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## *Proteins and Amino Acids*

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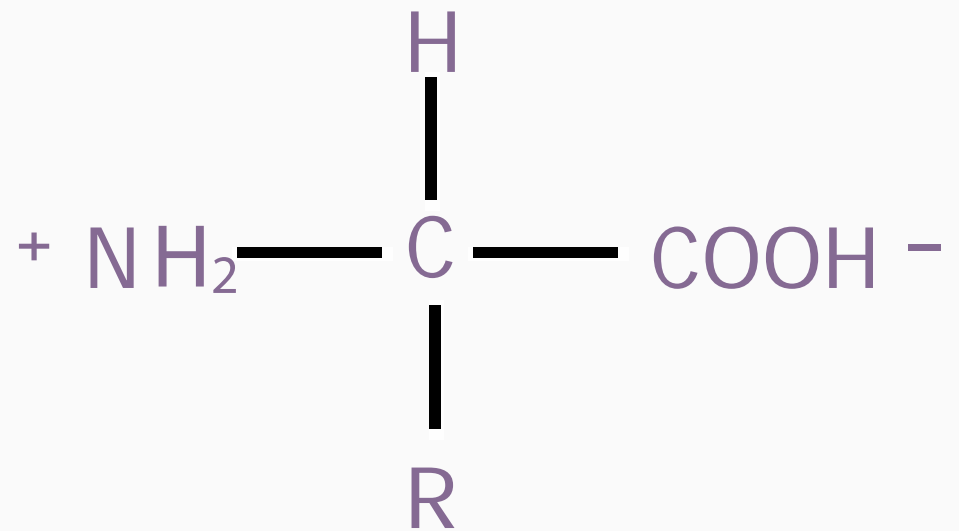
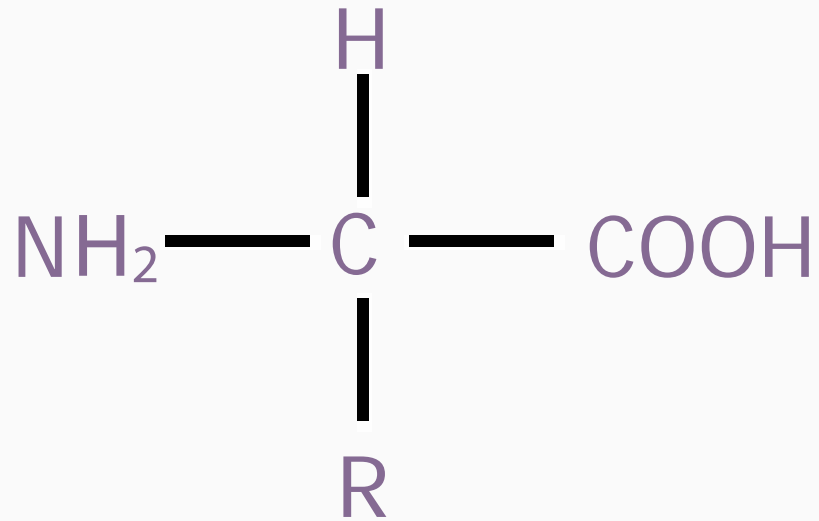
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## *Section A*

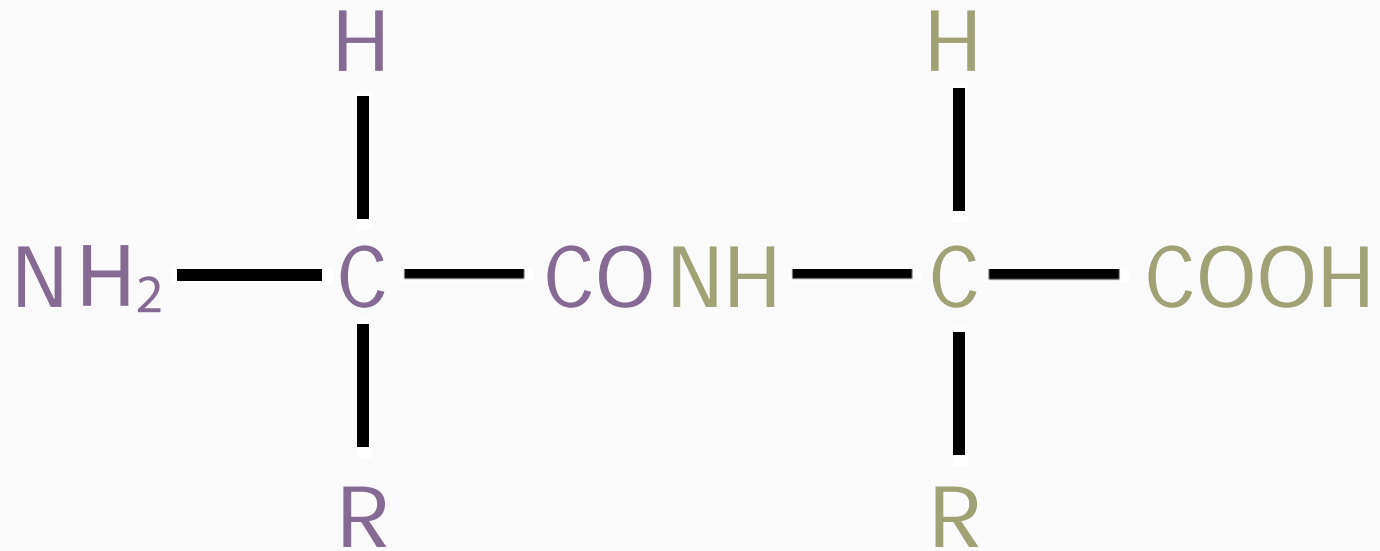
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Definitions

# Amino Acids



# Peptides



# *Human Amino Acid Requirements*

Valine

Leucine

Isoleucine

Phenylalanine

Tryptophan

Methionine

Lysine

Threonine

Cysteine

Arginine

Proline

Histidine

Glycine

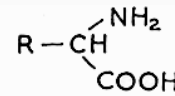
Glutamine

Alanine

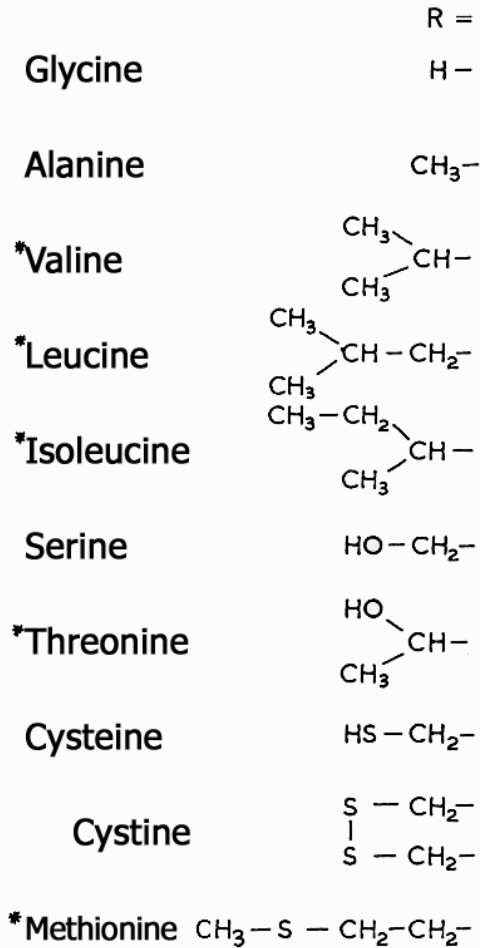
Glutamic acid

# Amino Acids Broken Down

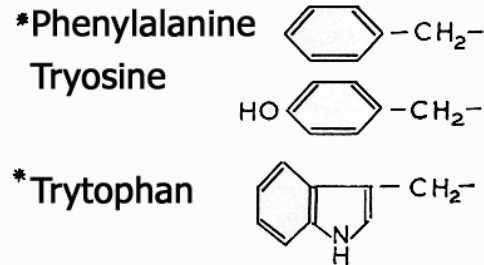
## General Formula:



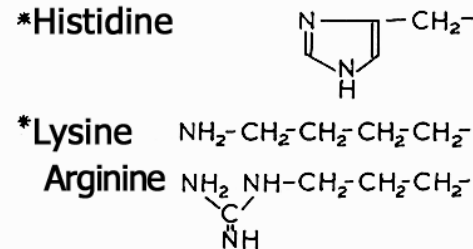
### ALIPHATIC AMINO ACIDS



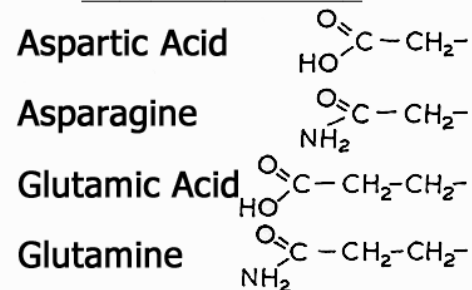
### AROMATIC and HETERO-CYCLIC AMINO ACIDS:



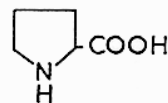
### BASIC AMINO ACIDS



### ACIDIC AMINO ACIDS and their AMIDES



Proline



## Other Uses for Amino Acids

- Glutamic acid      *Neurotransmitter*
- Tyrosine            *Catecholamines*
- Tryptophan        *Serotonin, niacin*
- Glycine             *Purines, pyrimidines*
- Cysteine            *Glutathion, taurine*
- Methionine        *Choline, creatine*





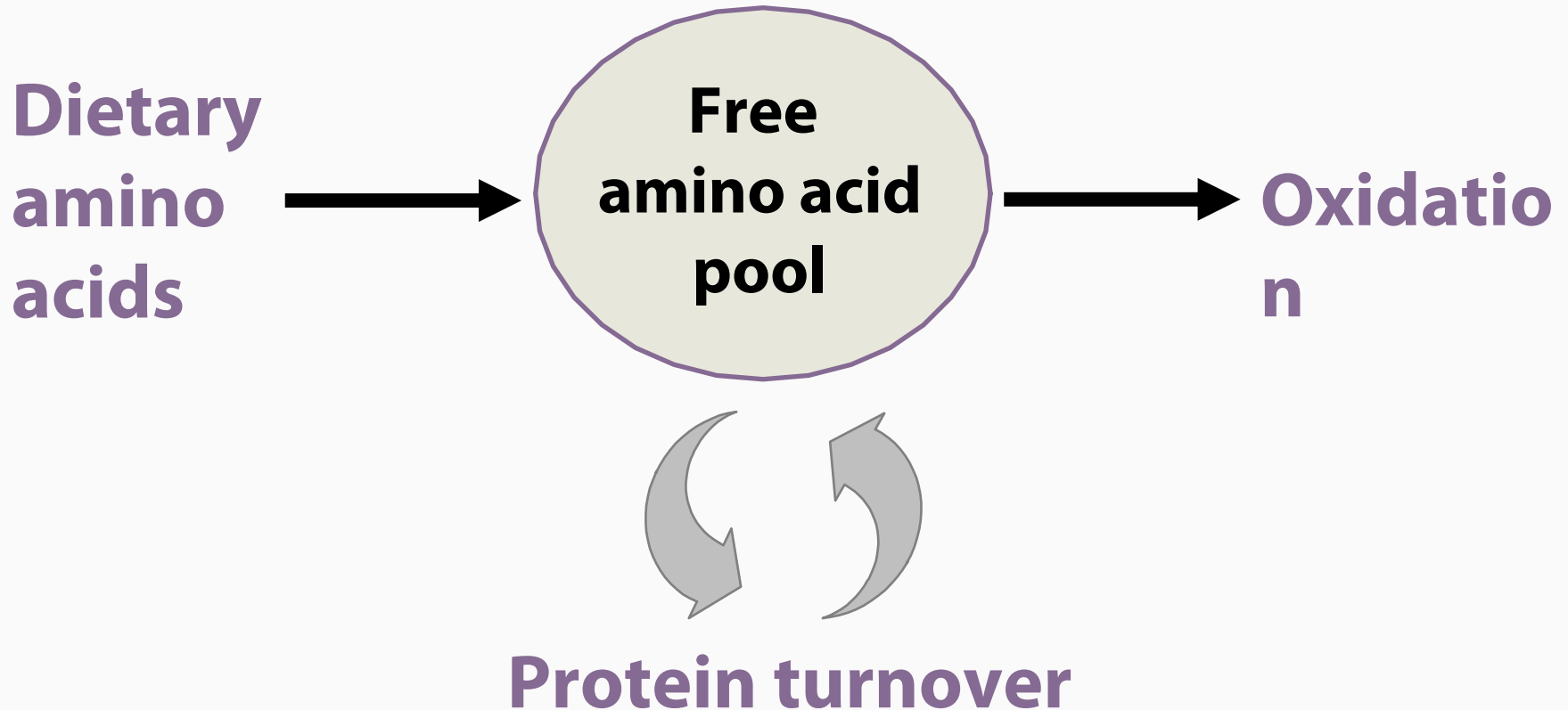
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## *Section B*

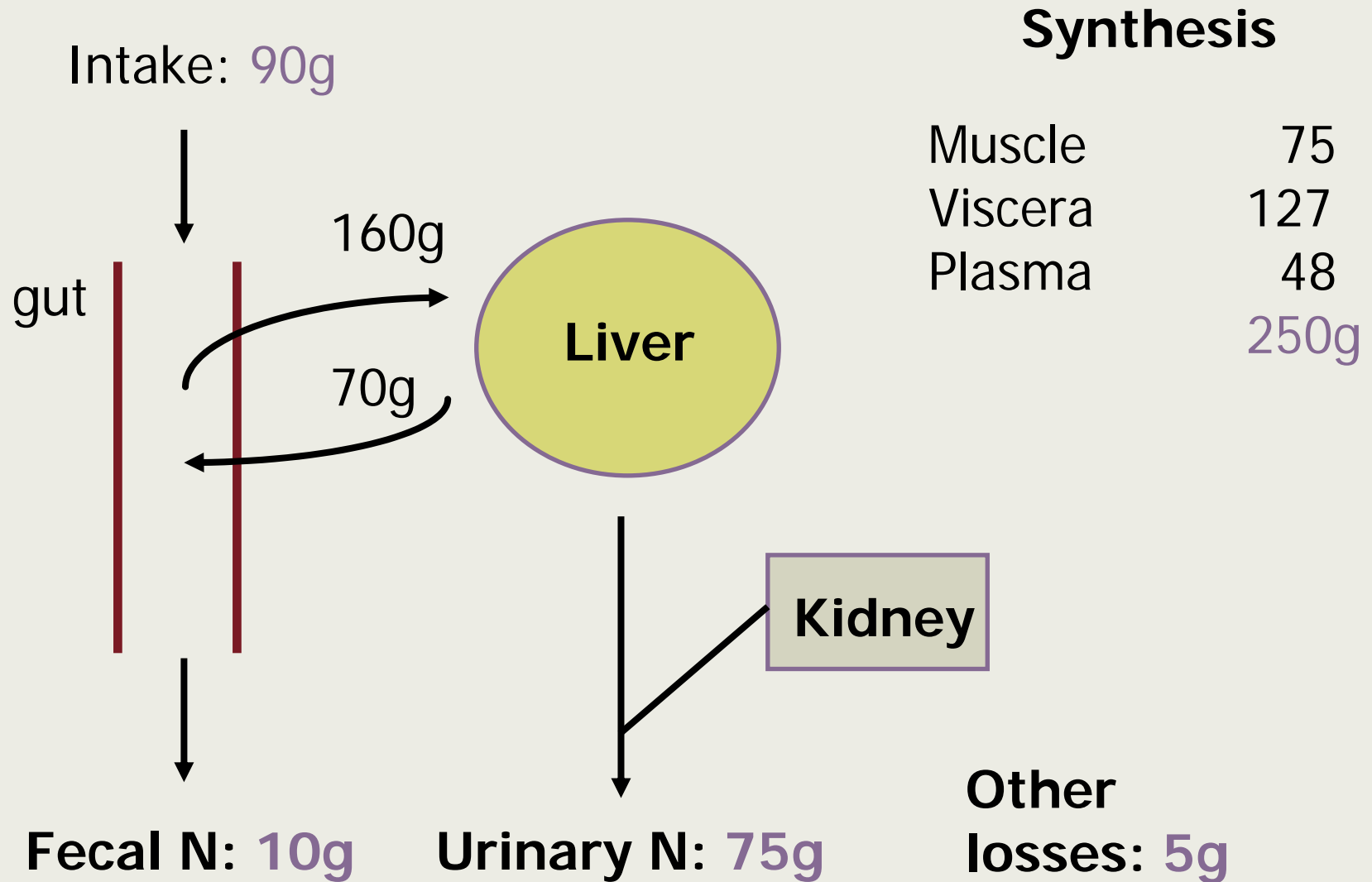
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Protein and Amino Acid Metabolism

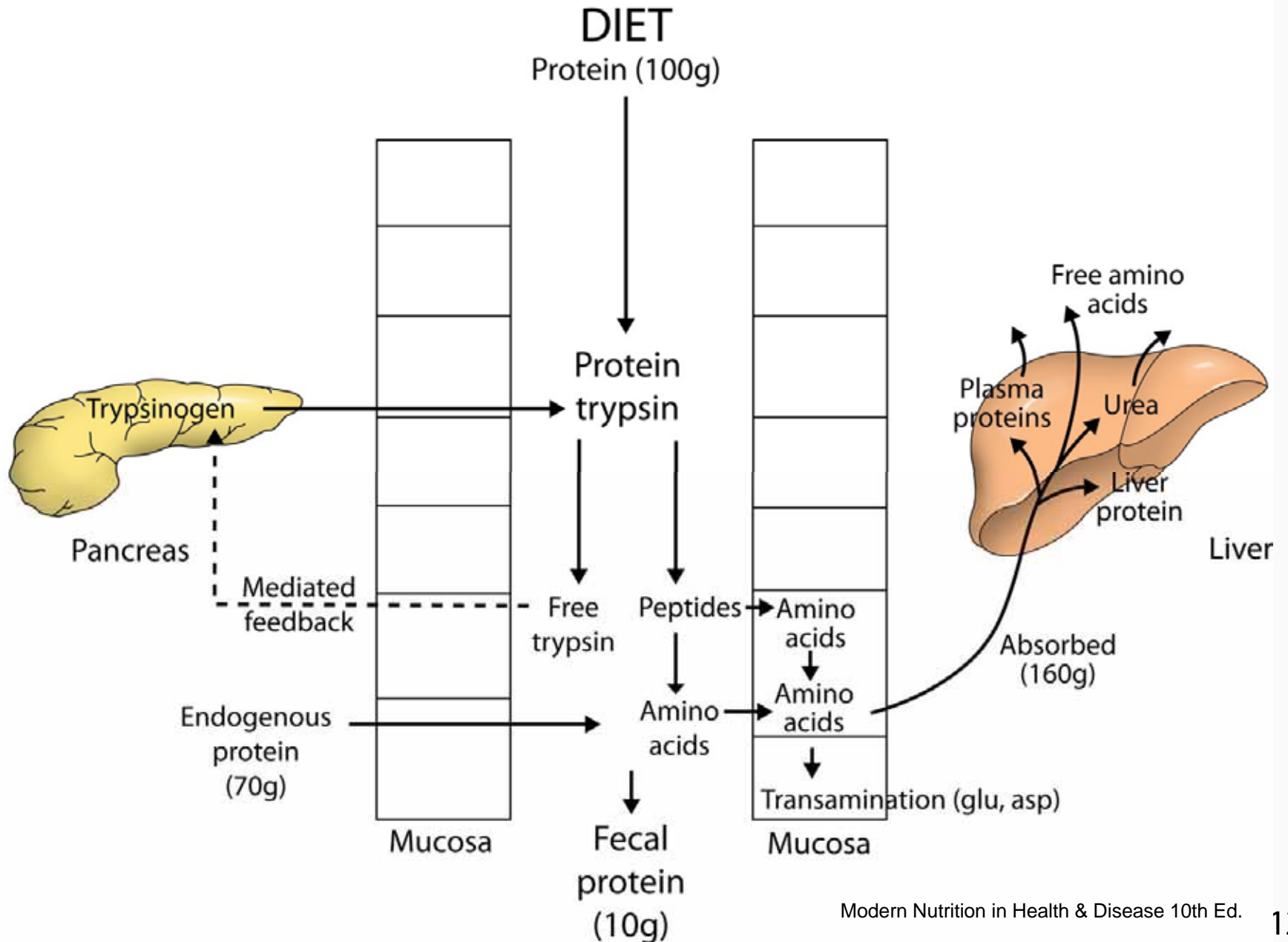
# Whole-Body Amino Acid Metabolism



# Protein Turnover



# Protein Digestion and Metabolism



## *Some Common Food Proteins*

<b>Protein</b>	<b>Source</b>	<b>MW</b>
Casein	Milk	34000
$\beta$ -lactoglobulin	Milk	35000
Ovalbumin	Eggs	44000
Gluten	Wheat	39000
Myosin	Meat	850000

# *Nitrogen Balance*

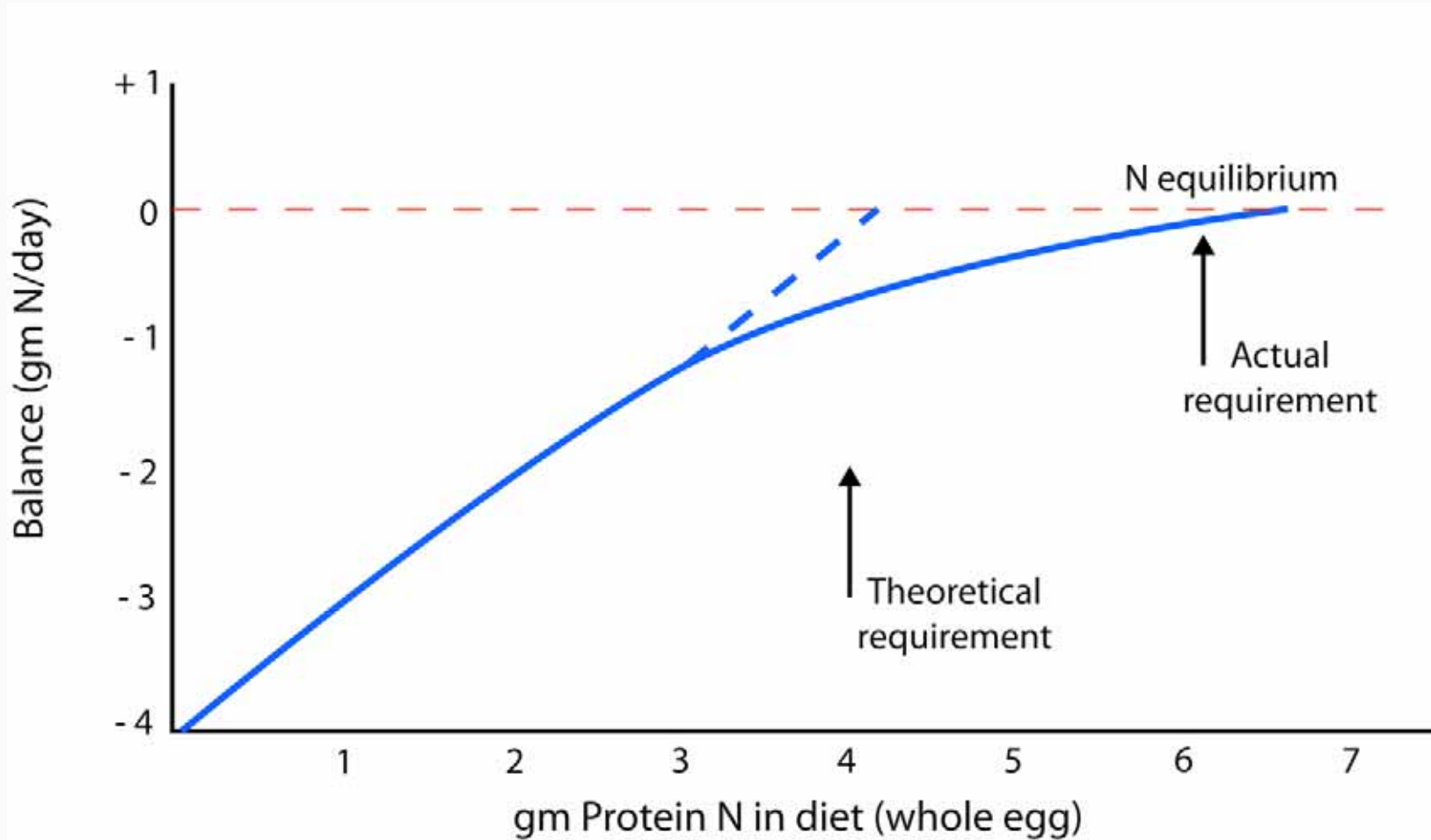
- Humans cannot store excess amino acids not used for protein synthesis; they must be degraded and the N eliminated in the urine
- In adults, dietary N requirements are determined by the need to replace obligatory losses
- Once the true requirement is met, the N balance will tend to remain close to zero

$$\text{Diet} \rightarrow \text{IN} - \text{OUT} = 0$$

– Fecal  
– Urinary  
– Insensitive

The diagram shows the equation  $\text{IN} - \text{OUT} = 0$ . A green arrow points from the word "Diet" to the "IN" term. Another green arrow points from the "OUT" term to a list of three items: "– Fecal", "– Urinary", and "– Insensitive".

# N Balance







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## *Section C*

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Protein Quality and Recommendations

# Protein Quality

- *Quality*
- *Digestibility*
- *Biological value*

- **Quality**—Content of essential amino acids relative to a reference protein

# Protein Quality

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# Protein Quality

- **Quality**—Content of essential amino acids relative to a reference protein
- **Digestibility**—Percent of ingested protein that is absorbed
- **Biological value**—Percent of absorbed dietary protein that is retained in the body; also, rate of growth per g of protein consumed

## *Digestibility of Some Proteins*

	True Digestibility	% of Reference
Egg	97	100
Milk	95	100
Meat	94	100
Maize	85	89
Rice (polished)	88	93
Beans	78	82

# Amino Acid Content of Some Food Proteins

<i>Percentage of Total Protein N:</i>				
<b>Protein</b>	<b>S-AA</b>	<b>Lys</b>	<b>Trp</b>	<b>Leu</b>
<i>Ideal</i>	<i>3.5</i>	<i>5.5</i>	<i>1.0</i>	<i>7.0</i>
Egg	5.5	6.4	1.6	8.8
Milk	3.3	7.8	1.4	9.8
Beef	3.8	8.7	1.2	8.2
Beans	2.6	6.4	1.0	7.0
Corn	3.2	2.9	0.6	3.0
Protein	1.5	6.1	0.9	7.0

## *Protein Content of Some Foods*

	<b>g/100g of Food</b>
Cassava	1.5
Potato	2.0
Cow's milk	3.3
Rice	7.0
Eggs	13.0
Lean beef	19.0



# *Protein Requirements*

- The lowest level of dietary protein intake that balances N losses when ...
  - Stable energy balance
  - Modest level of physical activity
  - Adequate for physiological conditions

# *Determination of Dietary Protein Requirements*

## ■ **Rationale**

- Amount that maintains N balance at different levels of energy intake

## ■ **Method**

- N balance data in adults

## ■ **Assumptions**

- Miscellaneous losses—8 mg N/day
- Acknowledges that protein BV is dependent on level of energy intake

# Protein Requirements

Energy (kcal/kg Body Weight)*	Mean Requirement of Dietary Protein for Zero N Balance (G Protein/Kg Body Weight)	Safe Allowance of Protein (Mean Requirement ÷ 2 Standard Deviations)	
		Grams Protein/Kg Body Weight	Grams Protein/70- Kg Man
40	0.78	1.02	72
45	0.56	0.74	52
48	0.51	0.62	44
57	0.42	0.50	35
Recommended dietary allowance		0.80	56

# *High and Low Limits of Protein Intake*

- **Adaptation to a low protein intake**
  - Is there a body protein reserve?
  - Limits of adaptation: Accommodation

# *High and Low Limits of Protein Intake*

- **Adaptation to a low protein intake**
  - Is there a body protein reserve?
  - Limits of adaptation: Accommodation
- **Adaptation to a high protein intake**
  - Is excess protein intake harmful?
  - Does a high-protein diet enhances performance?