Understanding Immunity through Cell Communication

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Table of Contents

Teacher Guide

I. Science Background

Cells are constantly able to detect what is going on around them and respond to cues within their environment and with neighboring cells. Typically, cells communicate with each other via chemical messengers to produce a chain of reactions within the cell to produce a response. For example, when your body temperature is rising, your cells can relay this message via a chemical messenger, causing your body to produce sweat and cool your temperature down.

Immunology is the study of the immune system and an important part of all medical and biological sciences. The immune system helps protect us from infection through various lines of defense and involves multiple cellular components to help protect our bodies from the infectious agents. One particular line of defense is granuloma formation. A granuloma is a structure formed during inflammation that is found in many diseases, as a way to wall off foreign substances the body is unable to eliminate. Granuloma formation involves a collection of immune cells, such as macrophages that produce chemical messages to help produce the specific immune response.

The goal of this unit is to allow students to apply the concepts of cell communication, as well as immunology, to explore how cells communicate with each other in various ways and are able to use their chemical messages to produce an immune response.

- What students will do and what technical skills they will learn

  Students will learn how to use an ELISA assay to quantify the amount of cellular

IV. Time requirements

- Class periods are 85 minute block schedule

  Estimated time= 6 block periods.

V. Advance Preparation

- List of equipment and materials

  Large white boards or lab bench as chalk board

  White board markers

  Lab handouts

  Computers with online access

  Paper cutouts, if necessary

  Giant Panda ELISA Kit from Biorad

- Directions for preparing solutions and other reagents

  See Biorad kit for preparation of solutions for kit

- Approximate preparation time

  About 60 minutes

VI. Materials and Equipment

- Student Computers for Notes/PowerPoint/online ELISA simulation (1 per person)
- Student handouts (1 per person)
- Playdoh (as needed)
- 3D models (as needed)
- Large whiteboards/whiteboard markers for cell communication activity and understanding immunity activity (1 set per group of 3 or 4)
- No safety equipment (goggles, aprons, etc.) needed at this time

VII. Student Prior Knowledge and Skills

- Expected prior content knowledge

  Students should have taken a basic biology class and have a basic understanding of biological concepts, related to cells and the human body. Students should have already learned about cells and cell components and should understand the basic components of a cell as well as the function of the organelles. Students will also have learned about cell differentiation and how cells can become specialized in order to perform a specific function. This will allow the students to have a better understanding of the cells of the immune system and how there are multiple cells within the immune system that can perform various roles.

  Students should have a general understanding of the immune system, its role in the human body and function against infectious material.

- Expected prior technical skills

  For ELISA laboratory experiment, students should have a background understanding of certain laboratory equipment such as micropipettes, centrifuges, and 96 well plates including their functions and uses.

VIII. Unit Plans

A.

immune responses (innate, humoral, cell-mediated). They will then develop a dynamic model of the assigned immune response and show how it works. They will use the model to explain the response to the other groups. When designing the model, they will be assigned components that should be represented in their models and should demonstrate the structures, as well as the functions, of the proteins involved. Models should also show the spatial reference (where these events occur). (See Appendix C)

Evaluate: ELISA

- https://www.biointeractive.org/classroom-resources/immunology-virtual-lab
- Students will work through an online ELISA simulation to investigate how antibodies are involved in the immune system. Through the online simulation students will explore the fundamental principles of an ELISA, as well as be able to explore a particular immunology laboratory technique. While the online simulation explores Systemic Lupus Erythematosus (SLE), following the laboratory investigation, students will be asked to explore additional antibodies and their involvement in a particular imm -0.002525ententemu 555.

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x Cell Communication cutouts

Description:

Students will work through “Modeling Cell Communication Activity.”[2] Students will work in groups, use Playdoh and cutout models to develop a dynamic representation of cell communication that involves either a G-

Description

Students will apply their knowledge of cell communication and the immune system to work through "Understanding Immunity-A modeling Activity." Again, students will develop a dynamic model of an assigned immune response. Responses include the innate response, humoral response, and cell-mediated response. Students will then demonstrate their models to another group to allow students to make connections amongst the different immune responses and see how cell communication applies to the immune system.

Day 5: ELISA Online Simulation
Materials : x Computer or device with internet access
Description: https://www.biointeractive.org/classroom-resources/immunology-virtual-lab This virtual laboratory will demonstrate how such a test, termed an enzyme-linked immunosorbent assay (ELISA), is carried out and some of the key experimental problems that may be encountered. Students will learn about the assay procedure and the equipment and materials that are needed. By completing this exercise, students will gain a better understanding of experimental design, key concepts in immunological reactions, and interpretation of data. As students work thought the completed online ELISA, they can be provided with a guided worksheet to help guide their thinking and record/analyze their results.

Day 6-8: Giant Panda Problem Kit -ELISA Lab from Biorad
Materials : x https://www.bio-rad.com/en-us/product/giant-panda-problem-kit-for-ap-biology?ID=OM5OWJE8Z (See Biorad Kit for components)
Description: Students will use this kit to practice the basic technique and biochemical interactions as they learn about humoral immune responses. In this investigation students will learn the technique of conducting an ELISA while determining if simulated urine samples from giant pandas contain disease antibodies. If time permits, students can support their knowledge by designing an ELISA to test for the presence of a panda hormone.

IX. Summative Assessment s

B. Discussion/Analysis

- Questions to guide data interpretation, Questions that link data to concepts, Probes for analyzing results, Probes for students to ask extension questions

Modeling Cell Communication

- What are the three main components of cell communication?
- What are the roles of secondary messengers?
-

Student Materials

*Appendix A

Everything You Didn't Want to Know About Snot

As you watch the video entitled "Everything You Didn't Want to Know about Snot," think through the following questions and use them to help guide our class discussion.

1. Why is mucus important?

2. Describe why snot is considered a "first line of defense?"

3. Explain what goblet cells are and why they are important to snot.

4. Predict what happens when bacteria or viruses pass this first line of defense.

*Appendix B

Name_____ AP Biology

Modeling Signal Transduction Pathways [2]

Purpose:
In this modeling activity, you will compare different signal transduction pathways by building models with clay. The focus of the activity is primarily transduction, but we will review signals and introduce responses as well.

Background:
We have identified at least four classes of signal transduction pathways. G-protein linked receptors, tyrosine kinase receptors, and ligand gated ion channels involve receptors located in the cell membrane. There are also receptors for cell signals located in the cytoplasm or nucleus of the cell. Note: you will not need to memorize all of the parts of all of these pathways, but by modeling the pathways you will better understand the idea of:
"Signal ÆTransduction ÆResponse"

Signal transduction pathways are initiated when the cell receives a signal, for example a hormone signal, from another cell. This signal initiates a series of changes in the cell (transduction) that allows cells to respond appropriately to the signal. The process of transduction is a relay of the message carried by the original signal. When the cell receives the initial signal, the receptor for the signal is either located in the cell membrane OR in the cytoplasm or nucleus of the cell. Think about the chemical composition of the signal and describe the properties of a signal that uses a membrane-based receptor compared to an intracellular receptor. How would they compare?

Once the signal interacts with the receptor multiple things can happen inside the cell. Ultimately, the cell will respond. Responses include, but are not limited to, dividing, creating particular proteins, or changing gene expression. In your group, you will build models of two different classes of

Procedure:

7. It is very important to note that some G-protein linked receptors initiate phosphorylation cascades and some tyrosine kinase receptors initiate second messengers. The point of this modeling activity is to let you see how a signal can remain outside of a cell, yet still cause an intracellular change. So, how would you summarize the ability of a cell to respond to a signal without the signal actually entering the cell?

8. Thinking ahead: Consider the following scenario:
    a. What if one of the proteins in the “transduction” part of the pathway had an abnormal shape (due to a gene mutation) that caused the pathway to be permanently “on” or permanently “off”? What would this mean for the cell? If you need help with this, look up the Ras subfamily of proteins online to get you started.

*Appendix C

Name_____

Understanding Immunity: A Modeling Activity

Purpose: In this activity, you will investigate the workings of innate immunity, the humoral response and the cell-mediated response.

Learning Objectives:
1. Understand key players and their functions in different types of immune responses (innate, and adaptive, including humoral and cell-mediated).
2. Relate the structures and functions of the different proteins and involved in immune pathways.

Directions:
Working in small groups, you will become the expert for one of the following types of immune responses assigned to you:
1. Innate response
2. Humoral response
3. Cell-mediated response

Your task is to make a dynamic model of the immune response assigned to you. You must show how it works and then use the model to explain the response to the other groups. When designing the model, you should demonstrate the structures as well as the functions of the proteins involved. Key cells, structures and proteins for each of the immune responses are listed below. You may include additional relevant terms that are not listed here. Models should also show the spatial reference, in other words, you need to show where these events are occurring.

Key terms that must be inclu ded in your model:

Innate Response	Humoral Response	Cell-mediated response
Pathogen		

After the model is assembled, you should practice your presentation, first in your small group and then to other groups that share the same immune response. We will be presenting these to the class to better understand the various defenses against pathogens.

When all presentations are completed, summarize the immune response with the activity on the following page.

After viewing the models of all the immune responses, complete the following:

1. General Comparison of the three types of immune responses:

	Innate Response	Humoral Response	Cell-Mediated Response
How it is initiated: what starts the process?			
Speed of response			
Types of cells involved			
Types of protein molecules involved			

Is memory acquired?
If so, what cells?

3. The innate immune response involves the body's first and second lines of defense and is considered a nonspecific response. However, the third line of defense is considered specific. Explain why these statements are true.

4. Discuss how vaccines/immunizations provide active immunity to a particular disease.

5. An individual receives the BCG vaccine, a vaccine used in areas with high rates of tuberculosis. Explain why this person may have received a false-positive on a skin test for tuberculosis.

6. How does cell communication play a role in our immune response? Give an example from one of the models.

7. You have a respiratory infection and the culprit is an adenovirus. Using a flow chart or infographic, show how the immune system responds to the virus.

References

[1]Trout, L., & High School POGIL Initiative. (2012). POGIL activities for AP biology.

[2]Freeman, S. (2014). Biological science

[3]Reece, J. B., & Campbell, N. A. (2011). Campbell biology. Boston: Benjamin Cummings / Pearson