Photosynthesis and cellular respiration slide deck

Biology 20

Unit C: Photosynthesis and cellular respiration

Light reactions in the thylakoid

Oxygen from pondweed in light

- Pondweed under a bright lamp releases a string of bubbles.
- Move the lamp away and the string slows.



Light, then two chemical products

- Chlorophyll and other pigments absorb light in the thylakoid.
- NADP is reduced to NADPH.
- Chemiosmosis at the membrane stores energy in ATP.

Key terms

thylakoid

The membrane sac inside a chloroplast where the light reactions occur.

chemiosmosis

ATP formation as hydrogen ions flow through ATP synthase in a membrane. ($NADP^+ + H^+$ becomes NADPH)

NADPH

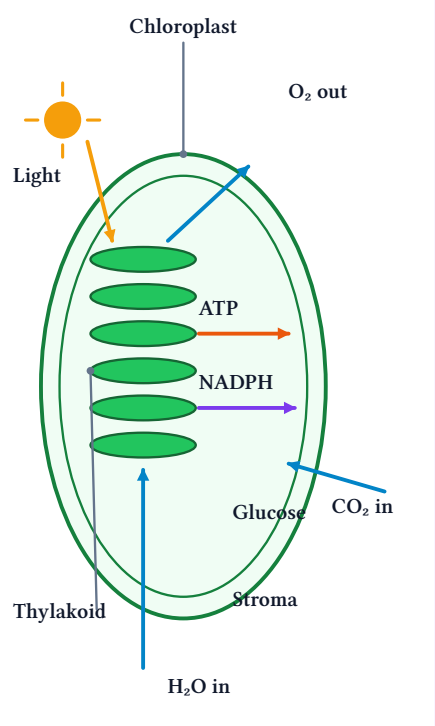
The reduced form of NADP, carrying chemical reducing power from the light reactions.

pigment

A molecule, such as chlorophyll, that absorbs visible light.

Light reactions happen in the thylakoid

- Light hits the stack of green thylakoid discs.
- Water enters the thylakoid and oxygen leaves. ATP and NADPH move into the stroma.
- The fluid around the stack is the stroma. Carbon dioxide enters it, and glucose is made there.



Factor and prediction

- Name light distance or brightness as the factor you change.
- Predict the bubble count in one minute.

Where each product forms

- Point to the thylakoid for NADPH and ATP.
- Save glucose for the stroma lesson.

Light reactions

- Place the light reactions in the chloroplast.
- Name NADPH, ATP, and oxygen.

The stroma uses NADPH and ATP

- NADPH and ATP are ready for carbon dioxide.
- Glucose is the product of that next set of reactions.

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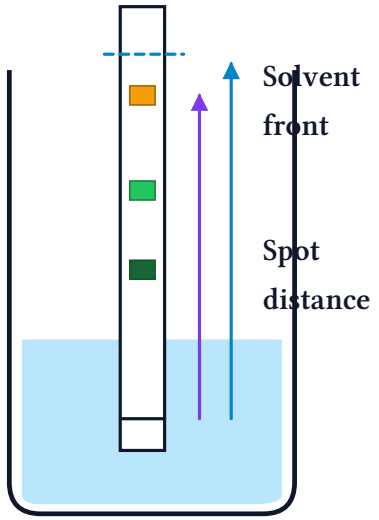
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Carbon fixation in the stroma

The yellow band travelled farthest

- The paper strip shows a yellow carotene band above two green bands.
- The caption says Rf is the spot distance divided by the solvent distance.



Rf = spot distance / solvent distance

The stroma uses NADPH and ATP

- NADPH and ATP move from the thylakoid into the stroma.
- Carbon dioxide enters that same fluid.
- Glucose is the sugar that leaves the reactions.

Key terms

stroma

The fluid in a chloroplast, around the thylakoids, where glucose is assembled.

Rf value

How far a pigment spot travels, divided by how far the solvent travels.

carbon fixation

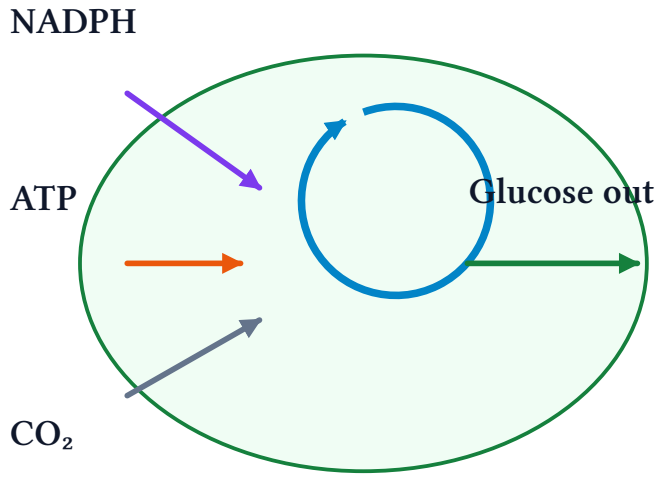
The set of reactions that attaches carbon dioxide into a sugar.

iodine test

A stain that turns blue-black where starch is present in a leaf.

The Calvin cycle in the stroma

- NADPH, ATP, and carbon dioxide point into the cycle.
- The cycle sits in the stroma.
- Glucose leaves along the green arrow.



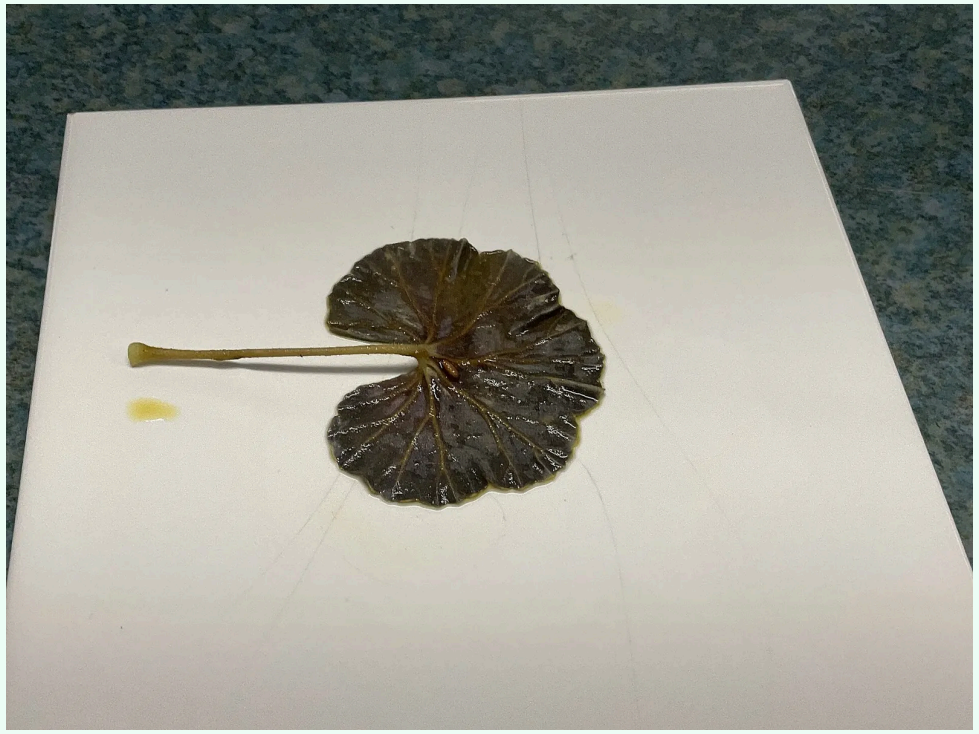
The cycle turns in the stroma

Divide the two distances

- Measure from the start line to the middle of the spot.
- Measure from the start line to the solvent front, then divide.

Stains and light

- The lit half of the leaf goes dark with iodine where starch formed.
- The covered half stays pale on the same leaf.



Stroma and strip

- Place glucose-building in the chloroplast.
- Show one Rf value with both distances.

Fields store and use this sugar

- Crops store the glucose this stroma path builds.
- The next lesson follows that sugar into farming and water loss.

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Photosynthesis in fields and labs

Grain holds sugar made in sunlight

- A barley field turns a summer of light into grain you can harvest.
- The same open leaves are losing water while they take in carbon dioxide.

Three field facts from one leaf path

- Agriculture and forestry harvest carbon that photosynthesis stored.
- Evapotranspiration rises when stomata stay open in sun and wind.
- A herbicide can block the electron path that makes NADPH and ATP.

Key terms

evapotranspiration

Water evaporating from soil and from leaves, including the water lost through open stomata.

herbicide

A chemical used to kill or stunt plants, sometimes by blocking the light reactions.

C4 photosynthesis

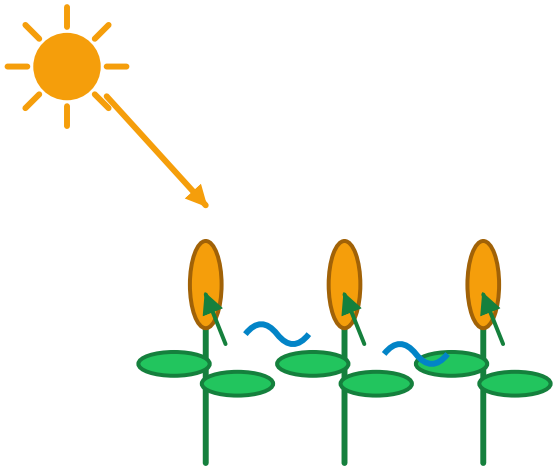
A leaf path, used by corn, that concentrates carbon dioxide for the sugar-building enzyme.

stomata

Pores in a leaf that let carbon dioxide in and water vapour out.

What the barley drawing shows

- The top bar says sunlight on the crop.
- Green arrows carry sugar into the grain head.
- Blue waves are water leaving the leaves.



Sugar arrow into the head

Waves are water leaving the leaf

Covered soil and pot mass

- Cover the soil so the loss is from the leaves.
- Compare one sunny hour with one shady hour.

One herbicide, one blocked step

- Name the crop and the product in the first sentence.
- Say whether the brief claims a block in the light reactions.

Field and lab

- Connect grain to photosynthesis.
- Explain a water-loss comparison and a herbicide block.

Respiration releases the energy in sugar

- Cells can release the energy stored in that glucose.
- The next lesson starts in the cytosol with glycolysis.

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Glycolysis and the Krebs cycle

The sugar splits before the loop

- A glucose hexagon in the cytosol leads to two pyruvate circles.
- NADH is marked in the cytosol and again by the matrix loop.

Cytosol first, matrix second

- Glycolysis in the cytosol forms pyruvate and NADH.
- The Krebs cycle turns in the mitochondrial matrix.
- That loop releases carbon dioxide and forms NADH and FADH.

Key terms

glycolysis

The cytosol pathway that splits glucose into pyruvate and forms NADH.

Krebs cycle

The loop in the mitochondrial matrix that releases carbon dioxide and forms NADH and FADH.

pyruvate

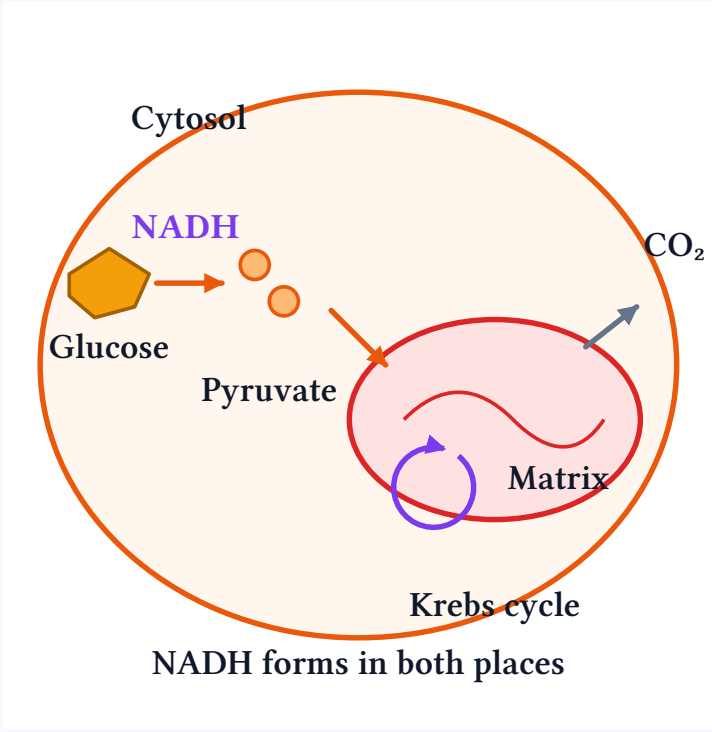
The three-carbon product that leaves glycolysis and can enter the mitochondrion.

FADH

A carrier, formed in the Krebs cycle, that holds reducing power for later ATP production.

Into the matrix

- Pyruvate moves from the cytosol into the mitochondrion.
- The loop drawn in the matrix is the Krebs cycle.
- The caption marks NADH in both places.



NADH forms in both places

Products from one glucose

- One glucose in glycolysis yields two pyruvate molecules.
- The matrix loop then forms NADH and FADH and releases carbon dioxide.

Pea flask comparison

- Germinating peas are the flask expected to warm.
- Dry dormant peas are the matched flask.



Two stages

- Place glycolysis and name its products.
- Place the Krebs cycle and name NADH, FADH, and carbon dioxide.

NADH and $FADH_2$ still lead to ATP

- NADH and FADH are holding reducing power.
- The inner membrane is where that power becomes ATP.

Image credits

pics pd, Mung bean sprouts, close-up, CC0 1.0

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ATP at the inner membrane

Hydrogen ions return through ATP synthase

- Hydrogen ions sit above the inner membrane bar.
- They flow down through ATP synthase, and ATP leaves into the matrix.

Reducing power becomes ATP

- NADH and FADH supply reducing power at the inner membrane.
- Chemiosmosis is the hydrogen-ion flow through ATP synthase.
- ATP forms in the matrix and can leave to do cell work.

Key terms

chemiosmosis

The flow of hydrogen ions through ATP synthase that stores energy in ATP.

ATP

The molecule that carries usable chemical energy for cell work such as contraction and active transport.

inner membrane

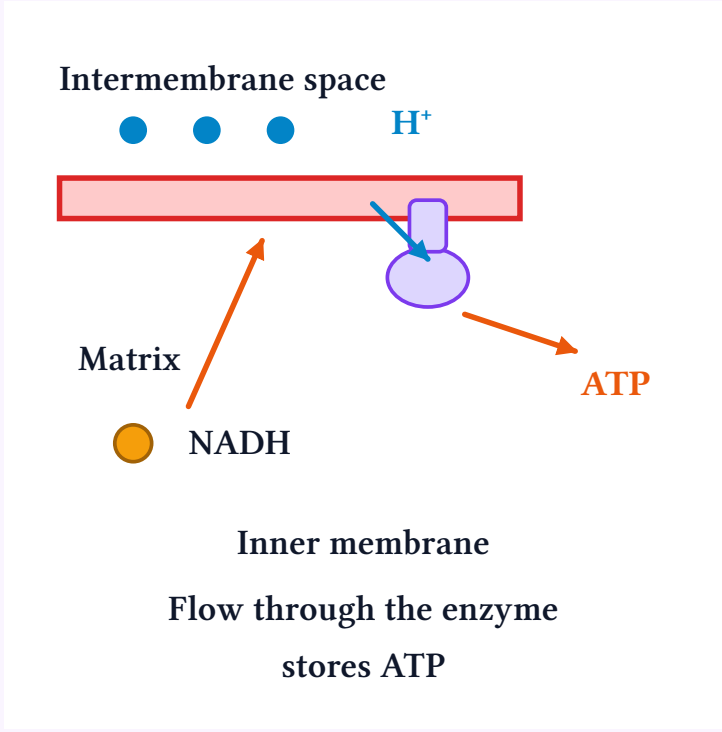
The mitochondrial membrane that holds the electron carriers and ATP synthase.

ATP synthase

The enzyme in the inner membrane that lets hydrogen ions flow back and forms ATP.

ATP forms at the inner membrane

- NADH is in the matrix, donating upward.
- The ion arrow points back through the enzyme.
- The caption says that flow stores ATP.



Send each element to its exit

- Carbon atoms from glucose leave as carbon dioxide.
- Hydrogen from glucose and inhaled oxygen meet in water.

Jobs that use ATP

- Contraction in the heart spends ATP.
- Active transport in the gut spends ATP too.

Ions and atoms

- Describe chemiosmosis at the inner membrane.
- Send glucose carbon and inhaled oxygen to their products.

Oxygen makes the larger ATP yield possible

- This membrane path needs oxygen to keep accepting electrons.
- Cells have shorter routes when oxygen is scarce.

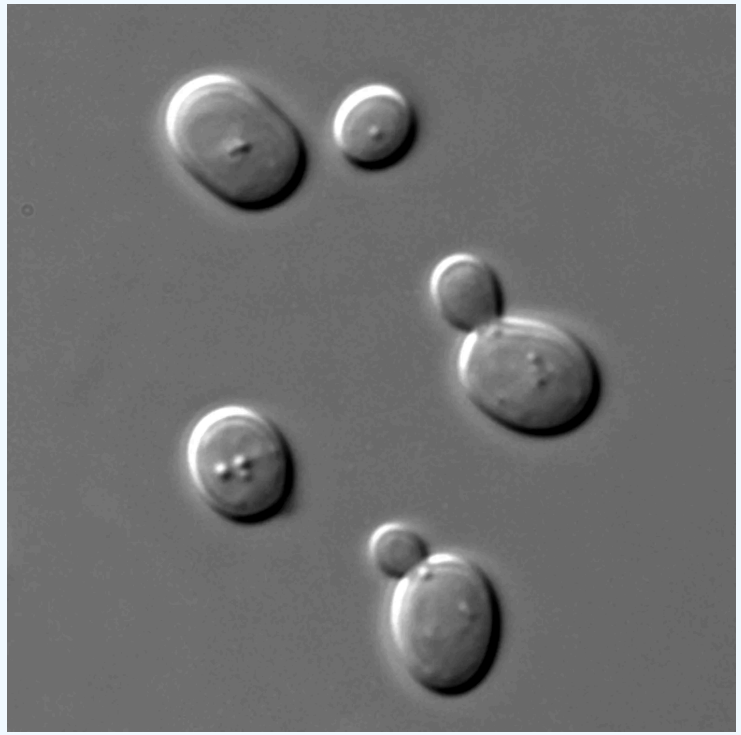
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Routes when oxygen is scarce

Three branches from pyruvate

- The oxygen branch shows a mitochondrion and a tall ATP stack.
- Muscle shows lactic acid and a short stack. Yeast shows alcohol, carbon dioxide, and a short stack.



Oxygen and ATP yield

- Aerobic respiration uses the mitochondrion and builds many ATP.
- Fermentation in muscle yields lactic acid and a short ATP count.
- Fermentation in yeast yields alcohol and carbon dioxide, also with a short count.

Key terms

fermentation

An anaerobic route that recycles pyruvate into lactic acid or into alcohol and carbon dioxide, with a small ATP yield.

metabolic toxin

A substance such as cyanide or hydrogen sulfide that blocks the aerobic path in the mitochondrion.

aerobic respiration

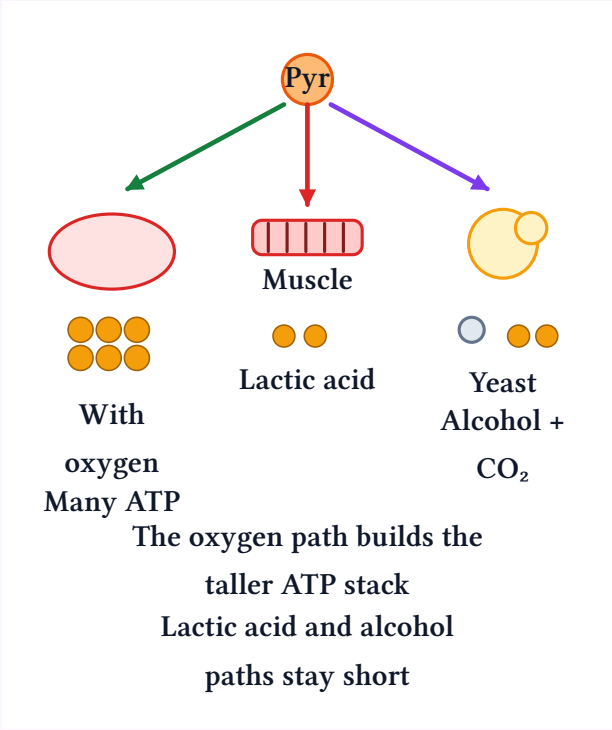
The oxygen-using path through the mitochondrion that builds the larger ATP yield.

lactic acid

The product muscle cells form from pyruvate when oxygen delivery lags behind a sprint.

Each route matches one kind of cell

- The tall stack sits on the branch labelled with oxygen.
- The striped fibre is the lactic acid branch.
- The budding cell is the alcohol and carbon dioxide branch.



Pea respiration data

- Germinating peas consume more oxygen and warm more.
- Dry dormant peas stay cooler and use less oxygen.

Checking a source on toxins

- A toxicology report names the chemical and the evidence.
- An advertisement is a weaker source for a health claim.

Three branches

- Compare ATP yield for oxygen, lactic acid, and alcohol.
- Name one industrial toxin that blocks the aerobic path.

The body has organs for these exchanges

- Cells still depend on food in and gases exchanged.
- Human organs are the next place those exchanges are organized.

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