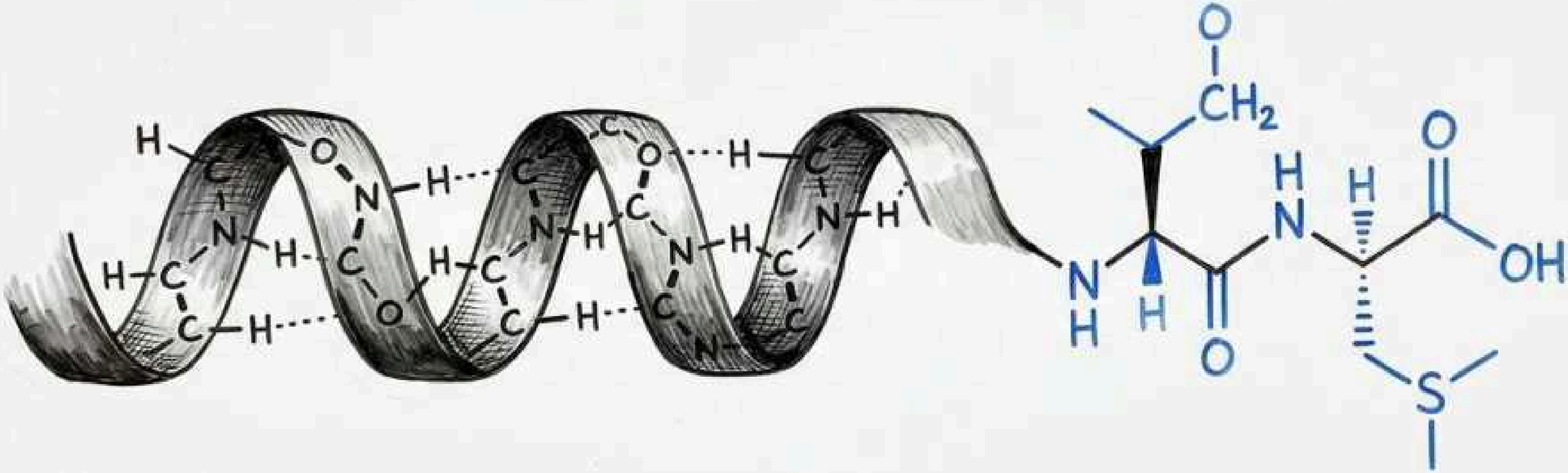
Proteins, Amino Acids, and Nitrogen

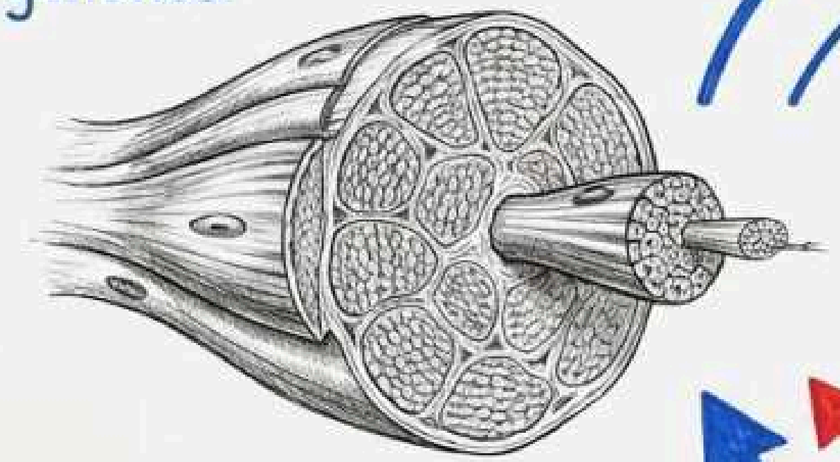
MED 502 B - Lecture 5



Anderson Academy

The continuous loop of protein turnover

The human body's proteins are constantly broken down and rebuilt in a process governed by genetics.

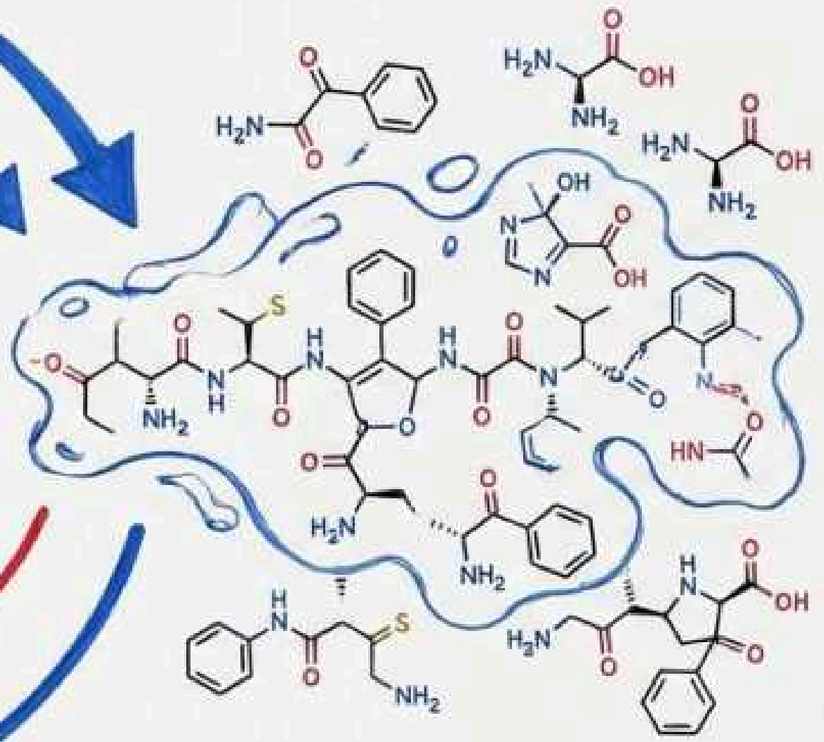


Body Proteins

Breakdown (Catabolism)

protease

Synthesis (Anabolism)



Amino Acid Pool

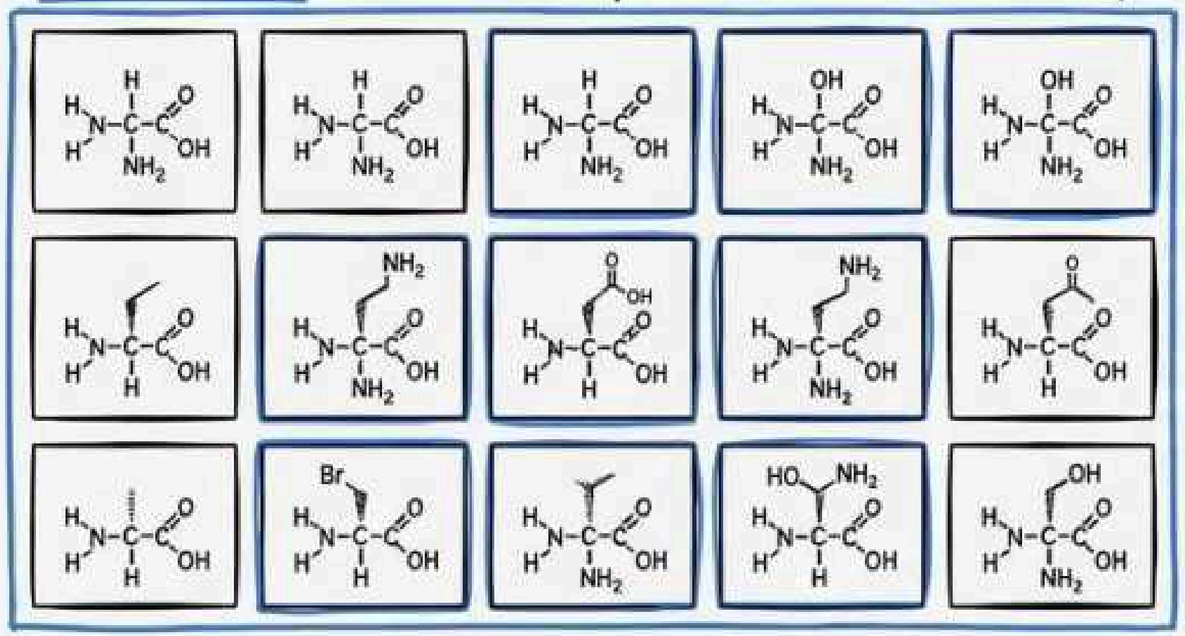
Adults break down and remake hundreds of grams of protein daily—far exceeding dietary intake. Most released amino acids are immediately recycled.

Nine amino acids must be sourced directly from the diet

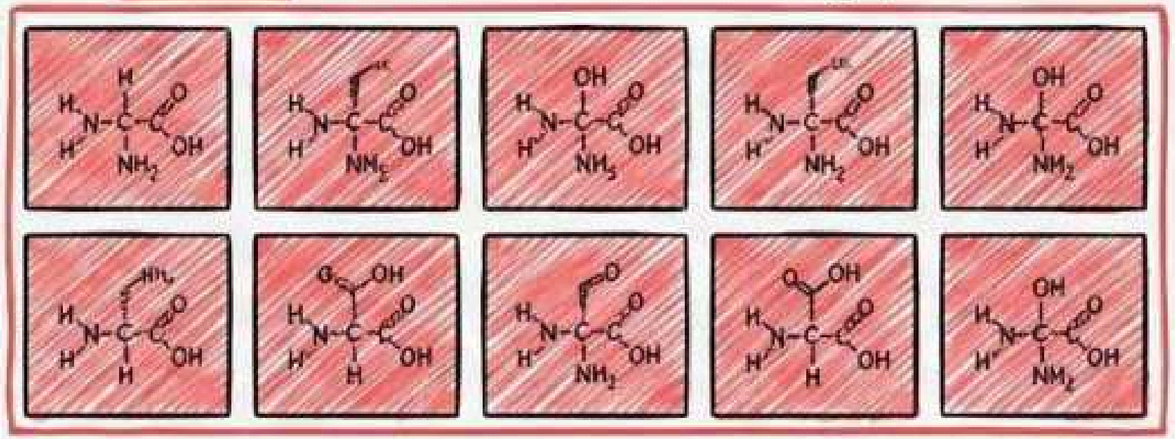
¶ 5.2

The human body lacks the machinery to synthesize all twenty required amino acids.

Non-essential: Built from simpler molecules in the body

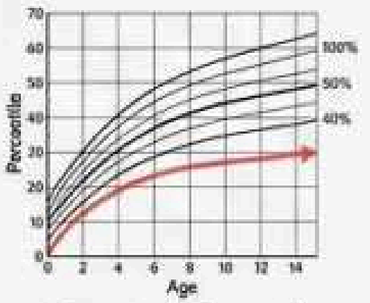


Essential: Cannot be made fast enough, or at all

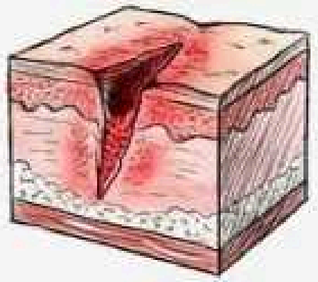




Wasted Bicep Muscle



Stunted Growth



Slow-Healing Skin Laceration

Dietary deficiency in these 9 essential building blocks leads directly to muscle wasting, stunted growth, weakened immunity, and slow healing.

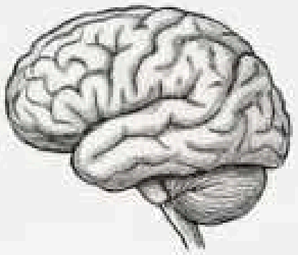
Amino acids act as carbon-skeleton precursors for vital messengers

¶ 5.3

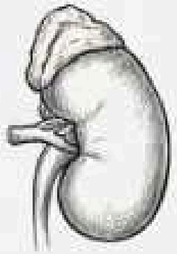
Beyond building proteins, amino acids are the starting materials for hormones and neurotransmitters.

Tyrosine

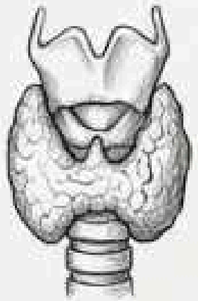




Dopamine

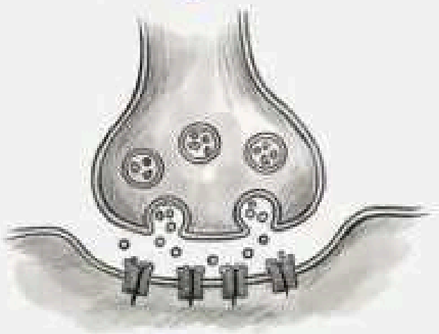


Noradrenaline / Adrenaline



Thyroid hormone

Tryptophan



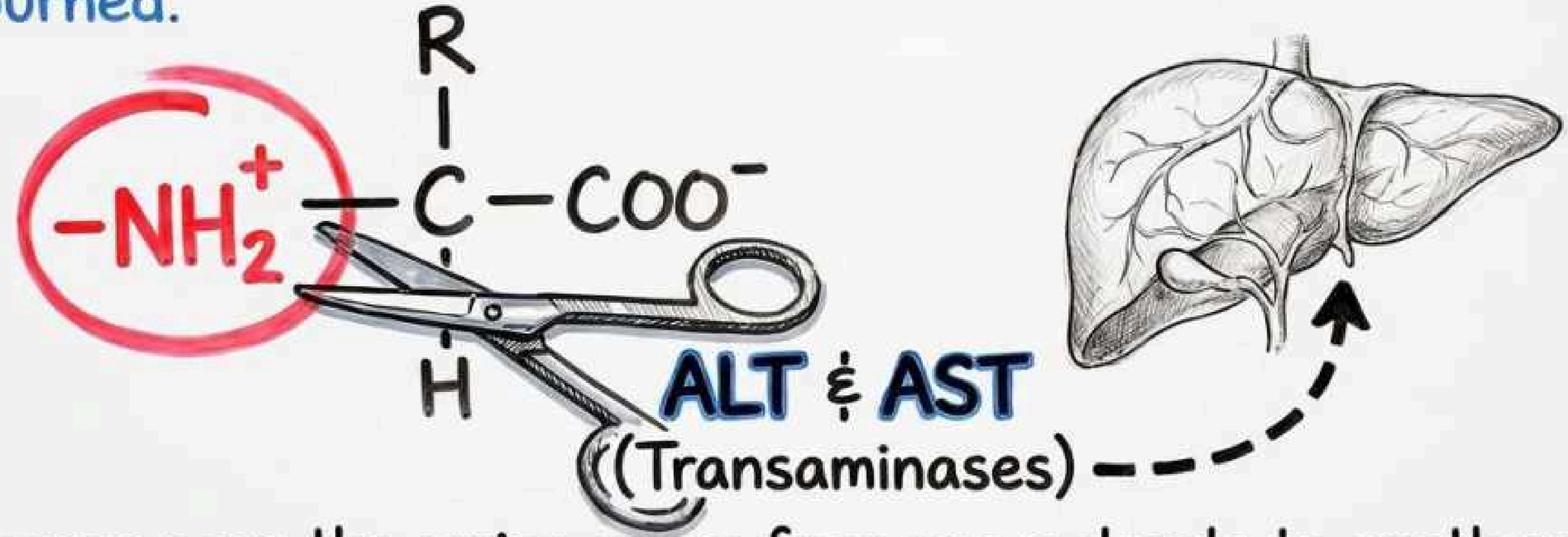
Serotonin

When not required for building, the underlying carbon skeletons can be burned for energy, or converted into glucose and fat.

The nitrogen problem requires transaminases for removal

¶ 5.4

Unlike carbohydrates and fats, amino acids contain Nitrogen. The amino group must be removed before the carbon skeleton can be burned.



Transaminases pass the amino group from one molecule to another. Elevated ALT and AST in the blood serve as primary clinical markers for liver injury.

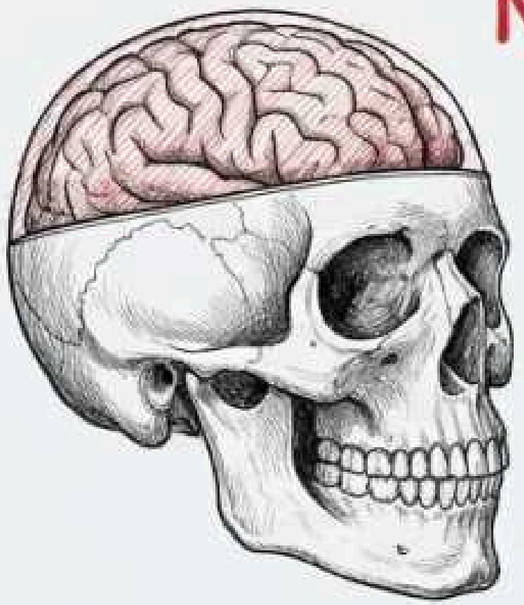
The body must rapidly neutralize neurotoxic ammonia

¶ 5.5

Removed nitrogen immediately becomes ammonia, which poses a severe threat to the brain.

Ammonia

NH_3



- Highly toxic.
- Causes confusion, drowsiness, and coma even with small blood rises.

Urea

$CO(NH_2)_2$

- Small, harmless, water-soluble.
- Safely excreted in urine.

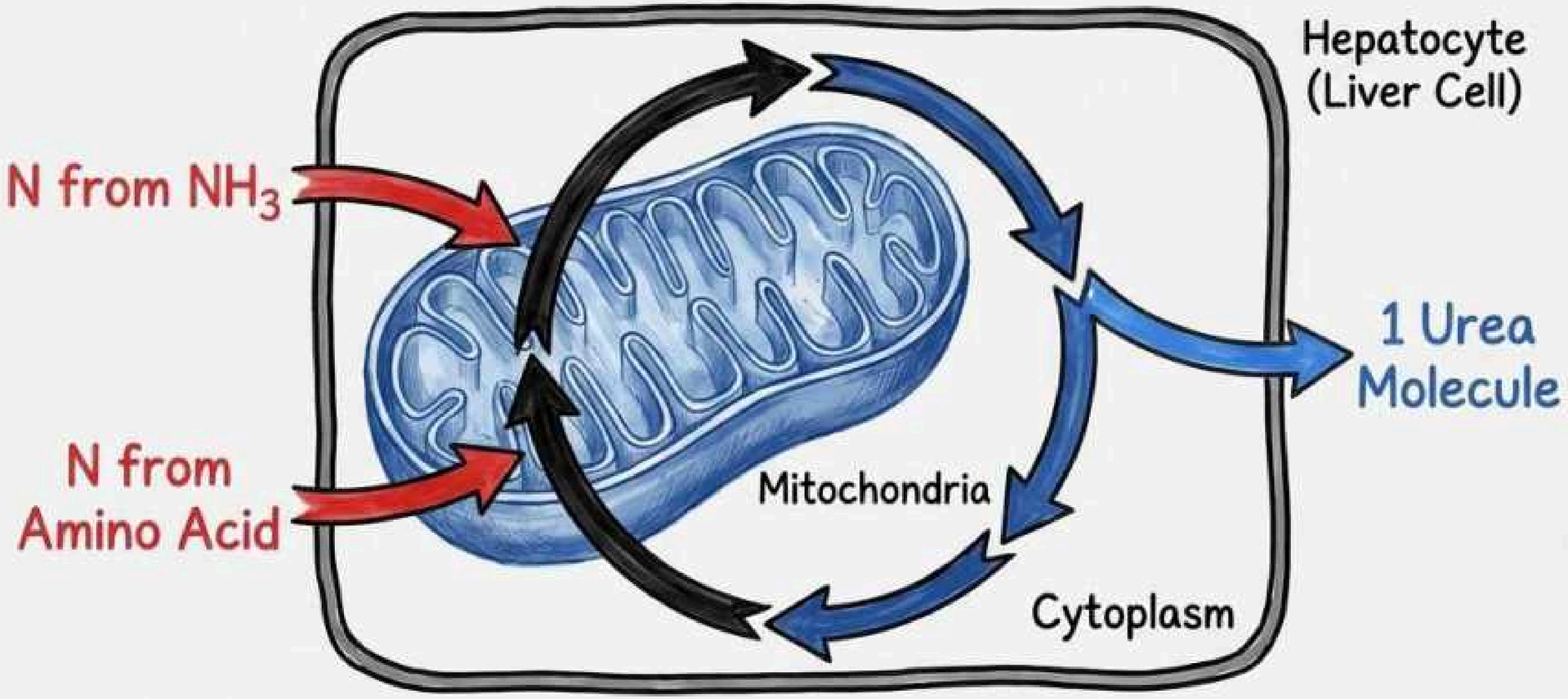


The biological solution is rapid conversion into safe, water-soluble urea for renal excretion.

The urea cycle processes nitrogen across two cellular zones

¶ 5.6

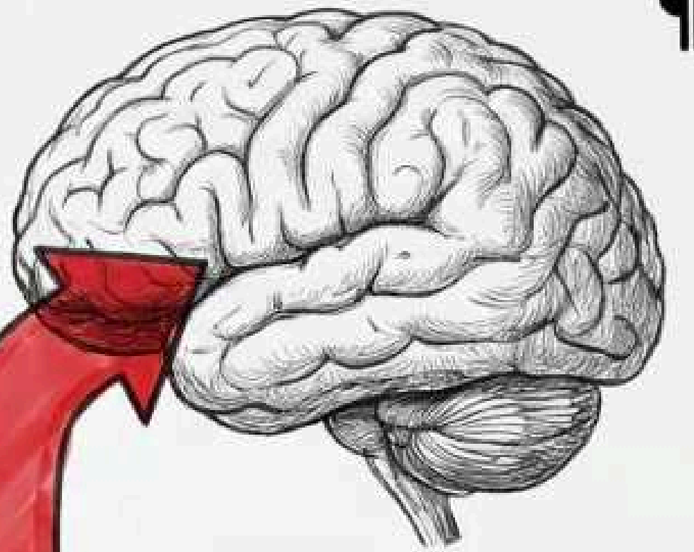
Discovered by Hans Krebs prior to the citric acid cycle, it is the first metabolic cycle ever identified.



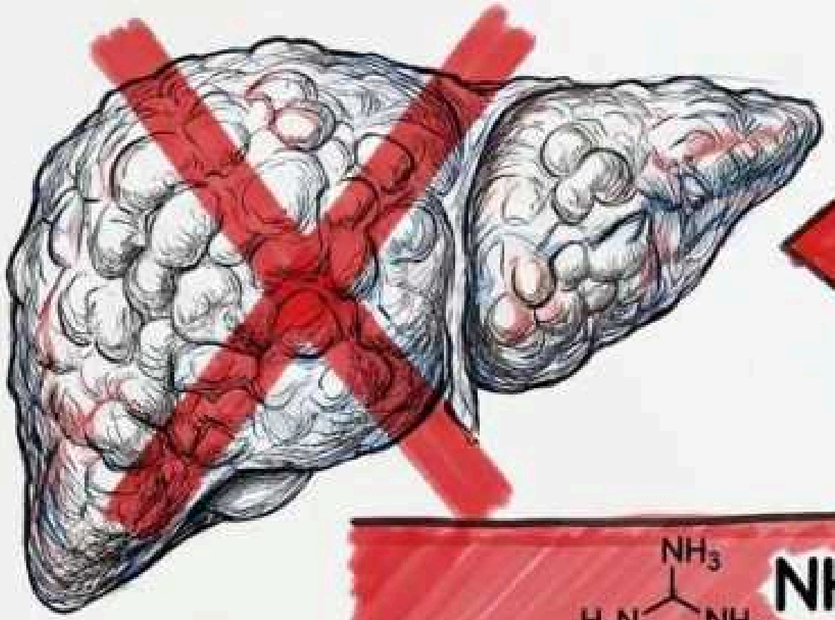
Each turn of the cycle takes place partially in the mitochondria and partially in the cytoplasm, consuming two nitrogen atoms to release one molecule of urea.

Severe liver disease causes toxic ammonia to flood the brain

When the liver fails, the urea cycle halts. Toxins normally processed by the liver accumulate in the blood.



Blood-Brain Barrier

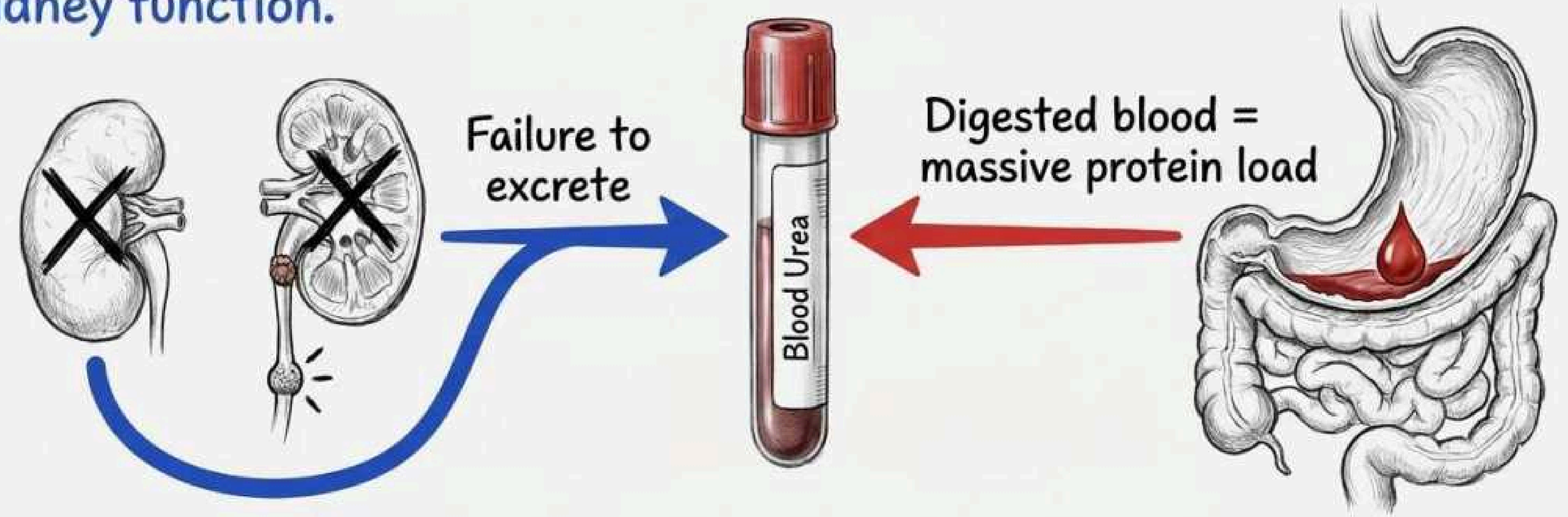


NH_3 (Ammonia)

This accumulation causes hepatic encephalopathy. Clinical treatments actively aim to reduce ammonia production and absorption directly from the gut.

Elevated blood urea requires careful clinical interpretation

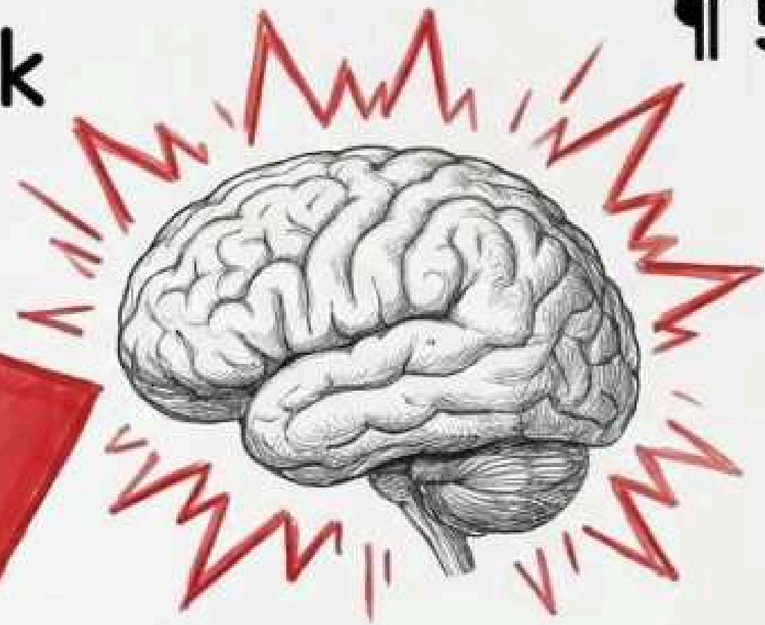
Measured alongside creatinine, blood urea is a primary check on kidney function.

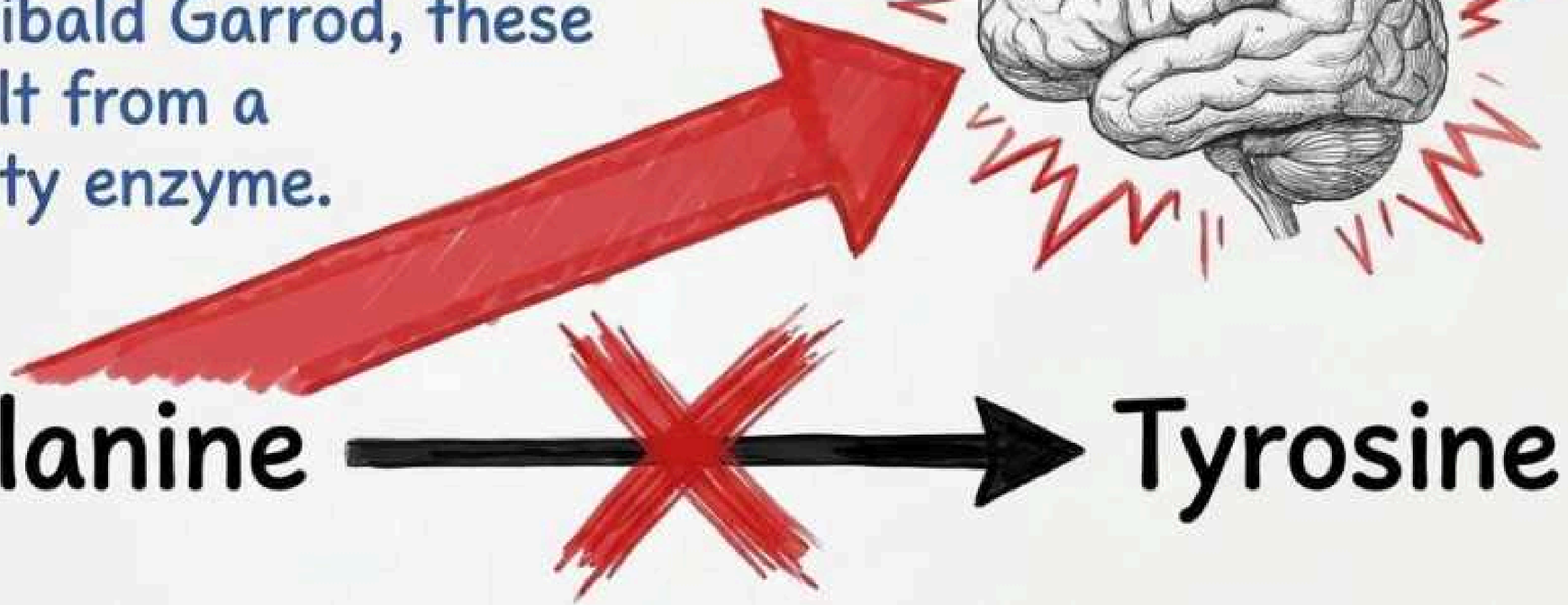


Levels rise when kidneys fail to excrete it, but also after internal GI bleeding. A single lab number is a clue to interpret, **never** an absolute diagnosis.

Inborn errors of metabolism block critical biochemical pathways

Coined by Archibald Garrod, these conditions result from a genetically faulty enzyme.





In Phenylketonuria (PKU), the inability to convert phenylalanine to tyrosine causes massive toxic buildup, leading to irreversible damage to the developing brain if untreated.

Early screening transforms a biochemical defect into a manageable condition

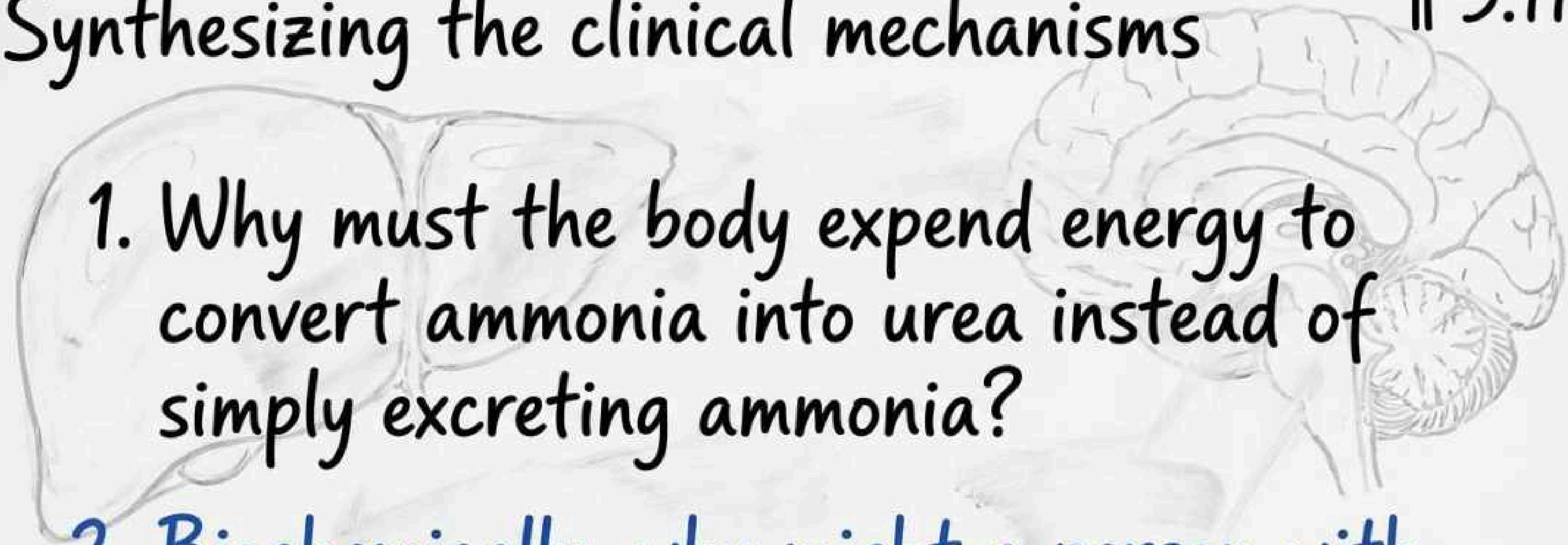
Newborn heel-prick screening identifies PKU immediately.



With careful dietary management restricting phenylalanine, infants develop entirely normally. Understanding a single missing enzyme has quietly changed thousands of lives.

Synthesizing the clinical mechanisms

¶ 5.11



1. Why must the body expend energy to convert ammonia into urea instead of simply excreting ammonia?
2. Biochemically, why might a person with severe liver disease become confused or comatose?

Bringing the course together in clinical biochemistry

The foundational principles of protein metabolism and nitrogen management will directly inform the final integration of the curriculum.



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