

Chemistry of Proteins
 Protein Uses
 Amino Acids
 Classification of Amino Acids
 Amino Acid Structures
 Amino Acid Structures (2)
 Classification
 Peptide Bond
 Collagen - Fibrous Protein
 Hemoglobin - Globular Protein
 Essential Amino Acids
 Metabolism
 Starvation
 Diabetes
 Atkin's Diet
 Energy Expenditures
 Exercise and Calories
 Metabolism

Outline

- Protein Uses
- Amino Acids
 - Structure, Classification, Properties
- Peptides and Proteins
 - Structure, Classification, Properties
- Metabolism
- Diet
 - Starvation, Diabetes, and Atkin's Diet
 - Vitamins

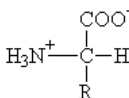
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- Structure - Some proteins (collagen, silk, ...) provide protection and support
- Catalysis - Enzymes are proteins that direct and accelerate biochemical reactions.
- Movement - Proteins are involved in all cell movements
- Defense - Blood-clotting, keratin in skin, ...
- Regulation - Peptide hormones (such as insulin) regulate key biochemical processes
- Transport - Proteins can assist movement of molecules into and out of cells or through body.

Amino Acids

Classification of Amino Acids

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Optically active

- Mirror image is NOT the same.
- In lab, get 50/50 mixture.
- In nature, "all" amino acids are "L" (left-handed)

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Non-polar (10)

- Ala, Cys, Gly, Ile, Leu, Met, Phe, Pro, Try, Val
- Don't contain any polar groups on side chain
- Water insoluble side chains

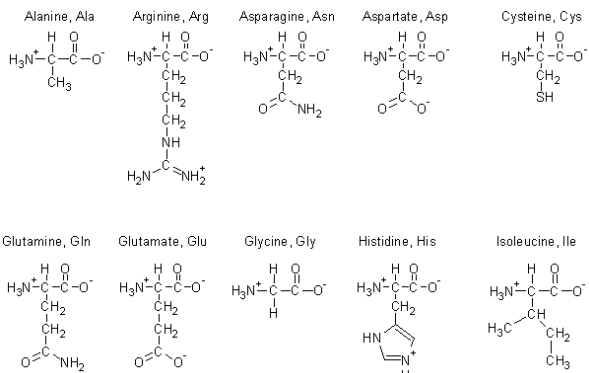
Polar (10)

- Arg, Asn, Asp, Gln, Glu, His, Lys, Ser, Thr, Tyr,
- Includes Neutral, Acidic, and Basic side chains
- Water soluble side chains

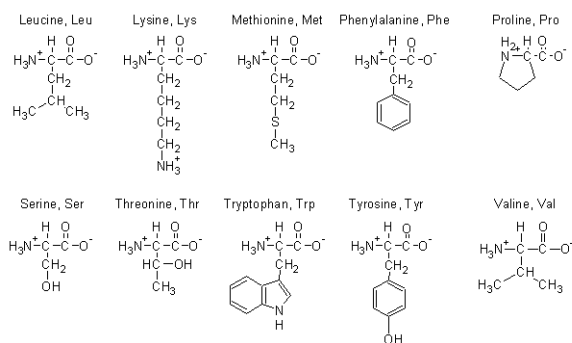
Amino Acid Structures

Amino Acid Structures (2)

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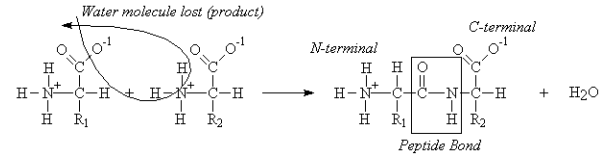


Classification

# amino acids	Name	Examples
1	amino acid	—
~2-50	peptide	oxytocin, GSH, insulin
~50+	protein	hemoglobin, collagen

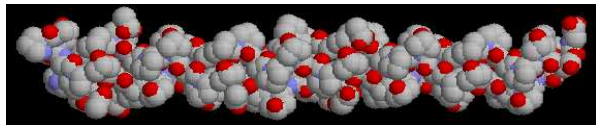
Peptide Bond

Peptides and Proteins are held together by peptide bonds.



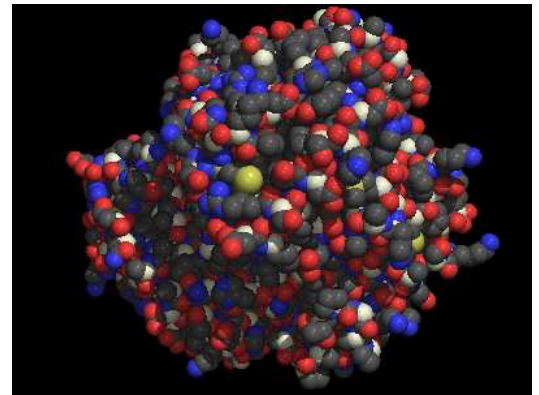
The peptide bond is formed by the reaction of the carboxylic acid group of one amino acid with the amine group of the second amino acid.

Collagen - Fibrous Protein



Collagen is a primary component of connective tissue

Hemoglobin - Globular Protein



Hemoglobin is responsible for the transport of oxygen.

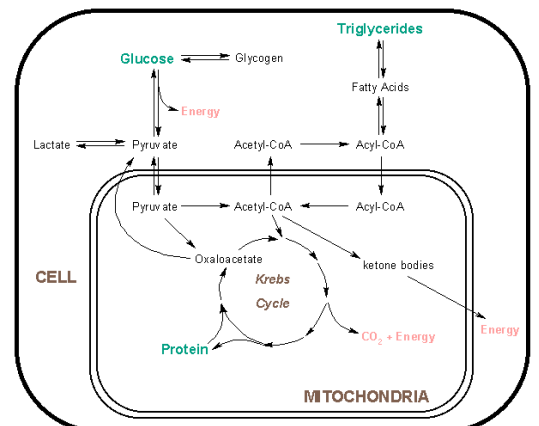
Essential Amino Acids

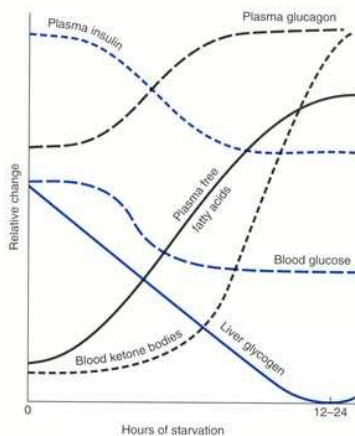
Humans are unable to synthesis nine (9) of the twenty (20) naturally-occurring amino acids in sufficient quantities, so these **essential amino acids** must be supplied in our diets.

Histidine	(basic)	Phenylalanine	(non-polar)
Isoleucine	(non-polar)	Threonine	(polar)
Leucine	(non-polar)	Tryptophan	(non-polar)
Lysine	(polar)	Valine	(non-polar)
Methionine	(non-polar)		

Meat is a good source of protein. Vegetarians need to be sure to consume complete proteins in order to avoid malnutrition.

Metabolism





Chemistry in Our World – 13 / 18

Untreated diabetes similar (from a metabolism perspective) to starvation.

- Blood sugar is high (especially after eating) because either insulin is not formed (Type I) or insulin receptors broken (Type II). Insulin is responsible for bringing glucose from bloodstream into cells.
- Since cells think glucose concentration is low, hormones released to produce more glucose.
- Cell concentration of glucose is low, so metabolism of fats primary fuel source.
- High metabolism of fat can lead to ketone bodies (acetone smell on breath).

Chemistry in Our World – 14 / 18

The Atkin's Diet, Protein Power Plan, and other diets require:

- Very low carbohydrate intake
- High fat intake (for fuel)
- High protein (to avoid muscle degradation)

Claim is that we consume too much simple sugar, which gives rise to diabetes.

American Heart Association recently warned that these diets can be dangerous.

Activity	Calories/min (180 lb person)
Aerobics (vigorous)	11
Basketball (vigorous)	15
Bicycling (11 mph)	9
Jogging (10 min/mile)	14
Running (7 min/mile)	18
Swimming (fast)	13
Walking (20 min/mile)	5

Taken from ACS Textbook "Chemistry in Context", 3rd Edition, Table 11.6 (p. 441)

Chemistry in Our World – 15 / 18

Chemistry in Our World – 16 / 18

One pound of fat \approx 3500 Calories

If 180 pound person runs 3 miles a day, 7 days a week he/she will use:

$$(7 \text{ min/mile}) * (21 \text{ miles}) = 147 \text{ minutes}$$

$$(18 \text{ Calories/min}) * (147 \text{ minutes}) = 2646 \text{ Calories}$$

But only \sim 1/3 of these are due to fat.

$$2646 / 3 = 882 \text{ Calories of fat per week}$$

To lose 1 pound fat

$$(3500 \text{ Calories}) / (882 \text{ Calories/week}) \approx 4 \text{ weeks}$$

Exercising this much will allow you to lose 1 pound of fat per month!

Basal Metabolism - Energy required to survive (heart, lungs, ...)

For most individuals:

$$\text{Basal Metabolism} = 1 \frac{\text{Cal}}{\text{kg hr}}$$

Thus, for our 180 pound individual:

$$180 \text{ lbs} \approx 80 \text{ kg}$$

$$1 \frac{\text{Cal}}{\text{kg hr}} \times 80 \text{ kg} \times 24 \text{ hours} = 1920 \text{ Calories/day.}$$

A key role of exercise is to increase basal metabolism. Direct calorie burning helps, but alone is not enough.

Chemistry in Our World – 17 / 18

Chemistry in Our World – 18 / 18