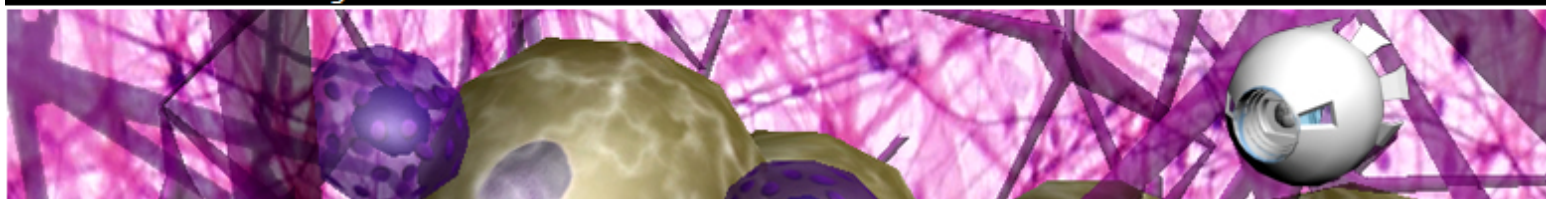




Grade & Topic: 9-12 The immune system, disease, and infection
Curriculum Expectations See website for regional curriculum expectations
Document Source: www.fas.org/immuneattack

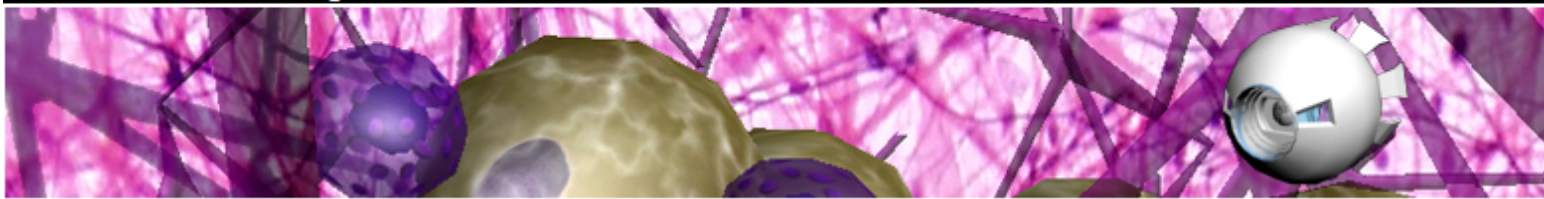
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Lesson Plan Overview

About <i>Immune Attack</i>	<i>Immune Attack</i> is an educational video game designed to engage and teach concepts of infection and the response of the human immune system. The game based around guided and self-directed learning and can be used in both the classroom and at home.
Curriculum Expectations	<i>Immune Attack</i> is suited for senior-level high school biology and entry level university students or as an extension exercise for general biology. Regional curriculum expectations can be found on the website at www.fas.org/immuneattack (click, Teachers Guide > Curriculum Alignments).
Game Objectives	<ul style="list-style-type: none">• The role of macrophages and neutrophils in the immune system.• The process of transmigration of monocytes.• How the body uses signals to find the site of infection.• How the body uses markers to recognize enemies.• How macrophages “call” neutrophils for “back up”
Materials Needed	<ul style="list-style-type: none">• PC computers, with speakers/headphones• High-speed Internet is required for download only• See page 6 for detailed system requirements
Classroom Use	<ul style="list-style-type: none">• Pre-game Discussion• Gameplay & My Learning Assistant (MyLA)• Post-game Discussion• Assessment
Recommended Background Knowledge	<ul style="list-style-type: none">• Basic cell anatomy.• Roles and functions of the major organelles.• The nature of the cell membrane and the extra-cellular matrix.• What a cell receptor is and the receptor’s role in cellular communication.
Assessment	<ul style="list-style-type: none">• Quiz• Discussion• Written assignments



Introduction

This lesson plan is designed to:

- help educators use *Immune Attack* in a classroom setting,
- illustrate how to connect *Immune Attack* to curriculum requirements, and
- help educators guide discussions about the immune system.

Immune Attack is educational computer game about the immune system and the cells involved in fighting a bacterial infection. The content is geared for senior level high school biology and first year university biology.

The game's storyline revolves around a girl who is confined indoors because she has a present yet nonfunctional immune system. Without active immune cells, exposure to bacteria and other pathogens in the outside world would quickly kill her. With the help of nanotechnology, users must activate specific immune cells so her body can fight infection and allow her to live a normal life.

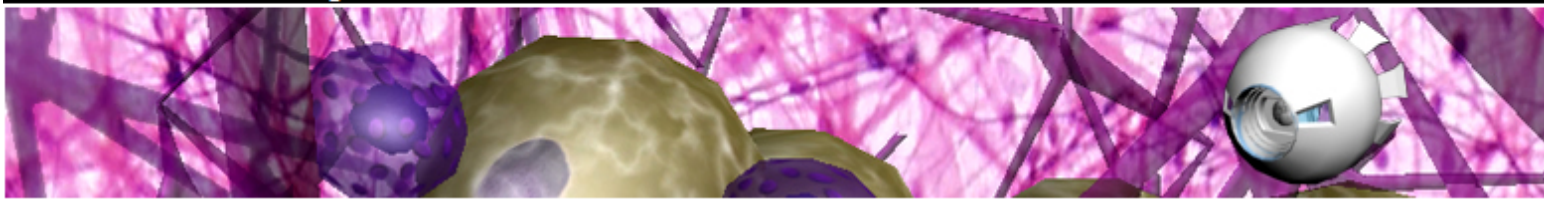
To play the game, users control a microscopic robot (the nanobot *explorer*) to navigate through a first-person 3D body, completing a series of increasingly sophisticated missions to detect a bacterial infection and activate the appropriate defensive immune cells. These stepwise missions follow the actual biological process that occurs during an infection and how immune cells are stimulated to kill the bacteria.

Immune Attack is a scientifically vetted supplemental teaching tool, designed to be used in conjunction with HS and freshman college biology textbooks, such as *Immunobiology* by Janeway, *Biology: Exploring Life* by Campbell, Williamson & Heydon; *Prentice Hall Biology* by Miller & Levine; and *Biology* by Campbell & Reece.

Curriculum

Immune Attack was designed around the latest scientific knowledge about the immune system; its educational approach was guided by varying United States based curriculums. As the content of *Immune Attack* is primarily for the high school senior's biology level, this lesson plan was written for grade 11 or 12 biology teachers. As curriculum varies by region, it is important to identify your curriculum expectations to be able to connect them with the content in *Immune Attack*. To find out about immunology related curriculum codes and expectations in you area, please view the regional **Curriculum Alignment** documents on the *Immune Attack* website at www.fas.org/immuneattack (click, **Teachers Guide > Curriculum Alignments**). Together, using this lesson plan and your specific curriculum expectations, a lesson or lessons incorporating *Immune Attack* will produce a rich and engaging learning experience in your classroom.

For additional information about teaching with *Immune Attack*, including learning objectives, questions for students, vocabulary, additional information about the immune system, please refer to the teachers guide page on the website at www.fas.org/immuneattack (click, **Teachers Guide > Curriculum Alignments**).



Immune Attack Content Expectations:

Immune Attack contains a tremendous amount of visual, audio, and text content. Based on your regional curriculum expectations you can guide the level of detail your students should be extracting from the game and parallel that information with class discussions. Generally, by playing the game, students will learn about components and functions of a number of major immune system components including:

- The general composition of blood.
- What are monocytes.
- How monocytes can move from the blood stream into the tissue.
- What is a macrophage and what does it do.
- What is a neutrophil and what does it do.
- How immune cells find their way to a site of infection.
- How the immune systems deals with two different types of pathogenic bacteria.

Curriculum Specific Expectations:

As noted above, specific expectations will vary from state to state and country to country. Please refer to the **Curriculum Alignment** documents on the *Immune Attack* website at www.fas.org/immuneattack (click, **Teachers Guide > Curriculum Alignments**). For more information about teaching with *Immune Attack* and your curriculum expectations, please refer to the teachers' page on the website at www.fas.org/immuneattack/teachers.

Recommended Background Knowledge

Immune Attack deals with aspects of the immune system on the whole-cell level and specific sub-cellular structures. Students are recommended to already have a general understanding of:

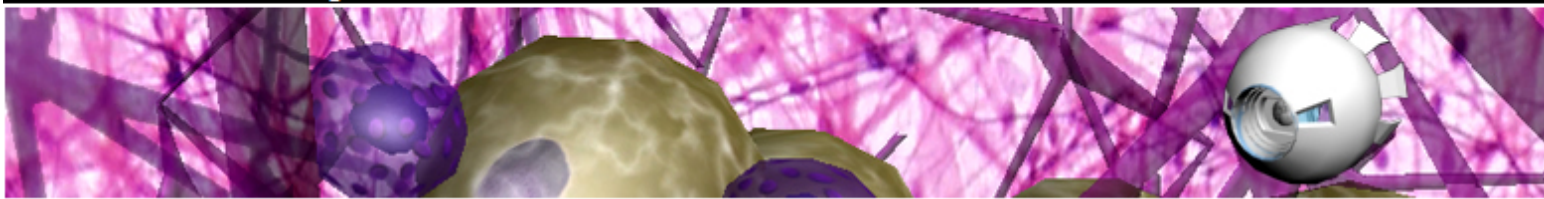
- Basic cell anatomy
- Roles and functions of the major organelles
- The nature of the cell membrane and the extra-cellular matrix
- What a cell receptor is and the receptor's role in cellular communication.



Learning Objectives Embedded in *Immune Attack*:

By working through the missions in *Immune Attack*, students will gain direct knowledge on the following functions of the immune system:

1. The role of macrophages and neutrophils in the immune system, including:
 - that they are the body's first responders to infection
 - that they fight bacterial infections
 - that they "eat" bacteria (phagocytosis)
2. The process of transmigration of monocytes, including:
 - that monocytes flow in the blood vessels
 - that selectins help monocytes "slow down"
 - that ICAMs help monocytes to "stop"
 - that ICAMs help monocytes to move through the blood vessel wall and into the connective tissue
 - that once a monocyte has entered the connective tissue, it is known as a macrophage
3. How the body uses chemical signals to find the site of infection, including:
 - that macrophages and neutrophils find the site of infection by following a chemical trail
 - that macrophages follow a chemical trail of C3a
4. How the body uses markers to recognize enemies, including:
 - how macrophages and neutrophils recognize LPS as an indicator of bacteria
5. How macrophages "call" neutrophils for "back up":
 - by releasing a chemical signal of CXCL8 molecules



Materials Needed:

Computers:

PC Computers with a monitor, computer speakers, standard US keyboard, standard 2 button mouse, and the *Immune Attack* preloaded on each machine

Internet Connection:

A high-speed internet connection is required for downloading *Immune Attack* onto a local computer. However, slower-speed connections are acceptable for access to resources, links, and extra activities on the *Immune Attack* website

(Note: an active internet connection is not required for running *Immune Attack*).

System Requirements:

Recommended System Requirements

Operating System: Windows XP (SP2), Vista
CPU: 2.0 GHz processor
Memory (RAM): 1000 Mb
Graphics Card: 64 Mb
Screen Resolution: 1024x768
Audio: Integrated sound card
Free Hard-drive Space: 700 Mb
Computer speakers or headphones
Standard US Keyboard
Standard 2 Button Mouse
Adobe Acrobat Reader
(www.adobe.com/products/acrobat)
Internet Connection: High-speed
Web Browser
Microsoft DirectX 9.0c

Minimum System Requirements

Operating System: Windows XP (SP2), Vista
CPU: 1.0 GHz processor
Memory (RAM): 512 Mb
Graphics Card: 32 Mb
Screen Resolution: 1024x768
Audio: Integrated sound card
Free Hard-drive Space: 700 Mb
Computer speakers or headphones
Standard US Keyboard
Standard 2 Button Mouse
Adobe Acrobat Reader
(www.adobe.com/products/acrobat)
Internet Connection: High-speed
Web Browser
Microsoft DirectX 9.0c

Note: when using *Immune Attack* in the classroom we strongly suggest that students use headphones.

Installation Instructions:

QUICK START:

Insert the *Immune Attack* game into your CD-ROM drive or double-click the Setup.exe file to install the program. Follow the on-screen instructions and allow approximately 10 minutes for the required program files to be copied to your hard disk.

Allow the setup program to install Microsoft DirectX 9.0c unless you are certain it is already installed.

NEED HELP? Contact your IT staff and inquire about permission settings related to installing new software.

Visit us at: www.fas.org/immuneattack



Getting Started with the Game

Before turning your students loose to play *Immune Attack*, review the following instructions to get them started:

1. Ensure that students have turned on their speakers with the volume raised
2. Direct students to the location of the *Immune Attack* icon on their computer desktop and instruct them to double click the icon to start the program. The icon will look like this:



Run *Immune Attack*

3. The Software will start with several production credits ending on a holding screen. By pressing the **enter** key on your keyboard, you will be taken to the *Immune Attack* main menu:



4. From the main menu you can click on a button that allows you to select:
 - **New Game:** This button begins a new game
 - **Options:** This button allows you to change a number of features that impact gameplay.
 - **Instructor Menu:** This button will allow you as an instructor to jump to specific points within the game (the password “abc” is required to access this feature).
 - **Exit:** This button will quit the game, returning you to the desktop.(Note that though there is a Load Game button, it is non-functional at this time – you cannot save progress.)
5. On a new game selected, you will have an option to choose the level of difficulty of gameplay (this does not affect content). Once selected the game will load and pressing any key will begin an introductory animation that will provide the storyline and game objectives for *Immune Attack*.

(Note: Detailed instructions and help is available in the **Game Guide** which can be found on the *Immune Attack* website)



Using *Immune Attack* in the Classroom

For teaching, *Immune Attack* can be used in a number of different ways. We recommend using it as a way to learn how aspects of the immune system work and as a facilitator (or “hook”) for classroom discussion. It is important that you spend some preparation time to become familiar with using *Immune Attack* and to better help guide your students. For detailed instructions on using the software please refer to the **Game Guide** on the *Immune Attack* website. We recommend that you should have played the game through at least once before presenting it to your students.

Time Planning

As using *Immune Attack* is dependant on available computers, this lesson can be spread out over several classes or weeks (if only a single computer is available). You may also want to send *Immune Attack* home with your students and have them play the game as homework and save class time for discussions.

Pre-game Discussion

Before you let your students play *Immune Attack*, you may want to initiate a small introductory discussion session and ask some of the following questions to get your students thinking about immunology and to gain a sense of your students current knowledge: (answers could be discussed as a class (or small groups) or suggest that a student record the answers on the board or large sheet of paper for later reference).

- **What is an infection?** *Defined as the detrimental colonization of a host organism by a foreign species.*
- **How do our bodies fight infections?** *Our bodies fight infection through their immune systems; a specialized group of organs, tissues, and cells that are designed to identify and destroy anything in the body considered to be foreign.*
- **What are bacteria?** *Unicellular microorganisms.*
- **How do medical doctors fight bacteria?** *Antibiotics.*
- **What is an antibiotic?** *Antibiotics are natural and synthetic compounds that can stop or slow the growth of bacteria. Antibiotics have NO effects on viruses.*
- **How do you think the cells of the immune system work to fight bacteria?** *Immune cells detect foreign bodies and disable or destroy them. They accomplish this by eating them directly or by “tagging” them and calling for backup from other immune cells which can then kill in a variety of ways.*
- **Why do we get fevers when we have an infection?** *Most invading bacteria thrive at our body temperature ~96°F (~37°C). During infection, the body raises its temperature to slow the growth of the bacteria, allowing the immune system to catch-up with clearing the bacteria.*
- **Do you have an infection at this very moment? How do you know?** *Our immune systems are always at work battling bacteria & viruses, cleaning up dead cells, and controlling cancer cells.*
- **What is the difference between bacteria and viruses?** *Bacteria are self-sufficient living organisms. Viruses are much smaller than bacteria and require host cells to reproduce. It is debatable whether viruses are “alive.”*



Connecting Game Content to Curriculum

Although the curriculum content you are responsible for varies among regions, aspects of your curriculum can be found within the game. Below are select content requirements that are found in a number of biology curriculums. Remind students that while they are playing the game they should be looking for the content that they are responsible for learning.

Story Intro and Basic Training

- The general composition of blood.
- Identifying some major cell types of the immune system

Game 1: Monocyte to Macrophage (Transmigration)

- What are leukocytes (white blood cells)?
- What is a macrophage and what does it do?
- Macrophages can travel to a site of infection.
- How leukocytes can move from the blood stream into the tissue.

Enter the Connective Tissue

Game 2: Follow the Chemical Trail (of C3a)

- Some immune cells can follow chemical trails
- Some of these chemicals are released from bacteria. Other chemical signals are released from wounded body tissue

Game 3: Recognize the Enemy (Activate LPS Receptors)

- What is meant by “self” and “non-self?”
- Macrophages must be activated to kill bacteria.

Game 4: Eat the Pseudomonas!

- Macrophages kill bacteria by eating them through a process called phagocytosis.

Introducing the Neutrophil

Game 5: Activate CXCL8 to call for Neutrophils

- What is a neutrophil and what does it do?
- Neutrophils must be called to the site of infection through a chemical signal (CXCL8).
- Neutrophils can eat bacteria

Game 6: Train the Neutrophil (Transference)

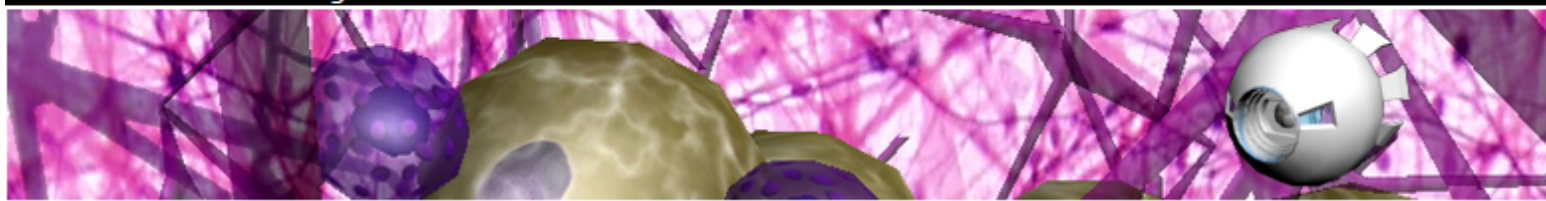
Game 7: Eat the Staphylococcus!

- Are all bacteria the same?
- How the immune system deals with two different types of pathogenic bacteria.

Post-game Discussion

After playing the game you can have the original groups' follow-up with the above questions. (Currently, there is always some news item in the newspaper or on television about an infectious disease or other aspects of disease such as HIV, bird flu, flu shots, Ebola, food allergies, etc.). Post-game discussions are a great opportunity to talk about these issues, where *Immune Attack* acts as a vehicle to initiate discussion.

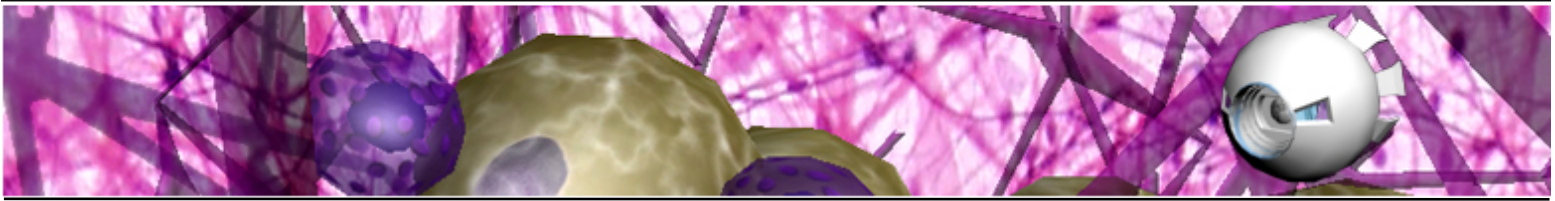
Fundamentally, the take-home message students should get is the bigger picture of what our immune system does for us. It is important to communicate to your students, that our immune cells are always fighting off bacteria and viruses. We only notice it (i.e. feel sick) when our immune system starts to lose the battle.



Game Controls:

Function	Keyboard	Mouse Action
Increase Throttle	W	Mouse Scroll Wheel Forward
Decrease Throttle	S	Mouse Scroll Wheel Reverse
Turn Left	A	Mouse Right Button + Move Left
Turn Right	D	Mouse Right Button + Move Right
Pitch Up	R	Mouse Right Button + Move Forward
Pitch Down	F	Mouse Right Button + Move Reverse
Reverse Thrust	X	
Engage Afterburners	TAB	
Deploy Airbrake	Z	
Spin Around 180 Degrees	B	
Toggle Mouse Flight/Free	SPACE	
Launch Drone	L	
Toggle Lights On/Off	I	
Initiate My Learning	ENTER	
Access Options Menu	F1	
Retract/Extend HUD	C	
Pause Game	P	
Close Active Window/Skip	ESC	
Body Map Zoom In	+	
Body Map Zoom Out	-	

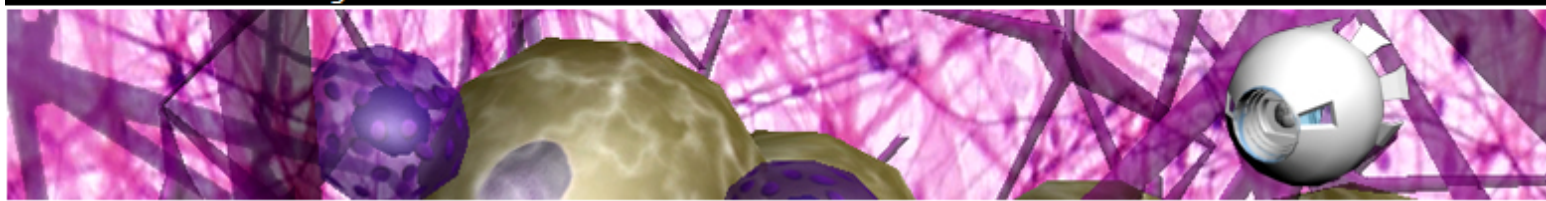
Note: it may be helpful to print this page for students to access while they are playing.



Using My Learning Assistant (MyLA)



My Learning Assistant (MyLA) is an information tool built into *Immune Attack*. It can be accessed by clicking on the MyLA icon in the control panel in the lower right of the screen. MyLA allows users and teachers access to additional content about immunology and further information on the biology experience in the game. For teachers, MyLA is a great resource for generating assessment questions and discussion questions. Some of the questions that we have provided (on page 13) were drawn from content from MyLA and not from direct gameplay. Encourage your students to access MyLA while playing the game. Much of the MyLA content is also available online under **Teacher Guide**.



Problem Areas for Students:

General Problems

Some students are lacking the proper analytical tools to see the "big picture." Notably, ESL students often have problems explaining, describing and visualizing the different cellular processes. This tool is a great way for students to actually "see" what is happening inside the body, on the surface of the cells and within the connective tissue, which is fantastic for visual learners who need this type of interaction. If they can see the way the immune cells are functioning and interacting, then they can describe it as a whole process with a specific outcome. If they can explain it, they understand it, and will remember it. If they just memorize it, they won't understand it, and they will forget.

Specific Problems

Depending on a student's background knowledge, some content maybe confusing, including details around cell surface receptors and the nature of the change in macrophage cell surface features. For most high school curriculum, these concepts are not required and are more inline with university level curriculum. These questions can be tackled outside of game play in class discussion.

Assessment Strategies

Traditional Assessment

A series of questions can be given to the students after playing *Immune Attack* to test knowledge (see page 13). Below are some examples of questions. Please visit the *Immune Attack* website for additional questions and evaluation resources.

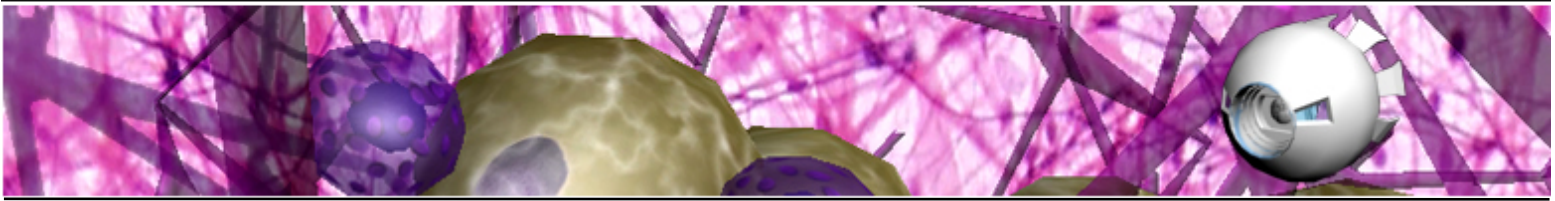
Alternative Assessments & Further Activities

How Do We Culture Bacterial Colonies and Prepare Them for Identification?

<http://www.scienceteacherprogram.org/biology/Orbe07.html>

Infectious Disease Case Study

<http://www.scienceteacherprogram.org/biology/Rucker05.html>



Assessment Questions for In-game Content

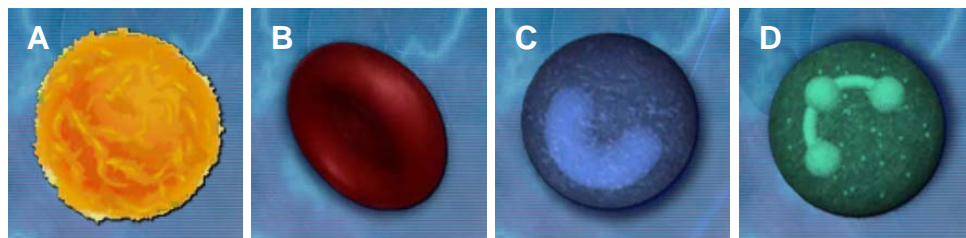
Note that some of this content comes from the in-game database of information, *My Learning Assistant* (MyLA). Much of the MyLA content is available online (see Teacher Guide section), and all is in the game.

Use this quiz as a post-game assessment, or as an “open-book” quiz.

Question Cluster: Basic Training

Question 1:

Which of the following cells is NOT a white blood cell?



- a) A
- b) B
- c) C
- d) D

Question 2: What is the role of macrophages and neutrophils in the immune system?

- a) They are cells that act as “fuel tankers.”
- b) They promote the growth of bacteria.
- c) They are eaten as food for red blood cells.
- d) They are the “first responders” of the immune system.
- e) They are the cells used to build arteries and veins.

Question Cluster: Game 1: Monocyte to Macrophage (Transmigration)

Question 3: The name macrophage comes from the Greek words *makros* and *phagein*, which roughly translate into:

- a) Furry eater
 - b) Big eater
 - c) Rolling chaser
 - d) Big roller
 - e) Big furry chaser
-



Question 4: What types of cell surface receptors are used to slow down monocytes moving through the blood so they can transmigrate to the site of infection?

- a) Ion channel
- b) ICAM
- c) IPOD
- d) IDA
- e) Selectin

Question 5: What types of cell surface receptors allow monocytes to transmigrate out of the blood to the site of infection?

- a) Ion channel
- b) ICAM
- c) IPOD
- d) IDA
- e) Selectin

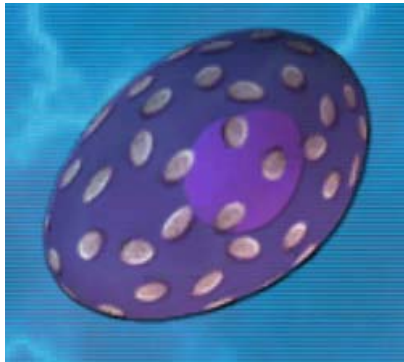
Question Cluster: Game 2: Follow the Chemical Trail (of C3a)

Question 6: In the game the chemical signal that the macrophage used to find Pseudomonas was:

- a) T42
- b) TK421
- c) C3a
- d) CD34
- e) TNT

Question 7: In your own words, why do you think immune system cells look for chemical signals as way to detect bacteria?

Question 8: What type of immune system cell is this?



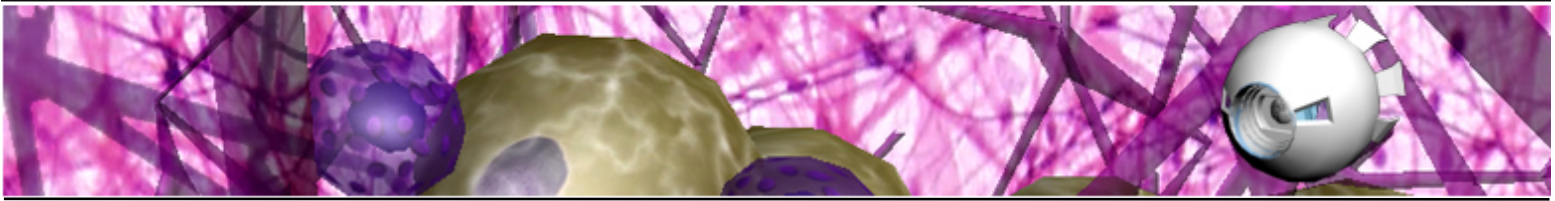
- a) T-cell
- b) Base-cell
- c) Post cell
- d) E-cell
- e) Mast cell

Question Cluster: Game 3: Recognize the Enemy

Question 9: In the game, how does the macrophage recognize bacteria?

- a) By its color
- b) By its LPS receptor
- c) By its RBC receptor
- d) By the length of its flagella
- e) By its weight

Question 10: Why do you think the surface of the cell changed as it became a macrophage?



Question Cluster: Game 4: Eat the Pseudomonas!

Question 11: In the game, pseudomonas is known to cause what disease

- a) Zits
- b) Bird flu
- c) Mad cows disease
- d) Swimmers' ear
- e) Athletes foot

Question 12: Macrophages eat bacteria through a process known as

- a) consumption
- b) pecking
- c) big eating
- d) pseudocheew
- e) phagocytosis

Question Cluster: Game 5: Activate CXCL8 to call for Neutrophils

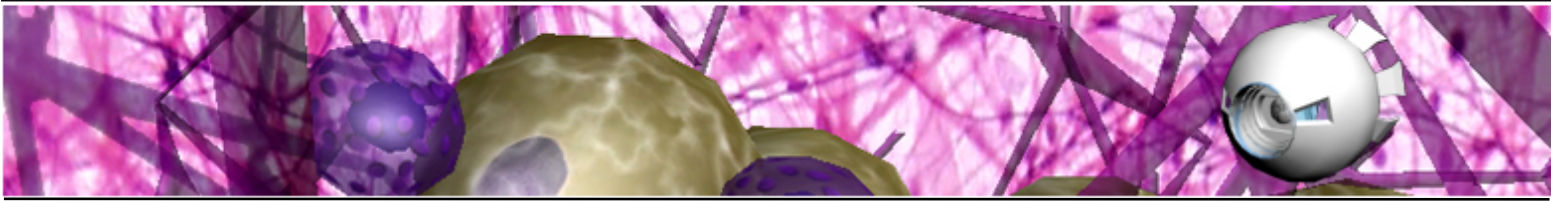
Question 13: what type of cell is a neutrophil?

- a) red blood cell
- b) blue blood cell
- c) hairy blood cell
- d) white blood cell
- e) stem cell

Question 14: Based on the activation of immune cells in the game, which of the following are in the correct order?

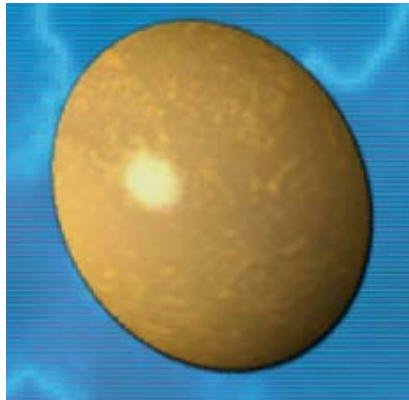
- a) Infection ► transmigrate ► chemical trace ► eat bacteria ► call for help
- b) Infection ► eat bacteria ► call for help ► transmigrate ► chemical trace
- c) Infection ► chemical trace ► call for help ► eat bacteria ► transmigrate
- d) Infection ► transmigrate ► eat bacteria ► chemical trace ► call for help
- e) chemical trace ► eat bacteria ► transmigrate ► Infection ► call for help

Question 15: What do you think macrophages need to call for backup?



Question Cluster: Game 6: Eat the Staphylococcus!

Question 16: From the game, the following image is a:

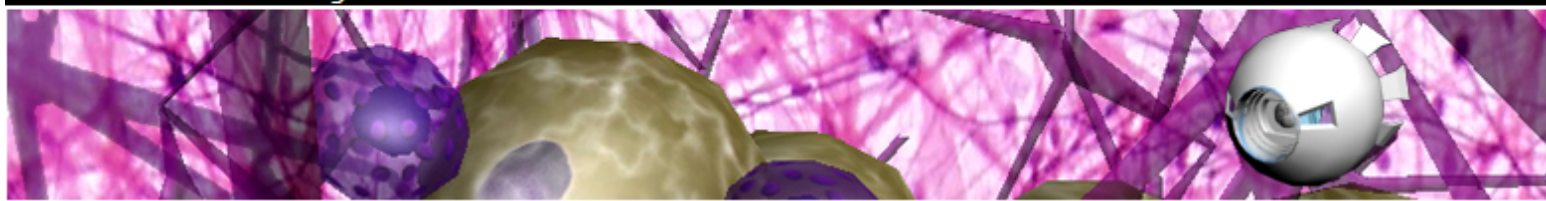


- a) egg cell
- b) yellow blood cell
- c) staphylococcus cell
- d) white blood cell
- e) Pseudomonas

Question 17: Where are all white blood cells made?

- a) They are made in the bone marrow.
- b) They are made in the ear tissue.
- c) You have a fixed number of white blood cells at birth.
- d) They are made from red blood cells.
- e) They are made from platelets.

Question 18: List some differences between staphylococcus and pseudomonas.



Assessment Answer Key:

Question Number	Correct Answer
1	B
2	D
3	B
4	E
5	B
6	C
7	essay
8	E
9	B
10	essay
11	D
12	E
13	D
14	A
15	essay
16	C
17	A
18	essay