BIOLOGY

Our Health and the Effects of Drugs

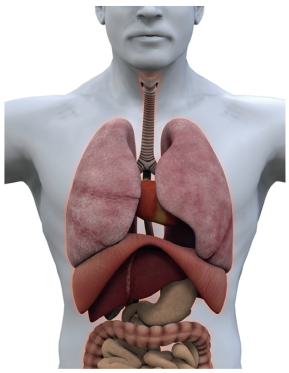
Ideas you have met before

Body systems

Our breathing system moves gases in and out of the body. It provides the body with oxygen for respiration and removes waste carbon dioxide.

Our digestive system breaks down large food molecules into smaller molecules, thus providing glucose for respiration.

The lungs are damaged by smoking. Cigarettes contain many poisonous chemicals including nicotine and tar.



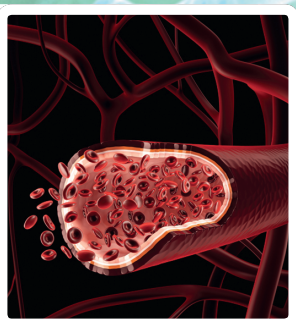
Anabolic steroids

Anabolic steroids increase muscle mass. They can be misused by sportspeople and have serious side effects, such as liver damage and risk of heart attack.

Role of blood

Blood carries substances such as oxygen and glucose to all the cells of our body, where they are needed in respiration.

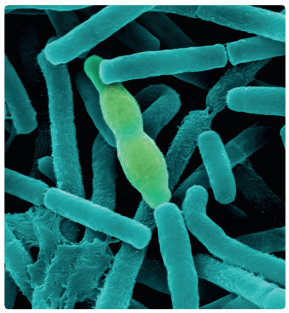
Blood carries carbon dioxide produced during respiration to our lungs to be breathed out.



Microbes

Microbes are tiny organisms that cannot be seen with the naked eye. They include bacteria, viruses and fungi.

Yeast is a fungus that is used in brewing and baking. It uses sugar as a food source and produces alcohol and carbon dioxide. Carbon dioxide causes bread to rise and froth to form on beer.



2.1

In this chapter you will find out

Cigarettes and alcohol

- Cigarettes and alcohol can affect many organs of the body.
- Passive smoking poses dangers for non-smokers.
- Addiction affects the brain and is very difficult to overcome.
- Alcoholism causes problems in society.

Effects of drugs

- People take drugs for medical reasons, but there is also much use of 'recreational' drugs.
- Drugs have side effects that can harm the body. For example paranoia can be caused by cannabis and heart failure can be caused by ecstasy.
- There are arguments for and against legalising cannabis.

Preventing and treating infection

- Blood contains white blood cells, which are part of our immune system, helping us to fight infections.
- Antibiotics can work against bacterial infections but sometimes they are not used properly.
- The discovery of vaccines allowed huge advances in the fight against infection.

Disease

- We need to use our knowledge of the characteristics of different microbes and how they infect the body to try to limit the spread of diseases.

Exploring types of drugs

We are learning how to:

- State examples of the four main groups of drugs.
- Describe the effects of different types of drugs on the body.
- Explain the effects of each type of drug on the body.

Drugs can be both beneficial and harmful. We may take paracetamol for a headache or decongestants for a blocked nose. Used like this, drugs are helpful. However, drugs can also be misused, causing harm to the body that may be irreversible. For example, taking too many paracetamol tablets can cause liver damage and even death.

Types of drugs

A drug is any substance that affects the way that the body functions. Drugs can be grouped into four main types:

- **Painkillers** relieve pain. Examples are paracetamol, codeine and morphine.
- **Stimulants** speed up body systems. Examples are caffeine, cocaine, ecstasy and amphetamines.
- **Depressants** slow down body systems. Examples are alcohol, cannabis, tranquillisers (sleeping tablets) and heroin.
- **Hallucinogens** cause us to see things that do not exist. Examples are LSD and psilocybin mushrooms.

Some drugs can be bought legally. These include caffeine (e.g. in coffee and chocolate) and paracetamol. **Prescription drugs** are prescribed by a doctor and are used to treat medical conditions. Sometimes these drugs can be misused and taken for the feeling they give, rather than for medical reasons. Other drugs, such as heroin and amphetamines, are bought illegally and are taken for the feeling that they give. Drugs that are not used for medical reasons are **recreational drugs**.

1. Describe the four types of drugs, giving examples.
2. Explain the difference between prescription drugs and recreational drugs.
3. Suggest why people may take drugs recreationally.

FIGURE 3.2.2a: What type of drug is in psilocybin mushrooms (magic mushrooms)?

Did you know...?

Ritalin is a stimulant used to treat attention-deficit hyperactivity disorder (ADHD). However, in the doses used to treat ADHD, it acts more like a depressant.

How do drugs affect us?

Each type of drug affects the body in a different way.

TABLE 3.2.2a: How different drugs affect the body

Type of drug	Effect on the body
painkiller	feelings of pain are reduced or removed; pain messages are blocked in the nervous system
stimulant	temporary increase in alertness and energy; brain activity is increased
depressant	relaxed feelings or sleepiness; the nervous system is slowed down
hallucinogen	sense of reality is distorted as chemicals in the brain are interfered with

4. Suggest why people drink coffee if they need to stay awake at night.
5. Ketamine is an anaesthetic that is used to put animals to sleep while they are operated on. Describe and explain which group of drugs ketamine belongs to.

Considering the negative effects of prescription drugs

Drugs can have **side effects**. These are unwanted effects caused by drugs. For example, antibiotics prescribed for an ear infection may cure the ear infection but may cause diarrhoea as a side effect. Often it is worth the risk of the side effect if the medical condition is treated.

TABLE 3.2.2b: The side effects of drugs

Drug	Possible side effects
painkiller	can cause vomiting, nausea and constipation because the drugs affect chemicals in the gut
stimulant	period of fatigue follows the 'high'; risk of heart attack because of increased heart rate; risk of weight loss
depressant	can cause depression in the long term; risk of death if overdosed because the drugs slow body systems down
hallucinogen	can lead to depression and anxiety because the drugs affect the balance of chemicals in the brain; risk of weight loss

6. Explain what 'side effects' are, giving examples.
7. Explain the risks of taking:
   a) ecstasy **b)** LSD.

FIGURE 3.2.2b: Painkillers interfere with the nervous system.

Key vocabulary

painkiller
stimulant
depressant
hallucinogen
prescription drug
recreational drug
side effect

Understanding the impact of smoking

We are learning how to:

- Describe the effects of smoking on the body.
- Explain the risks of smoking on the body.
- Examine the link between smoking and cancer.

Smoking is harmful to the breathing system, contributing to lung infections and lung cancer. However, smoking can also have negative effects on many other parts of the body.

The effects of smoking

Cigarettes contain chemicals including **nicotine** and **tar**. Nicotine is a stimulant drug that increases the heart rate. This can overwork the heart, making smokers more susceptible to heart attacks than non-smokers. Nicotine is also addictive, making it difficult for smokers to quit.

Some tar from cigarettes remains in the lungs and builds up in the alveoli (air sacs). This prevents gases from passing freely in and out of the lungs and the smoker may feel breathless. The tar also supports the growth of bacteria, leading to lung infections.

The tubes of the breathing system have tiny hairs inside them called cilia. Cilia sweep out dust and other particles that can irritate and damage the lungs. Cigarette smoke paralyses these cilia, allowing dust and other particles travel into the lungs. A smoker's cough is the result of the person trying to remove these irritants.

Nicotine and other chemicals in cigarettes affect the blood vessels, which become narrower. Circulation is reduced and less oxygen and nutrients are delivered to parts of the body. This leads to wrinkles forming in the skin and even to the loss of a limb.

1. Describe how three different parts of the body are affected by smoking.
2. Name two chemicals in cigarettes and give an example of their effect.

FIGURE 3.2.3a: What causes a smoker's cough?

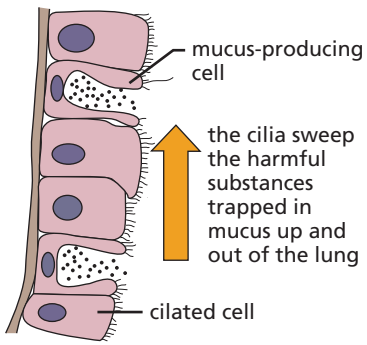


FIGURE 3.2.3b: Cigarette smoke prevents the cilia from working properly.

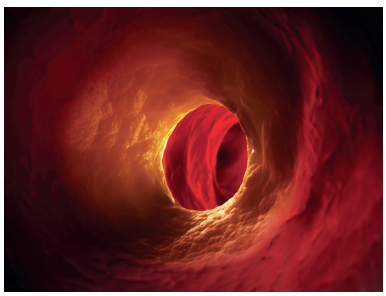


FIGURE 3.2.3c: Smoking can cause the blood vessels to narrow.

The dangers of passive smoking

When a cigarette burns or is smoked, the smoke is released into the air. This smoke may then be breathed in by others around the smoker – this is **passive smoking**.

The smoke from cigarettes can remain in the air for hours after a cigarette has been burned, even when a window is open.

The problems caused by passive smoking are similar to those caused by smoking, including an increased risk of lung **cancer**, heart disease and breathing problems.

3. Describe what 'passive' smoking is.
4. Explain how smokers could avoid damaging people around them with cigarette smoke.
5. Suggest how children in a house could be affected by smoke from cigarettes burned in another room.

The link with cancer

Smoking is the single biggest cause of cancer in the world. Studies show that smoking greatly increases the risk of lung cancer. A large study in 2011 suggested that four in every five lung cancers are caused by smoking. Those at the highest risk are people who smoke the most cigarettes and who started smoking at a young age.

Genetics appears to play a part in determining whether we develop cancer or not. Some people appear to be more prone to developing cancer, based on their genes.

6. Explain why people smoke even though the link with cancer is clear.
7. Explain why a person may develop lung cancer from passive smoking alone, while another person may smoke 40 cigarettes a day and never develop lung cancer.
8. In 2002, almost 40 000 people died from lung cancer. Predict how many of these cases were caused by smoking.

FIGURE 3.2.3d: Cigarette smoke can linger for hours.

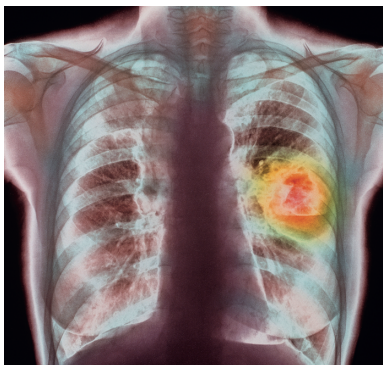


FIGURE 3.2.3e: The risk of lung cancer is increased greatly by smoking.

Did you know...?

Electronic cigarettes provide the nicotine that the user craves without the smoke and other harmful chemicals. There is debate about whether they help with quitting smoking or 'normalise' cigarette use and lead to more young people becoming addicted to nicotine.

Key vocabulary

nicotine

tar

passive smoking

cancer

Considering the dangers of cannabis

We are learning how to:

- Describe the medicinal uses for cannabis.
- Describe the negative effects of cannabis on the body.
- Give a balanced argument about whether cannabis should be legalised.

Cannabis is made from the dried flowers of the cannabis plant – hashish is formed from the leaves and stems. Cannabis is known for the relaxed feeling that it gives. However, it also has serious side effects.

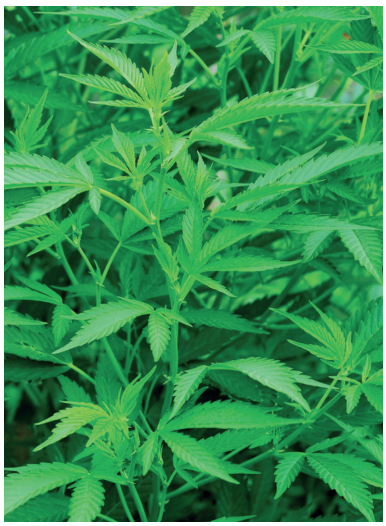


FIGURE 3.2.4a: The cannabis plant

Uses of cannabis

Cannabis falls into two groups of drugs – it is a depressant but can also be a hallucinogen. It is the most widely used illegal drug in Britain. Many people choose to use cannabis because of the 'chilled-out' feeling that it gives. However, some hospital doctors also prescribe cannabis for medical purposes.

Multiple sclerosis (MS) causes muscle spasms and the sufferer may shake. Cannabis can be prescribed to relieve these spasms. Cannabis can also be prescribed to relieve pain – for example pain caused by cancer, HIV or MS. Cannabis increases the appetite and can be prescribed for patients whose illnesses have caused weight loss.

1. Name the two groups of drugs to which cannabis belongs.
2. Describe one use of cannabis to reduce pain.
3. Give an example of a medical use of cannabis as a depressant.

FIGURE 3.2.4b: Cannabis can help multiple sclerosis sufferers.

Harmful effects of cannabis

Cannabis affects the way that the brain functions. It can cause feelings of anxiety, panic and paranoia as well as problems with concentration. In the long term, cannabis has been shown to increase the risk of developing mental illness such as schizophrenia.

Cannabis is usually smoked, although it can also be eaten. Cannabis contains some of the same harmful

chemicals that tobacco does. In fact, it contains a higher concentration of both tar and other cancer-causing chemicals. Smoking cannabis can cause lung infections and cancer, just as smoking tobacco can. If people smoke cannabis mixed with tobacco, their risks are increased. It is also thought that smoking cannabis can reduce fertility in both men and women.

Cannabis does not contain nicotine and so is less addictive than tobacco.

4. Name the chemical in cannabis that causes cancer.
5. Describe how cannabis can affect mental health.
6. Compare the harmful effects of smoking cannabis and tobacco.

FIGURE 3.2.4c: Cannabis can reduce the ability to concentrate.

Should cannabis be legalised?

It is illegal to possess cannabis and anyone caught could be given a five-year prison sentence. Criminals supplying cannabis could spend up to 14 years in prison.

Arguments about whether or not cannabis should be **legalised** have raged for many years.

TABLE 3.2.4: Some of the reasons for and against legalisation of cannabis

Arguments for legalisation	Arguments against legalisation
helpful for patients of MS, cancer, HIV	can cause mental health problems such as paranoia and schizophrenia
does not cause as many health problems as alcohol	may lead to the use of harder drugs
helps people to relax	has a negative effect on concentration and motivation
problems caused by dealing cannabis would be reduced	can cause cancer

7. Explain why supplying cannabis is given a longer prison sentence than possession.
8. Suggest what problems are caused by the dealing of cannabis.
9. Read the arguments in Table 3.2.4 and then create your own piece of writing, arguing for or against the legalisation of cannabis.

Did you know...?

The risk of having an accident after smoking cannabis *and* drinking alcohol is shown to be 16 times higher than when either substance is used on its own.

Key vocabulary

cannabis

illegal

legalise

Understanding the effects of alcohol

We are learning how to:

- Describe the short-term effects of alcohol on the body.
- Explain the long-term effects of alcohol.
- Suggest how alcoholism affects society.

Most people who drink alcohol will experience a hangover. The headache and sickness that can come with a hangover are not pleasant. However, there are more serious long-term effects linked with drinking alcohol regularly.

The effects of alcohol

Alcohol is a depressant drug. It slows down brain functioning. Soon after drinking alcohol, a person may feel more confident. This is because alcohol suppresses parts of the brain that make us feel shy. As more alcohol is consumed, problems with balance may occur, as well as an inability to speak properly. Some people become aggressive when they are drunk. Alcohol affects the speed at which people can react to external factors, making it dangerous for people to drive after drinking alcohol.

If people continue to drink past the stage of 'being drunk', alcohol poisoning can occur. The heart rate and breathing rate drop dangerously low and the person may slip into a coma. This can lead to death.

1. Describe some of the effects of alcohol on the body.
2. Explain why a person may feel more confident when they drink alcohol.
3. Describe how a person could die from alcohol poisoning.

Long-term damage

The government makes recommendations on safe levels of alcohol. The recommended maximum per week for women is 14 **units of alcohol** and for men it is 21 units. Generally, women break down alcohol more slowly than men (due to their smaller mass and lower water content in the body) and so they are advised to drink less. Drinking more alcohol than this on a regular basis can cause long-term damage to the body.

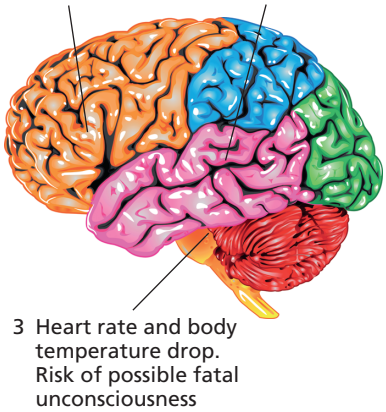


FIGURE 3.2.5a: How increasing amounts of alcohol affect the body

FIGURE 3.2.5b: One unit is 10 ml of alcohol. The alcohol content of drinks varies, depending on the strength of the drink.

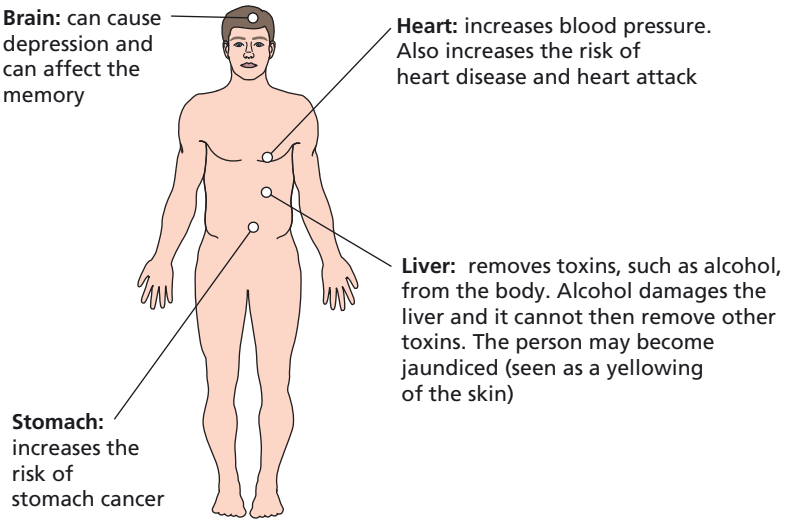


FIGURE 3.2.5c: Some of the long-term effects of alcohol

4. A single measure of vodka contains 1.5 units of alcohol. Calculate the maximum number of measures that a woman should drink in a week.

5. A large glass of wine contains 3 units of alcohol. Each bottle contains three large glasses.

a) How many units does a bottle of wine contain?

b) How many bottles of wine could a man safely drink in a week?

6. Draw up a table to summarise the long-term effects of alcohol on different organs in the body.

How does alcohol affect society?

Alcohol abuse (**alcoholism**) does not only affect the drinker. Families, including children, of **alcoholics** (alcohol addicts) may be subjected to violence caused by alcohol. Families may break up because of the emotional or financial strain.

Alcohol abuse costs society an enormous amount of money because of people repeatedly missing work or because they are not productive in the workplace. Alcohol can also contribute to accidents in the workplace.

Alcohol plays a massive part in road traffic accidents. Injuries and deaths caused by drunk drivers change people's lives forever.

7. Explain how alcohol abuse can affect the family of an alcoholic.

8. Explain how alcohol can affect society as a whole.

Did you know...?

Alcohol leads to dehydration by causing more water to be passed in urine than is taken in. This dehydration causes the brain to shrink away from the skull, resulting in a hangover headache.

Key vocabulary

alcohol

unit of alcohol

alcoholism

alcoholic

Exploring the effects of other drugs

We are learning how to:

- Describe the effects of different drugs on the body.
- Compare the dangers of different drugs.

Ecstasy, cocaine and heroin are all **class A drugs**. These are considered to be the most harmful types of drugs. Data shows that, after cannabis, cocaine and ecstasy are the most widely used illegal drugs.

Effects of ecstasy, cocaine and heroin

Ecstasy and **cocaine** are both stimulants. They cause an increase in heart rate and in body temperature. Both drugs cause users to feel energised and confident. After the effects wear off, users of both drugs experience a 'come down'. This can make people feel depressed and flu-like.

Ecstasy is rarely pure. The substances mixed in with it can be fatal. Cocaine is highly addictive. Both drugs are extremely dangerous for people with heart conditions.

Heroin is a depressant. It slows the breathing rate and heart rate. It gives users a feeling of warmth and relaxation. Heroin can cause vomiting, which is dangerous because the highly relaxed user cannot cough and may choke. Heroin is highly addictive, and is either smoked or injected. Injecting drugs can spread infections such as HIV.

1. Describe some of the problems caused by ecstasy and cocaine.
2. Explain why vomiting is dangerous after taking heroin.
3. Explain why ecstasy and cocaine are especially dangerous for those with a heart condition.

The size of the problem

Statistics are gathered on the use of different drugs every year. Information is collected about which drugs are used, the average age of users and the number of deaths caused by different drugs.

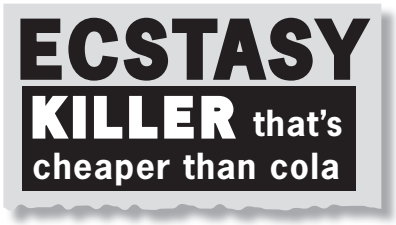


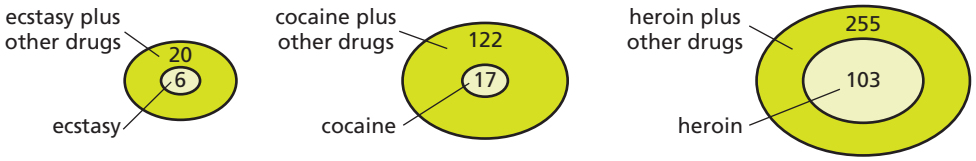
FIGURE 3.2.6a: Some ecstasy users have died after taking the drug just once.

Did you know...?

Drug dealers often mix drugs with other, cheaper, substances to maximise their profit. Heroin has even been mixed with brick dust and gravel.

FIGURE 3.2.6b: How could the user know that this drug is mixed with brick dust?

FIGURE 3.2.6c: Number of deaths caused by drugs in 2011 in England.



4. Suggest why it is difficult to monitor the number of deaths caused by drugs.
5. Explain what can be deduced from the data shown in Figure 3.2.6c.

Comparing the negative effects

TABLE 3.2.6: The negative effects of drug-taking

Ecstasy	Cocaine	Heroin
possibility of up to 7 years in prison for possession	possibility of up to 7 years in prison for possession	possibility of up to 7 years in prison for possession
often impure, containing lethal ingredients	'snorting' may lead to loss of cartilage in the nose; injecting can cause ulcers and damage veins	injecting can cause ulcers and damage veins
may become a habit	highly addictive	highly addictive
can lead to depression and anxiety	can lead to problems with depression and paranoia	over time the addiction becomes stronger and full dependency results
risk of heart problems and dehydration	high doses can cause heart attack and heart failure	can cause coma and death as breathing rate slows

FIGURE 3.2.6d: Injecting drugs carries risks of ulcers, collapsed veins and infections such as HIV, if needles are shared.

6. Describe some similarities of the dangers associated with ecstasy, cocaine and heroin.
7. Explain whether you agree that possession of each of these drugs should carry the same prison sentence.
8. Suggest which of these dangers you consider to be most important when trying to persuade people not to take these drugs.

Key vocabulary

class A drug

ecstasy

cocaine

heroin

Learning about addiction

We are learning how to:

- Define addiction.
- Describe how drugs affect the brain.
- Explain the effects of withdrawal on the body.

Although most people take drugs voluntarily at first, over time some drugs can change the brain in a way that makes the person addicted. Drug addicts are dependent on a drug, which may be illegal or prescribed, and they crave that drug both mentally and physically.

FIGURE 3.2.7a: Addiction can occur with both legal and illegal drugs.

What is addiction?

Casual drug use can lead to **addiction**. Addicts crave more of a drug, even when they know the harm that it is causing to themselves and those around them. The body becomes physically dependent on the drug and without it the person does not feel normal.

Vulnerability to addiction varies from person to person and there is no unique description of 'the addict'. Factors that influence whether or not a person becomes addicted include:

- genetic make-up
- traumatic experiences in childhood
- mental health issues such as depression
- how early in life drugs are experimented with
- the way that drugs are taken (smoking and injecting can lead more quickly to addiction).

Examples of addictive drugs include nicotine, alcohol, cannabis, sedatives, cocaine and heroin.

1. Describe what 'addiction' is.
2. List some examples of drugs that become addictive.
3. Explain why some drug users become addicts whereas others do not.

Did you know...?

Addiction is not restricted to drugs. People may become addicted to gambling, extreme sports, exercise or shopping, for example. This is because the chemicals that are produced during these activities can give a 'buzz'.

Changes in the brain

Drugs interfere with the way that the brain sends and receives messages. Some drugs, such as cannabis and heroin,

are similar to other chemicals in the brain. They fool the brain and abnormal messages are sent. Other drugs, such as cocaine, cause nerve cells to release large amounts of dopamine. Dopamine is a 'feel good' chemical that is usually released when we are happy. Drug users reach a point where they need to take the drug again to try to repeat these feelings.

Brain-imaging studies of drug-addicted individuals show physical changes in areas of the brain that are critical to judgement, decision making, learning and memory, and behaviour control. This explains why drug addicts may take risks that put themselves in danger to get more drugs.

4. Describe the changes in the brain caused by cannabis and heroin.
5. Explain why cocaine addicts continue to take cocaine.
6. Explain why drug addiction may be described as a disease, rather than just a habit.

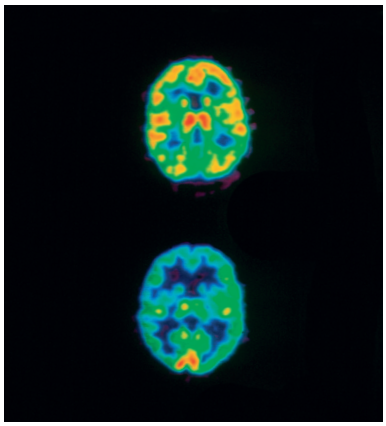


FIGURE 3.2.7b: Drugs affect chemicals in the brain. The yellow areas show the regions of high activity in the brain, in a healthy person (top) and in a cocaine addict (bottom) who has been drug-free for 4 months.

Overcoming addiction

It is not easy for someone who is addicted to stop taking drugs, but it is possible. **Withdrawal** is the process of coming off drugs and needs to be done in controlled steps. It can be dangerous for some addicts, such as alcoholics or heroin addicts, to stop taking their drug completely.

During withdrawal, physical and emotional symptoms may be experienced.

- Emotional withdrawal symptoms are experienced when coming off all drugs. Examples of emotional withdrawal symptoms include anxiety, insomnia, headaches, depression and poor concentration.
- Physical withdrawal symptoms are also experienced when coming off alcohol, heroin and tranquillisers. Examples of these include sweating, muscle tension, difficulty breathing, tremors, nausea, vomiting and diarrhoea.

Medical help should be sought when overcoming any addiction. **Rehabilitation** clinics allow drug addicts to stay during the withdrawal process. Counselling is also provided at the clinics.

7. Suggest why medical help should be sought when overcoming an addiction.
8. Suggest why rehabilitation clinics are often successful in helping addicts to overcome their addictions.

FIGURE 3.2.7c: Withdrawal from drugs can be traumatic.

Key vocabulary

addiction

withdrawal

rehabilitation

Applying key ideas

You have now met a number of important ideas in this chapter. This activity gives an opportunity for you to apply them, just as scientists do. Read the text first, then have a go at the tasks. The first few are fairly easy – then they get a bit more challenging.

Driving under the influence

Most people know that driving while under the influence of alcohol is dangerous. It is also common knowledge that if found to be over the legal level of alcohol, a driver can be charged, leading to a driving ban, a fine and a possible prison sentence.

FIGURE 3.2.8a: Breath testing

Alcohol level in the breath is assessed first using a breathalyser test at the side of the road. If this gives a positive result, the driver is then taken to a police station where the breath may be tested again or blood may be tested. The legal limit is 80 mg (milligrams) of alcohol per 100 ml (millilitres) of blood.

Alcohol is a depressant drug, which means that it will slow down body systems, including the ability to react. After consuming alcohol, drivers are also more likely to take risks.

There is less awareness about the dangers and the consequences of driving under the influence of other drugs. Driving under the influence of drugs carries the same penalties as drink-driving.

If a police officer believes that a driver may be under the influence of drugs other than alcohol, they may carry out a 'field impairment test' at the roadside. This involves the driver carrying out five activities that are simple when not under the influence of any drug, but difficult after taking drugs. The tests include standing on one leg while counting out loud, touching the tip of the nose with a finger while the eyes are closed and walking toe to heel in a straight line.

The description of driving under the influence of drugs does not differentiate between prescription drugs and illegal drugs. It is the responsibility of the driver to ensure that any prescription drugs do not affect their ability to drive safely.

In the last 30 years, the number of deaths caused by drink-driving has fallen dramatically. However, in 2011, there were still 230 fatalities due to drink-driving. It is believed that deaths caused by drug-driving are on the increase. Statistics show that in 2011 drug users were almost twice as likely to drive 'under the influence' than alcohol drinkers. One in five drug users admitted to driving after taking drugs. One in every 100 drug users admitted to driving under the influence almost every day.

FIGURE 3.2.8b: Drugs and alcohol increase the risk of road traffic accidents.

Task 1: Recognising effects

Compare the methods that are used to determine whether a driver is under the influence of alcohol or other drugs.

Task 2: Identifying the drug

Explain why it may be more difficult to determine that a driver is under the influence of drugs other than alcohol.

Task 3: Reaching the limits

Explain why different people can drink different amounts of alcohol before they reach the legal alcohol limit. Suggest why many other countries have stricter laws on drinking than the UK (with the legal level set, for example, at 50 mg of alcohol per 100 ml of blood).

Task 4: Gathering statistics

Compare the percentage of drug users and alcohol drinkers that admitted to driving 'under the influence' in 2011. Suggest why it is difficult to be sure that the data is accurate. Explain which of these statistics it would be most difficult to gather evidence for.

Task 5: Making the most of punishment

Discuss whether or not the current punishments for driving 'under the influence' are working as a deterrent. Suggest other ways to deter people from driving 'under the influence' of alcohol and other drugs.

Task 6: Arguing for drug testing

Provide an argument about whether or not regular, random drug tests should be carried out on drivers. Remember that you should present both sides of the argument and then make a clear conclusion.

Understanding how diseases are spread

We are learning how to:

- Describe how diseases are spread.
- Consider ways of reducing the spread of specific diseases.

Some micro-organisms (microbes) cause 'infectious diseases' that can be spread from one person to another.

What is disease?

A disease is a disorder of a function in our body that is not caused by physical damage. When a disease is caused by an infection it is an **infectious disease** – examples are influenza and chickenpox. Infections can be passed from one person to another. Other diseases, such as diabetes and cancer, cannot be passed on – these are **non-infectious diseases**.

If a disease-causing microbe enters your body, damage is caused to your cells and toxins (poisons) are released. You then start to notice some **symptoms** of the infection – you may get a fever (high temperature), a rash or feel pain.

FIGURE 3.2.9a: What are the symptoms of chickenpox?

1. Describe the difference between infectious and non-infectious diseases. Give examples of each.
2. How can we tell when we have an infectious disease?

How do diseases spread?

Infectious diseases can be spread in a variety of ways.

TABLE 3.2.9a: How infectious diseases are spread

How is it spread?	Details	Examples of disease
air	airborne droplets from the mouth and nose, for example when sneezing	chickenpox, common cold, influenza
faeces/ urine	tiny amounts of urine or faeces are passed from person to person or via an object	threadworms
blood	blood from one person comes into contact with another, such as during a blood transfusion or when sharing needles	HIV, hepatitis B and C
food/water	contaminated water or food is eaten	typhoid, salmonella
sex	body fluids are mixed during sexual contact	HIV, hepatitis B, chlamydia
animals	animal or insect bite	rabies, malaria

3. Suggest why typhoid is much more common in developing countries than in developed countries.
4. Suggest why threadworms are common in young children.

Preventing the spread of disease

It is impossible to keep ourselves completely free of infection throughout our lives. However, steps can be taken to reduce the risk of infection spreading.

TABLE 3.2.9b: How to prevent the spread of some diseases

Disease	How is it spread?	Action taken to avoid spread	Explanation
influenza	air	cover mouth when coughing or sneezeing	traps air-borne droplets
HIV	sex/blood	use a condom during sex	prevents mixing of body fluids that carry the virus
typhoid	water	boil water before drinking	destroys the microbes that cause typhoid
threadworms	faeces	wash hands after using the toilet	removes traces of urine or faeces

FIGURE 3.2.9b: Some types of mosquitos spread malaria.

5. Justify each of these measures used to reduce the spread of infection:
   a) Using alcohol gel as you enter hospital wards.
   b) Screening the blood given by donors before being used in transfusions.
6. Dogs entering the UK from some countries are held in quarantine. Explain how this may reduce the spread of rabies and suggest why some people object to it.

Did you know...?

Some infections cause no symptoms in the patient – an example is chlamydia. This can be easily treated but can cause infertility if left untreated. Screening is important for such diseases.

Key vocabulary

infectious disease

non-infectious disease

symptom

Exploring the body's defences

We are learning how to:

- Describe how the body resists infection.
- Explain the role of white blood cells in fighting infection.

Microbes are all around us and some of these microbes can cause disease. We have barriers to prevent microbes from entering the body but if microbes do enter, cells in our blood act as the next line of defence.

Our body as a barrier

The body has several barriers; these are our 'first lines of defence'.

1. Explain why a cut quickly forms a scab.
2. Describe the ways that the body defends against microbes trying to enter through the nose.
3. Why are these methods are called 'the first line of defence'?

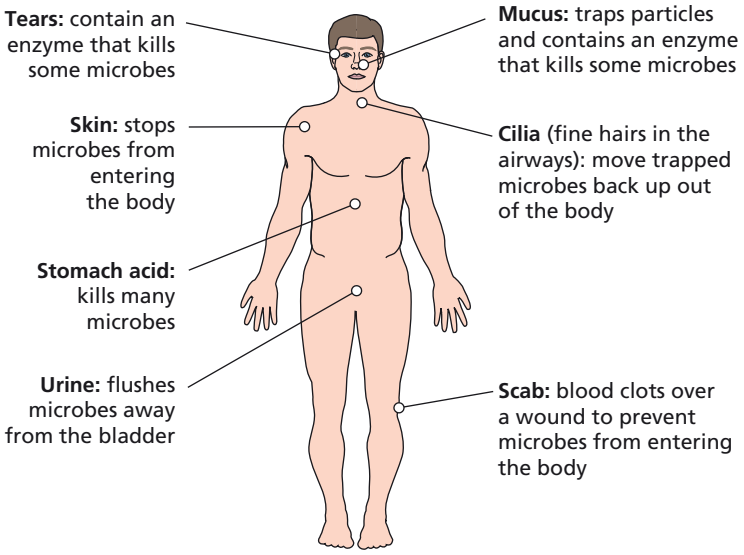


FIGURE 3.2.10a: The 'first lines of defence'

Defence by white blood cells

If disease-causing microbes manage to get past the barriers, **white blood cells** act as the next line of defence. The cells form part of our **immune system** – the system in the body that protects against disease.

There are three types of white blood cell:

- **Phagocytes** ingest microbes and destroy them.
- 'B-cells' produce **antibodies** – these are protein molecules that attach to the microbes and destroy them.
- 'T-cells' produce antitoxins – these are chemicals that neutralise the toxins produced by the microbes. These cells also co-ordinate the attack on the microbes.

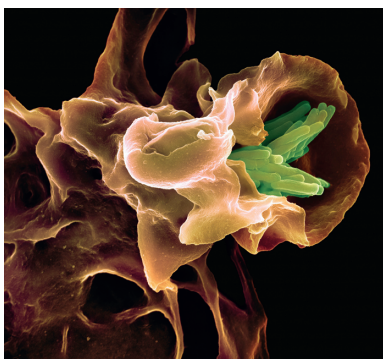


FIGURE 3.2.10b: A white blood cell surrounding bacteria

When microbes infect the body, white blood cell numbers increase and blood flows to the site of the infection.

4. Explain why the number of white blood cells would increase in someone with an infection.
5. Suggest why an infected cut may appear red and hot.
6. Draw an annotated diagram to show the roles of the three types of white blood cell.

Memory cells

Once an infection is overcome, the number of white blood cells returns to normal levels. However, some of both the T-cells and B-cells remain as **memory cells**. If the same type of microbe infects the body again, these memory cells react quickly. Antibodies are produced and microbes are destroyed before they have the opportunity to reproduce. This is why we rarely catch the same disease twice – we become immune to the disease.

Some microbes, such as those that cause influenza, regularly change their structure very slightly. This means that the body has no memory of the microbes and is why people can get flu each year.

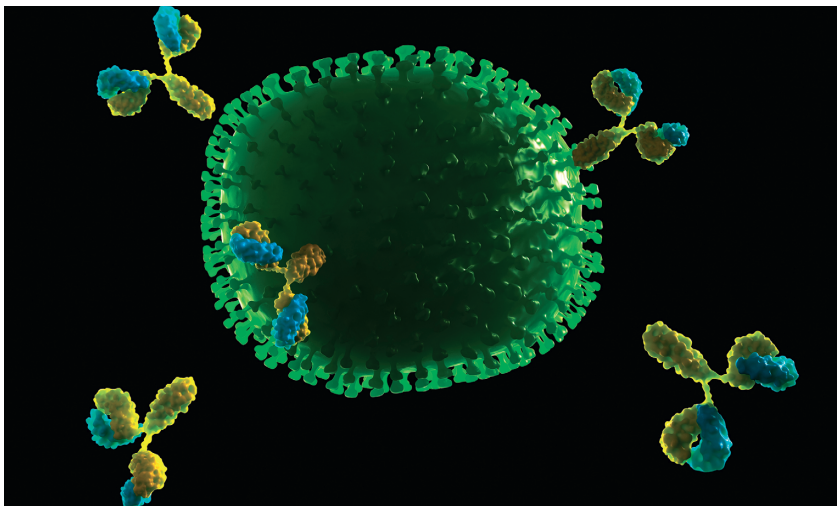


FIGURE 3.2.10d: This shows how antibodies attack a microbe.

7. Explain why it is rare to catch measles twice.
8. Antibodies produced by the immune system recognise proteins on the surface of microbes. Suggest how the microbe that causes influenza avoids us becoming immune to it.
9. Explain why it is helpful to have memory cells of both B-cells and T-cells.

Did you know...?

Platelets in the blood are responsible for blood clotting, which leads to a scab developing. Haemophilia is a genetic condition in which the blood does not clot. Without treatment, the person could bleed to death.

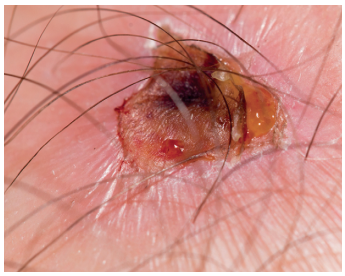


FIGURE 3.2.10c: How does a scab help to protect us?

Key vocabulary

white blood cell
immune system
phagocyte
antibody
memory cell

Comparing microbes

We are learning how to:

- Describe the characteristics of different types of microbe.
- Recall examples of diseases caused by bacteria, viruses and fungi.
- Evaluate a model of a microbe.

Micro-organisms (microbes) are too small to be seen with the naked eye. There are three main types – bacteria, viruses and fungi. Each infectious disease is caused by a specific type of microbe.

Comparing microbes

Each type of microbe has a different structure. Microbes are usually much smaller than animal cells.

Fungi are usually the biggest type of microbe. **Bacteria** (the singular is 'bacterium') are usually smaller than fungi but larger than viruses. **Viruses** are the smallest type of microbe – and they can only reproduce inside a host cell. For this reason, some people argue that viruses are not living things.

TABLE 3.2.11a: Diseases caused by microbes

Diseases caused by bacteria	Diseases caused by viruses	Diseases caused by fungi
salmonella food poisoning	common cold	athlete's foot
chlamydia	influenza	thrush
tuberculosis (TB)	chickenpox	
cholera	HIV	
typhoid	measles	

1. Construct a table to show if each type of microbe contains a cell wall, cell membrane and nucleus.
2. Give one reason why some people claim that viruses are not living things.
3. Suggest whether or not there is a relationship between:
   - **a)** the size of a microbe and its complexity
   - **b)** the size of a microbe and its ability to cause disease.

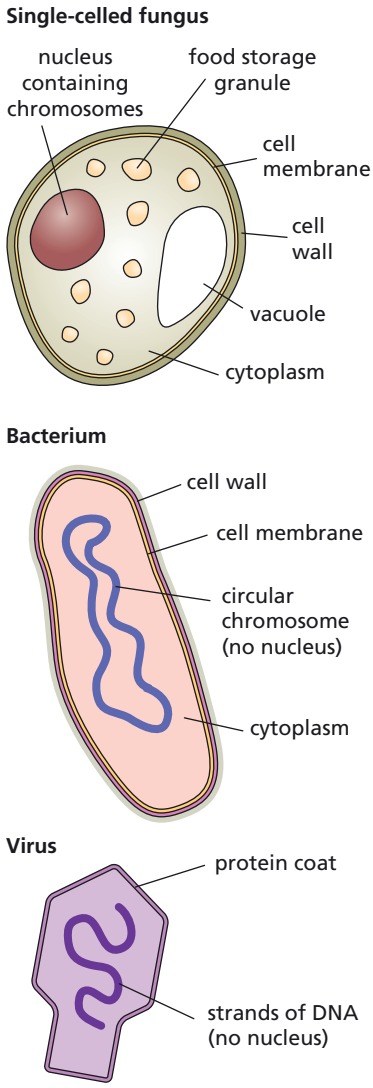


FIGURE 3.2.11a: Microbes vary in structure.

Which microbe is to blame?

We have not always known that microbes cause disease. An early theory was that 'bad air' produced by dead bodies caused disease. In the 1800s, a doctor called Robert Koch proved that microbes cause disease. He proved that the same type of microbe always caused the same disease.

4. Describe the discovery made by Robert Koch.

5. According to Robert Koch, which type of microbe would always be found in a case of athlete's foot?

6. Suggest why people may have believed that bad air from dead bodies caused disease.

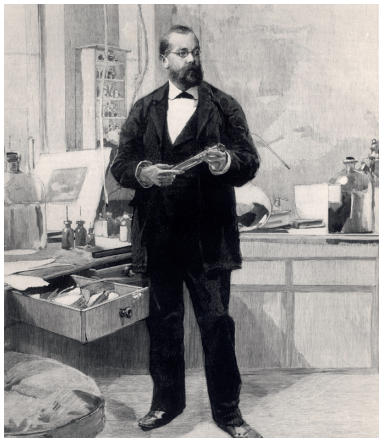


FIGURE 3.2.11b: Robert Koch proved that tuberculosis is caused by a bacterium.

Different shapes and sizes

Although each type of microbe has general features, within each group, bacteria, fungi and viruses can vary in shape and size.

Microbes are measured in **micrometres** (μm). One micrometre is a millionth of a metre, or a thousandth of a millimetre.

TABLE 3.2.11b: Bacteria and viruses come in different shapes and sizes

Shape and appearance	Size	Example of infection caused
round bacteria	1 μm	pneumonia
rod bacteria	1–2 μm	anthrax
spiral bacteria	2–5 μm	syphilis
bacteriophage	0.1–0.2 μm	infects bacteria, not humans
adenovirus	0.1 μm	conjunctivitis

7. The head of a pin is approximately 2 mm in diameter. Estimate how many:

a) round bacteria could fit on a pin head

b) adenoviruses could fit on a pin head.

8. Compare how many times bigger the largest bacterium is than the virus shown in Table 3.2.11b.

Did you know...?

Cold sores are caused by a virus. Most of us carry the virus but only a small proportion ever see any symptoms. It is likely that you were given the virus when you were kissed by someone carrying the virus when you were little.

FIGURE 3.2.11c: Cold sores are caused by a virus – herpes simplex.

Key vocabulary

fungus

bacteria

virus

micrometre

Investigating the growth of bacteria

We are learning how to:

- Describe what bacteria need to survive.
- Investigate bacterial growth in different conditions.
- Analyse bacterial growth data.

Bacteria are all around us, on every surface, including our skin. They are found in a wider variety of habitats than any other organism. Bacteria need certain conditions to keep them alive. Sometimes, the conditions in our homes promote the growth of disease-causing bacteria.

FIGURE 3.2.12a: Bacteria feeding on mucus

What do bacteria need to survive?

Bacteria have adapted to survive in many different conditions. Therefore, their requirements vary from species to species.

- Nutrients: Most bacteria need an external source of nutrients. They use enzymes to break down food such as carbohydrates and fats into glucose.
- Moisture: Most foods contain enough water for bacteria to survive.
- Temperature: Most bacteria like warm temperatures, with the optimum being 37 °C.
- Oxygen: Bacteria vary in their oxygen requirements. Some can survive with no oxygen (for example, those that live deep in the sea).
- pH: Most bacteria prefer neutral conditions (pH 7). But some can survive in acid or alkaline conditions.

1. Describe how bacteria obtain nutrients.
2. Explain why bacteria would not grow in dried foods such as milk powder.
3. Describe the temperature and pH conditions favoured by bacteria that live in the stomach.

Did you know...?

Some bacteria can survive in the hot springs of Yellowstone National Park, USA. The springs contain highly toxic, sometimes boiling water. The bacteria are fuelled by hydrogen and sulfur in the water.

FIGURE 3.2.12b: Bacteria produce many of the brilliant colours in Yellowstone's hot springs.

Growing bacteria in the laboratory

In order to study the structure, growth and effects of bacteria, we must grow them in the laboratory. This is a simple and commonly used technique. Bacteria are

transferred onto a plate containing nutrient **agar** jelly and then incubated to allow bacteria to grow.

When investigating bacterial growth, it is important that cultures are not contaminated with other bacteria. The **sterile technique** is used to avoid this.

- Petri dishes and nutrient agar jelly must be sterilised before use.
- Inoculating loops or cotton buds used to transfer bacteria onto plates must be sterile.
- Hands must be clean.
- After plates have been **inoculated** with bacteria, they are sealed before the plates are incubated over night.

Plates are then incubated to allow the growth of bacteria. Incubation is usually carried out at approximately 25 °C.

4. Describe what the 'sterile technique' is and why it is used.

5. Explain why agar plates are sealed after inoculation with bacteria.

6. Suggest the danger of incubating the inoculated plates at 37 °C.

Bacteria around the home

When bacteria grow on agar plates, **colonies** are formed. These are circular shapes that are formed from the growth of a single bacterium.

A study was carried out to compare the number of bacteria in different locations around the home. The results are shown in Table 3.2.12.

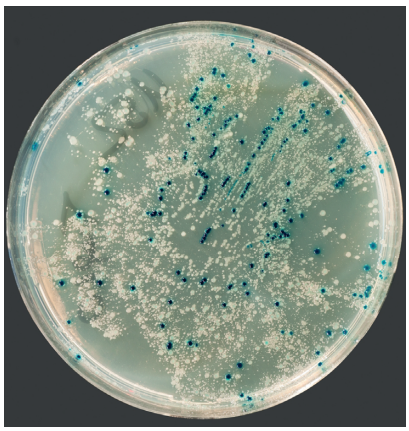


FIGURE 3.2.12d: Bacteria can be seen as colonies on agar plates.

7. Describe and explain what the results in Table 3.2.12 show.

8. Suggest why the results may vary if this investigation was repeated.

9. Suggest what else it would be useful to know about the bacteria, in addition to the number of them.

FIGURE 3.2.12c: Why is it important to wear clean gloves or have clean hands when inoculating plates?

TABLE 3.2.12: Numbers of bacteria found in a study

Location	Number of bacteria per cm^2
toilet bowl	3.2 million
kitchen worktop	488
TV remote control	70
pet food dish	2110
computer keyboard	64
kitchen cloth	134 630

Key vocabulary

agar

sterile technique

inoculate

colony

Understanding how antibiotics work

We are learning how to:

- Investigate the effect of antibiotics on bacteria.
- Explain how bacteria can become immune to antibiotics.
- Evaluate the impact of superbugs on our health.

Antibiotics are drugs that are used to kill bacteria inside the body – their use has helped human health enormously. However, their overuse and misuse is threatening to do us harm.

Killing microbes

Cleaning products that claim to 'kill bugs' usually contain a **disinfectant**. Disinfectants kill bacteria on contact when they are used at the correct concentration. Disinfectants include bleaches and alcohols. They are used to clean surfaces such as floors, toilets and worktops. Disinfectants are toxic.

Antiseptics also kill bacteria but these are used on the skin, rather than on surfaces. Some antiseptics are weak forms of disinfectants. Antiseptics are important in hospitals – for example to clean the skin before surgery and to clean hands before entering a ward.

1. Describe the difference between disinfectants and antiseptics.
2. Explain why both disinfectants and antiseptics are important in hospitals.
3. Suggest why surgery was more dangerous before antiseptics were widely used.

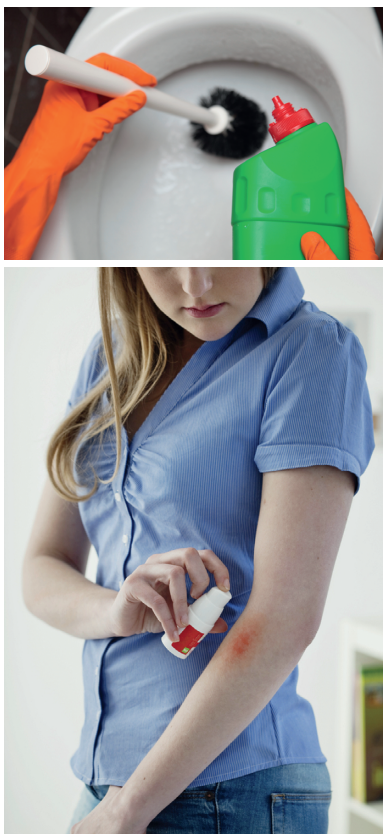


FIGURE 3.2.13a: Disinfectant and antiseptic both kill bacteria.

The effects of antibiotics

Antibiotics are drugs that kill bacteria without damaging human cells. They are used as a medicine to treat bacterial infections. Different antibiotics affect bacteria in different ways. For example some antibiotics disrupt the cell wall of the bacteria and they burst, whereas others prevent the bacteria from respiring and so they die.

To test the effectiveness of different antibiotics on bacteria, discs of paper soaked in antibiotic can be used. Figure 3.2.13b shows a Petri dish in which bacteria have been spread before laying antibiotic discs onto the plate.

A clear zone can be seen around each of the antibiotic discs where the bacteria have not grown.

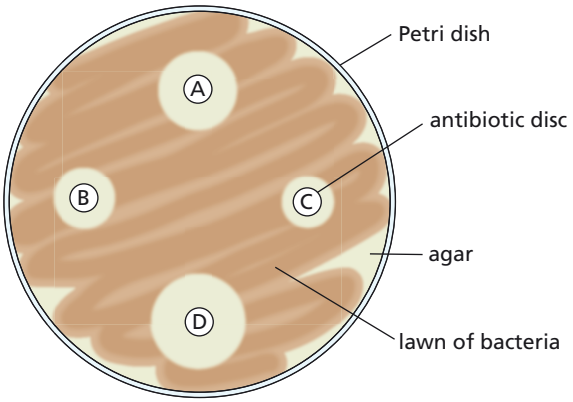


FIGURE 3.2.13b: Testing the effectiveness of different antibiotics

4. Describe some of the effects that antibiotics have on bacteria.
5. Look at Figure 3.2.13b. Explain:
   - **a)** which antibiotic a doctor should prescribe for an infection with this bacterium
   - **b)** whether the doctor should prescribe the same antibiotic for other bacterial infections.
6. Explain why a doctor will not prescribe antibiotics for a common cold.

Superbugs

As the use of antibiotics has increased, so too has the number of bacteria that are resistant to the drugs. When antibiotics are used, any bacteria that have a genetic **resistance** survive the medicine and reproduce to form whole populations of resistant bacteria. The antibiotics are then ineffective at fighting infection.

Antibiotic resistance is a huge problem in hospitals. There are some strains of bacteria that are resistant to many different antibiotics – these are called **superbugs**. One superbug is MRSA (methicillin-resistant *Staphylococcus aureus*). An infection by MRSA can be very difficult to treat.

7. Explain why some people believe that more money should be spent on developing new antibiotics.
8. Suggest why MRSA is more common in hospitals and nursing homes than in the rest of the population.
9. Discuss whether or not you think that antibiotics should be sold without a prescription.

FIGURE 3.2.13c: Infection caused by MRSA can be very serious.

Did you know...?

Following the discovery of the superbug MRSA, hospital doctors were required to stop wearing ties and long-sleeved shirts. It was thought that their clothing was carrying bacteria from one patient to another.

Key vocabulary

disinfectant

antiseptic

antibiotic

resistance

superbug

Learning about vaccination

We are learning how to:

- Describe how vaccines were discovered.
- Explain how vaccines prevent a viral infection.
- Evaluate the risks involved with vaccination.

Children are given vaccines for several diseases, including measles, mumps, rubella and tuberculosis. Before vaccines were developed, children died of these diseases. The discovery of vaccines has had a huge impact on society.

Discovery of vaccines

Smallpox was once a deadly disease, killing an estimated 30 million people in the 20th century. One in every three people who became infected by the smallpox virus died.

Edward Jenner was a country doctor. He noticed that milkmaids who caught the much less serious cowpox did not catch smallpox. He took fluid from a cowpox blister and inoculated a small boy with it. The boy became ill but made a full recovery. Jenner then scratched the boy's arm with smallpox but the boy did not show any symptoms of smallpox. The boy was immune to smallpox. This was the first use of a **vaccine**. Use of the smallpox vaccine worldwide led to the eradication of the smallpox virus.

FIGURE 3.2.14a: Smallpox once killed people all over the world.

1. State what causes smallpox.
2. Explain how Edward Jenner vaccinated against smallpox.

How do vaccines work?

A vaccine is a weakened or dead form of the disease. This means that the microbe from which the vaccine is made cannot reproduce inside the body. Vaccines are usually given by injection, although a recently developed influenza vaccine is sprayed up the nose.

Vaccines bring about an immune response in the body:

- The vaccine enters the body and causes white blood cells to produce antibodies.
- The microbe is quickly destroyed.
- Memory cells are formed inside the body.

Did you know...?

The first attempts to prevent people from catching smallpox involved scratching prisoners with fluid from smallpox blisters. Prisoners were used because they were not considered as important as other people. Many of them died.

- If the live form of the microbe enters the body, memory cells produce antibodies and antitoxins. The microbes are destroyed quickly before the person shows any symptoms.

3. Explain why a microbe is changed before it is used in a vaccine.

4. Draw a cartoon strip to show how a vaccine leads to immunity.

5. Suggest why some people may prefer to have a vaccine as a nose spray rather than as an injection.

Vaccines and side effects

As with any medicine, vaccines carry risks and side effects can occur. These side effects vary with vaccines but are usually minor, such as:

- pain and itching at the injection site
- headache
- fever
- mild rash.

The risks of these side effects outweigh the damage that could be caused by the disease.

In 1998, claims were made that the vaccine for measles, mumps and rubella (**MMR**) was linked to autism and bowel disease. The claims led to a huge decrease in the uptake of the MMR vaccine by parents for their children. Large-scale studies made since these claims have shown that there is no link between the MMR vaccine and either of these conditions. It is thought that the original studies may have been flawed.

6. Explain how you would respond to a parent considering not having their child vaccinated because of the side effects.

7. Explain how the claims that the MMR vaccine causes autism and bowel disease affected the number of cases of measles, mumps and rubella.

8. Suggest how the number of parents having their children vaccinated with the MMR vaccine could be increased further.

FIGURE 3.2.14b: Most vaccines are injected.

FIGURE 3.2.14c: Measles can have serious complications in children.

Key vocabulary

smallpox

vaccine

MMR

Checking your progress

To make good progress in understanding science you need to focus on these ideas and skills.

☐ Give examples of some different types of drugs.	☐ Describe the effects of different types of drugs on the body.	☐ Explain the effects of different drugs on the body, including harmful effects.
☐ Identify parts of the body damaged by smoking.	☐ Explain how the body is damaged by smoking and by passive smoking.	☐ Examine data about smoking and cancer, and draw a conclusion about the correlation.
☐ Describe the effects of cannabis on the body.	☐ Suggest some reasons why people use cannabis.	☐ Present, using evidence, arguments for and against the legalisation of cannabis.
☐ Describe some effects of alcohol on the body.	☐ Describe and explain several effects of alcohol on the body.	☐ Suggest how alcoholism affects society.
☐ Describe what addiction is and give examples.	☐ Describe the changes in the brain caused by drugs and how this can lead to addiction.	☐ Explain the effects of withdrawal from drug dependency on the body, including the brain.
☐ Describe and give examples of a way in which diseases are spread.	☐ Describe several examples of how specific diseases are spread and suggest how their spread may be reduced.	☐ Consider suggestions to reduce the spread of specific diseases and justify decisions.

☐ Describe the body's mechanisms to prevent infection.	☐ Describe the roles of white blood cells in fighting infection.	☐ Explain why we rarely catch the same infectious disease twice, but may catch influenza over and over again.
☐ State examples of diseases caused by microbes.	☐ Describe the characteristics of different microbes.	☐ Evaluate a model of a type of microbe.
☐ Describe the conditions that bacteria need to survive.	☐ Compare bacterial growth in different parts of the home.	☐ Analyse data about bacterial growth.
☐ Describe the effect of antibiotics on bacteria.	☐ Explain how bacteria become resistant to antibiotics.	☐ Explain what superbugs are and evaluate their impact on society.
☐ Describe what a vaccine is and how vaccines were discovered.	☐ Explain how vaccines prevent a viral infection.	☐ Evaluate the risks associated with vaccination.

Questions

Questions 1–7

See how well you have understood the ideas in the chapter.

1. What type of drug is paracetamol? [1]

a) stimulant **b)** depressant **c)** painkiller **d)** hallucinogen

2. Which drug in cigarettes causes the heart rate to increase? [1]

a) tar **b)** nicotine **c)** carbon monoxide **d)** carcinogen

3. Salmonella infection is mainly spread by: [1]

a) contaminated food **b)** blood **c)** sex **d)** air

4. What are the protein molecules called that attach to microbes and destroy them? [1]

a) platelets **b)** mucus **c)** antibiotics **d)** antibodies

5. Explain the difference between antiseptics and disinfectants. [2]

6. Give two examples of features that bacteria contain that viruses do not. [2]

7. Explain what drug addiction is, using examples. [4]

Questions 8–14

See how well you can apply the ideas in this chapter to new situations.

8. What group of drugs would a substance that causes a person to see imaginary spiders and monsters belong to? [1]

a) hallucinogens **b)** painkillers **c)** stimulants **d)** depressants

9. An unknown drug causing a person to become hyperactive is most likely to be: [1]

a) heroin **b)** ecstasy **c)** tranquilliser **d)** anaesthetic

10. If infection of a person with one microbe gives resistance to another microbe infection, which of the following is likely? [1]

a) The microbes have similar structure.

b) The person will not be infected by any microbe in the future.

c) The immune system of the person is not working properly.

d) Antibiotics may be needed.

11. Explain two measures that a school could take to reduce the spread of a disease-causing microbe that seems to be spread by air. [2]

12. You can reduce the spread of disease in a number of ways. Which is the only row in Table 3.2.16 that correctly states how you could best reduce the spread of the stated disease? [1]

TABLE 3.2.16

	Disease	Method of reducing spread
a)	threadworms	cover mouth when sneezing
b)	influenza	use a condom during sex
c)	rabies	wash hands after going to the toilet
d)	typhoid	boil water before drinking

13. Passive smoking may be banned in cars. Explain how this may affect the number of cases of lung cancer. [2]

FIGURE 3.2.16a

14. A student tested how well four different handwash products killed bacteria. Figure 3.2.16b shows the agar plate after incubation with discs soaked in the four samples of handwash. Explain what these results show, including which handwash you would recommend for use in a bathroom. [4]

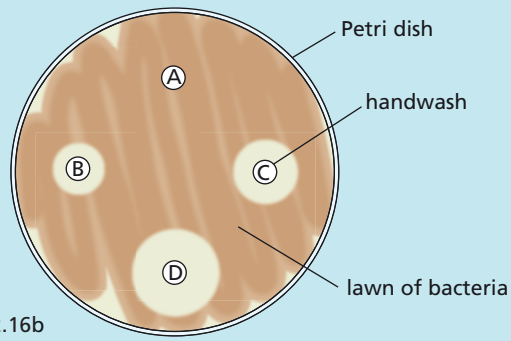


FIGURE 3.2.16b

Questions 15–16

See how well you can understand and explain new ideas and evidence.

15. A unknown microbe has been seen in a sample of faeces from a patient. Identify what type of microbe this is, with reasons, and explain whether or not antibiotics may be suitable to treat the patient. [2]

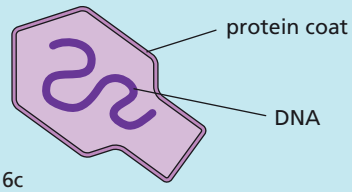


FIGURE 3.2.16c

16. Scientists have manufactured a new antibiotic drug. Explain why the effectiveness of this drug may decrease over time and suggest how this could be tested. [4]