Protein

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Proteins: large complex molecules composed of amino acids

- Contain carbon, hydrogen, oxygen, nitrogen
- Primary source of nitrogen in our diets
- 20 different amino acids are used to make proteins
Amino acids have the same skeletal backbone consisting of an alpha carbon, an amine group, and an acid group. It is the side group (R) that distinguishes one amino acid from another.
Amino Acids

Essential amino acids
- Cannot be produced by our bodies
- Must be obtained from food

Nonessential amino acids
- Can be made by our bodies
How Proteins Differ From Starch

Starch is composed solely of glucose units whereas a protein is composed of multiple amino acids connected together.
How Are Proteins Made?

Proteins are long chains of amino acids

Amino acids are joined to each other by *peptide bonds*

The structure of each protein is dictated by the DNA of a gene
How Are Proteins Made?

*Transcription*: messenger RNA copies the genetic information from DNA

*Translation*: the genetic information in RNA is converted into the amino acids sequence of a protein
Quaternary Structure - Hemoglobin
Protein Denaturation

Proteins uncoil and lose their shape
Caused by heat, acid, base, metals, alcohol
Protein function is lost
- Protein is denatured during digestion
- Denatured enzyme cannot do its job
- May occur during high fever or when blood pH out of normal range
Proteins in the Diet

For protein synthesis, all essential amino acids must be available.

*Limiting amino acid:*

- Essential amino acid that is missing or in the smallest supply
- Slows down or halts protein synthesis
Proteins in the Diet

*Incomplete protein*: does not contain all essential amino acids
  ♦ Not sufficient for growth and health
  ♦ Considered a “low quality” protein

*Complete protein*: contains sufficient amounts of all 9 essential amino acids
  ♦ Derived from animal and soy protein
  ♦ Considered a “high quality” protein
### Complementary Proteins

<table>
<thead>
<tr>
<th></th>
<th>Isoleucine</th>
<th>Lysine</th>
<th>Methionine</th>
<th>Tryptophan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Grains</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Together</strong></td>
<td></td>
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Legumes lack methionine and tryptophan whereas grains lack isoleucine and lysine. Combining these two foods together make a complete protein, thus legumes and grains are “complementary proteins”.
Amino acids are transported via the portal vein to the liver to be

- Converted to glucose or fat
- Build new protein
- Used for energy
- Released into the blood to other cells
Protein Quality

Reference protein – a standard against which to measure the quality of other proteins. Ex: egg protein

Methods to estimate protein quality
- Chemical score
- Protein digestibility
- Protein efficiency ration
- Biological value
Functions of Proteins

- Cell growth, repair, maintenance
- Enzymes and hormones
- Fluid and electrolyte balance
- pH balance
- Antibodies to protect against disease
- Energy source
- Nutrient transport and storage
How Much Protein Should We Eat?

Nitrogen balance determines protein needs

*Positive* nitrogen balance: a person consumes more nitrogen than is excreted
  ♦ Nitrogen retention occurs during periods of growth, pregnancy, recovery from illness

*Negative* nitrogen balance: a person excretes more than is consumed
  ♦ Protein is lost during starvation, severe illness
Proper protein intake depends on
- Activity level
- Age
- Health status

Example: a sedentary adult requires 0.8 grams protein per kg of body weight
# Recommended Protein Intakes

<table>
<thead>
<tr>
<th>Group</th>
<th>Protein Intake (grams per kilogram* body weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most adults¹</td>
<td>0.8</td>
</tr>
<tr>
<td>Nonvegetarian endurance athletes²</td>
<td>1.2 to 1.4</td>
</tr>
<tr>
<td>Nonvegetarian strength athletes²</td>
<td>1.6 to 1.7</td>
</tr>
<tr>
<td>Vegetarian endurance athletes²</td>
<td>1.3 to 1.5</td>
</tr>
<tr>
<td>Vegetarian strength athletes²</td>
<td>1.7 to 1.8</td>
</tr>
</tbody>
</table>

*To convert body weight to kilograms, divide weight in pounds by 2.2.
Weight (lb)/2.2 = Weight (kg)

Weight (kg) x protein recommendation (g/kg body weight per day) = protein intake (g/day)

**Sources:**
Too Much Protein Can Be Harmful

High cholesterol and heart disease
- Diets high in protein from animal sources are associated with high cholesterol

Possible bone loss
- High protein diets MAY cause excess calcium excretion leading to bone loss
Too Much Protein Can Be Harmful

Kidney disease

- High protein diets are associated with an increased risk of kidney disease
- Especially for people who may be susceptible to kidney disease
Good Protein Sources

- Meats
- Dairy products
- Soy products
- Legumes
- Whole grains
- Nuts
Vegetarian Diets

*Vegetarianism*: restricting the diet to foods of plant origin

There are many versions of vegetarianism

There are many reasons to adopt a vegetarian diet
Types of Vegetarians

• Semi-vegetarian – some animal products included in diet such as poultry and fish
• Lactovegetarian – will consume milk products in the diet
• Ovo-vegetarian – will consume eggs in the diet
• Lacto-Ovo vegetarian – will consume milk and eggs in the diet
• Strict Vegetarian (vegan) – no animal sources consumed, only foods of plant origin
Why Vegetarianism?

People chose vegetarianism for:
- Health benefits
- Ecological reasons
- Religious reasons
- Ethical reasons
- Concerns over food safety
Health Benefits of Vegetarianism

- Lower intake of fat and total energy
- Lower blood pressure
- Reduce the risk of heart disease
- Fewer digestive problems
- Reduce the risk of some cancer
- Reduce the risk of kidney disease, kidney stones, and gallstones
Challenges of Vegetarianism

Vegetarian diets can be low in some nutrients

Vegetarians must plan a varied and adequate diet

Vegetarians may use soy products as a protein source
Challenges of Vegetarianism

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Functions</th>
<th>Nonmeat/Nondairy Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B₁₂</td>
<td>Assists with DNA synthesis; protection and growth of nerve fibers</td>
<td>Vitamin B₁₂ fortified cereals, yeast, soy products, and other meat analogues; vitamin B₁₂ supplements</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Promotes bone growth</td>
<td>Vitamin D fortified cereals, margarines, and soy products; adequate exposure to sunlight; supplementation may be necessary for those who do not get adequate exposure to sunlight</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>Promotes release of energy; supports normal vision and skin health</td>
<td>Whole and enriched grains, green leafy vegetables, mushrooms, beans, nuts, and seeds</td>
</tr>
<tr>
<td>(vitamin B₂)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>Assists with oxygen transport; involved in making amino acids and hormones</td>
<td>Whole-grain products, prune juice, dried fruits, beans, nuts, seeds, leafy vegetables such as spinach</td>
</tr>
<tr>
<td>Calcium</td>
<td>Maintains bone health; assists with muscle contraction, blood pressure, and nerve transmission</td>
<td>Fortified soy milk and tofu, almonds, dry beans, leafy vegetables, calcium-fortified juices, fortified breakfast cereals</td>
</tr>
<tr>
<td>Zinc</td>
<td>Assists with DNA and RNA synthesis, immune function, and growth</td>
<td>Whole-grain products, wheat germ, beans, nuts, and seeds</td>
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</tbody>
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Challenges of Vegetarianism

Vegetarians should include complementary proteins

Vegetarians may use a Vegetarian Food Guide Pyramid to design their diet
Vegetarian Food Guide Pyramid

- Daily Beverage Recommendations:
  - 6 Glasses of Water
  - Alcohol in Moderation

- Weekly
  - Eggs & Sweets
  - Egg Whites, Soy Milk & Dairy

- Daily
  - Nuts & Seeds
  - Plant Oils
  - Whole Grains

- At Every Meal
  - Fruits & Vegetables
  - Legumes & Beans

- Daily Physical Activity

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