Science and the Sea

Always in Hot Water

Whether the temperature is high or very cold, most aquatic animals are in hot water when it comes to breathing. This is because they all require oxygen to survive, but water holds very little oxygen.

In a cool stream, there is about 20 times less oxygen than in air, and as water warms it holds even less oxygen. In warm tropical seas, there is 50 times less oxygen than in the sea air. To make matters worse, water is a very dense and sticky substance, which makes it difficult to extract its oxygen.

To solve these problems, many aquatic animals breathe through gills, which provide a very large surface area bathed by water. The total surface area of a fish's gills can be 10 times the surface area of the skin in slow or sedentary fishes, such as flounders, and up to 60 times the area of the skin in very active fishes, such as tunas. This is possible because of the very complex structure of the gills, with lots of tightly packed filaments and microscopic folds.

Rather than breathing in and out, like air-breathing animals, fishes pump water across the gills continuously, in one direction – in the mouth and out through the gill slits. This saves a lot of energy because the flow of water does not need to be stopped and reversed with every breath. As the oxygen-laden water flows over the gills in one direction, the oxygen-poor blood inside the gills flows in the opposite direction. This so-called "counter-current exchange system" maximizes the diffusion of oxygen into the fish's blood.

These adaptations to life underwater help fishes catch their breath even when they're in hot water.

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