HME103-Principles of Nutrition

Components in foods and their relationship with health: Proteins

Lesson Code: HME103-Principles of Nutrition

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PROTEİNS

Proteins are the main components that form the protoplasm of all living cells, animals and vegetables, and the structure of many hormones and enzymes.

After water, proteins constitute the largest part of the total body weight.

Proteins taken into the body in optimum quantity and quality provide body development with healthy nerve, muscle, teeth, bone and skin formation and are responsible for repairing worn tissues.

Hemoglobin, which forms the structure of red blood cells that provide the cells with their oxygen needs, is also a protein.

On average, 16% of the adult human body consists of protein. The amount of protein stored in the body is very small, the largest part comprising cells that work and perform specific tasks.

Proteins are broken down into amino acids, which form building blocks in the digestive system. It is carried to the liver, other tissues, and organs through the blood. They combine again in a particular order and take place in tissue and organ structures.

It is derived from the Greek word "proteios" and means "the most important" or "the foremost".

The building blocks of proteins are amino acids.

Proteins are polypeptides formed by covalent bonding of amino acids to each other in a characteristic straight chain of a certain type, in a certain number and in a certain order.

The structure of proteins contains approximately
50-55% C,
6.5-7.5% H,
22-24% O,
15-17% N,
0-3% S and
0-0.8% P.
The most important of these components is nitrogen. In some cases, proteins also contain elements such as Zn, Fe, and Cu.

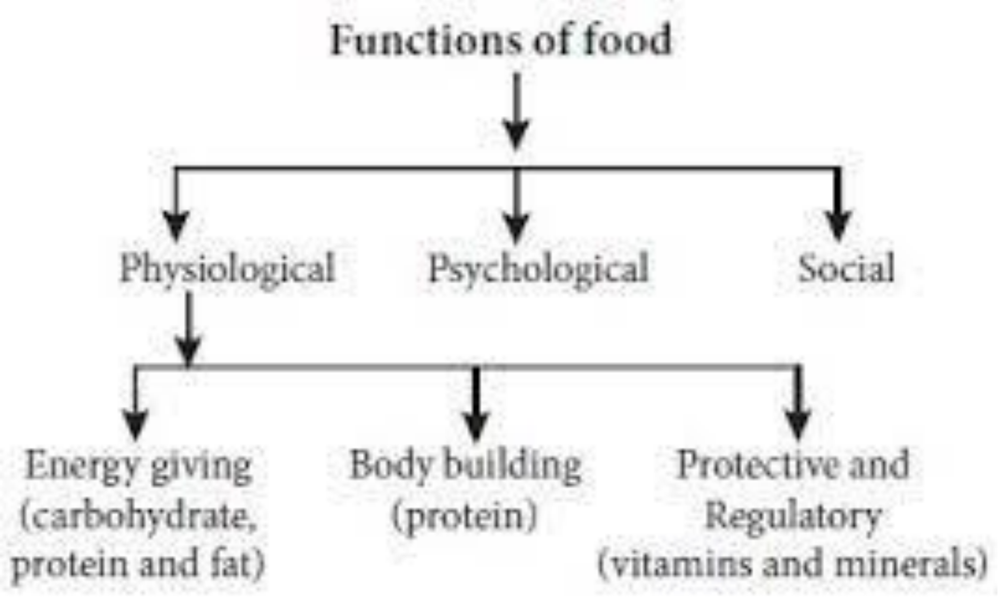


Fig 1.1: Functions of food

Amino Asids

Amino acids are the building blocks of hundreds of proteins synthesized in plant and animal cells.

There are 20 amino acids in the structure of proteins. The 20 standard amino acids can be thought of as an alphabet in which the language of protein structure is written. Thus, it is understood that there are many types of proteins. It is estimated that all living things on Earth have about one million protein types.

Table 1. Basic amino acids

Amino Acid	3 letter	1 letter
Alanine	Ala	A
Arginine	Arg	R
Asparagine	Asn	N
Aspartic acid	Asp	D
Cysteine	Cys	C
Glutamic acid	Glu	E
Glutamine	Gln	Q
Glycine	Gly	G
Histidine	His	H
Isoleucine	Ile	I
Leucine	Leu	L
Lysine	Lys	K
Methionine	Met	M
Phenylalanine	Phe	F
Proline	Pro	P
Serine	Ser	S
Threonine	Thr	T
Tryptophan	Trp	W
Tyrosine	Tyr	Y
Valine	Val	V

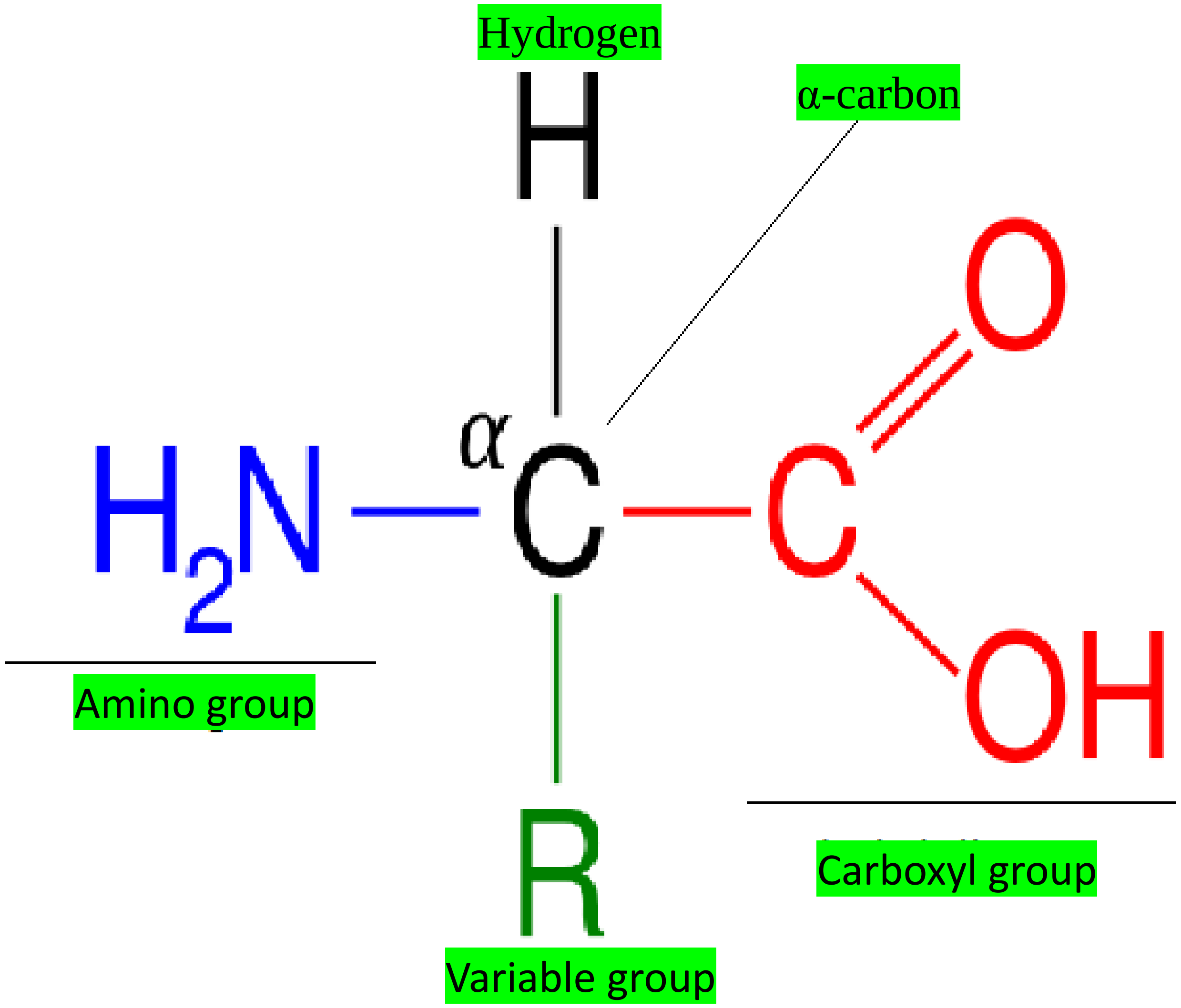
Structure of Amino Acids

The structure common to all 20 amino acids is:

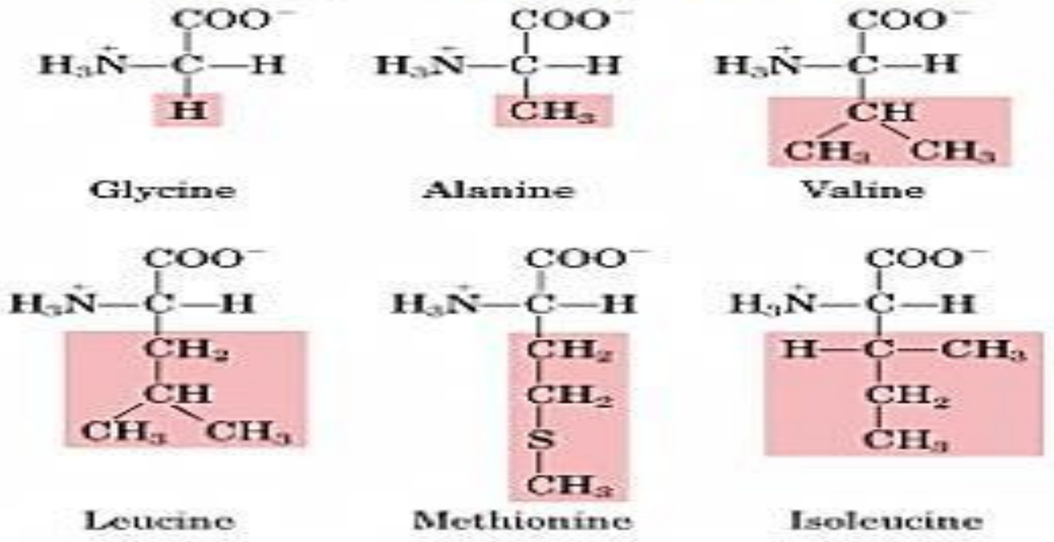
- Depending on a C atom;
- H (hydrogen),
- Carboxyl group (-COOH)
- Amino group (-NH2)
- Variable Side chains (R=Acyl group).

•The variable group, called akyl or aryl and denoted "R", consists of various amino acids.

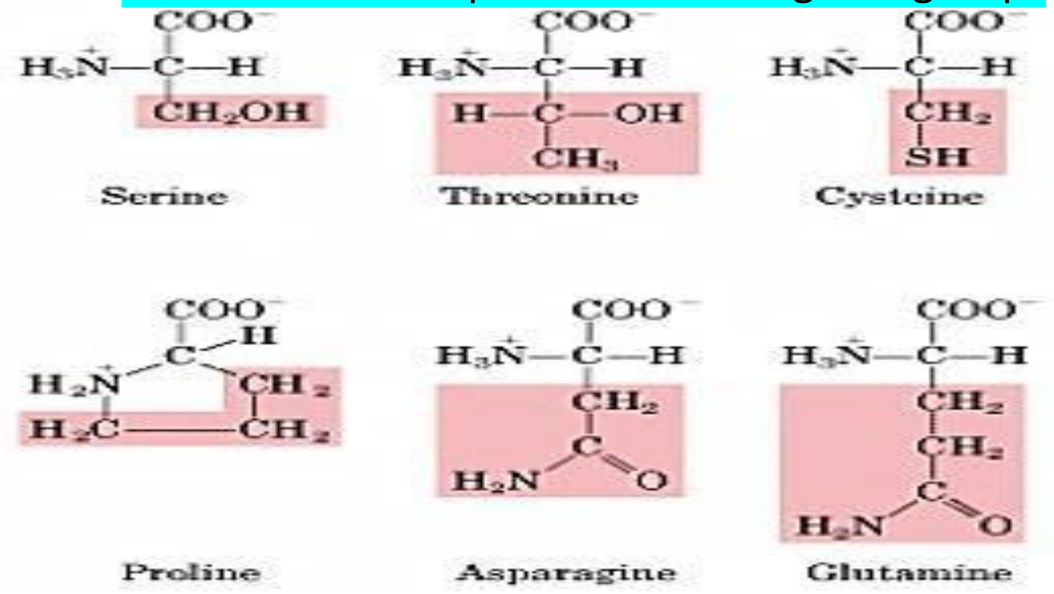
•The carbon to which the amino and carboxyl groups are bonded is called "α-carbon". Therefore, all amino acids that makeup proteins are α amino acids.



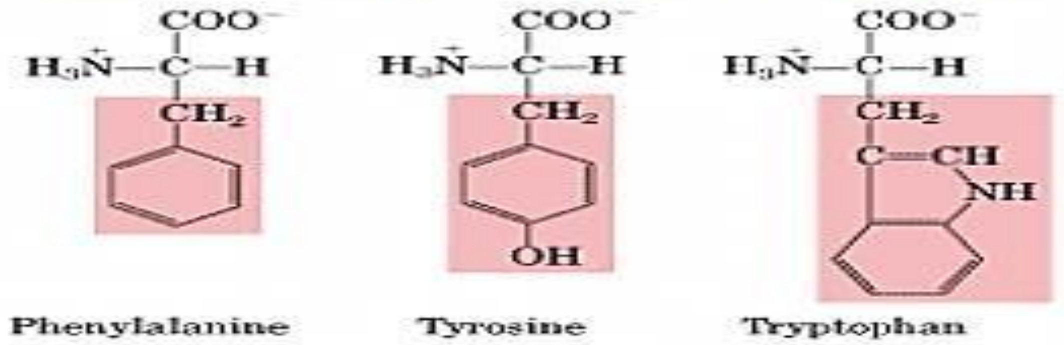
Nonpolar, aliphatic amino acids with R groups



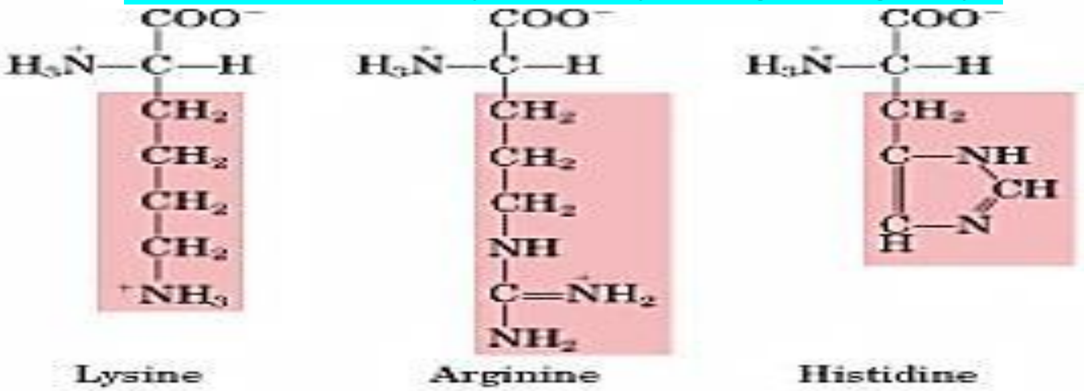
Amino acids with polar but uncharged R groups



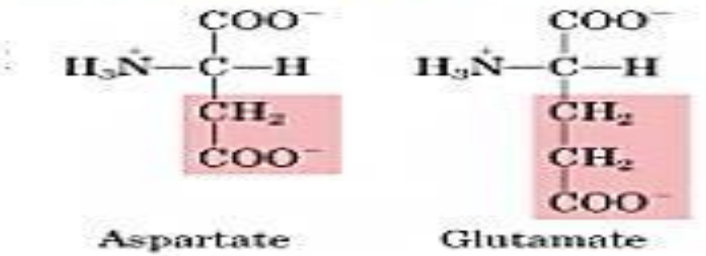
Amino acids that usually have nonpolar, aromatic R groups



Amino acids with positively charged R groups



Amino acids with negatively charged R group



The human body can synthesize 12 of the standard amino acids. Amino acids that cannot be synthesized by the body and must be taken from outside are called essential amino acids (exogenous).

A protein deficiency occurs in the body if these amino acids cannot be obtained from other animal and plant sources.

Essential amino acids are valine, leucine, isoleucine, phenylalanine, tryptophan, methionine, threonine, and lysine. The reason why the body cannot synthesize these 8 amino acids is that there is no gene-enzyme system in the body. Foods containing these 8 essential amino acids are called complete protein foods, which are generally eggs, meat, fish and dairy products.

3 Char	Amino Acid
Trp	Tryptophan
Ile	Isoleucine
Met	Methionine
Phe	Phenylalanine
Leu	Leucine
His	Histidine *
Thr	Threonine
Arg	Arginine *
Val	Valine
Lys	Lysine

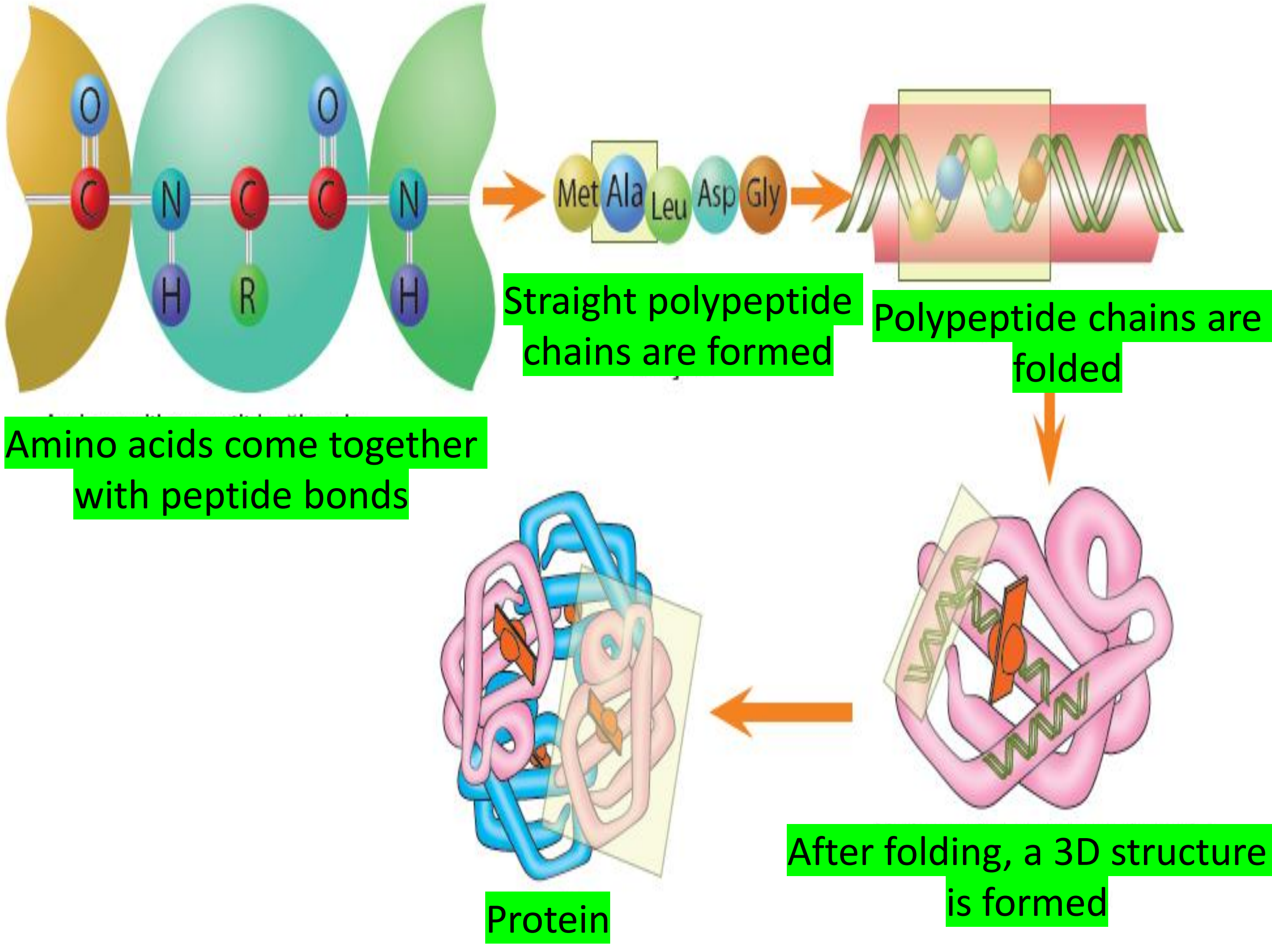
* Semi-essential (for kids)

Which of the following is NOT an essential amino acid?

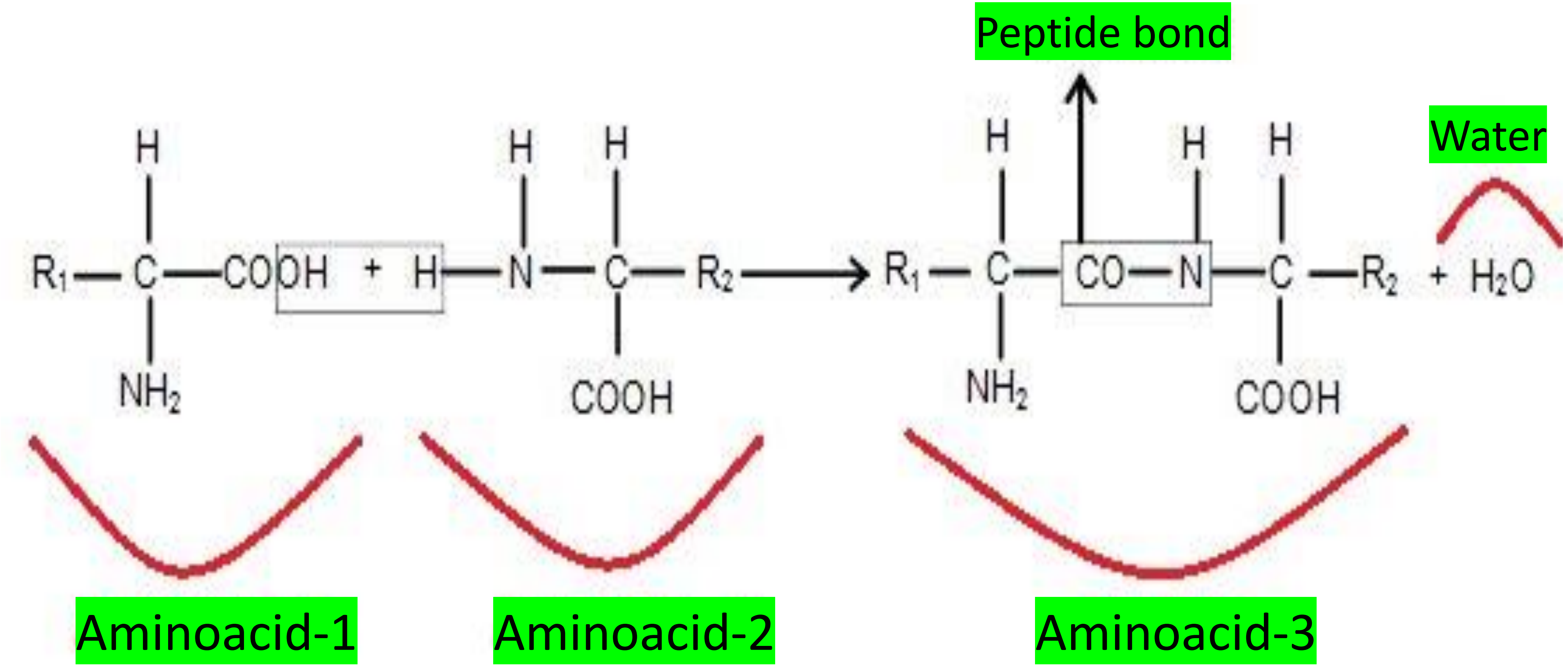
Select one:

- a. Lysine
- b. Proline
- c. Tryptophan
- d. Phenylalanine

While dipeptides and polypeptides are formed to obtain proteins from amino acids, the carboxyl group of one amino acid and the amine group of another amino acid combine to form a peptide bond and a molecule of H_2O is released.



Formation of protein molecule



During protein synthesis, peptide bonds are formed between amino acids and water is formed.

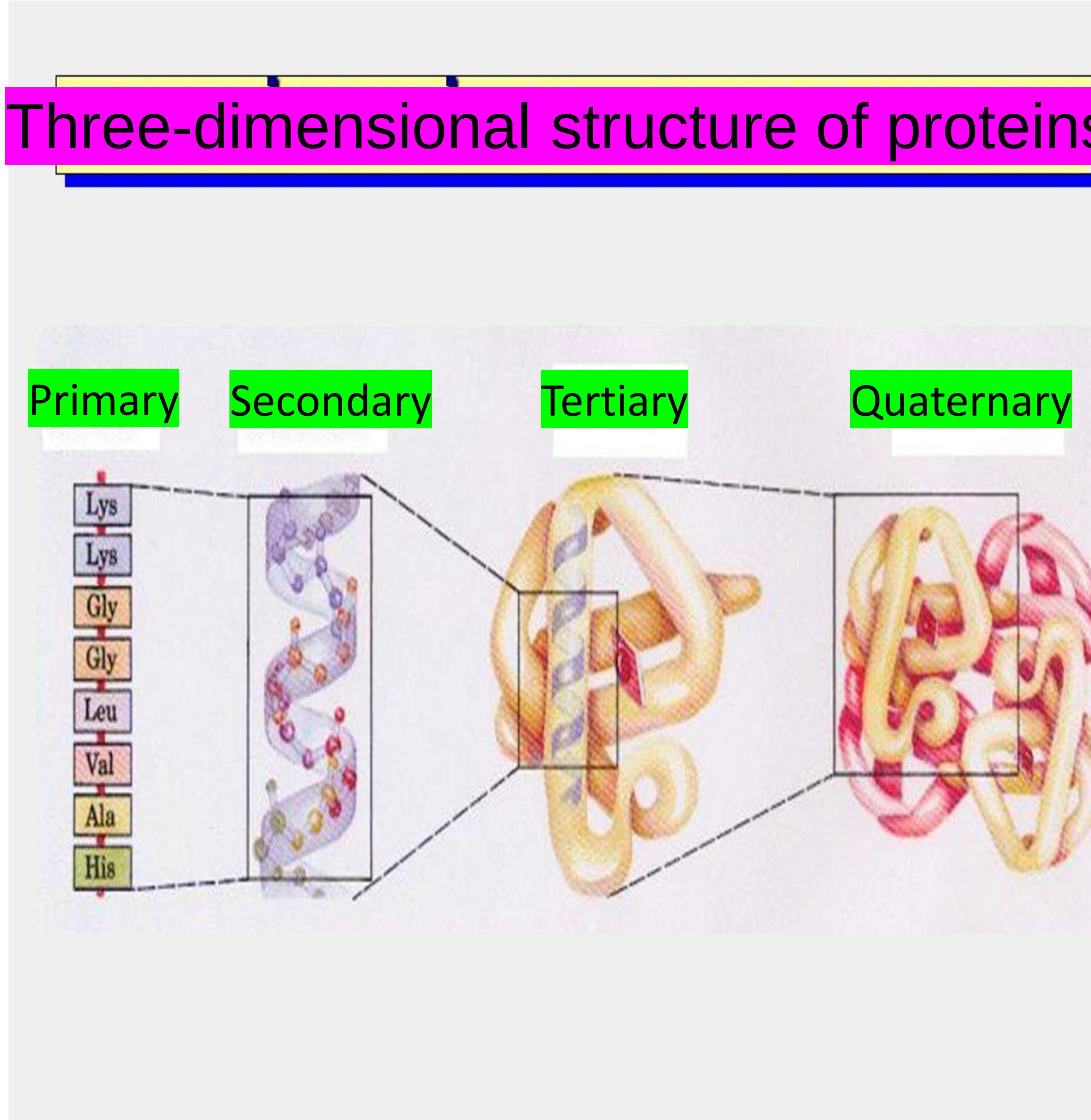
Conformation in Proteins (three-dimensional structure = 3D structure)

Characteristic three-dimensional structures of proteins are called as;

- primary
- secondary
- tertiary and
- quaternary

Primary Structure (Primary Structure)

It is a structure in the form of a polypeptide chain formed by amino acids of a particular type, in a certain number, and in a particular order, connected by peptide bonds. The primary structure is a protein's characteristic and genetically determined amino acid sequence.



Secondary Structure

A protein's secondary (second) structure is formed by bending and folding of polypeptide chains. Secondary structure can be seen in two ways.

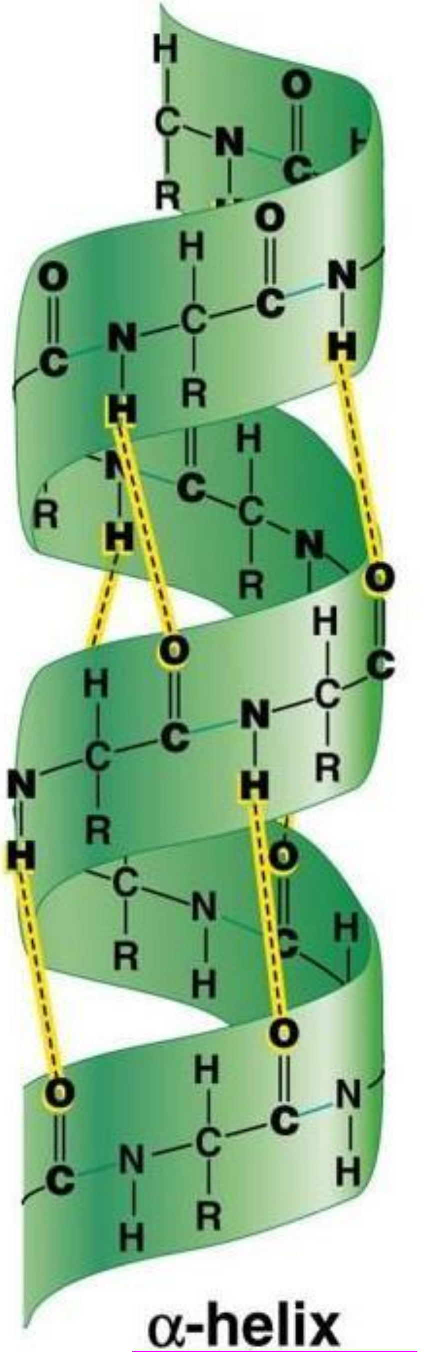
These;

Helix (α-helix)

Pleated layer structure (β-).

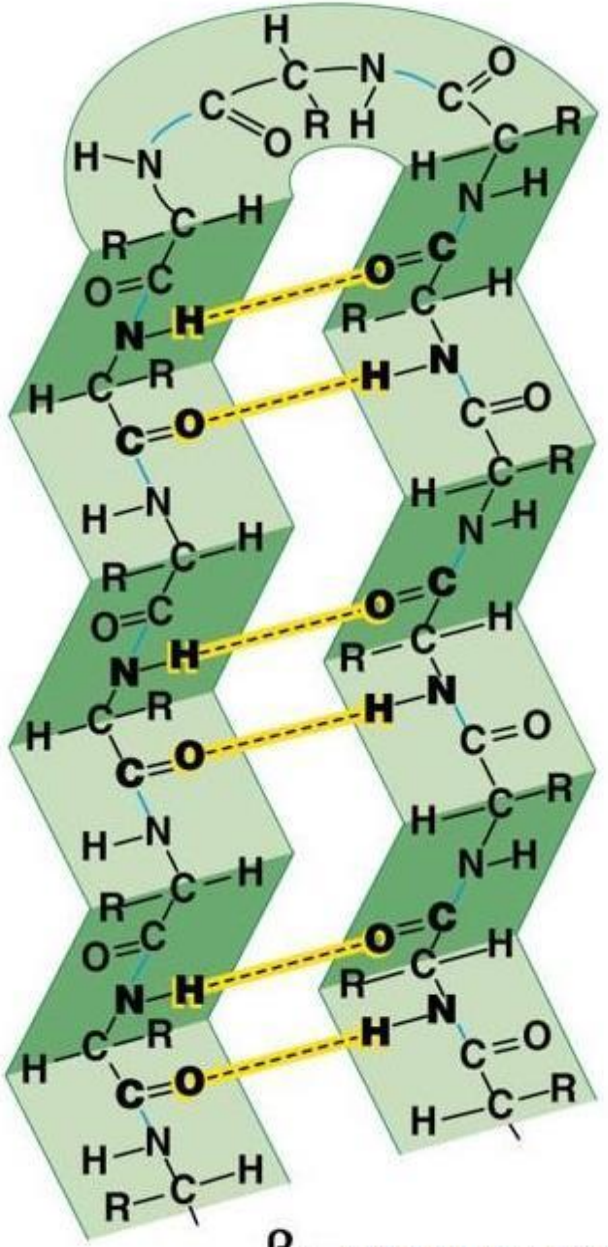
The amino acid chain is coiled into a helix in the helical structure. This is because of the hydrogen bond formed by each amino acid with the adjacent one.

Pleated structure (β-): It consists of various beta strands linked by hydrogen bonds between adjacent strands. Three to ten amino acids are combined to create a beta-strand polypeptide.



α-helix

Helix structure

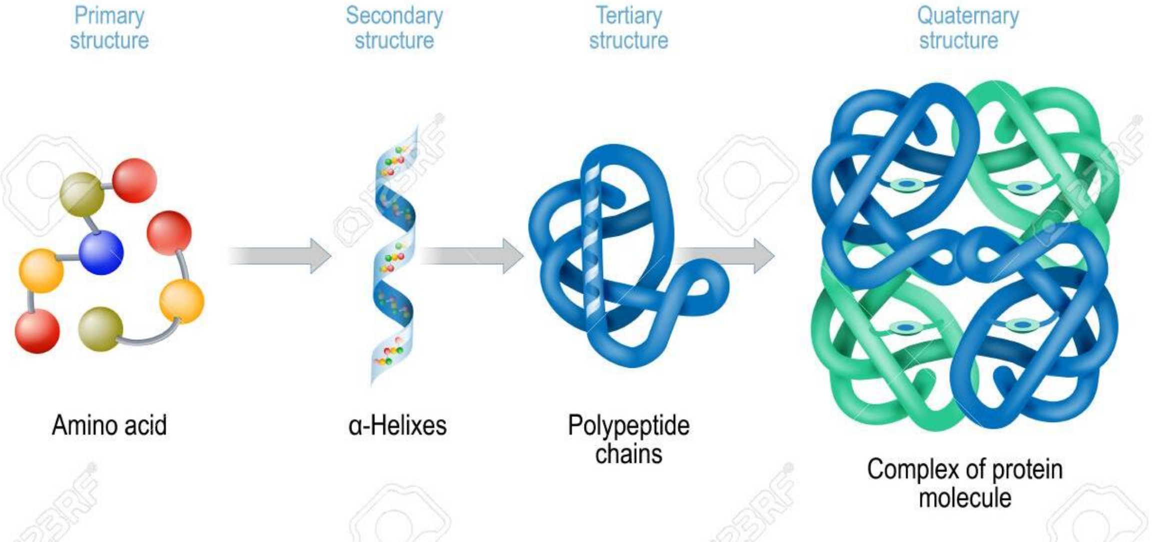


β- (Pleated structure)

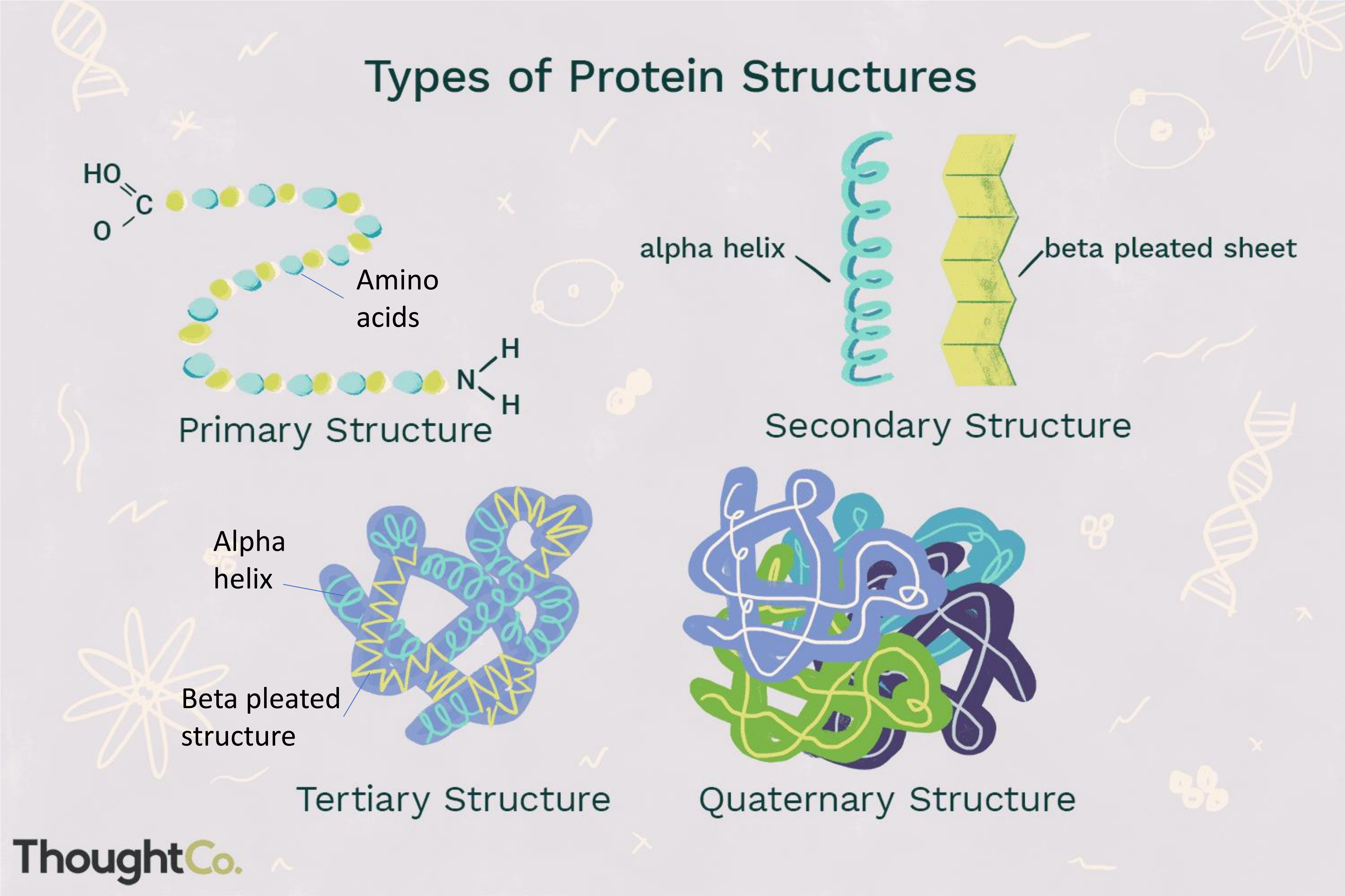
Tertiary Structure

It is the globular or fibrillar structure of the polypeptide chain, formed due to further folding or arrangement into fibers under the influence of some bonds after forming the secondary structure.

Quaternary Structure

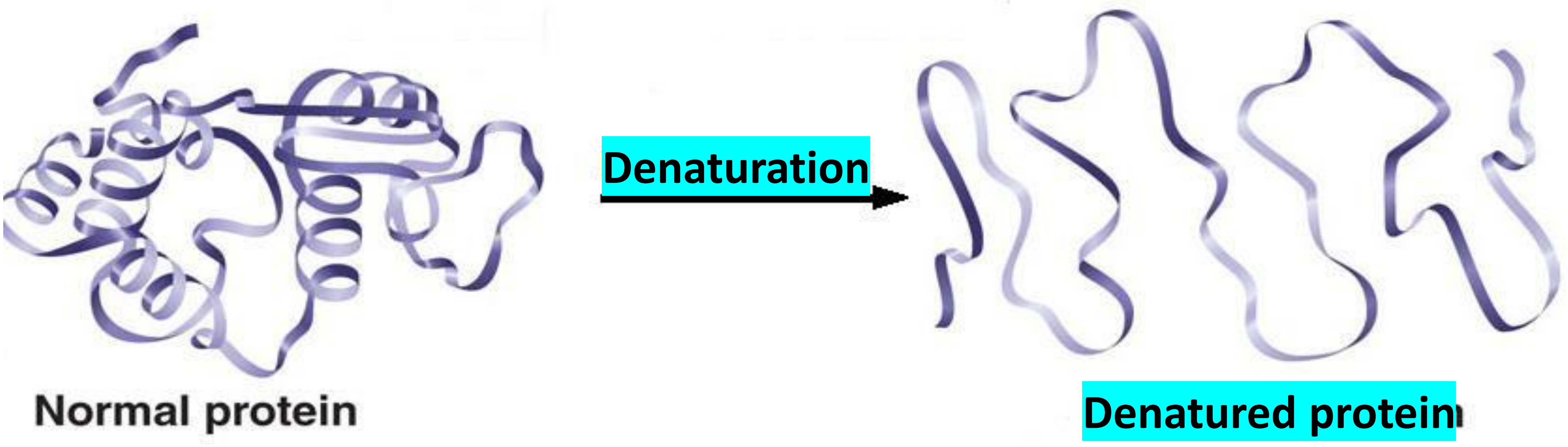


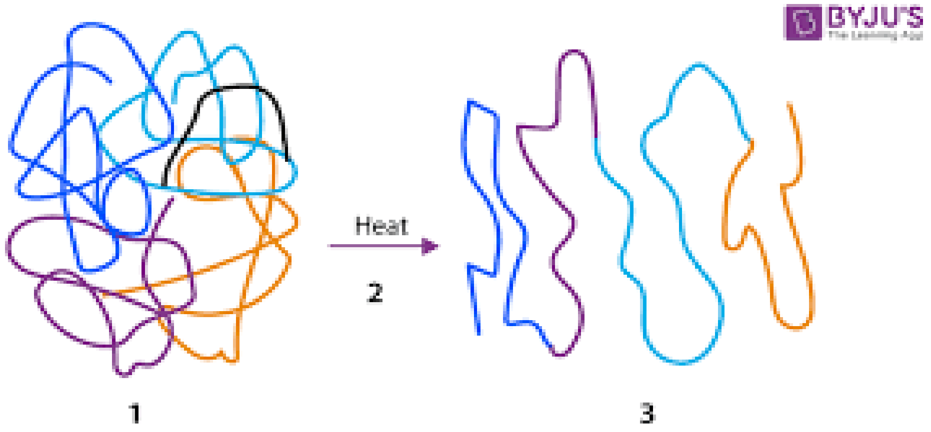
In some proteins, the functional form is achieved by combining subunits of two or more polypeptide chains. At this point, the quaternary structure level of the protein is mentioned. Not every protein may have a quaternary structure.


Types of Protein Structures
HO
C
O
Amino
acids
N
H
H
Primary Structure
alpha helix
beta pleated sheet
Secondary Structure
Alpha
helix
Beta pleated
structure
Tertiary Structure
Quaternary Structure
ThoughtCo.

Protein Denaturation

The bonds that form the secondary and tertiary structure of proteins break down under some conditions, causing the three-dimensional structure to deteriorate. Covalent bonds are preserved during denaturation. However, disulfide bonds are broken, revealing many sulfhydryl groups. In other words, the molecule cannot maintain its ball shape and begins to unfurl and take a flat shape. This situation is defined as denaturation. Factors that trigger the denaturation of proteins: heat, radiation, various chemicals, acidic and basic solutions, and concentrated salt solutions.





When food is cooked, the proteins are denatured and thus they are more easily digested.

What is the usefulness of protein denaturation?

Regarding digestion and internal protein recycling, denaturation is essential to “unravel” bonds that maintain secondary, tertiary levels of structure to allow proteases to hydrolyze peptide bonds and release amino acids.

Once proteins are denatured or uncoiled, enzymes have a shorter time facilitating the breakdown of proteins through enzymatic digestion. Enzymatic digestion breaks the protein into smaller peptide chains and ultimately down into single amino acids, which are absorbed into the blood.

What is the biological effect of denaturation of proteins?

It causes the loss of the biological activity of proteins. Example: Enzymes lose their catalytic ability after denaturation.

Classification of Proteins

Proteins can be classified in many ways according to their chemical and physical properties.

Proteins are divided into 3 groups according to their types;

- simple proteins,
- conjugated proteins and
- derivative proteins

A. Simple Proteins: These are proteins that yield only amino acids or amino acid derivatives when hydrolyzed.

Simple Proteins

Globular Proteins

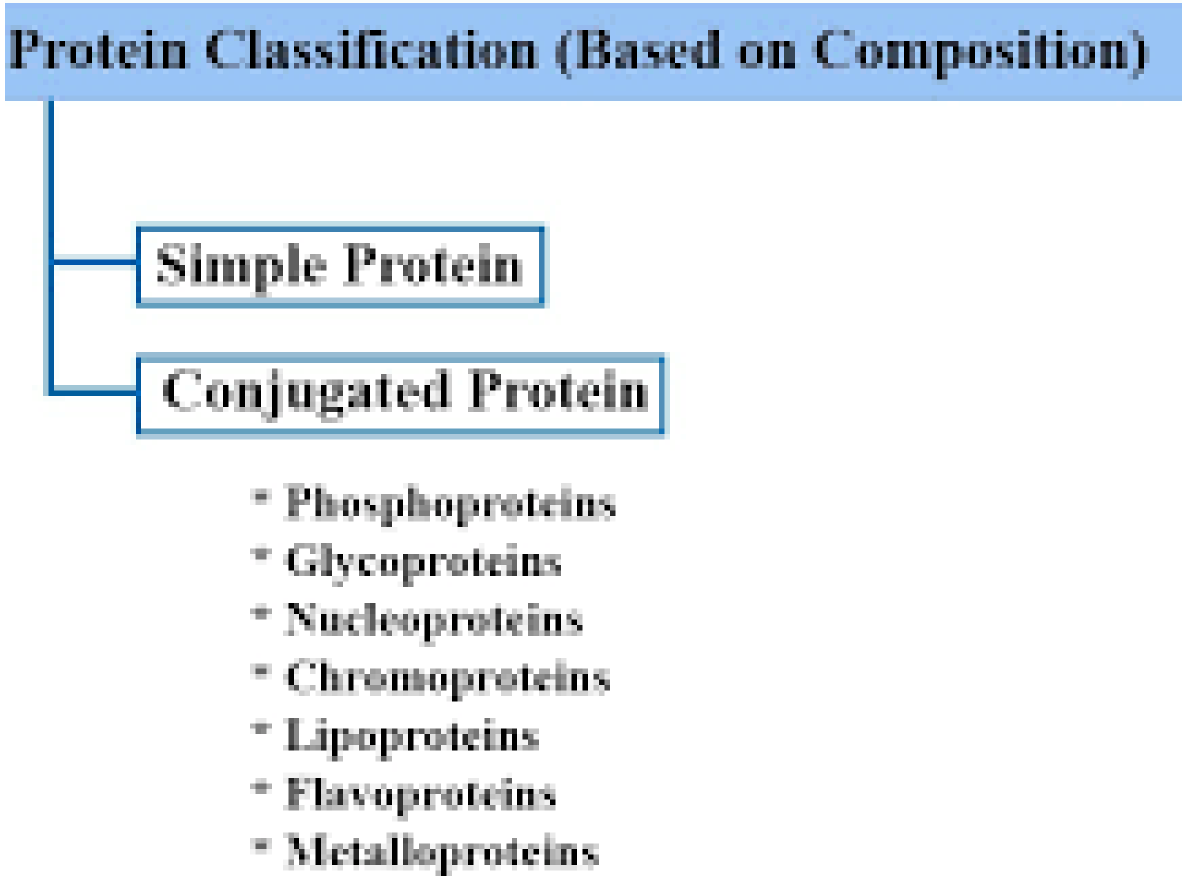
1. Albumins
2. Globulins
3. Glutelins
4. Prolamins
5. Albumoids (cleroproteins)
6. Histones
7. Protamines

Fibrous Proteins

1. Collagen
2. Keratin
3. Myosin
4. Elastin
5. Fibrinogen

B. Conjugated Proteins

They are composed of simple proteins and non-protein substances. The non-protein substance is called the prostatic group.



C. Derived Proteins:

This group is proteins derived from hydrolysis of proteins enzymatically or with acids.

Examples are: denatured proteins and peptides.

Quality of proteins

Depending on the source and type of protein, its use in the body varies. The degree to which the body utilizes protein is expressed as "protein quality". Protein quality varies depending on the type and amount of amino acids in the protein's composition, its digestion and absorption status, and ultimately its conversion into body proteins.

A high-quality protein should contain sufficient and balanced levels of essential amino acids, be a good source of nitrogen for synthesising non-essential amino acids, and be easily digested.

• DIGESTIBILITY OF PROTEIN

Proteins of animal origin	91-100%
Cereal proteins	79-90%
Legume proteins	69-90%

When breast milk and eggs are taken into the body, 100% of them are used, therefore they are full proteins. Since other animal foods such as milk and meat are 91-100% digested, they are called good quality proteins.

According to the degree of use of protein in the body:

Full protein: Exactly used

Good quality protein: Used almost completely

Low quality protein: Not fully utilized

Functions of Proteins in the Body

The main functions of proteins are;

- Proteins fulfil the body's need for essential amino acids.
- They are effective in the construction of new tissues during growth and adolescence.
- They have the function of repairing worn tissues.
- They are involved in the production of enzymes and hormones and are found in their structures.
- They play a role in the transmission of nerve impulses.
- They take part in providing support and movement for living organisms.
- They are used in the body's resistance to diseases and protection against disease agents.

Functions of Proteins in the Body

- They undertake a transport function in the organism. Therefore, many molecules and ions are transported by specific proteins and fulfil their functions.

For example, haemoglobin transports oxygen in red blood cells and myoglobin in muscle, while iron is transported by transferrin in blood metabolism.

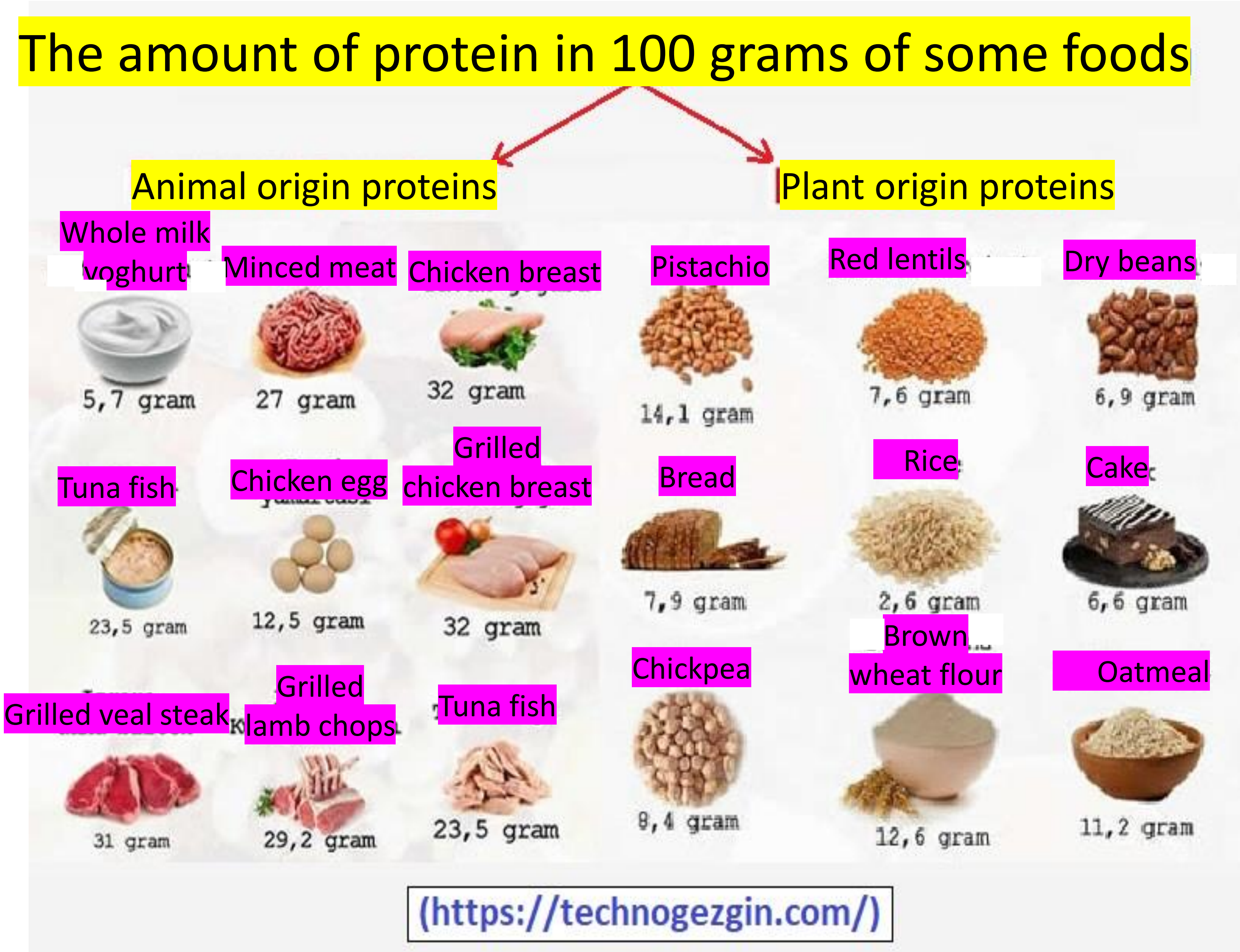
- Proteins are not the body's energy source. However, proteins are used as a source of energy when they are taken into the body in excessive amounts or when there is not enough energy source in the body. The combustion of 1 gram of protein gives 4 kcal of energy.

It is recommended that 10-20% of energy in the daily diet should come from proteins.

Protein sources

Sources of animal protein: Eggs, beef, poultry, mutton, fish, liver, kidney, cow's milk, cheese, cottage cheese are rich sources of good quality protein.

Vegetable protein sources: Rice, corn, soya beans, chickpeas, lentils, beans, sesame seeds, peanuts, walnuts, hazelnuts and wheat products are rich sources of vegetable protein.



Protein requirement

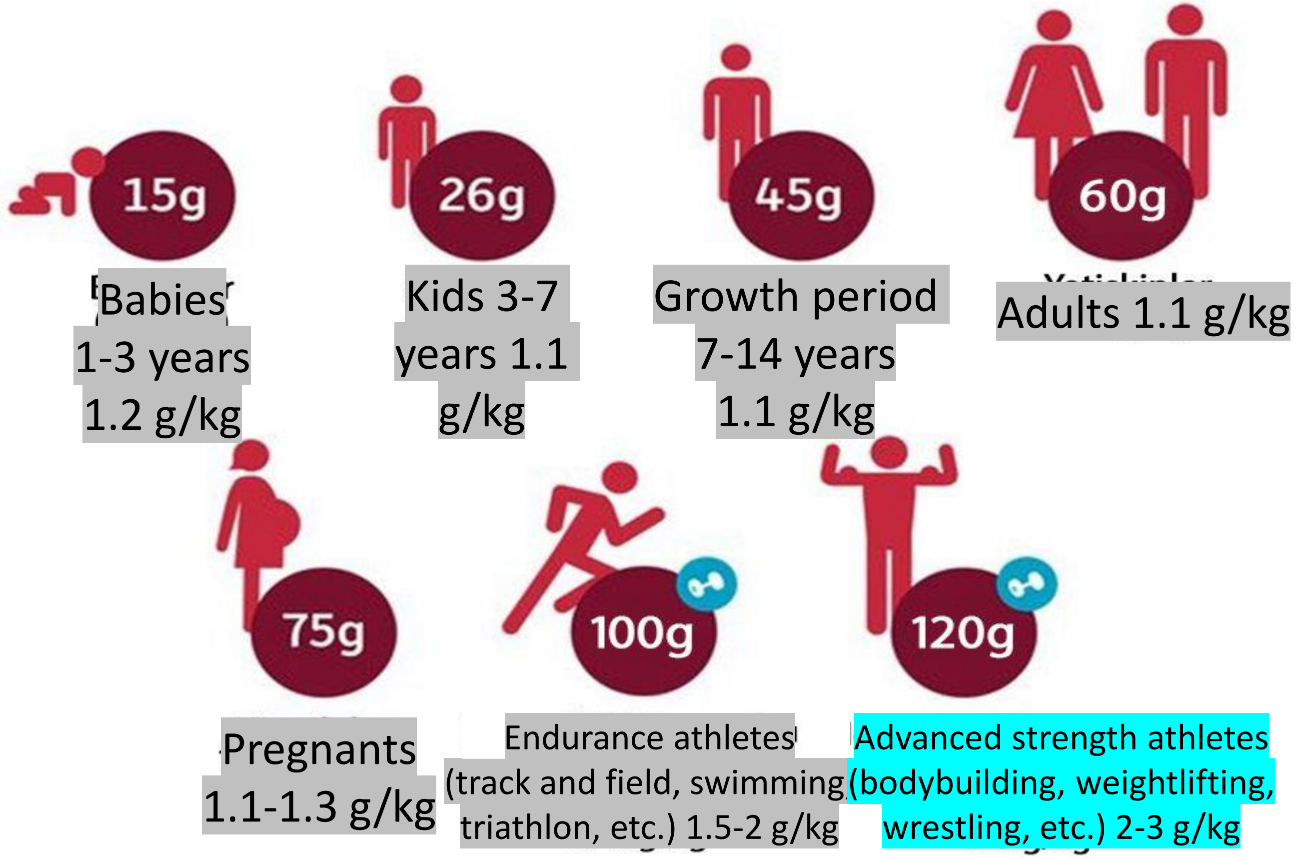
More than **1 billion** people worldwide are not adequately nourished with protein.

Protein deficiency leads to

- delayed growth,
- loss of muscle mass,
- deficiency of the immune system,
- and weakening of the heart and circulatory system.

The protein requirement of an adult human being is equal to the amount of protein excreted from the body. However, considering external factors, the intake should be slightly more than the excretion.

DAILY PROTEIN NEED



*The values stated are average values. It varies depending on the person's body weight and training level.

WEIDER GLOBAL NUTRITION

The daily protein requirement of an adult is approximately 1.0 g for each kg of body weight. This need increases in the early stages of growth, childhood and adolescence, and in pregnant and lactating women.

In other words, the daily protein requirement of a person weighing 70 kg is 70 g.