Shedding Light on Fluorescent Microscopy

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OVERVIEW OF THE ACTIVITY

In middle school, children are taught the basic concepts of cell structure, but usually not the intricacies of the cell membrane and how it can be used as a tool to treat major diseases, such as cancer. Throughout this activity, students will learn that cell membranes are decorated by a wide variety of surface markers which can be used to identify different cell types and targets for different disease treatments. To do this, we have created a brief lecture explaining the different cell markers expressed on cells. This talk will also outline how these can be tagged with fluorescent markers of different colors in order to identify distinct cell types using microscopy. A manual activity will then be conducted where the students will observe different painted marbles (simulating cells) through a handmade microscope. Through this demonstration, we hope to challenge students to draw conclusions on cell type based on their observations of different "fluorescently-tagged proteins", and discuss how this knowledge can be used in order to create particles with specific targets to carry drugs. The primary target audience for this lesson is 6th grade classrooms (20-30 students), although the project could be modified to fit a smaller group. Through this module, we hope to increase the understanding of biomaterials in young students, enhance their interest in these exciting topics, therefore encourage them to pursue STEM careers.

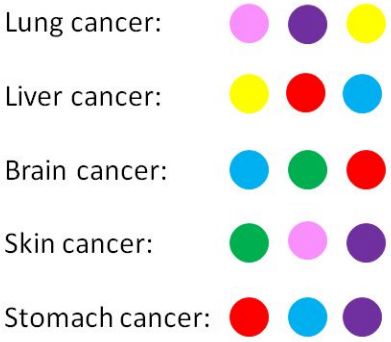
MATERIALS AND SUPPLIES LIST

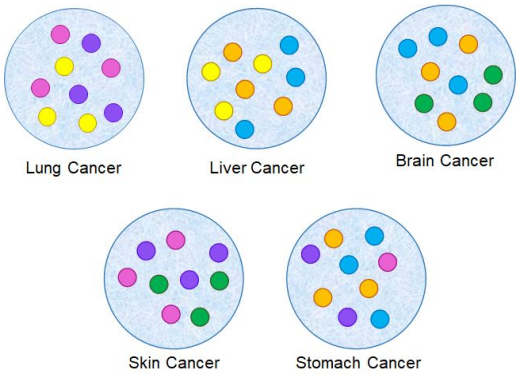
Project Materials		
5	Shoe boxes	Free from local stores
5	Pieces of cardboard (~7" x 5")	Free from local stores
50	Marbles	$7
6	Glow-in-the-dark paints	$10
1	Black paint	$3
Assembly Materials		
1+	Scissors	$5
1+	Hot glue gun	$10

Total Budget: $35

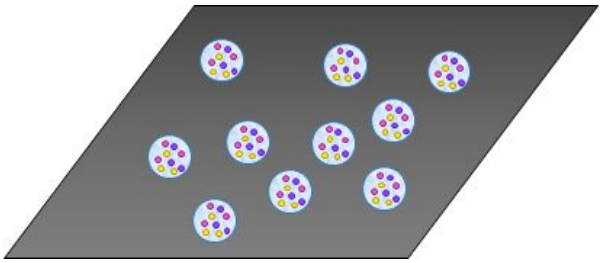
“Microscope” Assembly Instructions:

1. Paint inside and outside of the shoe boxes with the black paint. These will act as the “microscopes”. Place a number (1-5) on the outside of each microscope to be used for completing the worksheet.
2. Paint the 7”x5” pieces of cardboard with black paint as well. These will act as the “slides”.
3. Paint 10 marbles with each of the designated color combinations in glow-in-the-dark paint as shown in the image below:





4. Glue ~10 painted marbles to each of the 7”x5” pieces of cardboard using the hot glue gun. Each piece of cardboard will represent the slide for each cancer type, so be sure to place marbles according to the key. For example: the image below shows the “slide” for lung cancer.



5. While the glue dries, cut a hole in each of the shoeboxes for viewing the slides, as seen in the image below.

6. Place the “slides” in the sun for 30 minutes before the start of the lecture so that they can shine brightly.
7. Place the “slides” inside the “microscopes” for the activity portion of the module.

STEP-BY-STEP INSTRUCTIONS OF ACTIVITIES

The lesson lasts approximately 45 minutes, consisting of a 20-minute lecture, a 15 minute hands-on activity, and a 10 minute closing discussion. Prior to the lesson, teachers are given a packet of information, along with the PowerPoint lecture. The packet will include the breakdown of both the lesson plan and the hands-on activity, as well as how to set the project up and run the discussion session afterwards.

1. *Pre-survey before the lesson*

At the beginning of the lecture, the students are given a brief pre-survey to see what they know about the subjects prior to this lesson, and what their thoughts are about science and biomaterials in general. They are asked questions like do you think that the cell membrane surface is smooth, or does it have something on it, do you know what fluorescent microscopy is,and do you know how scientists can tell apart different cancer types?

2. *Short and simple lecture on cell surface receptors and fluorescent imaging techniques*

For the lecture portion of the module, we remind the students of basic cell biology, especially focusing on the cell membrane proteins and receptors. The subject of fluorescence is also introduced in the background. The two background topics are revealed to be connected through the fluorescent tagging of proteins. The lesson explains how this process is used for imaging and microscopy, helping scientists and engineers to visualize proteins on cells. The lecture portion concludes with the significance of fluorescent tagging for drug delivery, as being able to identify different cell types can allow for the creation of particles that carry drugs that target specific cells based on the proteins they express.

3. *Hands-on activity*

Following the lecture portion of the lesson, the hands-on activity will be introduced to the students. For simplicity, the hands-on portion of the lesson will only look at combinations of 6 different cell marker colors, representing 6 different surface proteins. Each different cancer cell (marble) will express a unique combination of 3 colors, which will had been painted on previously by the teacher with glow-in-the-dark paint. In this way, the students will be able to identify the cell type by observing the “cells” through the microscope and cross-referencing the provided key. Their task is to look through the hole at the top of their shoebox, or their microscope, to determine which cell type is contained within the box, based on what colors the cells are expressing. Their job is to write down which type of cancer is in each box and report it back to the lab.

The students will be divided into 5 randomized groups, each group being placed at a different shoebox. Each group will rotate through the 5 different boxes and identify each different cancer cell type. This entire process should take about 15 minutes, giving the students roughly 2 minutes at each station.

4. *Closing discussion on how to make biomaterials that target these proteins*

After the hands-on activity, there is a 10-minute closing discussion. We ask the students a few different follow-up questions to ensure see if they can connect the activity to what we were discussing in the lesson.

5. *Post-survey following the lecture and demonstration*

Lastly, we give the students a post-survey, where they are asked the same questions as in the pre-survey so we can obtain a metric for comparison.

WORKSHEETS FOR THE ACTIVITIES

Name_____

Write the number of the microscope that goes with each of the cancer cell types:

_____Lung
_____Liver
_____Brain
_____Skin
_____Stomach