



Supplemental Materials

for

Gamification of the Laboratory Experience to Encourage Student Engagement

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Appendix 1: Assignment overview.

Project Overview

The laboratory component of Microbiology (BIO 303) is contained within the framework of the fictional game Micropocalypse. The basic premise of the game is that an unknown pathogen destroys most of society and the CDC has asked you to help identify the unknown pathogen, destroy the pathogen with appropriate medicine, and then help reestablish society through your training and application of laboratory skills.

Dr. X, your contact at the CDC, will provide you with the relevant background knowledge and resources.

As you gain experience and laboratory skills, you progress in the game from "Student" to "Senior Scientist." You must reach each level before moving on to the skill sets and experiences of the subsequent level.

Requirements for each level in Micropocalypse:

Student - No special skills. This is just you.

Lab Technician - Skills include microscopy, aseptic technique, visualizing bacteria with appropriate stains.

Researcher Level 1 - Skills include the use of biochemical and metabolic tests, has passed the first lab practical.

Junior Scientist - Skills include demonstrated use of tests to identify and treat an unknown bacteria, has passed the second lab practical.

Senior Scientist - Skills include the ability to create energy and food from microorganisms.

Time Line

1. Train (Week 1 through Week 6) - Learning the basic techniques and skills of microbiology.
2. Identify the Pathogen (Week 7 through Week 10) - Identifying the unknown pathogen.
3. Eradicate the Pathogen (Week 11) - Testing the pathogen for susceptibility to chemotherapeutic agents.
4. Acquire Clean Water and Food (Week 12 through Week 16) - To acquire water, students must purify a contaminated water source with a student-selected method. Before and after results must be included in the final presentation. To acquire food, students must choose two types of fermentation (vegetable, dairy, bread, beverage) and create an edible and safe form of food/beverage.
5. Create Energy (Week 12 through Week 16) - You will construct a microbial fuel cell using soil as your source of energy. Then, you must modify the fuel cell to generate the strongest voltage possible.
6. Solve the mystery...? - Can you *translate* Dr. X's clues into a complete story?
7. Final Presentation (Week 16)

Final Presentation - Your final presentation should tell the story of the Micropocalypse. The format you use to tell this story is up to you, but it must be shared with your classmates. You can present this as a PowerPoint, digital story, graphic novel, flip book, whatever. It doesn't matter so much as the material that is presented and that it contains all of the following information.

1. How you identified the pathogen, including figures from your laboratory report.
2. Eradication strategies developed from your experiments with antibacterials. You must include data and images of your experiments.
3. Water purification. - Describe why you chose that treatment and how it works. Provide microbial counts from before and after treatment.

4. Food preparation. - Describe two types of fermentation and the food you produced. Include the recipe and microbial counts before and after fermentation. Include images of the process of fermentation. You must bring FRESH samples to share with the class.
5. Energy production. - Creation of a microbial fuel cell. Include data on initial and final voltages achieved.
6. Solving the mystery. - Who is responsible? How was the pathogen introduced? What happens next?

Appendix 2: Example laboratory exercise.

Example Communication from Dr. X. Page numbers refer to exercises in “Techniques in microbiology: a student handbook.”

You’re accumulating skills very quickly, just like Dr. Drace anticipated. The next step in your training is to learn how to work with various microorganisms in the laboratory. Very soon we will send you the unknown pathogen for you to identify. But, it’s too risky right now. You haven’t proven you can reliably work with and identify the strains.

The following material should go in your notebook before lab on Tuesday. Put all of the information on one page of your notebook; this will be your prepared material for the lab. Dr. Drace will give you additional instructions from there.

- Dr. X

Laboratory Notebook Format:

Title: Pre-Laboratory for 1/22/13

Experiment #5: Aseptic Transfer of Bacteria

Purpose: To inoculate culture media with specific bacteria without introducing contaminating microbes.

Expectations: I expect to develop aseptic techniques and that the only thing growing in my media will be what I inoculate.

Strains used:

Serratia marcescens (Ser-AH-tee-ah mar-SESS-enz)

Broth to Broth (pg 29), Broth to Slant (pg 32), Plate to Broth (pg 35)

Escherichia coli (esh-er-EE-key-ah KOH-lee)

Slant to Deep (pg 40)

Procedures:

A. Transferring from broth culture to broth culture (pg 29)

B. Transferring from broth to slant (pg 32)

C. Transferring from plate to broth (pg 35)

D. Transferring from agar slant to agar deep (pg 40)

Discussion Question:

How can you know what you grew was what you intended and not a result of contamination?

Experiment #6: Streak Plate (pg 42)

Purpose: To isolate bacterial colonies growing on an agar plate surface in order to prepare a pure culture from a mixture of bacteria.

Expectations: Each plate will contain individual colonies and I will be able to tell the difference between them. *S. marcescens* appears red, *S. aureus* appears yellow.

Strains used:

Serratia marcescens (Ser-AH-tee-ah mar-SESS-enz)

Staphylococcus aureus (staff-ill-oh-KOK-us ore-EE-us)

Procedures:

Perform streak plate isolation for *S. marcescens*, *S. aureus*, and a mixture of the two.

Discussion Question:

What are three reasons why it is important to isolate individual colonies?

Appendix 3: Back story of the Micropocalypse.

Instructor's Note: This component of the activity is completely optional, but the students appeared more engaged and interested in the activity after more of the back story was revealed. Dr. X was cast as a CDC researcher who only had access to the outside world through the course website. These brief communications were released approximately every two weeks on the course website after about a month into class. The intent was to allow students to figure out how the Micropocalypse occurred and who was responsible.

Micropocalypse Back Story

Now that you have demonstrated your abilities and your security clearance is increased, we feel more comfortable to share with you some of the details that have led us to this devastating situation. I'll be giving you more information each week, so stay tuned...

May 2009. Authorities contacted the CDC about a particular patient we refer to as "Patient Zero." This individual was brought to our labs after a "fatal" infection. The case presented as a typical bacterial infection, but produced some odd symptoms. Patient Zero was initially pronounced dead in their local hospital – no heartbeat, no functional brain activity, etc. However, severe muscle spasms continued afterwards.

Somehow, the still unknown microorganism was using the body of Patient Zero. It would sound like I was crazy, if we hadn't witnessed the effects ourselves. Patient Zero's body was restrained and brought to our labs for further investigation. Could the infection be using the body as a host? Even after death?

To be continued...

Dr. X

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ccggcgaccattgaaaacaccagcgaacgccagtgggcgagcttcccgatgatggcgtgccagaac  
patientserqwasfrqmmacqn
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December 2009. Weird. There was a lot of buzz around the labs when Patient Zero first arrived. Interesting stuff. Patient Zero was brought in and all the department heads were consulted about the possible pathogen that initiated the infection. The press was all over the place.

I'll say it; you're already thinking it. Zombies. Yeah right, zombies. I mean come on, hasn't this been played out enough already. We're biologists. You and I both know that an organism can't resist decomposition after death. There's obviously something else going on besides the walking dead trying to get at our brains.

Unfortunately, I wasn't part of the discussion. I took a job at the CDC just a year earlier, after finishing up my post-doctoral studies. Being so new to the CDC, they didn't see the need to include me in the conversation. So, I was only able to pick up bits and pieces of information from the rumor mill. And, man there were rumors flying.

Some said the pathogen was from outer space. Some said that it was terrorist attack. There was even talk about this being a hoax orchestrated to get the National Institutes of Health to increase our funding. No one I knew had the inside information. At least not at first...

Then silence. Like it never happened.

To be continued...

Dr. X

accatgaaccggcgacccatcagggcgaaaactgggcgagcatggcgaacatggcggatgaa
thepathqgenwasmanmade

August 2010.

All hell broke loose. Everyone was just about to forget Patient Zero, when they started to reanimate. Full blown zombie apocalypse. Yeah, I said it...zombies. We call them hubers. HUMAN Bodies Experiencing Reanimation.

No one knows for sure how the pandemic started. Our best guess is that the same pathogen that infected Patient Zero mutated to become easier to spread. This isn't a movie; you don't *have* to be bit by a huber to become infected. The infection route had become airborne, and it was spreading...fast. Once a huber showed up at a local hospital, it was only a matter of hours until the entire place was irreversibly infected. Symptoms began as quickly as a few hours. Oddly, the hubers needed light. So, mid-morning was the prime-time for attacks and infections. At night, the hubers seemed to go into stasis.

At the CDC, we were more protected. We have a secure facility that can withstand an outbreak like this. Apparently, it was designed with a scenario like this in mind. I came into work one day in August, and they wouldn't let me leave. No one could leave. No one could enter. We were officially quarantined.

We watched the news reports on the internet. Society was collapsing before our eyes. Schools closed, mass riots and looting; complete and utter chaos. Then nothing. The news agencies stopped reporting. A few of the scientists worried about their families, snuck out before internal security got too tight. They never returned.

To be continued...

Dr. X

gatcgcgctgcaaaaaaacagtggagcacccatgaaccggcgacccatcagggcgaaaac
draceknqsthepathqgen

March 2012

After a year and a half stuck in this compound, we've still got nothing. The press stopped reporting a few months ago, so we were kind of in the dark. When that happened, we sent a reconnaissance party outside the compound, but they never returned. It seems that now the only thing we have that connects us to the outside world is this internet portal.

Through this site, we were contacted by a group of political leaders stationed in Virginia, including the POTUS. We started working on a plan to address this global pandemic, but no one knew how to approach the situation. Anytime anyone left or went outside, they became hubers... quickly.

Time was running out. The CDC was rationing fuel stores to run the generators, so it was hard to get any scientific progress made without our electrical equipment. We were trying to go old school, but lacked the resources of even a small-liberal arts college science building. We needed to find some way to make substantial progress or we wouldn't be here much longer.

To be continued...

Dr. X

bio.lundberg.gu.se/edu/translat.html

December 2012 – Final Backstory Post

After several months of silence, I remembered that there was a once brilliant scientist who took a job teaching at Mercer University, not far from the CDC. This guy was remarkable. I knew him from graduate school, where he was a legend. He was always on the forefront of research and whenever anyone had an unresolved problem they contacted him (professors included). Come to think of it, no one knew what exactly he was working on – it was classified research for DARPA. At least that was the rumor.

So, that's how I came to contact Dr. Drace at Mercer. When I found out that he was running an undergraduate laboratory of up and coming scientists, I immediately suggested that we try to work out a collaboration to end this horrible pandemic that's swept the globe. If anyone could solve the world's problems, it had to be Dr. Drace.

Little did I know he might have played a role in its creation...

Dr. X

gatcgcgctgccaaccgcccagaagaaccatgaacgcgtgctgaaagc
draceprqkethervles

April 2013

Great news! We looked over your reports and we whole-heartedly agree with your conclusions. Now that we know the pathogen we can begin producing appropriate chemotherapeutic agents to respond to this pandemic. We are going through your laboratory notebooks to find the right treatment regimen.

In the meantime, we still need you to keep working in the laboratory. As our nation recovers, we need scientists like you (upgraded to Junior Scientist) to help society transition back to the real world. Electricity supplies are low, food supplies are low, and most critically potable water supplies are low. But, after all you've done in the lab this far, I'm sure you can manage.

I'll be in touch later this week to go over upcoming strategies. Check back on Monday.

Dr. X

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This message is for your eyes only.

We are very familiar with the pathogen you identified. According to our sources in Washington DC, the creation of this bacteria was funded by their DARPA program!

About ten years ago, DARPA funded a proposal that was supposed to change the world forever. The scientist in charge found a way to genetically modify a photosynthetic bacterium to become symbiotic with human hosts. The bacteria used energy from the sun to create nutrients for the host – carbon and nitrogen from the atmosphere, hydrogen and oxygen from water. Very little additional nutrients were required and they could be taken in a supplement form that was easy, cheap, and readily available around the world. Not a single child would go hungry again. It was a beautiful idea.

But, clinical trials didn't go as well as planned. Some patients responded to the bacteria with a violent immune reaction. However, some patients responded to this new relationship brilliantly. The bacteria and human host forged a symbiotic relationship where nutrients and resources were shared equally. The problem was the mental focus of the patient. Their new interests were lying out in the sun and lying out in the sun. They lost all motivation to do anything else. It was like the bacteria had taken over their bodies and was manipulating their behavior.



And with that, the project was shut down. Too risky. The project was classified and the scientist ordered to incinerate all samples of the bacteria and all research notebooks. That was the order anyway. DARPA was afraid that something as catastrophic as this current pandemic was on the horizon, and it looks like they were right.

Dr. X

gatcgcgctgccaatgccggaagcgaccgaagatacccatgaaccggcgacccatcagggcgaaaac  
dracecreatedthepathqgen

**Appendix 4:** Final presentation rubric.

| <b>Category</b>            | <b>Description</b>                                                                                                                                                                                                                                                                         | <b>Points</b>    | <b>Score</b> |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------|
| Proposal                   | Clearly presents your strategy for water purification and testing, food preparation and recipes, and presentation method.                                                                                                                                                                  | <b>5</b>         |              |
| Format and Presentation    | Presents the entire story of the Micropocalypse in a clear and logical way. Presentation is professional and neatly done.                                                                                                                                                                  | <b>5</b>         |              |
| Pathogen Identification    | Includes a brief description of how the pathogen was identified. Must include Gram Stain images, Flowchart, and relevant description and introduction to the pathogen identified.                                                                                                          | <b>5</b>         |              |
| Antibacterial Strategy     | Includes a brief description of how antibiotics/disinfectants were tested. Includes the table from results. Groups must come up with an implementation strategy that treats the infection in the population.                                                                               | <b>5</b>         |              |
| Water Purification Methods | Includes a brief description of the procedures used, including the mechanism of purification. Presents evidence of purification with a column graph - CFU - before treatment and after treatment.                                                                                          | <b>5</b>         |              |
| Food Preparation           | Includes a brief description of the two types of food or beverage produced, including cultural history. Data included must be images of the fermentation process overtime, a simple stain of the microorganisms involved (after fermentation), and a sample of the foods brought to class. | <b>5</b>         |              |
| Energy Production          | Includes a brief description of the how microbial fuel cells work and how your group modified the fuel cell. Presents evidence of energy production by determining the maximum energy output (in Watts) for unmodified and modified samples.                                               | <b>5</b>         |              |
| Solving the Mystery        | Identifies how the outbreak occurred, solves the clues, and creatively handles the resolution of the game.                                                                                                                                                                                 | <b>5</b>         |              |
| Lab Notebooks              | Everyone's lab notebook should have ALL of the above experiments and results. All notebooks turned in.                                                                                                                                                                                     | <b>5</b>         |              |
| Peer Evaluation            | Peer evaluations turned in on the day of presentations will help me determine you participation in this project.                                                                                                                                                                           | <b>5</b>         |              |
|                            | <b>Total</b>                                                                                                                                                                                                                                                                               | <b>50 points</b> |              |