Appendix 1. Introduction to the FMPH CURE.

BIO 1402 Research Project: Decreasing Bacteria in Food

Purpose: The purpose of this assignment is to give you experience in scientific investigation, both experimental and non-experimental, and an opportunity to discover new knowledge.

Importance: In this project, you will address the question: **"How can I safely decrease the number of bacteria on the food that I eat?"** You will use a four-step process (from McLaughlin et al., 2017) to design and execute an authentic research project. This experimental framework is consistent with the manner in which professional research scientists devise, design, execute, interpret, and communicate their experimental results. Use this opportunity to discover something that impacts your life and those around you!

Bacteria are everywhere around you and inside you. Most are neutral and harmless, but some are harmful. If you have had 'food poisoning,' illness due to ingesting bacteria or their toxins, then you understand the importance of decreasing harmful bacteria. Understanding what reduces bacteria will help you make decisions to avoid illness, sometimes with wide-reaching consequences. For example, published guidelines from the U.S. Food and Drug Administration (FDA) mandate that food workers are required to bring meats up to 68°C for 17 seconds, because experiments have determined this to be conditions that kill bacteria.

Below are the steps that you will follow in this course to conduct your own investigations.

Step 1: Learn Essential Techniques

1. Build literature research skills and background knowledge: Laboratory 1

To address your question, *"How can I safely decrease the number of bacteria on the food that I eat?,"* you will use previous knowledge to come up with an idea, test your idea, analyze the results of the test to determine if your idea worked and is feasible in daily life, and then decide what to do with this knowledge. This process is a form of the **scientific method**.

What is the scientific method, and how is it used to address questions and solve problems? This is the focus of Laboratory 1, in which you will:

- Review the steps of scientific investigation
- Practice finding and navigating reliable sources (especially peer-reviewed journal articles)
- Find and read background literature related to food microbiology

** Lab 1 is due at the beginning of lab, week 3.

2. Identify a problem, question, and hypothesis; gather background information

First, you will **identify a problem** here in Côte d'Ivoire caused by bacteria in food. Using what you found in your background research (step 1), you will **ask a question** about what might be done to decrease bacteria and **hypothesize** a method by which you may be able to decrease bacteria.

Next, you will **search for background knowledge related to your hypothesis**. This is similar to step 1, but now you have a focused hypothesis to investigate. Prepare a data table with the information you find and your sources.

For the **hypothesis**:

- Define your problem, question, and hypothesis

For the **background research**:

- Find what is already known about your problem and hypothesis, and organize the data in a table
- Write an introduction for your project: Using this information, you will write the "**Introduction**" section for your project report. This gives the readers the background information they need to understand your project as well as what the problem, question, and hypothesis are.

** The hypothesis and background research are due at the end of week 6, in your notebook.
** A draft of the "Introduction" section is due at the end of week 7.

Step 2: Design an experiment to test your hypothesis

The "protocol" is the step-by-step plan for the experiment in the form of a numbered list. This will be done with the instructor.

Before the discussion: Complete the "Protocol Brainstorm." Before discussing with the instructor, try to come up with a way to test your hypothesis. Identify your experimental and control groups.

After the discussion: Write the final protocol. Revise the protocol wording so that it is easy for you to read and understand.

** The "Protocol Brainstorm" should be written in the notebooks prior to the start of week 7 lab.
** The "Protocol" is due at the end of week 8.

Step 3: Carry out experiment

Following the steps outlined in the protocol, you will carry out your experiment to address your hypothesis. You will have a few laboratory sessions in which to do this. Some work may need to be done outside of class; in this case, plan accordingly, and communicate with your instructor.

Note that you may need to deviate from the protocol; record any changes. Additionally, you will have details to record such as exact weights and times, and any descriptive observations such as colony colors or food scents. The methods you use will become your "Materials and Methods" section, while the data you gather will become the "Results" section of your paper.

** A draft of the "Materials and Methods" section is due by the end of week 11.

Step 4: Interpret data and communicate results

Science has no benefit if it is not correctly interpreted and communicated so that the knowledge can be applied. You will first determine what your data means and then make conclusions and recommendations. Finally, you will compile what you did, why you did it, what you found, what it means, and how it can be applied in a written report, and then present your research to others during a scientific poster session open to the campus and local communities.

** A draft of the whole paper is due at the start of lab week 12.
** The presentation date will be determined later in the semester.

Timetable

Project component	Time	Assignment (Due date)	Points
Step 1: Learn Essential Techniques			
Build literature research skills and background knowledge	Week 2	Lab 1 (Start of Lab, Week 3)	Lab grade
Identify a problem, question, and testable hypothesis Gather background information	Weeks 3 – 6	Hypothesis and Background Research (Friday, Week 5)	15 pts.*
		Introduction Draft (Friday, Week 6)	5 pts.*
Practice working with bacteria	Week 6	Microbiology Lab (Start of Lab, Week 7)	Lab grade
Step 2: Design an Experiment			
Create a protocol (with instructor assistance)	Weeks 6 – 8	Protocol Brainstorm (Start of Lab, Week 7)	3 pts. for completion*
		Protocol (Friday, Week 8)	3 pts. for completion*
Step 3: Carry Out Experiment			
Carry out experiment	Weeks 9 – 11	Draft of "Materials and Methods" (Friday, Week 11)	4 pts. for completion*

Step 4: Interpret Data and Communicate Results			
Analyze your results	Weeks 8 – 12	Draft of Written Report (Friday, Week 12)	10 pts.*
Communicate your research	Weeks 12 & 13	Poster Presentations (TBA) * Written Report * Report Presentation	 40 pts.* 20 pts.*
		***Total:**	100

References

1. McLaughlin JS, Favre DE, Weinstein SE, Goedhart CM. The impact of a four-step laboratory pedagogical framework on biology students' perceptions of laboratory skills, knowledge, and interest in research. *J Coll Sci Teach.* 2017;47(1):83-91.
2. U.S. Food & Drug Administration. *Food code: U.S. Public Health Service*. Retrieved August 2, 2021, from https://www.fda.gov/downloads/food/guidanceregulation/retailfoodprotection/foodcode/ucm595140.pdf

**** For specific course materials, please contact Dr. Marie Smith at masmith10@utep.edu. ****

Appendix 2. End-of-semester poster evaluation rubric.

	Above Average (3 pts.)	Average (2 pts.)	Below Average (1 pt.)
Topic Selection	Identifies a focused and manageable topic that ***addresses potentially significant, yet previously less-explored***, aspects of the topic	Identifies a topic that, while manageable, is too narrowly focused and leaves out relevant aspects of the topic (i.e., the topic is not appropriately addressed)	Identifies a topic that is far too general, inappropriate for the structure of the CURE, and/or is not feasible to conduct given available resources
Existing Knowledge, Research, and/or Views	Synthesizes in-depth information from relevant sources representing various points of view and/or approaches	Presents information from relevant sources (rather than synthesizes), and the information presented is not comprehensive	Presents information from irrelevant sources representing limited points of view and/or approaches (i.e., incomprehensive info)
Design Process	All elements of the methodology are skillfully developed and appropriate for the proposed experiment(s)	Critical elements of the methodology are missing, incorrectly developed, unfocused, and/or inappropriate	Inquiry design demonstrates a misunderstanding or lack of methodology appropriate for the proposed work
Analysis	Organizes and synthesizes evidence to reveal insightful patterns, differences, or similarities related to the team's central questions/hypothesis	Organizes evidence to reveal insightful patterns, differences, or similarities related to the team's central question/hypothesis; ***little or no synthesis is present***	Lists evidence, but it is not organized and/or is unrelated to the team's central question and hypothesis
Conclusions	States a conclusion that is a logical extrapolation from the inquiry findings. ***Conclusions should be comprehensive****.*	States a conclusion that is focused ***solely*** on the inquiry findings. The conclusion arises specifically from and responds specifically to the inquiry findings.	States a conclusion that is ambiguous, vague, illogical, unsupported, or (in general) poorly developed
Limitations and Implications	Insightfully discusses in detail relevant and supported limitations and implications	Presents relevant and supported limitations and implications; ***limited discussion***	May present limitations and implications, but they are possibly irrelevant and/or are unsupported
Context/Purpose for Writing	Poster is appropriately targeted to a scientific audience	Poster is targeted to a scientific audience but exhibits instances in which non-scientific conventions (e.g., language that is too colloquial) are used	Poster demonstrates minimal attention to audience, and, as such, is not appropriate given the assigned task
Syntax/Mechanics	Demonstrates expert command of language that skillfully communicates meaning to readers with clarity and fluency; document is virtually error-free	Uses straightforward language that generally conveys meaning to readers Document contains only a few syntax/mechanics errors.	Use of language is crude and/or sometimes impedes meaning because of a high number of syntax/mechanics errors

Comments: