Acting Out the Immune Response

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Teacher Guide

I. Science Background

Humans are exposed to a large number of pathogens (disease causing organisms) every day, yet only a small number of those are successful in inducing infection and causing damage to host tissues. The human immune system is a complex collection of physical barriers, cells, and signaling systems that helps a human to respond to a pathogen invasion. The immune system can be thought of as two parts: the innate immune system that works nonspecifically against any invader, and the adaptive immune system that allows the human host to defend against specific pathogens. Sometimes, the immune system mounts a response to a foreign substance that is not a pathogen and is not really harmful. This type of a response to harmless environmental substances is called allergy. Recent scientific studies have shown that there has been an increasing incidence of allergy in developed nations such as the United States (Nova). Although the exact cause of the increase in allergy is not known, a number of suggestions have been proposed based on studies conducted by various scientists. One particular idea is called the Hygiene Hypothesis, and it is based on observations that in countries where individuals are exposed to a high frequency of pathogens (including chronic parasitic infections), the incidence of allergy is much lower. The converse is also observed with higher incidences of allergy being described in countries with a lower frequency of chronic parasitic infections. Both parasitic infections and allergies use the same pathways of the host immune response. The laboratory of Dr. Clinton Mathias has a specific focus on food allergy and is investigating the possibility that specific dietary components which are commonly found in the food of countries with a low incidence of allergy may inhibit the allergic response to other food molecules. One mechanism being studied in the lab is the induction of epigenetic modifications, which can then induce or suppress the allergic response.

Nova, Esther, et al. "Influence of health behaviours on the incidence of infection and allergy in adolescents: the AFINOS cross-sectional study." *BMC Public Health* 14 (2014): 19. *Academic OneFile*. Web. 26 Mar. 2015.

II. Student Outcomes

A. Science concepts covered in the unit

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1. A pathogen is a disease causing organism and an antigen is the part of the pathogen that a host recognizes and responds to.
2. The innate arm of the immune system responds nonspecifically to pathogens and includes physical barriers such as skin, mucus and cilia as well as a cellular response that includes cells such as macrophages, granulocytes, natural killer cells, mast cells, monocytes and dendritic cells.
3. The adaptive arm of the immune system responds to specific pathogens. This response includes dendritic cells, CD4 helper T cells, CD8 cytotoxic T cells and B cells.

4. Cytokines are molecules secreted by immune cells that stimulate a response in other immune cells by binding to specific target receptors, resulting in a cascade of signaling events inside the responding cell.
5. Allergy is an immune response to harmless substances such as pollen, cat dander, etc.
6. Epigenetic markers are the addition/deletion of methyl or acetyl groups either directly on DNA or on histone proteins. The epigenetic marker can either stimulate or suppress gene expression

B. Outcomes from the Next Generation Science Standards

1. HS-LS1-2.
    a. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

2. Disciplinary core ideas: LS1.A: Structure and Function
    a. Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
    b. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)
    c. Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
    d. Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

3. Cross-cutting concepts: Systems and System Models
    a. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

4. Common core state standards connections
    a. WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and

audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)

b. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)

C. Recommended Course Placement

This curriculum can be adapted to any level. It is aimed at high school college preparatory biology course. The goal of the acting out is to make a complicated process more concrete to students who will benefit by body movement and speaking to help understand and remember a process. By discussing this goal with students, the teacher will be teaching them metacognition, how to think about their own thinking and learning processes.

D. Relevance

The immune system is relevant to students' lives. It is important for them to understand how their body protects them against diseases and to understand what is going on in their body when they are sick. This will help them understand why doctors prescribe particular treatments and will help them to seek proper treatment when they are sick.

III. Learning Objectives

A. Students will demonstrate understanding of:

1. The innate and adaptive immune response by taking part in the "acting out the immune response" simulation.
2. Epigenetics by participating correctly in the acting out simulation.
3. The innate and adaptive immune response by creating an analogy to the immune response (see assessment section).
4. Basic vocabulary by answering a multiple choice quiz.

IV. Time Requirements

A. Day 1

1. Learn about epigenetics using lectures and short animations, and act out how an epigenetic change can affect gene expression.
2. Time estimate is 30-90 minutes.

B. Day 2

1. Learn the basics about the immune system including self vs. nonself (antigen, markers), pathogen types (virus, bacteria, worms, insects, protozoans, fungi, prions), methods of transfer of pathogen (air, water, vector, sex) and the innate immune response including the study of physical barriers (skin, mucus, tears, cilia, eyelashes, acid stomach/vagina).
2. Time estimate is 60-90 minutes.

C. Day 3

1. Learn about the adaptive response by lecture. Topics include macrophage, dendritic cell, T cell, B cell, antibody, cytokine.
2. Act out the innate and adaptive response.
3. Time estimate is 60-90 minutes.

D. Day 4

1. Learn about allergy (topics include allergy is immune response to a harmless antigen, what is IgE, role of histamines).
2. Act out the immune response to an allergen.
3. Time estimate is 60 minutes.

V. Advanced Preparation.

A. Set up

1. Tubes for Disease Spread simulation as described in the link below:
(https://www.koshland-science-museum.org/sites/default/files/uploaded-files/ID_Disease_Spread_Activity_FINAL.pdf

2. Make signs with role names that students can wear.
   One suggestion is to print the role names on 8 ½ X 11 paper, put in protective plastic sleeves and tie strings on the plastic sleeves so the student can wear the sign around the neck.

3. Photocopy one for each student: *A Tale of Two Mice (*http://www.pbs.org/wgbh/nova/body/epigenetics.html), Immune Response Analogy, Vocabulary quiz

VI. Materials and Equipment

A. For Disease spread simulation**. For details see website**
(https://www.koshland-science-museum.org/sites/default/files/uploaded-files/ID_D isease_Spread_Activity_FINAL.pdf

1. Test tubes
2. Test tube racks
3. Phenolphthalein
4. 1M Sodium hydroxide

B. For Acting out simulations (see Procedure section below for numbers of materials which may vary according to class size)

1. Role play signs
2. Protective plastic sign sleeves
3. Gloves (ex. latex or pvc) for pathogen antigen
4. Test tubes (preferably plastic) for pathogen receptors that will fit over a finger
5. Scissors
6. Copies of ligands and receptors to put in corresponding name sign sleeves

VII. Student Prior Knowledge and Skills

Students should already be familiar with the central dogma of gene expression and protein synthesis.

VIII. Daily Unit Plans

A. DAY 1

1. Review central dogma including transcription and translation.

2. Lecture on epigenetics (see attached powerpoint)
3. Show epigenetic video clips
    a. epigenetics explained
    http://learn.genetics.utah.edu/content/epigenetics/intro/ (1:47 min)
    http://learn.genetics.utah.edu/content/epigenetics/ (lick a rat – 2 min)
    http://www.pbs.org/wgbh/nova/body/epigenetics.html (Nova Spanish twin studies
    b. Identical twin studies - nature or nurture? (13.02 min)
    http://www.youtube.com/watch?v=Wd5Y3-F79LY (5:11 min)
    http://www.youtube.com/watch?v=qw3S35wGgT8 (Jim twins - 10 min)
    c. epigenetics of identical twins
    http://learn.genetics.utah.edu/content/epigenetics/twins/ (4:41 min)
    d. act out epigenetics
4. Homework

    Watch *A Tale of Two Mice* at the Nova website (http://www.pbs.org/wgbh/nova/body/epigenetics.html) and answer questions below:
    a. What is the "genome"? (you will have to look this up)
    b. What is the "epigenome"?
    c. Give an example of the epigenome.
    d. The program shows two identical twin mice who are different in coat color. What causes them to be different?
    e. What is BPA? Where is it found? How many people have BPA in their bodies? In the mouse study what happens to mice exposed to BPA?
    f. How did scientists counteract the effects of BPA?
    g. The idea of Nature/Nurture is that each organism is born with a DNA sequence and that environmental influence can alter or add to the expression of the DNA sequence. How does the idea of epigenetics confuse that Nature/nurture idea?

B. Day 2

1. Infectious Disease Spread Simulation
   https://www.koshland-science-museum.org/sites/default/files/uploaded-files/ID_Disease_Spread_Activity_FINAL.pdf
2. Small group brainstorming
   a. What does "infectious" mean?
   b. What are ways that diseases can be spread?
   c. Followed by whole class discussion
3. Small group contest
   a. Name as many infectious diseases as you can.
   b. Class shares lists and teacher writes disease names on the board, secretly grouping them by pathogen type.
   c. Students are challenged to guess the basis for the grouping.
   d. Pathogen is defined, groups are named, and pathogen differences are explained.
4. Small group brainstorming
   a. List as many ways as you can that the body has of blocking pathogens from entering...followed by whole class discussion and list
5. Notes/lecture: Innate immunity
6. Act out Innate Immunity - players are mucus/cilia, blood, macrophages, pathogen, dendritic cells, histamine (See student section for script.)

7. Homework: Start planning Immune System analogy (See student section for handout.)

C. Day 3

1. Notes/lecture: Adaptive immunity
2. Act out innate and adaptive Immunity (Teacher selects version that is appropriate for class level.)
3. Homework: Finish planning immune system analogy.

D. Day 4

1. Peers edit immune system analogy idea. Students who have not done planning will work with the teacher to make a plan.
2. Notes/lecture: What happens when the immune system does not work correctly? Autoimmune disease and Allergy
3. Act out immune response to an allergen.
4. New roles: Allergen, IgE antibody
5. Homework: Write immune system analogy.

IX. Summative Assessment

A. Immune system Analogy

B. Vocabulary quiz

Student Section

I. Rationale

The Immune system is very complex, so most learners need to learn it in a variety of ways. Research shows that for a student to be a self-directed learner, they need to experience the content through several modalities (i.e. written, oral, physical). This activity will allow students to learn by hearing the content and also associating the content with body movement. Students are also better learners if they are aware of how they learn best. If you know that you like to learn by doing, then this activity will help you to learn a lot, but only if you are actively thinking about each step of the activity and paying attention.

II. Materials

A. For Disease spread simulation

One test tube that represents your body fluids, Goggles

B. For Acting out simulations

Teacher will provide necessary materials

III. Procedure

Acting out Epigenetics

A. Roles/signs

Gene - 2 students to hold each end of the nucleotide sequence (Sequence should have negative charges.)
Promoter - 2 students holding each end
Histones - 4-8 students; signs have positive charges on them.
Methyl transferase - 1 student
RNA polymerase - 1 student
Acetyl transferase - 1 student
Props
Promoter - a strip of paper or cloth with promoter nucleotide sequence written on it
Gene - a strip of paper or cloth with gene nucleotide sequence written on it (TACGCA…….)
mRNA nucleotides - pieces of paper w/tape or large snap beads that have the A, C, U, G nucleotides written on them
Methyl Groups - paper with a methyl group printed on it and tape on the back so it will stick to student histone
Acetyl Groups - paper with an Acetyl group printed on it and tape on back

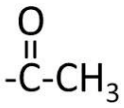
B. Methylation Script

(CH3 attaching to C nucleotides blocks gene)

1. Promoter and gene students arrange their nucleotide sequences with the promoter before the gene.
2. Promoter and gene students wrap their sequences very loosely around the histone students.
3. RNA polymerase arrives, attaches to the promoter and starts to make the mRNA by calling for the nucleotides that correspond to the gene sequence. Students holding the nucleotides bring them to the gene and the RNA polymerase assembles them into the mRNA
4. The person is now exposed to BPA (Bisphenol A). Methyl transferase methylates the C residues in the DNA
5. RNA polymerase tries to transcribe the gene, but the methyl groups get in the way. Transcription is blocked, the gene is off.

C. Acetylation Script

(Acetyl group binds to Lys in Histone, blocking + charge. This decreases the histone interaction with DNA negative charge. DNA wrapping around histone is loosened and Transcription can happen. Acetylation turns on gene).



1. Gene with Promoter wraps around the histones. The wrapping is tight for an “off” gene.
2. RNA polymerase tries to get to the promoter, but the wrapping is too tight, and the RNA polymerase cannot reach it. Gene is off, because transcription can’t happen.
3. Acetyl Transferase brings acetyl group and sticks them onto histones the + charges. The DNA wrapping loosens which allows the RNA polymerase access to the promoter.

D. Script for Acting Out the Immune System Response

Note to Teachers: This role play can be performed at many different levels. The script can be edited accordingly. Suggestions include

1. Perform a less complicated role play, so students just get the basics and a general idea of how the immune system works. Eliminating roles..ex. have only one type of CD4 T cell and/or B cell. Eliminate the Cytotoxic T cell. Eliminate the macrophage. Reduce the number of students playing each role.
2. Perform chosen script with teacher reading and directing students. Tell students that two of them will be chosen at random to be the director for a second and third read. Teacher can decide if students will swap roles or not for each performance.
3. Eliminate the script, assign roles and have students figure out how to make the performance happen.

E. Roles

Pathogen: 2-3 students
External Barriers
Host cells: 2-3 students
Mucus with Cilia: 2-4 students
Damaged cells:1-2 students
Innate immunity
Macrophage: 1-2 students
Mast cell: 1 student holding Histamine – 1 student
Dendritic cell: 1-3 students
Adaptive immunity
Bone Marrow: 1 student
Thymus: 1 student
CD4 "helper" T cells with various DNA sequences and receptors: 2-3 students standing in thymus in body
CD8 "Killer/cytotoxic" T cell: 1 student standing with Thymus
B Cells: 3-4 students standing in Bone Marrow
Regulatory T cell: as pathogens are controlled suppresses T cell proliferation: 1 student
Blood: 2-3 students
Lymph: 2-3 students

F. Director's Script

1. Mucus with cilia (2 students). Body is set up with tables as skin (if possible put one opening near a sink. Alternatively, clear an area of the room and use rope as the skin. Openings in the "skin" are lined with mucus/cilia.
2. Virus Pathogen (3-4 students with glove-antigens on a hand) get in through the mucus/cilia. One pathogen gets stuck in the mucus.
3. A Macrophage is sitting in the mucus and "eats" the stuck pathogen.
4. Mast cell in mucus binds pathogen.
5. Histamine is released from the mast cell and goes to blood vessel which will now let out dendritic cells to infection site.
6. Dendritic cell eats pathogen, takes off glove, and cuts off a couple of fingers from the glove. Then, puts the fingers on dendritic fingers.

Inside the body:

1. Bone Marrow (1 student) gives rise to B cells which go into the blood (2-3 students).
2. Thymus (1 student) gives rise to CD4 helper T cells (2-3 students) and cytotoxic T cell.
3. Cytotoxic T cell and Helper T cells moved by lymph to lymph node
4. 2 Pathogens attack host cell (2 students)
5. Dendritic cell is taken by lymph to the lymph node.
6. In lymph node, the dendritic cell contacts Helper T cell (1 student). The matching Helper T cell has test tube receptors that fit the antigen on the macrophage fingers.

7. Helper T cell sends out interleukin K which is carried by lymph and finds matching receptor on cytotoxic T cell (1 student).
8. Cytotoxic T cell has something pointed (a dropper or pencil) and pokes an infected host cell to kill it and the pathogen virus.
9. Helper T releases interleukin B1 into the lymph. Interleukin B1 "fits" receptor on B cell. B cell multiplies.
10. B cell makes antibodies (test tubes that fit antigen glove on virus). The antibodies are released into the blood.
11. Blood carries antibodies around. When near virus they stick the test tube antibodies onto the glove antigens.
12. Macrophage 2 eats the coated virus.
13. Helper T sends out Interleukin RT into the lymph
14. Lymph carries interleukin RT and it contacts Regulatory T Cell (1 student)
15. White blood cells congregate in the lymph node (swollen lymph node)

G. Allergic Response Script

1. Follow the same script as the pathogen exposure, except now the pathogen is an allergen student and the antibody made is an IgE antibody instead of an IgG antibody. This will represent the first exposures to the allergen when no allergic response occurs. Two IgE antibodies should stick to the Mast cell

2. Now the body will be exposed to the allergen again, but the initial response by the mast cell will be different because the mast cell now has specific IgE antibodies that will recognize the shape of the allergen.

   a. Mucus with cilia (2 students). Body is set up with tables as skin (if possible put one opening near a sink. Alternatively, clear an area of the room and use rope as the skin. Openings in the "skin" are lined with mucus/cilia.
   b. Allergen (3-4 students with glove- allergen antigens on a hand) get in through the mucus/cilia. One allergen gets stuck in the mucus.
   c. Mast cell in mucus binds pathogen. The two IgE antibodies will stick to an allergen.

      Lots of Histamine is released from the mast cell and goes to

      *the sink, causing runny nose and eyes (turns on sink to represent this)

*blood vessel which will now let out dendritic cells to infection site. This can cause fluid collapse of blood vessels (anaphylactic shock)

IV. Immune Response Analysis

IMMUNE RESPONSE ANALOGY

You will be writing an analogy story that compares an everyday event to an immune system's response to a pathogen. (Note: An analogy is a comparison between two different things and it tells how the two things are similar.) You will make a comparison between the immune response and some other event or situation that you think responds in a similar way. One possible analogy would be that a pathogen invading an organism is like an army invading a city.

I will make an analogy between the immune response and _____

_____.

Use the chart below to identify the job of the different parts of the immune system and the similar role in your analogy. Then, you can write your story. The story should be told with the analogy roles. Be sure that you show your understanding of the role of the character in the immune system by having the comparable part in the analogy act the same way. For example, if you are making the battle analogy, your Helper T Cell is the General. Your general should send signals just like the Helper T Cell sends signals to other immune cells.

Invader part/role	Job in the immune response	Comparable part in the analogy
Pathogen	the invading organism	
Antigen	the part of the invading organism that the host recognizes as foreign	
Host	the organism being invaded	
External Barrier to infection	skin, tears, acid in stomach or vagina, cilia/nose hairs, mucus, ear wax	
One		
Another one		
Nonspecific internal defense		
Macrophage	white blood cell in mucus and in lymph that eats pathogens and displays antigen on their membrane. Displayed antigen physically meets receptor on T cell to stimulate specific response.	
Histamine	chemical secreted by damaged cells that is a general summons to white blood cells and fluid. Causes runny eyes, nose and swelling.	
Specific Defense		
Helper T Cell	when contacted by macrophage, secretes interleukins to stimulate B cells and killer T cells	
Interleukins/lymphokines	chemical messengers between white blood cells	
B Cell	makes antibodies	
Antibody	protein made by B cells that is specifically shaped to match the antigen shape. Sticks all over pathogen stopping it from invading cells or moving.	
Cytotoxic T Cell/killer T cell	kills infected host cells	
Memory B Cell	B cell that remains after pathogen is eliminated so antibodies can be made quickly if invasion happens again in the future.	

Extra credit: Have the pathogen be spread by a vector or Make the story reflect the amount of time for immune response to happen.

Immune System Analogy Scoring Rubric

Category	A = Beyond Expectations, deep and thorough understanding of major concepts	B = Expectations met, understanding of major concepts	C = most expectations met, a few errors, general understanding of major concepts	D = some expectations made, many errors, some understanding of major concepts	F = few to no expectations met, major concepts not understood
Number of Analogies Made	An analogy is made for every word/concept assigned and some extra	An analogy is made for every word/concept assigned	An analogy is made for most of the words/concepts assigned	An analogy is made for a few of the words/concepts assigned	Few to no analogies are made
Quality of Analogies	Each word/concept analogy has a clear role in story which encompasses fine points of role in human body	An analogy is made for each word/concept that shows good understanding of basic role in human body	An analogy is made for most words/concepts that shows understanding of basic role in human body, a few analogies may show misconceptions	An analogy is made for some words/concepts that shows understanding of basic role in human body, many analogies do not show good understanding	Most analogies made do not show good understanding of the role of each concept/word in the human body
Creativity	Analogy is unique and presentation shows great creativity with both written and drawn components or an exceptional job of standard battle analogy is done	Analogy is standard battle analogy with some creative writing or visual components to the project	Analogy is made with no special effort at creativity	No effort at creativity is made	No project is done

General Comments:

V. Quiz

Matching:

____1. antibody	a. a disease causing organism
____2. antigen	b. general immunity
____3. macrophage	c. directs specific immunity
____4. pathogen	d. makes antibodies
____5. dendritic cell	e. part of the pathogen recognized as foreign
____6. innate	f. immunity against a specific pathogen
____7. CD4 helper T cell	g. proteins that match/immobilize pathogens
____8. Adaptive	h. displays the antigen to the host
____9. B cell	i. eats invading organisms

Open Responses
Select one question to answer from Group 1.

Group 1

1.1. Explain how something like a chemical in your diet or stress could change your genetic coding in a way that could be passed to your children.

1.2. Describe two ways that epigenetic markers could either turn on or turn off the gene.

1.3. It is important to protect the DNA of your reproductive cells from radiation and chemicals, so you don't get mutations in the genetic code that could be passed to your children. Through our discussion of epigenetics, you now know that a wider range of environmental exposure could change the DNA that is passed to your children. Explain how what you have learned may affect health decisions you make in your own life. Cite specific examples discussed in class.

Select one question to answer from Group 2.

Group 2

2.1. Explain why it is rare with some diseases (Ex. chicken pox) to suffer from the disease more than once, but with other diseases (Ex. flu, common cold, etc.), you can get sick over and over again. Use the following vocabulary: Antigen, Antibody, DNA, Memory B cell.

2.2. Explain how a person's body recognizes that a foreign organism is present in the body. Use the following terms in your response: antigen, host, marker protein, pathogen.

2.3 Your body is exposed to many potentially disease causing organisms each day, yet you only get sick once in a while. Explain why this happens.

V. Quiz Answer Key

Matching:

g 1. antibody	a. a disease causing organism
e 2. antigen	b. general immunity
i 3. macrophage	c. directs specific immunity
a 4. pathogen	d. makes antibodies
h 5. dendritic cell	e. part of the pathogen recognized as foreign
b 6. innate	f. immunity against a specific pathogen
c 7. CD4 helper T cell	g. proteins that match/immobilize pathogens
f 8. Adaptive	h. displays the antigen to the host
d 9. B cell	i. eats invading organisms

Open Responses

Select one question to answer from Group 1.

Group 1 – maximum of 4 points

1.1. Explain how something like a chemical in your diet or stress could change your genetic coding in a way that could be passed to your children.

Rubric – maximum of 4 points

1 point - Diet or stress changes methylation/acetylation/tightness of coiling of DNA

1 point - methylation/acetylation/tightness of coiling must happen in a reproductive cell

1 point - reproductive cell DNA with epigenetic marker is passed to offspring

1 point – cohesive explanation

1.2. Describe two ways that epigenetic markers could either turn on or turn off the gene

Any of the options below/ 2 points each, maximum of 4 points

- *Methylation in regulatory region blocks RNA polymerase from access to the DNA*
- *Acetylation of histone loosens DNA wrapping around histone, allowing access to RNA polymerase*

1.3. It is important to protect the DNA of your reproductive cells from radiation and chemicals, so you don't get mutations in the genetic code that could be passed to your children. Through our discussion of epigenetics, you now know that a wider range of environmental exposure could change the DNA that is passed to your children. Explain how what you have learned may affect health decisions you make in your own life. Cite specific examples discussed in class.

Rubric 4 points maximum

Must mention at least 4

Eat fruit/vegetable, don't smoke, stay away from BPA, eat less red meat, reduce stress, get more exercise, eat some soy, eat more whole grains

Select one question to answer from Group 2.

Group 2

2.1. Explain why it is rare with some diseases (Ex. chicken pox) to suffer from the disease more than once, but with other diseases (Ex. flu, common cold, etc.), you can get sick over and over again. Use the following vocabulary: Antigen, Antibody, DNA, Memory B cell.

4 points maximum

2 points for correct use of all vocabulary words

1 point for diseases you only get once: DNA coding for the antigen does mutate/change

1 point for disease you get over and over: DNA coding for the antigen can mutate

2.2. Explain how a person's body recognizes that a foreign organism is present in the body. Use the following terms in your response: antigen, host, marker protein, pathogen.

4 points maximum

4= excellent overall understanding of the concept. All vocabulary used correctly.

3= may have left out or mis-used a vocab word or lacking some general understanding

2= has some understanding, but writing shows some major misconceptions

1= some but very little understanding, most vocabulary not used correctly

0= complete lack of understanding or not done

2.3 Your body is exposed to many potentially disease causing organisms each day, yet you only get sick once in a while. Explain why this happens.

4 points maximum

4= excellent general understanding of external barriers and innate and adaptive immunity. Good use of applicable vocabulary

3= Good general understanding of innate and adaptive immunity. Could use more specific vocabulary

2= some general understanding. Only a few applicable vocabulary words used

1= limited general understanding. Only a few applicable vocabulary words used