

## Pharmaceuticals: Designing & Producing Effective Medicines

### NEW FOR 2025-2026!

- ★ Relevant real-world examples added: Youtube videos on painkillers including Ibuprofen and acetaminophen
- ★ Relevant real-world examples added: Youtube videos on the drug discovery process
- ★ Quality check was performed to ensure web links still work and equipment lists are up to date.

### SUGGESTED LESSON PLAN - 50 minute periods

Total Time ~75-100 minutes

- 27 minutes to watch the lab introduction video
- 20-30 minutes to build and test their drug delivery system
- 20-30 minutes to build a second iteration
- ~5-10 minutes closing activity or discussion

Optional Extension:

- Biological Drug Processing and Cell Fermentation

**Important:** Schedule a 30-45 min Zoom session at your designated class time and meet with an Engineer and College Engineering Student. We will meet your class wherever they are: Introducing the lesson, Building & designing, Testing, or Analyzing results.

Hook/Essential Question	Why might drugs be administered in different ways, like by mouth or by injection?
<p><b>Supplies to Have in Class</b></p>	<p><a href="#">ET Pharmaceuticals Kit</a> materials can be found at the end of this file.</p> <ul style="list-style-type: none"> <li>• colored tablets, water soluble stabilizers, napkins</li> </ul> <p>Additional Items to Consider Having on Hand:</p> <ul style="list-style-type: none"> <li>• Water</li> <li>• Paper Towels to clean up any spills</li> <li>• Sink, drain, or bucket to dump liquid at the end of the lab</li> <li>• Other types of paper to test and/or tape to secure the tablets</li> </ul> <p><b>NOTE:</b> The videos <b>below</b> should be unblocked for <b>teachers-only</b> if presenting the student workbook to the whole class OR for <b>all students</b> if they are completing the student workbook on their school devices</p> <p>Main Workbook</p> <ul style="list-style-type: none"> <li>→ <a href="https://www.youtubeeducation.com/watch?v=bNYc5JHfsqs">https://www.youtubeeducation.com/watch?v=bNYc5JHfsqs</a></li> <li>→ <a href="https://www.youtubeeducation.com/watch?v=uOE7TDmHBqM">https://www.youtubeeducation.com/watch?v=uOE7TDmHBqM</a></li> <li>→ <a href="https://www.youtubeeducation.com/watch?v=6YXag5oNU6k">https://www.youtubeeducation.com/watch?v=6YXag5oNU6k</a></li> <li>→ <a href="https://www.youtubeeducation.com/watch?v=Oxos77flsmc">https://www.youtubeeducation.com/watch?v=Oxos77flsmc</a></li> </ul> <p>(Optional Extension #1)</p>

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	→ <a href="https://www.youtubeeducation.com/watch?v=5eKdZ0dVCCo">https://www.youtubeeducation.com/watch?v=5eKdZ0dVCCo</a>
<b>Class #1</b>  Introduction and Procedure	Watch the <a href="#">Engineering Tomorrow: Pharmaceuticals Intro Recording</a> on the <a href="#">Pharmaceuticals webpage</a> either as a class or assign background section as pre-work (see above). <ul style="list-style-type: none"> <li>→ Have students answer the comprehension questions in the first 31 slides of the student workbook</li> <li>→ Watch the rest of the video that outlines the instructions for the challenge.</li> </ul> <p>Student teams begin to build and test drug delivery prototypes → research designs, review materials, test the initial design concepts and describe in their student workbook or worksheet (1 workbook or worksheet per team suggested)</p>
<b>Class #2</b>  Work Time and Testing	<ul style="list-style-type: none"> <li>→ Complete Prototypes #1 and 2 if not already done in previous class</li> <li>→ Determine Final Prototype Design and Test It</li> <li>→ Students measure the performance and determine which of the 3 designs was the best at matching a 5-second and a 30-second medicine delivery system.</li> <li>→ Student teams summarize and reflect on their final plane design and performance in the workbook or worksheet</li> </ul>
<b>Part of Class #3</b>  Possible Closing Questions and Activities	<p>Class Discussion Question: As more and more people suffer from cancer, what other types of medications and treatments are you aware of?</p> <p>Or watch the inspiring Keynote Speaker Video: (~25:00 -1:14:00 ) featuring a Q&amp;A with ET's Milton Davis and <a href="#">Dr. Liagliang Hao</a>, leading expert in cancer technology, at the Koch Institute. <a href="https://www.youtube.com/watch?v=9_ASw20sNWE">https://www.youtube.com/watch?v=9_ASw20sNWE</a></p>

### INTRODUCTION TO ENGINEERING TOMORROW:

- Click [here](#) to see an introduction of what Engineering Tomorrow can do for your students.

### INTRODUCTION TO THE ENGINEERING DESIGN PROCESS:

- Students should complete the [Engineering Design Process Introduction Activity](#) before starting the lab
  - NOTE: This activity only needs to be completed before the student's **first** ET lab, not repeated for every lab.

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### TEACHER NOTES:

- Students will work through the **Pharmaceuticals:** [Student Workbook](#) or complete the [Abbreviated Student Worksheet](#).
  - When assigning this lesson on Google Classroom, first make a copy of the slides to save within your Google Drive, then assign so that each student has their own copy.
  - The workbook and worksheet are designed to be interactive so that students can type directly into the files. It is suggested that the workbook or worksheet be completed over a few class periods (as the information is delivered to students).
  - Students may work individually or within groups (at the discretion of the instructor).

### ASSESSMENT:

- Informal assessments can be completed by looking at the reflection slides within the Student Workbook and/or the discussion questions in the Abbreviated Worksheet.
- Answer Keys** for the Student Workbook or Student Abbreviated Worksheet can be given upon teacher request.

### PRE AND POST WORK IDEAS:

- [Pre-work Assignment](#) - students watch an 8 min video that briefly highlights methods of drug administration

### EXTENSION ACTIVITIES:

- Play [Quizlet](#) or [Kahoot](#) to review concepts concerning drug delivery

### ADDITIONAL TEACHING REFERENCES

#### Curriculum Connections:

- Aligns with chemistry and biology curriculums in high school
- Chemical Engineering:** using math, science, and engineering concepts to design an enteric coating to delay the release of colored tablets inside the human body
- Biomedical Engineering:** designing and constructing drug delivery devices

#### Students will be able to:

- Analyze real-world problems and use critical thinking skills in order to solve them
- Explore developments in drug delivery systems
- Design and build a small-scale dual delayed drug release delivery system using material provided
- Explain the engineering process as it pertains to their design and reflect on opportunities to improve it

## Pharmaceuticals: Designing & Producing Effective Medicines

### Content Vocabulary/Terms:

- **Pharmaceuticals:** chemical substances used for the prevention or treatment of a disease, and to help restore or correct functions in the body
- **Drug Delivery Systems:** engineered technologies for the targeted delivery and/or the controlled release of the active pharmaceutical ingredient in the human body
- **Diffusion Flux:** the movement of particles
- **Fick's First Law of Diffusion:** diffusion flux from high to low concentration is directly proportional to the particle's concentration gradient
- **Polymers:** materials of long, repeating chains of molecules



### NEXT GENERATION SCIENCE STANDARDS:

**HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

**HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.


**HS-PS1-5:** Apply scientific principles and evidence to provide an explanation about the effects of changing temperature or concentration of the reacting particles on the rate at which a reaction occurs.

### MATERIALS:

TEACHER'S KIT		
<i>Materials will be distributed throughout the class.</i>		
Item/Link	Quantity	Photo
<a href="#">Box of Paper Clips</a>	1	
<a href="#">Colored Tablets</a>	1 jar ( $\leq 30$ students) and 2 jars ( $> 30$ students)	

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Materials Cont.→

STUDENT KIT ITEMS		
<i>1 kit: 3 students</i>		
Item/Link	Quantity	Photo
<a href="#">Paper Strips</a>	10	
<a href="#">Napkin</a>	1	