Marine O_2 and CO_2 Cycles: The Basics – Tutorial Script

All life can be separated into autotrophs and heterotrophs. **Heterotrophs** acquire their food by eating other organisms. **Autotrophs** make their own food, usually through a process called **photosynthesis**. Photosynthesis depends on the pigment known as **chlorophyll**, which absorbs all light energy except green. Chlorophyll reflects green light back to our eyes, which is why chlorophyll-containing autotrophs look green to us. Chlorophyll absorbs energy from the Sun and uses that energy to combine carbon dioxide and water molecules to produce sugar molecules. Sugar is a stored form of energy, which can be converted, when needed, into the energy used for things like growth and reproduction. The breakdown of sugar to release that stored energy in called **respiration**. All organisms must perform respiration, because all organisms need to grow and reproduce.

Decomposition, like respiration, is a process whereby the sugars in organic material are broken down back into their original components: carbon dioxide and water. Decomposition is assisted by bacteria and other organisms that feed on dead or discarded organic material, such as fecal pellets, exoskeleton molts, and dead carcasses – all of which tend to accumulate as they sink to the bottom of the seafloor.

When organic material and shells fall to the seafloor and collect, if they get buried before they decompose, then they can get incorporated into rocks and become part of the lithosphere.

Through photosynthesis, respiration, decomposition, and rock formation and weathering, carbon dioxide and oxygen are exchanged and transferred between **reservoirs** – temporary storage areas for these gases. The primary reservoirs for the oxygen and carbon dioxide cycles are the biosphere (organic material stored in living organisms), the atmosphere, the oceans, and the lithosphere (stored in rocks). In any given reservoir, carbon dioxide and oxygen are continually moving in and out based on what processes are at work. When carbon dioxide or oxygen is removed from a reservoir, we describe the location from which it has come or the process that has transported it, a **source**, and the location to which it goes, a **sink**. For example, photosynthesis removes carbon dioxide from the oceans and puts it into autotroph or heterotroph sugars, basically the living body. The reservoir it left, the source, is the oceans. The reservoir it travels to is the sink, in this case the marine organism itself, or the biosphere.

Which of these processes produces carbon dioxide gas as a byproduct? Decomposition, respiration, rock weathering (which includes fossil fuel burning on land), diffusion from the atmosphere, and volcanic outgassing (yep, volcanoes also erupt carbon dioxide, but not oxygen). Meanwhile, processes that remove carbon dioxide include photosynthesis and sediment deposition and burial. Conversely, oxygen is produced through photosynthesis and removed through decomposition and respiration.

Diffusion from the atmosphere is where most of the ocean's carbon dioxide and oxygen originally came. The distribution of that carbon dioxide and oxygen within the ocean is primarily controlled by rates of decomposition, respiration, and photosynthesis.

Pause now.

Can you pull together all these important processes that control carbon dioxide and oxygen distribution in the oceans and explain what we see in the actual distribution? This graph shows generalized carbon dioxide and oxygen concentrations with deptth. Notice that carbon dioxide is lowest and oxygen is highest at the surface. Whereas at depth, oxygen is much lower, and carbon dioxide is at its highest. Can you guess why? And at about 1000 meters depth, oxygen reaches its minimum (referred to globally as the oxygen minimum layer). Piece together what you know and see if you can come up with a logical explanation for all of these variations. One thing that might help: At about 1000 meters depth, there is a large congregation of marine heterotrophs – fish, jellyfish, and plankton – that hang out in darkness during the day to avoid their predators and then rise to the surface at night to feed. This congregation is known as the Deep Scattering Layer.

Pause now.

[end credits]

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