

How Medicine Moves – Exploring Drug Discovery and Pharmacokinetics



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Host Organization:
GENENTECH

ETP Type: CLASSROOM

Subject/Grade:
STEM/7th and 8th Grade

Cost: ~USD\$100

Length of Lesson:
Approximately 5 Weeks
[40 to 50 minutes class period
each day]

Abstract

This multi-week STEM unit, inspired by a Summer Teacher Fellowship at Genentech's DMPK (Drug Metabolism and Pharmacokinetics) Department, helps 7th–8th grade students learn how medicines are made and how they move through the human body. Students explore the drug discovery process and the four steps of pharmacokinetics: Absorption, Distribution, Metabolism, and Excretion [ADME]. They complete hands-on labs using food coloring, sponges, and timers to model how a drug travels in the body. Then, working in teams of four, students take on real biotech roles – like Project Manager, Principal Scientist, Budget Director, Public Health Communicator, and IT Architect – to design a new drug that treats a health issue affecting people in a local community [such as asthma, diabetes, or high blood pressure]. Teams manage a \$1,000,000 fictional budget, collect and graph lab data, and create a 2–3 minute AI video using tools like Canva or Kapwing to present their findings. This NGSS-aligned unit builds collaboration, data literacy, and real-world biotech career awareness.

Focal Content & Supporting Practices

Focal Content & Supporting Practices

This unit focuses on understanding how medicines move through the body using the ADME model: Absorption, Distribution, Metabolism, and Excretion. Students learn about how drugs are designed and tested in real life, just like scientists do in the biotech field. They take on team roles [like Principal Scientist, Project Manager, Budget Director, Public Health Communicator, and IT Architect], simulate how medicine works using hands-on labs, and apply their learning by designing a drug to help with asthma, diabetes, or high blood pressure. They manage a \$1,000,000 pretend budget, analyze data, and create an AI video to pitch their drug solution. The unit builds skills in teamwork, data analysis, research, and communication.

Next Generation Science Standards (NGSS) – Middle School Life Science

- *LS1.A: Structure and Function* – Students model how drugs interact with organs and systems.
- *ETS1.A: Defining and Delimiting an Engineering Problem* – Students design a drug to meet criteria and constraints (target organ, speed of delivery, cost).
- *ETS1.B: Developing Possible Solutions* – Teams test, model, and iterate on drug designs based on ADME results.

→ **Disciplinary Core Idea (DCI):**

- *LS1.A: Structure and Function*

Students explore how medicines interact with body systems and tissues, aligned with understanding the structure-function relationship in living organisms. They model how medicines are absorbed, distributed,

metabolized, and excreted in the body (ADME), and examine how pharmaceutical researchers study and optimize these processes.

→ **Science and Engineering Practices (SEP):**

- *Developing and Using Models*

Students build and test visual and physical models (e.g., 3D representations, animations) to simulate how medicine moves through the body and how scientists investigate these pathways using tools and data.

- *Analyzing and Interpreting Data*

Through hands-on lab simulations, such as the gelatin diffusion experiment, students collect, graph, and interpret data to understand drug distribution.

→ **Crosscutting Concepts (CCC):**

- *Systems and System Models*

Students investigate the body as an interconnected system and medicine as an input that interacts with subsystems over time.

- *Structure and Function*

Students consider how the structure of molecules, delivery systems, and body organs influence how medicine works and why scientists care about each ADME stage.

California Career Technical Education (CTE) Standards – Health Science & Medical Technology Pathway

Standard 2.0: Communications – Students apply written and visual communication in real-world science careers.

Standard 10.0: Technical Knowledge and Skills – Students simulate procedures in biomedical research and drug discovery.

California Standards for the Teaching Profession (CSTP):

Standard 3: Understanding and Organizing Subject Matter for Student Learning – Teachers integrate career awareness, local relevance, and hands-on exploration to connect abstract science with authentic community-based applications.

21st Century/Durable Skills and Applications

- **Critical Thinking & Problem Solving**

In this unit, students take on the role of biotech scientists to solve a real health problem. After researching local issues like asthma or diabetes, they design a small-molecule drug and predict how it will move through the body using the ADME model. Teams test their drug using sponge labs, then analyze the results.

Students also manage a \$1,000,000 budget, making smart choices about spending on research, testing, and marketing. They use their data to create charts and explain their findings in a video pitch.

This project helps students think carefully, solve real-world problems, and use evidence to support their decisions; just like professionals in science and biotech.

- **Collaboration and Teamwork**

Students work in teams to design a drug solution for a real health problem. Each team member has a role – Project Manager, Principal Scientist, Budget Director, Public Health Communicator, or IT Architect – and must help the group stay on track. Together, they run lab tests, analyze data, manage a budget, and build a final video pitch.

This unit shows how science happens in the real world: through teamwork. Students learn to communicate clearly, divide tasks, give helpful feedback, and work toward a shared goal – skills that matter in any career.

Measurable Objective(s)

1. **Students will explain** the pharmacokinetic process of ADME [Absorption, Distribution, Metabolism, and Excretion] by completing a sponge-based lab simulation using food coloring and timers. They will record their results in science notebooks and digital spreadsheets, then interpret how their drug moves through the body.
2. **Students will design** a small-molecule drug to treat a local health issue [asthma, type 2 diabetes, or hypertension] in Livermore, CA. Working in STEM team roles, they will complete digital lab data sheets with graphs and develop a \$1,000,000 budget plan.
3. **Students will create** a 2–3 minute AI video pitch using tools like Canva or Kapwing, including voice-over narration, visuals from their lab, scientific reasoning, graphs, and citations – demonstrating how their drug works and how their team collaborated to solve a real-world health problem.

Formative Assessment(s)

Formative Assessments will take place throughout the unit to check for understanding and support student progress. These include:

- **Daily Team Check-ins:** Students will share their group's progress and next steps in 5-minute stand-up meetings.
- **Digital or Printed Lab Guides/ Manuals:** Students will reflect on the ADME simulation lab, record observations, and answer prompts.
- **Digital or Printed Deliverables using RACI Chart:** Each team will complete checklists showing division of roles and milestones reached.
- **Budget Checkpoint:** Students submit a draft of their \$1,000,000 budget for teacher feedback on accuracy and reasoning.
- **Data Table Completion:** Students input and analyze ADME trial results in a spreadsheet.

Summative Assessment(s)

Summative Assessments include:

- **Final AI Video Pitch:** Teams create a 2–3 minute video explaining their small-molecule drug solution, supported by lab results, graphs, and budget data. Videos must include voice-over narration, at least 20 visuals, and citations.
- **Presentation Rubric [0–4 scale]:** Evaluates scientific reasoning [ADME process], teamwork, budget accuracy, data visualization, and communication.
- **Peer Feedback:** Students evaluate other teams' videos using a structured form.
- **Reflection Journal:** Students write about what they learned about science, health, teamwork, and careers.

Fellowship Description

This summer I work as a Teacher Fellow at Genentech, a global leader in biotechnology, in the Drug Metabolism and Pharmacokinetics (DMPK) department. In this department, scientists study what happens to medicines inside the body: how they are absorbed, distributed, metabolized, and excreted (ADME). My Fellowship gives me hands-on experience learning how scientists test and track drugs to make sure they are safe and effective before reaching patients.

Each day I learn directly from professionals like pharmacokinetic scientists, bioanalysts, and data modelers. I attend team meetings, observe real lab experiments, and use software like Phoenix WinNonlin and Synthace to study how long a drug stays in the body and how it moves through different organs. I also explore how scientists simulate drug actions using models and digital tools. I plan to connect with other science leaders in Livermore, including Lawrence Livermore National Lab, Lam Research, and Kaiser Permanente, to see how local biotech organizations work together.

This experience helps me see science in action, not just as facts in a textbook but as a process built on curiosity, creativity, and teamwork. I learn how experts across different departments solve problems

with data and make important decisions that impact public health. Careers related to this work include researchers, data analysts, project managers, and medical writers. All of these professionals help bring new medicines to life.

Fellowship Connection to School/Classroom

Inspired by my experience at Genentech, I created a multi-week STEM unit for my 7th and 8th grade students called the *Drug Discovery Challenge*. In this hands-on project, students form biotech teams to tackle real health problems impacting our local community, such as asthma, type 2 diabetes, or high blood pressure. Each team designs a small molecule drug and simulates how it behaves in the body using everyday lab materials like sponges, food coloring, and timers. These activities model key pharmacokinetic concepts – absorption, distribution, metabolism, and excretion (ADME) – in a way that’s simple, visual, and memorable.

But it’s more than just a science lab. Students take on real-world biotech roles: the Project Manager keeps the team on schedule, the Principal Scientist runs experiments and collects data, the Budget Director manages a \$1 million mock budget, and the IT Architect builds a digital dashboard with graphs and visuals. At the end, each team creates a professional video pitch using tools like Canva or Kapwing to present their drug design, lab results, and strategic plan.

Through this project, I want my students to *see themselves* in the biotech industry – not just as scientists in lab coats, but also as future professionals in business, HR, data, legal, marketing, and leadership roles. Whether they pursue a high school diploma, a community college certificate, or a PhD, there is a place for them in this field. I want them to believe: “*That could be me at Genentech someday.*”

Thanks to the connections I’ve made through this Fellowship, I also plan to bring in guest speakers from different parts of the biotech world to help students see the many career paths available – paths filled by people who once sat in classrooms just like theirs.

This Fellowship helped me reconnect with my roots in molecular biology and reimagine how science can be taught. Now, I get to pass that spark on to my students – making science personal, empowering, and full of possibility.

Instructional Plan

Unit Overview:

In this multi-week Biotechnology unit, students will learn how medicine moves through the body, from discovery in the lab to delivery to patients. They’ll explore the four main steps of ADME: Absorption, Distribution, Metabolism, and Excretion. Through hands-on labs, teamwork, and creative digital projects, students will see how science helps make medicine safe and effective for people.

Week 1 Focus: Introduction to Biotech & DMPK

Grade Level: 7th/8th Grade STEM

Time: 5 days, 40–50 min periods

Files/Document Materials with Rubrics: [Click on the LINKS →](#)

- [Bell Activity](#)

- [Lab Activities / Worksheets](#)

- [Exit Ticket](#)

A. Objective:

- Students will be introduced to the field of biotechnology, specifically Drug Metabolism and Pharmacokinetics (DMPK), and understand the journey of a drug from the lab to the patient.

B. Big Ideas & Essential Questions:

- What is biotechnology?
- How does medicine go from lab to patient?
- What is ADME, and how does it relate to drug safety?

C. NGSS Alignment

- **MS-LS1-3:** Use arguments supported by evidence for how the body is a system of interacting subsystems.
- **MS-ETS1-1:** Define a design problem that can be solved through engineering.
- **Science & Engineering Practices:** Developing and using models; Analyzing and interpreting data; Engaging in argument from evidence.

D. Day-by-Day Breakdown Week 1

➤ Week 1 Day 1: What is Biotechnology?

1. Bell Activity

"Write down 3 things you think scientists do in a lab. Then circle the one that sounds the coolest."

2. Activity and Worksheet

- Students watch and discuss the [VIDEO YouTube - Drug Discovery and Development Process](#). They engage in a Think-Pair-Share to explore how biotechnology differs from other types of science. Then, they complete the [WORKSHEET - Introduction to Biotechnology](#) to reinforce key concepts.

3. Exit Ticket

"Write 1 vocabulary word from today + its definition."

"Write 1 thing you learned that surprised you."

➤ Week 1 Day 2: From Molecule to Medicine

1. Bell Activity

"What do you think happens after a scientist discovers a new medicine?"

2. Activity and Worksheet

- Students are introduced to [ACTIVITY - Drug Discovery Pipeline Flowchart](#). In breakout groups, each team is assigned a specific stage (e.g., Target Identification, Preclinical Testing, Clinical Trials, FDA Approval). Groups research and discuss their stage, then present it to the class to collaboratively build a complete visual pipeline.

3. Exit Ticket

"Which step of the drug discovery pipeline do you think is the most important, and why?" (Explain in 1–2 sentences.)

"What surprised you the most about how long or complex the process is from lab to patient?"

"Imagine you are part of a drug discovery team – what job would you want and why?"

(Examples: Scientist, Tester, Project Manager, FDA Reviewer)

➤ Week 1 Day 3: Meet DMPK & ADME

1. Bell Activity

"What happens to a pill after you swallow it?"

2. Activity and Worksheet

- Students engage in direct instruction to learn what DMPK is and are introduced to ADME and related vocabulary. They then participate in a kinesthetic activity – [ACTIVITY - ADME Relay Game](#) – where they rotate through stations using laminated vocabulary cards for absorption, distribution, metabolism, and excretion.

3. Exit Ticket

"Choose ONE step from ADME (Absorption, Distribution, Metabolism, or Excretion). What does this step do in the body, and why is it important for drug safety?" Answer the questions in 2–3 complete sentences.

➤ Week 1 Day 4: Hands-On Simulation + Exit Ticket

1. Bell Activity:

"Which part of ADME is the most important for safety? Why?"

2. Activity and Worksheet

- Students conduct the [LAB - Medicine in Motion](#) activity, simulating ADME using colored water, sponges, and labeled zones representing the intestine, liver, and kidney. The activity includes hands-on setup, guided reflection questions, and an optional extension challenge.

3. Exit Ticket:

"What did this lab help you understand about how medicine moves through the body (ADME)?"
"Which stage (Absorption, Distribution, Metabolism, or Excretion) was the easiest or hardest to model, and why?"

> Week 1 Day 5: Career Spotlight

1. Bell Activity:

"What happens if your body can't get rid of medicine fast enough?" OR
"What careers do you think exist in biotech? Name 3."

2. Activity and Worksheet

- Students explore real-world careers in biotechnology and pharmacokinetics, then research and design a digital poster using Canva as part of a multi-week [PROJECT – Biotech Careers Investigator](#). They complete a companion [WORKSHEET – Biotech Careers Investigator](#) to organize their findings and prepare to present their career insights to the class.

3. Exit Ticket:

"Which biotech career did you investigate, and what did you find most interesting about it?"
"Would you consider this job in the future – why or why not?"

Week 2 Focus: ADME Labs + Plasma Protein Binding

Grade Level: 7th/8th Grade STEM

Time: 5 days, 40–50 min periods

Files/Document Materials with Rubrics: [Click on the LINKS →](#)

- [Bell Activity](#)

- [Lab Activities / Worksheets](#)

- [Exit Ticket](#)

A. Objective:

- Students will investigate how medicine moves through and interacts with the body by modeling each stage of the ADME process (Absorption, Distribution, Metabolism, Excretion). They will simulate how drugs are absorbed and bind to proteins in the blood, analyze how the body processes and removes drugs, and explore STEM careers connected to pharmacokinetics and drug development.

B. Big Ideas & Essential Questions:

- Medicines don't work instantly; they must travel, change, and exit the body in specific ways.
- The body processes drugs through a system called ADME: Absorption, Distribution, Metabolism, and Excretion.
- Protein binding in the blood affects how much of a drug is available to work in the body.
- Scientists use models and simulations to study how medicines behave inside us.
- Careers in pharmacology and bioanalysis help ensure that medicines are safe and effective for patients.

C. NGSS Alignment

- MS-LS1-3:** Use arguments supported by evidence for how the body is a system of interacting subsystems.
- MS-ETS1-1:** Define a design problem that can be solved through engineering.
- Science & Engineering Practices:** Developing and using models; Analyzing and interpreting data; Engaging in argument from evidence.

D. Day-by-Day Breakdown Week 2

> Week 2 Day 1: A for Absorption

1. Bell Activity

"What factors might affect how fast a medicine gets into the body?"

2. Activity and Worksheet

- Students begin by learning about absorption; where it happens in the body, how it works, and what factors affect it (such as pills vs. injections). They start their [WORKSHEET - ADME Concept Map - 'A'](#), focusing on the "A" for Absorption. To build understanding, students examine visuals comparing different drug delivery methods (e.g., pills, inhalers, patches, injections), and discuss real-world examples of common medications and how they're taken. A class demonstration using sugar cubes in water helps students visualize how quickly substances dissolve, reinforcing how form and route impact absorption.

3. Exit Ticket

"1. In your own words: What is absorption and why does it matter in medicine?"

"2. Today I learned that absorption happens in the _____, and it can be affected by _____."

"3. Why do you think a powdered medicine might work faster than a pill? Use the sugar cube demo or one of the drug delivery methods as an example."

> Week 2 Day 2: Gelatin Absorption Lab

1. Bell Activity

"Why do scientists care about how fast a medicine is absorbed?"

2. Activity and Worksheet

- Students conduct a hands-on [LAB - Gelatin Diffusion](#) by injecting food coloring into gelatin blocks to simulate how medicine is absorbed in the body. They measure how far and how fast the color spreads, compare results across groups (with variations in temperature or thickness if time allows), and discuss how this models absorption in the small intestine. They follow the step-by-step procedures, fill in the data table, draw and label diagrams, and create a graph in [Google Sheets](#) for analysis.

3. Exit Ticket

"In this lab, what does the gelatin represent? What does the 'spreading dye through the gelatin' represent?"

> Week 2 Day 3: D for Distribution + M for Metabolism

1. Bell Activity

"1. Multiple choice: "Which system helps deliver medicine to all parts of the body?"

(A. Digestive B. Circulatory C. Nervous)"

"2. Can a drug reach every part of the body once it's in your blood?"

2. Activity and Worksheet

- Students learn how medicine moves through the body in a mini-lesson on distribution, then complete a map activity tracing the path of a drug from the mouth to the muscles. In the next mini-lesson, they explore metabolism and the liver's role in transforming drugs, followed by an [ACTIVITY - Metabolism Case Study](#) analyzing a case study on the interaction between grapefruit juice and Tylenol. Students then update the "D" and "M" sections of their [WORKSHEET - ADME Concept Map - 'D' and 'M'](#).

3. Exit Ticket

"1. Which step – Distribution or Metabolism – do you think has the biggest impact on how a medicine works? Why?"

"2. In your own words, explain what happens to a medicine once it enters the bloodstream."

"3. Why is the liver such an important organ when it comes to medicines?"

> Week 2 Day 4: E for Excretion + Protein Binding Lab

1. Bell Activity

"1. True or False: Your liver changes drugs before they leave the body. Explain."

"2. True or False: All of the drugs in your blood can go straight to your tissues."

2. Activity and Worksheet

- Students explore plasma protein binding through a [WORKSHEET - Bound Drugs vs Unbound Drugs](#), then conduct a [LAB - Protein Binding Simulation](#) using red beads to represent bound drug molecules and blue beads for unbound ones. Only the blue beads pass through a mesh or filter into a "tissue" cup, demonstrating how only unbound drugs can reach body tissues. The lesson wraps up with a [WORKSHEET - ADME Concept Map - 'E'](#) overview of excretion, including a brief diagram or video explaining how the kidneys help remove drugs from the body.

3. Exit Ticket

- "1. In your own words, explain the difference between bound and unbound drugs."
- "2. Why can only the unbound drug molecules reach your tissues?"
- "3. Which type of drug molecule is more important for treating illness: bound or unbound? Why?"
- "4. How does protein binding affect where a drug can work in the body?"
- "5. In your own words, explain why excretion is important after a medicine has done its job in the body."
- "6. What organ is most responsible for excretion, and why does it matter for drug safety?"

> Week 2 Day 5: Career Spotlight

1. Bell Activity

"What would happen if your kidneys couldn't remove waste properly?"

2. Activity and Worksheet

- CONTINUED from Week 1 Day5 - Students revisit the STEM Career Connection by exploring the roles of a Clinical Pharmacologist and a Bioanalytical Chemist. As part of their multi-week [PROJECT – Biotech Careers Investigator](#), they research these careers and design a digital poster using Canva. They also complete the [WORKSHEET – Biotech Careers Investigator](#) to organize their research and get ready to present their career insights to the class.

3. Exit Ticket

"What organ is most responsible for excretion, and why does it matter for drug safety?"

Week 3 to Week 6 Focus: PROJECT-BASED LEARNING [PBL] – Drug Discovery Challenge

Grade Level: 7th/8th Grade STEM

Time: 5 days, 40–50 min periods

Files/Document Materials with Rubrics: [Click on the LINKS →](#)

- [Bell Activity](#)

- [Lab Activities / Worksheets](#)

- [Exit Ticket](#)

A. Objective and Learning Goals:

By the end of this challenge, students will:

- Simulate a small molecule drug discovery team to solve a real-world health problem.
- Apply pharmacokinetic principles (ADME: Absorption, Distribution, Metabolism, Excretion).
- Analyze scientific data from lab simulations and make informed design decisions.
- Manage a drug development budget using basic financial literacy and math.
- Collaboratively design digital presentations using data visualization tools.
- Communicate scientific ideas clearly and effectively, both verbally and visually.
- Connect classroom science to real-world biotech careers.

B. Big Ideas & Essential Questions:

- How can we design a safe and effective medicine to solve a real health problem in our community?

C. NGSS Middle School Alignment:

- **MS-LS1-3:** Use arguments supported by evidence for how the body is a system of interacting subsystems.
- **MS-ETS1-1:** Define the criteria and constraints of a design problem.
- **MS-ETS1-2:** Evaluate competing design solutions based on prioritized criteria and trade-offs.
- **MS-ETS1-3:** Analyze data from tests to determine similarities and differences among solutions.
- **Science & Engineering Practices:** Analyzing and Interpreting Data, Developing and Using Models, Engaging in Argument from Evidence.

[PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)

Project Scenario:

Your biotech team has been hired by a startup company in Livermore to design a new small-molecule drug to treat a common health issue found in the Tri-Valley region. Your team will simulate the DMPK

(Drug Metabolism and Pharmacokinetics) process to understand how your drug behaves in the body, run trials, and create a video pitch to present your prototype medicine.

Team Roles:

- **Principal Scientist:** Research & ADME Lab Lead
- **Budget Director:** Cost & Resource Manager
- **Project Manager:** Timeline & Team Coordination
- **Public Health Communicator:** Explains the impact on the Livermore community and IT Lead
- **Shared Responsibilities (All Team Members)::** Builds an AI video presentation.

Required Deliverables:

- **Research Local Health Concern:** Investigate a health issue impacting the local community. Students will analyze causes, current treatments, and affected populations.
- **Drug Design:** Based on their research, students will propose a small-molecule medicine that targets the identified health concern.
- **Simulated Absorption Model:** In this hands-on ADME lab, students will simulate how their drug travels through the body by modeling absorption, distribution, metabolism, and excretion. This activity helps visualize how different drug designs impact movement within the body.
- **Budget Spreadsheet:** Using Google Sheets, students will itemize materials, estimate costs, and document vendors to manage their project budget effectively.
- **AI Video Presentation:** With tools like Canva, Adobe Express, or Powtoon, students will follow a guided process to script, design, and produce an AI-narrated video showcasing their drug delivery system and design process.

Week 3 to Week 6 Focus: PROJECT-BASED LEARNING [PBL] – Drug Discovery Challenge

D. Day-by-Day Breakdown Week 3 - Project Launch + Local Health Concerns, + Drug Design

> Week 3 Day 1:

1. Bell Activity

"What are two common health issues in Livermore or nearby communities? Why do you think they matter?"

2. Activity and Worksheet

- Launch: [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
 - Introduce major Deliverables, Project Timeline, Assign RACI Chart
- Begin: [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)
 - Jigsaw research for the health issues (Asthma, Diabetes, Hypertension): symptoms, causes, local data

3. Assessments

- Response and Participation: [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)

4. Exit Ticket

"What local health issue did your team choose (or assigned), and why is it important?"

> Week 3 Day 2:

1. Bell Activity

"Research Local Health Concerns - Think about asthma, diabetes, and high blood pressure. Which one do you think is hardest to treat, and why?"

2. Activity and Worksheet

- Continue: [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)

3. Assessments

- Response and Participation: [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)

4. Exit Ticket

"Research Local Health Concerns - "What is one fact or trend about your health issue that stood out to you today?"

> Week 3 Day 3:

1. Bell Activity

"What kind of data or sources would help you prove your chosen (or assigned) health issue is serious?"

2. Activity and Worksheet

- Finish: [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)

3. Assessments

- Response and Participation: [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)

4. Exit Ticket

"If you could invent a medicine for your chosen (or assigned) health issue, what would it do?"

> Week 3 Day 4:

1. Bell Activity

"How does your chosen (or assigned) health issue connect to a specific part of the body or organ system?"

2. Activity and Worksheet

- Begin: [PROJECT WORKSHEET - Drug Design](#)
 - Plan drug design: Target organ; Delivery method (pill, spray, injection, etc.); Desired speed & duration; Sketch drug idea & delivery method

3. Assessments

- Response and Participation: [PROJECT WORKSHEET - Drug Design](#)

4. Exit Ticket

"What is one fact about your chosen (or assigned) health issue that could help you design your drug?"

> Week 3 Day 5:

1. Bell Activity

"If you were a patient taking a drug for your health issue, what would you want it to do quickly? What would you want it to do slowly?"

"Why do scientists study how fast drugs enter and leave the body? What could go wrong if a drug is too fast or too slow?"

2. Activity and Worksheet

- Continue and Finish: [PROJECT WORKSHEET - Drug Design](#)

3. Assessments

- Response and Participation: [PROJECT WORKSHEET - Drug Design](#)

4. Exit Ticket

"What part of your drug design is most important to make it effective?"

"What is one challenge you expect your drug might face once it enters the body?"

E. Day-by-Day Breakdown Week 4 - ADME Simulation + Budgeting + Graphing

> Week 4 Day 1:

1. Bell Activity

"Drug Design & Delivery Method Planning - What body part(s) would your drug need to target for the health issue your team chose (or assigned)? Why is targeting the right area important?"

2. Activity and Worksheet

- Introduce AND Begin: [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
- Begin: [PROJECT BUDGET - Materials Expense Spreadsheet](#) with [PROJECT BUDGET - Materials Cost and Vendors](#)

3. Assessments

- [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - Pre-Lab Questions, Summary of Procedures, and Participation

4. Exit Ticket

"Drug Design & Delivery Method Planning -What delivery method did your team choose? Why do you think this method could work well for your drug?"

➤ Week 4 Day 2:

1. Bell Activity

"Before the lab: Why do scientists test how fast a drug is absorbed into the body? How might that affect how well it works?"

2. Activity and Worksheet

- Continue: [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - Trial #1, Trial #2, and Trial #3
- Continue: [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
- Begin: [PROJECT BUDGET - Materials Expense Spreadsheet](#) with [PROJECT BUDGET - Materials Cost and Vendors](#)

3. Assessments

- [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - During the Lab Questions, and Participation

4. Exit Ticket

"What did you observe during Trial #1 about how your drug entered and moved through the body model?"

➤ Week 4 Day 3:

1. Bell Activity

"How do you think changing the delivery method (pill, spray, injection, etc.) will change how the drug behaves in the body?"

2. Activity and Worksheet

- Continue: [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - Trial #1, Trial #2, and Trial #3
- Continue: [PROJECT BUDGET - Materials Expense Spreadsheet](#) with [PROJECT BUDGET - Materials Cost and Vendors](#)

3. Assessments

- [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - During the Lab Questions, Data Table, and Participation

4. Exit Ticket

"What was different in how your drug moved during Trial #2? Which delivery method worked better?"

➤ Week 4 Day 4:

1. Bell Activity

"Which part of the body might be the hardest for your drug to reach or stay in? Why?"

2. Activity and Worksheet

- Continue: [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - Trial #1, Trial #2, and Trial #3
 - Graph A, Graph B, Graph C, and Graph D
- Continue: [PROJECT BUDGET - Materials Expense Spreadsheet](#) with [PROJECT BUDGET - Materials Cost and Vendors](#)

3. Assessments

- [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - During the Lab Questions, Data Table, Graph, and Participation

4. Exit Ticket

"Based on all 3 trials, which delivery method gave your drug the best chance to reach the target organ quickly and effectively?"

➤ Week 4 Day 5:

1. Bell Activity

"How can graphs help you explain how well your drug was absorbed and moved through the body?"

2. Activity and Worksheet

- Finish: [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - Trial #1, Trial #2, and Trial #3
 - Graph A, Graph B, Graph C, and Graph D

- Finish: [PROJECT BUDGET - Materials Expense Spreadsheet](#) with [PROJECT BUDGET - Materials Cost and Vendors](#)
- 3. Assessments**
- [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
 - Post-Lab Questions, Data Table, Graph, and Participation
- 4. Exit Ticket**
 “What pattern or trend in your graphs helped you understand your drug’s strengths or weaknesses?”

F. Day-by-Day Breakdown Week 5 - AI Video Production

> Week 5 Day 1:

- 1. Bell Activity**
 “What’s the most important thing your ADME test results prove about your drug design?”
- 2. Activity and Worksheet**
 - [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
 - Begin: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Begin storyboard for AI Video Presentation using ADME results
 - Check in with teacher for draft review
 - Start script writing
- 3. Assessments**
 - [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Storyboard Template
 - Storyboard Teacher’s Feedback and Approval
 - Daily Progress
- 4. Exit Ticket**
 “What ADME result will your team feature in your video to show that your drug is effective?”

> Week 5 Day 2:

- 1. Bell Activity**
 “What is the main message your team wants your audience to remember from your AI video?”
- 2. Activity and Worksheet**
 - [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
 - Continue: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Finish storyboard
 - Begin and finalize team’s script
 - Assign roles: narrator, visual lead, editor, researcher
 - Begin voiceover or visual recording
- 3. Assessments**
 - [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Storyboard Teacher’s Feedback and Approval
 - Daily Progress
- 4. Exit Ticket**
 “What is your job in the video project, and how will you make your part clear and effective?”

> Week 5 Day 3:

- 1. Bell Activity**
 “Which visual (graph, image, diagram) will help your audience best understand your drug’s journey through the body?”
- 2. Activity and Worksheet**
 - [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
 - Continue: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Record voiceover
 - Create or insert visuals: graphs, labeled diagrams, titles
 - Start assembling video timeline
- 3. Assessments**
 - [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Checklist of key elements
 - Daily Progress

4. Exit Ticket

"What did you complete today for your video, and what do you still need to polish?"

> Week 5 Day 4:

1. Bell Activity

"What makes a science video trustworthy and clear? Name one example your team is trying to include."

2. Activity and Worksheet

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- Continue: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Finish editing the AI video
 - Review the Checklist of Key Elements
 - Prepare for Peer Review on Day 5: rehearse, polish details, finalize script & visuals

3. Assessments

- [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Complete Checklist of Key Elements
 - Daily Progress

4. Exit Ticket

"What part of your video is the strongest so far – and what is one thing your team wants to double-check before Peer Review tomorrow?"

> Week 5 Day 5:

1. Bell Activity

"What makes peer feedback helpful? Write one example of GOOD feedback and one example of NOT helpful feedback."

2. Activity and Worksheet

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- Finish: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Finish editing video
 - Conduct a Peer Review Exchange using feedback form
 - Final revision planning

3. Assessments

- [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Draft AI Video Submission
 - Completed Peer Review Feedback for another team

4. Exit Ticket

"What feedback did you give to another team today? How do you think it will help them?"

G. Day-by-Day Breakdown Week 6 - AI Video Team Presentations

> Week 6 Day 1:

1. Bell Activity

"Looking back: What's a moment from this project that made you feel successful or proud?"

2. Activity and Worksheet

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- Continue: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Finalize edits based on feedback
 - Check visuals, titles, and citations
 - Export and submit final video
 - Prepare for Week 6 Day 3 Presentation Day

3. Assessments

- [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Final Submission of AI Video
 - Reflection Questions
 - Daily Progress

4. Exit Ticket

"What are you most proud of in your final video? What makes your message effective?"

> **Week 6 Day 2:**

1. Bell Activity

"Careers in Drug Discovery Reflection - Which of the STEM careers in this project (Scientist, Project Manager, Budget Director, Public Health Communicator) do you think fits you best? Why?"

2. Activity and Worksheet

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- Begin: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Watch and present team videos
 - Participate in Q&A

3. Assessments

- [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Presentation Rubric
 - [PROJECT EVALUATION - Team Evaluation Form](#)

4. Exit Ticket

"Would you want to work in a real STEM career like the role you had? Why or why not?"

> **Week 6 Day 3:**

1. Bell Activity

"What's something you learned during this project about how medicines are developed that you didn't know before?"

2. Activity and Worksheet

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- Continue: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Watch and present team videos
 - Participate in Q&A
 - Use Peer Evaluation Form for other teams

3. Assessments

- [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Presentation Rubric
 - [PROJECT EVALUATION - Team Evaluation Form](#)

4. Exit Ticket

"What is one other team project you found impressive or inspiring? Why?"

"Community Health Impact Reflection - How do you think your drug project could help real people in the Tri-Valley community if it were real? Who might benefit most?"

> **Week 6 Day 4:**

1. Bell Activity

"Community Health Impact Reflection - How do you think your drug project could help real people in the Tri-Valley community if it were real? Who might benefit most?"

2. Activity and Worksheet

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- Finish: [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Watch and present team videos
 - Participate in Q&A
 - Use Peer Evaluation Form for other teams
 - Teacher-Led debriefing

3. Assessments

- [PROJECT AI VIDEO - Production & Presentation Guide](#)
 - Presentation Rubric
 - [PROJECT EVALUATION - Team Evaluation Form](#)

4. Exit Ticket

"If you had the chance to do this kind of project again, what would you do differently or better?"

> **Week 6 Day 5:**

1. Bell Activity

"1. Final Reflection & Wrap-Up - What's the biggest skill you developed during this PBL project – scientific thinking, teamwork, budgeting, communication, or something else? Explain your answer."

"2. Looking back: What's a moment from this project that made you feel successful or proud?"

2. Activity and Worksheet

- CONTINUED from Week 2 Day5 - Students revisit the STEM Career Connection by exploring the roles of a Clinical Pharmacologist and a Bioanalytical Chemist. As part of their multi-week [PROJECT – Biotech Careers Investigator](#), they research these careers and design a digital poster using Canva. They also complete the [WORKSHEET – Biotech Careers Investigator](#) to organize their research and get ready to present their career insights to the class.

3. Assessments

- [PROJECT – Biotech Careers Investigator](#)
 - Canva slides

4. Exit Ticket

"If your team's drug were real, who in your community would benefit the most – and how?"

Additional Supports

Modifications for Struggling Students, Emerging Bilingual (ELL), or SPED Students:

1. Simplified Instructions:

- Provide step-by-step visual instructions for lab activities to make tasks clearer for struggling students. This could include pictures, videos, or a written guide alongside verbal explanations.
- For students with learning disabilities, use color-coded charts or visual-friendly charts and diagrams to support their understanding of complex concepts like ADME and PK graphs.

2. Peer Support:

- Pair struggling students with peers for group activities and labs. This helps reinforce learning through collaboration and peer teaching.
- Encourage students to explain key concepts in simpler terms to one another, which benefits both the student explaining and the one listening.

3. Use of Graphic Organizers:

- Provide students with graphic organizers (such as concept maps or flowcharts) to help them break down the content and visualize connections between key concepts like absorption, distribution, and metabolism in drug discovery.

4. Language Support for ELL Students:

- Offer bilingual glossaries for key vocabulary (e.g., ADME, pharmacokinetics) in both English and students' home languages.
- Use visual aids and video resources with subtitles to reinforce content for ELL students.
- Provide sentence starters for writing assignments/deliverables to help students organize their thoughts.

5. Extended Time:

- Offer extra time for assignments/deliverables and lab reports to give students the opportunity to process and complete tasks thoroughly.

Enhancements for Enrichment:

1. Advanced Research:

- Challenge advanced learners to research the latest trends and technologies in biotechnology and drug discovery. They can present their findings to the class in a mini-presentation or write an advanced report comparing current methods with emerging techniques.
- Allow enrichment students to work on more complex aspects of the drug discovery process, such as analyzing clinical trial data or exploring the ethical implications of drug testing.

2. Extension Activities:

- Provide opportunities for students to simulate drug interactions or model the impact of different variables (such as dosage or drug resistance) using computer simulations or

- advanced digital tools like **ChemSketch**.
- Enrichment students could also explore career opportunities in greater depth, such as creating a career pathway map from high school to a biotech career, detailing necessary qualifications and skills.

Social and Emotional Learning (SEL) and Culturally Responsive Instruction:

1. Community Building Activities:

- Incorporate team-building activities into the first few weeks of the unit, especially for new or remote students, to help them feel more connected to the class. Examples could include icebreaker questions or group problem-solving tasks where students can share their experiences and thoughts about the drug discovery process.

2. Encourage Reflection:

- At the end of the unit, students will write a personal reflection on how the unit has changed their view of medicine and careers. This helps students connect emotionally with the subject and recognize the real-world impact of their learning.

3. Inclusive Career Exploration:

- Integrate culturally responsive lessons by highlighting a diverse range of role models in the biotech field, including speakers from different cultural backgrounds or virtual field trips to companies that emphasize diversity in the workplace.
- Encourage students to consider how the global community benefits from drug discovery, recognizing that their contributions to science could have far-reaching impacts on public health worldwide.

4. Mindfulness Practices:

- Incorporate brief mindfulness exercises before challenging tasks to help students focus and manage any stress they may feel. This can include deep breathing or guided relaxation.

5. Addressing Diverse Learning Needs:

- Recognize that students come from varied educational and cultural backgrounds. Use examples in lessons that reflect a wide range of cultures and experiences, ensuring that all students see themselves in the content being taught.

Modifications for Remote/Hybrid Learning:

1. Virtual Labs:

- Use virtual lab simulations for activities like protein binding, drug absorption, and PK graph analysis. Platforms like **Labster** or **PhET** can provide online labs to ensure students can engage in the content even if they are learning remotely.
- In cases where physical materials are difficult to access, provide digital versions of the lab materials (e.g., mock data for PK graphs or a virtual simulation of drug diffusion).

2. Interactive Discussions:

- Set up live virtual discussions using tools like Zoom or Google Meet to allow remote students to participate in real-time discussions, ask questions, and share their insights. Use breakout rooms for small group activities to maintain engagement.

3. Online Collaboration:

- Use platforms like Google Classroom or Padlet for students to collaborate on group projects, share their work, and receive feedback. This allows for ongoing communication and collaboration, even in a hybrid or remote setting.

4. Asynchronous Learning Materials:

- Provide recorded lectures or tutorials for students who are unable to attend live sessions. These can be viewed at their own pace, ensuring that they don't miss any content.

Materials

Files/Document Materials with Rubrics: [Click on the LINKS →](#)

- [Bell Activity](#)

- [Lab Activities / Worksheets](#)

- [Exit Ticket](#)

Week 1 - Introduction to Biotech & DMPK

Day 1:

- [VIDEO YouTube - Drug Discovery and Development Process](#)
- [WORKSHEET - Introduction to Biotechnology](#)

Day 2:

- [ACTIVITY - Drug Discovery Pipeline Flowchart](#)

Day 3:

- [ACTIVITY - ADME Relay Game](#)

Day 4:

- [LAB - Medicine in Motion](#)

Day 5:

- [PROJECT - Biotech Careers Investigator](#) (Canva Poster Presentation)
- [WORKSHEET - Biotech Careers Investigator](#) (handout or digital worksheet)

Week 2 - ADME Labs + Plasma Protein Binding

Day 1:

- [WORKSHEET - ADME Concept Map - 'A'](#)

Day 2:

- [LAB - Gelatin Diffusion](#)
- [Google Sheets](#)

Day 3:

- [WORKSHEET - ADME Concept Map - 'D' and 'M'](#)
- [ACTIVITY - Metabolism Case Study](#)

Day 4:

- [WORKSHEET - Bound Drugs vs Unbound Drugs](#)
- [LAB - Protein Binding Simulation](#)
- [WORKSHEET - ADME Concept Map - 'E'](#)

Day 5:

- [PROJECT - Biotech Careers Investigator](#) (Canva Poster Presentation)
- [WORKSHEET - Biotech Careers Investigator](#) (handout or digital worksheet)

Week 3 to Week 6 - PROJECT-BASED LEARNING [PBL] – Drug Discovery Challenge

- [PROJECT-BASED LEARNING \[PBL\] – Drug Discovery Challenge](#)
- [PROJECT LAB - ADME Simulation: How Drugs Move in the Body](#)
- [PROJECT RESEARCH - Health Concerns in Livermore, CA](#)
- [PROJECT WORKSHEET - Drug Design](#)
- [PROJECT BUDGET - Materials Expense Spreadsheet](#)
- [PROJECT BUDGET - Materials Cost and Vendors](#)
- [PROJECT AI VIDEO - Production & Presentation Guide](#)
- [PROJECT EVALUATION - Team Evaluation Form](#)

STEM - DMPK ADME CurriculumClick on the **LINK** →https://docs.google.com/spreadsheets/d/1HjH_hGpm51j9rHOfQaiLo0ozuBUxOWO3sKvdRTqGubs/view

Item	Quantity	Estimated Cost 2025 (USD)	Use	Source
Plastic Syringes (no needles)	10	\$10	For simulating drug absorption in the gelatin blocks.	Amazon or local science supply stores
Clear Tubing	1 roll	\$8	To simulate blood vessels for the protein binding demo.	Amazon or science supply stores
Gelatin Blocks	15 blocks	\$15	To simulate drug absorption in the small intestine during Week 2 lab activities.	Amazon, grocery stores, or craft stores
UV Light (flashlight or lamp)	1	\$12	For UV-sensitive paper to simulate photolithography and drug delivery processes.	Amazon or educational supply stores
UV-Sensitive Paper	1 pack	\$10	To demonstrate drug absorption under UV light.	Amazon or educational supply stores
Stencils (black paper or vinyl)	5 sets	\$5	For simulating photolithography during Week 3's graphing lab.	Craft stores or Amazon
Sugar Cubes	1 box	\$3	To simulate etching for circuit patterning in Week 3's lab.	Grocery stores
Vinegar	1 bottle	\$2	For use in the sugar cube etching demo.	Grocery stores
Food Coloring	1 set	\$4	For coloring in timed diffusion lab during Week 3.	Grocery stores
Beakers or Clear Cups	10	\$10	For lab activities like the protein binding demo and absorption simulation.	Science supply stores or Amazon
Stopwatch or Timer	1	\$5	For timing diffusion processes in the graphing lab and other timed experiments.	Amazon or local stores
Plastic Droppers	10	\$6	For applying liquids in the protein binding demo and	Amazon or science supply stores

			timed diffusion lab.	
Item	Quantity	Estimated Cost 2025 (USD)	Use	Source
Laminated Graph Paper	10 sheets	\$1	For students to plot PK curves in Week 3.	Office supply stores or Amazon
Markers and Poster Board	10 sets of markers and 5 boards	\$8	For creating flowcharts and visual aids during the various lessons.	Office supply stores
iPads/Laptops with AI Video Software	1 per student/group	\$0 (assuming access to school devices)	For creating AI-narrated video presentations in Week 4.	School tech resources
Voice Recorder App or Tool	1 app per student	\$0	For recording voice narrations for AI presentations in Week 4.	Free apps from App Store/Google Play
Safety Gloves and Goggles	1 set per student (10 students)	\$20	For safety during hands-on lab activities.	Amazon or science supply stores
Lab Notebooks	10	\$10	For students to record observations, reflections, and results during each lesson.	Office supply stores or Amazon

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[VIDEO YouTube - Drug Discovery and Development Process](#)

[ARTICLE - What is ADME?](#)

[ARTICLE - Understanding Medicines and What They Do](#)

[ARTICLE - What Medicines Are and What They Do?](#)

[ARTICLE - Medicines: Using Them Safely](#)

[VIDEO - Aspirin journey through the body - \[A D M E \] Process in body](#)

[VIDEO - How Do Drugs Know Where to Go in the Body?](#)

[VIDEO - How Medications Get Absorbed By Your Body](#)

[VIDEO - Pharmacokinetics Absorption, Distribution, Metabolism, Excretion | Made Easy](#)

[VIDEO - Pharmacokinetics: Absorption, Distribution, Metabolism, Excretion - Pharmacology Basics](#)

[IMAGE - The Journey of a Pill](#)

[Biorender](#)

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[Kapwing](#)

[Canva](#)

onetonline.org

[RACI Chart](#)

[Random Name Picker](#)

Keywords

ADME, drug metabolism, biomedical careers, diffusion lab