

Photosynthesis – Calvin Cycle and Cyclic Electron Flow

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Introduction

Thanks for joining us for episode 2
Where more 'bout photosynthesis waits for you
We last saw how plant cells create,
O₂, ATP and NADPH.

Now we'll start with a twist on the light reactions
Called cyclic flow, we'll see how it happens,
Then we will investigate
How the Calvin cycle makes carbohydrate.

Cyclic Electron Flow

Non-cyclic flow is also called the Z-scheme
Put "Z" on its side and see what I mean,
Electrons rise in energy, then fall then rise again
Making ATP and NADPH my friends.

A variation on this is cyclic flow
Which makes ATP, no NADPH or O
Cyclic flow results from the Calvin Cycle's needs
It uses less NADPH than ATP.

NADPH buildup has the repercussion
Of inhibiting NADP⁺ reduction
'Cause NADPH clogs up reductase
Keeping NADP⁺ from moving into place.

So electrons don't go to NADP⁺
They're clogged, stuck, like a pimple's pus,
Where can they go from P700 [P-seven-Oh-Oh]?
Nature evolved them a place to flow.

A shunt pathway moves them to the ETC,
I'm talking 'bout the one in PS II, you see
These energized electrons flow and release energy
Which as you know is used to synthesize ATP!

Calvin cycle 1: Generation of G3P

Now it's time to learn the cycle named for Calvin
Which results in the fixation of carbon
Consider that each carbon in your bones, blood, and hair,
Was once in a CO₂ in the air.

The Calvin cycle has 3 parts,
Fixation of carbon is how it starts.
The molecules produced are then reduced
Cause reduction is the key thing that happens in part two.

Part two is the payoff, as you will see,
It produces molecule G3P
A reduced molecule with lots of energy,

And a starting point for all the molecules cells need.

Part three sets up conditions for the cycles' start
By recreating what's at the cycle's heart
RuBP or Ribulose Bisphosphate
A 5-carbon molecule, which seems to apparate.

'Cause RuBP's at the cycle's start,
Then reappears at the very last part,
The role of RuBP in the start and end,
In why this is a cycle, like the one named Krebs!

The cycle's inputs, are known to you,
NADPH and ATP and CO₂,
Fixation of carbon is catalyzed by,
RuBP Carboxylase enzyme.

This enzyme's nickname you should know,
Sounds like a cookie maker: it's Rubisco
An enzyme so old it was already here,
Before O₂ accumulated in the air!

The CO₂ enters through leaf stoma,
Diffusing through the leaf and arriving in the stroma,
There Rubisco grabs it in its active site
And squeezes it with RuBP tight!

RuBP has carbons 5
It has two phosphates, one on each side
When CO₂ combines with RuBP
It makes a six carbon compound you won't see.

It instantly dissociates,
Into two 3-phosphoglycerates.
Each with 3 carbons and 1 phosphate,
Each gets phosphorylated to bisphosphoglycerate.

Phosphorylated means each receives
A phosphate group from ATP
This phosphorylation, is followed by reduction,
And you know there's an enzyme with the function,

Of taking electrons and H from NADPH
And adding them to bisphosphoglycerate
Take off a phosphate to get glyceraldehyde 3 phosphate
A starting point for compounds like carbohydrates!

Calvin cycle: Regeneration of RuBP

Glyceraldehyde 3 phosphate, know as G3P
Is a product cells can harvest and I hope you see
How light reactions NADPH and ATP

Are needed to fix CO₂ and make organic energy. |
And to complete the cycle we must now regenerate
The starting point of Calvin cycle ribulose bisphosphate
The intermediates involved in taking G3Ps
And recombining them into RuBPs

Are too much for freshman biology
You can get the details when you get your PhD
But know for now that to get 3 RuBPs
from 5G3Ps costs 3 ATPs!

Conclusion

Now this journey ends, with its emphasis
On the reactions of photosynthesis
For nearly 4 billion years it's been the food chains' basis
In fossils from that era you can see the traces.

Of tiny cells, with prokaryotic form
Stromatolites that lived in waters warm
Through photosynthesis, they transformed our planet
So aerobic life can live upon it.

And so evolved sentient beings who can analyze
How photoautotrophs can photosynthesize!
You could say that photosynthesis gave birth
To conditions for consciousness on Planet Earth!