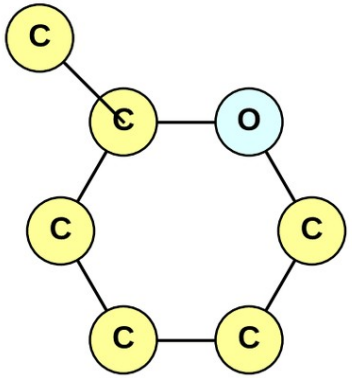
The Carbon Cycle

Essential Question

How do photosynthesis and cellular respiration move carbon through Earth's systems?

Carbon: The Backbone of Life

- All four types of biomolecules have carbon backbones
- Carbon atoms bond in chains and rings
- Carbon atoms are recycled, never used up



Glucose, $C_6H_{12}O_6$: a ring of carbon atoms
(H and OH groups not shown)

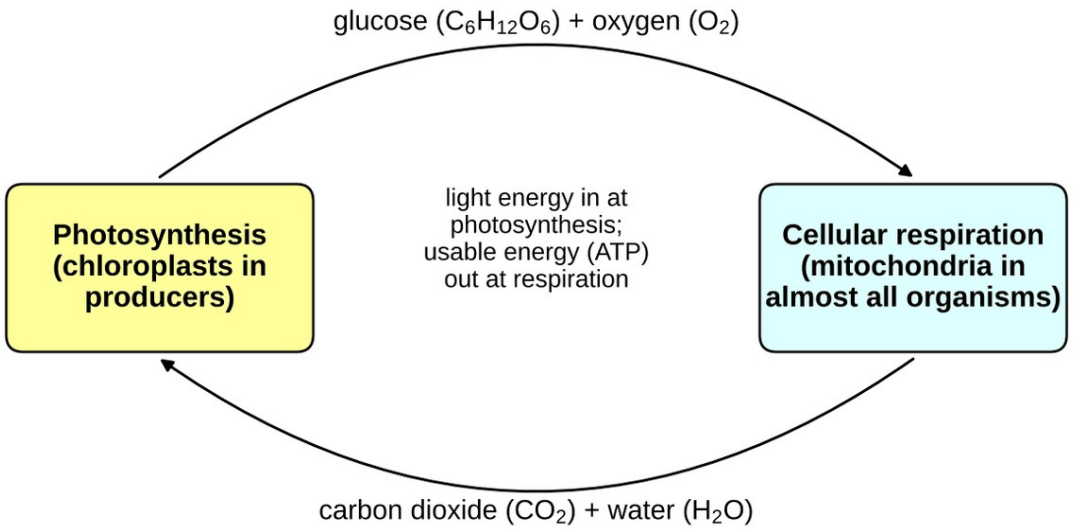
Carbon is in all four

- Carbohydrates: C, H, O
- Lipids: C, H, O
- Proteins: C, H, O, N, S
- Nucleic acids: C, H, O, N, P

The Carbon Cycle

Photosynthesis and Cellular Respiration

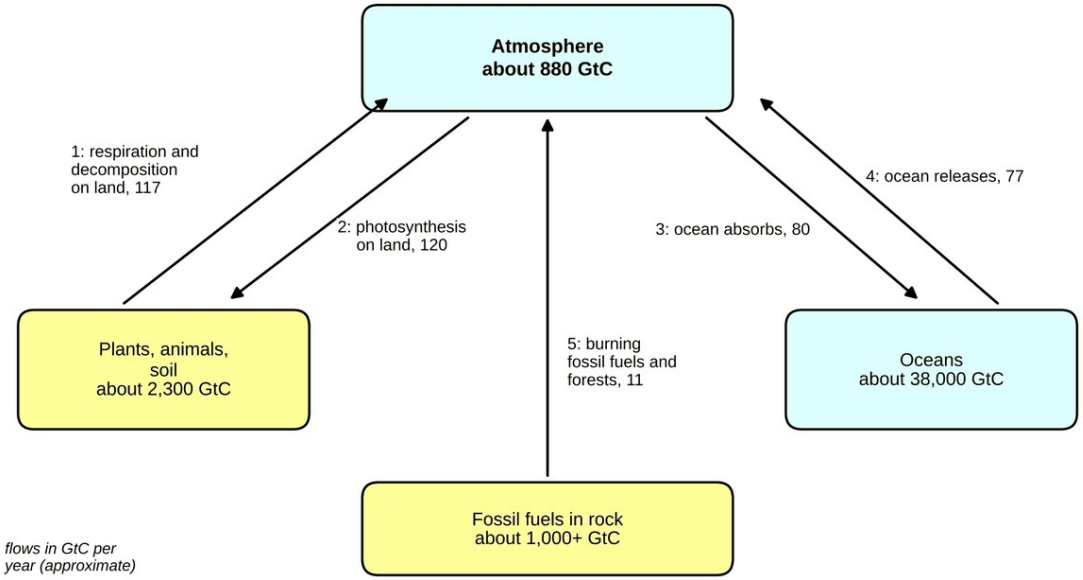
- Photosynthesis: CO_2 + H_2O + light energy → glucose + O_2
- Respiration: glucose + O_2 → CO_2 + H_2O + usable energy
- Each process uses the other's products



The Carbon Cycle

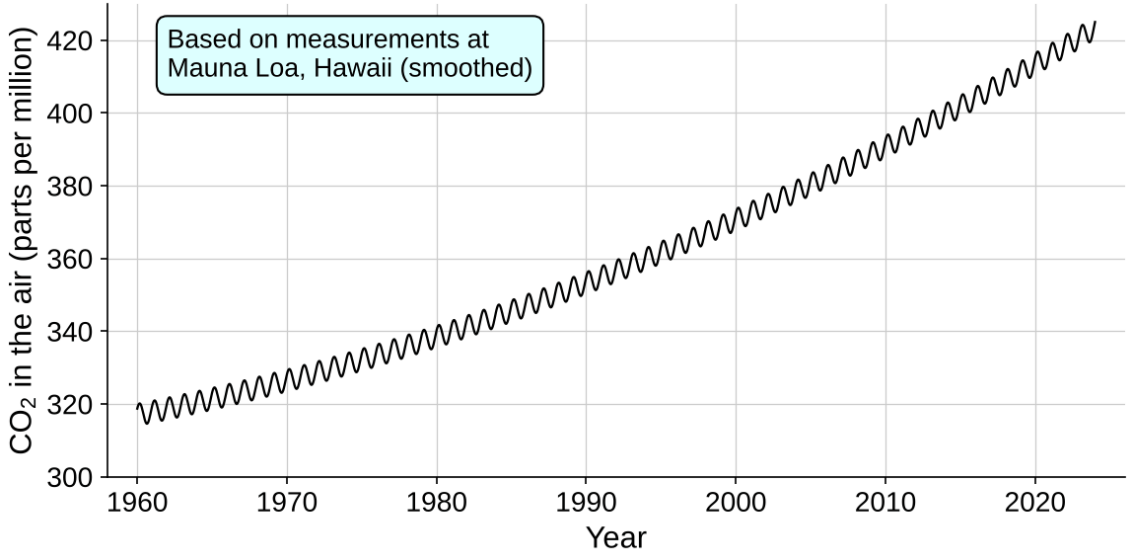
Carbon Reservoirs and Flows

- Reservoirs: air, living things and soil, oceans, rocks
- Photosynthesis and oceans remove CO_2 from the air
- Respiration, decomposition, and burning return it



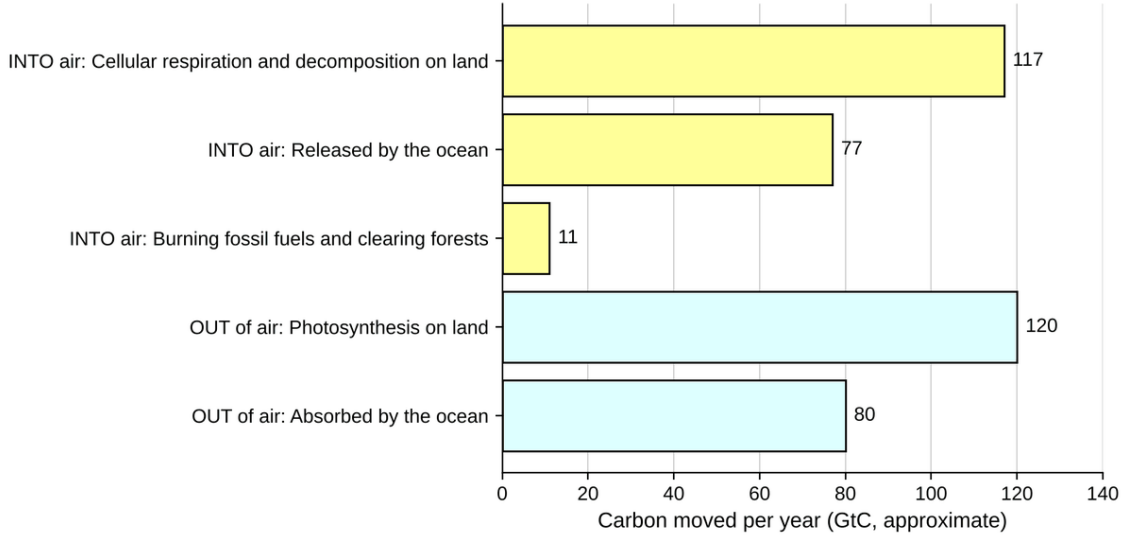
Carbon Dioxide in the Air Is Rising

- CO_2 measured in Hawaii since 1958
- Rising trend: from about 317 ppm to over 420 ppm
- Yearly zigzag: plants growing and resting



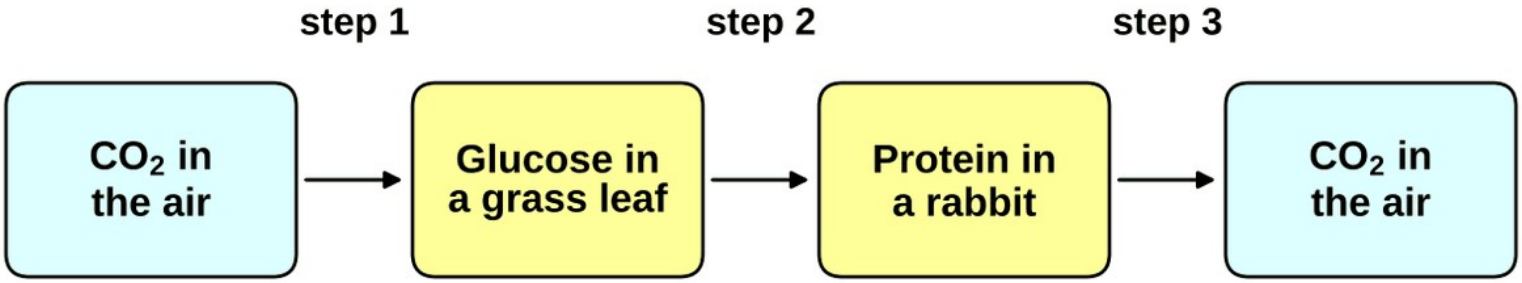
People and the Carbon Cycle

- Burning fossil fuels and forests adds about 11 GtC per year
- Plants and oceans absorb only part of it
- The rest builds up in the air



Example: Tracing a Carbon Atom

A carbon atom moves from the air into a blade of grass, then into a rabbit that eats the grass, then back to the air. Name the process at each step.



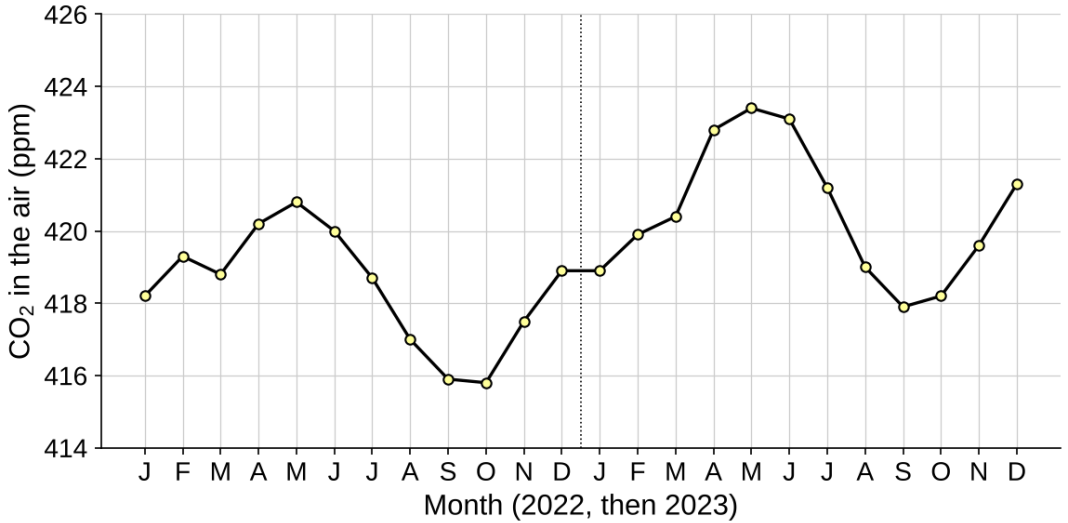
Example: Is Carbon Building Up in the Air?

Use the yearly flows below, which are rounded values for a simplified model. Find the total carbon added to the air and the total removed. What is the net change each year? About 2.1 GtC of carbon raises CO_2 in the air by 1 ppm. How fast is CO_2 rising?

Flow	Direction	GtC per year
Cellular respiration and decomposition	into the air	117
Released by the ocean	into the air	77
Burning fossil fuels and clearing forests	into the air	11
Photosynthesis	out of the air	120
Absorbed by the ocean	out of the air	80

Example: The Yearly Zigzag

The graph shows monthly CO_2 values at Mauna Loa for two years (sample values). In which months does CO_2 fall? Explain why. Then compare May 2022 with May 2023 to find the yearly increase.



The Carbon Cycle

Big Ideas

- Carbon is the backbone of all biomolecules
- Photosynthesis removes CO_2; respiration returns it
- Carbon cycles among air, life, oceans, and rocks
- Burning fossil fuels adds carbon faster than it is removed