Biology Magnets Module 1: Organic Molecules - Teacher and Student Guides

Teacher Information

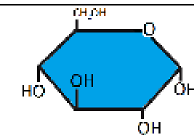
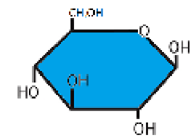
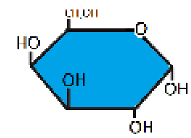
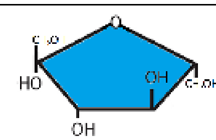
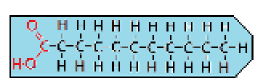
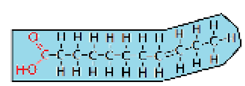
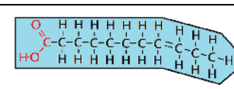
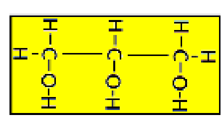
This module uses magnets designed for teacher and student interaction to guide learning the various classes of organic molecules. Contained in this guide are four different lesson ideas that can last from 10 minutes each to an entire class period, depending upon teacher preference. Each lesson has both teacher-centered and student-centered activities. The student-centered activities are most effective if students are in small groups. It may be necessary to have multiple magnet sets for large classes. A student handout is provided which can be printed out and given to each student group to help guide their progress as they work with the magnets. If budget or white board space is limited, groups can alternate between using a set of magnets and doing other activities. Teachers can refer to the videos posted at the Biology Magnet web site at Biologymagnets.com for guided teaching instructions.

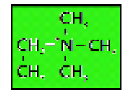
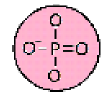
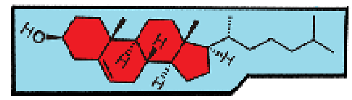
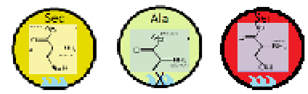
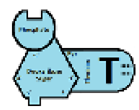
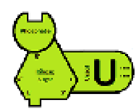
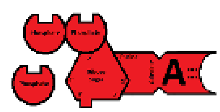
Magnet Care and Maintenance

Biology magnets are made to last for years. Periodically magnets will fall off or are knocked off the plastic. A piece of magnetic tape is included with each module, which should be able to replace around 10-12 magnets if necessary. Simply cut a new magnet and peel off the back to replace. Magnetic tape can be purchased from a hobby store to replace magnets lost over time. Laminate may peel off, especially on small pieces. Use transparent tape to re-attach laminate that comes loose, curling the tape over the back of the magnet. The machines used to cut Biology Magnets are not always perfectly accurate. Sometimes a bit of white or black outline on the edges occurs or a cut might be slightly off center. Use scissors to remove extra outline that is unnecessary if desired. Store magnets in the clasp envelopes in which they arrived for easy organization.

Organic Molecules Copyright Information

Biology Magnets Module 1 Materials List

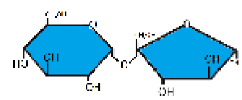
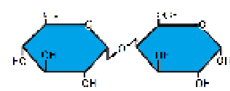
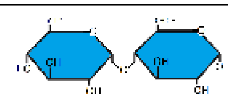
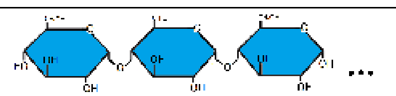
Magnet Name	Quantity	Picture
Alpha Glucose	4 (1 missing –OH and another missing –H)	
Beta Glucose	2	
Galactose	2	
Fructose	3	
Hydroxide Group	2	HO
Hydrogen	2	H
Saturated Fatty Acid	6	
Unsaturated Fatty Acid	3	
Unsaturated Fatty Acid	1	
Glycerol	3	

Nitrate Group (Choline)	2	
Phosphate Group	2	
Cholesterol	1	
Amino Acid	42	
String of Beads (represents primary protein structure)	2	
DNA Nucleotide	20	
RNA Nucleotide	12	
ADP + P	4	
3" Magnetic Tape Strip	1	
Total Quantity	**114**	

Lesson 1A – Carbohydrates (10-50 minutes)

Teacher Centered Activity (10-20 minutes): This lesson first utilizes the monosaccharides; alpha glucose, beta glucose, galactose, and fructose molecules. Begin the lesson by showing the students each molecule and their differences. These molecules are isomers, different structures of the same chemical formula, $C_6H_{12}O_6$. Explain to the students where each atom is located on the models and that scientists use shortcuts when drawing these molecules. For example, it is assumed that a carbon exists at each angle of the hexagon and that there are four bonds coming from each carbon atom. Discuss the function of these molecules, which are used for energy storage in photosynthesis by plants and algae, and for yielding energy to recycle ATP in all cells. Once the students have a good grasp of the monosaccharides, demonstrate that the molecules can come together (through dehydration synthesis/condensation reaction) to form disaccharides. Dehydration synthesis can be demonstrated with the models by removing the -OH from one glucose molecule and the -H from another which forms water and a covalent bond between the molecules. Demonstrate the reverse process of hydrolysis as well, breaking apart a disaccharide with water to yield two monosaccharides. Next, use the table (**Table 1.A.1**) to demonstrate some basic combinations that form disaccharides. Lastly, the monosaccharides bond together in long chains to form polysaccharides. Joining all of the monosaccharides forms the beginning of a polysaccharide. If possible, show pictures of polysaccharides such as starch, glycogen, cellulose, and chitin and discuss the differences. These pictures can be found on the internet or in textbooks. Describe polysaccharide functions, which range from long-term energy storage as in starch and glycogen to structural support as in cellulose and chitin.

Table 1.A.1: Common Carbohydrates Polymers

Monosaccharide Combination	Polymer	Example	Biology Magnet Configuration
Glucose + Fructose	Sucrose	Table Sugar	
Glucose + Galactose	Lactose	Milk Sugar	
Glucose + Glucose	Maltose	Malt Sugar	
Glucose + Glucose + Glucose + Glucose + Glucose…	Polysaccharide	Starch, Cellulose, etc.	

Student Centered Activity (10-30 minutes): After teaching the structures, put students into small groups. A copy of the student guide for carbohydrates may be given to each group if necessary. Have them take turns naming the monosaccharides and their function and "instructing" the other students in the group. Allow the students to correct and help one another. After finishing the monosaccharides, have them build and name the disaccharides. Have them show and describe condensation and hydrolysis reactions as well. Finally, have them build and name several examples of polysaccharides.

Extra exercises:

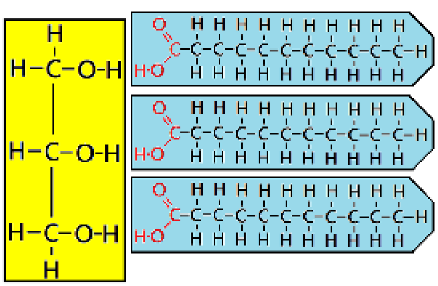
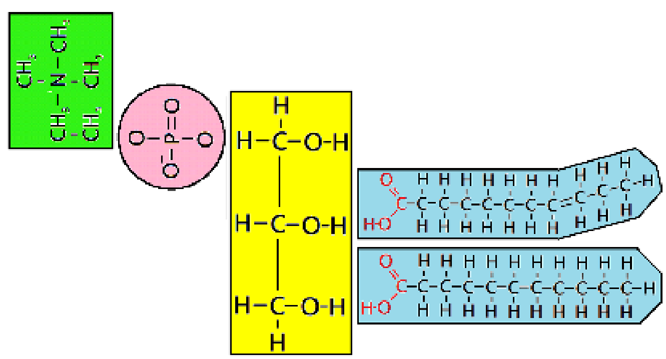
Research Monosaccharides: Have students go online and find other monosaccharides not represented with the magnets. Have them draw these with markers on the board. If you have extra magnetic tape, have the students draw them onto index cards and attach magnets to the back to create their own monosaccharide magnets. Students can research and build new disaccharides or polysaccharides as well if time allows.

Oral Quiz: Give an oral quiz by calling out names of molecules and have students identify or build them from memory.

3-D Modeling: If there are molecular modeling kits available, have the students build 3-D models of the various Biology Magnets. Have the students note the differences between the two-dimensional and three-dimensional representations.

Lesson 1B – Lipids (10-50 minutes)

Teacher Centered Activity (10-20 minutes): This lesson first utilizes the fatty acids. Describe and explain the difference between the saturated (straight chain) fatty acids and the unsaturated (bent chain) fatty acids which contain a double bond within the structure. Demonstrate how the fatty acids attach to the glycerol backbone. Explain that these are connected by a condensation reaction, where –OH is removed from glycerol and –H from the fatty acid to form water. Build a triglyceride, a glycerol with three fatty acid tails (**Figure 1.B.1**). Show how saturated fats can fit more closely together than unsaturated fats due to the straight chained fatty acids. This explains why saturated fats are normally solid at room temperature (butter) vs. unsaturated fats which are normally liquid (oils). Show phospholipid structure (**Figure 1.B.2**) by adding a phosphate group to the top of the outside carbon of the glycerol, and have two fatty acid tails, one saturated and one unsaturated, hanging from the OH groups on the bottom of the glycerol. Add a nitrogen group **(choline)** above the phosphate to complete the basic phospholipid structure. Demonstrate the amphipathic nature of a phospholipid molecule by showing that the phosphate and nitrate groups are polar, or charged (the phosphate is negatively charged and the nitrate is positively charged). This charge makes the head hydrophilic (attracted to water) while the fatty acid tails are uncharged and hydrophobic (not attracted to water). Thus, the phospholipids take on a bilayer formation with the fatty acid tails together and the polar heads facing water inside and outside the cell. This can be demonstrated by putting together two phospholipid molecules and turning one "upside down" so the ends of the fatty acid tails face one another. Show how the cholesterol molecule would sit in the membrane and also is amphipathic.

Figure 1.B.1: Triglyceride Structure	**Figure 1.B.2: Phospholipid Structure**
	

Student Centered Activity (10-30 minutes): After teaching the structures, have students form small groups. A copy of the student guide for lipids may be given to each group if necessary. One by one have them identify each magnet. They should be able to state the difference between a saturated and unsaturated fatty acid. Have them build a triglyceride and a phospholipid. For the phospholipid, have them identify the hydrophobic and hydrophilic ends and explain why each has that property. Let students in the group help and correct if necessary. Have students put together several phospholipids as they form either side of a cell membrane.

Extra exercises:

Research Lipids: Have students go online and find other lipids not represented with the magnets. Have them draw these with markers on the board. If you have extra magnetic tape, have the students draw them onto index cards and attach magnets to the back to create their own lipid magnets.

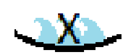
Oral Quiz: Give an oral quiz by calling out names of molecules and have students identify or build them from memory.

3-D Modeling: If there are molecular modeling kits available, have the students build 3-D models of the various Biology Magnets. Have the students note the differences between the two-dimensional and three-dimensional representations.

Lesson 1C – Proteins (15-80 minutes)

Teacher Centered Activity (15-30 minutes): This lesson utilizes the amino acids present in the kit. First, draw the structure of an amino acid in detail on the board. Discuss the various groups; the alpha carbon, the amino group, the acid group, and the R group (**Figure 1.C.1**). Describe how the R group is variable, and can be about 20 different molecular structures. Show students how the molecular structure is represented on each amino acid magnet (**table 1.C.1**). Describe how the different colors of magnets represent different binding properties of R-groups. The table shows the differences in the colors of the magnets and their properties. The symbol for the property is at the bottom of each magnet.

Table 1.C.1: Amino Acids and Properties

Names of Amino Acids	Magnet Color	Property	Symbol for Property
Arginine (Arg), Histidine (His), Lysine (Lys)	Purple	Positively Charged	+
Aspartic Acid (Asp), Glutamic Acid (Glu)	Blue	Negatively Charged	-
Serine (Ser), Threonine (Thr), Asparagine (Asn), Glutamine (Glu)	Red	Polar Uncharged (Hydrophilic)	
Alanine (Ala), Valine (Val), Isoleucine (Ile), Leucine (Leu), Methionine (Met), Phenylalanine (Phe), Tyrosine (Tyr), Tryptophan (Trp)	Green	Nonpolar uncharged (hydrophobic)	
Cysteine (Cys), Selenocysteine (Sec), Glycine (Gly), Proline (Pro)	Yellow	Special Cases	varies

Amino acids are bound together by **peptide bonds** into a chain to form the **primary structure.** Show how a peptide bond is made between two amino acids through dehydration synthesis. The primary structure can be represented as a string of beads (included in kit – it may be helpful to paint the beads various colors so they more accurately represent the protein model). These primary structures can bond together to form secondary, tertiary, and quaternary structures. Manipulate the string of beads to show the **alpha helix** and **beta sheet** formations as seen in the secondary structures, and explain that hydrogen bonding is mainly responsible for secondary structure (**Figure 1.C.2**). **Tertiary structure** mainly arise from folding that comes from disulfide bonds, ionic bonding (salt bridges), and hydrophobic and hydrophilic interactions. To demonstrate protein folding, form a chain of amino acid magnets on the board as follows:

Key: R=red, G=Green, P=Purple, B=Blue, Y=Yellow Cysteine (Cys)
GPGGRRGGGRRGYGGBGRRGGGYGGRR (**Figure 1.C.3**)

How would this protein fold in an aqueous (water) environment? First, consider the strongest bond, the disulfide bond. Fold the structure so the two yellow cysteine amino acids are touching (**Figure 1.C.4**). Then, consider the salt bridges. Move the structure so that the blue and purple amino acids are touching (**Figure 1.C.5**). Lastly, consider the hydrophilic and hydrophobic interactions. Adjust the amino acids so that the green hydrophobic amino acids are toward the middle, and the red hydrophilic amino acids are toward the outside. Remember, the order of the amino acid chain must remain intact (**Figure 1.C.6**). Fold the plastic string of beads into a tertiary structure to demonstrate further. Lastly, explain that a quaternary structure is the interaction between two tertiary structures. Use the second string of plastic beads folded into a tertiary structure and demonstrate it binding to the first.

Figure 1.C.1: Amino Acid Structure (left) on Biology Magnets (right)

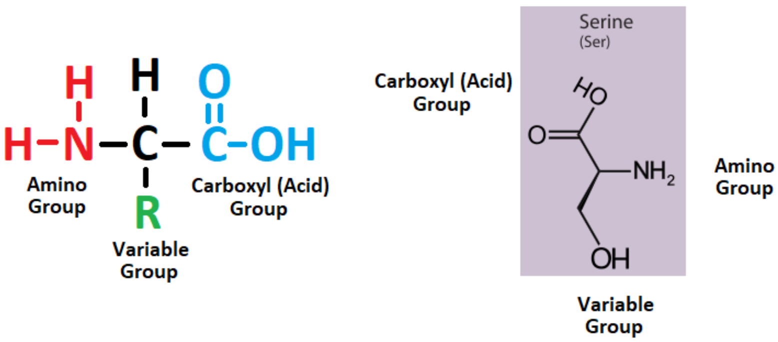


Figure 1.C.2: Alpha Helix and Beta Sheet Structures Modeled With Beads

Figure 1.C.3: Primary Structure of Demonstration Protein

Figure 1.C.4: Demonstration Protein After Disulfide Bond Between Cysteine R-groups

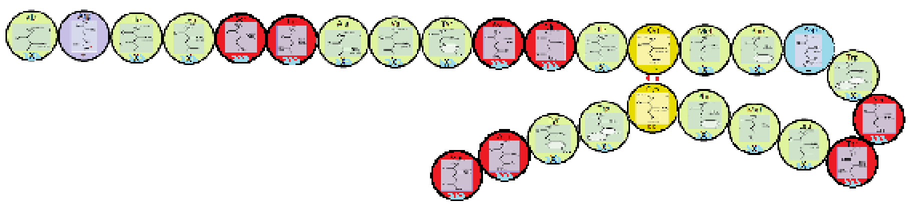


Figure 1.C.5: Demonstration Protein After Salt Bridge Formation

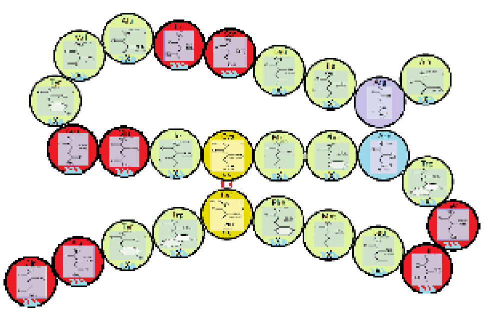
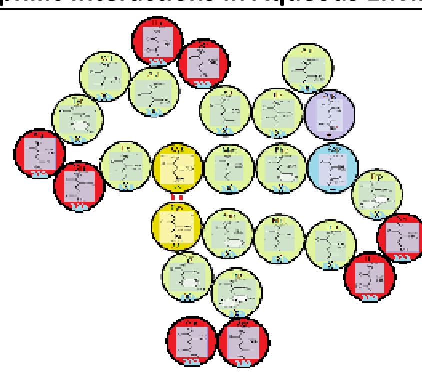
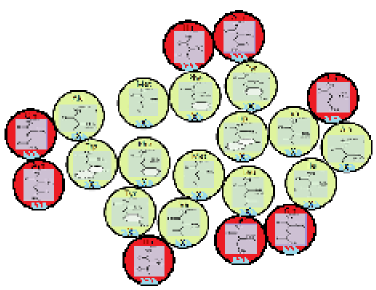
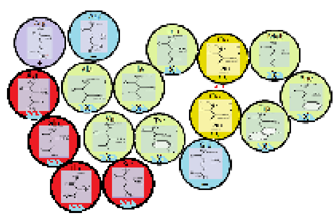
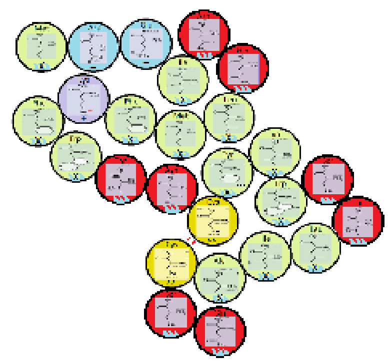


Figure 1.C.6: Demonstration Protein after Hydrophobic and Hydrophilic Interactions in Aqueous Environment



Student Centered Activity (20-50 minutes): After teaching protein structure, group the students into smaller groups. A copy of the student handout for proteins may be given to each group if necessary. Have them draw the structure of an amino acid on the board and discuss its various parts. Then have the students put several amino acids together to make a primary structure joined by peptide bonds. Have the students use the plastic beads to demonstrate secondary structures (alpha helixes and beta sheets). Then the groups should use the amino acid magnets to build the following three primary structures and try to figure out how they would fold in an aqueous environment. Sample answers are below, but there could be variability in the way students fold. If several groups are building the chains at the same time, let the groups compare their results and note the differences.

Protein chain 1: GGRRGGGRGGRRGGGRGGGGRR (**Figure 1.C.7**)
Protein chain 2: BGGGYGGGYBGGRRRRGGP (**Figure 1.C.8**)
Protein chain 3: GBBGRRGGGPGGRRYGGGRRGGGYRR (**Figure 1.C.9**)

Figure 1.C.7: Protein chain 1 – Possible Folding Configuration	**Figure 1.C.8: Protein chain 2 – Possible Folding Configuration**	**Figure 1.C.9: Protein chain 3 – Possible Folding Configuration**
		

Extra Protein Exercises:

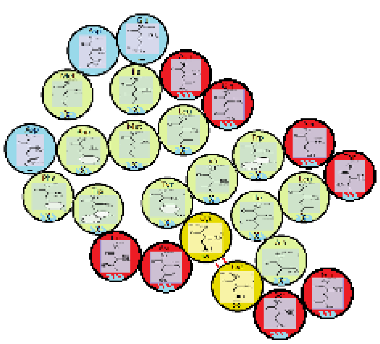
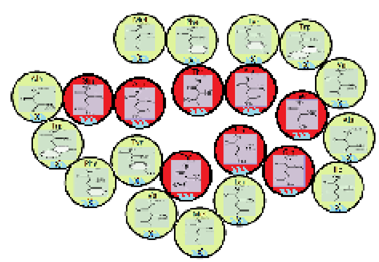
Mutation: Have the groups introduce a mutation in the third protein. Change the P (purple) amino acid to a B (blue). Have the students form the new shape (**Figure 1.C.10**). Have the students compare their structures with other groups.

Oil environment: Have each group build the same proteins but in an oil environment, where hydrophobic amino acids would move to the outside of the structure and the chains would look very different (**Figure 1.C.11**). Have the students compare their structures with other groups.

Unique Sequence: Have each group come up with their own amino acid sequence and figure out how it would fold. Have the students compare their structures with other groups.

Research Proteins: Have the students research short protein sequences and folding online. One example of a short protein chain is Bovine Serum Insulin A. Have them build the primary structure and model the protein they found with the amino acid models. A web site for a nice protein folding simulation can be found at https://learn.concord.org/resources/787/protein-folding.

3-D Modeling: If there are molecular modeling kits available, have the students build 3-D models of the various Biology Magnets. Have the students note the differences between the two-dimensional and three-dimensional representations.

Figure 1.C.10: Protein Chain 3 with a Mutation – Possible Folding Configuration	**Figure 1.C.11: Protein Chain 1 folding in an Oil Environment – Possible Folding Configuration**
	

Lesson 1D – Nucleic Acids (15-80 minutes)

Teacher Centered Activity (15-30 minutes): This lesson utilizes the nucleotides in the kit. Start by handing out a nucleotide to each student in the class so they can get an up-close look. Describe the three main parts of a nucleotide; the 5-carbon pentose sugar (deoxyribose or ribose), the phosphate group, and the nitrogen base, which can be either guanine, adenine, cytosine, thymine, or uracil. Explain that the purine bases (G and A) are double ringed while the pyrimidine bases (C,T, or U) are single ringed. (**Figure 1.D.1**). Use the magnets to show that, in the DNA molecule, a purine must bond with a pyrimidine, G to C, and A to T. Include in the discussion that the nucleotide must be turned "upside down" to make a proper fit, describing the 5' and 3' ends of the nucleotide and the antiparallel nature of the double helix molecule. In addition, note the number of hydrogen bonds between the nitrogen bases are depicted, with the G-C bases having three hydrogen bonds (3 lines) and the A-T bases having only two. This causes the G-C bond to be slightly stronger than the A-T bonds, which plays a role in control mechanisms involved in gene transcription (e.g. TATA box), among other things (**Figure 1.D.2**). Show the differences between DNA and RNA, in that RNA has ribose instead of deoxyribose and has uracil as a base instead of thymine. It also is normally found as single stranded where DNA is double stranded (**Figure 1.D.3**). Describe how the chains are used for storing information in the order of the bases. Discuss how bases are read in three letter sequences called codons, and that each three letter DNA sequence is code for a complementary RNA, which then codes for a specific amino acid. Students can use the codon table (**Figure 1.D.4**) to determine which RNA codons code for which amino acids, although the details of how that happens can be saved for a later module. Lastly, show the students the ATP magnets, and show that ATP is basically an adenine nucleotide with three phosphate groups instead of two, and show how the last bond between phosphate groups can be broken to release energy in the cell and yield ADP + P. Instead of an information carrying molecule, the cell uses ATP as a convenient molecule for storing and moving energy around the cell. (**Figures 1.D.5,1.D.6**).

Figure 1.D.1 – DNA Purine and Pyrimidine Nucleotide Details

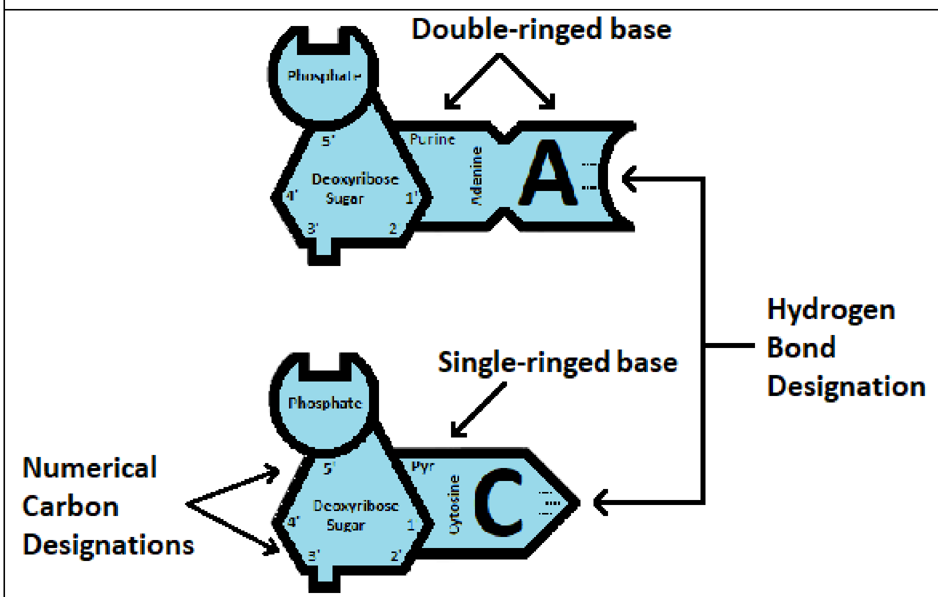


Figure 1.D.2 – Short DNA segment showing antiparallel nature

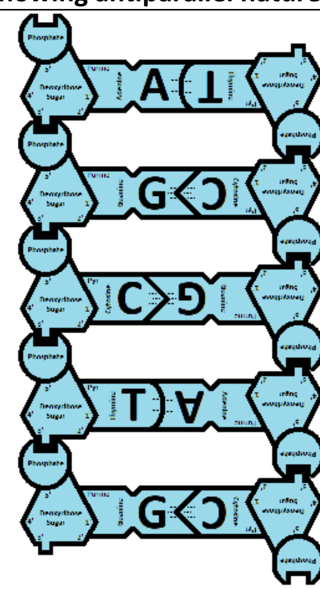


Figure 1.D.3: RNA vs. DNA differences

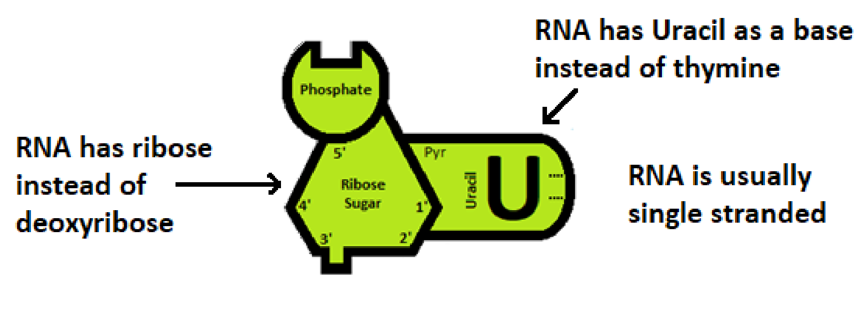


Figure 1.D.4 : RNA codon/amino acid table

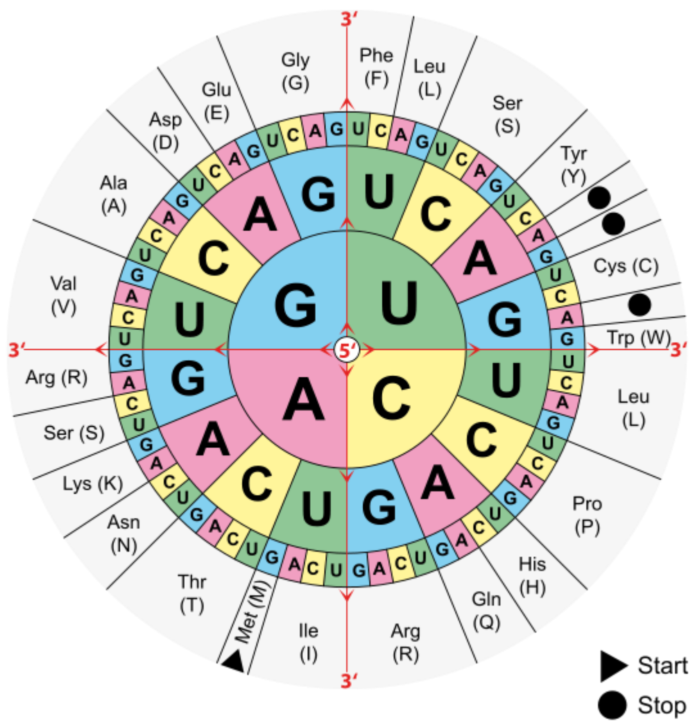


Figure 1.D.5 – ATP

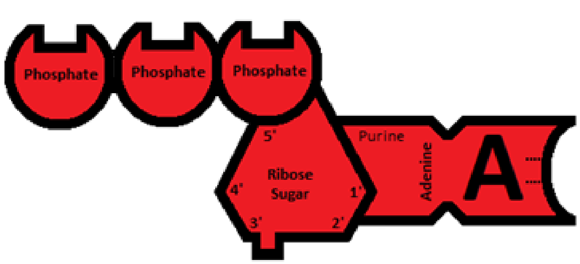
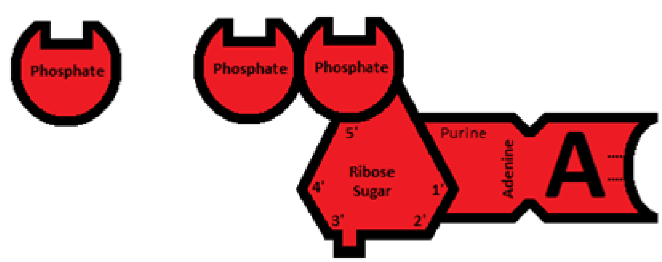


Figure 1.D.6 – ADP + P



Student Centered Activity (20-50 minutes): After teaching nucleotides, put the students into small groups. A copy of the student handout for nucleic acids may be given to each group if necessary. Have each student use the DNA magnets to identify and describe the three parts of a nucleotide (sugar, phosphate, nitrogen base) to the group, allowing group members to offer help and corrections if necessary. Have them build a DNA ladder and show the bonding rules (A-T, C-G) and antiparallel nature of the molecule. Have the students describe the variable numbers of hydrogen bonds and point that out on the models, and have the students show the difference between RNA and DNA nucleotides. In addition, have the students use the ATP magnet to show how ADP and P bond together to form ATP, and how ATP breaks apart to form ADP + P and releases energy from the broken bond. After each student has shown proficiency, have the group build each of the following DNA sequences (**table 1.D.1**). Then have them build the RNA strand that would bind to the DNA template. Remind them that the RNA strand is constructed in the 5'->3' direction. Then, using the Figure 16, determine the amino acid chain that would result. If available, have the students use the amino acid magnets to build the short amino acid chain that would result from each sequence.

Table 1.D.1: DNA Sequences for Student Models

DNA Sequence 5' -> 3'	Matching RNA sequence 5' -> 3'	Amino Acid Sequence
AATCGCATC	AAUCGCAUC	Asn – Arg - Ile
ATGCCCAGT	AUGCCCAGU	Met – Pro - Ser
TGCCATGAT	UGCCAUGAU	Cys – His – Asp

Extra exercises:

Working Backwards: If time allows, have the students use the following amino acid sequences (**Table 1.D.2**) to build a DNA chain that would yield that sequence. First, the students should use **Figure 1.D.4** to build an RNA strand that would yield that sequence. Then, the corresponding template DNA strand that would yield the RNA strand. Finally, the corresponding DNA strand that complements that DNA strand. Note that, because of the redundancy of the DNA code, there are several different DNA sequences that could code for the amino acid chain.

Table 1.D.2: Amino Acid Sequences for Working Backwards Activity

Amino Acid Sequence 1: Leu-Tyr-Gly (**Answer**: Sample DNA sequence: CTCTACGGA)
Amino Acid Sequence 2: Thr-Trp-Phe (**Answer**: Sample DNA sequence: ACATGGTTC)

Math questions:

1. If a DNA sequence were 81 nucleotides long with no stop codons, how many amino acids would that code for? (Answer = 27)
2. What if there was a stop codon at the end? (Answer=26)
3. If there were a protein with 30 amino acids, how many RNA nucleotides would be needed to code for that protein? (Answer=93 including stop codon)

Mutation 1: What if the DNA sequence 1 in the table above had a mutation so the first A was changed to a T. (Answer = **Tyr** would be the first amino acid instead of **Asn**)

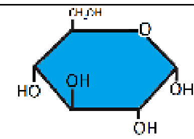
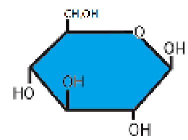
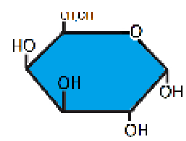
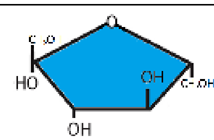
Mutation 2: What would happen if there was a mutation which deleted the first A? (Answer = The amino acid chain would be **Ile – Ala – X**)

3-D Modeling: If there are molecular modeling kits available, have the students build 3-D models of the various Biology Magnets. Have the students note the differences between the two-dimensional and three-dimensional representations.

Biology Magnets Module 1A – Carbohydrates – Student Guide

Student Centered Activity:

Step 1: Place the carbohydrate magnets onto the board and identify each magnets according to the following table. If you are in a group, have each member of the group identify the magnets. After you identify each one, try to do it without using the table.

Molecule Name	Picture
Alpha Glucose	
Beta Glucose	
Galactose	
Fructose	
Hydroxide Group	HO
Hydrogen	H

Step 2: Build the polymers below according to the following chart:

Monosaccharide Combination	Polymer	Example
Glucose + Fructose	Sucrose	Table Sugar
Glucose + Galactose	Lactose	Milk Sugar
Glucose + Glucose	Maltose	Malt Sugar
Glucose + Glucose + Glucose + Glucose + Glucose…	Polysaccharide	Starch, Cellulose, etc.

Step 3: Use the two special glucose molecules and the hydroxide and hydrogen groups to show the condensation reaction to form maltose and hydrolysis reaction to break it down.

Step 4: Repeat steps 1-3 above, but do it without looking at this student handout.

Extra Activities:

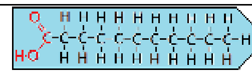
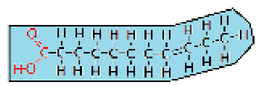
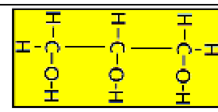
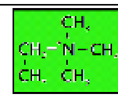
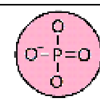
Research Monosaccharides: Go online and find other monosaccharides not represented with the magnets. Draw these with markers on the board, or, if you have magnetic tape, draw them onto index cards and attach magnets to the back to create your own monosaccharide magnets. Research and build new disaccharides or polysaccharides as well if time allows. Show your teacher and other groups the molecules you made!

3-D Modeling: If there are molecular modeling kits available, build 3-D models of the various Biology Magnets. Note the differences between the two-dimensional and three-dimensional representations.

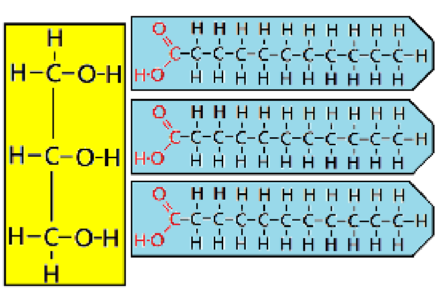
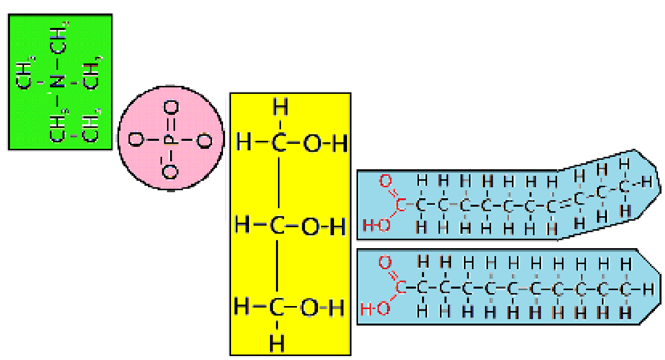
Biology Magnets Module 1B – Lipids – Student Guide

Student Centered Activity:

Step 1: First, place all of the lipid magnets on the board. One by one, identify each magnet. Use the chart below to help you. You should be able to state the difference between a saturated and unsaturated fatty acid. Memorize the names of each molecule. When you are ready, try to do it without looking at the chart. When you know the names of each molecule and can say them to other members of your group, move on to the next step.

Saturated Fatty Acid	
Unsaturated Fatty Acid	
Glycerol	
Nitrate Group (Choline)	
Phosphate Group	

Step 2: Build a triglyceride and a phospholipid. Use the chart below to help you. Identify the hydrophobic and hydrophilic ends and explain why each has that property. Put together several phospholipids as they form either side of a cell membrane. Break the molecules apart and build them again without looking at the chart. Each student must be able to do this.

Figure 1: Triglyceride Structure	**Figure 2: Phospholipid Structure**
	

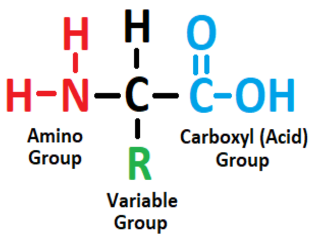
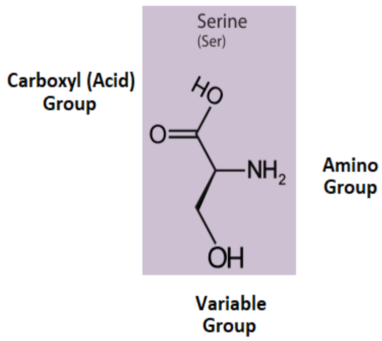
Extra exercise:

Research Lipids: Go online and find other lipids not represented with the magnets. Draw these with markers on the board. If you have extra magnetic tape, draw them onto index cards and attach magnets to the back to create your own lipid magnets! Show the other students the lipids you made and explain their function.

3-D Modeling: If there are molecular modeling kits available, build 3-D models of the various Biology Magnets. Note the differences between the two-dimensional and three-dimensional representations.

Biology Magnets Module 1C – Proteins – Student Guide

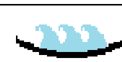
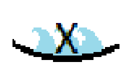
Student Centered Activity: First, put the amino acid magnets on the board. Use a marker to draw the structure of an amino acid on the board and name its parts. Also show where those parts are on the amino acid magnets. Use the diagram below to help you, then try to do it without looking at the diagram. After everyone in the group has mastered the parts of an amino acid, use the strings of beads to demonstrate how chains of amino acids fold into secondary structures, alpha helixes and beta sheets. Each group member should demonstrate it to the others in the group (see figure below).

Amino Acid Structure (left) on Biology Magnets (right)	Alpha Helix and Beta Sheet Modeled With Beads
 	

After that, use the magnets to build the primary structure of Protein chain 1 (below) joined by peptide bonds. Try to figure out how Protein chain 1 would fold in an aqueous environment by using the symbols at the bottom of each amino acid (see diagram below). After you have moved the amino acids to their locations, show your teacher. If several groups are building the chains at the same time, compare your results and note if there are differences. After completing chain 1, build and fold chains 2 and 3 below. Show your teacher and compare with other groups after folding.

Protein chain 1: GGRRGGGRGGRRGGGRGGGGRR
Protein chain 2: BGGGYGGGYBGGRRRRGGP
Protein chain 3: GBBGRRGGGPGGRRYGGGRRGGGYRR

Symbols at Bottom of Amino Acid Magnets

Magnet Color	Property	Symbol for Property
Purple	Positively Charged	+
Blue	Negatively Charged	-
Red	Polar Uncharged (Hydrophilic)	
Green	Nonpolar uncharged (hydrophobic)	
Yellow	*Special Cases*	*varies*

Extra exercises:

Mutation: After the group has successfully built the three chains, introduce a mutation in the third protein. Change the P (purple) amino acid to a B (blue). How would this affect the shape of the protein? Form the new shape and show your teacher.

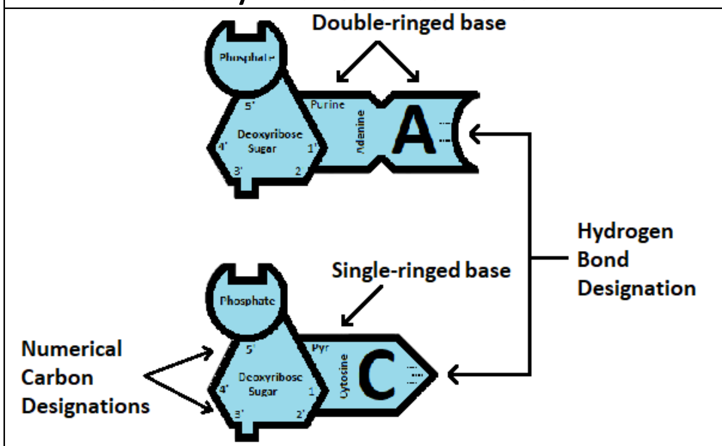
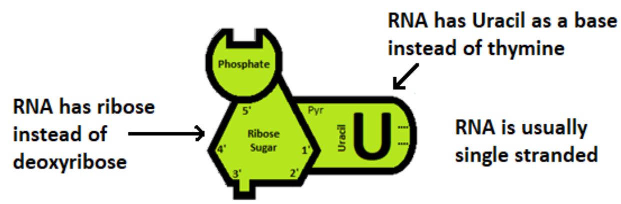
Unique Sequence: Each group come up with your own amino acid sequence and figure out how it would fold. After you build your unique sequence, and fold

Oil environment: Build the same primary structures you did before, but fold the protein as if it were in an oil environment. In an oil environment, hydrophobic amino acids would move to the outside of the structure and hydrophilic amino acids would move into the center of the structure. After you fold in an oil environment, show your teacher and compare to other groups.

3-D Modeling: If there are molecular modeling kits available, build 3-D models of the various Biology Magnets. Note the differences between the two-dimensional and three-dimensional representations.

Biology Magnets Module 1D – Nucleic Acids – Student Guide

Student Centered Activity: First, put the DNA and RNA magnets on the board. Each student in the group should Identify and describe the three parts of a nucleotide (sugar, phosphate, nitrogen base). Look at the magnets and make sure you understand what all of the words and symbols on the nucleotide magnets mean. Describe the difference between purines and pyrimidines to your group members. Also, discuss the differences between RNA and DNA nucleotides. When everyone has a good grasp of the nucleotide, build a DNA ladder and show the bonding rules (A-T, C-G) and antiparallel nature of the molecule. Each student should describe the variable numbers of hydrogen bonds and point that out on the models. Use the ATP magnet to show how ADP and P bond together to form ATP, and how ATP breaks apart to form ADP + P and releases energy from the broken bond.

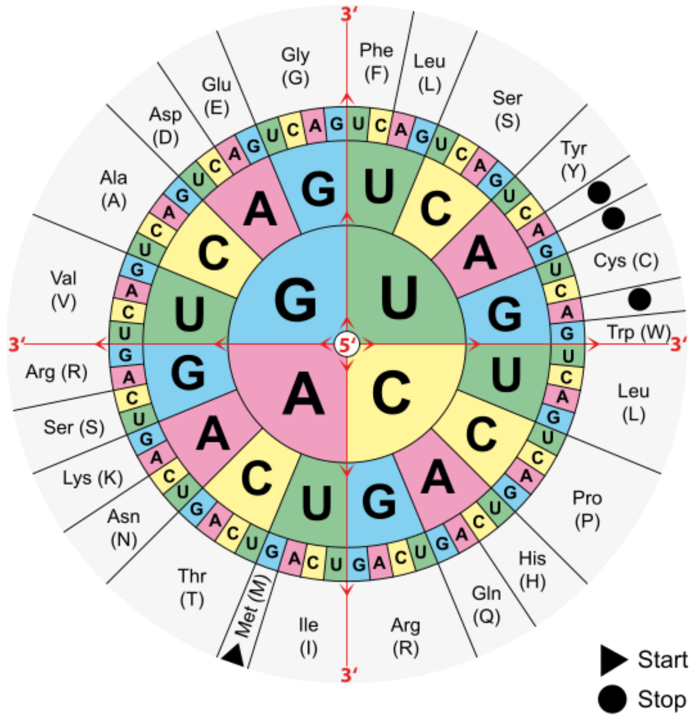
DNA Purine and Pyrimidine Nucleotide Details	**RNA vs. DNA differences**
	

After each student has shown proficiency, have the group build each of the following DNA sequences. Then build the RNA strand that would bind to the DNA template. Remember, the RNA strand is built in the 5'->3' direction. Then, using **Figure 16** on the next page, determine the amino acid chain that would result. If you have the amino acid magnets, build the short amino acid chain that goes with each sequence. Show your teacher after you have finished building the strands.

DNA Sequences for Student Models

DNA Sequence 5' -> 3'	Matching RNA sequence 5' -> 3'	Amino Acid Sequence
AATCGCATC	AAUCGCAUC	Asn – Arg - Ile
ATGCCCAGT	AUGCCCAGU	Met – Pro - Ser
TGCCATGAT	UGCCAUGAU	Cys – His – Asp

Figure 1.D.4: **RNA codon/amino acid table**



Extra exercises:

Working Backwards: Use the following amino acid sequences to build a DNA chain which would yield that sequence. First, the students **Figure 1.D.4** above to build an RNA strand that would yield the DNA sequence. Then, build the corresponding template DNA strand that would yield the RNA strand. Finally, build the DNA strand that complements that DNA strand. Note that, because of the redundancy of the DNA code, there are several different DNA sequences which could code for the amino acid chain.

Amino Acid Sequence 1:	Leu-Tyr-Gly
Amino Acid Sequence 2:	Thr-Trp-Phe

Math questions:

1. If a DNA sequence were 81 nucleotides long with no stop codons, how many amino acids would that code for?
2. 2)What if there was a stop codon at the end?
3. If there were a protein with 30 amino acids, how many RNA nucleotides would be needed to code for that protein?

Mutation 1: What if the DNA sequence 1 in the table above had a mutation so the first A was changed to a T.

Mutation 2: What would happen if there was a mutation which deleted the first A?

3-D Modeling: If there are molecular modeling kits available, build 3-D models of the various Biology Magnets. Note the differences between the two-dimensional and three-dimensional representations.