VACCINATIONS

ACTIVITY SHEET

INTRODUCTION

THIS IS ONE OF TWO ACTIVITIES THAT CAN BE USED WITH THE ANIMATIONS IMMUNECRAFT, LOOP, AND BATTLE OF BLISTER. RESEARCHERS ARE WORKING TO UNDERSTAND MORE ABOUT HOW OUR BODIES RESPOND TO INFECTION WITH THE DUAL GOAL OF IMPROVING VACCINES FOR DISEASES SUCH AS INFLUENZA AND MALARIA AND HOW TO FIGHT AUTOIMMUNE DISEASES SUCH AS RHEUMATOID ARTHRITIS WHERE THE BODY'S IMMUNE SYSTEM TURNS ON ITSELF.

AIMS

- To understand how vaccination can stop a disease spreading through an otherwise susceptible population
- To understand how a change in vaccine threshold alters how a disease spreads through the population
- To understand how hard immunity works

MATERIALS

For each group of students you will need a 64 square chess/draughts board and counters of 2 different colours. You will need a minimum of 56 counters of one colour to represent 'vaccinated' and 32 counters of the other colour to represent 'susceptible'.

Count out the counters into small bags starting with 32 vaccinated and 32 susceptible, and then change this to 48 vaccinated and 16 susceptible, then 56 vaccinated and 8 susceptible.

STARTER

ASK THE FOLLOWING QUESTION AND RECORD THE RESPONSES.

"What diseases have you been vaccinated against?"

A LIST OF VACCINATIONS (UK) CAN BE FOUND AT:
www.nhs.uk/Conditions/vaccinations/Pages/vaccination-schedule-age-checklist.aspx

METHOD

DIVIDE THE CLASS INTO SMALL GROUPS AND GIVE EACH GROUP A CHESSBOARD AND A NUMBER OF (PRE-COUNTED) COUNTERS.

Start with 32/32 split of colours (representing 50% vaccine threshold).

Get the students to randomly spread the counters on the board, so that each square has a counter on it – and the colours are mixed.

Pick a starting point and remove that counter to represent the first case of infection. All susceptible neighbours (vertically and horizontally but not diagonally) are now infected and players remove them from the board.

Keep removing infected neighbours until there are no adjacent susceptible counters. The outbreak is then over.

Count the total number of cases in the outbreak.

Repeat the exercise to show that the number of cases can change based on the starting point of the outbreak and the distribution of 'vaccinated' counters.

Repeat the exercise with 48/16 (75% vaccine threshold) and 56/8 (87.5% vaccine threshold) splits. Count the total numbers of cases in each outbreak depending on threshold.

These can then be plotted onto a graph to show frequency of each size outbreak (for the whole class) or individually to show the numbers of those infected in each simulation.

DISCUSSION

WHY DID SOME SUSCEPTIBLE COUNTERS NOT GET INFECTED DURING THE SIMULATIONS OF THE OUTBREAK?

They are surrounded by vaccinated counters. Herd immunity – not everyone in the community needs to get vaccinated to benefit from it.

WHY DID THE SIZE OF THE OUTBREAK VARY DEPENDING ON WHERE YOU STARTED AND HOW THE COUNTERS WERE DISTRIBUTED?

WHAT WOULD HAPPEN IF YOU COULD ALSO INFECT THE COUNTERS AT DIAGONAL ANGLES FROM THE INFECTED CASE?

This would increase the number of susceptible people in the population, simulating a pathogen with higher reproductive rate. As such, you would need to have a higher vaccination threshold to reach herd immunity.

WHAT WOULD HAPPEN IF WE HAD A HIGHER VACCINE THRESHOLD?

IS 75% VACCINATION THRESHOLD ENOUGH TO MAKE THIS OUTBREAK DIE OUT?

WHAT ARE THE PROBLEMS WITH BASING THE HEALTH OF A POPULATION ON HERD IMMUNITY?

WHAT IF EVERYONE ASSUMES THAT THE REST OF THE POPULATION IS VACCINATED AND DOESN'T DO IT – THE FREE RIDER PROBLEM?

WHAT IF PEOPLE DON'T WANT TO GET VACCINATED? HOW DOES THIS AFFECT VACCINATION POLICY?

SOME OTHER FOLLOW UP QUESTIONS/BACKGROUND INFORMATION:

WHAT ARE SOME WAYS THAT INFECTIOUS DISEASES ARE TRANSMITTED FROM ONE PERSON TO ANOTHER?

- Droplets in the air (e.g. cold, flu, tuberculosis)
- Via food or water (e.g. Salmonella, food poisoning)
- Via mosquitoes, ticks (e.g. malaria, West Nile virus, Denge Fever)
- Physical contact (e.g. conjunctivitis, herpes, chickenpox, sexually transmitted diseases)

You can catch an infectious disease due to a virus by getting it on your hands and then touching your mouth or eyes or eating food you have touched with unwashed hands.

The AIDS virus is not spread this way but is transmitted from one person to another by having vaginal or anal intercourse with a person who is infected with HIV, by sharing needles with someone who is infected with HIV, from an infected mother to her baby during pregnancy, birth or nursing or form a blood transfusion with contaminated blood.

WHAT ARE SOME WAYS YOU CAN PREVENT THE SPREAD OF AN INFECTIOUS DISEASE?

- Avoid close contact with people who are infected
- Use tissues if you have a cold or flu and throw them away
- Wash hands especially before eating, after using toilet, or after contact with someone who has an infection
- Don't touch other people's blood or body fluids (e.g. soiled tissues from someone who has a cold)
- Don't share toothbrushes, eating utensils etc
- Eat nutritious food to keep the body healthy

HOW MIGHT THE SPREAD OF THESE DISEASES DIFFER FROM THE SPREAD OF DISEASES THAT DEPEND ON PERSON-TO-PERSON CONTACT?

The simulation showed the way a disease could spread if the spread of disease depends on person-to-person contact. Examples of this kind of disease include conjunctivitis, chickenpox and herpes (lip sores).

Other diseases, such as colds and tuberculosis, can be spread by germs in the air. Airborne diseases can be spread to multiple people at the same time and can be spread to people who are nearby but not in direct contact.

IN ADDITION TO EXPOSURE TO GERMS (BACTERIA OR VIRUSES), WHAT OTHER FACTORS INFLUENCE YOUR RISK OF GETTING AN INFECTIOUS DISEASE? WHAT DEFENCES DOES YOUR BODY HAVE THAT CAN PREVENT YOU FROM GETTING SICK, EVEN WHEN YOU HAVE BEEN EXPOSED TO GERMS?

Susceptibility to infection can be reduced by good hygiene practices, such as washing your hands after possible exposure to pathogens before touching your eyes, mouth or mucous membranes where infection may occur. Susceptibility may be increased by a weak immune system due to age, previous illness, inadequate nutrition etc. Resistance to a specific infectious disease can be increased if you have had this infectious disease previously or been vaccinated against this disease. Important defences include barriers such as the skin and mucous membranes, chemicals such as acid in the stomach, inflammation and phagocytic cells.

The specific immune system also contributes to defences against infection, but more slowly.

ONCE YOU HAVE CAUGHT A COLD OR FLU, YOU DO NOT STAY SICK FOREVER. HOW DOES YOUR BODY EVENTUALLY GET RID OF THE VIRUSES THAT CAUSE A COLD OR FLU?

If a cold or flu virus gets past the first set of defences (such as the skin and mucous membranes) and infects your body, your immune system is stimulated to produce specific immune system cells (B cells and T cells) that can effectively fight the particular virus that has infected your body. This response takes time, especially the first time you are exposed to a specific virus, so you are sick with a cold or flu until the specific immune cells become effective enough to rid your body of the virus.

After an infection, your body will have memory cells which can produce a rapid defence if you are exposed to the same virus a second time, so you will be able to fight off a second infection rapidly and effectively and the level of viruses will be kept low so that you may never even feel sick. A vaccination induces the production of memory cells which can mount a rapid defence against that particular infection.

WHY IS A PERSON WITH AN HIV INFECTION UNABLE TO GET RID OF THIS INFECTION THE WAY A PERSON CAN GET RID OF AN INFECTION WITH A COLD OR FLU VIRUS?

In almost every case, a person who becomes infected with the HIV virus is infected for the rest of his or her life. With highly effective modern medical treatment, a person may survive a long time with an HIV infection. However, an untreated HIV-infected individual is very likely to eventually develop AIDS and die. There are many reasons why our bodies are unable to get rid of an HIV infection. One important reason is that HIV infects an important type of T cell, the Helper T cell, which is crucial in mobilising other immune cells to fight infection. As more and more Helper T cells are killed by HIV infection, the body becomes less and less able to fight infections, including HIV infection.

Another reason why the body cannot get rid of HIV infection is that the genetic material of the HIV virus is incorporated in the DNA of infected cells, and some of these infected cells can survive undetected by the immune system over long periods of time. Scientists are very interested in the genetic and immune system differences of the tiny number of people whose bodies appear to be able to control or eliminate HIV infection.

EXTENSION QUESTIONS

THESE CAN BE USED WITHIN THE SESSION TO STIMULATE DEBATE OR FOR HOMEWORK/INDEPENDENT STUDY TASKS.

- Would you be prepared to take a new vaccination?
- Should it be a legal requirement to be vaccinated? If so, against what?
- What things do you do to avoid infection?
- Should you go to work/school when you are ill?

OTHER RESOURCES

THIS GIVES INSTRUCTIONS FOR A MORE ACTIVE CLASSROOM SIMULATION OF THE SPREAD OF INFECTION AND WORKS WELL WITH A LARGER NUMBER OF STUDENTS:

http://www.ifm-sei.org/files/up/79-81-immunisation-game.pdf

THERE IS A GOOD ONLINE SIMULATION OF THE EFFECTIVENESS OF VACCINATION IN STOPPING THE SPREAD OF DISEASE:

http://www.techydad.com/Vaccinate/

HOW TO TACKLE ANTI-VACCINATION STAND POINTS:

http://mic.com/articles/85725/7-biggest-lies-spread-by-the-anti-vaccine-movement-de-bunked-by-science#.5VmUq2X0L

THE ABPI EDUCATIONAL RESOURCE PAGES ON IMMUNITY AND VACCINATIONS CAN BE FOUND AT:

http://www.abpischools.org.uk/page/modules/infectiousdiseases_immunity/index.cfm?coSiteNavigation_allTopic=1

A THOROUGH BUT ACCESSIBLE REVIEW OF THE IMMUNE SYSTEM AND HOW IT WORKS CAN BE DOWNLOADED HERE:

http://www.imgt.org/IMGTeducation/Tutorials/ImmuneSystem/UK/the_immune_system.pdf

SYLLABUS LINKS FOR A-LEVEL BIOLOGY

AQA

Topic 2 Cells

EDEXCEL SALTERS NUFFIELD

Topic 8 Immunity Infection and Forensics

EDEXCEL B

Topic 2 Cells, viruses and reproduction of living things
Topic 6 Microbiology and pathogens

OCR A

Module 4 Biodiversity evolution and disease

OCR B ADVANCING BIOLOGY

Module 3 Cell division, development and disease control

WJEC

Component 3 option Immunology and Disease

SILENT SIGNAL