##  Teacher Refresher Information



**Key Stage 4**

## Introduction to Microbes

Micro-organisms are living organisms too small to be seen with the naked eye; they are microscopic. Micro-organisms are found almost everywhere on Earth and can be both useful and harmful to humans. It is important to clarify that microbes are not innately “useful” or “harmful”. Rather, that some microbes can be useful to humans whilst others can be harmful depending on the situation. For example, the mould *Aspergillus* is used to help make chocolate, however can cause harm to humans if inhaled into the lungs. Although extremely small, microbes come in many different shapes and sizes. The three groups of microbes covered in this resource are viruses, bacteria and fungi.

**Viruses** are the smallest of the three and are generally harmful to humans. Viruses cannot survive by themselves. They require a ‘host’ cell in which to live and reproduce. Once inside the host cell, they rapidly multiply destroying the cell in the process. There are over 250 different kinds of virus causing the common cold. One of the most common of these is *Rhinovirus*.

**Bacteria** are single celled organisms that, under the right conditions, can multiply exponentially, on average once every 20 minutes. During their normal growth, some produce substances (toxins) which can be harmful to humans and cause disease (*Staphylococcus* *aureus*). Some bacteria are completely harmless and can be extremely useful (such as *Lactobacillus* in the food industry), or even necessary for human life (such as *Rhizobacterium*, which is involved in plant growth). When bacteria are harmless, they are called non-pathogenic, while bacteria that cause harm are known as pathogenic. Over 70% of bacteria are non-pathogenic (harmless) micro-organisms.

Bacteria can be divided into three groups by their shapes – cocci (balls), bacilli (rods) and spirals. Cocci can also be broken down into three shapes -clusters, chains, or groups of two. Scientists can use these shapes to help identify the microbes and tell which infection a patient has.

**Fungi** are generally multi-cellular organisms that can be both useful and harmful to humans. Fungi obtain their food by either decomposing dead organic matter or by living as parasites on a host. Fungi range in size from being microscopic to very large and include mould, mushrooms and mildew. While fungi can be harmful by causing an infection or being poisonous to eat; others can be useful or harmless e.g., *Penicillium* produces the antibiotic penicillin and *Agaricus bisporus* can be eaten (the common button mushroom). Fungi spread through the air in small hard seed-like spores. When these spores land on bread or fruit, they can open and grow under the right conditions (such as dampness).

## Useful microbes

One of the main ways in which bacteria are beneficial is in the food industry. The natural by-products created during normal microbial growth can be used to make many of the food products we eat.

Fermentation is a process by which bacteria break down complex sugars into simple compounds like carbon dioxide and alcohol. Optional background information on each of the pack topics are included to help you plan your lessons and introduce the topic to students.

There are different types of fermentation, acetic acid fermentation produces vinegar and lactic acid fermentation produces yoghurt and cheese. Some fungi are also used to make blue cheese. The yeast, *Saccharomyces cerevisiae*, is used to make bread and dough products through fermentation. Wine and beer are also produced in the same manner although alcohol is produced following fermentation when the microbes are grown without oxygen. The chocolate industry also relies on bacteria and fungi. These organisms produce acid through fermentation which eats away at the hard pod and makes it easier to get at the cacao beans.

When the bacteria *Streptococcus thermophilous* or *Lactobacillus bulgaricus* are added to milk they consume the sugars during fermentation, turning it into yoghurt. So much acid is produced in fermented milk products that few potentially harmful microbes can survive there.

*Lactobacillus* bacteria are generally referred to as useful or ‘friendly’ bacteria. They help us digest food and have been termed probiotic bacteria that we find in our yoghurts and probiotic drinks. Although even ‘friendly bacteria’ can cause infection in people who are immunocompromised.

## Harmful Microbes

Some microbes can be harmful to humans and can cause disease: the *Influenza* virus causes the “flu” (short for “Influenza”), *Campylobacter* bacteria can cause food poisoning and the dermatophyte fungi, such as *Trichophyton*, can cause diseases such as athlete’s foot and ringworm. Microbes like these are known as pathogens. Each pathogenic microbe can make us ill in different ways.

Bacterial toxins can damage tissues and organs and make us very unwell, fortunately this is rare.

Viruses need to live within a cell in order to survive. Once inside a cell, they multiply until fully grown and leave the host cell. Dermatophytes generally prefer to grow or colonise under the skin. The products they produce while feeding cause swelling and itching.

Someone who is ill because of a harmful disease-causing microbe is said to be infected. Many harmful microbes can pass from one person to another by a number of different routes – air, touch, water, food, aerosols (such as sneezes and water vapour), animals, etc. Diseases caused by such microbes are said to be infectious diseases.

In some cases, infectious diseases can spread in communities or large areas, this is called an epidemic. When the disease spreads to over an entire country or around the world this is known as a pandemic. The COVID-19 pandemic started when a new virus SARS-CoV-2 caused the disease COVID-19, infecting a population in China. Because this virus was very infectious, and global travel is so commonplace, it was able to spread quickly and infect people all over the world.

It is important to remember that not all microbes are harmful, and some microbes are only harmful when taken out of their normal environment. For example, *Salmonella* and *Campylobacter* live in the gut of chickens usually without causing them any harm. However, when they enter the human gut, the toxins they release through their normal growth can make us very ill.

Our bodies have also adapted to help us get rid of these infections; this may be in the form of

* Fever: Microbes prefer to live at normal body temperature at 37oC. A fever or increase in body temperature is one of the body’s immune responses to eliminate the perceived threat (microbe) inside the body.
* Swelling: A cut on the hand may result in swelling; this is our body responding in a similar way to a fever only in a more localised way.
* Rash: This is our body’s reaction to microbial toxins.

# Teacher Answers

## SW1 Disease Match Sheets

Also available in TS1

1. Infectious Microbe

|  |  |
| --- | --- |
| **Infectious Microbe** | **Disease** |
| Bacteria | Bacterial meningitis, Chlamydia, MRSA  |
| Virus | HIV, Chickenpox, Flu, Measles, Glandular Fever  |
| Fungi | Thrush |

1. Symptoms

|  |  |
| --- | --- |
| **Symptoms** | **Disease** |
| Asymptomatic | Chlamydia, MRSA  |
| Fever | Flu, Measles, Chickenpox, Bacterial meningitis  |
| Rash | Bacterial meningitis, Chickenpox, Measles |
| Sore Throat | Flu, Glandular fever  |
| Tiredness | Glandular fever  |
| Lesions | HIV |
| Whitish Discharge | Chlamydia, Thrush |

1. Transmission

|  |  |
| --- | --- |
| **Transmission** | **Disease** |
| Sexual Contact | Chlamydia, HIV, Thrush  |
| Blood | Bacterial meningitis, HIV |
| Touch | Flu, Measles, Chickenpox, MRSA  |
| Inhalation | Flu, Measles, Chickenpox, Bacterial meningitis  |
| Mouth to mouth | Flu, Glandular fever  |

1. Prevention of Infection

|  |  |
| --- | --- |
| **Prevention** | **Disease** |
| Wash hands | Flu, Measles, Chickenpox, MRSA, Bacterial meningitis  |
| Cover coughs and sneezes | Flu, Measles, Chickenpox, Bacterial meningitis  |
| Use a condom | Chlamydia, HIV, Thrush  |
| Avoid unnecessary antibiotic use | MRSA, Thrush  |
| Vaccination | Chickenpox, Measles, Flu  |

1. Treatment of Infections

|  |  |
| --- | --- |
| **Treatment** | **Disease** |
| Antibiotics | Chlamydia, Bacterial meningitis, MRSA  |
| Bed rest | Chickenpox, Glandular fever, Measles, Flu  |
| Antifungals | Thrush  |
| Fluid intake | Chickenpox, Glandular fever, Measles, Flu  |

Points to Note

MRSA is an antibiotic resistant bacterium; it is specifically resistant to methicillin and some other commonly used antibiotics. Its resistance status is attributed to the overuse and misuse of this and other antibiotics. Treatment is still via antibiotic therapy, however, MRSA is also developing resistance to these as well.

## SW2 Disease Match Differentiated Disease Match

Also available in TS2

1. Infectious Microbe

|  |  |
| --- | --- |
| **Infectious Microbe** | **Disease** |
| Bacteria | Chlamydia |
| Virus | Chickenpox, Flu, Measles |
| Fungi | Thrush |

1. Symptoms

|  |  |
| --- | --- |
| **Symptoms** | **Disease** |
| Asymptomatic | Chlamydia |
| Fever | Flu, Measles, Chickenpox |
| Rash | Chickenpox, Measles |
| Sore Throat | Flu |
| Whitish Discharge | Chlamydia, Thrush |

1. Transmission

|  |  |
| --- | --- |
| **Transmission** | **Disease** |
| Sexual Contact | Chlamydia, Thrush |
| Touch | Flu, Measles, Chickenpox |
| Inhalation | Flu, Measles, Chickenpox |
| Mouth to mouth | Flu |

1. Prevention of Infection

|  |  |
| --- | --- |
| **Prevention** | **Disease** |
| Wash hands | Flu, Measles, Chickenpox |
| Cover coughs and sneezes | Flu, Measles, Chickenpox |
| Use a condom | Chlamydia, Thrush |
| Avoid unnecessary antibiotic use | Thrush |
| Vaccination | Flu, Measles, Chickenpox |

1. Treatment of Infections

|  |  |
| --- | --- |
| **Treatment** | **Disease** |
| Antibiotics | Chlamydia |
| Bed rest | Flu, Measles, Chickenpox |
| Antifungals | Thrush |
| Fluid intake | Flu, Measles, Chickenpox |

## SW3 Harmful Microbes Fill in the Blanks

Also available in TS3

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disease** | **Pathogen** | **Transmission** | **Symptoms** | **Prevention** | **Treatment** | **Problems** |
| HIV/ AIDS | Virus | Exchange of bodily fluids (e.g. sharing needles) and breast milk from infected mother  | Early - flu like symptoms. Later - immune system so damaged that get infections easily  | Barrier during intercourse, screening of blood, not sharing needles and bottle feeding. No vaccine  | Anti-retroviral drugs allow sufferers to live very long life. Stem cell transplants (novel treatment in early stages of research and development)  | Fatal if not treated. In some people, the virus has become resistant to the antiretroviral medication leading to concerns for the future of HIV treatment  |
| Measles | Virus | Inhalation of droplets from sneezes and coughs  | Red rash and fever  | MMR Vaccine  | No treatment  | Can be fatal if there are complications  |
| Salmonella | Bacteria | Contaminated food or food prepared in unhygienic conditions  | Fever, abdominal cramps, vomiting and diarrhoea  | Good food hygiene  | Antibiotics given to the young and very old to prevent severe dehydrations  | Can cause long term health problems, though this is rare. The bacteria are becoming resistant to some antibiotics  |
| Gonorrhoea  | Bacteria | Sexually transmitted  | Early symptoms include yellow/ green discharge from infected areas and pain when urinating | Condoms   | Antibiotics  | If untreated can lead to infertility, ectopic pregnancy, and pelvic pain. The bacteria are becoming resistant to antibiotics meaning they are more difficult to treat |
| Malaria  | Protist  | Vector - mosquito  | Flu-like symptoms  | Preventing mosquitos from breeding and mosquito needs treated with insecticide | Anti-malarial drugs  | Fatal if not treated, with children under 5 the most vulnerable group. In some regions, antimalarial drug resistance has become a problem |
| COVID-19  | Virus | Droplet transmission  | Flu-like symptoms  | Wearing a face cover Practicing social distancing COVID-19 vaccine  | Symptomatic treatments  | Long term effects of disease unknown – ongoing research in this area  |