

The High-Yield Comparison

Decoding the C3 vs. C4
Photosynthetic Pathways

C3 Plants

C4 Plants

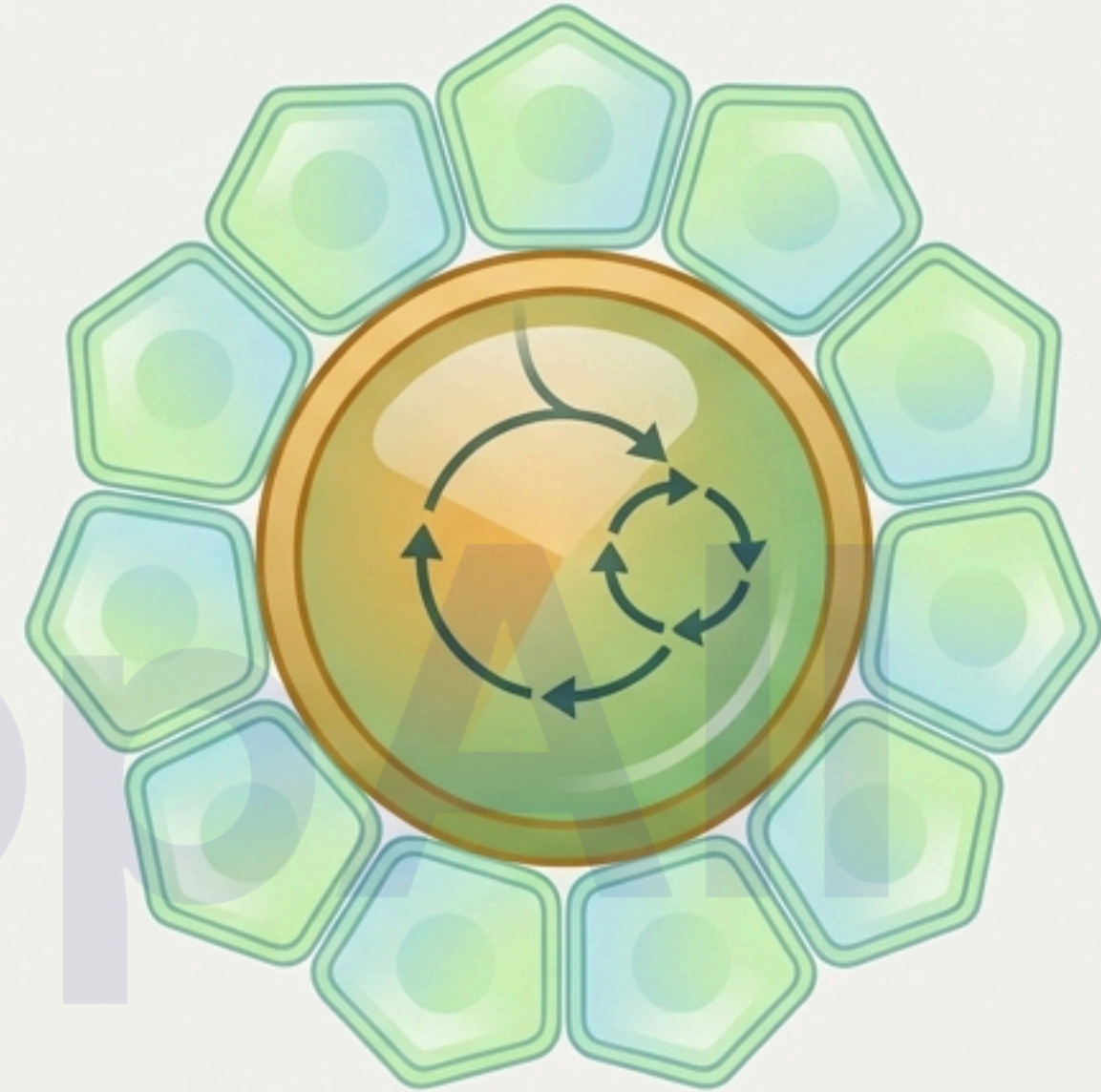
Calvin cycle cell type	[Mesophyll]	[Bundle Sheath]
Initial carboxylation cell type	[Mesophyll]	[Mesophyll]
Primary CO ₂ acceptor	RuBP (5C)	PEP (3C)
First CO ₂ fixation product	PGA (3C)	OAA (4C)
Primary Enzyme	RuBisCO	PEPcase
Photorespiration (High light)	[High]	[Negligible]
Optimum Temperature	20-25°C	30-40°C

C3 Plants



Calvin Cycle occurs in the Mesophyll.

C4 Plants



Calvin Cycle isolated in the Bundle Sheath.

Why the shift? C4 plants use Kranz anatomy—thick, impervious walls around bundle sheath cells—to physically block O₂ from entering the Calvin cycle.



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$$E=mc^2$$



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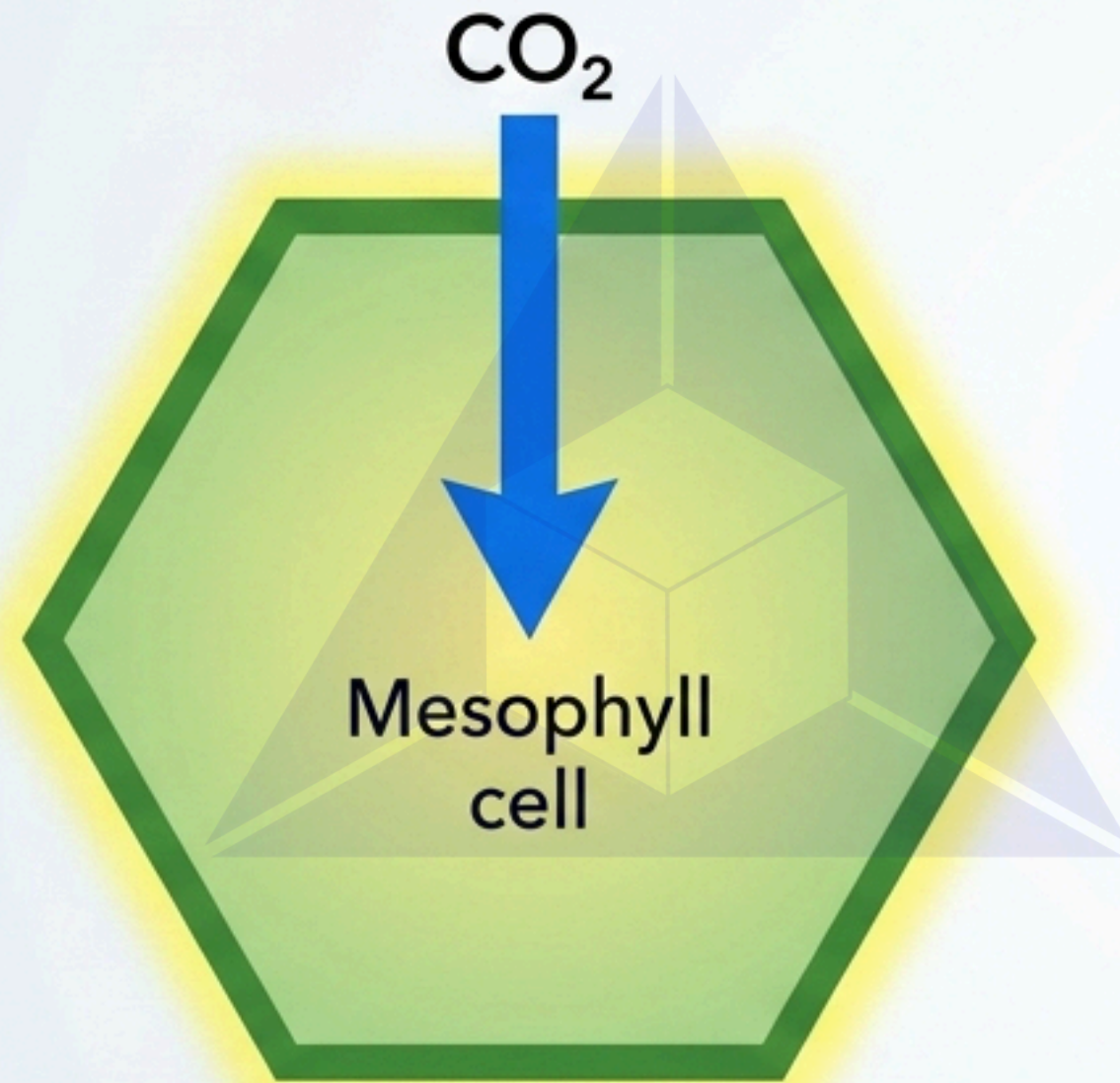
Key Highlights

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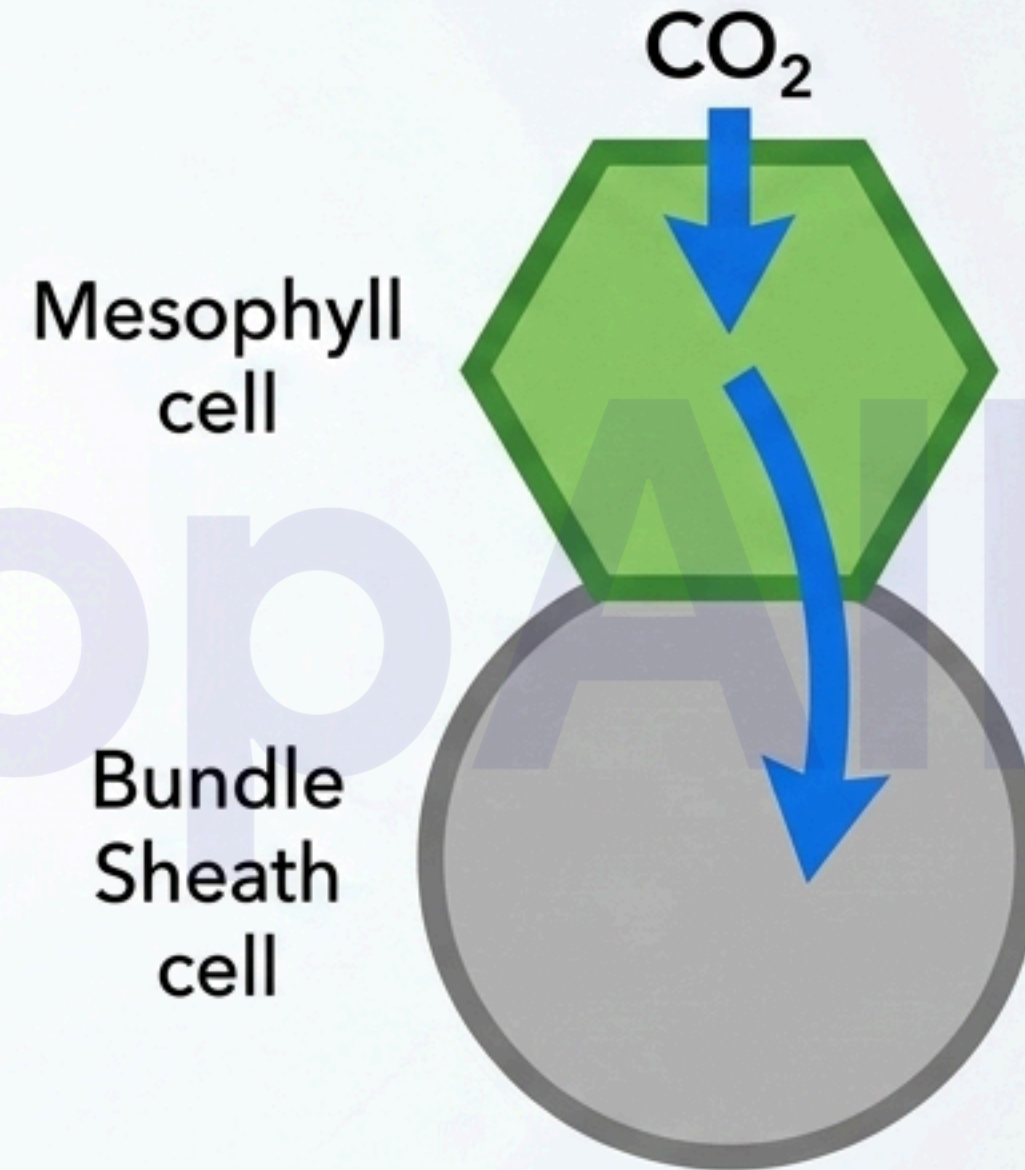
INITIAL CO₂ CARBOXYLATION

C₃ Initial Carboxylation

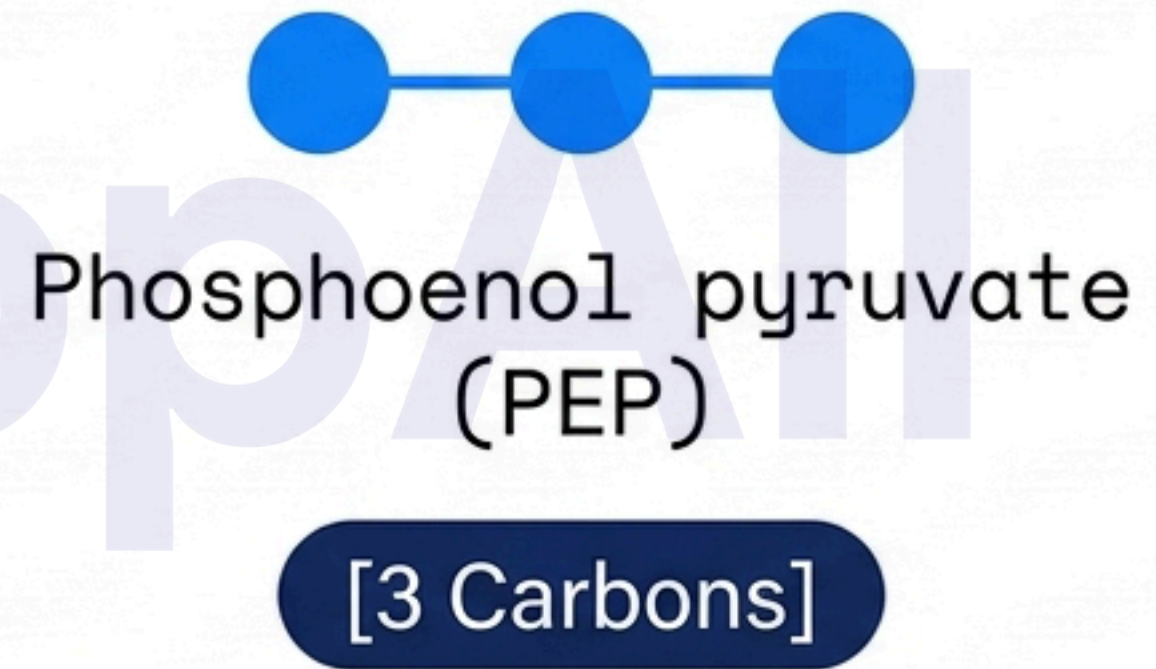
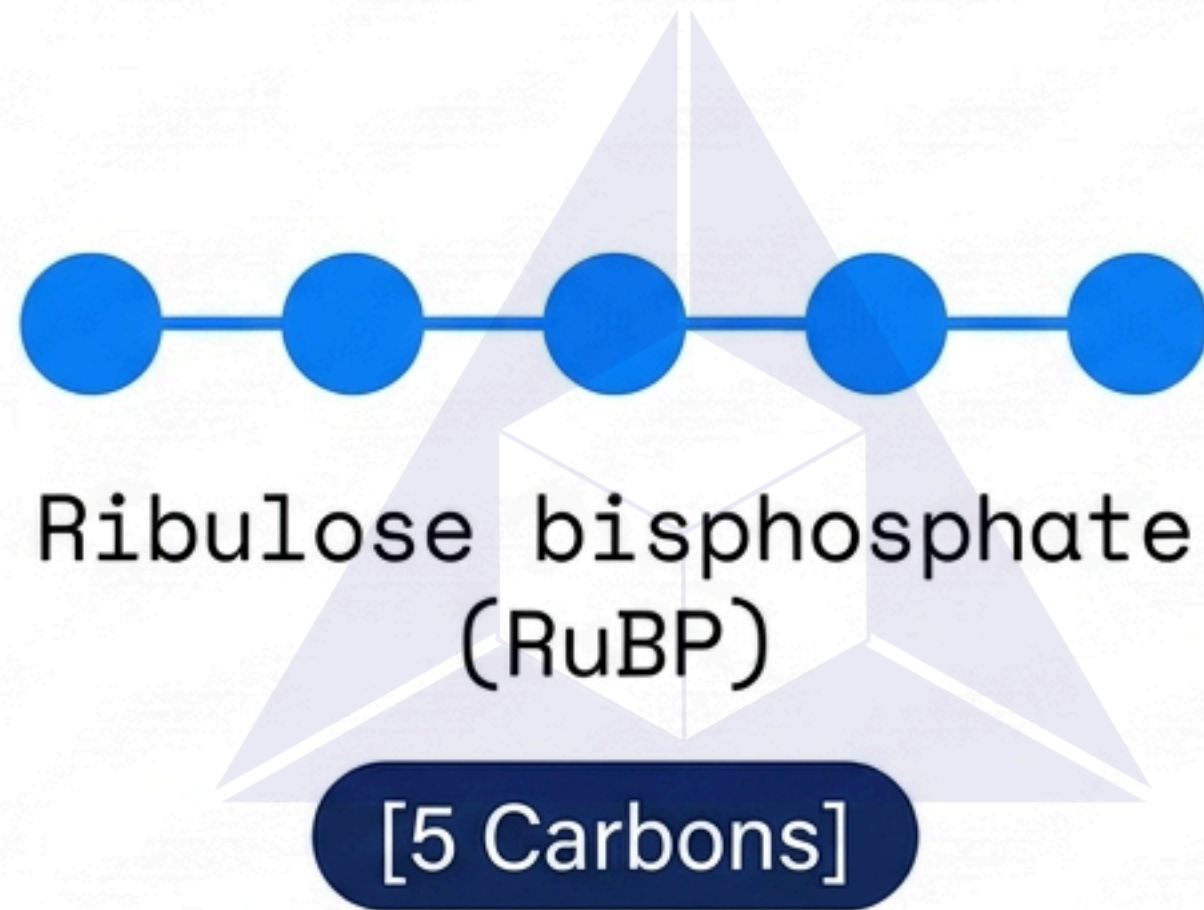


Final Destination. CO₂ is fixed and immediately processed by the Calvin cycle in the same cell.

C₄ Initial Carboxylation



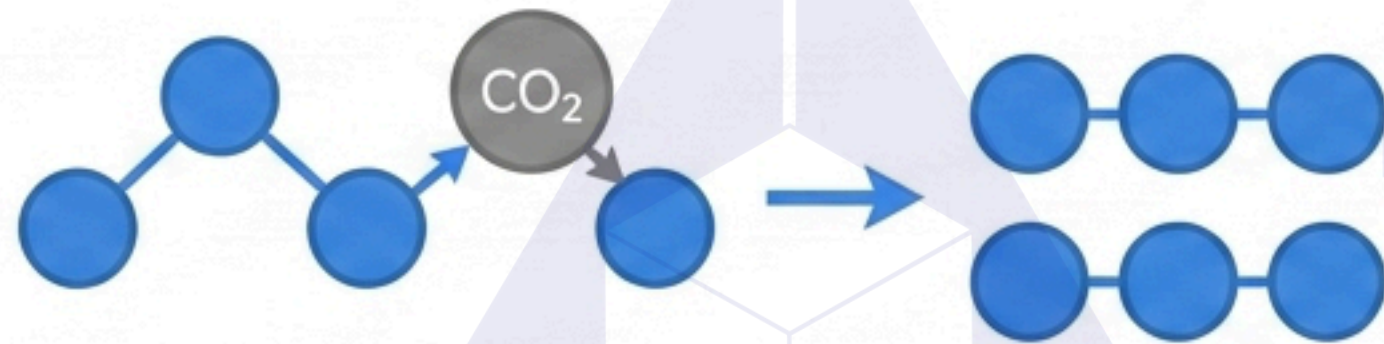
The Preliminary Pump. CO₂ is initially fixed in the Mesophyll, but only as a transport mechanism to move it to the Bundle Sheath.



The C₄ pathway uses a smaller, 3-carbon acceptor for its initial capture, changing the subsequent math of the entire photosynthetic process.

FIRST STABLE PRODUCTS

C3 Product



3-phosphoglyceric acid (PGA)

[3 Carbons]

The first stable product is a 3-carbon acid, giving C3 plants their name.

C4 Product



Oxaloacetic acid (OAA)

[4 Carbons]

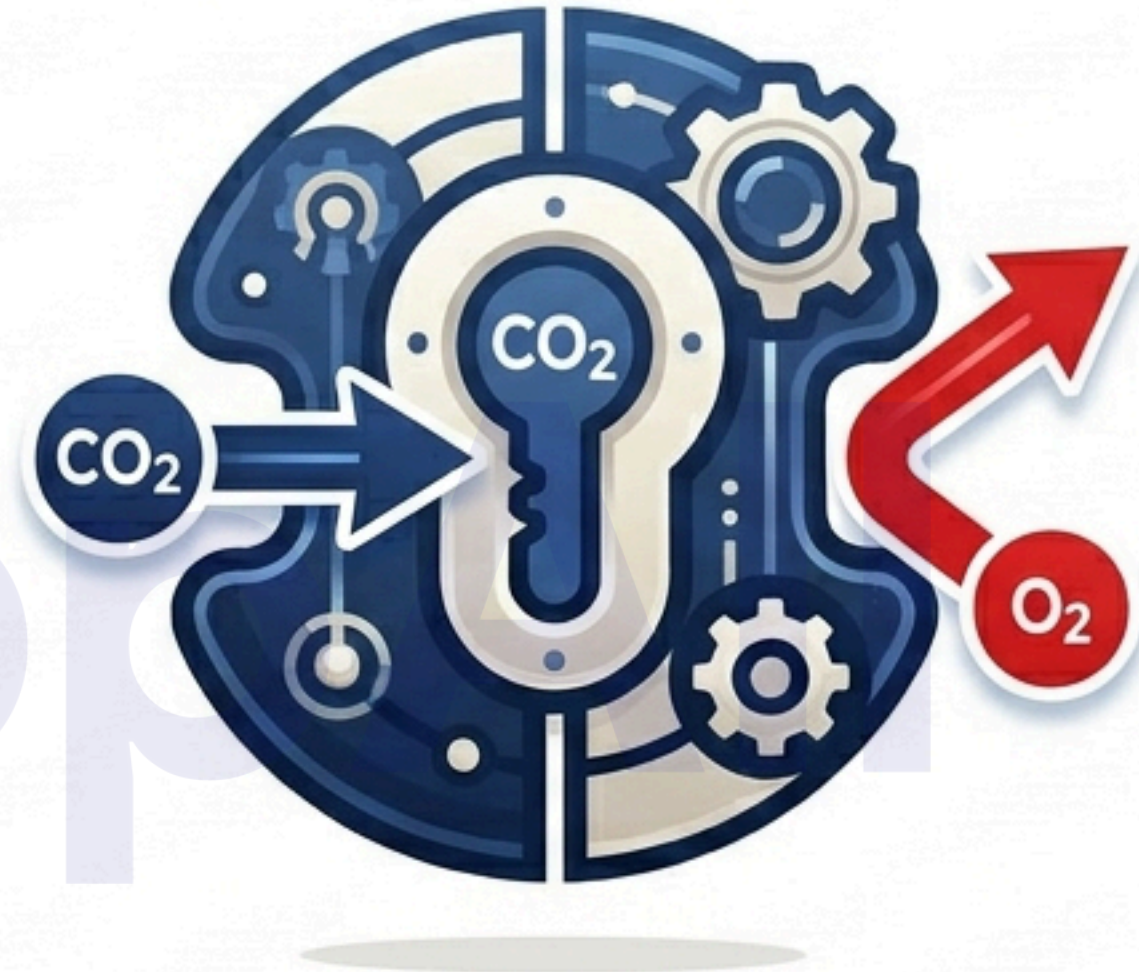
The first stable product is a 4-carbon acid, giving C4 plants their name.

C3: RuBisCO's Flaw



Photorespiration (Wasteful).
RuBisCO binds O_2 instead of CO_2 ,
releasing fixed CO_2 and wasting ATP.

C4: The PEPcase Solution



PEPcase has zero affinity for O_2 .
It pumps CO_2 into the bundle sheath,
flooding the RuBisCO there with CO_2
so photorespiration cannot occur.

The High-Yield Takeaway



C4 plants are an evolutionary workaround to the inefficiency of the RuBisCO enzyme.

- By utilizing a specialized initial acceptor (PEP) and spatial separation (Kranz anatomy), C4 plants effectively eliminate wasteful photorespiration.
- This biological 'carbon pump' requires more energy upfront, but allows C4 plants to achieve much higher biomass productivity.
- **Result:** They dominate in high-temperature, high-light, and dry environments where C3 plants would lose massive amounts of energy to photorespiration.



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