

The Wasteful Side Reaction

Understanding the Mechanics and Costs of Photorespiration



[RuBisCO: The World's Most Abundant Enzyme]

Carboxylase Activity

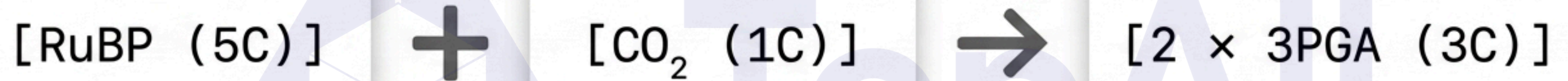


Oxygenase Activity



Binding is competitive. The dominant reaction depends strictly on the relative atmospheric concentrations of O_2 and CO_2 .

The Ideal Path (Normal Reaction)

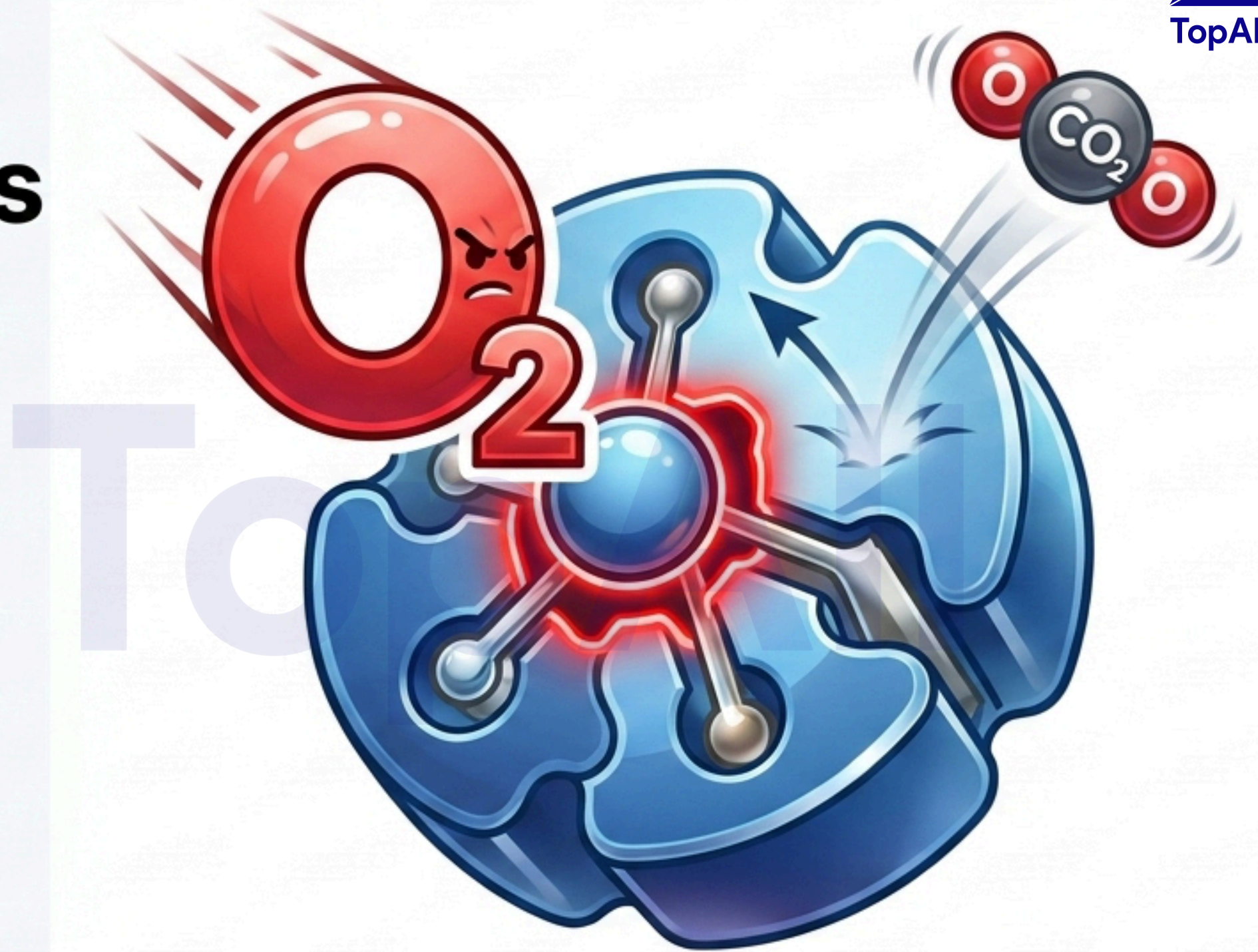


The Ideal Path: This normal carboxylase reaction forms the foundational 3-carbon molecules required for all subsequent sugar production.

[C3 Plants]

The Flaw: O₂ Hijacks the System

Under conditions like high O₂ or low CO₂, the system breaks down. **RuBisCO** binds with oxygen, stalling the standard carbon fixation cycle.





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$$E=mc^2$$



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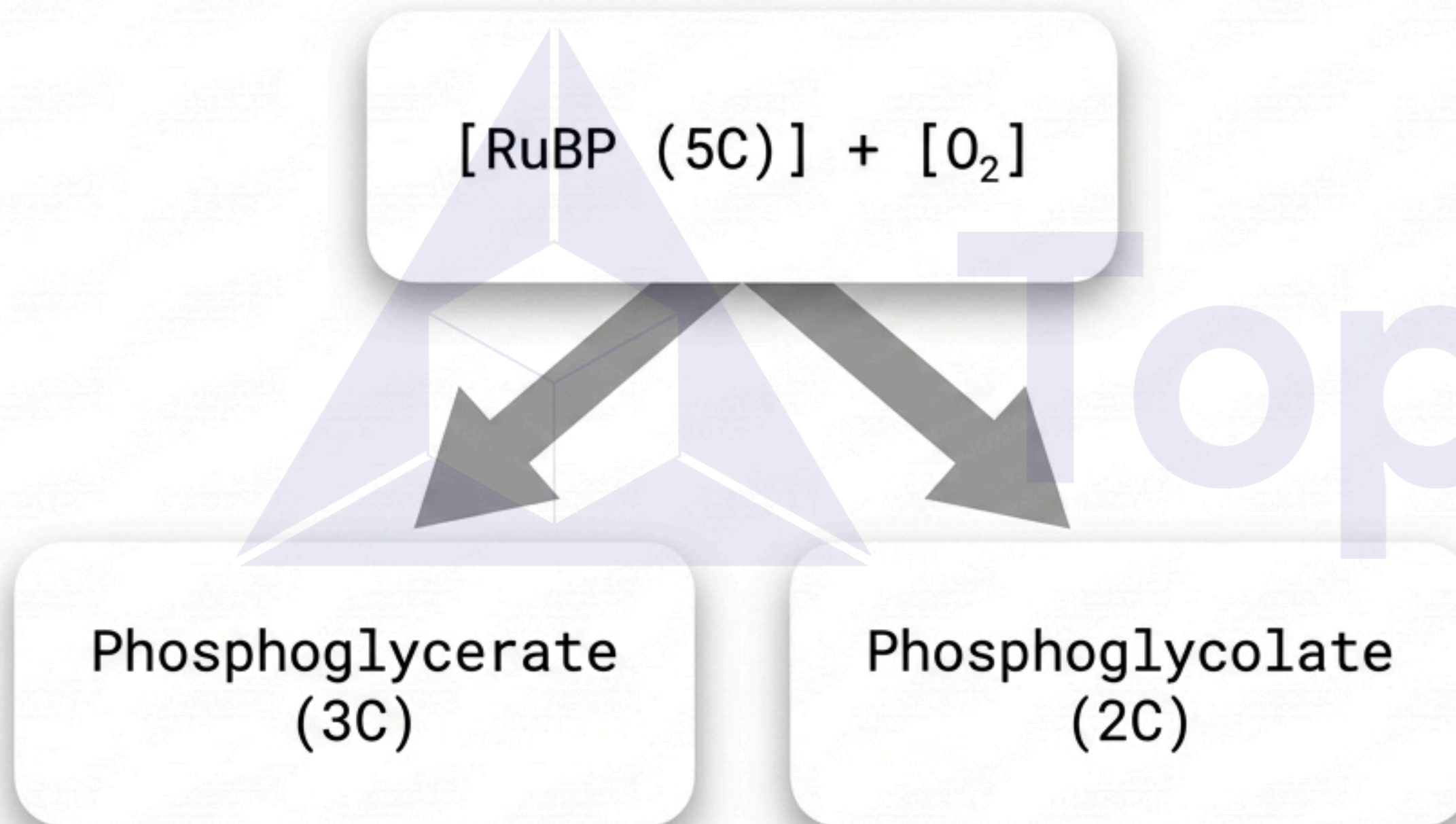
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The Diverted Pathway



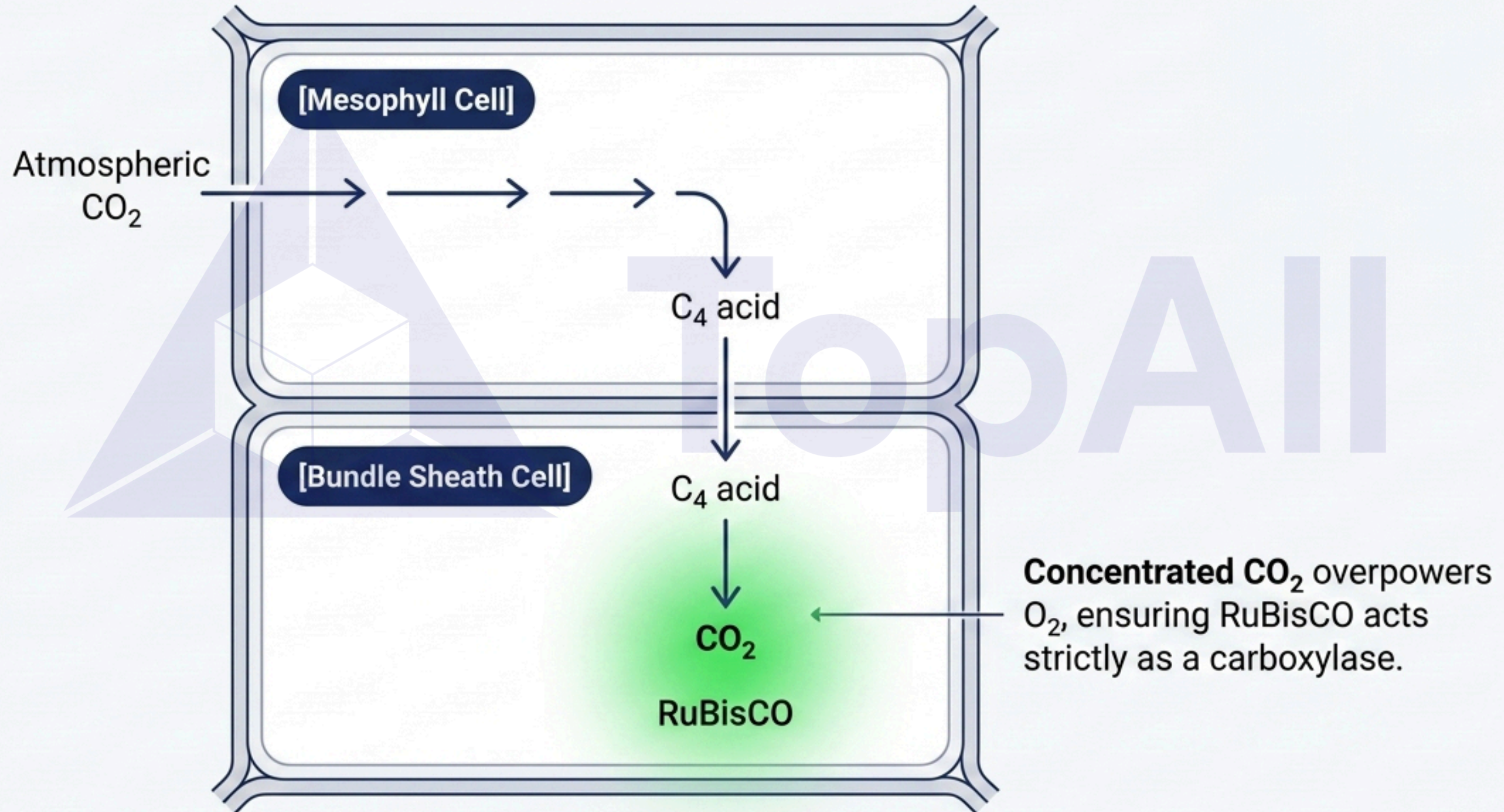
A Mathematical Mismatch: Instead of yielding the normal six carbons (two 3PGA molecules), oxygenation fragments the molecule into a metabolically useless pair.

The Metabolic Cost

OUTPUT	RESULT
Sugar Synthesis	0
ATP Synthesis	0
NADPH Synthesis	0

Net Loss: Photorespiration not only fails to produce energy, it actively **CONSUMES** cellular **ATP** and **RELEASES** previously fixed CO_2 back into the atmosphere.

The C4 Workaround: A Spatial Firewall



[Key Takeaway]

The Evolutionary Bypass

Photorespiration is a competitive, wasteful **oxygenation** reaction that halts energy production and consumes ATP in C3 plants. In response, C4 plants evolved a spatial **workaround to bypass this flaw**, artificially concentrating CO₂ to maximize photosynthetic efficiency and biomass productivity.



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