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# Year 9 Headstart Science

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Cells and Organisms

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Term 1 – Week 3

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## TERM 1 – WEEK 3 – THEORY

### UNICELLULAR ORGANISMS

You will remember from Week 1 that cells can be either unicellular or multicellular. A **unicellular** organism is one which consists of only one cell, while a **multicellular** organism consists of groups of cells working together.

Unicellular organisms have the capacity to survive without the help of any other cells, and they have the ability to perform all the functions required for their continued existence.

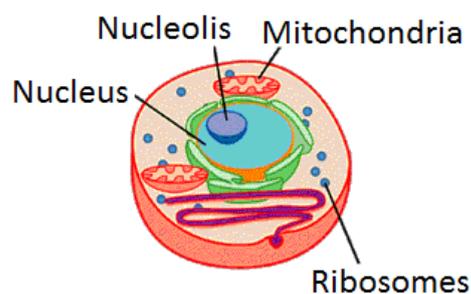
Examples of unicellular organisms can be taken from three of the major kingdoms we looked at in Week 2. All bacteria from the Monera Kingdom are unicellular, as are most of the protists, and some kinds of fungi. Most of these unicellular organisms are of microscopic size, and thus they are referred to as a **microorganism**.

In Week 1, we looked at the structure of some different multicellular organisms, such as plant and animal cells. The structure of bacteria is different again, and it is important to have an idea of some of their unique characteristics, and why they are important

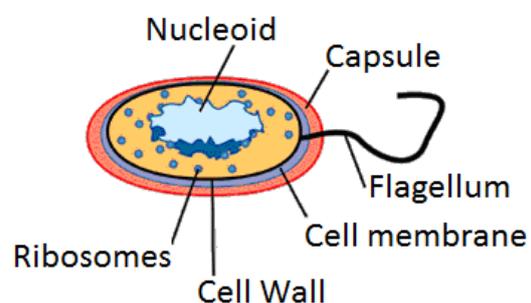
### STRUCTURE OF BACTERIA

Remember from week 1 that bacteria fall into a class of cells known as prokaryotes. The important feature of prokaryotes is that they do not have a cell nucleus to house their genetic information. Rather, they have a single **nucleoid** which contains genetic material without being surrounded by an envelope, as a nucleus. They also lack some other membrane-bound organelles such as mitochondria and a Golgi apparatus.

#### Eukaryote



#### Prokaryote



## OTHER IMPORTANT STRUCTURAL FEATURES OF BACTERIA

**Cell wall:** The cell wall of bacteria can be either thick or thin depending on the type. Like other organisms, the cell wall is important in maintaining rigidity, but in bacteria, the cell wall can sometimes have special properties which are important in causing disease

**Capsule:** Some bacteria are closely surrounded by a layer known as a capsule. The capsule doesn't help the bacteria grow, but it is important in helping bacteria hide from the human body's defense mechanisms, and also in allowing bacteria to stick to tissue surfaces.

**Flagella:** The flagella are a rope-like structure attached to the bacterial membrane. They can act like propellers and allow the bacterial cell to swim

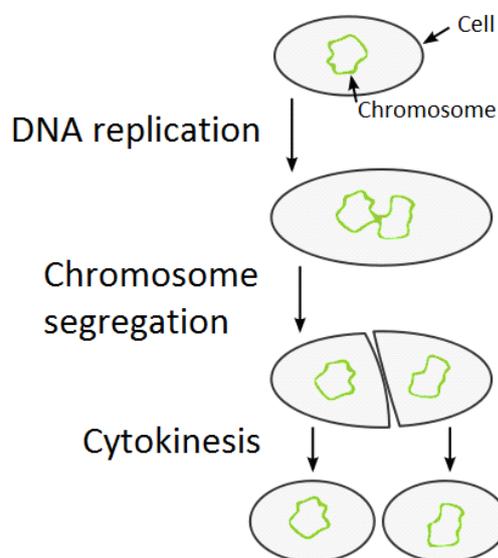
## REPRODUCTION IN UNICELLULAR ORGANISMS

Bacterial cells reproduce by a process known as binary fission, or cell division. This is a form of asexual reproduction, in which an offspring arises from a single parent, and inherits all the genes of that parent only. What this means for the bacterial cell, is that the cell divides into two parts which have equal amounts of DNA, and each part has the potential to grow to the size of the original cell. In this way, bacterial cells can continue to multiply without needing the help of another bacterial cell.

Binary fission begins with DNA replication. Basically the DNA of the parent cell copies itself so that there are now two identical bits of DNA in the one cell. The cell then becomes wider, causing the two bits of DNA to separate, and move to opposite sides of the cell.

Eventually, a process known as cytokinesis occurs – this means splitting of the cell to separate the parent cell into two identical daughter cells. Each of these daughter cells therefore has the same properties as the original parent bacterial cell.

This process of cell division is one of the reasons why bacteria can spread and cause disease so quickly.



## HOW DO THESE TINY CELLS CAUSE DISEASE?

To some bacteria, the human body is a warm, moist environment which provides food for growth, and is often perfect for causing a disease! These bacteria are known as **pathogens**. They can invade the body and stop it from functioning normally. When this happens, we can get very sick. We can also pass this illness on to other people, for example, the common cold.

The symptoms of the illness will depend on what tissues the bug affects, for example if it is in the respiratory tract, we will get symptoms such as a cough or runny nose, whereas if it is in the stomach, we might get tummy pain and feel nauseous.

Many different organisms can cause disease, not just bacteria. Other pathogens include viruses, fungi, and worms (protists).

### BACTERIA

Pathogenic bacteria have mechanisms which allow them to grow in the host (e.g. humans), while at the same time causing damage to the host's tissue or organ function.

Bacteria can live on food provided by the host, and reproduce via binary fission. Once the numbers of bacteria become too great, they can cause disease.

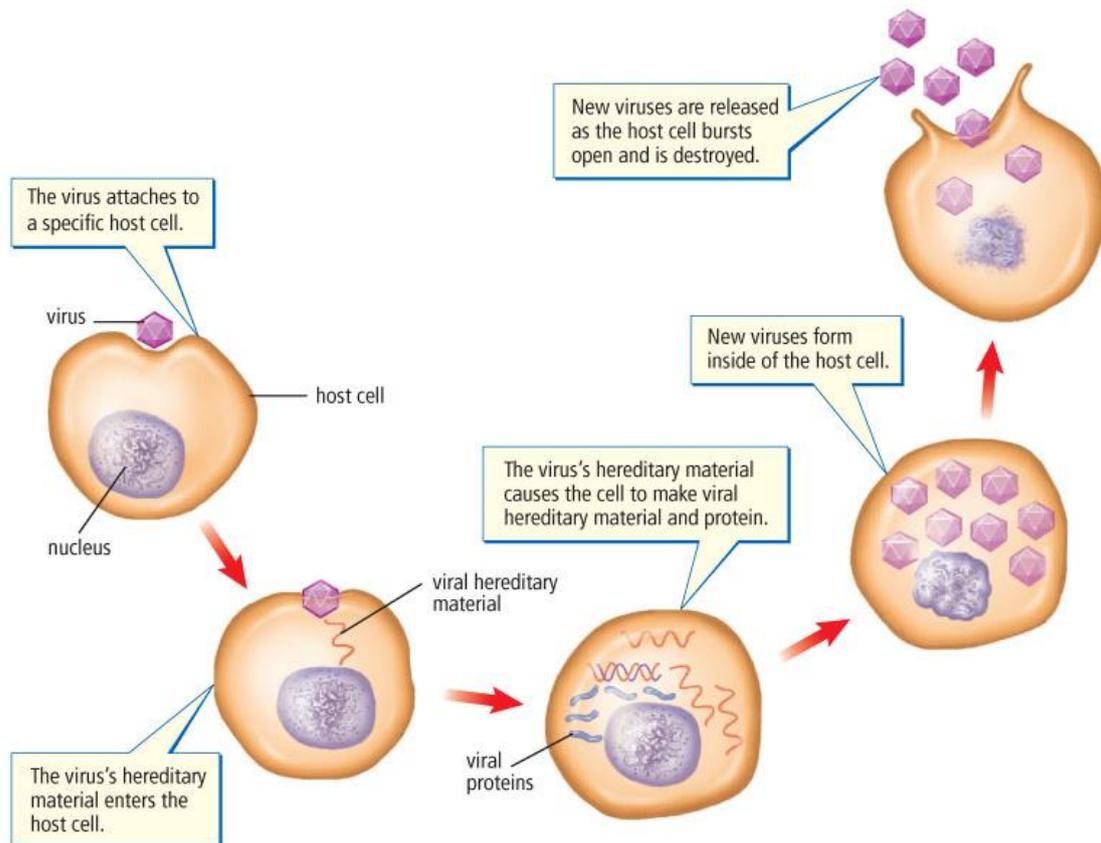
The steps by which bacteria cause disease include:

- **Entry** into the human body, e.g. through a tear in the skin
- **Colonisation**: Once inside, bacteria can use special mechanisms to stick to different body surfaces, and reproduce to form a colony
- **Tissue destruction** and toxin formation then occurs, which damages the surrounding host cells, or stops the host from performing their normal function, resulting in disease

Examples of bacterial diseases are pneumonia, food poisoning, gastroenteritis, and pimples.

**VIRUSES**

Viruses are so small, they can only be seen by very powerful microscopes, and their small size allows them to pass through filters which stop most bacteria. Viruses are a difficult thing to classify, as there is still debate as to whether or not they are living things. As such, viruses are not included in the five kingdoms discussed in week 2.



Viruses have a complex pathogenic mechanism. Unlike bacteria and other unicellular organisms which have the ability to perform all the functions required for their continued existence, a virus must first invade a host cell.

Once inside a host cell, it 'borrows' the machinery of the cell to perform its functions such as reproduction. Viruses will reproduce to make thousands of copies of itself, until the copies eventually break open the host cell, effectively destroying it, then spreading to surrounding cells.

By this process of destruction, viruses can cause disease. Like bacteria, the type of disease they cause depends on what tissues they are destroying.

The most common viral illnesses are respiratory tract diseases, such as influenza and the common cold.

## PROTOZOANS

Protozoans are a type of parasite which can cause diseases in humans. A parasite is an organism which depends on their host for food and shelter. Parasitic diseases are especially important in tropical areas where they can cause a large amount of deaths. Examples include malaria and African sleeping sickness. There are also larger parasites, such as tapeworms and roundworms.

Parasites cause disease by invading the host, then attaching to specific cells or organs. They can then hide from the body's defence system, and produce toxic substances which destroy tissue.

In addition, some can physically obstruct and damage organs and tissues because of their size alone. For example, tapeworms are huge worms found in the intestine. They can block the intestine and release waste substances into the host's bloodstream.

## FUNGI

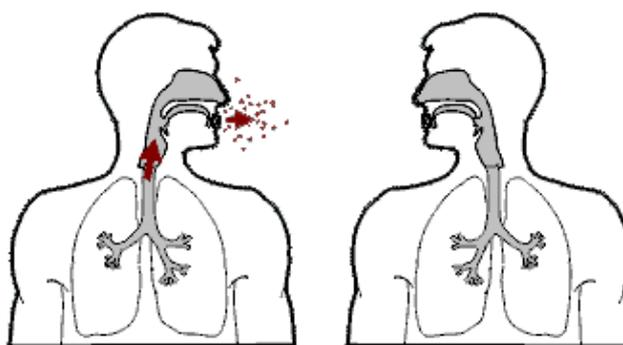
Fungi include things like moulds and yeasts. Examples are tinea (which causes athlete's foot), thrush and ringworm. Often, fungi will live in areas such as the mouth, the vagina, and the digestive system without causing any trouble. It is usually only when a person's body defence mechanisms are compromised that fungi are able to cause disease.

## HOW DOES DISEASE SPREAD?

Diseases caused by pathogenic microorganisms are known as infectious diseases. This is because they are capable of being spread from person to person. There are several main ways that infectious diseases can be spread:

**Direct contact:** this includes touching or being touched by another person who also has the disease. For example, cold sores can be spread from person to person by direct contact with an open sore. Fungal diseases such as tinea can also be spread by touching

**Spread by droplets:** Coughing and sneezing can produce small air-borne droplets which can be carried through the air for short distances. If a person who is infected coughs and produces air droplets, these droplets may carry bacteria or viruses which can spread to other people, e.g. influenza. Influenza is a very contagious disease, and it is very easily spread. Other types of indirect contact may occur by touching infected items such as bedclothes



**Spread by vectors:** A vector is an organism which carries disease from one person to another. For example, malaria is carried by a mosquito, which needs to bite a person for them to become infected. Other vectors include rats and mice, which are capable of passing on pathogens carried on their fur and feet. Vector-borne illnesses are considered infectious; however, because they are not spread between people, it is not a contagious disease.

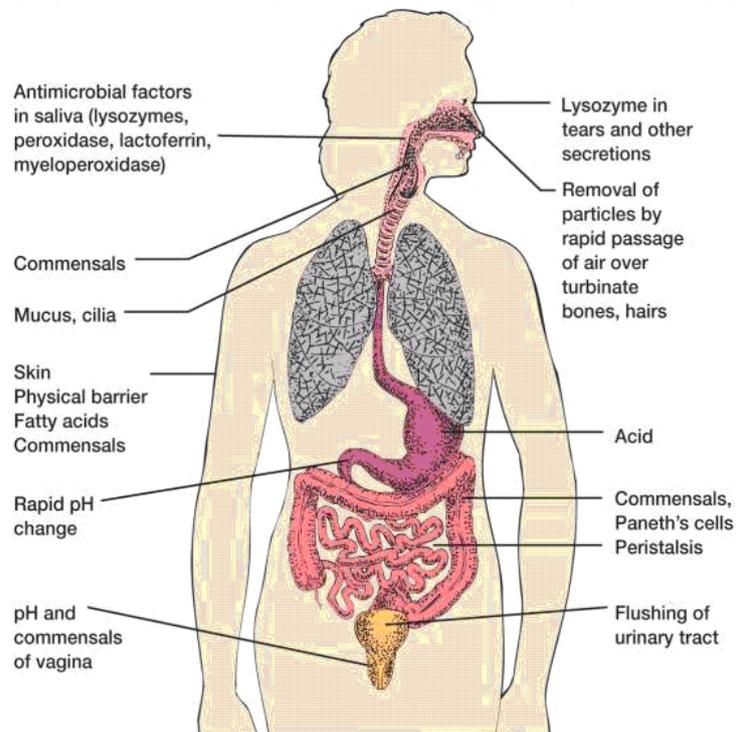
**Spread through food or water:** People who work in restaurants or cafes need to be extremely careful in the way they prepare food, especially to keep the food at the right temperature, and to wash their hands well between different activities to prevent pathogens being transferred into the food. If food is contaminated, it may cause disease in the person who eats it, thus transferring the pathogen to a new host. Some pathogenic organisms also live in water, which is why our household water supplies are usually chemically treated to kill any pathogens before they reach our household taps.

### WHY AREN'T WE SICK ALL THE TIME?

With the number of pathogens out there, it would seem as if humans should constantly be sick with one infection or another. However, this isn't the case, and often we can go months, or even years without being sick. The reason why humans aren't constantly fighting coughs or colds is that the human body has extraordinary mechanisms which fight to protect our bodies from pathogens. This is known as our body's immune system.

There are two main types of defence systems: natural barriers which prevent pathogens from getting into, or colonizing the human body, and internal defense systems which can help to fight pathogens once they have invaded the body.

#### Natural barriers



- The skin acts as a physical barrier
- The nose has special hairs which stops pathogens from getting in
- Many body surfaces have sticky mucus which can trap pathogens and allow them to be discarded, e.g. by coughing up the mucus
- Chemicals which have anti-pathogen properties, such as saliva, and tears
- Acid in the stomach kills many pathogens before they reach the small intestine
- The vagina is quite acidic as well, which makes it difficult for pathogens to grow

### Internal defense systems

Inflammation is a response by the host to pathogens which manage to get into the human body. Even though inflammation seems bad, it is actually performing an important function. For example, if you scratch yourself, you will often notice that the area becomes tender, swollen or red. This is a result of the body's internal defense systems trying to destroy the invading pathogens.

White blood cells in the body will often move into damaged areas to surround and destroy foreign particles. Many times, white blood cells will also be killed in the process. The mixture of dead skin and white blood cells is commonly called pus.

Lymph nodes are located all throughout the human body and act as filters or traps for foreign particles. Once a lymph node traps a foreign pathogen, the white blood cells will migrate to this area to destroy the trapped material before it can get into the bloodstream.

The spleen helps to filter the blood, in case any pathogens have managed to make their way into the bloodstream. If they do, the spleen contains cells which can capture and destroy these foreign pathogens.

### THE GOOD BACTERIA

It is important to be aware that not all bacteria are pathogens. In fact, there are even some bacteria which we eat, for example, yoghurt and some cheese. As well, there are lots of bacteria which live in the human body without causing any disease at all – these are known as **normal flora**. They play an important role in the human body, for example they provide competition to pathogenic bacteria, so that the normal flora takes up all the space, stopping from pathogenic bacteria from colonizing. They can also provide vitamins and help to eliminate toxins.

## TERM 1 – WEEK 3 – HOMEWORK

1. Define unicellular organisms. [1 mark]

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2. Identify the three kingdoms in which unicellular organisms can be found. [1 mark]

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3. Distinguish prokaryotes and eukaryotes. [2 marks]


4. Describe the function of the bacterial capsule and flagella. **[2 marks]**

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5. Describe the process of binary fission. **[3 marks]**

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6. Compare the different mechanisms by which bacteria and viruses cause disease and for each mechanism, suggest a way to minimise the chance of infection. **[5 marks]**

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7. A year 9 teacher recorded the number of students who were sick on Monday compared to the number of students who were sick on Friday. Use the data from the two tables to answer the following questions:

**Monday**

Illness	Number of students ill
Influenza	1
Malaria	1
Food poisoning	0
Fungal infection	0

**Friday**

Illness	Number of students ill
Influenza	12
Malaria	1
Food poisoning	5
Fungal infection	0

- a. Explain why the number of students with influenza rose during the week, while the number of students with malaria stayed the same. **[3 marks]**

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- b. Assuming the five students who had food poisoning all ate at the same restaurant on Wednesday, what might the chef have done which caused them all to get sick? **[2 marks]**

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- c. Give a reason for why no one was sick with a fungal infection on Monday or Friday. **[1 mark]**

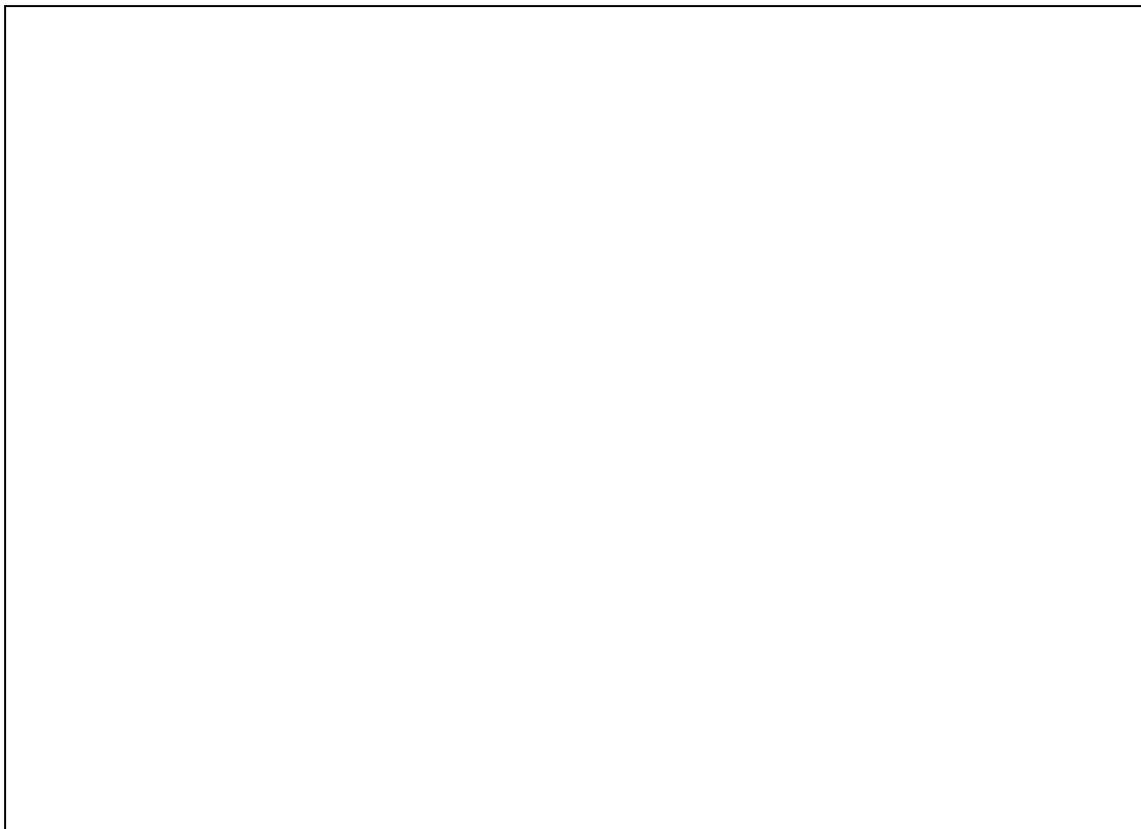
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- d. Use the data provided in the table to draw a bar graph comparing the number of students ill on Monday and Friday. **[3 marks]**



8. Natural barriers can be physical or chemical. Complete the following table:

Physical Barriers	Chemical Barriers

9. Describe how pus is created. **[3 marks]**

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10. Describe the role of lymph nodes. **[2 marks]**

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11. Identify some beneficial effects of bacteria. **[2 marks]**

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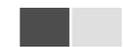
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**End of homework**

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