

- Explain how a peptide is formed from individual amino acids.
- Explain why the sequence of amino acids in a protein is important.

$$\text{H}_3\text{N}^+-\underset{\text{R}}{\text{CH}}-\overset{\text{O}}{\parallel}{\text{C}}\text{O}^- + \text{H}_3\text{N}^+-\underset{\text{R}'}{\text{CH}}-\overset{\text{O}}{\parallel}{\text{C}}\text{O}^- \longrightarrow \text{H}_3\text{N}^+-\underset{\text{R}}{\text{CH}}-\overset{\text{O}}{\parallel}{\text{C}}\text{NH}-\underset{\text{R}'}{\text{CH}}-\overset{\text{O}}{\parallel}{\text{C}}\text{O}^- + \text{H}_2\text{O}$$

Peptide bond

[illegible][NH3+]CC(=O)NCC(=O)NCC(=O)[O-]

N-terminal end

Ser-ala-cys
Tripeptide

C-terminal end

Figure 18.5.1: Space-filling model of bradykinin. (Public Domain; [Fvasconcellos](#))

Note: Order is Important

For peptides and proteins to be physiologically active, it is not enough that they incorporate certain amounts of specific amino acids. The order, or *sequence*, in which the amino acids are connected is also of critical importance. Bradykinin is a nine-amino acid peptide (Figure 18.5.1) produced in the blood that has the following amino acid sequence:

arg-pro-pro-gly-phe-ser-pro-phe-arg

This peptide lowers blood pressure, stimulates smooth muscle tissue, increases capillary permeability, and causes pain. When the order of amino acids in bradykinin is reversed,

arg-phe-pro-ser-phe-gly-pro-pro-arg

the peptide resulting from this synthesis shows none of the activity of bradykinin.

Just as millions of different words are spelled with our 26-letter English alphabet, millions of different proteins are made with the 20 common amino acids. However, just as the English alphabet can be used to write gibberish, amino acids can be put together in the *wrong sequence* to produce nonfunctional proteins. Although the correct sequence is ordinarily of utmost importance, it is not always absolutely required. Just as you can sometimes make sense of incorrectly spelled English words, a protein with a small percentage of “incorrect” amino acids may continue to function. However, it rarely functions as well as a protein having the correct sequence. There are also instances in which seemingly minor errors of sequence have disastrous effects. For example, in some people, every molecule of hemoglobin (a protein in the blood that transports oxygen) has a single incorrect amino acid unit out of about 300 (a single valine replaces a glutamic acid). That “minor” error is responsible for sickle cell anemia, an inherited condition that usually is fatal.

Summary

The amino group of one amino acid can react with the carboxyl group on another amino acid to form a peptide bond that links the two amino acids together. Additional amino acids can be added on through the formation of addition peptide (amide) bonds. A sequence of amino acids in a peptide or protein is written with the N-terminal amino acid first and the C-terminal amino acid at the end (writing left to right).

Concept Review Exercises

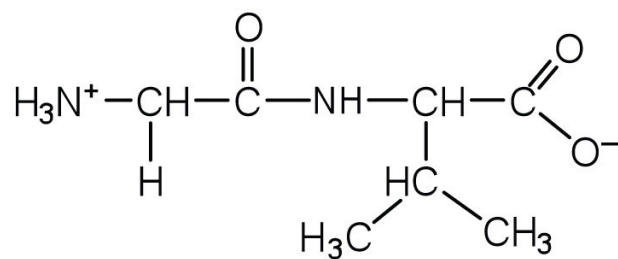
1. Distinguish between the N-terminal amino acid and the C-terminal amino acid of a peptide or protein.
2. Describe the difference between an amino acid and a peptide.
3. Amino acid units in a protein are connected by peptide bonds. What is another name for the functional group linking the amino acids?

Answers

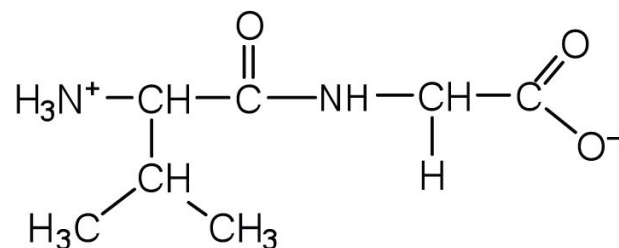
1. The N-terminal end is the end of a peptide or protein whose amino group is free (not involved in the formation of a peptide bond), while the C-terminal end has a free carboxyl group.
2. A peptide is composed of two or more amino acids. Amino acids are the building blocks of peptides.
3. amide bond

Exercises

1. Draw the structure for each peptide.
 - a. gly-val
 - b. val-gly
2. Draw the structure for cys-val-ala.
3. Identify the C- and N-terminal amino acids for the peptide lys-val-phe-gly-arg-cys.
4. Identify the C- and N-terminal amino acids for the peptide asp-arg-val-tyr-ile-his-pro-phe.



1. a.



b.

3. C-terminal amino acid: cys; N-terminal amino acid: lys

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