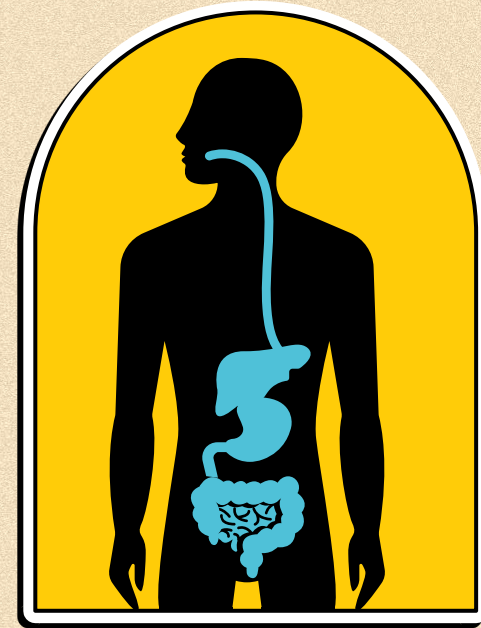


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# Digestion of Proteins & Amino Acids

By: Ashley Khorsandi, Kella Kane, & Mariana Garcia

○ Physiology 3







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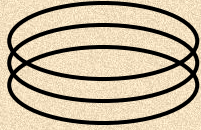
**Related Terms**





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**01**



# Chemical Structure



Proteins & Amino Acids



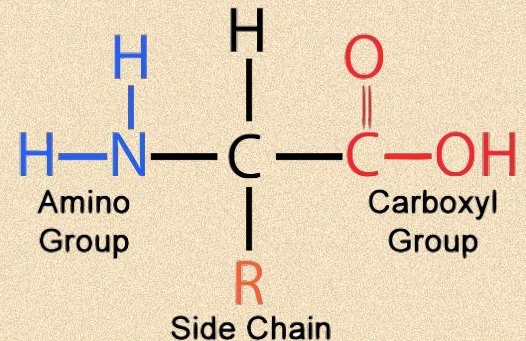
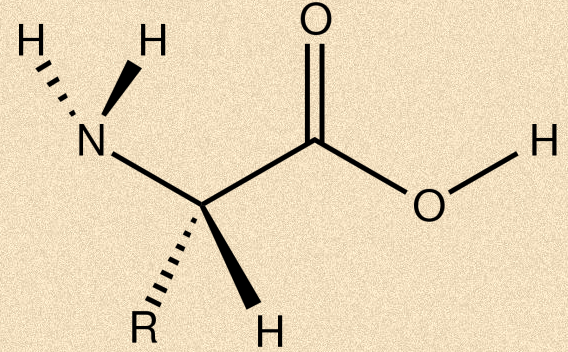


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# Chemical Structure of Amino Acids

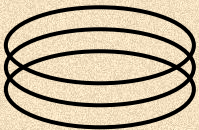
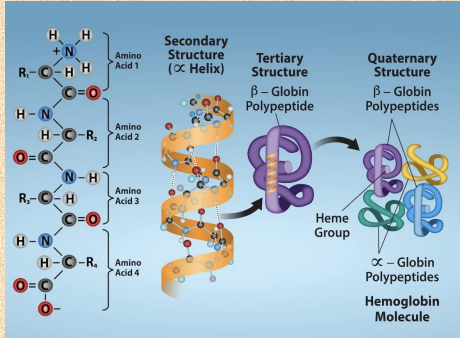


- Amino acids are subunits of proteins
- Amino Acids consist of a central carbon, amine group, carboxyl group, and a functional group (R group)
- Bonds between amino acids form from dehydration synthesis, where the hydrogen atom of one amino acids amino group combines with the hydrogen of another amino acids carboxyl group
- Bonds between amino acids are called peptide bonds

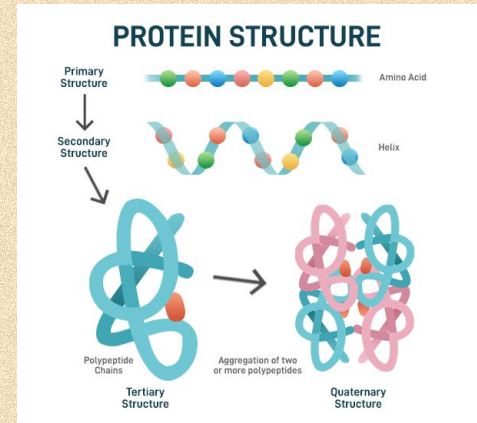




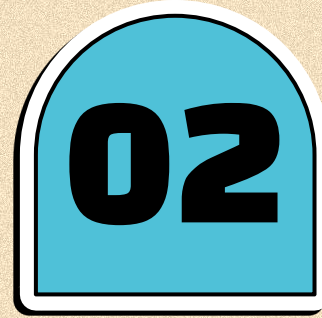
# Chemical Structure of Proteins



- Proteins are made up of a polypeptide chain of amino acids
- Chemical interactions between amino acids constitute the four levels of protein classification
- **Primary** structure: the sequence of amino acids in a protein chain
- **Secondary** Structure: Weak hydrogen bonds, alpha helix or beta pleated sheet shape
- **Tertiary** structure: 3- Dimensional shape of protein formed by functional group bonds
- **Quaternary** structure: Bond between multiple polypeptide chains

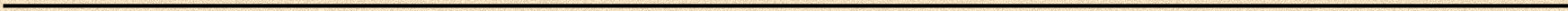
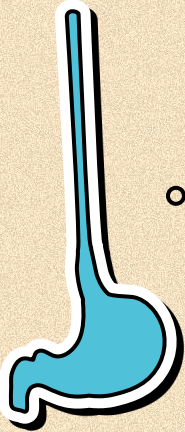






# Function & Digestion

Mouth, Esophagus, Stomach & Small Intestine

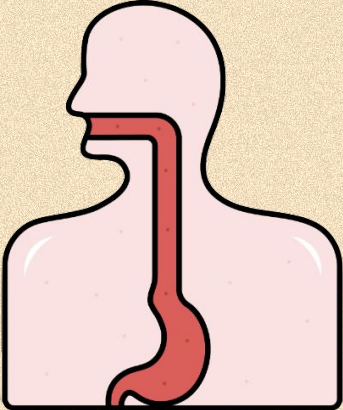
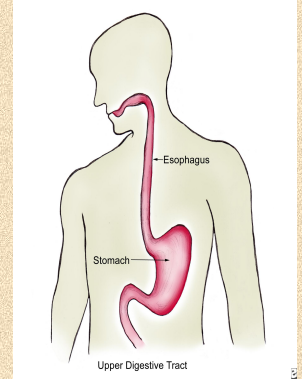




# Function & Digestion in Mouth/Esophagus



- Substances are broken down in the mouth through mastication
- Saliva from the mouth provides a coating (bolus) for easier passage through the esophagus and into the stomach
- When particles are smaller they are ready to enter the stomach through the esophagus
- After mastication, food moves from the mouth and into the esophagus, where the esophagus contracts when moving particles into the stomach
- Though saliva in the mouth contains lipase and amylase, these enzymes do not break down proteins





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# Functions of the Stomach



**Initial Protein Digestion**



**Transport chyme to Small Intestine**







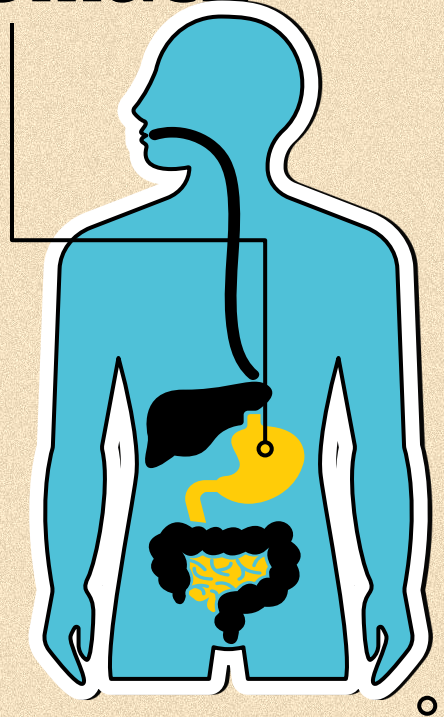
# Protein Digestion in the Stomach

## Mechanical Digestion

- Begins with mastication and continues to stomach
- Peristalsis churns the stomach's food content with HCL and chyme is formed
- Acidic Chyme (pH 2) will eventually move into small intestine and be neutralized by pancreatic juice (alkaline)

## Chemical Digestion

- Stomach secretes GI enzymes and hormones (gastrin, pepsinogen & renin--*infants only*)
- Inactive pepsinogen combines with HCL and creates Pepsin
- Pepsin (endopeptidase) will denature proteins into smaller peptides and amino acids via hydrolysis and moves these amino into the small intestine





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# Function of the Small Intestine



**Final Protein Digestion**



**Nutrient Absorption**

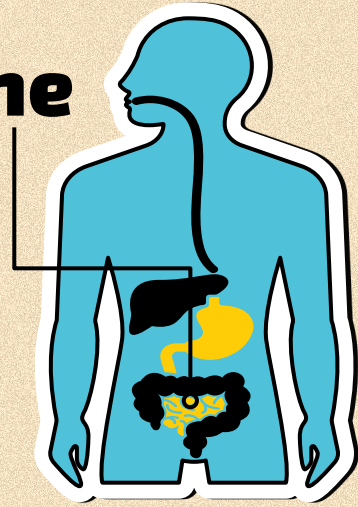


**Move Food along GI Tract**





# ✧ Protein Digestion in the Small Intestine



- Chyme (pH 2) from stomach enters duodenum and interacts with pancreatic juice via the ampulla of Vater and neutralizes chyme

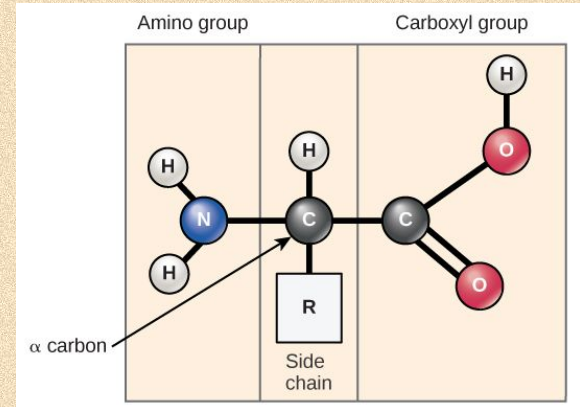
- Pancreatic juice contains the following protein digestive enzymes: ***trypsin, chymotrypsin, elastase, and carboxypeptidase.***

○ - Polypeptide chains are digested into free amino acids, dipeptides, & tripeptides

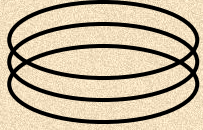
- Dipeptides, & tripeptides are further broken down by **aminopeptidase**

- Each enzyme breaks apart a specific peptide bond to produce smaller peptides or amino acids

- Free amino acids can now be absorbed across the brush border membrane to begin absorption.







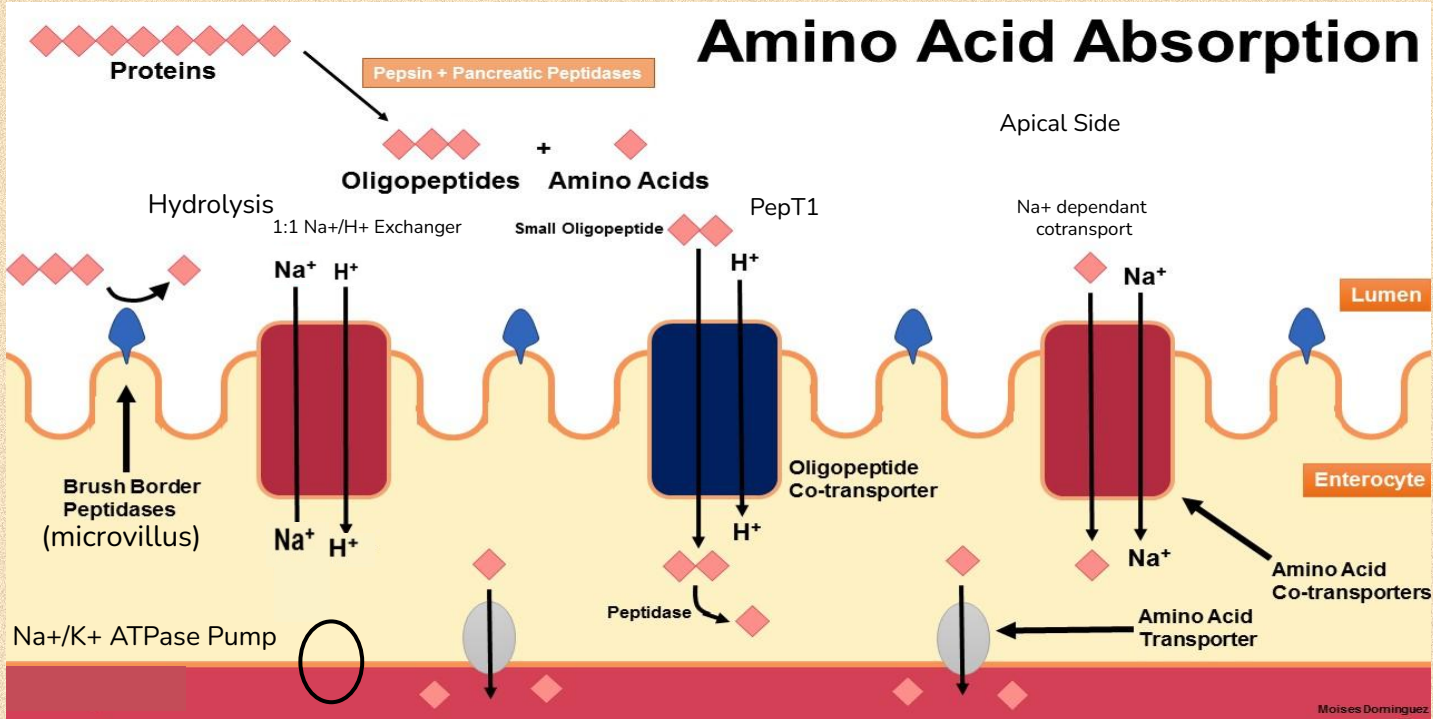
# Absorption

Small Intestine



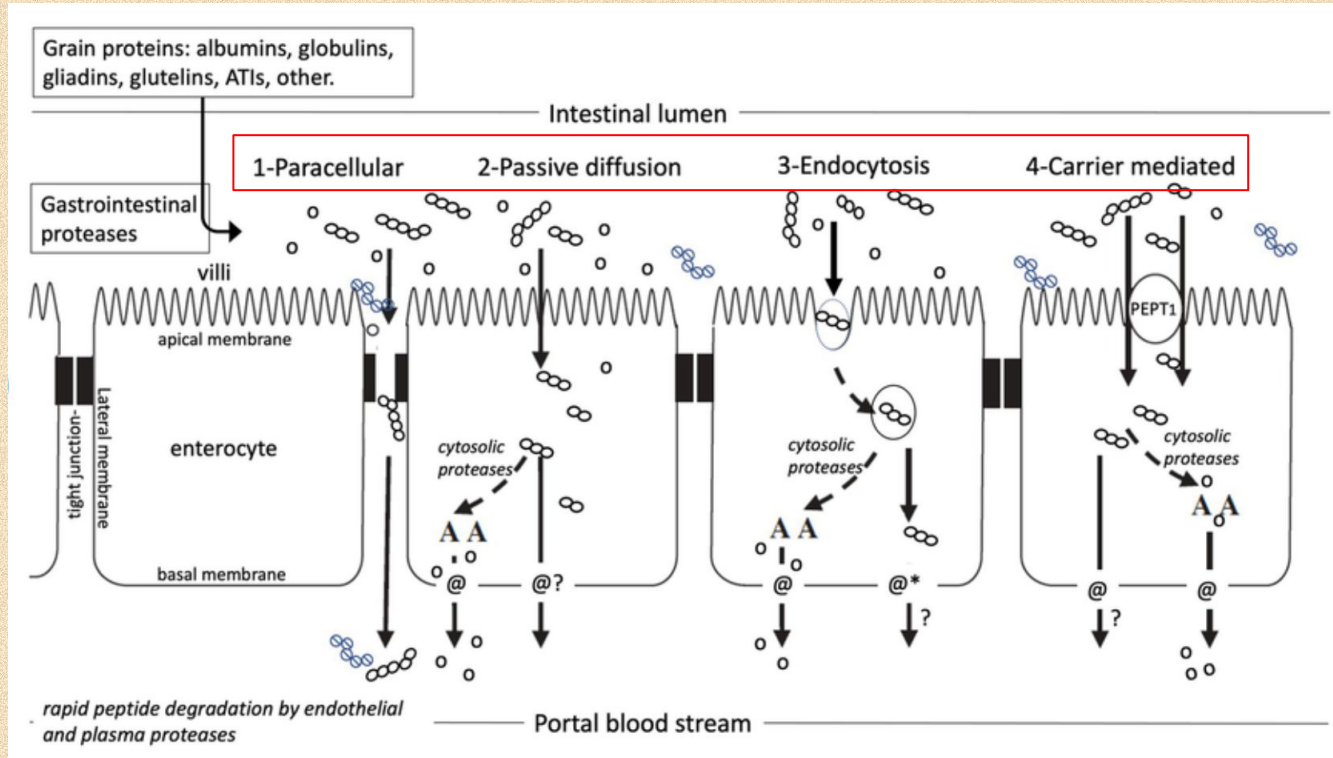


# Absorption of Amino Acids





# Absorption of Amino Acids

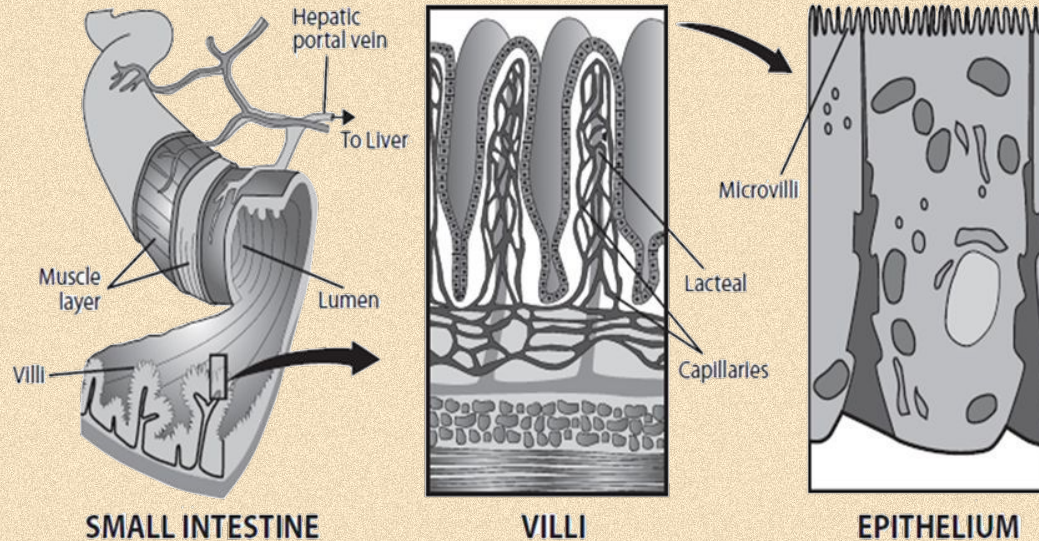




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# Amino Acids to the Bloodstream

Basolateral membrane → interstitial fluid → capillaries → hepatic portal vein → liver

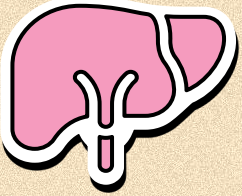


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# Fate of Amino Acids

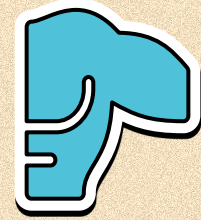


- **Liver**

- Protein synthesis
- Controlling amino acid concentration
- Distributing of amino acids to the whole body
- Can convert excess amino acids into other products

- **Large Intestine**

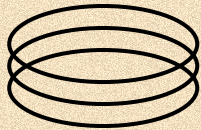
- Small percentage of amino acids are excreted through the feces



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# Related Terms



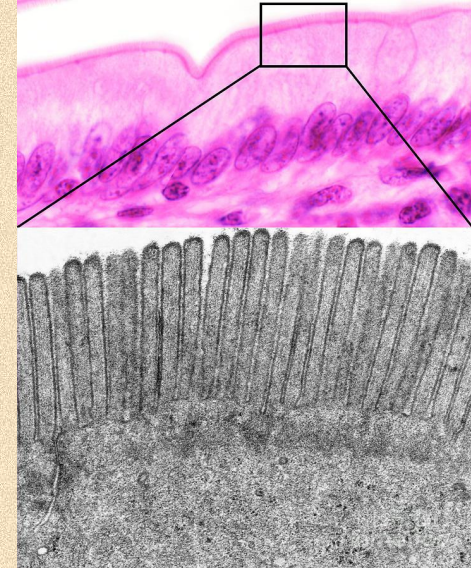




# Brush Border



- Folding of apical plasma membrane of epithelial cells within the small intestine called microvilli
- When describing the small intestine, microvilli and brush border are used interchangeably
- Brush border/ microvilli provides a large surface for absorption
- The brush border contains digestive enzymes that hydrolyze polypeptides and more... brush border enzymes are not secreted in the lumen but remain attached with exposed active sites
- The brush border enzyme enterokinase (enteropeptidase) activates trypsin, a protein digesting enzyme

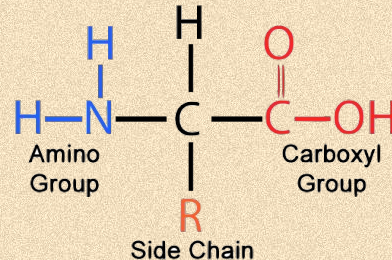




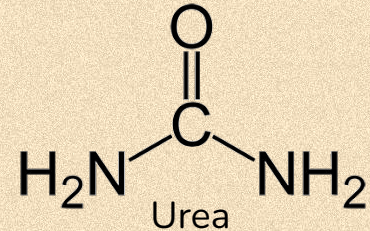
# Deamination, Ammonia, & Urea



- Deamination: process of **removing an amino group** from an amino acid and converting the amino group into **ammonia** ( $\text{NH}_3$ ). This process occurs in the **liver**
- When amino acids are metabolized, ammonium ions ( $\text{NH}_4^+$ ) are produced
- Ammonia and ammonium ions are both toxic waste products



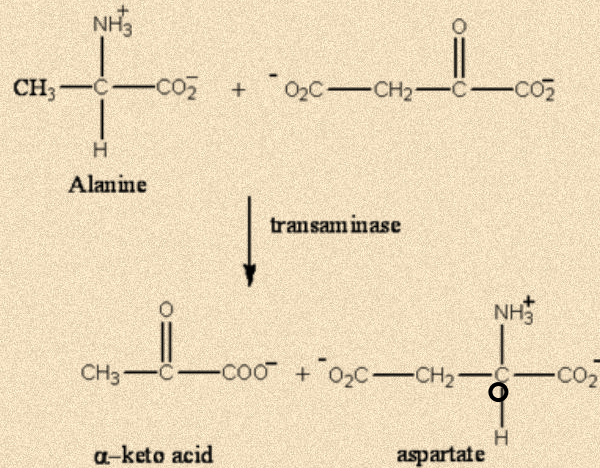
- Ammonia reacts with carbon dioxide and water to form urea
- Urea is produced as a **less toxic waste** product and is **excreted** through urine
- **Deamination (liver)**  $\rightarrow \text{NH}_3 \rightarrow \text{NH}_4^+$   
 $+ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{Urea (liver)} \rightarrow \text{blood}$   
 $\rightarrow \text{kidney} \rightarrow \text{excreted}$





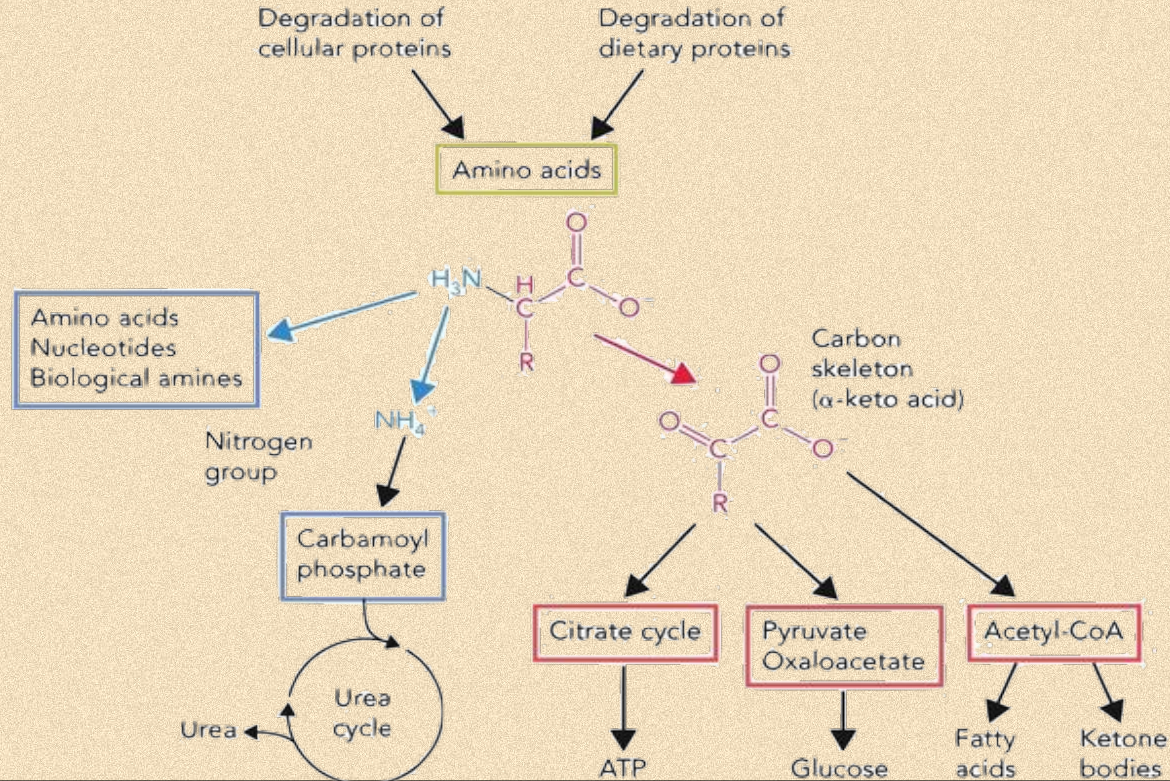
# Transamination

The process of an amine group from an amino acid being transferred to a keto acid molecule. Catalyzed by the enzyme transaminases. Keto Acids formed can be used in krebs cycle for energy production





# Amino Acid VS Keto Acid



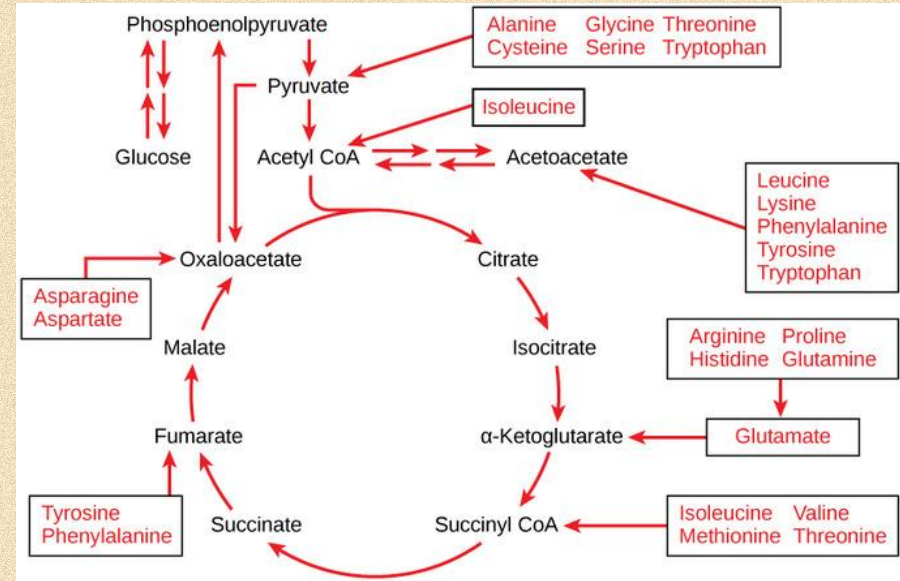




# Amino Acids for ATP Production



- If there are excess of protein in the body or if the body is undergoing starvation, amino acids will be broken down to enter the Krebs cycle
- Deamination occurs prior to entry into the Krebs cycle
- Amine group enters the urea cycle as ammonia to be removed in through urine
- Remaining keto acid can then enter Krebs cycle
- Deaminated amino acids can enter Krebs cycle by converting to intermediate molecules





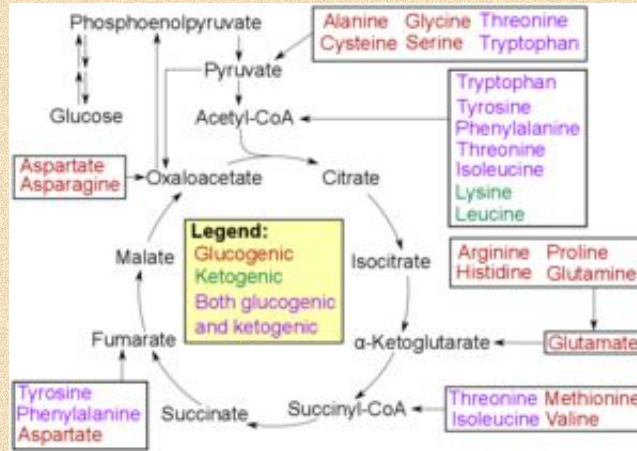


# Amino Acids into Fats and Glucose



## Amino Acids into Fats

- Excess protein from our diets can be converted into fats
- Converting to fats or other substances allows the body to store proteins
- Having a fat reserve allows our bodies to go longer periods without food
- Fat is the most efficient way to store nutrients
- Amino Acids → fats: Mainly stored as TAGs (triacylglycerides) in adipose tissue
- Can be directly converted into Acetyl CoA, or Acetoacetyl CoA which is then converted into fats
- Ketogenic Amino Acids



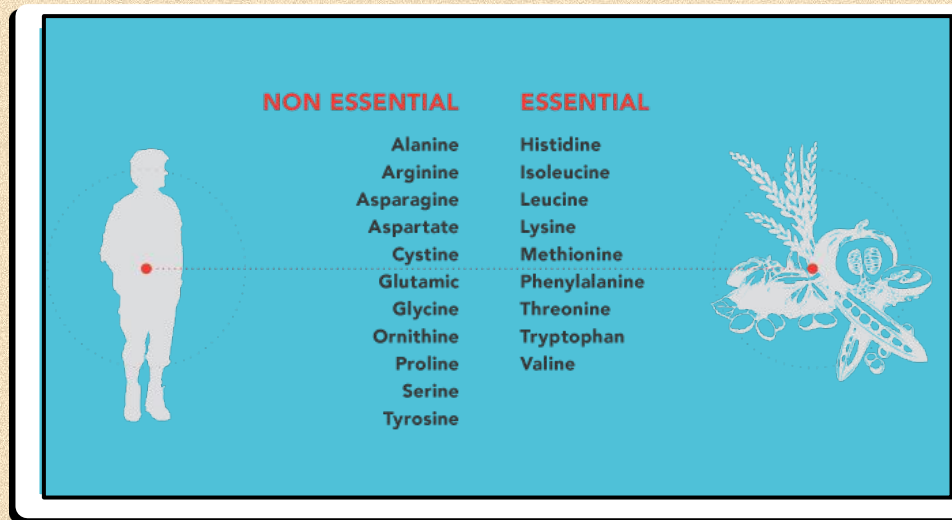
## Amino acids into Glucose

- Gluconeogenesis is the process of noncarbohydrates (in this case amino acids) being converted into glucose
- Occurs during fasting, when the liver secretes glucose into the blood
- Happens because the liver helps to maintain blood glucose concentration
- Amino Acids → glucose: mainly stored as glycogen in liver
- Can be converted directly into Pyruvate, oxaloacetate, and other intermediates of Krebs cycle and the converted into glucose
- Glucogenic Amino Acids





## 20 Essential & Non-Essential



There are 9 essential amino acids that are not naturally synthesized in the adult human body and must be obtained through our diet.

-8 in children

There are 11 non-essential amino acids that are naturally synthesized in the adult human body.

Our liver is constantly reutilizing amino acids for protein synthesis, create glucose or fatty acids, and send them off to stimulate muscle growth.

Therefore, a continuous supply of dietary amino acids is required to replace those used.

- Growth and repair body tissue
- Make hormones and brain chemicals
- Provide an energy source
- Build muscle
- Sustain digestive system



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# Conclusion



Chemical Structure



Function & Digestion



Absorption

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# THANK YOU!

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