MISSION MICROBE

FIVE-STEP QUEST

Mission Microbes Five Step Quest follows the journey of germs that cause illnesses and what children can do to stop themselves, family and friends from getting ill.

The concepts covered by **Mission Microbes Five Step Quest** include what the different types of germs are, how they are transferred and **cause** illness and how antibiotics work.

Q1: Can antibiotics be used whenever we feel ill?

No, antibiotics can only be used when we have a bacterial infection, and only when we have been prescribed antibiotics by a doctor, nurse, or pharmacist.

Q2: Should antibiotics only be used when we have a bacterial infection?

Yes, 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.

Q3: Can you stop taking antibiotics when you start to feel better?

No, it is very important that we finish the whole course of antibiotics to effectively clear the infection and make us feel better. If we stop taking antibiotics before we have finished the course, the bacteria can mutate and then the antibiotics won't work any longer, allowing the bacteria to grow in our bodies and make us unwell.

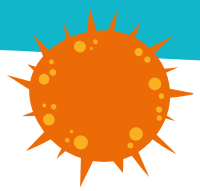
Q4: What is the difference between bacteria and a virus?

Bacteria are living and can multiply independently, both in us and on surfaces. Viruses must have a host (humans) to multiply and cause disease, they only survive on surfaces for short period of time (a few days). Cleaning surfaces and washing hands can remove bacteria AND viruses and keep us healthy. Bacteria can be treated with antibiotics, however, antibiotics don't work against viruses.

Q5: How can we stop germs spreading?

We can stop germs from spreading by washing our hands with soap and water and then drying them. If we catch the germs from our coughs and sneezes in a tissue and then throw it away, the germs are gone and not on our hands. If the germs go into our elbow, we must make sure we wash those clothes! Catch our germs so we don't make our family and friends poorly.

Additional information for educators:



Antibiotic resistance

Antibiotic resistance is an increasing problem worldwide it is thought by 2050 that many of the antibiotics that we rely on today will no longer be effective. One solution to the problem of antibiotic resistance is increased education on the importance of appropriate use of these drugs. A key age to introduce this concept is between 7- 11 years.

Concepts that children need to understand include; the importance of completing courses of antibiotics, not sharing antibiotics with family members or friends and understanding the difference between a virus and bacteria and when antibiotics are required for treatment of an infection. Understanding the importance of these actions from a young age will help in the fight against antibiotic resistance and preserve current antibiotics for future use.

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.

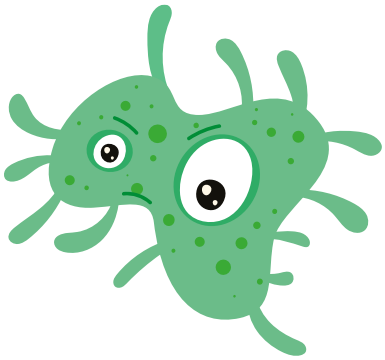
Ribosomes: This are the machines that take the RNA code and use it to make proteins.

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.

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.

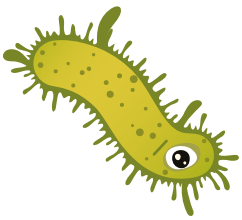
Knowing if a bacterium is Gram positive or negative is useful because it can affect the choice of antibiotic used to treat an infection.

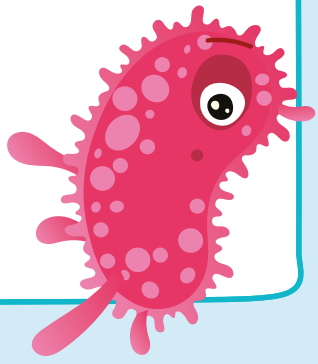
Bacteria have a single DNA chromosome (just one chapter in their instruction manual), but some of them have additional small pieces of DNA, that give them extra genes. These small pieces of DNA are in circles called plasmids. The extra genes allow the bacteria to live in extreme conditions or to resist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



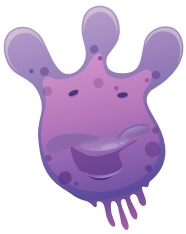


Viruses

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.



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.

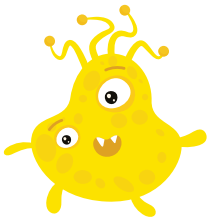
The antibiotic Ciprofloxacin is able to get all the way inside the bacterial cell and stop the DNA from replicating. If the bacteria cannot replicate its DNA, it can't divide and grow.

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.

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.



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.