Paleoclimate

Unlocking Past Climate Secrets

Dr. Prabhin Sukumaran
CHARUSAT-Changa

Reviewed by:
Prof. Stanely Ambrose, UIUC-USA
Dr. Naveen Chauhan, PRL-India

Everyone around the world is concerned about climate change and sustainable practices.

But can we really predict what will happen to our climate in the future?

To make accurate predictions, we need to understand our planet's past better!

- So, how do scientists figure out what the climate was like millions of years ago?
- The answer lies in the science taught in schools.
- For instance, in your 4th-grade textbook, students learn about the parts of a leaf and the process of photosynthesis.

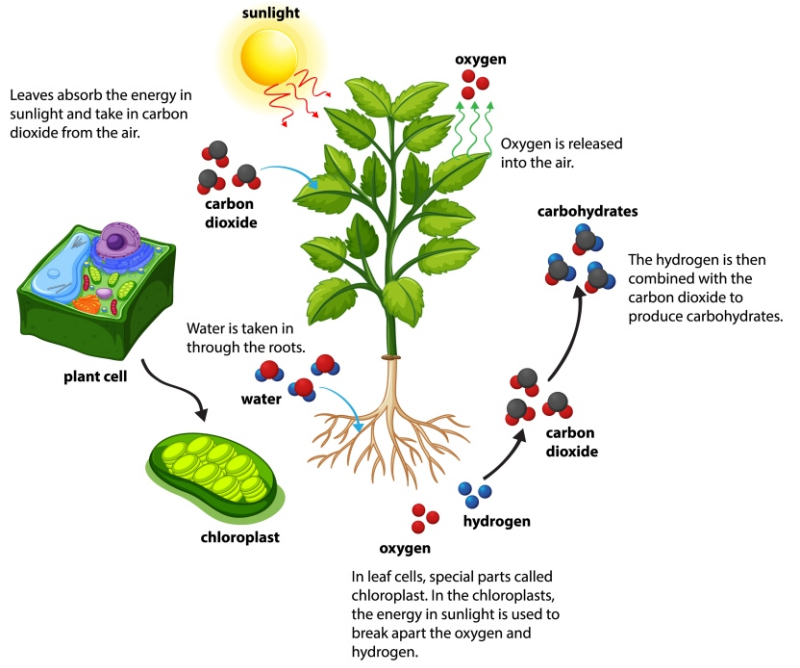
But did you know that these same PRINCIPLES are used by world-famous scientists to uncover the secrets of Earth's ancient climates and climate change?

Let's understand some facts!

Every plant takes carbon dioxide from the air through a process called photosynthesis. Plants make (synthesize) their own food using sunlight (photo), carbon dioxide and water! Climate and environment affect photosynthesis in ways that scientists can measure. Imagine Earth as a big history book buried under layers of soil. Each layer is like a page in this book. Just like ancient civilizations left clues behind, so did the plants that lived millions of years ago. Their buried remains are made of carbon that can be analysed by scientists.

But where does all that carbon go?

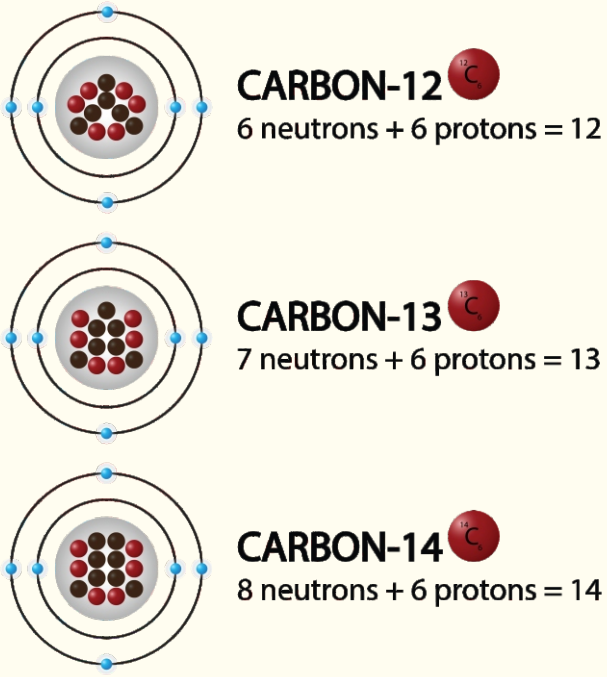
Process of Photosynthesis



Some of it stays in the soil as organic matter, and some reacts with soil minerals like calcium to make something called calcium carbonate, which can harden into limestone nodules over time.

Different types of plants take carbon dioxide from air in different ways. Scientists call these plants C3, C4, or CAM plants based on how they do photosynthesis. Each type of plant leaves behind a different kind of carbon in the soil.

Types of Carbon Isotopes



Now, think of carbon atoms like siblings in a big family of all chemical elements. They're all carbon but some are heavier than others. Carbon-12 is the light one. Carbon-13 is heavier and Carbon-14 is the heaviest. These tiny differences in weight are crucial for unlocking secrets from long ago because light carbon atoms respond to climatic and environmental conditions faster than heavy ones.

Plants have two main strategies for photosynthesis. C3 plants, like wheat and rice, prefer cooler, wetter and shady place. They assimilate carbon dioxide with more carbon-12 atoms. On the other hand, C4 plants, like corn and sugarcane, and CAM plants like cactus, pineapples and aloes, love hot, sunny environments. They capture carbon dioxide more efficiently including the slower heavy carbon-13 dioxide in the air. They have about 1% more carbon-13 compared to C3 plants.

Now, imagine you're a detective investigating Earth's ancient climates. How do you use this science to find out what the climate was like millions of years ago?

It's actually quite simple!

You are what you eat!

Plants preserve the slight difference between C3 and C4 plant carbon weights. This difference in percentages of heavy carbon provides a natural label or tracer the proportions of C3- and C4-derived carbon in our diets, and in the soil organic carbon and carbonate carbon. Scientists collect very old soil and find bits of calcium carbonate or plant remains in it, and archaeologists and palaeontologists collect teeth and bones and shells. Then they measure how much Carbon-13 and Carbon-12 is there. This tells them what kinds of plants were living in that soil when the calcium carbonate formed. Radioactive Carbon-14 is also assimilated. It decreases over time and it can be used to determine how old the soil or fossil is. This helps us understand what the climate was like long ago.

So, by studying these carbon clues from plants, soils and animals, scientists can determine whether it was hot and dry or cool and wetter in the past.

They use percentages of heavy to light carbon, and amount of radioactive carbon to piece together the story of Earth's ancient climates and learn valuable lessons for protecting our planet's future.