**Modeling Cell Labeling to Identify Cell Types**

*Document Overview:*

Cancer researchers are using nanomolecules to specifically identify and treat cancer cells in mice. The use of nanomolecules allows for the delivery of chemotherapy drugs to only nanomolecule-labeled tumors, in effect, eliminating the standard chemotherapy side effects. As an analogy to this process, in a lab setting, students investigate unknown solutions and test for the presence of lipids, proteins, and simple and/or complex carbohydrates. Students will learn which reagents positively identify each type of macromolecule, and then use this information to help identify macromolecules present in an unknown solution. This will be analogous to what the cancer researchers look for among cells of the body, to see how selective cell labeling can isolate cells of interest in a commingled population of different cell types.

*Minnesota State Academic Science Standards:*

9.1.1.2.1 Conducting Experiments
Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations and draw conclusions supported by evidence from the investigation.

9.1.2.2.1 Constraints on Designs
Identify a problem and the associated constraints on possible design solutions.

*NGSS Standards*:

HS-ETS1-2
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

*Objectives:*

* I can explain how identifying macromolecules in an unknown correlates to how cancer is identified and treated using nanomolecule cell labeling.
* I can discuss how selective cell labeling may allow doctors to better detect, diagnose, and ultimately treat cell mediated disease.
* I can use an experimental procedure to identify unknowns through qualitative chemical testing.

*Concepts and Keywords:*Macromolecule functions, selective cell labeling, targeted drug therapy, inquiry

*Type of Activity:* Lab

*Duration:* One 50 minute class period

*Description of Activity:*In this investigation, students will model cell specific labeling to identify cancerous cells by testing several solutions with reagents that detect the presence of macromolecules.

*Connection to Nobel speakers:*

Dr. Jennifer West uses nanoparticle selective cell labeling to identify cancerous cells within an organism. After cells have been selectively labeled, cancerous cells can be targeted for direct chemotherapy delivery to cancerous cells increasing the efficacy of the drug on infected cells and minimizing systemic toxic side effects.

Dr. West’s previous Nobel speech: <https://cf.gac.edu/events/nobelconference/2006/west-lecture.cfm>

*Pre- lab:*Show this short (2:30) video which provides an overview of the use of nanobots identifying and treating cancer cells in mice. <https://www.youtube.com/watch?v=7wuujmiqD-w>

*Teacher Lab Notes:*

Prior to Lab:

1. Obtain/prepare 75 mL of each of the following and label according to key below:

Cell Type A: 75 mL of distilled water

Cell Type B: 75 mL of cooking oil

Cell Type C: 75 mL of Apple juice

Cell Type D: 75 mL of gelatin solution (5g of gelatin powder and add distilled water to make 75 mL of solution)

Cell Type E: 75 mL of potato solution (5g of potato starch powder and add distilled water to make 75 mL of solution)

2. Set up eight sets of five test tubes in test tube racks; two sets per station. Label the test tubes Cell Types A-E.

3. Dispense 5 mL of each solution into their corresponding test tubes.

4. Distribute two sets of test tubes to each of four stations.

5. Obtain/prepare one 25 mL dropper bottle of each of the following and label according to the key below:

 Reagent 1: Sudan III Stain

 Reagent 2: Biuret’s Reagent

 Reagent 3: Benedict’s Solution

 Reagent 4: Iodine Solution

6. Distribute one reagent to each of the four stations.

7. Place the corresponding reagent test directions at each station.

Reagent 1 Test

1. Your station contains a set of 5 Cell Type Samples (A-E). It also contains a set of Cell Type Controls, for comparison. Set aside the Controls.
2. Add 10 drops of Reagent 1 to each test tube.
3. **GENTLY** shake/swirl the contents of each test tube. **CAUTION!!!** This Reagent will stain both your skin and your clothing.
4. Use your Cell Type Controls to compare the color of the test tubes containing Reagent 1. Reagent 1 is positive if it stains the cell type solution red. In the Data Table, write “+” for the presence of red solution, or “-“ if the solution does not turn red.

Reagent 2 Test

1. Your station contains a set of 5 Cell Type Samples (A-E). It also contains a set of Cell Type Controls, for comparison. Set aside the Controls.
2. Add 5 drops of Reagent 2 to each test tube.
3. **GENTLY** shake/swirl the contents of each test tube. **CAUTION!!!** This Reagent contains a strong base - if you get some on your skin, rinse immediately with water and notify your teacher. This Reagent will stain both your skin and your clothing.
4. Use your Cell Type Controls to compare the color of the test tubes containing Reagent 2. Reagent 2 is positive if it changes from a blue to violet. In the Data Table, write “+” for the presence of violet solution, or “-“ if the solution stays blue.

Reagent 3 Test

1. Your station contains a set of 5 Cell Type Samples (A-E). It also contains a set of Cell Type Controls, for comparison. Set aside the Controls.
2. Add 10 drops of Reagent 3 to each test tube.
3. **GENTLY** shake/swirl the contents of each test tube. **CAUTION!!!** This Reagent will stain both your skin and your clothing.
4. Place the test tubes in the hot water bath for 3-5 minutes. Remove the test tubes using the test tube holders.
5. Use your Cell Type Controls to compare the color of the test tubes containing Reagent3. Reagent 3 is positive if it changes to a rusty brown/orange color, or green/yellow color. In the Data Table, write “+” for the presence of rusty brown - yellow solution, or “-“ if the solution stays blue.

Reagent 4 Test

1. Your station contains a set of 5 Cell Type Samples (A-E). It also contains a set of Cell Type Controls, for comparison. Set aside the Controls.
2. Add 5 drops of Reagent 4 to each test tube.
3. **GENTLY** shake/swirl the contents of each test tube. **CAUTION!!!** This Reagent will stain both your skin and your clothing.
4. Use your Cell Type Controls to compare the color of the test tubes containing Reagent 4. Reagent 4 is positive if it changes from yellow to brown color. In the Data Table, write “+” for the presence of brown solution, or “-“ if the solution stays yellow or clear.

8. Obtain/prepare 50 mL of Unknown Cell Type Solution. Consider using the following:

2% milk, half and half, peanut butter solution, clear sports drink, chicken liver broth/solution

9. Place 5 mL of the Unknown into each of four labeled test tubes.

10. Determine where and how class data will be collected, (i.e. projected on board, inserted into Google Doc Table, spreadsheet, etc).

11. Print one copy of **Modeling Cell Labeling to Identify Cell Types** Lab Sheet for each student (found at end of this document).

12. Cue and preview Pre-Lab video.

Post-Lab Discussion:

Discuss group and class data. Ask students to write and discuss conclusions that can be drawn from both.

*Extension and Follow-up Activity:*

Post-Lab Follow-Up: Jennifer West Video

<https://www.youtube.com/watch?v=K0L5QdTZOeY>

<https://www.youtube.com/watch?v=7wuujmiqD-w>

Additional Video Resources:

<https://www.youtube.com/watch?v=gBYkYzj7CKM>

Video: <https://www.youtube.com/watch?v=7wuujmiqD-w>

*Source:*

Adapted from [www.waynecountyschools.org](http://www.waynecountyschools.org)

**Modeling Cell Labeling to Identify Cell Types Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Purpose**

Identify varying cell types by testing each with cell-type specific reagents (nanomolecules).

**Background**

Cancer researchers are using nanomolecules to specifically identify and treat cancer cells in mice. Nanomolecules are VERY small (0.000000001 m across). They can easily fit inside any cell. Researchers can design the nanomolecules to use chemical signals to identify cancer cells and “label” them so they can be treated by other nanomolecules containing chemotherapy drugs, as seen in the video. Currently, chemotherapy (drugs used to kill cancer cells) is the most common form of treatment for cancer. Chemotherapy drugs are injected into the patient. Chemotherapy drugs cause a variety of side-effects like nausea, vomiting, fatigue and infection. These side-effects occur because the chemotherapy drugs attack all cells, not just the cancerous ones. The use of nanomolecules allows for the identity and delivery of chemotherapy drugs to only nanomolecule-labeled tumors, in effect, eliminating the standard chemotherapy side effects.

This lab will use various “cell types” that will be tested for a change using “reagents” that mimic how researchers use nanomolecule cell-labeling to identify and treat cancer cells. Each group will test a different reagent on 5 “cell types” and determine which react. When all the tests are completed, the class will pool their results to create a data table together. Finally, each group will be given an “unknown” cell type. The class will pool their data to identify the component(s) of the unknown cell type.

**Materials for each group/station:**

Set of 5 Cell Type Controls (for comparison)

Set of 5 Cell Type Samples

Extra test tubes

1 Nanomolecule Reagent

Test Tube Rack

Hot plate (if needed)

Test Tube Holder

Beaker (if needed)

**YOU MUST WEAR GOGGLES FOR THE ENTIRE LAB**

**Procedure**

1. Add reagent to each cell type using the directions at the station. Use the controls to determine if a change occurred.
2. Record your results in the correct spot on the data table. Use a ‘+’ to indicate a change, and a ‘-’ to indicate no change.
3. Transfer your findings to the class data table.
4. When the class data is compiled, the teacher will distribute the unknown to each group. Using the steps above, test the unknown.
5. Record your results in the correct spot on the data table. Use a ‘+’ to indicate a change, and a ‘-’ to indicate no change.
6. Transfer your findings to the class data table.

**Data Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Reagent 1 | Reagent 2 | Reagent 3 | Reagent 4 |
| Cell Type A |  |  |  |  |
| Cell Type B |  |  |  |  |
| Cell Type C |  |  |  |  |
| Cell Type D |  |  |  |  |
| Cell Type E |  |  |  |  |
| Unknown A |  |  |  |  |
| Unknown B |  |  |  |  |
| Unknown C |  |  |  |  |

Analysis Questions

1. In this investigation several reagents were used. What do the reagents used in this model represent in the cancer research? What do the cell types represent?
2. Another Cell Type, F, is found to be positive for Reagents 2 and 3. How might cancer researchers develop a treatment for this cell type?
3. How could nanomolecule selective cell labeling allow doctors to treat a patient with cancer?
4. In this experiment, what is the purpose of having the set of control solutions?
5. The individual test data was compiled into one set of class data. How did this compilation of experimental data strengthen the conclusions of the experiment?