Biofilms

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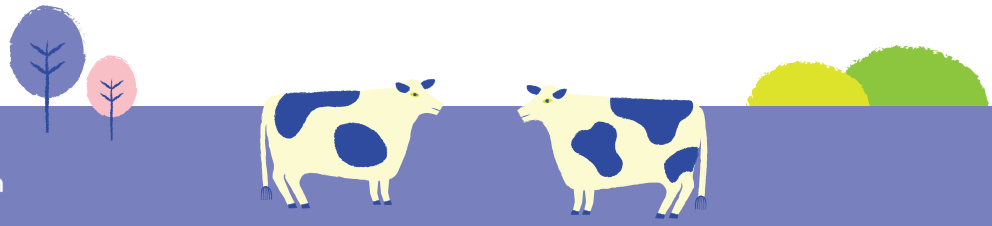

This Biofilms resource was funded by the National Biofilms Innovation Centre, lead by Heriot-Watt University and supported by STEM.

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Let's find out about **biofilms!** What are they? And how do **antibiotics** affect them?

TOP TIP

Any words that are highlighted in the text are either defined on the page or are explained further in the glossary at the back.

What are antibiotics?

Antibiotics treat illnesses and infections caused by caused by tiny organisms called bacteria.

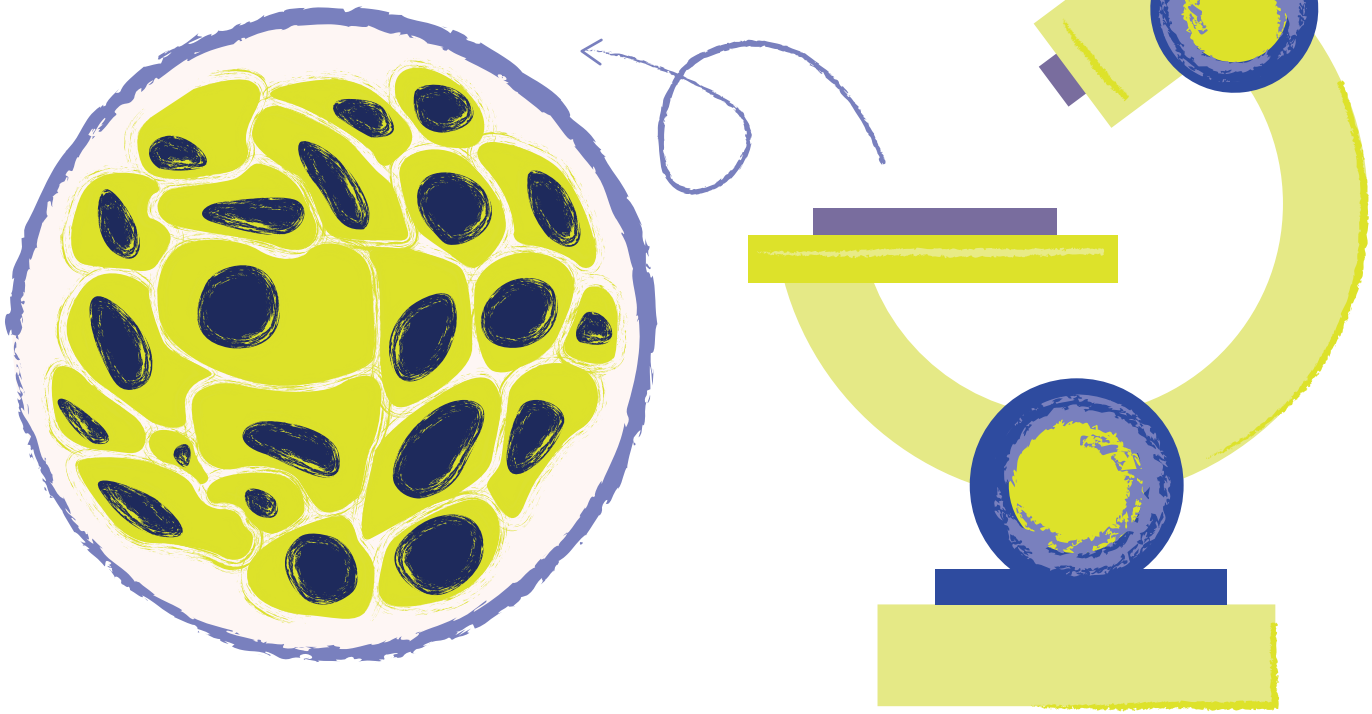
What are biofilms?

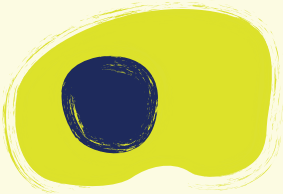
Biofilms are slimy layers on a surface made up of lots of **bacteria** and other tiny **organisms.** Bacteria are living things that are very small. They can't be seen with the naked eye. A **microscope** allows us to see them.

Bacteria can stick to each other and to surfaces. They make a gooey slime called **extracellular polymeric substance** (we call it EPS for short) – this helps them stick together and to the surface. This is called a biofilm.

What is a microscope?

A microscope is a piece of equipment used to make things look bigger, like an extra powerful magnifying glass.





What is an organism?

An organism is one single living thing, like an individual animal, plant or bacterium.

Where are biofilms found?

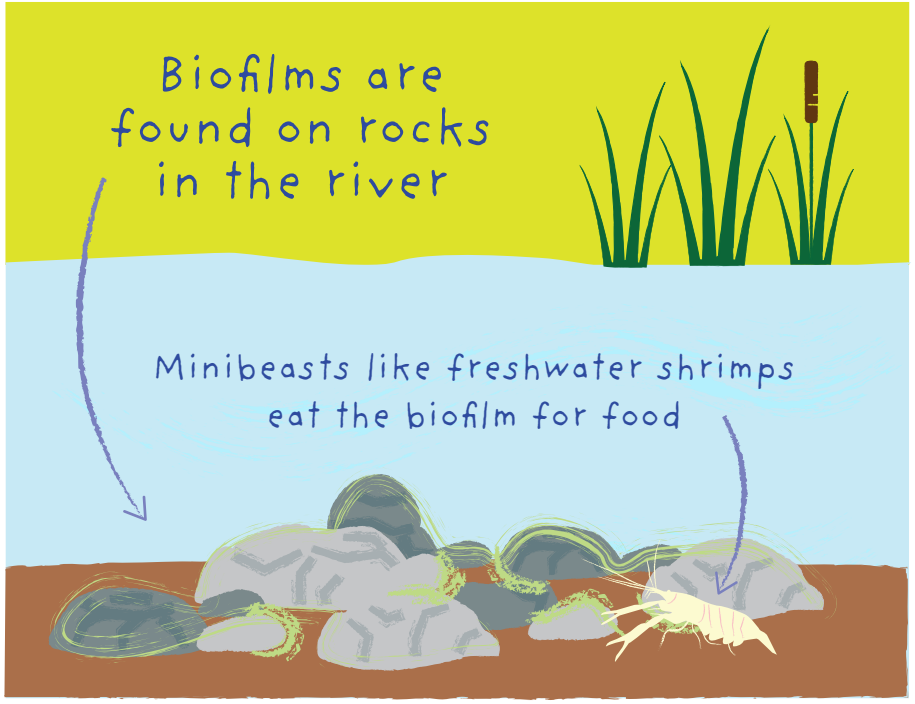
Biofilms can be found in many **environments**, including in rivers, on surfaces in your home, and in the human body – the **plaque** on your teeth is an example.

Being in a biofilm helps bacteria to stay alive. It helps to **protect** them from being eaten, from drying up, from sunlight, and from other **harmful** things in their environment.

The importance of biofilms in waters

Biofilms are important in our waters. They **provide** food for small animals called **invertebrates** – otherwise known as 'minibeasts'. These in turn are then eaten by fish, birds or frogs which are then eaten by other birds and fish.

River biofilms also have lots of "good" bacteria which can help clean up **unwanted pollutants** in our waters. However, some pollutants can change or harm how the bacteria in biofilms work.



Antibiotics and how they can affect biofilms

One group of **chemicals** that can be a problem for bacteria in river biofilms are antibiotics. The doctor may give us **antibiotics** when we're ill and vets or farmers sometimes give antibiotics to sick animals. They are **designed** to kill "bad" bacteria in people and animals, but if those antibiotics get into water, they can also kill the good bacteria in biofilms, or change the way they work.

Antibiotics can get into water through our **wastewater** (sewage) because some pass out of our bodies after we have taken them. They can also run off farmland from animal **manure** into streams and rivers.

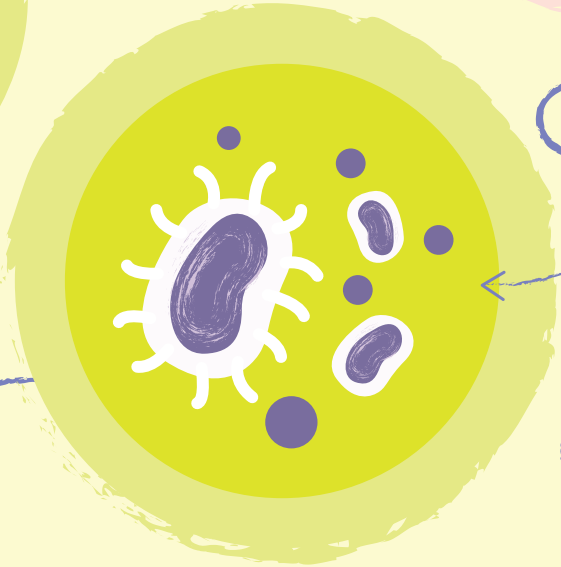
It is important to only use antibiotics when they are needed both in humans and animals. We can help make sure we need antibiotics as little as possible by washing our hands well before eating and after using the toilet. If we are given antibiotics by the doctor, it is important to take them exactly as the doctor tells us so that none of the bacteria they are trying to kill can survive.

Studying biofilms in rivers can give us information about river health. Let's find out how it's done...

Hi, my name is Claire and I am a microbiologist.

What is a microbiologist?

A scientist who studies very small living creatures such as bacteria.



Bacteria can also be found in rivers and streams – which is what I research! Come and find out what I get up to..

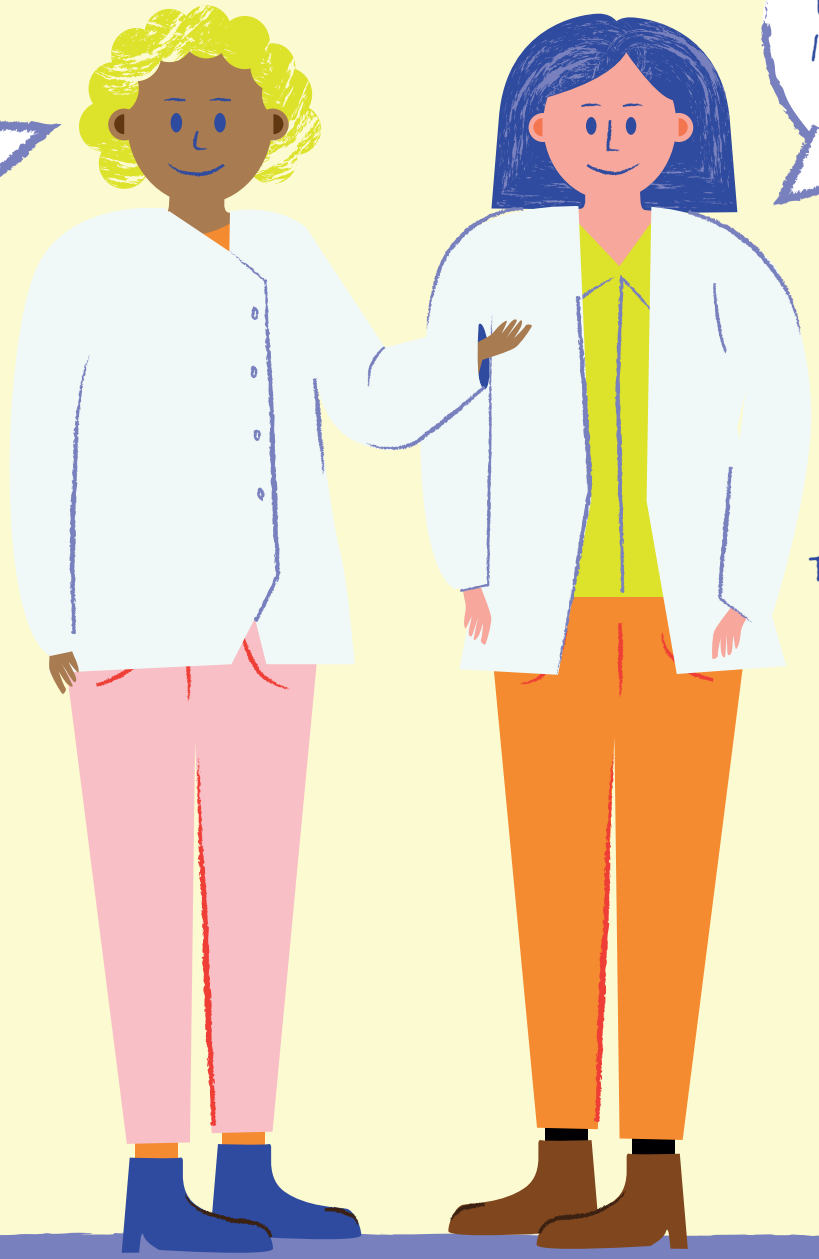
Good and bad bacteria

Bad bacteria in our bodies can cause diseases and make us feel very unwell. Not all bacteria are harmful though. Cheese and yoghurt can contain good bacteria which is good for our gut and helps with digestion!

River research!

Claire, I have an important project for you... we need to research how healthy our rivers are! By looking at the different bacteria in biofilms in samples from the river, we can find some answers!

The project sounds really interesting! I will make a plan and carry out the research.



Anna
THE PROJECT MANAGER

Claire
THE MICROBIOLOGIST

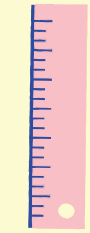
What is a sample?

A sample is a small part of something bigger that we can use to find out more about the larger thing, e.g. a sample from a river could be a small amount of water which we can test to tell us about the river water in general.

Turn the page to see Claire's step by step process.

Step 1: Planning

Items I will need:


Ruler


Tooth brush


Map


Life jacket


Sample bottles


Gloves


Camera


Waders


Notebook

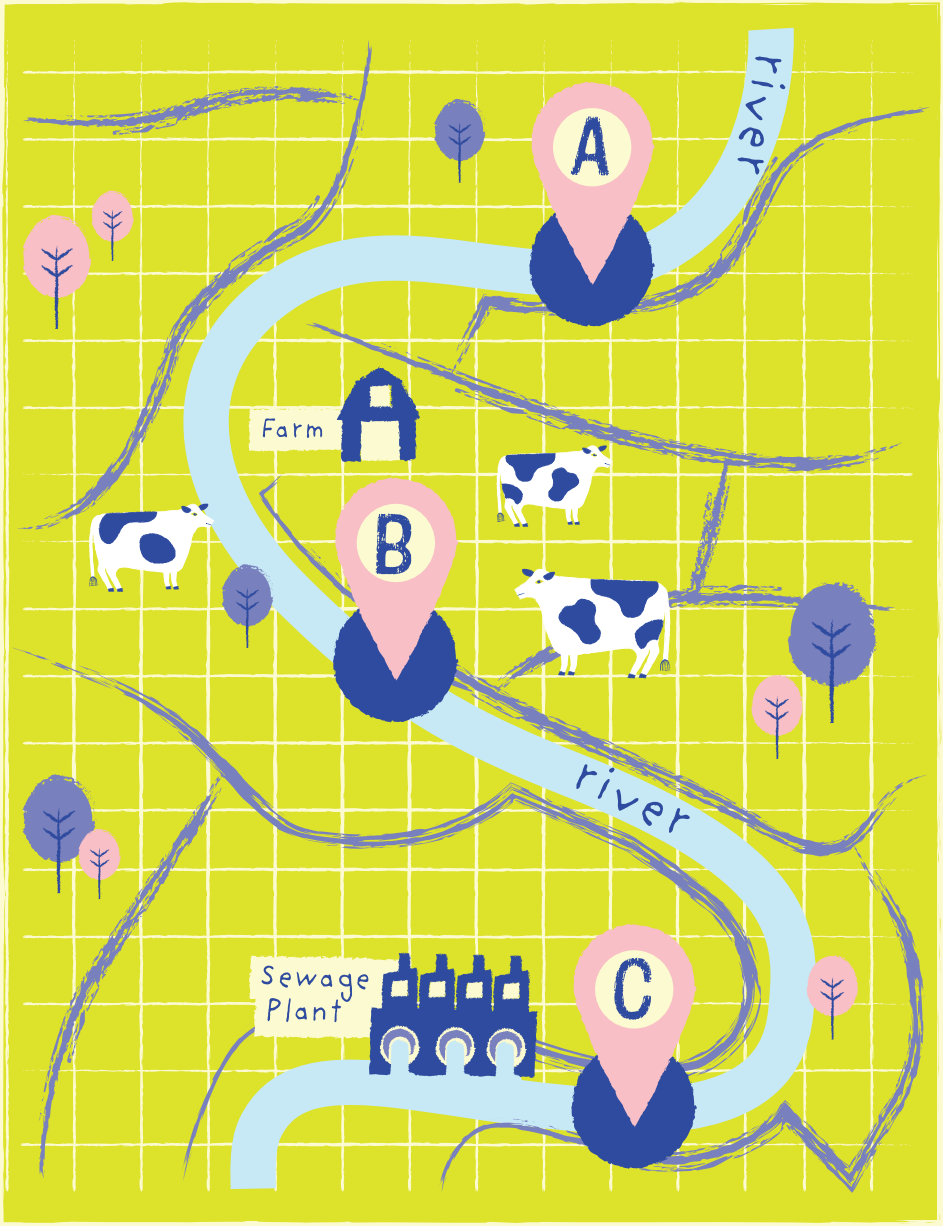

Pen


Raincoat

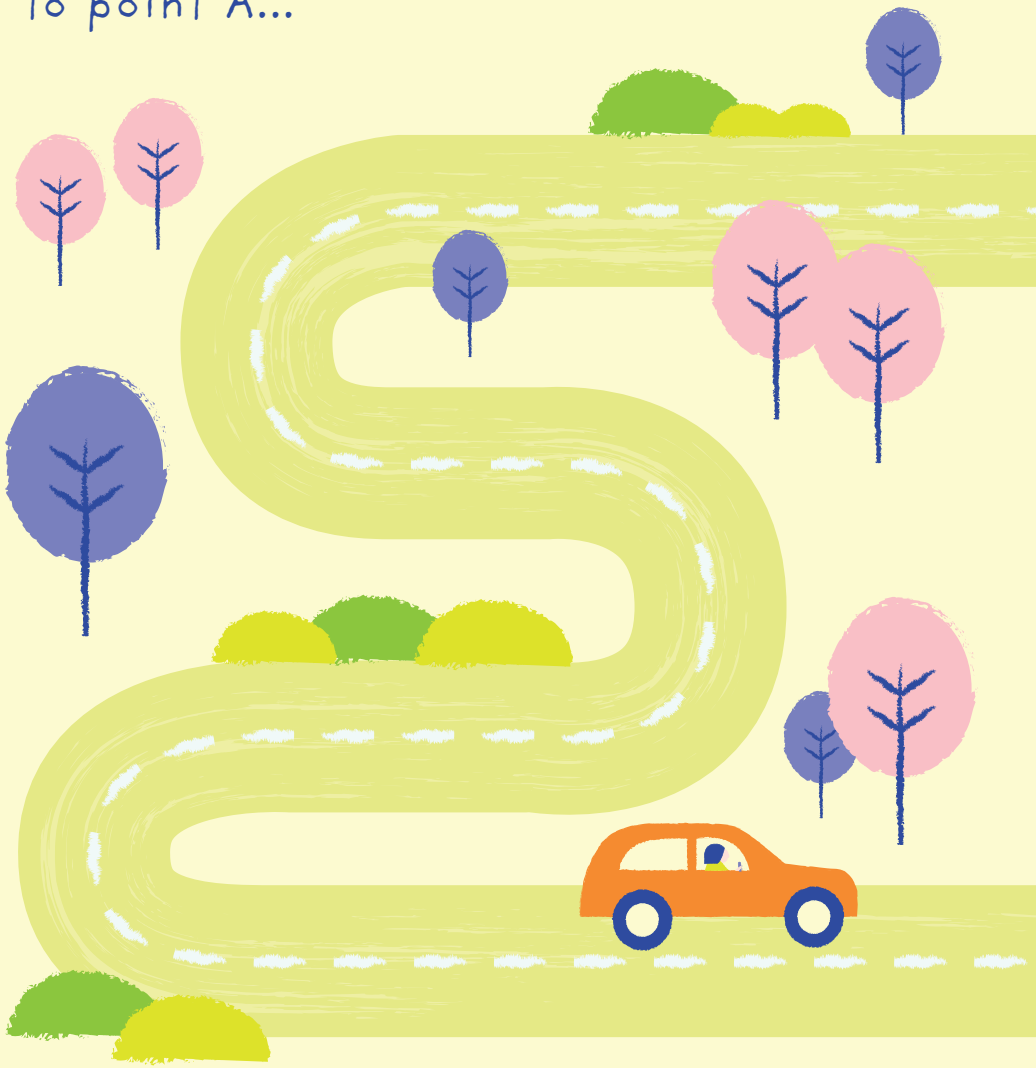
Warm hat


Measuring stick

Step 2: Location, location, location



On the map Claire has picked multiple points along the river to collect her samples. First she is off to drive to point A...



Step 3: Safety first

Rivers can be a dangerous place. So thinking about the potential hazards when taking samples is very important.

Here are some safety measures for Claire to think about...

- Can you swim?
- Does the river look high?
- Does anybody know where you are on the river?
- Do you have the right protective clothing?
- Is there a safe place to enter the water?
- Is the river flowing too fast?

Step 4: All checked?

Can I swim?

Yes – I need to be able to swim in case I get into trouble in the water and need to swim to safety.

Does the river look high?

I can use a measuring stick to check the height of the river, to see if it is safe to enter.

Is the river flowing too fast?

If the river is high it is likely to be flowing fast too. Checking the weather can also help – if there has been lots of rain the river levels will rise.

Do I have the right protective clothing?

Yes – I have waders (long wellies that keep me dry), a life jacket to keep me safe and warm, waterproof clothes.

Is there a safe place to enter the water?

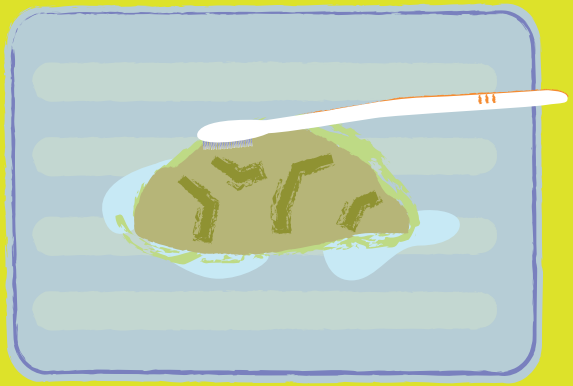
I need to be careful when climbing down to reach the edge of the water, and once I know the river level is below my knees I can enter the water.

Does anybody know where I am on the river?

Yes – I have let my friends and project manager know where I am collecting samples. If I get into trouble someone should know where to look for me.

Step 5: Gathering samples

Luckily, this bit of the river isn't too deep so Claire can step across to a stony area to gather some samples. She has found and picked up several rocks to bring back to the edge of the river.



She uses a clean toothbrush and some clean water to scrub the slime from the rocks into a tray. This is the biofilm!

Claire carefully tips the slimy liquid into a sample bottle.

Step 6: Back to the Lab!

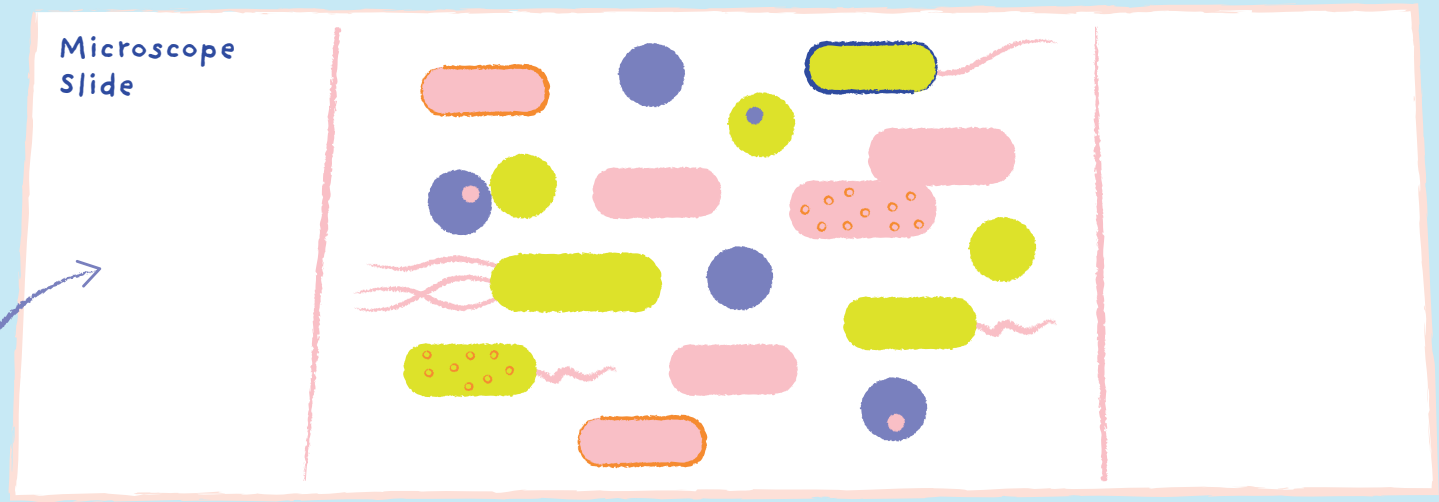
After taking a few samples along the river Claire took them back to the laboratory to look at the biofilm down a microscope. There are different ways she can count the bacteria and to check if they are resistant to antibiotics.

Help Claire count the different types of bacteria.

Round bacteria are called "cocci"

Cylinder-shaped bacteria are called "bacilli"

Some bacteria have wiggly 'tails' that help them swim. These are called "flagella"



How many cocci are there?

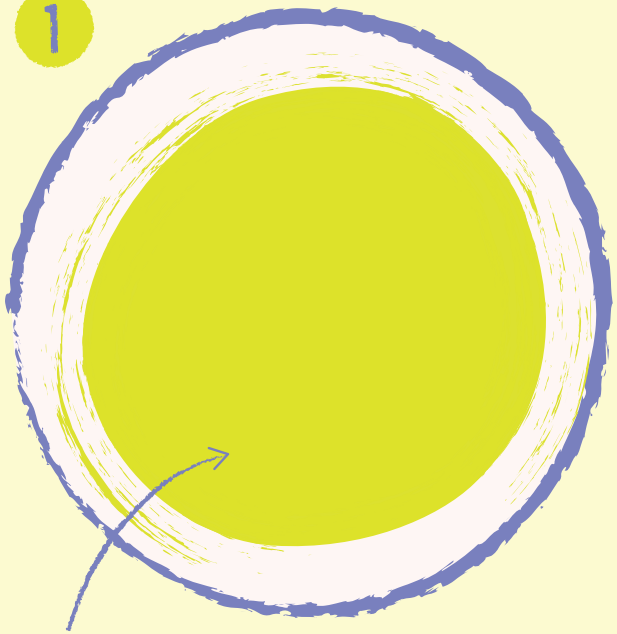
How many bacilli are there?

How many bacteria have flagella?

Step 6 continued: Back to the lab!

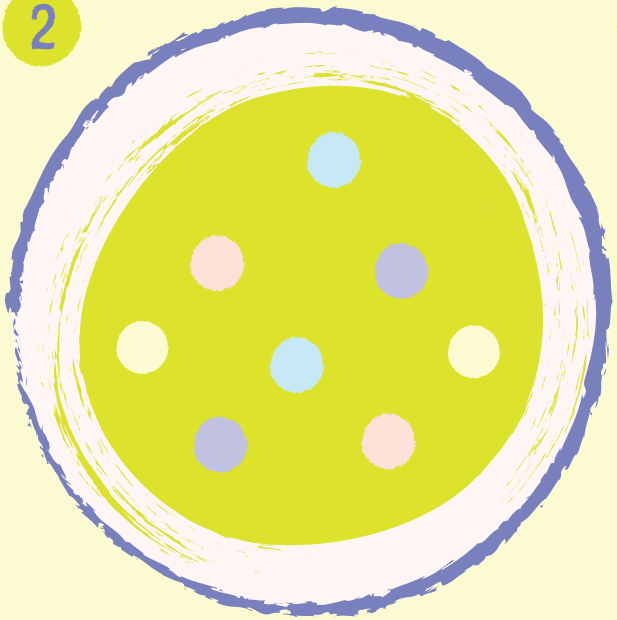
How to measure antibiotic resistance

1



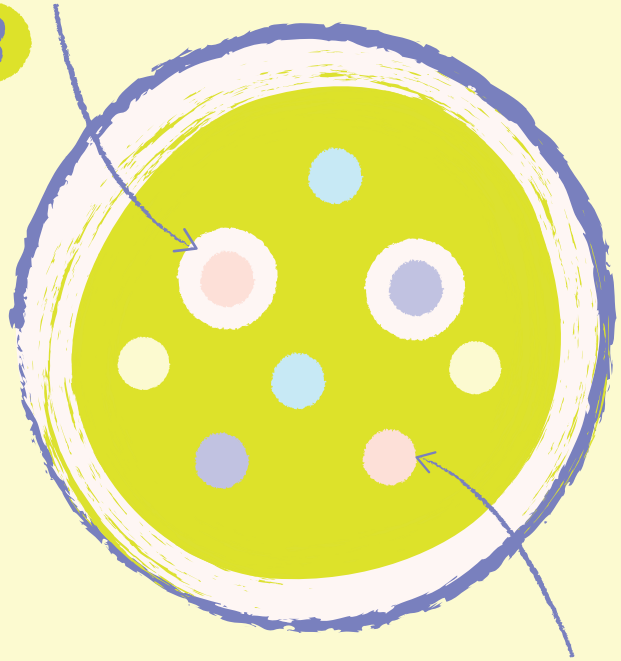
Spread bacteria of a single type all over the agar plate.

2



Place little discs containing antibiotics on top and leave the bacteria to grow.

3



If they don't leave a clear ring, they are able to grow in the presence of the antibiotic and therefore resistant to it.

If they grow leaving a clear ring around the disc, they are not resistant to that antibiotic.

What is an agar plate?

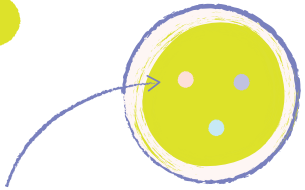
An agar plate is a dish filled with a jelly-like substance made from sea-weed that bacteria can grow on in the laboratory.

On the third plate how many antibiotic discs are the bacteria not resistant to?

Step 7: What the results tell us

After counting the bacteria, I shared the results with Anna the project manager to discuss what the results can tell us.

1



We found that bacteria in biofilms had become resistant to antibiotics in different places in the river.

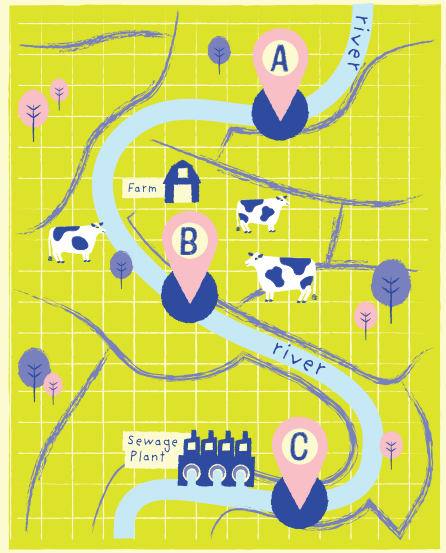
This can tell us that the **river is getting polluted** by different things, like **chemicals**.

2 We found there were more antibiotic resistant bacteria close to where run-off was coming from a farm **(Point B)** and where there was treated sewage going into the water **(Point C)**.

3 We found the bacteria which makes up the **biofilms, were being affected in these places**. This can cause the river to be **less healthy**.

4 When bacteria change, (like becoming resistant to antibiotics) they can **lose their original function**. This could be bad for the river health if bacteria in **biofilms can no longer break down the normal nutrients** in the river.

If the biofilms struggle to break down nutrients, the water will build up too many nutrients and the **water creatures will find it harder to live** there. This is because there **isn't enough oxygen for them to survive** in that area of the river.



5

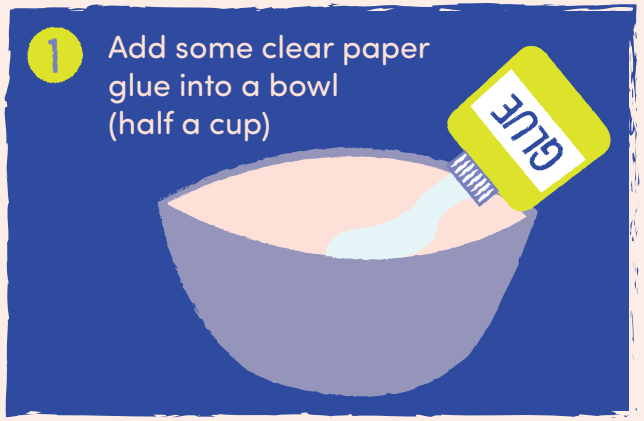
Lastly, if people or animals **come into contact** with the resistant bacteria in the river, **they can become sick**. It is harder to make them better because antibiotics that usually would work, **no longer help**.

Time for some biofilm activities!

Make your own slimy biofilm!!

Make sure an adult helps you with this activity! You (and your grown up!) should wear disposable gloves and safety goggles or glasses while doing this activity – cover your clothes and the surface you are working on and avoid getting the slime or the ingredients on your skin or on carpets/furniture etc.

Part one: Make your slime!



4 Play with the slime in your hands. If there are hard lumps, massage the liquid into the hard glue.

5 Add more eyedrops when the slime goes stringy in your hands (1tsp).

6 Add 3 drops of green food colouring gel.

7 Leave for 4–5 days until the slime goes clear.

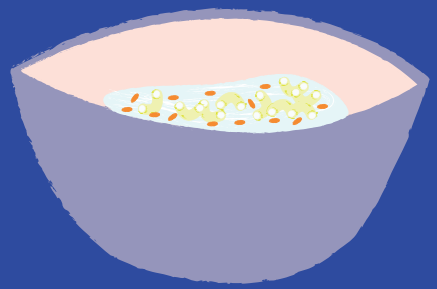
Tip: leaving the bowl in the sun speeds this process up.

Part two: Add your bacteria

Take some macaroni pasta and some lentils, and sprinkle some of these into your slime (you can also use rice or dried herbs). These are the pretend bacteria! Bacteria are often shaped like small cylinders (a bit like jelly beans) or round, so you can use anything that is fairly small and add these shapes to make your biofilm!

8 Once the slime goes clear find something you can use for your bacteria, like pasta or lentils.

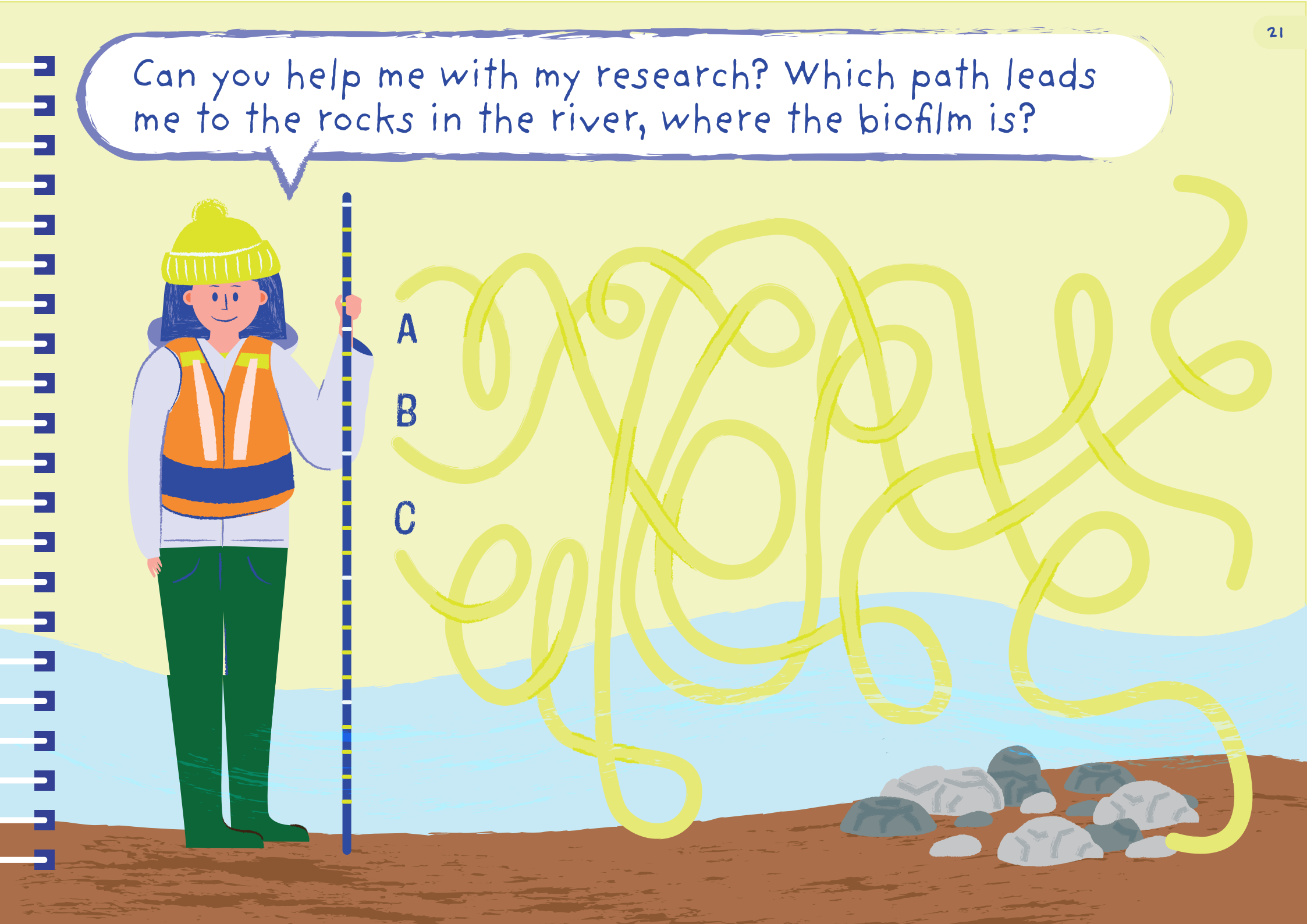
9 Add in your "bacteria".



More slime ideas

This video gives you some great ideas of how to make slime!
www.youtube.com/watch?v=dH2xsueXojo

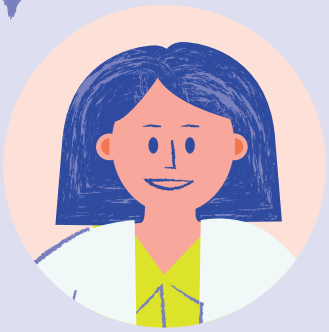
Can you help me with my research? Which path leads me to the rocks in the river, where the biofilm is?



Wordsearch

Can you find all of the words related to biofilms in our rivers?

d	t	m	s	l	g	w	f	c	u	r	m	s	b
s	t	n	l	b	s	s	b	p	i	e	d	o	h
l	c	u	i	t	u	r	u	s	r	a	o	e	e
a	e	t	m	r	c	t	n	r	s	g	t	o	e
c	t	r	e	a	n	m	t	u	f	i	n	o	c
i	o	i	n	p	o	l	l	u	t	a	n	t	s
m	r	e	t	o	a	e	h	a	o	f	c	r	t
e	p	n	a	p	s	u	p	m	a	d	f	e	r
h	t	t	i	t	a	b	a	c	t	e	r	i	a
c	s	s	t	c	e	b	c	t	e	c	r	i	o
e	t	e	i	m	i	n	i	b	e	a	s	t	s
r	e	t	a	w	a	a	e	f	t	s	n	m	r
t	h	a	n	t	i	b	i	o	t	i	c	s	e
l	c	f	o	o	d	w	e	b	c	f	e	u	r



bacteria
food web
slime
damp
nutrients
water
surface
antibiotics
pollutants
protect
goo
minibeasts
chemicals

Maze time!

Blobby the bacterium knows that there are some nutrients trapped in the biofilm that he could eat!

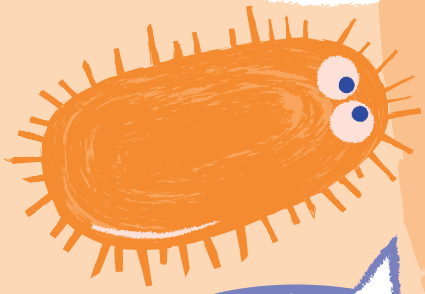
Help blobby the bacterium to find his way to the tasty food trapped in the middle of the biofilm!

Blobby is good at breaking down phosphates and nitrates and using them as food.

What are phosphates and nitrates?

Nitrates and phosphates are chemicals made up of nitrogen and phosphorus. They are one of the building blocks of plants, animals and people. They can also cause pollution in waters.

START



Yum yum! Can you help me find my dinner?

Glossary

Agar plate – An agar plate is a dish filled with a jelly-like substance made from sea-weed that bacteria can grow on in the laboratory

Antibiotics – medicine given to make us better if we have an illness caused by bacteria – a medicine which kills bacteria

Bacteria – tiny living things (single celled organisms) that are so small we can't see them unless we use a microscope

Biofilm – a mixture of slime and bacteria usually found on a surface in a damp or wet area

Chemicals – a chemical is a substance that has known properties we can use to identify it

Designed – something that is designed has been carefully planned to work in a particular way or reach a certain goal

Environments – all the physical surroundings on Earth. Everything living and everything non living are part of the environment. We can also think of different environments on Earth, from small areas like a park or garden to large regions like Europe or Antarctica, which have different conditions

Extracellular polymeric substance (EPS) – this is a gooey slimy chemical made by bacteria which they use to stick to each other and to different surfaces

Harmful – something that has a bad effect on something else, especially on a person's health

Invertebrates – animals without a backbone or internal skeleton. There are many different types of invertebrates but some examples are worms, spiders, insects, crabs and jellyfish

Laboratory – a room or building in which scientific experiments and tests are done

Location – A particular place or position

Manure – animal waste (poo) it contains lots of useful chemicals that help plants grow

Microbiologist – somebody who studies bacteria, viruses or fungi

Microscope – equipment used to make things look bigger, like an extra powerful magnifying glass

Nitrates and phosphates – are chemicals made up of nitrogen and phosphorus. They are one of the building blocks of plants, animals and people

Organism – one single living thing, like an individual animal, plant or bacterium

Plaque – a sticky layer on our teeth where bacteria can live, which can cause tooth decay

Protect – keep safe from danger

Provide – to provide is to give something that is needed

Glossary

River sampling – taking samples (see below) from a river in different places, e.g. the water, the soil and rocks at the bottom of the river

Samples – a sample is a small part of something bigger that we can use to find out more about the larger thing, e.g. a sample from a river could be a small amount of water which we can test to tell us about the river water in general. Another example could be a sample of cake that you taste to see if you would like a bigger portion

Pollutants – a pollutant is a chemical that can be harmful in a particular environment, e.g. like plastic pollution or an oil spill in the ocean or the gases in the air that cause climate change

Wastewater – this is used water which is dirty and comes from things like flushing the toilet or water that goes down the drains (bathwater, clothes washing water, water from factories). Wastewater is often cleaned at a treatment plant but it still usually has some chemicals and microorganisms left in it.

Answers

Step 6: Back to the lab – P12

How many cocci are there?
Answer: 7

How many bacilli are there?
Answer: 10

How many bacteria have flagella?
Answer: 4

Step 6: Back to the lab continued – P13

On the third plate how many antibiotic discs are the bacteria not resistant to?
Answer: 2

Path Puzzle – P18

Answer: Path B

Wordsearch – P19

Maze – P20