## Penn State RET in Interdisciplinary Materials

## Teacher’s Preparatory Guide

### Modeling Bioimaging in the Classroom

**Purpose** This lab is designed to help students understand the importance of early detection for cancer and to model future possibilities for imaging.

**Objectives** Students will create a 3-D model using ballistic gel and dye to simulate a tumor. Students will compare their model to current imaging methods and discuss the importance of improvements in imaging and the effects that would have on cancer treatments.

**Time required** This lab will take 2, 90min class periods (lab may not take all of the class time the first day, ballistic gel must cool overnight)

#### Pennsylvania Science Education Standards [Biology Grades 9-10)

3.1.10.A4

* Describe the cell cycle and the process and significance of mitosis.

3.1.10.A8

* Investigate the spatial relationships of organism’s anatomical features using specimens, models, or computer programs.

3.1.10.B4

* Explain how genetic technologies have impacted the fields of forensics, medicine, and agriculture.

#### Next Generation Science Standards

HS.LS.1-4

* Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

3.1.10.A8

* Investigate the spatial relationships of organism’s anatomical features using specimens, models, or computer programs.

3.1.10.B4

* Explain how genetic technologies have impacted the fields of forensics, medicine, and agriculture.

**Teacher Background:** This lab works well at the end of the mitosis unit. Students should be familiar with what causes cancer, how cancer progresses, and why early detection is important. This lab will help students understand the way that the sciences, engineering, and technology work together to solve problems.

#### Materials

* Dye
* Ballistic gel and mold
* Hot pad to remove mold from the oven
* Oven
* Syringes with needle
* Smartphone with 3D imaging app or camera and laptop with Autodesk Recap 360 or similar program

**Advance Preparation**

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| --- | --- |
| **Material** | **Purchasing Location** |
| Ballistic Gel and mold | <https://www.clearballistics.com/> |
| Download 3D imaging app | Many options: Scann3D works for both android and iphone and is free. Trnio is good but is only an apple app. Be familiar with the apps. You may have trouble if the gel is too reflective.  Autodesk has a great online program(Recap360) that is an easy download. They offer free downloads for educational purposes- contact them. |
| Dye | Any dye could be used, even food coloring. An extension project could look at the difference between dye and the same dye encapsulated with nanoparticles if resources permit. |

Teacher should place ballistic gel in the oven at least 2.5hrs before the class so it is melted and ready for students.

On day 2: The ballistic gels are difficult to remove from the mold. This may be good to do before school that day. If students are careful, it is easy, but does take time.

**Safety Information** The Ballistic gel is nontoxic unless consumed or made into an aerosol. The MSDS is available on the Clear Ballistics Website. The person removing the mold from the oven, needs to wear heat resistant gloves or oven mitts. Students must take care to not touch the mold while the gel is cooling-it will be hot.

Students should wear safety googles while injecting air pockets into the ballistic gel.

Know the chemical property of the dye you choose and make sure students wear googles and gloves as necessary.

**Teaching Strategies:** Students should be familiar with mitosis and how cancer cells form.This lab can be done in groups of 4 students or the gel can be made as a class and each group has time to photograph and analyze the gel and discuss the questions. During downtime on Day 1, go over current imaging strategies and their limitations.

**Resources:** Use youtube videos to make sure students are familiar with the basics of imaging. Either post or print pictures of current imaging technology (MRI or PET,etc) so students can compare their 3-D model to a 2D model.

**Directions for the activities**

**Procedure**

**Day 1**

1. Teacher places ballistic gel in oven to melt several hours before class. (This may require purchase of several molds if all classes complete the lab the same day)
   1. It is easiest to spray the mold with release spray sold by Clear Ballistics for easy release.
   2. Clear Ballistics gel in the small mold takes 2+ hrs to melt at 250-270° F.
2. Take the Ballistics gel mold out of the oven and let cool for 15 minutes.
3. Fill the syringe with about 1cc of air
4. Insert the syringe in the gel and depress the plunger to make a bubble in the gel. (The bubbles will rise to the surface. If the gel is too hot, the bubbles will rise and pop, if the gel is too cold, the bubbles won’t form) It is helpful if the teacher experiments with the gel ahead of time (Clear Ballistics gels can be melted and reused)
   1. Once the gel has 5-8 bubbles, allow it to cool overnight.
   2. 1cc of air is a starting size, students can try to vary bubble size for a unique gel

**Day 2**

1. Carefully Release the ballistic gel from the mold using a spatula
   1. If the gel has imperfections in the sides that make it difficult to see the bubbles, hold a hair dryer close to that side until the gel becomes clear. Check every 30 seconds so it doesn’t melt too much of the gel.
2. Carefully use a syringe to fill each air bubble with dye.
   1. At this step, the person injecting dye should be wearing a lab coat or apron. If a bubble is overfilled, dye can squirt out of the bubble.
   2. Once the bubbles are filled, the gel is stable unless it is squeezed hard. Depending on your class, you may want to use a hairdryer for a minute or 2 on the top of the gel so that the injection spaces melt and reseal so that no dye escapes.
3. Move the gel to a location for easy 3D scanning. Each group will use a smartphone or camera to capture the pictures.
4. Walk slowly around the gel taking photos to form 3D image according to app instructions. Students need to walk around the gel 360°
5. Analyze 3-D image and compare to current tumor imaging methods (Show pictures of MRI scans or PET scan.

**Cleanup**

Ballistics Gel can be re-melted for other classes according to manufacturer instructions or stored as an example.

Follow disposal instructions for the dye you choose to use for your class.

## Example Student Worksheet or Guide

### Modeling Bioimaging in the Classroom (with Answers in Red)

#### Introduction

Cancer diagnosis and treatment depends on accurate imaging techniques. Current images are costly and/ or expose the patient to radiation. Now that geneticists have found genetic markers for cancer, the goal for the future would be to have people with genes that predispose them to cancer to undergo full body scans that could detect cancer when the tumor is only a few cells.

You will look at an imaging possibility and make a plan to improve it for future use. You will inject Ballistic gel (it has a similar texture to human soft tissue) with dye that simulates a tumor and form a 3D scan of the tumor.

#### Materials [list]

* + Smartphone or ipad with 3D scan app
  + syringe
  + dye
  + pencil

#### Prelab:

#### What is cancer?

#### Why is early diagnosis important?

#### Why can’t patients receive multiple full body scans using current imaging technology?

#### Procedure

1. Get the Ballistic Gel out of the oven using a hot pad and set it on a heat resistant surface to cool for about 20 min.
2. After 20 min have passed, fill a syringe with 1cc of air.
3. Insert the syringe into the gel and depress the plunger to release the air, forming a bubble. The bubble will float close to the surface.
4. If the bubble floats to the surface and pops, your gel is too warm, wait 5 minutes and try again.
5. Make at least 5 bubbles in your gel of different sizes. You can change the size of the bubble by filling the syringe with more or less air.
6. When you have bubbles in the gel, let it cool overnight and return the syringe to your teacher.

Day 2

1. Find your gel
2. Using a spatula, gently release your gel from the mold \*This will take time.
3. Fill the syringe with dye and insert the dye into the air bubbles you formed yesterday.
4. When all the bubbles are filled with dye, return the syringe to your teacher and move to an area that will allow you to walk around your gel 360.
5. Open the 3D imaging app.
6. Walk around your gel taking pictures per the app instructions. Be careful to keep the camera at the same level as you walk around your gel.
7. You may have to try several times to get a good 3D image of your model
8. When you have an image, share it with the teacher and answer the questions below.

**Analyze the Results**

1. Compare your 3D chemical model to the other images of tumors on the board. Write your observations below. Be detailed.

Draw Conclusions

1. If you are the scientists in charge, what could you add to the dye particles to make them go only to the tumor location? *Answers will vary: ATP, sugars, specific proteins*
2. How would the 3D image you made help a doctor or surgeon determine a treatment plan for someone with cancer? *Answers will vary, but should mention that 3D image will give more detail about how advanced the tumor is*
3. What do the people who design new imaging need to know or consider to get the detail desired? *Answer will vary but should be well thought out*

**Assessment and rubrics:** *Students should work with their group to produce thoughtful answers. Students should identify that this topic requires knowledge of biology, chemistry, engineering, math.*