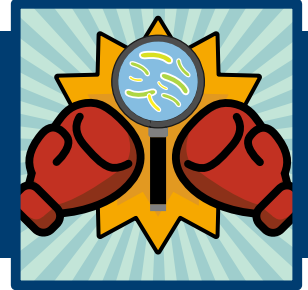


Teacher Directions

UNIT: TUBERCULOSIS

LESSON 3: ME VS. TB - BOOSTING THE IMMUNE SYSTEM TO DEFEAT AN ANCIENT ADVERSARY

ACTIVITY 3D: DON'T SPILL THE TB!! A SCIENCE THEATER



TEXAS BIOMEDICAL
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HEALTH STARTS WITH SCIENCE

Objectives

- › Interpret which treatment will most effectively prevent the progression of TB.
- › Conclude which cell death pathway will prevent the progression of TB within individuals.
- › Identify how Host Directed Therapies (HDTs) will affect the pathways.
- › Justify how the parts of the immune system contribute to the vitality of the human organism infected with TB.
- › Compare the different cell death pathways that contribute to the progression of TB within an organism.

Activity Rationale

In this activity students will act out a dramatization of a cell undergoing necrosis due to a TB infection. Recall the two cell death pathways **apoptosis** (A-pop-toe-sis) and **necrosis** (neh-CROW-sis) mentioned in the article *Me vs. TB – Boosting the Immune System to Defeat an Ancient Adversary*. Apoptosis is the natural cell death, where the cell membrane does not break apart, keeping all cellular contents inside. When a cell is infected with TB, the bacteria deactivate the natural cell death pathway of apoptosis and activates the necrosis cell death pathway. The necrosis cell death pathway causes the cell membrane to break apart, releasing contents into the body. If the cell contains TB bacteria, the necrosis cell death pathway releases the bacteria into the body, contributing to the spread of TB throughout the body. Scientists are investigating how to boost the immune system to fight TB infection. By boosting the immune system, there will be less reliance on drug treatments which will also address drug-resistant TB. In this activity, students will act out the scientific method as they dramatize different therapeutic approaches to treating TB. During the activity, data is collected and analyzed to determine the best therapeutic approach to treating TB.

Supplies

- › 100 ping pong balls
- › Role cards:
 - Macrophage- pick up ping pong balls (TB) using one hand. Ping pong balls can only be held in the other hand.
 - HDTs- order Macrophages to perform apoptosis.
 - Antibiotic- take one ping pong ball at a time from the floor and deposit each ping pong ball in a bucket. Repeat.
 - Other Immune Cells- surround ping pong balls (TB) to stop Macrophages.

MIDDLE & HIGH SCHOOL LEVEL

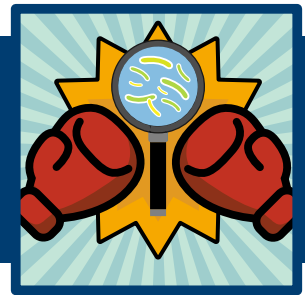
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NIH SEPA Project #1R25GM142021-01A1

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“Director” Notes

Ping pong balls are used to represent TB bacteria. Dropping a ping pong ball during the dramatization represents the necrosis cell death pathway caused by TB bacteria. Each student will play one of the following roles: Macrophage, HDTs, Antibiotics and other Immune Cells. Along with demonstrating one of the cell death pathways, the two treatments described in the transformed article, HDT's and antibiotics, are simulated applying the scientific method (control, separate tests for each treatment, test of treatment combinations). Each Act is timed at 15 minutes. After each Act, data will be collected and analyzed.



Directions

Step 1: Cast students to the roles below. When a role is assigned, provide the student with a description card. Each description card has the role title on one side and the required actions to be played out in the dramatization on the back. The role card may be worn like a lanyard for easy reference.

› Casting Actors: This drama works best with 30 students. However, this number can be adjusted as needed. Students who are not acting can be audience members.

→ Act 1 Cast:

- › Ratio: 1 **Other Immune Cell** for every 5 **Macrophages**.
- › 30 students: 5 **Other Immune Cell** actors, 25 **Macrophage** actors.

→ Act 2 Cast:

- › Ratio: 1 **Antibiotic** for every 5 **Macrophages**.
- › Actors who played **Other Immune Cells** remain in that role.
- › Select 5 actors playing the role of **Macrophages** to become **Antibiotics**.
- › 30 students: 5 **Other Immune Cell** actors, 5 **Antibiotic** actors, 20 Macrophage actors.

→ Act 3 Cast:

- › Ratio: 1 **HDT** for every 5 **Macrophages**.
- › Actors who played **Other Immune Cells** remain in that role.
- › Actors who were **Antibiotics** in Act 2 are temporarily recast as **Macrophages**.
- › 30 students: 5 **Other Immune Cell** actors, 5 HDT actors, 20 **Macrophage** actors.

→ Act 4 Cast:

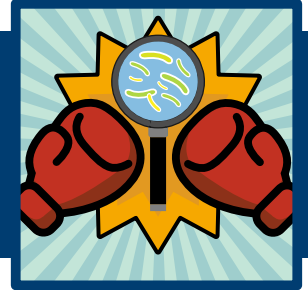
- › 30 students: 15 **Macrophage** actors, 5 **Other Immune Cell** actors, 5 **Antibiotic** actors, and 5 **HDT** actors.
- › Actors who were originally **Antibiotics** resume their Antibiotic role.

Teacher Directions

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Step 2: The science theater includes four acts. During each act, students will act out their assigned roles. Instructions may be displayed on the screen (using activity 3D PowerPoint) or distributed as a script (below) as each act is played out. Students need to stay in character and can refer to their role card. The Director (the teacher) can always give directions or clues to specific actors throughout the drama.

SCRIPTS

ACT 1: The Scientific Method - Control

- › The scientific method applies a control. A control in an experiment that examines what happens in a system when no actions or interventions are taken.
- › In Act 1, students dramatize how the immune system responds to a TB infection without introducing any therapeutics or medications.
- › Actors who portray Other Immune Cells use their arms to encircle TB, preventing Macrophages from picking up these ping pong balls. They represent granulomas which encapsulate TB bacteria.
- › The macrophage actors use one hand to collect ping pong balls and transfer the ping pong balls to their other hand. They need to hold all collected TB in one hand. If a macrophage actor drops a ping pong ball, they must drop all their ping pong balls on the floor and sit down on the floor. This represents necrosis.
- › The above steps continue until the act ends (Recommend no more than 1 minute).
- › **Data Collection:** At the end of Act 1, count the number of ping pong balls left on the floor and the number of macrophages left standing and those sitting on floor. Record the data in the data table.

ACT 2: The Scientific Method - Introducing Antibiotics

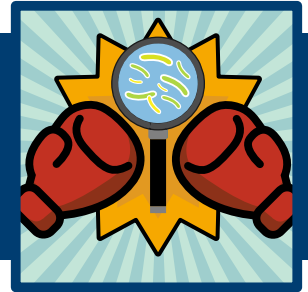
- › The scientific method examines how variables affect a system.
- › In Act 2, students dramatize how antibiotics (a variable) treat a TB infection.
- › Actors who portray Other Immune Cells continue their role to encircle TB, making the TB inaccessible to Macrophages.
- › Macrophage actors collect as many ping pong balls as possible. If they drop a ping pong ball, they need to drop all the ping pong balls on the floor and sit down on the floor. This represents necrosis.
- › Antibiotic actors take a single ping pong ball from the floor and deposit in a bucket. Repeat until the Director calls time.
- › **Data Collection:** At the end of Act 2, count the number of ping pong balls left on the floor and the number of macrophages left standing. Record the data in the data table.

Teacher Directions

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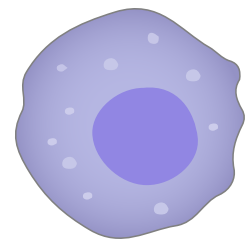


ACT 3: The Scientific Method - Introducing HDTs, a New Variable

- › The scientific method tests different variables and their impact on a system.
- › In Act 3, students dramatize how HDTs treat a TB infection. Act 3 dramatizes how HDT's (a different variable) impact the immune system on TB infection.
- › Macrophage actors continue to collect as many ping pong balls as possible. If they drop a ping pong ball, they need to drop all ping pong balls on the floor and sit down on the floor (necrosis).
- › HDTs tell Macrophage actors they are holding too many ping pong balls. The Macrophages then deposit their ping pong balls in a container and take a seat in a chair, not on the floor. This represents apoptosis.
- › The actors who were originally Other Immune Cells continue to act as Immune Cells.
- › The above steps continue until the Act ends.
- › **Data Collection:** At the end of Act 3, count the number of ping pong balls left on the floor and the number of macrophages left standing. Record the data in the data table.

ACT 4: Combining HDTs and Antibiotics

- › Actors originally cast as Antibiotics return to their Antibiotic role.
- › HDT actors continue their role.
- › The actors who were originally Other Immune Cells continue to act as Immune Cells.
- › There are now 15 actors portraying Macrophages.
- › If Macrophages drop a ping pong ball, they drop their ping pong balls on the floor and sit down on the floor (necrosis).
- › Antibiotic actors continue picking up ping pong balls one at a time and depositing them into the container.
- › If an HDT connect with a Macrophage, the Macrophage deposits their ping pong balls in the container and sits down in a chair (apoptosis).
- › The above steps continue until the Act ends.
- › **Data Collection:** At the end of Act 4, count the number of ping pong balls left on the floor and the number of macrophages left standing. Record the data in the data table.



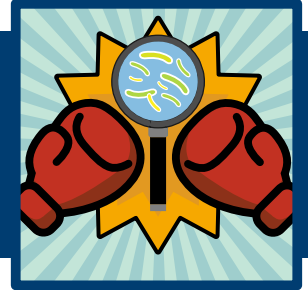
Macrophage

Teacher Directions

UNIT: TUBERCULOSIS

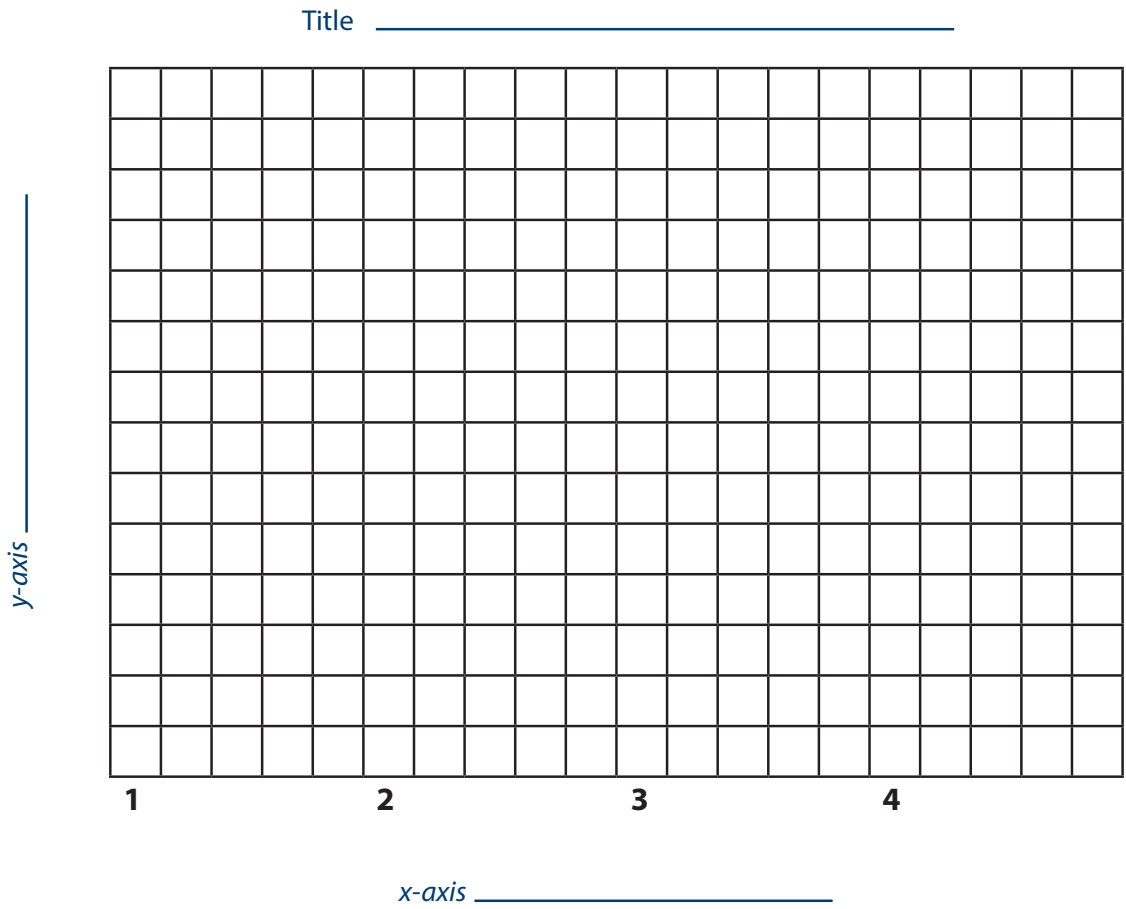
LESSON 3: ME VS. TB - BOOSTING THE IMMUNE SYSTEM TO DEFEAT AN ANCIENT ADVERSARY

ACTIVITY 3D: DON'T SPILL THE TB!! A SCIENCE THEATER



Don't Spill the TB!! A Science Theater Experience	Number of TB Remaining on the Floor	Number of Macrophages Still Standing	Apoptosis Macrophages (seated in chairs)	Necrosis Macrophages (seated on floor)
ACT 1: Control				
ACT 2: Introducing Antibiotics				
ACT 3: Introducing HDTs				
ACT 4: Combining Antibiotics and HDTs				

Use the data from the data table to create a graph. As always, label each axis, include a title, and create a legend.



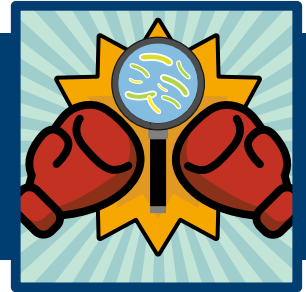
Include the graph title, label the X and Y axis, and create a legend identifying X axis numbers (acts) and what 'treatment' was used each act.

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Teacher Note - Aligning CER with Scientific Method: Using data from the graph, students are to create a claim. The CER process aligns with the Scientific Method. The Claim can be written as a hypothesis, the Evidence equates to Data, and Reasoning aligns with Data Analysis/Results. To elevate the activity, encourage student to create a hypothesis. Hypotheses are based on observations. Although a common practice, true hypotheses are not "if/then" statements. A hypothesis seeks to connect a variable to a measurable outcome. For example: The introduction of HDTs as a TB treatment increases apoptosis thereby reducing the spread of TB. A claim or hypothesis is limited to one sentence.

Claim/Hypothesis: Look at your graph. What do you observe? Write your claim based on your observations. Hypotheses are not educated guesses. Hypotheses are informed by observations, not assumptions. Hypotheses are proposed explanations about the observations, not "if/then" statements. A claim or hypothesis is limited to one sentence.

Evidence/Data: Interpret the bar graph. Describe what you see. This is the evidence or data that supports your claim.

Reasoning/Data Analysis: Ascribe meaning to your evidence. This means giving meaning to the data. In other words, how does the evidence support your claim?