

## Instructor Supplement: Ideas for Workshop Extension Activities

### **Core Competency: Explain concepts to different audiences**

One of the core competencies for genetics education identified by the Genetics Society of America based on the NSF/AAAS *Vision and Change* report is that students should be able to “explain concepts to different audiences” ([http://www.genetics-gsa.org/education/GSAPREP\\_CoreConcepts\\_CoreCompetencies.shtml](http://www.genetics-gsa.org/education/GSAPREP_CoreConcepts_CoreCompetencies.shtml)). This skill is critical to enable scientists to share their knowledge with the general public in a meaningful way that will have a positive impact in society. Below, I outline an extension activity that develops this core competency. Instructors could ask students to complete this activity after doing one or more of this resource’s Active Learning Workshops in their course.

1. Ask student groups to pick one specific concept addressed in one of the workshops to explain to a non-science audience. They might pick a specific non-science audience, such as fourth graders, high school students, or adults without any scientific expertise.
2. Have students develop a short (maximum five minutes) presentation that explains the concept to their chosen audience in language that audience would be expected to understand. The presentation should use some type of visual support (drawing on the board, physical models, “acting” the concept, etc.), but NOT Powerpoint. Be sure students know that they need to convey why the topic they’re explaining is important to catch the interest of their audience.
3. Have students present to the rest of the class, and have the other students give anonymous feedback on how well the presentation matched the chosen audience.
4. Give instructor feedback using a rubric like the one shown below.
5. As an optional further extension for students who are interested, arrange for them to create a mini-lesson targeted at elementary, middle-school, or high-school students and to teach it to an actual class. Emphasize that their lesson should have some sort of hands-on or participatory component.

Example Grading Rubric:

Criterion	Points earned					
	5	4	3	2	1	0
Scope of information conveyed was appropriate for a 5-min presentation.						
Level of detail and vocabulary were appropriate for the chosen audience.						
All information was correct.						
The significance of the topic was clearly conveyed. (“Why should they care??”)						
Visual aids were appropriate and used effectively.						
Presentation showed evidence of rehearsal and effective group collaboration.						
TOTAL						/30

**Instructor Supplement for Protein Structure Workshop****Clicker questions to use with this workshop (in addition to amino acid group identification)**

(Correct answers are in bold type.)

1.  $\alpha$ -helices and  $\beta$ -sheets make up what level of protein structure?
  - A. Primary
  - B. Secondary**
  - C. Tertiary
  - D. Quaternary
2. Peptide bonds
  - A. refer to all bonds within a protein.
  - B. form between amino acid R groups.
  - C. link the carboxyl group of one amino acid to the amino group of another amino acid.**
  - D. are covalent bonds that form between two different cysteines in a protein.
3. Amino acid R groups are most important for stabilizing this level of protein structure.
  - A. Primary
  - B. Secondary
  - C. Tertiary
  - D. Quaternary
  - E. Both tertiary and quaternary**
4. Only some proteins have this level of structure.
  - A. Primary
  - B. Secondary
  - C. Tertiary
  - D. Quaternary**
5. An ionic bond could form between
  - A. two acidic amino acids.
  - B. two basic amino acids.
  - C. one acidic and one basic amino acid.**
  - D. two polar amino acids.
  - E. two nonpolar amino acids.
6. A hydrogen bond could form between
  - A. two acidic amino acids.
  - B. two basic amino acids.
  - C. one acidic and one basic amino acid.
  - D. two polar amino acids.**
  - E. two nonpolar amino acids.

7. Hydrophobic interactions could occur between
- acidic amino acids.
  - basic amino acids.
  - one acidic and one basic amino acid.
  - polar amino acids.
  - nonpolar amino acids.**
8. A disulfide bond
- is a type of covalent bond.
  - involves one specific kind of amino acid.
  - can stabilize the tertiary and quaternary structures of proteins.
  - A, B, and C are all correct.**
9. The image below compares a short stretch of primary sequence from five proteins. The black shading highlights amino acids that are identical in all five of the proteins. Supposing this approximate level of identity extends throughout the entire primary sequences of these five proteins, which of the following would be valid hypotheses based on these data?

F	N	L	N	Y	P	N	P	M	N	F	L	R	R	I	S	K	A	D	D	Y	D	I	Q	S	R	T	L	A	K	F	L	L	E	I	S	L	V	D	F	Protein 1
F	E	L	G	W	P	G	P	M	S	F	L	R	R	I	S	K	A	D	D	Y	E	H	D	T	R	T	L	A	K	Y	L	L	E	S	T	I	M	D	H	Protein 2
F	E	I	G	W	P	G	P	M	P	F	L	R	R	I	S	K	A	D	D	Y	D	F	E	P	R	T	L	A	K	Y	L	L	E	T	T	I	V	E	P	Protein 3
F	N	I	G	W	P	N	P	L	N	F	L	R	R	I	S	K	A	D	D	Y	D	P	V	N	R	N	I	G	K	F	I	L	E	Y	A	Y	C	C	H	Protein 4
Y	N	I	S	L	P	N	P	L	N	F	I	R	R	I	S	K	A	D	N	Y	C	I	E	T	R	N	M	A	K	F	I	M	E	Y	S	I	C	C	N	Protein 5

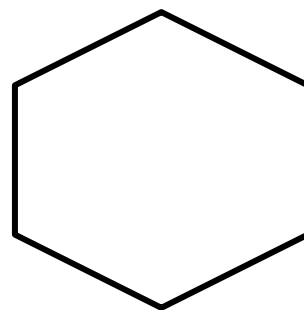
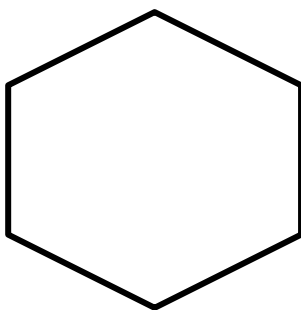
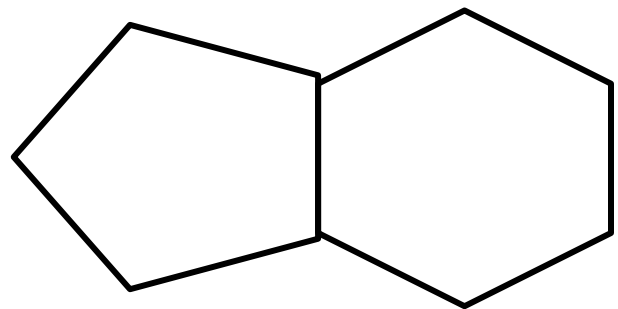
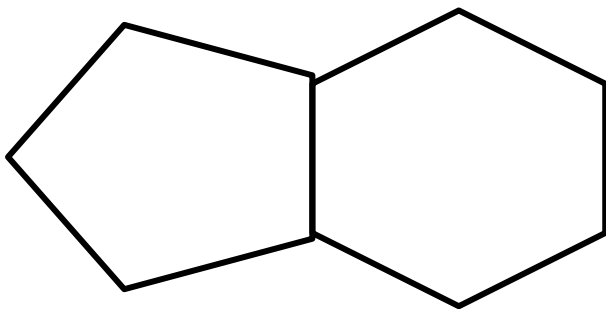
- These five proteins likely have very similar secondary and tertiary structures.
  - These five proteins likely perform similar functions in the cell.
  - The genes that encode these five proteins likely have a common evolutionary ancestor.
  - A, B, and C are all correct.**
  - This is a remarkable coincidence, but you can't form any hypotheses based on these data.
10. Refer to the figure of all the amino acid structures (Appendix A) to answer this question:  
Suppose a change in the DNA sequence of a given gene causes an aspartate amino acid in the primary structure of the protein encoded by that gene to be changed to a different amino acid. Which of the following amino acid substitutions would likely have the smallest effect on the function of that protein?
- Aspartate switched to alanine
  - Aspartate switched to glutamate**
  - Aspartate switched to lysine
  - Aspartate switched to serine

**Instructor Supplement for DNA/RNA Structure Workshop****A. Mnemonic devices to share with the students**

- To remember the structures and identities of purines and pyrimidines: purine is the shorter word but the larger molecule (double ring); pyrimidine is the longer word but smaller molecule (single ring). Pyrimidines are CUT (C, U & T), only one ring. Another version of this mnemonic is "Two rings, PURe As Gold" (Two Rings = Purines = Adenine and Guanine).
- To remember the 5' and 3' ends of nucleic acids: five-prime and phosphate both start with the "F" sound.

**B. Purine and pyrimidine templates for Question C5:**

(Give one set of cut-out templates to each group.)



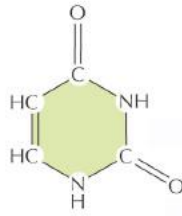
**C. Clicker questions to use with the DNA structure workshop**

(Correct answers are in bold type.)

1. Which of the following is NOT true about RNA vs. DNA?
  - A. RNA nucleotides contain ribose while DNA nucleotides contain deoxyribose.
  - B. RNA contains G, C, A, and U bases, while DNA contains G, C, A, and T.
  - C. Both RNA and DNA nucleotides are linked by phosphodiester bonds to form polymers.
  - D. RNA is a more stable molecule than DNA.**
2. Which is a correct base-pairing interaction found in DNA?
  - A. G—A
  - B. A—U
  - C. C—G**
  - D. T—C
3. Which of the following are pyrimidines?
  - A. G, A
  - B. C, U, T**
  - C. C, A, T
  - D. G, C
4. Which is/are (a) true statement(s) about the reaction that adds a nucleotide to a nucleic acid polymer?
  - A. It involves formation of a hydrogen bond.
  - B. It links the hydroxyl group of one nucleotide to the phosphate group of another.**
  - C. It is a hydrolysis reaction.
  - D. Both B and C are true.
5. A phosphodiester bond
  - A. is a covalent bond between two nucleotides.
  - B. links the hydroxyl group of one nucleotide to the phosphate group of another.
  - C. is a hydrogen bond between two nucleotides.
  - D. Both A and B.**
6. During transcription (which we will discuss later), the two DNA strands of the double helix must separate to allow the use of one strand as a template for making a complementary RNA strand. Given what you know about base pairing, what would you predict about the nucleotide composition of the DNA at the point it separates to begin transcription?
  - A. It would likely have a higher number of A—T base pairs than G—C base pairs.**
  - B. It would likely have a higher number of G—C base pairs than A—T base pairs.
  - C. The specific sequence is unlikely to matter.

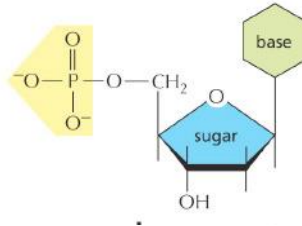
7. Is the nitrogenous base shown below a purine or a pyrimidine?

- A. Purine.
- B. Pyrimidine.**



8. Is the nucleotide shown below a ribonucleotide or a deoxyribonucleotide?

- A. Ribonucleotide.
- B. Deoxyribonucleotide.**
- C. It's impossible to know because the identity of the base is not specified.
- D. It's impossible to know because there are bonds shown to unidentified atoms.



## Instructor Supplement for Mitosis/Meiosis Workshop

### A. Web animations to use with this workshop

1. Shows chromosome arrangements on the spindle in mitosis and meiosis and describes the genetic composition of the cells produced from the two processes:  
[http://highered.mheducation.com/sites/0072495855/student\\_view0/chapter2/animation\\_comparison\\_of\\_meiosis\\_and\\_mitosis\\_quiz\\_1.html](http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation_comparison_of_meiosis_and_mitosis_quiz_1.html)
2. Longer video that emphasizes the differences between mitosis and meiosis using checklists:  
<https://www.youtube.com/watch?v=IzfJSxa-uA>
3. Another longer video that emphasizes diploid and haploid chromosome numbers in human cells and how these relate to the processes of mitosis and meiosis (includes terms for the various stages of mitosis/meiosis, which are not part of this workshop):  
<https://www.youtube.com/watch?v=bRcjB11hDCU>
4. Illustrates chromosome 21 nondisjunction in meiosis II:  
<https://www.youtube.com/watch?v=EA0qxhR2oOk>
5. Illustrates chromosome nondisjunction in both meiosis I and meiosis II, and includes an interactive component: <http://www.uic.edu/classes/bios/bios100/lectures/nondisjunction.htm>
6. Illustrates chromosome nondisjunction in both meiosis I and meiosis II, and emphasizes the outcomes upon fertilization:  
[http://glencoe.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::550::400::/sites/dl/free/0078695104/383925/Chapter11\\_NGS\\_VisualizingNondisjunction\\_10\\_10\\_06.swf::VisualizingNondisjunction](http://glencoe.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::550::400::/sites/dl/free/0078695104/383925/Chapter11_NGS_VisualizingNondisjunction_10_10_06.swf::VisualizingNondisjunction)

### B. Clicker questions to use with this workshop

(Correct answers are in bold type.)

1. TRUE or FALSE? Only single-celled organisms can generate offspring by asexual reproduction.  

TRUE	<b>FALSE</b>
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2. Which of the following cell divisions reduces the number of distinct chromosomes by half?
  - A. Mitosis
  - B. Meiosis I**
  - C. Meiosis II
  - D. All of the above
  - E. Mitosis & meiosis I
  - F. Mitosis & meiosis II
  
3. Homologous recombination (crossing over) occurs prior to which of the following cell divisions?
  - A. Mitosis
  - B. Meiosis I**
  - C. Meiosis II
  - D. Mitosis & meiosis I
  - E. Mitosis & meiosis II

- F. Meiosis I & II
4. For which of the following divisions is the starting cell diploid and the product haploid?
- A. Mitosis
  - B. Meiosis I**
  - C. Meiosis II
  - D. Mitosis & meiosis I
  - E. Mitosis & meiosis II
  - F. Meiosis I & II
5. For which of the following divisions are both the starting cell and the product diploid?
- A. Mitosis**
  - B. Meiosis I
  - C. Meiosis II
  - D. Mitosis & meiosis I
  - E. Mitosis & meiosis II
  - F. None of the above
6. A diploid eukaryotic cell with its genome contained in a single chromosome could undergo which type(s) of genetic mixing during meiosis?
- A. Crossing over**
  - B. Independent assortment
  - C. Both independent assortment and crossing over
  - D. None of the above
7. The genome of a diploid eukaryotic organism has 8 distinct chromosomes in its genome. Which of the following cells from this organism would be classified as aneuploid?
- A. A somatic (non-germline) cell with 16 chromosomes
  - B. A sperm cell with 8 chromosomes
  - C. A somatic cell with 15 chromosomes
  - D. An egg cell with 9 chromosomes
  - E. Both C and D**
8. What process begins with two haploid cells and ends with one diploid cell?
- A. Recombination
  - B. Meiosis
  - C. Mitosis
  - D. Fertilization**
  - E. Independent assortment
11. A defect in the spindle would likely lead to
- A. Recombination
  - B. Fertilization
  - C. Chromosome nondisjunction
  - D. Aneuploidy



**E. Both chromosome nondisjunction and aneuploidy**

12. Sister chromatids separate in which of the following divisions?

- A. Mitosis
- B. Meiosis I
- C. Meiosis II
- D. Mitosis & meiosis I
- E. Mitosis & meiosis II**
- F. Meiosis I & II