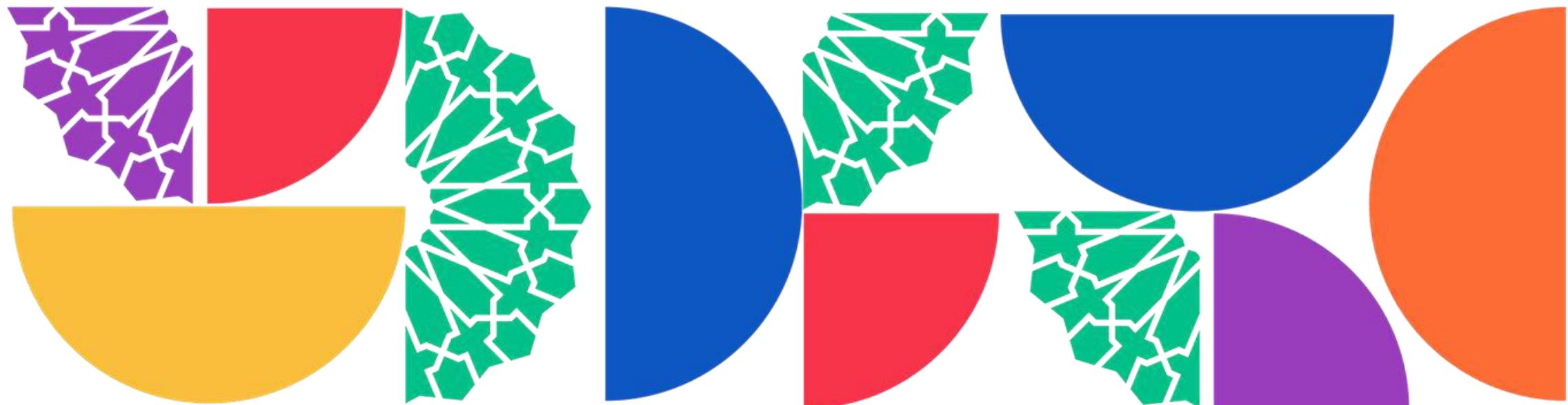


Health Awareness and Nutrition

Department of Clinical Nutrition and Dietetics

College of Health Sciences

Lecture 4: Proteins



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Introduction

- The human body contains an estimated 30,000 different kinds of proteins.
- Proteins are more complex than carbohydrates or fats.
- They are vital cellular working molecules.
- They constitute approximately 20 % of body weight
- **Proteins are available as:**
 - > ***Working proteins*** (enzymes, antibodies, hormones, cellular “pumps”...)
 - > ***Structural proteins*** (cell membranes, tendons, ligaments, muscles, bones, teeth, hair, nails...)

Proteins

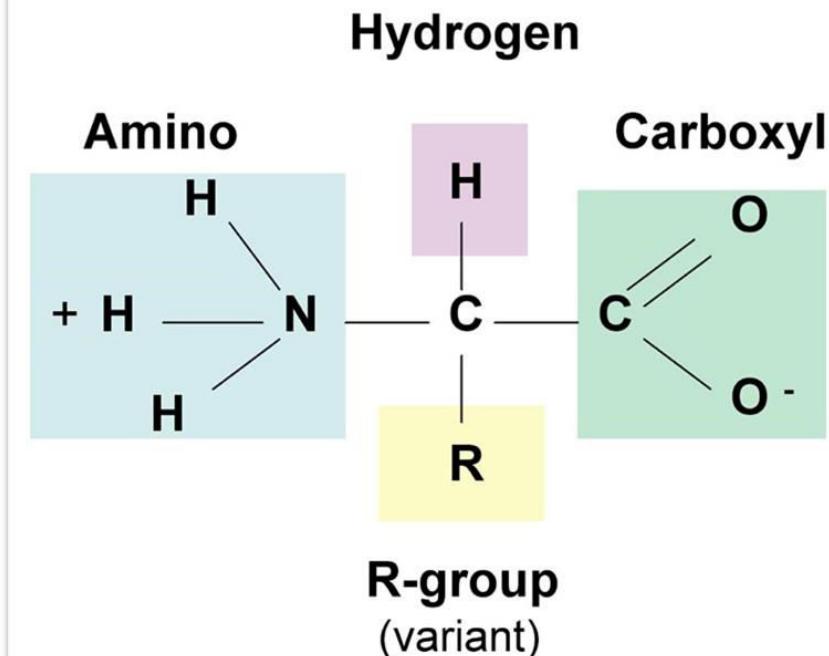
- Proteins contain:
 - > Carbon
 - > Hydrogen
 - > Oxygen
 - > Nitrogen

Arranged into **amino acids** linked in a chain.
- Proteins are **macromolecules**. They are constructed from chains of amino acids (**peptides**)
- Some are much smaller peptides and some much larger (the largest protein found in skeletal and cardiac muscle)

Amino Acids

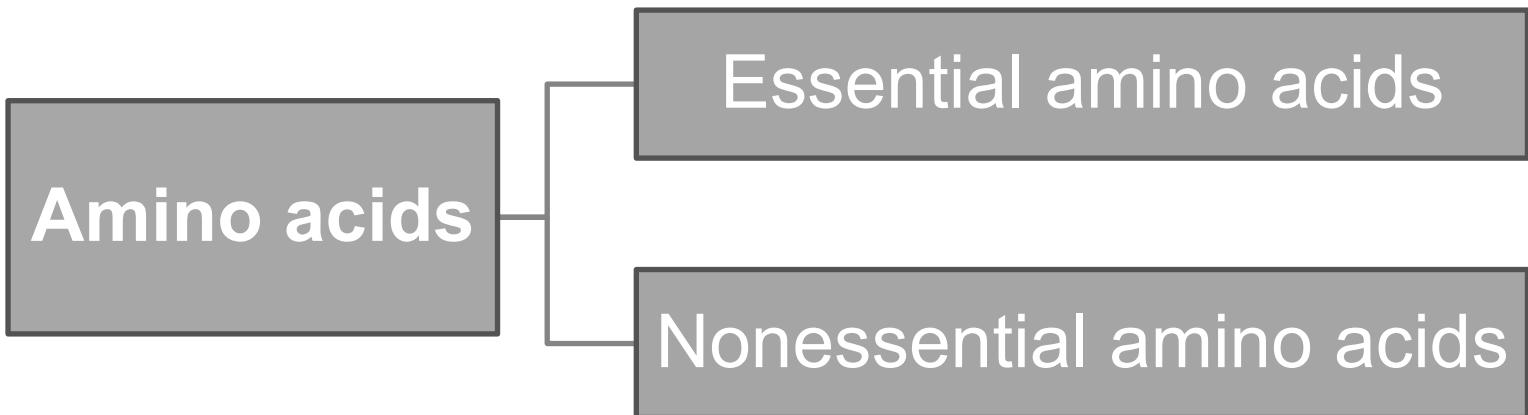
- Amino acids are the building blocks of proteins.
- All amino acids have the same base structure:
 - > an amino group
 - > an acid group
 - > a hydrogen atom,
 - > a special side group
 all attached to a central carbon atom.
- The side groups on amino acids vary from one amino acid to the other
- There are 20 different type of amino acid each has a different side group.

Amino Acid Structure



Amino Acids

- There are 20 different amino acids that occur in nature of which 9 are essential.
- Each amino acid has different characteristics.



Amino Acids

Essential amino acids

1. Histidine
2. Isoleucine
3. Leucine
4. Lysine
5. Methionine
6. Phenylalanine
7. Threonine
8. Tryptophan
9. Valine

Nonessential amino acids

1. Alanine
2. Arginine
3. Asparagine
4. Aspartic acid
5. Cysteine
6. Glutamic acid
7. Glutamine
8. Glycine
9. Proline
10. Serine
11. Tyrosine

Amino Acids

Essential amino acids



- Indispensable
- Cannot be synthesized by the body
- Required to be consumed in diet

Nonessential amino acids

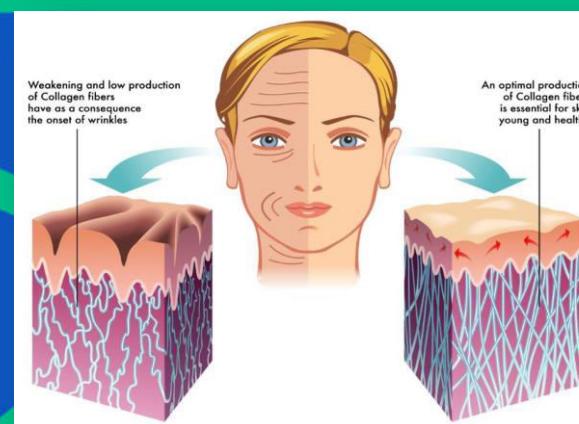
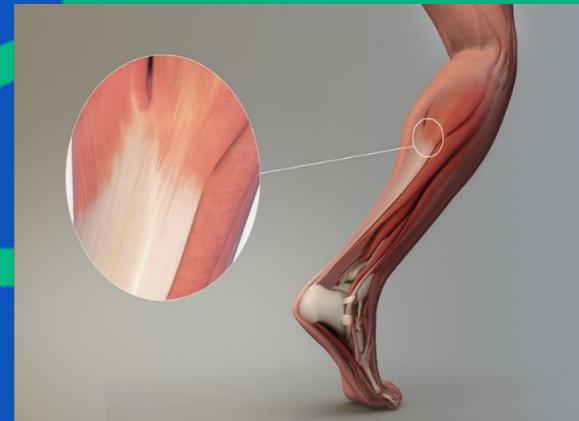


- Dispensable
- Can be formed in the body

Conditional amino acids:

They are non-essential amino acids that become conditionally essential until the metabolic pathways are developed to make those amino acids in adequate quantities (e.g. in times of illness, stress or early childhood).

Functions of protein in the body



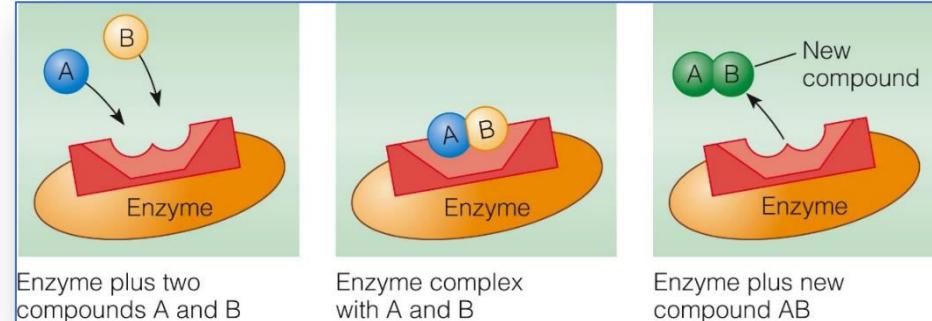
1. Growth and repair material

- Proteins form the building blocks of muscles, blood, and skin.
- Important for teeth and bones, and provides material in scar tissue and blood clots, ligaments and tendons.
- Proteins are needed for replacing dead or damaged cells.

Functions of protein in the body

2. Enzymes

- For the regulation of biochemical reactions.
- Enzymes break down substances, and build substances (such as bone), and transform one substance into another (amino acids into glucose)



3. Hormones

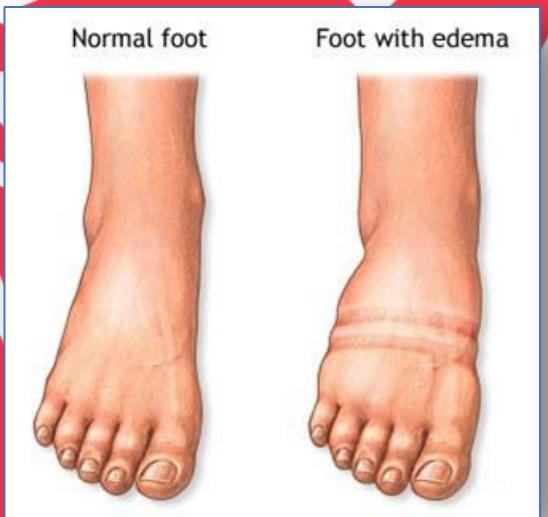
- Messenger molecules.
- Many hormones are proteins such as insulin, glucagon and the thyroid hormone.
- Transported in blood to target tissues.



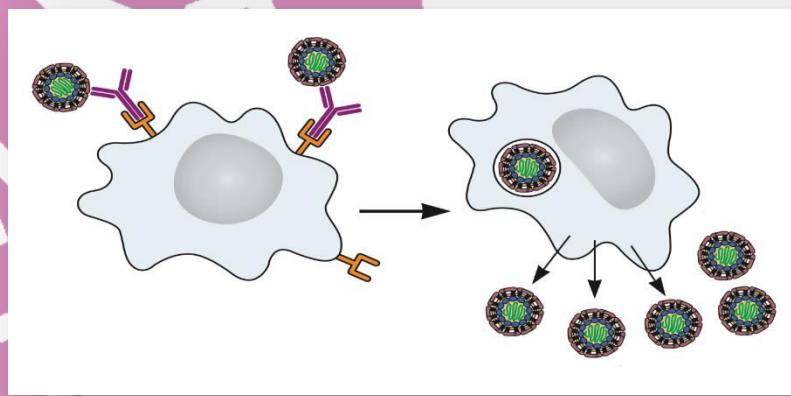
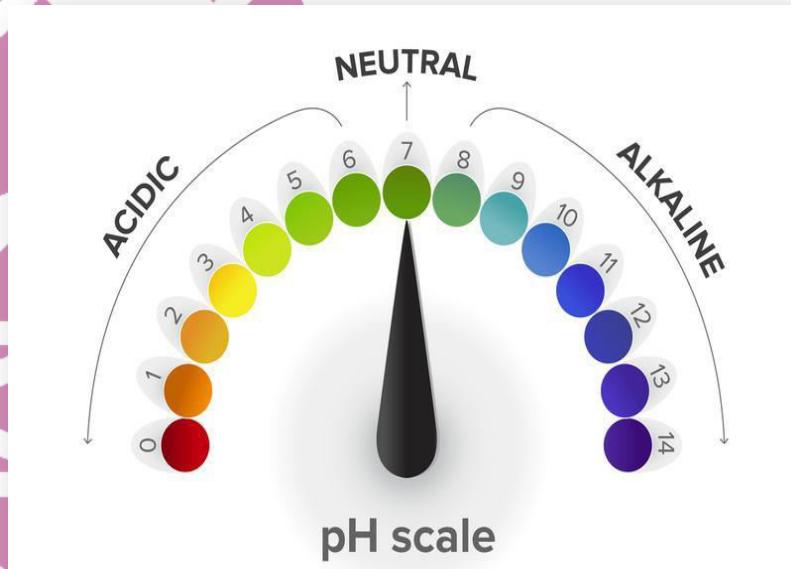
Functions of protein in the body

4. Regulators of fluid balance

- Proteins help maintain body fluid and electrolyte balance in two ways:**
 1. They attract fluids: Proteins in the bloodstream, the cells, and the space surrounding the cells work together to keep both fluids and electrolytes moving across the space.
 2. They move and retain fluids in the proper quantities to help us maintain both fluid balance and blood pressure.
- In protein deficiency,** Edema can be observed (disease condition characterized by swelling of body tissues caused by fluid leakage).



Functions of protein in the body



5. Maintaining acid-base balance

- Blood proteins act as buffers in order to maintain the pH conditions of the blood constant.
- 1. **Acidosis**- excess of acid in the body fluids: protein attract hydrogen
- 2. **Alkalosis**- excess of base (alkali) in the body fluids: protein release hydrogen

6. Antibodies

- Body defense molecules against foreign substances.
- They are proteins produced by the immune system in response to the invasion of the body by foreign molecules.

Functions of protein in the body

7. Source of energy and glucose

- Proteins can be used for energy in case there is insufficient fat and CHO
- > The body will break down its tissue proteins to make amino acids available for energy or glucose production.
- > In this way, protein can maintain blood glucose levels, but at the expense of losing lean body tissue.

1 g of protein = 4 Kcal

- Important note:** There is no storage form of protein in the body



Denaturation of proteins

- ▶ When protein are subject to heat, acid and other condition that disturb their stability, they undergo denaturation.
- ▶ **Denaturation:** The change in a protein's shape and loss of its function from heat, agitation, acid, base, alcohol, heavy metals, or other agents.
- ▶ **Examples**
 - > Cooking an egg
 - > Curdling of milk
 - > Stiffening of egg whites

Protein Digestion

■ Proteins are crushed and moistened in the mouth, but the real action begins in the stomach.

In the stomach:

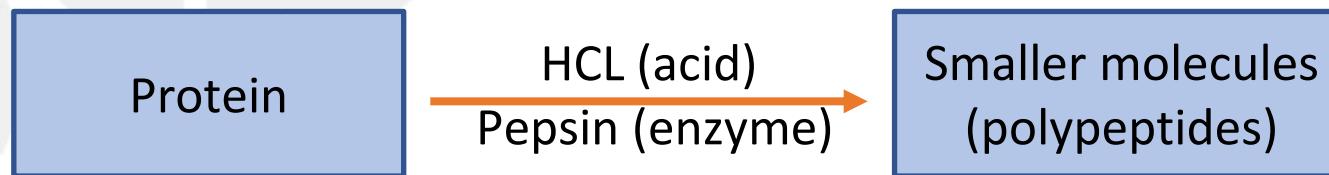
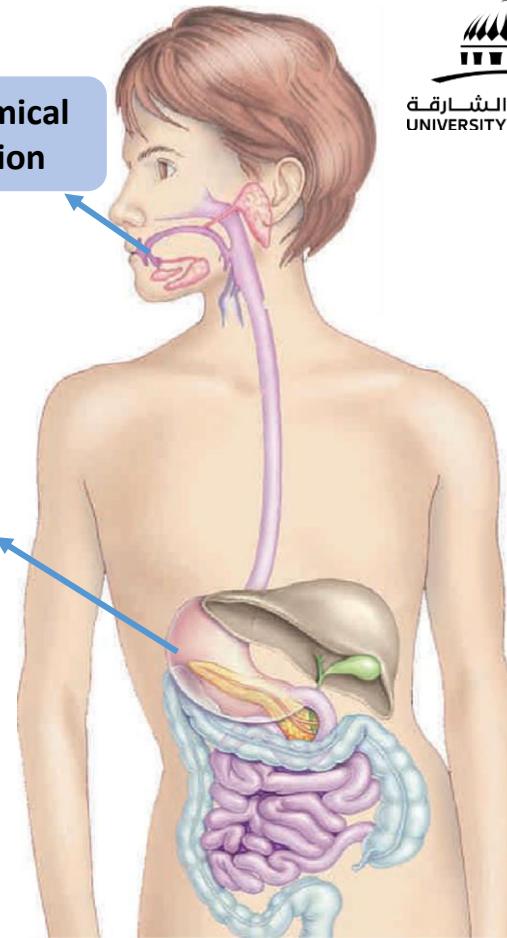
Partial breakdown (hydrolysis) of proteins by pepsin enzyme.

→ Hydrochloric acid (HCl) in the stomach

- Denatures protein
- Activates the pepsin enzyme

No chemical digestion

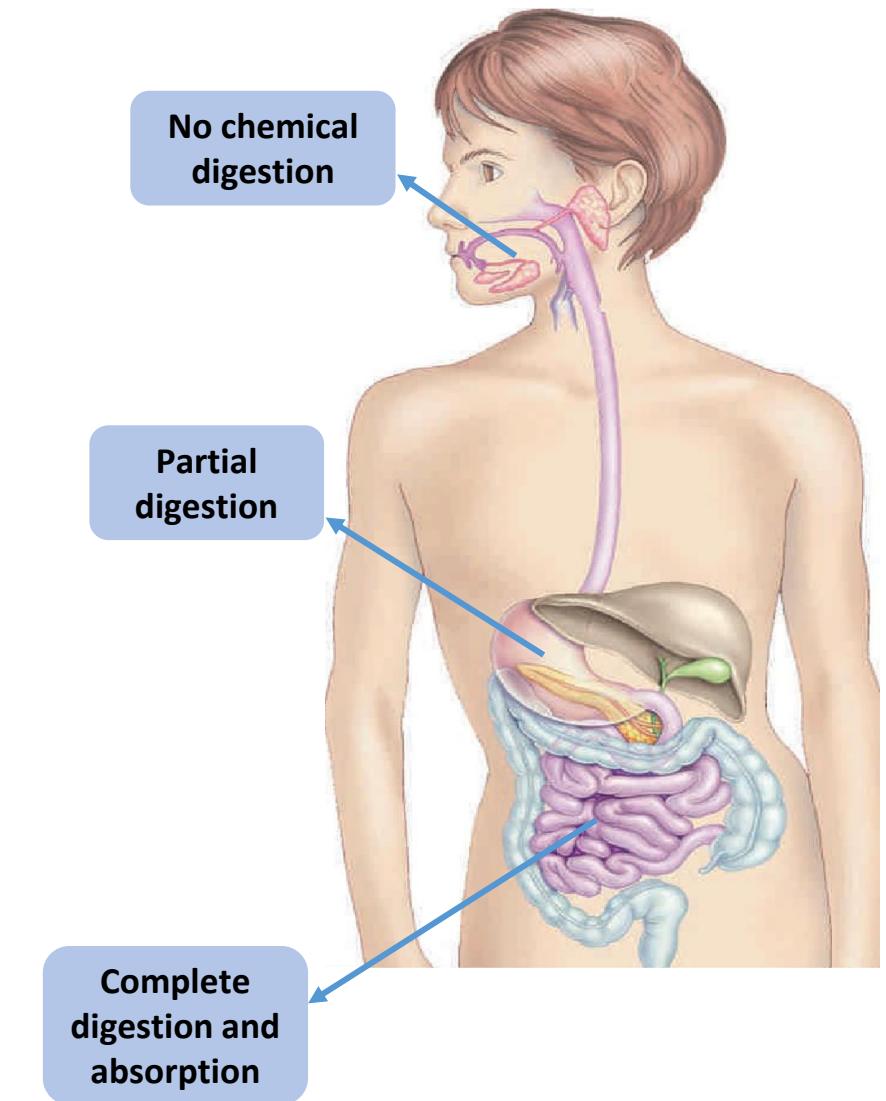
Partial digestion



Protein Digestion

In the small intestine:

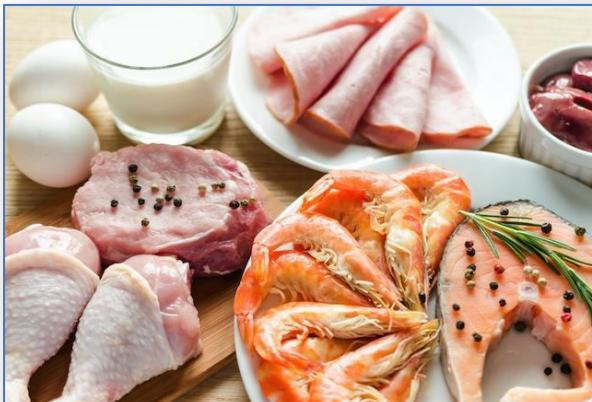
- Hydrolysis reactions (break down of polypeptides)
- Peptidase enzymes (enzymes in the small intestine)
Peptidases enzymes break down the peptides into amino acids which are absorbed by the villi in the small intestines.
- Once the amino acids are absorbed, they are released into the bloodstream, which carries them to the cells in the body for repairing tissue and building muscle



Sources of protein

Animal sources

Milk and dairy,
Meat, Poultry, Fish
(complete proteins)



Plant sources

Pulses, Legumes,
Beans, Nuts, Oil Seeds
(incomplete proteins)

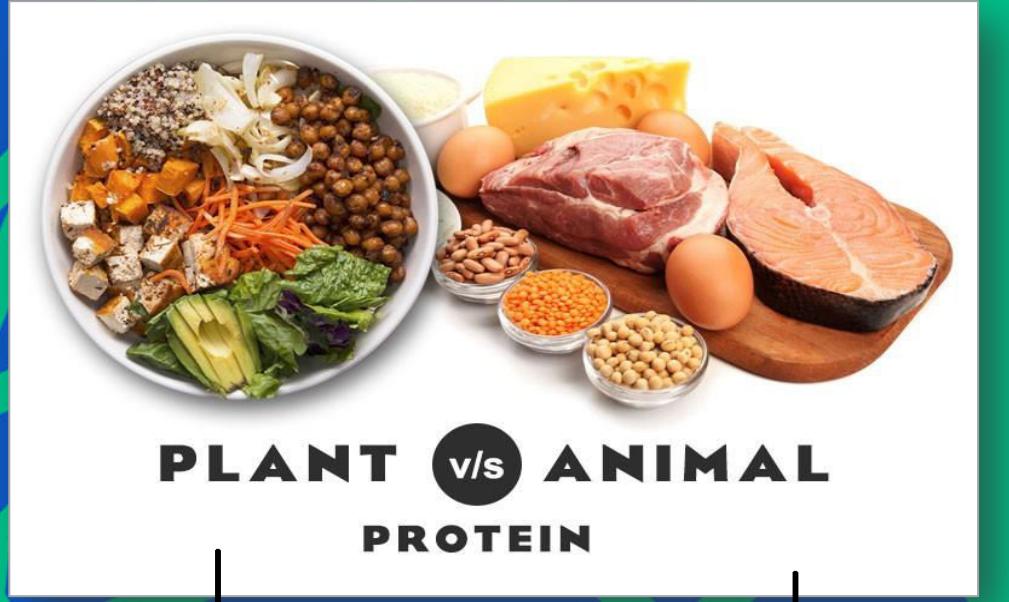


Protein Quality

- Determines how well a diet supports the growth of children and the health of adults.

- Influenced by:
 - > Protein digestibility
 - Protein source
 - > Amino acid composition
 - Essential amino acid consumption





↓
Exception: Soybean



↓
Exception: Gelatin



Protein Quality



Plant Proteins

- > Low digestibility/quality
 - > Don't contain all the essential amino acids
- Incomplete proteins**

Exception: Soybean



Animal Proteins

- > High digestibility /quality
 - > Contain all the essential amino acids
- Complete proteins**

Exception: Gelatin

Protein Complementation

- Protein quality is of utmost importance in poor countries where people rely on plant proteins as the main source of proteins in the diet.
- **The concept of complementation:** plant proteins can provide enough amounts of all essential amino acids when combined to complement each other.
 → The essential amino acids missing from one are supplied by the other

	Ile	Lys	Met	Trp
Legumes	✓	✓		
Grains			✓	✓
Together	✓	✓	✓	✓





Body Protein Needs

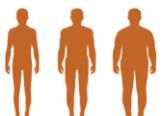
- Protein recommendations for infants, growing children, and pregnant and lactating women and athletes **are somewhat higher** than those for the general population.
- Even athletes in training do not typically need to increase their protein intakes because the additional foods they eat to meet their high energy needs deliver protein as well.

Body Protein Needs

Depends on



> **Age:** requirements decrease with age



> **Body size:** increase with body size/weight



> **Pregnant and lactating women:** higher than other adults



> **Sick or immuno-compromised:** higher



> **Infants and growing children:** recommendation is higher



Adults

RDA for Adults:

> 0.8g/kg/day

> 10-35% of total daily calories



Body builders

RDA for body builders:

> 1- 2 g/kg/day

Health Effects of Protein

Protein deficiency

- Protein-energy malnutrition
- Marasmus and kwashiorkor

Heart disease

- Animal-protein intake

Cancer

- Protein-rich foods such as red meat and processed meat; not protein content of diet

Adults bone loss (osteoporosis)

- Increase in calcium excretion
- Protein-to-calcium ratio

Weight control

- High protein diets

Kidney disease

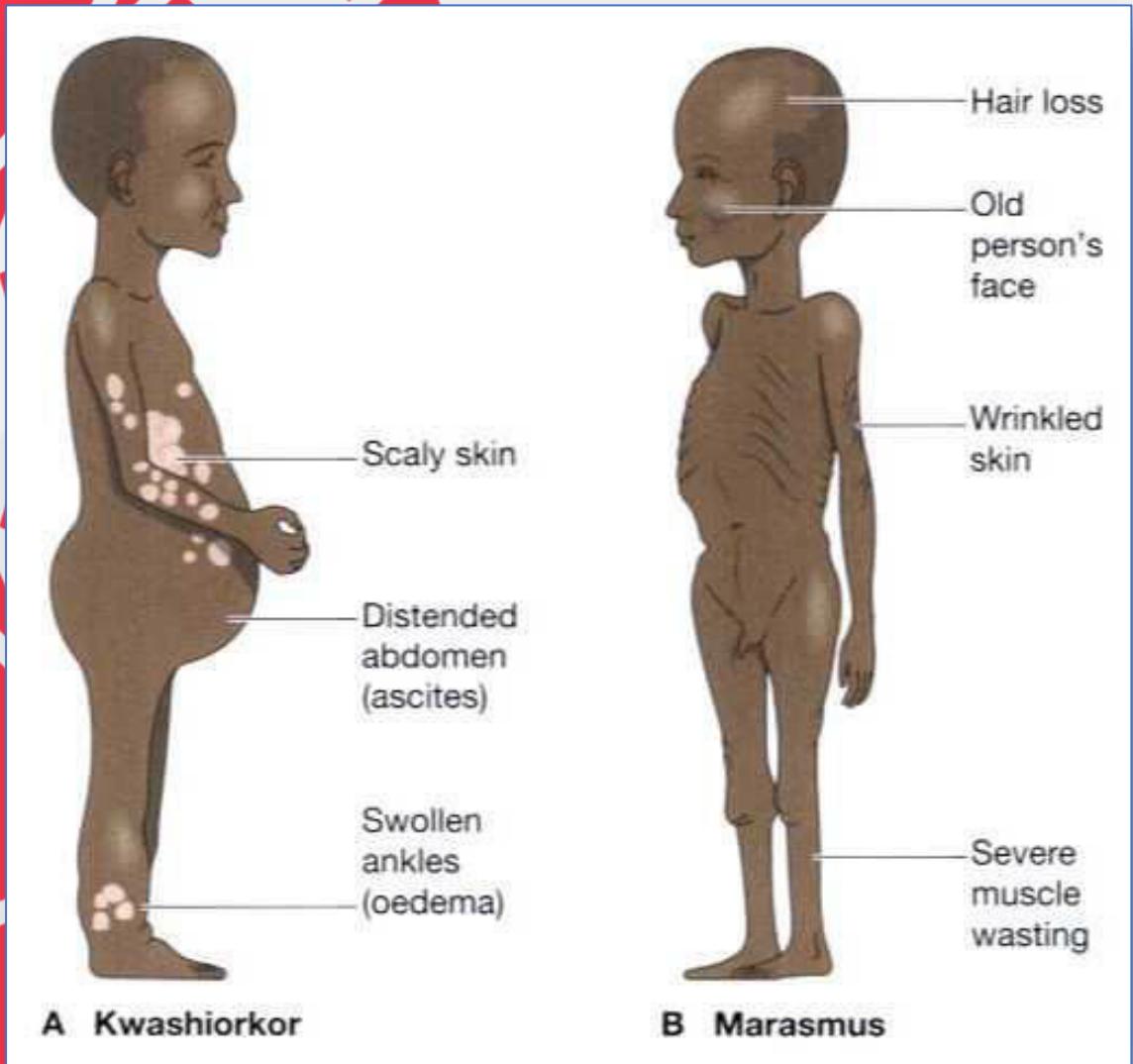
- Acceleration of kidney deterioration



Protein Energy Malnutrition

- When people are deprived of protein, energy, or both, the result is **Protein-Energy-Malnutrition (PEM)**. It is the most widespread form of malnutrition in the world today.
- PEM strikes early in childhood: **Marasmus and Kwashiorkor**
- PEM can touch many adult lives as well: **AIDS, Cancer patients, Alcoholics, drug addicts, etc.**

Protein Energy Malnutrition



A. Kwashiorkor

- > **Too little protein** to support body functions
- > Swollen belly and skin rash are present
- > Risk of infection
- > Severe acute malnutrition
- > Happen when weaning the baby in developing countries

B. Marasmus

- > Chronic inadequate food intake
- > Muscle wasting (heart failure)
- > **Inadequate energy**, vitamin, mineral, and protein intake
- > Person is shriveled and lean all over

High Protein Diets



- > High protein diets are being used to induce rapid weight loss, however excess protein intake (**more than twice the RDA**) is associated with many health risks:

Associated risks:

- > Increased blood acidity (Ketosis)
- > Kidney stones & renal failure
- > Cardiovascular disease (high in saturated fat)
- > Osteoporosis
- > Decreased vitamins, minerals, and fiber intake



Vegetarian Diets



- > People who opt to become vegetarian can still meet their daily protein requirement by carefully planning their meals and by knowing about protein complementation.
- > **Vegetarian diets are often characterized by:**
 - Lower fat, cholesterol and calorie intake
 - Increased vitamins, antioxidants and fiber intake

Positive health aspects:

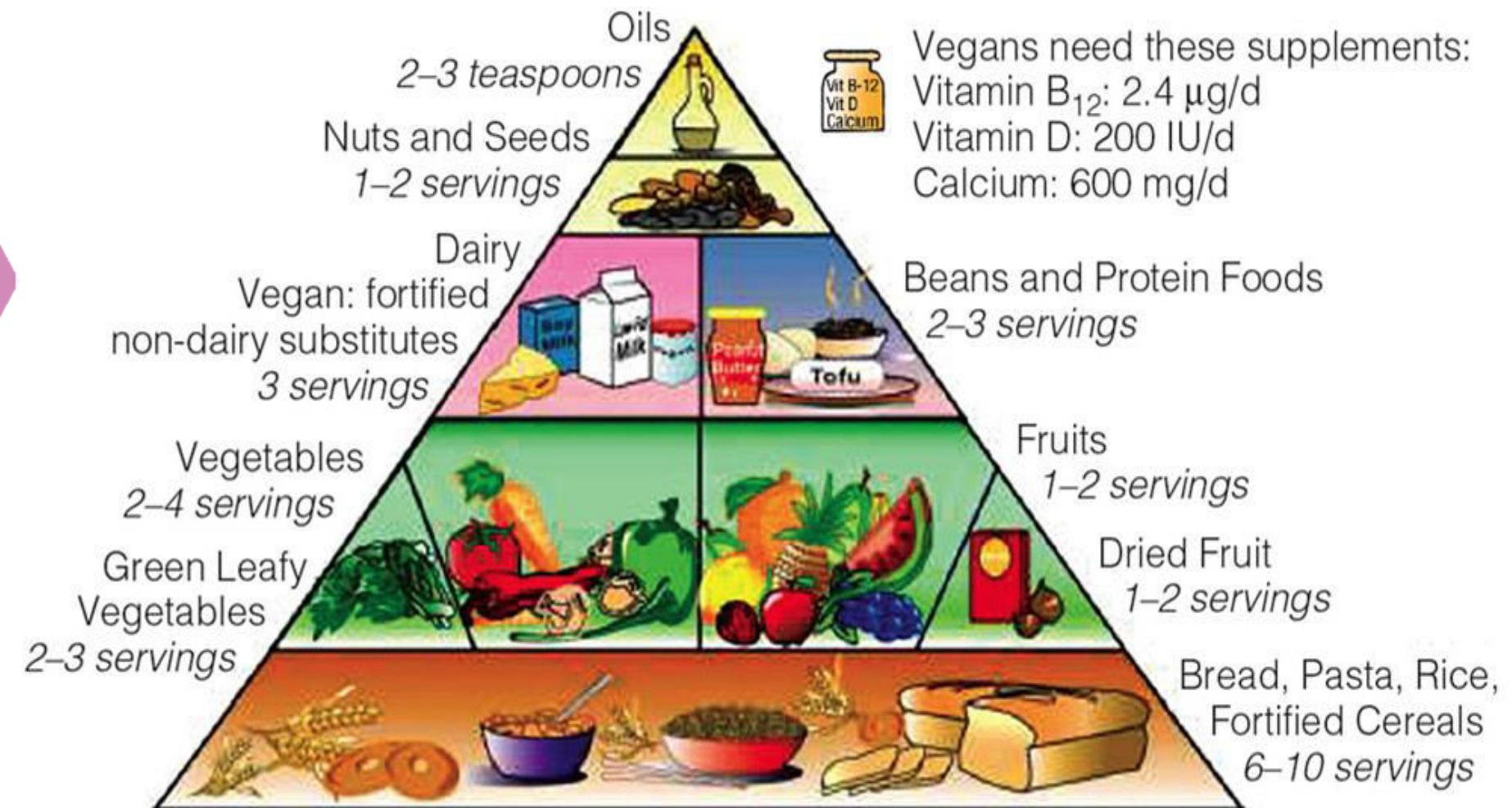
- > Lower incidence of obesity & Cardiovascular diseases(CVD)
- > Lower blood pressure
- > Lower incidence of diabetes
- > Lower cancer risks
- > Lower incidence of constipation





Info for your interest

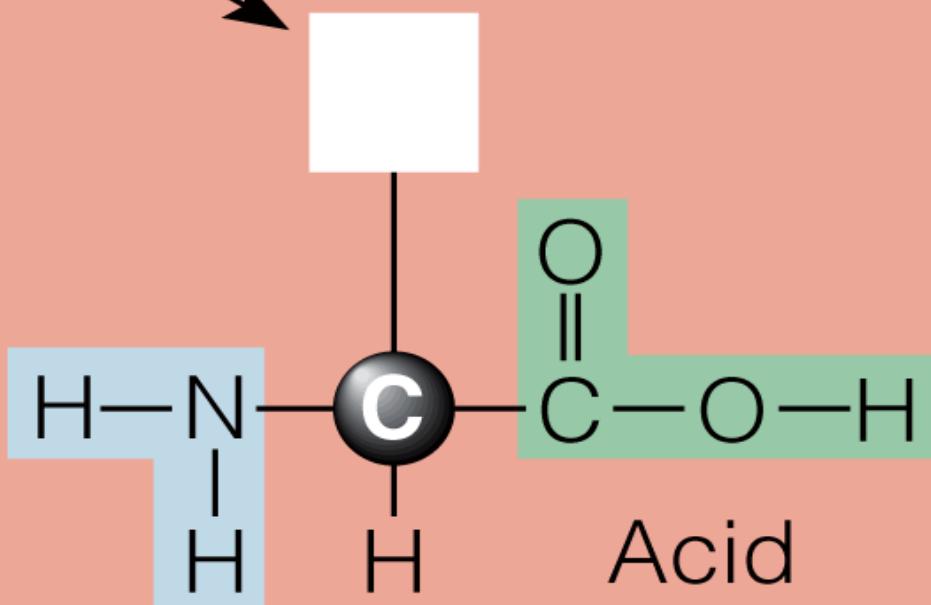
Vegetarian Food Pyramid



Amino Acids

Side group
varies

Amino
group

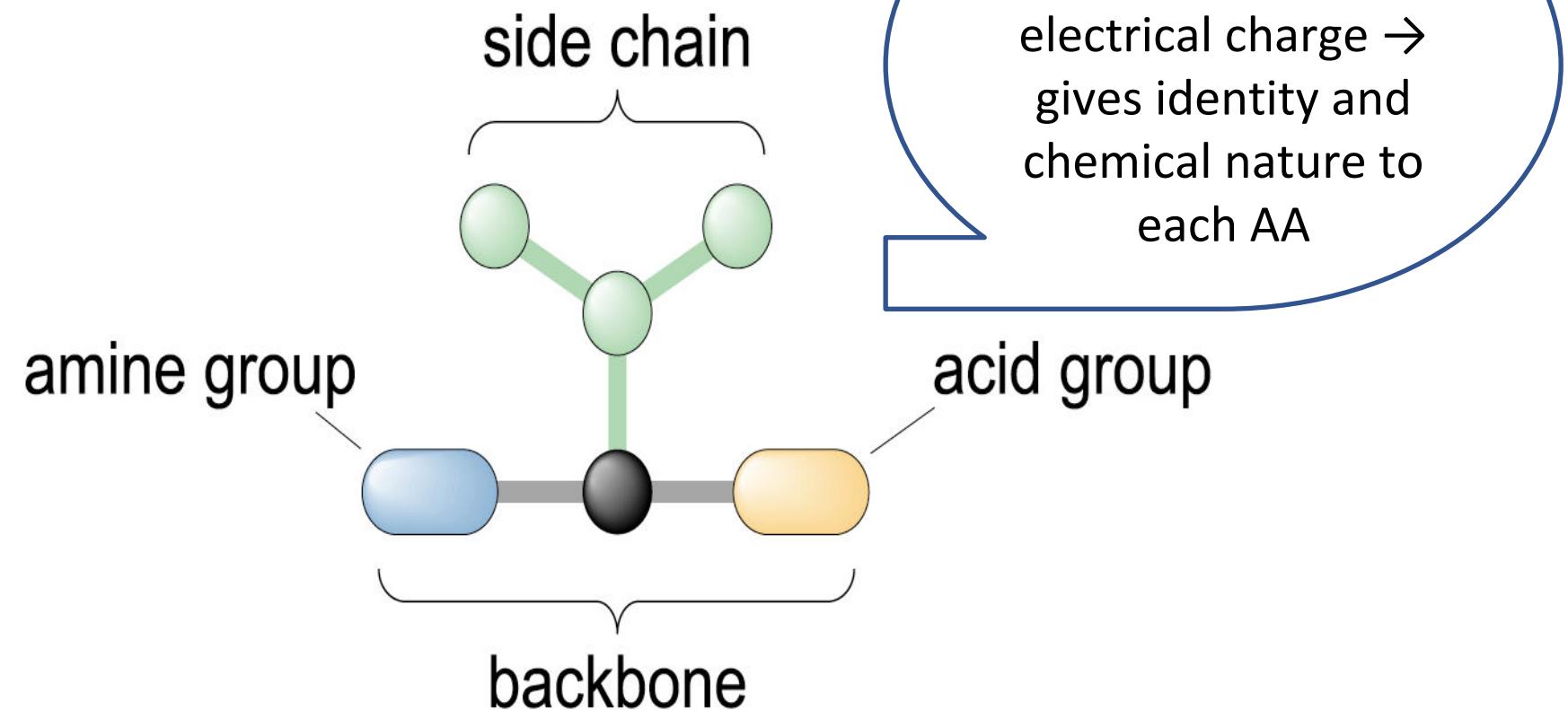


Acid
group

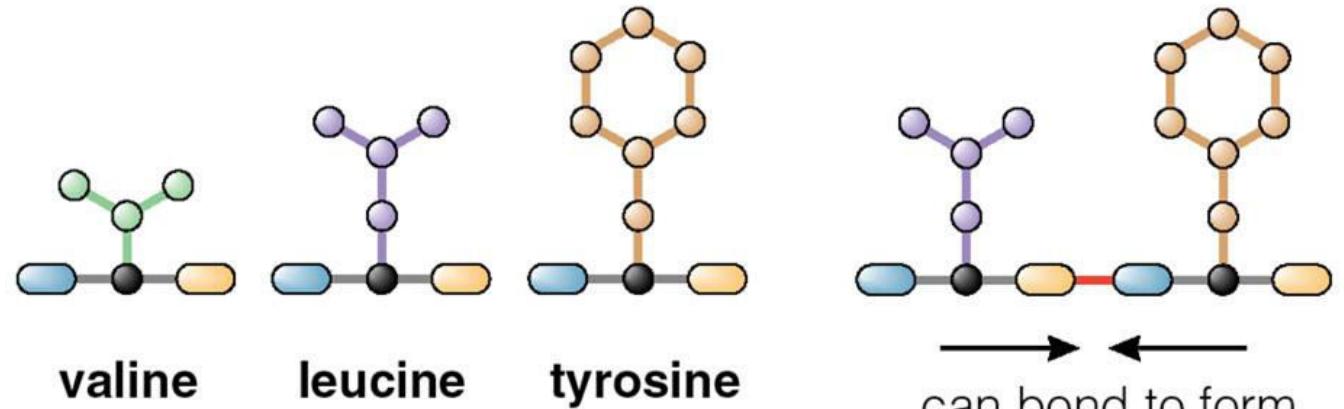
Amino Acids

Each AA contains:

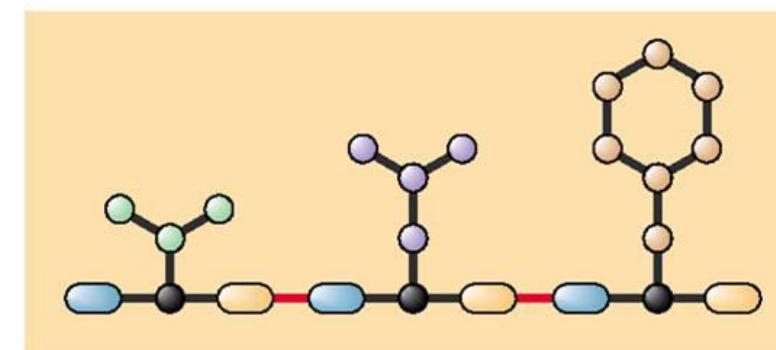
- an **amine group** at one end (nitrogen – containing part)
- an **acid group** at the other end (COOH)
- a distinctive **side chain**



Amino Acids

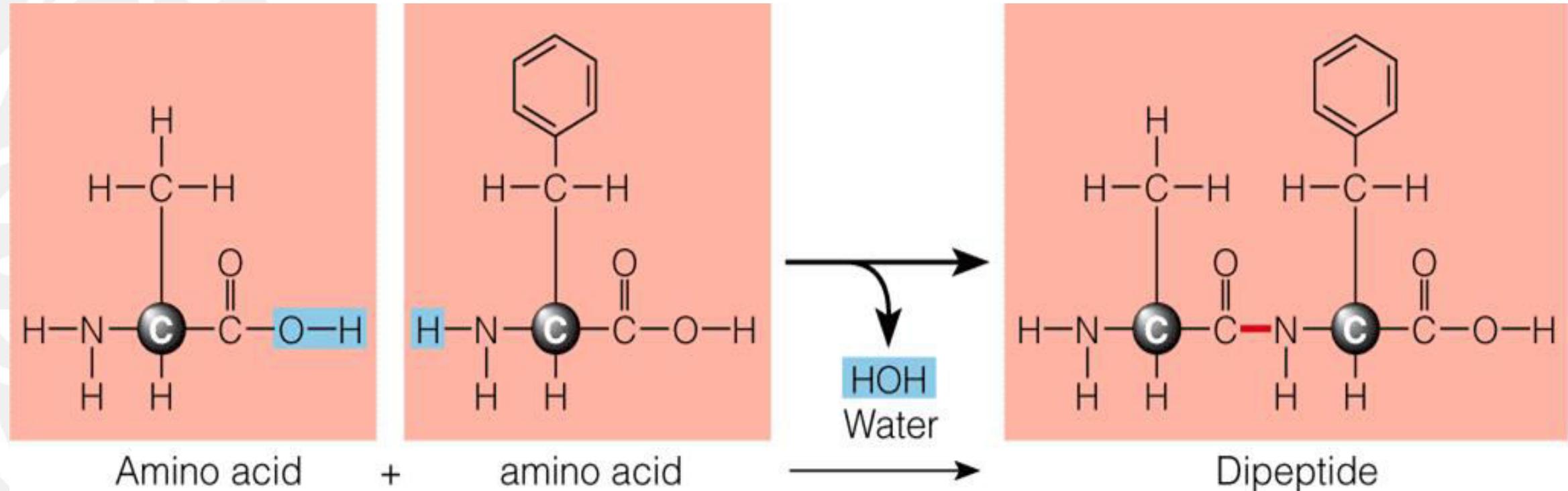


Single amino acids with different side chains...



a strand of amino acids, part of a protein.

Proteins: Composition



An OH group from the acid end of one amino acid and an H atom from the amino group of another join to form a molecule of water.

A peptide bond (highlighted in red) forms between the two amino acids, creating a dipeptide.

Terms Used to Describe Vegetarians and Their Diets

- **fruitarian** includes only raw or dried fruits, seeds, and nuts in the diet.
- **lacto-ovo vegetarian** includes dairy products, eggs, vegetables, grains, legumes, fruits, and nuts; excludes flesh and seafood.
- **lacto-vegetarian** includes dairy products, vegetables, grains, legumes, fruits, and nuts; excludes flesh, seafood, and eggs.
- **macrobiotic diet** a vegan diet composed mostly of whole grains, beans, and certain vegetables; taken to extremes, macrobiotic diets can compromise nutrient status.
- **ovo-vegetarian** includes eggs, vegetables, grains, legumes, fruits, and nuts; excludes flesh, seafood, and milk products.
- **partial vegetarian** a term sometimes used to mean an eating style that includes seafood, poultry, eggs, dairy products, vegetables, grains, legumes, fruits, and nuts; excludes or strictly limits certain meats, such as red meats.
- **pesco-vegetarian** same as partial vegetarian, but eliminates poultry.
- **vegan** includes only food from plant sources: vegetables, grains, legumes, fruits, seeds, and nuts; also called *strict vegetarian*.
- **vegetarian** includes plant-based foods and eliminates some or all animal-derived foods.