**Design Brief: Antimicrobial Product**

# Introduction

Prior to the 20th century, infections that we think of as being easily treatable today, such as pneumonia and dysentery, were often fatal to those infected. It is in large part due to the use of antibiotic drugs that these infections have become so little a threat to human life. In addition to drug treatment, we’ve also discovered the importance of surrounding ourselves with clean and disinfected surfaces to stop the spread of infectious pathogens. Paul Ehrlich, in the late 19th century was one of the first scientists to postulate that compounds might be developed that could target certain bacteria without harming other cells [1]. This idea was essential to the development of antimicrobial treatments. There are many chemicals that are effective at killing infectious cells like bacteria, but most would also damage our own cells.

Today, scientists and engineers are investigating and developing a variety of materials with antimicrobial properties that are effective at killing bacteria, and that are safe to our cells. Many of these materials are polymers that can be molded and formed in numerous ways. These polymers could be incorporated into items and surfaces with which we come into contact every day, thereby reducing our contact with infectious pathogens.

For this challenge, you are joining a research team, headed by Dr. Whitten, that has just developed a material that is an oligomer falling into the category of oligo-phenylene ethylynenes (OPEs). This particular OPE has remarkable antimicrobial properties, has proven safe for human contact, is highly durable, and can be molded into a variety of shapes and sizes or integrated into a variety of materials. Your task is to design a product that can be made from or can utilize OPE and that can be marketed and sold by a major company.

# Student Learning Outcomes

Students will be able to:

* research key concepts in cell biology (pathogens, antimicrobials, antibiotic resistance);
* work collaboratively in a team;
* propose a product with an antimicrobial purpose and justify its marketability; and
* communicate the product’s potential in a pitch, backed by a supporting document.

# Project Constraints

Your product must be an application of the OPE material, such as a surface coating applied to an object already being manufactured (though you can propose changes to the design or manufacture). Your proposed product must be **specific**, not a general class of objects or a setting. You must show that it is a feasible to use OPE in your product, that there is a market for the product and that it would prove useful to consumers. You may not propose a product such as a wipe or spray, as these are already in production.

# Material Specifications

OPEs are a new material developed over the past two years by Dr. David G. Whitten’s lab at UNM.

* Cost to manufacture *(estimated)*: $1.41/mg, and 1 mg/cm2 of surface area
* Safety to humans: Laboratory studies have shown that OPEs are safe for eukaryotic cells. Testing has not been conducted on potential risks if the product was inhaled/ingested or otherwise used internally.
* Safety to the environment: Unknown at this time.
* Durability: Assume the OPEs surface will last for the lifespan of the product
* Mechanism: Non-specific killing mechanism

# Project Management

Teams will include people with whom you are not acquainted. Your team was formed using CatMe software, which uses your input and extensive research on effective teams. All members contribute to all aspects of design process and completion of deliverables. Each team member will serve in the role of designer during your design process and spokesperson during the final pitch. Each aspect of the teamwork will have a designated leader:

|  |  |
| --- | --- |
| **Job title** | **Job Description** |
| Project Manager | Responsible for submitting team deliverables, keeping the team on track and managing group progress. Everyone will pitch in with the design and aid in the brainstorming, but at some point you will need to decide on an idea, and the project manager has final say. This reflects the real world, and sometimes ideas may be selected that are not your own. Compromise to make a better product! |
| Lead Research Scientist | Leads the team in conducting research. This person should organize documents and information gathered by the team and can assign specific research tasks to members of the team. This person should be organized and analytic. |
| Lead Market & Financial Analyst | Oversees market research on existing products. Confirms accuracy of numbers and accounts for how the team spends time. When you are working as a professional engineer, you will be responsible for justifying the time spent to your client. This person needs to be good at attention to detail and have strong ethics. |
| Lead Requirements Engineer | Responsible for keeping stakeholder requirements and customer needs in focus. This person should be able to empathize with customer experience and consider different points of view, while also considering material constraints.  |

Some Useful References

The following are sample references that you may use to supplement your own research. They
are cited using a numbered style, so use them as a reference when citing your own documents.

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| [1]  | Microbiology Society. The History of Antibiotics.http://www.microbiologysociety.org/outreach/antibiotics-unearthed/antibiotics-andresistance/history-of-antibiotics.cfm (accessed Aug. 4, 2016) |
| [2]  | UN Environment. Press Release: Antimicrobial resistance from environmental pollutionamong biggest emerging health threats. https://www.unenvironment.org/news-andstories/press-release/antimicrobial-resistance-environmental-pollution-among-biggest(accessed Aug 10, 2019) |

Project Deliverables

You will be expected to meet the following criteria to receive full credit for this challenge.

|  |  |
| --- | --- |
| **Deliverable (completed as a group)**  | **Points** |
| 1. Initial activity (in class)• Identify your prior knowledge & gaps in your understanding• Plan your research• Generate initial ideas | 10 |
| 2. Understand the problem• Do research to fill in gaps in understanding• Define your problem | 10 |
| 3. Market Research• Product idea• Market research & potential | 15 |
| 4. Final Presentation• 3-minute pitch delivered to class• Supporting document (infographic, flyer, ppt, prezi, etc.) Pitch anddocument to be persuasive and include data about problem.Document should include references, market data, and designschematic and should also be persuasive. | 40 |
| **TOTAL**  | **75** |

# Antimicrobial Product Deliverable 1: Team formation and planning

*completed as a team*

**Team Number:**

**Date:**

**Task #1.** Decide on team roles and detail the responsibilities for each team member. Plan what each team member will contribute to the whole project.

|  |  |
| --- | --- |
| **Team member name** | **Tasks** |
| **Project Manager:** |  |
| **Lead Research Scientist:** |  |
| **Lead Market & Financial Analyst:** |  |
| **Lead Requirements Engineer:** |  |

**Task #2:** Share contact information with your teammates. What is the best way to get in touch with each other?

**Task #3:** Set a meeting time before the next CBE 101 class. Write the date, time, and location below.

**Task #4:** In your studies and in the workplace, you will be faced with team work and challenges related to working in teams. Professional engineers collaborate with each other and with non-engineers throughout their work. Research shows that team members learn from each other and that diverse teams come up with better solutions. In this class, you’ll work in a team the whole semester. This assignment will help you establish the kind of team you want to be.

a) How often, where, and when will your meetings be?

b) How will you share and collaborate on documents? For instance, will you use googledocs, dropbox, Office 365, email, something else?

c) The most common issues teams face are:

* No-shows: Person X does not show up to meetings.
* Hitchhikers/coat-tail riders: Person X does not complete their work, does low quality work, or does not contribute during meetings.
* Domineering/enabling: Person X has to get a perfect score on everything and does most of the work on all assignments, making it hard for others to contribute and enabling the hitchhikers.
* Divide-and-conquer failures: Team members divide up the work, and then paste it into one document without bringing the assignment together.
* Despite having issues, team members wait until the last minute to seek help, at which point, there is little the instructors can do.

Come up with at least 5 rules for your team that you can agree on. The rules should cover the issues described above, including the consequences and what you will do if issues arise. In addition to turning in this assignment, make sure all team members have a copy of your rules!

**1.**

**2.**

**3.**

**4.**

**5.**

**Task #5: Plan your next steps using the activity below.**

After you have reviewed the design brief and watched the video, discuss with your team to answer the questions below. When you pitch your product, you will need to be able to explain how OPEs work and why they are better than other available options. As a team, you should begin by figuring out what you already know, and what you need to do research on.

Just write down your best ideas and what you know. Do not do any research now. You’ll have time to do research later. Don’t worry if you are accurate at this point. Research shows that generating ideas BEFORE doing research helps you learn.

**What are antibiotic, antibacterial, and antimicrobial products? How are they different from one another? What organisms do they kill? How do they work?**

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| --- | --- |
| **What do you know about these questions?** | **What do you need to research? What gaps in understanding do you have? What tools/resources will you use to find information?** |
|  |  |

**What questions do you have about OPEs? What do you need to know about them?**

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**Generate ideas:** Begin coming up with possible ideas for products. List at least ten surfaces people come into contact with that support the spread of pathogenic microbes. Consider people of all ages and of various occupations.

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**Get to know your team**

# Option 1: mini design challenge

Prep: fill a bag or box with either ~70 small objects or 70 pictures of objects. The objects should be common, familiar objects.

As students walk in, they draw an item/picture from the box.

In their teams, they must come up with a use for the objects collectively. This can be scenario-based, such as:

“You are going on a camping trip and your backpack falls off a cliff into a river and is carried away. However, you find a bag containing these things. What do you do with them?”

# Option 2: Wrong theory design

Sometimes, being wrong helps you think in new ways about a problem. You task is to work as a team to come up with the WORST possible solution for the following scenario:

Your friend has a large dog and needs a dog house for it. He is worried that in the summer, the dog gets too hot in the sun, as there is no shade in the yard. In the winter, the yard is windy and cold.

# Option 3: Paper tower

Each team gets two sheets of paper. They are told to build the tallest tower they can out of a single sheet. After 5 minutes, they are asked to reflect on what worked or did not work, then they redesign with the second sheet.

# Option 4: Desk bridge

Each member of the team needs to be sitting side by side in a row for this to work. Each team gets a bag with a couple sheets of paper, 10 paper clips, 4 rubber bands, 10 toothpicks, a couple small random objects, and a gumball. Their task is to move the gumball across all team member desks without pushing it. The gumball must not be given any additional force (meaning it cannot be thrown or tossed by hand, nor can it be sling-shot by rubber band, but it can be released so gravity can act upon it). It must touch each desk.

**Deliverable 2: Antimicrobial Product: Problem Definition**

*completed as a team*

**Team Number:**

**Date:**

**Task 1: Write down what each team member contributed to this assignment. If someone did not contribute, do not enable them!**

|  |  |
| --- | --- |
| **Team member name** | **Tasks** |
| **Project Manager:** |  |
| **Lead Research Scientist:** |  |
| **Lead Market & Financial Analyst:** |  |
| **Lead Requirements Engineer:** |  |

**Task 2: Understand the problem**

*You may need to do some research to answer the questions below. Include the citation or website address. You will need the citation when you present your pitch!*

|  |  |  |
| --- | --- | --- |
| **Antibiotic product** | **Antibacterial product** | **Antimicrobial product** |
| **What types of organisms does each kill?** |
|  |  |  |
| **How do they each work?**  |
|  |  |  |
| **What are some examples of each product?**  |
| **1.** **2.** | **1.** **2.**  | **1.** **2.** |
| **What are some of the problems with each?** |
|  |  |  |
| **Bacteria** | **Fungi** |
| **Describe the distinguishing characteristics of bacterial and fungal cells** |
|  |  |
| **Which infection—bacterial or fungal—is easier to treat? Why?** |
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**Idea selection:** Discuss as a team and choose three ideas that your team feels represent a need for an innovative product. State your reasons for choosing this one over others discussed. For each idea, identify at least two types of potential customers and how/why they need this product. It may be helpful to consider underserved or vulnerable customers.

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| Idea #1: Customers: |

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| Idea #2: Customers: |

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| --- |
| Idea #3: Customers: |

# Deliverable 3: Antimicrobial Product: Market Potential

*completed as a team*

**Team Number:**

**Date:**

**Task 1:** Write down what each team member contributed to this assignment. If someone did not contribute, do not enable them!

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| --- | --- |
| **Team member name** | **Tasks** |
| **Project Manager:** |  |
| **Lead Research Scientist:** |  |
| **Lead Market & Financial Analyst:** |  |
| **Lead Requirements Engineer:** |  |

**Task 2: Market Research:** List and describe at least two products currently on the market. How are they similar to and different from yours? Who is currently buying those products? Why are they using these products? How much do these products cost? Existing products may or may not include antimicrobial properties.

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| --- |
| Product 1:Product 2: |

**Cost Estimate:** Estimate the cost of your proposed product based on the approximate dimensions of your product and the volume of OPE material to be used. You’ll need to factor in the cost the product itself as well as the cost of the OPE material. Decide as a team what the retail price you will be for your product.

|  |
| --- |
| Current base price of existing product:Surface area of product to be coated:Cost of OPE material to be used (Estimates: $1.41/mg, and 1 mg/cm2 of surface area):Cost of proposed product (base + OPE):Proposed retail price:  |

**Innovate:** Your product will likely cost more because of the added OPE material. How could you change your design to minimize this difference? Alternatively, how could you communicate how much safer your product is? Can you identify any weakness of existing products compared to your product? How will you show that your product is better in some way (quality, effectiveness, efficiency, etc.)?

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# Pitch Guidelines

You will make a pitch to class and invited guest judges. You must turn your presentation materials (PowerPoint or Prezi) prior to presenting. Your pitch should be persuasive yet communicate accurate information about the problem.

**Pitch**

*Your pitch should meet the following elements*

**Time:** Your pitch can be no longer than 3 minutes. Keep this in mind when putting your slides together. We suggest three to six slides.

**Dress:** Dress professionally.

**The Problem:** Concisely explain the problem and needs addressed by your design.

**Use-case**: A good pitch helps the potential investor envision how the product will be used, not just what it looks like. Sharing a (very) short story about how it will change customers’ lives for the better will help seal the deal. The story should communicate what makes your product better than existing products.

**Creativity:** An idea viewed as novel will be received better than an ordinary one. Your pitch should highlight what makes your product stand out.

**Market potential:** Your pitch should concisely convey the market potential of your product, including the assumptions you made regarding estimated costs.

**Slides:** Your PowerPoint or Prezi slides should include the following:

* Use a sans serif, easy-to-read professional font
* Do not use font size smaller that 20pts
* Use color and images professionally
* Include citations as appropriate (these may be a smaller font at the bottom of the slide)

If you choose to do a prezi, you may want to look at examples in their gallery: <https://prezi.com/gallery/> or search for prezi pitch templates.

Evaluation

Each team will be evaluated by a panel. Panelists use the form below to evaluate your performance.

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| --- | --- | --- | --- | --- | --- |
| *TEAM XX**Please evaluate the students on the following:* | *Strongly agree* | *Agree* | *Neutral* | *Disagree* | *Strongly disagree* |
| The students presented confidently or worked to overcome any nervousness |  |  |  |  |  |
| The students concisely explained the problem and needs addressed by their design. |  |  |  |  |  |
| The pitch helps clarify how the product would be used, how it could change customers’ lives, and what makes their product better than existing products |  |  |  |  |  |
| The idea presented is creative |  |  |  |  |  |
| The pitch conveys the market potential of their product |  |  |  |  |  |
| The slides are professional, legible, and include appropriate citations |  |  |  |  |  |
| Please provide any comments here: |