

Shoreline Biotech Experience: Cancer Biology Kit Schedule Synopsis

In the SBE Cancer Biology Kit, students are presented with a cohort of twelve fictional breast cancer patients. Each of these patients has breast cancer. Each patient is tested in duplicate. The students work through multiple lab procedures to determine the following:

1. What is the likelihood that this patient's cancer has metastasized?
 - This is determined using an ELISA test to measure the amount of a biomarker called CA 27.29 in the patient's serum
2. What is/are the probable cause(s) of this patient's cancer?
 - This is determined using multiple assays including:
 - a. Polymerase Chain Reaction (PCR) and gel electrophoresis to determine whether the patient's HER2 gene has been amplified.
 - b. The Basic Local Alignment Search Tool (BLAST) bioinformatics tool to compare BRCA1 DNA and protein sequences to determine whether the patient has a mutation in the BRCA1 gene that could increase their likelihood of developing cancer.
 - c. Fluorescent cell staining (electronic or hard copy staining images) to determine whether the patient is over-expressing cell membrane-bound Estrogen Receptor

Once the students have assembled all of their data for all patients, they can 'stratify' the patients into different groups based on the assay results. At this point students can discuss what additional tests and/or therapies might be useful for the patients whose cancer may have metastasized. Students can also discuss which targeted anti-breast cancer therapies might have the highest probability of being effective for which patient sub-groups.

The kit is designed for students to work in 8 groups of 4, with each group conducting tests and analysis (ELISA, PCR, etc) on 3 patient samples. In this way, a total of 24 samples can be analyzed – 2 samples from each of the 12 patients.

Background information is provided regarding: the immune system, cancer biology, breast cancer, the cell cycle, the ELISA test, Polymerase Chain Reaction, potential treatments for breast cancer.

A summary of labs and other activities, as well as the suggested number of class periods dedicated to each activity, is as follows:

Activity	Number of Class Periods (not block periods)	Notes & Comments
<u>Micropipetting Practice Lab 1:</u> Students practice micropipetting small volumes (20 uL and smaller) <i>See also: Micropipetting videos at: URL</i>	0.5-1	Not necessary if students have already learned how to use micropipettes
<u>Micropipetting Practice Lab 2:</u> Students practice	0.5-1	Not necessary if students have already learned how to use

<p>micropipetting larger volumes and gaining familiarity working with 96-well plates (75-15 uL, "Suncatchers"). Also included here is an activity using the Suncatchers the students make to calculate their pipetting accuracy.</p> <p><i>See also: Micropipetting videos at: URL</i></p>		micropipettes
<p><u>Serial Dilution Practice Lab 3:</u> Students practice making serial dilutions using colored water.</p>	0.5-1	
<p><u>Introduction to Cancer:</u> The first 16 slides of this PowerPoint presentation introduces students to the basics of the cancer biology</p> <p><u>Exploring Cells, Genes & Cancer:</u> Think, Pair, Share activity and concept map</p>	1 period	Links to documents and videos giving further explanation of: Cancer Biology are available on the Canvas Page.
<p><u>HHMI Short Video</u> <u>HHMI Gene Card Activity:</u> Students learn about Oncogenes and Tumor Suppressor genes</p>	1 period	
<p><u>HHMI Patient Card Activity:</u> Students learn that the same type of cancer may have multiple genetic causes</p>	1 period	
<p><u>Introduction to Breast Cancer:</u> Part of the <u>Introduction to Cancer</u> PowerPoint presentation specifically about the causes of breast cancer</p> <p><u>Teacher demonstration of the OncoKB site</u> The teacher demonstrates how to find information about different oncogenes and tumor suppressor genes on OncoKB</p>	1-2 periods	
<p><u>Introduction of the Kit 'Scenario'</u> <u>Introduction to Biomarkers:</u> A PowerPoint introducing the concept of 'biomarker'</p>	1-2 periods	

Discuss metastasis		
<u>Introduction to the ELISA and the Immune System:</u> A PowerPoint that introduces the Immune System, Antibodies and the ELISA test <u>Antibody Model Activity:</u> Students create a 3 dimensional model of an antibody protein using chenille stems and Perler beads	1-2 periods	This activity was developed by Science Education Partnership. This activity works well in concert with the 'Intro to the Immune System' ppt
<u>Overview of the ELISA Test and ELISA Model Activity:</u> The PowerPoint presentation introduces students to the ELISA test. Students use models to construct what is happening in and ELISA well (both positive and negative controls).	1-2 periods	Teachers may want to start the ELISA test on one of these days. The first coating step can go overnight in the fridge. Teacher may want to review and/or do the 'Serial Dilution' activity at this point
<u>ELISA Lab:</u> Students conduct an ELISA assay to detect the presence of a biomarker for breast cancer metastasis in 'patient' samples.	1-2 periods	This activity can be done either as: -A positive/negative assay, where students only determine if antibody is present or not -A trinary assay, where positive results may be high antibody positive or low antibody positive Stop reaction can be included in the kit if teachers wish to bring plates back to SCC to generate numerical values on our plate reader (for graphing activities).
<u>Excel Graphing Activity:</u> Students use Excel to graph the values of their standard curve and generate the equation of a line. The equation of the line is then used to calculate the concentration of the biomarker in the 'patient' samples.	1-2 periods	Not necessary if teachers choose to do a positive/negative assay.
<u>Introduction to Targeted Therapies:</u> Part of the <u>Introduction to Cancer</u> PowerPoint presentation that introduces students to the concept of targeted therapies and explains	1-2 periods	

the mode of action of several breast cancer targeted therapies		
<u>Introduction to Polymerase Chain Reaction (PCR):</u> A PowerPoint presentation that introduces students to polymerase chain reaction	0.5-1 period	This lecture works well in concert with the paperclip PCR modeling activity.
<u>Paperclip PCR Model Activity:</u> Students carry out virtual pcr reactions using colored paperclips or other model	0.5-1 period	
<u>PCR Lab:</u> Students carry out PCR reactions on 'patient' DNA samples to detect the number of copies (per chromosome) of the HER2 gene.	1-2 periods	
<u>Agarose Gel Electrophoresis Lab:</u> Students run their PCR reactions on agarose gels to determine the number of copies of the HER2 gene.	1-2 periods	
<u>Record Data and Discuss</u> Circle back to Targeted Therapies for breast cancer	1 period	
<u>Introduction to Fluorescent Cell Staining:</u> A PowerPoint presentation introducing students to fluorescent cell staining. <u>Virtual Staining Activity</u>	1-2 periods	
<u>Analysis of Patient Staining Data:</u> Student look at images of stained breast cancer cells from each patient to determine the levels of mER expression	1 period	
<u>Breast Cancer Case Study:</u> An introduction to Bioethics	1-2 periods	
<u>Introduction to the Basic Local Alignment Search Tool (BLAST):</u> A PowerPoint presentation introducing students to BLAST	0.5-1 periods	
<u>BLAST Lab:</u> Students use BLAST to compare	1-1.5 periods	

'patient' Brca1 gene DNA sequences with the sequence of a BRCA1 gene with no mutations		
<u>Introduction to Cn3D:</u> Students visualize wild type and mutated BRCA1 proteins	0.5-1 period	
<u>Introduction to Large Data Sets:</u> Students are introduced to TCGA and OncoKB	1-2 periods	

Teacher preparations worksheets are included. Teachers can tailor the kit to the level of their students. There are some sections that can be removed or simplified. There are multiple 'build out' activities for teachers who wish to teach an area more in-depth to advanced students.