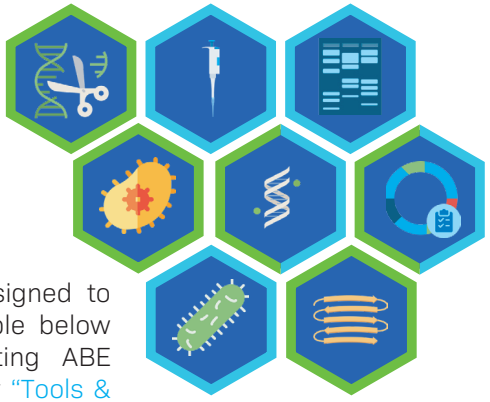
LabXchange™ AMGEN® Biotech Experience
Scientific Discovery for the Classroom



Using LabXchange to Enhance the ABE Labs

How can I use LabXchange with ABE?

The lab simulations, interactives and pathways created by LabXchange are designed to support and supplement the ABE labs to maximize time with students. The table below demonstrates how you can integrate LabXchange materials with the existing ABE curriculum. The LabXchange resources described here are included in the pathway "Tools & Techniques in Biotechnology: Micropipetting" from the LabXchange ABE cluster. These pathways can be customized and assigned to a class or you can create and assign your own.

LAB 1.1: HOW TO USE A MICROPIPETTE

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **A P-20 Micropipette** • **Four Micropipette Volumes** Covers the same content as the introduction to Laboratory 1.1.	The "How to Use a Micropipette" video, ABE Teachers Mary and Dave explain way micropipettes are needed in the lab. The "Introduction to the Micropipette" scrollable interactive allows students to explore parts of a micropipette and the proper use of this equipment in the lab..
In-class Session	
Work together to complete Laboratory 1.1 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the micropipetting solutions simulation to practice using a micropipette in a virtual lab setting. Skills emphasized in this simulation include dispensing different volumes and using the first and second stop.. Students who are absent can use the micropipetting solutions simulation to carry out the experiment. and interpret results based on their actions in the simulation.
Assessment Opportunities	
	• Measuring Small Volumes Assignment • What Do You Know about Micropipettes Assignment
Optional Supports and Extensions	
	• Real World Applications of Gel Electrophoresis video • Life in the Lab: Working in a DNA Sequencing Pipeline video • What is Gel Electrophoresis text

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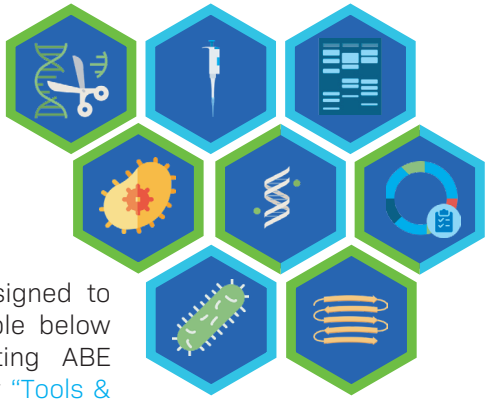

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LAB 1.2: GEL ELECTROPHORESIS (FOCUS ON THE TECHNIQUE)

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: What is Gel Electrophoresis? Covers the same content as the introduction to Laboratory 1.2.	The "Separating DNA with Gel Electrophoresis" scrollable interactive allows students to scroll at their own pace to see how DNA molecules travel through an agarose gel. The reading "DNA Gel Electrophoresis Equipment" helps students become more familiar with specific pieces of equipment and their roles in the process.
In-class Session	
Work together to complete Laboratory 1.2 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the gel electrophoresis simulation to preview the tools, technique and protocol before class and complete a formative self-check of their understanding in the reflection section. Students who are absent can use the gel electrophoresis simulation to carry out the experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
	Complete the assessment questions about Gel Electrophoresis Equipment and Applications.
Optional Supports and Extensions	
	Review micropipetting: • How to Use a Micropipette video • Introduction to the Micropipette scrollable interactive • Micropipetting Solutions simulation **Explore applications of gel electrophoresis:** • Real World Applications of Gel Electrophoresis video • Sanger sequencing and the Human Genome Project article • Animation showing the process of DNA sequencing **Explore other types of gel electrophoresis:** • How to run a protein gel or perform Western Blotting • Pathway showing how Western blotting relates to CRISPR • Protein Gel simulation and Western Blotting simulation

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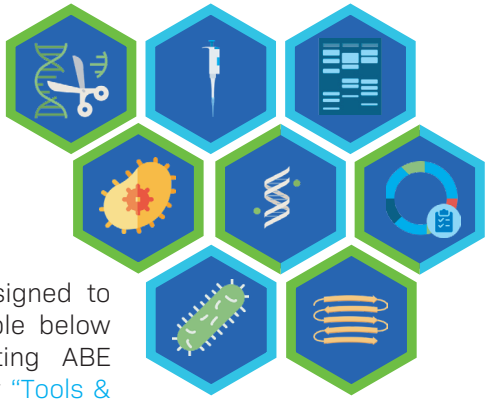

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In-class Session	
Work together to complete Laboratory 1.2 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the gel electrophoresis simulation to preview the tools, technique and protocol before class and complete a formative self-check of their understanding in the reflection section. Students who are absent can use the gel electrophoresis simulation to carry out the experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
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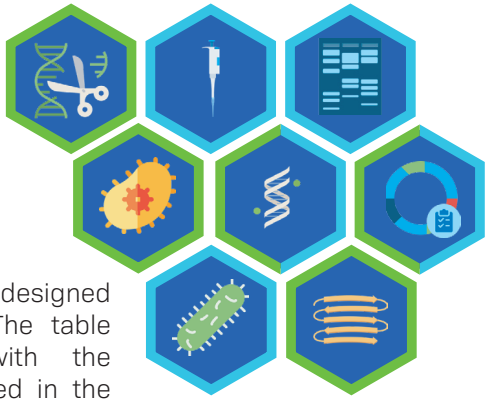

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LAB 2: PREPARING TO CLONE THE RFP GENE: DIGESTING THE PKAN-R AND PARA PLASMIDS

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **Plasmids** • **Restriction Enzymes** • **Creating the pARA-R Recombinant Plasmid** Covers the same content as the introduction to Laboratory 2.	The "How Do Restriction Enzymes Cut Plasmids?" scrollable interactive allows students to visualize the mechanism by which restriction enzymes cleave DNA. The "Recombinant Plasmid" assignment reviews DNA structure and recombinant plasmids, as well as how proteins are expressed from a recombinant plasmid through transcription and translation.
In-class Session	
Work together to complete Laboratory 2 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the restriction enzyme digest simulation to preview the tools, technique and protocol before class and complete a formative self-check of their understanding in the reflection section. Students who are absent can use the restriction enzyme digest simulation to carry out the experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
	Complete the Recognizing Restriction Enzyme Sites and the How Are Restriction Enzymes Used in Biotechnology assignments.
Optional Supports and Extensions	
	Explore plasmids and restriction enzymes: • From DNA to Protein video • What is a Plasmid? video • Components of a Plasmid Vector assignment • The Careful Selection of Restriction Enzymes text • Creating a Recombinant Plasmid assignment • Restriction Enzyme Digest and Gel Electrophoresis video • DNA Cloning and Its Applications video • My Career in Genomics: Antibiotic Resistance video

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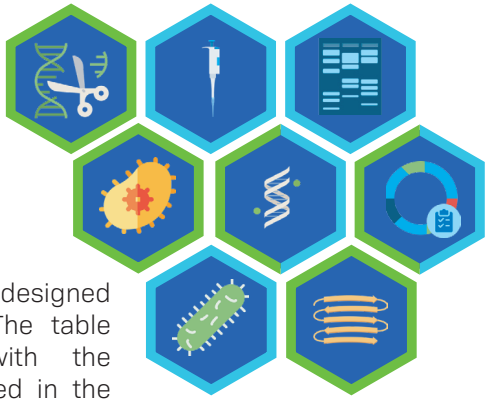

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LAB 3: BUILDING THE PARA-R PLASMIDS

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **Ligases** • **Ligation of DNA Fragments in Genetic Cloning** • **Verification Method When Making A Recombinant Plasmid**	The "Role of DNA Ligase in DNA Replication" scrollable interactive provides an overview of DNA replication and the key enzymes involved, highlighting the role of DNA ligase. The "What is DNA Ligase" text describes the function of DNA ligase, its role in DNA replication, and the way it is used to create recombinant DNA in genetic engineering. The "Role of DNA Ligase in Gene Cloning" scrollable interactive shows how DNA ligase can be used in biotechnology to create recombinant plasmids by connecting DNA fragments.
In-class Session	
Work together to complete Laboratory 3 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can watch the DNA Ligation video to preview technique and protocol before the in-class lab. Students use the ligating DNA fragments simulation to practice performing a ligation reaction in a virtual lab setting.
Assessment Opportunities	
	Complete the How is DNA Ligase Used in Cloning? assignment.
Optional Supports and Extensions	
	• Possible Ligation Products image • DNA Cloning and Its Applications video • DNA Cloning and Recombinant DNA video • Creating the pARA-R Recombinant Plasmid text

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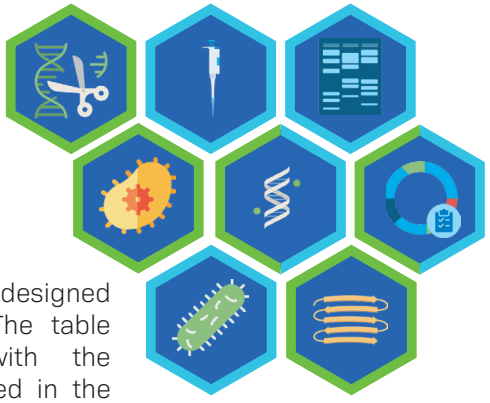

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LAB 4: VERIFICATION OF RESTRICTION AND LIGATION USING GEL ELECTROPHORESIS

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **How to verify the recombinant plasmid** • **Plasmid configurations** Covers the same content as the introduction to Laboratory 4.	The "Separating DNA with Gel Electrophoresis" scrollable interactive allows students to scroll at their own pace to see how DNA molecules travel through an agarose gel. "The DNA Ladder" scrollable interactive takes students on a tour of the DNA double helix, explaining how nucleotide base pairing leads to DNA's unique shape.
In-class Session	
Work together to complete Laboratory 4 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the verifying a recombinant plasmid by gel electrophoresis simulation to preview the tools, technique and protocol before class and complete a formative self-check of their understanding in the reflection section. Students who are absent can use the verifying a recombinant plasmid by gel electrophoresis simulation to carry out the experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
	Complete the assessment questions about Creating a Recombinant Plasmid.
Optional Supports and Extensions	
	Review micropipetting: • How to Use a Micropipette video • Introduction to the Micropipette scrollable interactive **Explore applications of gel electrophoresis:** • Real World Applications of Gel Electrophoresis video • Sanger sequencing and the Human Genome Project article • Animation showing the process of DNA sequencing **Explore other types of gel electrophoresis:** • How to run a protein gel or perform Western Blotting • Protein Gel simulation and Western Blotting simulation **Explore plasmids and restriction enzymes:** • Restriction Enzyme Digest and Gel Electrophoresis video • DNA Cloning and Its Applications video

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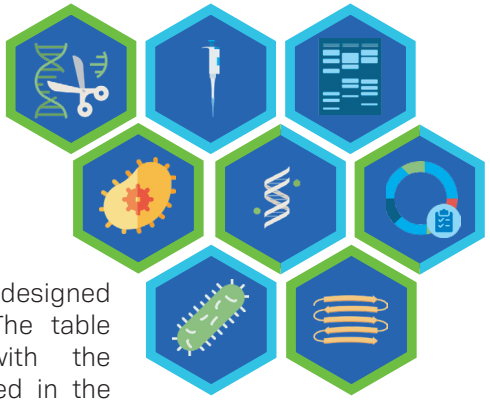

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LAB 5: TRANSFORMING BACTERIA WITH THE LIGATION PRODUCTS

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **Bacterial Transformation** • **From Plasmid DNA to Protein** Covers the same content as the introduction to Laboratory 5.	The "Mechanism of DNA Transfer in Bacteria" text describes the mechanisms for sharing short strands of DNA from one bacterial cell to another. The "Transformation" video describes how bacterial cells can be made to take up foreign DNA in the lab through a process called transformation. The "Co-Regulated Genes in Prokaryotes: The ara Operon" interactive explores the regulation of the araBAD operon, a set of co-regulated genes that metabolize arabinose in *E. coli*.
In-class Session	
Work together to complete Laboratory 5 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the Transforming Bacteria simulation to practice transforming bacterial cells with a recombinant plasmid using the heat shock method. Students can use the Plating Transformed Bacteria simulation to carry out the end of the transformation experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
	Complete the assessment questions about Creating a Recombinant Plasmid.
Optional Supports and Extensions	
	• Plating Bacteria and Selective Media text • GMOs! video • Treating Disease with Gene Cloning text • Structure and Replication of Bacterial Cells video • Operons and Gene Regulation in Bacteria video • Historical Basis of Modern Understanding text • DNA Cloning and Its Application video

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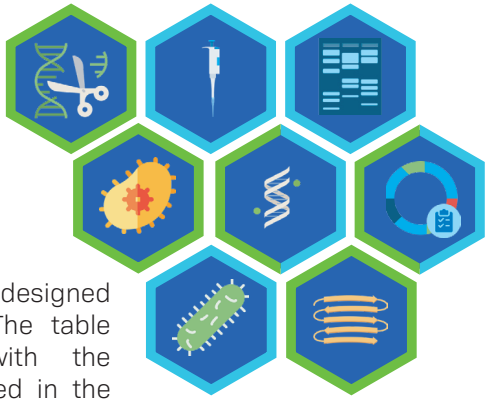

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LAB 6: PURIFYING THE FLUORESCENT PROTEIN

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **Bacterial Growth** • **Protein Folding** • **Protein Purification by Column Chromatography** Covers the same content as the introduction to Laboratory 6.	The "Protein Packing Inside the Cell" video reveals the high concentration of proteins in the cytoplasm of the cell. The "Bacterial Growth in the Lab" video describes how bacteria are cultured in the lab and the different phases of bacterial growth. The "Protein Folding" simulation explores the role of hydrophobic and hydrophilic interactions in protein folding. The "Column Chromatography" video explains how to sort small molecules using the technique.
In-class Session	
Work together to complete Laboratory 6 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the purifying protein by column chromatography simulation to explore how a protein of interest, like red fluorescent protein, can be purified from cell lysate using hydrophobic column chromatography.
Assessment Opportunities	
	Complete the assessment questions about Creating a Recombinant Plasmid.
Optional Supports and Extensions	
	• Proteins text • Role of Proteins in the Cell scrollable interactive • DNA to Protein simulation • Treating Disease with Gene Cloning text • Protein Folding scrollable interactive • Recombinant Proteins text • Exploring the Hydrophobic Core simulation • Protein Structure and Folding pathway • Proteins pathway

LESSON PLAN

GEL ELECTROPHORESIS

Objective

This lesson will help students understand how gel electrophoresis separates biological molecules by size and charge and the roles of each piece of equipment used in the process. Students will also be able to demonstrate how to perform gel electrophoresis and interpret their gel results.

Lesson Materials

Access to internet, computer (preferred for virtual simulations)

Prior Knowledge

Basic understanding of Micropipetting as a tool to measure small volumes. (For more information, review the Tools and Techniques pathway on Micropipettes.)

Prepare

- Before the lesson, we recommend completing each of the learning experiences in the Tools and Techniques in Biotechnology: Gel Electrophoresis pathway to familiarize yourself with some of the assets available for learning more about this technique.
- Create a class to facilitate online learning. This allows you to share content privately with a group of learners, engage in conversation through private discussion boards and monitor the progress of how learners are engaging with the content you post. Have your students create learner accounts and join the class.

Lesson Contents

Check for Prior Knowledge: Use a brief assessment on micropipettes to gauge their level of understanding of micropipetting. If students would like to review this topic more, suggest the Tools and Techniques pathway on Micropipettes.

Engage: Ask students via the private discussion board: Have you heard of gel electrophoresis? What can it be used for? Then, have students watch this video discussing real world applications of gel electrophoresis.

Explore: Have students explore the technique by completing the gel electrophoresis scrollable interactive and virtual lab simulation. After this experience, ask students to post in their own words on the discussion board a response to the question, "What is gel electrophoresis? How does it work"

Explain: Now that students have had a common experience with electrophoresis virtually, elaborate on the specific tools they are using and how each component contributes to how the technique works. This text provides an explanation and this assignment can be used to check for understanding.

Elaborate: Ask groups of students to do additional research on a particular application of gel electrophoresis and discuss the role of the technique and how it has changed the field. Students can present their understanding through a discussion board thread or create a pathway to show what they have learned. Encourage other learners to post questions for each group based on their presentation or pathway.

Evaluate: Use the formative assessments built into prior stages and a self reflection from students to assess understanding. Alternatively, create your own assessment questions to evaluate students' understanding of the topic as appropriate for their level and context.

Personalize and Differentiate

If you would like to customize the content in this pathway for your learners, you can create a copy of the pathway and add different content from the LabXchange library or add your own to share privately with your class.

SUGGESTED PATHWAY

Tools & Techniques in Biotechnology: Gel Electrophoresis

LabXchange

This pathway introduces gel electrophoresis, a technique used to separate biological molecules. This pathway also supports ABE lab 1....

8 Favorites

- What is Gel Electrophoresis?
- DNA Gel Electrophoresis Equipment
- Gel Electrophoresis Simulation
- Real World Applications of Gel Electrophoresis
- Gel Electrophoresis Equipment and Applications

MORE RESOURCES

- Gel Electrophoresis
- Loading an Agarose Gel
- Separating DNA With Gel Electrophoresis
- The Gel Electrophoresis Unit

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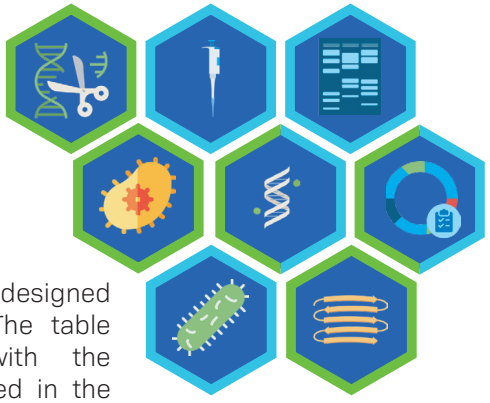

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LAB 5A/5B: TRANSFORMING BACTERIA WITH RECOMBINANT PLASMIDS

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **Bacterial Transformation** • **From Plasmid DNA to Protein** Covers the same content as the introduction to Laboratory 5.	The "Mechanism of DNA Transfer in Bacteria" text describes the mechanisms for sharing short strands of DNA from one bacterial cell to another. The "Transformation" video describes how bacterial cells can be made to take up foreign DNA in the lab through a process called transformation. The "Co-Regulated Genes in Prokaryotes: The ara Operon" interactive explores the regulation of the araBAD operon, a set of co-regulated genes that metabolize arabinose in *E. coli*.
In-class Session	
Work together to complete Laboratory 5 Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the Transforming Bacteria simulation to practice transforming bacterial cells with a recombinant plasmid using the heat shock method. Students can use the Plating Transformed Bacteria simulation to carry out the end of the transformation experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
	Complete the assessment questions about Creating a Recombinant Plasmid.
Optional Supports and Extensions	
	• Plating Bacteria and Selective Media text • GMOs! video • Treating Disease with Gene Cloning text • Structure and Replication of Bacterial Cells video • Operons and Gene Regulation in Bacteria video • Historical Basis of Modern Understanding text • DNA Cloning and Its Application video

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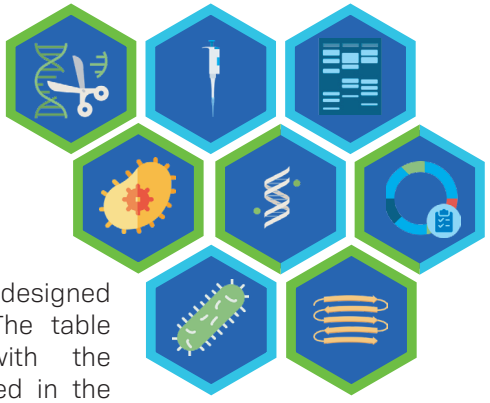

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LAB 2A: PREPARING TO VERIFY THE RFP GENE: DIGESTING THE PARA-R PLASMID

WHAT THE MANUAL SUGGESTS	ADDITIONAL EXTENSIONS AND SUPPORT FROM LABXCHANGE
Pre-learning Activities	
The reading: • **Plasmids** • **Restriction Enzymes** Covers the same content as the introduction to Laboratory 2A.	The "How Do Restriction Enzymes Cut Plasmids?" scrollable interactive allows students to visualize the mechanism by which restriction enzymes cleave DNA. The "Recombinant Plasmid" assignment reviews DNA structure and recombinant plasmids, as well as how proteins are expressed from a recombinant plasmid through transcription and translation.
In-class Session	
Work together to complete Laboratory 2A Answer the "Before the Lab Questions" and the STOP and THINK questions.	Students can use the restriction enzyme digest simulation to preview the tools, technique and protocol before class and complete a formative self-check of their understanding in the reflection section. Students who are absent can use the restriction enzyme digest simulation to carry out the experiment and interpret results based on their actions in the simulation.
Assessment Opportunities	
	Complete the Recognizing Restriction Enzyme Sites and the How Are Restriction Enzymes Used in Biotechnology assignments.
Optional Supports and Extensions	
	Explore plasmids and restriction enzymes: • From DNA to Protein video • What is a Plasmid? video • Components of a Plasmid Vector assignment • The Careful Selection of Restriction Enzymes text • Creating the pARA-R Recombinant Plasmid text • Creating a Recombinant Plasmid assignment • Restriction Enzyme Digest and Gel Electrophoresis video • DNA Cloning and Its Applications video • My Career in Genomics: Antibiotic Resistance video