Follow the carbon atoms

Carbon moves among air, water, organisms, soil and rock. A reservoir stores carbon; a transfer moves it. The same atoms can pass through several chemical forms.

1. THE FAST BIOLOGICAL PATHWAYS

Carbon dioxide in air or water	Photosynthesis →	Organic carbon in producers
Carbon compounds in food	Feeding →	Carbon in consumers
Organic molecules in living cells	Respiration →	Carbon dioxide in air or water
Dead material and waste	Decomposition →	Microbial biomass; carbon dioxide

2. CONNECT THE PATHWAYS

Producers incorporate carbon dioxide into organic molecules. Consumers obtain carbon by eating. Death and waste transfer organic carbon to detritus. Decomposers use this material; their respiration releases carbon dioxide, while some carbon remains in soil organic matter.

Plants respire too. Photosynthesis stores energy in organic compounds; respiration releases usable energy. Carbon is recycled, while energy ultimately dissipates as heat. Decomposition does not make all dead material into fossil fuel.

Biological transfers: OpenStax, Biology 2e 46.3.
Reservoir interactions and fast cycling: College Board, ERT-1.D.1-3.

Scope: College Board AP Environmental Science CED (2025), Topic 1.4, p. 39.

Stores operate on different timescales

A carbon stock is the amount held in a reservoir. A flux is a transfer rate, such as a mass of carbon per year. Large stores do not necessarily exchange carbon quickly.

1. COMPARE THE MAJOR RESERVOIRS

Atmosphere	Carbon dioxide and methane; exchanges with organisms and surface waters.
Living biomass	Organic molecules in plants, animals and microbes; storage ranges from short-lived tissues to long-lived wood.
Soils	Dead material and organic compounds; some turn over rapidly, while other carbon persists much longer.
Oceans	Dissolved inorganic carbon, especially bicarbonate, plus organic carbon. Surface exchange is faster than deep-ocean turnover.
Rocks and fossil fuels	Carbonate rocks, sedimentary organic carbon and buried fuels can retain carbon for millions of years.

2. A SLOW ORGANIC-CARBON PATHWAY

Organic remains → Some escape full decay

Burial → Sediment accumulates

Fossil fuels → Heat and pressure; long time

Special burial and geological conditions are required; only a small fraction follows this route.

Another slow route: carbon enters carbonate shells and sediments, which can become rock. Weathering, transport and sedimentation redistribute carbon; geological heating and volcanic activity can return carbon dioxide to the atmosphere.

Reservoirs and ocean exchange: NOAA, What is the carbon cycle?
Burial, carbonate rocks and geological return: NASA, The Carbon Cycle.

Scope: College Board AP Environmental Science CED (2025), Topic 1.4, p. 39.

Human activity changes the balance

A reservoir is a net sink when it takes in more carbon than it releases over a stated period. It is a net source when releases exceed uptake. Either can have transfers in both directions.

1. COMBUSTION: SLOW STORAGE, RAPID RELEASE

Burning coal, oil and natural gas converts stored organic carbon into carbon dioxide. Fuel formation takes geological time, but combustion releases that carbon rapidly. Burning biomass also releases carbon; its net balance depends on regrowth, land use and the timescale considered.

2. LAND-USE CHANGE: TWO EFFECTS

Removing forests can release stored carbon through burning and decomposition. It can also reduce future carbon uptake by photosynthesis. Soil disturbance may release additional carbon. Reforestation and protecting carbon-rich ecosystems can increase storage, but stored carbon can later be lost.

3. OCEAN UPTAKE HAS CONSEQUENCES

Carbon dioxide crosses the air-sea surface in both directions. Net uptake removes some atmospheric carbon dioxide. Dissolved carbon dioxide changes seawater chemistry, increasing hydrogen ions and lowering pH. Reduced carbonate availability can make shell and skeleton formation harder.

4. TRACK NET CHANGE, NOT JUST ONE ARROW

Change in stored carbon = inputs - outputs

Illustrative example: a forest takes up 12 carbon units and releases 9 during one year. Its stock increases by 3 units: it is a net sink for that year. The figures are invented to demonstrate mass balance, not measurements.

Human transfers and land-use effects: NOAA, Carbon cycle; NASA, Carbon Cycle.
Ocean chemistry: NOAA, What is Ocean Acidification?

Scope: College Board AP Environmental Science CED (2025), Topic 1.4, p. 39.