Protein

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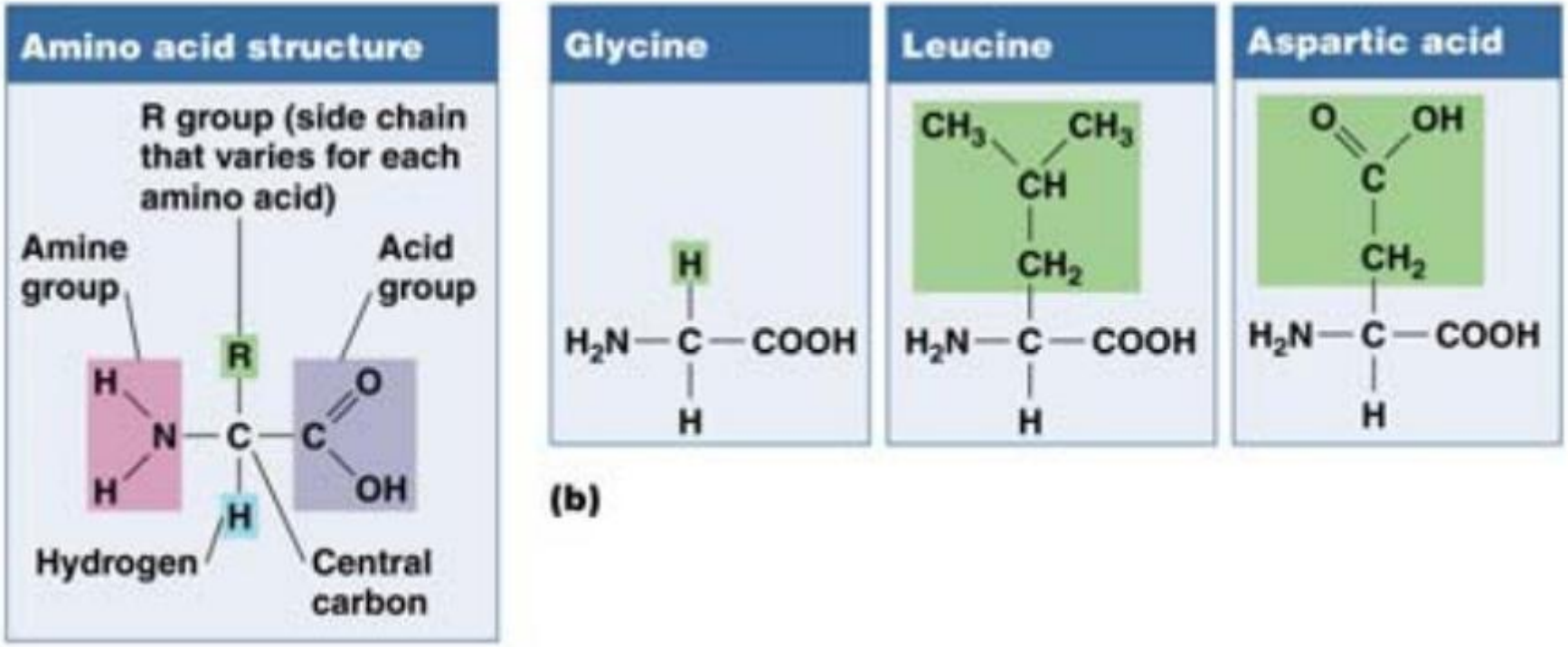
What Are Proteins?

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

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

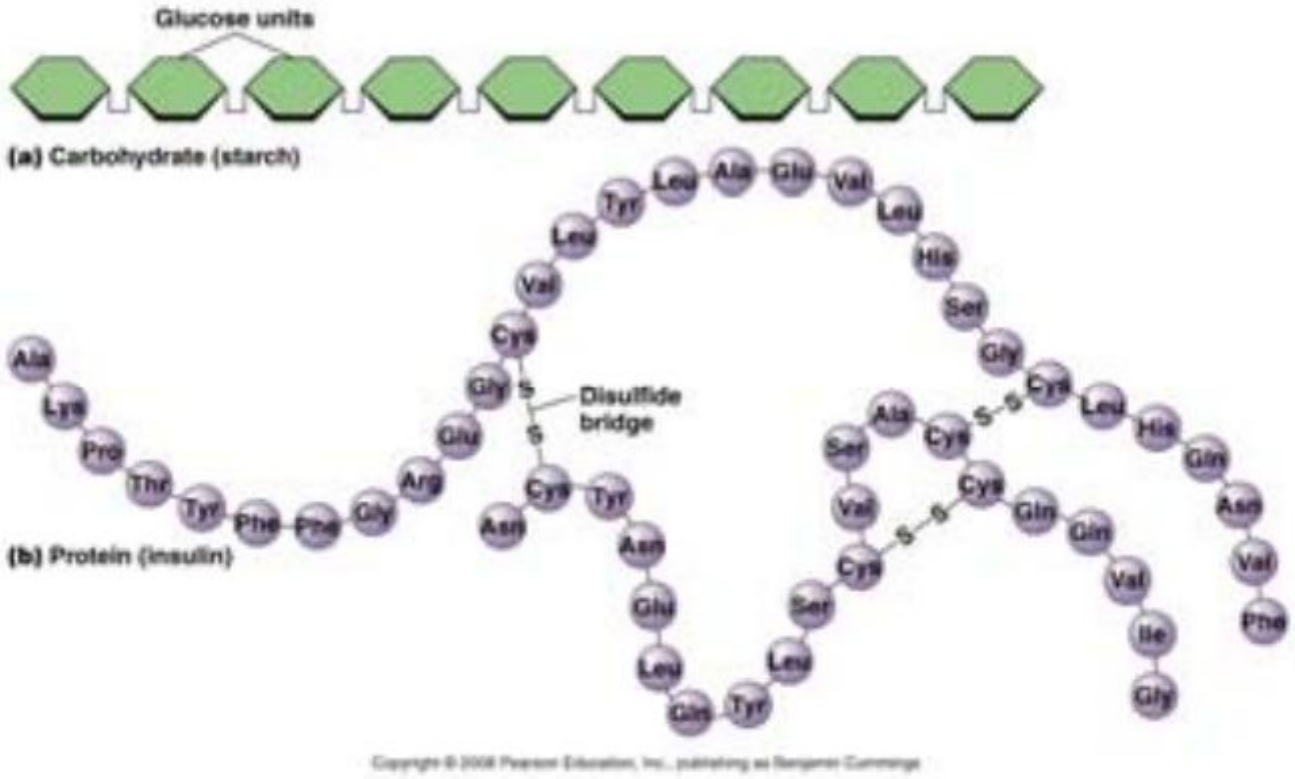
- Cannot be produced by our bodies
- Must be obtained from food

Nonessential amino acids

- Can be made by our bodies

How Proteins Differ From Starch

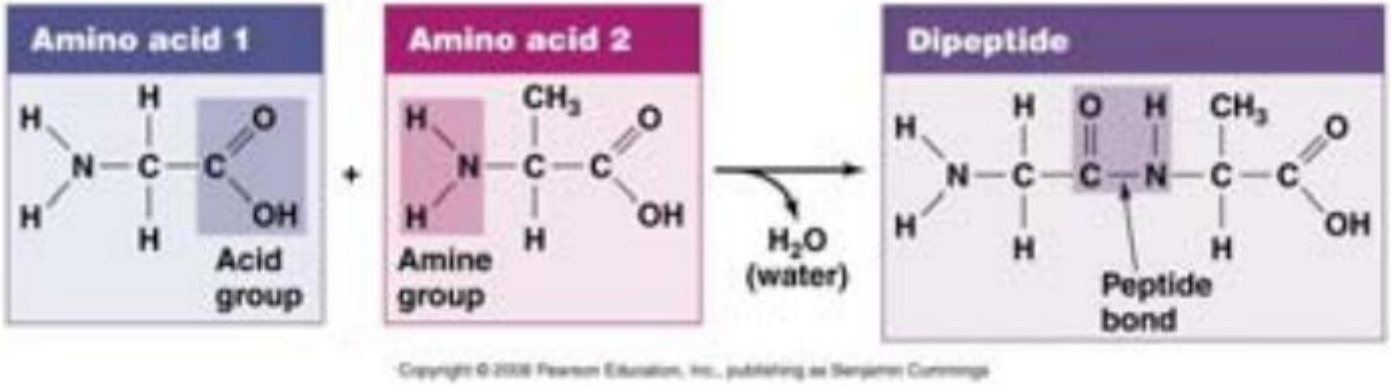
Starch is composed solely of glucose units whereas a protein is composed of multiple amino acids connected together.



How Are Proteins Made?

Proteins are long chains of amino acids

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



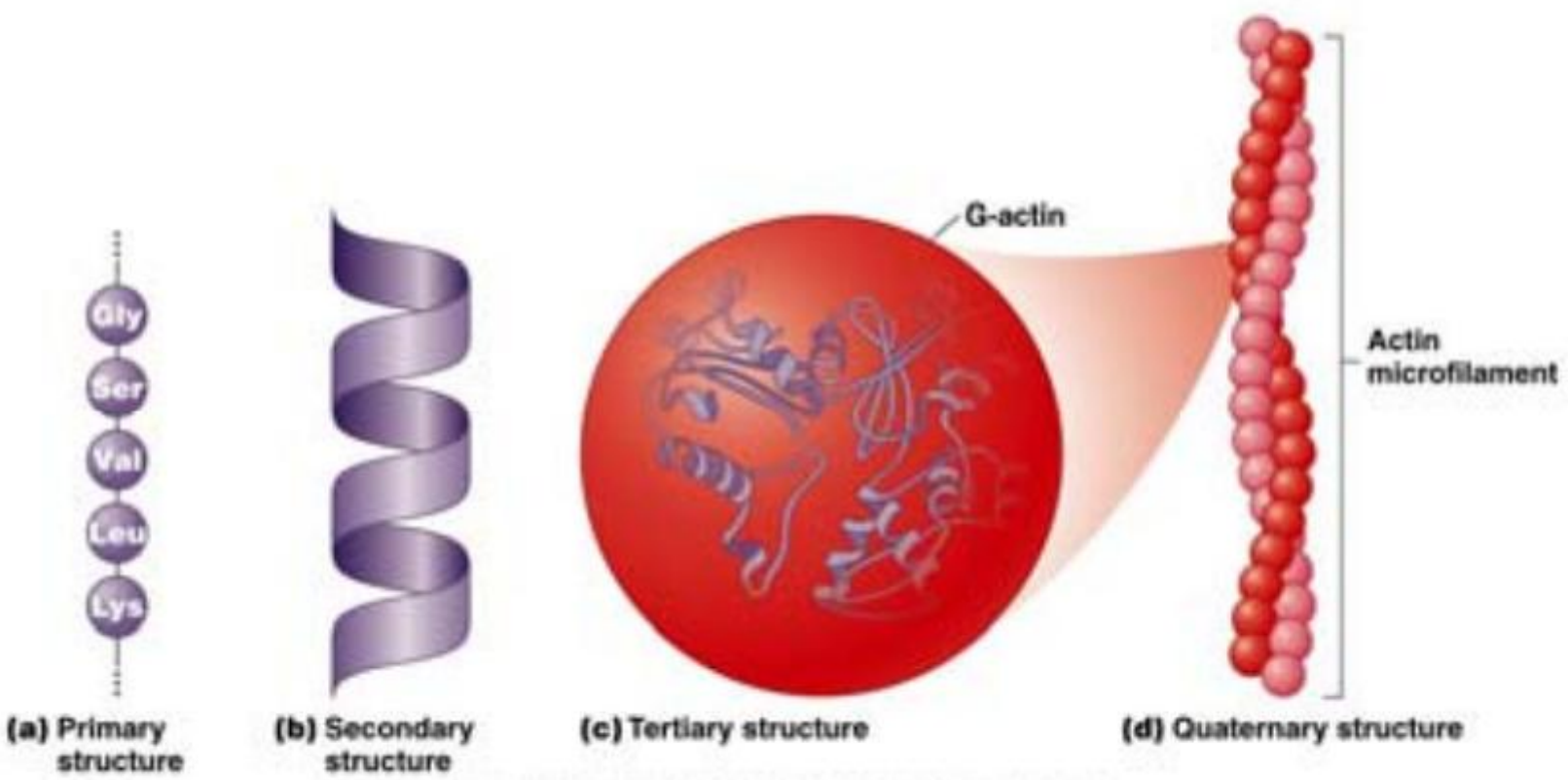
The structure of each protein is dictated by the DNA of a gene

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

Protein Organization



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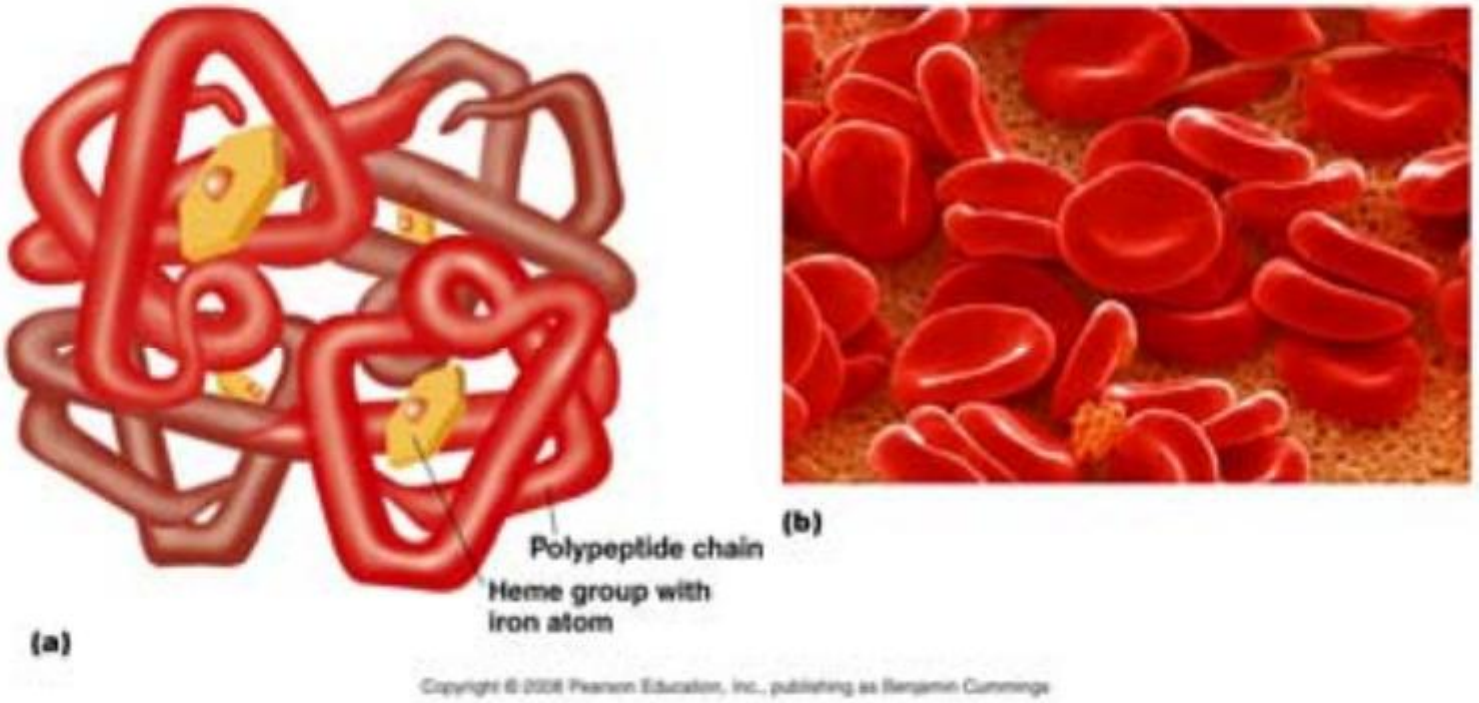
Quaternary Structure - Hemoglobin



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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

	Isoleucine	Lysine	Methionine	Tryptophan
Legumes	■	■		
Grains			■	■
Together	■	■	■	■

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 Acid Transport

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

How Much Protein Should We Eat?

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 6.3 Recommended Protein Intakes

Group	Protein Intake (grams per kilogram* body weight)
Most adults[1]	0.8
Nonvegetarian endurance athletes[2]	1.2 to 1.4
Nonvegetarian strength athletes[2]	1.6 to 1.7
Vegetarian endurance athletes[2]	1.3 to 1.5
Vegetarian strength athletes[2]	1.7 to 1.8

*To convert body weight to kilograms, divide weight in pounds by 2.2.
Weight (lb)/2.2 = Weight (kg)
Weight (kg) × protein recommendation (g/kg body weight per day) = protein intake (g/day)

Sources: [1]Food and Nutrition Board, Institute of Medicine. 2002. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients). Washington, DC: National Academies Press, pp. 465–608. Reprinted by permission.
[2]American College of Sports Medicine, American Dietetic Association, and Dietitians of Canada. 2001. Joint Position Statement. Nutrition and athletic performance. *Med. Sci. Sports Exerc.* 32: 2130–2145.

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 6.7 Nutrients of Concern in a Vegan Diet

Nutrient	Functions	Nonmeat/Nondairy Food Sources
Vitamin B_{12}	Assists with DNA synthesis; protection and growth of nerve fibers	Vitamin B_{12} fortified cereals, yeast, soy products, and other meat analogues; vitamin B_{12} supplements
Vitamin D	Promotes bone growth	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
Riboflavin (vitamin B_2)	Promotes release of energy; supports normal vision and skin health	Whole and enriched grains, green leafy vegetables, mushrooms, beans, nuts, and seeds
Iron	Assists with oxygen transport; involved in making amino acids and hormones	Whole-grain products, prune juice, dried fruits, beans, nuts, seeds, leafy vegetables such as spinach
Calcium	Maintains bone health; assists with muscle contraction, blood pressure, and nerve transmission	Fortified soy milk and tofu, almonds, dry beans, leafy vegetables, calcium-fortified juices, fortified breakfast cereals
Zinc	Assists with DNA and RNA synthesis, immune function, and growth	Whole-grain products, wheat germ, beans, nuts, and seeds

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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