AMINO ACIDS & PROTEINS

C, H, O, N, S

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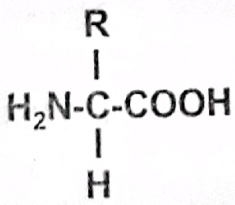
Amino acids

- **amino group**, **carboxyl group**, hydrogen and a **variable** side group (residue) each joined to a central carbon atom



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Types of amino acids

- Amino end and carboxyl end can be ionised NH_3^+ and COO^- to give acidic and basic characteristics
- At pH 7 both groups are ionised
- The residues are side chains which give the individual properties to the amino acid (acidic, basic, neutral and nonpolar).

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Functions of amino acids

- Protein synthesis, energy reserves, hormones (thyroxin)
- **20 different amino acids** used in protein synthesis though others do occur in nature
- Essential amino acids cannot be synthesised by the organism and must form part of their diet.

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The peptide bond

- Carboxyl group + amino group form a strong covalent bond releasing water in the process = a **condensation reaction** (the reverse is hydrolysis)
- Amino acids join together in a long chain: **N** terminal end to **C** terminal end = a **polypeptide.**

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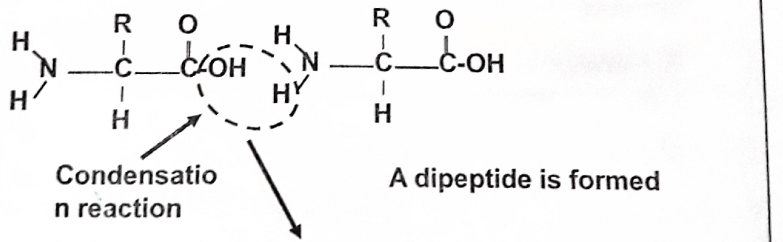

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Protein structure

- Primary structure

MGDVEKGKKIFIMKCSQCHTVEKGG
KHKTGPNLHGLFGRKTGQAPGYSY
TAANKNKGIIWGEDTLMEYLENPKK
YIPGTKMIFVGIKKKEERADLIAYLKK
ATNE

- The primary structure of human cytochrome C
- Each letter represents an amino acid
- This protein has 105 amino acids.

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Protein structure

- 3-D structure of human cytochrome C

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Proteins classified by function

- **CATALYTIC**: enzymes eg rubisco
- **COMMUNICATION**: hormones (eg insulin) and neurotransmitters
- **PROTECTIVE**: eg immunoglobulin, fibrinogen, blood clotting factors
- **STRUCTURAL**: eg collagen, spiders silk
- **PIGMENTS**: eg rhodopsin
- **STORAGE**: eg ovalbumen (in eggs), casein (in milk)
- **TRANSPORT**: eg hemoglobin
- **CONTRACTILE**: eg actin, myosin
- **TOXINS**: eg snake venom

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Essential, Nonessential, and Conditional

- Essential – must be consumed in the diet
- Nonessential – can be synthesized in the body
- Conditionally essential – cannot be synthesized due to illness or lack of necessary precursors
  - Premature infants lack sufficient enzymes needed to create arginine

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Table 6.1

The Mighty Twenty

Essential Amino Acids	Nonessential Amino Acids
Histidine (His)*	Alanine (Ala)
Isoleucine (Ile)	Arginine (Arg)[b]
Leucine (Leu)	Asparagine (Asn)
Lysine (Lys)	Aspartic acid (Asp)
Methionine (Met)	Cysteine (Cys)[b]
Phenylalanine (Phe)	Glutamic acid (Glu)
Threonine (Thr)	Glutamine (Gln)[b]
Tryptophan (Trp)	Glycine (Gly)[b]
Valine (Val)	Proline (Pro)[b]
	Serine (Ser)
	Tyrosine (Tyr)[b]

* Histidine was once thought to be essential only for infants. It is now known that small amounts are also needed for adults.
[b] These amino acids can be "conditionally essential" if there are either inadequate precursors or inadequate enzymes available to create these in the body.

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Structure of the Protein

- Four levels of structure
  - Primary structure
  - Secondary structure
  - Tertiary structure
  - Quaternary structure

Any alteration in the structure or sequencing changes the shape and function of the protein

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Denaturing

- Alteration of the protein's shape and thus functions through the use of
  - Heat
  - Acids
  - Bases
  - Salts
  - Mechanical agitation
- Primary structure is unchanged by denaturing

Denaturing a Protein

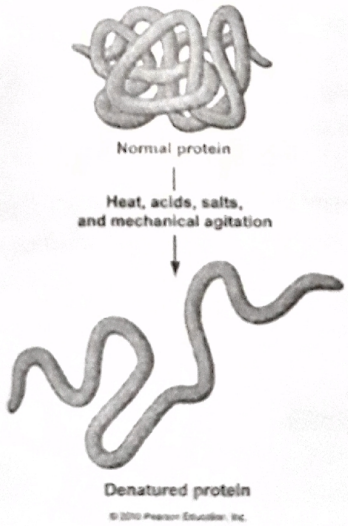

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Figure 6.5

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Quick Review

- Proteins are chains of combination of amino acids
- Amino acids contain carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur
- Unique amino acids consist of a central carbon with a carboxyl group, a hydrogen, a nitrogen-containing amine group, and a unique side chain
- There are 20 side chains and 20 unique amino acids
  - 9 essential amino acids
  - 11 nonessential amino acids
    - At time these become conditionally essential
- Amino acids link together with peptide bonds by condensation and break apart by hydrolysis

Quick Review

- Attractions and interactions between the side chains cause the proteins to fold into precise three-dimensional shapes
- Protein shape determines its function
- Proteins are denatured and their shapes changed by
  - Heat
  - Acids
  - Bases
  - Salts
  - Mechanical agitation

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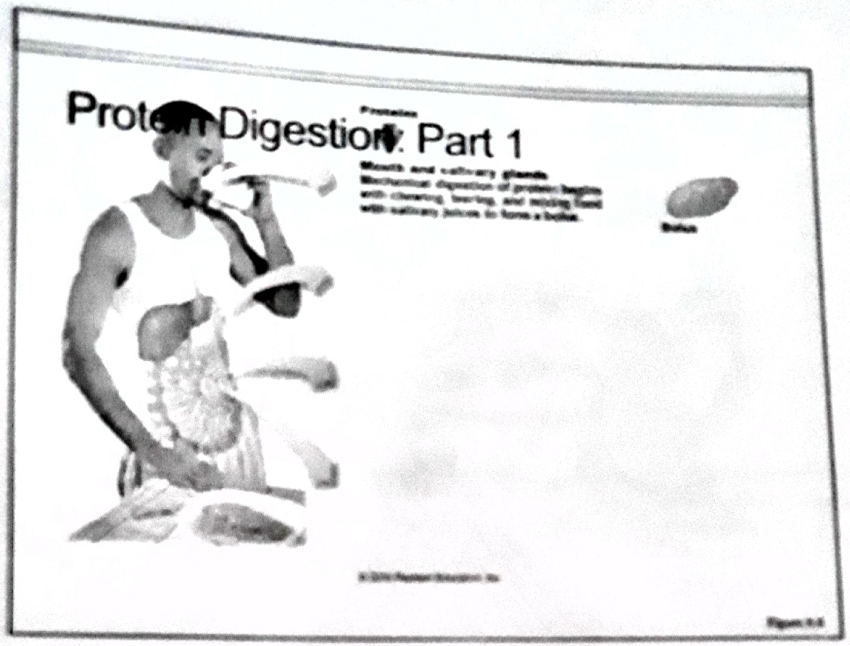

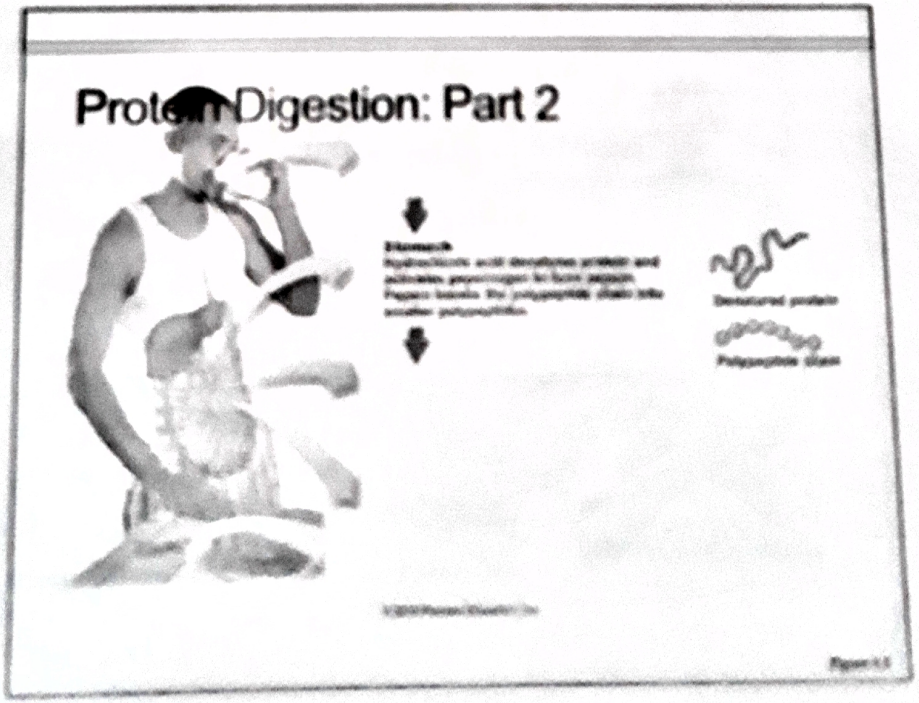

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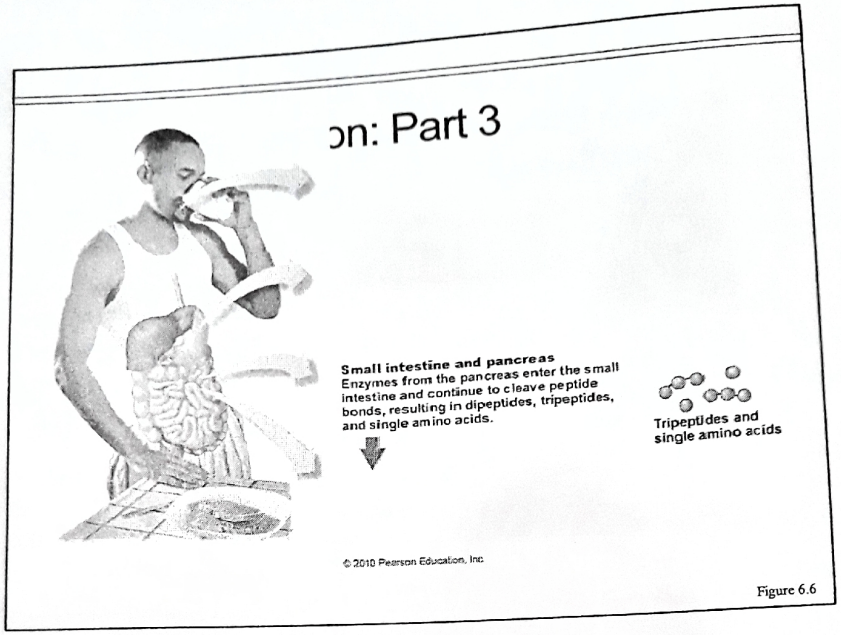

Figure 6.6

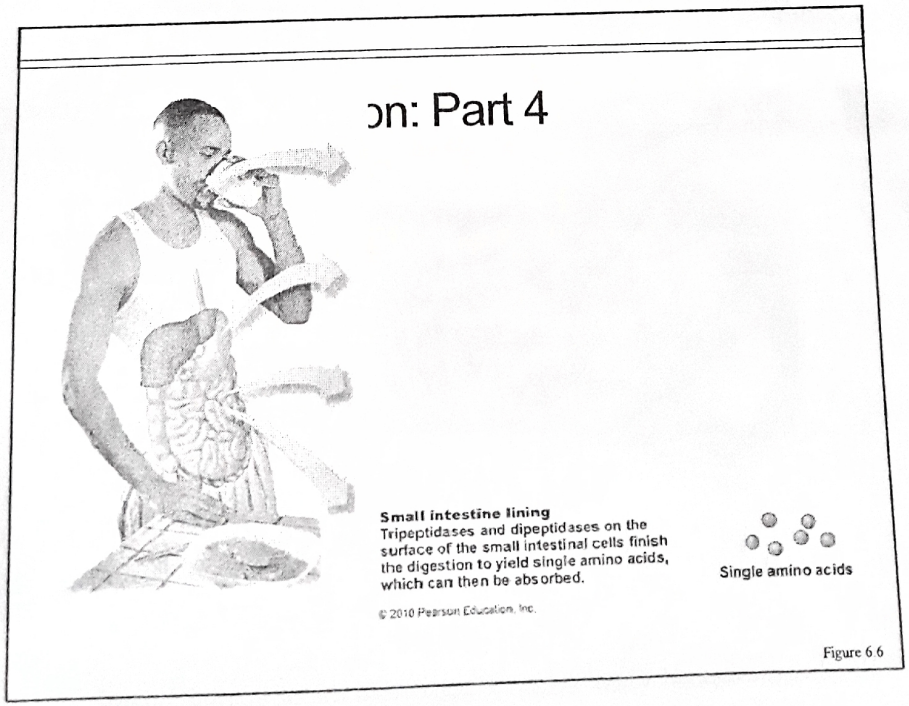

Figure 6.6

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Amino Acid Absorption

- Amino acids are absorbed in the small intestine
- Amino acids are transported to the liver from the intestines via the portal vein
- In the liver, amino acids are
  - Used to synthesize new proteins
  - Converted to energy, glucose, or fat
  - Released to the bloodstream and transported to cells throughout the body
- Occasionally proteins are absorbed intact

Amino Acid Metabolism

- Liver metabolizes amino acids, depending on bodily needs
- Most amino acids are sent into the blood to be picked up and used by the cells
  - Amino acid pool is limited but has many uses
- Protein turnover – the continual degradation and synthesizing of protein

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