

Growing Cultures

Growing Cultures is all about bacteria. Specifically, the project was about the discovery of penicillin which led to the development of antibiotics. The inspiration for Growing Cultures came from the story of the penicillin culture vessel that was originally manufactured in Stoke-on-Trent.

Before we had antibiotics even common illnesses or injuries could be fatal because of deadly infections.

This activity pack will tell you all about the discovery of penicillin and different types of bacteria.

If you have some clay or salt dough you can try to make your own bacteria cells to learn more about how they look and what they do.



If you want to do some more research on bacteria and the fascinating world of microbiology, take a look at the website for last year's Bacterial World exhibition at the Museum of Natural History, University of Oxford.

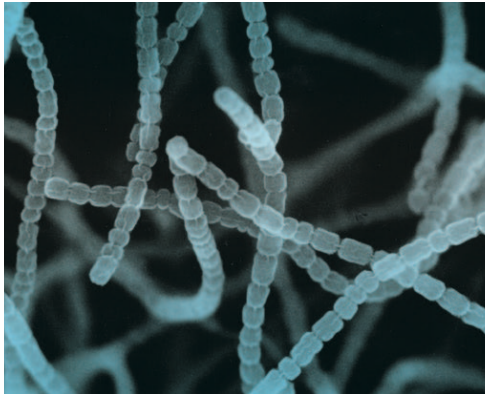
Click here to find out more: <http://www.oum.ox.ac.uk/bacterialworld/>

Bacteria: Good or Bad?

Bacteria are everywhere! But even though you may hear a lot about 'bad bacteria', or bacteria that causes illness, the majority of bacteria are harmless to humans. In fact, we have a lot of bacteria in our bodies that we need to survive.

Below are just a small number of examples of good and bad bacteria.

The Good



Streptomyces

Found in soil and water.

Streptomyces play a part in decomposing dead plants.

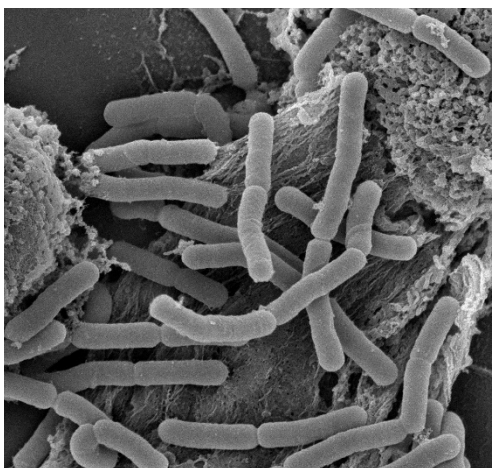
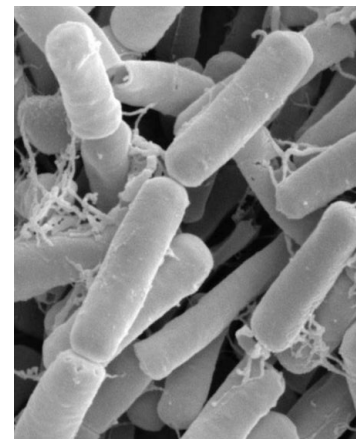
They can also be used to produce antibiotics. About 60% of antibiotics come from this strain of bacteria.

Bacillus thuringiensis

Found in soil, insects and plants.

Can be used as a pesticide as it produces spores and protein crystals that are toxic to insect larvae.

It is safe for humans and beneficial to insects and wildlife.



Lactobacillus

Found in human and animal intestines, dairy, meat, plants and fermented products.

Well known probiotic that helps to lower cholesterol, improve lactose metabolism, and keep your gut healthy.

It is used in the production of yogurt and helps to ferment vegetables (pickles and sauerkraut), beverages (wine and juices), sourdough breads, and some sausages (salami).

The Bad



Escherichia coli (E. Coli)

Found in the intestines of humans and animals.

Not all E. Coli are bad for you, many are harmless producing vitamin K and helping to protect against pathogenic bacteria.

However, some strains can cause serious infections e.g. cystitis, an infection of the bladder, and food poisoning.

Not washing hands properly after using the toilet, changing a nappy or contact with animals can spread harmful E. Coli bacteria and cause illness.

Mycobacteria Tuberculosis

Can be found in human lungs.

These bacteria cause Tuberculosis (TB). TB usually affects the lungs but it can spread to any part of the body, including the glands, bones and nervous system.

Symptoms include:

- persistent cough often resulting in coughing up blood
- loss of appetite leading to weight loss
- high temperature
- tiredness and fatigue.



TB was also known as 'Consumption' because of the effects of the disease's symptoms.

We now have a vaccine that can prevent people from getting TB, however, in 2014 there were about 480,000 new cases of multidrug-resistant tuberculosis (MDR-TB). This form of tuberculosis is resistant to the two most powerful anti-TB drugs.

MDR-TB requires treatment courses that are much longer and less effective than those for non-resistant TB. Globally, only half of MDR-TB patients were successfully treated in 2014.

Penicillin Discovery Timeline

1928: Penicillin was discovered by Alexander Fleming

- Discovery was partly accidental – Fleming returned from holiday and started to sort through some of his petri dishes. In a dish containing staphylococcus bacteria, he noticed that there was a blue-green mould in the same plate that was inhibiting the growth of the original bacteria. Intrigued by this, he isolated the mould and grew a pure culture, which he named penicillin.



1939: Heatley, Florey and Chain develops a way to purify the penicillin and extract from the mould.

- Howard Florey and Ernst Chain worked to find a way to purify the penicillin culture and find a medical application.
- They worked with Norman Heatley, who engineered the process which made use of growing the cultures in bedpans, milk churns and baths.

1940: First trials of penicillin in mice

- By the height of the blitz in May 1940 the team was at a point where they could carry out that crucial experiment in mice. It would really test for the first time whether penicillin could be an effective antibacterial drug. The results of the experiment were clear and impressive.

1941: First Clinical Trials of Penicillin

- The first patient Albert Alexander, a 43-year-old policeman, was treated with penicillin on 12 February 1941.
- Penicillin truly looked like a miracle drug: infections that had been killing people previously were cured. As companies in the US and UK began to take up manufacture of penicillin, enough was being produced to treat some of the military.

1944: WWII – D-Day

- Supplies of penicillin were sent with the troops during the D-Day landings in June. The average wait time for a wounded soldier to see a doctor was 14 hours. As penicillin was effective against gangrene, administering the drug as soon as possible helped to limit the number of amputations necessary, as well as significantly decreasing the number of deaths from infection.

1945: Fleming, Florey and Chain jointly awarded the Nobel Prize

- The efforts of Florey, Heatley and Chain, and their colleagues in the U.S. ensured that by the end of WWII penicillin could be produced in sufficient enough amounts to be widely available to all.
- It was marketed as a 'miracle drug'.



Penicillin Culture Vessel



Once it had been proven that penicillin was effective against harmful bacteria, they needed to find a way to produce large amounts of it.

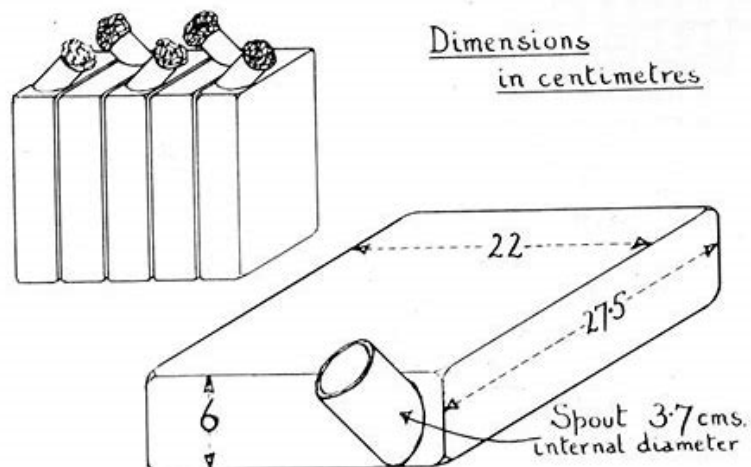
'Treating and curing infections in mice was one thing, but humans are roughly 3000 times bigger and would need 3000 times more penicillin.'

Howard Florey, 1940

Norman Heatley worked with ceramic manufacturer, James Macintyre and Co. Ltd, in Burslem to develop a bottle that could be used to mass produce the penicillin needed in quantity for trials.

Heatley wanted the bottle to be made from a transparent material, but due to the restrictions of wartime this was not possible. Glass bottles would have also taken a much longer time to produce, so Heatley settled on ceramics.

The design is partly based on the shape of a bedpan. Heatley had previously found these to be useful for growing cultures in his lab. It was designed to be stackable – both during the growing process and cleaning (either horizontal or vertical). The bottles were glazed on the inside, but not on the outside, for efficiency and practicality.



Bacteria and Viruses: What is the Difference?

Like Bacteria, not all viruses are harmful to humans. But you are probably more familiar with ones that might make you sick. The common cold and flu are types of virus.

Bacteria

Bacteria are single celled organisms that get the nutrients they need to survive from the environment around them. Bacteria can exist on their own or inside of other living things, such as plants, animals and people.

Virus

Viruses are much smaller than bacteria. They also require a 'host' to survive for long periods of time. While viruses can survive for a short period of time on surfaces like wood and metal, they can only flourish inside a living thing – like an animal or human being. Viruses attack the cells of the host they are living in causing illness.

An organism that causes a disease is called a PATHOGEN
There are four types of pathogen:

- Viruses
- Bacteria
- Fungi
- Protists

There are two types of diseases based on the way they can be spread and 'transmitted' from one person to another. Illnesses caused by bacteria and viruses are known as Communicable Diseases because they can be transferred from one organism to another.

Communicable Disease

A disease that can be transferred from one person to another, or from one organism to another, e.g. in humans, these include measles, food poisoning and malaria.

Non-Communicable Disease

A disease that is not contagious or transferable from one human to another. Causes can be random genetic abnormalities, heredity, lifestyle or environment.

There are different types of transmission of communicable diseases, these are:

- Direct contact
- Water
- Air
- Unhygienic Food Preparation
- Vector

Hand Washing: the best method of prevention from illness

Did you know?

Around 33% of people don't use soap when washing their hands.

Most people only wash their hands for 6 seconds.

Only about 5% of people wash their hands correctly.

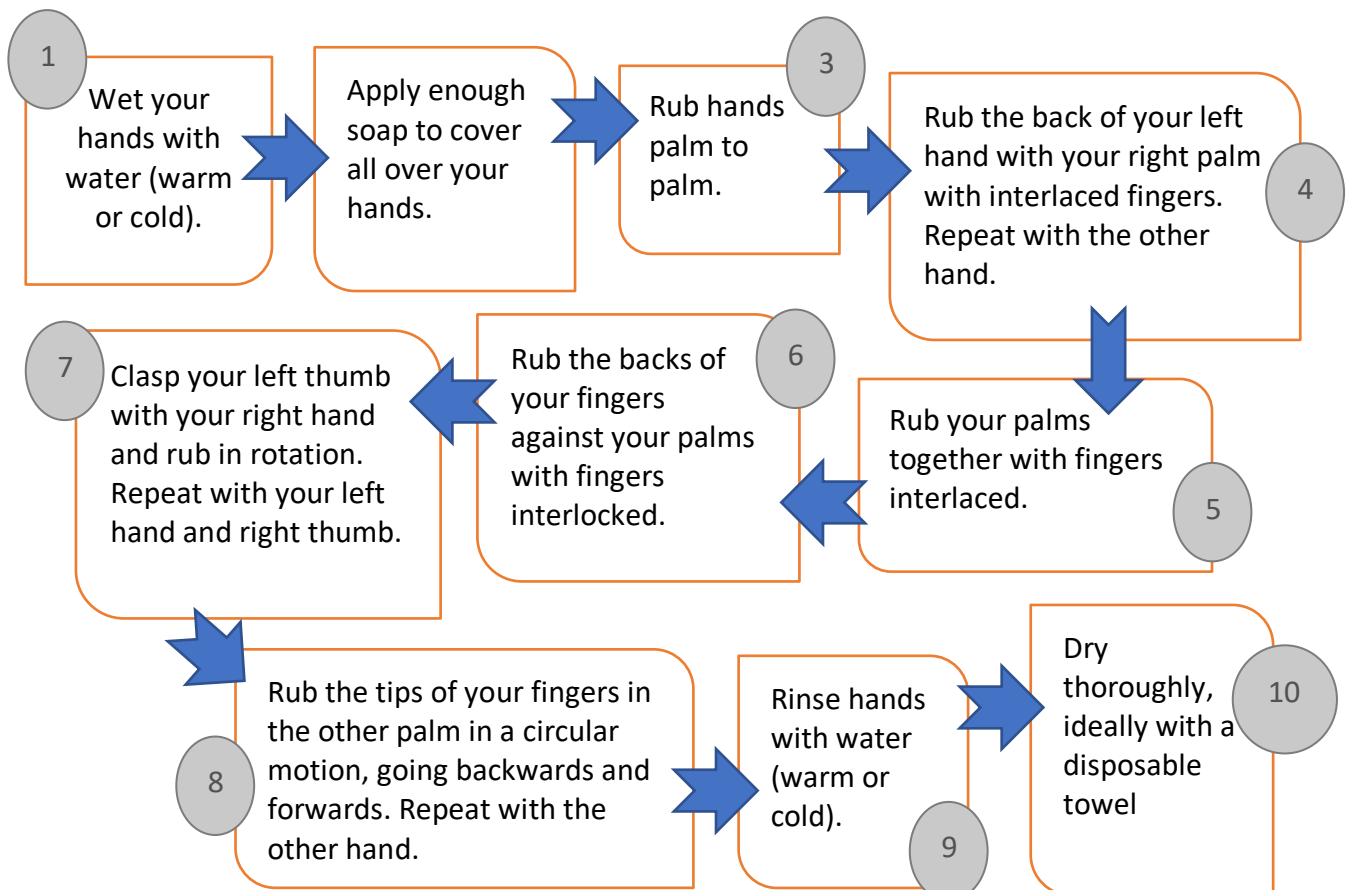
On average, you come into contact with 300 surfaces every 30 minutes exposing you to 840,000 germs.



Damp hands are 1,000 times more likely to spread bacteria than dry hands. Only about 20% of people dry their hands after washing them.

The most common way that germs are passed from one person to another is through the hands. Up to 80% of communicable diseases are spread by the hands.

10 Step Guide to Handwashing from the NHS



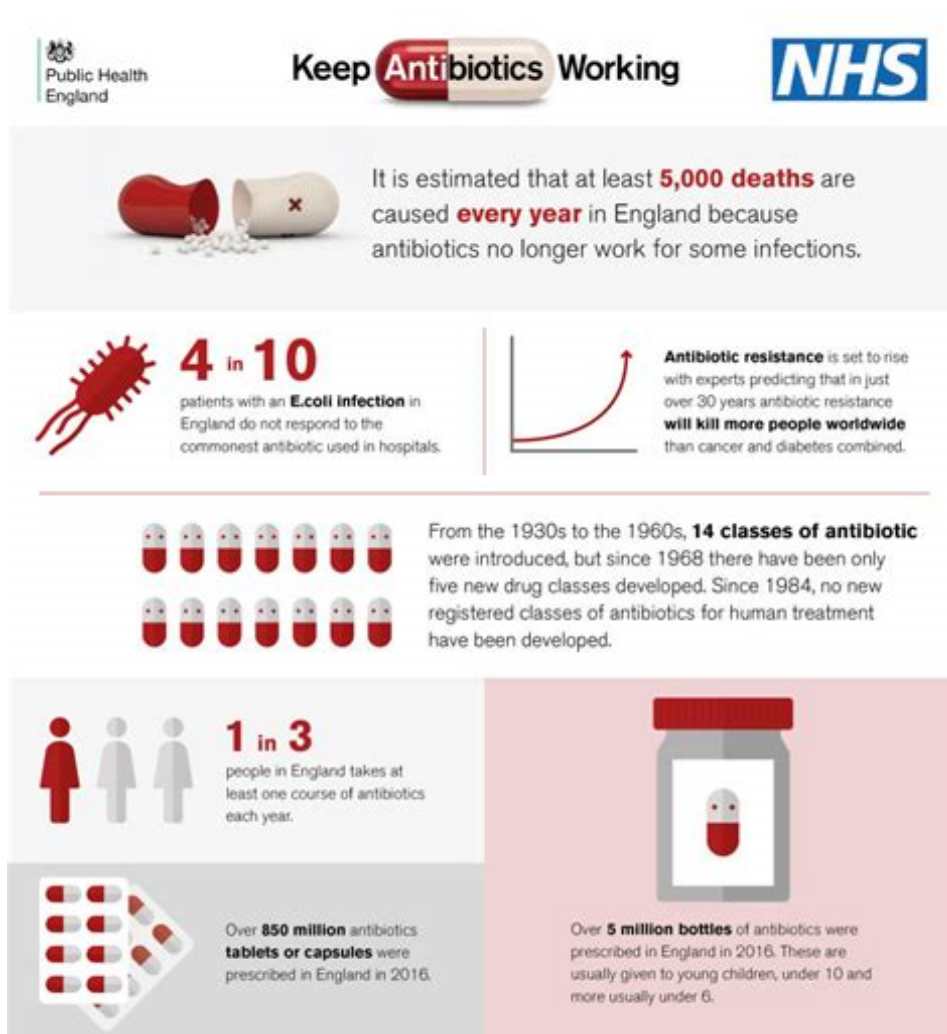
Antibiotic Resistance

Antibiotic resistance is when bacteria are no longer killed by antibiotics. The bacteria change and become resistant to the antibiotics used to treat the infections that they cause.

Chain and another scientist, Edward Abraham, reported the first indication of antibiotic resistance to penicillin in 1940. They observed an E. coli strain that produced the penicillinase enzyme, which was capable of breaking down penicillin and completely negating its antibacterial effect

Reasons for antibiotic resistance:

- Over prescribing of antibiotics
- Patients not finishing their prescribed treatment
- Overuse of antibiotics in livestock and fish farming
- Poor infection control in hospitals and clinics
- Lack of hygiene and poor sanitation
- Lack of new antibiotics being developed



Growing Cultures Activities

The History of Penicillin

What is Penicillin?

When was it discovered?

How was it discovered?

Who discovered it?



The Penicillin Culture Vessel

Heatley designed the Penicillin Culture vessel to mass-produce the penicillin mould so that it could be developed into usable medicine.

What is happening in this picture?



Where was the Penicillin Culture Vessel made? What was its purpose?



What was important about the time period that penicillin was developed in? What major event was happening? How could this event have affected the development of penicillin into a medicine?



Penicillin: 'Wonder Drug'

What was the major benefit of Penicillin?



What was the danger of penicillin and antibiotics being marketed as a 'wonder drug'?

When was antibiotic resistance first noticed by scientists?