The Immune Response

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For Teachers

Introduction

The immune system is a complex network of cellular and molecular interactions, but unless it is overwhelmed we are unaware of its existence. A slight fever might be the only clue that our immune system is engaging in a complex fight against a pathogen.
In this program the three levels of defence are explored in isolation and as part of a disparate yet interconnected system. Through the use of clear animation the nature of our specific and nonspecific defence mechanisms is explained. Cell-based and protein-based immunity and the concept of 'self ' and 'non-self' are explored in detail.

Timeline

Recommended Resources

http://library.thinkquest.org/03oct/00520/

http://www.hhmi.org/biointeractive/disease/immunology_primer/01.html

http://nobelprize.org/educational/medicine/immunity/index.html

http://www.learner.org/courses/biology/units/infect/index.html

http://medmyst.rice.edu/

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Student Worksheet

Initiate Prior Learning

1. Why is it convenient to categorise disease into infectious and non-infectious disease?

   Classify the following diseases under these two headings Infectious Disease and Non-infectious Disease, in the table below.

Alzheimer's	*Anthrax*
Arthritis	*Asbestosis*
Cholera	*Cystic Fibrosis*
Diabetes	*Dwarfism*
Hepatitis	*HIV*
Influenza	*Leukemia*
Malaria	*Measles*
Obesity	*Tuberculosis*

Infectious Disease	Non-infectious Disease

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2. Think back to when you were last sick from an infectious disease.

   a) How did you know you were sick?

_____

_____

   b) What were the symptoms?

_____

_____

_____

_____

   c) How do you think you got this illness?

_____

_____

   d) How was the disease transmitted?

_____

_____

   e) What did you do to get better?

_____

_____

   f) What medicines or treatment did you get?

_____

_____

   g) How long before you started feeling better?

_____

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3. This program is about the immune system. What would you consider to be the components of the immune system? Check back after the video to see if you had all the components covered.

_____

_____

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_____

4. Think Pair Share. Systems. Can you name the other systems in the human body and their roles? Write down as many as you can. Pair up with someone else and finally your list with the class. Fill in any information you missed.

Body System	*Tissue/Organs*	*Function*

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Active Viewing Guide

The first line of defence

1. List the components of the First Line of Defence.

_____

_____

_____

2. Natural flora are a component of the first line of defence. How would a probiotic drink that contains large numbers of non-pathogenic bacteria potentially assist in defence against disease?

_____

_____

_____

The second line of defence – protein-based responses

3. Circle which of the following is a subclass of Cytokines:

   Complement Proteins or Interferons

4. What advantage(s) result from interferon ability to act quickly and over short distances when fighting pathogens such as the flu virus?

_____

_____

_____

5. Name the three roles of complement proteins.

_____

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The second line of defence – cell-based responses

6. Outline the five steps involved in phagocytosis

_____

_____

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7. Inflammation, clotting and fever are often the only visible signs that you are fighting an infection. Why might taking medicines that reduce inflammation or reduce fever actually be counterproductive?

_____

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8. Categorise the following under the appropriate heading in the table below.

Identity of Pathogen unimportant.

Identity of Pathogen critical.

Has Memory.

No Memory.

Same Response.

Differential Response.

Specific	Non-Specific

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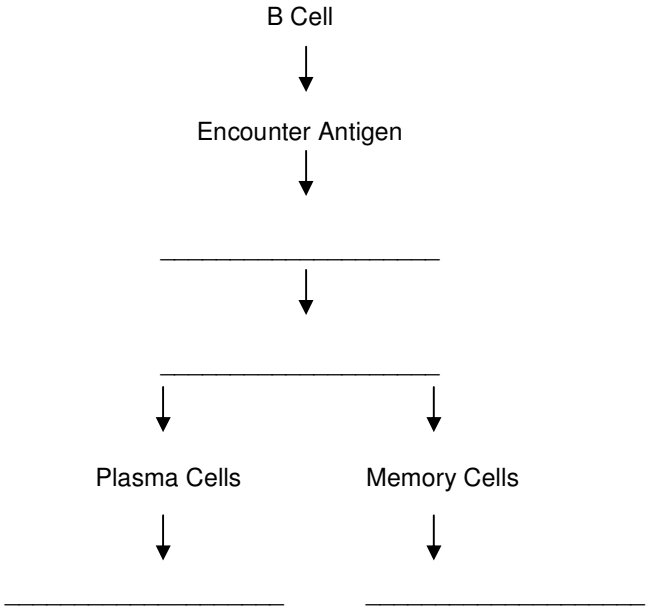
The third line of defence- Humoral Immunity

9. Fill in the missing words from the Clonal Selection Theory below

Clonal Selection Theory



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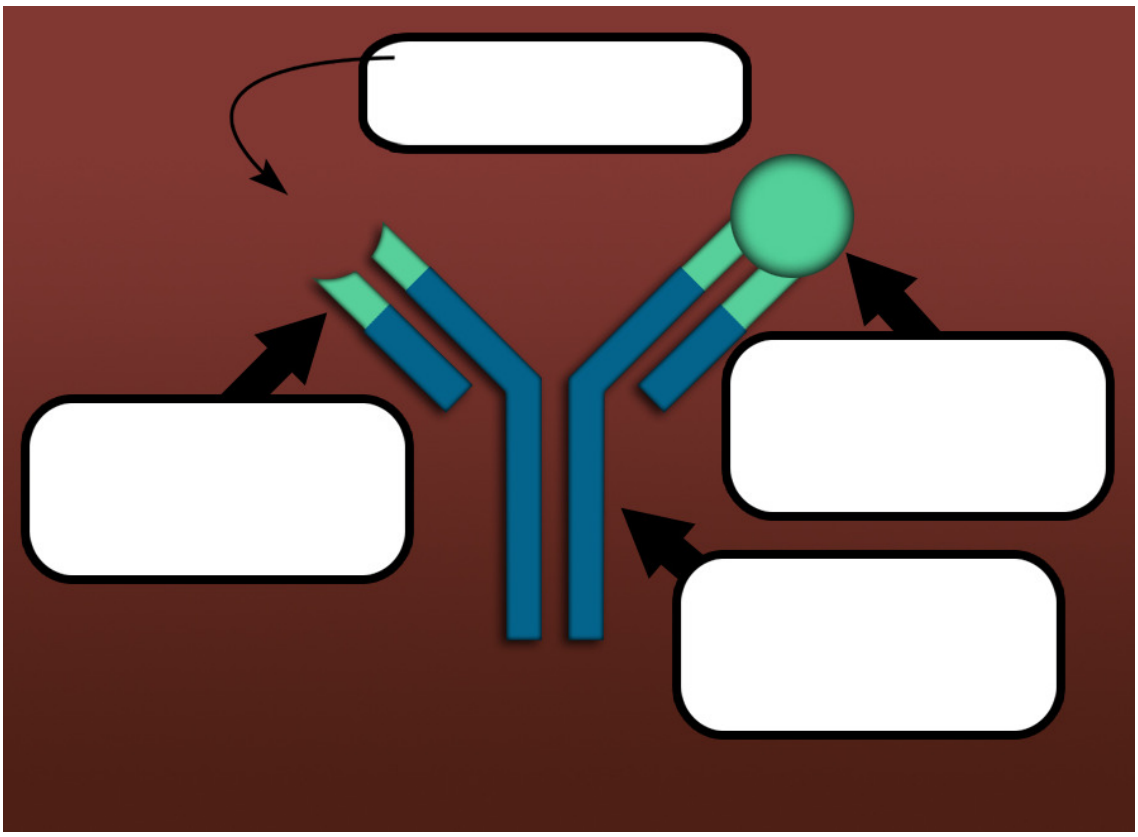
10. Label the diagram of an Antibody-Antigen Complex using the supplied labels.

Constant Region Variable Region Antigen Binding Site Antigen



11. Explain how it is possible to have billions of possible antibodies. Imagine you are trying to tailor this explanation to someone with very little science background - how would you explain the concept clearly?

_____

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Extension Activities

1. Analogies - Making the abstract more concrete

   There is a range of analogies that could be used to describe the functions of the immune system. Think about a situation that might fit with what you have learned about the immune system, the three lines of defence, and the components of these defence systems, and develop an analogy. Some ideas for contexts to get you started include, armed forces defending a territory, police and judiciary defending society, a sports team defending territory, a computer game. Write up your analogy with as many connections as you can find.

   Did you find the task straightforward? Was it possible to fit all the components and interactions of the immune system convincingly into your analogy?

2 Prepare a mind map showing the interrelationships between the components of the immune system

3. Looking at it from the other side:

   What would a pathogen see? Imagine a bacteria or virus' journey of invasion
   Choose a pathogen and detail how it gets past those levels of defence in order to make you sick

4. It's hard to imagine but the Germ Theory was only widely accepted in the late 1800's. There were a range of theories to explain disease including the Miasma theory which held that foul smelling 'bad' air was responsible for diseases such as cholera. The theory led to improvements in urban design, such as preventing air from sewers entering houses, and drainage systems designed to reduce pools of stagnant water in cities like London.

   a) Why would the subsequent reduction in infection following such improvements in sanitation support the Miasma theory?

   b) Explain why the improvements in sanitation are better explained using your understanding of germ theory and the fact that Vibrio cholerae is the bacterium responsible. You might wish to find out more about this bacteria and work of John Snow in uncovering evidence to support the Germ Theory http://en.wikipedia.org/wiki/John_Snow_(physician)

5. The discoverers. There have been a total of eleven Nobel Prizes awarded to the Scientists who have uncovered the intricacies of our defence against disease. Go to the following link http://nobelprize.org/nobel_prizes/medicine/immune_responses.html and find out more.

   Choose one scientist and create a short summary of their biography and/or contribution.
   Can you find out why they chose science and immunology in particular as a career?

6. The vaccination debate: There is some debate about the efficacy and safety of vaccination but the nature of the debate is at least as interesting as the debate itself!
   Look at the Australian Vaccination Networks Website http://www.avn.org.au/, search for information about Dr Andrew Wakefield. Finally http://www.youngausskeptics.com/ and search for AVN. Select one side of the argument and write a compelling report in favour of it or as a class, debate the issues regarding vaccination.

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Suggested Student Responses

Initiate Prior Learning

1. Why is it convenient to categorise disease into infectious and non-infectious disease?
   An infectious disease is caused by some agent such as a bacteria, virus, or fungi, whereas a non-infectious disease is internal in origin. While there may be a genetic basis (for example cystic fibrosis) which means that it can be inherited, it does not require a pathogen.

   Classify the following diseases under these two headings Infectious Disease and Non-infectious Disease, in the table below.

Alzheimer's	*Anthrax*
Arthritis	*Asbestosis*
Cholera	*Cystic Fibrosis*
Diabetes	*Dwarfism*
Hepatitis	*HIV*
Influenza	*Leukemia*
Malaria	*Measles*
Obesity	*Tuberculosis*

Infectious Disease	Non-infectious Disease
Tuberculosis **Influenza** **Malaria** **HIV** **Hepatitis** **Measles** **Anthrax** **Cholera**	**Diabetes** **Cystic Fibrosis** **Obesity** **Alzheimer's** **Arthritis** **Dwarfism** **Asbestosis** **Leukemia**

2. Think back to when you were last sick from an infectious disease.
   Answers will vary

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3. This program is about the immune system. What would you consider to be the components of the immune system? Check back after the video to see if you had all the components covered.
   Answers will vary but could include:
   Lymphatic System, Skin, lymphocytes eg Macrophages, T Cells, B Cells. Complement System Proteins such as Antibodies. Interferon, Cytokines.

4. Think Pair Share. Systems. Can you name the other systems in the human body and their roles? Write down as many as you can, Pair up with someone else and finally share as a class your list. Fill in any information you missed.

Body System	*Tissue/Organs*	*Function*
Digestive system:	**mouth, esophagus, stomach and intestines.**	**Digestion of food**
Cardiovascular system:	**heart, arteries and veins**	**Circulation of blood**
Endocrine system:	**Glands such as Thyroid, Adrenal, Pituitary, Hypothalamus, Testes, Ovaries**	**Production of hormones whose role is coordination and control.**
Urinary system:	**Bladder, kidney, ureter, urethra**	**eliminating wastes from the body**
Integumentary system	**skin, hair and nails**	**Protects body from physical damage. The point of interaction with external environment.**
Muscular system	**muscles**	**movement**
Nervous system:	**brain and nerves**	**collecting, transferring and processing information**
Reproductive system	**sex organs penis vagina, Uterus, Testes, Ovaries**	**To produce offspring.**
Respiratory system	**Lungs, airways, Diaphragm**	**With the circulatory system responsible for delivering oxygen and removing Carbon dioxide.**
Skeletal system	**Bones, ligaments, tendons, muscles and cartilage.**	**structural support and protection through**

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Active Viewing Guide

The first line of defence

1. List the Components of the First Line of Defence.
   Skin
   Sweat
   Mucous
   Saliva
   Stomach Acid
   Tears
   Natural Flora

2. Natural Flora are a component of the first line of defence. How would a probiotic drink that contains large numbers of non-pathogenic bacteria potentially assist in defence against disease?
   Large numbers of non-pathogenic bacteria compete for resources, food and water with pathogenic bacteria. Therefore, taking a drink with non-pathogenic bacteria may possibly reduce the numbers of potentially pathogenic bacteria.

The second line of defence – protein-based responses

3. Circle which of the following is a subclass of Cytokines:

   Complement Proteins or **Interferons**

4. What advantage(s) result from interferon ability to act quickly and over short distances when fighting pathogens such as the flu virus?
   Interferons act quickly prior to activation of specific defences overwhelming relatively small numbers of invaders. By working at short distances they can contain infections to point of entry.

5. Name the three roles of complement proteins.
   Attach
   Attract Phagocytes
   Destroy Membrane

The second line of defence – cell-based responses

6. Phagocytosis- Outline the five steps involved in this cell eating process.
   Stages of Phagocytosis include Chemotaxis (Attraction) Adherence (Sticking to Pathogen) Engulfment (By Pseudopodia) Formation Phagosome (Membrane-encased pathogen) Destruction (Lysosomes fuse with phagosome causing destruction)

7. Inflammation, clotting and fever are often the only visible signs that you are fighting an infection. Why might taking medicines that reduce inflammation or reduce fever actually be counterproductive?
   Both inflammation and fever have a role in fighting the pathogen. Inflammation is caused by dilation of blood vessels allowing more lymphocytes to enter the site of infection, Fever is a resetting of the body's core temperature which increases the rate of metabolism to fight the pathogen as well as retarding its growth. Medicines that prevent either inflammation or fever therefore inadvertently reduce the ability of the body to fight the infection.

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8. Categorise the following under the appropriate heading in the table below.

Identity of Pathogen unimportant. Identity of Pathogen critical.

Has Memory. No Memory.

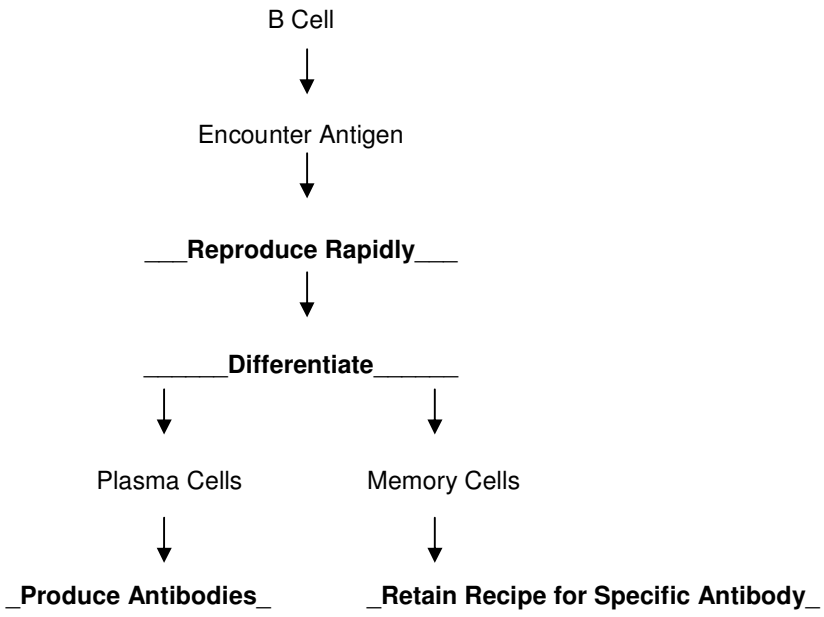
Same Response. Differential Response.

Specific	Non-Specific
Identity Pathogen critical	**Identity of Pathogen unimportant**
Has Memory **Differential Response**	**No Memory** **Same Response**

The third line of defence- Humoral Immunity

9. Fill in the missing words from the Clonal Selection Theory below

Clonal Selection Theory



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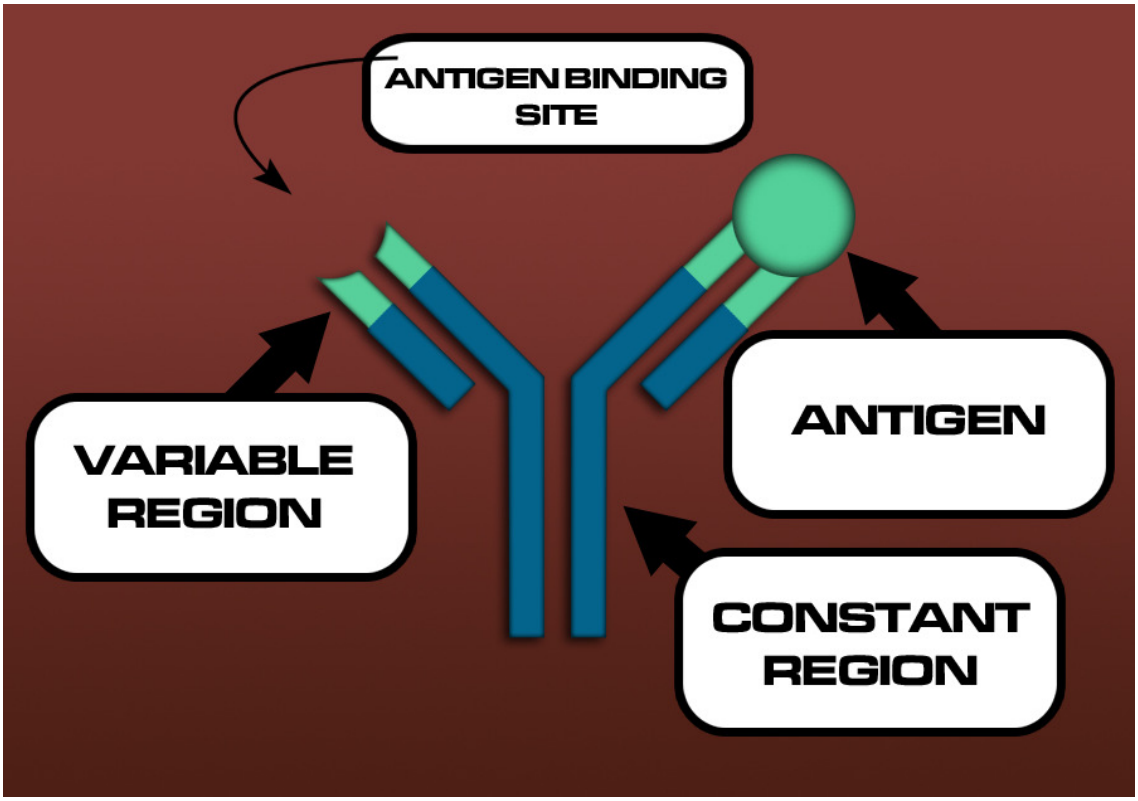

11. Explain how it is possible to have billions of possible antibodies. Imagine you are trying to tailor this explanation to someone with very little science background - how will you explain the concept clearly?

The billions of antibodies are created by constructing the variable region by mixing and matching a range of genes to form proteins with a unique combination of amino acids with unique antigen-binding properties.

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