What is the Calvin Cycle (Dark Reactions of Photosynthesis)?

Worksheet

The Calvin cycle is the set of light-independent reactions in the chloroplast stroma that fix CO2 using the enzyme RuBisCO and the ATP/NADPH from the light reactions to build glyceraldehyde-3-phosphate (G3P), the precursor of glucose.

Questions

1. What molecule accepts CO2 at the start of the Calvin cycle?

A) G3P
B) RuBP
C) Glucose
D) Pyruvate

2. How many ATP and NADPH are needed to make one glucose molecule via the Calvin cycle?

A) 9 ATP, 6 NADPH
B) 18 ATP, 12 NADPH
C) 6 ATP, 6 NADPH
D) 12 ATP, 18 NADPH

3. Why are the Calvin cycle reactions called 'dark reactions'?

A) They only occur at night
B) They don't use light directly, only ATP/NADPH from light reactions
C) They destroy chlorophyll
D) They occur in the dark side of the leaf

4. Which organelle compartment hosts the Calvin cycle?

A) Thylakoid lumen
B) Mitochondrial matrix
C) Chloroplast stroma
D) Cytoplasm

5. To fix 3 CO2 molecules and produce 1 net G3P, how many ATP and NADPH does the Calvin cycle use?

6. How many total CO2, ATP, and NADPH are needed to build one glucose molecule (C6H12O6)?

7. A leaf fixes 40 CO2 molecules per second in the Calvin cycle. How many ATP molecules does it consume per second?

8. Define: What enzyme fixes CO2 in the Calvin cycle?

9. Define: Where does the Calvin cycle occur?

10. Define: What is the direct product of the Calvin cycle?

Answer Key

1. B) RuBP - RuBP (ribulose-1,5-bisphosphate) is carboxylated by RuBisCO to accept CO2.

2. B) 18 ATP, 12 NADPH - Glucose requires 2 G3P, so the per-G3P cost (9 ATP, 6 NADPH) doubles to 18 ATP and 12 NADPH.

3. B) They don't use light directly, only ATP/NADPH from light reactions - They don't absorb light themselves, but they still normally happen during the day since they need light-reaction products.

4. C) Chloroplast stroma - The Calvin cycle enzymes, including RuBisCO, are located in the chloroplast stroma.

5. Each CO2 fixed costs 3 ATP and 2 NADPH 3 CO2 3 ATP = 9 ATP 3 CO2 2 NADPH = 6 NADPH Result: 9 ATP and 6 NADPH are used to make 1 G3P

6. Glucose has 6 carbons, so 2 G3P molecules (3 carbons each) must combine Each G3P requires 3 CO2, 9 ATP, 6 NADPH 2 G3P 6 CO2, 18 ATP, 12 NADPH Result: 6 CO2, 18 ATP, and 12 NADPH per glucose

7. ATP cost = 3 ATP per CO2 fixed 40 CO2 3 ATP/CO2 = 120 ATP Result: 120 ATP consumed per second

8. RuBisCO (ribulose-1,5-bisphosphate carboxylase/oxygenase), the most abundant enzyme on Earth.

9. In the stroma of the chloroplast.

10. Glyceraldehyde-3-phosphate (G3P); two G3P molecules combine to form glucose.