# Biology Partnership

## Lesson Plan #1

### RNA Transcription and Translation

### Identifying Information:

Teachers in the Lesson Study Group:
Amanda Bloomer, Teacher, Graceville High School, Graceville, FL  
Amanda.bloomer@jcsb.org  
Phillip Vosbrink, Teacher, Chipley High School, Chipley, FL  
phillip.vosbrink@washington.k12.fl.us  
Barbara Rutledge, Teacher, Gateway Military Academy, Bonifay, FL  
Barbara.rutledge@teenchallenge.cc  
Schellane Smith, Teacher, Marianna High School, Marianna, FL  
schell.smith@jcsb.org

Mentor – Katie McCurdy

Lesson: Time frame- Two 50 min period class periods  
  Lesson #1 mRNA Transcription  
  Lesson #2 tRNA Translation and mutation

Level of course: Biology (General)

### Motivation:

Prior to Lesson #1, the teacher will present a Pre-test (10 min) and follow-up with an identical Post-test at the conclusion of the class session.

Bell-ringer (5-7 min): Students are presented with a small pastry to eat. Displaying to the class a large cookbook, the teacher offers to loan the cookbook (with the pastry recipe) to one student. If others want the recipe, the cookbook can be passed around from person to person, until all have copied and made the recipe.

**DISCUSSION QUESTIONS:**

What are some of the problems with this form of sharing information?  
*The cookbook might get lost. The pages would become ragged or some may fall out. It would take a long time to get it into the hands of everyone who needs it.*

What is a more efficient way of getting the recipe to each of you who want it?  
*Photocopying and distributing, writing it down on paper*

What are some problems that may occur in the copying process?  
*Forget to copy the whole set of directions in the recipe/ not enough toner in the copier so recipe is not readable/wrong page gets copied/*

Teacher will review the facts about DNA composition. It is the “blueprint” or “recipe” for all of our physical construction. It is necessary to copy the information accurately so that cells can build proteins.
Prior to Lesson #2, the students will view a YouTube clip on transcription of mRNA. The first 55 seconds will review the process. Use the following video from YouTube: "From RNA to Protein Synthesis". http://www.savetubevideo.com/?v=NJxobgkPEAo

**Needed Materials & Set-Up:**

**Materials:**
- Before the lesson, the teacher will purchase one pastry or one cookie for each student in the class.
- Before the lesson the teacher will need to make copies of the pre-test and post-test for each student.
- Before the lesson, the teacher will need to make a copy of the student note taking worksheet, one copy for each student.
- Before the lesson, the teacher will need one copy of the codes table for the role-play activity.
- Before the lesson, the teacher will need 32 copies of the tRNA template card. These cards will be used for the role-play activity. Using the codes table, the teacher will copy one tRNA anticodon listed on the codes chart on each of the 32 tRNA template cards.
- Before the lesson, the teacher will need one copy of the two-page amino acid cards for the role-play activity. The amino acid cards should be paired with the correct tRNA template card using the codes chart.

**Set-Up:**
- The layout for the room the desks will arranged into rows. As the students enter the room they will sit in their assigned seat. No specific groups are needed for this lesson.
- After the students are seated the teacher will start the motivation section which is listed above.
- After the motivation on Day 1, the lesson transitions to direct instruction. During this time students remain in their seats facing the board and remain seated for the duration of the lesson.
- After the motivation on Day 2, the lesson transitions to direct instruction. During this time students remain in their seats facing the board while taking notes.
- Following the note-taking segment of the lesson, students will be called in pairs to the whiteboard to participate in the role-play activity.

**Outcomes**

**Next Generation Sunshine State Standards:**
SC.912.L.16.5 Explain the basic processes of transcription and translation, and how they result in the expression of genes.
SC.912.L.16.4 Explain how mutations in the DNA sequence may or may not result in phenotypic change; Explain how mutations in gametes may result in phenotypic changes in offspring.
SC.912.L.16.9 Explain how and why the genetic code is universal and is common to almost all organisms.

**Dimensions of K-12 Science Education Standards:**
Dimension 1: Scientific and Engineering Practices
1. Asking questions
2. Developing and using models
Dimension 2: Crosscutting Concepts
2. Cause and effect: Mechanism and explanation
6. Structure and function
Dimension 3: Disciplinary Core Ideas
Life Sciences
LS 3: Heredity: Inheritance and variation of traits

Common Core Literacy Standards:
Reading Standards: Integration of Knowledge and Ideas
Writing Standards: Production and Distribution of Writing
Language Standards: Conventions of Standard English

Specific Learning Outcomes:
1. Given a code of amino acids in a DNA strand, the students will create an mRNA strand of codons with 100% accuracy (SYNTHESIS).
2. Given a lecture on translation, during a role-play activity, the students will accurately construct a protein consisting of 32 amino acids (SYNTHESIS).
3. Given a lecture on translation and transcription, for homework the students will demonstrate an understanding of these processes by correctly answering questions with 80% accuracy or better (COMPREHENSION).

Presentation and Participation:

Day 1:
- When the students first walk in they will go to their assigned seat and complete the pre-test (7-10 minutes).
- The teacher will lead the students through the motivation activity (5-7 minutes).
- The teacher will distribute copies of the student note taking worksheet for students to complete during direct instruction.
- The teacher will explain to the students that the note-taking worksheet will be used to summarize the process of transcription. Any blanks should be filled in as the teacher explains the process (15-20 minutes).
- The teacher will project the student note taking worksheet on the board as an instructional guide during the lecture.
- Through lecture, the teacher will explain the differences between RNA and DNA, and then model the process of transcription on the whiteboard (BEHAVIOR). The image of the student note-taking worksheet will be projected on the board.
- Students will fill in key terms as the teacher explains the process and label the appropriate sections of the note-taking worksheet (COGNITIVE).
- To review the process of transcription using video animation, the teacher will play a video and verbally explain the process as the video plays (Note: turn volume to mute and stop the video at :55 seconds). (4 minutes)
- Use the following video from YouTube: "From RNA to Protein Synthesis".
  - http://www.savetubevideo.com/?v=NJxobgkPEAo
- The teacher asks the students to practice pairing mRNA nucleotides with DNA at the end of the note-taking worksheet.
- Students practice the skill of pairing nucleotides to synthesize an mRNA strand and the results are reviewed by the teacher (OTHER).
- The teacher walks around the room to visually check to see that students are able to correctly
synthesize an mRNA strand from a given DNA sequence.

Day 2

- The teacher will explain to the students that the lesson goal for today is to connect the process of transcription (Day 1) to the process of protein synthesis.
- To review the process of transcription discussed on Day 1 of the lesson, using video animation, the teacher will play the same video and verbally explain the process as the video plays (Note: turn volume to mute and stop the video at :55 seconds). (4 minutes)
- Use the following video from YouTube: "From RNA to Protein Synthesis".
  - http://www.savetubevideo.com/?v=NJxobgkPEAo
- The teacher explains that now that the mRNA has left the nucleus, the message it carries will be used for something important in the cytoplasm of the cell (3 minutes).
- The teacher will instruct the students to use the **student note taking worksheet** that they received on Day 1 for today’s lesson.
- The teacher will advise students to fill in the missing information in the blanks during the lecture period and label structures in the process.
- The teacher explains the process of transcription using a projected image of the **student note-taking worksheet** on the whiteboard (15 minutes) (BEHAVIOR).
- To review the process of translation, using video animation, the teacher will play the video and verbally explain the process as the video plays (Note: turn volume to mute and start the video at :56 seconds). (4 minutes)
- Use the following video from YouTube: "From RNA to Protein Synthesis".
  - http://www.savetubevideo.com/?v=NJxobgkPEAo
- The teacher explains to the students that the class will role-play1 the process of translation to produce the hemoglobin protein (COGNITIVE) (10-15 minutes).
  1. The teacher will give each student a tRNA template card with an anticodon and the corresponding amino acid card. If there are less than 32 students, give some students more than one tRNA template card and corresponding amino acid card.
  2. The teacher will draw a ribosome on the whiteboard and the mRNA codon sequence (32 codons) for the hemoglobin protein (see codes chart for codon sequence).
  3. The teacher will describe the cell location of protein synthesis.
  4. The teacher will have the ribosome read the first two mRNA codons and ask the students, “Who has the tRNA match for the first two codons?”
  5. Have the student(s) come up with his/her tRNA and match the tRNA anticodon with the mRNA sequence. Do this for two codons at a time.
  6. The students will bond the second amino acid to the first with tape.
  7. The teacher will ask the students to describe what the tape represents.
  8. The teacher will have the first two tRNA molecules sit down, and call up the next two tRNA molecules.
  9. The teacher will repeat this process until finished synthesizing the hemoglobin protein at the STOP codon.

The teacher explains that the class just produced a hemoglobin protein!

- The teacher will introduce “point mutation” and “frameshift mutation”. The teacher will substitute a single base with an alternate base. The class will note that the amino acid may be different, or it may remain the same, as there are several combinations of codons that code for the same amino acid (5 minutes).
The teacher will remove a single base to demonstrate the total “shift” of codons, now reading totally different amino acids in the protein structure.

The teacher will distribute one copy of the post-test to each student. Each student will complete the post-test in class (10 minutes).

The teacher will collect the post-test from each student and distribute the homework questions.

For homework, students are assigned six questions to answer about the processes of transcription and translation and mutations (see questions section).

Questions:

1. Explain the relationship between DNA, mRNA and tRNA? Justify why all three are necessary to the process of building a single protein molecule. (ANALYSIS)

   All three use coded information to produce one end product- a protein-, although they have different functions. DNA is the code for making proteins; the mRNA (messenger) “copies” the code, and the tRNA (transfer) retrieves the “parts” for the building of the proteins. DNA must remain in the nucleus to be protected from any possible damage. The amino acid components are located in the surrounding cytoplasm, thus requiring an agent to “fetch” and deliver them.

2. Explain how the translation process knows when to begin and end the protein chain components. How do you justify mRNA having a “start” and “stop” codon on either end of the mRNA strand, even though they are not used to construct the protein? (ANALYSIS)

   Having the extra codons allows a sort of “lead tape” to insure that the full coded message is not accidently lost in the beginning or end of the protein production.

3. What would happen if a single base pair was changed to another base pair in the DNA coding? (SYNTHESIS)

   Potentially no change in amino acid production will occur as several combinations of base pairs produce the same amino acid. If the amino acid is altered by the substitution, then a change in the protein complex will occur.

4. How would a geneticist or a physician determine that a mutation had probably occurred? (SYNTHESIS)

   There would be evidence that a normal body function could not be performed, such as in the pancreas producing insulin (resulting in diabetes) or a tumor growing into a cancerous growth.

5. Suppose that an entire codon is deleted from the mRNA being read for building a protein that removes excess cholesterol from the blood stream. What would be the outcome? (ANALYSIS)

   The individual would most likely develop atherosclerosis from high cholesterol buildup in the arteries. They may shorten their lifespan with a heart attack.
6. Explain the potential value of human gene altering by geneticists. An example of this would be to add to the DNA the protein for uptake of cholesterol from the blood. Justify why or why not this is ethical. (EVALUATION)

If an embryo stage individual was known to carry a detrimental gene, geneticists might “correct” the gene and increase the individual’s quality of life. Students may suggest that there is no evidence that an alteration would not be damaging to other parts of the genetic code. It is difficult to test on living specimens outside of bacteria, lower life forms or plant life. Genes create a probability that error or disability may occur, but there are many factors on many different genes that appear to work together to produce the outcome expressed.

Reflection:

An initial pre-test at the onset of the day 1 lesson plan will provide the teacher an assessment of the students’ initial set of knowledge prior to the instruction. An identical post test administered at the close of the day 2 class session will measure cognitive growth. The test consists of 13 multiple-choice questions and two completion questions.

Formative assessment will also occur throughout the lesson as the teacher circulates and asks questions during the teaching session.

Verbal feedback will be provided to individuals throughout the lesson based on their answers to the teacher’s oral questions as well as during the groups’ interpretation of RNA data.

The results of the post-test will be provided to the students on the following day. Students who fail to accurately answer 80% of the questions on the post-test will be required to complete a homework project.

Homework project details:

Students are assigned a homework project— “Draw a flow chart depicting the protein building process of cells from transcription to translation.” The teacher will show an example of a flow chart using a recipe in the cookbook. A rubric of 50 points will be awarded as follows, with a 5 point reduction for each error:

Students are assigned a homework project— “Draw a flow chart depicting the protein building process of cells from transcription to translation.” The teacher will show an example of a flow chart using a recipe in the cookbook.

A rubric of 50 points will be awarded as follows.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Superior (20 points)</th>
<th>Adequate (10 points)</th>
<th>Unacceptable (0 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order of process</td>
<td>The process of protein production is in chronological order</td>
<td>The process is chronological, but one or two steps are</td>
<td>The process is not in chronological order and more than two</td>
</tr>
</tbody>
</table>

Gather all ingredients  
Preheat oven  
Mix dry ingredients
and includes all of the mechanisms involved. ommitted, or one main component (rRNA, tRNA, ribosome, amino acid) is missing. components are omitted.

Terms usage

All terms from the term list provided are incorporated into the flow chart and applied accurately. There are no spelling errors.
One or two terms have been omitted, or one or two terms are not identified accurately. One to three spelling errors are evident.
More than two terms are missing or incorrectly used in the flow chart. There are more than three spelling errors.

Appearance and flow

The flow chart is neat and clearly drawn, of sufficient size, and easy to follow.
The flow chart is small and somewhat “congested” to read or it contains some text boxes that are not neatly drawn.
Disorganized. Text boxes are sloppily drawn and difficult to distinguish. The print is difficult to understand in some parts.

Safety:

On the day prior to beginning this lesson, the teacher will advise the students that pastries will be provided for the next day. Students with food allergies should be advised that the pastries may contain nuts.

During the motivation activity on Day 1, students will be offered a pastry to eat. Students with allergies should be advised that the product may contain nuts in the event that a student has a food allergy.

To prevent overcrowding or behavioral conflicts during the role-play activity, students are called up to the board in pairs instead of the entire class at one time.

The room lights will be darkened during the note-taking segment of the lesson and during videos. Adequate safety lighting should be available in case students need to exit the room.

Transformative:

1. Visual learners-The lesson includes videos that model the concepts discussed in the lecture segments.
2. ESE/ESOL – The lesson is broken into two instructional days to reduce the content into smaller, more manageable chunks.
3. ESOL/LEP students- As the key terms are introduced during lecture, the teacher should address the root words, suffixes and prefixes to help students correlate new vocabulary with existing vocabulary with the same root words, prefixes or suffixes.
4. ESE/ESOL- The student note-taking worksheet provides an outline of the key concepts the students should understand for the lesson.

**Utilize:**

- After reviewing missed questions on the pre and post-tests, determine what if any concepts need to be readdressed. If the same test question was answered incorrectly on both tests by 40% or more of the students, these items will need to be reviewed in the next day’s lesson.

- For the Level 1 and 2 readers, the following web clip is useful in reiterating the scientific principles taught in this lesson: [http://www.youtube.com/watch?v=B6O6uRb1D38&feature=related](http://www.youtube.com/watch?v=B6O6uRb1D38&feature=related)

- Students may need to come up with a way to remember the pairing of bases. One method is straight letters (A and T) together and curved letters (C and G) together.

- It should be stressed that not all mutations cause change. The more serious mutation is the frameshift, which alters all amino acids in succession following the addition or deletion of a base pair.

- Students having difficulty grasping the idea that the tRNA shift and transfer their amino acid while on the ribosome can use the role-play materials at their lab tables or desks with a partner to reinforce the process.