## SEEDBEd Activity: Sickle Cell, Amino Acids and Protein Folding[1]

1) In small groups, transcribe and then translate the DNA sequences found in Table I.
2) Using your colored pencils, color the amino acids on Table I according to Table II below.
3) Place the amino acid pieces onto the plastic, flat round chart using the "key" provided.
4) Using the 4 foot Toober, attach the correct amino acids (translated in your chart) to each metal "C" clamp.

5) Then "fold" your protein into the correct functional shape. You will need to follow some basic laws of chemistry to do this:
   Acidic groups and basic groups tend to form salt bridges.
   Hydrophobic side chains are buried inside the protein to avoid water.
   Polar (Hydrophilic) side chains have an affinity for water.
   Cysteines will form a disulfide bond to stabilize protein shape.
6) As a group, share evidence with your classmates of proper folding using your "protein" model of the four rules listed in Step 4.

7) Scientists number the amino acids beginning with the N-terminus just as they were numbered in the diagram of the Mini-Toober you folded. Those numbers are called residue numbers. The N-terminus is the first amino acid that is put in place when the protein is made during a biological process called translation. Each amino acid is then added one at a time until the sequence is complete. The numbers allow researchers to easily refer to a specific amino acid residue in the chain.

8) Use the folded Mini-Toober you just completed and change one of the acidic amino acids in your sequence to glutamic acid. If you already have a glutamic acid in your chain, just leave it.
   Look up the properties of glutamic acid on the Amino Acid Chart.
   Is it polar or non-polar? _____
   Hydrophilic or hydrophobic? _____
   Acidic, basic or neutral? _____
9) Sickle cell anemia is a disease caused by a single mutation in the gene that codes for β-globin, a subunit of hemoglobin. Amino Acid #6, glutamic acid, is replaced with another amino acid at that position. The new amino acid is valine. This mutation leads, to sticky, deformed red blood cells.
   Look up the properties of valine.
   Is it polar or non-polar? _____
   Hydrophilic or hydrophobic? _____
   Acidic, basic or neutral? _____

[1] Activity Adapted from Models and Literature of 3-D Molecular Designs http://www.3dmoleculardesigns.com/ and the Milwaukee School of Engineering Center for BioMolecular Modeling http://www.rpc.msoe.edu/cbm/

Table I:

| DNA | TTT | ACG | GAA | GTA | TCA | CCA | CTA | ACA | CGA | CAA | GAA | TGA | CTT | CAA | ATA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mRNA | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| DNA | ACG | GGG | ACC | CTC | AAA | AAA | CTG | GTC | GAT | TAA | GTG | ACG | GCC | TTA | TTA |
| mRNA | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | |

Table II:

| **Amino Acid** | **Color** | **Reason** |
|---|---|---|
| Lysine (Lys) | Blue | Basic |
| Arginine (Arg) | Blue | Basic |
| Histidine (His) | Blue | Basic |
| Aspartic Acid (Asp) | Red | Acidic |
| Glutamic Acid (Glu) | Red | Acidic |
| Glycine (Gly) | Yellow | Hydrophobic |
| Alanine (Ala) | Yellow | Hydrophobic |
| Valine (Val) | Yellow | Hydrophobic |
| Leucine (Leu) | Yellow | Hydrophobic |
| Isoleucine (Ile) | Yellow | Hydrophobic |
| Methionine (Met) | Yellow | Hydrophobic |
| Phenylalanine (Phe) | Yellow | Hydrophobic |
| Tryptophan (Trp) | Yellow | Hydrophobic |
| Proline (Pro) | Yellow | Hydrophobic |
| Serine (Ser) | White | Polar |
| Threonine (Thr) | White | Polar |
| Tyrosine (Tyr) | White | Polar |
| Asparagine (Asn) | White | Polar |
| Glutamine (Gln) | White | Polar |
| Cysteine (Cys) | Orange | Cysteine (S-S) |