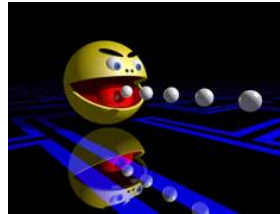


Regents Biology

IMMUNOLOGY?



Ann H Williams, PhD.

Associate Professor of Biology
University of Tampa, Tampa, FL

Regents Biology

Next Generation Sunshine State Standards

SC.912.L.14.52 Explain the basic functions of the human immune system, including specific and nonspecific immune response, vaccines, and antibiotics.

What are your successful strategies in teaching this standard?

What are your challenges in teaching this standard?

Regents Biology

Regents Biology

The specific information students should know about this benchmark are:

*Students will identify and/or explain the basic functions of the human immune system, including specific and nonspecific immune responses.

*Students will describe how the human immune system responds to vaccines and/or antibiotics.

*Students will explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspective of both individual and public health.

Regents Biology

Vision and Change in Undergraduate Biology Education: A Call to Action

Book published in 2011 by the American Association for the Advancement of Science which describes best practices and strategies for teaching Biology.

Some ideas from the book:


case studies/ scenarios in the classroom

role playing/play acting

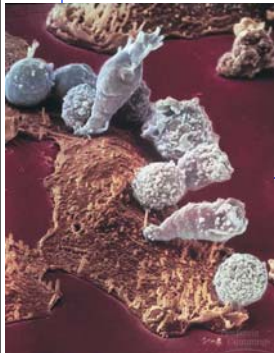
Regents Biology

Regents Biology

"Fighting the Enemy Within"

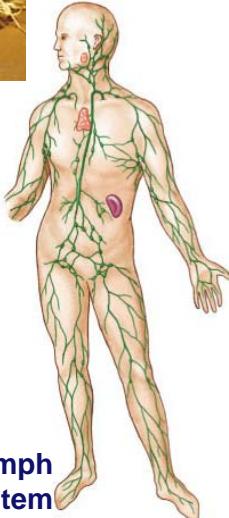


phagocytic leukocyte



lymphocytes attacking cancer cell

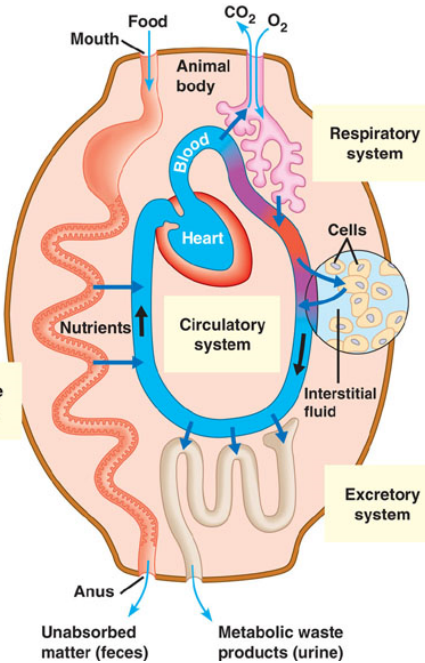
Immune System



lymph system

Avenues of attack

- **Points of entry**
 - ◆ digestive system
 - ◆ respiratory system
 - ◆ urinary system
 - ◆ genitals
 - ◆ break in skin
- **Pathways for attack**
 - ◆ circulatory system
 - ◆ lymph system

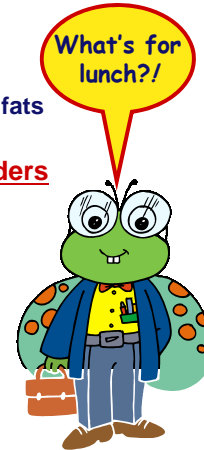


Regents Biology

Regents Biology

Why an immune system?

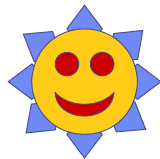
- **Attack from the outside & inside**
 - ◆ lots of organisms want you for lunch!
 - ◆ we are a tasty vitamin-packed meal
 - cells are packages of proteins, carbohydrates & fats
 - no cell wall
 - ◆ **animals must defend themselves against invaders**
 - **viruses**
 - ◆ HIV, flu, cold, measles, chicken pox, SARS
 - **bacteria**
 - ◆ pneumonia, meningitis, tuberculosis
 - **fungi**
 - ◆ yeast
 - **protists**
 - ◆ amoeba, Lyme disease, malaria
 - ◆ **cancer cells**
 - **abnormal body cells**



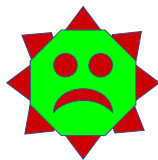
Re

How are invaders recognized?

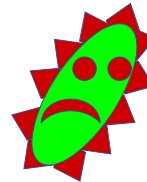
- **Antigens**
 - ◆ **chemical name tags on the surface of every cell**
 - “self” vs. “invader”



one of your own cells
antigens say:
“I belong here”



disease-causing virus
antigens say:
“I am an invader”



disease-causing bacteria
antigens say:
“I am an invader”

Regents Biology

Lines of defense

- **1st line: Barriers**
 - ◆ broad, external defense
 - “walls & moats”
 - ◆ **skin & mucus membranes**
- **2nd line: Non-specific patrol**
 - ◆ broad, internal defense
 - “patrolling soldiers”
 - ◆ **phagocyte (eating) WBCs**
- **3rd line: Immune system**
 - ◆ specific, acquired immunity
 - “elite trained units”
 - ◆ **lymphocyte WBCs & antibodies**
 - B & T cells



IMMUNOLOGY IS LIKE...







Regents Biology

Regents Biology

1st line: Physical Barriers

- non-specific defense
- external barriers
 - ◆ skin & mucus membranes
 - ◆ excretions
 - sweat
 - stomach acid
 - tears
 - mucus
 - saliva
 - ◆ “lick your wounds”




Lining of trachea: ciliated cells & mucus secreting cells

Regents Biology

2nd: Generalist, broad range patrols

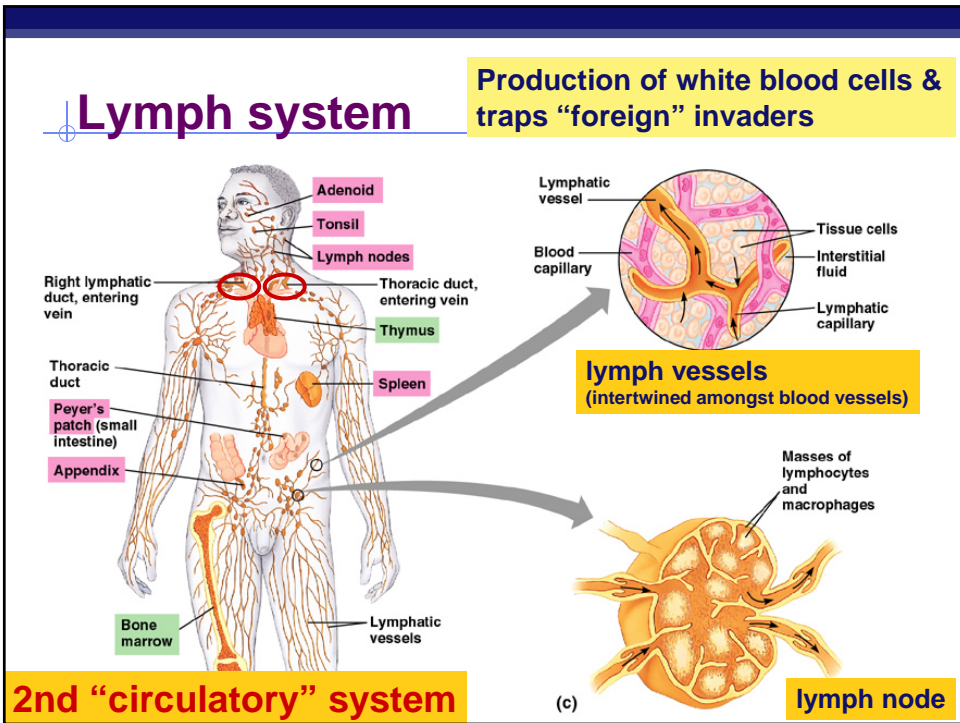
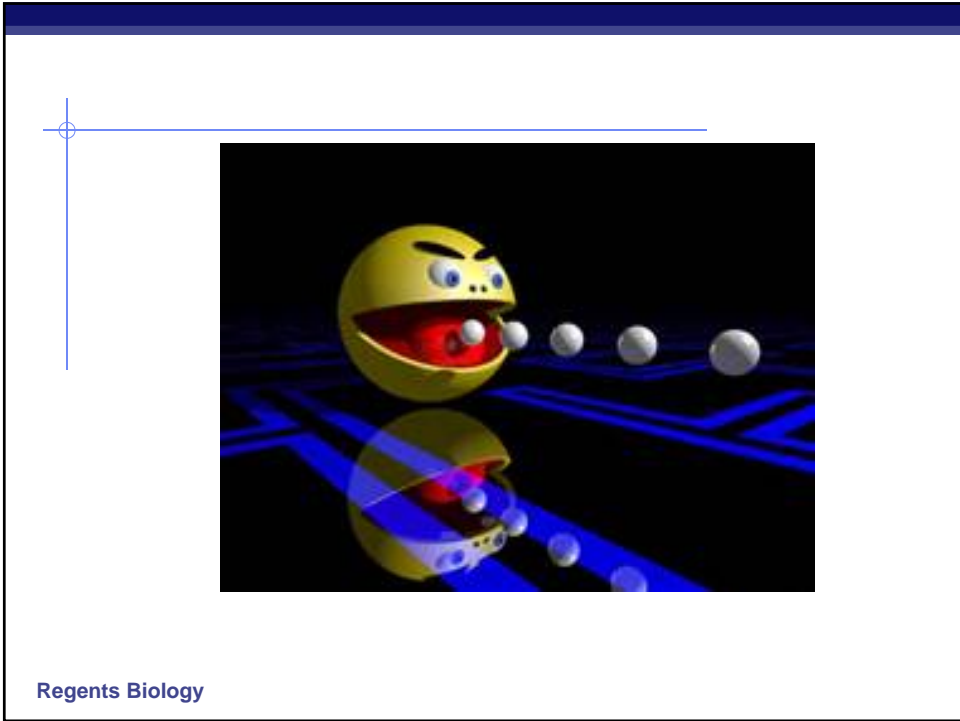
- Patrolling white blood cells
 - ◆ attack invaders that get through the skin
 - recognize invader by reading antigen
 - ◆ surface name tag
 - ◆ phagocyte cells
 - macrophages
 - “big eaters”



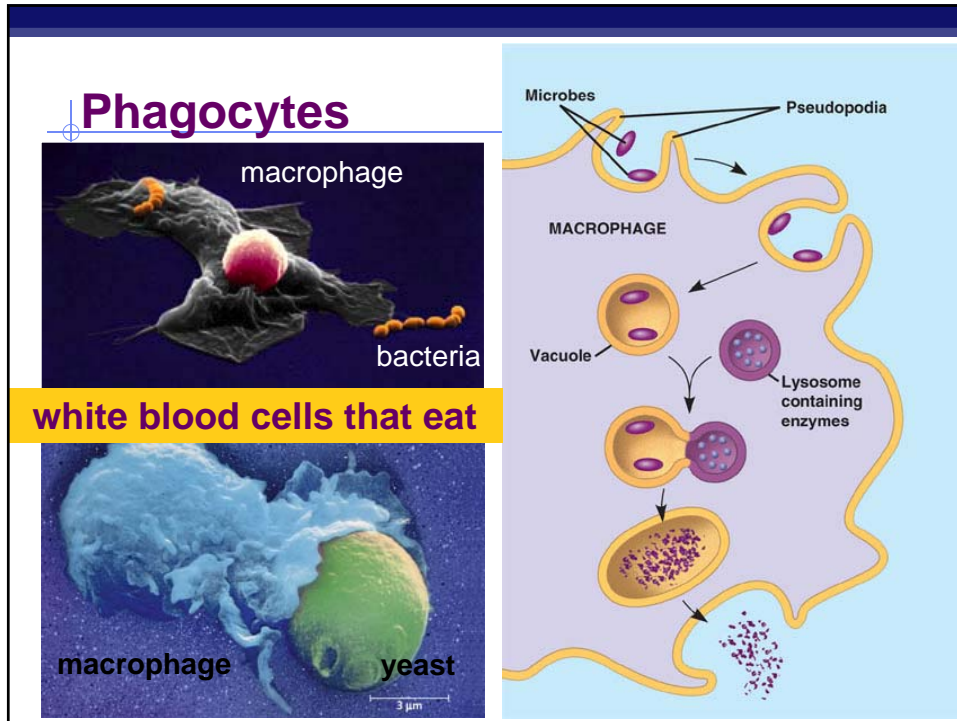
Macrophage “eating” bacteria

Regents Biology

Regents Biology



Regents Biology



Why do injuries swell?

- **Inflammation**
 - ◆ injured cells release chemical signals
 - **histamines**
 - ◆ increases blood flow
 - ◆ brings more white blood cells to fight bacteria
 - ◆ brings more red blood cells & clotting factors to repair

Pin or splinter
Bacteria
Chemical alarm signals
Blood vessel
Swelling
Blood clot
Phagocytes

Regents Biology

Regents Biology

Fever

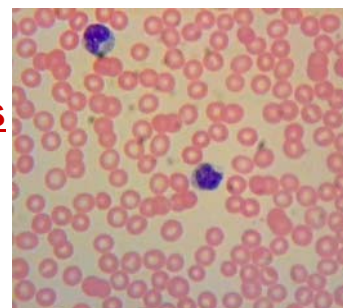
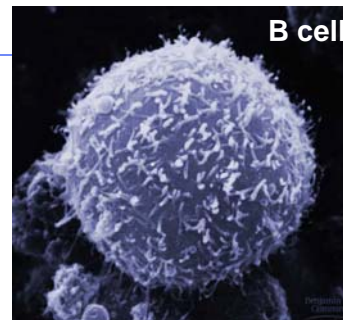
- **When a local response is not enough**
 - ◆ full body response to infection
 - ◆ raises body temperature
 - ◆ higher temperature helps in defense
 - slows growth of germs
 - helps macrophages
 - speeds up repair of tissues



Regents Biology

3rd line: Lymphocytes

- **Specific defense**
 - ◆ responds to specific invaders
 - recognizes specific foreign antigens
 - white blood cells
 - ◆ B cells & antibodies
 - ◆ T cells



Regents Biology

Regents Biology

B cells & antibodies

- **B cells**

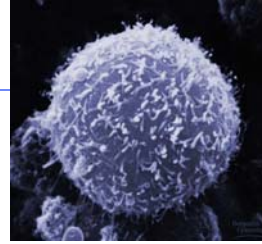
- ◆ white blood cells that attack invaders in blood
- ◆ mature in **B**one marrow

- **Plasma B cells (patrolling)**

- ◆ **make antibodies against invader immediately**

- **Memory B cells**

- ◆ **remembers invader**
- ◆ can make antibodies quickly the next time
 - protects you from getting disease more than once



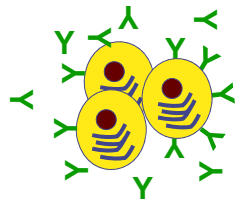
Regents Biology

Antibodies

- **Proteins made by B cells that tag invaders in the blood so macrophages can eat them**

- ◆ tag says “this is an invader” → gotcha!
 - biological “handcuffs”
- ◆ **antibody attaches to antigen of invader**

B cells releasing antibodies



invading germs tagged with antibodies




macrophage eating tagged invaders



Regents Biology

Regents Biology

Antibodies are like Clothespins
-clip onto antigen invader
Tail end is recognized by macrophage
DO NOT actually engulf microbe invader
Specific!!!!



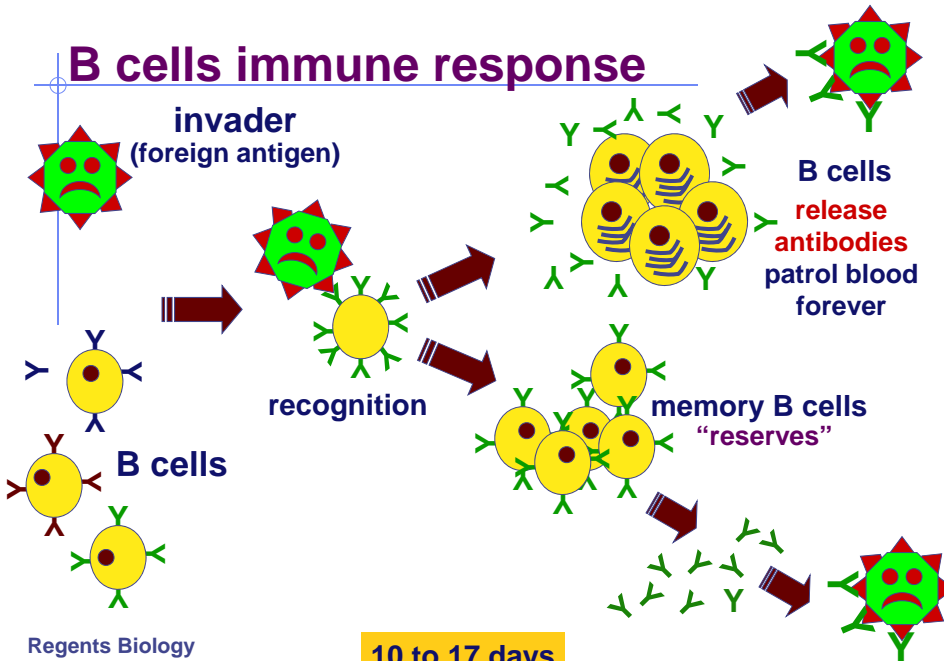
Macrophage

Infection

<http://www.youtube.com/watch?v=lrYIZJiuf18&feature=related>

Regents Biology

B cells immune response



invader (foreign antigen)

B cells

recognition

memory B cells "reserves"

B cells release antibodies patrol blood forever

10 to 17 days

Regents Biology

Regents Biology

Vaccinations

- **Exposure to harmless version of germ (DECOY)**
 - ◆ **stimulates immune system to produce antibodies to invader, but no disease**
 - ◆ rapid response if future exposure
- **Most successful against viral diseases**

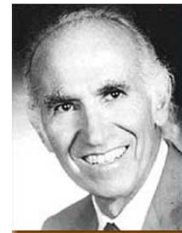


Regents Biology

1914 – 1995

Jonas Salk

- **Developed first vaccine**
 - ◆ against polio



April 12, 1955



Reg

Regents Biology

Polio epidemics

1994:
Americas polio free

Regents

Protecting you from disease

- **Vaccinations**
 - ◆ advantage
 - don't get illness
 - long term immunity
 - ◆ produce antibodies for life
 - works against many viruses & bacteria
 - ◆ disadvantage
 - not possible against all invaders
- **Breastfeeding**
 - ◆ mother's milk gives baby antibodies & keeps baby healthy`

IMPORTANT PROTECTION
antibodies pass from mother to baby in breast milk

Reg

Regents Biology

Deadly Hershey's Kiss



Regents Biology

Primary Response

1st time immune system sees antigen
B & T cells respond – slow & lower antibody production
Also makes B Memory cells (specific)

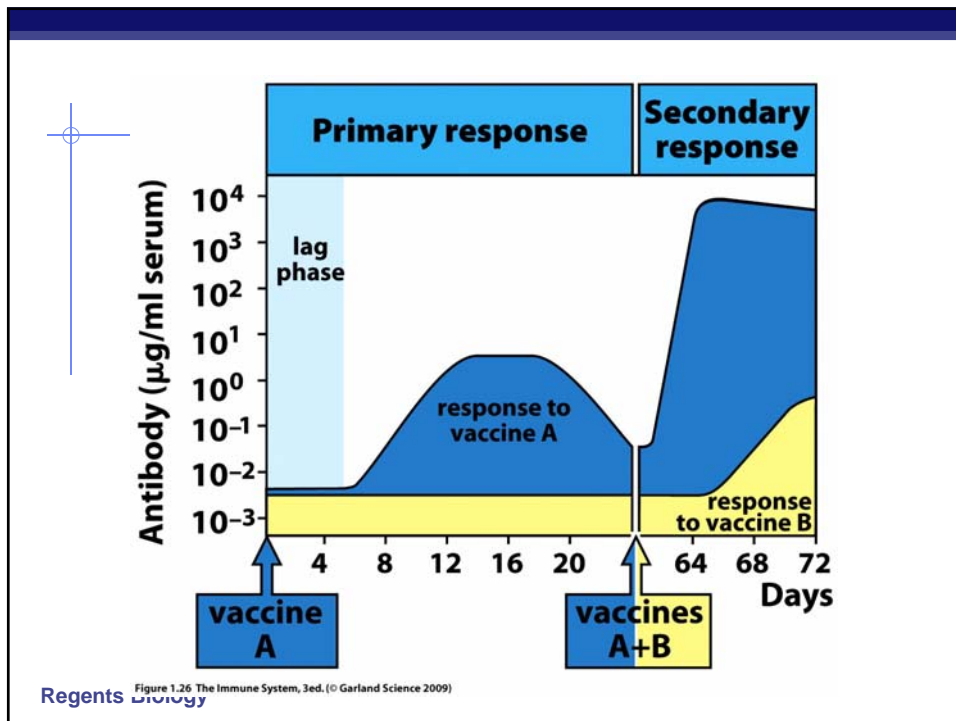
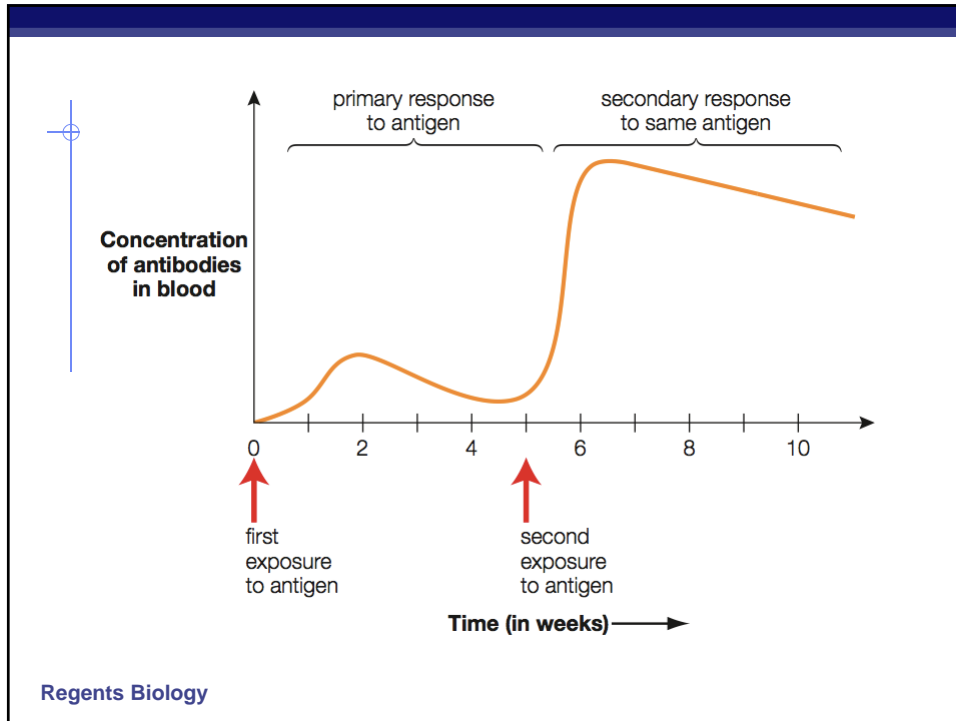
Secondary Response

2nd time immune system sees same antigen
B Memory cells respond – fast & higher antibody production

What is purpose of B Memory cells?

Regents Biology


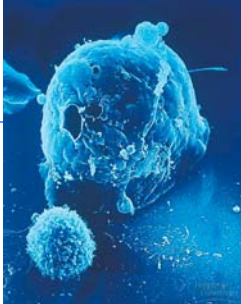
Regents Biology



Regents Biology

What if the attacker gets past the B cells in the blood & infects some of your cells?

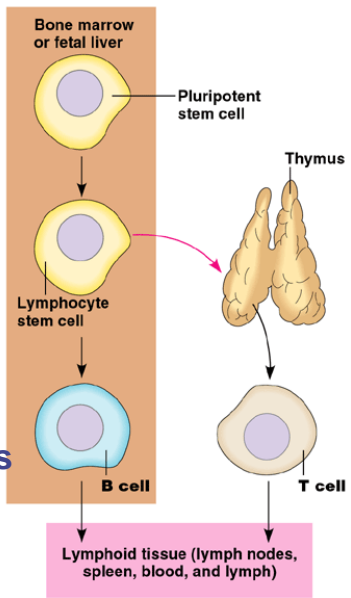

You need trained assassins to kill off these infected cells!

AP Biol

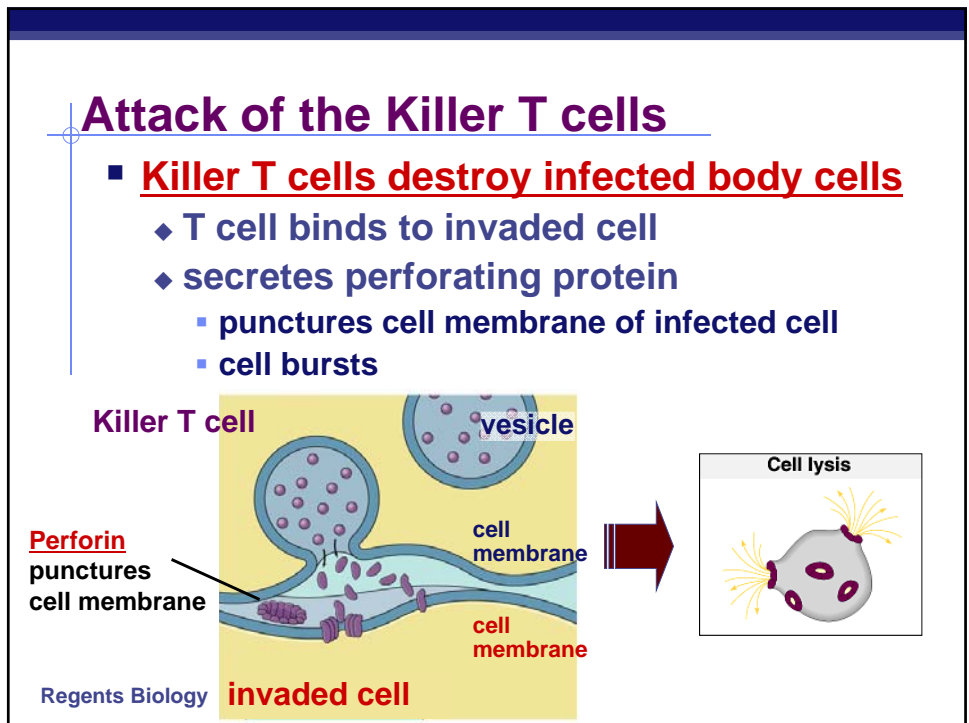
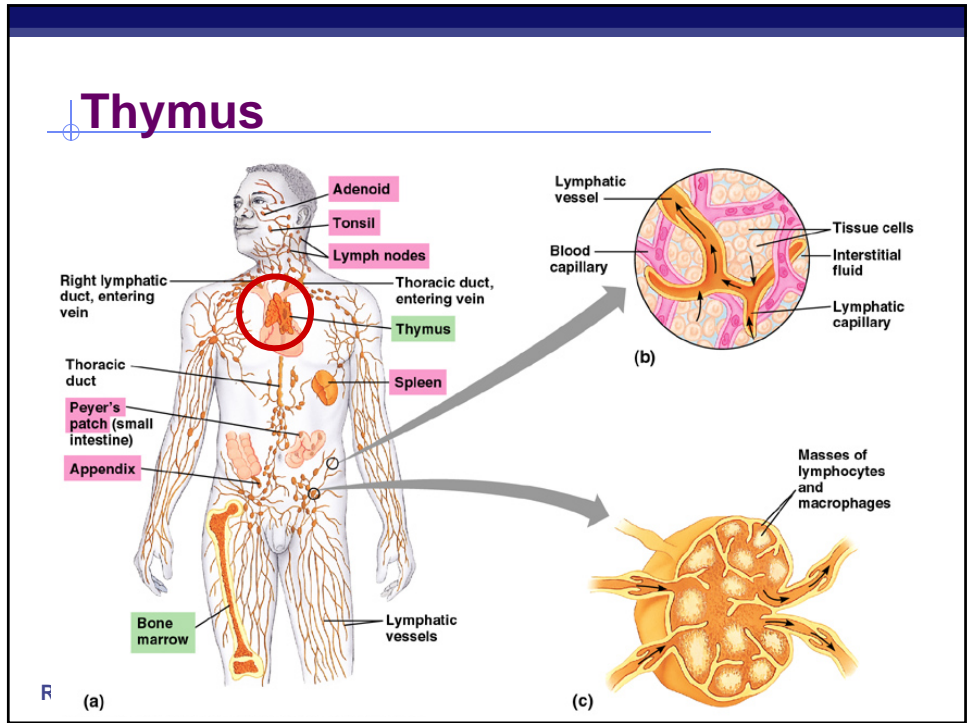
T cells

- T cells mature in Thymus
- Helper T cells
 - ◆ sound the alarm for rest of immune system
- Killer T cells
 - ◆ destroy infected body cells
- Memory T cells
 - ◆ remembers invader & reacts against it again quickly

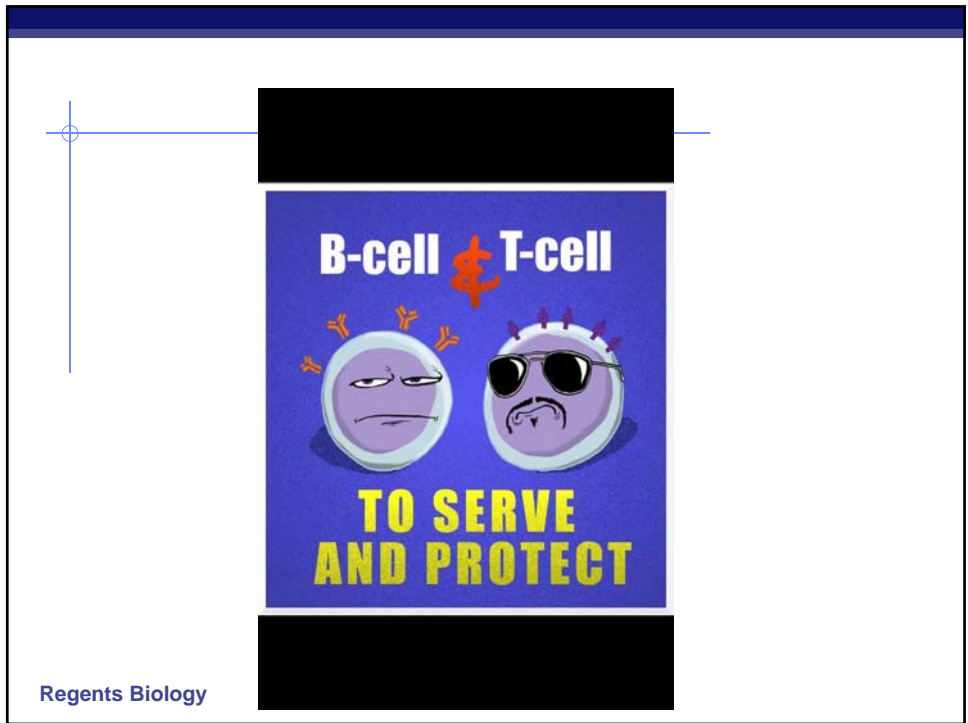
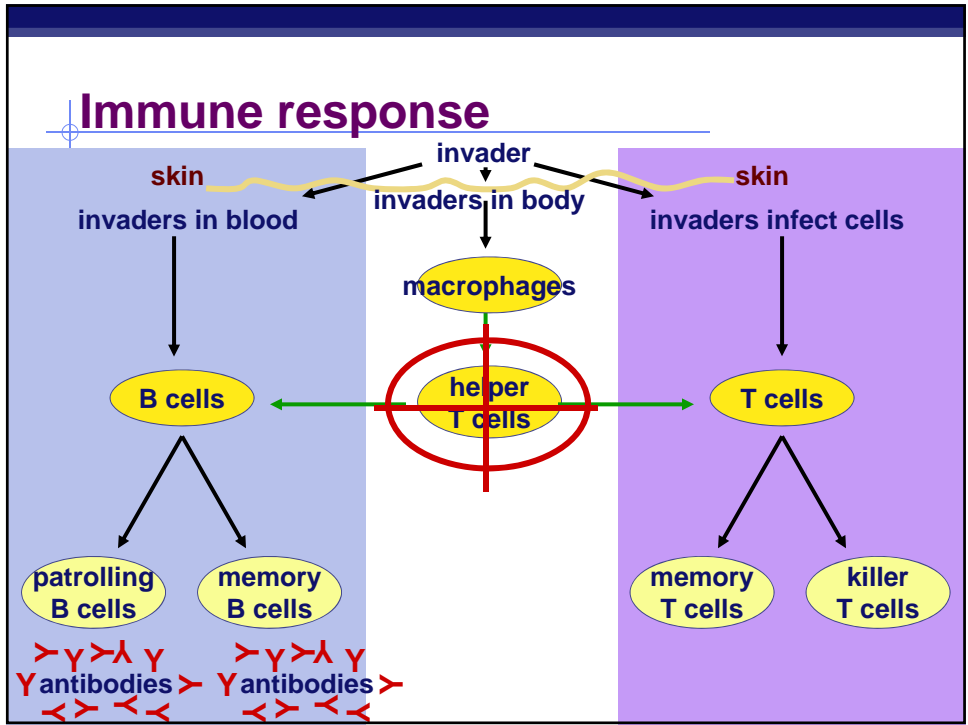



biology

Regents Biology



Regents Biology



Regents Biology

B & T cell & Specificity Game & Visual

- 1) Construction paper & shapes

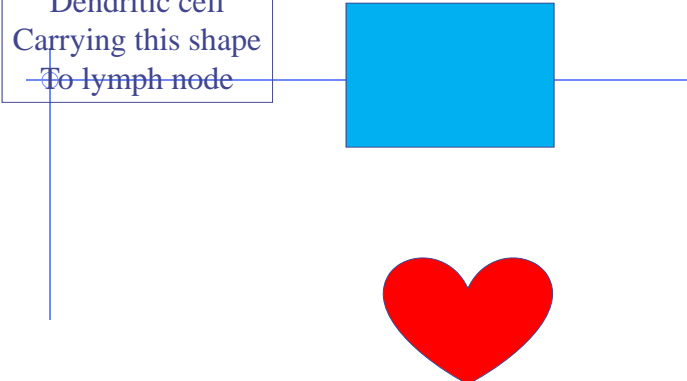
- 2) Visual with no props needed

Regents Biology

<u>B cells</u>	<u>T cells</u>
<div style="display: flex; align-items: center;"> <div style="border-left: 1px solid #000080; border-top: 1px solid #000080; width: 10px; height: 10px; margin-right: 5px;"></div> <div style="border-top: 1px solid #000080; width: 450px;"></div> </div> <p style="margin-top: 10px;">Receptor recognizes:</p> <ol style="list-style-type: none"> 1. Green circle 2. Blue star 3. Red smiley face 4. Yellow square 5. Red square 6. Purple heart 7. Blue rectangle 8. Green square 9. Red heart 10. Red star 11. Yellow oval 12. Purple rectangle 13. Black heart 14. Red circle <p style="margin-top: 10px;">Regents Biology</p>	<div style="border-left: 1px solid #000080; border-top: 1px solid #000080; width: 10px; height: 10px; margin-right: 5px;"></div> <div style="border-top: 1px solid #000080; width: 450px;"></div> <p style="margin-top: 10px;">Receptor recognizes:</p> <ol style="list-style-type: none"> 1. Black heart 2. Green circle 3. Red heart 4. Red smiley face 5. Yellow oval 6. Yellow square 7. Red square 8. Purple heart 9. Green square 10. Blue rectangle 11. Red star 12. Purple rectangle 13. Red circle 14. Blue star

Regents Biology

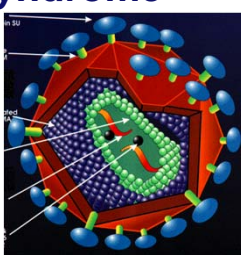
Dendritic cell
Carrying this shape
To lymph node



Regents Biology

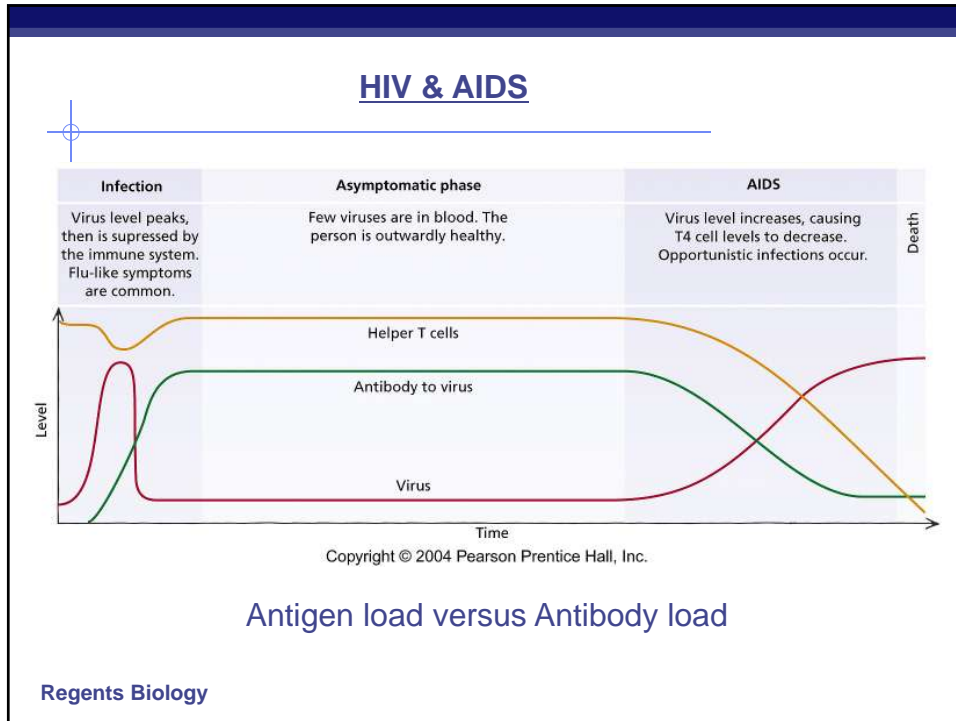
Diseases of the immune system

- **HIV: Human Immunodeficiency Virus**
 - ◆ **infects helper T cells**
 - ◆ helper T cells can't activate rest of immune system
 - body doesn't hear the alarm
- **AIDS: Acquired ImmunoDeficiency Syndrome**
 - ◆ **immune system is weakened**
 - ◆ **infections by other diseases**
 - ◆ death from other invading diseases or cancer



Regents Biology

Regents Biology



Curing you of disease




- **Antibiotics = medicine (decrease microbial load)**
 - ◆ **advantage**
 - **kill bacteria that have successfully invaded you**
 - ◆ **make you well after being sick**
 - ◆ **disadvantage**
 - **use only after sick**
 - **only good against bacteria**
 - **possible development of resistance by bacteria (if don't use correctly)**

Regents Biology can get sick again

Regents Biology

Immune system malfunctions


- **Auto-immune diseases**
 - ◆ immune system attacks own cells
 - **lupus**
 - ◆ antibodies attack many different body cells
 - **rheumatoid arthritis**
 - ◆ antibodies causing damage to cartilage & bone
 - **diabetes**
 - ◆ insulin-making cells of pancreas attacked & destroyed
 - **multiple sclerosis**
 - ◆ T cells attack myelin sheath of brain & spinal cord nerves
 - ◆ fatal

ogy

Immune system malfunctions

- **Allergies**
 - ◆ **over-reaction to harmless compounds**
 - **allergens**
 - ◆ proteins on pollen
 - ◆ proteins from dust mites
 - ◆ proteins in animal saliva
 - **body mistakenly thinks they are attackers**

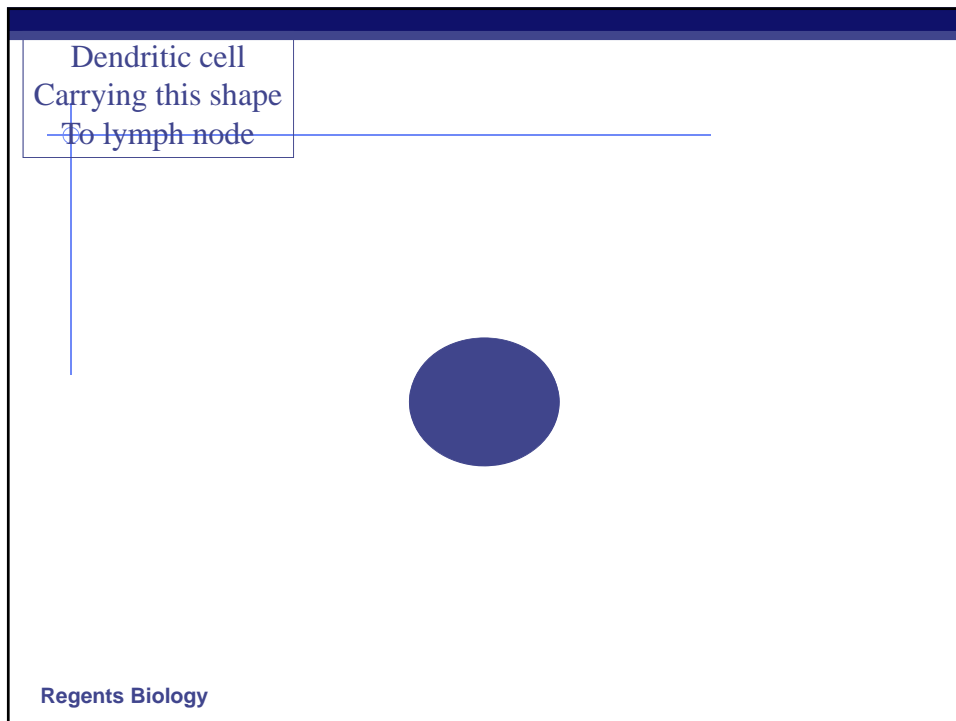


Regents Biology

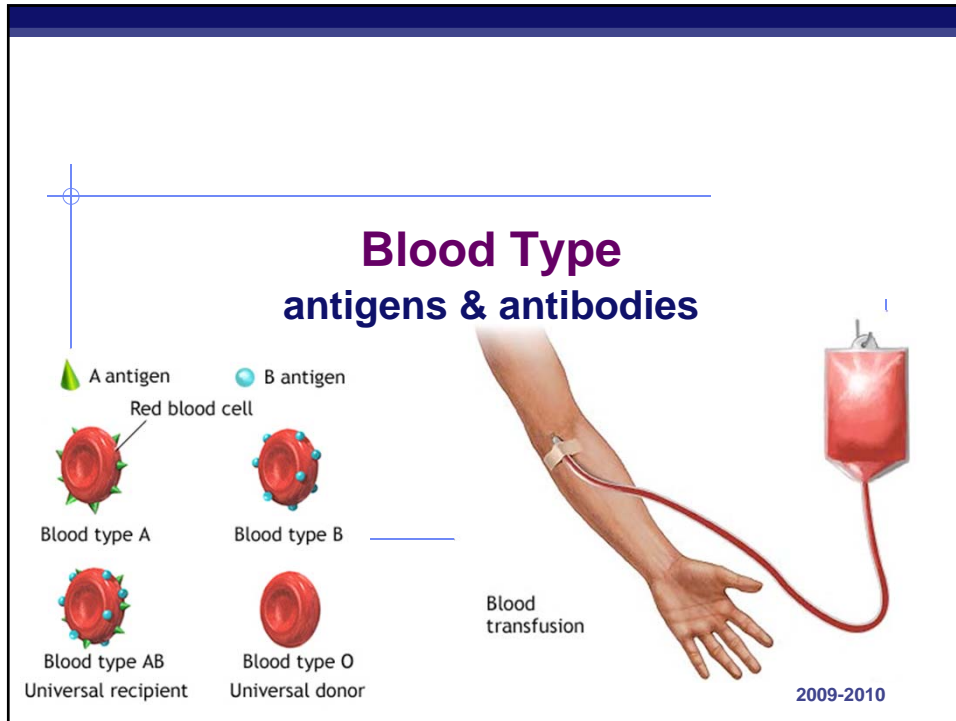
Regents Biology

<u>B cells</u>	<u>T cells</u>
Receptor recognizes:	Receptor recognizes:
1. Green circle	1. Black heart
2. Blue star	2. Green circle
3. Red smiley face	3. Red heart
4. Yellow square	4. Red smiley face
5. Red square	5. Yellow oval
6. Purple heart	6. Yellow square
7. Blue rectangle	7. Red square
8. Green square	8. Purple heart
9. Red heart	9. Green square
10. Red star	10. Blue rectangle
11. Yellow oval	11. Red star
12. Purple rectangle	12. Purple rectangle
13. Black heart	13. Red circle
14. Red circle	14. Blue star

Regents Biology



Regents Biology



















Blood type; antigens & antibodies

blood type	antigen on RBC	antibodies in blood	donation status
A			—
B			—
AB			
O			

Matching compatible blood groups is critical for blood transfusions
A person produces antibodies against foreign blood antigens

Regents Biology

Blood donation

(a) Phenotype (blood group)	(c) Antibodies present in blood serum	(d) Results from adding red blood cells from groups below to serum from groups at left			
		A	B	AB	O
A	Anti-B				
B	Anti-A				
AB	—				
O	Anti-A Anti-B				

Regents Biology

HOOK



Meningitis outbreak: UC Santa Barbara lacrosse player's feet amputated
[December 04, 2013](#) | By Alicia Banks and Carla Rivera

A University of California, Santa Barbara student had both of his feet amputated after he contracted meningitis in an outbreak that sickened three other students, school and health officials said. Aaron Loy, an 18-year-old freshman lacrosse player, had both of his feet amputated when the disease affected the blood supply to his limbs.

Regents Biology

Regents Biology

INFECTION

Immunology Game to
Visualize Immune Response to Infection,
Microbial load versus antibody load,
& Steps taken to clear Infection

WHO WILL WIN ?
MICROBE vs. IMMUNE SYSTEM

Primary & Secondary responses – specific & memory
-as a group of 5

Let's Play!

Regents Biology

You should have:

INFECTION introduction & case study sheet

Lymph node board

Immune system Game pack contents (bag of balls)

-instruction sheet

-picture key

Microbial load game pack contents (bags of beans, dice)

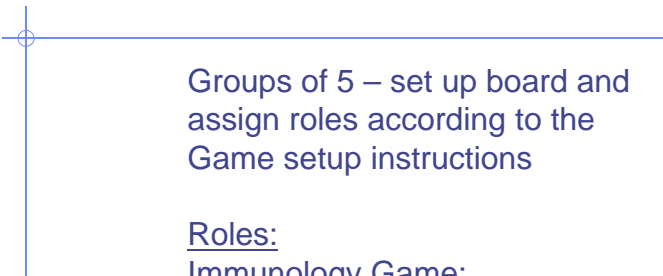
-instruction sheet

-Score card

-graphing components

Regents Biology

Regents Biology



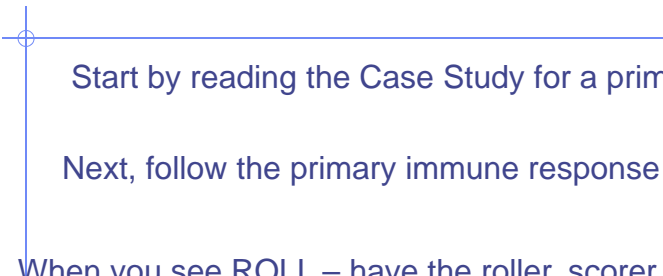
Groups of 5 – set up board and assign roles according to the Game setup instructions

Roles:

Immunology Game:
Reader
Piece mover

Microbial Load Game:
Die roller
Scorer
Bean person

Regents Biology



Start by reading the Case Study for a primary response

Next, follow the primary immune response instructions



When you see ROLL – have the roller, scorer, & bean person follow the directions on their bacterial load instruction sheet

Now read the Case Study for a secondary response

Follow the secondary immune response instructions

Regents Biology

Regents Biology



5 Groups to model different things

- 1) Specificity of Immune Response
- 2) Effects of HIV
- 3) Vaccinations
- 4) Autoimmune Issues
- 5) Princeton Meningitis Case

Read case study for each scenario and
then model the case study with the INFECTION game!

Regents Biology