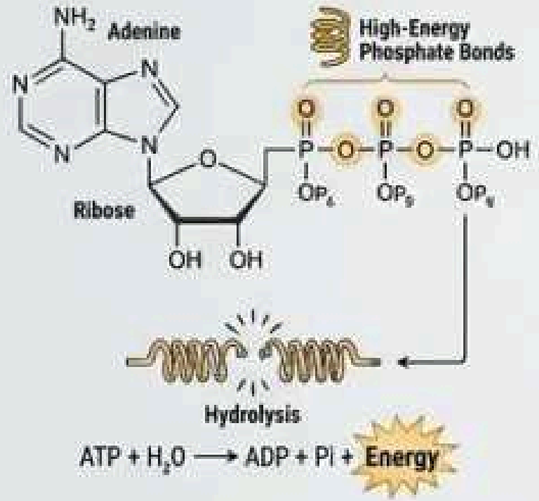
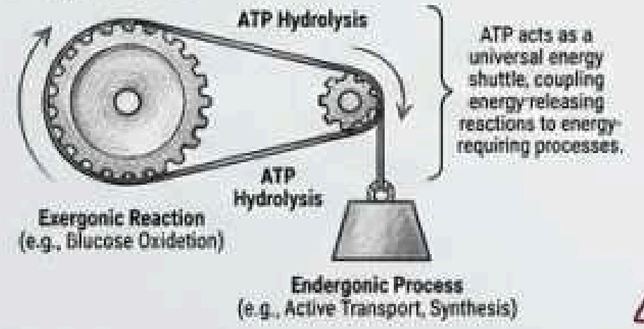
Energy, ATP, and the Pathways of Glycolysis

MED 502 B • Visual Study Guide

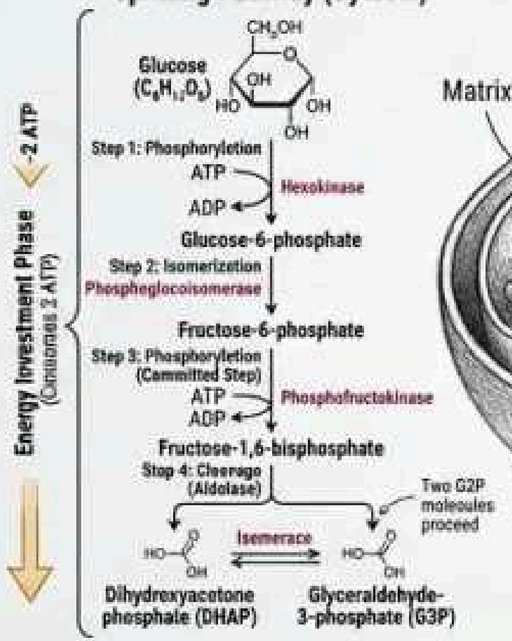
ATP: The Cellular Energy Currency

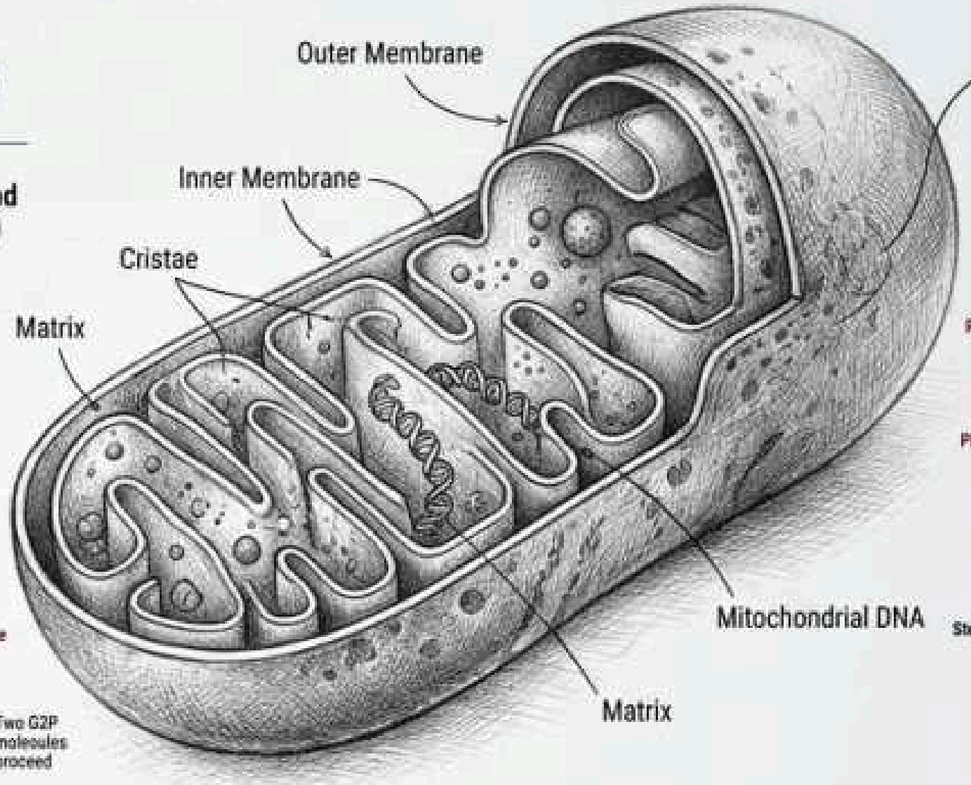


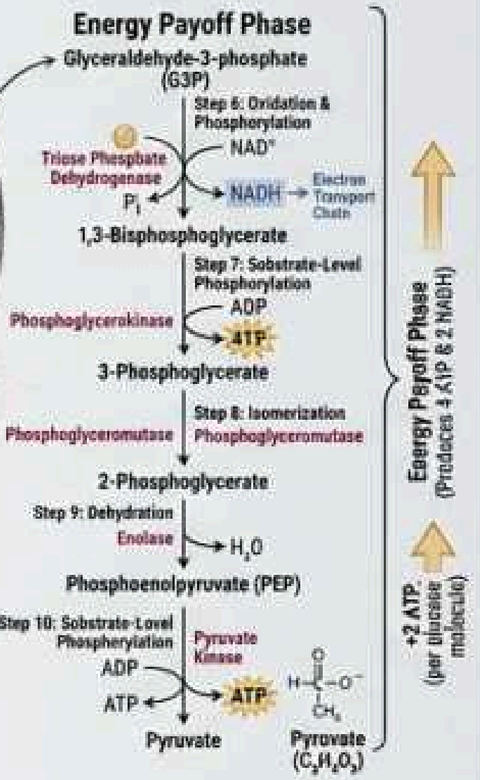
Energy Coupling Metaphor



GLYCOLYSIS: The Priming and Splitting Pathway (Cytosol)







Fermentation (Anaerobic)



Lactic Acid Fermentation

Pyruvate + NADH ⟶ Lactate + NAD⁺

Lactate Dehydrogenase



Alcohol Fermentation

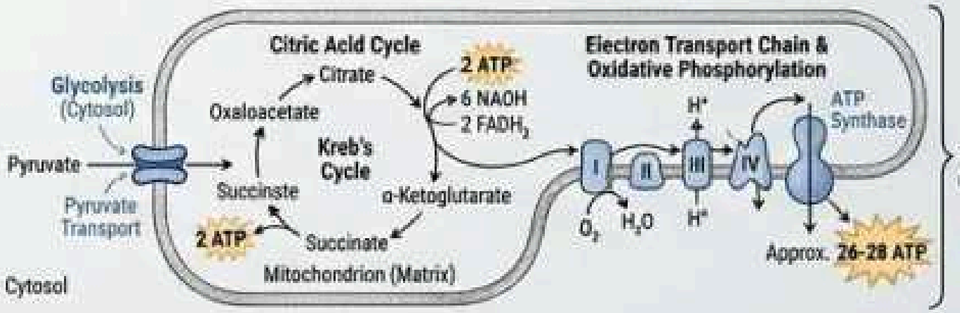
Pyruvate ⟶ Acetaldehyde + CO_2

Pyruvate Decarboxylase

Acetaldehyde + NADH ⟶ Ethanol + NAD⁺

⚠ **WARNING:** Fermentation regenerates NAD⁺ but yields minimal ATP (2 ATP total per glucose) and produces toxic byproducts.

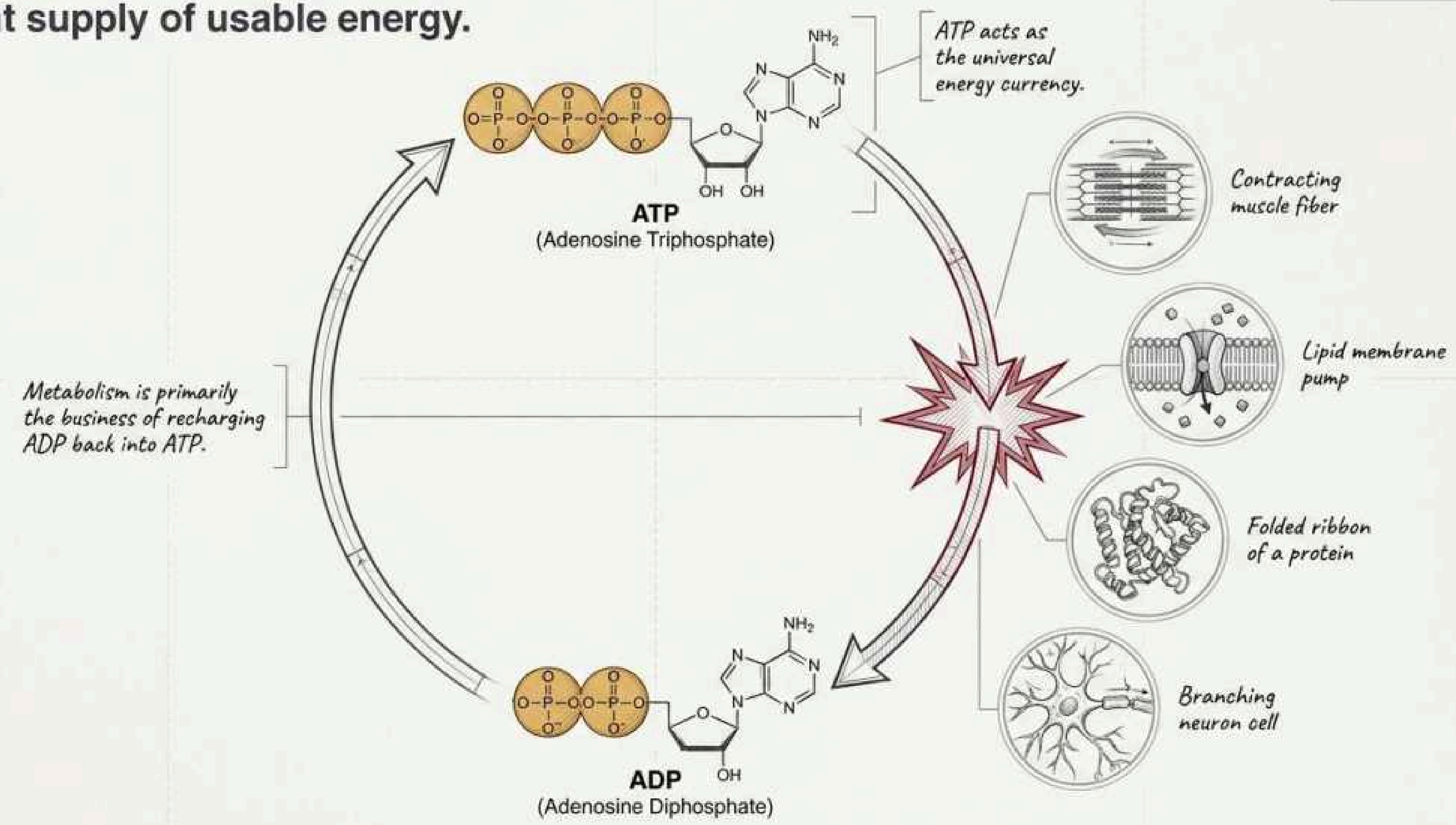
Cellular Respiration Overview (Eukaryotes)



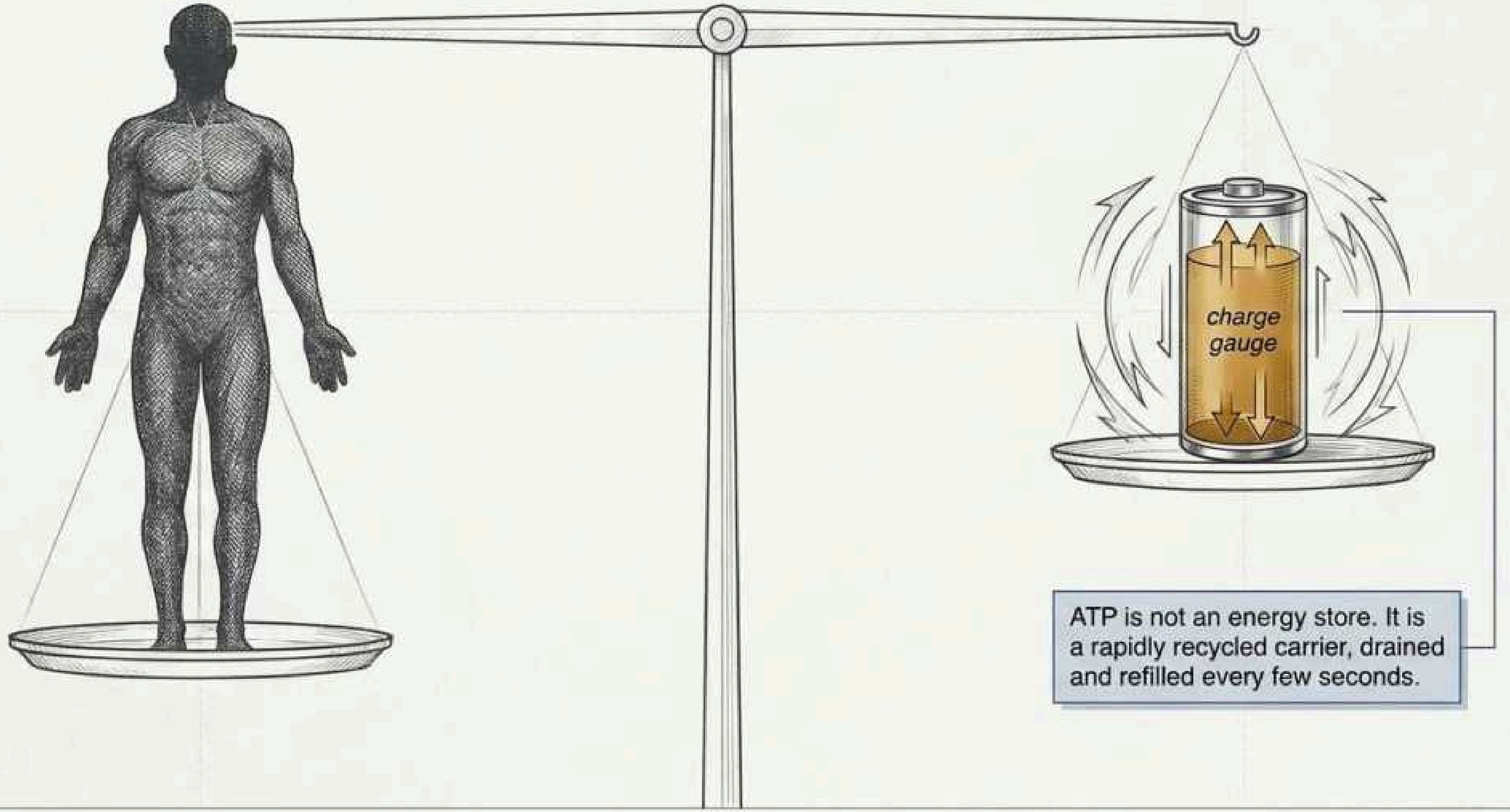
OVERALL NET: 1 Glucose + 2 ADP + 2 Pi + 2 NAD⁺ ⟶ 2 Pyruvate + 2 ATP + 2 NADH + 2 H_2O + 2 H⁺

Every living cell requires a constant supply of usable energy.

¶ 2.1



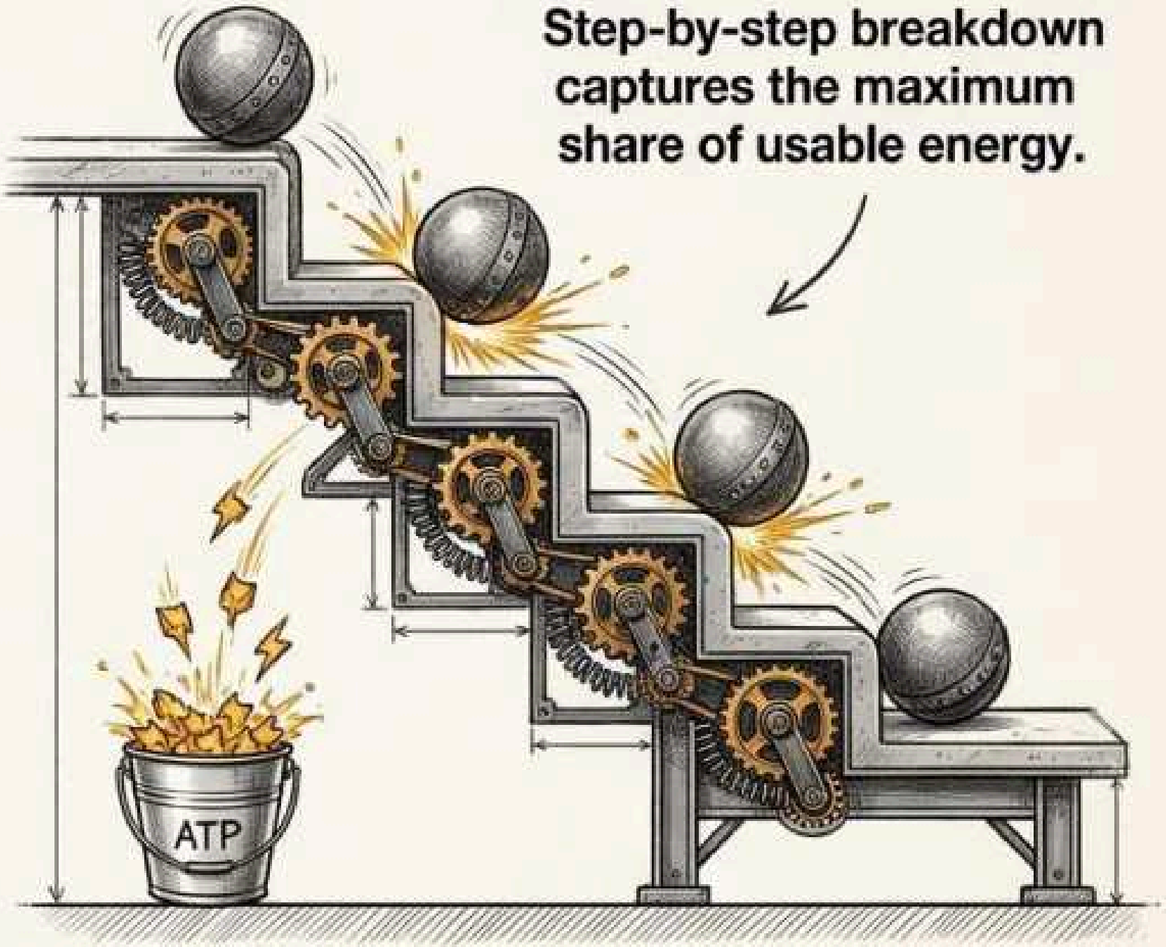
The body turns over its own weight in ATP every day, yet only a few grams exist at any moment.



ATP is not an energy store. It is a rapidly recycled carrier, drained and refilled every few seconds.

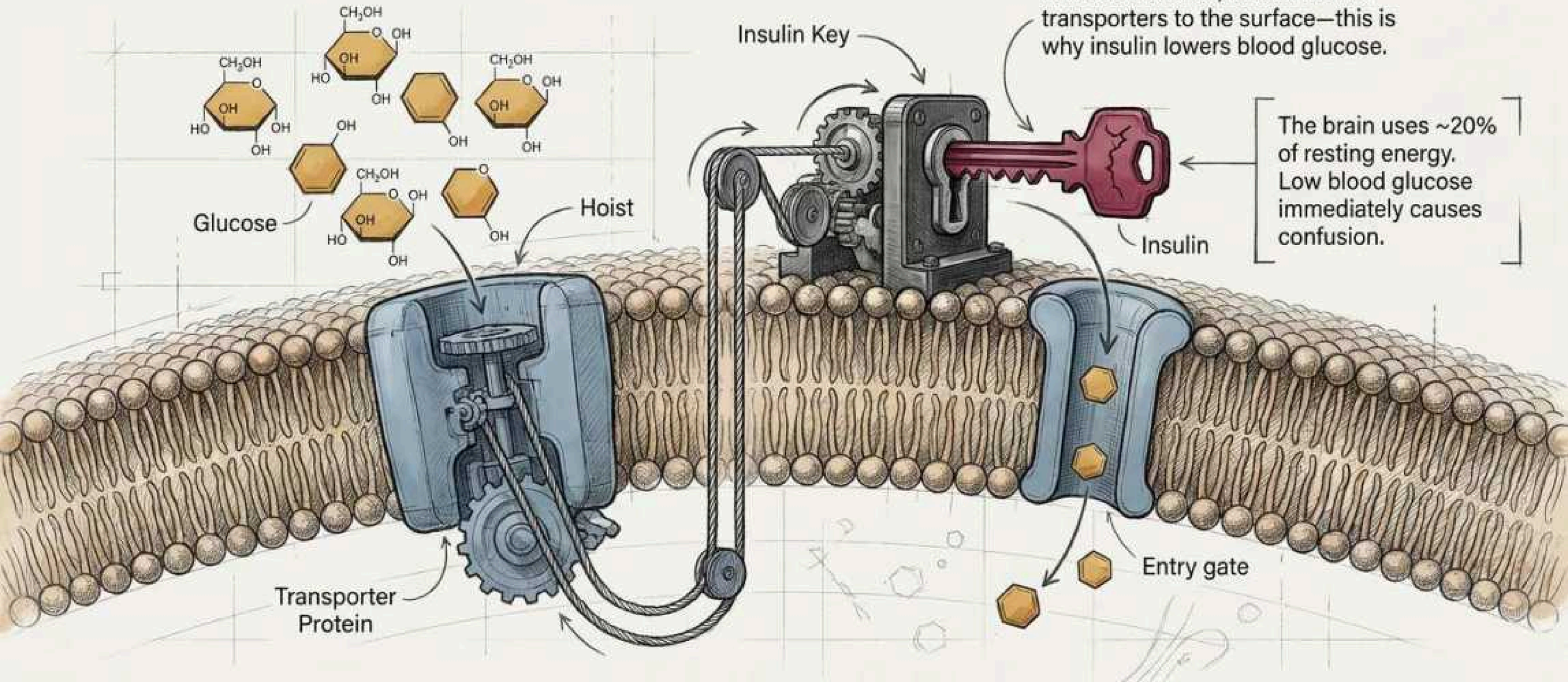
Energy from carbohydrates, fats, and proteins is released in small, controlled steps.



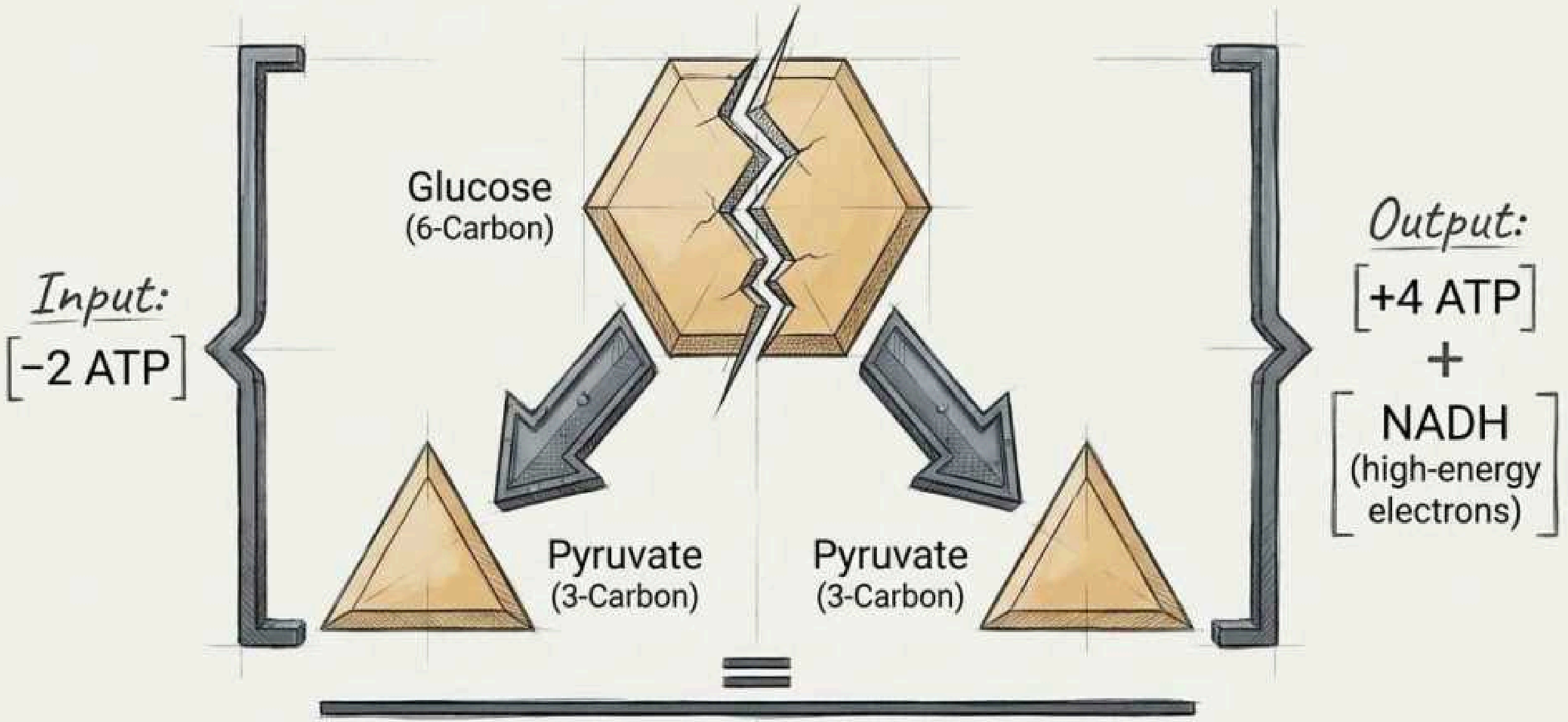


Glucose is the central fuel, requiring specific transport proteins to enter the cell.

¶ 2.4



Glycolysis splits a single sugar molecule in the cytoplasm through a ten-step sequence.

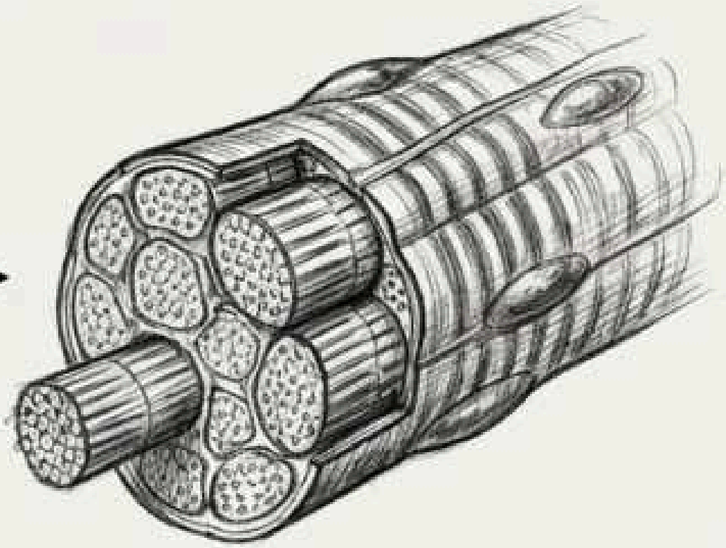


Glycolysis is ancient, universal, and possesses one critical advantage: it operates without oxygen.



No Mitochondria
(Entirely Reliant)

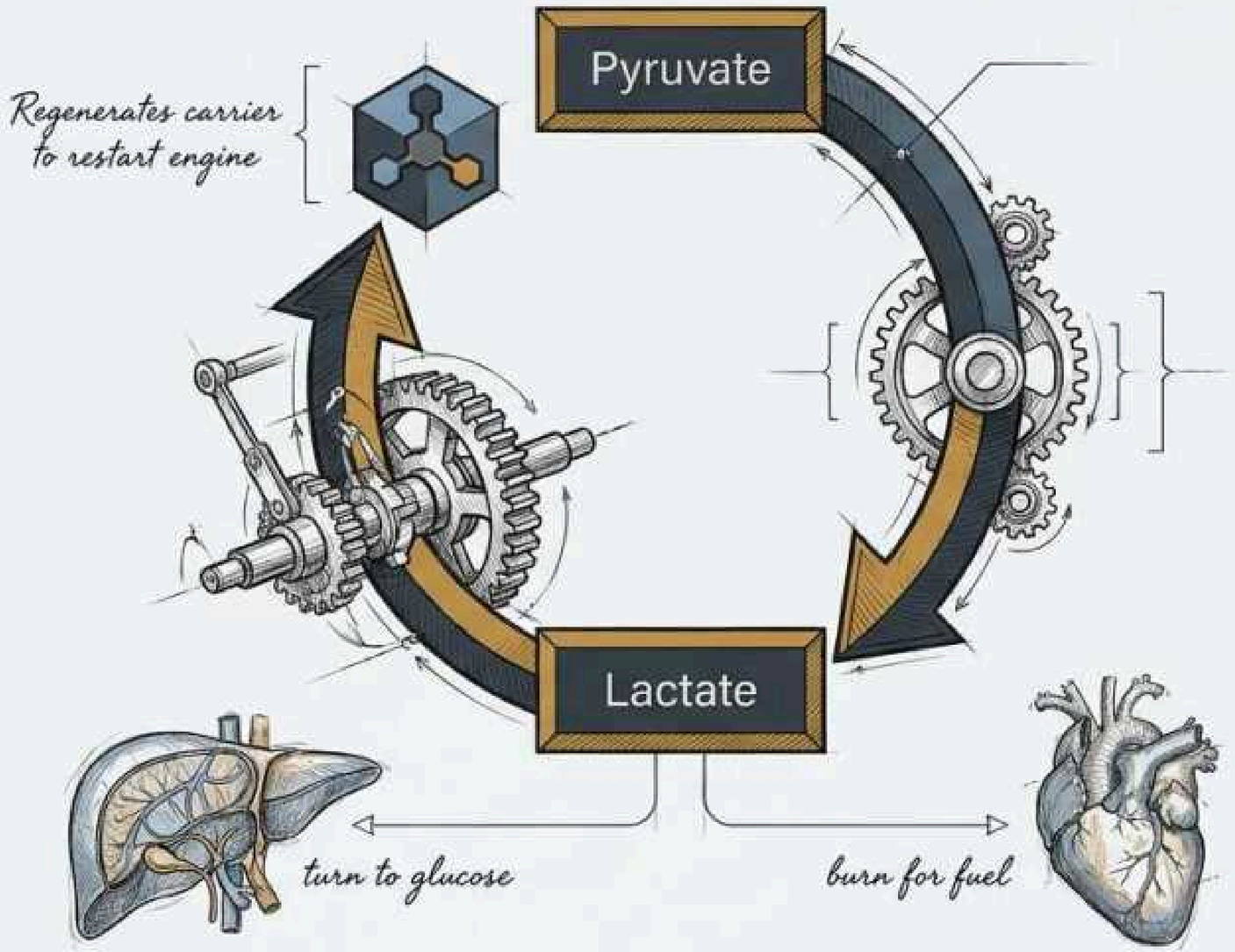
O_2



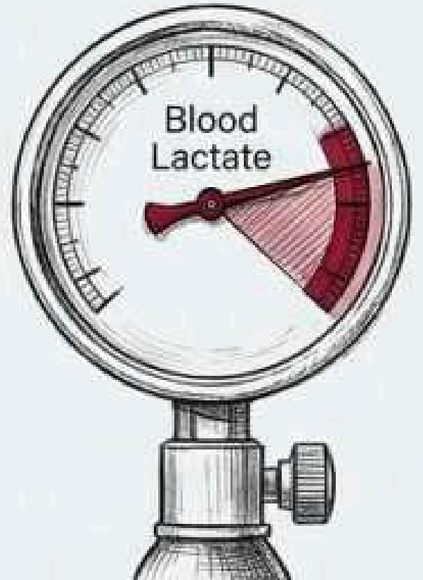
Sprint Exceeds Delivery
(Heavily Reliant)

Without oxygen, pyruvate converts to lactate to regenerate molecules that keep glycolysis running.

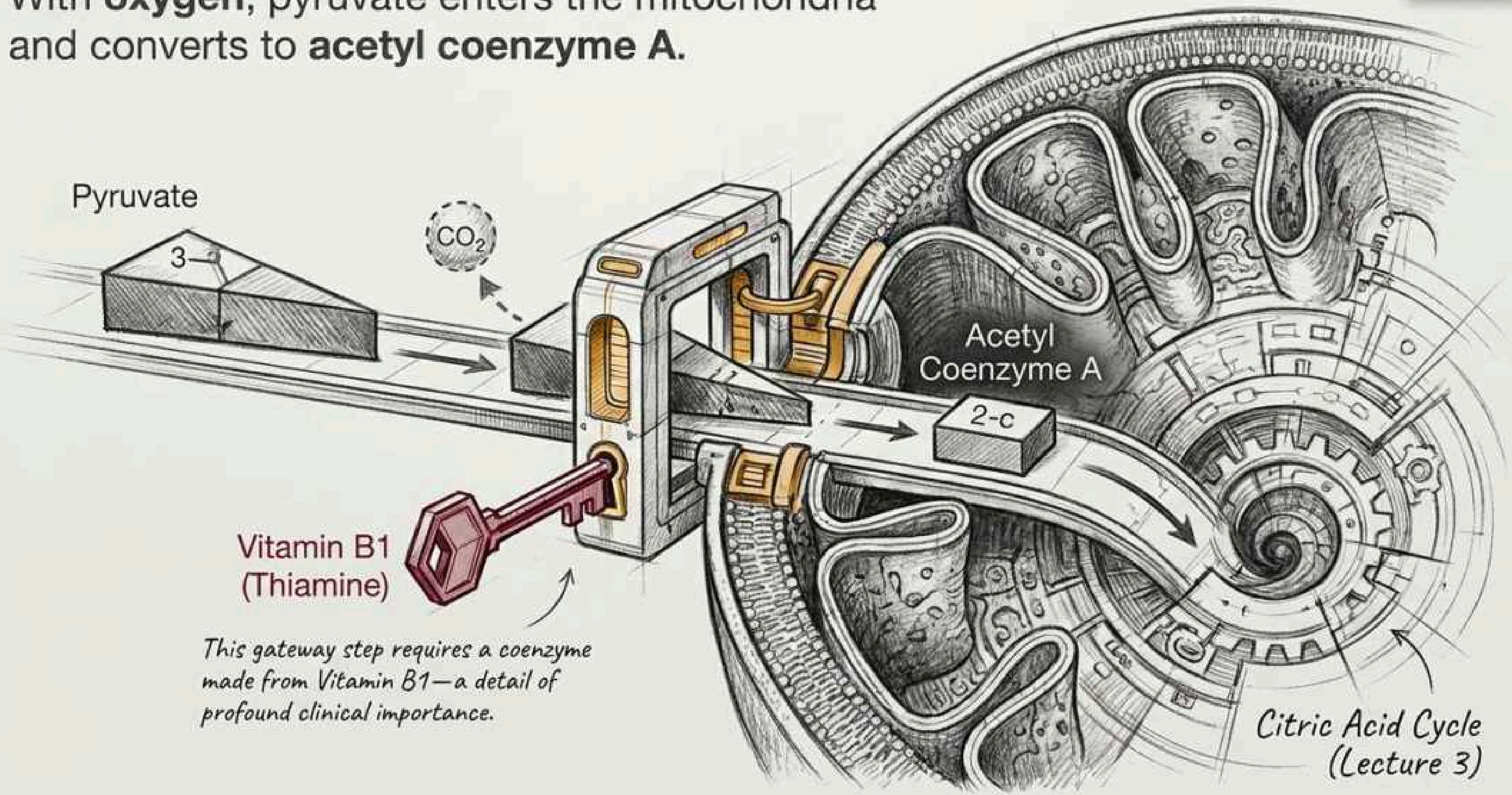
¶ 2.7



Lactate is not just waste—it is a transportable fuel and a vital clinical indicator of severe shock.

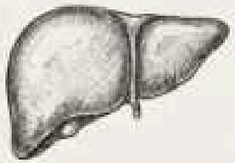


With **oxygen**, pyruvate enters the mitochondria and converts to **acetyl coenzyme A.**

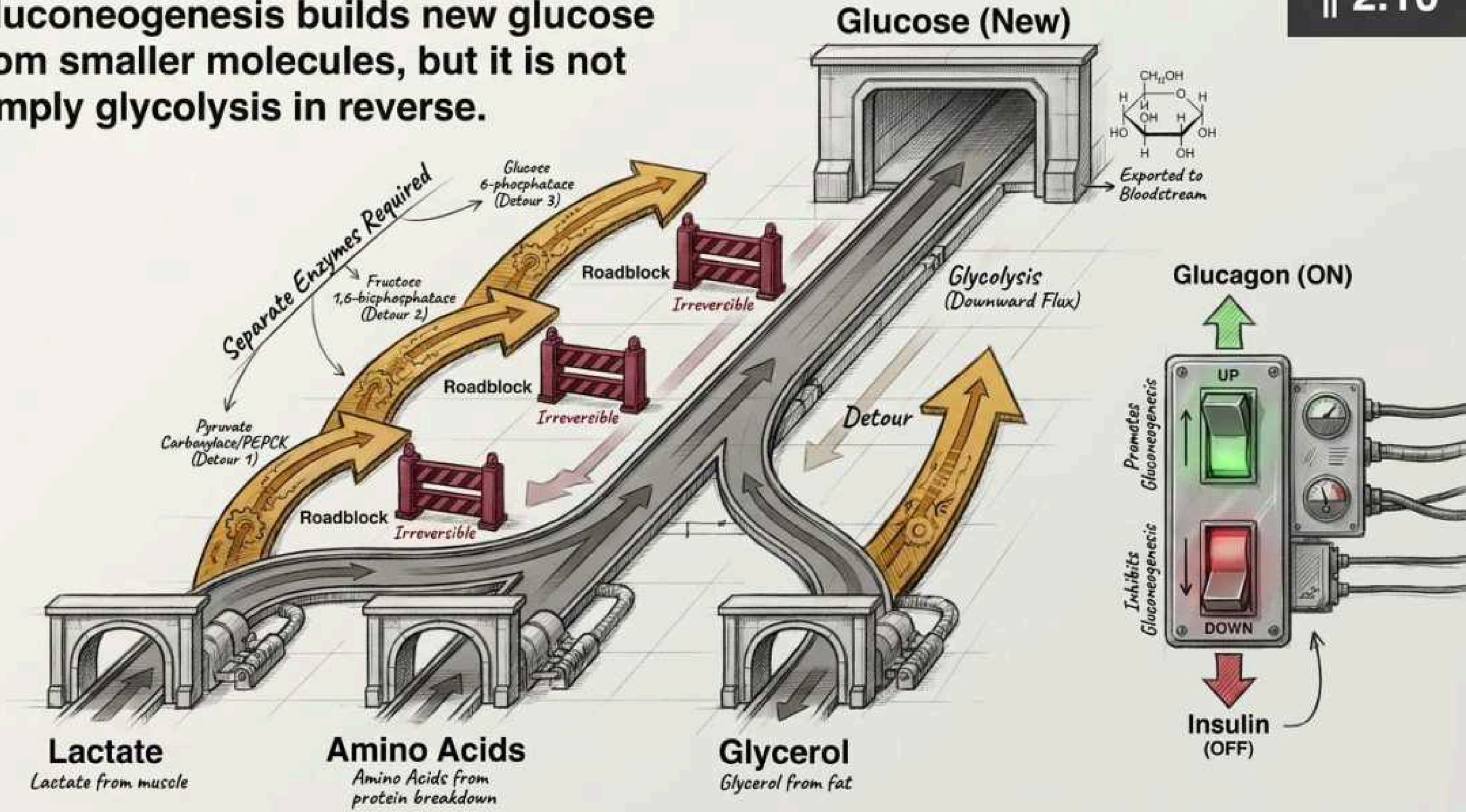


The body stores glucose as glycogen, but liver and muscle manage their reserves entirely differently.

Glycogen: A large branching chain of glucose units (Total supply depletes in ~1 day)

	 **Liver Glycogen**	 **Muscle Glycogen**
Target Audience	Whole Body	Local Muscle Only
Release Mechanism	Secretes back into bloodstream	Trapped inside the cell
Primary Function	Steady blood sugar between meals	Internal fuel for exercise

Gluconeogenesis builds new glucose from smaller molecules, but it is not simply glycolysis in reverse.



Synthesis Question: Where do Red Blood Cells get their energy, and why does this dictate their fuel source?

Net +2 ATP from Glycolysis



Universal Rule: Every living cell needs ATP.

Without mitochondria to unlock the aerobic pathway, RBCs **survive** exclusively on the 2 net ATP yielded from glycolysis, demanding a **constant, steady supply** of blood glucose to avoid cellular death.

The real power remains remains locked inside.

¶ 2.12

In Lecture 3, we follow acetyl coenzyme A into the mitochondria—where the vast majority of the body's ATP is manufactured.

