SECTION 3

Structure of the Protein α Helix

PRE-ACTIVITY ASSIGNMENT

1. Draw a dipeptide at pH 7 with the N-terminus to the left and C-terminus to the right.

2. On your drawing, do the following:
   a. Circle the α carbons.
   b. Draw a box around the R-groups.
   c. Circle the atoms capable of hydrogen bonding.
   d. Highlight the atoms involved in the formation of the peptide bond.

3. Describe the atoms that can participate in hydrogen bonding.

4. Using any knowledge you have from previous courses, what do you already know about a protein α helix?

IN-CLASS ACTIVITY

Why

Biochemists have numerous ways of depicting biological macromolecules. Becoming familiar with visual conventions is an essential first step in mastery of biochemical concepts.

Learning Outcomes

1. Recognize that the amino acid R-groups of a protein α helix point out from the helix.
2. Recognize that the interior of the protein α helix consists of backbone atoms.
3. Compare and contrast the three representations (stick, ribbon, space filling) of the structural features of the protein α helix.
4. Identify distribution of R-groups around the turns of an α helix.

Activity contributed by Stephen Dunham, Anne Kruchten, and Julie Verdoni

All images in this section were created with PyMOL

Critical Thinking Questions

Part I. Use Model 1A, stick model of a protein α helix, to answer questions 1-8.

1. Which color stick represents C _____

   O _____ N _____

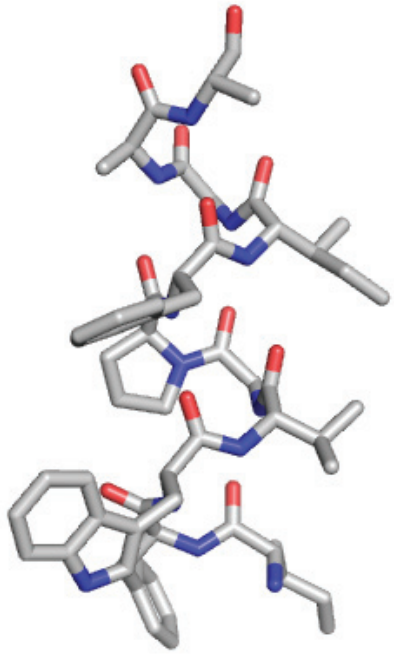
2. How many amino acid residues are in this polypeptide?

3. How did you determine that number?

4. How many peptide bonds are there in this polypeptide?

5. Circle four peptide bonds.
6. Label the N and C terminus of the peptide with "N" and "C".
7. Identify with an asterisk (*) two backbone hydrogen bonds stabilizing the α helix. Hydrogen atoms are not depicted in this representation. Draw them in where needed to show a hydrogen bond.
8. Place a square around four separate amino acid side chains (R-groups).

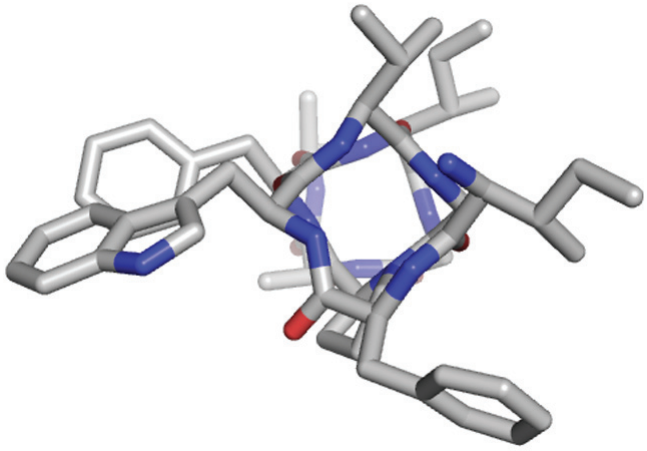
Model 1A
Vertical view of a stick model of a protein α helix



Part II. Use Model below 1B to answer questions 9 through 12. The stick model from Part I has been rotated 90° to face you, looking down on top of the protein α helix.

9. Label the central axis (interior) of the helix.
10. Label the exterior of the helix.
11. Place a square around four separate amino acid side chains (R-groups).
12. Are the amino acid side chains (R-groups) facing the interior or exterior of the protein α helix?

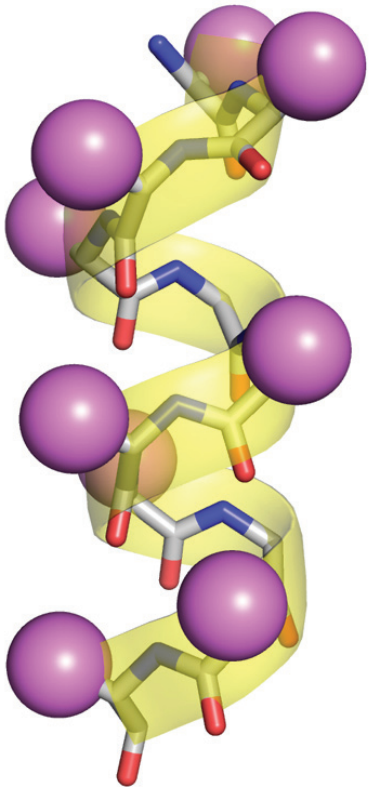
Model 1B
Stick model of a protein α helix, N-terminus view



Part III. Use Model 2A to answer questions 13 through 17. A ribbon diagram (shown in yellow) has been superimposed on a stick diagram of a protein α helix.

13. Label the N and C terminus with "N" and "C".
14. Circle four peptide bonds.
15. What intramolecular force stabilizes secondary structures but is not explicitly shown on a ribbon diagram?
16. What groups are not represented on a ribbon diagram (in yellow)?
17. What does the ribbon diagram reveal about the peptide structure?

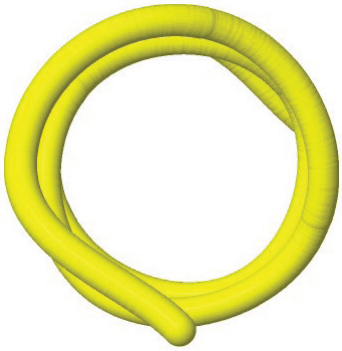
Model 2A
Protein α helix ribbon diagram (in yellow) superimposed on a stick diagram. R-groups are shown as purple balls.



Part IV. Use Model 2B to answer questions 18 and 19. It is a protein α helix ribbon diagram rotated toward you 90°.

18. On the ribbon diagram, starting at 12 o'clock, indicate the position of 4 amino acid side chains (R-groups).
19. Are the amino acid side chains (R-groups) facing the interior or exterior of the protein α helix?

Model 2B
Protein α helix ribbon diagram, N-terminus view

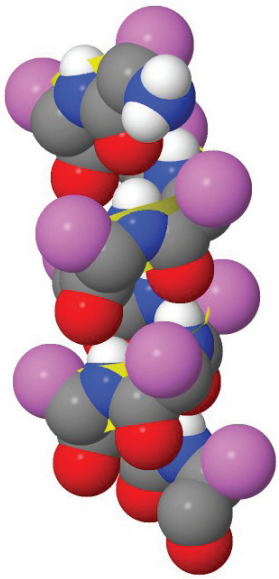


Part V. Use Model 3a to answer questions 20 and 21. It is a space filling diagram of a protein α helix superimposed on a ribbon diagram.

20. Label the N and C terminus with and "N" and "C".

21. Place a square around four separate amino acid side chains (R-groups).

Model 3a
Space filling diagram of a protein α helix superimposed on a ribbon diagram (shown in yellow). R-groups are shown as purple balls.



Part VI. Use Model 3b to answer questions 22 through 27. It is a space filling diagram of a protein α helix rotated toward you 90°.

22. Identify the central axis (interior) of the helix.

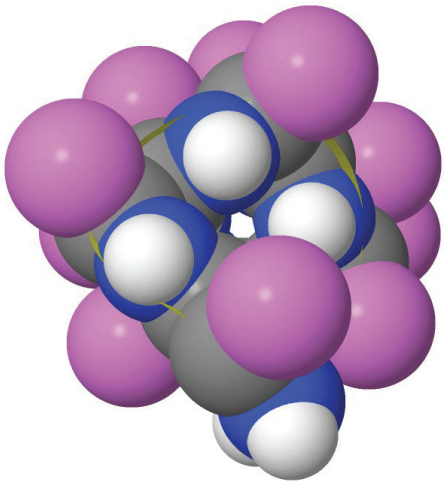
23. Identify the exterior of the helix.

24. Identify the four amino acid side chains (R-groups) with a square.

25. Are the amino acid side chains (R-groups) facing the interior or exterior of the protein α helix?

26. How does the space filling model change your perception of the inside of the protein α helix as compared to ribbon diagram in Model 2b?

Model 3b
Space filling diagram of a protein α helix, N terminus view. R-groups are shown as purple balls.



27. Can a single protein α helix serve as a pore to allow water pass through a membrane? Why or why not?