**Teacher Pack Activity 3** - **Superbugs**

Cover page

**Learning outcomes**

In this activity, students will discuss the key causes and effects of bacterial infections, biofilms along with ways they can be treated or prevented. It is expected that the students will have a better understanding of:

1. What problems biofilms can cause and where they’re likely to form.
2. The problem with over-use of antibiotics.
3. How different surface treatment methods can be used to prevent biofilms.

**Link to curriculum**

\*Ties into the key idea from GCSE syllabus “living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways”.

\*Ties into AS-Biology syllabus AS 3.1 Unit 2: 3.2.10 Adaptation and selection are major components of evolution and make a significant contribution to the diversity of living organismsandGenetic variation in bacteria

Candidates should be able to:

* apply the concepts of adaptation and selection to other examples
* evaluate methodology, evidence and data relating to **antibiotic** resistance
* discuss ethical issues associated with the use of antibiotics
* Discuss the ways in which society uses scientific knowledge relating to antibiotic resistance to inform decision-making

**Equipment needed**

* *Optional* A3 Paper and Pens
* Information sheets A, B and C
* Computer and projector to show animation
* Animation found: http://bit.do/superbiomaterials

**Risk assessment**

Provided within this teacher pack is also a detailed risk assessment of the activity highlighting any potential risks and hazards that could be associated to the activity. Please note this is an example only and any risk assessments should be independently assessed and reviewed.

**Instructions for Teacher** - **Superbugs**

Introduction Watch video from RS visit found here: http://bit.do/superbiomaterials

**Starter exercise**

Discuss with the class:

* What are antibiotics used for?
* Who can get antibiotics?
* When shouldn’t antibiotics be given?
* What are some of the problems with antibiotics?
* What does ‘resistant’ mean?

It is hoped that the students will discuss how it is inappropriate to give antibiotics for viral infections etc. Problems include not finishing a course of antibiotics as this can lead to resistance, and over use of antibiotics.

**Main exercise**

1. Split the class into three groups, giving each group either sheet A, B or C.
2. Ask the students to read through the information, summarise it and have a discussion on the follow-up questions.
3. Let the students know they have 20 minutes to do this, after which they will feedback to the class.
4. Suggest that each group nominates a speaker to feedback to the class. You can provide paper and pens for students to use for feedback.

**Discussion points**

After the groups have given their feedback, discuss what the key conclusions were.

 In particular:

* Why is it important not to over-use antibiotics?
* What is a biofilm?
* How can we stop biofilms?
* How can we stop the spread of infections?

**TEXT A** - **Superbugs**

**TB**

*Mycobacterium tuberculosis* causes tuberculosis (TB), which is an infectious disease that mainly affects the lungs. Some antibiotic resistant strains of this bacterium are known as Multi-drug-resistant tuberculosis (MDR-TB). These strains are resistant to the two most commonly used antibiotics to treat TB. As of 2013, 3.6% of new tuberculosis cases are caused by MDR-TB. The World Health Organisation (WHO) estimates that there were almost 0.5 million new MDR-TB cases in the world in 2012. MDR-TB can have a mortality rate of up to 80% and the drugs used to treat MDR-TB are more expensive than those used to treat TB and they can have adverse side effects. To treat TB well you need to take 2, 3 or 4 antibiotics at once. Not taking them correctly (due to lack of money in developing countries or counterfeit antibiotics) has led to increased resistance, so it has now become a major problem.

**MRSA**

Methicillin-resistant Staphylococcus aureus (MRSA) is a bacterial strain that is resistant to beta-lactam antibiotics and cephalosporins. MRSA infections can be very difficult to treat. MRSA infections are more common in people in hospitals or care settings, but they can also occur in the community. MRSA causes skin infections most often, but can also cause pneumonia (lung infection) and if left untreated sepsis (blood infection) can result. MRSA rates have fallen in the last few years, due to increased awareness, efforts to tackle infection control in hospitals e.g. thorough handwashing and swabbing patients, and reduction of broad spectrum antibiotic use. In 2006, 1.8% of hospital patients were reported to have MRSA and this fell to 0.1% in 2012.

***Campylobacter***, (genus *Campylobacter*), is a group of spiral-shaped [bacteria](https://www.britannica.com/science/bacteria) that can cause human diseases such as campylobacter [enteritis](https://www.britannica.com/science/enteritis) ([campylobacteriosis](https://www.britannica.com/science/campylobacteriosis)), which begins abruptly with fever, headache, [diarrhea](https://www.britannica.com/science/diarrhea), and significant abdominal pain.

[Cattle](https://www.britannica.com/animal/cattle-livestock) and [chickens](https://www.britannica.com/animal/poultry-agriculture) are often colonized by *Campylobacter* without showing signs of illness; as a result, processed meats, uncooked [poultry](https://www.britannica.com/animal/poultry-agriculture), and raw milk can become contaminated with the bacterium. In the home, knives and cutting boards can also become contaminated, spreading the bacteria to other raw or lightly cooked foods that are prepared with the same unwashed utensils. After being ingested, the bacteria pass through the acid [environment](https://www.merriam-webster.com/dictionary/environment) of the stomach and subsequently colonize the [small intestine](https://www.britannica.com/science/small-intestine). Sometimes the bacteria spread to the bloodstream, where they can cause a life-threatening infection ([bacteremia](https://www.britannica.com/science/bacteremia)).

1. <https://apps.who.int/medicinedocs/documents/s16211e/s16211e.pdf>
2. <https://www.food.gov.uk/safety-hygiene/campylobacter>
3. <https://www.who.int/tb/areas-of-work/drug-resistant-tb/en/>

**Activity**

Read the information above.

In your groups you have 20 minutes to use the information above to discuss and answer the following questions. You need to prepare a short presentation summarising your answers and you will deliver this to the class after 20 minutes. You can use the paper and pens provided to help.

1. Summarise the information you have been given.
2. What different ways do bacterial infections spread
3. Can you think of any possible solutions to reduce the spread of infection or use of antibiotics?
4. Why would these be effective?

**Glossary of terms**

* **Resistant** – bacteria that are resistant to antibiotics are not killed by the antibiotics
* **Strain** – a variety of bacteria within a species that have specific characteristics
* **Mortality rate** – Number of deaths over time
* **Broad spectrum antibiotic** – an antibiotic that acts against a wide range of bacteria and is not specific
* **Contaminated** - exposed to bacteria
* **Ingested** - eaten
* **Gastrointestinal** – relating to the stomach and intestines
* **Urinary tract** - the series of channels by which urine passes out of the body

**TEXT B**  - **Superbugs**

Infections contracted in healthcare settings can develop either as a direct result of healthcare interventions such as medical or surgical treatment, or from being in contact with a healthcare setting. 1 in 25 people admitted to hospital get a health care associated infection. Medical devices (eg. A pacemaker, hip replacement, catheter) that are implanted into the body can often cause an infection. The most common cause of infection comes from catheters which are estimated to cost the UK NHS and USA approximately £1 billion and approximately $88 billion respectively.

A catheter is a tube inserted into your urethra. It drains urine from your bladder into a collection bag. You may need a catheter if you have had surgery or cannot control your bladder function, and there is a need to closely monitor how much urine your kidneys are producing.  Bacteria can transfer onto a catheter during insertion via a number of routes eg. From the patient or from the hospital staff.

 Bacteria can gather on the surface of catheters and form tightknit communities known as biofilms “slime cities” that help protect them from the immune system and antibiotics. Not all biofilms are harmful, for example biofilms in your nasal passages help prevent harmful bacteria entering your body. They can however provide a source from which bacteria can escape and cause infection elsewhere. For example, if bacteria from biofilms on a catheter pass into a person’s urine and then enter the bladder or kidneys, this can lead to an infection.  To treat these infections doctors, tend to administer antibiotics and given the prevalence of this type of infection medical professionals often use antibiotics as a preventative measure, rather than as a treatment. However, every time bacteria are exposed to antibiotics, they have the opportunity to develop resistance.

This means sometimes these antibiotics just don’t work. This is because, over the decades, the bacteria that cause these infections have evolved increasing resistance to medications that used to be effective. This resistance could prove to be deadly. It’s estimated that a continued rise would lead to 10 million people dying from drug-resistant infections per year by 2050.

An analysis of more than a million UTI samples by Public Health England, carried out in 2016, showed that one in three infections is caused by bacteria that are resistant to at least one major antibiotic. Some infections are caused by bacteria that have acquired resistance to almost all available antibiotics. When these occur, they are very difficult to treat.

1. <https://www.nice.org.uk/guidance/ng113>
2. <https://www.cdc.gov/hai/ca_uti/uti.html>
3. <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/656611/ESPAUR_report_2017.pdf> 



**Activity**

Read the information above.

In your groups you have 20 minutes to use the information above to discuss and answer the following question. You need to prepare a short presentation summarising your answers and you will deliver this to the class after 20 minutes. You can use the paper and pens provided to help.

1. Summarise the information you have been given.
2. What are biofilms and why can their presence make it more difficult to treat bacterial infections?
3. Does this influence the prevalence of antibiotic resistance bacteria? How?

**Glossary of terms**

* **Resistant** – bacteria that are resistant to antibiotics are not killed by the antibiotics
* **Contracted** - caught/ exposed to
* **Interventions** – action taken to improve a medical disorder
* **Preventative** – designed to keep something undesirable such as an illness from occurring
* **Prevalence** – commonness/ likelihood of a condition or thing
* **UTI** – Urinary tract infection
* **Urinary tract** - the series of channels by which urine passes out of the body

**TEXT C** - **Superbugs**

Infections in hospitals can be spread through contact with infected people or through contact with devices that are populated with bacteria. Antibiotics are used to treat bacterial infections however, overuse and misuse of antibiotics has led to some bacterial strains becoming resistant, meaning they cannot be killed by antibiotics.

 In a healthcare setting, bacteria can enter the body by being present on a medical device such as an implant, pacemaker or catheter. Instead of researching new antibiotics, some scientists are investigating developing new materials that prevent bacteria from attaching, thus removing one route of infection. Silver is known to have antibacterial properties and researchers developed silver coated catheters, however in a study involving 40, 000 patients, there was not a significant reduction in infection rates. Scientists have also tried catheters coated in antimicrobial chemicals; however, these didn’t show an improvement either. What’s more, antimicrobial chemicals – including antibiotics – can make the situation worse. When bacteria are exposed to antibiotics it causes selective pressure whereby those resistance or able to mutate survive and the others die. The survivors then multiply increasing the number of bacteria resistant to that antibiotic which can then spread.

It has been discovered that bacteria can talk to each other using signal molecules, synchronising themselves and behaving as a group rather than as single cells – something now called ‘quorum sensing’. Subsequently, they discovered that quorum sensing is also used by pathogenic bacteria to cause infection, opening up an intriguing idea: what if it was possible to stop infections by blocking bacteria’s ability to communicate, rather than by killing them with antibiotics? They worked closely with materials scientists to discover a polymer that prevented bacterial attachment.

It’s here that the new coating would have a massive advantage: it wouldn’t attempt to kill the bacteria, but instead would stop biofilms forming in the first place.

1. Williams P. Microbiology 153(12):3923-3938 doi:10.1099/mic.0.2007/012856-0
2. Lam TBL, Omar MI, Fisher E, Gillies K, MacLennan S, (2014) Types of indwelling urethral catheters for short‐term catheterisation in hospitalised adults, Cochrane Database of Systematic Reviews (9), 1465-1858.
3. Hook, A.L., Chang, C-Y., Yang, J., Luckett, J., Cockayne, A., Atkinson, S., Mei, Y., Bayston, R., Irvine, D.J., Langer, R., Anderson, D.G., Williams, P., Davies, M.C. and Alexander, M.R. (2012) Combinatorial discovery of polymers resistant to bacterial attachment. *Nature Biotechnology* 30(9), 868-875.

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**Activity**

Read the information above.

In your groups you have 20 minutes to use the information above to discuss and answer the following question. You need to prepare a short presentation summarising your answers and you will deliver this to the class after 20 minutes. You can use the paper and pens provided to help.

1. Summarise the information you have been given.
2. How can people be exposed to infections in hospitals?
3. Using the information above can you think of any solutions to reduce patient exposure to bacteria explaining why you think they will work.

**Glossary of terms**

* **Resistant** – bacteria that are resistant to antibiotics are not killed by the antibiotics
* **Strain** – a variety of bacteria within a species that have specific characteristics
* **Catheter** – a flexible tube inserted through a narrow opening into a body cavity, particularly the bladder, for removing fluid
* **Antimicrobial** – active against microbes
* **Synchronising** – coordinate and work together to do things at the same time
* **Pathogenic** – a microbe (bacteria/ virus etc) that causes a disease
* **Polymer** – a substance that has a molecular structure made up of many subunits (called monomers) joined together. Plastic is an example of a polymer.