



SEEDBED Activity: Sickle Cell, Amino Acids and Protein Folding¹

- 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.msoc.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)