Explore the 3D Structure of Insulin

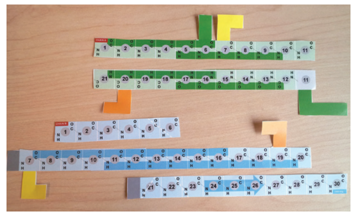
pdb101.rcsb.org

The Insulin hormone controls blood glucose levels. To learn more about the function of insulin, visit **pdb101.rcsb.org** and read the *Molecule of the Month* on Insulin.

To learn more about the primary, secondary, tertiary and quaternary levels of protein structure, watch the *What is a Protein?* video at **bit.ly/2AlDxW7**

1. Preparation:

Cut out the five strips on the dotted line. Make sure to separate the conjoined strips. The green, orange, and yellow tabs have to remain attached to their respective strips.

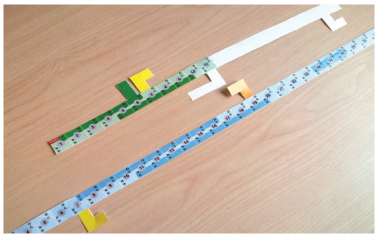


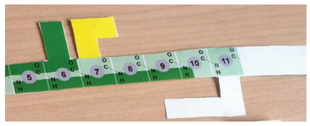
Primary Structure

2. Protein Chains:

Proteins are polymer **CHAINS** of amino acid residues. Each number on the model represents one amino acid residue.

Insulin has 2 chains. Chain A is green; chain B is blue.



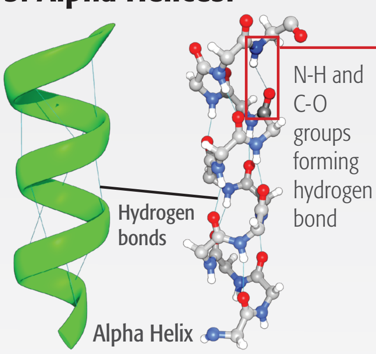


2.1. Chain A: Tape together the two pieces of the A chain (green) so that residue 11 is back-to-back in the two pieces, as shown in the picture.

2.2. Chain B: Tape together the three pieces of the B chain (blue) by overlapping the gray tabs at the ends, so that all the numbers are visible on one side and all the numbers are in order.

Secondary Structure

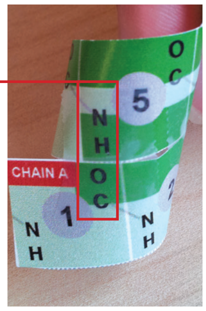
3. Alpha Helices:



Some sections of amino acid chains curl and form **ALPHA HELICES** due to **HYDROGEN BONDS** between N-H and C-O groups.

The helix regions on the model are marked on the chains with **darker shades of green and blue.**

3.1. Chain A: Starting with residues 1 and 5 form a hydrogen bond between C-O and N-H, and tape together.



3.2. Keep creating the hydrogen bonds until you reach the end of the darker colored area. When you reach residue 6, make sure the green tab is on the **outside** of the helix.

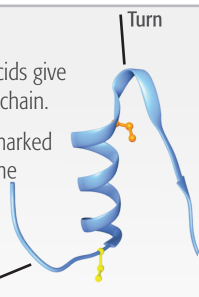
3.3. Create another alpha helix starting with residues 17 and 21. Keep creating hydrogen bonds until you reach the end of the darker colored area.

3.4. Chain B: Starting with residues 7 and 11, form a hydrogen bond. Keep creating the alpha helix until you reach the end of the darker colored area.

4. Turns:

Some amino acids give a **TURN** to the chain.

The turns are marked on chain B of the paper model with the **white dashed lines**.



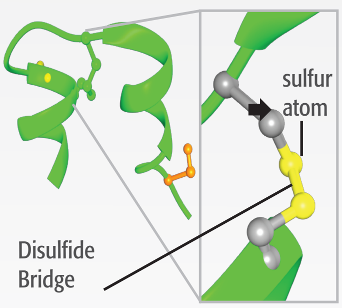
4.1. Fold outwards on the white dashed lines to create the turns. You can secure the folds with tape.

Note: Chain B also includes a beta strand marked with a blue arrow.

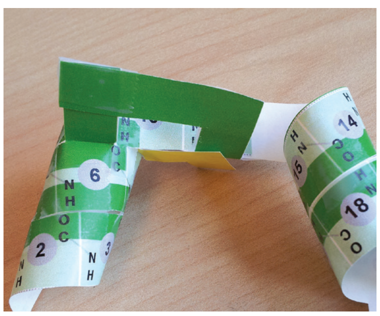
Tertiary and Quaternary Structure

5. Disulfide Bridges:

The structure of Insulin is stabilized by **3 DISULFIDE BRIDGES**. A disulfide bridge is formed when a sulfur atom from the residue cysteine forms a single covalent bond with a sulfur atom from a second cysteine.

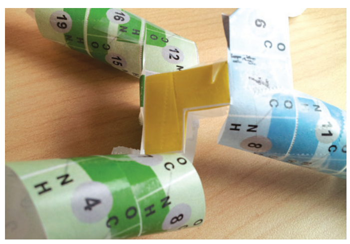


5.1. The first disulfide bridge connects 2 cysteines in chain A. To form the bridge, connect the green tabs as seen on the photo.



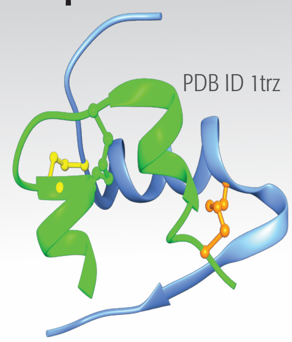
The second and third disulfide bridges (represented by orange and yellow tabs) are formed between chains A and B.

5.2. Connect the **yellow** tabs, matching their shape while making sure the colored sides are facing the same way.



5.3. Connect the **orange** tabs matching their shape while making sure the colored sides are facing the same way.

Complete model:



Go to **pdb101.rcsb.org** *(Learn > Paper models)* to **DOWNLOAD** additional copies of this model, to watch a **VIDEO DEMONSTRATION** of how to build it, and to access a **DIGITAL ACTIVITY PAGE** allowing for further exploration of the 3D model.

PDB-101 is the educational portal of RCSB Protein Data Bank (**rcsb.org**)

RCSB PDB-101

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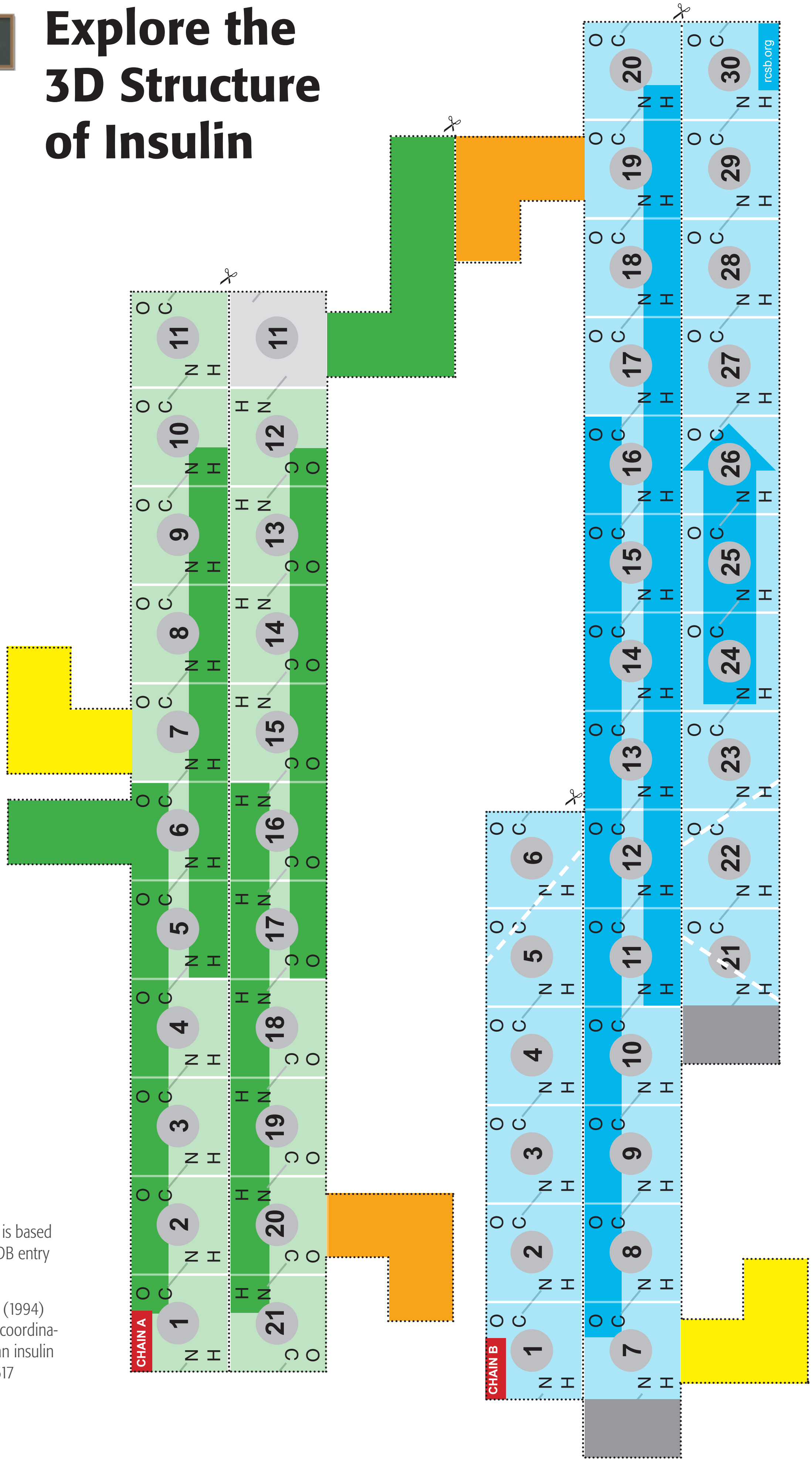

The template for this paper model is based on the human insulin structure (PDB entry 1trz, chains A and B).

PDB ID 1trz: E. Ciszak, G. D. Smith (1994) Crystallographic evidence for dual coordination around zinc in the T3R3 human insulin hexamer. *Biochemistry* **33**: 1512-1517