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FREEDIVING EDUCATION

Beginner Freediving

manual

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TRIBUTE TO NATALIA MOLCHANOVA

The aspiration of Natalia Molchanova was always to strive for safe and efficient freediving, achieving this through the provision of education, training, and premium freediving equipment trusted by top athletes. Everything we create now is based on this philosophy and strategy. We use the latest developments in education, technology, and scientific research when cultivating our own education system and freediving equipment.

We are inspired and honored to have had Natalia as our founder. Without her, the Molchanovs Movement would not exist today.

ABOUT NATALIA MOLCHANOVA

Natalia was a freediving world champion and held 42 world records. She remains the most titled freediver in the world, achieving world records in all freediving disciplines. She won a total of 22 individual gold medals and two team gold medals at freediving world championship events during her career. On September 25th, 2009, she became the first woman to surpass 100m (328ft) of depth on a breath-hold in Constant Weight with a freedive to 101m (331ft).

Natalia was the president of the Russian Freediving Federation. She designed and established the educational program of the federation from beginner- to elite freediver-level. Natalia shared her passion and knowledge of freediving through her courses and with her university students in Moscow. Today, thousands of freedivers have been trained by the Russian Freediving Federation and several hundred instructors share the knowledge of Natalia with a new generation of freedivers. In 2015, the presidency was passed on to her son, Alexey Molchanov, who is also a freediving world champion and multiple national and world record holder.

Natalia led research in freediver physiology and was interested in relaxation techniques and improving freediving performance and safety. She is the author of many articles, books, and educational materials on freediving, and much of her work has been translated from Russian into English. Her love and passion for the sea is also reflected in poems she wrote and a short artistic movie she created, for which she received several festival awards.

The life of Natalia was centered around freediving. She once said, 'Freediving is not only a sport, it is a way to understand who we are.'

MOLCHANOVS MOVEMENT

Natalia and her son, Alexey Molchanov, founded the Molchanovs brand in 2010 with a focus on developing freediving equipment and a new education system.

The Molchanovs Movement as it is today was formally launched in 2018. Molchanovs took the education and training system of Natalia, added the expertise of a group of top freedivers (including Alexey Molchanov) and freediving trainers in the world, and launched the Molchanovs Movement in August 2018. The Molchanovs Movement covers education, training, and shared freediving experiences. The principal aim is to help freedivers learn and train like an elite free-diver under the expert instruction of Molchanovs instructors and with the support of the global freediving Molchanovs community.

Molchanovs also recognizes that recreational freedivers and world champions alike require ergonomic and highly efficient equipment to allow them to dive comfortably and let them continuously rediscover their limits in a safe manner. Therefore, the other aim of Molchanovs is to continue to develop and provide the highest quality of equipment to the freediving community.

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FOREWORD

It was in 2018 that Alexey Molchanov, Adam Stern, and I were sitting in a coffee shop in Bali, worrying about the state of the freediving world.

It seemed inevitable that freediving was going to end up as a de facto subspecialty of scuba diving. The big scuba education organizations were moving into freediving with their fat marketing budgets, slick ads, and huge dive center networks, and their advance seemed unstoppable. The purer freediving systems seemed outgunned by the big fishes that had unceremoniously entered our small corner of the ocean.

We talked about what the freediving world was missing and how a system that tied together first-rate education, community training, and shared experiences was the future of freediving. As the conversation went on into the night, we became increasingly excited and convinced that now was the time to create a new system and a new community, by freedivers for freedivers. That conversation became the seed of the Molchanovs Movement.

We are a freediving community dedicated to education, training, and experiences that not only make better, stronger, and safer freedivers, but most importantly, instill a love for this life-changing sport and bring more and more people into the freediving lifestyle. Based on the freediving principles taught by one of the greatest freedivers in history, Natalia Molchanova, and re-envisioned by the Molchanovs team, the Molchanovs mission is to build global and local freediving communities that stoke the passion for freediving.

Thank you for joining our freediving movement and we hope that the Molchanovs Movement will be a part of your freediving journey. Welcome!

Chris Kim
Molchanovs Founding CEO

MOLCHANOVS FREEDIVING EDUCATION

Molchanovs Freediving Education can take you from learning the basics of freediving to becoming an elite competition freediver. There are four open water course levels, each of which is known as a Wave course. All levels are also available as Lap courses, which cover the same theory and pool requirements as the corresponding Wave course but do not include open water sessions. Therefore, a Lap certification only certifies you to freedive in a pool — it does not certify you to freedive to depth in open water.

Additionally, there are online Theory courses you can take if you do not currently have access to water. At a later date, you can easily convert a Theory certification to Lap certification by adding the pool sessions. To convert to the corresponding Wave certification, you only need to add the open water sessions. Ask your Molchanovs instructor if you would like to do this.

Your learning for each Lap/Wave course starts with our online course, which features content from some of the top freedivers in the world, including World Champion Alexey Molchanov. Qualified Molchanovs instructors then take you through this learning and help you develop your understanding and practical skills.

Once you have completed an Online (T), Lap (L), or Wave (W) course, you can continue your training and track your progress in the Molchanovs Dashboard Base Training program. This is a global freediving community founded on the philosophy and strategies of Natalia Molchanova and is a place to share your knowledge, skills, and experiences with other freedivers. Training programs for freedivers of all levels are published weekly to help you progress through your learning and develop your freediving skills.

LAP/WAVE 1 — BEGINNER FREEDIVING

In this beginner course, you learn the basics of freediving and discover your natural freediving ability. You are taught techniques to hold your breath beyond one minute and a half. Topics include the physics and physiology of freediving, an introduction to freediving equalization, relaxation, and breathing techniques, an introduction to no-fins technique, and rescue and safety procedures. If you are taking the Lap 1 course, you are taught to freedive a distance of 30m (98ft) horizontally in the pool. If you are taking the Wave 1 course, you are also taught to freedive to a depth of 12–20m (40–66ft) in open water.

LAP/WAVE 2 — ADVANCED FREEDIVING

In this advanced course, you learn how to train your body for freediving and how to hold your breath for more than two and a half minutes. Topics include pre-dive optimization, improvement of Frenzel equalization, and an introduction to monofin technique. If you are taking the Lap 2 course, you are taught to freedive a distance of 50m (164ft) with fins and 35m (115ft) without fins horizontally in the pool. If you are taking the Wave 2 course, you master the skills and knowledge needed to freedive comfortably to a depth of 24–30m (79–99ft) in open water.

LAP/WAVE 3 — MASTER FREEDIVING

In this master course, you learn how to equalize below your residual volume to achieve greater depth performances and how to hold your breath for over three and a half minutes. Topics include advanced relaxation techniques, such as attention deconcentration, and an introduction to mouthfill equalization. If you are taking the Lap 3 course, you are taught to freedive a distance of 75m (246ft) with fins and 50m (164ft) without fins horizontally in the pool. If you are taking the Wave 3 course, you are taught how to train to freedive comfortably to a depth of 34–40m (112–131ft) in open water.

Following the completion of Lap/Wave 3, you are permitted to act as an assistant instructor in Molchanovs Lap and Wave courses (conditions apply) and you may also participate in a **Molchanovs Instructor Course**. Please speak to your Molchanovs instructor for further information.

LAP/WAVE 4 — COMPETITIVE FREEDIVING

This unique course teaches you the skills and finesse required for competitive freediving. Topics include mastering mouthfill, handling pre-competition jitters, and competitive training methodologies. If you are taking the Lap 4 course, you are taught to freedive a distance of 100m (328ft) with fins and 75m (246ft) without fins horizontally in the pool. If you are taking the Wave 4 course, you learn how to master your body to freedive to depths of 50m (164ft) and beyond in open water.

PURPOSE OF DOCUMENT

This manual is aimed at the beginner freediver. It is divided into a number of chapters, each of which introduces key topics about freediving. Each chapter is self-standing, although we do recommend that you work your way through the manual. Take notes as you go and ask your Molchanovs instructor to answer any queries you may have. A glossary of general terms used in freediving is provided at the end of the document. Glossary terms are highlighted in gold for reference.

INTRODUCTION

“Freediving is about feelings, whether it is the euphoria that comes from weightlessness or our amazement at the beauty of the underwater world. We freedive for the moments of joy, which come from a deeper understanding of our thoughts and experiences. We freedive for the pleasure of solitude, where inner peace and awareness calm our racing minds. Freediving offers us happiness from nothing more than a single breath of air.”

Natalia Molchanova

1.1 What is Freediving?

Freediving, also called apnea, is the practice of **holding your breath when diving underwater without the use of breathing equipment**. It is undertaken for a variety of reasons: to become more physically and emotionally aware of your body, to be free from heavy scuba equipment, as a way to take underwater photos, to catch food, or to compete professionally. Freediving is a **safe** and increasingly popular activity. To some, it always remains recreational, to others, it becomes a way of life. Freediving is developing in four main areas.

GENERAL HEALTH AND FITNESS

Freediving is accessible to anyone with good health and fitness. Regular and focused freediving improves your physical fitness and mental well-being through **anaerobic exercise**. Anaerobic exercise generally promotes strength, power, and fitness while building lean muscle mass and physical endurance.

Light hypoxic training, where oxygen availability in your body is limited by using specific training techniques, is known to have a positive effect on your **physiological systems**. Freediving can also improve your **mental health** by increasing your ability to consciously relax, manage stress, focus and concentrate, and become more mindful and self-aware.

RECREATIONAL FREEDIVING

Recreational freediving remains a **leisure activity** aimed purely at seeking pleasure from a dive and is **non-competitive**. You can learn and develop new techniques to freedive underwater while also enhancing your physical, psychological, and emotional state. Training can cover general diet and fitness, techniques such as the breath-hold, as well as relaxation exercises. Recreational freediving, either in a pool or in open water, can help to reset your mind, allow you to feel renewed, and help you to find harmony with nature and your inner calm.

APPLIED FREEDIVING

Applied freediving signifies the more advanced skills and techniques used by freedivers to **support their daily underwater activities** such as hunting for seafood, exploring the underwater world, providing assistance as part of rescue training, or undertaking scientific research with giant manta rays. Freediving as part of daily life has been undertaken all over the world for **thousands of years**. The female Ama divers in Japan hunt for seafood and pearls while the Bajau people, indigenous to Indonesia, Malaysia, and the Philippines, live at sea and spearfish. Freediving is their life and their existence.

COMPETITIVE FREEDIVING

Competitive freediving focuses on the specific skill development of a freediver for competition and record attempts. There are different disciplines for pool and open water freediving, including static apnea (breath-hold without moving), dynamic apnea (diving to distance on a breath-hold), and various forms of depth diving. Freedivers perform these disciplines while competing against others to **achieve personal bests** and **break records**. There are different rules and equipment for each discipline. Reaching the top of the competitive freediving community requires total

commitment as a **professional athlete** to physical fitness and skills development as well as mental training, diet, and rest. Competition freedivers have a strong social community where experiences, skills, and knowledge are shared regularly.

1.2 Lap/Wave 1 — Beginner Freediving

The Lap/Wave 1 — Beginner Freediving course is intended to help you discover the underwater world while holding your breath through a fun and relaxed experience with a strong focus on safety. As a beginner freediver, you will be able to explore the underwater world comfortably. You will learn how to practice freediving safely, what happens inside your body during a breath-hold, how to dive more efficiently, and how to mentally prepare yourself before a freedive. By the end of the course, you will understand breath-holding technique and experience distance disciplines in the pool, both with and without fins, focusing on technique and efficiency. If you are taking the Wave 1 course, you will also learn how to dive safely and comfortably between 12–20m (39–66ft), both by pulling on a rope and using fins to descend to depth. Additionally, you will be taught how to provide safety for your freediving buddy and practice rescue techniques in all disciplines.

This course emphasizes:

- Understanding the human body's adaptations that make freediving possible.
- Correct freedive preparation, pre-dive breathing, and recovery breathing.
- Safe freediving procedures, practices, and rescue techniques.
- Using the Frenzel maneuver to equalize compressible air spaces underwater.
- The use of basic freediving equipment.
- The importance of training to further improve your freediving skills.

1.3 Lap/Wave 1 Course Structure

The Lap/Wave 1 course consists of four elements:

KNOWLEDGE DEVELOPMENT

Knowledge development covers the following:

- An **online course or classroom sessions** presenting videos to guide you through the main topics and a summary of key points.
- A **course manual** providing further information and detail on all topics. This supports the online course or classroom sessions provided by your instructor.
- A **knowledge review** with your Molchanovs instructor.
- An **online exam** consisting of 30 questions to review and test the knowledge you have acquired during the course. In places without sufficient internet connection, a pen and paper exam can be conducted as well (ask your instructor if this is the case). Your instructor will review all the incorrect exam answers with you.

DRY SKILLS SESSIONS(S) (FOR ALL CERTIFICATIONS)

During dry skills session(s), your Molchanovs instructor introduces you to appropriate **relaxation and breathing techniques** as well as additional exercises to help you improve these techniques further. You also learn a number of **basic equalization techniques** and the differences between each.

POOL (CONFINED WATER) SESSIONS (FOR LAP/WAVE 1 CERTIFICATION)

Your Molchanovs instructor conducts a minimum of **3 hours** of pool (confined water) training during which you learn the basic skills of freediving including static breath-holding (**Static**) and diving to distance with (**Dynamic with Bifins**) and without fins (**Dynamic No Fins**). For both disciplines, you also learn how to take care of a freediver (i.e., **buddying**) and how to perform an appropriate **rescue** for a buddy who is experiencing difficulties.

OPEN WATER SESSIONS (FOR WAVE 1 CERTIFICATION)

You apply what you have learned in the dry and pool sessions during **4.5 hours** of open water training. Your Molchanovs instructor introduces you to and helps you develop basic skills such as **equalization, duck diving, correct head and body posture**, and appropriate **finning technique**. This allows you to perform comfortable dives to depth.

Your Molchanovs instructor also introduces you to a number of freediving disciplines, i.e., diving to depth by pulling yourself along a line (**Free Immersion**), or diving to depth using only your fins (**Constant Weight with Bifins**). Procedures for buddying, safety, and rescue are an important part of this learning.

1.4 Lap/Wave 1 Course Structure

To pass the Lap/Wave 1 course, you should successfully complete the following:

- **Self-Study or Classroom Sessions:** Take the online course by viewing the videos and understanding the key points. Go through any queries or areas which require explanation with your Molchanovs instructor.
- **Online Exam:** Take the online exam and answer 80% of the questions correctly.
- **Skills Demonstration:** Demonstrate the practical skills required for the Lap/Wave 1 course.

To note:

- For **Online T1 certification**, you need to pass the exam, learn and master the dry skills, and pass the static performance requirements (on dry land).
- For **Lap 1 certification**, you need to additionally master all water-based skills in the pool (or confined water).

- For **Wave 1 certification**, all additional open water skills and performance requirements need to be completed successfully.
- Skills which can be performed with a monofin should be first completed with bifins. Once performance requirements have been met, a monofin can be used.
- All skills in open water are first performed with a mask, including Free Immersion. After having passed the requirements with a mask, a nose clip can be used. The exception to requiring a mask are no-fins and monofin skills where the use of a nose clip is permitted.

See overleaf for skills demonstration requirements for pool and open water.

Table 1. Lap/Wave 1 Skills Demonstration Requirements

	TYPE	REQUIREMENT	EXPLANATION
T - CERTIFICATION	PRE-REQUISITES	Medical Statement completed and signed	Complete and sign the medical statement.
		Liability Release completed and signed	Complete and sign the liability release.
	DRY	Lap/Wave 1 Theory	Understand all theory concepts presented in the Lap/Wave 1 course.
		Lap/Wave 1 Exam passed	Pass the Lap/Wave 1 exam with a score of 80% or higher.
		Relaxation Technique: Body Scan	Perform all steps of the body scan correctly.
		Optional: Three Chest Breaths	Understand how to make a controlled chest breath.
		One Full Breath	Perform all the steps of a full breath correctly.
		Recovery Breathing	Perform all the steps of the recovery breathing technique correctly.
		Introduction to Frenzel	Perform Frenzel maneuver on dry.
		Visualization	Understand how to perform visualization in preparation for a freedive.
		Introduction to Base Training	Understand the different types of training, the different zones of training, and how to access Molchanovs Base Training workouts.
	POOL OR DRY SKILLS PERFORMANCE	STA 1'30"	Complete a breath-hold for a minimum of 1 minute 30 seconds while lying face-down and stationary in the water at the surface.
L - CERTIFICATION	PRE-REQUISITES	200m swimming non-stop	Complete a non-stop 200m swim.
	POOL PERFORMANCE	DYNB 30m (98ft)	Perform a 30m horizontal swim with bifins with good technique.
	POOL SKILLS	STA Buddying	Perform correct buddying technique for a static breath-hold at the surface of the water.

	TYPE	REQUIREMENT	EXPLANATION
L - CERTIFICATION	POOL SKILLS	STA Rescue	Perform all the correct steps to rescue a buddy completing a static breath-hold at the surface of the water.
		DYNB Posture and Head Position	Perform correct posture and head position during a horizontal swim.
		DYNB Finning Technique	Perform correct finning technique during a horizontal swim.
		DYNB Turn	Perform a correct turn during a horizontal swim with bifins.
		Dynamic Disciplines Buddying	Perform correct buddying technique for a horizontal swim.
		Dynamic Disciplines Rescue	Perform all the correct steps to rescue a buddy completing a horizontal swim.
		Introduction to DNF	Understand the DNF technique.
W - CERTIFICATION	OPEN WATER PERFORMANCE	CWTB 12–20m (39–66ft)	Comfortably complete freedives to 12–20m depth with same weight for descent and ascent with good technique using bifins. Optionally with monofin after, once performance requirements have been met.
		FIM 12–20m (39–66ft)	Comfortably complete freedives to 12–20m depth by pulling down and back up a dive line, with same weight for descent and ascent. Fins worn for safety reasons.
		CWTB Buddying 6–10m (20–33ft)	Perform the correct buddying technique from a depth of 6–10m.
		CWTB Rescue 6–10m (20–33ft)	Perform all the correct steps to rescue a buddy from a depth of 6–10m.
	OPEN WATER SKILLS	Relaxation Position	Correctly perform the relaxation position.
		Surface Exhale Test	Correctly perform a surface exhale test.
		EQ: Valsalva or Frenzel	Correctly perform either the Valsalva or Frenzel maneuver.
		FIM Basics	Correctly perform the techniques required for a FIM freedive.
		Duck Dive Technique	Perform the correct technique for a duck dive.
		CWTB Body Position	Perform the correct body position while completing a CWTB freedive.
		CWTB Line Orientation	Perform correct orientation to the dive line while completing a CWTB freedive.
		CWTB Finning Technique	Perform correct finning technique while completing a CWTB freedive.
		CWTB Forward TumbleTurn	Perform a correct forward tumble turn while completing a CWTB freedive.
		Use of Freediving Lanyard	Demonstrate how to correctly use a freediving lanyard.

STA	Static	A breath-hold performed face-down and stationary at the surface.
DYN	Dynamic with Fins	Horizontal swim underwater. Bifins or monofin.
DYNB	Dynamic with classic Bifins	Horizontal swim underwater. Bifins. No monofin kick.
DNF	Dynamic No Fins	Horizontal swim underwater. No fins.
CWT	Constant Weight	Freedive to depth. Same weight for descent/ascent. Bifins or monofin.
CWTB	Constant Weight Bifins	Freedive to depth. Same weight for descent/ascent. Bifins. No monofin kick.
CNF	Constant Weight No Fins	Freedive to depth. Same weight for descent/ascent. No fins.
FIM	Free Immersion	Freedive to depth pulling down/up a line. Same weight for descent/ascent. Fins on for safety.

PHYSICS

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Freediving is not only a sport; it is a way to understand who you are.

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Natalia Molchanova

This chapter explains the physics of water pressure and buoyancy and how they affect you when freediving. Your physiological state is also described. Understanding these key principles allows you to make safe choices while freediving and feel at ease underwater.

2.1 Pressure and Boyle's Law

It is important to understand how pressure affects you during a freedive. The atmosphere above you has a weight equivalent to approximately 10m (33ft) of water, and as you descend underwater, the pressure above you increases. This is both atmospheric pressure and the pressure of the water above you.

Therefore, the ambient pressure (i.e., surrounding pressure) is the sum of atmospheric pressure and water pressure. This is measured in atmospheres (atm) or bar.

- Atmospheric pressure (atm) is the weight of atmospheric air and is 1 bar (or 1 atm) at sea level.
- Water pressure, also known as hydrostatic pressure, is the weight of the water column above your body. It increases by 1 bar every 10m (33ft) of depth.

Therefore, at **10m (33ft) of depth**, the total ambient pressure exerted on your body is:

1 bar (atmospheric pressure) + 1 bar (water pressure) = **2 bar**

With this, you experience a total ambient pressure of 3 bar at 20m (66ft), 4 bar at 30m (99ft), and so on.

BOYLE'S LAW

Most of your body tissues consist mainly of water, making them non-compressible. This means your body is largely unaffected by the change in ambient pressure as you dive to depth. However, **gas is compressible**, so freediving affects enclosed air spaces in your body. During a freedive, the air in these cavities is affected by changing ambient pressure. This is why, as you descend, you feel pressure in your ears (specifically your middle ears) as ambient pressure is exerted on your body. Aside from your ears, air is also enclosed in other non-compressible spaces, such as your sinuses and the space between your face and the front of your mask. Your lungs are also filled with air; however, you do not need to equalize them as they are compressible.

Boyle's Law explains how the volume of a gas in these air spaces varies with the surrounding pressure. It states:

'At a fixed temperature, the volume of a gas is inversely proportional to the pressure exerted by the gas.'

Depth (m/ft)	Pressure (ATM/Bar)	Gas Volume	Lung Volume (L)	
0m (0ft)	1	1	6L	Average adult male total lung capacity (TLC) is 6 litres
10m (33ft)	2	1/2	3L	
20m (66ft)	3	1/3	2L	
30m (99ft)	4	1/4	1.5L	
40m (131ft)	5	1/5	1.2L	Average adult residual volume is approx. 20% of TLC

Figure 1. Boyle's Law

As pressure increases at depth, the volume of the gas decreases proportionately:

- If you take a balloon to **10m (33ft)**, the total ambient pressure is 2 bar. Therefore, the balloon would be **one-half (1/2)** of its original size.
- If you take a balloon to **20m (66ft)**, the total ambient pressure is 3 bar. Therefore, the balloon would be **one-third (1/3)** of its original size.
- If you take a balloon to **30m (99ft)**, the total ambient pressure is 4 bar. Therefore, the balloon would be **one-quarter (1/4)** of its original size.
- And so on.

IMPACT ON YOUR EARS, NASAL CAVITIES, AND SINUSES

The cavity of your middle ear is an air-filled space. As you descend, **increasing ambient pressure** causes this air to compress and your eardrum to bend inward toward your middle ear. You use an equalization technique at depth to overcome this. Should you continue your descent without equalizing, the increasing pressure causes your eardrums to bend further inwards and cause pain or injury. Failing to equalize can result in ear barotrauma (i.e., a rupture of your eardrum). Therefore, you must equalize **carefully and regularly**, ideally before you feel pressure in your ears. Pain indicates that it is too late to equalize; if you feel pain in your ears, **stop your descent immediately and return to the surface**.

Your sinuses and nasal cavities are almost incompressible, so the enclosed volume of air does not change during descent. When equalizing pressure in your ears, the pressure in these connected air spaces is equalized automatically. The pressure in these air spaces typically **decreases automatically on ascent**, so there is no need to equalize.

IMPACT ON YOUR MASK

The air space between your mask and your face also requires equalization. As ambient pressure increases with depth, your **mask presses increasingly tighter**, creating a sucking effect on your face and eyes. To counter this and equalize the pressure, exhale a small amount of air through your nose and into your mask as you descend. Equalize the pressure in your diving mask **regularly** during your descent. Otherwise, this can lead to red eyes and damaged blood vessels. The pressure in your diving mask decreases automatically on ascent, so there is no need to equalize.

A soft mask with a **nose pocket** and **low internal volume** is often used for freediving. The flexibility of a soft mask makes it a little more forgiving as to when you should equalize pressure. Note that swimming goggles and masks without a nose pocket should not be used for dives deeper than **1.5m (5ft)** to prevent eye injury. This is because you are unable to exhale air into these air spaces to equalize the pressure.

IMPACT ON YOUR LUNGS AND GASTROINTESTINAL TRACT

The lungs are the largest air-filled spaces in the human body. You **do not need to equalize your lungs** as they are compressible. However, the volume of gas in your body, specifically in your lungs, significantly affects your buoyancy in the water and can determine whether you sink or float. This is detailed further in Section 2.2 Buoyancy and Archimedes' Principle.

The compressibility of your lungs is limited by the **elasticity of your diaphragm** and the **mobility of your ribs**. On descent, the volume of air in your lungs decreases to its residual volume. Residual volume (RV) is the volume of air in your lungs after a maximum exhalation and is approximately 25% of the total lung capacity (TLC) for the average person. The percentage of the RV to TLC tends to gradually increase with age due to the decreasing elasticity of the diaphragm and reduced mobility of the ribcage.

Your gastrointestinal tract contains flatus (i.e., gas in the stomach or intestines) as a by-product of digestion. Approximately 0.5 to 1.5 liters is created by your body each day. Pressure equalization is not required because the walls of your gastrointestinal tract are **soft and easily compressed** during a dive. You may notice that the abdomen of a freediver curves inwards during a dive. This is the diaphragm moving upward when the volume of the lungs and gastrointestinal tract decreases.

Equalization for freediving is detailed further in Chapter 5 — Equalization. It is also essential to always have a buddy supervising your dives. The important concept of buddying is discussed in Section 10.2 The Buddy System.

2.2 Buoyancy and Archimedes' Principle

ARCHIMEDES' PRINCIPLE

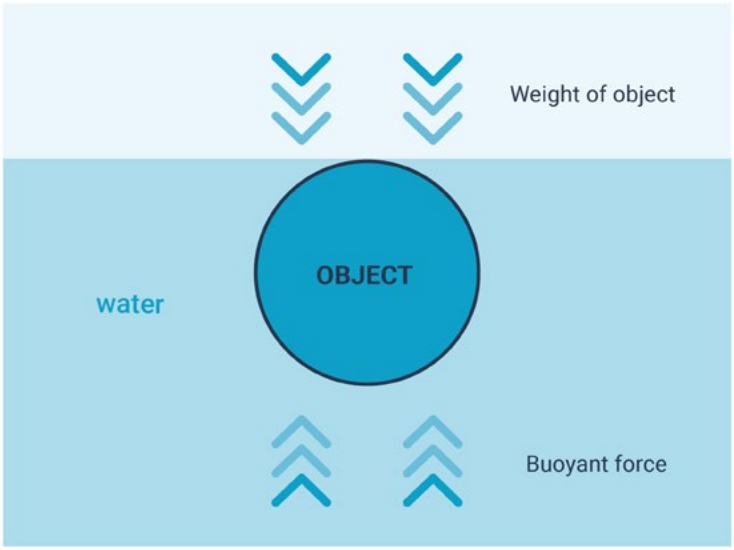


Figure 2. Archimedes' Principle

Your buoyancy significantly affects your freediving, and it is important to understand what influences this buoyancy. Archimedes' Principle states that:

'An object immersed in water experiences a buoyant force equal to the weight of the water it displaces.'

Two forces are acting on the object: its weight and the buoyant force equal to the weight of the water it displaces.

This is the same for your body. The upward buoyant force exerted on a body immersed in water is **equal** to the weight of the water that the body displaces. Therefore, if your body displaces 60kg (133lb) of water, there is an upward buoyant force equivalent to 60kg pushing you up to the surface. If you are lighter than 60kg, you float up or stay at the surface. Note that 1L of salt water (e.g., the ocean) is heavier than 1L of fresh water (e.g., lake or pool); therefore, the buoyant force of salt water is greater than that of fresh water. This is why we float more diving in the ocean and need more weights compared to diving in a lake.

Understanding the principle of buoyancy is key to learning how to duck dive and descend underwater. Many people experience difficulty with diving head-first underwater. This is because the water pushes your body upwards at a force usually **greater than your body weight**. Therefore, you must overcome this surplus of buoyant force by using techniques such as the duck dive.

BUOYANCY

There are three types of buoyancy:

Positive buoyancy

You are positively buoyant and **float** when the buoyant force exceeds the weight of your body. With this, a reasonable amount of effort is needed to exert against this force at the surface in order to duck dive. Positive buoyancy can be used to **aid your ascent** and allows you to stop kicking and pulling during the last 5m (16ft) before surfacing.

Negative buoyancy

You are negatively buoyant and **sink** when the weight of your body exceeds the buoyant force. With this, **more effort** is needed to swim upwards towards the surface.

Neutral buoyancy

You are neutrally buoyant. You **neither float nor sink** when the buoyant force is equal to the weight of your body. With this, you can move along underwater horizontally with **no effort** and without floating to the surface or sinking to the bottom.

FACTORS INFLUENCING BUOYANCY

During a dive, your buoyancy is dependent on several factors:

Depth

Buoyancy changes with depth. During a descent, as ambient pressure increases, the air in your body compresses (particularly in your lungs) and you slowly become less buoyant. At the surface, you are **positively buoyant** (i.e., the buoyant force exceeds your weight). As you descend, you slowly become **neutrally buoyant**. If you descend further, you become **negatively buoyant** (i.e., your weight exceeds the buoyant force). As negative buoyancy increases with depth during a dive, a point is reached where gravity overcomes your body's buoyancy, and you enter a state called 'freefall.' When this happens, you can stop finning and allow yourself to fall effortlessly.

On ascent, the **opposite** occurs. As ambient pressure decreases, the air in your body expands (particularly in your lungs) and you soon become neutrally buoyant. Towards the surface, you become positively buoyant. As you approach, you can stop finning and allow the positive buoyancy to return you to the surface.

Water density

The density of seawater is greater than the density of freshwater due to its **salt content** — the greater the density of water, the greater the buoyancy. Therefore, with the same equipment, you require more lead weights when freediving in salt water than in fresh water.

Equipment

The equipment you wear affects your buoyancy, particularly your wetsuit. A thick wetsuit is very effective in keeping warm. However, the thicker your wetsuit is, the more volume you have, leading to more water volume being displaced. This makes you more **positively buoyant**. Lead weights are required to offset this buoyancy, and a weight belt is often worn to hold

them. Additionally, neoprene wetsuits contain small bubbles of air that, according to Boyle's Law, compress under pressure. This will affect your buoyancy by making you less buoyant as you descend deeper in water. Equipment is discussed further in Chapter 11 — Equipment.

Volume of air in your lungs

You become less buoyant as the volume of air in your lungs decreases. The next time you are in the water, notice that exhaling causes you to sink a little. Once you have selected your weights to offset your wetsuit's buoyancy, starting your dive with a consistent amount of air in your lungs is important. This is **full lungs** for a beginner freediver.

Body composition

Your buoyancy depends upon the composition of your body. Fatty tissues are positively buoyant in water, whereas muscles are negatively buoyant. The proportions of these different tissues in your body affect your buoyancy in the water and determine your **personal weighting requirements**. Note that your weighting can be very different from your buddy's.

2.3 Weighting for Freediving

WHY OVERWEIGHTING IS UNSAFE

Although it is easier to start your descent by carrying more weight, the ascent is more **difficult**, and you use more energy. It is also not a safe practice to overweight yourself when planning to dive horizontally (i.e., along a coral reef). When swimming in the zone of neutral buoyancy, it is easy to change your depth through small movements of your body, such as stretching out your hand. This makes freediving easier and more efficient, but can also cause you to descend quickly without warning. Overweighting in this situation is dangerous as you may **constantly struggle** against your weight to maintain your position in the water, and even more so in an emergency.

WHY UNDERWEIGHTING IS NOT IDEAL

If you are underweighted, positive buoyancy pushes you upward. As a result, it may be challenging to **dive down** and also to maintain a comfortable depth. You also **expend significant energy** fighting against positive buoyancy, which is tiring and prevents you from having an enjoyable dive.

In the Lap/Wave 2 course, you will learn how to perform a neutral buoyancy check. This skill allows you to fine-tune the amount of weight worn and to set your neutral buoyancy depth as you dive deeper.

SAFE WEIGHTING

Establish that you are not overweighted by conducting a surface exhale test.

Surface exhale test

As a general rule, you should not sink below the surface after a comfortable deep exhale.

Follow these steps:

- Hold on to a buoy and exhale deeply but without forcing all the air out of your lungs.
- Hold your breath on this exhale, relax your body, and slowly let your hands slide off the buoy.
- You should **not** sink. It is acceptable if your head bobs underwater, but you should **not** begin to sink any further. Should you sink further, hold onto the buoy immediately or use your fins to return to the surface. Remove some weight and repeat this test until you no longer sink.

Weighting for dynamic disciplines

Weight yourself to be neutrally buoyant at approximately **1m (3ft)** below the surface for dynamic dives in the pool. Note that you carry **more weight** for a pool dive than for a depth dive as you are neutrally buoyant at a much shallower depth. This assumes all other factors, such as wetsuit and pre-dive breathing, are the same as in open water.

To test your weighting:

1. Wear the amount of weight you would like to test and the same equipment you use for your dynamic dives.
2. Take a consistent pre-dive breath, sink into the water, and push straight off the pool wall at approximately 1m (3 feet) below the surface.
3. Assume the arrow position (arms extended and joined over your head) as you push off the wall and glide. Finalize your body posture by executing an arm stroke and bringing both arms to your body with your hands slightly touching your thighs.
4. Glide in this position until you come to a stop.
5. If you tend to rise or fall in the water column as your glide ends, adjust your weight accordingly for the next attempt.
6. Test your weighting several times until you are consistently neutrally buoyant at the end of your glide.

2.4 Summary

1. Boyle's Law explains how the volume of a gas in your air spaces varies with the surrounding pressure. It states 'at a fixed temperature, the volume of a gas is inversely proportional to the pressure exerted by the gas.'
2. As pressure increases during descent, the volume of air enclosed by the lungs, sinuses, middle ears, and mask decreases and must be equalized during a dive.
3. Archimedes' Principle states that 'an object immersed in fluid experiences a buoyant force equal to the weight of the fluid it displaces.'
4. There are three types of buoyancy: positive, negative, and neutral. Your buoyancy depends on equipment, water pressure, water density, the volume of air in your lungs, and body composition.
5. You manage your buoyancy by using weights.
6. Be positively buoyant at the surface after a deep exhalation. This surface exhale test will ensure you are not overweighted.
7. Weight yourself to be neutrally buoyant at approximately 1m (3ft) below the surface for dynamic dives in the pool.

PHYSIOLOGY

‘

There time will recognize
The deepness of the space
And, flowing to infinity of being,
We kindly wait for sense.
This time — it is
Just breath.
And then the love that fills
The deepness of the heart
To all the living.

’

Natalia Molchanova

This chapter explains the role of oxygen and carbon dioxide in your body and covers two important topics: hypercapnia and hypoxia. It explains what they are, how they can affect you when freediving, and how to practice safe freediving with them in mind. This chapter also covers the short-term and long-term ability of your body to adapt to hypoxia over time.

3.1 Oxygen and Carbon Dioxide

The following gases are involved in cellular respiration:

OXYGEN (O_2)

Take a breath in and slowly exhale. You breathe air continuously; as you breathe, oxygen (O_2) enters through your mouth or nose and makes its way into your lungs. Here, oxygen molecules pass into your bloodstream and your red blood cells carry them around your body for cellular respiration.

Cellular respiration is the process used by your cells to make energy available for activity, and they require oxygen to make this happen. During this process, oxygen molecules break down glucose molecules in your cells and energy in the form of ATP is released. ATP is used by your body to power all functions. A byproduct of this process is carbon dioxide.

CARBON DIOXIDE (CO_2)

Carbon dioxide (CO_2) is created as a byproduct of cellular respiration and is carried back in your blood to your lungs for exhalation. The primary function of exhalation is to expel carbon dioxide from your body.

When you hold your breath in freediving, you do not exhale, leading carbon dioxide to **build up** in your body. This increase in carbon dioxide causes the **urge to breathe**. Note that the urge to breathe is not caused by decreased oxygen in your body.

3.2 The Effects of Breath-holding

HYPERCAPNIA

Hypercapnia is caused by an elevated (i.e., higher than normal) level of carbon dioxide in your blood. When you hold your breath, you experience this as an urge to breathe. As a beginner freediver, you may feel some **discomfort and anxiety** when experiencing this for the first few times.

To explain this further: when the level of carbon dioxide in your blood reaches your individual threshold, chemoreceptors (which monitor and respond to changes in the partial pressure of carbon dioxide in your blood) signal the respiratory center in your brain. This results in a rising

urge to breathe, which builds up until you may experience one or several involuntary spasms of your respiratory muscles. These spasms are known as contractions. However, upon surfacing from a freedive and once you resume normal breathing, the balance of all gases in your blood is restored quickly, the hypercapnic state is resolved, and any contractions disappear.

HYPOXIA

Hypoxia, or **oxygen deprivation**, is caused by an insufficient supply of oxygen to your body tissues. When you hold your breath, you begin to use up the limited amount of oxygen you have in your body. After an extended time of breath-holding, the resulting **low level of oxygen** is known as hypoxia. During the early stages of hypoxia, you may actually feel very comfortable underwater and experience a sense of euphoria. However, as your hypoxic state continues, the level of oxygen in your blood falls and the level of carbon dioxide increases. **Always end your freedive at this point and do not allow this hypoxic state to develop any further.**

If you continue to hold your breath and exceed your personal limits, you are in danger of losing consciousness. This is known as a blackout. Blacking out is an **unacceptable part of freediving**, even in competition. Many world champions have never had a blackout. There is no advantage to blacking out; therefore, it is not recommended and must be avoided at all times.

Note that mild hypoxia in freediving is known as exercise-induced hypoxia and is not dangerous.

How to avoid a blackout and the warning signs and symptoms of hypoxia are explained in Section 9.1 Trauma Relating to Hypoxia.

3.3 Freediving Safely

It is important to freedive safely and continually monitor your physical and mental state throughout your freedive. The following recommendations may help you achieve this.

RELAX YOUR BODY AND MIND

Relaxation is very important before, during, and after your freedive. You can achieve a more comfortable and deeper dive and a longer breath-hold if you are more relaxed. Experienced freedivers are able to expertly relax their body and mind underwater. This results in a **slower production of carbon dioxide**, which in turn delays the urge to breathe and any related discomfort. Experienced freedivers also have a lower sensitivity to carbon dioxide due to prolonged exposure during training.

As a beginner, you may react relatively quickly to the urge to breathe because your body is not used to elevated levels of carbon dioxide. This is an important **safety mechanism** for you and allows you to gauge when to end your freedive. The urge to breathe increases towards the end of your freedive when there are very high levels of carbon dioxide. In theory, you can continue your freedive even when feeling the urge to breathe because your body still has oxygen available. However, this is not recommended for recreational freediving. Always begin your ascent as soon as you experience the urge to breathe.Always begin your ascent as soon as you experience the urge to breathe.

Note that some freedivers have a very low sensitivity to carbon dioxide, and combined with the ability to relax so deeply, they may experience weaker signals to end their dive. Therefore, during a dive, always be fully aware of your body and pay close attention to your sensations, in particular to your clarity of mind.

As a beginner freediver:

- Focus on relaxation before, during, and after a breath-hold or dive.
- Always freedive in a comfortable state and surface before you feel the urge to breathe.
- End your dive immediately should you experience the urge to breathe.
- Remember that progress in freediving involves making consistent and conservative freedives.
- Never push yourself to the limit.

BUILD CO_2 AWARENESS AND TOLERANCE

Should you fail to end your breath-hold in good time and push yourself to the point of an uncomfortable urge to breathe, the partial pressure of oxygen may drop below a **critical level**. This is because your resources are limited. Should you persist by continuing to push your dive and ignoring your discomfort, your bodily resources will eventually become exhausted. This triggers a protective mechanism in your central nervous system, which shuts down the conscious parts of your brain functions and results in a **blackout**.

AVOID BLACKOUT

It is very important not to exceed your individual limits during a breath-hold. This is because the sensitivity of your respiratory chemoreceptors to carbon dioxide **varies from individual to individual**. Through training, you learn to read the signals of rising carbon dioxide, making you a more competent and safer freediver.

In recreational freediving, statistics (breath-hold time in seconds and distance and depth in meters or feet) are not important. Instead, as a beginner, you should focus on:

- Mental relaxation and focus
- Physical relaxation
- An efficient freediving technique

ALWAYS FREEDIVE WITH A BUDDY

Remember to always freedive with a competent and qualified buddy (i.e., a person who has taken a freediving course of equivalent level or higher) who can supervise and provide assistance if required. This applies to both training situations and recreational freedives. The importance of the buddy system is discussed in Section 10.2 The Buddy System.

FREEDIVING AND SCUBA

Freediving and scuba diving both give you the opportunity to peek into the underwater world. However, scuba divers breathe compressed air while diving, which requires them to ascend slowly and 'off-gas' excess nitrogen accumulated in the blood before returning to the surface. Additionally, breathing compressed air requires an extended surface interval before returning to depth safely. For this reason, it is recommended that after scuba diving, you should wait until your **'no-fly' time has elapsed**. If you dived while wearing a dive computer, it should give you a specific 'no-fly' time to follow. If you are not using a dive computer, wait for a period of **24 hours** before freediving.

Scuba activities can be safely enjoyed after freediving to **shallow depths** (less than 15m/49ft) if you have had enough time to recover from any fatigue, rehydrate, and are able to equalize without any pain or discomfort.

It is recommended to never take air from a scuba diver while you are freediving. Taking air into already-compressed lungs at depth and returning to the surface can cause significant lung injury due to Boyle's Law (see Section 2.1 Pressure and Boyle's Law.) If you take air from a scuba diver, you would have to end your dive as a scuba diver rather than returning to the sur-face as a freediver. Therefore, it is **safer and simpler** for freedivers to altogether avoid taking air from scuba divers.

3.4 Short-term and Long-term Adaptations

Significant physiological changes happen in your body when you hold your breath and when you freedive. As a result, your body can adapt to high levels of carbon dioxide and, to a certain extent, a hypoxic state.

These physiological changes are divided into two categories:

- **Short-term adaptations** are bodily changes that happen during a dive or freediving session, which allow your body to function more efficiently under new conditions. They generally disappear when you resume breathing.
- **Long-term adaptations** are changes to your body after regular training, making it more efficient when encountering hypoxic situations. These changes can last for months, years, or a lifetime.

SHORT-TERM ADAPTATIONS: THE MAMMALIAN DIVE REFLEX

Short-term adaptations are often referred to as the Mammalian Dive Reflex (MDR).

Several triggers produce this reflex:

- Immersion of your face in water; receptors in your skin register when you are immersed in water
- Breath-hold (hypoxia and hypercapnia); e.g., you begin to have a lower heart rate and blood shift due to hypoxia
- Rising environmental pressure as you freedive deeper
- Cold water temperature

These triggers cause a number of physiological changes:

Slowing of the heart rate and blood flow velocity

Your heart rate slows, which reduces the energy consumed by your heart. This is known as **bradycardia**. Additionally, this limits the consumption of oxygen to your vital organs and tissues and **slows your metabolic processes**. Metabolic processes take place in all living cells and provide energy to sustain your vital processes and the synthesis of cellular material.

Spleen effect

Your spleen contracts and releases stored red blood cells containing **hemoglobin** into the bloodstream. This increases the **oxygen-carrying capacity** of your blood due to increased concentrations of hemoglobin binding with oxygen.

Peripheral vasoconstriction

The blood vessels in your extremities — your hands, arms, feet, and legs — **constrict** and push more blood towards your **core** to optimize the supply of oxygen to your vital organs and your brain.

Blood shift

Blood increasingly **compensates** for the space created when the air in your lungs compresses. Therefore, blood vessels in your lungs expand and are engorged with blood to compensate for the loss of air volume. This increases their ability to handle the rise in pressure.

Central vasodilation

While blood vessels in your extremities contract (i.e., peripheral vasoconstriction), other blood vessels around your vital organs (e.g., heart, brain, and lungs) **dilate** to allow more blood flow; this is known as central vasodilation.

Further effects of the Mammalian Dive Reflex

Due to peripheral vasoconstriction, blood moves away from your extremities towards your vital organs. Therefore, a reduced flow of blood to your muscles in your extremities increases the rate at which your muscles fatigue. This reduced flow accelerates the **build-up of lactic acid** in your muscles, causing a feeling of heaviness or muscle fatigue. You can train your body to tolerate higher levels of lactic acid over time with repeated freediving.

Finally, **immersion diuresis** brings about an increase in urine production due to the hydrostatic pressure exerted on your body, vasoconstriction, and a decrease in body temperature when you freedive. This is one of the reasons why it is essential to keep hydrated throughout your freediving session.

Stories from Adam Stern

When I am in really good shape and I have been training a lot, my MDR is very strong and I really feel it engaged. For example, when I enter the water, I try not to wet my face until the very last minute before a deep dive. And when I first wet my face, I feel a rush of tingles up and down my legs and my arms as my blood vessels are constricting and pushing the blood to my core.

LONG-TERM ADAPTATIONS

Long-term adaptations to hypercapnia and hypoxia through training result in multiple changes in your organs and tissues. You can improve your freediving through **consistent practice**, allowing your body to adapt gradually to situations with elevated carbon dioxide and lowered oxygen levels. The more regularly you train, the greater the long-term effect on your body.

For example, your body's tolerance to high levels of carbon dioxide can increase. When you first start freediving, you may not be able to hold your breath for very long without experiencing the urge to breathe. However, with regular training, you can hold your breath for longer without discomfort and remain fully aware of the effects of rising carbon dioxide. You may experience contractions, but they no longer cause you significant distress.

The better and more regularly you train, the better your body manages oxygen and the longer you can hold your breath before putting yourself in a potentially dangerous situation. It generally takes some time to improve the ability of your body to handle hypoxia; however, the ability of your body to tolerate higher levels of carbon dioxide can change quite quickly. Regular training can result in **dramatic improvements** in a short period of time. Should you stop training, these improvements generally reduce very quickly. However, if you have raised your CO_2 tolerance to a certain level, you can usually return to this level more quickly.

Effects of hypoxic training in humans include the following:

Polycythemia

An increase in the concentration of red blood cells in your blood, which improves your oxygen-carrying capacity.

Lowered critical threshold for partial pressure of oxygen

A lower critical threshold for the partial pressure of oxygen increases the capacity for your brain and muscles to work in low oxygen conditions.

Changes in cell membranes

An increase in mitochondria and cell respiratory enzymes helps your cells to consume oxygen more efficiently.

Increased capacity and efficiency of your respiratory system

Your inhalation capacity is maximized due to increased gas exchange surface in your lungs, greater capacity of your ribcage, and stronger respiratory muscles.

Increased elasticity of your arteries and arterioles

An increase in elasticity allows a greater capacity of blood to be stored in the blood vessels that supply your heart and lungs.

3.5 Summary

1. Hypoxia in breath-hold diving is called exercise-induced hypoxia. It is a temporary functional state. Practiced incrementally with conservative progression, breath-hold induced hypoxia is neither dangerous nor worsens your health.
2. Early stages of hypoxia may result in you feeling very comfortable underwater and experiencing a sense of euphoria.
3. **Hypercapnia** occurs when there is an elevated level of carbon dioxide in your blood; it is characterized by a rising urge to breathe.
4. When the partial pressure of carbon dioxide in your blood reaches a threshold value, chemoreceptors gradually trigger the respiratory center in your brain, causing the urge to breathe and subsequent contractions.
5. As a beginner freediver, freedive in a comfortable state and surface as soon as you feel a slight urge to breathe.
6. Exceeding your personal limits triggers a protective mechanism in your central nervous system, which can lead to a loss of consciousness known as a blackout.
7. The degree of hypoxia experienced depends on the duration of your breath-hold, the power of your muscle work, and level of mental activity. It can be improved by physical and mental relaxation and an efficient freediving technique.
8. Always maintain optimal movement throughout a breath-hold dive.
9. Typical short-term physiological reactions during a breath-hold dive include a slower heart rate and blood flow, greater contractility of your heart, ejection of extra blood cells from your spleen, centralization of blood flow (i.e., peripheral vasoconstriction), and widening of capillaries (i.e., central vasodilation). Other effects include hormonal regulation, muscle fatigue, and immersion diuresis.
10. Long-term adaptions to hypoxia and hypercapnia include polycythemia, lowered critical threshold for partial pressure of oxygen, changes in cell membranes, increased capacity and efficiency of your respiratory system, and increased elasticity of your arteries and arterioles.

BREATHING AND RELAXATION

‘When you find yourself alone in a silent underwater world, you’ll reconsider your previous thoughts and attitudes and discover new things. Thoughts pass and disappear in a few seconds, and this silence has a calming and nurturing effect on our restless souls.’

Natalia Molchanova

This chapter introduces basic breathing and relaxation techniques and explains how you can maximize your performance and freedive safely.

4.1 Basics of Breathing and Relaxation

Breathing techniques have evolved significantly over recent years and can be divided into three main areas:

- Preparation
- Filling your lungs before a freedive (the 'one full breath')
- Recovery breathing

Training regularly to develop your relaxation and breathing practice can enhance your performance and allows you to have a more enjoyable breath-hold.

PREPARATION

The aim of preparation is to achieve maximum relaxation of your mind and body before a freedive. This is best achieved by using a relaxation technique such as the body scan. This relaxation technique involves bringing awareness to different body parts, finding any tension, and releasing this tension before moving to the next part.

Body Scan

Practice your preparation for a breath-hold by following these steps:

1. Find a comfortable position. On land, lay face-up with your arms and legs relaxed on the floor. In the pool or open water, use a mask and snorkel and float at the surface. If you are negatively buoyant, use a pool noodle under your chest and arms to keep you afloat.
2. Focus on an area of your body, such as your head. As you breathe in a relaxed way, imagine your head becoming warm and completely relaxed.
3. Move to the next area of your body, such as your neck. Do the same; notice any tension in your neck and simply let it go.
4. Scan your entire body. For example, head, face (eyebrows, eyelids, eyeballs, cheeks, lips, tongue, jaw), neck, shoulders, back, arms, hands, chest, abdomen, pelvis, and so on). Bring an inner calm and peace of mind as you pass from area to area. If you feel any tension, simply notice it and let go of it.
5. Continue your body scan for a minimum of two minutes or until you feel that you released any tension in your body and quieted all internal dialogue.

There are different ways of scanning your body, such as beginning at the top of your head and scanning down to your toes. Alternatively, you can start at your toes and scan up through your body or simply focus on key areas of tension. You will learn which is suitable for you and develop your practice and ability to scan your body as you learn. To note, keep your mask on during preparation.

ONE FULL BREATH

Once you have reached a state of complete relaxation, it is time to comfortably fill your lungs with air. Do this in a relaxed manner to avoid the build-up of any unnecessary tension. You use two of your major breathing muscle groups, one after the other, to fill your lungs with air. These muscles are your **diaphragm** and your **intercostal muscles**.

Follow these steps to fill your lungs:

1. **Inhale using your diaphragm.** The diaphragm is a large muscle that separates the upper and lower part of your torso. It sits right below your lungs and allows you to access a significant portion of your lung volume. As you inhale using your diaphragm, your abdomen (belly) slowly bulges out, which is also called belly breathing. Inhale as much as you comfortably can into your belly first.
2. **Keep inhaling using your intercostal muscles.** Once you have finished inhaling using your diaphragm, activate the muscles between your ribs. This expands your torso and further fills your lungs with air. This is also known as chest breathing.
3. **Relax.** Once you have expanded your chest comfortably to its maximum, it is important to fully relax again and release any tension built up during this full inhalation. The best way to achieve this is by locking your throat. Then emulate, or say out loud, the sound 'hhha.' This is the same sound you would make when preparing to lift a heavy weight, where you inhale deeply and lock your throat just before lifting. This closes your vocal folds and keeps the air in your lungs from flowing out, allowing you to completely relax your torso.

This practice is the most efficient way to fill your lungs with air with minimal waste of energy. Once you are completely relaxed and have full lungs, you are ready to freedive. Make sure you take only one full breath to avoid hyperventilation, which is discussed further in Section 4.2 Hyperventilation.

RECOVERY BREATHING

Recovery breathing is about re-oxygenating your body as quickly as possible after reaching the surface. This is an integral part of your safety when freediving. To note, a freedive is not complete when you surface; it is complete after your recovery breathing. Even after shallow freedives, you must use correct recovery breathing, **making it a habit** so that you will perform it automatically every time you dive.

To practice recovery breathing, follow these steps after you surface:

- Exhale passively and let the air from your lungs flow out.
- Inhale actively with an open mouth to allow the maximum intake of air into your lungs. This sounds like you are saying 'hope' on your inhale.
- Exhale approximately half of your air with light resistance. Do this by pursing your lips or by using your tongue to restrict the airflow. This increases air pressure in your lungs and facilitates oxygen transfer to your blood and the removal of carbon dioxide.
- Inhale actively with an open mouth to allow the maximum intake of air into your lungs.
- Repeat steps 3 and 4 a minimum of three times or until you feel fully recovered and are able to resume normal breathing.

OPTIONAL: ADD THREE CHEST BREATHS

During your first breath-holds, you have a very personal experience of rising carbon dioxide in your body. This is because your level of tolerance to rising carbon dioxide is individual to you. Your Molchanovs instructor can add three controlled chest breaths, which can make a **comfortable breath-hold** more accessible to those with low CO_2 tolerance. These controlled chest breaths deliberately and moderately lower your level of CO_2 before your breath-hold. The chest breath technique allows you to gain confidence and self-awareness through an enjoyable breath-hold.

A chest breath is inhalation from the intercostal muscles only. Technically, it is an activation of the inspiratory intercostal muscles as you perform it during the full breath before your breath-hold. It is essential that the rest of your body stays fully relaxed while performing a chest breath, in particular your abdominals, shoulders, neck, and face. The exhalation of a chest breath is passive. It is important to simply let the air flow out as if you are sighing.

Chest Breathing Technique

The technique is as follows when including three chest breaths before the full breath:

- Relax: Complete the body scan for two minutes
- Complete three chest breaths with passive exhalation
- Take one full breath
- Start your breath-hold

Your Molchanovs instructor will help you to learn and apply this technique correctly. Should this technique work for you, it is important to practice it with a snorkel to prepare you to freedive in open water. If you find that your freedives are more enjoyable when using the chest breath technique, then use it for now. However, your long-term aim is to **reduce the chest breaths** from three, to two, to one, and finally to none as you progress through the Lap/Wave 1 course or within subsequent Lap/Wave courses.

The key principle for a safe and longer breath-hold is to develop your ability to relax and your tolerance to carbon dioxide.

4.2 Hyperventilation

Hyperventilation is defined as breathing more air in and out than your body needs. Hyperventilation does not store more oxygen in your blood because your body does not have the means to accumulate additional oxygen before a freedive. However, breathing more than needed increases **the rate at which carbon dioxide is removed**. This results in a lower partial pressure of carbon dioxide in your lungs and arterial blood and can give rise to a number of symptoms.

SYMPTOMS OF HYPERVENTILATION

Symptoms of hyperventilation include:

- Lightheadedness / dizziness
- Tingling in your fingers or other parts of your body
- Increased heart rate
- Euphoria
- Numbness around your mouth
- Metallic taste

WHY YOU SHOULD AVOID HYPERVENTILATION

There is a common misconception that hyperventilating before a freedive can help you stay longer underwater. During a breath-hold dive, you experience a continually increasing urge to breathe as the partial pressure of carbon dioxide rises in your blood. This urge to breathe acts as an important signal for you to **gauge when you should surface**.

Trying to 'get plenty of air before a freedive' by breathing rapidly and deeply does remove carbon dioxide from your blood and causes your respiratory system to signal the urge to breathe later than usual. However, this is **extremely dangerous** and is not recommended. A hyperventilated freediver may experience a false sense of well-being and no urge to breathe, even when the oxygen level in the blood drops below critical levels. In this instance, there is a significantly increased risk of a blackout, sometimes with no warning beforehand.

Therefore, relax before a breath-hold and breathe naturally. Should any symptoms of hyperventilation arise, resume your relaxation exercises and do not freedive until they disappear.

4.3 Summary

1. Preparation for a breath-hold is about achieving maximum relaxation of your mind and body. Release any tension in your body and find inner calm and peace of mind by focusing on a relaxation technique called the body scan for a minimum of two minutes. Add three chest breaths to finish your preparation if appropriate.
2. Filling your lungs is a slow and deliberate process of 'filling your belly' first, followed by your chest.
3. Recovery breathing allows your body to re-oxygenate as quickly as possible after reaching the surface. It consists of a passive exhalation followed by active inhalations and increasingly longer exhalations against light resistance. Perform three cycles of this breathing or continue until you are fully recovered and breathing normally once more.
4. During a breath-hold dive, you experience an increasing urge to breathe as the partial pressure of carbon dioxide increases in your blood. This is an important signal for you to safely gauge when it is time to return to the surface.
5. Hyperventilation is defined as breathing more air in and out than your body requires. This form of breathing reduces the partial pressure of carbon dioxide in your lungs and blood and can allow you to stay underwater without experiencing an urge to breathe. However, it is extremely dangerous to hyperventilate before a breath-hold dive and is not recommended.
6. Symptoms of hyperventilation include light-headedness and dizziness, tingling in your fingers or other parts of your body, euphoria, and an increased heart rate.
7. A hyperventilated freediver may experience a false sense of well-being and no urge to breathe even when the oxygen level in the blood drops below critical levels. In this instance, there is a significant risk of a blackout without any warning beforehand.
8. CO_2 tolerance is individual. Deliberately and moderately lowering CO_2 by means of chest breaths can make a breath-hold more accessible to those with low CO_2 tolerance. However, your long-term aim is to reduce the chest breaths from three, to two, to one, and finally to none as you progress through the Lap/Wave 1 course or within subsequent Lap/Wave courses. The key principle for a safe and longer breath-hold is to develop your CO_2 tolerance.

EQUALIZATION

‘

If you are in a hurry, you never experience the harmony and immensity of the ocean around you.

’

Natalia Molchanova

This chapter explains the basic theory and concept of equalization, introduces equalization techniques such as the Valsalva and Frenzel maneuvers, and recommends which techniques are suitable for freediving. It also provides exercises to help aid equalization and skills and tips on practicing it safely and effectively.

5.1 Equalization Theory and Concept

Section 2.1 Pressure and Boyle's Law explains that pressure increases the deeper you freedive. This causes the air in your body cavities to compress and decrease proportionately. To prevent pain or injury from occurring in these air spaces, this build-up of pressure requires **active or passive equalization**. On ascent, as the pressure decreases, the air in your body cavities increases proportionately and usually disperses naturally. There is no need to actively equalize on ascent.

There are three main air spaces to equalize:

- Ears, or more specifically, the middle ear
- Sinuses
- Mask

Your lungs do not require equalization because they compress as pressure increases on descent, later expanding again as pressure decreases on ascent. Middle ear and sinus barotrauma are the most common injuries arising from increasing water pressure and failure of appropriate equalization. This is explained further in Section 9.2 Barotrauma.

THE ANATOMY OF EQUALIZATION AND KEY TERMS

Eustachian tubes

Your Eustachian tube is a canal that connects your middle ear cavity to the upper part of your throat and the back of your nasal cavity (also known as the nasopharynx). The pressure within your middle ear is managed by your Eustachian tube to ensure it is equal to the pressure outside your body. Your Eustachian tubes are **normally closed** and open only with certain movements such as yawning, swallowing, or chewing. Then they open, which allows air to enter your middle ears and equalize the pressure. When there are rapid changes in atmospheric pressure (atm or bar), such as during a freedive, you must purposely equalize your ears.

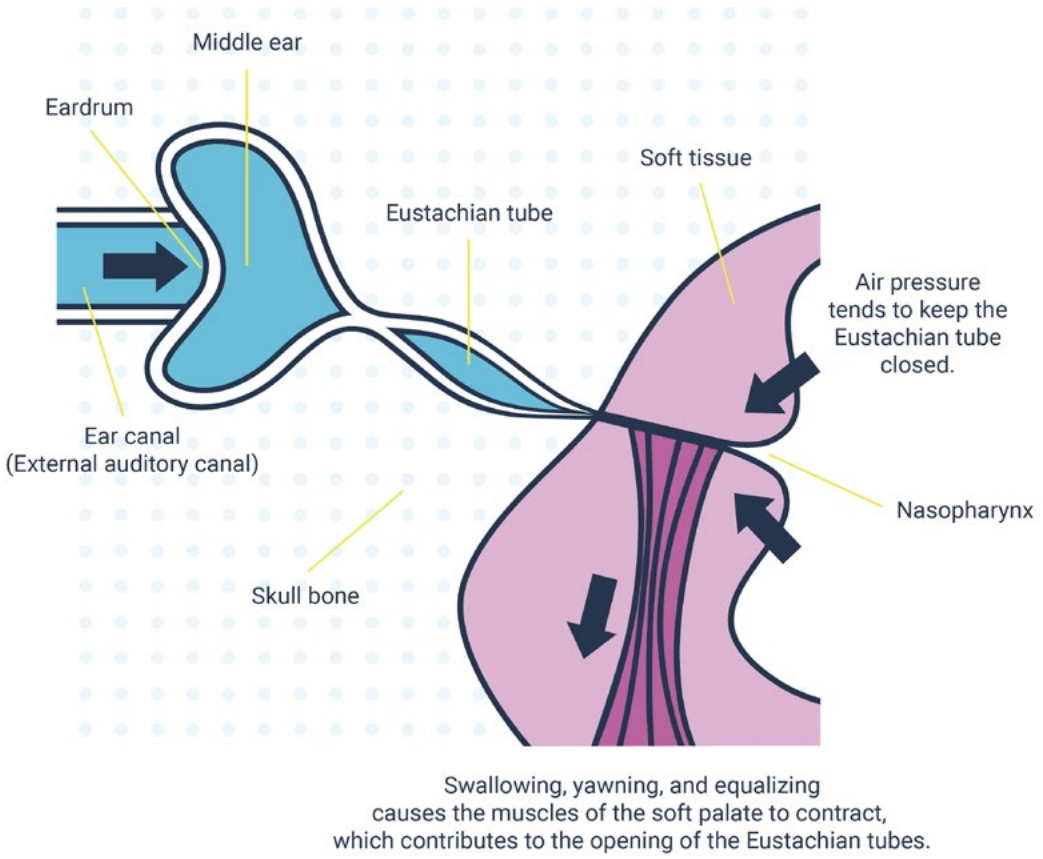


Figure 3. Eustachian tube

Middle ear

Your middle ear is the part of the ear between your eardrum and the oval window to your inner ear. The middle ear is also known as the tympanic cavity. During a freediving descent, ambient pressure increases, which puts pressure on your eardrums and causes them to **bend inward**. Your eardrums are very sensitive to pressure changes, but you can purposely equalize this pressure by performing equalizing techniques. Should your Eustachian tubes remain closed or are not opened sufficiently after equalization, you may experience **pain and discomfort**. While you are freediving, if you continue to descend without equalizing, your eardrums can **rupture**. During ascent on a freedive, ambient pressure decreases. The expanding air within your ears opens your Eustachian tubes automatically so you do not need to equalize.

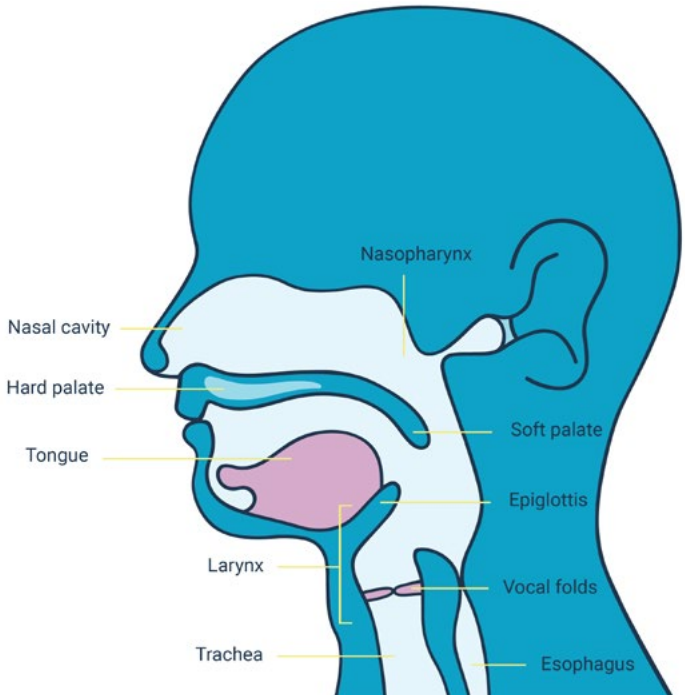


Figure 4. Anatomy of equalization

Nasopharynx

The nasopharynx is the upper part of your throat that connects with your nasal cavity above the soft palate.

Soft palate

Your soft palate separates your nose and mouth cavities and directs the flow of air in and out of your lungs.

- When you inhale and exhale through your nose, your soft palate touches your tongue to direct air out of your nasal cavity.
- When you inhale and exhale through your mouth, your soft palate moves up and back to direct air out of your oral cavity.
- When your soft palate is in a neutral position, air passes through both your mouth and nose.

To perform the Frenzel maneuver (which is discussed later in the chapter), your soft palate is in a **neutral position**. To note, when you feel stressed underwater or try to equalize too hard, your soft palate can close up against your nasal cavity and stop air from entering. Therefore, it is important to stay relaxed when you equalize.

Epiglottis

Your epiglottis is a flap of cartilage located at the top of your larynx near the base of your tongue. It protects your vocal folds and prevents food from entering your larynx. To note, your epiglottis closes the opening of your larynx during swallowing and is not used during Frenzel.

Vocal folds

Your vocal folds, also known as 'vocal cords,' are comprised of two folds of mucous membrane lying horizontally across your larynx. The opening between the vocal folds is called the glottis, which also includes muscles located around the vocal folds. The vocal folds separate your oral cavity (i.e., your mouth) from your thoracic cavity (i.e., your lungs). The opening of your vocal folds widens on inhalation and narrows on exhalation with a normal breath. Holding your breath causes your vocal folds to close.

Larynx

Your larynx controls the flow of air and is also known as your voice box. It is a tube about 5cm (2in) long in adults. It sits above the trachea (i.e., your windpipe) in your neck and in front of your esophagus (i.e. your food pipe).

5.2 Equalization of Air Spaces

There are a number of techniques that can be used to equalize the pressure in your air spaces.

MASK EQUALIZATION

Equalize the pressure within your diving mask regularly throughout your descent. This prevents your mask from suctioning onto your face, potentially resulting in red eyes at the end of your freedive.

Equalizing your mask is very simple:

1. Release your pinched nose.
2. Move a small amount of air through the nose and into the mask.
3. Repeat frequently on the descent or as you feel the pressure build in your mask.

To note, on the ascent, the pressure gradually decreases automatically. There is no need to equalize. You may also see or hear bubbles escaping from your mask as you ascend. This is the air that you exhaled into your mask, nose, and sinuses during your freedive.

EAR EQUALIZATION

Normally you pinch your nose to equalize. When one of the following equalization techniques is used, this traps and builds air pressure in your nasal cavity and passes air through your Eustachian tubes and into your middle ears for equalization.

There are two ways to build up pressure in your nasal cavity to equalize your middle ear as a beginner freediver:

1. Exhaling against pinched nostrils and using the air in your lungs to create pressure. This is called the Valsalva maneuver.
2. Pushing with your cheeks or with your larynx and tongue against pinched nostrils to create air pressure. This is called the Frenzel maneuver.

It is recommended to use the Frenzel maneuver for freediving. The Frenzel maneuver is further discussed below in Section 5.3 Equalization Techniques, along with an explanation of how to perform it and helpful exercises to train the technique.

SINUS EQUALIZATION

Your sinuses do not require separate equalization. When you equalize your ears, your sinuses generally automatically equalize too. Your sinuses are lined with a membrane that produces mucus. Over half a liter is produced each day by your body. This amount increases when, for example, you have a cold or you work in a dusty or air-conditioned environment. It can then become difficult to equalize your sinuses. A mucus blockage can prevent air from getting into one or several of your sinuses and can prevent equalization altogether. Should you feel any pressure in your sinuses when freediving, either under your eyes or on your forehead, **return to the surface** to prevent any further difficulties and to avoid rupture of your blood vessels.

5.3 Equalization Techniques

THE VALSALVA MANEUVER

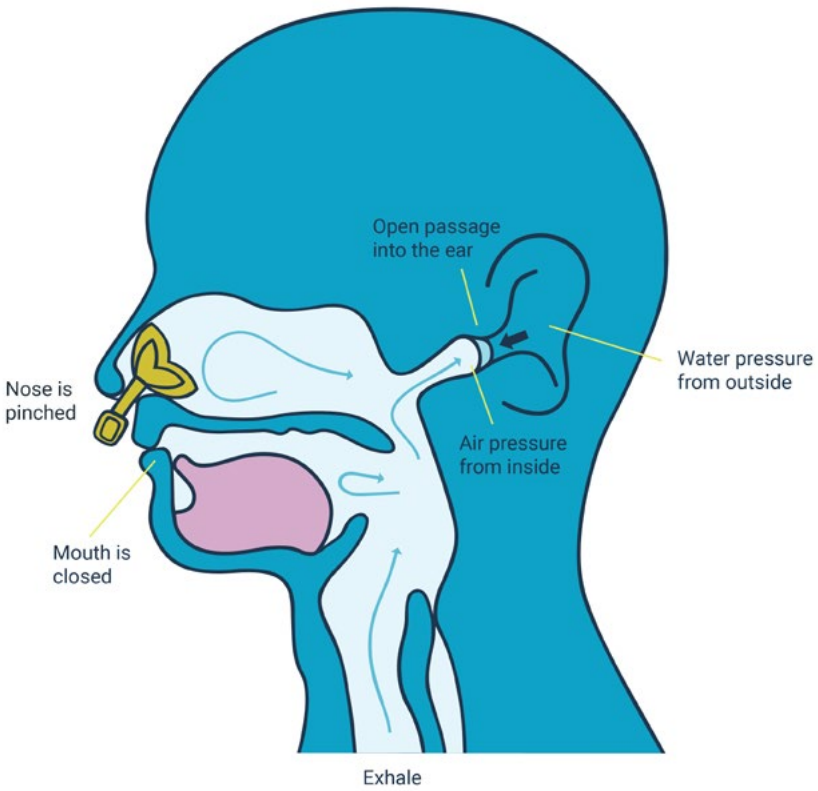


Figure 5. Valsalva maneuver

The Valsalva maneuver is generally considered to be the easiest equalization method and is commonly used by scuba divers and many beginner freedivers. It is named after Antonio Maria Valsalva, an 18th-century physician and anatomist from Bologna, Italy. He treated otopyosis (pus in the middle ear) by piercing the eardrum and asking the patient to exhale forcefully while keeping both their mouth and nose closed.

To equalize pressure in your middle ear using the Valsalva maneuver:

- Exhale through your nose against a pinched nose and a closed mouth. By doing this, air cannot escape through your nose. Instead, the air is pushed into your middle ear through your Eustachian tubes, returning your eardrums to their natural position.
- Your ears make a popping sound as the pressure is equalized.

Why the Valsalva maneuver is not recommended

Although the Valsalva maneuver is often taught to beginners due to its simplicity, it is not the ideal way to equalize because you are using air from your lungs by pressing on them with your respiratory muscles. It is also **less effective at greater depths**. This technique becomes **progressively harder** and **eventually fails** the deeper you go and the more the air in your lungs is compressed. You may begin freediving using Valsalva equalization, but as you progress, you must eventually learn to use the Frenzel maneuver, detailed further in the section below.

THE FRENZEL MANEUVER

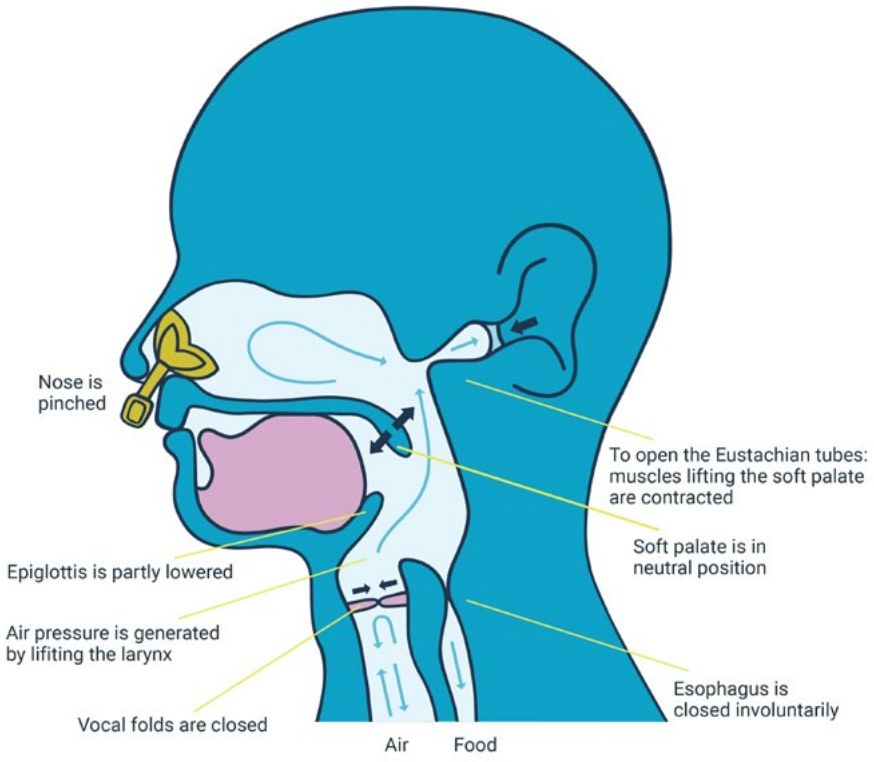


Figure 6. Frenzel maneuver

The Frenzel maneuver is the preferred method for freediving because smaller muscle groups are used to perform the technique and there is no need to use your breathing muscles to push air up from your lungs into your nasal cavity. This helps you remain relaxed at depth and is also a more controlled way to equalize.

PERFORMING THE FRENZEL MANEUVER

To perform the Frenzel maneuver, follow these steps:

1. Pinch your nostrils
2. Position the front of your tongue at the roof of your mouth as if you are making a 'T' or 'K' sound. These are tongue locks called the T and K locks. Alternatively, squeeze your lips and cheeks as if you are saying 'P' forcefully. This is the P lock, where your cheeks are used to equalize instead of your tongue.
3. Close your vocal folds and lift your larynx up to push air out of your mouth and into your nose.
4. You will feel a popping or clicking sound as the air equalizes in your middle ear.
5. Repeat the above steps each time you need to equalize.

To note, **keep your soft palate in a neutral position** to let the air pass from your mouth through your Eustachian tubes.

If you are equalizing your ears without any thoracic or abdominal movement, you are doing it correctly. You will also hear a click or pop in your ears and feel air entering your nose under your fingers and inflating your nostrils. If you do not, your vocal folds are still open and the air is leaking back to your lungs. Alternatively, if the air remains in your mouth but equalization has failed, your soft palate is still in the raised position and is preventing air from entering your nose. Learning to Frenzel equalize takes time and patience. Ask your Molchanovs instructor to demonstrate this technique so you can practice.

PRACTICING THE FRENZEL MANEUVER

To improve your Frenzel technique, you can complete a series of exercises designed to better control the flexibility and strength of your vocal folds, larynx, soft palate, and tongue. You can practice a number of these exercises on your own or with the help of the EQ Trainer. The EQ Trainer is an adjustable nose piece with a balloon attached that allows you to connect the balloon to your nose. It allows you to adjust the airflow to make exercises easier or more challenging as you gain experience. Please see Section 5.4 Equalization Exercises for further information about the EQ Trainer and equalization exercises you can perform with or without one.

Stories from Adam Stern

Having equalization challenges when you are freediving is incredibly common. In fact, I find that around 30% of my students have some form of an equalization problem. The good news is that I am yet to encounter a student who has not resolved an equalization issue. There are some easy steps you can take to solve any issues to become a happier, safer, and better freediver. The key to learning how to equalize is patience. Never be angry with your body. You can only allow it to do what is possible at that moment. Know that with repetition and practice, it gets better.

OTHER EQUALIZATION TECHNIQUES

A number of people can equalize without pinching their nose. They open their Eustachian tubes by using the muscles of their soft palate and throat. This is known as 'hands-free' equalization, or Béance Tubaire Volontaire (BTV) in French and Voluntary Tubal Opening (VTO) in English. It is possible to learn this technique; however, it is difficult and generally takes specific exercises and training over an extended period of time. It is recommended to focus solely on learning the Frenzel maneuver for freediving.

5.4 Equalization Exercises

INTRODUCING THE EQ TRAINER

Figure 7. Molchanovs EQ Trainer

The Molchanovs EQ Trainer is a tool that helps you work on your Frenzel technique on dry land. A balloon is attached to an adjustable nose piece, allowing you to change the amount of air going through it. With the EQ Trainer, you can perform specific exercises to strengthen and improve control of your tongue, vocal folds, and soft palate. The adjustable nose piece allows you to make exercise **more challenging** as your technique becomes more proficient. You can use the EQ Trainer regardless of your level of expertise as it is also useful for more **advanced equalization techniques** you will learn as you progress deeper as a freediver.

The following exercises are useful in training the different elements involved in performing the Frenzel maneuver. Some exercises may be performed on their own while others require an EQ Trainer or a regular balloon and are marked as such.

SOFT PALATE, LARYNX, VOCAL FOLD, AND TONGUE CONTROL EXERCISES

Neck Rotations with Inhale — Vocal Fold Hold

1. Inhale and hold your breath while keeping your mouth open. Your vocal folds automatically close.
2. Perform neck rotations slowly and gently while holding your breath.
3. Try to maximize your range of motion.
4. Complete ten rotations in each direction.

Neck Rotations with Exhale — Vocal Fold Hold

1. Exhale and hold your breath while keeping your mouth open.
2. Perform neck rotations slowly and gently while holding your breath.
3. Try to maximize your range of motion.
4. Complete ten rotations in each direction.

Vocal Fold Control 1

1. Hold your breath, inhale, and use your vocal folds to stop the airflow gently and slowly.
2. Then, exhale and use your vocal fold to stop the air flow gently and slowly.
3. Repeat this process for two minutes.

Vocal Fold Control 2

1. Exhale, hold your breath, and pull against your vocal fold gently.
2. Continue for two minutes.

SOFT PALATE CONTROL EXERCISES

Soft Palate Awareness

1. Inhale with an open mouth. Interchange between breathing in through your nose and mouth by regulating airflow using your soft palate.
2. Change the airflow several times in one breath while keeping your mouth consistently open.
3. Repeat the exercise again, this time exhaling the air while keeping your mouth consistently open.
4. Repeat several times (minimum 3–5 repetitions).

EQ Trainer Exercise: Soft Palate Control 1

1. Inflate the balloon with the EQ Trainer in.
2. Close one nostril with your fingers and position the EQ Trainer against your other nostril so that the air from the balloon applies pressure on your soft palate.
3. Release your soft palate gently with your mouth open so air escapes from your mouth.
4. Practice starting and stopping the flow of air.
5. Repeat several times (minimum 3–5 repetitions).

Balloon Exercise: Soft Palate Control 2

1. Inflate a balloon with your mouth. Hold your breath by closing your vocal folds. Make sure that your cheeks and tongue are relaxed, your tongue is not touching your soft palate, and the air from the balloon and your mouth share one space.
2. Allow the air from the balloon to escape through your nose by relaxing and tensing your soft palate at small intervals. Repeat several times (minimum 3–5 repetitions).
3. Repeat on an inhale and repeat again on an exhale. Alternate with pinching and releasing your nose and changing nostrils.

LARYNX AND TONGUE CONTROL EXERCISES

Larynx and Tongue Control 1

The goal of this exercise is to increase your awareness and mobility of your larynx and tongue (i.e., the root, middle, and tip of your tongue):

1. Use your larynx and tongue to create piston-like vertical movements with your Adam's apple (or the location it would be on a woman).
2. Repeat with a full inhale and repeat with a full exhale.

Tongue Control 2

This exercise should be performed only after the Larynx and Tongue Control 1 exercise has been mastered.

1. Without pinching your nose, practice the K, T, and P locks while keeping your soft palate closed and pressurizing the air by using your larynx and tongue.

COMBINATION CONTROL EXERCISE

Combo Control

1. Pinch your nose and apply pressure for each of the K, T, and P locks.
2. Release your fingers so that air is immediately released from your nose. This means that your soft palate is open.
3. Keep pinching your nose to equalize.

5.5 Tips for Effective Equalization Practice

COMPLETE WARM-UP EXERCISES

Perform the following warm-up exercises prior to a freedive to prepare the muscles around your Eustachian tubes:

1. Massage the skin in front of and behind your ears.
2. Pull on your ears. Start from the bottom at the ear lobe and work your way up to the top (known as the helix).
3. Push the little lobe at the front of your ear (known as the tragus) in against your ear and massage it with circular motions.
4. Stretch your jaw down and relax into this position.
5. Move your jaw left and right.
6. Rotate your jaw.

To note, perform jaw movements carefully, otherwise it is possible to damage the delicate joints and muscles which move your jaw. Should you continue to experience problems with equalizing, practice equalization gently. Do not push yourself to go deeper as this can lead to more discomfort or injury.

Remember that regularly performing equalization exercises will improve your control over the required muscles and help you to equalize with minimal effort.

EQUALIZE EARLY AND FREQUENTLY

Prior to a freedive, equalize your ears and mask at the surface. This facilitates equalization at depth. During your descent, equalize early and frequently. Ideally, you should equalize your ears **before** you feel a sensation of pressure inside them and equalize your mask **before** you feel pressure on your face. To note, your eardrum returns easily to its normal position once you have equalized; however, it will be harder if significant pressure has built up. **Never wait until you feel discomfort or pain.** Stop your descent by grabbing the rope and tilting your head to the opposite side if you are unable to equalize an ear. For example, to equalize a problematic left ear, tilt your head towards your right side, which lengthens the left side. Try to equalize again in this position. Should you freedive deeper without equalizing your ears, **you may not be able to equalize at all**. This is because the difference in pressure between your middle ear and the external environment is too great.

SLOW DOWN YOUR DESCENT

The slower you descend, the **easier** it is to equalize pressure in your ears. Your eardrums and Eustachian tubes also adapt to pressure changes with regular training, leading you to equalize with less effort. As you descend deeper, the relative difference in pressure between each meter decreases and you find that you can equalize less frequently the deeper you go. Slowing down and relaxing helps you to **establish your own pace** to equalize and makes equalization easier.

RELAX

Mental stress can cause **muscular tension**. Tension in your abdominal and intercostal muscles can hinder lung compressibility. Tension in your head and neck (in particular in your soft palate and in the muscles attached to your Eustachian tubes) can hinder ear equalization. This can result in **blocked Eustachian tubes**. Therefore, two freedivers with different elasticities of their diaphragm and different abilities to relax mentally attain different maximum depths. **Relaxation is key.** Therefore:

- Take your time preparing for a freedive. Begin your dive only when you feel completely relaxed.
- During your freedive, focus on your neck and facial muscles to release tension in your head and neck and focus on relaxing your mind.
- Make your first freedives in shallow water with good visibility to minimize and conquer any fear.

5.6 Summary

1. Pressure increases the deeper you freedive. This causes the air in your body cavities to compress and decrease proportionately. To prevent these air spaces from causing discomfort, pain, or injury, this build-up of pressure requires active or passive equalization.
2. There are three main air spaces to equalize: the middle ear, the sinuses, and the mask.
3. There are two ways you can build up pressure in your nasal cavity to equalize your middle ear:
   a. Exhale against pinched nostrils and use the air in your lungs to create pressure. This is called the Valsalva maneuver.
   b. Push with your cheeks or with your larynx and tongue against your pinched nostrils to create air pressure. This is called the Frenzel maneuver.
4. It is recommended to use the Frenzel maneuver while freediving because smaller muscle groups are used to perform the technique and there is no need to use your abdominal muscles to push air up from your lungs into your nasal cavity. It is a more relaxed and more controlled way to equalize.
5. To perform the Frenzel maneuver, follow these steps: Pinch your nostrils. Place the front of your tongue at the roof of your mouth as if you are making a 'T' or 'K' sound. These are also called T or K tongue locks. You can also simply squeeze your lips and cheeks as if you are saying the letter 'P'. This is known as the P lock. Lift the back of your larynx up to push air out of the mouth and into the nose. If performed correctly, you will feel a popping or clicking sound as the air equalizes in your middle ear and feel air entering your pinched nose under your fingers. Repeat the above steps each time you need to equalize.
6. Equalize your ears frequently and before you feel pressure building up against your eardrums. Do not wait until you feel pain. Your eardrums and Eustachian tubes adapt to pressure changes with regular training and you can then equalize with less effort. Equalize your mask before you feel too much pressure on your face.
7. Use the EQ Trainer to help train your larynx, vocal folds, soft palate, and tongue and develop your overall Frenzel technique.
8. To equalize pressure in your diving mask: Release your nose pinch. Move a small amount of air through the nose and into the mask. Repeat frequently on descent before you feel pressure building in your mask.
9. Facilitate ear equalization by equalizing early and frequently and performing warm-up exercises beforehand. Descend slowly and relax your neck and facial muscles.

DIVING TECHNIQUES

‘

The pool is where you train. The sea is where a freediver is made.

’

Natalia Molchanova

This chapter introduces you to the bifin technique and no-fins technique, including how to perform them and develop your style.

6.1 Introducing the Bifin Technique

A great bifin technique, also known as the 'flutter kick,' is the basis of freediving. This technique has just recently become a competitive discipline under the acronym CWTB (Constant Weight with Bifins). But even more so, the bifin technique is used for much of recreational freediving, acting as a buddy or safety diver, swimming from shore to reach a diving location, teaching, and the first technique taught to students to descend to depth without the aid of the dive line in FIM.

OVERVIEW

The bifin technique greatly benefits from new developments in freediving gear. Modern freediving fins are skillfully produced with fiberglass or carbon blades that allow for dives to depths that looked impossible only a few years ago. But the best gear is of little use if your technique needs work. Even the greatest piece of gear will not enable you to achieve your goals; a great bifin technique always comes first!

TECHNIQUE SUMMARY

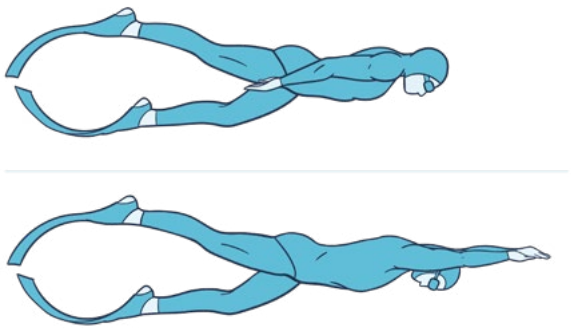


Figure 8. Bifin technique

Arrow position or arms down?

The arrow position involves holding the arms above the head in a straight position so that the entire body takes a shape similar to that of an arrow. This position has certain advantages, mainly for the monofin technique, where the arms and hands help to stabilize the upper body while the lower part of the body is moving.

There is some debate on whether the arrow position is really more hydrodynamic. However, it is safe to say that the arrow position benefits the diver only if they are very flexible in the shoulders, does not greatly affect the overall body posture, and does not cause any muscle stress in the shoulders and upper back. If you assume the arrow position despite a lack of shoulder flexibility, you will most likely compensate with an arched lower back. This, in turn, will cause some resistance in the water.

As a general rule, try standing in front of a mirror, raising your arms above your head, tucking them behind your ears, and placing your hands on top of each other. If this is not affecting your overall body posture, you may try to use this position in the water. However, if you need to arch your lower back or whole body to assume this position, the arrow position will not yet work for you in the water.

Several studies have tried to show that the arms down posture is as hydrodynamic ('streamlined') as the arrow position due to its more drop-shaped profile, but these findings are up for debate. However, it is safe to say that a perfectly relaxed, straight, 'arms down' body posture is not an inferior position for your CWTB dives.

The knees

The optimum kick is defined by many factors, such as leg-to-body ratio, overall leg length, strength, flexibility, fin length, and stiffness. In the past, the bifin technique used to be performed with stiffer fins, which lead to either a strong kick with wide amplitude and low frequency or the 'bicycle kick,' where the legs make a similar motion to riding a bicycle, using almost exclusively the underside of the fin. A modern flutter kick is done with soft to super-soft fins, low amplitude, a higher frequency, and near-perfect symmetry. This proved to be a much more efficient way to cover depth or distance with **minimal effort**.

In general, the knees should not have too much bend. How much is too much depends on the many factors mentioned above, but generally speaking, the knees should not bend more than 45°. It will greatly benefit you to see yourself doing a DYNB dive on video to get an outside perspective.

It is, of course, neither possible or recommended to keep the knees perfectly straight, either!

The key to a great flutter kick lies in **symmetry**: while your left leg kicks to the front, the right leg will move the other fin backward. The more symmetrical these two movements are, the more efficient your kick becomes. A great flutter kick technique should not feel like you are kicking 'left, right, left, right,' but more like 'open, close, open, close.'

The feet

During the front kick, your ankles will be stretched to their maximum. You can relax the calf muscles in that phase, possibly even flexing them slightly inwards to maximize efficiency. However, this stretch at the top of your foot might feel quite intense, which can result in you feeling some discomfort, especially during or after longer DYNB sessions. Do not overload your body with too much training too soon. Your body will adapt, and soon you will be able to 'point' your feet like a ballerina, but you need to approach this process by carefully increasing your training load. The controlled approach of regular Base Training will allow you enough time to adapt.

Your calves play a major role during the back kick when the fin moves backward from the frontal extension. The goal is to keep the ankles fairly straight throughout the entire back kick. As with the knees on the front kick, additionally the ankles on the back kick cannot be kept absolutely straight, nor do they need to be. Also, generally speaking, the ankles should never assume an angle of 90° — that would be too much. You will see this clearer on a **video** taken of you from the same depth and parallel to you.

The key is to **visualize** yourself 'pushing with the underside of the foot' throughout the entire back kick, pressing against the sole of your feet. Depending on the function and shape of your fins, you can support the back kick by also engaging the soles of your feet: if your foot pockets allow it, 'curling the feet' at the end of the back kick supports an optimum angle of the fins. This is the reason why some of the Molchanovs competition foot pockets come in an open heel design, which allows for better activation of the soles of the feet.

6.2 Introducing the No-fins Technique

Several freediving disciplines are performed without fins, including Dynamic No Fins (DNF) and Constant Weight No Fins (CNF). Constant Weight No Fins is considered one of the most physically demanding disciplines and is introduced in the Lap/Wave 2 course.

Dynamic No Fins (DNF) is a horizontal underwater swim without fins. The stroke most commonly used is a variation of the breaststroke.

WHAT IS NO FINS?

The basis for the no-fins technique is the breaststroke — the familiar, classic style of swimming you may have learned as a child and use today. You usually swim breaststroke on the surface, but you may have swum underwater breaststroke for one cycle when pushing off the wall at the start of your swim. You may also have seen competitive swimmers push off the wall and swim breaststroke underwater until they surface to continue their swim.

Learning a good breaststroke technique improves your streamlining, endurance, and strength as it uses your whole body. It is one of the more tiring and physically demanding styles. Still, by establishing a good technique, you add to the variety of swimming styles available to you, which is very beneficial for freediving. This, in turn, increases your options for training. Establishing variety in your training is important, and you improve significantly in freediving by using different training methods and practicing other styles, both with and without fins.

A fundamental part of swimming is how much you feel the glide and the propulsion and how well you support yourself. By developing your no-fins technique, you engage more of your muscle groups and naturally develop a better feel and sense of the water. It is harder to develop this when swimming with fins. The no-fins technique not only develops and builds your confidence and comfort in the water but also improves and fine-tunes your coordination.

Learning this technique gives you complete freedom and flexibility to freedive anywhere in the world without needing fins — you will simply need goggles (in the pool only) or a mask.

THE BASIC TECHNIQUE

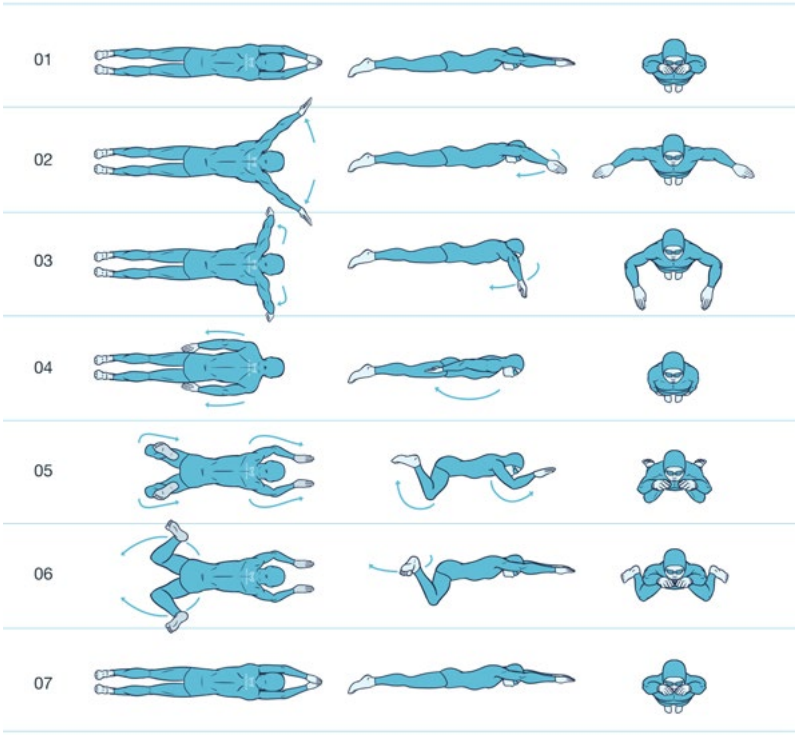


Figure 9. No-fins technique

Follow these steps to develop the correct technique:

1. **Start.** Begin with your hands and feet together in the arrow position. Arms are extended out in front of you.
2. **Arm pull.** Pull your arms and hands from above your head all the way down to your hips, keeping your elbows high during your arm pull. Your arms are held in a similar position as if you were hugging a large fitness ball (i.e., your arms are curved forward and your elbows are high). Pull down with your arms for as long as possible and **slowly** move your elbows to your sides as you move them down.
3. **Leg kick.** Bring your heels up and open your legs (while keeping your knees close together) to prepare for your kick. Extend your arms forward at the same time. Once your arms are fully extended, push your legs down in a frog-like motion by squeezing your knees close together when straightening your legs. Finish with straight legs and pointed toes.
4. **Glide.** Continue with your arms extended into a glide and resume your starting position once more in preparation for your next cycle.

The key to the no-fins technique is to keep your upper body still and horizontal in the water while your arms and legs do the work. Your Molchanovs instructor will explain and demonstrate the breaststroke technique to you as this is a requirement for the Lap/Wave 1 course. Ask your instructor any questions you may have and include this as a regular part of your ongoing training.

6.3 The DYNB, DNF, and DYN Pool Turn

At the end of a lap in the swimming pool, you will need to perform a turn in order to keep going. Mastering a proper turn technique will help you save energy while also staying on the correct trajectory.

OVERVIEW

Once you see the 'T' at the bottom of the swimming pool (or alternatively, the mark placed by your Molchanovs instructor on the bottom of the pool or floor), you prepare for the turn by extending one arm in front of you and using this arm on the wall of the swimming pool to begin the rotation. You want to make yourself as small as possible to minimize the resistance of the water, and you will end in the arrow position in the same lane where you executed the turn.

TECHNIQUE SUMMARY

1. Around 1.5m (5ft) from the wall (the 'T'), stretch one hand toward the wall, slightly reaching toward the direction in which you want to turn.
2. Keep the momentum going, and with your hand on the wall, turn the body while tucking your knees and ankles against your hamstrings and bum to make yourself smaller. Your lower back should be close to the wall.
3. Use your other hand to push against the water in order to finish the turn, if needed.
4. Stretch your arms forward in the arrow position.
5. THEN
    a. Place your heels on the wall at the same level as your hips.
    b. Push against the wall while keeping your body straight and your arms in the arrow position.

    OR (only for DYNB or DYN)

    a. Straighten your legs by pushing your shins down against the water to gain some momentum.
6. Use the glide before performing an arm stroke (if you choose to keep your arms along the body during the entire dive).

Alternative turn techniques are available depending on your setup, such as using the bottom of the pool or floor. Your Molchanovs instructor will guide you through these techniques if necessary.

6.4 The Duck Dive Technique for CWTB

At the beginning of a dive, you must overcome the positive buoyancy that you have at the surface, which takes some effort. To minimize this effort and conserve energy while also descending vertically along the dive line, freedivers use the duck dive technique. Performed properly, this technique will help you descend comfortably and in a relaxed manner despite the positive buoyancy.

OVERVIEW

Think of the overall movement as 'rolling over a barrel.' You are sending your hips and butt up and then extending your legs straight up in the air so that their weight is pushing you down. You finish the duck dive with a smooth arm pull.

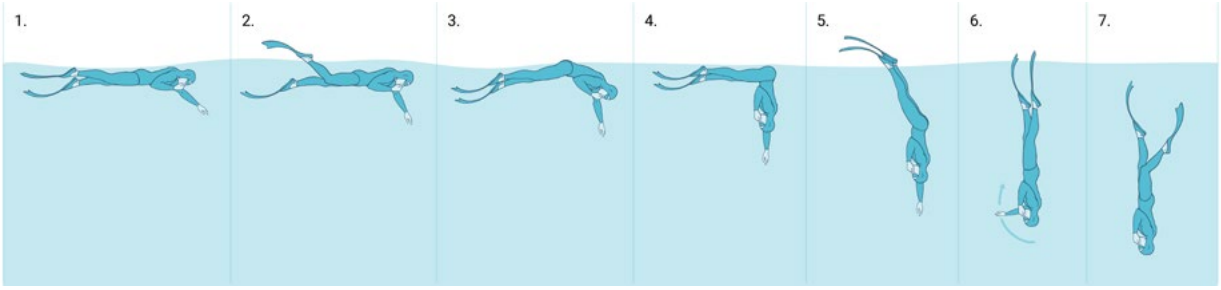


Figure 10. Duck dive technique

TECHNIQUE SUMMARY

The duck dive technique can be performed in different ways; however, we are focusing on relaxation and comfort first. The steps of the duck dive are as follows:

1. While laying horizontally and face-down in the water, take one full breath, then remove your snorkel from your mouth and equalize at the surface.
2. Take one second to fully relax. One arm stays on the nose to equalize while the other points toward the pool/ocean floor.
3. Perform a flutter kick to get a bit of momentum along the buoy until your hips are next to the dive line (this will position you facing the line after your duck dive is complete).
4. Send your hips and butt up like you are trying to 'roll over a barrel' and bend your upper body down at a 90° angle. One arm stays pointing down to the pool/ocean floor, the other hand remains on your nose to let you equalize when needed. Your legs remain straight and parallel to the surface during this movement.
5. Swing your legs straight up in the air. Once they are completely vertical, perform an arm pull with your non-equalizing arm.
6. Start finning once your fins are underwater.

6.5 The Forward Tumble Turn in Open Water

Once you reach your target depth, it is important to perform your bottom turn in a controlled and relaxed manner by using the dive line. This ensures that you don't stretch too much at depth, which could place stress on your lungs. A proper turn will also allow you to pull on the dive line, gaining momentum for the beginning of the ascent and signaling to your buddy that you are on your way back to the surface. The forward tumble turn is the technique we will use for all depth disciplines.

OVERVIEW

Grab the line in front of your eyes with the thumb pointing toward your destination (the surface). Continue descending along the line until your grabbing hand is at waist level and use your momentum and gravity to perform a slow and relaxed front flip before pulling once on the line.

Figure 11. Forward tumble turn demonstration video

TECHNIQUE SUMMARY

1. Stop your descent by grabbing the line in front of your eyes with your thumb pointing to your destination (the surface).
2. Continue descending along the line until your grabbing hand is at waist level.
3. Fold your body forward (making a front flip) around the grabbing hand.
4. You should end up next to the line after finishing the front flip while still holding the line.
5. Pull once with the grabbing hand to start the ascent, which also signals to your buddy that you are coming up.

6.6 Summary

1. The bifin technique is used for much of recreational freediving, acting as a buddy or safety diver, swimming from shore to reach a diving location, teaching, and the first technique taught to students to descend to depth without the aid of the dive line in FIM.
2. A modern bifin technique is done with soft to super-soft fins, low amplitude, a higher frequency, and near-perfect symmetry. This technique proved to be a much more efficient way to cover depth or distance with minimal effort.
3. Several different freediving disciplines are performed without fins, including Dynamic No Fins (DNF) and Constant Weight No Fins (CNF).
4. Dynamic No Fins is a horizontal underwater swim without fins and uses a variation of the breaststroke.
5. Learning good breaststroke technique improves your streamlining, endurance, and strength as it uses your whole body. The no-fins technique not only develops and builds your confidence and comfort in the water, but also improves and fine-tunes your coordination.
6. Key points of technique to remember for the breaststroke: **Arm pull.** Keep your elbows high during your arm pull. **Leg kick.** Push your legs down in a frog-like motion by squeezing your knees close together when straightening your legs.
7. A well-performed turn in the swimming pool will allow you to save energy and turn 180° to stay in the same pool lane.
8. A well-performed duck dive will allow you to overcome positive buoyancy in an efficient and relaxed way and start your dive facing the dive line.
9. In open water, a well-performed forward tumble turn will allow you to turn efficiently at the bottom without stretching too much at depth. It will also allow you to pull on the line to start your ascent and signals to your buddy that you are coming up.

MENTAL TECHNIQUES

“A freediver should have a positive attitude and chase away all negative thoughts related to the forthcoming freedive.”

Natalia Molchanova

This chapter introduces and explains a simple mental technique that you can begin to use prior to a freedive. Further techniques to enhance and improve your mental state are introduced in later Lap/Wave course manuals.

7.1 Technique: Visualization

Preparing yourself mentally is important and beneficial to your overall freediving experience and safety. Visualization can be used prior to a freedive and is a powerful tool used by many athletes in different sports. It is an effective way to **increase performance** and alleviate anxiety from an activity.

WHAT IS VISUALIZATION?

What you see, what you remember, and what you imagine fire in the visual cortex of your brain in a **similar** way; in fact, the brain does not differentiate between them at all. This phenomenon allows you to imagine a freedive and convince your mind that you have performed the freedive before — no need to worry! Diving to a certain depth is much easier the second, third, and fourth time.

Performing a visualization is simple. You imagine the freedive you are about to perform with **great detail** and with everything going **well** — detail is important. The more detailed the visualization, the more convincing the story becomes. You imagine the positive sensations of the dive: the feeling of water on your face, the power of kicking your fins, and the joy of reaching the end of the line. Choose whatever you believe gives you the **strongest emotional response** and imagine it vividly as you go through the dive in your mind.

A few key points for a successful visualization

- Imagine something possible.
- Imagine it happening here and now.
- Imagine it with as many details as possible, especially sensory details (e.g., feeling of the flow of the water on your body, temperature, the sensation of the rope in your hands or the water against your fins, etc.).
- Imagine it in a positive way: focus on what you want to do, not on what you want to avoid (e.g., 'keeping my legs straight' versus 'not bending the knees').

Visualization Example

Use the following visualization as a guideline for your practice.

While resting at the surface prior to your freedive, focus first on your body scan until you feel completely relaxed. Then visualize your freedive for 1–2 minutes, paying close attention to every detail and aspect:

1. Finish your pre-dive breathing, take one full breath, and then pause for a second to relax.
2. Remove your snorkel from your mouth and perform an equalization at the surface.

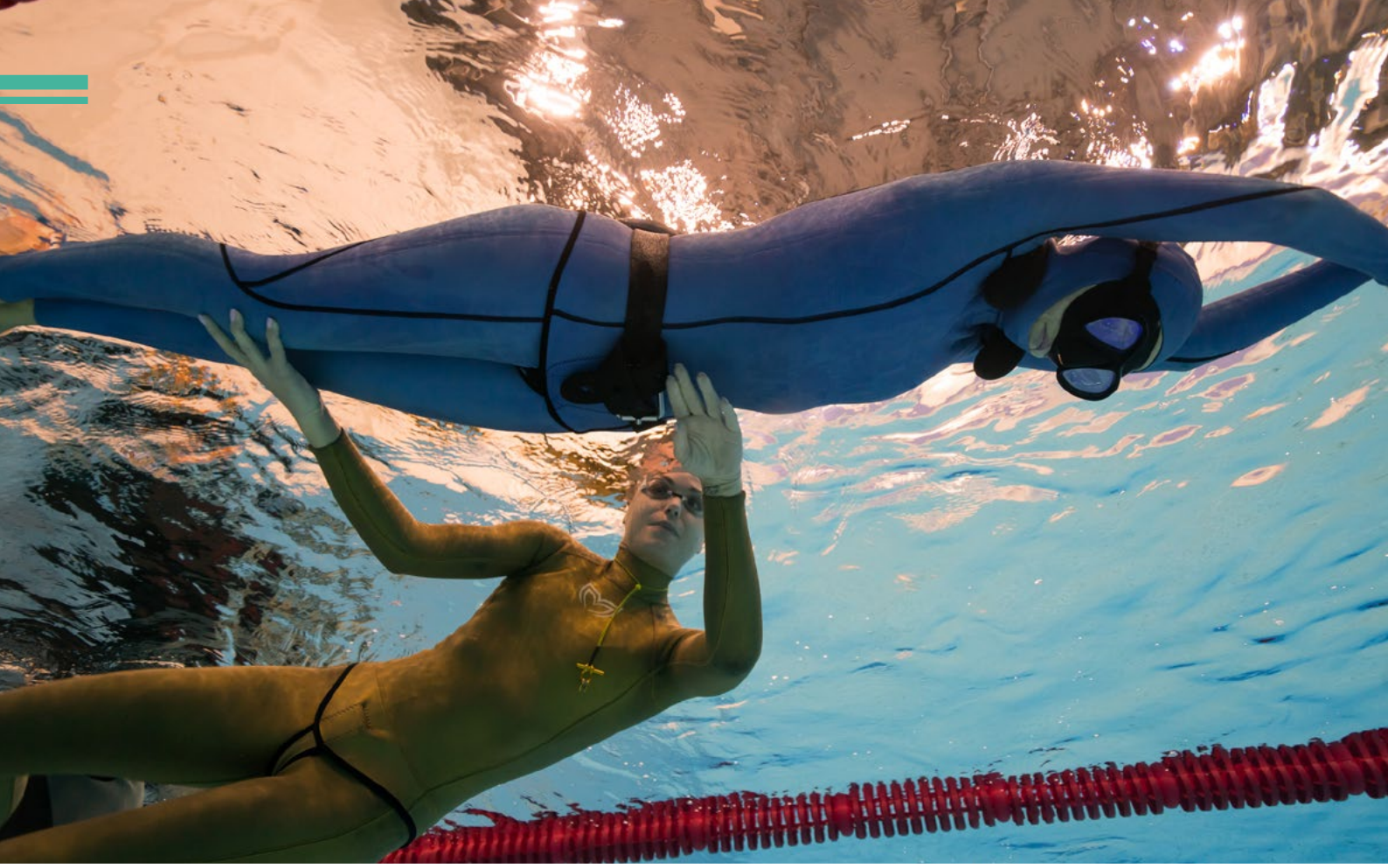
3. Imagine starting with a perfect duck dive, then facing the dive line and staying close to it as you descend.
4. Keep your head in line with your body.
5. Equalize the pressure in your ears and mask regularly.
6. Keep your legs straight and make strong, powerful kicks at a moderate pace.
7. Execute a turn by grabbing the dive line with your hand and making a perfect forward turn.
8. Start your ascent by making strong, powerful kicks.
9. Reduce the effort as you get closer to the surface.
10. Close to the surface, allow the positive buoyancy to push you upward with minimal effort.
11. Grab the buoy and perform at least three recovery breaths. Signal your buddy that you are OK.
12. Feel the joy of a successful dive.

Then, to ready yourself to start your actual descent:

1. Check that you are fully relaxed.
2. *Optional:* Perform up to three relaxed chest breaths (if needed).
3. Take one full breath to fill your lungs.
4. Start your descent.

7.2 Summary

1. Visualization is an effective method used by many athletes in different sports to increase performance and alleviate anxiety from an activity.
2. When you perform a visualization, you imagine the freedive you are about to perform in great detail with everything going well.
3. Before each descent, spend 1–2 minutes visualizing your freedive step by step.
4. When readying yourself for your descent: check if you are fully relaxed, perform up to three relaxed chest breaths (if needed), take one full breath to fill your lungs, and start your descent.



BASE TRAINING

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You should always enjoy the initial stages of training. Otherwise, what is the point of doing it?

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Natalia Molchanova

After registering for a Molchanovs course, you are eligible to become a Molchanovs Movement member, which gives you access to Base Training and other benefits (such as a discount on Base Training + programs). This chapter explains the importance of training and introduces Base Training and Base Training +. It also goes over how to measure your progress by using Base Levels and training 'Zones.'

8.1 The Importance of Training

More than just an activity, freediving is a sport. As such, it requires regular training to progress and feel the lasting mental and physical benefits. During the Lap/Wave 1 course, you are learning the basic theories and principles of freediving. You are also receiving practical training from your Molchanovs instructor in the pool (and additionally in open water for Wave 1) to begin freediving and use basic freediving techniques. Motor skills take time to master and require a lot of repetition to become fluid and automatic. Moreover, as emphasized in Chapter 4 — Physiology, the mechanisms that help you cope with the urge to breathe or pressure underwater can be trained to activate faster and stronger.

With regular training, your physical condition and your technique will improve — your body will develop better lung capacity, improved mobility, and become more accustomed to higher levels of carbon dioxide and lower levels of oxygen. Freediving is also fundamentally a discipline of the mind, so you will begin to develop greater internal awareness, a deeper state of relaxation, a stronger focus, and a better ability to deal with stress.

Below are the different types of training you can and should practice as a freediver.

DRY TRAINING

If you do not have access to open water or a pool, dry training is a great way to stay in shape for freediving, improve your mobility, and work on your technique. It is also very useful for people who want to increase their training time without inadvertently overtraining. In addition, some skills, such as mental preparation, are practiced only on dry land. These exercises must be practiced over a period of time to be effective, so you should not wait until the last minute to work on them. Developing a dry routine for mental preparation is a great way to progress, minimize your stress, and maximize your enjoyment, both in training and in life in general.

Breathing can also be practiced on dry land, helping you optimize your relaxation for freediving and improve your immune system.

Equalization can and should also be practiced on dry. After all, during an open water diving session, if you perform around 10 dives that last 1 minute each, you are spending only 30 seconds working on your equalization on each dive (on the descent). In total, that is only 5 minutes of equalization work where you are also dealing with the other aspects of your dive. On dry land, you can focus solely on your equalization work using helpful tools (such as the Molchanovs EQ Trainer) and work purely on your equalization for a longer period of time.

POOL TRAINING

The swimming pool has its own disciplines: Static (STA), Dynamic (DYN), Dynamic with Bifins (DYNB), and Dynamic No Fins (DNF). They all require repetition to master the specific techniques, increase CO_2 tolerance, and increase the capacity to handle low oxygen levels. If you are more inspired by the open water aspects of freediving, pool training is also a great tool to improve the specifics of your technique and prepare for your future open water sessions.

SAFETY CONSIDERATIONS: It is recommended to always have a passive safety, even for Solo programs. You are required to have an active safety for Group programs. A passive safety is a designated person who can see your activities and respond to any obvious sign of trouble (e.g., pool lifeguard). An active safety is a designated freediver responsible for observing you throughout your training dives, beginning at your pre-dive breathing and ending once you have completed your recovery breathing without any signs of distress.

OPEN WATER TRAINING

Nothing fully replaces open water training when it comes to progressing in terms of depth. Freediving to depth requires adaptation, and therefore, repetition in open water, along with plenty of patience.

SAFETY CONSIDERATIONS: Active safety required for all workouts.

8.2 Base Training

BASE TRAINING

Base Training is a collection of structured freediving training programs and workouts that help you make progress step by step . There are different levels, each designed for a specific level of certification.

Accessing your first training program

Prior to or during your course, your Molchanovs instructor will set a Base Training level for you. There are 4 different Base Training levels.

Based on your Base Training level, a selection of programs will be available to you directly on your home page. You can select the one that fits your needs at the current moment or your instructor may assign you a program based on your abilities and needs.

Base Training programs for each level consist of several weekly workouts that are designed to be completed over the course of several weeks. Your Molchanovs instructor will provide you guidance on which one to choose and will guide you through the registration process for your first Base Training program.

Workout Generator

In addition to the standard Base Training programs, you can also access the Base Training Workout Generator. If you are in need of inspiration for one workout, but do not have time or do not want to follow a whole training program, you can generate a single workout adapted to the needs of your session.

8.3 The Zones

While working out during Base Training, 'Zones' help keep you in the appropriate intensity level. They are designed for you to be able to identify how you should feel during the training and are an indicator of the intensity of the workouts. Make sure you stick to these zones for safety and in order to avoid overtraining. Adapt the times or distances proposed in the workouts as needed, because as freedivers, our work is based on feeling, not on absolute numbers.

ZONES

The different zones defined:

Zone 1 — No urge to breathe or discomfort is felt.

Zone 2 — Urge to breathe/contractions for 3–5m (10–16ft) of the swim / STA 5–10 sec.

Zone 3 — Urge to breathe/contractions for 10–15m (33–49ft) of the swim / STA 20–30 sec.

Zone 4 — Urge to breathe/contractions for 20–25m (66–82ft) of the swim / STA 40–50 sec.

Zone 5 — Urge to breathe/contractions for 30–35m (98–115ft) of the swim / STA 60–70 sec.

Zone 6 — Urge to breathe/contractions for 35m+ (115ft+) of the swim / STA 70+ sec.

ACTIVE AND PASSIVE SAFETY

A passive safety is a designated person who can see your activities and respond to any obvious sign of trouble (e.g., pool lifeguard). An active safety is a designated freediver responsible for observing you throughout your training dives, beginning at your pre-dive breathing and ending once you have completed your recovery breathing without any signs of distress.

Passive safety is acceptable only when training in:

- Zone 1 for Base Training levels 1 and 2
- Zone 1 and 2 for Base Training levels 3 and 4

8.4 Evolution of Base Training Levels

UPGRADING YOUR BASE TRAINING LEVEL

As you progress, you may need to upgrade your Base Training level at some point. You will know that you are ready for the next Base Training level when the workouts of your current level consistently feel easier than the Zone connected to those workouts. Any Molchanovs instructor you work with can upgrade your Base Training level. You can simply choose the instructor as your mentor on your home page.

Once you have a mentor, you can ask them to upgrade your Base Training level. Before doing so, your mentor will evaluate the Base Training level you are ready for and update it accordingly.

DOWNGRADING YOUR BASE TRAINING LEVEL

Just like with any other sport, resuming training after a long break might be challenging, and you might need to downgrade your Base Training level to match your current freediving abilities. You will know that you need to decrease your Base Training level when the workouts consistently feel more difficult than the Zone connected to those workouts. You can downgrade your Base Training level yourself on your homepage. However, to upgrade back to your original level or to a higher Base Training level, you will need to ask your mentor to upgrade you.

8.5 Base Training +

Base Training + is a collection of paid programs taught by top freedivers who are experts in their disciplines. Each program targets a specific goal and contains videos that give you step-by-step instructions, guided workouts, stretches, and tips to achieve your desired freediving goals. A one-time purchase of a program gives you lifetime access to complete it at your own pace and on your own time.

8.6 Logging your Workouts

At the end of each workout, whether it is an individual workout from the Workout Generator or a Base Training program, you will have the opportunity to log your workout. In each log, you will rate the difficulty of the workout and how much you liked it with up to five stars. Logging your workouts only takes a couple of seconds and is essential to keep track of your achievements. You can find the stats of your logged workouts directly on your homepage.

In addition to giving you stats about your achievements, logging your workouts helps Molchanovs consistently improve the database to improve future workouts.

Figure 12. 16 x 25m badges for performing Dynamic No Fins as quickly as possible in the following times: Purple — 20 min.; Green — 18 min.; Gold — 12 min.; Blue — 16 min.

8.7 Badges

Badges recognize key milestones in your freediving journey. A number of the badges are performance-based (e.g., the Benchmark Badges and the Complete Freediver Badges). Others are meaningful or fun challenges and accomplishments. Badges are awarded to you by your Molchanovs instructor. You can view the full list of badges here.

Your freediving journey is just beginning - by participating in this freediving course, you are now a part of the Molchanovs Movement. Ask your instructor to help you choose the Base Training program that's right for you and continue on your journey of becoming an experienced freediver!

8.8 Summary

1. Freediving is a sport and requires you to continually train physically and mentally if you expect to further your abilities in the water.
2. You can train solo or with a partner on dry land and in the pool. It is recommended to always have a passive safety.
3. Depth training sessions must always be done with an active safety.
4. Effective and safe training includes knowing and using the different training Zones prescribed for every workout.
5. During the different workouts, you will use a passive or active safety depending on the workout. Passive safety is acceptable only when training in Zone 1 for Base Training levels 1 and 2 and Zone 1 and 2 for Base Training levels 3 and 4.
6. Base Training is a collection of structured freediving training programs and workouts that will help you progress as a freediver.
7. Base Training + is a collection of paid programs created and taught by top freedivers who are experts in their disciplines. There are programs designed for all capability levels in all disciplines of freediving.
8. Log your dives and personal best performances to see your progress over time and earn some performance badges in the process.

POTENTIAL TRAUMA

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Freediving should be associated with internal calm, but never with struggle. 'In good time' is a key principle in freediving.

’

Natalia Molchanova

This chapter explains two main types of trauma that can occur in freediving:

- Trauma related to hypoxia during a breath-hold
- Barotrauma, or physical damage to your body tissues caused by changes in ambient pressure

It is important that you develop an awareness and understanding of how to prevent these types of trauma and learn how to freedive safely and responsibly.

9.1 Trauma Relating to Hypoxia

You can risk suffering from a loss of motor control (LMC), also referred to as a 'samba' among some freedivers, if you push a breath-hold too far. Therefore, it is critical to learn and understand key preventative measures to ensure your own safety and the safety of your buddy.

HYPOXIA AND SAFETY

Freediving is not a dangerous activity provided that you are aware of the risks and follow important safety rules. Section 3.2 The Effects of Breath-holding explains that hypoxia induced by freediving may cause you to experience a number of **temporal effects** (e.g., a sense of euphoria) but that these effects do not cause any damage to your brain. If you are a healthy and fit freediver, you generally recover quickly after freedives with no lasting adverse effects. However, should the partial pressure of oxygen in your lungs and blood fall below critical level, you will suffer from **acute oxygen deprivation** and may experience a blackout.

The partial pressure of oxygen can decrease for two reasons:

- Oxygen consumed by your body.
- Ambient pressure that decreased on ascent from depth. This means that even though you may feel well at depth, you can become hypoxic on ascent simply due to the decrease in pressure.

It is important to recognize the warning signs of acute hypoxia, which can vary considerably from person to person. Remember to ascend well before experiencing any symptoms of hypoxia. To note, currently there are no pressure-resistant or waterproof pulse oximeters available which can monitor the partial pressure of oxygen, or in other words, the level of hypoxia in your body.

SIGNS AND SYMPTOMS OF ACUTE HYPOXIA

The most common symptoms of acute hypoxia include:

- Clouding of consciousness
- Disorientation
- Tunnel vision
- Increasing weakness of your body
- Feverish feeling in your body
- Heaviness in your muscles
- Strain in your neck muscles

Acute hypoxia may be also be characterized by the following signs:

- Loss of coordination
- Loss of balance

Surface immediately as soon as you notice any of the symptoms listed above.

The key to safe freediving is learning to read the symptoms of increasing levels of carbon dioxide in your body during a breath-hold. As you progress in your training, you become more **tolerant** to higher levels of carbon dioxide. However, you still experience these symptoms and you learn to judge when is the right time to end a breath-hold.

LOSS OF MOTOR CONTROL

A loss of motor control (LMC) is a late warning sign that can precede a blackout. Involuntary contractions generally develop in your neck, shoulders, arms, and occasionally in your leg muscles. These contractions are caused by **lack of oxygen** in the motor zone of your cerebral cortex. Although a loss of motor control may lead to a blackout, you can occasionally regain control over your muscles through good recovery breathing. Therefore:

- Carefully monitor all minor changes which take place in your body throughout a freedive. Watch for any symptoms of increasing carbon dioxide.
- End your breath-hold immediately if you experience any symptoms of acute hypoxia.
- Always end your breath-hold dive in a comfortable state with sufficient reserves.

BLACKOUT

After a hypoxic blackout in the dry (e.g., during a breath-hold exercise at home), you generally **regain consciousness** without assistance. However, if you are alone and a hypoxic blackout occurs while your airways are submerged in water, spontaneous recovery does not happen and so the danger of death is real. Should you blackout during a freedive, water does not enter your lungs for some time. This is due to the occurrence of a **laryngospasm**, which is a sudden involuntary spasm of your vocal folds due to an intense hypercapnic stimulus. Once your buddy brings you quickly to the surface and exposes your airways to air, this spasm usually stops and normal breathing resumes. Your buddy supports this by performing several cycles of Clear, Blow, Talk.

- **Clear** all facial equipment such as mask, goggles and nose clip.
- **Blow** onto the area below your eyes to dry your skin. This causes your skin receptors to signal to your brain that you can resume normal breathing. When practicing, just blow next to the face out of courtesy.
- **Talk** to you by calling your name and asking you to breathe. Your unconscious mind is able to recognise your name being called and this can help bring you back to consciousness.

This is explained in further detail in Section 10.3 Rescue Procedures.

Artificial respiration, known as rescue breaths, must be provided should you not recover from the initial attempts to revive you (**10–15 seconds** of Clear, Blow, Talk). Occasionally, for cases of severe hypoxia, rescue breaths should be given immediately at the surface. To note, you can still black out at the surface while actively breathing.

After regaining consciousness, you are generally unable to recall what has happened; therefore, you should be supported by your buddy until you are fully in control of your mind and body. You may suffer from fatigue, headache, vertigo, nausea, and body aches following a blackout. Changes in your body caused by acute hypoxia are reversible. Full recovery generally takes 1–2 days, so **do not freedive** until this time has passed and until you are **fully recovered**.

Following a blackout:

- If available, breathe pure oxygen for 5–10 minutes. This lowers the oxygen debt as quickly as possible.
- Have a good rest to accelerate recovery.
- Drink plenty of water.
- Eat nourishing and nutritious foods.
- Do not freedive for a minimum of 24 hours.
- Establish the reasons for your blackout and correct your technique prior to freediving again. Speak to your Molchanovs instructor if you require help to do this or if you have any questions.

Rescue procedures to be followed in the event of a loss of motor control or blackout are explained in detail in Section 10.3 Rescue Procedures.

PREVENTING LOSS OF MOTOR CONTROL AND BLACKOUT

The following is recommended to reduce the risk of a loss of motor control or blackout.

Relax mentally and physically

Relaxation of your mind and body is critical to ensuring both a safe and pleasurable experience before, during, and after a freedive. Preparing yourself mentally is important. The more relaxed you are, the better the freedive experience, the deeper the freedive, and the longer the breath-hold.

Practice and use correct relaxation and breathing techniques

Poor pre-dive preparation and recovery breathing can lead to a loss of motor control or blackout. Hyperventilation before a freedive can reduce the amount of carbon dioxide in your blood to such a degree that you do not subsequently experience the urge to breathe during the freedive, even when you are already experiencing symptoms of acute hypoxia. Therefore, it is recommended that you **avoid hyperventilating** before a freedive. Instead focus on your body scan and breathing. Finally, practicing a good recovery breathing technique and using it each time you surface is also important. Without correct recovery breathing, you are often unable to recover lost oxygen promptly enough, which may result in **acute hypoxia**.

Section 4.1 Basics of Breathing and Relaxation and Section 7.1 Technique: Visualization introduced you to a number of techniques which can help you relax before a freedive. Review these again now and practice them under the guidance of your Molchanovs instructor.

Freedive within your limits

A blackout can occur if you overestimate your ability and exceed your individual limits. Therefore:

- Be considerate of your personal limits.
- Freedive conservatively.
- Surface if you experience any symptoms of acute hypoxia.

The key to safe freediving is to **progress in good time**. There is no rush. **Repeat** your current freedive performance several times before setting your next goal (e.g., a deeper or longer freedive). Increase your goals in small and manageable increments.

Monitor your physical and mental condition

It is generally difficult to assess your **personal limits** before you start freediving as they are dependent on many factors: your physical condition, emotional state, and fatigue from recent training. For example, you use oxygen resources more quickly if you are stressed because activity, which causes muscle tension to increase. As a result, even if you have planned your freedive (i.e., depth, distance, and/or time), remember to:

- Constantly monitor your condition throughout your freedive.
- Listen to your body.
- End your freedive in good time.

As a beginner freediver, focus on relaxation, monitor all changes in your body, and ascend as soon as the first sign of discomfort in your breath-hold arises.

Focus on developing a good freediving technique

As a beginner freediver, it is important to spend time practicing, improving, and mastering your **freediving techniques** (e.g., equalization, body posture, and finning technique). At this stage, you generally use more oxygen in comparison to a seasoned freediver because you are developing and enhancing your techniques. As your techniques improve and your experience increases, you are able to monitor and recognize the warning signs and symptoms of hypoxia more easily. This significantly reduces the risk of acute hypoxia.

9.2 Barotrauma

Barotrauma refers to the physical damage of body tissues resulting from a difference in pressure between internal body cavities and the external environment. Freedivers often refer to a barotrauma as a 'squeeze' (e.g., a sinus barotrauma would be called a 'sinus squeeze').

BOYLE'S LAW

The following principle explains why a barotrauma occurs. Boyle's Law states that:

'The pressure and volume of a gas have an inverse relationship. As the volume of a container decreases, the concentration of the gas inside it and its pressure both increase.'

Therefore, as you descend and water pressure rises, the air volume in your lungs becomes smaller. However, there are a few air spaces in your body which do not change, or only change slightly in volume as the surrounding pressure rises. The middle ear and the sinuses are two examples, and you need to **equalize** these cavities as you descend.

MIDDLE EAR BAROTRAUMA

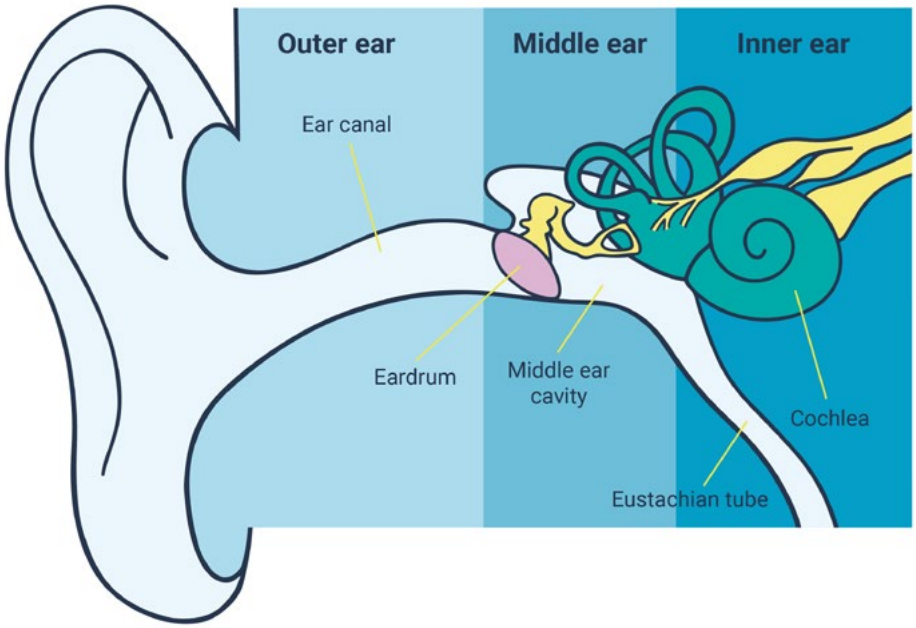

Figure 13. Middle ear anatomy

Your middle ear is surrounded by cranial bones and cannot change in volume. Your Eustachian tube is the auditory tube which connects your middle ear with the upper part of your throat behind your nose. If you do not equalize during a descent, your Eustachian tube remains closed. As a result, the amount of air in your middle ear remains the same as at the surface before your freedive, while ambient pressure increases with depth. This results in a **pressure difference** on both sides of your eardrum and the external and internal surfaces of the blood vessels in your middle ear. This causes your eardrum to curve inward and the walls of your blood vessels

to stretch. If the pressure difference is too high, your eardrum ruptures and or the weakest blood vessels tear. This is called a middle ear barotrauma.

There are three degrees of ear barotrauma. To note, either one or both ears can be affected.

Table 2. Degrees of ear barotrauma

MILD	MODERATE	SEVERE
Visible injury (otoscopic picture*)		
○ Moderate reddening and curving of eardrum	○ Pronounced redness of eardrum ○ Blood in middle ear from surrounding tissues	○ Rupture of eardrum
Signs and symptoms		
○ Ear pain ○ Stuffiness in ears	○ Severe pain ○ Feeling of stuffiness ○ Fluid in ears ○ Hearing impairment	○ Sharp pain in ear ○ Nausea ○ Vertigo ○ Bleeding from the external auditory canal ○ Hearing impairment ○ Ear infection
Length of recovery		
○ Heals within 2 weeks	○ Between 2 weeks and 2 months	○ May require up to 2 months for full recovery or surgery to repair damage

*An otoscopic image is what your doctor looks at during a checkup of your ears.

Should you rupture your eardrum, you may experience momentary pain and mild bleeding from your ear canal. This bleeding may not be apparent until you surface. Additionally, water can enter your middle ear and irritate your inner ear. A ruptured eardrum is classified as a **severe ear barotrauma**.

This may cause:

- Vertigo
- Nausea
- Vomiting
- Hearing impairment
- Pain

If you suspect you may have ruptured your eardrum during a freedive, **ascend immediately, stop freediving, and seek medical advice**. Ear barotrauma can also result from a wetsuit hood that is too tight or excessive earwax in your ear canal. Both can trap air in your ear canal during a freedive. The pressure of this trapped air becomes lower than the equalized air pressure in your middle ear, resulting in your eardrum curving outward toward your ear canal.

To avoid middle ear barotrauma:

- Frequently equalize pressure in your middle ear, ideally before you feel pressure in your ears. Do not wait until there is pain and discomfort.
- Before starting your freedive, allow some water to enter into your hood if it is tight.
- Stop your descent if equalization fails.
- Do not freedive if you are suffering from a cold, congestion, or inflammation in your upper throat.

If you suffer from an ear injury of any type:

- Keep the affected ear dry until fully healed
- Avoid blowing through your nose
- Avoid using alcoholic ear drops

Occasionally, you may hear a **squeaking noise** in your ears during equalization. This results from obstructed air passing through the Eustachian tubes. An obstructed Eustachian tube can result from:

- A swelling of your mucous membranes, Eustachian tubes, and upper throat.
- Your anatomical structure, such as a narrow or curved Eustachian tube.

If this occurs, equalize with particular care and do not try to compensate for the reduced air flow by applying excessive pressure during equalization. If you cannot equalize comfortably and in a relaxed manner, it is safer to stop freediving for the day.

INNER EAR BAROTRAUMA

Blowing too hard into your nose to equalize may cause an inner ear barotrauma. Key signs and symptoms are:

- Prolonged vertigo
- Gait disorders
- Impairment of orientation
- Nausea
- Vomiting
- Ear noise or tinnitus

Inner ear barotrauma may lead to temporary or permanent hearing disturbances. To avoid permanent hearing impairment, always **seek medical advice** if you experience any of the above.

To avoid inner ear barotrauma:

- Never force equalization
- Avoid freediving with any ear-related illness

If you have chronic ear disease or a hearing impairment, consult a doctor and take special care of your ears during your freedives. It is common to find that equalizing one ear is more difficult than the other. It is the **slower ear** that defines the speed of your descent. Should you fail to equalize during a descent, stop immediately and return to the surface.

REVERSE BLOCK

Ear barotraumas are unlikely to occur on ascent. This is because your Eustachian tubes open automatically when pressure in your middle ear exceeds the surrounding pressure. However, a condition called a middle ear 'reverse block' can develop during ascent. In this instance, air in your middle ear is blocked by a **closed Eustachian tube** (e.g., filled with mucus). The trapped air expands on ascent and causes pressure and pain in your ears. A reverse block can damage both your eardrum and your inner ear and can even cause a blackout if the pain makes it difficult to reach the surface.

Similarly, you may also experience a sinus reverse block if your sinus is filled with mucus on the ascent.

If you experience a middle ear or sinus reverse block, you should:

- Stop your ascent by holding on to the dive line.
- Move your lower jaw left, right, forward, and backward.
- Make swallowing movements.
- Continue ascending slowly should the blockage persist.

To avoid a barotrauma from a reverse block, avoid freediving when your respiratory tract is **inflamed** (e.g., with a cold or an ear infection). Also remember that the effects of any medication you take is **temporary** and can wear off during a freedive. This can result in a reverse block when you try to ascend.

VERTIGO

Vertigo is a condition where you have a false illusion that the world is spinning or swaying around you. Vertigo during a breath-hold dive can be caused by exposure of your inner ear to cold, middle or inner ear barotrauma, or reverse block. The sensation of vertigo is caused by unequal signals received by your inner ears. This can arise from **unequal states** of equalization or a barotrauma in one of your middle ears. This is also known as an 'alternobaric barotrauma.'

SINUS BAROTRAUMA

There is no need to specifically equalize your sinuses. When you equalize pressure in your middle ear on descent, pressure in your sinuses are normally also equalized. However, the openness of these channels may be **impaired** by inflammation, allergic reaction, or a rapid descent. The growing pressure differential may lead to an injury of your mucus membranes in the affected sinus cavities.

This is called a sinus barotrauma or 'sinus squeeze.' Typical symptoms include:

- Pain in the maxillary and/or frontal sinuses and the bridge of your nose.
- Bloody nasal discharge.
- Radiation of pain to your forehead, eye sockets, or upper teeth.

To avoid sinus barotrauma:

- Avoid freediving if you have a cold or are congested.
- Equalize your ears regularly.
- Stop your descent immediately if equalization fails.

Blood in your diving mask is usually a sign of either a sinus barotrauma or a nosebleed. A nosebleed can result from forceful equalization of the ears or can even be an **individual predisposition** unrelated to freediving. The following first aid can be provided when blood is seen in your diving mask:

- Keep your head upright. Do not tip it back as this causes blood to enter your throat.
- Avoid blowing your nose as this may further traumatize damaged blood vessels.
- Apply a cold wet cloth to your nose. The cold promotes vasoconstriction and slows the flow of blood.

Occasionally, you may find blood in your diving mask if you have a cyst (a small fluid-filled sac) in your sinus. Increasing pressure on descent may cause this cyst to rupture. When this happens, the contents of the cyst blocks the channels connecting your sinuses and the expanding air causes significant pain.

FACIAL BAROTRAUMA

Facial barotrauma, more commonly known as 'mask squeeze,' can occur when you fail to equalize your mask. Mask squeeze can result in damage of the capillaries in your eyes and skin. To avoid mask squeeze:

- Exhale regularly into your mask
- Never inhale from the mask space
- Release your nose pinch from time to time during equalization
- Use a well-fitting, low-volume mask
- Adjust the length of your mask strap so that it is not too tight

If you experience a mask squeeze, you should stop diving until the symptoms have completely disappeared.

DENTAL BAROTRAUMA

Dental barotrauma occurs when the pressure in air-filled cavities in your teeth changes. Air bubbles in a **dental cavity** (a hole in the tooth resulting from tooth decay) or under a **dental crown** can squeeze a nerve, which can cause pain. Occasionally, a toothache caused by barotrauma will disappear after surfacing, but it can also continue for a period of time until it subsides. To avoid dental barotraumas, see a dentist and mention to them that you are a diver to ensure any dental cavities are filled and to ensure that no air pockets are left behind.

9.3 Summary

1. Loss of consciousness or blackout during a breath-hold dive is caused by the partial pressure of oxygen in your brain dropping below a critical level.
2. The partial pressure of oxygen can fall due to oxygen consumed by your body and/or surrounding pressure decreasing on your ascent from depth.
3. Symptoms of acute hypoxia include: clouding of consciousness, disorientation, tunnel vision, increasing weakness in your body, a feverish feeling in your body, heaviness in your muscles, and strain in your neck muscles.
4. Acute hypoxia may be also be characterized by the following signs: loss of coordination and loss of balance
5. A loss of motor control (LMC), or 'samba,' is a late warning sign that can precede a blackout. Involuntary contractions usually develop in your neck, shoulders, arms, and sometimes legs, which are caused by a lack of oxygen in the motor zone of your cerebral cortex.
6. When you black out during a freedive, water does not enter your lungs for some time because of laryngospasm, a brief involuntary contraction of your vocal folds. When brought to the surface, an intense hypercapnic stimulus stops laryngospasm, which usually causes you to resume breathing naturally.
7. You can also black out while already on the surface and breathing actively. During a freedive, vasoconstriction (narrowing of the blood vessels) occurs, which causes body tissues receiving less blood than normal. This results in an increase in the total oxygen debt.
8. After suffering from a blackout, breathe pure oxygen if available for 5–10 minutes. Rest, drink plenty of water, and eat well-balanced and nutritious food to help recovery. Do not free-dive for a minimum of 24 hours. Establish the reasons for your blackout and correct your technique prior to freediving again.
9. Assess your abilities before freediving and only freedive in good physical and mental condition. Poor freediving techniques and improper breathing before and after a freedive can increase the risk of loss of motor control or a blackout.
10. A barotrauma occurs in body tissues located around air spaces. This is because pressure in these air spaces may differ from the ambient pressure during both descent and ascent.
11. To prevent middle ear barotrauma: equalize pressure in your middle ear before any discomfort is felt in your ears, let some water enter into your wetsuit hood if it is too tight, stop your descent immediately if equalization fails, and never freedive with inflammation in your nasopharynx or ears.
12. Symptoms of an inner ear barotrauma include: loss of orientation, vertigo, nausea, ear noise (tinnitus), and gait disturbances.
13. To prevent inner ear barotrauma, never force equalization.
14. Acute pain in your forehead during a freedive indicates that you have inflammation in your frontal sinus. Avoid freediving until you are fully recovered.

15. To prevent barotrauma in your sinuses, equalize pressure regularly, ascend immediately if equalization fails, and never freedive with a cold or any inflammation of your airways.
16. Excessively forceful equalization using the Valsalva maneuver is dangerous and may cause a lung injury if performed at depth.
17. To prevent facial injuries from mask squeeze: exhale into your mask by regularly releasing the nose pinch during equalization, avoid inhaling from your mask, and adjust your mask strap properly to ensure it is not too tight.

SAFETY AND RESCUE

‘You make new discoveries each day by entering the world of freediving and going deeper in both the literal and figurative sense. To enjoy these discoveries, you should be skillful enough to freedive safely. As a beginner, you should first learn three important things: to be yourself, to be at depth, and to be yourself at depth. The last is the most important of all.’

Natalia Molchanova

This chapter explains important safety procedures to follow when freediving, along with rescue techniques to be used in the event of a loss of motor control (LMC) or a blackout. The buddy system is also introduced.

10.1 Key Safety Measures

The following key safety measures are important to ensure comprehensive preparation and safe conduct during a freedive.

ALWAYS FREEDIVE SAFELY

The most important part of safety in freediving is **how you freedive**. Firstly, be well trained for your level, mentally and physically prepared, and in good health before considering freediving. Secondly, and even more important, is your attitude and approach when freediving. Be relaxed, progress and improve in small increments, and never push your limits. Be a responsible freediver.

Always consider the following prior to each freedive or training session:

- Always freedive with a trained buddy.
- Focus on good technique and relaxation. Avoid hyperventilation.
- Always take your snorkel out before a freedive.
- Always perform recovery breathing when surfacing from your breath-hold dive.
- If you feel unwell, restrict your freediving training to learning and fine-tuning your swimming technique at the surface. Avoid breath-holding.
- Freedive correctly weighted.
- Check weather conditions and currents. When in doubt, seek advice from local freedivers.
- Stay well-hydrated.
- Never push your freedive.
- Bring a buoy or float.

PROGRESS IN GOOD TIME

Progressing in good time is a sensible principle to remember and follow. It does not mean that you do not challenge yourself, but it does mean that you do so in a **controlled and planned manner**. For example, if you reach a specific depth for the first time, repeat freedives to this depth until you are fully comfortable with your performance. As a guide, this means that you can comfortably:

- Equalize at your target depth
- Spend a few moments at this depth before starting your ascent

Once, you have achieved this repeatedly, you are ready to add a few meters to your next freedive.

ALWAYS FREEDIVE WITH A BUDDY

Formerly, freedivers commonly freedived alone in rivers, seas, and oceans, sometimes at great risk to themselves. Nowadays, safety is paramount and is a fundamental part of freediving training. Some freedivers push beyond sensible personal limits (e.g., if they remain underwater for too long while trying to break a personal record or if they become too absorbed in their surroundings or the marine life). Freediving alone in these situations is extremely dangerous. Remember to always freedive with a **competent and qualified buddy** (i.e., a person who has taken a freediving course of equivalent level or higher) who can supervise and provide assistance if required. This applies to both training situations and recreational freedives. The importance of the buddy system is discussed in Section 10.2 The Buddy System.

RESPECT SURFACE INTERVALS

To date, there are no conclusive studies regarding what minimum surface intervals are required to ensure safe freediving. However, there is consensus in the freediving world regarding a **general rule of thumb** to follow, and this also includes both buddying and recreational freediving. We have defined and used conservative surface interval rules to keep our freedivers safe. Please use the following to calculate your required surface interval.

Rule 1: SI = P x T, where P is rounded up to the next full number.

Rule 2: Freedives deeper than 60m (197ft): **1 freedive in a 24h period**

Key:

SI = Surface interval

P = Maximum pressure in bar (or atm)

T = Dive time in minutes or seconds

Rule 1 is referenced from **Richard Wonka*

Examples

Example 1

A freedive to 7m (23ft) with a 30-second duration.

Using Rule 1, the minimum surface interval is 60 seconds **(SI = 2 x 30, 1.7 bar rounded up to 2)**.

Your surface interval is a minimum of **60 seconds**.

Example 2

A freedive to 15m (49ft) with a 36-second duration.

Using Rule 1, the minimum surface interval is 108 seconds, or 1 minute and 48 seconds **(SI = 3 x 36, 2.5 bar rounded up to 3)**.

Your surface interval is a minimum of **1 minute and 48 seconds**.

Example 3

A freedive to 28m (92ft) with a 60-second duration.

Using Rule 1, the minimum surface interval is 240 seconds or 4 minutes **(SI = 4 x 60, 3.8 bar rounded up to 4)**.

Your surface interval is a minimum of **4 minutes**.

Example 4

A freedive to 35m (115ft) with an 80-second duration.

Using Rule 1, the minimum surface interval is 400 seconds or 6 minutes and 40 seconds **(SI = 5 x 80, 4.5 bar rounded up to 5)**.

Your surface interval is a minimum of **6 minutes and 40 seconds**.

Example 5

A freedive to 48m (157ft) with a 100-second duration.

Using Rule 1, the minimum surface interval is 600 seconds or 10 minutes **(SI = 6 x 100, 5.8 bar rounded up to 6)**.

Your surface interval is a minimum of **10 minutes**.

Example 6

A freedive to 62m (203ft) with a 140-second duration.

Using Rule 2, freedives deeper than 60m (197ft): **1 freedive in a 24h period**.

Do not freedive for **24 hours**.

10.2 The Buddy System

Always freedive under the supervision of a competent buddy. A buddy acts as a safety freediver, playing a different role and using different techniques depending on the discipline (whether in the pool or open water). You will learn how to become a skilled and dependable buddy. Remember that freediving with a buddy not only keeps you safe, but is also more fun. The main responsibilities of a buddy are to **provide safety** and **assess the physical condition of a freediver** (i.e., their buddy) during their freedive and once they have resurfaced.

As a good buddy:

- Be attentive at all times.
- Know what your buddy is doing at all times and ensure your buddy also knows where you are and what you are doing.
- Be able to assess the physical condition of your buddy accurately and promptly.

- Provide accurate and prompt feedback about the hypoxic or physical load which results from a freedive. To note, your buddy cannot always feel or judge their personal limits accurately.
- Advise your buddy to avoid attempting the same distance or depth immediately again, or if their personal limits have been exceeded, advise them against further freediving.
- Be trained and proficient in rescue procedures.

Recognize the key signs which indicate that your buddy has exceeded personal limits:

- If your buddy surfaces from a breath-hold dive with blue lips, note it and tell them. This change of lip color can be caused by a slightly lowered but not yet dangerous level of oxygen in their blood. This is also called cyanosis. Your buddy cannot feel this and relies on you as their buddy to tell them. Blue lips can also be a sign of being cold (i.e., hypothermic). If this is the case, advise your buddy to stop freediving because they are using too much oxygen too quickly.
- If you notice one or more of the following signs: unfocused eyes or loss of motor control (LMC) after surfacing, a sudden exhalation, or an abrupt change in movement such as speeding up or slowing down towards the end of a freedive.

This is detailed further in Section 10.3 Rescue Procedures.

STATIC BREATH-HOLD BUDDYING

Static breath-hold training in the pool is performed stationary in shallow water under the supervision of a buddy. Prior to the breath-hold, the buddy team (i.e., you and your buddy) agree on time intervals for a safety check and which verbal or non-verbal cues will be given during the breath-hold and when. This could include a tap on your buddy's arm or shoulder, asking for a signal, or saying how much time has passed. **Regular checking is vital.**

For example, you may agree that you will notify your buddy that it is one minute prior to the planned breath-hold, then 30 seconds, and then the start. Then you may also notify your buddy every 15 seconds during their breath-hold. To note, notification of preparation and breath-hold times are very much a **personal preference**. Some freedivers like a verbal notification, others prefer just a tap. Some like to be checked regularly with time notifications while others like to be checked at random intervals with no indication of time.

During the breath-hold:

- Always stand next to your buddy.
- Conduct a regular and agreed-upon safety check on your buddy. At each check, your buddy must respond and indicate they are in control. They can do this by showing a visible hand signal (e.g., the OK sign or lifting an index finger).
- Confirm to your buddy that you have seen their signal either verbally or with another tap.
- Carefully monitor their body position and physical condition to ensure they do not black out.
- Keep them close to the pool edge at all times.

Towards the end of the breath-hold, your buddy holds on to the wall and places their feet on the pool floor while keeping their face immersed in the water. When they are ready to finish their breath-hold, they slowly bring their head out of the water and start recovery breathing. Continue to supervise this activity and prompt them to take their recovery breaths. Make an **assessment** of the physical and mental condition of your buddy at this point.

DYNAMIC BUDDYING

During dynamic disciplines in the pool, as a buddy, you swim above and to the side of the freediver (i.e., your buddy) to assess progress, monitor their condition, and ensure they are not in any danger. To note, you do not wear weights at the surface and you always use fins and a snorkel to ensure you conserve energy and are ready to assist at any time. As a buddy, practice '**sideways finswimming**' so that your fins stay submerged during the entire finning cycle. This way, you are able to easily stay head-to-head with a fast freediver. Your buddy swims close to the pool wall or a lane rope so they can grasp it immediately after finishing their freedive. Should your buddy experience difficulty keeping their head above water after they surface, help them stay up.

DEPTH BUDDYING

In depth disciplines, agree with your buddy on the estimated dive time of their next freedive and at what depth you will meet to return together to the surface. The meeting point should be at a minimum **one-third (1/3) of the target depth** of your buddy. Then, roughly calculate how long it will take you to get to the agreed meeting point and when to start your freedive. For example, your buddy estimates it will take 1 minute to complete a 30m (108ft) freedive. You estimate that it will take 10 seconds to descend 10m (33ft and one-third of the target depth) and 10 seconds to ascend to the surface. Therefore, you will begin your freedive at 40 seconds, meet your buddy at 10m at 50 seconds, and ascend to the surface together, completing the freedive in 1 minute.

During the freedive, meet your buddy at the agreed-upon depth and accompany them up to the surface. Do this by swimming face-to-face at about one arm's length away from the dive line, keeping the line positioned between you both. To note, pay special attention to your buddy's eyes as they ascend. If their focus changes, this is a strong warning sign and you must ascend next to your buddy and surface within arm's reach, ready to act when needed.

10.3 Rescue Procedures

The following procedures should be followed step by step in the event that your buddy shows visible signs of a loss of motor control (LMC) or experiences a blackout. Remember to respond to your buddy as quickly as possible, but without compromising the **quality of assistance** you provide.

Loss of motor control (LMC)

Your buddy may experience a loss of motor control after a freedive if their oxygen levels are too low. This is known by some freedivers as a 'samba' due to the jerky movements of the head, body, and limbs, and freedivers are often unaware that it is happening.

Blackout

A blackout is a loss of consciousness due to insufficient levels of oxygen in your body. A loss of motor control can result in a blackout if the freediver does not resume breathing quickly enough and their oxygen levels continue to drop.

KEY SIGNS

In dynamic or depth disciplines, it is easy to see if your buddy is in trouble because their movement is affected. They stop moving and generally exhale some air so you see bubbles. Although your buddy is not swimming in static disciplines, there are still visible signs.

Signs of LMC or blackout during a static breath-hold

The following signs can be identified during a static breath-hold:

- No response from your buddy after a repeated verbal and non-verbal safety check
- Sudden and strong exhalation of air
- Unfocused eyes after surfacing
- Convulsive muscle contractions after surfacing

Should your buddy experience an LMC, bring their head out of the water, help them keep their airways above the surface, and protect their head from hitting the pool wall.

Signs of LMC or blackout during a dynamic breath-hold

The following signs can be identified during a dynamic breath-hold:

- Slowing down to a stop
- Sudden acceleration and/or quicker arm strokes
- Decline or loss of technique (e.g., bicycle kicking)
- Loss of coordination
- Sudden and strong exhalation of air

RESCUE PROCEDURE FOR LMC

In the event that your buddy experiences an LMC, follow these key steps:

1. Prompt your buddy to breathe.
2. Support your buddy, keep their airways clear, and protect their head from hitting any hard objects, such as a pool wall.
3. Remove all facial equipment such as mask, goggles, and nose clip (also neck weight and hood, if needed).
4. Check for injury.
5. Once fully back in control, remind your buddy to stop freediving for the remainder of the day.
6. Assess why the loss of motor control occurred and understand how to prevent it from happening again.

RESCUE PROCEDURE FOR BLACKOUT

In the event that your buddy has a blackout, follow these key steps:

Return your buddy to the surface

If your buddy is still underwater, your main priority is to return them immediately to the surface:

- If your buddy blacks out in the zone of negative or neutral buoyancy, consider removing their weight belt and/or removing your own, particularly if they are heavy and/or you are quite small or inexperienced.
- If the blackout occurs in the zone of positive buoyancy, keep weight belts on. Lift your unconscious buddy to the surface as quickly as possible.

Follow these key steps:

1. Approach your buddy from behind.
2. Reach with one hand **under** their arm to the front of your buddy.
3. With the same hand:
    a. Close your buddy's mouth with the palm of your hand.
    b. Secure their mask by putting two fingers on the glass. This helps to ensure that their airways are closed. To note, a laryngospasm is a protective reflex activated by a blackout and is an involuntary closure of the vocal folds, which prevents water from entering the lungs. In this rescue scenario, it may help to keep the airways of your buddy from flooding, however, do not rely on it.
4. Place your hand on the back of your buddy's head, keeping their head straight and aligned with their body. **Do not tilt their head backward.**

5. Twist your entire body away from your buddy so that the outside of your hip is touching them. This allows you to move your fins freely. If you are rescuing someone who is not significantly taller, you may also extend your arms straight up over your head instead of twisting your hips away from your buddy.
6. Start finning and bring your buddy to the surface as fast as possible. Aim to surface next to the buoy during your ascent.

Perform the Clear, Blow, Talk technique

1. Once you have reached the surface, follow these key steps which include the Clear, Blow, Talk technique.
2. At the surface, keep their face and airways out of the water. Despite being positively buoyant at the surface already, drop their weights and yours if you haven't done so already.
3. **Clear** all facial equipment such as mask, goggles and nose clip.
4. **Blow** onto the area below their eyes to dry their skin. This causes their skin receptors to signal to their brain that they can resume normal breathing. When practicing, just blow next to their face out of courtesy.
5. **Talk** to them by calling their name and asking them to breathe. Their unconscious mind is able to recognize their name being called, which can help bring them back to consciousness. In the majority of cases, their body is waiting to be shown a signal that it is in a safe place where it can revive itself and begin breathing. The clearest signal is fresh air entering their lungs.
6. If they have not regained consciousness within 10–15 seconds, start giving rescue breaths. If no pulse is present, initiate CPR.

Provide rescue breaths

An unconscious freediver very often resumes breathing and regains consciousness without the need for any rescue breaths. However, should they not regain consciousness, follow these steps:

1. Lift them onto the poolside (if you are in open water and/or too far away from shore or a boat, continue the procedure in step 2 below with them floating face-up at the surface). Remember to keep their airways out of the water.
2. Open their airway by opening their mouth and tilting their head backward.
3. Support their head with one hand, pinch their nose with the other, and cover their mouth with your mouth to form a seal.
4. Breathe into their mouth, giving up to five rescue breaths. They should generally regain consciousness after a couple of rescue breaths. If you are in open water, keep providing rescue breaths while towing them to shore or to the boat.
5. Should they still not resume breathing, call emergency services for help and evacuate them to the nearest medical facility. If no pulse is present, initiate CPR.

6. If available, pure oxygen should be provided to accelerate recovery. The freediver should rest and stop freediving for the day.
7. Assess and understand why the blackout occurred and how to prevent it from happening again.

We strongly advise freedivers to take a reputable CPR and First Aid course. This is also a mandatory requirement for the Lap/Wave 3 — Master Freediving course.

POST-BLACKOUT CARE

After regaining consciousness following a blackout, you are generally unable to recall what has happened and should be supported by your buddy until you are fully in control of both mind and body. You may suffer from fatigue, headache, vertigo, nausea, and body aches following a blackout. Full recovery generally takes **1–2 days**. Do not freedive until this time has passed and until you are fully recovered.

Following a blackout:

- Stop freediving immediately for a minimum of 24 hours.
- Breathe pure oxygen, if available, for 5–10 minutes. This lowers the oxygen debt as quickly as possible.
- Have good rest to accelerate recovery.
- Drink plenty of water.
- Eat nourishing and nutritious foods.
- Before you freedive again, assess and understand why your blackout occurred and what you can do to prevent it from happening again.

The key to safe freediving is learning to read the symptoms of increasing carbon dioxide in your body. As you progress in your training, you become more tolerant of increasing levels of carbon dioxide. However, you will still experience these symptoms and learn to judge when is the right time to end a breath-hold. Freedive conservatively to avoid repeated blackouts and any resulting damage to your body.

10.4 Summary

1. Safe freediving depends mainly on your responsible behavior.
2. Always undertake freediving with a qualified buddy.
3. Be attentive and assess the physical condition of your buddy. Inform them about the hypoxic or physical load caused by their freedive, and if necessary, advise them against further freediving.
4. During static breath-hold, stand next to your buddy and carefully monitor their condition while keeping them close to the pool edge. Conduct regular safety checks. If your buddy loses control, they may not show an OK signal when tapped or asked repeatedly. They may also make a sudden, strong exhalation into the water or experience convulsive contractions in the neck and shoulders.
5. When your buddy undertakes a distance dive, swim sideways with fins and snorkel (without weights) above and to the side of them and monitor their movement. Signs of a loss of motor control or blackout during a distance dive include slowing down to a stop, suddenly speeding up, loss of coordination, exhalation of air, and convulsive muscle contractions.
6. If your buddy has blacked out, bring them to the surface immediately. Keep their face and airways out of the water. Remove facial equipment. Use the Clear, Blow, Talk technique: **Clear** all facial equipment. **Blow** onto their face. **Talk** to them by calling their name and asking them to breathe. If they do not regain consciousness within 10–15 seconds, provide rescue breaths. Should they still not resume breathing, call emergency services for help and evacuate them to the nearest medical facility. If no pulse is present, initiate CPR.
7. It is strongly advised for freedivers to take a reputable CPR and First Aid course. This is also a mandatory requirement for the Lap/Wave 3 course.
8. Following a loss of motor control (LMC) or blackout, do not freedive for at least 24 hours. Assess and understand why it occurred and how to prevent it from happening again.

EQUIPMENT

“Those who have never made breath-hold dives are usually very surprised when freedivers tell passionate stories about the freedives they have made on their journey to penetrate deeper and deeper into the water and to overcome personal fears and doubts. People wonder what attracts freedivers to deep blue water which can be almost completely black at depth. What drives them to set out on these challenging and unusual adventures? There is no single answer to this question. Each freediver has their own personal reasons.”

Natalia Molchanova

This chapter provides an overview of the basic equipment used by freedivers, together with recommendations on how to choose and maintain your equipment.

11.1 Competition Equipment

The following equipment is recommended for beginner freediving:

WETSUIT

Figure 14. Molchanovs SPORT Wetsuit 3mm

The thermal conductivity of water is 800 times higher than that of air. This means that the human body loses heat around 25 times faster in water than in air of the same temperature. To keep warm underwater, freedivers often wear neoprene wetsuits of varying thicknesses and surface types depending on the temperature of the water.

A wetsuit made with a **smooth skin** neoprene exterior combined with an inner lining of elastic fabric is the best choice for a beginner freediver. Although this is not the warmest wetsuit available, the inner fabric makes it easy to put on and take off the wetsuit without the need for lubricant.

A wetsuit made with an **open cell** interior lining provides good protection against the cold, and when combined with a fabric exterior, is more durable. The open cell lining clings to your skin, so a lubricant (e.g., baby shampoo or biodegradable shampoo/conditioner mixed with water, which has a less harmful impact on the ocean) may be needed to put on the wetsuit. Alternatively, it is easy to put this type of wetsuit on in the water.

A wetsuit with a **smooth skin neoprene exterior and an open cell interior lining** provides the highest thermal protection, but is also more fragile and difficult to put on and take off. This high-quality and usually more expensive neoprene wetsuit helps a freediver to feel more streamlined and unrestricted underwater.

A freediving wetsuit should be snug but not too tight, as this restricts normal breathing. When trying on a new wetsuit, take into account that it feels looser in the water than on dry land. To note, as you go deeper, the water pressure compresses your suit, gradually making it thinner and reducing its thermal protection and buoyancy. You should also consider the water temperature you generally freedive in as well as your tolerance to the cold when choosing wetsuit thickness.

Care and maintenance

To keep your wetsuit in the best possible condition, follow the guidelines below:

- Be sure not to use your fingernails when pulling the wetsuit into place or taking it off, especially as smooth skin and open cell wetsuits are susceptible to tearing with long fingernails.
- Rinse your wetsuit in fresh water after every saltwater freedive, otherwise, the build-up of salt crystals can damage the neoprene. If fresh water is not available immediately after a freedive, pack your suit into a plastic bag filled with some salt water to prevent the wetsuit from drying before you can rinse it in fresh water.
- Make sure to always dry your suit in the shade as direct sunlight, radiator heat, or fire heat can damage the neoprene.
- Store your wetsuit in a cool, dry place and avoid folding it for long periods of time.

NEOPRENE SOCKS AND GLOVES

Figure 15. Molchanovs CORE Gloves and Socks

Neoprene socks and gloves are used for cold water freediving. An inner layer made of open cell neoprene provides better thermal protection, while a nylon outer layer ensures high durability. Tuck your socks under your suit legs and pull your gloves over your sleeves for maximum streamlining.

WEIGHT BELT

Figure 16. Molchanovs SPORT Weight Belt

A weight belt compensates for the positive buoyancy of a freediving suit and helps you to pass through the zone of positive buoyancy on descent. The weight belt should be made of elastic rubber, silicone, or polymer so that it is **flexible** enough to be tightened around your hips. While silicone weight belts are stretchier, softer, and can be more comfortable, they are more expensive and less durable than rubber weight belts. Polymer weight belts are more durable than silicone and more elastic than rubber weight belts.

Note that freediving weight belts should be worn on the hips so your belly is free to expand while taking your one full breath. The Marseille buckle is generally considered to be the most reliable buckle as it has a quick release, allowing you to remove your weight belt easily in an emergency; spring-loaded buckles are also widely used for freediving. Metal buckles are recommended as plastic ones tend to be weaker, less durable, and can open suddenly without warning.

WEIGHTS

Figure 17. Molchanovs Lead Weights

Freedivers generally use lead weights either on a rubber belt or as a neck weight. During the descent, if weights are located on your hips, it is easier for you to perform your one full breath. Neck weights are typically more **streamlined**; however, it is recommended that you use a neck weight only once you become an experienced freediver as it can take some time to become accustomed to the feeling of having weight around your neck.

The weights on your belt should be adjusted according to the density of water you are diving in (e.g., fresh water lakes and pools or the ocean), your wetsuit thickness, your body composition, and the depth at which you wish to be neutrally buoyant. The weights should also be evenly spaced out on your belt.

Some general rules for choosing weights for an average person:

- **3mm wetsuit:** You may use 3kg (6.6lb) for freedives up to 20m (66ft) and 2kg (4.4lb) for freedives up to 30m (99ft).
- **5mm wetsuit:** You may use 5kg (11lb) for freedives up to 20m (66ft) and 4kg (8.8lb) for freedives up to 30m (98ft).

For your first in-water session, your instructor will assist you in choosing the right number of weights in accordance with the wetsuit you are wearing. From there, you will have a frame of reference to work from in the future. However, before you get into deep bodies of water, it is important to perform the **surface exhale test and adjust your weights accordingly** (see Section 2.3 Weighting for Freediving).

MASK

Figure 18. Molchanovs CORE Freediving Mask

A mask used for freediving should have a **low internal volume** so less volume of air needs to be equalized on the descent. It should also have a **soft skirt** so that it can compress comfortably between equalizations. Some masks have lower-profile nose pockets or more flexible material for freedivers with smaller noses. When selecting a mask, remember that it should fit your face perfectly.

Check for a good mask fit by following the steps below:

1. Flip the strap of the mask to the front and out of your way.
2. Look up.
3. Place the mask on your face without wiggling or pushing.
4. Have someone check if there are any gaps between the mask and your face. You can also verify this by inhaling through your nose and seeing if the mask sticks to your face.
5. Make sure that you can equalize with the mask on and verify that your fingers have easy access to your nose.

If the mask sticks to your face easily with no gaps and you are able to equalize easily with the mask on, it is a good fit.

Other factors to consider when choosing a mask are the curvature of the lens and the flexibility of the frame. A slightly curved lens improves peripheral vision but tends to distort the image seen. A flat lens gives a truer, though more restricted, field of vision. A flexible frame facilitates equalization, while a more rigid frame requires more effort to equalize. The choice is a personal preference.

Prior to first use, read the manufacturer label carefully. If you are using a glass mask that already has an anti-fog layer, use the mask as it is. If not, wash the glass lens with shampoo or toothpaste to remove the oily film which protects the lens during production; this prevents the mask from fogging during your freediving. If you are using a mask with plastic lens, use the mask as is (toothpaste will scratch the lens). If you are not sure, ask your Molchanovs instructor to assist you.

It is recommended that you wash your mask with shampoo or dishwashing liquid every two weeks. To prevent fogging, you can spit on the lens, rub it over the entire lens surface, and rinse in water right before you put the mask on. If you are using a mask with plastic lenses, **take special care** when transporting and storing the mask, as plastic tends to scratch and become damaged easily.

SNORKEL

Figure 19. Molchanovs CORE Freediving Snorkel

Freedivers use a snorkel when resting at the surface, freediving for exploration, and for supervising a buddy. These snorkels are simple snorkels with no need for valves or other features. If you plan to freedive along a reef, attach your snorkel to your mask at the back of your mask strap. If you are freediving to depth, you can either attach your snorkel to your mask or attach it to the buoy with a rope so that you do not lose it. Prior to your freedive, you can drop it from your mouth or pass it to your buddy and start your descent.

Never freedive with a snorkel in your mouth. In the event of a blackout, water rushes into your mouth through the snorkel and can make rescue extremely difficult.

BIFINS

Figure 20. Molchanovs CORE Silicone Bifins

Using stiff, long fins in the pool can be challenging if you are just starting to freedive because significant energy is expended trying to keep your legs straight while finning. Instead, you can use short rubber or silicone fins to develop technique, strength, and stamina during pool training sessions. Short fins especially help you master the **foundation of the flutter kick** by allowing you to keep your legs as straight as possible for maximum transfer of power. Additionally, freediving-specific short bifins like the Molchanovs CORE Silicone Bifins also have enough length and power for open water training.

Figure 21. Molchanovs Competition Bifins 2x Carbon

For open water training, you would typically use freediving bifins with long blades and soft foot pockets. For freedives to depth, long fins made specifically for freediving are more **efficient**. Blades are generally made of plastic, fiberglass, or carbon fiber, and foot pockets are made of rubber. The choice of blade stiffness depends on your technical skill, body weight, flexibility, and strength, although you should generally start with soft stiffness so they do not tire you out as you begin your freediving training.

Plastic bifins are strong, durable, and generally more affordable, but do not typically come in different types of stiffnesses. Fiberglass bifins are more flexible and responsive, but also more delicate and expensive. Carbon fiber bifins are considered premium due to their light weight and responsive feedback during the kick cycle, but are generally the most expensive blades you can purchase.

FREEDIVING LANYARD

Figure 22. Molchanovs PRO Freediving Lanyard 2

A freediving lanyard is an important **safety tool** that prevents you from getting lost in the open water. One end of the lanyard is attached to the dive line with a carabiner and the other end is attached to you. This keeps you close to the line in case of sudden current, enables you to find the dive line if you are diving in darker waters, and allows for rescue from the surface by simply pulling the dive line up with your buddy attached if your buddy blacks out deeper than you can reach (e.g., your equalization fails on the way down to reach them).

A freediving lanyard is mandatory:

- If you plan to freedive deeper than 20m (66ft)
- If the current is considerably strong
- When freediving beyond surface visibility

A freediving lanyard should have the following features:

- Strong enough to hold your weight
- Metal components are made of marine-grade stainless steel to prevent rusting
- Shaped to glide snag-free, even along thicker ropes
- A wide cuff with a quick-release tab that opens easily in an emergency (e.g., when the lanyard becomes entangled at depth)

- The flexible part of the lanyard should be approximately 1m (3ft) long and made of a non-twisting material to prevent it from tangling with the dive line (e.g., stainless steel wire enclosed in plastic casing)

To note, when freediving with fins, attach the freediving lanyard to your **wrist**. During FIM (Free Immersion) when pulling on a line, attach it to your **ankle**. During a CNF (Constant Weight No Fins), it can be attached to a harness, or alternatively, to a separate belt around your waist.

Do not attach the lanyard to a simple weight belt. Weight belts are not designed for this; if you are being pulled to the surface in an emergency via your lanyard, the weight belt may open or even potentially slip down your legs and off of your body. Additionally, if you or your buddy needs to remove your weight belt at depth in an emergency situation, the lanyard will go with the weight belt.

When you are not using your freediving lanyard, avoid carrying it or attaching it to the buoy in an open loop. This can result in either you or your buddy getting tangled in it and is particularly dangerous if you are in an emergency situation or rescue. Instead, twist and loop your lanyard twice or more as shown below.

Figure 23. Looped lanyard

In a competition environment, or for very deep freedives in general, a **counter ballast system** is used where a very heavy weight is attached to the other end of a dive line. In an emergency, this heavy weight on the counter ballast system can be released, enabling an unconscious freediver attached to the dive line by a lanyard to be lifted quickly to the surface in an emergency. In this extreme emergency situation, the lanyard becomes a vital piece of safety equipment, as it is the only connection of the freediver at depth with the dive line, and in turn, the counter ballast system.

11.2 Summary

1. The thermal conductivity of water is higher than that of air, which causes you to lose heat faster in water. To keep warm underwater, freedivers wear neoprene wetsuits of varying thicknesses and materials depending on the water temperature and their tolerance to the cold.
2. A freediving wetsuit should be snug but not too tight as this restricts normal breathing. Take into account that a wetsuit loosens in the water and the increasing water pressure compresses your suit at depth, making it thinner and reducing its thermal protection and buoyancy.
3. A weight belt and weights compensate for the positive buoyancy of a freediving suit and help you to pass through the zone of positive buoyancy on the descent. The weight belt should be made of elastic rubber, silicone, or polymer and have a quick-release buckle for emergency removal.
4. Freedivers usually use lead weights either on a weight belt or as a neck weight. The amount of weight depends on the density of water you are diving in (e.g., fresh water lakes and pools or the ocean), your wetsuit thickness, body composition, and the depth at which you wish to be neutrally buoyant.
5. A freediving mask should have a low internal volume and a soft skirt that saves air for equalization during a freedive. When selecting a mask, check that it fits your face perfectly, that you can easily pinch your nose to equalize, and consider your preference regarding the curvature of the lens and frame flexibility.
6. You should use a snorkel when resting at the surface, freediving for exploration, or supervising your buddy.
7. Long bifins made specifically for freediving are more efficient than shorter fins or scuba fins. The blades are made out of plastic, fiberglass, or carbon fiber. The choice of blade stiffness depends on your technical skill, body weight, flexibility, and strength, although freedivers should generally start out with soft stiffness.
8. A freediving lanyard prevents you from getting lost in the open water. One end of the lanyard is attached to a dive line and the other end attaches to you.

CONCLUSION

This manual was written to guide students taking the Lap/Wave 1 - Beginner Freediving course. The main topics covered serve as a basic foundation from which you may begin your own journey into the world of freediving.

This manual has covered the basic theories, principles and techniques of freediving, specifically:

- The laws of physics and how they affect you underwater
- The physiological changes which take place in your body during a breath-hold dive
- Pre-dive preparation, one full breath, and recovery breathing technique
- Equalization techniques which you can use during a breath-hold dive
- Mental techniques to relax and condition your mind before and during a freedive
- Availability of Molchanovs Base Training to improve your freediving
- Potential traumas that can affect freedivers
- Safety measures and the buddy system
- Rescue techniques
- Basic equipment used for freediving

Should you have any questions about the information contained in this manual, contact your Molchanovs instructor for further explanation. They can answer your queries and guide you through key learning points.

To note, it is very common at this stage to feel overloaded with new information and overwhelmed by a new experience. It is important to discuss any concerns you may have with your Molchanovs instructor. Through measured and regular practice at a pace suited to you, you will begin to develop your freediving skills and also understand the changes happening in your body.

Thank you for learning with Molchanovs!

GLOSSARY

Active safety	A designated freediver responsible for observing you throughout your training dives, beginning with your pre-dive breathing and ending once you have completed your recovery breathing without any signs of trouble.
Alternobaric barotrauma	Vertigo caused by unequal pressure stimulation in each ear. Occurs during descent, ascent, or immediately after surfacing from a dive.
Ambient pressure	The sum of atmospheric pressure and water pressure. This is measured in atmospheres or bar.
Apnea	The cessation of respiratory airflow. In freediving, this is a voluntary breath-hold during a freedive or with the face below the surface of the water.
Archimedes' Principle	Achimedes' Principle states: 'An object immersed in a fluid experiences a buoyant force equal to the weight of the fluid it displaces.' Therefore, there are two forces acting on the object: its weight and the buoyant force equal to the weight of the water it displaces.
Arrow position	A freediving position: arms extended and joined over your head.
Atmospheric pressure (atm)	The weight of atmospheric air measured in atm or bar. The atmosphere above you has a weight that is equivalent to approximately 10m (33ft) of water. Therefore, there is 1 bar of atmospheric pressure (atm) at sea level.
Bar	A unit of pressure equivalent to the weight of the earth's atmosphere at sea level. 1 bar equals 1 atm.
Barotrauma	The physical damage of body tissues that results from a difference in pressure between internal body cavities and the external environment. Also known as a 'squeeze' among freedivers.
Belly breathing	A breathing technique used for relaxation. Belly breathing involves inhaling by moving the upper part of the abdomen forward, which lowers the diaphragm. This brings air into the abdomen and expands the belly. Also known as 'abdominal breathing.'
Bifins	Fins specifically designed for freediving with long blades and soft foot pockets.
Blackout	A blackout is a loss of consciousness due to insufficient levels of oxygen in the body. A loss of motor control can result in a blackout if oxygen levels are not restored quickly enough.
Blood shift	Blood flow to your extremities is redistributed to your head and chest during a freedive.

Body scan	A relaxation technique you can use to prepare for a freedive to bring about an inner calm and peace of mind. It involves bringing awareness to different parts of the body in turn, finding any tension, and releasing this tension before moving to the next part.
Boyle's Law	Boyle's Law explains how the volume of a gas within an enclosed air space varies with the surrounding pressure. It states: 'At a fixed temperature, the volume of a gas is inversely proportional to the pressure exerted by the gas.' Therefore, as the pressure increases, the volume of the gas decreases proportionally.
BTV / VTO equalization	Béance Tubaire Volontaire in French or Voluntary Tubal Opening in English. You contract your soft palate muscles and upper throat muscles to hold the Eustachian tubes open. This equalization method does not require pinching your nose. Also known as 'hands-free equalization.'
Buddy	Your training partner who looks after and supervises you before, during, and after your freedive. A buddy trades roles from safety diver to diver and vice versa.
Buoyancy	The tendency of an object to float in water due to the upward force of the water pushing up.
Buoyant force	The buoyant force on an object immersed in a fluid is equal to the weight of the fluid it displaces. If the weight is equal to or less than the buoyant force, the object will float. If the weight is greater, it will sink.
Carbon dioxide (CO_2)	A colorless, odorless gas produced by burning carbon and organic compounds and by respiration. Carbon dioxide consists of a carbon atom bonded to two oxygen atoms. Also written as CO_2.
Cellular respiration	The process used by our cells to make energy available for activity. Oxygen molecules break down glucose molecules in our cells to produce energy in the form of ATP, which is then used by our bodies to power all functions. A byproduct of this process is carbon dioxide.
Chest breathing	An inhalation from the intercostal muscles only.
Clear, Blow, Talk	To be used in the event of a blackout. Clear all facial equipment such as mask, goggles, and nose clip. Blow onto the area below the eyes of the freediver to dry their skin. Talk to the freediver by calling their name and asking them to breathe.
Constant Weight (CWT)	A freedive to depth with the same weight for descent and ascent using bifins or a monofin. Any technique.
Constant Weight Bifins (CWTB)	A freedive to depth with the same weight for descent and ascent using bifins. No monofin kick.
Constant Weight No Fins (CNF)	A freedive to depth with the same weight for descent and ascent. No fins.

Contraction	An involuntary spasm in your respiratory muscles caused by an elevated level of carbon dioxide in your body and the rising urge to breathe.
Cyanosis	A bluish discoloration of the skin or mucous membranes due to a low level of oxygen in the tissues near the skin surface.
Duck dive	A technique used to dive head-first under the surface of water at the start of a freedive.
Dynamic No Fins (DNF)	A horizontal swim underwater with no fins.
Dynamic with Fins (DYN)	A horizontal swim underwater with bifins or a monofin.
Epiglottis	A flap of cartilage located at the top of your larynx near the base of your tongue which protects your glottis and prevents food from entering your larynx.
EQ Trainer	Also known as the 'Molchanovs Equalization Training Tool.' The EQ Trainer is a nosepiece with an attached balloon used for exercises to improve equalization technique.
Equalization	The equalization of pressure between your body cavities and the surrounding environment as you freedive to depth. There are three main air spaces to equalize: your ears (more specifically, your middle ear), your sinuses, and your mask. There are a number of techniques that can be used to equalize the pressure in your air spaces, including the Frenzel and Valsalva maneuvers.
Eustachian tube	A canal that connects your middle ear cavity to the upper part of your throat and the back of your nasal cavity. The pressure within your middle ear is managed by your Eustachian tube to ensure it is equal to the air pressure outside your body.
Free Immersion (FIM)	A freedive to depth by pulling down and then back up a dive line with the same weight for descent and ascent. No fins.
Freediving lanyard	A freediving lanyard prevents you from getting lost in the open water. One end of the lanyard is attached to a dive line and the other to you.
Frenzel maneuver	Pushing with your tongue or cheek muscles against your pinched nostrils to create air pressure.
Glottis	A group of muscles located around the vocal folds and the slit-like opening between them.
Hypercapnia	An elevated (higher than normal) level of carbon dioxide in your blood.
Hyperventilation	Breathing more air in and out than your body needs. Symptoms of hyperventilation include light-headedness, dizziness, tingling in the fingers or other parts of the body, euphoria, and an increased heart rate.
Hypoxia	An insufficient supply of oxygen to the body tissues.
Inner ear barotrauma	Ear damage caused by pressure differences between the inside of the ear and the outside of the ear.

Larynx	The larynx controls the flow of air and is also known as your 'voice box.'
Loss of motor control (LMC)	A late warning sign that can precede a blackout. Involuntary contractions generally develop in the neck, shoulders, arms, and occasionally in the leg muscles. A loss of motor control can happen following a freedive if your oxygen levels are too low, and you are often unaware that it is happening. A loss of motor control is sometimes known as a 'samba' among freedivers due to the jerky movements of the head, body, and limbs.
Mammalian Dive Reflex (MDR)	The bodily changes that happen during a freedive or freedive session that allow your body to function more efficiently under new conditions. They generally disappear when you resume breathing.
Mask	A freediving mask has a low internal volume and a soft skirt to save air for equalization.
Middle ear	The part of the ear between your eardrum and the oval window to your inner ear. The middle ear is also known as the 'tympanic cavity.'
Monofin	A single fin for both feet used primarily for freediving.
Nasopharynx	The upper part of your throat which connects with your nasal cavity above the soft palate.
Neoprene socks / gloves	Used for cold water freediving and made of open cell neoprene to provide better thermal protection.
Neck weight	A weighting system that goes around your neck, similar to an over-sized necklace, which can be easily removed in a rescue situation.
Neutral buoyancy	Neither floating nor sinking in a water column while being completely relaxed.
Neutral buoyancy check	A check at depth to determine your point of neutral buoyancy.
Nose clip	A device designed to hold the nostrils closed to prevent water from entering and air from escaping during water activities.
Oxygen (O_2)	A colorless and odorless gas. Oxygen consists of two atoms of oxygen in every molecule. Also written as O_2.
Oxygen debt	A cumulative deficit of oxygen resulting from intense exercise. This deficit should be balanced once the body is resting.
Partial pressure	The partial pressure of a gas is defined as: 'The total pressure multiplied by the fraction of the gas in the mix.' For example, the partial pressure of oxygen at the surface is 1 bar x 0.21 = 0.21 bar.
Passive safety	A designated person who can see your activities and respond to any obvious signs of trouble (e.g., pool lifeguard).
Pre-dive breathing	The focus is on the rhythm of your breathing and the movement of your abdomen to prepare for a breath-hold. The aim of pre-dive breathing is to maximize psychological relaxation.

Recovery breathing	Recovery breathing consists of active inhalations and long exhalations against light resistance. The main goal of recovery breathing is the elimination of oxygen debt and fast recovery after a breath-hold. Also known as 'post-dive breathing.'
Rescue breaths	Artificial respiration.
Residual volume (RV)	The volume of air in the lungs after a maximum exhalation, which is approximately 20% of the total lung capacity (TLC) for the average person.
Reverse block	A reverse block can develop during ascent. In this instance, the air in the middle ear is blocked by a closed Eustachian tube, for example, if plugged by mucus. The trapped air expands on ascent causing pressure and pain in the ears.
Ruptured eardrum	Classified as severe ear barotrauma, a ruptured eardrum can give rise to the following symptoms: vertigo, nausea, vomiting, hearing impairment, and pain.
Safety diver	A freediver who has a dedicated role in a training or competition setting and whose task is to act as a safety diver in the session without performing dives for themselves.
Snorkel	Used by freedivers when resting at the surface. Freedivers use simple snorkels without valves.
Sinus barotrauma	An injury of the mucus membranes in your sinuses. Also known as a 'sinus squeeze' among freedivers.
Sinuses	Four pairs of air-filled spaces that surround your nasal cavity. Your frontal sinuses are above your eyes, your maxillary sinuses are located under your eyes, your sphenoidal sinuses are behind your eyes, and your ethmoidal sinuses are between your eyes.
Soft palate	The soft palate separates your nose and mouth cavities and directs the flow of air in and out of your lungs.
Static (STA)	A breath-hold while lying face down and stationary on the surface of the water.
Surface exhale test	A safety check at the surface before freediving to ensure you are not overweighted. You should remain at the surface after a comfortable, passive exhale.
Surface interval	The required minimum time spent at the surface between two freedives to minimize the risk of decompression illness.
Tongue locks	There are four different Frenzel Maneuver tongue positions (referred to as 'locks') to enable equalization: the P, T, K, and SP locks.
Total lung capacity (TLC)	The total amount of air in our lungs after a maximum inhale.
Valsalva maneuver	Exhaling against pinched nostrils and using the air in your lungs to create pressure.
Vertigo	A sensation of feeling disorientated or off balance. You may have a false illusion that the world is spinning or swaying around you.

Visualization	A simple mental technique that you can begin to use before a freedive. This involves imagining each step of the freedive you are about to perform in great detail.
Vocal folds	Comprised of two folds of mucous membrane lying horizontally across your larynx. Also known as 'vocal cords.'
Water pressure	The weight of the water column above the body. Increases by 1 bar every 10m (33ft) of depth. Also known as 'hydrostatic pressure.'
Weight belt	A rubber, silicone, or polymer belt worn around the waist to which lead weights are attached. Used to compensate for the positive buoyancy of a wetsuit and to aid the descent.
Weights	Lead weights worn either on a rubber, silicone, or polymer belt around the waist or as a neck weight.
Wetsuit	Used by freedivers to keep warm underwater. Freediving wetsuits are available in various materials and thicknesses and are chosen according to the temperature of the water.

TABLES AND ILLUSTRATIONS

TABLES

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