



### Introduction

This lesson plan covers antibiotics and explores the use of antibiotics and the rise of resistant bacterial strains. An animation and presentation is provided to introduce how antibiotics work, how resistance arises and how resistance spreads. Students can then test their knowledge on antibiotic use in the common misconceptions quiz, before comparing their answers to a wider population. Worksheets cover key topics and students are asked to analyse data through tables and graphs.

### Learning Outcomes

- Antibiotics do not work on viruses, as bacteria and viruses have different structures.
- Bacteria are continually adapting to develop ways of not being killed by antibiotics, this is called antibiotic resistance.
- Taking antibiotics also affects your useful bacteria, not just the ones causing an infection.
- Antibiotic resistant bacteria can be carried by healthy or ill people and can be passed on silently to others.
- Antibiotic resistance spreads between different bacteria within our body.
- Controlling antibiotic resistance is everyone's responsibility including you.

### Exam Specification Links

This lesson plan covers several topics found in the AQA, OCR, Edexcel and WJEC exam specification for A-level Biology, Human Biology and related subjects. More information can be found on our 'Examination Links' webpage.

### Key Words

Antibiotic, Antibiotic resistance, Antibiotic development, Broad spectrum, Narrow spectrum, Viruses, Horizontal gene transfer, Vertical gene transfer

### Materials required

Graph paper for completion of SW2

### Available web resources

Animation and presentations available on the [e-Bug Young Adult teacher website](#)





### Background Information

Antibiotics are used to treat bacterial infections such as meningitis, tuberculosis and pneumonia. They do not work on viruses, so antibiotics cannot treat viral infections such as colds and flu. Antibiotics work by targeting structures unique to bacteria; thereby they do not cause damage to human cells and they do not kill viruses.

Antibiotics are either bactericidal, meaning they kill the bacteria, or they are bacteriostatic, meaning they slow the growth of bacteria. Penicillin is an example of a bactericidal antibiotic, which targets the peptidoglycan layer in the cell wall leading to cell death. Bacteriostatic antibiotics interfere with processes the bacteria need to multiply, such as protein production, DNA replication or metabolism.

Antibiotics can be narrow spectrum, affecting only one or two species of bacteria, or broad spectrum, affecting many different species of bacteria in the body, including useful bacteria in the gut. As a result of killing many bacteria in the gut, broad spectrum antibiotics are more likely to cause diarrhoea.

Bacteria are continually adapting to develop ways of not being killed by antibiotics. This is called antibiotic resistance. Resistance develops due to mutations in the bacterial DNA. The genes for antibiotic resistance can spread between different bacteria in our bodies through horizontal gene transfer, which includes transformation, transduction and conjugation. Resistance genes can also spread by vertical gene transfer when genetic material in chromosomes is passed from parent to offspring during reproduction.

Antibiotic resistant bacteria can be carried by healthy or ill people and can spread to others just as other types of microbes would, for example by shaking hands or touching all types of surfaces on animals, vegetables or food where bacteria are present.

Antibiotic resistance arises in our bodies bacteria, or in animals, due to the overuse and misuse of antibiotics. The more often a person takes antibiotics, the more likely they are to develop antibiotic resistant bacteria in their body. To prevent resistance, antibiotics should only be taken as prescribed by a doctor or nurse. The important points to remember are:

1. antibiotics do not need to be taken for colds and flu or most coughs, sore throats, ear infections or sinusitis as these usually get better on their own
2. it is important to take the antibiotic exactly as instructed and complete the course of antibiotics, to decrease the risk of emergence of resistance
3. antibiotics are personal and prescribed for individuals and for a particular infection. They should not be shared or taken for a different illness





### Introduction (20mins)

1. Explain that students are going to learn about how antibiotics work to kill bacteria and how the bacteria are fighting back and becoming resistant to the antibiotics. Antibiotic resistance is becoming an increasing problem worldwide and it can affect everyone – antibiotic resistance bacteria can easily spread from person to person. It is everyone's responsibility to ensure antibiotics are used correctly.
2. Show the students the 2 minute Antibiotic Guardian video to introduce the topic. The video is available at <http://antibioticguardian.com>.
3. Watch the e-Bug animation on antibiotics. Throughout the animation there are choice points to allow for a pause and discussion with the students. A teacher sheet to accompany the animation is available, should you wish to provide extra information.
4. Following the animation, view the powerpoint on antibiotic discovery and development.
5. Highlight that the discovery of new antibiotics has slowed down and explain that many pharmaceutical companies are no longer spending money on developing new antibiotics, due to the increasing problem of resistance.

### Main Activity (15-20 mins)

1. View the powerpoint quiz on common misconceptions associated with antibiotics.
2. Ask the students to vote on true/false before the answer to each question is revealed.
3. Show the students the survey data and discuss how their answers correlate with the rest of the population.
4. Highlight data from the 15-24 age group – this group has a lower understanding of antibiotics than the older population.
5. SH1, containing the quiz answers, can be given to students at the end of the exercise.
6. Provide students with a copy of SW1 and/or SW2 worksheets. SW1 has questions based on the animation, whereas SW2 contains a series of Maths questions around antibiotic resistance rates. Graph paper will need to be provided for completion of SW2.
7. Ask the students to complete the worksheets. Answer sheets are provided for the teachers.





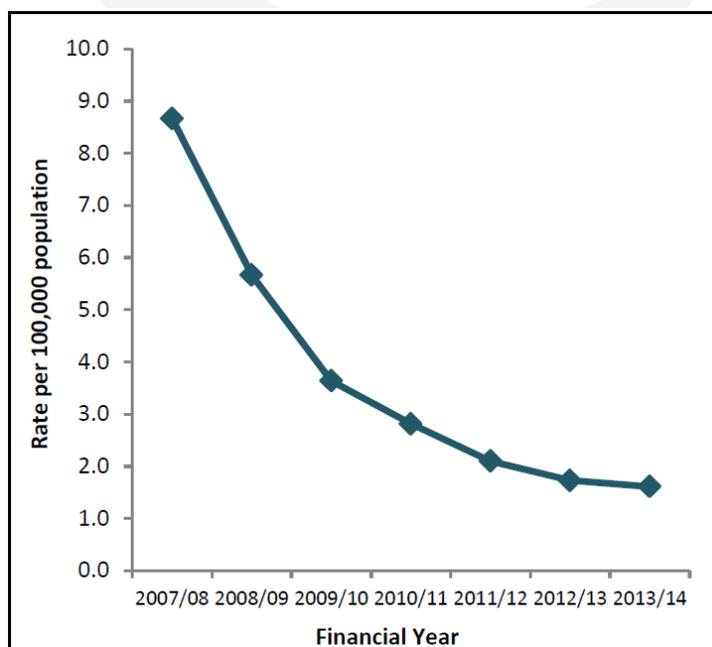
*Optional:* One or both worksheets can be provided for homework, should time be restricted. The final question on SW1 asks students to create a slogan or poster title that can be used to promote correct antibiotic use to the public and other members of the school community. Students could be asked to design the full poster as homework.

### Plenary (10 mins)

1. Discuss the worksheet answers with the students.
2. What is their understanding of antibiotic resistance?
3. Ask what resistant bacteria they have heard of? Describe Methicillin-resistant *Staphylococcus aureus* and tuberculosis as two examples:

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 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.

**Figure 1.** Trend in rates of MRSA bacteraemia between 2007 and 2014. Data taken from the Public Health England Annual Epidemiology Commentary 2013/14





Some antibiotic resistant strains of tuberculosis (TB) 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 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.

### Extension activity

1. Ask the students to write an essay based on the message from the animation and the common misconceptions they have learnt about during the lesson.
2. They should consider the following points:
  - a. What are the most common misconceptions around antibiotics and why might there be such widespread misunderstanding?
  - b. How would tackling common misconceptions around antibiotics help to slow or prevent the rise of resistance?
  - c. What methods or approaches should be used to tackle misconceptions?
  - d. Personal, family or friends experiences of antibiotics can also be included, such as why antibiotics were taken and if the user thought they may have been unnecessary. What would have helped in this situation?

### Advance Preparation

1. Locate the animation on the Young Adult Teacher [e-Bug website](#)
2. Download the presentations from the Young Adult Teacher [e-Bug website](#)
3. Copy SW1 and SW2 for each student

