Name:
Date:

WA9 – Histones, Superhelices, and Quaternary Structures

Download and then open the file, **1aoi_Superhelices_Animation** using PyMOL. This particular structure contains a DNA double helix, which is itself wrapped in a helix around a collection of α-helices. This is a type of protein called a histone, which wraps and orders DNA into chromosomes.

1. The central protein in this macromolecule is made from many α-helices, which are held together by hydrogen bonds. What would happen to the secondary structure of the polypeptide chains if these hydrogen bonds were removed? **Select Protein_polar_conts** to visualise them.
   The secondary structures, which are α-helices, are held together by hydrogen bonds. Removing these hydrogen bonds would cause the protein to **denature**, and the secondary structures would lose their shape.

2. What would happen to the quaternary structure of the protein if these hydrogen bonds were removed?
   The **quaternary structure is the overall protein shape made by combining the individual polypeptide chains**. The quaternary structure will be held together, in part, by hydrogen bonds, so removing these would disrupt the structure. As the secondary structures will have denatured, the polypeptide chains will be **unable to form the specific quaternary structure** which is shown.

3. What would happen to the primary structure if these hydrogen bonds were removed?
   Nothing, as the primary structure is simply the sequence of amino acids in a polypeptide chain.

4. Using your knowledge of proteins, explain why the amino acids which constitute a protein have formed this particular shape and structure. Include in your answer: Primary, Secondary, Tertiary, and Quaternary Structure. Condensation. Hydrogen bonding. α-helices. Polypeptide.
   The **amino acids polymerise** in a **condensation** reaction between the amino group of one, and the carboxylic acid group of another, to form long chains of amino acids called **polypeptides**. The order of amino acids in a polypeptide is called the **primary structure**. These polypeptide chains have lots of varying **side chains**, which have different chemical groups and **properties**. These side chains will **interact**, **folding** the polypeptide chain into a specific shape called its **secondary structure**. An example of a secondary structure is an **α-helix**, which is a regular coiled structure, held together by **hydrogen bonding** between the amino acid side chains. A polypeptide chain can have many secondary structures along its length, and the overall shape of the polypeptide chain, including its individual secondary structures, is known as the **tertiary structure**. This is the ove**rall 3D shape of a polypeptide**

chain. The interactions which hold the secondary and tertiary structures in place, such as hydrogen bonding, **disulfide bridges**, and **ionic interactions** can also cause different polypeptide chains to interact and join together using **non-covalent bonds**. When multiple polypeptide chains combine in this way, they produce a **quaternary structure**.

5. Using your knowledge of DNA, explain why the nucleotides which constitute it have formed into a double helix structure. Include in your answer: Nucleotide. Base. Double Helix. Complementary. Condensation. Ribose.

   Nucleotides are **monomers** which have three parts, a variable nitrogenous **base**, a ribose **sugar** group, and a **phosphate** group. The nucleotides combine via **condensation** reactions between the sugar of one, and the phosphate group of another. This forms a **polynucleotide** which has a **sugar-phosphate backbone**. Two DNA **strands** will combine when the DNA bases on each **hydrogen bond** to each other, forming a **double helix** structure. This can only happen when the bases on one strand are **complementary** to the bases on the other, such that the DNA bases will pair up specifically as **AT** and **CG**, where A=adenine, T=thymine, C=cytosine, and G=guanine.