Within this lesson plan, students aged 16-18 years will run a 1 hour lesson with students in the same educational establishment or a linked organisation. The lesson can be delivered to students in key stage 3 (ages 11-14), key stage 4 (ages 14-16), or even other key stage 5 students.

Value of peer education

Peer education is becoming an increasingly popular educational tool due to the benefits for all involved. For the peer educators, benefits can include positive changes in knowledge, skills, attitudes and confidence, and development of key communication and social skills. By teaching others, students gain a deeper understanding of the topics covered, and have increased knowledge in the area, when compared to didactic learning.

Students taught by their peers may identify more closely with their educator, which allows the development of positive relationships and a greater level of trust between educator and student.

What is covered?

Within this lesson plan, all students will cover the important topics of antibiotics and antibiotic resistance. Not only will students learn the science behind how antibiotics work and how resistance to antibiotics comes about, they will also learn essential health information, such as how to take antibiotics correctly, which is important for PSHE education.

The lesson plan is designed to cover topics in key stage 5. These topics are then presented in a simplified and understandable way for younger students, allowing both the students and peer educators to learn key information around this area.

Running the lesson

The lesson set-up is flexible and can be arranged to suit any educational establishment. Peer educators could be split up to teach all classes across a year group, for example with 5-6 key stage 5 students teaching each class. The peer educators should work in small teams, of between 2 and 6 students, to deliver the lesson, deciding between themselves how to divide up the lesson delivery.

The peer educators should be encouraged to adapt the activities and script to suit their own style. The information provided here can be used as a guide. Allow the peer educators time to prepare and practice before the lesson delivery. See Advance Preparation for information on what is required before the lesson.

Optional homework is also provided for those being peer educated. This could be marked by the key stage 5 students, allowing them to receive feedback on their lesson.
National curriculum/exam specification links

Key Stage 5:
This lesson plan covers several topics found in the AQA, OCR, Edexcel and WJEC examination specification for Biology, Human Biology and related subjects. More information can be found on our ‘Examination Links’ webpage.

Key Stage 3/4:

Biology –
- Working Scientifically – Scientific Attitudes, Experimental skills and investigations, Analysis and evaluation
- Structure and Function of Living Organisms - Cells and Organisations

PSHE - Core Theme 1: Health and Wellbeing

Learning outcomes for key stage 5

- Many infections get better on their own without the need for antibiotics
- Bacterial and viral infections may cause similar symptoms
- Antibiotics work on bacteria and have no effect on viruses
- Bacteria are continually adapting to develop ways of not being killed by antibiotics (known as antibiotic resistance)
- Antibiotic resistance can spread between different bacteria in our body
- Antibiotics can affect all the bacteria in your body, not just the ones which cause an infection.
- Antibiotic resistant bacteria can be carried by healthy or ill people and passed on silently to others
- The more often you take antibiotics, the more likely you are to have an antibiotic resistant infection
- You should not share antibiotics as each antibiotic is personal to you and your infection.
- Antibiotics should always be taken as instructed by a doctor or nurse, because overuse may make the antibiotics less effective against the bacteria, and then the next time we have an infection they may not work.
Antibiotics are special medicines which can only be prescribed by a doctor or nurse. 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. Penicillin was the first antibiotic to be discovered in 1928 by Alexander Fleming and is still used to treat some sore throats and pneumonia today. Other examples of antibiotics include amoxicillin for chest infections, flucloxacillin for skin infections and trimethoprim for urine infections.

Antibiotics can be broad spectrum, affecting many different species of bacteria, or narrow spectrum, affecting only one or two. Antibiotics work by targeting structures unique to bacteria, so they are not dangerous to human cells and they do not kill viruses. Targets include the bacterial peptidoglycan cell wall, the ribosome (needed for protein production), DNA replication (needed for cell division) and metabolic enzyme activity (needed for cell growth).

Bacteria are continually adapting to develop ways of not being killed by antibiotics. This is called antibiotic resistance. Resistance develops due to a change in the bacterial DNA. These genes for antibiotic resistance can then spread between different bacteria in our bodies. 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 touching surfaces where bacteria are present.

Antibiotic resistance arises 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. Many infections get better on their own, without the need for antibiotics
2. Antibiotics should only be taken for bacterial infections and not viral infections such as colds and flu, and most coughs, sore throats, ear infections or sinusitis
3. It is important to take antibiotics exactly as instructed (for example three times daily), to ensure all bacteria within your body are killed and to prevent the development of antibiotic resistance
4. Antibiotics are personal and prescribed for individuals and for a particular infection. They should not be shared or taken for a different illness
Section 1: Introducing Antibiotics (15-20 mins)

Begin by asking the students if they know three types of microbes that can cause infections – bacteria, virus and fungi, and explain the relative sizes of the microbes. A student hand-out is available to help with this explanation. Explain that infections are treated differently depending on the microbe that has caused it.

Introduce antibiotics – ask who has heard of them and if anyone knows which microbe they affect. Explain that they are now going to look in more detail at the differences between human cells, bacterial cell and viruses, to try and understand why antibiotics only affect bacteria.

Activity:

Give the students 3 pieces of paper, one for a bacterium, a virus and a human cell. Ask the students to work in pairs to fill in the cells with the correct cellular contents (these can be drawn in or cut out from additional pieces of paper). The cells should contain:

- Human cell contains: a nucleus, a mitochondria, a cell membrane
- Bacterial cell contains: free DNA plasmid (not in nucleus), a cell wall, a cell membrane
- Viral cell contains: free DNA (not in nucleus), a protein coat

Prior to the lesson, research the role of each cellular component. Ask students if they know the function of the different components?

Explain that antibiotics target structures unique to the bacteria and this is why they do not harm human cells and why they do not work on viruses.

Ask the students if they know any illnesses caused by viruses? Is it easy to tell the difference between bacterial and viral infections? How should viral infections be treated?

It is also important to say that many bacterial infections get better on their own without antibiotics.
Section 2: Antibiotic Resistance (15-20 mins)

Introduce antibiotic resistance by explaining that bacteria are continually developing ways to avoid being killed by antibiotics, and that this is known as antibiotic resistance. Antibiotic resistant bacteria can be very dangerous as they cannot be treated.

Ask if anyone has heard of MRSA? Describe MRSA and antibiotic resistant TB – information can be found on the Public Health England, NHS Choices, MRSA Action UK and the Stop TB Partnership websites.

Next, give the students a short presentation on the discovery of antibiotics and antibiotic resistance. The presentation available on the senior student e-Bug website may be used, or alternatively you can use a presentation that you have prepared yourself. It is important to make the presentation fun without too many words.

Now explain that you will show a demonstration to describe antibiotic resistance.

Activity:

Line up around 4-6 balloons, mostly yellow with one or two red ones (different colours may be used but yellow and red will be used here to describe the demonstration). Put sellotape or parcel tape on the red balloons. Clear parcel tape works the best; if sellotape or brown parcel tape is used, several layers may be required for the experiment to work. The sellotape is best placed on the end of the balloon where the balloon is thickest. The yellow balloons represent bacteria and the red balloon with tape on represents antibiotic resistant bacteria. The pin represents the antibiotic.

Brown tape is used for demonstration but clear parcel tape is ideal to use as resistant is carried slightly/invisibly in people who are not ill.

When we give an antibiotic, bacteria are killed or damaged – pop some yellow balloons with the pin. In particular, one group of antibiotics (the penicillins) damage the bacterial cell wall. However in bacteria that are antibiotic resistant, the cell walls are now not affected by the antibiotics – put the pin through the sellotape in the red balloons, it will not pop.
This makes it more likely for the resistant bacteria to survive and reproduce. They have a selective advantage.

Ask if anyone knows where resistance comes from? Explain it is due to a change in the bacterial DNA/genes that tell the bacteria how to make the cell wall or enzyme.

Explain that bacteria can pass these resistant genes on to other bacteria – put sellotape on a remaining yellow balloon, which represents the transfer of antibiotic resistance to another bacterium. This can happen in our body.

Resistance is also passed on when bacteria reproduce – demonstrate this by blowing up another red balloon and putting sellotape on in.

Explain that resistant bacteria can be passed from person to person just as normal bacteria can be. Ask how these bacteria can spread? The easiest way is via our hands. Examples include direct skin to skin contact or touching surfaces which may contain bacteria.
Section 3: Taking Antibiotics Correctly (15 mins)

To prevent bacteria becoming resistant to antibiotics, we should always take antibiotics correctly, as the doctor or nurse prescribes.

The more often we take antibiotics, the more likely we are to have antibiotic resistant bacteria in our bodies. Therefore overusing antibiotics may make them less effective.

Ask if anyone knows what we mean by responsible use of antibiotics?

The cartoon storyboards shown in student handout 1 describe how antibiotics should be taken. Discuss these with the students. The correct ways are:

- Only using antibiotics for infections that need them, not for viral infections such as colds and flu or for mild sore throats, ear ache or skin infections
- Antibiotics should never be shared with other people or used on other infections. An antibiotic given to you by your doctor or nurse is personal to you and to your infection.
- Always take antibiotics exactly as prescribed, for examples 3 times a day. If you forget to take a dose, take it as soon as you remember even if it means taking two at once. Then continue with the rest of the course.
- You should always complete the full course of antibiotics prescribed to, even if you are feeling better before the end.

To demonstrate the last point, explain that you are going to show an experiment which will help the students understand why the full course should be taken.

Activity:

Show the students a test tube containing the yellow solution and explain that it represents a healthy person’s body with no bacterial infection. The test tube with the red solution represents an ill person who has a bacterial infection. See ‘Advance preparation’ for details on how to make the solutions.

Say that the doctor has prescribed the ill person a course of 7 antibiotics to take (adjust to your test of the solution). Start to add drops of the dilute vinegar using a pipette and ask the children to count with you. Halfway through the dosage show the students that some of the solution has turned yellow – say that this shows that the person is feeling better.
Then mix the solution with a pipette (it will stay red) and say that even though the person is feeling better, the solution is still red showing the bacteria are still there, so they must keep taking their antibiotics until they are completely healthy. Finish adding the dose and mix to make the solution yellow.

Tell the students that because they finished the whole course of antibiotics, the person is completely healthy. Explain that if the person didn’t finish the whole course of antibiotics, the bacteria could have come back stronger.

End by repeating the ways antibiotics should be taken correctly.

Optional: Extension activity

As an extension, show the students the Antibiotic Guardian video, available at http://antibioticguardian.com. The clip can be used to stimulate a discussion between the students. Ask the students to become an Antibiotic Guardian by pledging to use antibiotics responsibly.

Optional: Homework

Ask the students to create a poster promoting the correct use of antibiotics. This can cover any of the topics they have learnt in the lesson.
**Advance Preparation**

**Section 1:** Research the role of cellular components in human, bacterial and viral cells.

**Section 2:** Research information on MRSA and TB. Information can be found on the [Public Health England](https://www.gov.uk/government/world/health-and-social-care), [NHS Choices](https://www.nhs.uk), [MRSA Action UK](https://www.mrsa.org.uk) and the [Stop TB Partnership](https://www.stoptb.org) websites.

*Optional:* Make a 5 minute presentation on antibiotic discovery and resistance. Alternatively download the ‘Antibiotic use and resistance’ presentation from the [e-Bug website](https://www.e-bug.info), which is suitable for key stage 3 students. Blow up around 4 balloons in one colour and 2 balloons in another colour. Add a strip of sellotape or parcel tape to the end of the two balloons which are a different colour.

**Section 3:** Prepare test tubes (enough for two test tubes per group) by filling a third full with water and adding a drop of phenol red indicator. This will turn the water red. Dilute vinegar in a small bowl with water (only a few drops of vinegar are required). This will represent the antibiotics. Test the experiment to see how many drops of vinegar are required to turn the solution in the test tube yellow. Ideally this should be around 7. Strengthen or dilute the vinegar solution as required. Keep the yellow solution as a ‘healthy person’ to show the students.

### Materials required

- **Section 1:** paper, pencils and scissors
- **Section 2:** antibiotic discovery and resistance presentation, balloons, sellotape or parcel tape, pin
- **Section 3:** student handout 1, plastic pipettes, vinegar, phenol red indicator, test tubes and test tube holder

### Available web resources

- Antibiotic discovery and resistance presentation – available [here](https://www.e-bug.info)
- Student Hand-out 1 – available [here](https://www.e-bug.info)
- Student hand out on the three types of microbes and their relative sizes – hand out SH1, available [here](https://www.e-bug.info).

### Key words

- Bacteria, Virus, Antibiotic, Antibiotic resistance, Disease, Infection

### Acknowledgements

This lesson plan was written by Dr Vicki Young and the activities in Section 1 and 2 were devised by Dr Carwyn Watkins.
When Amy got home, her mother decided to take her to the doctor. He said that she had a bad cold.

Go home and get some bed rest, take some painkillers for the headache if you need to.

But she’s ill, you have to give her some antibiotics.

I’m sorry, but there’s no need.

Harry didn’t come to school the next day so Amy called around to see him on her way home from school.

You weren’t in school today, are you OK?

No, my knee started to get really painful in the night so my Mum took me to see the doctor. He said that my cut got infected.

Oh no, did he give you painkillers?

No, he gave me antibiotics to help fight the infection but told me to take them until they were all finished.

During lunch Amy was talking to her friend Harry about her headache and runny nose.

It really hurts and I think I’m getting a cough.

Don’t you have any antibiotics at home you can take?

That’s a good idea. We still have some from when my sister had an ear infection. I’ll ask my mum.