

Research update from NTNU

university – industry collaboration in baromedicine






The Dealing with depths project

- Four-year research collaboration (2018-21/22)
- Led from NTNU, funded by the Norwegian Research Council and Equinor via the PRSI pool
- 100% dependent on diver participation and access to TechnipFMC dive campaigns
- Focused on physiological mechanisms involved in saturation divers' health and fitness
- Also includes studies of decompression sickness in sports- and recreational divers

NORMAL ADAPTATIONS TO SATURATION DIVING







- Mild anemia development

Hemoglobin During and Following a 4-Week Commercial Saturation Dive to 200 m







 Damian Łuczyński¹,  Jacky Lautridou¹,  Astrid Hjelde¹,  Roxane Monnoyer¹ and  Ingrid Eftedal^{1,2*}

- Changes in the divers' bacterial flora

Shifts in the Oral Microbiota During a Four-Week Commercial Saturation Dive to 200 Meters

 Roxane Monnoyer^{1*},  Kjersti Haugum^{2,3},  Jacky Lautridou¹,  Arnar Flatberg²,  Astrid Hjelde¹ and  Ingrid Eftedal^{1,4}

Functional Profiling Reveals Altered Metabolic Activity in Divers' Oral Microbiota During Commercial Heliox Saturation Diving

 Roxane Monnoyer^{1*},  Ingrid Eftedal^{1,2},  Astrid Hjelde¹,  Sanjoy Deb^{1,3},  Kjersti Haugum^{2,3} and  Jacky Lautridou¹






DISEASE AFTER DIVING

- Decompression sickness

Acute Effects on the Human Peripheral Blood Transcriptome of Decompression Sickness Secondary to Scuba Diving

 Kurt Magri¹,  Ingrid Eftedal^{2,3},  Vanessa Petroni Magri⁴,  Lyubisa Matity⁴,  Charles Paul Azzopardi¹,  Stephen Muscat¹ and  Nikolai Paul Pace^{5*}

Hemoglobin During and Following a 4-Week Commercial Saturation Dive to 200 m

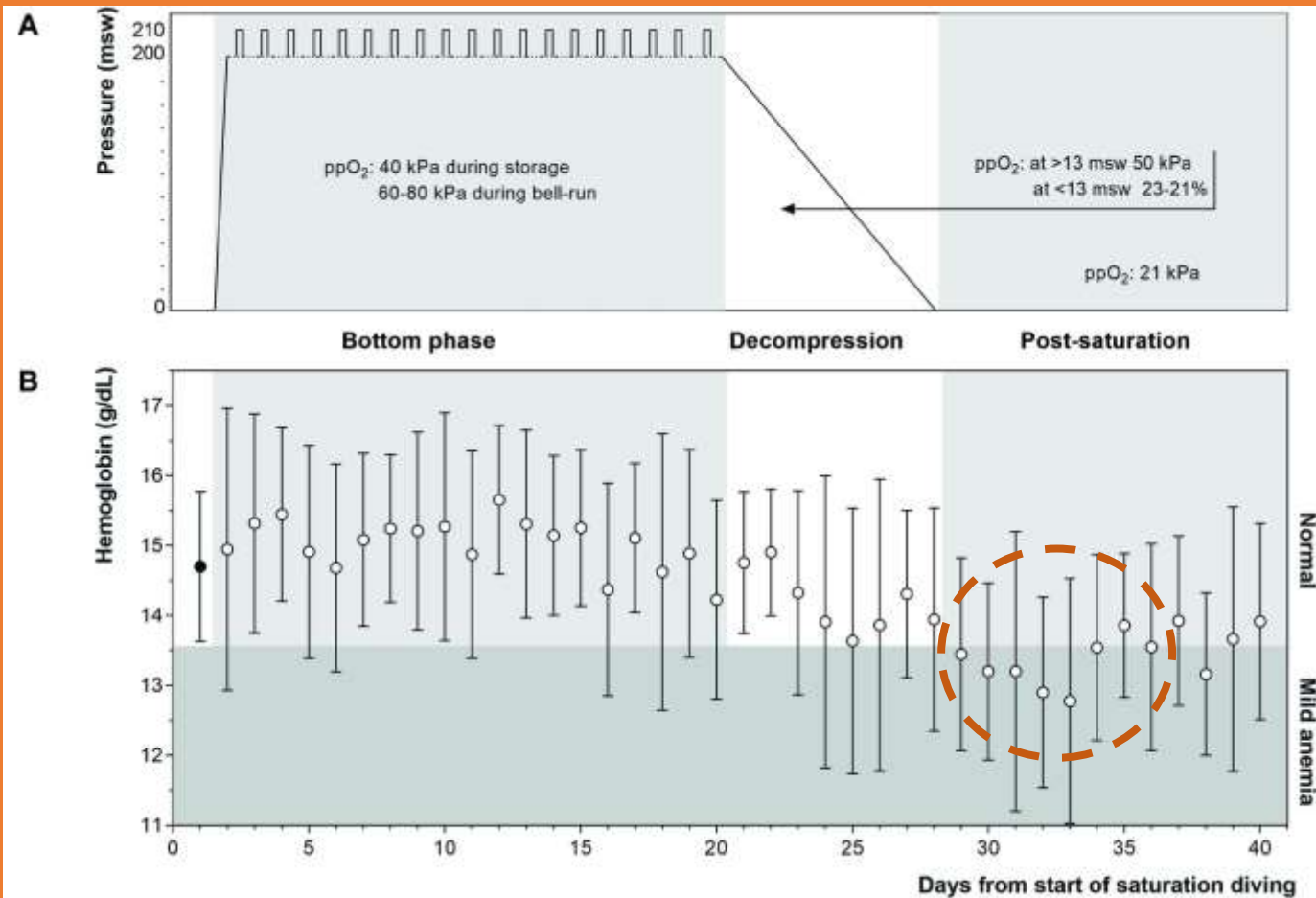
 Damian Łuczyński¹,  Jacky Lautridou¹,  Astrid Hjelde¹,  Roxane Monnoyer¹ and  Ingrid Eftedal^{1,2*}

- Fatigue is common in the first days after saturation diving.
- Anemia can cause fatigue, and hemoglobin levels are low in people with anemia.
- We monitored 11 divers' hemoglobin daily through a 4-week saturation dive, and for about 2 weeks after.
- The divers did the hemoglobin readings themselves. We collected and analyzed the data.



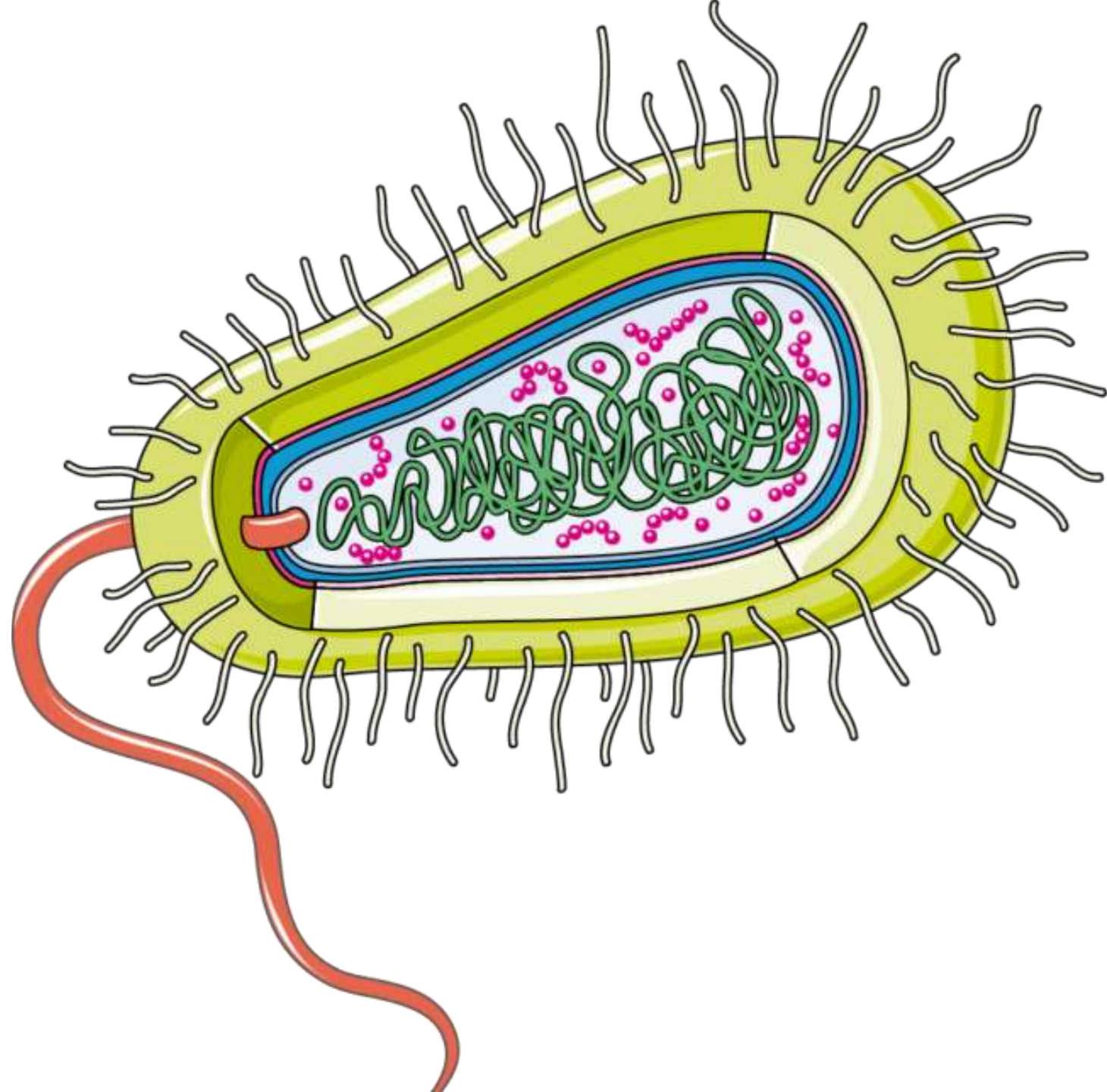
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The divers were mildly anemic for one week after saturation

Over to Roxane



What happens in the oral cavity
during saturation diving?

What do we know?

- **Saturation diving:** affects all life present
- **The healthy oral cavity:** home to over 700 bacterial species
 - Oral bacteria are classified according to their **oxygen needs**
- **Oral microbiota:** microorganisms inhabiting the oral cavity
 - **Interactions** with the host: symbiotic relationships to keep the host healthy
 - **Diversity** due to the host's lifestyle or the environment of the oral cavity

Why does it matter?

- Environmental adaptations of the oral microbiota in contact with the breathing gas during the heliox saturation dive

- **Composition?**

- Identify the types of bacteria present in the divers' mouth



Why does it matter?

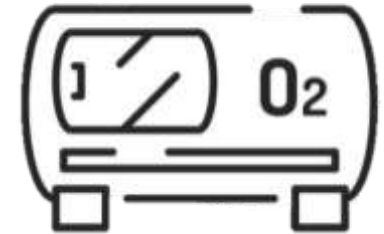
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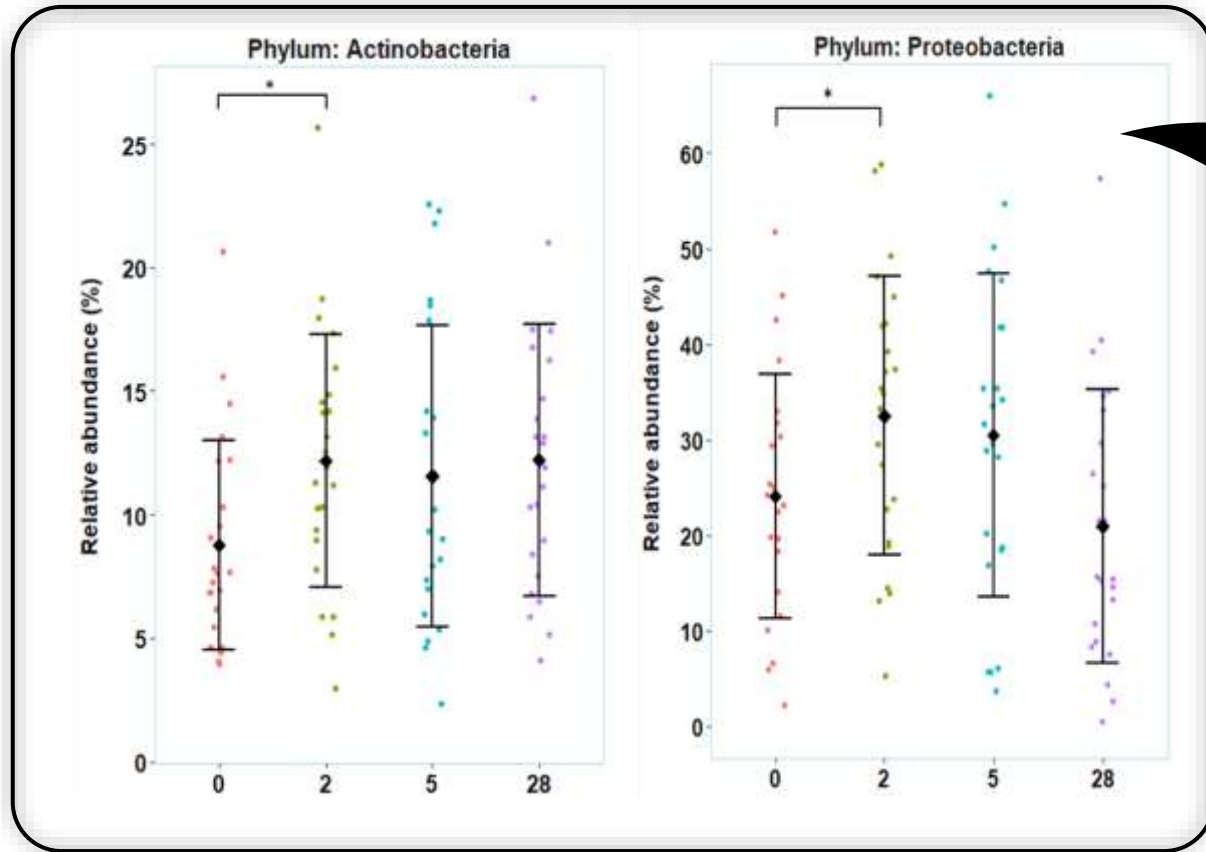
- **Activity?**

- Investigate whether changes in bacterial composition affect the divers' health and fitness



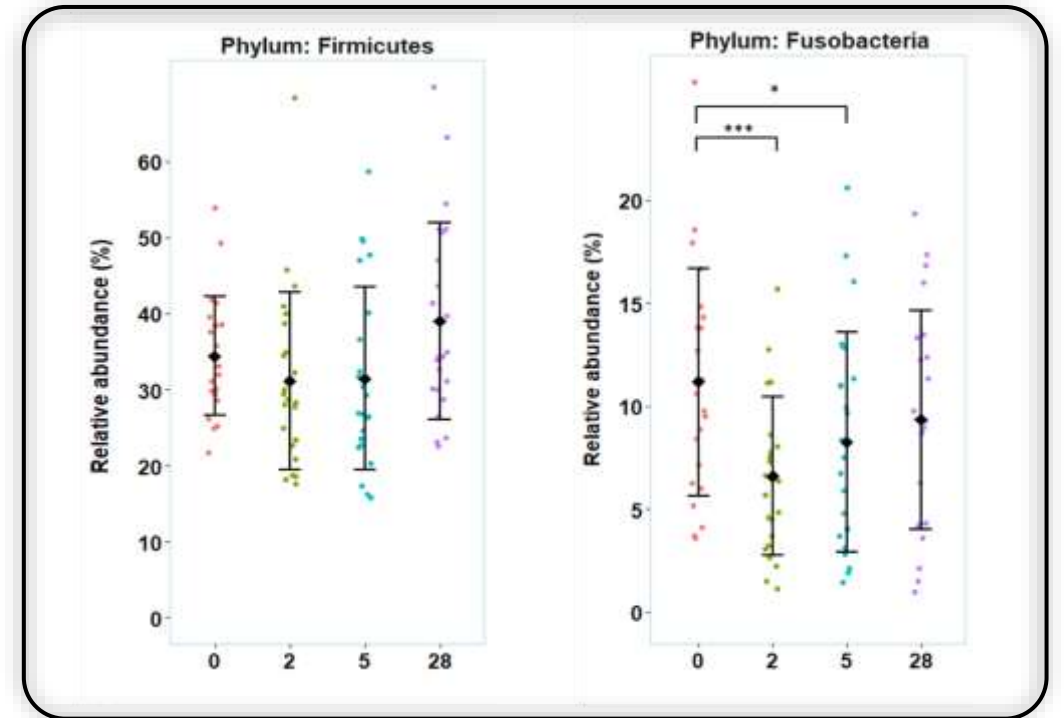
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Increase of facultative anaerobes/aerobes

Bacterial composition

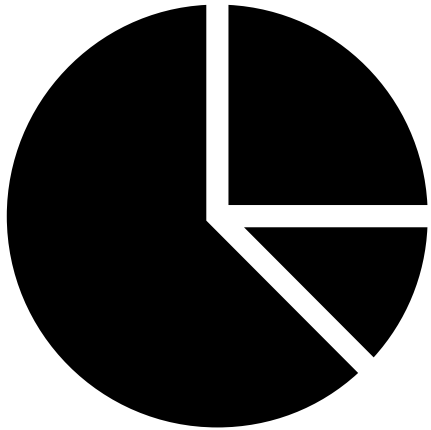


Decrease of obligate anaerobes

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Composition of the oral microbiota

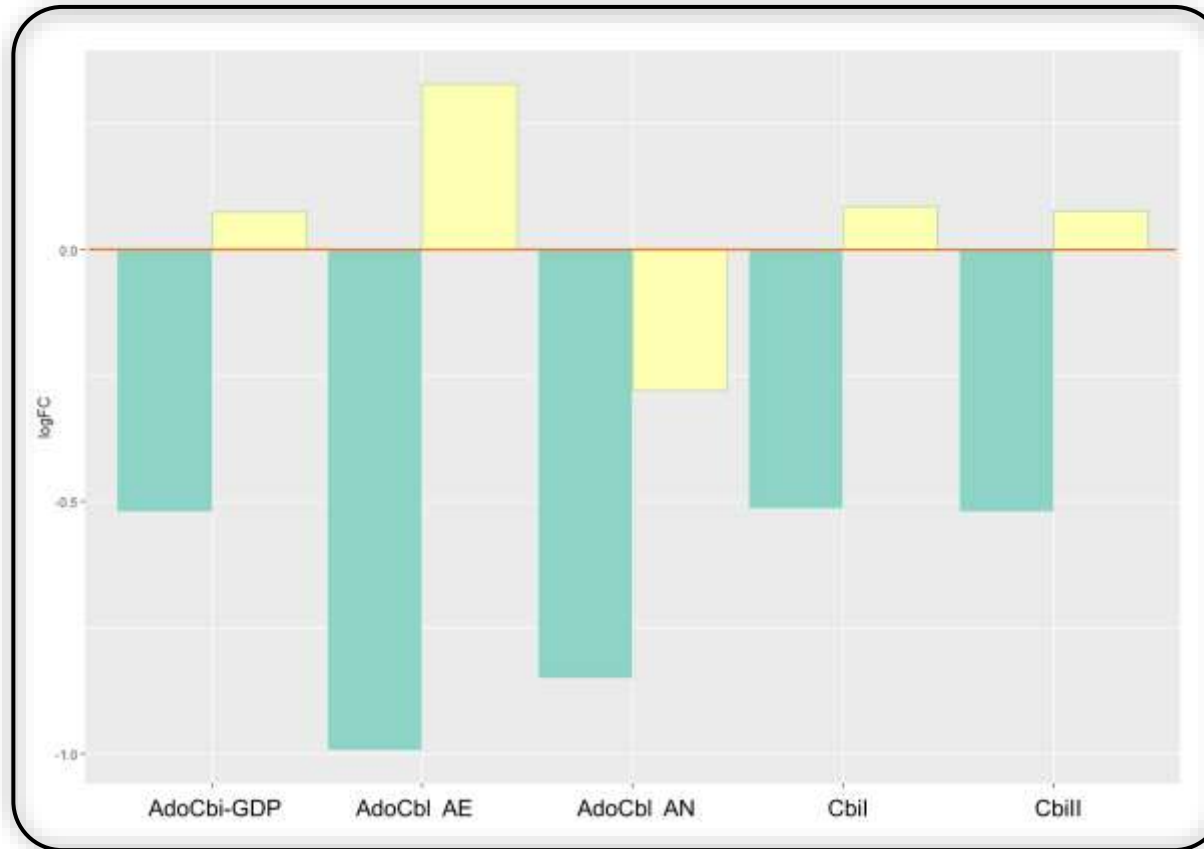


- ✓ Reduction in the bacterial complexity
- ✓ Shift of aerobic bacteria over anaerobic bacteria
- ✓ Transient changes during the heliox dive

Vitamin B₁₂ biosynthesis

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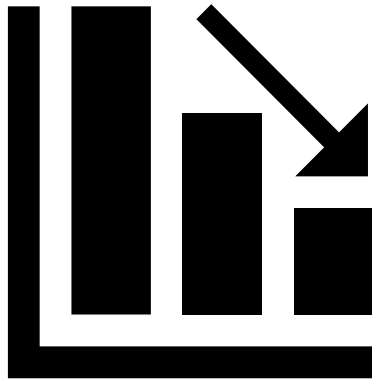
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Bottom phase
Post-saturation





“Vitamin B₁₂ and folate are involved in the production of red blood cells and are linked to EPO activity”
(Deb, Swinton, & Dolan, 2016)

Activity of the oral microbiota



- ✓ Decrease in vitamin B₁₂ biosynthesis
- ✓ Supports the nutritional recommendations for vit.B₁₂ supplements as part of the divers' diet

Acute Effects on the Human Peripheral Blood Transcriptome of Decompression Sickness Secondary to Scuba Diving

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Mapping inflammation and immune responses in decompression sickness

Decompression sickness (DCS)

is caused by dissolved gases emerging from solution in the form of bubbles inside body tissues during decompression

Why did we perform this study?



The pathophysiology of DCS is not completely understood



There are limited treatment options



10-20% of cases result in long-term sequelae



Better understanding of the pathophysiology may identify druggable targets

The necessary ingredients for the DCS study



Clinical competence and treatment facilities



Analytic platforms for molecular biology and bioinformatics



Divers with and without DCS

The grail

Malta





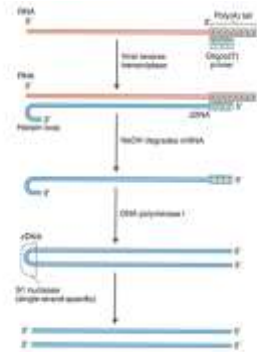
Cutis marmorata in divers with DCS

- A cardinal sign when appearing in divers with suspected DCS
- Appears in type 1 DCS (non-neurological), with high likelihood for progression into neurological DCS
- Hypnotized to be caused by:
 - 1) local formation of bubbles in the skin or blood vessels; or
 - 2) arterialization of venous bubbles across a right to left shunt (RLS/patent foramen ovale)

The analysis



**Blood RNA
extraction**



**Conversion to
cDNA + library
prep**



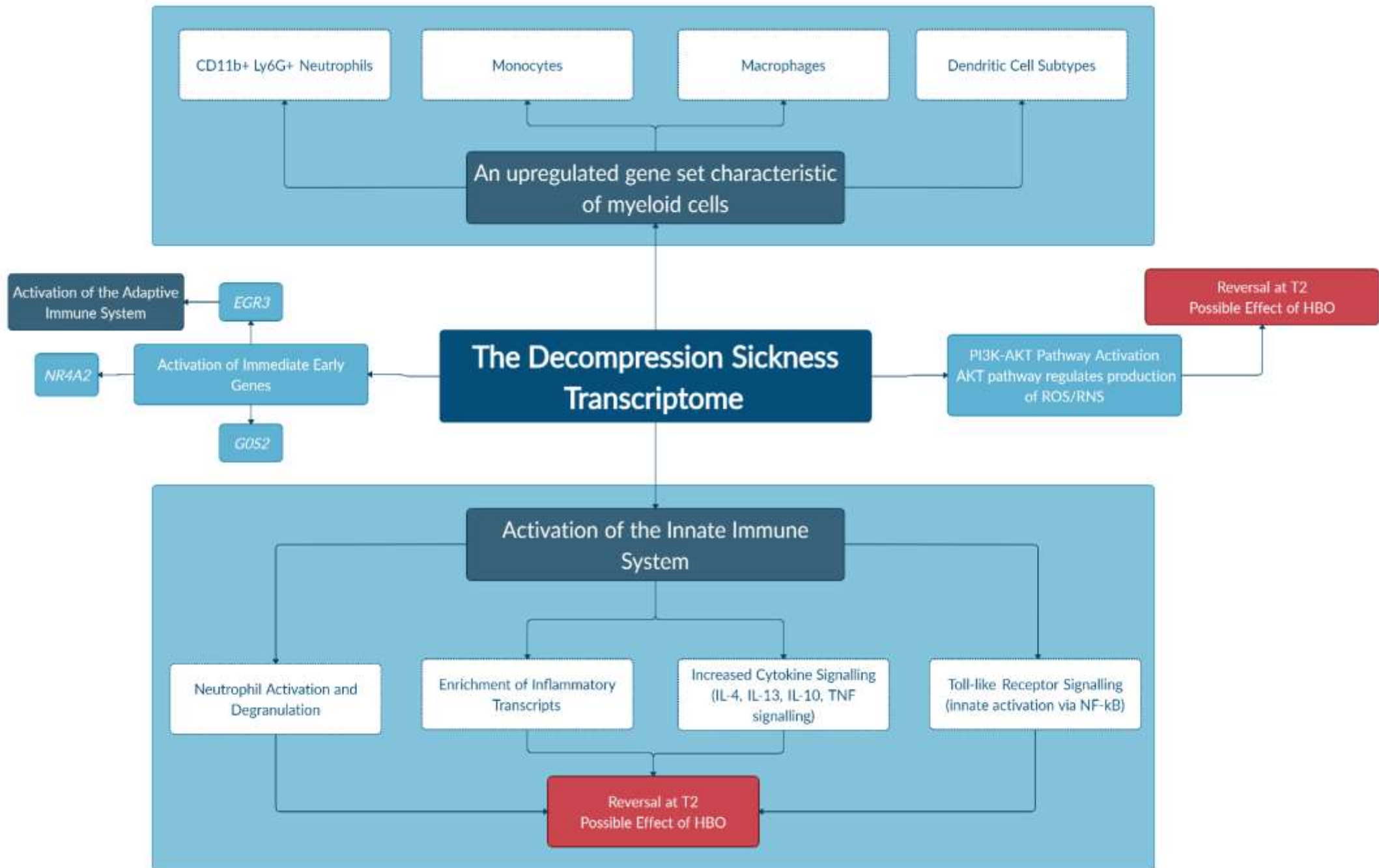
Sequencing



**Bioinformatics:
Data processing
and statistics**



**Biological
interpretation**





**Gene Expression Changes
Common to Diving and DCS**

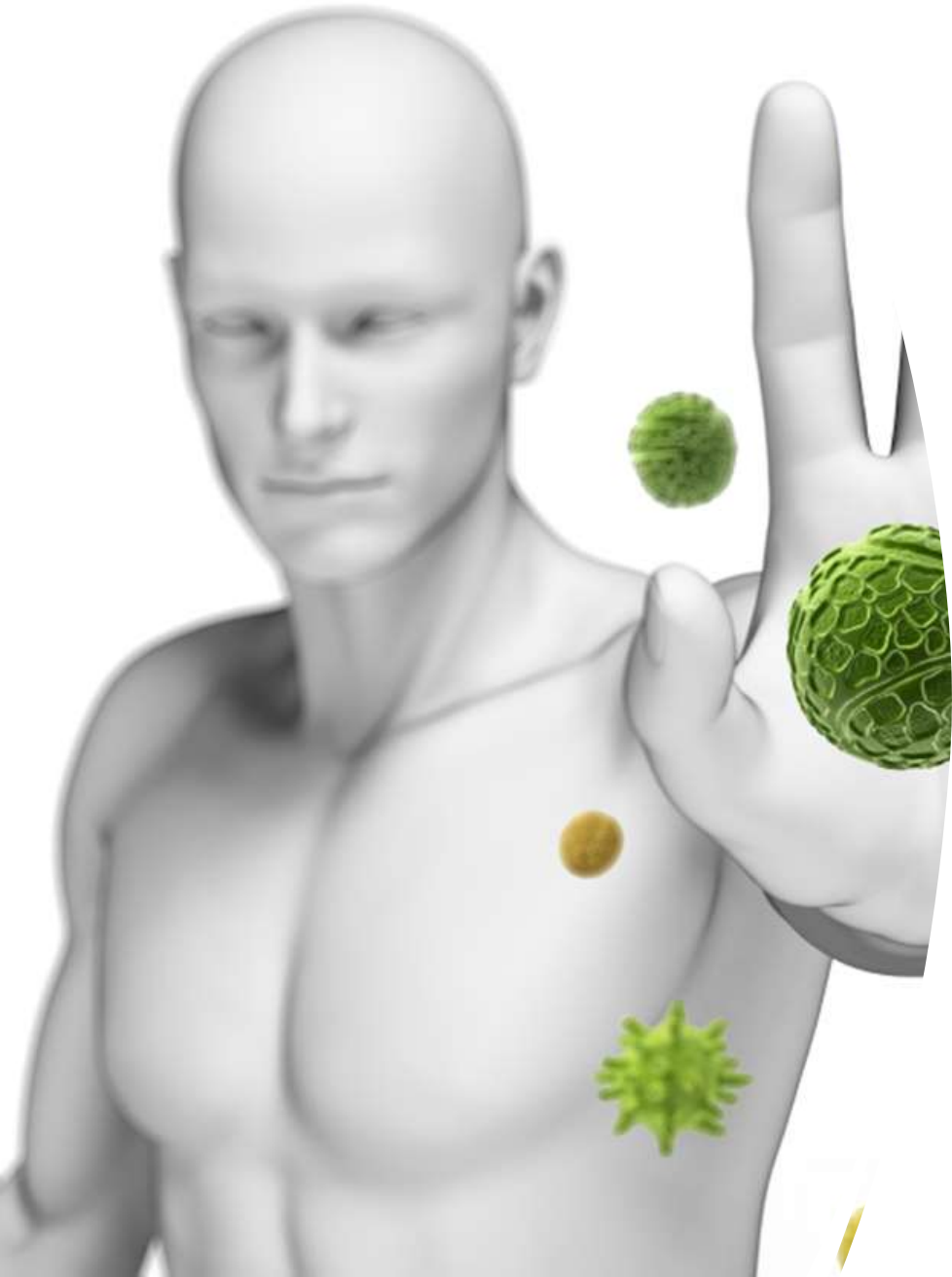
Upregulation of Genes expressed by
Myeloid Cells

Main conclusions

DCS is accompanied by a dynamic regulation of **inflammatory and innate immune pathways**, with a pronounced increase in activity characteristic of the myeloid lineage. “

Oxidative stress: “there is prominent activation of free radical scavenging mechanisms.

When the levee breaks: Our findings reinforce the role of acute inflammation in DCS and provide evidence for a continuum between the physiological response elicited by uneventful diving and diving complicated by DCS



How can we apply the results?

The long-term goal: Biomarker development for rapid identification of DCS vs. differential diagnoses.

Fundamental physiology: Improved understanding of the interplay between environmental stress and pathophysiological responses.



Come talk with us in the
exhibition area 😊