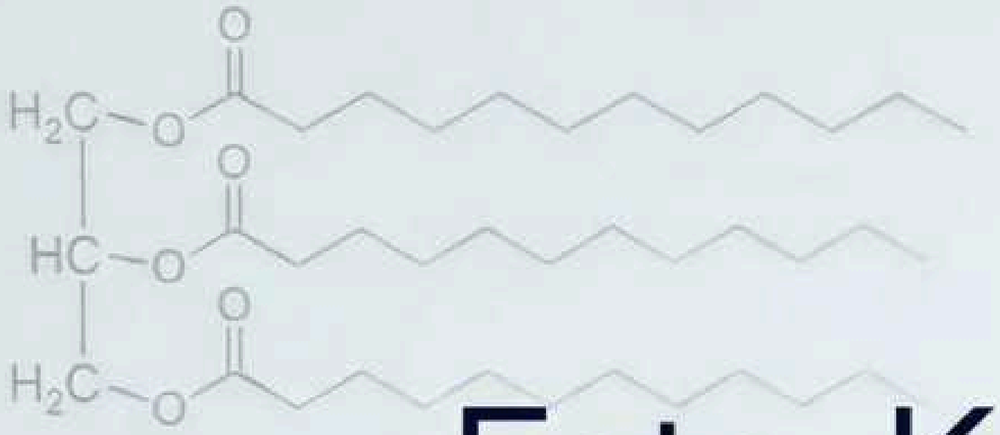
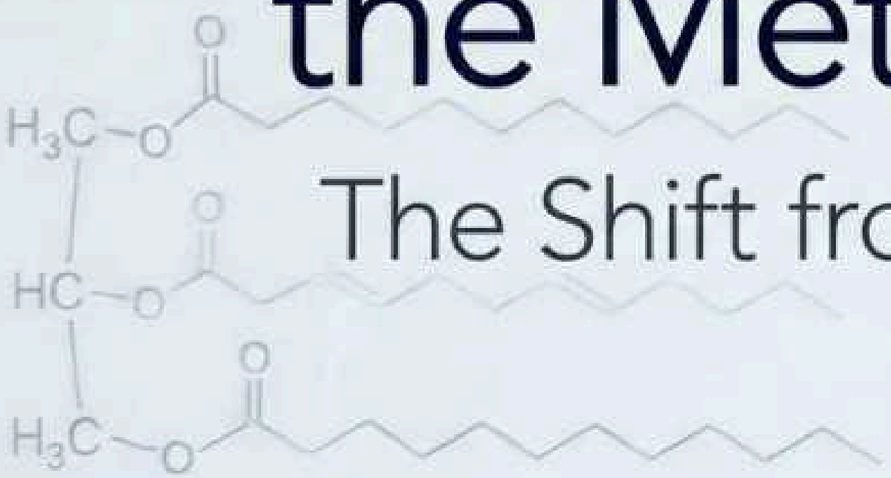




Fats, Ketones, and the Metabolic Timeline

The Shift from Fed to Fasting States

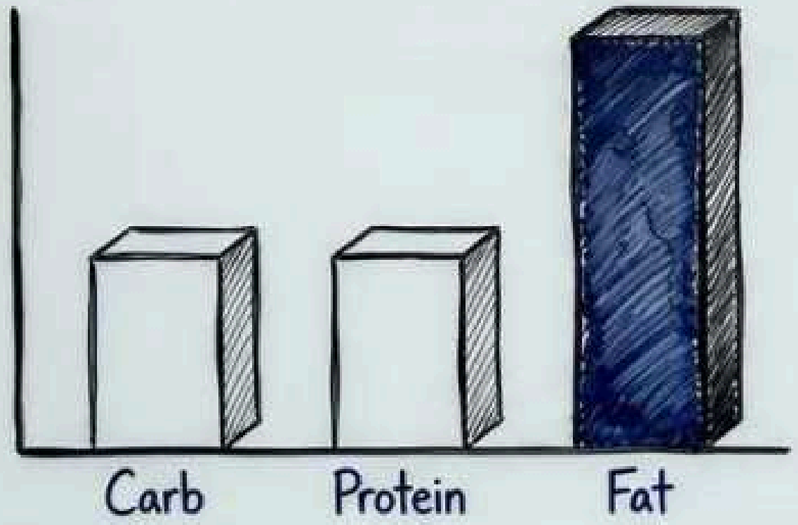




MED 502 B · Lecture 4

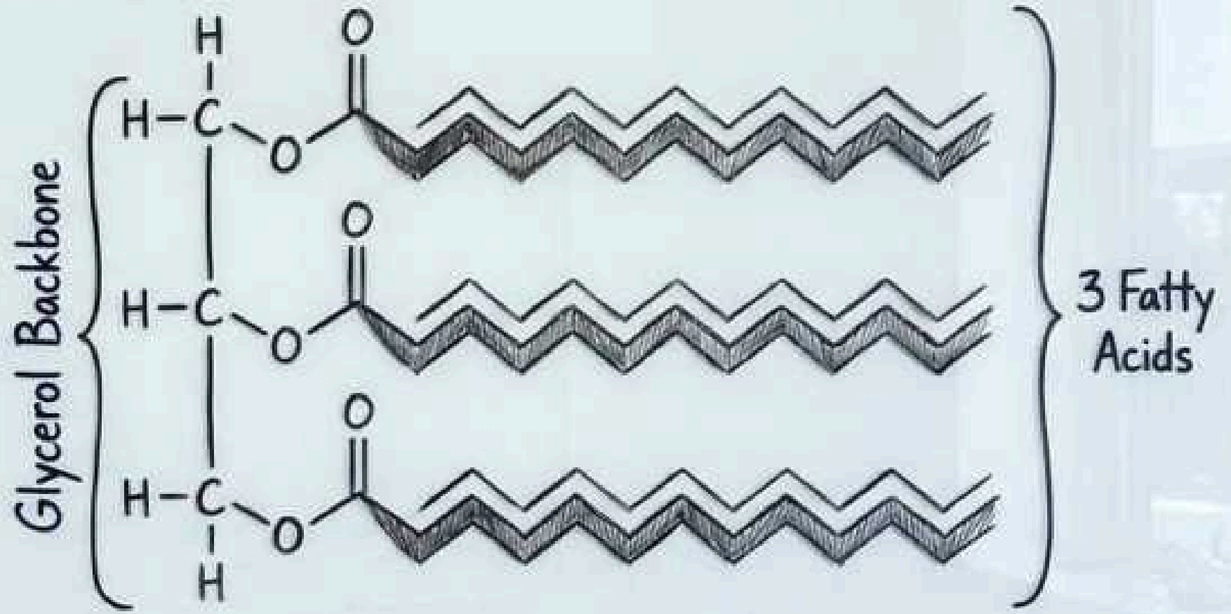
The Math

1g Fat > 2x Energy of 1g Carb/Protein



- Fat is the body's primary long-term energy store.
- Anhydrous storage: stored without water, making it incredibly compact.
- Capacity: A lean adult carries several weeks of fat energy vs. roughly a single day's worth of glycogen.

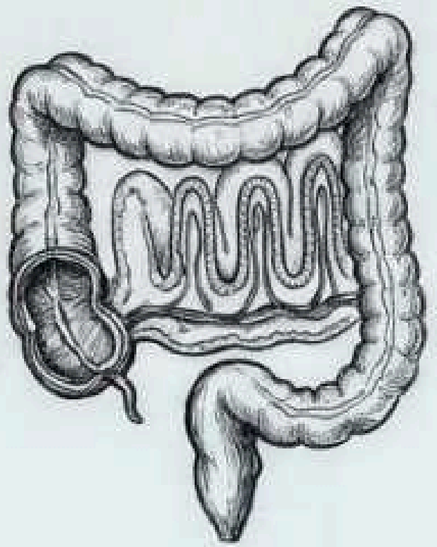
The Molecule



¶ 4.2

① Intestine

+ Bile & Pancreatic Enzymes

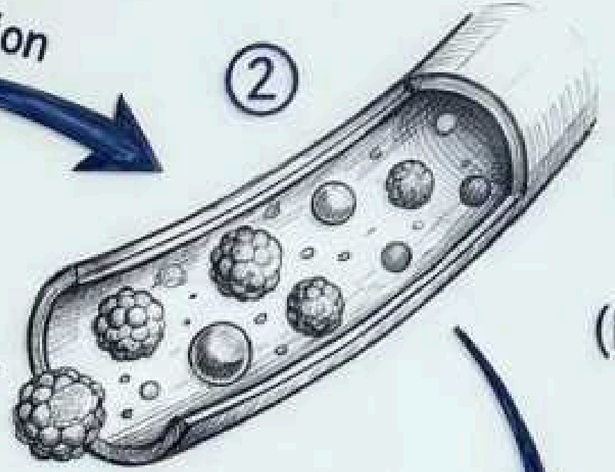


Digestion & Absorption

② Bloodstream

Lipoproteins

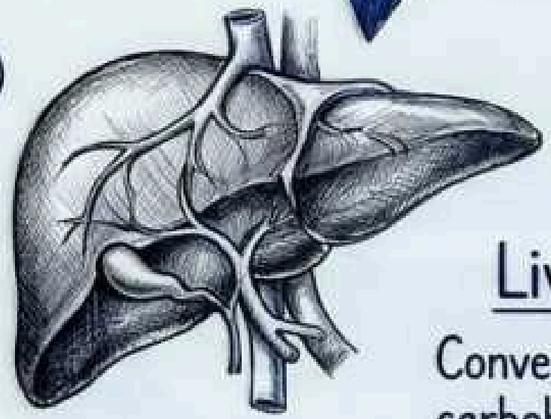
(Fat does not dissolve in water)



Transport

③ Liver

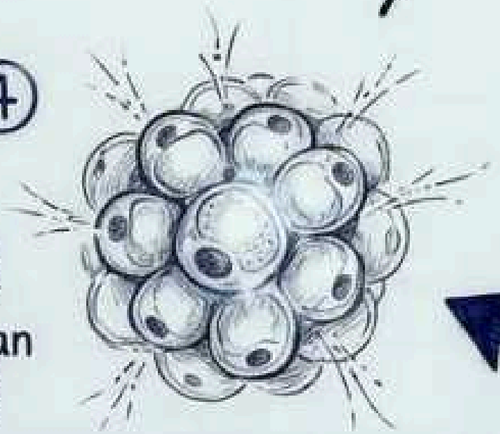
Converts excess carbohydrate to fat



Storage & Synthesis

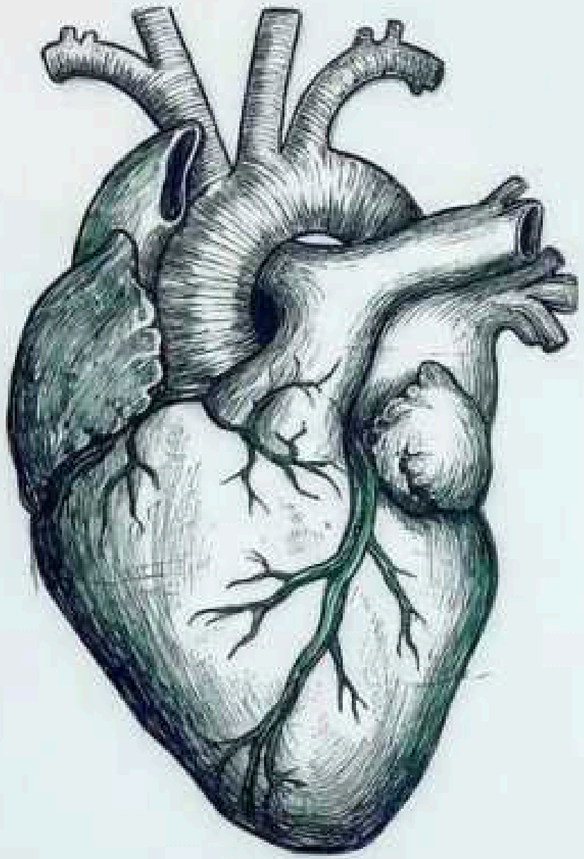
④ Adipose Tissue

Active endocrine organ releasing hormones

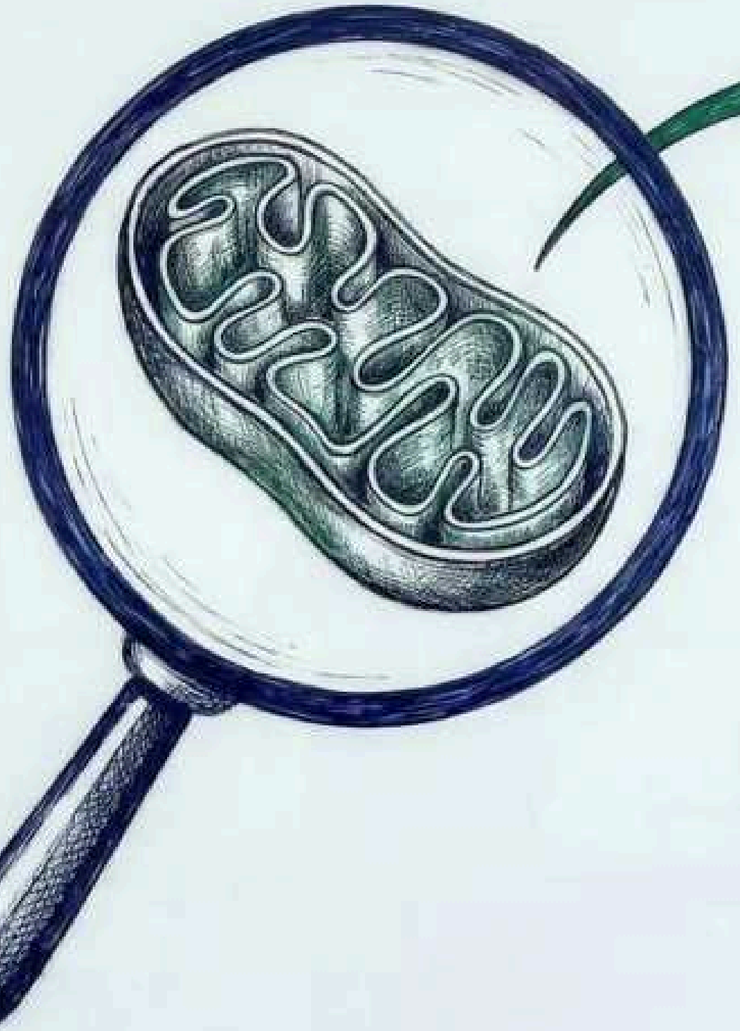


¶ 4.3

Beta-Oxidation



Heart relies on fatty acids at rest



Stored Triglycerides

↓

Free Fatty Acids



↓

2-Carbon Acetyl-CoA



The pancreas runs the entire system with two opposing hormones.

INSULIN:
The Accelerator of Plenty

Triggered by rising blood glucose post-meal.

- ↑ Cell glucose uptake
- ↑ Glycogen & Fat storage
- ↓ Fat breakdown
- ↓ Gluconeogenesis

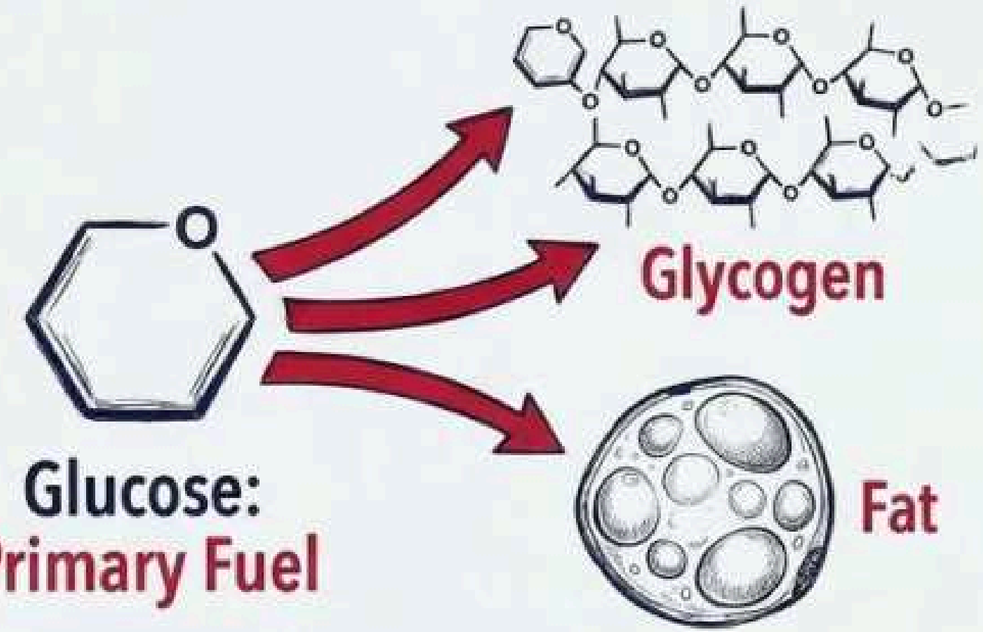


GLUCAGON:
The Brake of Scarcity

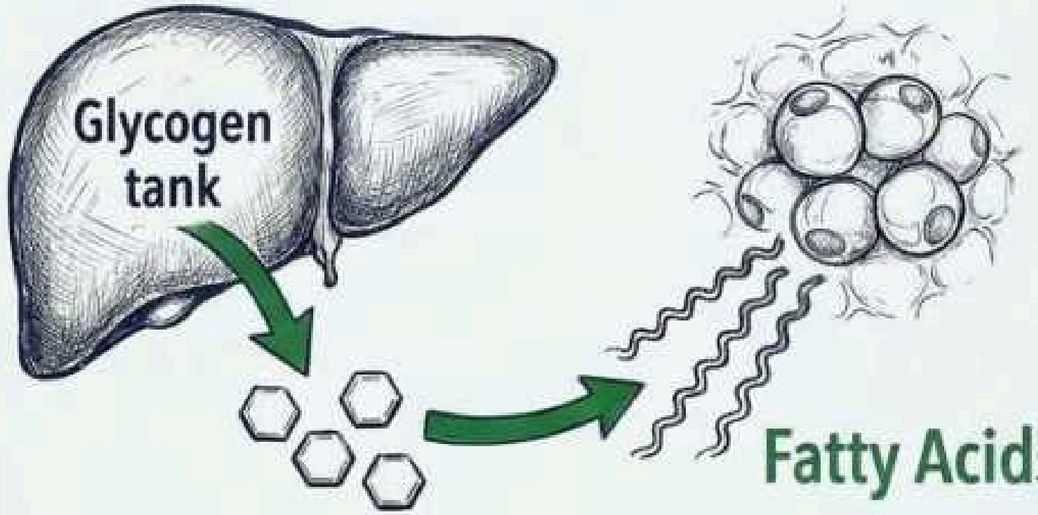
Triggered by falling blood glucose.

- ↑ Glycogen breakdown
- ↑ Gluconeogenesis

High Insulin



Falling Insulin, Rising Glucagon



Fatty acid burn spares glucose for the brain and red blood cells.

You Are Here

Fed State
(Hours post-meal)

Early Fasting
(Overnight)

Fasting & Starvation

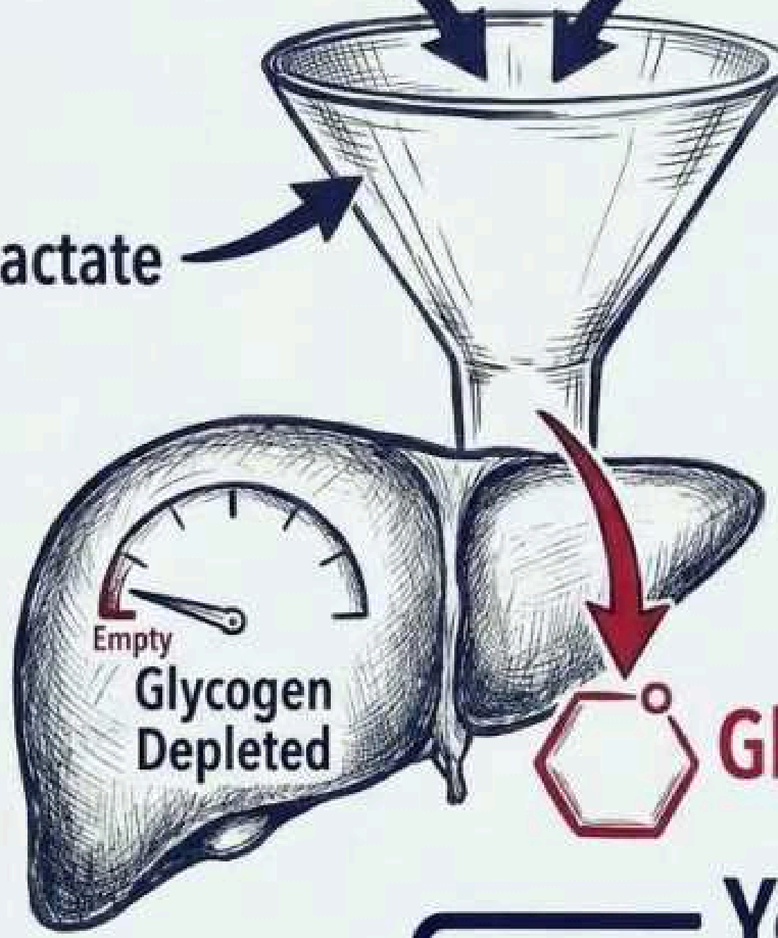


Warning: Unchecked, the body would break down too much of its own muscle.

Amino Acids

Glycerol

Lactate



Glucose

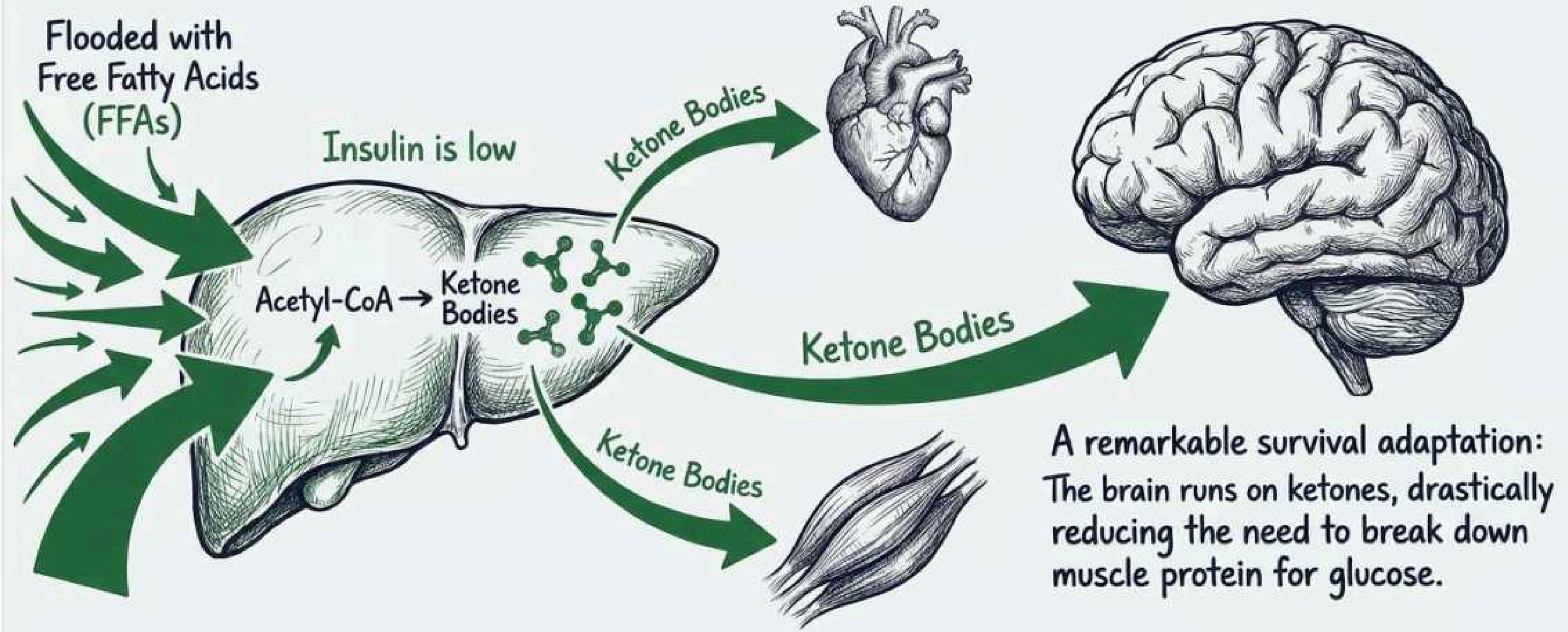
Gluconeogenesis: Building new glucose.

You Are Here

Fed State
(Hours post-meal)

Early Fasting
(Overnight)

Fasting (> 24 hours) & Starvation



A remarkable survival adaptation:
The brain runs on ketones, drastically reducing the need to break down muscle protein for glucose.

You Are Here

Time Axis

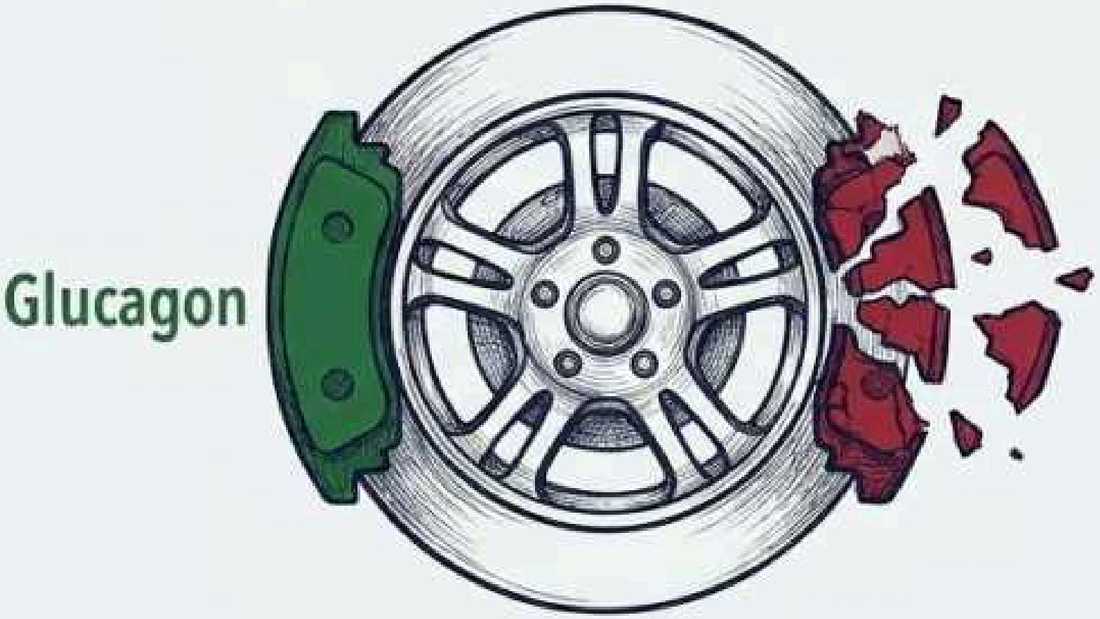
Prolonged Fasting / Starvation

Physiologic Fasting Ketosis



- Modest ketone rise
- Controlled blood acidity
- Intact insulin regulation

Diabetic Ketoacidosis (DKA)

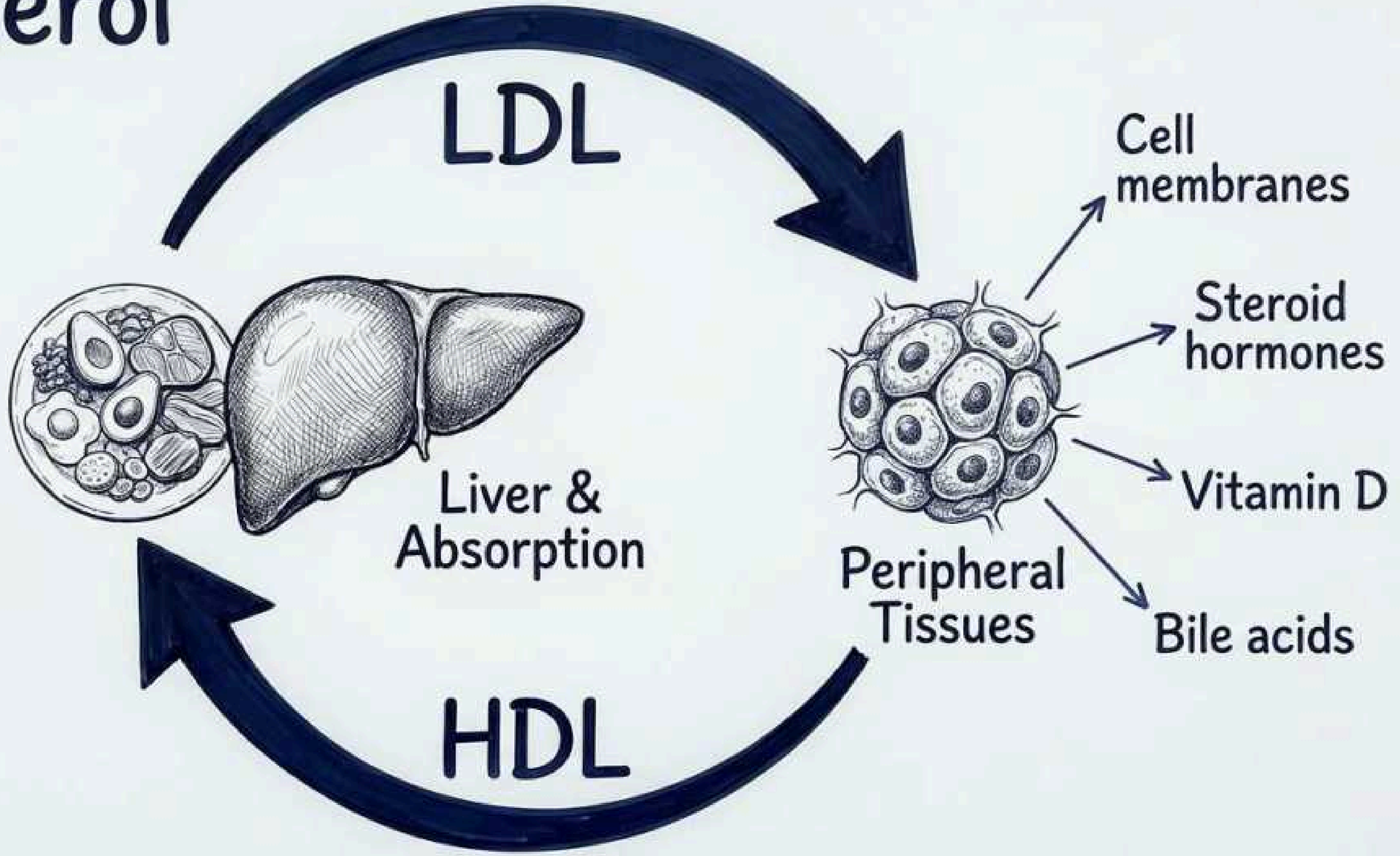


- **Unrestrained fat breakdown**
- **Massive** ketone outpouring
- **Dangerously acidic** blood pH

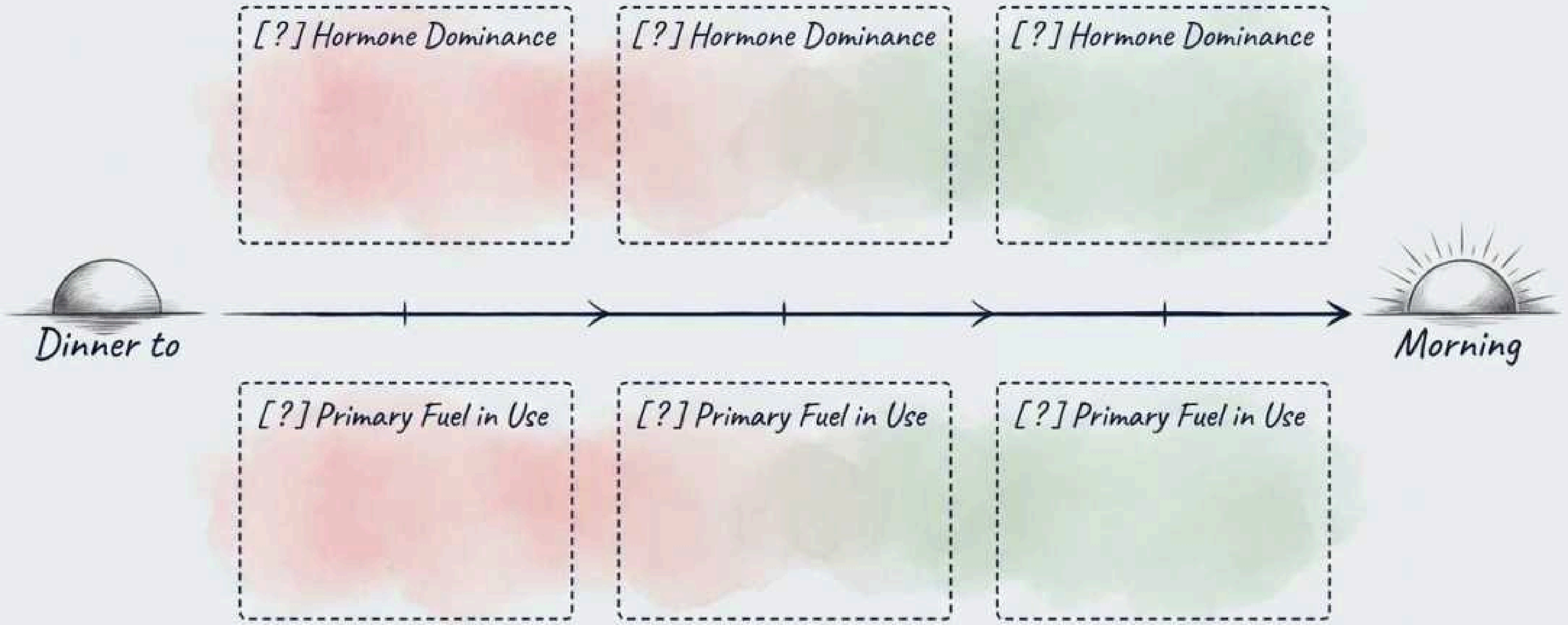
Ketone bodies are acids. Without insulin (as in Type 1 Diabetes), the metabolic brake is missing entirely. This is a medical emergency.

Cholesterol is NOT a fuel.

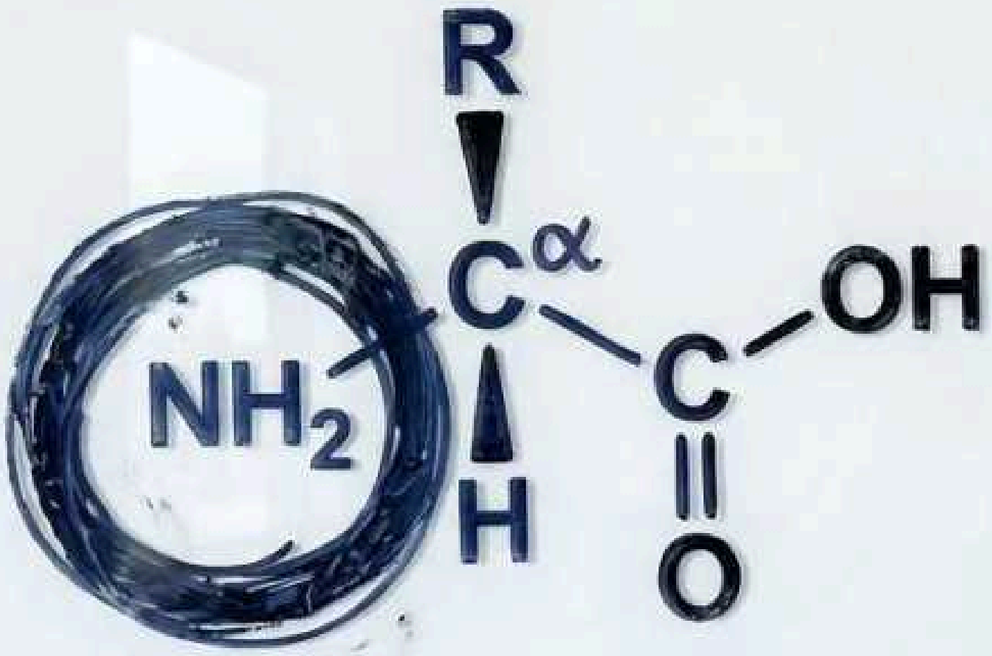
¶ 4.9



Synthesis Exercise: Map the metabolic shift from finishing dinner to waking up the next morning. Mentally fill in the blanks using the frameworks established in ¶ 4.4 and ¶ 4.5.



¶ 4.11



Coming Next in Lecture 5:
Proteins and Amino Acids.

The special problem of nitrogen disposal.