

GUT PUNCHED!!!

Immunology : The Role of Gut Microbiota in Inflammatory Disease

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Teacher Section

I. Abstract

“Can gut microbiota be altered in order to diminish the incidence of inflammatory disease?”

Inflammatory diseases such as Crohn’s disease and rheumatoid arthritis negatively affect quality of life for many Americans. During my summer laboratory internship through the AAI High School Teachers Program, we tested bacterial loads in the gut of antibiotic-treated and control mice and examined correlation between certain levels of bacteria and the incidence of inflammation. Based on this experience I designed a curriculum for my students in which they will explore the relationship between the incidence of inflammatory disease and the presence of certain gut microbiota. Students will become familiar with immunological terminology, inflammatory diseases, and how diet can contribute to inflammatory pathogenicity. They will participate in an Immunology “Boot Camp” where they will receive lectures on immunological principles that help them identify bacterial loads through the use of graphs, compare and contrast inflammatory disease mechanisms, and explore unique laboratory techniques. This will allow students to gain a thorough knowledge of how environment and lifestyle affect gut microbiota and lead to inflammatory disease. Upon completion of this unit students will have a working knowledge of how the immune system works, what triggers an immune response, and how an improperly functioning immune system affects organisms. The goal of this unit is to prepare students to understand how the immune system works in tandem with the rest of the body to maintain the health of the individual.

II. Overview

This Curriculum was designed to introduce high school students to the basic principles of modern immunology. The curriculum contains lecture material, introductory activities, and laboratory practices that explain the basic functioning of the immune system. Additionally, the materials included contain information about the research conducted at the University of Miami School of Medicine that determines if diet can contribute to inflammatory pathogenicity. Students will begin their journey into immunology in a “Boot Camp” style format with a classic case study that explains the modes of disease transmission. On days one and two of the boot camp, students will watch two videos pertaining to the history of immunological discovery. On days three and four students will be exposed to two classic inflammatory diseases, Crohn’s disease and rheumatoid arthritis, their symptoms, and how they affect the body and treatment modes will be discussed. Students will begin days 5 and 6 with a brief explanation of gut microbiota and their role in the incidence of inflammatory diseases. Additionally, students discover the effect of diet on the occurrence of disease; a brief introduction on gut microbiota will take place and importance of a balanced diet will be discussed. Days 6 and 7 will take us into laboratory techniques commonly used in research labs and will explore some of the information that I used in the immunology lab this summer. They will begin by completing a basic PCR WebQuest and then be shown animations on PCR vs. RT-PCR and then another on gel electrophoresis. Once students have seen the animations, I will explain their application in the world of science research, criminal justice, and other fields, so they have real-world knowledge of the importance of these techniques. On days 9 and 10, students will complete a formal assessment reflecting the information they learned in the boot camp in the form of an oral

report, written report, or group project. The final portion of the boot camp will end with an assessment of the project as a whole. Students will judge the boot camp on effectiveness and delivery by using a Likert Survey. The survey will also include a written portion which will help me utilize this module and make any necessary improvements.

III. Student Learning Objectives

Primary Objective

The MAIN GOAL of this unit is to help students understand how the immune system works in tandem with other organ systems to maintain the health of the individual.

Secondary Objective:

- To introduce students to the basic principles of immunology
- To enhance high school students' understanding of immunological principles and their application to scientific research
- Students will become familiar with immunological terminology, inflammatory diseases, and how diet can contribute to inflammatory pathogenicity.

Student Outcomes

After extensive exposure to the immunology principles, the students will have a better understanding and greater respect for the field of immunology.

At the end of the Boot Camp students know and understand:

- ❖ that pathogens invade the body and trigger disease
- ❖ the general mechanism of disease transmission
- ❖ the devastating effects of inflammatory diseases
- ❖ basic experimental design protocol
- ❖ how researchers utilize certain laboratory techniques to further aid in scientific and medical discovery

IV. State Standards

Sunshine State Standards

SC.912.L.14.52

SWBAT Explain the basic functions of the human immune system, including specific and nonspecific immune response, vaccines, and antibiotics.

SWBAT learn about the immune system and how disease can affect personal and public health.

V. Target Student Audience

This curriculum was designed to target high school biology students who are struggling readers. Animations and online labs are used to supplement reading and lecture materials and the hands on components of the lessons are limited to simple instructions and procedures. Additionally, this material can be used in classrooms where teachers have limited access to resources and funding.

VI. Time Requirements

Time requirements include about twelve school days total, with 5-6 days requiring actual completion of the boot camp before participating in the culminating project, which includes an oral presentation (individual or group) in any format students choose.

Note: The Boot Camp is based on block scheduling, with each block being 105 minutes long, with a different set of students every other day. Therefore, days I and II entail the same activity but for a different set of students.

VII. Prior Knowledge Required from Students

Students should have a general understanding of the processes of DNA replication and protein synthesis. Other concepts being taught in the boot camp don't require an enormous amount of prior knowledge except appropriate laboratory techniques in order to avoid injury.

VIII. Daily Curriculum Plan

Boot Camp Curriculum Design

- ❖ Days 1-2: Basic Immunology Lecture with a Classic Opener Case (Typhoid Mary)
 - Activity : Disease Transmission with Glow Gel and Black Light
 - Video : The Sneeze, How Germs are Spread (youtube.com)

- ❖ Days 3-4: WebQuest on Inflammatory Diseases Discussion and Treatment Regimens
 - Showcase: Rheumatoid Arthritis and Crohn's Disease via Pictures
 - Rheumatoid Arthritis: A Personal Account (My Battle with RA)

- ❖ Days 5-6: Establishing a Connection between Diet and Inflammatory Diseases
 - Explanation of Contribution of Diet to Inflammatory Disease
 - Activity: Students will design their own food collage that will indicate the types of foods and diet that will encourage the growth of healthy gut microbiota

- ❖ Days 7-8: History of PCR WebQuest
 - DNA Replication Review AND Explanation of Immunology Lab Techniques Used in the Summer Internship Program (Dr. Chen's Lab)
 - PCR Animation
<http://www.dnalc.org/view/15475-The-cycles-of-the-polymerase-chain-reaction-PCR-3D-animation-with-no-audio.html>
 - Real Time PCR Animation
<http://www.dnalc.org/resources/animations/pcr.htm>
 - Gel Electrophoresis Animation
<http://learn.genetics.utah.edu/content/labs/gel/>
 - Pictures of The Gel and the RT-PCR from the Internship will be shown and a brief description of the research that we did will be explained.

- ❖ Days 9-10 Formal Assessment
 - Group Presentations or Oral Report including:
 1. Immune System
 2. Lab Techniques
 3. Contribution of Diet to Incidence of Inflammatory Disease
 4. Inflammatory Diseases Discussed during Boot Camp.

- ❖ Days 11 and 12 : Students will Assess the Boot Camp on Design and Effectiveness (Likert Survey)



Image from Clip Art

Daily Curriculum Plan

Days I and II: Part 1 Basic Immunology Lecture with a Classic Story Opener

This introduction will be used as a “hook” to gain students’ attention into the world of immunology and explain how harmful pathogens can lead to infectious disease.

An introductory story about Mary Mallon, otherwise known as “Typhoid Mary” will lead to a short lecture and brief discussion on the transmission of disease. After reading this story, I want students to make inferences and connections about disease exposure and transmission. Additionally, students will learn official vocabulary that will serve as a basis for the rest of “boot camp” and assist with students’ understanding of the mechanisms of the immune system.

The Woman Named Mary

Part I:

Mary: “Well today is going to be quite a busy day, I have to wash the windows, do laundry, scrub and wax the floors, clean the bathrooms and cook dinner.” (she looks at the bucket and gloves and sighs) “Well I best get started as I have a lot ahead of me.”

Mary: (3 hours later) Wheeeeeew I’m pooped but I still can’t stop, I’ve cleaned the rest of the house. Now I better get down to cooking before Mr. and Mrs. Smith return home as they’ll be quite hungry from working well into the evening. (Mary hums as she readies the cooking utensils) and then states “Yesssss...I’ve cut the carrots, onions, potatoes, celery, peas and chicken. This is going to be one good stew” (Mary finishes preparing the stew’s ingredients and then leaves them to cook; After 2 hours Mary comes back to check on the stew and takes a sniff)

Narrator: It is 5:00 pm. Mr. and Mrs. Smith arrive home and they are famished. Mary carefully sets out a bowl of stew for each of them. They both ate 2 bowls they were so hungry. Mary

hurriedly washed the dishes, collected her pay, and was off to her night job with the Kings' family. Today is Sunday. Mary won't see the Smith's again until Wednesday afternoon)

Mr. Smith: That was a really good stew that Mary made, wasn't it dear?

Ms. Smith: Yes it was! I've always loved Mary's cooking.

Mr. Smith: Me too! Well let's shower and get ready for bed. (Mr. Smith motions and then states "after you....")

Narrator: They both take their showers and get bed in order to get ready for work tomorrow morning.

Later that evening at the King's home.....

Narrator: Mary is about to begin preparing dinner, but before she starts dinner she needs to use the bathroom. After she finishes, she begins dinner immediately. She takes out ground beef and begins making the meatballs for the spaghetti. Each meatball is made perfectly round, baked and then added into Mary's special pasta sauce. Dinner would be ready momentarily.

Mr. King: Johnny, make sure you eat your meatballs, Mary made them nice and big for you!

Johnny: Yes, sir.

Narrator: They both ate and Mary again went along her way. This time she went home, her feet are hurting and she was tired. (She falls asleep on the couch that night)

Part II

Narrator: It's Tuesday and Mrs. Smith isn't feeling so good and neither is her husband. Mr. Smith feels a general sense of malaise and Mrs. Smith has diarrhea. They both called in to work today as they are both "under the weather". Five miles down the road Johnny King isn't feeling well either, he has severe diarrhea and has developed a fever. Both parties go to the doctor and receive antibiotics and have fully recovered.

Mary takes time off to go visit her family for a week; neither the Smith's nor the King's have seen her and boy they have missed her cooking!

Narrator: When Mary returns, it's back to business as usual. She returns back to work and begins her daily duties of cleaning, dusting, and cooking for both families. Four days later, Mr. Smith is once again stricken with a high fever and a severe bout of diarrhea. After 1 whole day of being glued to the toilet he finally goes to the emergency room and receives a diagnosis of typhoid fever.

Critical Thinking Questions

1. What do you think is making the families that Mary works for sick? Explain your answer.
2. Name and explain 2 possible reasons why Mary is not becoming ill.

3. What is the likely mode of transmission of typhoid fever?
4. Why do you think Mr. Smith got much sicker the second time around?

Initially, students may not be able to answer the critical thinking questions; but after the introduction of vocabulary and an explanation of innate and adaptive immunity, students should have a thorough understanding of how the immune system works. Next, I will briefly discuss the real story of “Typhoid Mary”, which can then lead into how diseases are spread and how the immune system serves as a barrier to protect us from pathogenic organisms.

Post- Story Q & A Session

1. What was Mary’s responsibility once she found out she was causing people’s sickness?
2. Was it ethical to quarantine Mary against her wishes? Explain.
3. How can individuals like Mary avoid instances like this in the future?
4. Is it right to quarantine those who put the public at risk?

This lesson directly allows students to make the connection between the disease and a causative agent. Students will also have to recall some information about how carriers pass on disease but are not affected by the disease themselves as a point of reference. This information was introduced in the fall semester. After this brief synopsis, an introduction of basic biological terms and an explanation will be introduced to further enhance discussion as well as prepare us for the next few days of our boot camp.

Basic Immunology Vocabulary List

1. Antigen – proteins derived from cells that serve as its “ID badge” that induce an immune response.
2. Antibody – proteins that circulate in the blood looking for immune system “invaders” After the invaders are located they are attacked by the antibodies. This is known as the antigen-antibody response.
3. Pathogen- any bacteria, virus, or microorganism that can cause disease.
4. Autoimmune Disorder- a condition that occurs when the immune system mistakenly attacks and destroys healthy body tissue.
5. Carrier- a person that passes an infectious agent to others that cause them to get sick but are not affected by the pathogen themselves.
6. Immunity- the general ability of your body to fight infection.
7. Passive Immunity- occurs when antibodies are transferred from one individual to another, such as transfer of anti-serum. These antibodies are not made by the individual’s own immune system.

8. Active Immunity- occurs when exposure to an antigen of a disease-causing organism triggers the immune system to produce antibodies to that particular disease. (i.e. vaccination)
9. Innate Immunity- the part of the immune system that is always ready to function. This portion is very nonspecific in its response. There are several components involved in innate immunity including but not limited to skin, sweat, tears, physical barriers, macrophages, leukocytes, dendritic cells, and natural killer (NK) cells. The skin is your first line of defense. The physical barriers create a barrier to deny pathogenic entry; however, once those physical barriers are compromised, then certain cells which are circulating in the blood begin to take over in host defense.
10. Adaptive Immunity – the part of the immune system that is highly specific and responds to a particular pathogen.
11. B cells- white blood cells that mature in the bone marrow and secrete antibodies that are specific to a particular pathogen. These cells are part of the body's adaptive immunity.
12. T cells – white blood cells that mature in the thymus; they seek out and find pathogenic threats to the individual's immune system with the help of other circulating cells. There are two main types: helper T cells and cytotoxic cells. Helper T cells release chemicals into the environment which can activate other cells of the immune system. Cytotoxic T cells patrol the body looking for infected or damaged cells that they will destroy directly. These cells attach themselves to the infected cell and cause apoptosis to occur. These cells are part of the body's adaptive immunity.
13. Primary Immune Response- The primary response involves the first encounter with the specific pathogen. Once the pathogen is destroyed, "memory" of the pathogen is recorded for the purposes of protecting the individual should they encounter the pathogen again.
14. Secondary Immune Response - If the individual encounters the pathogen again, the immune response will be heightened.
15. Incubation Period – describes the time period between the exposure to the pathogenic organism and the physical symptoms of disease.

After being introduced to the vocabulary above, the students will be able to fully grasp the concept of the “Typhoid Mary” story and the purpose of upcoming hand washing lab. Through the explanation of innate and adaptive immunity, students will understand that although they may encounter pathogenic organisms daily, innate immunity protects them from getting sick and/or displaying physical symptoms of fighting illness.

Typhoid Mary Follow-Up Lab Activity

In order to teach students about the modes of transmission there will be follow-up activity conducted. This lab aids students in learning the importance of hand washing and the prevention of communicable disease. Students will be asked to serve as participants in a restaurant cleanliness study. Five students will be asked to volunteer to serve as a panel of patrons visiting the restaurant in question. The remainder of the class will be split into 2 groups which will be designated A and B. Before the patrons walk inside the classroom the remaining students will be asked to rub an unidentified substance on their hands and look at it under a glow light. Next, the group labeled A will be instructed to wash their hands with soap and water and the students labeled B will be instructed to wash their hands with water only. They will look at their hands under the black light again and then the patrons will be invited back in. When the patrons walk in they will shake hands with any person from the “wait staff” before they sit down and get ready to “eat”. The patrons will not know that the members of the wait staff have been designated A or B. The wait staff will bring out a “menu” and a “basket of rolls” making sure that members from group A and group B have touched the items. After the scenario is finished, we will look at all the items that were touched by the wait staff under the black light. Students from the wait staff will identify themselves as being a part of group A or group B.

After all the students identified themselves they will engage in a brief post-discussion.

www.glogerm.com

Post Lab - Q & A Session

1. What was the purpose of the lab?
2. If this were a restaurant, which set of “cooks” would you want handling your food? Why?
3. Patrons: Now that you’ve seen the results of the hand washing test, Can you tell us a possible connection between improper hand washing procedures and food borne illnesses?
4. Why do you think washing your hands after using the bathroom is important for the safety of public health?
5. What did the lab teach you about disease transmission?
6. How do you think the immune system responds to a germ that the body encounters?
7. Explain why 2 people can be exposed to the same pathogen but yield totally different immune responses to that organism.

Days I and II – Closing

The day will close out with a short video on germs that will stem conversation for days 3 and 4 of the Boot Camp.

Q&A Session

Questions will vary based on level of interest and discovery during the lesson.

In the next section, students will recall the characteristics and the role of white blood cells in the immune response in order to actively engage in the discussion on Crohn's disease and rheumatoid arthritis, two classic inflammatory diseases.

Days III and IV- Part 1

Students will need access to computers in order to complete a WebQuest on two classic inflammatory diseases. Before starting the Inflammatory Disease WebQuest students will be referred back to the prior discussion on antigen-antibody interactions. Students should be able to apply the basic understanding of immunology to the concept of the topic of autoimmune disease. Students will utilize the mobile computer labs to research autoimmune diseases in general and then choose one of two classic inflammatory diseases. They may choose between rheumatoid arthritis or Crohn's disease; therefore the questions below pertain to either disease.

The questions they will explore are below:

1. What is an autoimmune disease?
2. How is the response mechanism for autoimmune diseases different from normal immunological responses?
3. What are some of the general effects of autoimmune disorders?
4. What is rheumatoid arthritis or Crohn's disease?
5. What causes rheumatoid arthritis or Crohn's disease?
6. What are the symptoms of rheumatoid arthritis or Crohn's disease?
7. What are the long-term effects of rheumatoid arthritis or Crohn's disease?
8. What are 2 possible treatment regimens for rheumatoid arthritis or Crohn's disease?
9. In general, describe how anti-inflammatory medicines work?
10. What are NSAID's?
11. What are biologic medications and how do they work in the treatment of rheumatoid arthritis or Crohn's disease?

Extra Credit Challenge

Find and describe the symptoms of any other disease that is considered inflammatory and describe its symptoms and treatment regimens. (20 points)

After students complete the WebQuest, we will review the information together and clear up any misconceptions pertaining to the information collected on both diseases and their treatment regimens. Before our Visual Showcase begins similarities and differences between the two diseases will be discussed. Next, students will engage in a Q&A Session after hearing about a personal account with rheumatoid arthritis.

Days III and IV- Part 2

- Inflammatory Diseases Discussion and Treatment Regimens
- Showcase and Explanation of Disease Progression with Pictures: Rheumatoid Arthritis and Crohn's Disease.
- My Personal Account with RA

Picture Showcase

- Students will view Normal vs. Diseased Patient Pictures and the Progression of Disease will be explained to students along with possible mobility limitations, lifestyle adjustments, and side effects associated with both diseases.

NOTE to Teachers: There are several images online that catalog the disease progression of both diseases. Feel free to design your own showcase or view the websites in the reference section for suggested images.

After the picture showcase students will be able to understand the severity and progression of both diseases and their impact on the normal functioning of the immune system.

Q&A Session

Questions will vary based on level of interest and discovery during the lesson.

Days III and IV- Part 3

After the showcase students will receive a personal account from a teacher that was diagnosed with rheumatoid arthritis beginning in 2006, her treatment regimens (past and present), and personal lifestyle adjustments after diagnosis.

In the next section students discover the effect of diet on the occurrence of disease. A brief introduction on gut microbiota will take place and the importance of a balanced diet will be discussed.

Days V and VI: Part 1

Students will begin days 5 and 6 with a brief explanation of gut microbiota and their role in the incidence of inflammatory diseases.

Introduction

Microorganisms are all around us. They live in our mouths, on our skin and several live inside our stomachs. There are several hundred types of different bacteria inhabiting the gastrointestinal tract, some of which have a symbiotic relationship and aid in digestion by absorbing nutrients; other bacteria when present in certain numbers have been linked to inflammatory diseases like the ones described above. No matter the level of involvement, the presence of these microorganisms can increase the incidence of disease in the body by altering the intestinal flora; the natural environment present in the gut. The type of bacteria present in the gut differ from person to person, are dependent upon genetics and have been shown to fluctuate based on dietary

consumption. Current research has shown a possible correlation between inflammatory disease incidence and a change in gut microbiota.

(<http://www.nature.com/nri/journal/v9/n5/abs/nri2515.html>)

Furthermore, the promotion of probiotic use has been ever present in television commercials. A probiotic is any microorganism that maintains the natural balance of intestinal flora. Although more research is needed, perceived benefits range from maintaining cholesterol levels to controlling inflammation and infections. The benefits that are associated with probiotics have driven an increasing trend of including live bacteria in certain foods. For example, Activia the yogurt company has spent millions on advertisements, “the Activia Challenge” and a jingle in order to increase awareness of the probiotic properties. Activia contains the bacteria *Bifidus regularis* which boasts to increase bowel regularity after just two weeks of including it in your regular diet. Even if you haven’t joined the “Activia Challenge” drugstores also have the shelves stocked with probiotic supplements that claim to help keep the digestive track in shape. I suspect that as probiotic research increases that the probiotic craze will continue and may contribute to healthier individuals as a whole.

Days V and VI: Part 2

After the discussion students should have a general understanding of the significance of gut microbiota as well as the helpful properties of probiotics. Students will create a collage which identifies the foods that may encourage the healthy growth of gut microbiota; thereby *possibly* lowering the incidence of disease; particularly inflammatory diseases.

Post Lab –Discussion Session

After the students create their collage we will review the importance of maintaining a healthy diet to increase overall health. Students will explain their individual collages to the class. Closing questions will include:

1. Why do you think it’s important to regulate intestinal flora?
2. Are probiotic supplements and foods like Activia worth the price? Explain your answer thoroughly.

Days VII and VIII – Part I

Students will receive a brief overview on the biomedical techniques of PCR, Real-Time PCR and Gel Electrophoresis and their applications in the real world. Next, students will review animations and discussion of the application of these immunology techniques used in my summer internship laboratory experience.

Explanation of Basic Biological Laboratory Techniques

The **polymerase chain reaction (PCR)** is a biochemical technology used in molecular biology to amplify a single or a few copies of a piece of DNA, generating thousands to millions of copies of a particular DNA sequence.

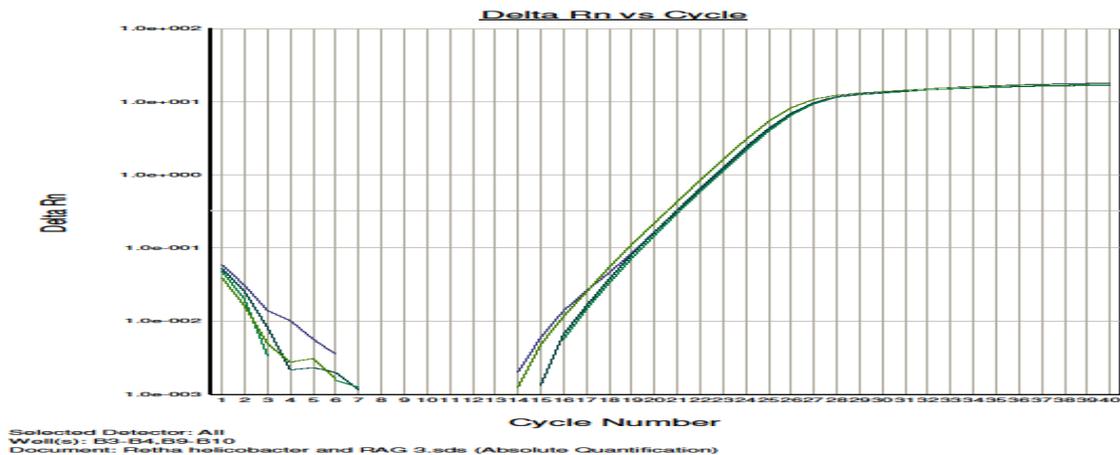
Quantitative Polymerase Chain Reaction (qPCR) is the process that measures DNA amplification results as each cycle is taking place. Scientists use both of these processes as a way of “counting” gene expression.

Gel electrophoresis is a method for separation and analysis of macromolecules (DNA, RNA, and proteins) and their fragments, based on their size and charge. It is used in clinical chemistry to separate proteins by charge and/or size (IEF agarose, essentially size independent) and in biochemistry and molecular biology to separate a mixed population of DNA and RNA fragments by length, to estimate the size of DNA and RNA fragments or to separate proteins by charge.^[1]

www.wikipedia.com

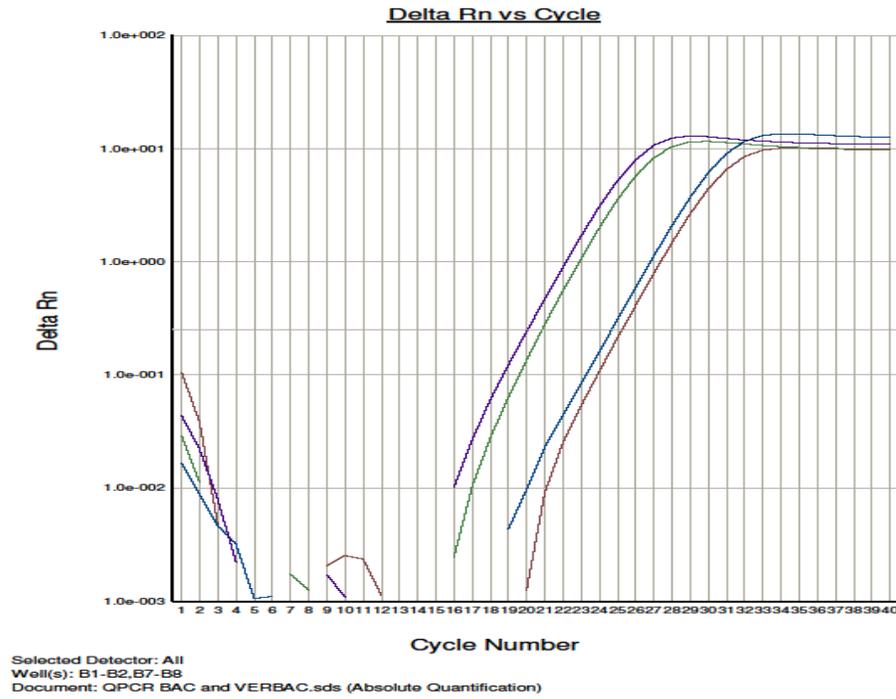
Nucleic acid molecules are separated by applying an electric field to move the negatively charged molecules through an agarose matrix. Shorter molecules move faster and migrate farther than longer ones because shorter molecules migrate more easily through the pores of the gel. After a brief overview of the techniques above, an explanation of how the techniques were utilized in my summer research experience is briefly highlighted.

During my summer experience in the lab we amplified 2 genes. First we amplified the beta-casein gene which was used as a reference of comparison for amplification. Secondly, we quantified gene numbers for 16s rRNA that are specific for different types of bacteria to determine the bacterial load in the body. After amplification of the genes we ran a gel electrophoresis to verify the amplification of the correct genes.

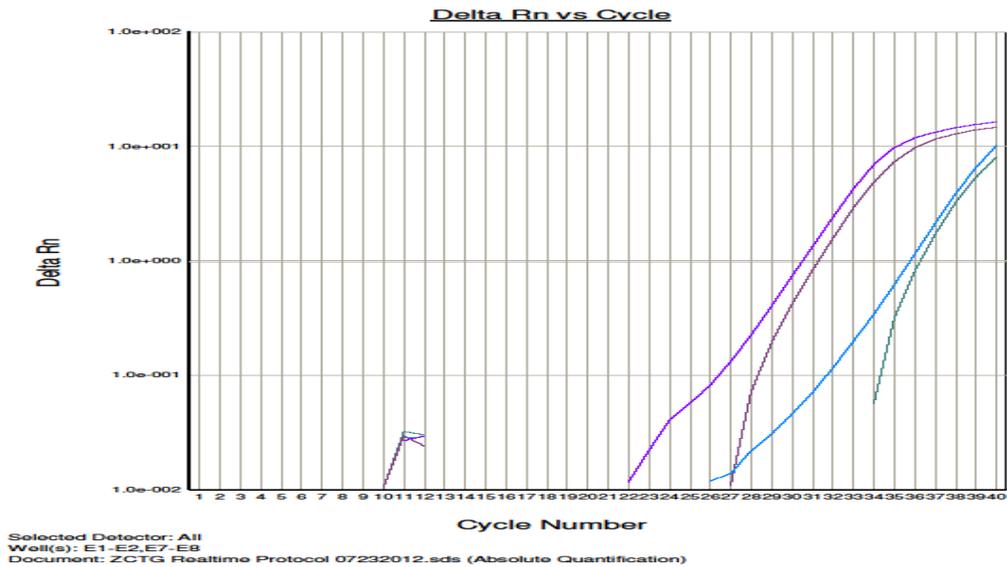


qPCR for eukaryotic genomic DNA control, for the beta-casein gene.

We utilized PCR for the detection of inflammatory pathogens in control vs. experimental mice.



qPCR for total bacterial 16s rRNA gene for a control animal (left lines) and an experimental animal.



qPCR for Helicobacterial 16s rRNA gene for a control animal (left lines) and an experimental animal

Steps of Gel Electrophoresis

1. Plasmid Vector DNA added → Add DNA Sample onto Agarose Gel → DNA Bands will Separated by size → Dye Binds to DNA base pairs → DNA bands are exposed under UV light. (molecularstation.com for image of gel electrophoresis)

Ctrl Sample Well #1	Ctrl Sample Well #2	Ctrl Sample Well #3	Ctrl Sample Well #4	Ab- Treated Well #5	Ab- Treated Well #6	Ab- Treated Well #7	Ab Treated Well #8	Empty Well #9	Well #10 DNA Ladder
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Gel Electrophoresis for Helicobacterial 16s rRNA genes. First 4 lanes are 10-fold series of a control animal; the next 4 lanes are for an animal treated with antibiotic. The last lane is for molecular weight marker (DNA ladder). (Provided by Dr. Zhibin Chen, University of Miami)

Days IX and X

For this portion of the curriculum I will use a differentiated instruction model which will meet their academic needs and allow them to showcase their knowledge in a way that makes them comfortable. As a result of this lesson students will be able to create a brief review lesson on the history of immunology, application of techniques in the laboratory, and the inflammatory diseases that we discussed in the boot camp.

Visual and Oral Presentations will be out of 16 points maximum. Students will have the opportunity to earn up to 5 points extra credit if the lesson/visual presentation is innovative.

Grading of student projects will be based on the rubric in the student section below.

Student Section

I. Oral Presentation Rubric

	Poor 1 point	Fair 2 points	Good 3 points	Excellent 4 points	Comments
Science Content	Explanations are lacking. Content is inaccurate. No connections are made between lab experiences and computer models	Explanations are poor. Content is accurate but lacks support. No connections are made with the lab experiences. Text is used extensively.	Explanations are adequate. Content is accurate and well-supported. Connections are made between lab experiences and the concept used. Text is used extensively.	Concepts fully and properly explained. Content is accurate, comprehensive, and well-supported. Connections between a lab experience the concept is used. Text is used extensively.	___/4
Graphics	Graphics are confusing or needed graphics are absent	Graphics are confusing or not in support of the content and explanations	Easily understood graphics, but they may not clearly support the content and explanations.	Easily understood graphics which clearly support the content and explanations. Word are clearly and neatly lettered.	___/4
Organization	Cluttered, with no definitive sections, missing parts, hard to follow	No headings for sections, hard to follow, missing parts	All material present in defined sections but unclear - may need to be reread for clarity	Defined sections, clear headings, flows nicely to assist the reader without help.	___/4
Presentation	Does not hold attention of viewer. Effort obviously lacking	No headings for sections, hard to follow, missing parts	Will engage but not stimulate - lacking aesthetic appeal. Demonstrates good effort	Interesting, engaging, and visually stimulating, with aesthetic appeal. Clearly a finished product, demonstrating superior effort	___/4
					Total: ___/16

II. Post Boot Camp - Likert Scale Survey

Answer the following questions on a scale by circling the appropriate description below.

1. The lesson helped me learn more about basic immunological principles.
1 – Strongly Agree 2- Agree 3- Disagree 4- Strongly Disagree
2. The lesson was delivered in a manner that differentiated instruction for struggling learners.
1 – Strongly Agree 2- Agree 3- Disagree 4- Strongly Disagree
3. The lesson included activities that helped create a better understanding of laboratory principles.
1 – Strongly Agree 2- Agree 3- Disagree 4- Strongly Disagree
4. The lesson adequately prepared me to understand the application of biomedical technology in other professions.
1 – Strongly Agree 2- Agree 3- Disagree 4- Strongly Disagree
5. The lesson got me interested in the field of immunology and disease prevention.
1 – Strongly Agree 2- Agree 3- Disagree 4- Strongly Disagree

Classroom Discussion – Reflection Questions

1. What was the purpose of this lesson?
2. What did you learn from this lesson that you didn't know before?
3. How could this lesson have been improved?
4. How can this lesson influence you to make healthier choices when choosing foods to eat knowing that diet contributes to a change in intestinal flora?
5. Based on what you learned, do you think that you can “influence” your immune system to protect you from disease?

References

Note : Numbers 8-12 contain the images relating to the picture showcase.

1. [Youtube.com](#) (Video: The Sneeze: How Germs are Spread)
2. <http://www.dnalc.org/view/15475-The-cycles-of-the-polymerase-chain-reaction-PCR-3D-animation-with-no-audio.html> (PCR Animation)
3. <http://www.dnalc.org/resources/animations/pcr.htm> (RT-PCR animation)
4. <http://learn.genetics.utah.edu/content/labs/gel/> (gel electrophoresis animation)
Gel provided by Dr. Zhibin Chen(University of Miami Miller School of Medicine)
5. www.wikipedia.com
6. http://missinglink.ucsf.edu/lm/immunology_module/prologue/objectives/obj02.html
7. http://www.vdh.state.va.us/epidemiology/factsheets/Typhoid_Fever.htm
8. www.images.google.com
9. www.easypediatrics.com
10. www.adameducation.com
11. www.webmd.com
12. www.rheumatology.org
13. www.healingwell.com
14. www.thecrohnsdiseasesymptoms.com