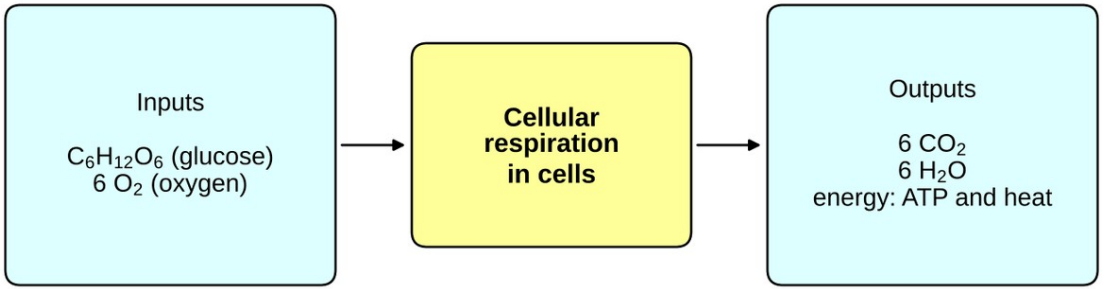
Essential Question

How do cells release the energy stored in glucose?

Cellular Respiration Releases Energy From Glucose

- Inputs: glucose ($C_6H_{12}O_6$) and O_2
- Outputs: CO_2, H_2O, and energy
- Energy is captured in ATP; the rest is heat
- Done by almost all organisms, including plants

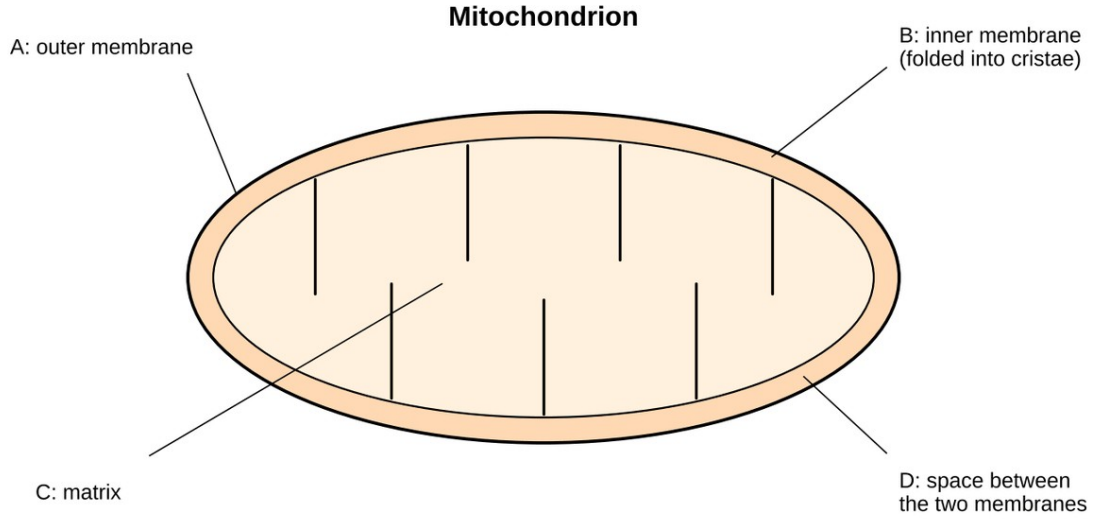


$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy (ATP and heat)

Bonds of glucose and O_2 break; new bonds form in CO_2 and H_2O; the energy released is used to make ATP

Where Cellular Respiration Happens

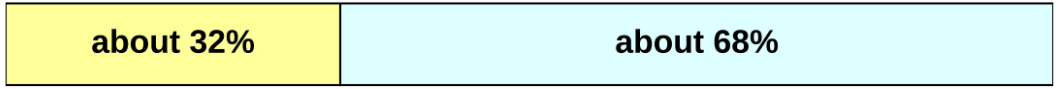
- Glycolysis: in the cytoplasm
- The rest: in the mitochondria
- Mitochondria have two membranes
- The inner membrane is folded into cristae



How Much Energy Does the Cell Capture?

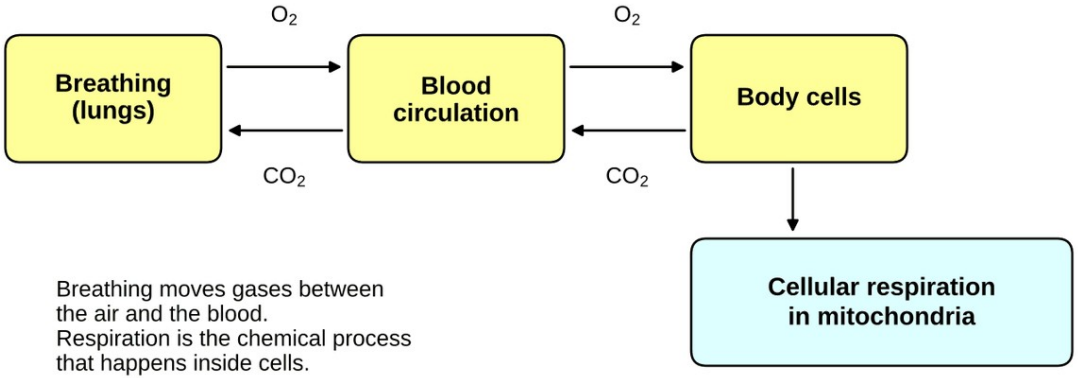
- About 32% of the energy goes into ATP (model)
- About 68% is released as heat
- Heat helps keep body temperature steady
- ATP powers movement, growth, and active transport

Where the energy from one glucose goes (model values)



Breathing Is Not Cellular Respiration

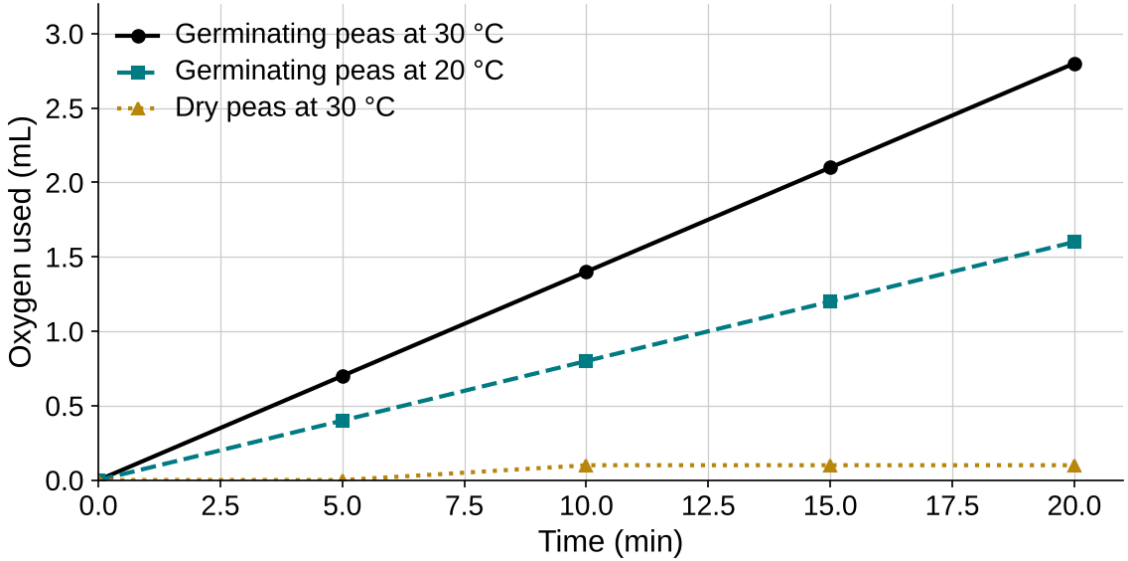
- Breathing: moves air in and out of the lungs
- Blood carries O_2 to cells and CO_2 away
- Cellular respiration: the chemical process in cells
- They are linked, but they are not the same



Breathing moves gases between the air and the blood.
Respiration is the chemical process that happens inside cells.

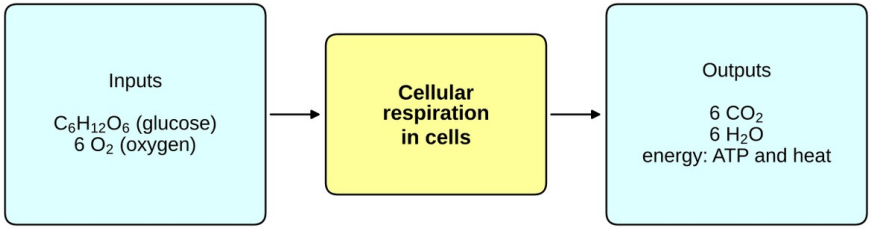
Evidence: Germinating Peas Use Oxygen

- A respirometer measures O_2 used
- Germinating peas use O_2 steadily
- Warmer peas use it faster
- Dry peas use almost none



Example: Counting Inputs and Outputs

A cell respires 5 molecules of glucose. Use the balanced equation, $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy. (a) How many molecules of O_2 are used, and how many of CO_2 and H_2O are made? (b) In the model, 1 glucose makes about 30 ATP. How many ATP are made? (c) Check that the oxygen atoms balance.

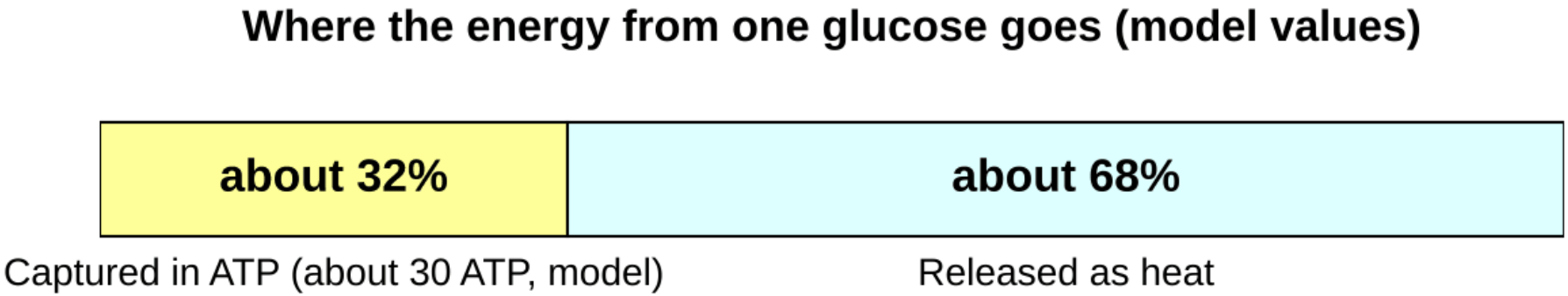


$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy (ATP and heat)

Bonds of glucose and O_2 break; new bonds form in CO_2 and H_2O; the energy released is used to make ATP

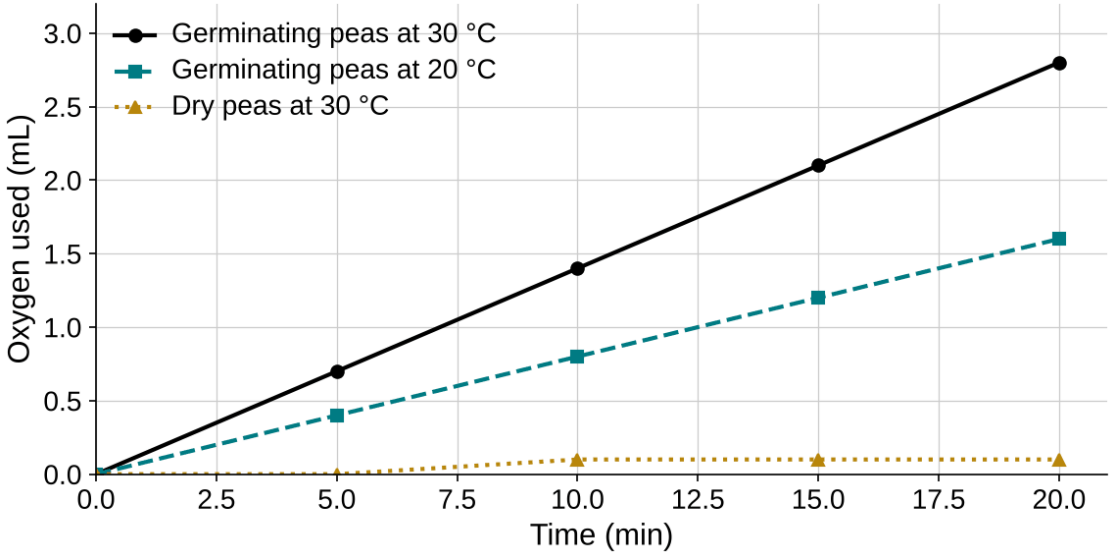
Example: How Much Energy Is Captured?

A mole of glucose releases about 2,870 kJ when it is respired. The cell makes about 30 mol of ATP, and each mole of ATP stores about 30.5 kJ. (a) What percent of the energy is captured in ATP? (b) How much is released as heat? (c) What happens to the heat?



Example: Respiration in Peas

Use the respirometer data. (a) Find the rate of O_2 use for germinating peas at 30 °C and at 20 °C, in mL/min. (b) How many times as fast is respiration at 30 °C? (c) State a claim about the dry peas, with evidence and reasoning.



Cellular Respiration

Big Ideas

- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy
- Glucose and O_2 bonds break; CO_2 and H_2O bonds form; energy is released
- About 32% of the energy goes into ATP (model); the rest is heat
- In cells with a nucleus, glycolysis is in the cytoplasm and the rest is in the mitochondria
- Breathing is not cellular respiration