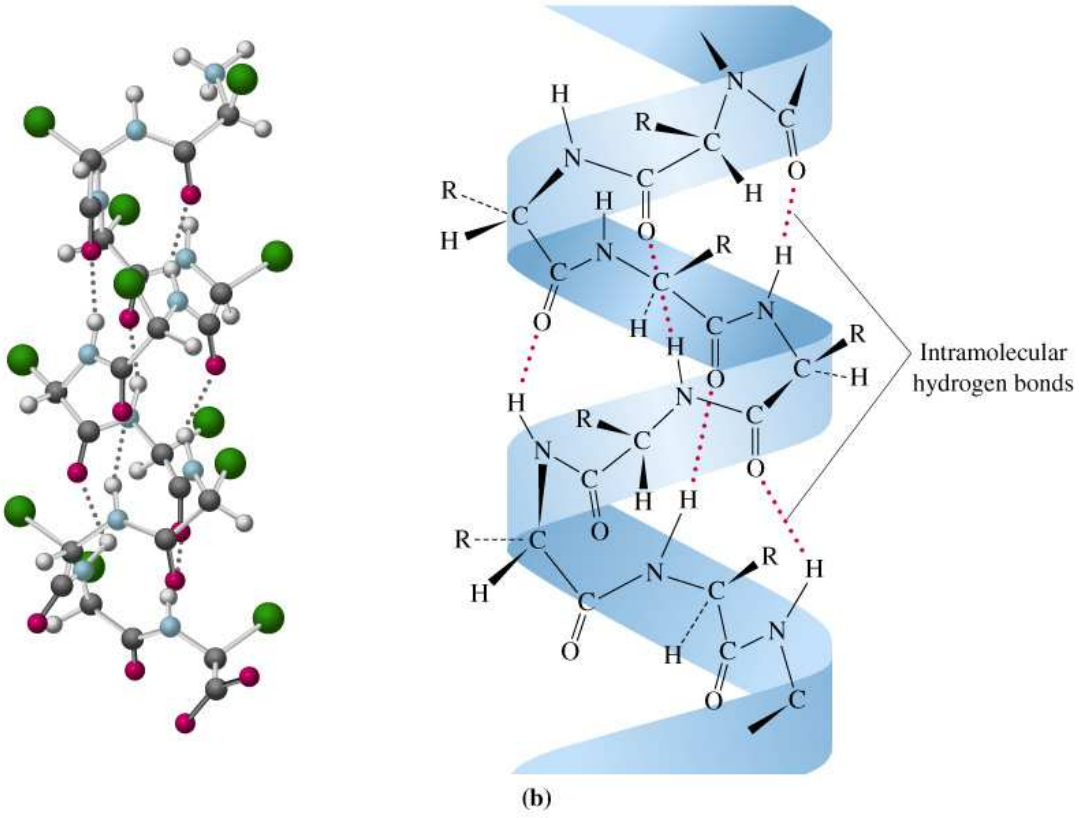
# Linus Pauling: Discovering Protein

In the 1950's, Linus Pauling became known as the founder of molecular biology due to his discovery of the spiral structure of proteins (Taton, 1964). Pauling's discoveries contributed to Watson and Crick's breakthrough of the DNA double helix. Pauling made it possible for geneticists to crack the DNA code of all organisms and develop techniques to help prevent the inheritance of genetic disorders.

In 1922, Pauling studied a technique known as X-ray crystallography "which makes it possible to determine the arrangement of atoms in a crystal" (Taton, 1964, p.298). Although X-ray crystallography was discovered by scientist W.H. Bragg, Pauling quickly deduced rules of interpreting X-ray diffraction, allowing him to figure out the shape of proteins and provoking the discovery of the DNA double helix. In 1948, Pauling was stricken with an illness that confined him to bed. During this time, he was able to ponder on Astbury's idea that "globular proteins are made up of polypeptide chains that are folded to make balls", (Gribbin, 2002, p. 561). Pauling used his knowledge of X-ray crystallography and his understanding of chemistry rules to determine how amino acids fit together to make proteins (Gribbin, 2002). After using paper to make models and working with jigsaw puzzles, he eventually figured out the structure of the alpha helix of globular proteins. Pauling discovered the hydrogen bond that forms been the hydrogen in the amine group of one amino acid and the oxygen from the carboxyl group of another amino acid. The large number of hydrogen bonds within a protein that is formed between each amino acid strengthens proteins, (H. Hart, Craine, D. Hart, 1999). Because of the size of the amino acids and the proteins, the molecule forms a helix.




*Images taken from google images*

Because Pauling determined the alpha helix of globular proteins, he was able to contribute to the discovery of the difference in the hemoglobin between people with and without sickle-cell. In 1940, a medical student at Johns Hopkins by the name of Irving Sherman noticed a difference in the transmission of light through red blood cells of patients with and without sickle cell, (Bloom, 1995). Dr. William Castle of Harvard told Pauling about Sherman's observation one day on a train ride. Pauling later performed a technique comparing proteins among people with sickle cell, without sickle cell and carrying a gene for sickle cell (Bloom, 1995). He found that the hemoglobin of those with sickle cell differed from those without it. The carriers of sickle cell had both types of hemoglobin, (Bloom, 1995). Pauling concluded that there is a difference in a gene of the two types of protein.

In 1956, Vernon Ingram of Cambridge further studied the protein hemoglobin (Bloom, 1995). Hemoglobin is a protein in red blood cells that allows oxygen to bind and be transported to various tissues within the body, (Platt & Sacerdote, 2002). The abnormal shape of red blood cells of people with sickle cell prevents oxygen from binding which causes them to receive less than adequate amounts of oxygen. The lack of oxygen to organs causes pain and damaged red blood cells become destroyed leading to anemia, (Platt and Sacerdote, 2002).

*The following picture shows sickle shaped red blood cells and normal shaped red blood cells.*


*Images taken from google images*
*www.pueblo.gsa.gov*

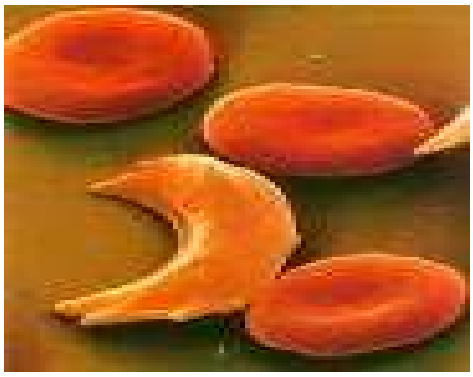
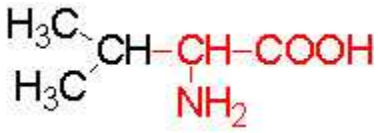


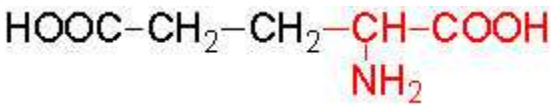
*Image taken from google images*
*http.www.defiers.com*

Cambridge discovered that the amino acid valine was present in the hemoglobin of people with sickle cell and glutamic acid was in the hemoglobin of people without sickle cell. Both valine and glutamic acid have a steric number of 3, trigonal planar geometry, sp2 hybridization, and a bond angle of 120. This difference between valine and glutamic acid that affects the bonding of oxygen is the side chain. Glutamic acid, the amino acid in normal hemoglobin has an acidic side chain, but valine, the amino acid in abnormal hemoglobin, has a nonpolar side chain. The side chain in all amino acids always faces outward. (Hart *et al*, 1999). Valine's nonpolar side chain, which faces outward is hydrophobic and will not form a hydrogen bond with oxygen. This deoxygenated hemoglobin begins to clump causing the red blood cells to form a sickled shape in those with or carrying a gene for sickle cell (McMurry & Fay, 1995).

***VALINE***



***GLUTAMIC ACID***



*Molecules in black are the side chains that vary in each of the 20 amino acids, giving them their unique properties. Red are the common structure in amino acids. Images taken from http://inquiry.uiuc.edu/bioweb/tutorial/amino_acids.htm*

Contributions made by Pauling, Mendel, Watson and Crick, just to name a few, have laid the foundation for the technological advances such as the human genome project and stem cell research. However, just as controversy existed in the past concerning these advances, they continue to exist. According to Aldous Huxley's Brave New World says "Work, play-at sixty our powers and tastes are what they were at seventeen. Old men in the bad old days used to renounce, retire, take to religion, spend their time reading, thinking-*thinking*!" (Huxley,1932, p.55).

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