

## Proteins and Amino Acids

Unlike carbohydrates and fats, proteins contain nitrogen

### Amino Acids

- Essential amino acids: amino acids that cannot be synthesized by the body
  - Without these essential nutrients, the body cannot make the proteins it needs
  - Includes histidine, leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine
- Nonessential amino acids: can be synthesized by the body
  - Includes: alanine, arginine\*, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine
  - \*Under certain circumstances, a nonessential amino acid can become essential
- Recycling amino acids: in addition to making amino acids, the body breaks down proteins and reuses those amino acids
- Cells can use amino acids for energy, providing access to fuel (glucose) and discarding the nitrogen atoms as waste

How do amino acids build proteins?

- Peptide bonds: connect one amino acid to another

Proteins can be denatured (distorted in shape) by heat, radiation, alcohol, acids, bases, or the salts of heavy metals; denaturing also occurs during digestion and cooking

Can eating extra protein make muscles grow larger?

- No
- Hard work is the trigger for the genes to build more muscle tissue
- Exercise stimulates DNA to begin the process of building up muscle fibers

## Protein Digestion

- Failure to understand the mechanism of protein digestion can lead to being misled by advertisers making false claims
- Even the stomach's digestive enzymes are denatured when their jobs are through

## Roles of Protein in the Body

- Supporting growth and maintenance
  - Amino acids must be continuously available to build the proteins of new tissue
  - Proteins help replace worn-out cells and internal cell structures
    - RBCs only live 3-4 months
    - Cells lining the intestinal tract live only 3 days
    - Skin cells are constantly being shed and replaced
  - Protein turnover: each day ~25% of available amino acids are irretrievably diverted to other uses, such as being used for fuel
- Building enzymes, hormones, and other compounds
  - Enzymes are among the most important of the proteins formed in living cells
  - Hormones: chemical messengers secreted by a number of body organs in response to conditions that require regulation
- Building antibodies
  - Antibodies: large proteins of the blood that are a part of the immune system, each designed to destroy specific invaders
    - Some immunities are lifelong while others must be "boosted" at intervals
- Maintaining fluid and electrolyte balance
  - Too much fluid in a cell—the cell ruptures
  - Too little fluid—the cell is unable to function
  - Water can diffuse freely in and out of cells; proteins cannot
  - Proteins attract water: by maintaining internal proteins, cells retain the fluid levels they need
- Maintaining acid-base balance
  - Normal processes of the body continually produce acids (substances with a pH <7) and bases (substances with a pH >7)
  - Blood proteins act as buffers to maintain the blood's normal pH (7.35-7.45)
- Providing energy
  - Degradation of amino acids for energy
    - Amine groups (N-containing) are stripped off and incorporated by the liver into urea
    - Fragments that remain are composed of carbon, hydrogen, and oxygen
  - Unlike fatty acids, many amino acids can be converted to glucose
  - There is no specialized protein energy storage compound, thus energy deficiency (starvation) always incurs wasting of lean body tissue as well as loss of fat

- If amino acids are oversupplied, the body cannot store them and they can then be used to meet energy needs or converted to glucose for storage as glycogen

#### The Fate of an Amino Acid

- To prevent the wasting of dietary protein and permit the synthesis of needed body protein, dietary protein must be adequate in quantity
  - The diet must supply all of the essential amino acids in proper amounts
  - Enough energy-yielding carbohydrates and fat must be present to permit the dietary protein to be used as it should

#### Protein and Amino acid Supplements

- People who use protein supplements as a replacement for foods can put themselves in danger, especially when used in weight loss diets
- "Liquid protein" diets have caused deaths and heart problems

#### Food Protein: Quality, Use, and Need

- The body's response to protein depends on:
  - The body's state of health—malnutrition or infection may greatly increase the need for protein
  - Other nutrients and energy taken with the protein
  - The protein's quality

#### What kinds of protein-rich foods are easiest to digest?

- Food preparation impacts protein digestibility
- Cooking with moist heat (boiling, stewing, braising, etc.) improves protein digestibility
- Cooking with dry heat (searing, frying, baking, etc.) can impair protein digestibility

#### Amino Acid Composition

- High-quality proteins: dietary proteins containing all of the essential amino acids in adequate amounts; may also contain nonessential amino acids
- Limiting amino acids can limit protein synthesis
- All or None Principle: if some of the amino acids are missing, the complete protein cannot be synthesized and is therefore unable to function