**Fight Against Resistance Workshop Additional Information**

**Learning Outcomes**

By the end of this workshop, participants should:

1. Be aware of the basic differences between viruses and bacteria.
2. Know that viral infections cannot be treated with antibiotics.
3. Understand the importance of not sharing antibiotics.
4. Understand the importance of finishing the course of antibiotics.
5. Be aware of the risks of antibiotic resistance.

The scenario in the story is that a child has a sore throat, and that the readers need to choose the best course of action. There are three decision points, with activities around each decision.

**Decision 1 (LO1 and 2)**: There are two elements to decision 1:

a) Is it a viral or bacterial infection?

b) How should it be treated?

Scientific Information

a) It is important to know what has caused the sore throat, because viral infections should not be treated with antibiotics. Antibiotics are chemicals that target bacteria but have no effect on viruses. Knowing the difference between viruses and bacteria can help with understanding why the antibiotics don’t work against viruses.

**Activity 1**

Resources required: Virus worksheet, parts 1 and 2 of bacteria worksheet, case file #1 and #2, patient casefile

The first activity is to build a simple model of a virus and a bacterium. Additional information on the differences is provided in the ‘cheat sheets’.

Using antibiotics for a viral infection is a waste of medication and can lead to the development of antibiotic resistance.

Using the casefiles supplied in the book, workshop participants should agree that the sore throat was caused by *Streptococcus* bacteria.

b) The casefiles also provide information on the best treatment for *Streptococcus.* This leads into the second decision point.

**Decision 2 (LO3)**: should the antibiotics being used to treat the sore throat be shared with another child who has a different infection?

Scientific Information

Antibiotics are medicines, that have to come into direct contact with the bacteria in order to destroy the bacteria. Different antibiotics act on different bacteria and are not necessarily universally effective against all bacteria. Healthcare professionals know which antibiotics work against which specific bacteria and prescribe accordingly.

**Activity 2**

Resources required: Part 3 of bacterial worksheet, antibiotic fact-file

This activity encourages the students to determine if the antibiotic they have created matches exactly with another student’s antibiotic attachment site on their bacteria.

**Decision 3 (LO4)**: Should you finish the course of antibiotics?

Not all the antibiotics were used in the fight against the *Streptococcus* bacteria although the infection seems to be over – should the remaining antibiotics course be completed or saved for another day?

Scientific Information

The cheat sheets provide basic information on how cells work, the differences between bacteria and viruses, how antibiotics work and how antibiotic resistance develops.

**Activity 3**

Resources required: Video cards and videos

Use the cards that display how many antibiotics were taken in a week then watch the videos. The videos demonstrate the differences between taking a full/partial/none of the prescribed antibiotic course, on the treatment of the bacterial infection and/or the development of antibiotic resistance.

**Cheat Sheet 1: Cell Biology**

Every living thing, or organism, is made of cells. Some only have one cell; others have millions of cells.

Some key terms relating to cells are given below.

**DNA**: Deoxyribonucleic Acid (dee-oxy-rye-bow-new-clay-ic). A complex molecule that carries the information for life. The DNA is organised into structures called chromosomes. Every chromosome can be divided into sections of code, known as genes. It can help to think of the DNA as the instruction manual for the organism, where every chromosome is a different chapter. Some organisms only have one or two chapters, whereas others have lots. Humans have 46 chapters in their instruction manual. Bacteria have one chapter.

**Proteins**: Proteins are the workhorses of the cell. They carry out lots of important jobs within the cell, carrying other molecules around, passing on messages and making sure that all the chemical reactions that keep the cell alive happen. Proteins are made by following the instructions in the DNA manual. If there is a mistake in the DNA code, there will be a mistake in the way the protein is made.

**RNA**: Ribonucleic Acid. A molecule that is very similar to DNA but not the same. The machines that make the proteins, although they can’t read DNA directly, need to have to DNA code translated into a form they can read. This is RNA.

**Ribosomes**: This are the machines that take the RNA code and use it to make proteins.

**Mutations**: A mutation is when there is an error (like a spelling mistake) in the DNA instruction manual. This can result in mistakes in the protein, and then it can’t do its job properly. Sometimes however, the mistake allows the protein to do jobs that it couldn’t do before.

**Cheat Sheet 2: Bacteria (a bacterium)**

Bacteria are single-celled organisms that can live independently. They are microscopic; they can be seen with a light microscope. Bacteria are usually between 1-5µm in length (1µm = 1/1000th of 1mm. µ = micron).

There are many different species of bacteria. Each one has its preferred place to live. Bacteria can live and grow almost anywhere such as:

* under the Arctic ice,
* at the bottom of the sea,
* in hot water springs,
* in soil contaminated with heavy metals (poisons),
* inside your intestines (both ‘good’ and ‘bad’ bacteria),
* on your skin (both ‘good’ and ‘bad’ bacteria).

Most bacteria fall into one of two categories: Gram positive or Gram negative. This relates to how they react with a certain staining technique that allows them to be seen under a light microscope.

- Gram positive bacteria such as *Streptococcus* have a thick coat or ‘cell wall’ that protects them from the environment. This is made of a special mixture of sugars and proteins that is only found in bacteria. It is called peptidoglycan (pep-tid-o-gly-can).

- Gram negative bacteria, like *E. coli*, only have a thin layer of peptidoglycan, so they have membranes made of fats and sugars to protect them.

Knowing if a bacterium is Gram positive or negative is useful because it can affect the choice of antibiotic used to treat an infection.

Bacteria have a single DNA chromosome (just one chapter in their instruction manual), but some of them have additional small pieces of DNA, that give them extra genes. These small pieces of DNA are in circles called plasmids. The extra genes allow the bacteria to live in extreme conditions or to resist antibiotics.

Plasmids can be shared very easily between bacteria, including bacteria of different species. This means that the genes for antibiotic resistance can be passed around to lots of different bacteria.

Bacteria multiply through a process called binary fission. Everything inside the bacterial cell is doubled, the cell grows to twice it’s normal size, then it divides into two. Some bacteria can do this every 20 minutes in the right conditions, although most bacteria take longer. Bacteria will continue to grow and multiply as long as there is enough food available to them, and nothing prevents them from multiplying (such as an antibiotic or the immune system).

Because bacteria are constantly growing and dividing, mistakes (mutations) will be made in their DNA, in both the main chromosome and in the plasmids. Sometimes these mutations change the bacterial proteins in such a way that the bacteria are able to live in conditions that would previously have killed them. This is how antibiotic resistance develops.

**Cheat Sheet 3: Viruses**

Viruses are even smaller than bacteria – they can be 1/100th of a bacterium. They can only be seen with very powerful (big expensive) electron microscopes.

Viruses are very simple – they consist of short pieces of either DNA or RNA, inside a protective protein box called a capsid. Lots of viruses also have a membrane outer layer, and some will have extra proteins in this membrane (such as the spike protein of SARS-CoV-2).

Because they are so small, viruses cannot live on their own. They do not have the machinery needed to make copies of themselves, so they have to get inside other cells, and use the machinery of the hijacked cell to make viral copies.

Some viruses, like the Rhinovirus that cause colds, can start replicating (making new copies of themselves) straight away. They make lots of new copies of themselves until they are released from the host cell. The new viruses then go on to take over another cell. Every time we cough or sneeze, we release viruses that can infect other people.

Some viruses will hide inside the cell for a long time before they start making copies. The virus that causes cold sores will do this.

Antibiotics do not work for viral infections. Antibiotics are chemicals that interact with specific elements of the bacteria destroying them or inhibiting their growth. Viruses do not have these elements so there is nothing for the antibiotics to interact with.

**Cheat Sheet 4: Antibiotics**

Antibiotics are chemicals that interact specifically with bacteria. Some antibiotics will kill the bacteria (although not immediately) whereas other antibiotics slow down the growth of the bacteria so that the immune system can clear the infection.

The antibiotic Penicillin interferes with the building of the peptidoglycan cell wall. This will eventually kill the bacteria. It is more effective on Gram positive bacteria who have the thicker cell walls.

The antibiotic Ciprofloxacin is able to get all the way inside the bacterial cell and stop the DNA from replicating. If the bacteria cannot replicate its DNA, it can’t divide and grow.

Antibiotic resistance means the bacteria have developed ways to stop the antibiotics from working. In some bacteria, proteins will act as chemical scissors and cut up the antibiotics. In other bacteria, the proteins form mini-pumps that pump the antibiotics out of the cell.

If there is not enough antibiotic in an environment to kill the bacteria, or quickly stop it growing, it gives the bacteria more time to develop resistance. Not taking a course of antibiotics properly, or not finishing the course will help the bacteria become resistant.

Antibiotic resistance is a big global problem, and it is getting bigger. More and more bacteria are developing resistance. This means that infections will be harder to treat now and in the future. It also means that a lot of medical procedures such as cancer operations, organ transplants, or treating people who have been injured in accidents will be harder to conduct because there will be no antibiotics to stop any potential infections.