Teacher's written guide for "Discovering medicines, using robots and computers", a BLOSSOMS Blended Learning Module

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Lesson Plan Overview

Logistics for the lesson plan The lesson will take about 50 minutes, including the video segments (29 minutes) plus the in-class activities. The teacher should prepare all the necessary materials for the activities in advance – namely, printed handouts, a set of cups, and some candies or stones. In the major in-class activity in this lesson, there are materials for 30 different "samples". The teacher can decide whether to have students work independently or in groups of 2-3; the 30 samples should be divided among them. Thus, in some classrooms, a student or group of students may need to work on several samples rather than just one.

Summary: Scientists who are working to discover new medicines often use robots to prepare samples of cells, allowing them to test chemicals to identify those that might be used to treat diseases. It is a needle-in-a-haystack problem to find which chemicals affect cells in a way that indicates the chemical will be a good medicine. Sometimes, these experiments involve using robot microscopes to take images (pictures) of cell samples. Students will meet a scientist who works to identify new medicines. She created free software that "looks" at images of cells and determines which images show cells that have responded to the potential medicines. Students will learn about how this technology is currently enabling research to identify new antibiotics to treat tuberculosis. Students will complete hands-on activities that demonstrate how new medicines can be discovered using robots and computer software, starring the student as "the computer." In the process, the students learn about experimental design, including positive and negative controls.

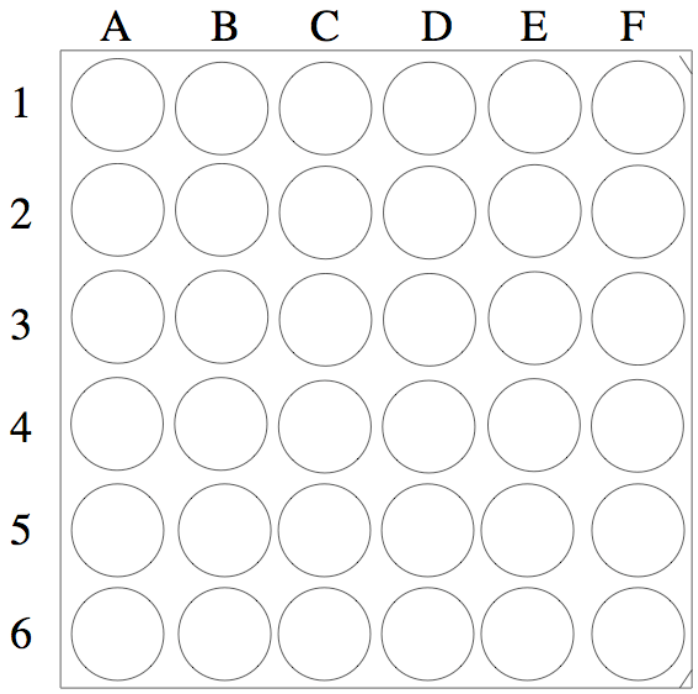
Prerequisite knowledge: Students should have some introductory knowledge about the following topics: (1) biology: students should have a basic understanding of infection and good hygiene, they should know what bacteria and cells are; (2) chemistry: the students should know what a chemical compound (molecule) is. They should have an understanding that medicines, also called "drugs", are chemical compounds; (3) basic experimental design: students should understand the terms "samples" and "testing".

Guidance for effective teaching:
The video will pause between segments for hands-on activities as well as discussions. This lesson is designed to reflect real science, where the answers are not always clear and straightforward. Students who are accustomed to lecture-style science training where facts are memorized might be uncomfortable when presented with questions that have no clear answer, or where the student has insufficient information to deduce the correct

answer. But brainstorming ideas and thinking about many possible answers are necessary skills for carrying out research science. During the discussion sessions when students are asked to predict results or think about an issue, the goal is not for the students to achieve the "right" answer but instead for the students to think of many possible answers and debate those answers. Even in the main activity in this lesson, where each student tests a chemical to see if it might be a good antibiotic, the experiment is set up realistically: the results yield several chemicals with promising results rather than one obvious best chemical, so the students will need to debate which chemical(s) might be good to pursue. Encourage the students to be comfortable giving "guesses" rather than "answers": focus on the students producing a diversity of ideas and explaining their reasoning rather than focusing solely on coming up with the correct answer.

Materials needed:

- Printed handouts - digital files (PDF format) are provided on the lesson's website. A good quality printer or copier may be necessary for the handouts to be usable.
    - "Testing bacterial growth" handout (Segment 2 activity): print one copy for each student or for each group of students (every student receives the same handout). The teacher's guide reveals the correct answers.
    - "Chemical Structures" handouts (Segment 3 activity): print one copy of the entire set of 36 structures; 6 will which will be held by the teacher and 30 will be divided amongst the students. There is also an answer key for the teacher.
    - "Identifying new antibiotics" handouts (Segment 6 activity): print one copy of the entire set of 36 images; 6 will be held by the teacher and 30 will be divided amongst the students
- Materials for the "Identifying new antibiotics" experiment/demonstration (Segment 5 activity):
    - One cup for every sample (36 total), representing the multi-well plate where the samples will be prepared.
    - A handful of "human cells" to sprinkle into the experimental cups – these could be candies or stones of a particular color
    - A handful of "tuberculosis bacteria" to sprinkle into the experimental cups – these could be candies or stones of a particular color (the bacteria shown in the lesson are green)
- The "Lab Notebook": Draw a multi-well plate on a blackboard or piece of paper at the front of the class for the students to record their experimental results (Segment 5 & 6 activities). It should look something like this, with enough space in each "well" to write a chemical's name plus the three numbers they will measure for each sample:



(if a blackboard or large piece of paper is unavailable, you can also print out a copy of the file “Lab Notebook” on a regular piece of paper)

- (Optional) A blackboard or piece of paper at the front of the class to facilitate discussion during several of the breaks