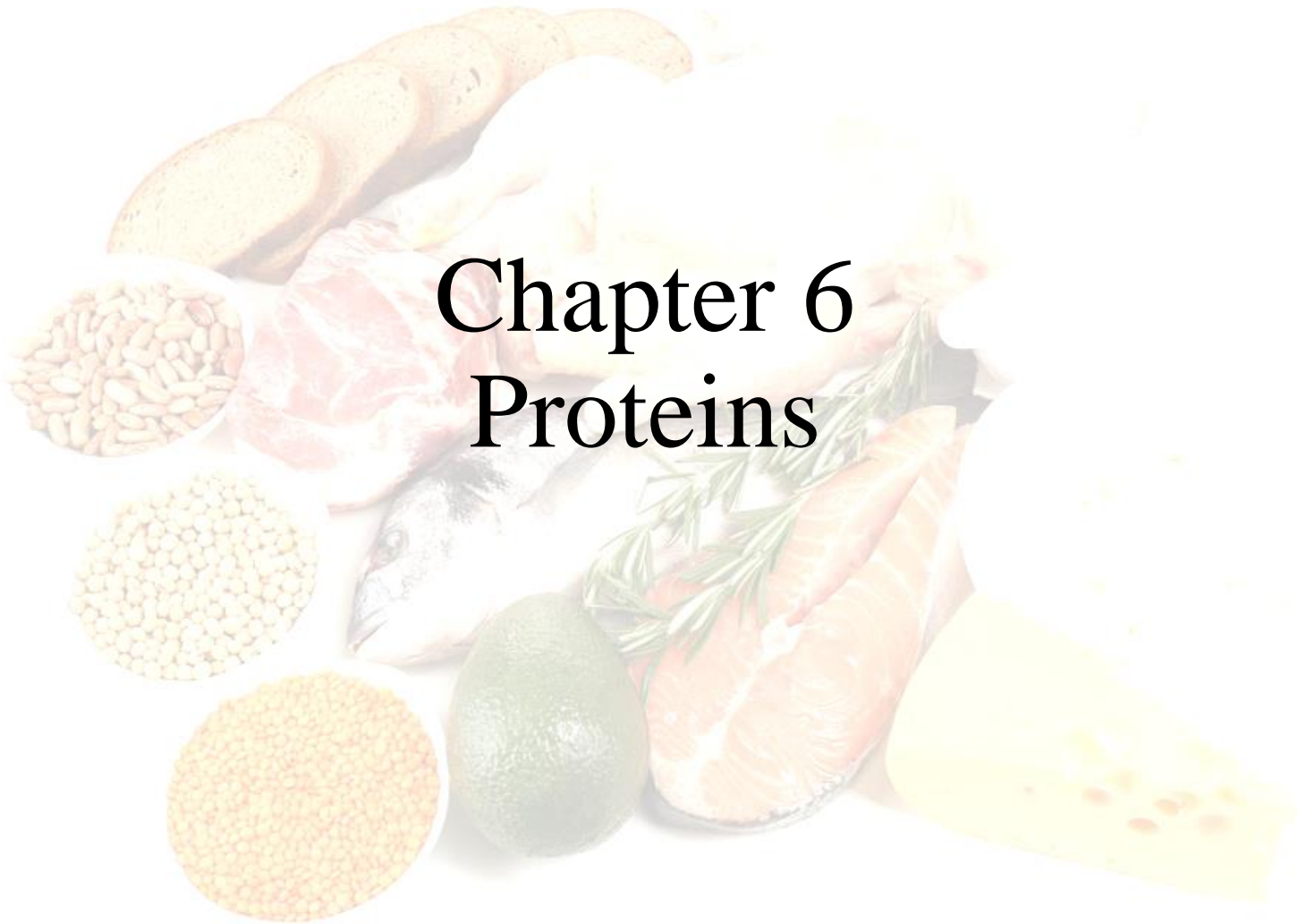


# Chapter 6

## Proteins



# What Are Proteins?

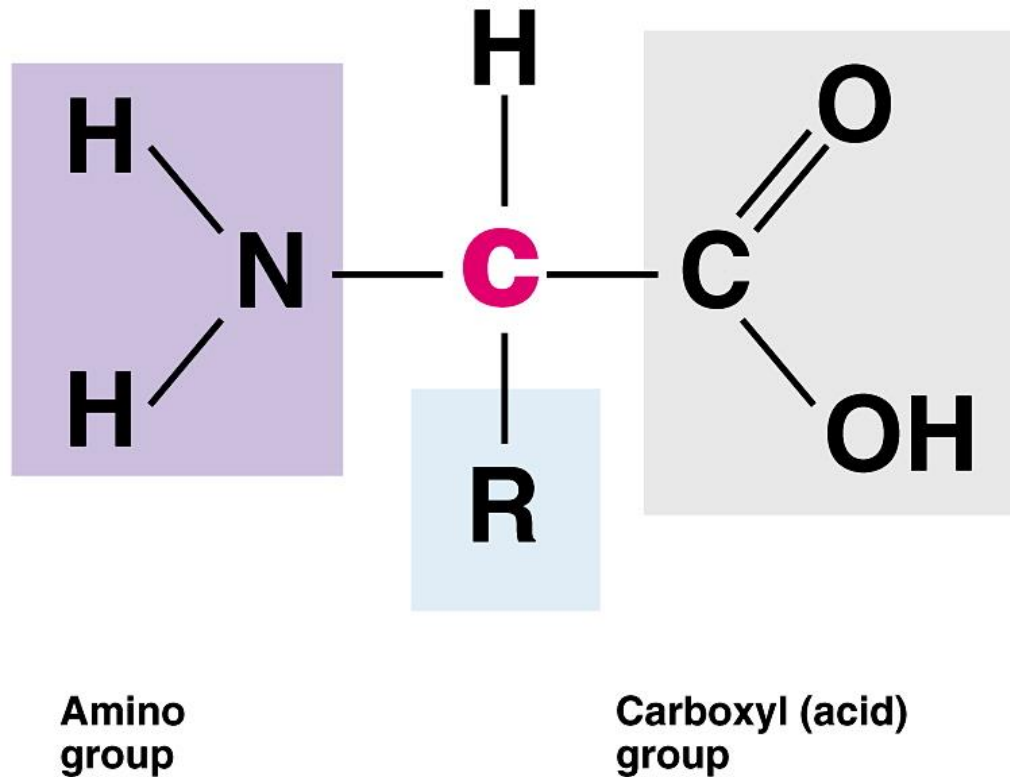
- Proteins are large, complex molecules composed of amino acids found in the cells of all living things
  - Critical components of all the tissues of the human body
  - Function in metabolism, immunity, fluid balance, and nutrient transport
  - In certain circumstances, provide energy
  - Contain a special form of nitrogen our bodies can readily use



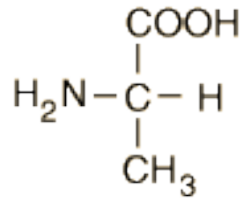
# Amino Acids

- Amino acids are the nitrogen-containing molecules that combine to form proteins.
- There are **20 amino acids** in the body.
- **Essential amino acids**
  - Cannot be produced by our bodies
  - Must be obtained from food
  - 9 of 20 amino acids in our bodies are essential
- **Nonessential amino acids**
  - Can be made by our bodies

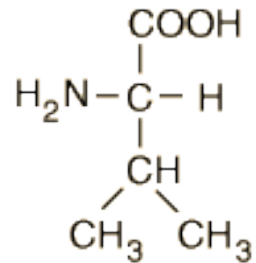
# Structure of an Amino Acid



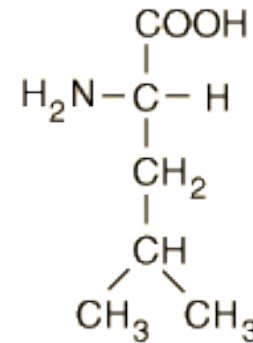
# Examples of some Amino Acids



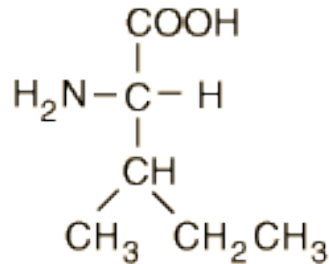
Alanine (ala)



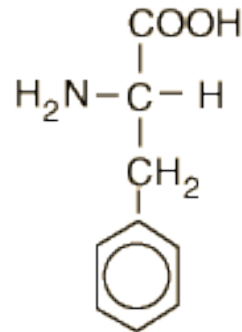
Valine (val)\*



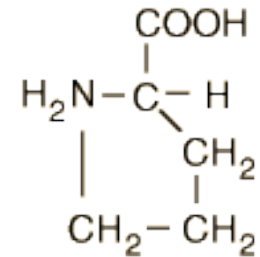
Leucine (leu)\*



Isoleucine (ile)\*



Phenylalanine (phe)\*

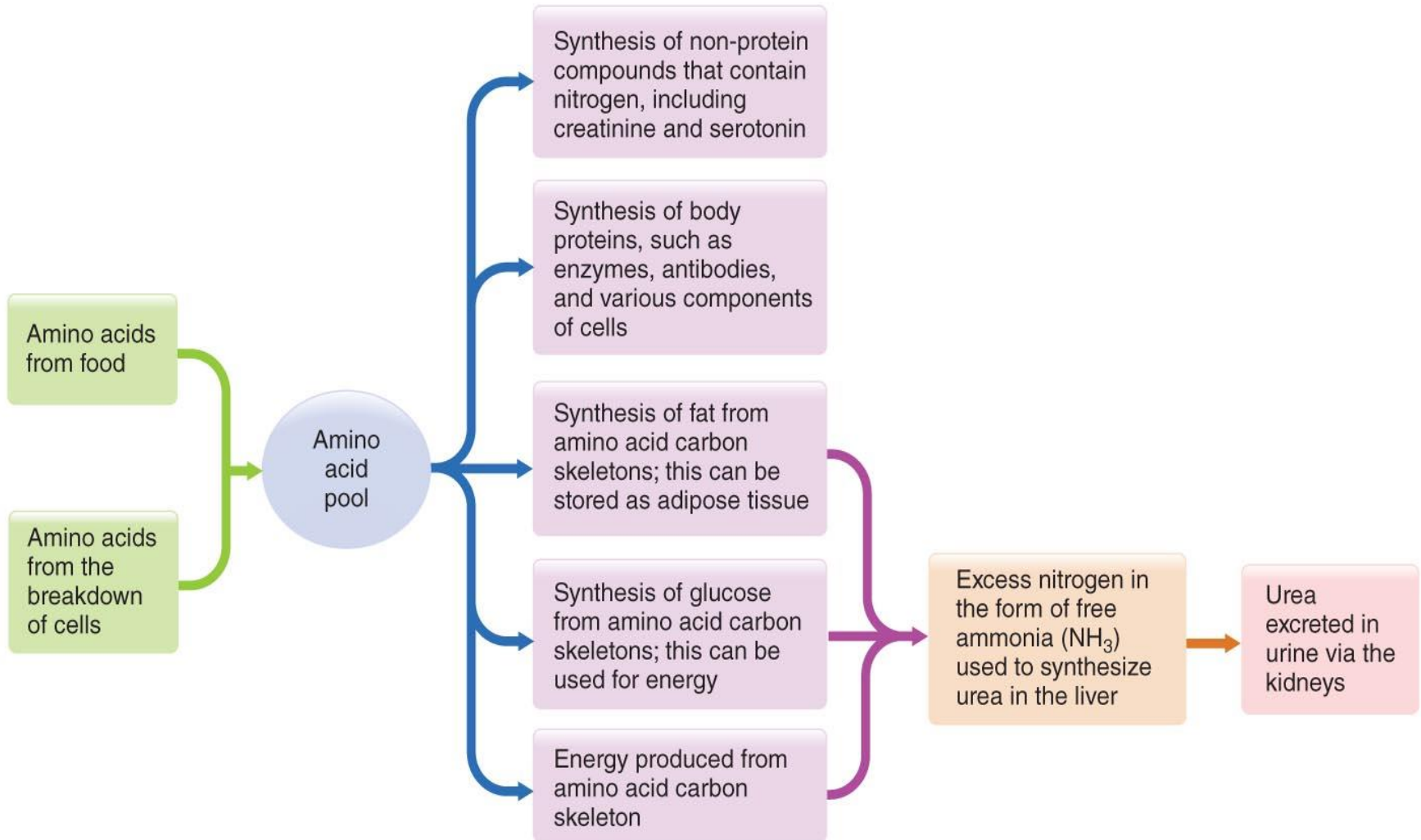


Proline (pro)

# Amino Acids of the Human Body

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

# Synthesis and Breakdown



# Incomplete vs. Complete Proteins

- **Incomplete protein** do not contain all essential amino acids in sufficient quantities
  - Growth and health are compromised
  - Considered a "low-quality" protein
  - Examples include nuts, seeds, rice, beans, grains
- **Complete protein** contain sufficient amounts of all nine essential amino acids
  - Considered a "high-quality" protein
  - Examples include egg whites, meat, poultry, fish, milk, soybeans, quinoa







# Protein Synthesis Can Be Enhanced

- **Complementary proteins** are two protein sources that together supply all nine essential amino acids
  - Example: beans + rice



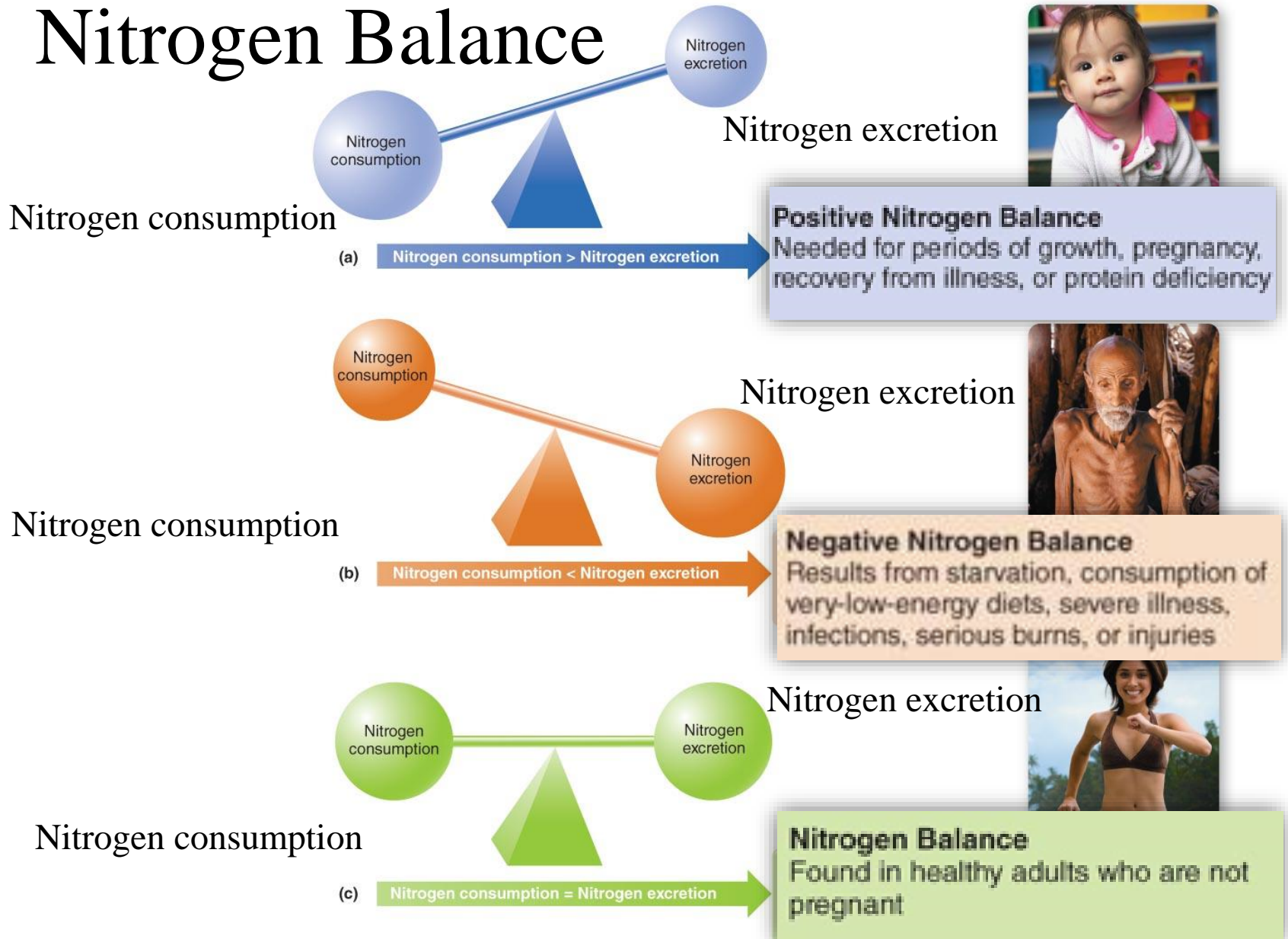
# Combining Complementary Foods

Limiting Amino Acids		Complementary Foods		Complete Protein Combinations
<b>Legumes:</b> limited in methionine and cysteine	+	<b>Grains</b> <b>Nuts and Seeds</b>	=	Red beans and rice Minestrone soup Chickpeas and couscous Hummus (garbanzo beans and sesame seeds) 
<b>Grains:</b> limited in lysine	+	<b>Legumes</b>	=	Peanut butter and bread Barley and lentil soup Corn tortilla and beans 
<b>Vegetables:</b> limited in lysine, methionine, and cysteine	+	<b>Legumes</b> (lysine) <b>Grains</b> (methionine and cysteine) <b>Nuts and Seeds</b> (methionine and cysteine)	=	Tofu and broccoli with almonds Spinach salad with pine nuts and kidney beans 
<b>Nuts and Seeds:</b> limited in lysine and isoleucine	+	<b>Legumes</b>	=	Lentil soup with slivered almonds Sesame seeds with mixed bean salad 

# Why Do We Need Proteins?

- Cell growth, repair, and maintenance
- Enzyme and hormone production
- Fluid and electrolyte balance
- pH balance
- Antibodies to protect against disease
  - Defensive proteins of the immune system
- Energy source
- Transport and storage of nutrients

# Nitrogen Balance



# Too Much Protein Can Be Harmful

The risks of too much dietary protein include

- **High cholesterol** - Diets high in protein from animal sources are associated with high blood cholesterol
- **Kidney disease** - High-protein diets are associated with an increased risk of kidney disease in people who are susceptible

There is no evidence that high-protein diets lead to bone loss, except in people consuming inadequate calcium

# How Much Protein Should We Eat?

- Recommended Dietary Allowance (RDA) for protein is **10–35% of total energy intake**
  - 0.8 grams of protein per kilogram of body weight per day
- Nitrogen balance describes the relationship between how much nitrogen (or protein) we consume and excrete each day.
- Most Americans meet or exceed the RDA for dietary protein
  - This is true for many athletes as well
  - Certain groups of athletes, such as distance runners, figure skaters, female gymnasts, and wrestlers who are dieting, are at risk for low protein intake

# Recommended Protein Intakes

Generally, **vegetarian strength athletes** require the most dietary protein.

Group	Protein Intake (grams per kilogram* body weight)
Sedentary adults <sup>†</sup>	0.8
Nonvegetarian endurance athletes <sup>‡</sup>	1.2 to 1.4
Nonvegetarian strength athletes <sup>‡</sup>	1.2 to 1.7
Vegetarian endurance athletes <sup>‡</sup>	1.3 to 1.5
Vegetarian strength athletes <sup>‡</sup>	1.3 to 1.8

# Protein is Much More Than Meat!

- Some **legume sources of protein** include:
  - Soybeans, kidney beans, pinto beans, black beans, chickpeas, lentils, green peas, and black-eyed peas.
- Various nuts are also a good source of protein. Some research indicates that consuming 2-5 ounces of nuts/week can **reduce** the chances of:
  - Cardiovascular disease
  - Type 2 diabetes



# Protein Content of Common Foods







Food	Serving Amount	Protein (g)	Food	Serving Amount	Protein (g)
<b>Beef:</b>			<b>Beans:</b>		
Ground, lean, baked (15% fat)	3 oz	22	Refried	1/2 cup	6
Beef tenderloin steak, broiled (1/8-in. fat)	3 oz	22.5	Kidney, red	1/2 cup	8
Top sirloin, broiled (1/8-in. fat)	3 oz	23	Black	1/2 cup	7.6
<b>Poultry:</b>			<b>Nuts:</b>		
Chicken breast, broiled, no skin (bone removed)	1/2 breast	27	Peanuts, dry roasted	1 oz	6.7
Chicken thigh, bone and skin removed	1 thigh	28	Peanut butter, creamy	2 tbsp.	8
Turkey breast, roasted, Louis Rich	3 oz	13	Almonds, blanched	1 oz	6
<b>Seafood:</b>			<b>Cereals, Grains, and Breads:</b>		
Cod, cooked	3 oz	19	Oatmeal, quick instant	1 cup	6
Salmon, Chinook, baked	3 oz	22	Cheerios	1 cup	3.4
Shrimp, steamed	3 oz	19	Grape-Nuts	1/2 cup	7.2
Tuna, in water, drained	3 oz	16.5	Raisin Bran	1 cup	4.7
<b>Pork:</b>			Brown rice, cooked	1 cup	5
Pork loin chop, broiled	3 oz	22	Whole-wheat bread	1 slice	3.6
Ham, roasted, extra lean (5% fat)	3 oz	18	Bagel, 3-1/2-in.-diameter	1 each	10.5
<b>Dairy:</b>			<b>Vegetables:</b>		
Whole milk (3.25% fat)	8 fl. oz	7.7	Carrots, raw (7.25 to 8.5 in. long)	1 each	0.7
1% milk	8 fl. oz	8.2	Broccoli, raw, chopped	1 cup	2.6
Skim milk	8 fl. oz	8.3	Collards, cooked from frozen	1 cup	5
Low-fat, plain yogurt	8 fl. oz	13	Spinach, raw	1 cup	0.9
American cheese, processed	1 oz	5			
Cottage cheese, low-fat (2%)	1 cup	27			
<b>Soy Products:</b>					
Tofu, firm	1/2 cup	10			
Tempeh, cooked	3 oz	5.5			
Soy milk beverage	1 cup	8			

# Can Vegetarian Diets Provide Protein?

- **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 Vegetarian Diets

	<i>Plant-based foods</i> 	<i>Red meat</i> 	<i>Poultry</i> 	<i>Fish/Seafoods</i> 	<i>Dairy foods</i> 	<i>Eggs</i> 
<i>Vegan</i>	✓	✗	✗	✗	✗	✗
<i>Lacto-ovo Vegetarian</i>	✓	✗	✗	✗	✓	✓
<i>Ovo Vegetarian</i>	✓	✗	✗	✗	✗	✓
<i>Lacto Vegetarian</i>	✓	✗	✗	✗	✓	✗
<i>Semi Vegetarian</i>	✓	✗	✓	✓	✓	✓

# Health Benefits of Vegetarianism

- Lower intake of fat and total energy
- Lower blood pressure
- Reduced risk for heart disease
- Reduced risk for some types of cancer
- Fewer digestive problems
- Reduced risk for kidney disease

# Do Athletes Need More Protein?

- Simple answer: Yes

**Should athletes get this extra protein through supplements?**

Not necessarily. Most North Americans eat much more protein than what they require (almost twice the Recommended Dietary Allowance).

**A balanced diet is usually sufficient; however, protein supplements can be very convenient and cost effective.**