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ETP Type: Create a New Lesson
Subject Area: AP Biology, 11-12
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Educational Transfer Plan (ETP)
From Jellyfish to Glowing Bacteria

0. Abstract

Students will be making bacterial cells glow in the dark! In this lab the students will transform bacterial cells to express the Green Fluorescent Protein (GFP) from a bioluminescent jellyfish. The students will then write a formal lab report and present their findings to the class.

I. Standards/Skills/Objectives/Assessment

From AP Biology Framework (Highlighted is that part of the standard that I am focusing on):

1. Genetic engineering techniques can manipulate the heritable information of DNA and, in special cases, RNA.
    a. To foster student understanding of this concept, instructors can choose an illustrative example such as:
        i. Electrophoresis
        ii. Plasmid-based transformation
        iii. Restriction enzyme analysis of DNA
        iv. Polymerase Chain Reaction (PCR)
    b. Illustrative examples of products of genetic engineering include:
        i. Genetically modified foods
        ii. **Transgenic animals**
        iii. Cloned animals
        iv. Pharmaceuticals, such as human insulin or factor X

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2. Measurable Objective(s):

Students will insert a plasmid containing GFP into *E.coli*. Those cells that are successfully transformed will express the newly inserted GFP protein and glow under UV light. They will demonstrate their knowledge of this through their lab report and their oral presentation.

3. Assessment:

The assessment will assess whether the students are able to take the process of bacterial transformation and relate it to an example listed above in the standard. This will happen through their lab report conclusion/connection and also through their oral presentation to the class. They will be graded using a rubric for the presentation in order to prepare the students for speaking in front of a group in their higher education.

The students will also be assessed on their ability to understand the process of transformation itself. They will be given a previous AP FRQ, which will be graded with the College Board rubric.

On the second day of the lab, there will be a lab quiz to ensure the students are on the right track with the process of transformation. The lab quiz will be taken individually, but the group will be given one score. The group must have a 75% passing rate in order to receive credit (it will be credit no credit and will be added onto their lab report grade). This is to ensure that all of the students understand what is going on in the lab and force discussion if there are misunderstandings among group members.

II. Fellowship Connections

1. 21st Century Skill(s):

There will be many 21st century skills that the students will be using, but I will focus on 2. Learning and Innovation Skills.

-Interpret information and draw conclusions based on the best analysis
-Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts

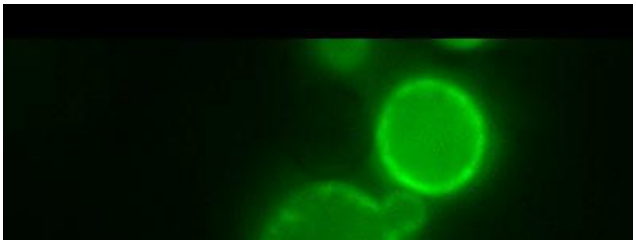
21st Century Skill(s) Application:

The students will be evaluating their results and seeing if any of their bacteria cells took in the plasmid. If it did not, or if some cells did not, they will have to reason as to why this happened.

There will be various forms of communication that will be used in this lab. The students will need to orally communicate to their lab partners while performing the experiment. They will need to make sure that everyone in the group understands what is happening in the protocol. The students will work together to form one lab report. Through Google Docs, they will need to communicate and put together one lab report for 4 people. The final piece of communication will be their oral report at the end of the lab.

3. Fellowship Description:

In this fellowship I am working in Professor Thorner's



lab which works with yeast. In the project I am working on, our goal is to identify the proteins that the alpha arrestins in yeast interact with. Understanding what proteins the alpha arrestins interact with can eventually lead to strategies for therapies for different disorders. In this fellowship I am being exposed to a research scientist position. I am working with Arpita, who is a postdoc working on the project described above. During my fellowship I am gaining many different skills used by researchers (PCR, gel electrophoresis, bacterial and yeast transformation, DNA purification, how to design primers, etc.). In this lab many of the scientists are from many different countries and educational backgrounds, which is really interesting to talk to them about.

The picture to the right is of yeast cells I transformed to contain the marker GFP to a certain protein found in the cell membrane. This is why the outside of the cell glows!

4. Fellowship Connection to School/Classroom:

The inspiration for my ETP came from when I did a bacterial transformation and inserted a GFP plasmid into the bacteria. It reminded me of the pGLO lab that I had my students perform two years ago that completely failed. Now that I have a connection for lab supplies, I would like to try this again!

There are so many connections with this fellowship and my classroom. There are many curricular topics that the lab is working on. For example, cell membranes, proteins and the techniques that are used in biotechnology. Going back to the classroom I will have different examples to give the students when we are talking about the various topics/techniques. For example, when we are talking about GFP for the lab, I can show the the picture of the yeast that I transformed to have the GFP protein and they can see where the protein is located due to where it glows. I also want to bring back to the students the importance of data and patience within a lab. Often times that students are just looking for one "right" answer or set of data and don't realize it doesn't work perfectly every time. In a lab, you very frequently have failures and need to repeat the procedure multiple times often adjusting the protocol to make it work.

III. Instruction

1. Instructional Plan:

Day 1: (50 minutes)

Introduce the students to biotechnology, restriction enzymes and transformation with Restriction Enzyme and Transformation lecture.

Day 2: (50 minutes)

Go over the transformation powerpoint, which includes the process of transformation and also the lab procedure. The second slide in this presentation I will go over the poster I made this summer and explain to the students where my inspiration for this lab came from.

Handout the lab procedure protocol to the students and have them read through it. When you get to the slide 25, the students should get in their lab groups and fill out the questions under lesson 2.

Day 3: (50 minutes)

The students will then do a pre-lab in their notebook and also a procedure flow-chart (see lab notebook guidelines for what is to be included). This step can either be done in class or given as homework.

Day 4: (50 minutes)

It is optimal to do this on a Friday so the plates can grow over the weekend and Monday (Unless you have an incubator).

The students will perform the transformation lab according to the lab protocol. All the plates should be streaked by the end of the period. If you are leaving the plates at room temperature, they need to set for 3 days. If you are using an incubator, put them in 37 degrees Celsius overnight.

Day 5: (50 minutes)

Today the students will analyze the data and see if there are any cells that were transformed. The students will answer the follow up questions after the lab. A week from the completion of the lab, the lab report will be due.

Day 6: (50 minutes)

The students will take the biotechnology FRQ in class. Give them 20 minutes to complete this.

2. Additional Instructional Context: (*Optional)*

This will be apart of the Biotechnology unit we will be doing.

This lab also needs set up by the teacher multiple days prior to the students conducting the lab. The specifications of timing and what the teacher needs to prepare before the lab is located in the BioRad Lab Guidelines attachment.

3. Supply List:

BioRad pGLO Bacteria Transformation Kit (can be purchased here: http://www.bio-rad.com/en-us/product/pglo-bacterial-transformation-kit?pcp_loc=catprod)

I suggest to not make your own agar plates. It is very time consuming to make them all and hard to keep them sterile. You can buy them through a biological supply company.

Transformation Kit Components(enough for 8 lab groups)
E. coli HB101 K–12, lyophilized (1 vial)
Plasmid (pGLO), lyophilized, 20 µg (1 vial)
Ampicillin, lyophilized, 30 mg (1 vial)
L (+) Arabinose, lyophilized, 600 mg (1 vial)
Transformation solution (50 mM CaCl2, pH 6.1), sterile, 15 ml (1 bottle)
LB nutrient broth, sterile, 10 ml (1 bottle)
LB nutrient agar powder, sterile (to make 500 ml), 20 g (1 pouch)
Pipettes, sterile, individually wrapped (50)
Inoculation loops, sterile, 10 µl, packs of 10 loops (8 packs)
Petri dishes, 60 mm, sterile packs of 20 (2 packs)
Multicolor microcentrifuge tubes, 2.0 ml (60)
Foam micro test tube holders 9 (8)
UV pen light (1)
Instruction manual (Available online or printed manual available by request) (1)

Required Accessories – Not included in this kit
Clock or watch to time 50 sec
Microwave oven
Temperature controlled water bath, 1–6 liter (catalog # 166-0504EDU)*
Thermometer that reads 42oC 1 L flask 500 ml graduated cylinder Distilled water, 500 ml
Crushed ice, not cubed ice, and containers (foam cups work well) 10 ml of bleach (household variety), 10% solution
Permanent marker pens
* If a temperature controlled water bath is not available, obtain a container (foam is best) for hot water and use a hot plate or hot tap water to get the water to 42°C.

Optional Accessories
Vortexer Micropipette, adjustable volume, 2–20 µl
(catalog #166-0506EDU or 166-0551EDU)
Parafilm laboratory sealing film 2–20 µl pipet tips
37°C incubator oven (catalog #166-0501EDU)**
Vernier Blue Digital BioImaging System (BL-DBS)

** If an incubator oven is not available, try using an electric blanket or construct a homemade incubator with a cardboard box and a low voltage light bulb inside. Otherwise incubate agar plates 48 hours to 72 hours at ambient room temperature (see General Lab Skills–Incubation).

4. Bibliography:

1. "Engineering Education Resources." *Engineering Education Resources*. University of Wisconsin-Madison, n.d. Web. 18 July 2016.
2. "Biotechnology Explorer the PGLO Bacterial Transformation Kit." (n.d.): n. pag. BIO RAD. Web. 14 July 2016.
3. Foglia, Kim. *Chapter 20: Biotechnology*. N.p.: n.p., n.d. PPT.
4. Ets. "AP Biology 2009 Scoring Guidelines (Form B)." (n.d.): n. pag. *College Board*. College Board. Web. 14 July 2016.

5. Keywords:

Transformation, AP Biology

IV. Attachments

1. Bacterial transformation lab key
2. Bacterial transformation lab quiz
3. Bio Rad lab guidelines
4. Biotechnology FRQ
5. Lab notebook and lab report guidelines
6. Lab presentation rubric
7. Lab Report Rubric
8. pGLO lab handout (student)
9. pGLO lab handout (KEY)
10. pGLO presentation
11. Transformation and restriction enzyme lecture
12. Jessie Polivka Poster 2016