and responsible consumer. Maintain your gear in good condition to extend its lifespan, repair items before buying new ones, buy second hand ones and consider if a new item is a necessity or not. Consume less, consume better. All of these actions are going to help both your pocket and the environment.
- Choose ecotourism destinations, sustain environmental conservation project and promote the setup of Marine Protected Areas
- Promote the use of renewable energy sources, support political decisions that promote them.
- Make every dive a clean-up dive.

Be an ambassador of the ocean. The best way to make a difference in the ocean is for us to work together and to educate others. Be a role model and take responsibility on each of your everyday activities.

Chapter 10 Knowledge Review

Why does the oxygen we breathe come from the ocean?

What factors are contributing to global warming?

Why will animals with shells be affected by acidification of the ocean?

Why are the corals important for marine ecosystems?

What is the reason corals become white (a “white appearance”)?

Things you can do to help protect seagrass and corals.

AIDA MEDICAL STATEMENT (AIDA4)

IMPORTANT - PLEASE READ

Freediving is a strenuous activity carried out in the underwater environment, which may, under certain conditions, increase your risk of injury. This risk may be significantly increased if you have certain physical conditions. These same physical conditions would not necessarily be a safety factor in other strenuous activities or sports. AIDA therefore uses the following questionnaire to make you aware of these conditions. Failure to address these conditions prior to engaging in breath-hold diving activity may endanger your health, your safety and the safety of any person you may dive with in the future.

The purpose of this Medical Questionnaire is to find out if you should be examined by your doctor before participating in freedive training. A positive response to a question does not necessarily disqualify you from freediving. A positive response means that there is a pre-existing condition that may affect your safety while freediving and you **MUST** seek the advice of a physician prior to engaging in freedive activities. The physician needs to sign at the bottom of the form to say that he/she finds no medical conditions incompatible with freediving if any "**YES**" box is ticked.

Please answer the following questions on your past or present medical history by ticking the box marked **YES** or **NO**. If you are not sure, answer **YES**.

NAME OF FREEDIVER ______________________________

		YES	NO
1	**Medication:** Any medication taken on a regular basis either over-the-counter or prescribed by a physician? If yes, please specify		
2	**Mental and Mood Conditions:** Current or history of mental illness or mood disorder including, but not limited to schizophrenia, paranoid disorder, bouts of hysteria. If yes, please specify		
3	**Neurological Conditions:** Including, but not limited to any history of seizure disorder, stroke, brain surgery, repeated blackouts or fainting fits, severe migraine headaches, or aneurysm of the brain's blood vessels. If yes, please specify		
4	**Cardiovascular Conditions:** Including, but not limited to heart attack, heart surgery, irregular heartbeat, pacemaker, uncontrolled elevated blood pressure. If yes, please specify		
5	**Pulmonary Conditions:** Including, but not limited to asthma, history of spontaneous collapsed lung, collapsed lung due to injury, cysts or air pockets of the lungs, severe damage to lung tissue, emphysema, any lung problem which interferes with your ability to breathe. If yes, please specify		
6	**Ear, nose and throat Conditions:** Including, but not limited to tumor, polyps, or cyst of the sinus cavities or nasal passages, major sinus surgery, persistent sinus infection, permanent holes of the eardrums, history of ruptured eardrum, permanent tubes in ear-drums, severely impaired hearing or hearing loss in one or both ears, major ear surgery. If yes, please specify		
7	**Eye Condition:** Including, but not limited to severe myopia, retinal detachment, eye surgery. If yes, please specify		
8	**Diabetes Mellitus:** Type I Diabetes (Insulin dependent) or Type II Diabetes, which requires Insulin or oral medication for control. Any form of Diabetes that is unstable, "brittle" or produces episodes of hypoglycemia (low blood sugar reactions), hyperglycemia (extremely high blood sugar with ketosis) or if there is related kidney disease, eye disease, heart disease or blood vessel disease. If yes, please specify		

9	**Freediving/Scuba Diving History:** Including, but not limited to previous history of a diving accident, severe blackout, decompression sickness, decompression of the inner ear of air, reverse block, lung squeeze, any lung squeeze producing pink foam, pulmonary bleeding If yes, please specify		
10	**General Medical Problems:** Any physical and/or emotional condition not mentioned that might affect your safety in an underwater environment or affect your judgment under times of physical or emotional stress. If yes, please specify		
11	**Pregnancy:** If you are presently pregnant.		

I certify that I have answered the above questions accurately and honestly.
I am responsible for omission regarding my failure to disclose any current or past health condition.

Name of Participant:

Signature of Participant:

Date of Birth*:

Date of Signing:

***To enrol in the AIDA4 Master Freediver Course, the participant must be at least 18 years of age.

Physician to complete (If any "YES" box from page 1 was ticked)

☐ I find no medical conditions that I consider incompatible with freediving

☐ I am unable to recommend this individual for freediving

Name of Participant:

Physician´s Name:

Physician´s Signature:

Date:

Physician´s phone number:

Physician´s Stamp or Postal Address:

My signature on the above verifies that I have completely reviewed this applicant´s Medical Statement and find no counter-indications for freediving.

AIDA LIABILITY AND ASSUMPTION OF RISK (AIDA4)

TO AIDA INTERNATIONAL AND AIDA INSTRUCTOR

I ______________________________ hereby declare that I am aware that freediving has inherent risks, which may result in serious injury or death. I still choose to participate in the freediving activities with ______________________________.

I understand and agree that neither my instructor ______________________________ nor AIDA International, nor any of their respective employees, officers, agents, contractors or assigns (herein after referred to as the "Released Parties") may be held liable or responsible in any way for any injury, death or other damages to me, my family, estate, heirs or assigns that may occur as a result of my participation in freediving activity with AIDA International or as a result of the negligence of any party, including the Released Parties whether passive or active.

In consideration of AIDA International allowing me to participate in the freediving activity, I hereby personally assume all risks of the experience, whether foreseen or unforeseen, that may befall me while I am freediving with ______________________________.

I declare that I am in good mental and physical fitness for freediving and that I am not under the infleuence of alcohol, nor am I under the influence of any drugs that are contraindicatory to freediving. I declare that if requested as a result of completion of the AIDA Medical Statement, I have seen a physician and have approval to freedive.

I further declare that I am of lawful age and legally competent to sign this liability release. I understand the terms herein are contractual and not a mere recital, and that I have signed this document of my own free act and with the knowledge that I hereby agree to waive my legal rights. I further agree that if any provision of this Agreement is found to be unenforceable or invalid that provision shall be severed from this Agreement. The remainder of this Agreement will then be construed as though the unenforceable provision had never been contained therein.

Date of signing: ______________________________

Signature of participant*: ______________________________

***To enrol in the AIDA4 Master Freediver Course, the participant must be at least 18 years of age.

CREDITS

Responsible for AIDA International

Brian Crossland

Lead Author

Oli Christen

Medical Advice

Irina Zelenkova

Layout

Sun Choi

Contributing Authors (Chapter)

Agata Bogusz (3, 4, 5)
Brian Crossland (6)
John Folkvord (3, 4)
Robert King (7, 8)
Stefan Randig (3, 4)
Timothy Oehmigen (3, 4)
Diana Garcia Benito (10)
Giovanni d'Erasmo (10)
Luke Webster (10)
Nanna Kreutzmann (10)

Editors (Chapter)

Agata Bogusz (6, 7, 9)
Alexandra Schaef (7, 9)
Brian Crossland (7, 8, 9)
Felice Mastroleo (4, 5, 7)
Irina Zelenkova (7)
Oli Christen (3, 4, 5, 7, 8)
Robert King (5)
Sun Choi (3, 4, 5, 7, 9)

Proof-reading

Agata Bogusz
Alexandra Schaef
Brian Crossland
Felice Mastroleo
Oli Christen
Sun Choi

Other contributors

Jean-Pol François
Mj Kuhn
Rémy Dubern
Wendy Timmermans
David Watson (10)
Louisa Collyns (10)

Photographs

Agata Bogusz	Fig 6.5, 7.9
Andrew Critchley	Ch 2, 9 cover, Fig 3.11, 5.8, 6.2, 6.3, 6.9, 8.1, 8.3, 9.6
Brian Crossland	Ch 1 cover, Fig 7.8
Catherin Crossland	Ch 5 cover
Daan Verhoeven	Ch 10 cover

Felice Mastroleo	Fig 6.6 (right), 6.8
Hyunho Seong	Fig 2.2-2.13
Jaegon Kim	Fig 6.11
Jerome Hulin	Fig 7.5-7.10
Kyeongjin Yong	Main cover
Markus Dirschl	Ch 6 cover, Fig 5.6
Su Yeol Lee	Ch 3, 4 cover, Fig 3.1-3.4, 4.4-4.7, 6.4
Sun Choi	Fig 3.5-3.7, 5.7, 6.1, 6.4, 6.6 (left), 6.7, 6.10, 9.1-9.5
Pixabay - ID 2719743	Ch 7 cover
Pixabay - ID FotoshopTofs	Ch 8 cover
Livio Fakeye	Page 110, 117 (bottom), 121
Nanna Kreutzmann	Page 102, 113, 117 (top), 120
Vardhan Patankar	Page 115

Illustrations

Sun Choi	Fig 2.1, 3.5-3.8, 3.10, 4.1-4.3, 5.1-5.5, 7.1-7.4, 8.2, 8.4 8.5, 2.14 (with Rémy Dubern), 3.9 (with John Folkvord) 7.3 (with Agata Bogusz)
Carmen Tromballa	Page 103, 104, 107, 112, 118
Sea-Bird	Page 108
NOAA	Page 114

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