

Creating artificial gills

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Questions 1-10

You will hear a woman giving a talk at a popular science convention. She is describing research into artificial gills designed to enable humans to breathe underwater.

Complete the notes below.

Write **NO MORE THAN TWO WORDS** for each answer.

Creating artificial gills

Background

- Taking in oxygen; mammals - lungs; fish - gills
- Long-held dreams - humans swimming underwater without oxygen tanks
- Oxygen tanks considered too **1**..... and large
- Attempts to extract oxygen directly from water
- 1960s - prediction that humans would have gills added by **2**.....
- Ideas for artificial gills were inspired by research on fish gills fish swim bladders animals without gills - especially bubbles used by **3**.....

Building a simple artificial gill

- Make a watertight box of a material which lets **4**..... pass through
- Fill with air and submerge in water Important that the diver and the water keep **5**.....
- The gill has to have a large **6**.....
- Designers often use a network of small **7**..... on their gill

Main limitation - problems caused by increased **8**..... in deeper water

Other applications

- Supplying oxygen for use on **9**.....
- Powering **10**..... cells for driving machinery underwater

Solution:

- | | |
|------------|-----------------|
| 1. heavy | 6. surface area |
| 2. surgery | 7. tubes |
| 3. beetles | 8. pressure |
| 4. gas | 9. submarines |
| 5. moving | 10. fuel |

Audioscript:

In my talk today I'll be exploring the idea of artificial gills. I'll start by introducing the concept, giving some background and so forth and then I'll go on to explain the technological applications, including a short, very simple, experiment I conducted.

Starting with the background ... As everyone knows, all living creatures need oxygen to live. Mammals take in oxygen from the atmosphere by using their lungs, and fishes take oxygen from water by means of their gills, which of course in most fishes are located either side of their head.

But human beings have always dreamt of being able to swim underwater like the fishes, breathing without the help of oxygen tanks. I don't know whether any of you have done any scuba diving but it's a real pain having to use all that equipment. You need special training, and it's generally agreed that tanks are too heavy and big to enable most people to move and work comfortably underwater. So scientists are trying a different tack: rather than humans carrying an oxygen supply as they go underwater, wouldn't it be possible to extract oxygen in situ, that is, directly from the water, whilst swimming?

In the nineteen sixties the famous underwater explorer Jacques Cousteau, for example, predicted that one day surgery could be used to equip humans with gills. He believed our lungs could be bypassed and we would learn to live underwater just as naturally as we live on land. But of course, most of us would prefer not to go to such extremes.

I've been looking at some fairly simple technologies developed to extract oxygen from water - ways to produce a simple, practical artificial gill enabling humans to live and breathe in water without harm. Now, how scientists and inventors went about this was to look at the way different animals handled this - fairly obviously they looked at the way fishes breathe but also how they move down and float up to the surface using inflatable sacs, called swim bladders. Scientists also looked at animals without gills, which use bubbles of air underwater, **notably** beetles. These insects contrive to stay underwater for long periods by breathing from this bubble which they hold under their wing cases.

By looking at these animal adaptations, inventors began to come up with their own 'artificial gills'. Now making a crude gill is actually rather easy - more straightforward than you would think. You take a watertight box ... which is made of a material which is permeable to gas, that is, it allows it to **pass through**, inwards and outwards. You then fill this with air, fix it to the diver's face and go down underwater. But a crucial factor is that the diver has to keep the water moving, so that water high in oxygen is always in contact with the gill, so he can't really stay still. And to maximise this contact it's necessary for your gill to have a big surface area. Different gill designers have addressed this problem in different ways but many choose to use a network or lattice-arrangement of **tiny** tubes as part of their artificial gills. Then the diver is able to breathe in and out - oxygen from the water passes through the outer walls of the gill and carbon-dioxide is expelled. In a nut-shell, that's how the artificial gill works.

So, having read about these simple gill mechanisms, I decided to create my own. I followed the procedure I've just described and it worked pretty well when I tried it out in the swimming pool ... I lasted underwater for nearly forty minutes! However, I've read about other people breathing through their gill for several hours.

So the basic idea works well, but the real limitation is that these simple gills don't work as

the diver descends to any great depth because the pressure builds and a whole different set of problems are caused by that ... Research is being done into how these problems might be overcome . but that's another story which has to be the subject of another talk!

Despite this serious limitation, many people have high hopes for the artificial gill and they think it might have applications beyond simply enabling an individual to stay underwater for a length of time. For example, the same technology might be used to provide oxygen for submarines ... enabling them to stay submerged for months on end without resorting to potentially dangerous technologies such as nuclear power. Another idea is to use oxygen derived from the water as energy for fuel cells. These could power machinery underwater, such as robotic devices ...

So, in my view, this is an area of technology with great potential. Now, if anyone has any questions, I'd be happy to answer ...