Key Stage 4

Teacher Refresher Information

In some cases, the immune system needs help. Antimicrobials are medicines used to kill or slow the growth of microbes. Antimicrobials can be grouped according to the micro-organisms they act primarily against. 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 bacteria found in the body, animals, or the environment, 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.

Teacher Answers

Agar Experiment Advanced Preparation

Also available in TS1

The following preparation is for 1 group of 5 students

Materials Required
Petri dishes
Hydrochloric acid
Wax Crayon/marker
Base Agar
5 Test tube racks
Cork borer
Phenol Red
20 Test tubes
Disposable droppers
Hot plate

Agar Plate Preparation
1. Make up 100ml of base agar following the manufacturer's instructions.
2. When cooled slightly, but not solid, pour 1 agar plate (to demonstrate no growth). When complete add enough (~10 drops) 2 – 4% Phenol Red to turn the agar a deep red/dark orange and mix well.
3. Pour approx 20ml into each petri dish and leave to cool.
4. When solidified, make 5 evenly spaced bore holes in each agar plate.
5. Label each Petri dish with Patient A, B, C and D

Antibiotic (test-tube) Preparation
1. Set up a test tube rack of 5 test tubes for each patient. Label each test tube with one of the following labels a. Penicillin b. Meticillin c. Oxacillin d. Vancomycin e. Amoxicillin
2. Transfer 5ml of the following solutions into the appropriately labelled test tube

Patient	Pencillin	Meticillin	Erythromyocin	Vancomycin	Amoxicillin
A	Water	Water	Water	Water	Water

B	10% HCl	5% HCl	1% HCl	0.05% HCl	5% HCl
C	Water	Water	1% HCl	0.05% HCl	Water
D	Wate	0.05% HCl	0.05% HCl	0.05% HCl	Water

NB: It is extremely important to have the correct concentrations of HCl (antibiotics) for each patient.

3. Set up a work bench for the group as follows:
a. Place the appropriate patient's agar plate next to each corresponding rack of test tubes at 4 stations across the bench
b. A dropper for each test tube
c. A ruler with mm markings
d. It may be easier for students if they place each patient's agar plate on a piece of white paper and label the paper next to each bore hole with the antibiotic name.

SW1 Agar Experiment Results

Also available in TS2

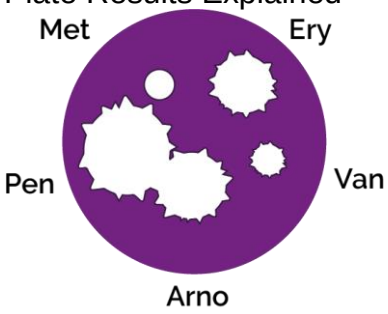
Plate Result

Organism sensitivity to antibiotics

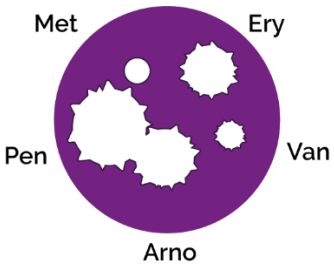
Patient	Penicillin	Methicillin	Erythromycin	Vancomycin	Amoxicillin	Diagnosis
A	X	X	X	X	X	Influenza
B	Y	Y	Y	Y	Y	Strep throat
C	X	Y	Y	Y	X	Staphylococcus wound infection
D	X	X	X	Y	X	

Y – sensitive – zone of no growth visible; X – not sensitive – no zone visible

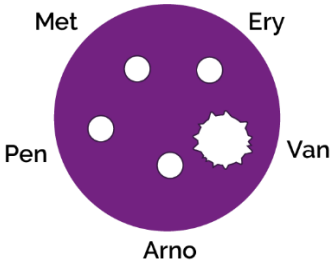
Plate Results Explained



Patient A: Influenza is caused by a virus and as such none of the antibiotics will have an effect as antibiotics can only be used on bacterial infections.

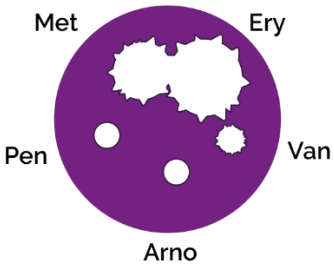


Patient B: Sore throat infections are quite common and generally get better on their own. In severe cases, most antibiotics will treat this infection. Penicillin is the antibiotic of choice for this infection as the group of bacteria responsible (*Streptococcus*) have yet to develop a mechanism of resistance. Antibiotics should not be given unnecessarily for mild sore throats as 80% of sore throats are due to viruses and other bacteria can develop resistance during treatment.



Patient C: Methicillin Resistant *Staphylococcus aureus* (MRSA) infections are becoming increasingly difficult to treat. These *S. aureus* bacteria have developed resistance to Methicillin, the previous antibiotic of choice. Vancomycin is one of the last lines of defence against these potentially fatal bacteria

however some organisms have been detected which also show resistance to this antibiotic.



Patient D: Penicillin was the first antibiotic discovered and produced, unfortunately many people viewed it as a 'wonder drug' and used it to treat many common infections. This resulted in the majority of *Staphylococcal* bacteria quickly developing resistance to this antibiotic. As Ampicillin is a derivative of penicillin, *Staphylococcus* bacteria are resistant to it as well. Methicillin is the drug of choice for this sensitive Staphylococcus infection

SW2 and SW3 Agar Experiment Conclusions

1) Antibiotics don't cure the cold or flu, what should the doctor recommend or prescribe to patient A to get better?

Antibiotics can only be used to treat bacterial infections; the cold or flu is caused by a virus. The doctor should prescribe medicines to help with the symptoms.

2) Methicillin used to be used to treat a *Staphylococcal* infection, what would happen to Patient C's infection if they had been prescribed Methicillin?

Nothing. MRSA is resistant to antibiotics.

3) If you had some amoxicillin left over in your cupboard from a previous chest infection, would you take them later to treat a cut on your leg that got infected? Explain your answer.

No, you should never use other people's antibiotics or antibiotics which have been prescribed for a previous infection. There are many different types of antibiotics which treat different bacterial infections. Doctors prescribe specific antibiotics for specific illnesses and at a dose suitable for that patient. Taking someone else's antibiotics may mean your infection does not get better.

4) Patient D doesn't want to take the prescribed flucloxacillin for their wound infection. *"I took more than half of those pills the doc gave me before and it went away for a while but came back worse."* Can you explain why this happened?
It is very important to finish a course of prescribed antibiotics, not just stop halfway through. Failure to finish the course may result in not all the bacteria being killed and possibly becoming resistant to that antibiotic in future.

SW4 Antibiotics Right or Wrong

Statement 1: Wrong

Most common infections that cause coughing and sneezing are caused by viruses and will get better by themselves with bed rest and fluid intake. Antibiotics are not effective against viruses.

Statement 2: Right

Antibiotics should be taken exactly as advised by your healthcare professional.

Statement 3: Wrong

You must not use other people’s or any leftover antibiotics.

Statement 4: Right

Most common infections that cause coughing and sneezing are caused by viruses and will get better by themselves with bed rest and fluid intake. Antibiotics are not effective against viruses.

Statement 5: Wrong

Antibiotics can help severe bacterial infections such as pneumonia or kidney/urine infections.

Statement 6: Wrong

Antibiotics should be taken exactly as advised by your healthcare professional.

Statement 7: Wrong

Antibiotics are not effective against headaches or viruses, such as the one that causes flu.

Statement 8: Right

If you over-use antibiotics they might not work when you really need them for a severe infection.