# Dolphins Have a Mysterious Network of Veins That Could Be Key to Preventing the Bends

**It might be possible to make an external device that protects divers from the deadly condition**

By Matthew Berger, Smithsonian.com, MAY 25, 2018

Inside the chests of dolphins and toothed whales there is an anatomical mystery: a maze of tiny, worm-like blood vessels called the "thoracic rete," the purpose of which has long baffled scientists. Joy Reidenberg, an anatomist at Mount Sinai's Icahn School of Medicine, thinks she she's figured out what it's for. If she's right, it could hold the key to developing a device that would be able to prevent the deadly condition that all divers fear: the bends.

Reidenberg is one of several researchers whose work is narrowing in on how marine species manage to dive down to—and safely return from—the oceans' depths. And that growing understanding of the anatomy of dolphins, whales, turtles and fish is bringing dreams of allowing human divers to dive deeper, faster and more safely a little bit closer to reality. Reidenberg examined 10 dead dolphins and porpoises that were stranded onshore to trace the connections between the mysterious blood vessels and the rest of the animals' anatomies. What she found was a network that she suspects could work as a sort of "coin sorter" for gases, trapping the nitrogen bubbles that form as divers resurface by catching them in smaller and smaller vessels. This in turn keeps them away from entering joints and blocking blood supply to organs, which can cause lethal decompression sickness, aka the bends. She still needs to fully test this theory, but other recent research seems to lend credence to her idea. A study published in April by researchers at the Woods Hole Oceanographic Institution and the Fundacion Oceanografic in Spain found that marine mammals' lungs compress under pressure in such a way that nitrogen bubbles are kept out of the bloodstream.

It's different in humans. As you dive deeper, increasing pressure causes the nitrogen in the air you've breathed to dissolve into your blood. Rise too quickly and that nitrogen un-dissolves to form gas bubbles in the bloodstream, where they expand and can get stuck in joints and vital organs. Without marine mammals' adaptations, divers need to rise slowly, often with breaks, to avoid this problem. That allows the nitrogen bubbles time to gradually work their way from the blood to the lungs, where they can be exhaled at the surface—the way you'd carefully, slowly open a soda can to release the gases that have built up under pressure.

To test her theory of the rete's function, Reidenberg would pump a seltzer-like solution through the veins of a dolphin carcass and place that carcass inside a recompression chamber that's been inserted in a CT scanner. As she increases the pressure to simulate a dive, the gases in the fluid would dissolve into the bloodstream. Then, as the nitrogen begins to reemerge as "microbubbles" during the simulated ascent, the thoracic rete would — hopefully — siphon them off to keep them away from vital organs until they can be released into veins leading the lungs to be exhaled at the surface.

"As they get closer to the surface, the bubbles would be shunted out and the lungs would be able to re-expand and the bubbles eventually pumped to lungs," Reidenberg says. The rete would act as a sort of "bypass loop to catch that extra gas." If that function of the rete is proven, the risks and wait time for human divers could be slashed—by creating, essentially, an external rete for humans. The possibilities are significant: Imagine Navy SEAL divers doing covert ops, Reidenberg says. "The last thing you'd want is for them to be sitting ducks a few yards from the surface, waiting at the last decompression stop, which is the longest stop. Nowadays, they might forgo that stop, surface faster and risk getting the bends." But if they had a device tucked away on their backs, hooked into their circulation system via a blood vessel near the surface of the skin, the dive would be faster and safer—both from a health and military perspective. It would be bulky at first, but, Reidenberg says, no more so than an IV system a hospital patient might be hooked into.

Not everyone is convinced about the future of such a device. “People have been looking at diving animals for decades wondering how they deal with the depth and pressure,” says Laurens Howle, a mechanical engineer at Duke University who has worked on modelling the severity of the bends in different scenarios. He says Reidenberg’s theories about the rete are interesting and “could be the case,” but he noted that a difference between marine mammals and terrestrial ones is that they take one breath at the surface before diving. We, meanwhile, breathe continuously through air tanks, which means we have more nitrogen available to form bubbles. As for the bulky protoype? “Yeah, I don’t know that I would want to try that,” says Howle.

Interestingly, marine mammals aren’t always successful as avoiding the bends. Recent research on whale skeletons has revealed that even whales can get bone damage characteristic of the bends. Unexpected stressors like sonar are thought to be the main culprit, shocking the animals into speeding toward the surface, causing them to decompress their lungs too quickly. Anti-bends ideas aren’t the only things we can learn from such animals when designing the next generation of diving technology. One of the biggest advancements inspired by marine mammals are flippers based on dolphin anatomy. The “monofin” has been around since the 1970s and has slashed dive times for free divers by replacing our awkward two feet with a dolphin-like fluke. There have been several advances on that fin since then to make it even more dolphin-like.

“It looks just like the tail of diving mammals like whales, dolphins, etc., as it provides a very efficient way of transferring power from your muscles into forward thrust in the water. Hence why nature has adopted it,” said Stephan Whelan, creator of the online diving community DeeperBlue.com. Other fins copy the bumps, or tubercles, humpbacks have on their flippers, which reduce drag and improve maneuverability. “They’ve been used in windmills, fans, a McLaren race car spoiler. The UK company Zipp used them on bike wheels. Airplanes, of course. Speedo produced a training fin called Nemesis,” says Frank Fish, a biologist at the University of West Chester in Pennsylvania who has developed a number of biomimetic products — applications inspired by animal physiology — including the humpback-inspired tubercles. There are new wetsuits that have copied the overlapping teeth-like denticles of shark skin to reduce drag, and goggles that copy how fish and some flowers trap water to create a clearer view.

Some animal adaptations, however, aren’t mimicable. John Davenport, a marine biologist at University College Cork in Ireland, has worked to figure out how and why leatherback sea turtles’ trachias, which progressively collapse as the animals dive deeper, are built the way they are. He calls the structure “basically an alternative, 140-million-year-old evolution” of marine mammals’ respiratory structure. But, he said, “I’m afraid that I can’t see an obvious use of the leatherback tracheal structure in human diving.” Copying the collapsing lungs of dolphins and whales seems unfruitful, too; human lungs are sticky and don’t readily reinflate once they’ve collapsed. But that could be another, perhaps even more valuable, way in which we could mimic marine mammals’ anatomy. Reidenberg is still searching for funding to pursue a bends-preventing diving device, but in the meantime she has already begun trying to learn from the animals’ lungs. In a new collaboration, she has teamed with other researchers to map the vascular system of a fetal whale in an effort to figure out how whale lungs change their elasticity and how we can apply that to reversing lung diseases like emphysema in humans. It’s one more way in marine mammals might help us find a way to breathe easier—in the water and on land.

**Article Questions**

1. What is the purpose of the thoracic rete?
2. Which organisms are researchers studying to learn more about the thoracic rete?
3. Describe the “coin sorter” concept discovered by Reidenberg.
4. How does the breathing of marine mammals and terrestrial mammals differ?
5. What advantage did the “monofin” offer divers?
6. How are the trachias of sea turtles unique?