UBC Department of Microbiology and Immunology

Case by Case: A Foundations in Microbiology OER

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Background

In 2022, MICB 201, Introduction to Environmental Microbiology, was transformed into MICB 211, Foundations in Microbiology. Part of this course transformation included the addition of case studies derived from primary literature. In order to complement this new course structure, the MICB 211 team built an open educational resource (OER) in the form of an electronic textbook that includes the case studies in order to facilitate a flipped classroom experience.

1. Define Learning Outcomes:

The OER consists of 3 units: (1) foundations in microbiology, (2) environmental and (3) medical microbiology. Each unit has about 5 chapter with their own corresponding learning outcomes.

Learning Objectives

By the end of this chapter, students will be expected to:

1. format scientific names based on the proper conventions
2. describe how biologists organize organisms and how prokaryotes are classified
3. distinguish between eukaryotic and prokaryotic cells
4. distinguish between the different branches of microbiology, specifically microbial ecology, environmental and medical microbiology
5. appreciate the diversity of the microbial world and why we study microbiology through model organisms
6. describe how Bacteria are generally classified
7. use your observation skills as a training scientist to describe qualitative and quantitative data

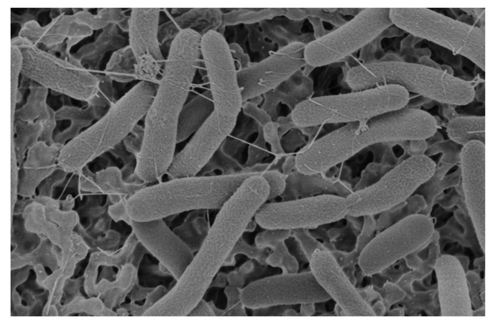
2. Provide scaffolding:

Each chapter introduces students to core concepts including the scaffolding needed to understand the case studies such as lab techniques.

Interpreting Qualitative Data

Qualitative data can often be presented as visual figures that can show structures and components. It requires observational skills to point out characteristics that may be of interest and changes or features that may not be expected.

Let's have a look at the microscopic image of a bacterial cell (Fig 1.7). You may want to observe it using these steps:



1. Consider what you would expect? (You may consider what shapes bacteria come in, how big they normally are, what structures they have on the surface)

2. Are there characteristics that you know of that you can identify? (What is the shape of the bacteria, how large it is, does it have a tail (flagella)?)

Figure 1.7. Example of qualitative data[6].

3. Introduce case study context:

We start each case study by defining the research objective(s) and hypothesis of the paper.

Case Study: Getting comfortable with data

This case study was adapted from: **Chong et al., 2020**

Chong, Garrovilla, Huang, and Naidu. 2020. Cell elongation induced by *ftsZ* antisense RNA expression in *Escherichia coli* strain DH5α increases T4 bacteriophage adsorbed per cell. UJEMI 25:1-7

Overview

This study was conducted by 4th UBC students in MICB 421! The students who published this study were interested in how longer cells could be more susceptible to being infected by bacteriophage, a type of virus that specifically infects bacteria. They observed that bacteriophage adsorb (ie.bind) to the surface of bacterial cells and this binding allows them to inject their DNA into the host where they can then reproduce and cause the cell to lyse. ***Chong et al. hypothesized that longer Escherichia coli cells have more binding sites and would be more susceptible to bacteriophage infection***.

4. Analyze data:

Students analyze both qualitative and quantitative data using guiding questions. Students are encouraged to go through the questions before class.

Step 1: Creating longer cells

What is a wild-type?

Phenotype that represents a form of a species that occurs in nature.

Chong et al. first had to find a strain of *E. coli* that are longer than ***wild-type*** cells. They obtained a mutated strain of *E. coli* that has a deletion of the *ftsZ* gene. This gene is important in regulating how the cell divides. Chong et al., ***hypothesized*** that deleting this gene would result in problems with cell division leading to elongated cells.

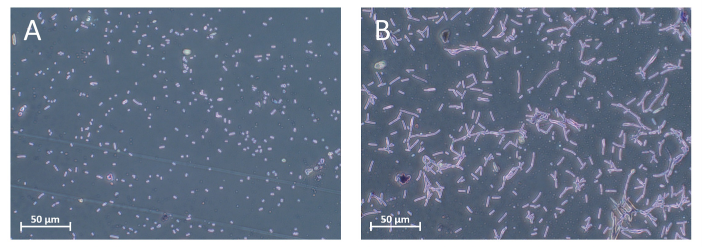
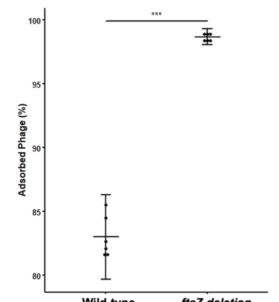


Figure 1.11. E. coli cells stained using crystal violet and imaged using light microscopy. (A) wild-type E. coli cells. (B) Mutant strain of E. coli with a deletion of ftsZ.

Step 2: Measuring the amount of phage infection



Statistical Significance!

Good data is normally collected in replicates. Replicates show that they conducted the measurement independently several times. It is common to consider the average or median of all these measurements to give a more accurate representation of the findings. Not all independent measurements, however, will be exactly the same. Variation can exist in the data for various reason, external factors, errors, etc. The variability has to be taken in consideration when comparison two sets of data. Statistical measures have been developed to determine, using the average, standard deviation, and other variables, whether the change you see between two group is significant or not. The significance is usually indicated on a graph as asterisks (*).

*Figure 1.12. Measuring the amount of phage adsorbed into E. coli cells in the wild-type and ftsZ deletion strain. *** indicates that the comparison is statistically significant. Bars represent the distribution of the data where the middle bar is the average.*

Questions to consider:

1. What is the y-axis showing? What has been measured and how?
2. What is the x-axis showing?
3. Is this type of data qualitative or quantitative?
4. Why do you think the authors chose to show this as a scatterplot rather than other formats?
5. What is the treatment and what is the control group?
6. What is the sample size (ie. number of replicates) for each strain? (Note that each data point represents one measurement)
7. What is your initial impression of the data? Is the treatment higher or lower than the control?
8. If you do see a difference between the two comparison groups, is this significance statistically significant? What does that mean to you?
9. Do you agree with the author's original hypothesis?

in-class components

5. Discuss in class:

Students read corresponding textbook chapters to prepare for a discussion of the case study in class. The purpose is to define the takeaways for each data figure/table.

6. Determine how it aligns to the hypothesis and research aims:

After compiling the takeaways from the figures/tables that students analyze, students define the key conclusions and relate them back to whether they feel it supported or refute the hypothesis or if additional data is required.

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