AGENDA for 02/18/14

- AGENDA:
  1. 3.2.3. Does Changing One Nucleotide Make a Big Difference?

- OBJECTIVES:
  1. Use computer simulated proteins to visualize the interactions between amino acids
  2. Analyze protein structural changes

- HOMEWORK:
  - Due **<u>Thurs, 02-20</u>**
    1. 3.2.3 Activity Packet

  - 3.2.3 Conclusion Quiz

3.2 Key Terms

1. Amino Acid
2. Anticodon
3. Codon
4. Hydrophilic
5. Hydrophobic
6. Messenger RNA (mRNA)
7. Mutation
8. Nucleotide
9. Protein
10. Protein Synthesis
11. Ribonucleic Acid (RNA)
12. Ribosome
13. Transcription
14. Transfer RNA (tRNA)
15. Translation

Essential Questions for 3.2.2

4. How does the sequence of nucleotides in DNA determine the sequence of amino acids in a protein?
5. What is a mutation?

Activity Objectives – 3.2.2.

1. Decode the DNA message
2. Investigate the effect that various mutations have on protein production

3.2.2. Conclusion Question

1. Describe (in words) the effect of the mutation.
2. Was the mutational effect greater in a substitution or a deletion? Explain your answer clearly.
3. Why do you think scientists call a substitution a “point mutation”? Why do you think scientists call a deletion (or an insertion) a “frameshift mutation”?
4. Note the two transcribed and translated DNA strips below. The two strips are identical except for a point mutation, where the 15^{th} base was changed from a G to a T. Fill in the corresponding mRNA, tRNA, and letter in the blanks below for the mutated DNA strip. In the space below, explain how this point mutation changes the protein.

   Normal DNA:
   GTTGGCGAATGAACGGAGGCTGACGTCTAAGCCTAGAAAAATTGG
   mRNA:
   CAACCGCUUACUUGCCUCCGACUGCAGATTCGGAUCUUU UUAACC
   tRNA:
   GUUGGCGAAUGAACGGAGGCUGACGUCUAAGCCUAGAAAAAUUGG
   Sentence:
   SHE READS A LOT
   Mutated DNA:
   GTTGGCGAATGAAC_T__GAGGCTGACGTCTAAGCCTAGAAAAATTGG
   mRNA:
   CAACCGCUUACUUG___CUCCGACUGCAGATTCGGAUCUUU UUAACC
   tRNA:
   GUUGGCGAAUGAAC___GAGGCUGACGUCUAAGCCUAGAAAAAUUGG
   Sentence:
   SHE __EADS A LOT
5. What is the difference between normal and sickle hemoglobin at the DNA, RNA, and protein (amino acid) level?
6. What type of mutation is the sickle hemoglobin mutation? Explain.
7. Glutamic acid (Glu) and valine (Val) are two amino acids with different molecular structures. (Glutamic acid is a strongly hydrophilic molecule, and valine is a strongly hydrophobic molecule. This is something you will learn more about in the next activity). Why do you think switching the hemoglobin gene’s sixth amino acid from glutamic acid to valine would affect the hemoglobin protein?

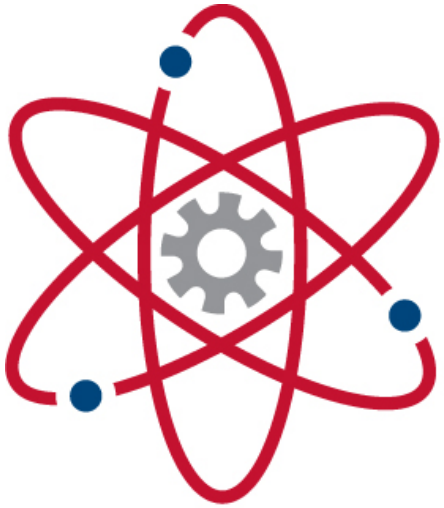
First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	(start) methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

Essential Questions for 3.2.3

6. What determines the shape of a protein?
7. Is the shape of a protein affected by its surrounding environment?
8. How does a change in the DNA code affect the shape of a protein?
9. Can changing just one nucleotide in a gene change the shape of a protein?

Activity Objectives – 3.2.3.

1. Use computer simulated proteins to visualize the interactions between amino acids
2. Analyze protein structural changes



PROJECT LEAD THE WAY

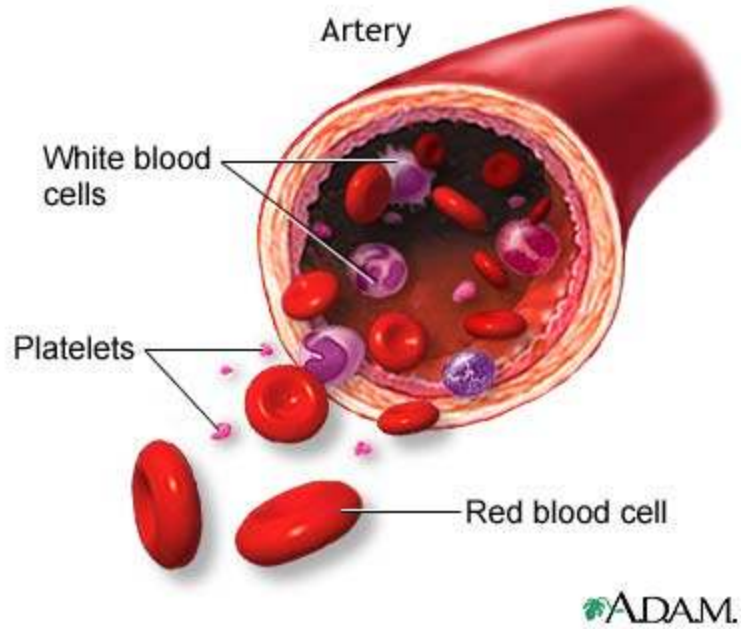
PLTW

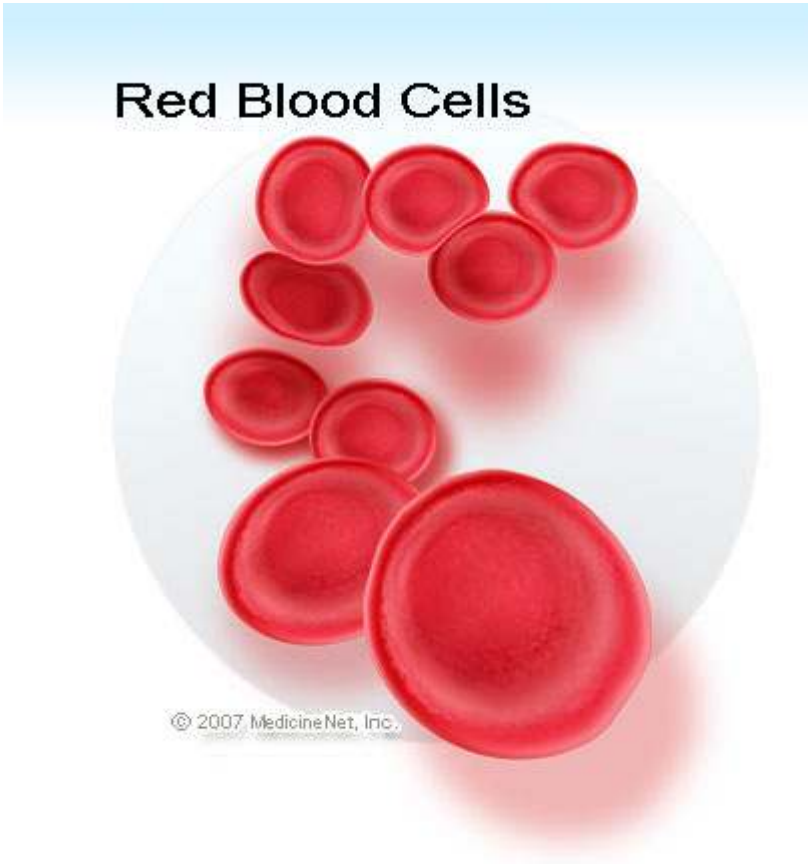
Igniting imagination and innovation through learning.

3.2.3 Notes: Hemoglobin

Red Blood Cells

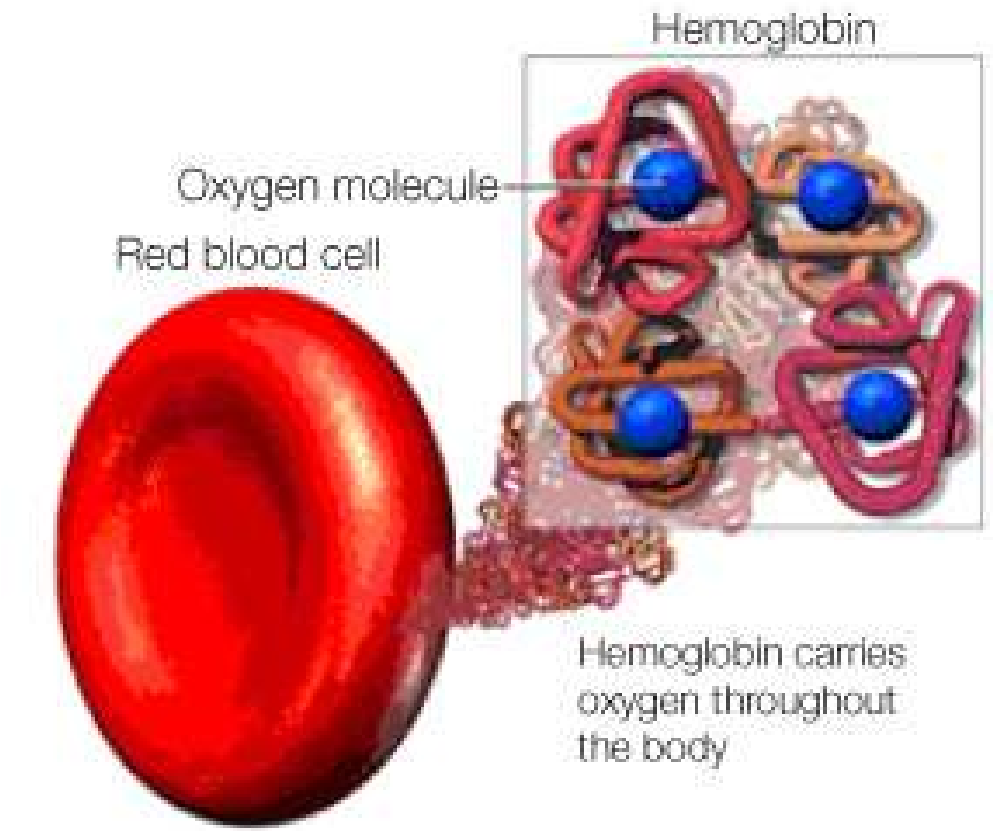
- Carries oxygen from lungs to all cells of the body via the blood





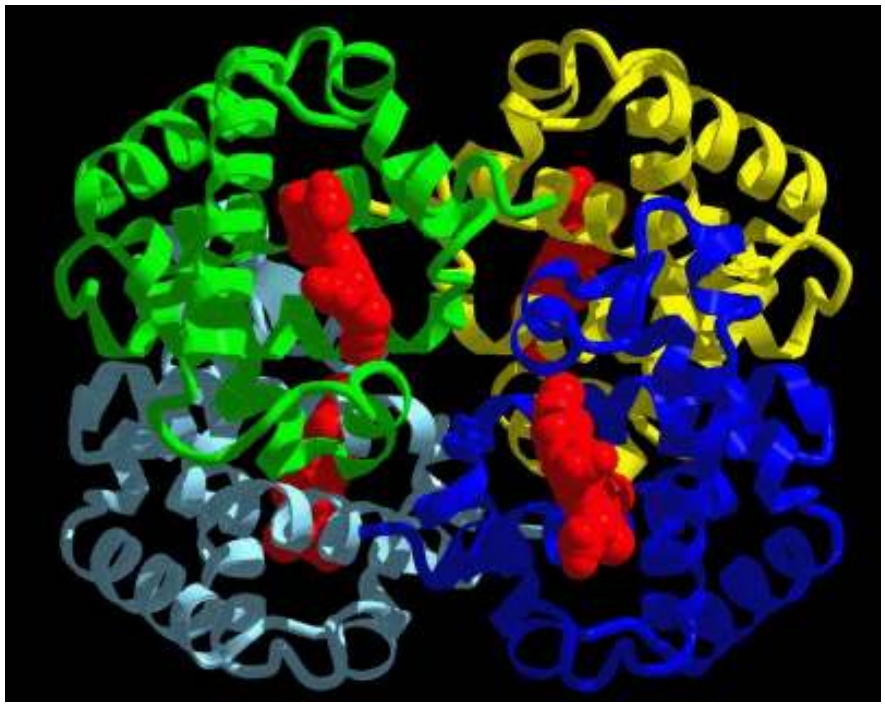
Hemoglobin

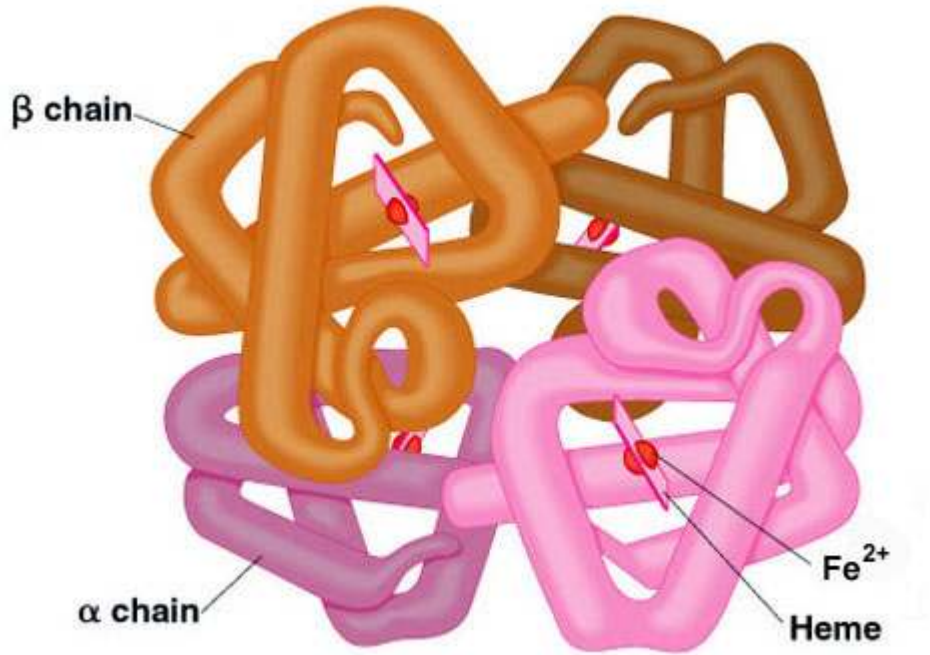
- Main component of red blood cells
- It is a protein
- Main job is to bind oxygen and carry to other cells



Hemoglobin

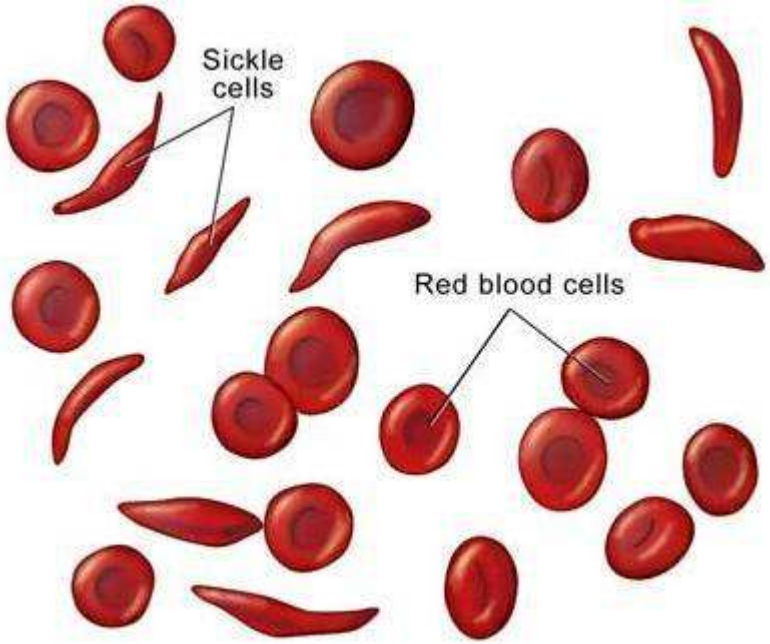
- Composed of 4 subunits
- Each subunit has a *heme* group made of iron (Fe) which binds to oxygen

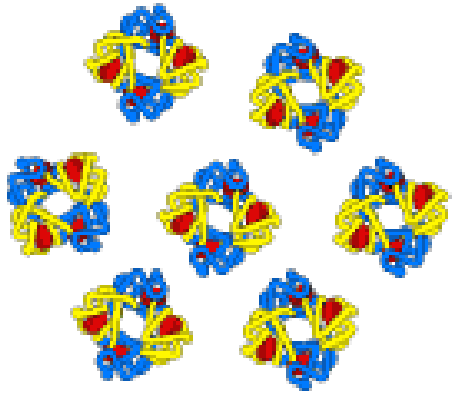




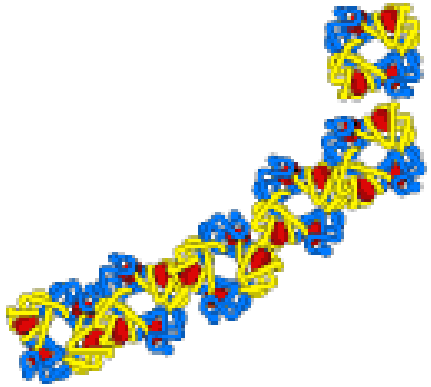
Hemoglobin in Sickle Cell

- Hemoglobin in sickle cells are abnormal
- They clump together and form the sickle shape
- They clog arteries and are not able to bind oxygen effectively

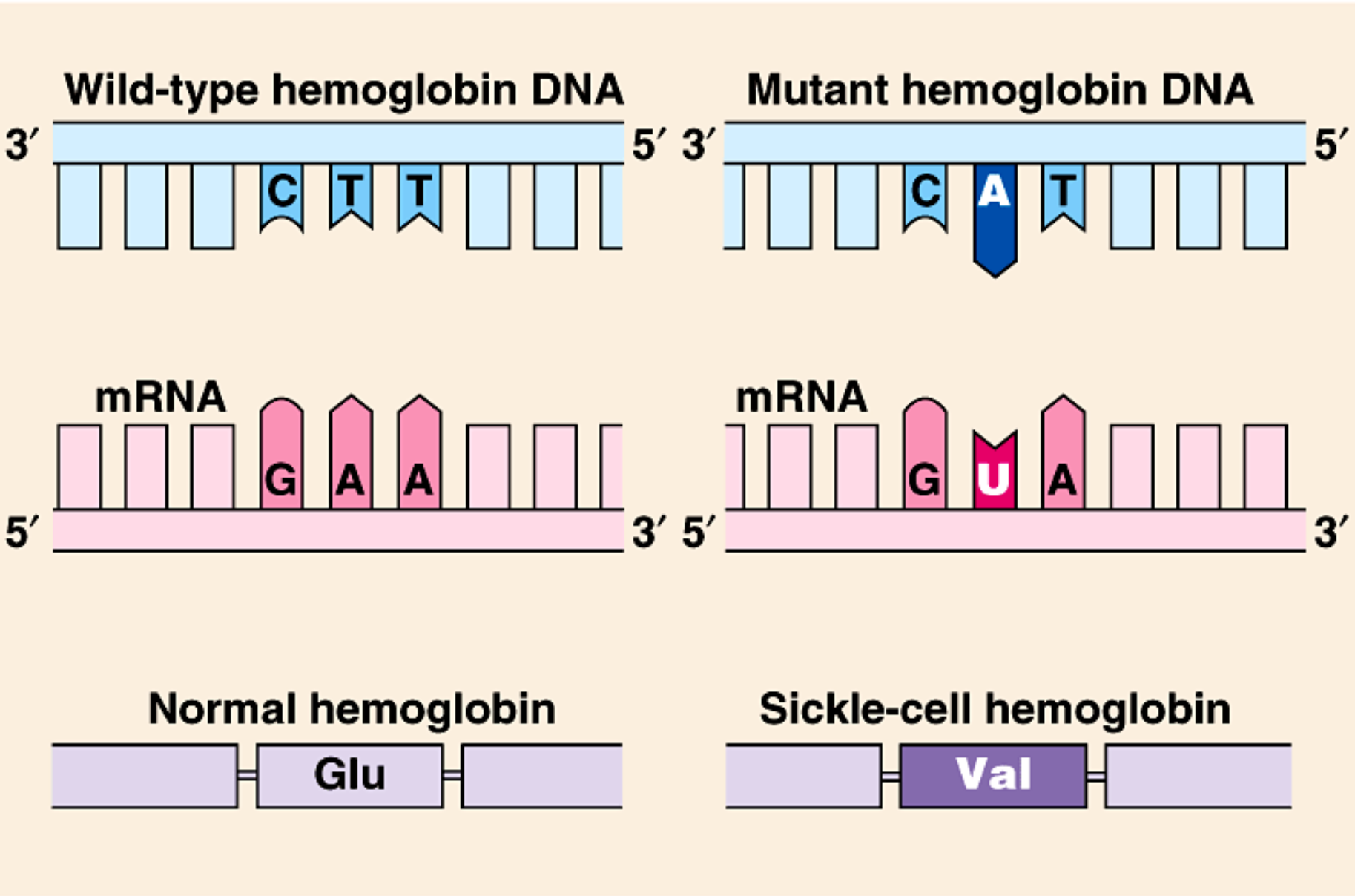




NORMAL HEMOGLOBIN

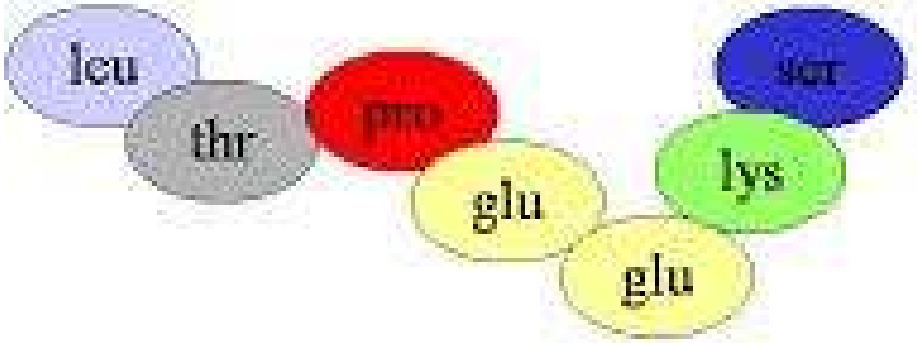


CLUMPED HEMOGLOBIN

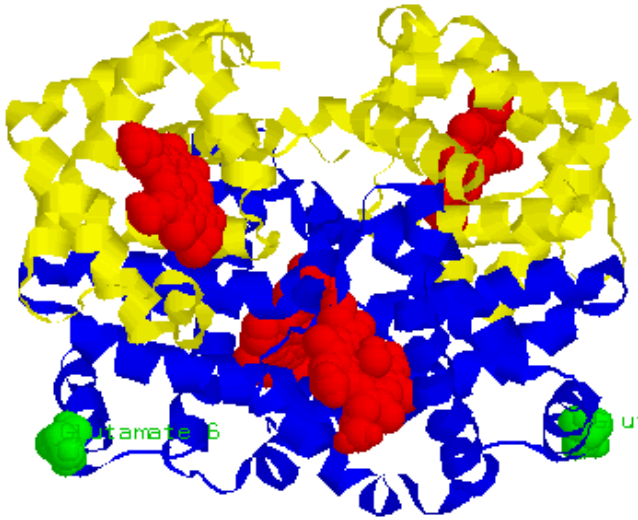


Amino Acid Sequence

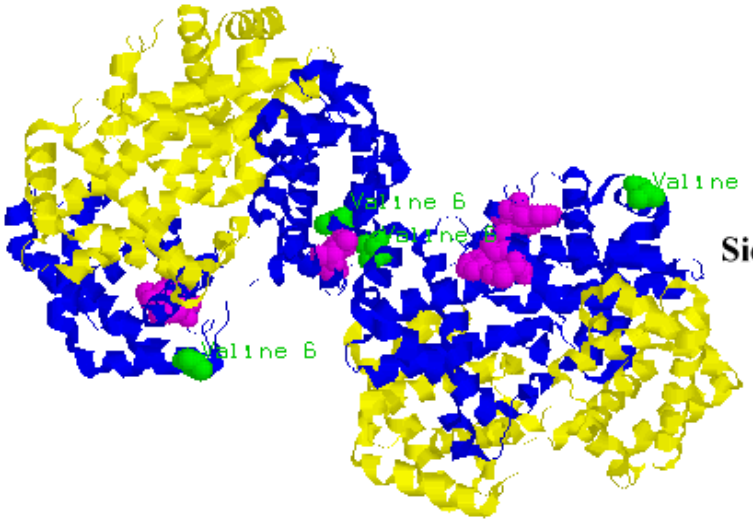
Normal hemoglobin (HbA)



Sickle cell hemoglobin (HbS)

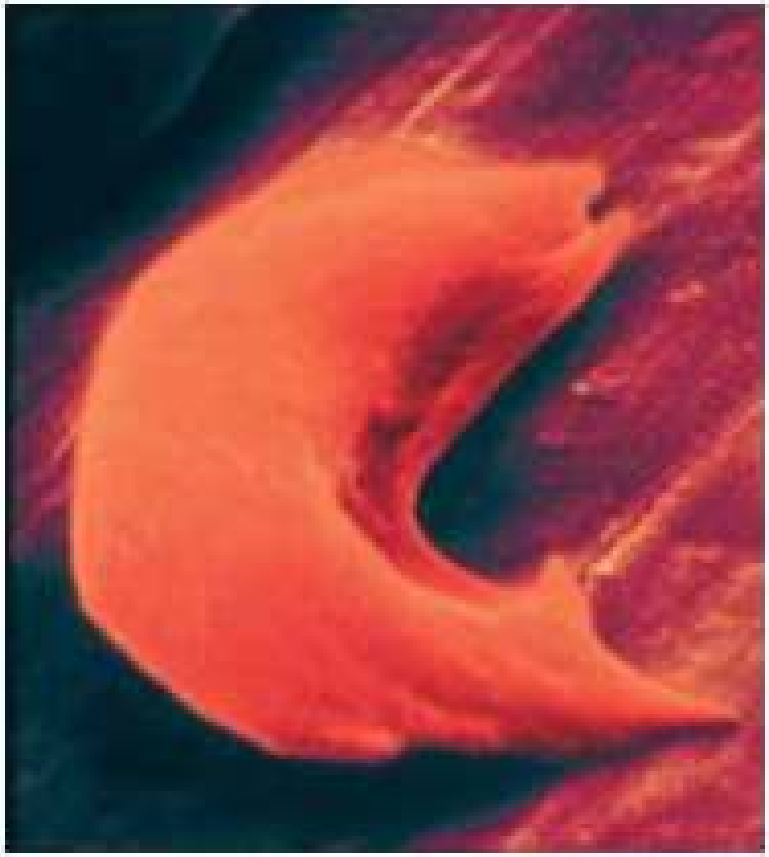


Normal Hemoglobin



Sickle Hemoglobin

Note: The Sickle hemoglobin image is drawn at 50% of the size of the Normal hemoglobin



Sickle-cell phenotype

Normal phenotype

3.2.3 Activity Checklist

1. 3.2.3. Compare and Contrast Sickle Cell Anemia and Tay Sachs (NB) 3
2. 3.2.3. How Do Amino Acids React to Water and Oil (NB) 3
3. 3.2.3. Molecular Workbench – Part 1 (NB) 5
4. 3.2.3. Molecular Workbench – Part 2 (NB) 5
5. 3.2.3. Participation STAMP 2

Total = 18

3.2.3. Activity Directions

3.2.3. Compare and Contrast Sickle Cell Anemia and Tay Sachs (NB)

1. Refer to curriculum file for more detailed instructions
2. Refer to steps 1-3
3. Click on the link to watch the video: **http://www.pbs.org/wgbh/nova/genome/program_t.html**
   - Watch from 15:07 to 25:23 (you may watch the entire video at home)
4. Using a graphic organizer (Venn diagram, chart, table) of your own choosing, compare and contrast sickle cell anemia to Tay Sachs disease
5. Must have at least **15 bullet points total**

3.2.3. How Do Amino Acids React to Water and Oil (NB)

1. Refer to curriculum file for more detailed instructions
2. Refer to step 5
3. Go to the link: **http://www.concord.org/~btinker/workbench_web/unitV/mol_water_bg.html**
4. Answer the following questions in your NB:
   - List and describe, in your NB, the **4** forces acting on amino acids placed in water. These four forces ultimately determine the shape of a protein.
   - Write definitions, in your NB, for the words *hydrophobic* and *hydrophilic*.
   - Describe, in your laboratory journal, how hydrophobic and hydrophilic amino acids react to water and to oil.

3.2.3. Molecular Workbench – Part 1 (NB)

1. Refer to curriculum file for more detailed instructions
2. Refer to steps 6-28
3. You will be accessing a molecular simulation program for this activity at this link: **http://mw.concord.org/modeler/** (let the teacher know if there are problems accessing this program)
4. Follow the instructions outlined in the curriculum file
5. Answer or do the following questions in your curriculum file:
   - 13, 14, 21, 22, 27

3.2.3. Molecular Workbench – Part 2 (NB)

1. Refer to curriculum file for more detailed instructions
2. Refer to steps 29-49
3. You will be accessing a molecular simulation program for this activity at this link: **http://molit.concord.org/database/activities/281.htm** (let the teacher know if there are problems accessing this program)
4. Follow the instructions outlined in the curriculum file
5. Answer or do the following questions in your curriculum file:
   - 34, 48
6. Print **1** report (you and your partner's name should both be on the same report) **If the printing option is not available, copy and paste it onto a word document and put it in the dropbox or e-mail it to the teacher.*

3.2.3. Participation

1. Instead of answering *Conclusion Questions*, we will be trying something different this semester
2. After the activity, reflect on the questions and the objectives of the activities
3. Be prepared to give your responses to:
   a) Essential Questions
   b) Conclusion Questions
   c) Questions about Key Terms
   d) Questions about the activities
   e) Your thoughts and explanations
4. You will receive a stamp for satisfactory responses

3.2.3. Conclusion Questions

1. What type of mutation is responsible for sickle cell disease and Tay Sachs disease?
2. Tay Sachs disease is caused by a mutation of one nucleotide for a protein that disrupts the activity of an enzyme in the brain. This leads to a toxic level of a substance to build up in neurons in the brain and spinal cord, leading to severe brain damage and eventually death. Why do you think that the change in one nucleotide can cause Tay Sachs disease to be fatal, whereas the change in one nucleotide causes sickle cell disease, a disease in which a person can lead a functional life?
3. What is the property of alanine (the amino acid that makes up this polymer chain) that helps explain its reaction to water and oil?
4. How are the properties of glutamic acid and valine different?
5. What effect do you think this change in amino acid sequence will have on the structure of the polypeptide?
6. Explain how just a change of one amino acid has such an effect.
7. Explain why the replacement of the glutamic acid by valine changes the way that molecules of b-globin interact with each other.
8. Explain why the change in the way that molecules of b-globin interact with each other lead to the sickling of the red blood cells in sickle cell anemia.