Improving Student Preparation to Answer MCAT Laboratory Technique Questions

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GRADUATE STUDENT EMERGING IDEAS SESSION APRIL 18-20 | NASHVILLE, TN
One of three online science modules will be discussed in the order shown below during each 15 minute segment of this session. Handouts with additional information on each of the science modules will be provided during the session.

1. *Western Blot Technique* by Aurore Lebrun
2. *Transformation & Cloning* by Bridget Curran & Alex Haber
3. *DNA Replication & qPCR Techniques* by Rogan Magee & Tess Cherlin
Why online modules?

• Association of American Medical Colleges added laboratory technique questions to the MCAT
• Some students feel ill-prepared to answer them
Designed for whom?

- Thomas Jefferson University
- Postbaccalaureate Pre-Professional Program (P4)
- Designed for individuals seeking to complete their basic science requirements in preparation for entrance to medical and other health-professional schools
- Non-science major students

Let’s begin with our first module presentation.
Western Blot Technique
An Online Self-Paced Module
Presentation 1
Aurore Lebrun, Ph.D.
Postdoctoral Fellow
How?

Western Blot Technique online tutorial

– Blackboard Learn
– Nearpod lecture
– VoiceThread assignments
Module Introduction

Welcome video with closed captioning

Learning outcomes

Introduction

Welcome to the laboratory technique MCAT preparation module on Gel Electrophoresis!

Meet the Instructor

Learning Outcomes

The focus of this self-paced module is gel electrophoresis and, more specifically, on a technique called Western Blot. This module is intended to help you get ready to answer MCAT question related to laboratory techniques.

After completion of this module, you will be able to:

- Define the vocabulary specific to Western Blot
- Compare and contrast native electrophoresis and SDS-PAGE blotting
- List and/or sketch all the steps necessary to complete a Western Blot procedure
- Interpret band patterns on a gel or a membrane
- Measure protein’s molecular weight from a gel
- Explain how Western Blot can be used in a clinical setting
- Answer an example of MCAT question related to Western Blotting

Please be sure to access the content and complete the activities in the order in which they are presented.

Thank you!
Tasks At A Glance Section

Module Tasks

This module includes 5 tasks as shown below, and while some of these tasks are designed to assess your understanding of the content, the scores will not count toward your course grade. Completion of this module will help you understand the Western Blot technique and self-assess your understanding along the way.

Before you begin reviewing the content, please be sure to complete Task 1 - the Initial Thoughts questionnaire. Your responses to some of the Initial Thoughts questions will be, in part, compared to the task 5 - Follow Up Reflection responses that were designed to help you see where you might need some additional support on this topic in preparation for the MCAT Exam. Tasks 2, 3 and 4 will provide you with the content in multiple formats and will include practice questions with feedback. You will find instructions for each task on their corresponding pages. Additionally, you can find useful information in the Orientation Module to help you navigate the various platform used in this module and complete your assignments.

1. Submit an Initial Thoughts
2. View a lecture on Western Blot
3. Measure protein's molecular weight on a gel
4. Practice MCAT question related to Western Blot
5. Submit a Follow-up Reflection on Western Blot

Please proceed to Task 1 now - Initial Thoughts questionnaire. Thank you!

List of the tasks the students will need to complete to finish the module.

Note that the module is self-paced and therefore lacks “due dates”.
Interactive Lecture

Overview of lecture & objectives
Videos of Western Blot workflow
  ➤ 3 videos from StarCellBio
Embedded assessments
  ➤ Multiple choice questionnaire, fill-in the blank, open-ended question & “draw it” question
Video feedback
  ➤ For each assessment, a video with correct answer and further explanations
Narrative slides
  ➤ Real life examples Western blot clinical applications
Adaptation of a preexisting online module from the California State University Northridge:
- Authorization obtained from Professor Carol Shubin
- Exercise divided into three parts:
  ➔ Teaching students how to retrieve data from a gel
  ➔ Teaching students the calculation of unknown protein molecular weight and basic statistics
  ➔ Feedback in the form of a full solution to calculation and statistics
Explaining how to analyze an MCAT passage via the VoiceThread platform

- Instruction
- Audio recording using the drawing function of an MCAT passage by instructor
- Slide with an MCAT passage for students to analyze
- As assignment, choice of audio recording or text-based analysis by the students
- Second VoiceThread with audio recording containing the solution to the MCAT passage
Pre- and Post-Assessments

Perceptions of Current Understanding and New Learning

Short written paragraphs

Before reading/viewing the Nearpod lecture on Western Blot procedure, write a short paragraph that briefly describes what you currently know about gel electrophoresis and Western Blot.

There are no wrong or right answers, only your personal thoughts or current understandings of this topic. Please answer the question in whatever format you prefer (including bullet list format). In terms of the length of the response, write until you feel you have completely answered the question. Since you will not be incorporating any course materials in your response, I do not expect this to be a particularly long response. It should be about what you think and feel based on your current understandings, which may be limited.

You can submit your assignment on this page. Please name your document: FirstName_LastName_InitialThoughts.

After completing this module on Western Blot procedure, write a short paragraph that briefly describes what you have learned about gel electrophoresis and Western Blot.

There are no wrong or right answers, only your personal reflection on this topic. Please answer the question in whatever format you prefer (including bullet list format). In terms of the length of the response, write until you feel you have completely answered the question. Since you will not be incorporating any course materials in your response, I do not expect this to be a particularly long response. It should be about what you feel after completing this module.

You can submit your assignment on this page. Please name your document: FirstName_LastName_FollowupReflection.

By submitting this paper, you agree (1) that you are submitting your paper to be used and stored as part of the SafeAssign™ services in accordance with the Blackboard Privacy Policy, (2) that your institution may use your paper in accordance with your institution's policies, and (3) that your use of SafeAssign will be without recourse against Blackboard Inc. and its affiliates.
Additional Resources

Formative assessments with immediate feedback provided throughout the module will inform students of strengths and areas of need. Additional support is provided in the form of:

- Readings
- Websites

Let’s move on to our second module presentation.
Bacterial Transformation and Cloning
An Online Self-Paced Online Module

Presentation 2

Bridget Curran
In collaboration with Alex Haber
Doctoral Students

HOME OF SIDNEY KIMMEL MEDICAL COLLEGE
Module Content and Objectives

Welcome to the Bacterial Transformation and Cloning Tutorial

Introduction

Hello and welcome to the Bacterial Transformation and Cloning Tutorial! Bridget and Alex are your science-loving creators of this module. We hope that it is a helpful resource to you and that you have as much fun as possible completing this lab-based research technique focused module. This module focuses on providing you with information on the basic concepts and steps involved in bacterial transformation and how they apply to the biomedical sciences. During this tutorial, you will:

1. Complete a brief pre-assessment to gauge your knowledge and feelings on bacterial transformation and cloning
2. Progress through three mini-lectures focused on different aspects of bacterial transformation and cloning that each contains their own brief individual assignments
3. Complete a larger MCAT styled activity to practice your skills learned from the mini-lectures in a more practical setting
4. Complete a post-assessment to see how your knowledge and feelings have changed towards bacterial transformation and cloning

Learning Objectives

By the end of this tutorial you will be able to:
- Identify the critical components of DNA plasmids and explain why they are needed for bacterial transformation.
- Outline the steps necessary for the successful transformation of bacteria with plasmids.
- Solve MCAT questions on bacterial transformation and cloning.
Mini-Lectures and Check Points

OVERVIEW OF STEPS FOR TRANSFORMATION

1. Insertion of desired DNA into plasmid
2. Transformation of Bacteria
3. Selection of Successful Transformation
4. Recovery of DNA

Mechanisms of bacterial gene transfer

Preview Test: Checkpoint 1

Description: The proceeding checkpoint has a few questions for you to complete in order for you to assess how well you understood the main concepts learned from Mini-Lecture 1.

You may complete the questions in any order you see fit and have 3 attempts to do so.

Instructions:

Multiple Attempts: This test allows 2 attempts. This is attempt number 1.
Force Completion: Once started, this test must be completed in one sitting. Do not leave the test before clicking Save and Submit.

Question 1

Why is using bacteria (and the process of transformation) to make human proteins an advantage?

- The proteins will be exactly like human proteins.
- Bacteria process their DNA the exact same way that humans do.
- Scientists can utilize vertical gene transfer, which is similar to the way humans reproduce.
- Bacteria are cool and just fun to use.
Ruby Researcher is interested in investigating the effects of a newly discovered gene that has been suggested to be involved in regulating cellular metabolism called JEFF. JEFF is a 239 amino acid (AA) long protein that is thought to be important in catalyzing the conversion of sugars to their constituent molecules which it does via specific AAs located between positions 216-220. Ruby wants to design 2 plasmids: Plasmid A which contains the wild-type protein, and Plasmid B that is a mutated form of the protein with changes to the amino acids mentioned above to confirm that these residues are indeed important for JEFF's function. She takes the plasmid map of JEFF to her boss Ryan who tells her that he has immediately spotted a key flaw in Ruby's plasmid design. He tells Ruby that once she identifies this mistake the plasmid will be ready for cloning in bacteria.

**MCAT Practice - Scenario #1**

**Question 1**
The plasmid map for JEFF that Ruby created is shown above. What is missing from this plasmids so that it will be able to be amplified successfully in bacteria?

- Antibiotic resistance
- Promoter
- Restriction sites
- Primer sequence

**Question 2**
Which selection marker should Ruby use to ensure that her plasmids were uptaken into the bacteria successfully?

- Primer sequence
- Antibiotic resistance
- Promoter
- All of the above

**Question 3**
Ryan walks into Ruby's office the next day and tells her that it would be a great idea to also add a GFP tag to JEFF to make it easy to visualize in cells. Where should Ruby put this tag?

- In the middle of JEFF
- At the end of JEFF
- In front of the promoter
- After the antibiotic resistance
Additional Support

Let’s continue on to our final module presentation.

Supplemental Resources

The resources contained here are for your information only - review of these materials is not required for this tutorial. We hope you will find them helpful. Here you will find supplemental videos, diagrams, and articles related to bacterial transformation and cloning! Feel free to look these over if you desire to delve deeper into the subject matter presented in the mini-lectures.

- Biological and Biochemical Foundations of Living Systems: Content Category 2B: The structure, growth, physiology, and genetics of prokaryotes and viruses
- A video resource on Transformation with Competent Cells

DNA Replication & qPCR Techniques
An Online Self-Paced Module

Presentation 2
Tess Cherlin & Rogan Magee
Doctoral Students
Main question: How will RT-qPCR be presented on the MCAT?
Strategy: Build an online Blackboard module to teach these concepts using interactive online learning technologies.
What’s in our module? A pre-test MCAT style passage and assessment, and a different post-module assessment. How has student understanding changed?

Detailed Feedback Provided
What’s in our module? A video explanation of the pre-module assessment to guide students through the questions, to teach them to how to take the MCAT.

MCAT Passage and Questions Video

The Video Explanation

Now that you hopefully learned some new DNA Replication & qPCR content, we are going to revisit the Pre-Test that you took at the beginning of this module. We’ve filmed a break down of the MCAT style passage that you had to read for this Pre-Test. The passage covers qPCR and then prompts you on five questions related to the subject. We will go through how to read the questions and each individual section of the passage first, pointing out relevant information. We will then go through each of the five questions step-by-step, pointing back to the passage to show you where the right and wrong answers come from. The videos are split up by content for your convenience.

Video Directions

1. Download the the MCAT Passage and Questions document to follow along with the video. Helpful to have a hi-liter!
2. Click the red arrow on the embedded MCAT Passage Video YouTube video. If the video doesn’t work click the youtube links next to each Video segment.

MCAT Passage RT-qPCR

When scientists want to study transcription, the amount of gene product being made, they employ a molecular technique called reverse transcription quantitative polymerase chain reaction (RT-qPCR). RT-qPCR is able to quantify the amount of mRNAs in a sample in real time. RT-qPCR allows for RNA quantification by first making cDNA. In order to make cDNA, scientists harness the power of reverse transcriptase, an enzyme that uses random primers to synthesize a complementary strand of DNA from RNA. Once the cDNA is synthesized, it is amplified or multiplied using DNA polymerase and small oligonucleotides called primers that are complementary to regions within the gene of interest.

SYBR-Green is a non-specific fluorescent dye that can intercalate between double-stranded DNA and is commonly used to quantify ds-DNA synthesis. By using SYBR-Green, scientists are able to measure the amount of a gene transcript being produced in a sample. However, because SYBR-Green is non-specific, it can bind to and measure DNA contamination or primer dimers. It is therefore extremely important to mitigate contamination when preparing samples for qPCR. Also, it is vital to high quality primers that will not dimerize to produce a background signal. qPCR experiments normally run for 40 cycles of polymerase amplification, with each cycle containing a step to amplify existing DNA copies, a step to stop the reaction, and a step to

Materials for In-depth Explanations

- document containing the passage and questions
- guided videos
What's in our module? An interactive tutorial with:

**Theoretical explanations**

**Checks-for-understanding**

**Interactive games**

**Answer explanations**

Reverse Transcriptase – Polymerase Chain Reaction!

An interactive tutorial by Tess Cherlin and Rogan Magee

Let's learn about...

1. **Theoretical explanations**
   - What's in our module? An interactive tutorial with...
   - Reverse Transcriptase – Polymerase Chain Reaction!
   - An interactive tutorial by Tess Cherlin and Rogan Magee
   - Let's learn about...
   - Theoretical explanations

2. **Interactive games**
   - Interactive games
   - Help me transcribe this RNA

3. **Answer explanations**
   - Let's review the answers to question 7.
   - This question is purely quantitative, and can be solved with application of a bit of logic. The four answers are ranked in descending order. Since the question asks which answer signifies the highest amount of starting cDNA relative to the others, we know that we're looking for one of the extremes - either A or D. If we think back to the description, high Cq values actually represent low amounts of cDNA. So we can safely pick D.

4. **Checks-for-understanding**
   - Quick question 7...
   - Which Cq value means you have a lot of starting cDNA (relative to the others)?
     - a) 40
     - b) 35
     - c) 30
     - d) 25
   - Type these letters to answer MCQs. Click the arrows to change slides.
Our goal was to teach an MCAT level understanding of reverse transcriptase - polymerase chain reaction to postbaccalaureate students from diverse backgrounds.

Hello and welcome to our tutorial on DNA replication and qPCR techniques, geared towards the MCAT!

Our names are Rogan and Tess. We’ll be your hosts for this learning experience.

Module Learning Objectives:

1. Students will be able to identify their own DNA Replication and qPCR content learning gaps
2. Students will participate in an interactive learning tutorial to address content knowledge gaps
3. Students will learn test-taking techniques by watching a video that guides the student through a step-by-step analysis of a qPCR-related MCAT passage question
4. By the end of the DNA Replication & qPCR tutorial, students will be able to accurately answer new qPCR-related MCAT questions
Thank you!

Instructions for the Session Evaluations Contest can be found on the next slide.

Be sure to come to visit us during our session. We will have additional materials on these modules and the overall project.
Session Evaluations Contest

- Download and open OLC Conferences mobile app
- Navigate to specific session to evaluate
- Click “Evaluate Session” at the bottom of session details screen
- Complete session evaluation*

*Each session evaluation completed (limited to one per session) = one contest entry

Five (5) $25 gift cards will be awarded to five (5) individuals
Must submit evals using the OLC Conferences mobile app or website