

# Guidelines for Final Paper

ENVE 4385 and 5331 – Microbial Applications in Env. Engineering

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Due Date of Final Paper: **Friday, November 19<sup>th</sup>.**

Other information regarding deadlines:

- I strongly recommend you send me an email outlining your topic in 2 – 3 sentences or an email asking for help in selecting a topic no later than **November 5<sup>th</sup>**. I can help you focus your topic and/or identify sources.
- If you'd like me to review your 1-page overview, please send me by 11/9 (incomplete drafts are fine) and I'll give you comments by 11/12.
- **Submit your paper via Blackboard on November 19<sup>th</sup>.**

**Description:** This paper will answer the following prompt:

*It has been said that microorganisms are significantly underutilized in environmental engineering applications. Identify an aspect or problem in environmental engineering that could be (better) addressed by implementing a specific microbial feature, attribute, or function. Explain whether this problem would be better addressed using microorganisms directly (biological system) or by mimicking the biological aspect or aspects (biomimetic design).*

To address this prompt, students will:

- Describe a weakness or vulnerability (if approached from an engineering perspective) of one specific aspect of environmental engineering
- Identify a particular microbial characteristic, function, or property that could be used to address this weakness
- Construct an argument:
  - Demonstrating an understanding of critical microbial reactions, pathways, and properties
  - Describing in detail how these microbial properties may be applied to the problem above, outlining any knowledge that would need to be obtained prior to application
  - Stating whether the proposed approach should be biological or biomimetic, and explaining why.
- Draft a paper to address the prompt. The final product should be logical, scientifically accurate, and written in a concise, professional format.

*Note: This paper prompt builds upon the capstone design project for ENGR 1320 (Biologically Inspired Design), a required course for students who entered the Whitacre College of Engineering in 2019 or later. If, fortuitously, your ENGR 1320 project topic will also satisfy my prompt above, you may use the same topic. However, ENVE 4385 is a senior-level course that describes microbial process in much more detail than information presented in the freshman-level ENGR 1320 course, and your term paper must reflect this to earn a passing paper grade.*

As papers typically must adhere to very strict formatting requirements, this project does too. Formatting requirements are described in the paper overview but can be summarized as:

- Font: 12-point Times New Roman or 11-point Arial, 1.5-spaced (overview is single-spaced).
- 1" margins
- Page limit: 1-Page Overview, followed by a minimum of six pages of description *but Overview + document should not exceed 10 pages*. This does not include references.
- Maximum area of space occupied by cumulative pictures/graphics: 1 page

Below is a suggested outline for your paper. *You do not have to adhere to this format strictly, as long as you fully describe your project.* For a paper of this length, there are typically four components, as described below. *The lengths are guidelines and will likely vary in your paper.*

### **1. Overview (1 page)**

### **2. Background (~33% of Paper):** This can be set up as:

- Opening paragraph(s) about your topic. Should be an expansion of the opening sentence from your 1 page summary. Should be very easy to read.
- What is known about your topic. A literature review. Should be technical in nature.
- What is unknown about your topic, or identification of a “problem” that needs to be addressed. Identification of “a gap”, as well as identification as to why that gap is important.
- The background section should contain citations from a minimum of 9 sources.
  - ENVE 4385: I will accept up to 4 non-published websites. You are welcome to access your other 5+ sources electronically, but they must additionally be published in some capacity (journal, book, or published report).
  - CE 5331: A minimum of 8 sources must be peer-reviewed journal articles.

### **3. Overview of Proposed Microbial Solution (~10%):** Broadly, how are you going to address “the gap” that you identified in the paragraph above?

- Clearly define what you hope will be accomplished using microorganisms. First sentence is an objective. The objective must link back to the gap in the knowledge/need that you identified in the paragraph before, because it must fill the gap/meet the need described

**4. Approach (40-60% of Paper):** What is the scientific rationale behind why you think the proposed microbial solution will work, and how would you recommend implementing this technology?

- This section should demonstrate a solid background in microbiology – do you understand the fundamental principles of what you are proposing?
- This section should also provide a general discussion as to whether microorganisms will be directly harnessed in your solution, or whether their behavior/structure will be modeled. We will discuss a few examples of this in class, but below is an example of a global problem that could be solved using a microbial feature, either with microorganisms directly or by mimicking a specific microbial feature:

*Phosphate accumulating organisms (PAOs) accumulate orthophosphate ( $PO_4^{3-}$ ) in their highly specialized cell membranes when oxygen is present. This is an excellent way to recover phosphate, which is a limited resource globally. Agricultural runoff represents a waste stream with high phosphorous loading where phosphorous is rarely recovered. In this circumstance, phosphate could be recovered:*

- *By funneling agricultural runoff through a series of wetlands containing PAOs (biological), or*
- *By creating a specialized membrane that mimics the cell membranes of PAOs and is therefore able to preferentially adsorb phosphate (biomimetic)*

*In this example, there are pros and cons to both the biological and biomimetic solutions (not all scenarios will have both, and that's fine too). In the instance where the solution could be both biological and biomimetic, you need to pick one and support it.*

**5. Potential Impacts of Proposed Work (10-15%; ~ 1 page):** This is an expansion of your project rationale. However, it should be longer and more detailed, and should contain a well-defined argument as to why this work is important, outlining possible implications and advantages.

Additionally, your paper should contain a reference section. The reference section does not have to include page numbers, and I have three general requests (no specific format required):

- Number the references
- Cite directly in text
- The reference format should include the names the primary author (at minimum) and the full title and journal (if applicable) names. If a website – include the URL.