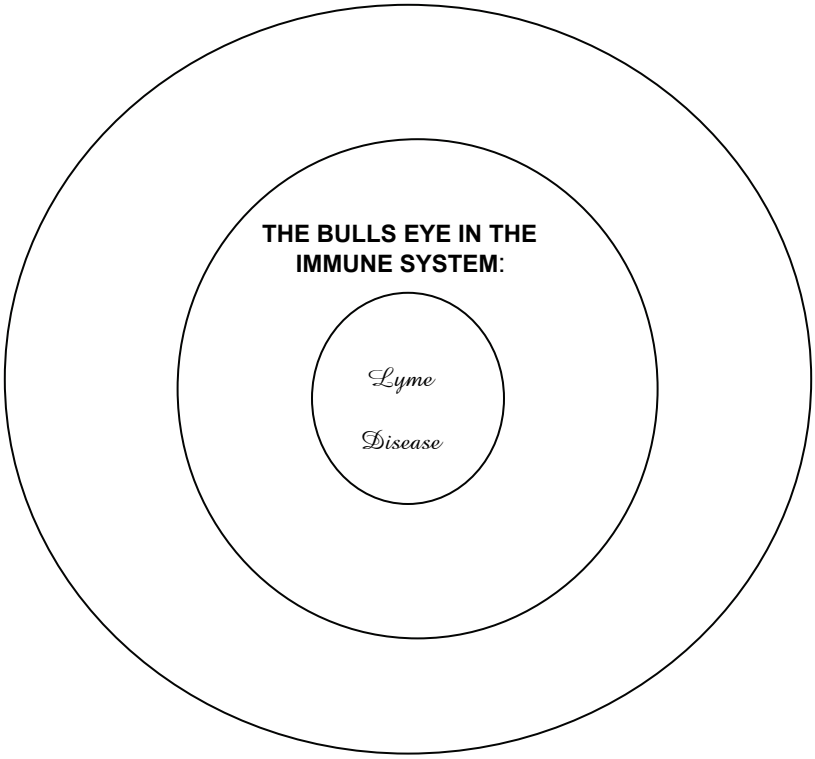
Immunology Educational Unit
By
Tamica A. Stubbs



The Bulls Eye of the Immune System
Immunology Educational Unit
By
Tamica Stubbs

An Introduction

Imagine if you will, on a given random day you as the instructor walk into the room and present an elaborate looking gift box to a student. What would happen? Immediately it would trigger a cascade of responses from his or her surrounding peers. What have you done? Instructionally speaking, you have just introduced the topic of immunology to your students. At this point you could use this analogy to work in your benefit to introduce terms like the immune system, white blood cells, antigens, antibodies and immune responses. This would open your unit and provide a premise for discussion as the unit progresses.

In this educational unit: "The Bulls Eye in the Immune System", students will learn immunology concepts as they progress through the unit of the cell. The unit achieves the deliverance of "double dosed" information by engaging students in a variety of activities. Each lesson is designed with a Construcivist educational philosophy in mind. All lessons begin with a focus activity or investigation. This provides a transition into the topic at hand. It then permits time for instruction or attaching meaning phase of the lesson. It follows with reinforcement practices within the same lesson or through the next lesson. Suggested homework assignments are provided as well as suggested key questions for each lesson.

Additionally, students will be exposed to the inflammatory process linked to the development of Lyme Disease. Each lesson relates to this particular topic while strengthening the cell and immunology topics. The progressive nature of the unit will reinforce all previously taught concepts and trains students to become "experts" on the topic of Lyme Disease.

Appropriate grade levels for this unit:

All – this unit is flexible in terms of its adaptability. It is age appropriate for all levels of biology.

The overall goals of this unit are as follows:

a) To develop creative scientific inquiry.
b) To promote a better understanding of laboratory techniques employed within research labs.
c) To develop a stronger understanding of Lyme disease.
d) To describe the structure and function of the immune system.

The lab skills and techniques that students will acquire throughout the unit are:

a) ELISA
b) Gel Electrophoresis
c) PCR

d) Southern Blotting
e) Western Blotting
f) Cell purification
g) Science process skills: observing, inferring, analyzing, graphing, communicating, collecting data and interpreting data.

This unit employs the following instructional practices:

a) Simulations
b) Modeling
c) Guided inquiry
d) Lecture
e) Animation presentations
f) Wet labs
g) Dry labs
h) Essay writing
i) Instructional games
j) Graphing

Each lesson is structured on the following template:

I Overview:
II Learning Objectives:
III Science Background:
IV Student Prior Knowledge and Skills:
V Time Requirements:
VI Materials and Equipment:
VII Suggested Lesson Sequence:
a) Focus Activity/ Investigative Introduction:
b) Discussion of Activity:
c) Attach Meaning:
d) Independent Practice:
e) Closing:
VIII Assessment:
IX Key Questions:

The biological concepts that students are introduced to within this unit include the following:

a) scientific method
b) cell structure and function
c) cell specialization
d) cell membrane structure and function
e) cellular transduction
f) enzyme structure and function
g) DNA structure and function

h) DNA replication
i) Protein Synthesis / Gene Expression
j) Gene regulation
k) Genetic engineering
l) Biotechnology practices: Southern Blot, Western Blot, Gel Electrophoresis, cell purification, PCR, ELISA, recombinant DNA, pharmocogenics, and transfections.
m) Immunology concepts including: composition of immune system, lines of defense, antigen/antibody interactions, inflammation process, induction pathways in macrophages, communication between white blood cells, maturation and development of blood cells, cytokine and kinase role in the immune system and the development of Lyme Disease

Overall, this unit attempts to develop students in basic biological concepts while simultaneously introducing students to the basics of the immune system. Students are challenged and are engaged in various instructional strategies. Furthermore, they become experts on Lyme disease.

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #1

I Overview:

Sound science process skills are the hallmark of any budding scientist. Skills such as observation, inferring, communication, measuring, forming/interpreting data, analyzing, and evaluating are paramount to a student's success in any science classroom. In this lesson, students of all academic levels will employ, identify and learn to strengthen these skills while being introduced to the basics of Lyme disease/ immunology simultaneously.

II Learning Objectives:

Upon completion of this lesson students will:

a) Describe the induction process of Lyme Disease.
b) Identify the major process skills of science.
c) Identify the major symptoms associated with Lyme Disease.

III Science Background:

"*Borrelia Burgdorferi* (Bb) is the causative agent of Lyme disease, a highly prevalent vector-transmitted infection that is endemic in areas of the United States". (*Anguita, 2005*) Bb is a spirochette (spiral shaped bacteria) that is carried in and transmitted from their vector/host; ticks. It is through the bite of the tick that Bb is bestowed invasion power in other hosts like humans for instance

Lyme disease itself is a multi-symptomatic disease. A trademark, bulls eye skin rash and flu like symptoms are typical in the early stages of the disease. As the disease progresses, there is a constant inflammation of the musculoskeletal, cardiovascular, and neurological tissues. Both stages, however are manifested via cellular induction, the recruitment and transmittance of "chemical message" from a particular antigen (foreign body). It is a disease that isn't curable at present day.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Define disease.
b) Have some basic knowledge of the body systems (identification of system and general function).
c) Have a basic foundation in research.
d) Experience with some of the basic science skills: observing, analyzing and collecting data.

V Time Requirements:

- 1, 90 minute block.
- 2, 45-minute period.
- Can be modified to fit a smaller frame of time such as 1, 45 minute period.

VI Materials and Equipment:

- Computer Access
- Projector
- Color hole punches or small colorful pieces.
- Dart board (create a paper template).
- Typed messages for simulation
- Index cards
- Copies of Worksheet (see student worksheets)

VII Suggested Lesson Sequence:

a) Focus Activity/ Investigative Introduction:

Students will run the induction simulation activity. (See teacher directions)

b) Discussion of Activity:

Upon completion of the simulation, the instructor needs to probe students for an explanation of the entire process. Allow for students to explain things in their own wording. Stress for students to describe the **entire process**. Probe students to provide an explanation to how the removal of 1 or two individuals would affect the entire process. For instance, "What would be the end result of the process be if I removed person # 3?" Continue until students understand how 1 variable (you could introduce this term here) influences an inductive (probe for a constructed meaning of the word here) process like the one simulated.

Additionally, explain to students that they were performing active science in this activity. Place these skills on the board with a general definition and ask students to identify which skills were employed.

c) Attach Meaning:

Provide students with the induction diagram of Lyme disease inflammation (see diagram 1). Then, have students identify their position in the diagram. Finally, have students to provide a verbal or written description for the induction process. Encourage student to utilize the actual terms stressed in the diagram's legend.

Again, ask students which skills did they employ in this segment of the lesson.

d) Independent Practice: Students can complete one of the following at this point:

*Write a paragraph that describes the induction process of Lyme disease symptoms.

*OR Create an alternative diagram to the induction process.

Now, assign students to research Lyme disease on computers or accessible books. Access the American Lyme Disease Foundation Information at http://biology.kenyon.edu/Microbial_Biorealm/bacteria/borrelia/borrelia.htm

Be certain that students address four major questions:

1) What is Lyme disease?
2) What are the symptoms of Lyme disease?
3) What are the causative agents of Lyme disease?
4) How is the disease transmitted to humans?

e) Closing: Probe students for their understanding of Lyme disease, the symptoms and how those symptoms come about!

VIII Assessment:

Homework: Research the following questions

1) What are the three types of immunity?
2) Which type of immunity was simulated in class today?
3) Explain response #2.

IX Key Questions:

1) What is Lyme disease?
2) Describe the symptoms of Lyme disease?
3) How is this disease transmitted to humans?
4) How does induction influence the progression of Lyme disease?
5) What are some scientific skills that are critical to disease specialist career?

Teacher Directions for Simulation
(Lyme Disease)

Purpose:

The purpose of the simulation is to teach students via a constructivist manner the basics of Lyme disease. The induction processes involved with the manifestation of this disease are eluded and students learn to articulate themselves by associating their position in the simulation with actual factor involved with actual process.

Procedure:

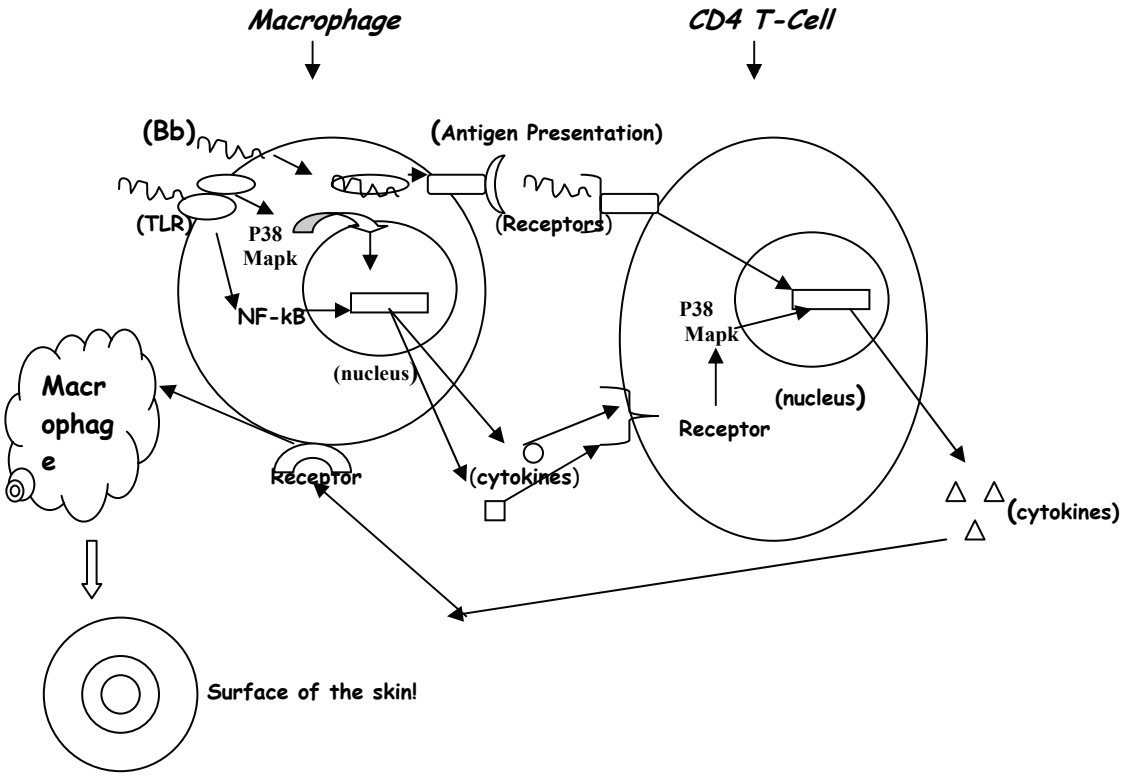
1) Look over diagram #1 and study all the positions within the transduction process.
2) Count the positions and assign a title for each factor (not the actual names).
3) Record the names of the positions and their respective functions. The final function should be a dart shooter. This person will shoot the dart until a bullseye target is achieved. (The bullseye can be constructed from paper with simple dart constructs used to replace the darts). The target specialist can only shoot once for every complete pathway.
4) Type up a message for the transcription factors to relay to the DNA. This can be a simple go or now do this type of message.
5) Another message from the DNA should be transmitted to the cytokines to move to the next cell.
6) The overall point is to assign all students a role in this pathway. Students need to come to an understanding that all roles rely on the input of the previous role. It is a domino affect as it is in the cell.
7) Use various materials enhance the simulation.
8) For smaller classes simply time how fast the target is achieved. For larger classes create two cells (groups) and create a challenge to which group can complete the task first.

Assess:

Instruct students to look over the diagram and indicate their role in the induction pathway of Lyme disease. Aid students with pronunciation. Eventually, students should be able to explain the inductive process via student roles, actual name/roles or mixed roles (student and actual).

Diagram #1

Transduction Pathway for the Inflammatory Response to *Borrelia burgdorferi!*



Key for Diagram

Bb = Borrelia burgdorferi (bacteria)
P38 Mapk = p38 map kinase There are 3 kinases that play "tag" before this one is activated.
NF-kB = Necrosis Factor / Transcription factor inhibitor.
TLR = toll like receptors (two parts)
→ = activity / direction of pathway
macrophage = white blood cell
CD4 T-cell = special white blood cell with unique CD4 receptor.
▭ = DNA
Macrophage takes action = the macrophage attacks tissues where the infection agent Bb is located. This causes a rash resembling a bulls eye on the skin in addition to other symptoms associated with Lyme disease.
Cytokines produced from macrophage= Il-12 and TNF-alpha
Cytokines produced from T-cell= IFN-gamma

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #2

I Overview:

Cells are the basic unit of life. It is the independent and co-independent functions of these discrete structures which permit life as we know it. Although, they can be viewed as the smallest structure of life, smaller discrete parts called organelles within each cell pull their functions together collectively. This lesson focuses on the structure and function of prokaryotic and eukaryotic cells and how cells such as white blood cells are highly specialized to perform various functions.

White blood cells are the second line of defense in the immune system. They are inclusive of macrophages (non-specific attackers), neutrophils (toxin secreters) and natural killers (those who induce apoptosis).

II Learning Objectives:

Upon completion of this lesson students will:

a) Describe the structure and function of cells.
b) Compare/contrast the structure and function of prokaryotic and Eukaryotic cells.
c) Evaluate the pros and cons of cell specialization in the immune system.

III Science Background:

White blood cells are the highly specialized cells in eukaryotes which are capable of fighting pathogens (foreign substances with a negative effect). Once the first line of defense has been penetrated, the white blood cells detect and seek to destroy these foreign invaders. There are various types of white blood cells. They are as follows:

a) Leukocytes: macrophages, neutrophils and natural killer cells.
b) T-cells (T because they mature in the thymus): helper T-cells, memory T-cells, cytotoxic T-cells and suppressor T-cells.
c) B-cells (travel in lymph & blood).

The development of the symptoms associated with Lyme disease are created via the functions of macrophages and CD4 (a particular antigen present) T-cells. The communication between the two sets off an attack mechanism towards all Bb present in the body. This means that wherever the pathogen is present, the macrophage will seek out to attack. However, if it weren't for their specialization, this sequence of events might not occur.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Cells (at least that they exist in all organisms)
b) Various immune responses (1^{st}, 2^{nd}, and 3^{rd} line of defenses)

V Time Requirements:

- 1 90 minute block.
- 2 45-minute period.

Can be modified to fit a smaller frame of time such as 1- 45 minute period.

VI Materials and Equipment:

- Computer (s)
- LCD projector
- Diagram of cell transduction
- Red Cross WBC flyer (see Red Cross Flyer)
- Diagram displaying various white blood cells and their functions (text book)

VII Suggested Lesson Sequence:

d) Focus Activity/ Investigative Introduction:

Examine elodea and human cheek cells. See student worksheet #1 for protocol.

Discussion of Activity: Review inquiry questions with students from handout!

c) Attach Meaning: Discuss inference questions. Introduce the parts and functions of the following organelles:

- cell membrane
- cell wall
- cytoplasm
- nucleus
- chloroplasts
- ribosome
- lysosome
- vacuole

These organelles can be introduced via the following website(s):

- http://www.wiley.com/legacy/college/boyer/0470003790/animations/cell_structure/cell_structure.htm (this site introduces students to cell types, organelle structure and function and invites students to construct a cell to assess their knowledge)

Introduce and briefly discuss the concept of cell specialization by emphasizing the following:

1) Contrasts in cell structure / size as it relates to function.

2) Comparison / contrasts in various cell organelles to support their function

d) Independent Practice:

Give student handout #2 of various white blood cells and corresponding questions. (see hand out Red Cross)

e) Closing:

Conduct a brief discussion on student questions.

VIII Assessment:

H-W: Revisit Diagram and complete the following:

* Identify which cells are prokaryotic and/or eukaryotic.

* Identify the quantity of specialized cells in the diagram.

IX Key Questions:

a) What are cells?
b) How does having smaller components allow for the cell to function as a whole?
c) What is specialization and how does it allow for the immune system to prosper in complex eukaryotes?

Student Worksheet # 1

Elodea / Cheek Cell Warm-up

Objectives:
To view your own human cheek cells under the microscope.
To compare plant and animal cells.

Procedure: Part 1 - Cheek Cell
1. Place a small drop of Iodine onto a clean slide.
2. Using a toothpick, gently scrape the inside of you cheek.
3. Place the toothpick tip into the iodine and mix. The iodine stains the cells so that you can see them.
4. Place the slide under low power (4x). Draw what you see.
5. Switch to high power (10x). Draw 2 or 3 cells. Label the nucleus, cell membrane, and cytoplasm.

Data: Part 2- Cheek Cell Create the following:
Drawing of the cheek cell in low power (4x)
Drawing of the cheek cells in high power (10x)
Label the nucleus, cell membrane, and cytoplasm.

Analysis:
1. Why did we add iodine to our cheek cells?
2. What structure in the cheek cell was stained the darkest?
3. Is your cheek cell an animal cell?

Procedure: Part 2 - The Elodea leaf
1. Place a drop of water on a clean slide.
2. Place an Elodea leaf in the drop of water, place a coverslip on top.
3. Observe under low power first (4x), then under high power (10x) Draw observations.
4. Label the following organelles: nucleus, cytoplasm, cell wall, and chloroplasts.

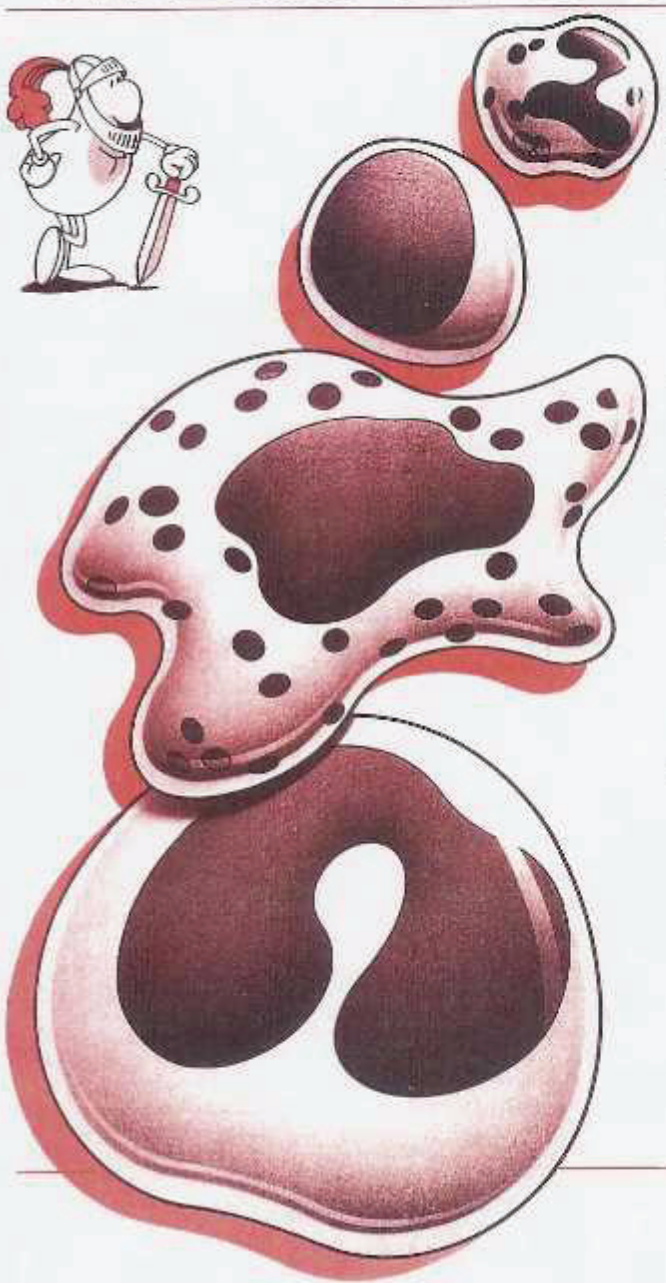
Data: Part 3 – The Elodea Cell. Create the following:
Drawing of the Elodea cell in high power (10x) (half page)

Analysis:
1. Was anything happening in your cell?
2. What structures were in the plant and animal cell?
3. What structures were only in the Elodea cell?

Conclusion: 2-3 sentences on what you learned.
YOU MUST CLEAN UP! ALL SLIDES ARE CLEANED AND PUT AWAY.

Infernece Questions:
1) What is a cell?
2) What are organelles? What purpose do they serve the cell?
3) Compare the quantity of visible organelles in plants and animals?
4) Are all cells made the same? Explain.

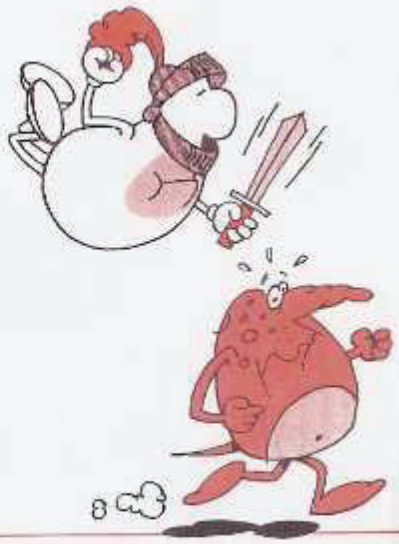
White Blood Cells



White blood cells are important to your body in several ways:

- They fight off infections and help you recover from viral diseases, such as chicken pox.
- They keep you from catching the same viral disease over and over again. This is called "being immune."
- They "eat" harmful bacteria, the kind you would have in a cut and scraped knee, or in an infected ear.

An average adult's body normally contains over 35 billion white cells—one for every 600 to 700 red cells.

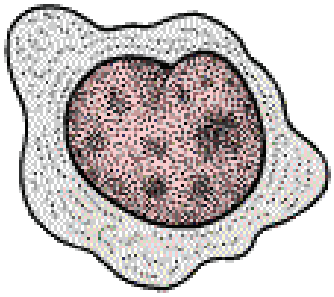


American Red Cross

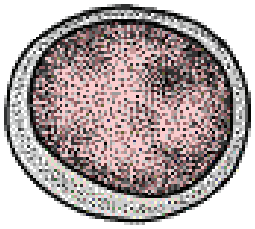
WBC's Student Handout #2

Purpose: In this lesson you will learn how to infer the various functions of white blood cells based on their organelle composition. Some cells are equipped with more of one particular organelle in the effort to perform a very specific function. Your specific aim is to make careful observations of the cells you see below along with the Red Cross Flyer and indicate which cells are more adept to particular jobs. All are a part of the immune system. Therefore, you should discover some similarities as well.

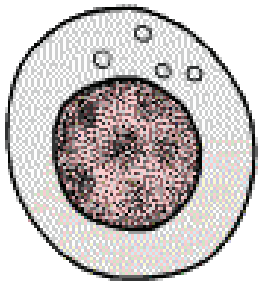
Macrophage



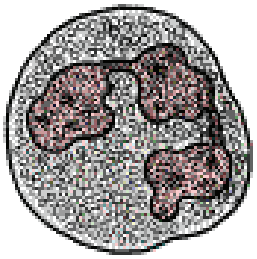
Lymphocyte



Natural Killer Cell



Neutrophil



Read the information in the Red Cross flyer.
View the WBC names and their corresponding detailed composition above.
Bring this information together and complete the corresponding questions below to enhance your understanding of immune cells.

1) **How are they similar/ different in structure?**
2) **Based on organelle structures, describe how their jobs may differ from one another.**
3) **Is this an example of cell specialization within the immune system? Explain your response**

Respond here:

_____
_____
_____
_____
_____
_____
_____

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #3

I Overview:

In this lesson, students will continue to strengthen their understanding of specialization within the immune system. Students will access various websites to research immunology specialization and even investigate careers in hematology. Finally, students will engage and assess themselves in online games that simulate the immune system.

II Learning Objectives:

Upon completion of this lesson students will:

a) Describe the maturation process of blood cells.
b) Have an appreciation for hematologists.
c) Assess their knowledge of various cell types involved with the immune system.

III Science Background:

Hematology is the study of blood. It is essential for these specialists to understand the specialization/maturation process of blood as it is critical to understanding the function of these particular cells. Totipotent cells are usually at the root of a specialized cell lineage. Blood cells mature in various places of the body and are usually noted for that within its name. For instance, T-cells are denoted as such because they mature in the thymus of a complex organism. Beyond this process each cell is assigned a special function and carries out this function throughout its life span.
Students are exposed to this information and more of the Puget Sound Blood Center Website: http://www.psbc.org/hematology/01_index.htm

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) The structure and function of cells.
b) Describe the nature of cell specialization.
c) Know the significance of a WBC as compared to other cells in the body.

V Time Requirements:

* 1, 90 min block.
* 2, 45 min blocks.
* Can be modified to fit a smaller frame of time such as 1, 45 minute period.

VI Materials and Equipment:

- **Computer access**

VII Suggested Lesson Sequence:

e) **Focus Activity/ Investigative Introduction:**
Introduce the nature and purpose of activity. Review some ideas from previous lesson: cell structure, function, and specialization.

f) **Discussion of Activity:**
Help students to get started on activity.

g) **Attach Meaning:**
Discuss the activity as needed with individual students.

h) **Independent Practice:**
Student activity sheet (Handout #3). / Immunology Games!

i) **Closing:**
Probe students for their understanding of content in activity and how it relates to their understanding of the development & curing of Lyme disease.

VIII Assessment:

Allow students to assess themselves. Students may simply record a number 1-10 that specifies their understanding of the content. Finally, encourage students to record any discrepancies and turn those into the teacher.

IX Key Questions:

1) What is hematology?
2) How does understanding the maturation / specialization process of WBC's enhance the understanding of Lyme disease?

Student Handout Worksheet #3
Puget Sound Blood Center Research
Immunology Game

Purpose:

The purpose of this activity is to introduce you the purpose and composition of blood. You will explore careers that revolve around this topic and assess your understanding of various white blood cells via an immunology game.

Part I: Active research.

1) Access the following website: http://www.psbc.org/hematology/01_index.htm
2) Click on Course Introduction. Read and summarize the overview of the website.
3) Click on the Basics
   a) ***The Cell***- provide a summary of this information.
   b) ***Cell Specialization***- What is a megakaryocyte?
   c) ***Cell Maturation***- What is a stem cell and how does this one cell give rise to the various types of cells in blood?
   d) ***Cell Maturation***- Describe the process of cell maturation.
4) Click on What is Blood?
   a) ***What is Blood?*** – Address this opening question.
   b) ***Red Blood Cells*** – How are red blood cells specialized to perform the job of carrying oxygen?
   c) ***Plasma***- How does the constituents of plasma contrast to blood?
   d) ***Blood is made…*** - Where & how does blood develop?
5) Click on Careers?
   a) ***Careers***- List five careers that involve a strong understanding of blood composition and function. Research at least two and elaborate on their positions.

Part II: Assessment

1) Access the following website: http://www/pbs.org/wgbh/nova/aids/immunewave.html
2) Engage the game entitled: "Keeping this body healthy"
3) Record your success on a scale of 1-10 (1 being the lowest) _____
4) Try the game again.
5) Record your second score: _____

The Bulls Eye in the Immune System: Lyme Disease

Immunology Educational Unit

By

Tamica Stubbs

Lesson #4

I Overview:

The composition of the cell membrane is the crux of cell identity, memory and reception. It is the critical component of the cell that makes the immune system what it is. In this lesson, students will peer into an understanding of this organelle and how it regulates the aforementioned functions. By understanding the basic constituents of the membrane students will be able to relate its functions to process of cell induction and inevitably, Lyme disease inflammatory symptoms.

II Learning Objectives:

Upon completion of this lesson students will:

a) Describe the structure and function of the cell membrane.
b) Explain how cellular membrane functions regulate the activity of macrophages.
c) Describe the antigen / antibody structure present/produced on the surface of cell membranes.

III Science Background:

Antigens are protein structures that are presented on the surface of the cell membrane that provokes a specific immune response. These receptors can detect self from non-self cells in the body. It is this one factor that will solicit the production of antibodies in the presence of pathogens like Bb or other in vivo biological contaminants. This triggers what we know as humoral immunity.

All antibodies have similar constituents called constant regions, while containing variable regions which discern it from others. These antibodies can make a difference in returning invaders rendering devastating effects on the body or being defeated upon re-entry. Nevertheless, these small structures are critical in the sustaining of one's health.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Know the basic function of the cell membrane.
b) Follow a structured template for note taking.
c) Infer.
d) Comprehend the idea of transport within a living system.

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minute periods.
- Can be modified to fit a smaller frame of time such as 1, 45 minute period.

VI Materials and Equipment:

- Computer(s)
- Cell membrane note template.
- Potatoes
- Saline solution (40%)
- Beakers
- Rulers
- Electronic balances.
- Slides and slide covers.
- Microscopes
- Elodea
- Hand out for warm-up (See Transport Warm-up)
- Paper towels.
- Potassium permarganate.

VII Suggested Lesson Sequence:

a) **Focus Activity/ Investigative Introduction:**

Complete inquiry activity (see student hand out #4). Then, instruct students to identify as many people in the class as they can by name. Ask students how they were able to identify each individual in the class.

b) **Discussion of Activity:**

Continue to probe students until they understand that the outward appearance of an individual is what triggers identification memory. Remind them that sometimes scents and sounds can also trigger identification. Utilize this analogy and transport inquiry activity to introduce the purposes of the cell membrane in the cell: reception, transport and identification (antigens).

c) **Attach Meaning:**

Provide students with the Cell Membrane computer activity (handout #5). Through engaging animations and research, student will attach new vocabulary to their knowledge of the cell membrane.

d) **Independent Practice:**

Students will complete the cell membrane computer activity (handout #5) independently.

e) **Closing:**

Close this particular lesson by asking students to identify some transport processes that occur in the cells. Encourage them to think about how these processes assists/influences the immune system in completing is job as well as other bodily functions.

VIII Assessment:

Homework:

Look back over the induction diagram. Identify the transport processes that are essential to allowing this overall process to occur. Elaborate your responses.

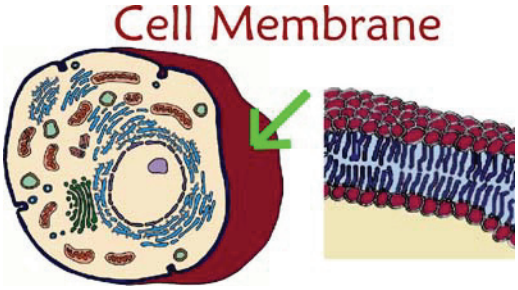
IX Key Questions:

1) How does the cell maintain homeostasis in living systems?
2) How does the process of cell transport influence the productivity of the immune system?
3) Identify a cellular membrane process that contributes to humoral immunity.
4) How does the process of phagocytosis contribute to antigen presentation in the development of Lyme disease?

Name: _____

Cell Membrane / Cell Structure Review

Student Handout #5



Purpose: The purpose of this activity is to introduce you to transport processes that take place in the cell daily. These transport processes maintain homeostatic balances within any living system. It is in fact critical to sustain life. You will discover that the environment of the dictates a lot about how it functions and how long it will survive.

Go to the listed websites and follow all of the corresponding directions / questions!

I Go to http://science.nhmccd.edu/biol/bio1int.htm

a) Click on cell transport. You should see a listing!
b) Click on and view: Phospholipid bilayer. Complete the activity and the following:
   a. Create a diagram of one phopholipid. Label the phosphate group and label the fatty acids. -->
   b. What are the two types of structures can phospholipids form when placed in water? _____ & _____
   c. Which of the two are present in our bodies? _____
   d. What organelle does it construct? _____

II Go Back to listing! View: Dynamic Membrane and address the following:

a. The Cell Membrane is often referred to as the fluid mosaic model. Based on this animation, which part of that title is being described?

_____

_____

III Go back to the listing! Click on and go through: Construction of a membrane (Wisconsin). Address the following:

a. What are the two types of proteins found in cell membranes?
_____ and _____

b. List three examples of these proteins. Next to their listing, indicate whether they are integral or peripheral (just by the appearance / features of them)
   1) _____ _____
   2) _____ _____
   3) _____ _____

c. What types of materials and/or substances requires assistance to pass through the cell membrane? _____ .

d. How do these types of materials conflict with the lipids that make up the membrane?

_____

e. What is the phospholipid bilayer?

_____

f. Which part of the phospholipid bilayer is hydrophilic? _____ What does it mean to be hydrophilic? _____

g. Which part of the phospholipids bilayer is hydrophobic? _____ What does it mean to be hydrophobic? _____

h. What are the four main purposes of the proteins in the cell membrane?

1) _____
2) _____
3) _____
4) _____

i. What is purpose of cholesterol in the cell membrane?

_____

Complete the review questions and record how many you had correct out of 10. _____ / 10

IV Go to http://www.zerobio.com/drag_gr11/memb.htm

a. Construct the cell membrane without cheating. Then check your structure against the correct one labeled: "this one".

V Go back to the main listing. Click on and view Passive and Active Transport (Northland Community College)

a) Click on Passive Transport.

1) What is passive transport? _____
2) What are the different types? _____
3) What is meant by the concentration gradient? _____
4) What 4 factors determine the rate of diffusion?

_____
_____
_____
_____

5) (Go through all of the slides on Facilitated Diffusion) How is facilitated diffusion different than regular diffusion?

_____

(Hint what does it use that simple diffusion does not?)

6) What is osmosis? _____
7) How are diffusion and osmosis
   Similar? _____
   Differrent? _____
8) What is a hypertonic solution? more _____ and less _____.
   What is a hypotonic solution? more _____ and less _____.
9) Active Transport requires _____. Energy in the cell is called _____.
10) Why does active transport require ATP? _____
11) View ion pumps and co-transport!
12) View endocytosis. What is it? _____

13) What are the three types? _____, _____ & _____.

14) In the process of endocytosis, what is wrapped around the incoming particle? _____

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #5

I Overview:

Students require reinforcement for all ideas that they have been introduced to. In the effort to maximize their learning, this lesson attempts to give students a hands-on approach to understand the structure and function of the cell membrane. Students will be actively involved in constructing a model of the membrane and will prepare a concise written description of their model as it relates to white blood cells in the immune system.

II Learning Objectives:

Upon completion of this lesson students will:

a) Construct a functional model of the cell membrane.
b) Identify the major components of the membrane and relate its functions to immune responses.

III Science Background:

Antigens are protein structures that are presented on the surface of the cell membrane that provokes a specific immune response. These receptors can detect self from non-self cells in the body. It is this one factor that will solicit the production of antibodies in the presence of pathogens like Bb or other in vivo biological contaminants. This triggers what we know as humoral immunity.

All antibodies have similar constituents called constant regions, while containing variable regions which discern it from others. These antibodies can make a difference in returning invaders rendering devastating effects on the body or being defeated upon re-entry. Nevertheless, these small structures are critical in the sustaining of one's health.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Identify the components of the cell membrane.
b) Describe the function of the cell membrane.
c) Identify the location and purpose of antigens on the cell membrane's outer surface.

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minute periods.
- Can be modified to fit a smaller frame of time such as 1, 45-minute period.

VI Materials and Equipment:

(See student hand out #6) / Copy of Directed Reading Activity.

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

Review the basics of the cell membrane's structure and function orally. Review the directions of model activity.

c) Discussion of Activity:

Discuss discrepancies with students as questions arise.

d) Attach Meaning:

Discuss discrepancies with students as questions arise.

e) Independent Practice:

Students will construct models of a cell membrane and describe its relevance to immune responses, particularly as it relates to the development of Lyme Disease.

f) Closing:

Allow students to perform a brief gallery walk around the classroom to perform peer reviews. Students can utilize a standard numerical rubric to grade each students work. Students should play a vital role in establishing this rubric.

VIII Assessment:

Students will create a rubric for grading their models and descriptions with the assistance of the instructor. Students will then perform a gallery walk and contribute to each student's grade. Finally, students will tabulate their averages and submit it to the teacher for final assessment and grading.

IX Key Questions:

Students should address the following key questions in their descriptive cards to accompany their models.

1) What is the cell membrane?
2) What are the major constituents of the cell membrane?
3) Why are embedded / surface proteins critical to the cell's functionality?
4) How do antigen structures compare/contrast to normal transport proteins?
5) How does antigen function compare/contrast to normal transport proteins?
6) Provide an explanation to how WBC macrophages involved in Lyme disease are at the mercy of the cell membrane functioning properly.

Student Handout #6

Cell Membrane Directed Reading / Model Activity

Purpose: The purpose of this activity is to reinforce your understanding of the cell membrane. You will construct a model of the cell membrane and pronounce within that model the structure and functions of most constituents of the membrane. You will then tie in this structure to the functionality of white blood cells in the immune system.

Pre-lab Questions

1) What is the function of the plasma membrane?
   _____
2) How does it maintain homeostasis?_____
3) Which types of cells have a membrane around each of its organelles? (Eukaryote, Prokaryote)

Using the materials: Beans / Peas, toothpicks, paper plates, glue and yarn. Create the following:

- a complete plasma membrane around the cell (paper plate)
- Incorporation of integral and peripheral proteins.
- Incorporation of a glycoprotein (antigen)
- Create an antibody attaching to the antigen.
- Identify: phospholipid, carbohydrates, bilayer, polar region and non-polar region
- Demonstrate through your membrane the following: active transport, diffusion, facilitated diffusion, endocytosis (show just part of the process) and exocytosis.
- Identify each process as being active or passive transport.

On an index card articulate the following:

a) What does your model mimic?
b) What is the purpose of the cell membrane?
c) Describe the nature of the surface and integral structures.
d) Explain how the overall structure is critical to the functionality of the immune system.

The Bulls Eye in the Immune System: Lyme Disease

Immunology Educational Unit

By

Tamica Stubbs

Lesson #6

I Overview:

Enzymes are proteins that contribute to the activity of body processes. Enzymes are biological catalysts that are also critical in intracellular transduction. In this lesson, students will apply their newly generated knowledge of enzymes and relate it to kinase activity and cytokine functions in the immune system.

II Learning Objectives:

Upon the completion of this lesson students will:

a) Describe the structure and function of enzymes.
b) Identify the significance of kinases and cytokines in cellular processes.

III Science Background:

Enzymes are biological catalysts that expedite bodily functions. They are composed of protein and have the ability to lower the activation energy in most biochemical reactions. Enzymes are affected by the presence of inhibitors, variations in temperatures, and the pH of their environment. Nevertheless, enzymes are critical in sustaining living systems.

Kinases are enzymes that establish and process biochemical pathways in the cell. They are initially activated by a stimulation of some sort. This is inclusive of but not limited to antigens of pathogens or inorganic substances. Once activated, a phosphorylation cascade is set into action until transcription factors are released and a desired outcome (like antibody production) is achieved. P38 is an example of a kinase.

Cytokines are proteins produced and released from the immune cells. They are capable of triggering responses and are key to cell-mediated responses in the immune system. IL-12 is an example of a cyotkine.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Describe the structure and function of various immune cells.
b) Have a basic understanding of the cellular transduction process

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minutes periods.
- Can be modified to fit a smaller frame of time such as 1, 45 minutes period.

VI Materials and Equipment:

- computer

- LCD projector
- Liver chunks (room temp and frozen). Each piece should be 5 mm by 5 mm.
- Test tubes
- Hot plate (s)
- Beakers
- Hydrogen peroxide
- Distilled water
- Pipettes
- Student directions (hand outs)
- Test tube racks
- Paper towels

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

Students will complete an inquiry activity. Students will inadvertently learn the properties of enzymes by manipulating liver with the substrate: H2O2. (see hand out #7)

b)Discussion of Activity:

The instructor will probe students to explain their observations. Allow students to attach their own words to describe the phenomenon. The instructor will then apply some real terms to their constructed explanations and utilize this as a transitory point into the presentation.

c) Attach Meaning:

The instructor will introduce enzymes to students by presenting the following:
http://www.dannynicholson.co.uk/enzymetale.swf
http://programs.northlandcollege.edu/biology/Biology1111/animations/enzyme.swf
The presentations solicit student cooperation. They have review questions incorporated into the presentations.

d) Independent Practice:

Revisit the Lyme disease diagram and point out where the action of enzymes are prevalent. At this point, students should be re-introduced to the terms kinase and cytokine.

e) Closing: Discuss the importance of enzymes in the role of cellular transduction.

VIII Assessment:

Assign students the following question to assess their understanding of enzymes.
Homework: How are enzymes considered critical to the development of Lyme disease?

IX Key Questions:

1) What is the main function of enzymes?
2) How are intracelluar phosphorylation cascades related to enzyme activity?
3) What is the relationship between Lyme disease and enzyme activity?

Student Handout #7

Biology Inquiry Warm-up Activity

Purpose: The purpose of this short lab is to introduce you critical elements the enable the cell to perform functions in a more efficient way. Your job is to construct your own idea of what these elements are and to describe what environmental factors affect their functions.

Pre-lab question: How would you know if a chemical reaction is occurring?

_____

Part I

a) **Obtain two pieces of room temperature liver.**
b) **Place one piece into one test tube each.**
c) **Be sure that each piece is at the bottom.**
d) **Add 6 drops of hydrogen peroxide (H_2O_2) to one tube and 6 drops of water (H_2O) to the other.**
e) **Record observations: _____**
_____
f) On a scale of 1-5 (5 being greatest) rate the scale of activity that you observed with the *Peroxide _____ and * Water _____
g) Conclusion: If you add _____ to _____ then _____.

Part II

Repeat part I with frozen liver. Obtain the frozen liver from the freezer.

Observations:

_____

_____

Scale Scores:

Peroxide: _____ **Water: _____**

Conclusion:

_____

_____

Part III

Repeat part 1 *Observations:*

_____

_____

Scale Scores:

Peroxide: _____ **Water: _____**

Conclusion:

_____

_____

The Bulls Eye in the Immune System: Lyme Disease

Immunology Educational Unit

By

Tamica Stubbs

Lesson #7

I Overview:

ELISA is a technique commonly used in labs to detect specific proteins (quantity and quality). It is critical in the detection of various viral particles and activated enzymes in the cells. In this lesson, students will simulate this process and analyze the results as it pertains to HIV and Lyme Disease.

II Learning Objectives:

Upon completion of this lesson students will:

a) Assess the significance of the ELISA technique.

III Science Background:

ELISA (Enzyme Linked ImmunoSorbent Assay) is a technique used in research laboratories to detect the presence or absence of a particular protein. This includes cytokines, kinases, antigens and antibodies.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Basic pippetting techniques
b) Understanding of antibodies and antigens
c) Functional knowledge of enzymes
d) Comprehend the cellular transduction pathways involved in Lyme Disease inflammation.

V Time Requirements: (this activity should be executed within the same day)

- 1, 90 minute block.
- 2, 45 minute periods.

VI Materials and Equipment:

Access the following websites:

http://biotech.biology.arizona.edu/labs/ELISA_assay_teacher.html (for instructor guide)

http://biotech.biology.arizona.edu/labs/ELISA_assay_students.html (for student guide)

Pull up and print the teacher's instructions and student handouts.

The materials for this simulation are listed on the original document.

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

Opening questions: How can we detect the presence of HIV in our systems?

Do you believe that enzymes play a role in its detection?

Create a mini discussion on the opening questions and try to solicit creative thinking on the student's end before informing them of the process.

c) **Independent Practice:**

Students will run the ELISA simulation. The activity will be modified to accommodate the unit on Lyme Disease.

d) **Closing:**

Allow students to recant the steps involved with the process and articulate clinical applications of the technique. Finally, direct students to understand how the ELISA technique assists the immunology research community.

VIII Assessment:

Homework: Food for thought!

How does the ELISA technique assist scientists in studying the transduction Pathway(s) associated with Lyme disease?

IX Key Questions:

1) What is ELISA?
2) How does your knowledge of enzymes apply to the technique?
3) What are some clinical applications of ELISA?
4) How does the ELISA technique assist the immunology research community?

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson # 8

I Overview:

DNA is the genetic code which underlies all life forms. Its unique composition and structure allows for it encode for traits fundamental to these life forms. In this lesson, students will explore the intricate structure and function of this polymer. Students will come to an understanding that without DNA the manifestation of immune responses would not be possible.

II Learning Objectives:

Upon completion of this lesson students will:

a) Describe the structure and function of DNA.
b) Sequence steps necessary to extract DNA.
c) Explain why some blood cells require DNA at maturation while others don't.

III Science Background:

DNA is the acronym for Deoxyribonucleic acid. It is the molecular basis of heredity that yields common and variant traits within living systems. It is composed of repeating units of nucleotides which construct a ladder-like structure. This overall structure is twisted in helical fashion, thus being referred to as the double helix. The sugar and phosphate components of the nucleotide occupies the backbone of the structure while the nitrogenous bases adenine (A), cytosine (C), guanine (G) and thymine (T) constitute the rungs or steps of the ladder. It is the unique sequence of the nitrogenous bases that dictate traits such as cytokine production in WBC's. Any mishaps called mutations in this sequence can offset the original desired trait.

Upon successful completion of a phosphorylated pathway, transcription factors initiate the reading sequences in DNA (genes) in the effort perpetuate traits like the production of cytokines such as IL-12 and IFN gamma.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Define cytokine.
b) Understand the purpose/function of the nucleus in the cell.
c) Explain the significance of a transduction pathway within a cell.

V Time Requirements:

- 1 90 minute block.
- 2 45 minute periods.
- Can be modified to fit a smaller frame of time such as 1, 45- minute period.

VI Materials and Equipment:

- .9 % salt water
- small cups
- 30-50 ml test tube or other small container
- 25% soap solution.
- Ice cold alcohol (95% ethanol)
- Teaspoons
- Nucleotide cut outs
- Tape
- Student handouts.

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

As an introduction, step students through the process of spooling their own DNA. This is an inquiry activity. So, step for step, allow students to explain what components of the cell are being affected by certain materials such as the soap water. Administer directions orally as it will promote discussion for each individual step. Access the following website for teacher and student directions: http://www.life.uiuc.edu/hughes/footlocker/Activities/Cheek.DNA.pdf

This site also includes great graphics on DNA and associated structures. It further supplies a graphic on reactions of the cell to chemicals in the process of DNA spooling.

b) Discussion of Activity:

Upon completion of the extraction activity, show students what they have spooled (molecular model of DNA) via a model, or via an image on a projector. Tap into students' knowledge of DNA at this point. This will set the stage for note taking.

c) Attach Meaning:

Inform students that they are about to develop their own understanding of DNA in a group setting. Emphasize that upon the conclusion of the activity that they will engage in will make them somewhat of experts on DNA. Therefore, they should be prepared to address questions upon conclusion of the activity. At this point, students will complete the DNA inquiry lesson (adopted from the Woodrow Wilson institute site). See student hanout #8. Discuss / probe their findings.

Additional introductory information to this material may also be presented via the following website: http://gslc.genetics.utah.edu/units/basics/index.cfm

Click on tour the basics. This provides great visuals and explanations to what DNA is and how it functions.

d) Independent Practice:

For independent practice, allow students to construct responses to the following questions:

1) What is the job of DNA?
2) How does what you spooled from your cheek cells aid in the development of Lyme disease.

3) How does this "stuff" influence characteristics of your immune system?

e) Closing:

Discuss the independent practice questions.

VIII Assessment:

Homework: Review the specialized white blood cells components and structures and complete the following questions:

1) List those cell types with DNA. (remember where DNA is found in the cell)
2) List by composition, some similar messages that all WBC's follow from their DNA?
3) List by composition, some different messages that each of the WBC's follow from their DNA.
4) If all cells have the same DNA in the human body, then how does DNA specify for cell specialization?

IX Key Questions:

1) What is DNA and what is its relationship to the functionality of white blood cells in the immune system?
2) What sequence in the transduction process of Lyme Disease would be affected if the DNA in the macrophage was mutated?

Teacher Directions for Handout #8
Discovering DNA Structure

Introduction

Instead of giving students copious notes and diagrams on the structure of DNA, why not let them discover the structure?

Teacher Information

Background Information: In this paper lab students will work in cooperative groups of four and manipulate paper nucleotides to discover the structure of DNA. When you have finished with this lab, you will have a great model of DNA that you can hang on the ceiling; it will reach to the floor and then some probably. This paper model can serve as a continual illustration as you discuss mitosis, amino acid sequences and protein synthesis. Students enjoy this lab and you save many frustrating moments trying to teach your students DNA structure.

Materials: copies of the student pages of "Discovering DNA Structure" (1/student); paper nucleotides (1/student) (enlarge the nucleotides so that each nucleotide fits on one sheet of paper); tape.

Teacher Preparations: Enlarge the nucleotides so that ONE nucleotide will fit on ONE sheet of paper. Each student will get one giant nucleotide to color and cut out. Color coding should be left on the sheet. Make sure that you prepare enough nucleotides so that 1/4th of each class represents each of the four DNA nucleotides. When assigning the cooperative learning groups of four, give one student an adenine nucleotide, one student a cytosine nucleotide, etc. When the groups come together the next day, each nucleotide will be represented.

Extension: Have your students learn the DNA SONG. When they learn and sing this little song, they know the structure of DNA. This would make a good follow-up to this lab. This song is to the tune of "Row, Row, Row Your Boat." Your students will have a lot of fun with this one. You might have them sing it in rounds, or have a contest between classes.

We love DNA
Made of nucleotides.
Sugar, phosphate and a base
Bonded down one side.

Adenine and thymine
Make a lovely pair.
Cytosine without guanine
Would feel very bare.

Oh-h-h, de-oxy-ri-i-bo
Nu-u-cleic acid
RNA is ri-i-bo
Nu-u-cleic acid

Student Handout #8

STUDENT PAGE
Discovering DNA Structure

D = deoxyribo
N = nucleic
A = acid

DNA contains the information for carrying out the activities of the cell. How this information is coded or passed from cell to cell was at one time unknown. To break the code, today you will do a paper lab to determine the structure of DNA and show how the genetic code is carried. Each member of your group has a molecule called a NUCLEOTIDE. DNA is made up of repeating units of nucleotides.

- Look at your nucleotide and the nucleotides of the other members of your group. What are the THREE common parts of a nucleotide?

  What is the ONE part of a nucleotide that differs among the four DIFFERENT nucleotides in your group?

  List the four different kinds of nitrogen bases.

- Manipulate the nucleotide pieces until you find the best fit. Join the nucleotide molecules in your group together like a puzzle. Use tape to connect and reinforce the molecules. You now have a molecule of DNA.

  In the space below, explain WHERE the nucleotide molecules connect to each other.

  A real DNA molecule consists of THOUSANDS of these pairs of nucleotides. What is the pairing arrangement of nitrogen bases?

  _____ pairs with _____and _____ pairs with _____

  Are there always going to be an EQUAL number of adenine and thymine nucleotides in a molecule?

  Why?

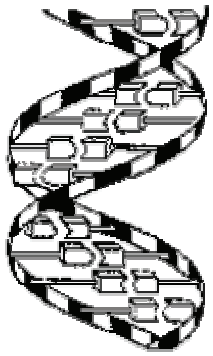
  Are there always going to be an EQUAL number of guanine and cytosine molecules in a molecule of DNA? Why?

  Scientists abbreviate the nitrogen bases by using the first letter of each base. So,
  A always binds to ____
  G always binds to ____

  In the space below, use the letters to show the sequence (order) of the bases in the DNA molecule that your group constructed. Begin at the top left side of your molecule.

____goes with ____
____goes with ____

The structure of DNA is actually in a DOUBLE HELIX arrangement.



DOUBLE HELIX means that the two long chains of nucleotides are arranged in a spiral like a twisted ladder.

The sides (or "uprights") of the ladder are made up of alternating _____ and _____ molecules. The steps (or "rungs") of the ladder are made of _____ held together by HYDROGEN BONDS.

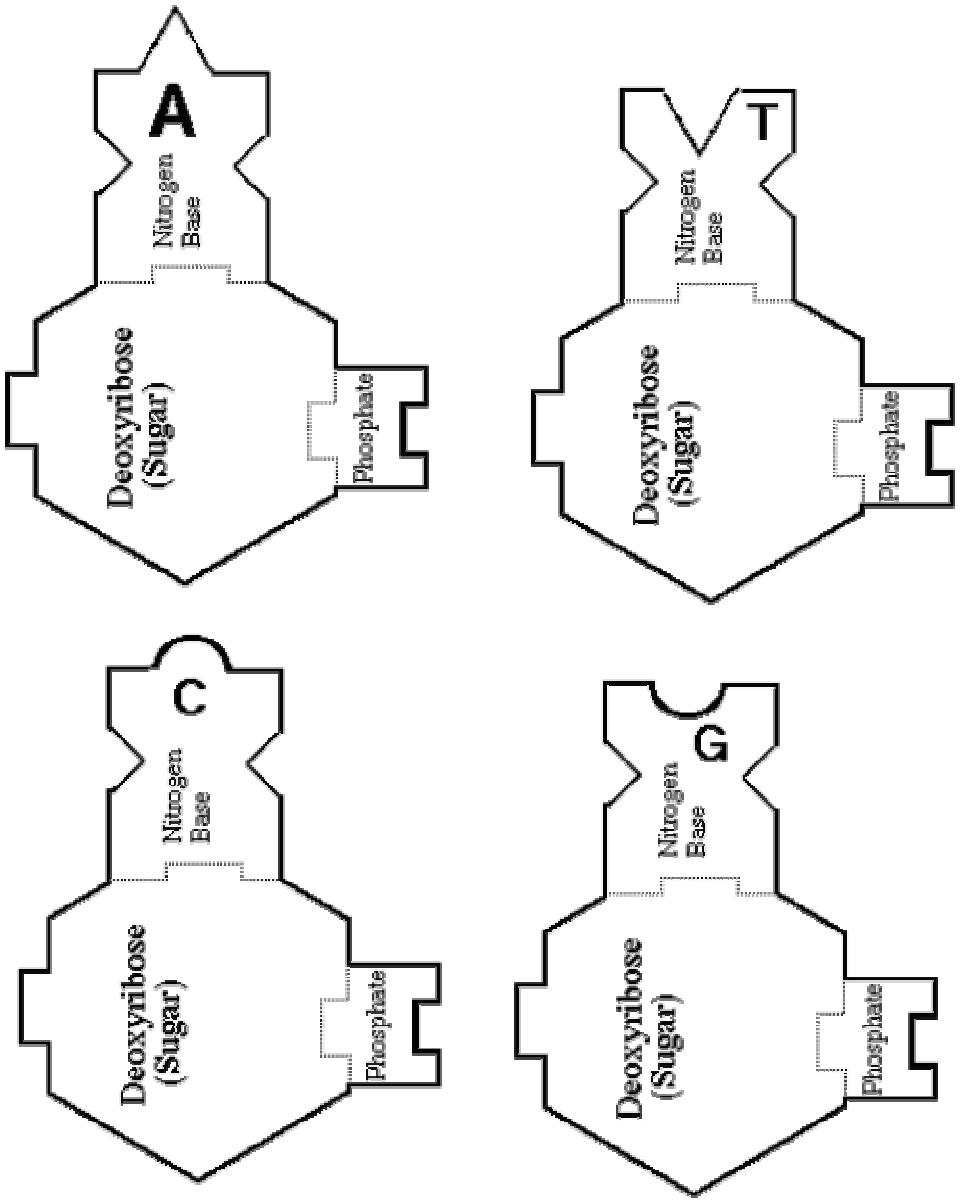
- Bring your molecule to the front of the room and join it to the molecules of the other groups. We now have one large DNA molecule.

Student Page (Enlarge to one nucleotide per page)
DNA Nucleotides

Color the nucleotides using the following key:

Deoxyribose = red	Phosphate = blue
A (Adenine) = green	C (Cytosine) = yellow
G (Guanine) = purple	T (Thymine) = orange

Cut out your nucleotides.



The Woodrow Wilson National Fellowship Foundation • *webmaster@woodrow.org*
CN 5281, Princeton NJ 08543-5281

Tel:(609)452-7007 • *Fax:(609)452-0066*

The Bulls Eye in the Immune System: Lyme Disease

Immunology Educational Unit
By
Tamica Stubbs

Lesson #9

I Overview:

DNA is the molecule of life. It determines structures and therefore, functions of all organisms. A comprehensive study of this genetic material within various organisms can explain why we vary as organisms. It can also explain why variant species are utilized as models to produce products useful to Homo sapiens. Manipulation of such material can and has unveiled the aforementioned as well as much more. This lesson explores each of these premises and exposes students to biotechnological techniques that allow for us to gather such information.

II Learning Objectives:

Upon the completion of this lesson, students will:

a) Evaluate the ethics exploring model organisms in laboratory practices.
b) Formulate a hypothesis to how some cures for Lyme disease can be created.
c) Develop skills useful for analyzing DNA samples.

III Science Background:

In the effort to understand and elucidate factors surrounding the development of Lyme disease, many laboratory settings utilize the murine (mouse) model for study. The murine model is an effective modeling agent for the following reasons:

1) Mice consistently develop symptoms in a histological pattern that resembles humans.
2) Inflammation peaks 2-4 weeks.
3) Symptoms / disease resolves in 10 months.

These factors assist greatly in the study of and hopeful resolution to Lyme disease.

Biotechnological techniques such as DNA fingerprinting are monumental in absolving cause and effect relationships amongst living organisms. It can establish ancestral and evolutionary ties or lack thereof within a species or beyond that species' gene pool. The succession of steps involved in this process (in its most simplistic fashion) are inclusive of the following:

a) Extract DNA sample from organism(s).
b) Fragment the sample using endonucleases.
c) Load the digested samples in question into an agarose gel with a standard.
d) Electrically charge the gel.
e) Stain and analyze banding patterns.

By charging the gel and samples, fragments of varying lengths are separated out according to size. Smaller fragments have a tendency to migrate further down the gel. Its weight and size is more conducive to the reptation through the pores of the gel. This produces a

banding pattern for that particular DNA (DNA fingerprint). This allow for scientists to conclusively infer relationships (as different organisms produce varying banding patterns).

Within the scope of the Lyme disease study, successful gene transfers into mice would appear in their DNA fingerprints, even if the DNA is foreign. This, in essence, allows scientists to determine if gene transfer is successful. Such genes transferred in like the p38 dominant/negative gene (inhibits the normal p38 protein in the transduction pathways) need to be detected. This is a testament to its effectiveness. In the scenario involving p38 , cytokine production should be slowed or stopped in the presence of this protein, via its gene (p38 d/n gene). DNA fingerprinting will determine not only if its present in the macrophages but its effectiveness as well.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Basic pippetting skills (if completing the actual wet lab).
b) Basic understanding of structure function of DNA.
c) Understand the induction pattern/pathway associated with Lyme disease.
d) Strong science skills: observing, analyzing and collecting data.

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minute periods.
- Note: if the class is completing the actual wet lab, then more time will be required. Suggestion an extra ½ block or 1 full 45 minute period.

VI Materials and Equipment:

- computer(s)
- DNAi student handouts: access http://www.dnai.org/index.htm
  - Click on teacher / instructor's resources.
  - Scroll down to model organisms and click on students handout.
  - Print and copy for each student.
- Student handouts for Biotechnology techniques (Gel Electrophoresis)
  - Paper simulation: access dnai.org, click on teacher/instructor resources, scroll down to gel electrophoresis, click on and print all necessary templates and instructions for this simulation.
  - Computer simulation
    - Access http://www.biologycorner.com/worksheets/fingerprint.html
    - Print and make copies (all directions and objectives are listed on the student sheet)
  - Wet Lab
    - See student handout entitled: "Electrophoresis and Migration Distance" (materials, background information and directions are listed here). This handout was adopted from the Princeton University Molecular Workshop listings of teacher resources.

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

Complete the DNAi activity (see materials) as a class. This activity emphasizes genetic similarities in various species of organisms. Allow students to complete the worksheet with guiding comments from the instructor. This should promote leads for discussion.

b)Discussion of Activity:

Upon completion of the focus activity, discuss with students the purpose of utilizing mice in lab work to discover a cure for diseases such as Lyme disease.

c) Attach Meaning:

How do we know that mice actually possess the same genes as we do? Lead students into this understanding by exploring one of the biotechnological processes responsible for this conclusion: gel electrophoresis. Using paper, computer or actual wet lab procedures (see materials) introduce students to the technique. Emphasize the importance of each step and how they contribute to the overall process.

d) Independent Practice:

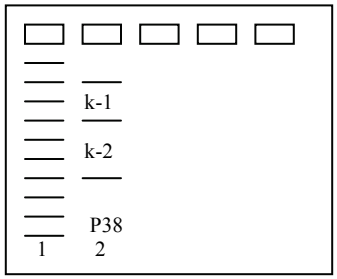
Students will address analysis questions associated with the simulation of choice.

e) Closing:

Pull practices together by emphasizing how genes (dominant / negative forms of a particular kinase p38) are inserted into mice to counter the effects of Lyme disease and that Gel Electrophoresis can be used to detect if the transfer was successful.

VIII Assessment:

Homework: Create a worksheet that has displays a diagram of an agarose gel with wells. Identify well 1 as the standard. Create a random fingerprint to show standards 1kb ladder (increments by the thousands). Identify well 2 as p38 inhibitor gene + kinases 1 and 2 genes. This column should show three bands. Associate any band with any kinase and inhibitor gene. See diagram:



Based on this information assign students to complete the following tasks:

1) Show the fingerprint of a mouse with proximal matching to p38 d/n infected mouse.
2) Show the fingerprint of mouse with the kinases but failed to take in the p38 d/n gene.
3) Finally, show a mouse who is genetically identical to the standard mouse on the gel.

IX Key Questions:

1) How does the technique of DNA fingerprinting aid in the resolving process of Lyme disease?

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #10

I Overview:

DNA replication is a semi-conservative process that yields identical quality and quantity of the original DNA to each cell in the body. With chemical cues in place, cells undergo this process naturally. This process can too be artificially executed beyond the membrane of the cell via Polymerase Chain Reaction (PCR) process. This process has allowed for science to ascend to many levels as it amplifies many copies of useful genes more expediently than the natural process itself. In this lesson, students will explore the natural and artificial process of DNA replication. Students will further apply their knowledge of the process to formulate hypothesis to eradicate Lyme disease.

II Learning Objectives:

Upon conclusion of this lesson students will be able to:

a) Describe the steps involved in DNA Replication.
b) Assess the pros and cons of artificially stimulating DNA replication.
c) Evaluate the usefulness of PCR in the resolution of Lyme disease.

III Science Background:

Polymerase Chain Reaction (PCR) is technique which artificially generates / duplicates multiple copies of DNA quickly. This process can be used to amplify genes in particular. Genes of special interest like insulin genes for example, are targeted and amplified ultimately for diabetics. Other uses include creating recombinant DNA (two foreign DNA fragments spliced together) or creating transgenic organisms (organisms that have foreign DNA inserted into their genomes) for study. Both are beneficial in soliciting desired outcomes or products. Both are equally harmful in their degree of unpredictability. Nevertheless, this process renders itself useful in the biotechnology community for a plethora of reasons.

PCR can summarized in 3 oversimplified steps:

1) Isolate gene of interest.
2) Introduce gene of interest to solutions with enzymes necessary to execute DNA replication. Such enzymes include ligase, polymerase and helicase.
3) Expose sample (in micropippette) to various temperatures for specific time intervals. This induces the cycle of denaturing and annealing to produce multiple copies of DNA.

Once genes have amplified, the genes of interest may be introduced to a host organism (an organism to see to it that genetic code is sufficiently propagated). Such organisms may include prokaryotes like E. coli or eukaryotes like mice. These genes are introduced via mechanical or biological vectors. When and if the gene of

interest has been successfully inserted into to the genome of the host, its presence will be identified by production non-indigenous proteins, new functions performed and / or DNA fingerprint analysis. This is how transgenic organisms are produced for the intensive purpose of studying Lyme Disease.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Describe the structure and function of DNA.
b) Explain the function of enzymes.
c) Have a basic understanding that all living organisms must grow.
d) Sequence the steps involved in gel electrophoresis.
e) Graphing skills.

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minute periods.

VI Materials and Equipment:

- DNA model(s) optional
- Model of ligase, polymerase, & helicase (optional)
- Computer
- Projector

VII Suggested Lesson Sequence:

a) Focus Activity/ Investigative Introduction:

Engage students in opening discussion on formulating ideas of DNA replication. Initiate the discussion with following opener:

> We know now that white blood cells house the same DNA as your cheek cells or lung cells via cell specialization. However, if all organisms begin as one cell, then how does your white blood cells obtain a copy of the one original strand? Open the floor for suggestions. Probe their response until you have reached a great transition into the topic itself.

b) Discussion of Activity:

The focus activity includes the discussion segment of this lesson.

c)Attach Meaning:

Introduce the process of DNA replication through the following sequence:

1) Draw or display a model of DNA for students to view. Indicate this as the beginning.
2) Display to students a model or drawing of the final product of DNA replication and indicate this as the final products.
3) Display to students a model or drawing of the key players: ligase, helicase, polymerase and free nucleotide units. Emphasize the names to the students as it may implicate each to a particular process within the process.

4) Allow students to walk you through the process by instructing you to manipulate the models or drawings. Continue to probe until a sensible explanation is achieved.
5) Now, permit ample time for students to record this information.
6) Next access http://science.nhmccd.edu/biol/bio1int.htm
7) Project for all students. Scroll down to sites that animate DNA replication and play for students. This will allow for students to compare / contrast their constructed responses to the actual process.
8) Explain to students that this the natural way of replicating DNA and that this can be done so artificially. The artificial method is called PCR.
9) From the same website, access one or two animations that shows the PCR process.
10) Briefly discuss the students understanding of both processes.
11) Finally, show students how this amplified material is transferred to organisms to make transgenic organisms by clicking cloning or transgenic organisms. This will be a basic introduction to vectors as well.

d) Independent Practice:

Instruct students to create a Venn Diagram and lists comparing and contrasting traits involved with natural and artificial DNA replication processes.

e) Closing:

Summarize and close the lesson by presenting students with the following:

If we wanted a gene in our body to counter the effects of any inflammatory disease, where could we obtain it? How could we amplify it? What could we do we with our amplified products? Why? What might be some drawbacks to such an endeavor?

VIII Assessment:

Homework: Present students with the following scenario:

The scientific community is looking for a gene to PCR to resolve Lyme disease. This gene must inhibit the inflammation process associated with Lyme disease. The gene will have to be transfected into macrophages of mice. Finally, the gene has to be tested for its effectiveness.

Your task as a scientist is to

1) *Create a sequence for this gene.*
2) *Come up with a creative name for the gene.*
3) *Indicate what the gene codes for and how it inhibits the inflammation process.*
4) *Create a graph that will display your anticipated results.*

For example, p38 dom/neg form competes with the normal kinase and slows down the production of IL-12 and IFN gamma. Thus, slowing down the entire inflammation process.

IX Key Questions:

1) How does the natural and artificial processes of DNA replication compare and contrast?
2) How might PCR assist in the remedy or quest for a cure to Lyme disease?

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #11

I Overview:

Protein Synthesis is the crux of a cell's functionality. It is the manifestation of orders encoded in all genetic material. Without this process, there would be no cell structures and consequently no cell functions. In this lesson, students will explore the process of protein synthesis and examine how manipulation of any its key players can have a positive or negative impact on the organisms' appearance or how it functions.

II Learning Objectives:

Upon completion of this lesson students will be able to:

a) Describe the process of protein synthesis.
b) Explain how the manipulation of DNA alters the output of the protein synthesis process.
c) Describe what luciferase is and how this protein from various organisms can enhance the studies of Lyme Disease.

III Science Background:

Protein Synthesis is a process that manifests the production of protein in living systems. Its activity determines the viability of these systems and thereby becomes the crux of functionality of all organisms. The process occurs in a successive fashion terminates via positive and negative inhibition regulatory mechanisms. The steps (simplified version) of this process are summed accordingly:

1) DNA serves as a blueprint for protein (directions)
2) DNA is unwound at particular point of origin with a gene.
3) A complimentary nucleic acid strand is created. This called mRNA. RNA is different in that it substitutes uracil for thymine, it has ribose sugar and is single stranded.
4) MRNA is modified (via the excision of introns and other processes) and moves out of the nucleus to ribosome (rRNA).
5) RRNA reads the mRNA in discrete units called codons (sequence of 3 base pairs).
6) Each codon codes for a particular amino acid.
7) These amino acids brought to the ribosome via tRNA and are unified to create a polypeptide unit → protein.
8) Upon completion of reading the mRNA, the protein is released and is modified in another part of the cell and ensues its destiny.

Luciferase is an illuminating protein found in specific organisms like the firefly. The activity of the gene that codes for this enzyme can be manipulated, cleaved and transferred. Its trademark trait (glow) makes it ideal for experimental studies.

The luciferase gene has been and continues to be an indicator of successful transfections of organisms being studied in labs. The insertion of the dom/neg p38 gene into mice for instance is sometimes coupled with this gene (cotransfection) to quantify p38 dom/neg expression. In order to hold effective in studies, these two genes must inserted within the same operon (cluster of genes expressed together for a particular trait). Nevertheless, both are influenced by the process of protein synthesis and can be critical in its resolution of Lyme disease.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Define cytokine
b) Describe structure and function of genes
c) Describe the transduction pathway that leads to Lyme Disease.

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minute periods.

VI Materials and Equipment:

- computer
- projector for computer

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

Instruct students to look back onto or recall the opening simulation to this unit. Ask the messenger to repeat the message on the paper. What was the message? What did the person receiving the message have to do? Where did the directions come from? Continue questioning until students have a clear understanding of the simulation.

b)Discussion of Activity:

Now explain that even though the simulation was a simplified version compared to what actually goes on in a cell. Then ask students what if the original message was altered? How would that affect the overall pathway? Discuss this briefly and then pursue the instruction of protein synthesis.

c) Attach Meaning:

Prepare students for the lesson by saying that we are going to explain this small part of the process in detail (the message & following the message part). We will unveil this process by first understanding what makes fireflies glow. Next, follow this sequence of instruction:

1) Access the genetic science learning center at http://gslc.genetics.utabh.edu/units/basiscs/index.cfm
2) Scroll down to basics and beyond.
3) Click on "What Makes a Firefly Glow?" and run the animation.
4) Probe students throughout the animation. Students will learn luciferase here.

5) Relate the process learned in the animation (protein synthesis) to the opening discussion.

d) Independent Practice:

Organize students into teams of four. In these teams instruct students to create compelling arguments to support the use of the gene for luciferase in studies focused on Lyme disease. Students may need some help getting started. Remind them of the purpose of transfections and that scientists always need a standard to justify their observations. Give groups at least fifteen minutes to gather their thoughts and open the floor for some arguments.

e) Closing:

Continue to hear arguments and add input with emphasis on how protein synthesis influences the inflammation process in Lyme disease and can be quantified just by the output (intensity of glow or number of enzymes produces). Reinforce that this output is critical in establishing protocols to remedy this endemic disease.

VIII Assessment:

Homework: *Student Instructions*

MHC (major histocompatability complex) genes are those that code for various glycoproteins (sugar proteins / antigens) on the surface of all cells. This influences identity of the cell and is perpetuated mostly by the protein synthesis process. Using the following descriptions/sequences of MHC genes for T cells and macrophages, create a diagram of the surface for these two cells. Finally, describe how protein synthesis lends to the uniqueness of cell surfaces.

Teacher Instructions:

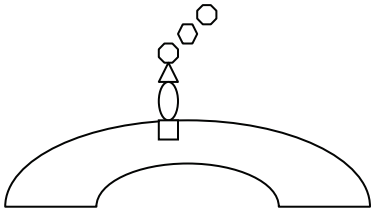
Create a unique sequence for each cell's DNA. Create a shape/color code for the amino acids created from these sequences. Finally find a creative way to add sugar units of varying amounts on the proteins to give it a unique surface.

Example:
DNA sequence macrophage: AATTCCGATGGGATCTAT

Amino acids
Red square = UUA

For each gene with a triple GGG sequence add 3 glucose units atop the protein structure.

Expected diagram:



IX Key Questions:

1) What is protein synthesis?
2) Why is it fair to say that protein synthesis is the crux of all cell functionality?
3) How does understanding the process of protein synthesis aid in finding a cure to Lyme disease?

The Bulls Eye in the Immune System: Lyme Disease
Immunology Educational Unit
By
Tamica Stubbs

Lesson #12

I Overview:

MRNA, the relay messenger in the protein synthesis process is a powerful tool in biotechnological studies. MRNA is only produced when its cDNA counterpart is active. Thus, mRNA found in the cytoplasm of a cell at any given time is a strong indicator of gene activity. It is an indicator of what genes are active or in fact inactive during specific cellular processes. In this lesson students will explore the power of mRNA as they learn techniques of Southern Blotting and Cell purification through positive and negative selection. Finally, students will assess how these techniques are used in murine studies of Lyme disease.

II Learning Objectives:

Upon completion of this lesson students will be able to:

a) Describe the technique of Southern Blotting.
b) Infer the sequence of steps involved with Western Blotting.
c) Simulate the process of protein purification.
d) Relate the techniques of Southern Blotting, Western Blotting and Protein Purification to the resolution of Lyme Disease.

III Science Background:

Southern Blotting is a technique used in biological studies and is used to identify the presence of certain genes versus others. The process is initiated through the implementation of all steps involved with gel electrophoresis. However, as opposed to being stained, the gel is exposed to a nitrocellulose paper (which denatures the DNA into single strands) via compression and DNA is blotting onto the nitrocellulose paper. This paper is then incubated with labeled radioactive nucleic acids and photographed. The radioactive "probes" that display a band are those successful in the hybridization process. This means that they annealed with the open DNA strands denatured earlier in the process.

MRNA extraction and further processing of it can be used in conjunction with the Southern Blot method to identify the activity of certain genes versus others. MRNA can be processed with reverse transcriptase to create cDNA (its compliment). This cDNA then can be processed in the exact fashion as the aforementioned Southern Blot technique and will thus yield information about which gene was active at the time that the mRNA was extracted from the cell.

WBC purification is a technique used to separate one type of the cells from its counterparts present in the body simultaneously. The process is executed in the following manner:

1) Obtain cells from the spleen of an organism.
2) Lyse the red blood cells. This leaves all of the white blood cells.
3) Add biotinalated antibodies specific to WBC being selected for.

4) Add magnetic beads. These will draw into the antibodies with biotin.
5) Run sample through magnetic column.
6) The beads will attract to and stick in the column and the others will run through.

The cells that are stuck to the column are positively selected for while the others that were channeled through the column have been negatively selected for. The cells positively selected for can then be further analyzed for specific intracellular activity or stimulated for further study.

IV Student Prior Knowledge and Skills:

For successful completion of this lesson, students will be expected to possess the following knowledge and/or skills:

a) Scientific skills: inferring
b) Describe the basis of cellular transduction pathways involved with development of Lyme disease.
c) Describe the significance of macrophages in the immune system.
d) Be equipped with the understanding of how genes work.

V Time Requirements:

- 1, 90 minute block.
- 2, 45 minute periods.

VI Materials and Equipment:

- computer
- projector
- Pieces for Southern Blot simulation
  - Narrow strips of paper with 15 letter DNA seqeuces.
  - 8.5" by 11" sheets of white paper with various 15 letter DNA sequences. Some will or will not compliment the narrow strips.
  - Construction paper 8.5" by 11".
  - Glue
- Metal balls
- Small rectangular magnets
- Small rectangular pieces of wood.
- 1 Large magnet

VII Suggested Lesson Sequence:

a)Focus Activity/ Investigative Introduction:

Review the process of protein synthesis by viewing the RNAi movie.

1) Access website: http://www.nature.com/focus/rnai/animations/index.html
2) Click on movie and view at least twice.

3) Probe students to identify the various key players of this process in the movie.

b) Discussion of Activity:

4) Review the overall process orally or by emphasizing points demonstrated in the movie.

c) Attach Meaning:

Invite students to see the power of mRNA by introducing the techniques of

1) Southern Blotting: access http://science.nhmmcd.edu/biol/bio1int.htm
2) Click on Biotechnology Websites by McGraw Hill.
3) Click on Southern Blotting title.
4) Run animation.
5) Review how mRNA is made.
6) Explain how mRNA can provide insight into the activity of certain genes.
7) Encourage students to think about how this method of identifying genes can be helpful in the development creating a remedy for Lyme disease
8) Explain the process of cell purification. This process can be simulated with the utilization of magnetic and non-magnetic pieces.
9) Finally, reinforce how this process allows immunologists like those studying Lyme disease to focus on specific factors while studying the development of a particular disease.

d) Independent Practice:

Students will perform a Southern Blot simulation to further understand the process!

Southern Blot simulation:

a) Give students each 3 strips of paper. Tell them that they are scientists studying individual mice. They are to determine the activity of the gene for p38, the gene for p38 dom/neg and the gene for luciferase. The paper is their cDNA made from mRNA extracted from their mice. Their mice have been cotransfected. We need to know if the process was successful. Which genes are active after having been exposed to Bb for seven days.
b) Give students their gels (8.5 by 11) sheets of DNA sequences.
c) Allow students to locate matching sequences and lay their strip face down on that particular compliment.
d) Students are then to add a drop of glue to the top of each strip with a compliment.
e) Lay down the other strips anywhere on the gel.
f) Lay the construction paper over the gel paper.
g) Lift and highlight the genes present.
h) Assist students in identifying which gene codes for which protein, as it is determined by the instructor.

e) Closing:

Western Blotting is a process used to determine the presence of a particular protein. Based on their knowledge of Southern Blot, encourage students to articulate a protocol for Western Blot.

VIII Assessment: Homework:

Instruct students to make some original suggestions to how immunologist studying Lyme disease can use southern blot, western blot and cell purification to study this disease.

IX Key Questions:

1) How do the techniques of Western blot, southern blot and cell purification aid in the successful studies of immunology?

Immunology Educational Unit: The Bulls Eye in the Immune System (Lyme Disease)

By

Tamica Stubbs

Overview / Purpose:

Students sometimes require non-traditional forms of assessment in order to be successful. This holds especially true in the science field. In order to truly determine whether students are thinking scientifically, instructors must create inquiry based assessments. The final section of this unit provides a suggestion for a cumulative assessment that does so in a manner consistent with inquiry.

Student Information

Project Title: *Curing Lyme Disease, One Individual at a time!*

Provisions of the project:

As a well-informed scientist of Lyme Disease study, you are to create a plan of action that can remedy this endemic disease. Throughout your action plan your are to integrate the following:

a) Two or more techniques learned throughout the unit.
b) Extensive immunology vocabulary within your script. Please do not refer to units as "those things" or "stuff". Secure the reader in your knowledge of the vocabulary that you learned throughout the unit.
c) Murine models as your subjects.
d) Provide an explanation to why there is not one cure for all*

Presentation Format:

Your project may be presented in any creative fashion that you desire. This includes, but is not limited to:

a) Powerpoint presentations
b) Posters.
c) Bounded Reports
d) Recorded Songs
e) Art forms / posters (diagramed with subtitles and descriptions of course)

Grading Rubric:

Based on a 100 point scale, each of the following will bear equal weight on your final grade:

1) Creativity
2) Accurate Content
3) Well constructed solution
4) Vivid and informative diagrams
5) Quality of overall presentation
6) Consistency of scientific thought throughout the project

Timeline:

The specifics of the timeline should be established by the instructor.

To further educate students on the "No one cure for all" part of the projec,t students should research the topics of SNP's (Single Nucleotide Polymorphisms) and Pharmocogenics (The practice of making individualized pharmaceutical products).

- **Students can access the Genetic Science Learning Center at :** http://gslc.genetics.utah.edu/basics/index.cfm
- **Students can then click on SNP and Pharmocogenic links. These links will allow students read up on these topics while providing great visuals. Students are provided with practice activities that may prove helpful in their project products.**

Acknowledgments

The construction of this educational unit was created through the generous support of the following:

- ***Dr. Juan Anguita and his laboratory staff.***
  Dr. Anguita and his staff of the University of North Carolina in Charlotte* (UNCC) served as excellent mentors in developing my knowledge of Lyme Disease. They introduced me to many techniques and provided me with adequate resources to further develop my knowledge of immunology. This team dedicated four weeks of their hard- pressed research schedules to provide me with a priceless education on Lyme disease and biotechnology techniques. I am forever grateful for their time and efforts.

- ***American Association of Immunologists.***

The American Association of Immunologists sponsored this summer research experience. AAI provided the funding for compensation of my time in the laboratory and out. This association provides exceptional educational opportunities for educators like myself annually. Through the AAI Teacher Research Fellowship, I was able to select an AAI member and work in his laboratory. This is has been one of my most informative professional development opportunities that I have taken part in throughout my education career. Thanks for your support.

- ***Dr.Arthur Tzianabos Ph.D.***
  Dr. Tzianabos was critical to the success of my endeavor. He worked hard in assisting me with the process of locating and committing a mentor. He assisted me through the application process and was very encouraging throughout. I really appreciate his time and efforts. Thanks for your support Dr. Tzaianabos.

***** *Note Dr. Juan Anguita and his staff are now pursuing research studies at the University of Massachusetts (Umass).*