

Food Webs: Energy Moving Through Ecosystems



- - **Core question:** How does energy flow through living communities?
- - **Food chain:** a simple, linear path of energy transfer
- - **Food web:** a complex, interconnected network of feeding relationships
- - **Energy flows one way:** Sun → Producers → Consumers → Heat
- - Understanding energy flow is key to ecosystem health and stability

The First Step: Producers Capture the Sun's Energy



- Producers (autotrophs) are the entry point for all ecosystem energy



- Photosynthesis converts solar energy into stored chemical energy (glucose)



- Key producers: terrestrial plants, phytoplankton, and algae



- Producers form the broad base of every food web

The Consumers: Trophic Levels and Feeding Roles



Herbivores eat plants, carnivores eat meat, omnivores eat both



Example chain: grass → grasshopper → frog → snake → hawk

The 10% Rule: Why Energy Shrinks at Every Step

- Only ~10% of energy transfers to the next trophic level
- 90% lost as metabolic heat, waste, and undigested matter
- Energy pyramid:
 $100,000\text{J} \rightarrow 10,000\text{J} \rightarrow 1,000\text{J} \rightarrow 100\text{J}$
- This loss limits most food chains to 4–5 levels
- Explains why top predators are rare and vulnerable



From Chain to Web: A More Realistic View

- Multiple food chains interweave to form a complex food web
- Most organisms eat, and are eaten by, more than one species
- A keystone species, like the sea otter, shapes the whole community
- Web redundancy provides stability and resilience against disruptions



The Cleanup Crew: Decomposers and Detritivores



- Decomposers (bacteria, fungi) chemically break down dead matter



- Detritivores (earthworms, vultures) directly consume dead material



- They recycle nutrients for producers; last energy is lost as heat



- Decomposition restores soil fertility, fueling new plant growth



- Matter cycles continuously; energy flow is always one-way

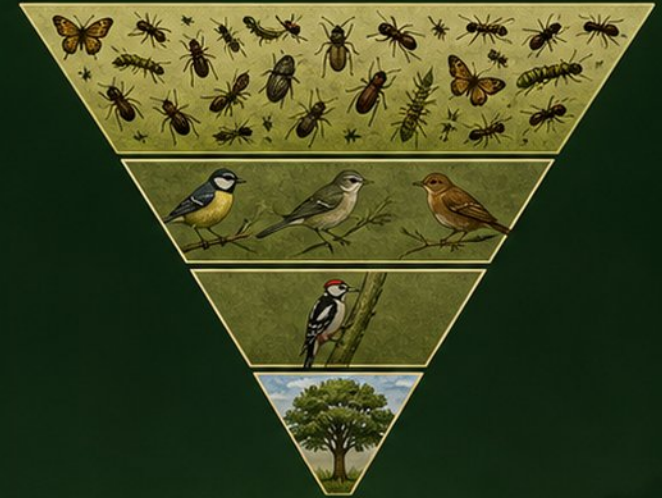
Visual Models: Three Ecological Pyramids



Pyramid of Energy:
always upright, shows
energy loss at every level



Pyramid of Biomass:
total mass of living matter
at each trophic level



Pyramid of Numbers:
counts organisms;
can appear inverted

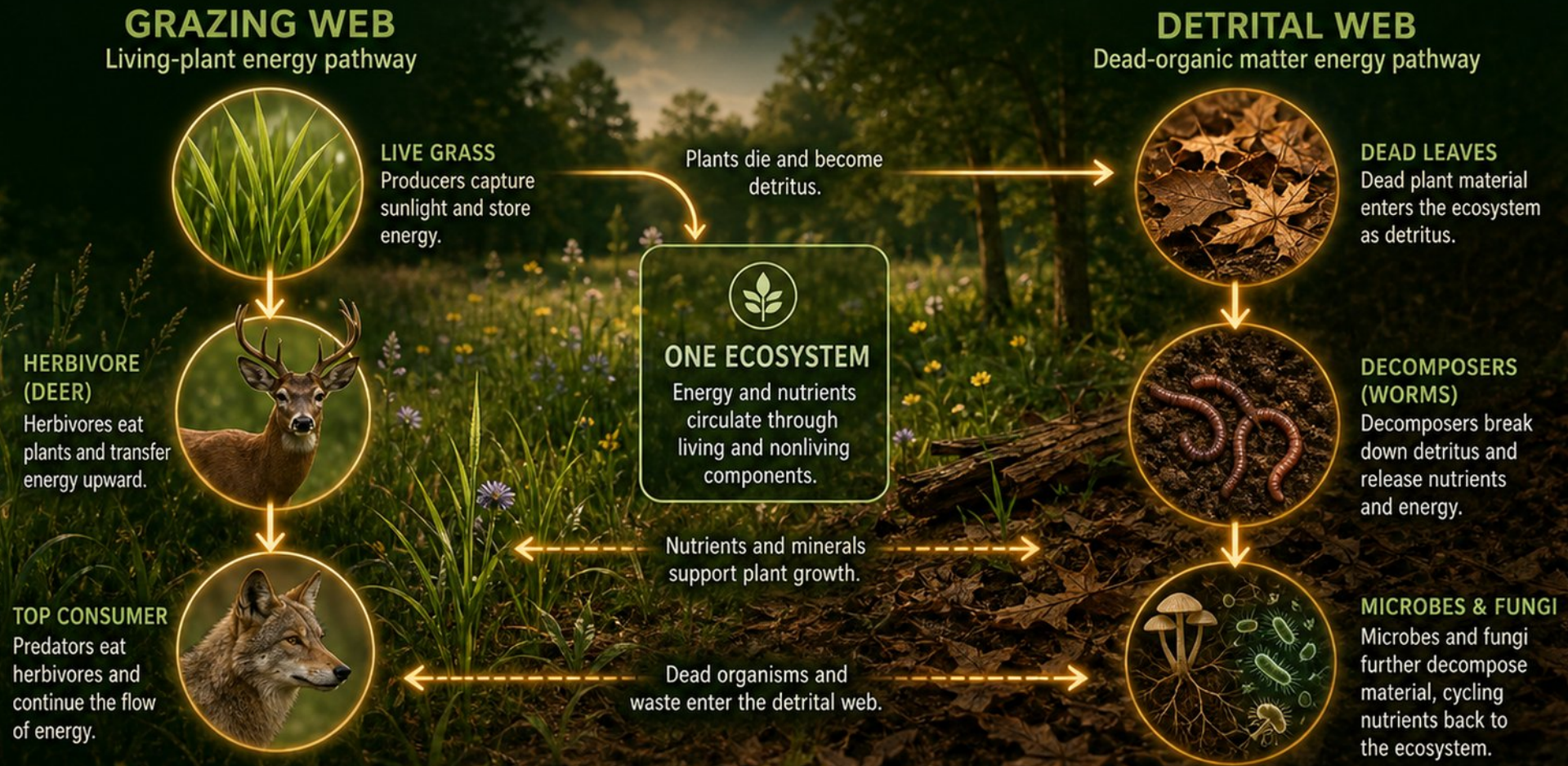


A single tree can support
thousands of insects,
inverting the pyramid



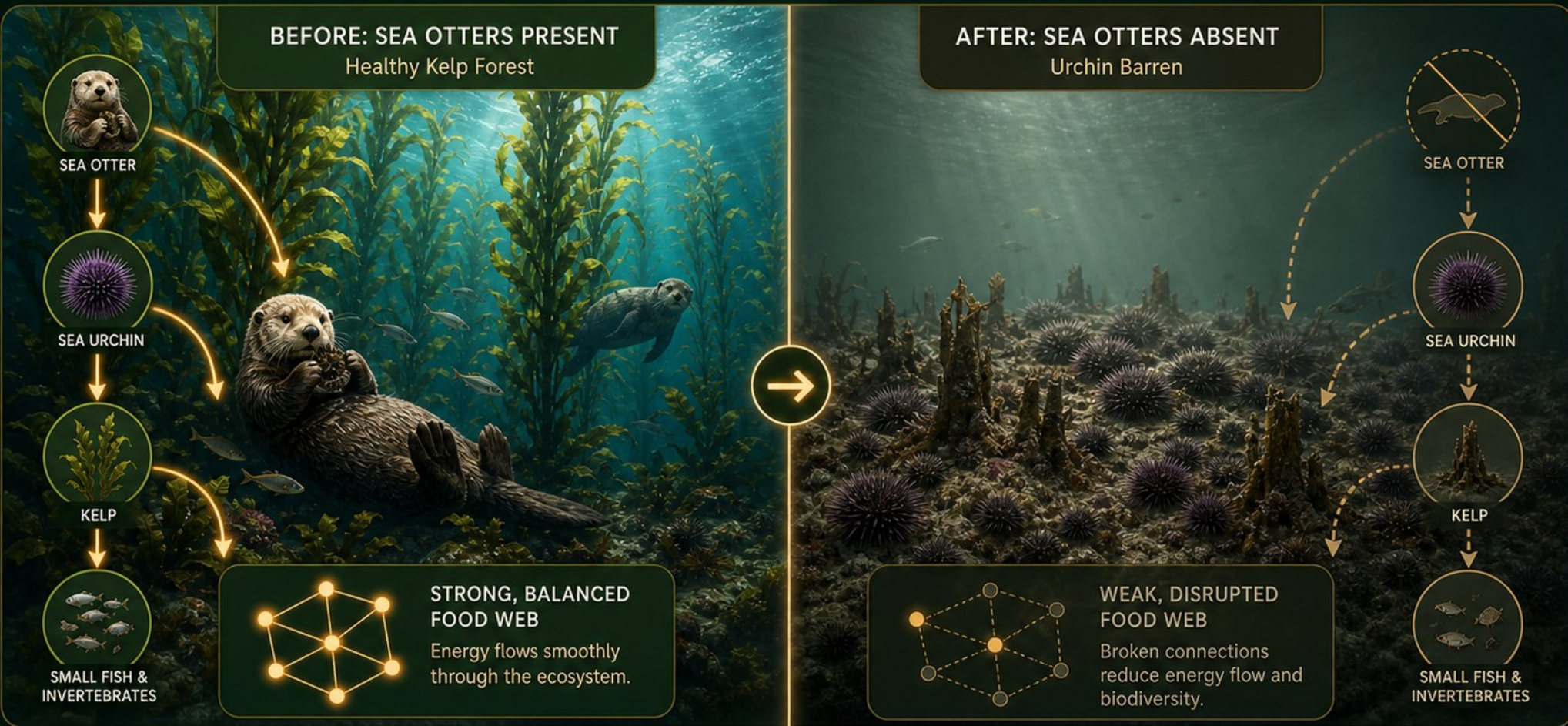
Energy flow is the unbreakable
rule governing all pyramid shapes

Grazing Webs and Detrital Webs: Two Energy Pathways



- “- Grazing webs start with living plants and move up through herbivores”
- “- Detrital webs start with dead organic matter, driven by decomposers”
- “- Both webs interconnect in a single ecosystem like a meadow or forest floor”
- “- Much of an ecosystem’s energy actually flows through the detrital web”

Ecosystem Disruption: What Happens When a Link Breaks?



- Trophic cascade: ripple effect from adding or removing a species



- Without sea otters, urchins overgraze and destroy kelp forests



- With sea otters, urchins are controlled and lush kelp thrives

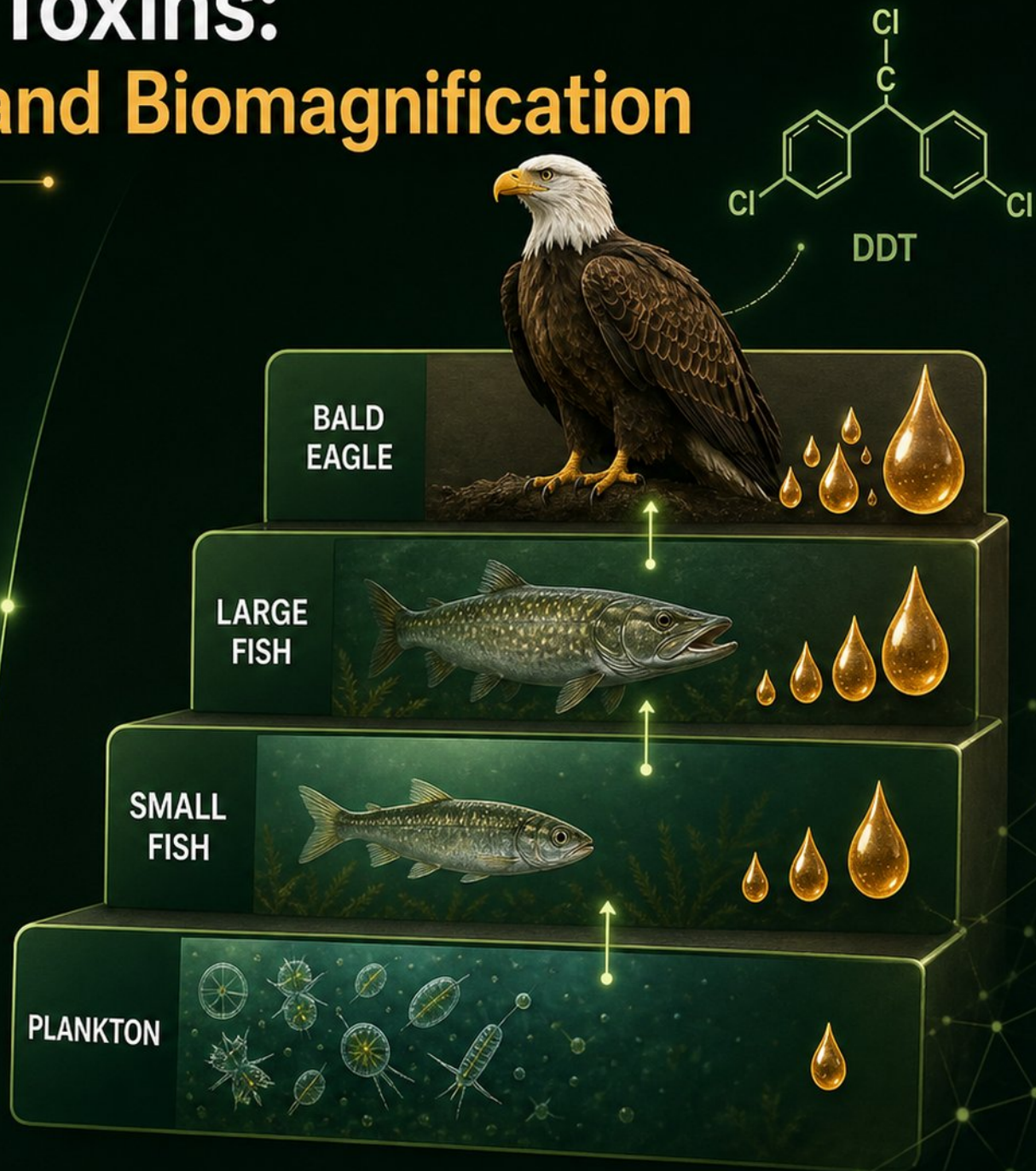


- Overfishing and pollution disrupt energy flow and food webs

Accumulating Toxins:

Bioaccumulation and Biomagnification

- Bioaccumulation: Toxins accumulate in a single organism over its lifetime.
- Biomagnification: Toxin concentration multiplies moving up each trophic level.
- Example: DDT in water → plankton → small fish → large fish → bald eagle.
- DDT caused eagle eggshell thinning, nearly wiping out the species.
- The 10% rule applies to pollutants—top predators face the greatest risk.



Ancient Sunlight: Fossil Fuels in the Energy Picture



- Fossil fuels are ancient, compressed organic matter from past photosynthesis”



- Coal formed from woody swamp plants; oil and gas from marine plankton and algae”



- Formation took millions of years; we are burning it in just a few hundred”



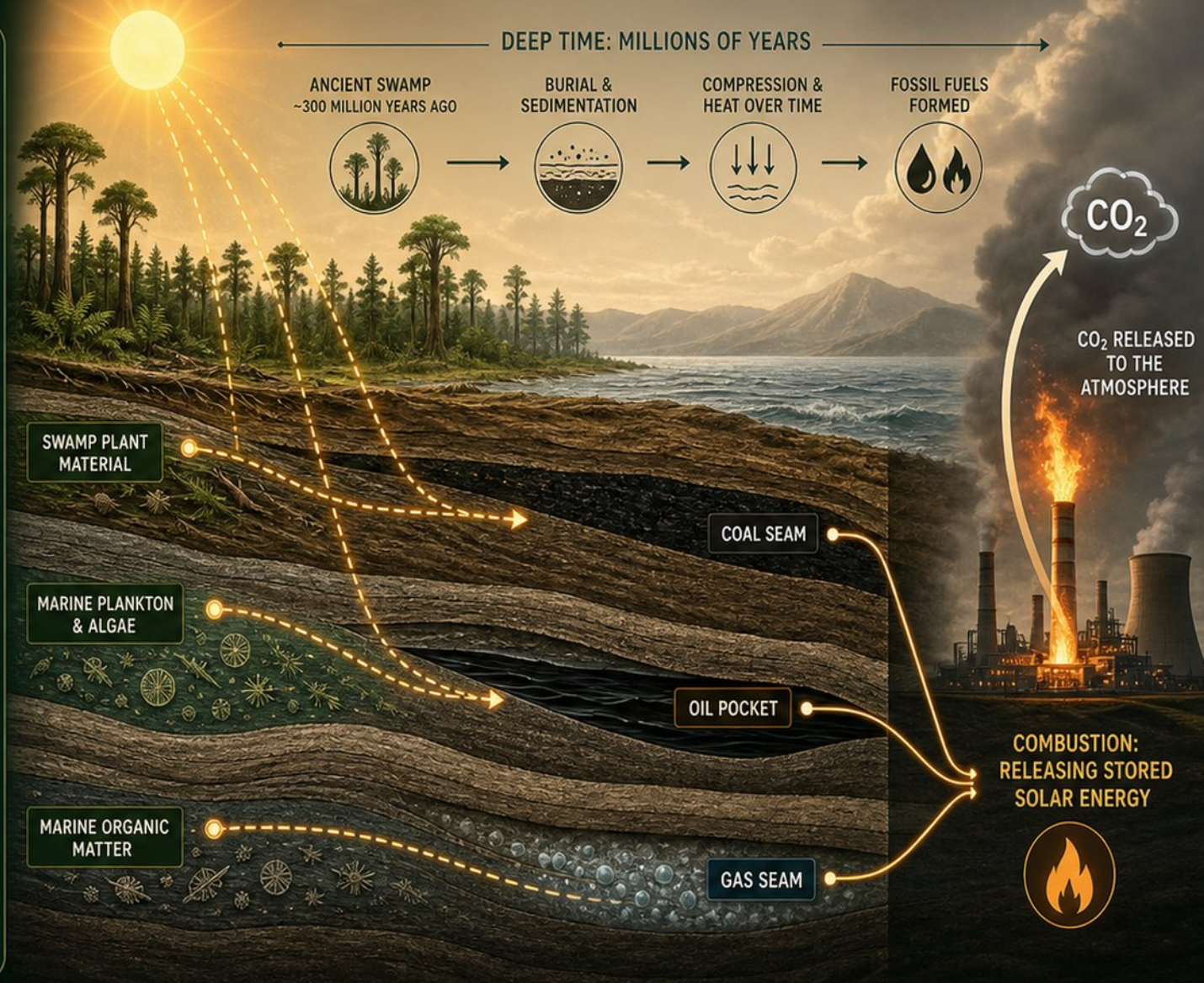
- Combustion releases solar energy originally captured by ancient food webs”



- Burning fossil fuels reverses the carbon storage process, releasing CO2”



FOSSIL FUELS ARE ANCIENT SUNLIGHT, STORED BY EARTH'S SYSTEMS FOR MILLIONS OF YEARS—WHEN WE BURN THEM, WE REVERSE THE NATURAL CARBON STORAGE PROCESS.



Our Role in the Web: Summary and Reflection



- Energy flows one way:
Sun → Producers →
Consumers →
Decomposers → Heat



- The 10% rule limits
chain length; top
predators are rare



- Humans occupy
multiple trophic levels
(omnivores)



- Dietary choices affect
energy efficiency and
ecosystem pressure



- Individual actions
connect to local and
global ecosystem health

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