Chapter 6

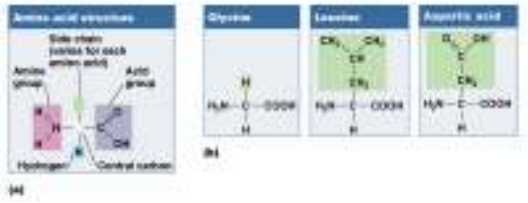
Protein: Amino Acids

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

Essential amino acids

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

Nonessential amino acids

- Can be made by our bodies

Amino Acids

Essential Amino Acids	Nonessential Amino Acids
These amino acids must be consumed in the diet.	*These amino acids can be manufactured by the body.*
Histidine	Alanine
Isoleucine	Arginine
Leucine	Asparagine
Lysine	Aspartic acid
Methionine	Cysteine
Phenylalanine	Glutamic acid
Threonine	Glutamine
Tryptophan	Glycine
Valine	Proline
	Serine
	Tyrosine

How Are Proteins Made?

Proteins are long chains of amino acids.

Amino acids are joined to each other by peptide bonds.

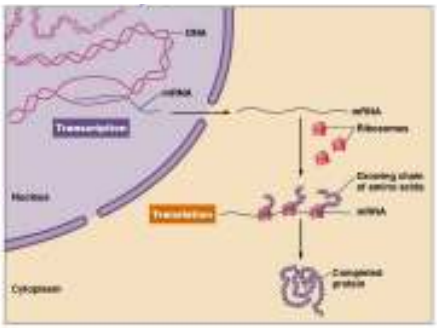
The structure of each protein is dictated by the DNA of a gene.

How Are Proteins Made?

Transcription: use of the genetic information in DNA to make RNA.

Translation: conversion of genetic information in RNA to the amino acids sequence of a protein.

How Are Proteins Made?



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.

- Considered a "high quality" protein

Proteins in the Diet

Mutual supplementation: using two incomplete proteins together to make a complete protein.

Complementary proteins: two protein sources that together supply all 9 essential amino acids.

- Example: beans and rice

Complementary Food Combinations

Food	Limiting Amino Acid	Foods High in Limiting Amino Acid	Complementary Food Combination
Legumes	Methionine and cysteine	Grains, nuts, and seeds	Rice and lentils Red beans and rice Rice and black-eyed peas Hummus (garbanzo beans and sesame seeds)
Grains	Lysine	Legumes	Peanut butter and bread Barley and lentil soup Corn tortilla and beans
Vegetables	Lysine, methionine, cysteine	Legumes (lysine) grains, nuts, and seeds (methionine and cysteine)	Tofu and broccoli with almonds Spinach salad with pine nuts and kidney beans

Digestion of Proteins

Digestion of proteins begins in the stomach.

- Hydrochloric acid breaks down protein structure
- Hydrochloric acid activates pepsin

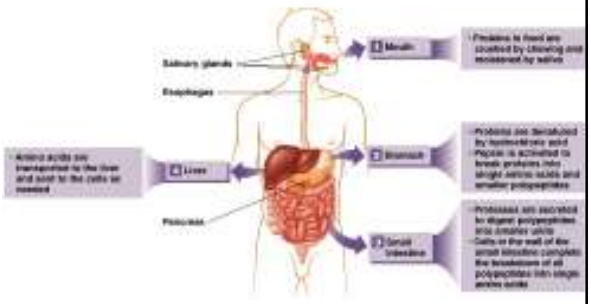
Pepsin: an enzyme that breaks down proteins into short polypeptides and amino acids.

Digestion of Proteins

Digestion of proteins continues in the small intestines.

- Pancreatic enzymes called proteases complete the digestion of proteins into single amino acids
- Indigestible proteins are of lower quality for nutrition

Digestion of Proteins



Functions of Proteins

- Cell growth, repair, and maintenance
- Enzymes
- Hormones
- Fluid and electrolyte balance
- pH balance
- Antibodies to protect against disease
- Energy source

How Much Protein Should We Eat?

Proper protein intake depends on

- Activity level
- Age
- Health status

Example: each day, a sedentary adult requires 0.8 grams protein per kg of body weight.

How Much Protein Should We Eat?

People who require more protein include

- Children
- Adolescents
- Pregnant or lactating women
- Athletes
- Vegetarians

How Much Protein Should We Eat?

Recommended Dietary Allowance (RDA)

- 0.8 grams protein per kg body weight
- 10-35% of total energy intake should be from protein
- Assumptions
  - People are healthy.
  - Protein is mixed quality.
  - The body will use protein efficiently.

How Much Protein Should We Eat?

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

Sources: Food and Nutrition Board, Institute of Medicine, Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients), (Washington, DC: National Academies Press, 2002), 365–408.
[1] American College of Sports Medicine, American Dietetic Association, and Dietitians of Canada, Joint Position Statement: Nutrition and athletic performance. Med. Sci. Sports Exerc. 32 (2000): 2130–45.
* To convert body weight to kilograms, divide weight in pounds by 2.2.
Weight (pounds)/2.2 = Weight (kilograms)
Weight (kilograms) × protein recommendation (grams/kilogram body weight/day) = protein intake (grams/day)

Health Effects and Recommended Intakes of Protein

Protein deficiency and excesses can be harmful to health.

Protein deficiencies arise from protein-deficient diets and energy-deficient diets.

This is a worldwide malnutrition problem, especially for young children.

High-protein diets have been implicated in several chronic diseases.

Health Effects and Recommended Intakes of Protein

Protein-Energy Malnutrition (PEM) – also called protein-kcalorie malnutrition (PCM)

- Classifying PEM
  - Chronic PEM and acute PEM
  - Maramus, kwashiorkor, or a combination of the two

Health Effects and Recommended Intakes of Protein

PEM

- Marasmus
  - Infancy, 6 to 18 months of age
  - Severe deprivation or impaired absorption of protein, energy, vitamins and minerals
  - Develops slowly
  - Severe weight loss and muscle wasting, including the heart
  - < 60% weight-for-age
  - Anxiety and apathy
  - Good appetite is possible
  - Hair and skin problems

Health Effects and Recommended Intakes of Protein

PEM

- Kwashiorkor
  - Older infants and young children, 18 months to 2 years of age
  - Inadequate protein intake, infections
  - Rapid onset
  - Some muscle wasting, some fat retention
  - Growth is 60-80% weight-for-age
  - Edema and fatty liver
  - Apathy, misery, irritability and sadness
  - Loss of appetite
  - Hair and skin problems

Health Effects and Recommended Intakes of Protein

PEM

- Marasmus-Kwashiorkor Mix
  - Both malnutrition and infections
  - Edema of kwashiorkor
  - Wasting of marasmus

Health Effects and Recommended Intakes of Protein

PEM

- Infections
  - Lack of antibodies to fight infections
  - Fever
  - Fluid imbalances and dysentery
  - Anemia
  - Heart failure and possible death
- Rehabilitation
  - Nutrition intervention must be cautious, slowly increasing protein.
  - Programs involving local people work better.

Health Effects and Recommended Intakes of Protein

Health Effects of Protein

- Heart Disease
  - Foods high in animal protein also tend to be high in saturated fat.
  - Homocysteine levels increase cardiac risks.
  - Arginine may protect against cardiac risks.

Health Effects and Recommended Intakes of Protein

Health Effects of Protein

- Cancer
  - A high intake of animal protein is associated with some cancers.
  - Is the problem high protein intake or high fat intake?
- Adult Bone Loss (Osteoporosis)
  - High protein intake associated with increased calcium excretion.
  - Inadequate protein intake affects bone health also.

Health Effects and Recommended Intakes of Protein

Health Effects of Protein

- Weight Control
  - High-protein foods are often high-fat foods.
  - Protein at each meal provides satiety.
  - Adequate protein, moderate fat and sufficient carbohydrate better support weight loss.
- Kidney Disease
  - High protein intake increases the work of the kidneys.
  - Does not seem to cause kidney disease

Good Sources of Protein

Good low- or nonfat sources of protein include:

Beef, poultry, pork and lamb

Fish and shellfish

Dairy products, including cottage cheese, cheese, yogurt and milk

Eggs, egg whites or egg substitutes

Dry beans, peas, oats and legumes

Tofu and soy products

Nuts and seeds

Can You Eat Too Much Protein?

The risks of too much protein may include

- 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

Can You Eat Too Much Protein?

The risks of too much protein may include

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

Health Effects and Recommended Intakes of Protein

Protein and Amino Acid Supplements

- Many reasons for supplements
- Protein Powders have not been found to improve athletic performance.
  - Whey protein is a waste product of cheese manufacturing.
  - Purified protein preparations increase the work of the kidneys.

Health Effects and Recommended Intakes of Protein

Protein and Amino Acid Supplements

- Amino Acid Supplements are not beneficial and can be harmful.
  - Branched-chain amino acids provide little fuel and can be toxic to the brain.
  - Lysine appears safe in certain doses.
  - Tryptophan has been used experimentally for sleep and pain, but may result in a rare blood disorder.

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.

Vegetarian Diets

Why Vegetarianism?

People chose vegetarianism for

- Health benefits
- Ecological reasons
- Religious reasons
- Ethical reasons
- Concerns over food safety

Famous Vegetarians

Orlando Bloom
Charles Darwin
Susan B. Anthony
Benjamin Franklin
Jane Goodall
Isaac Netwon
Mahatma Ghandi

Thomas Edison
Steve Jobs (Apple)
Olivia Newton-John
Eddie Veder
Shania Twain
Cameron Diaz
Carl Lewis (Olympic gold metalist)

Health Benefits of Vegetarianism

- Lower intake of fat and total energy
- Lower blood pressure
- Reduce the risk of heart disease
- Reduce the risk of some types of cancer
- Fewer digestive problems

Challenges of Vegetarianism

Vegetarian diets can be low in some vitamins and minerals.

Vegetarians must plan a balanced and adequate diet.

Vegetarians should include complementary proteins.

Vegetarians should use a Vegetarian Food Guide Pyramid to design their diet.

Vegetarians and Protein

Vegetarians can consume adequate amounts of protein.

- Vegetarians who eat dairy products and eggs can still choose from a variety of plant and animal protein sources.
- Vegans who eat only plant sources of food can still rely on tofu, soy products, oats, beans, lentils and peanut butter for protein.

Protein – Energy Malnutrition

Protein-energy malnutrition: a disorder caused by inadequate intake of protein and energy.

There are two common forms:

- Marasmus
- Kwashiorkor

Protein – Energy Malnutrition

Marasmus: disease resulting from severely inadequate intakes of protein, energy, and other nutrients.

Marasmus symptoms include

- Severe wasting of muscle tissue
- Stunted physical growth
- Stunted brain development
- Anemia

Protein – Energy Malnutrition

Kwashiorkor: disease resulting from extremely low protein intake.

Kwashiorkor symptoms include

- Some weight loss and muscle wasting
- Edema resulting in distention of the belly
- Retarded growth and development

Kwashiorkor is often seen in children in developing countries.

Genetic Diseases

Some genetic diseases can result in protein abnormalities.

The genetic diseases include

- Phenylketonuria
- Sickle cell anemia
- Cystic fibrosis