EASTER BUSH SCIENCE OUTREACH CENTRE

Get hands-on with real-life science

HostBusters Researcher Guidance

Learning level	Secondary: S1-3
Research themes	Microbiology Infectious Diseases Food Security
Duration	Secondary – (100 min) double lesson

HostBusters overview:

HostBusters is an activity best suited for a classroom, although individual components like the game can be played in a science festival or community outreach table setting. This activity is suitable for 1st, 2nd and 3rd year secondary students and is planned for classes of max. 30 people divided into 5 working groups.

In this activity, participants will learn about how bacteria infect humans or animals. First, the concept that bacteria are everywhere will be introduced and will be reinforced by looking at examples of bacteria that live in human skin, food, etc. Next, we will explain the concept of “good” and “bad” bacteria, that can be beneficial or harmful (for e.g. “good” bacteria in gut vs “bad” bacteria in throat infection).

The next step will be to explain how bacteria can spread quickly and easily. We will demonstrate this concept using the Glo Germ kit. Each group of participants will form a line and the first participant in the line will touch a model of a sponge farm animal with Glo Germ before shaking the hand of the person behind them. This new person will shake the hand of the person behind them and so on until they reach the end of the line. UV light will show the spread of Glo Germ through the line, at which point the demonstrator can explain in more detail how bacteria can spread and the need for strategies to stop this from happening. At this point the demonstrator asks for another examples of bacterial transmission (other than direct contact).

The concept of pathogenicity and virulence factors will be introduced using an animation where bacteria pick up pathogenic traits called “power-ups” and become stronger with each one. For example, the bacteria can catch info for a sword (representing a toxin) that gives protection against neutrophils or an invisibility cloak that hides bacteria from being recognized by antibodies. The

combination of the “power-ups” that they catch make them good at infecting a specific animal and causing disease. Bacteria can collect new “power-ups” (plasmids or phages) or improve the “power-ups” they already have (mutations) to make them better at infecting a host.

The participants will now play the host-busters game in their groups. The game starts with players choosing a bacteria, either *Staphylococcus aureus* or *Escherichia coli*. Next players will roll a dice three times to pick up their first three “power-ups” from box A. The aim of the game is to infect as many animals as possible by either changing the shape and colour of the “power-up” (representing gain of new virulence factors) or by only changing the colour of the “power-up” (representing DNA mutations). The laminated sheets show the players which combination of “power-ups” they need to infect a new host. The players have 10 coins to spend from box B to change their “power-ups”, which explains that gain or loss of virulence factors comes at a cost to the bacteria. Players can then choose to roll either a) the 12-sided dice, which allows them to replace the tokens shape and colour and costs them two coins or b) the 6-sided dice, which allows them to change the colour of the token and costs them one coin. The dice represents the concept of luck. The right combination of virulence factors allows a bacteria to infect a host and by changing their virulence factors a bacteria can jump from host to host, but that takes time. After playing the game, each player will count how many animals they have infected and scores will be added to the leaderboard on the whiteboard.

In the final section of the activity, scientists will sum up the concepts explained during the activity with a summary powerpoint slide. This is an opportunity to explain what *Staphylococcus aureus* and *Escherichia coli* are and gives the scientists an opportunity to talk about their science.

Learning objectives:

S1-3

- Understand that bacteria can be found everywhere
- Understand that bacteria can be beneficial or pathogenic.
- Understand how bacteria spreads.
- Understand that bacteria uses different tools and strategies to fight and escape the host immune system.

Before the activity:

- Familiarise yourself with the HostBusters game and the materials in the box. Confirm that the animals covered with GloGerm, they might need to be covered with more powder before the activity.
- Adapt the activity powerpoint presentation, inserting some information about yourself and your research in the appropriate places.
- Complete the attached template risk assessment and send to the school, the Health & Safety team (ros48@exseed.ed.ac.uk) and the EBSOC team (ebsoc@ed.ac.uk).

Activity protocol:

Exercise	Description	Timing	Equipment
Introduction	Introduce yourselves	1min Slide 1	Computer, projector
What are bacteria and where can you find them?	Warm up introduction about what bacteria are and where they are found. To help start a conversation, give the groups 5 min to write on the whiteboards what they think bacteria are (One whiteboard and whiteboard pen per group). Give definition. Ask for some examples where they think bacteria can be found. Show the pictures, starting from usual to extreme environments, from small to big animals, insects and plants, and finally very close to us, in the classroom, in our lunch, cell phones, and finally in us. So bacteria can be found almost everywhere.	7min Slides 2-3	Computer, projector, small whiteboards and whiteboard pens
Are all bacteria bad?	Ask if they think that all bacteria are bad (maybe with thumbs up - if bacteria can be good or thumbs down - if all bacteria are bad) Explain that the bacteria that live on our gut and skin are essential for our survival, by providing us vitamins and helping fighting invading microbes. Show examples of cases where bacteria "work for us" and finally explain that some bacteria can live on us without causing any harm, but can take advantage of some situations, like us being sick, stress or have a hound and make us very sick. Show different newspaper headlines (e.g. "bad" *E. coli* in salad compared to "good" bacteria in gut or in food production) and ask them if they think that in a particular situation the bacteria is being "good" or "bad" as ask them to run to different sides of the room if depending on the answer.	5-10 min Slides 4-14	Computer, projector
How do bacteria spread?	To understand how bacteria can jump from one animal to another, we first need to understand how bacteria spread. Explain that bacteria can spread quickly from one animal to another using Glo Germ and UV light. Spread GloGerm in a model of a sheep/cow/rabbit. Make lines of 4/5 people: the first person touches the model and then shakes the hand of the person behind them and so on. Check with the UV light each individual's hands to see where the bacteria have spread.	10-15 min Slides 15-18	GloGerm kit, rubber animal, wet wipes

	Ask them to discuss in their groups: - How many got "bacteria" their hands. How did these bacteria "spread" and how could they have stopped the transmission. Show the examples of other ways of bacteria spread: airborne bacteria, ingestion of contaminated food.		
How bacteria make an animal sick and how do bacteria jump from one animal to another.	Explain that when a pig-infecting bacteria infects a pig, the pig's defences (or immune response) try to destroy the bacteria. However, the bacteria have power-ups (or virulence factors) that they use to fight the pig's defences (hiding from them or killing the pig's cells). That allows the bacteria to multiply and infect the pig. When the same bacteria spreads to a chicken. Similar thing happens, the chicken immune response try to destroy the bacteria and the bacteria try to fight with their power-ups. However, the power-ups are specific for pig's defences and don't work on chicken's cells. So for the pig-infecting bacteria to become a chicken-infecting bacteria they have to change their fighting tools. They can do it by two processes, by mutating the power-ups that they already have, or by collecting new power-ups specific for chickens.	10 min Slide 19-22	Computer, projector
Game rules	The rules will be explained in each group, while they play the first game. Explain just that they will be a bacterium and the goal is to infect as many animals as possible, using different power-ups. Rules: 1. Choose a bacterium (*Staphylococcus aureus* or *Escherichia coli*) 2. Spin the arrow in the Power-up Wheel three times to collect the first "power-ups" 3. Put the power-ups into the bacterium card 4. Using an whiteboard pen, mark the power-ups in the power-up card (that helps checking combinations and making decisions) 5. Check if you infected any animal. 6. Decide if you want to: 6.1 Pay 2 coins to spin the wheel and get a new power-up. Replace an old power-up for the new one (you don't need to replace if you don't want to) 6.2 Choose one power-up that you want to change colour (mutate). Pay 1 coin. Roll the mutation dice. Change the colour of the power-up to the new colour.	20-25 min Slides 23-29	Game rules and game pieces (1x dice, 1x spin wheel, 36x power-ups, 10x coins), laminated score sheet, white board markers, tissue

	7. Mark the new power-up in the power-up card (use a tissue to clean marks and use different whiteboard marks, it helps sometimes to make decisions about which power-up you want to replace). 8. Check if with the new combination you infected an animal. 9. Repeat until you spent the 10 coins. Mark all the animals that you infected in the card.		
Tally up scores on the leaderboard		5 min	Whiteboard markers or sticky notes
What did we learn with the game	Make connections with the bacteria jumping between humans to animals and animals to animals. Bacteria can acquire new "power ups" or mutate the "power-ups" that they already have. However, acquiring new "power-ups" or mutate them comes with a cost which was represented by the coins. As in the game, acquiring the right thing is a question of luck (dice) and it takes time.	5 min Slides 24-28	Computer, projector
What we do at the Roslin institute	Use the opportunity to talk about the Roslin, your research and the research that is done in the bacteriology labs at Roslin.	2 min Slide 29-30	Computer, projector
Feedback forms	Give the feedback forms	5 min	Feedback forms