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Plant Biology: Photosynthesis

Printable Flashcards — Pre-Med Biology

Light reactions, Calvin cycle, chloroplast structure, stomata, limiting factors, and C3/C4/CAM comparisons.

190 cards — Print double-sided, flip on long edge, then cut along dashed lines.

190 cards — Printable Flashcards

Free & Open-Source

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1

Photosynthesis in one line is basically...

2

Overall photosynthesis equation (high-level):

3

Trap: oxygen released in photosynthesis comes from CO2. True or false?

4

Where does the carbon in glucose come from?

5

Photosynthesis is mainly an energy conversion from...

6

Do plants do cellular respiration too?

7

At night, plants are doing... (photosynthesis? respiration?)

8

Trap: photosynthesis is just 'respiration backwards'. True or false?

2

$CO_2 + H_2O$ + light -> glucose (sugars) + O_2.

1

Using light energy to build sugars from CO_2 and H_2O (and releasing O_2).

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4

CO_2.

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3

False. It comes from H_2O.

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6

Yes. All the time.

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5

Light energy -> chemical energy (stored in sugars).

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8

False (oversimplified).

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7

Respiration only (no light -> no photosynthesis).

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9

Autotroph means...

10

Heterotroph means...

11

Quick reality check: do plants 'eat sunlight'?

12

Main input gas used in photosynthesis:

13

Main gas released in photosynthesis:

14

Photosynthesis: {{c1::CO2}} + {{c2::H2O}} + light -> sugars + {{c3::O2}}.

15

Photosynthesis happens in the...

16

Chloroplast has a double membrane. Why does that matter?

10

Needs to eat organic molecules made by other organisms.

9

Makes its own organic food from inorganic sources (like CO_2).

12

CO_2

11

No. They use sunlight to build sugars, then use sugars for energy/material.

14

Photosynthesis: CO_2 + H_2O + light -> sugars + O_2.

13

O_2

16

It creates compartments (outside, stroma, thylakoid space) for controlled reactions.

15

Chloroplasts (in plants/algae).

17

Stroma is...

18

Thylakoids are...

19

Granum (plural grana) is...

20

Light reactions happen on the...

21

Calvin cycle happens in the...

22

Thylakoid lumen is...

23

Trap: Calvin cycle happens in the thylakoid membrane. True or false?

24

Quick map: light reactions make... and Calvin cycle uses...

18

Membrane sacs inside chloroplasts where light reactions happen.

17

The fluid inside the chloroplast (outside the thylakoids).

20

Thylakoid membrane.

19

A stack of thylakoids.

22

The inside space of a thylakoid.

21

Stroma.

24

Light reactions make ATP + NADPH. Calvin cycle uses ATP + NADPH to fix CO2.

23

False. It happens in the stroma.

25

Locations: light reactions in {{c1::thylakoid membrane}}; Calvin cycle in {{c2::stroma}}.

26

Stack of thylakoids is called a:

27

Chlorophyll's job is to...

28

Why are plants green?

29

Chlorophyll absorbs light best in the...

30

Accessory pigments (like carotenoids) are useful because...

31

Carotenoids also help because they...

32

Trap: light is 'used up' in photosynthesis like a reactant. True or false?

26

Granum

25

Locations: light reactions in thylakoid membrane; Calvin cycle in stroma.

28

They reflect/transmit green light more than they absorb it.

27

Absorb light energy and excite electrons.

30

They absorb extra wavelengths and pass energy to chlorophyll (plus protection).

29

Red and blue regions (not green).

32

False.

31

Protect against excess light (reduce damage).

33

If a plant gets more intense light, photosynthesis rate always increases forever. True or false?

34

If a plant is in darkness, the light reactions... and the Calvin cycle...

35

Photosystems are basically...

36

Trap: Photosystem I works before Photosystem II because 1 comes before 2. True or false?

37

Plants look green because chlorophyll reflects {{c1::green}} light and absorbs mostly {{c2::red}} and {{c3::blue}}.

38

Main pigment in photosynthesis:

39

Light reactions are called 'light-dependent' because they...

40

Main outputs of light reactions are...

34

Light reactions stop; Calvin cycle stops soon after (no ATP/NADPH supply).

33

False.

36

False.

35

Pigment-protein complexes that capture light and move electrons.

38

Chlorophyll

37

Plants look green because chlorophyll reflects green light and absorbs mostly red and blue.

40

ATP, NADPH, and O2.

39

Require light to excite electrons and start electron flow.

41

Light reactions happen on the thylakoid membrane because...

42

Photolysis means...

43

When water is split, what happens to the oxygen?

44

When water is split, the electrons are used to...

45

When water is split, the H^+ (protons) contribute to...

46

Electron transport chain (ETC) in photosynthesis mainly...

47

ATP synthase makes ATP by...

48

In chloroplasts, protons build up mainly in the...

42

Splitting water using light energy.

41

You need a membrane to build a proton gradient for ATP synthase.

44

Replace electrons lost by chlorophyll in Photosystem II.

43

It forms O2 gas and is released.

46

Moves electrons and pumps protons to create an H^+ gradient.

45

The proton gradient in the thylakoid lumen.

48

Thylakoid lumen.

47

Letting H^+ flow down its gradient (chemiosmosis).

49

Where does ATP end up being made (which side of the thylakoid membrane)?

50

NADPH is made when...

51

Trap: NADH is the main electron carrier in photosynthesis. True or false?

52

If $NADP^+$ isn't available (not enough), what happens to electron flow?

53

Photosystem II's main job is to...

54

Photosystem I's main job is to...

55

Non-cyclic electron flow produces...

56

Cyclic electron flow (around PSI) mainly produces...

50

$NADP^+$ is reduced (gains electrons) at the end of the light reactions.

49

On the stroma side.

52

It can back up because $NADP^+$ is the final acceptor in non-cyclic flow.

51

False. It's NADPH.

54

Re-energize electrons and help reduce $NADP^+$ to NADPH.

53

Start the electron flow and help build the proton gradient (via water splitting and ETC).

56

ATP only (no NADPH, no O2).

55

ATP + NADPH + O2.

57

Why might a plant use cyclic electron flow?

58

Light reactions outputs: {{c1::ATP}}, {{c2::NADPH}}, and {{c3::O2}}.

59

In photosynthesis, H^+ builds up in the {{c1::thylakoid lumen}} and flows back to the {{c2::stroma}} through ATP synthase.

60

Electron carrier used in photosynthesis (reduced form):

61

Process of making ATP using a proton gradient is called:

62

Calvin cycle's job is to...

63

Why is it sometimes called 'light-independent'?

64

Main inputs of Calvin cycle are...

58

Light reactions outputs: ATP, NADPH, and O_2.

57

To make extra ATP without making extra NADPH.

60

NADPH

59

In photosynthesis, H^+ builds up in the thylakoid lumen and flows back to the stroma through ATP synthase.

62

Fix CO_2 into organic molecules (make sugar building blocks).

61

Chemiosmosis

64

CO_2, ATP, and NADPH.

63

It doesn't use light directly.

65

Main output of Calvin cycle (direct) is...

66

Trap: Calvin cycle directly makes glucose each turn. True or false?

67

Rubisco is...

68

Why is Rubisco famous (and annoying)?

69

The Calvin cycle has 3 big phases:

70

Why does the Calvin cycle need ATP?

71

Why does the Calvin cycle need NADPH?

72

Where does the Calvin cycle happen again?

66

False.

65

G3P (a 3-carbon sugar), not glucose directly.

68

It's slow and it can bind O2 instead of CO2 (photorespiration).

67

The enzyme that attaches CO2 to RuBP (starts carbon fixation).

70

To provide energy for building and regenerating molecules in the cycle.

69

Carbon fixation, reduction, regeneration of RuBP.

72

Stroma.

71

To provide electrons (reducing power) to build carbohydrate from CO2.

73

If ATP and NADPH run out, Calvin cycle...

74

If CO_2 is limited (stomata closed), Calvin cycle...

75

Classic number (hard): fixing 3 CO_2 gives you...

76

Classic number (hard): for 3 CO_2 -> 1 G3P, the cycle uses...

77

So to make 1 glucose (6C), you need net...

78

Trap: Calvin cycle produces ATP. True or false?

79

Trap: light reactions use ATP they make. True or false?

80

Calvin cycle inputs: {{c1::CO2}}, {{c2::ATP}}, {{c3::NADPH}}. Direct output: {{c4::G3P}}.

74

Slows because carbon fixation can't happen fast.

73

Slows/stops even if CO_2 is available.

76

9 ATP and 6 NADPH.

75

1 net G3P (3-carbon).

78

False.

77

2 G3P (so 6 CO_2 total).

80

Calvin cycle inputs: CO_2, ATP, NADPH. Direct output: G3P.

79

False (mostly).

81

Main carbon-fixing enzyme in Calvin cycle:

82

Plants get CO_2 mainly through...

83

Stomata are controlled by...

84

Why do plants close stomata in hot/dry conditions?

85

Main downside of closing stomata is...

86

Transpiration means...

87

If CO_2 concentration increases (in the environment), photosynthesis rate usually...

88

If temperature increases, photosynthesis rate...

82

Stomata (tiny pores in leaves).

81

Rubisco

84

To reduce water loss.

83

Guard cells.

86

Water loss from leaves (mainly through stomata).

85

Less CO_2 enters -> Calvin cycle slows; O_2 builds up -> more photorespiration risk.

88

Increases up to an optimum, then decreases (enzymes get less efficient/denature).

87

Increases (until another factor limits).

89

Main limiting factors for photosynthesis (classic trio):

90

If light is low, the limiting factor is...

91

If light is high but CO_2 is low, the limiting factor is...

92

If CO_2 and light are fine but temperature is too low, the limiting factor is...

93

Why does a plant still need minerals from soil if it can make sugar?

94

Stomata let {{c1::CO2}} in, but they also let {{c2::water vapor}} out (transpiration).

95

Leaf pores for gas exchange are called:

96

Most common photosynthesis type is...

90

Light intensity.

89

Light intensity, CO_2 concentration, temperature.

92

Enzyme activity (Calvin cycle slows).

91

CO_2 concentration (carbon fixation).

94

Stomata let CO_2 in, but they also let water vapor out (transpiration).

93

Sugar gives carbon/energy, but minerals provide essential elements (N, P, etc.) for proteins/DNA.

96

C3.

95

Stomata

97

Why are they called C3 plants?

98

Photorespiration happens when Rubisco binds...

99

Photorespiration is more likely when...

100

C4 plants solve the photorespiration problem by...

101

CAM plants solve water loss by...

102

Key difference between C4 and CAM (super simple):

103

Which types are best adapted to hot/dry conditions?

104

Trap: CAM plants keep stomata open during the day to take in CO2. True or false?

98

O_2 instead of CO_2.

97

The first stable product of CO_2 fixation is a 3-carbon compound.

100

Concentrating CO_2 near Rubisco.

99

CO_2 is low and O_2 is high inside the leaf (often when stomata close).

102

C4 separates steps by space (different cells). CAM separates steps by time (night/day).

101

Opening stomata at night and storing CO_2 for daytime use.

104

False.

103

C4 and CAM.

105

If an exam says 'stomata open at night', think...

106

If an exam says 'CO2 concentrated around Rubisco', think...

107

C4 separates CO2 fixation and Calvin cycle by {{c1::space}}; CAM separates them by {{c2::time}}.

108

Photosynthesis mainly happens in...

109

Cellular respiration mainly happens in...

110

Photosynthesis builds glucose. Respiration...

111

Which process releases O2?

112

Which process consumes O2 (in most organisms)?

106

C4 (or CAM, but usually C4 if they mention special CO_2 concentration).

105

CAM.

108

Chloroplasts.

107

C4 separates CO_2 fixation and Calvin cycle by space; CAM separates them by time.

110

Breaks glucose to make ATP.

109

Mitochondria (in eukaryotes).

112

Aerobic respiration.

111

Photosynthesis.

113

Electron carriers: photosynthesis mainly uses... while respiration mainly uses...

114

Both chloroplasts and mitochondria make ATP using...

115

Where do protons build up in mitochondria vs chloroplasts? (basic trap)

116

In respiration, final electron acceptor is... In photosynthesis (non-cyclic), final acceptor is...

117

Photosynthesis stores energy in {{c1::glucose}}; respiration releases energy as {{c2::ATP}}.

118

Respiration final electron acceptor: {{c1::O2}}. Photosynthesis final acceptor (non-cyclic): {{c2::NADP$^+$}}.

119

Scenario: A plant is in bright light but CO2 is very low. What happens to photosynthesis rate?

120

Scenario: A plant is in high CO2 but very low light. What happens to photosynthesis rate?

114

A proton gradient and ATP synthase (chemiosmosis).

113

NADPH; NADH (and FADH2).

116

O2; $NADP^+$.

115

Mito: intermembrane space.
Chloro: thylakoid lumen.

118

Respiration final electron acceptor: O2.
Photosynthesis final acceptor (non-cyclic): $NADP^+$.

117

Photosynthesis stores energy in glucose; respiration releases energy as ATP.

120

It stays low because light reactions can't supply ATP/NADPH fast.

119

It plateaus/limits because Calvin cycle can't fix carbon fast enough.

121

Scenario: Stomata close due to drought. Which two things immediately change inside the leaf?

122

Scenario: stomata closed -> CO_2 low -> Rubisco binds O_2. The process is called...

123

Scenario: You shine only green light on a plant. Photosynthesis rate is likely...

124

Scenario: You increase light intensity gradually. Rate rises then flattens. Why?

125

Scenario: A leaf is sealed in a jar in the dark. Over time, O_2 goes... and CO_2 goes...

126

Scenario: Same leaf in bright light (enough CO_2). Over time, O_2 goes... and CO_2 goes...

127

Scenario: If light reactions are blocked, what happens to NADPH levels?

128

Scenario: If Calvin cycle is blocked, what happens to $NADP^+$ availability?

122

Photorespiration.

121

CO_2 drops and O_2 rises.

124

Another factor becomes limiting (CO_2, temperature, enzyme capacity).

123

Lower than under red/blue light (because green is poorly absorbed).

126

O_2 increases; CO_2 decreases.

125

O_2 decreases; CO_2 increases.

128

$NADP^+$ becomes scarce because it stays reduced as NADPH.

127

They drop (can't be made).

129

Scenario: A plant has lots of ATP but low NADPH. Which electron flow can help fix the imbalance?

130

Scenario: A plant needs extra ATP relative to NADPH. Which pathway helps?

131

Photophosphorylation means...

132

Trap: photophosphorylation means adding a phosphate directly to glucose. True or false?

133

Carbon fixation means...

134

Oxidation vs reduction (quick): reduction is...

135

In photosynthesis, $NADP^+$ gets reduced to NADPH. So $NADP^+$ is acting as...

136

ATP is mainly used for...

130

Cyclic electron flow (PSI cycle).

129

Non-cyclic flow makes NADPH; cyclic flow doesn't.

132

False.

131

Making ATP using light energy (via electron transport and proton gradient).

134

Gain of electrons (or hydrogen).

133

Turning inorganic CO2 into organic carbon compounds.

136

Energy (powering reactions).

135

An electron acceptor.

137

NADPH is mainly used for...

138

Trap: NADPH is basically 'energy' like ATP. True or false?

139

If you forget everything: light reactions =

140

If you forget everything: Calvin cycle =

141

Most 'glucose' made in plants is actually stored as...

142

Trap: oxygen is needed for photosynthesis. True or false?

143

Trap: water is only needed to 'cool the plant'. True or false?

144

Which part is directly powered by photons: light reactions or Calvin cycle?

138

Kind of false.

137

Reducing power (providing electrons for building molecules).

140

Use ATP/NADPH to fix CO2 into sugar building blocks (G3P).

139

Make ATP/NADPH (and O2).

142

False (oxygen is produced, not required as input).

141

Starch (in plants) or transported as sucrose.

144

Light reactions.

143

False.

145

If someone says 'dark reactions happen only at night', the fix is...

146

Light reactions make {{c1::ATP}} and {{c2::NADPH}}; Calvin cycle uses them to fix {{c3::CO2}}.

147

Direct product of Calvin cycle (not glucose):

148

If you add CO2 to a plant in light, which stage benefits most immediately?

149

If you add light (brighter) but CO2 is fixed low, which stage is 'stuck'?

150

If you block ATP synthase in chloroplasts, the immediate effect is...

151

If you block Photosystem II, what happens to O2 production?

152

If you block Photosystem I, what happens to NADPH production?

146

Light reactions make ATP and NADPH; Calvin cycle uses them to fix CO2.

145

They don't need light directly, but they usually run in daytime because they need ATP/NADPH.

148

Calvin cycle (carbon fixation).

147

G3P

150

Less ATP production -> Calvin cycle slows.

149

Calvin cycle becomes limiting.

152

It drops a lot (can't reduce $NADP^+$ efficiently).

151

It stops (no water splitting).

153

Where does the energy in ATP come from in chloroplasts?

154

Why do we need an electron transport chain at all?

155

In a leaf cross-section, the cells with the most chloroplasts are usually in the...

156

Why are leaves thin and flat?

157

Trap: photosynthesis happens in roots too (normally). True or false?

158

If a question says 'rate-limiting step' in photosynthesis at high light, the likely bottleneck is...

159

Why is Rubisco sometimes the limiting factor?

160

If you remove chlorophyll from a plant (no pigment), the first thing to fail is...

154

To convert high-energy electrons into a usable gradient (and not just waste the energy as heat).

153

From the proton gradient created by electron transport.

156

To maximize surface area for light and CO_2 diffusion.

155

Palisade mesophyll (near the top).

158

Carbon fixation (Rubisco/Calvin cycle).

157

False (usually).

160

Light absorption -> light reactions stop.

159

It's slow and can bind O_2, not just CO_2.

161

Space inside a thylakoid where H^+ builds up:

162

Fluid region of chloroplast
where Calvin cycle occurs:

163

Process that splits water in light reactions:

164

O2 released in photosynthesis comes from splitting {{c1::H2O}}, not {{c2::CO2}}.

165

PS{{c1::II}} acts before PS{{c2::I}} in the main electron flow.

166

Prompts usually mix these up: light reactions happen in thylakoid..., Calvin cycle in stroma...

167

NADPH vs NADH: which one is photosynthesis?

168

O2 release: water or CO2?

162

Stroma

161

Thylakoid lumen

164

O_2 released in photosynthesis comes from splitting H_2O, not CO_2.

163

Photolysis

166

Light reactions = thylakoid membrane; Calvin cycle = stroma.

165

PSII acts before PSI in the main electron flow.

168

Water.

167

NADPH.

169

Direct Calvin product: glucose or G3P?

170

PSII vs PSI: which one splits water?

171

Light reactions make ATP. Calvin cycle uses ATP. So which one is 'energy-producing'?

172

If you see 'chemiosmosis' in photosynthesis, think...

173

If you see 'carbon fixation', think...

174

If you see 'stomata closed', think...

175

If you see 'stomata open at night', think...

176

Light reactions: {{c1::thylakoid membrane}}. Calvin cycle: {{c2::stroma}}.

170

PSII (linked to water splitting).

169

G3P.

172

ATP synthase powered by H^+ gradient in thylakoids.

171

Light reactions produce ATP; Calvin cycle spends ATP to build carbs.

174

Less CO2, more photorespiration risk, lower photosynthesis.

173

Calvin cycle (Rubisco).

176

Light reactions: thylakoid membrane. Calvin cycle: stroma.

175

CAM plants.

177

ATP is mainly an {{c1::energy}} currency; NADPH is mainly a {{c2::reducing}} (electron) currency.

178

Water splitting (photolysis) produces {{c1::O2}}, {{c2::electrons}}, and {{c3::H^+}}.

179

Non-cyclic electron flow makes {{c1::ATP}} + {{c2::NADPH}} + {{c3::O2}}; cyclic flow makes {{c4::ATP}} only.

180

Stomata are controlled by {{c1::guard cells}}.

181

Main organelle of photosynthesis (plants/algae):

182

Main outputs of light reactions (2 energy molecules):

183

Where do light reactions happen?

184

Where does Calvin cycle happen?

178

Water splitting (photolysis) produces O_2, electrons, and H^+.

177

ATP is mainly an energy currency; NADPH is mainly a reducing (electron) currency.

180

Stomata are controlled by guard cells.

179

Non-cyclic electron flow makes ATP + NADPH + O_2; cyclic flow makes ATP only.

182

ATP and NADPH

181

Chloroplast

184

Stroma

183

Thylakoid membrane

185

Main enzyme that fixes CO_2 in C3 plants:

186

Pores that let CO_2 into leaves:

187

Cells that open/close stomata:

188

Process where Rubisco binds O_2 instead of CO_2 (wastes energy):

189

Photosynthesis type with stomata open at night:

190

Photosynthesis type that separates steps by space (CO_2 concentration):

186

Stomata

185

Rubisco

188

Photorespiration

187

Guard cells

190

C4

189

CAM