

Health, disease and the development of medicines

revision notes

This topic covers what health means, the pathogens that cause communicable disease and how they spread, and how the body defends itself and is helped by immunisation, antibiotics and new medicines. It also covers non-communicable diseases, such as cardiovascular disease, and how lifestyle affects them. Triple only and Higher tier content is flagged.

For Edexcel GCSE Combined Science 1SC0, **Higher tier** is only on the Higher paper.

1 Health and disease Spec 5.1-5.3

What is health? Spec 5.1

Health is not just about being free from illness. The World Health Organization (WHO) defines **health** as a state of complete **physical, mental and social well-being** and not merely the absence of disease or infirmity.

The three parts of health		
Part of health	What it means	Example of it going wrong
Physical	The body is working properly and is free from disease	Having an infection such as tuberculosis
Mental	Being able to think clearly and cope with everyday life	Long-term anxiety or depression
Social	Having good relationships and a place in the community	Being isolated or lonely

Someone can have no disease and still not be healthy by this definition. For example, a person who is physically fit but severely stressed and isolated is not in a state of complete well-being.

Exam tip: If you are asked for the WHO definition, include all three words: physical, mental and social. Missing one can cost you the mark.

Communicable and non-communicable diseases Spec 5.2

A **communicable disease** can be passed from one organism to another. It is caused by a pathogen, so it is also called an infectious disease. Cholera, tuberculosis and malaria are communicable.

A **non-communicable disease** cannot be passed from one person to another. It is not caused by a pathogen. Cardiovascular disease, many cancers and diseases linked to nutrition are non-communicable.

Communicable and non-communicable diseases compared		
	Communicable	Non-communicable
Cause	A pathogen	Not a pathogen; often a mix of several factors
Passed on?	Yes, between people (or animals or plants)	No
Examples	Cholera, tuberculosis, malaria, HIV	Heart disease, lung cancer, liver disease

Common mistake: Do not say that non-communicable diseases are 'not infectious' and leave it there. State that they are not passed on from person to person and are not caused by pathogens.

How one disease can lead to another Spec 5.3

Having one disease can make you more **susceptible** (more likely to catch) other diseases. There are several ways this happens.

- **A weakened immune system.** HIV destroys white blood cells, so the body cannot fight off other pathogens. People with HIV are much more likely to develop infections such as tuberculosis.
- **Damaged barriers.** A disease that damages the skin or the lining of the airways makes it easier for other pathogens to get in.
- **Poor nutrition.** Some diseases make it hard to eat or absorb food. A poorly nourished body makes fewer of the cells and chemicals needed for defence.
- **Mental health.** A long-term physical illness can lead to depression or anxiety. Poor mental health can in turn make physical health worse.

Using data

You may be given a table, graph or **scatter diagram** linking two diseases. A scatter diagram can show a **correlation**: as one variable changes, the other changes too. A correlation does not prove that one disease causes the other. Something else could be responsible for both.

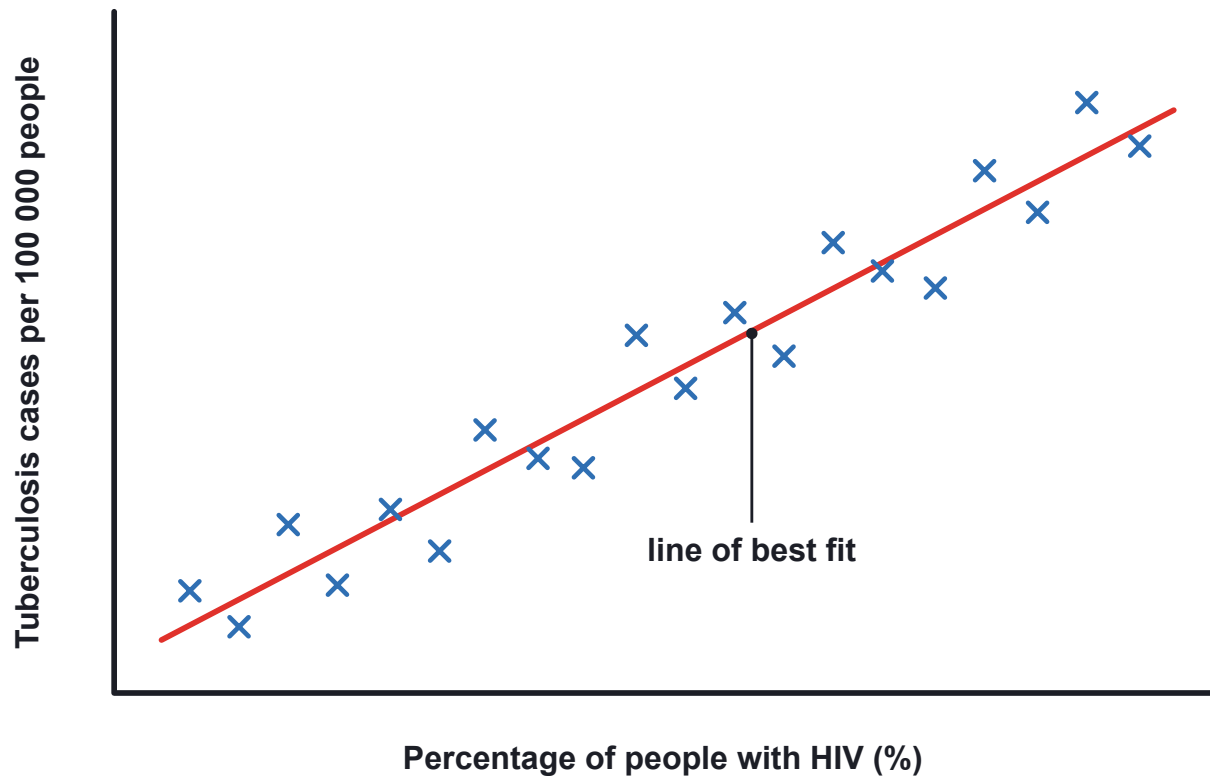
Data from a larger, randomly chosen **sample** is more reliable than data from a small one. Also check that the people sampled are representative of the group the conclusion is about.

Reading a scatter diagram

A scatter diagram shows that in 20 regions, the regions with more people infected with HIV also have more people with tuberculosis. Describe the pattern and state what can be concluded.

1. The points slope upwards from left to right.
2. As HIV infections increase, tuberculosis cases increase, so there is a positive correlation.
3. A correlation does not show cause, but it is consistent with HIV making people more susceptible to tuberculosis.

Answer: Positive correlation between HIV and tuberculosis. It supports, but does not prove, that HIV increases susceptibility to tuberculosis.



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Regions with more HIV also have more tuberculosis: a **positive correlation**, which does not on its own prove cause.

Quick check

1. Give the WHO definition of health.
2. What is the main difference between communicable and non-communicable diseases?
3. Explain why someone with HIV is more likely to get tuberculosis.
4. What does a positive correlation on a scatter diagram show?

2 Pathogens and infections Spec 5.4–5.8

What is a pathogen? Spec 5.4

A **pathogen** is a disease-causing organism. The four types you need to know are **viruses**, **bacteria**, **fungi** and **protists**.

Types of pathogen		
Type	Key facts	Example
Virus	Not a cell; much smaller than bacteria; can only reproduce inside a host cell	HIV
Bacterium	A single-celled organism with no nucleus	Cholera bacterium
Fungus	Includes single-celled and many-celled organisms	Chalara ash dieback fungus
Protist	A single-celled organism with a nucleus	Malaria protist

Exam tip: Link each pathogen type to an example from the spec. Examiners often ask you to name the type of pathogen that causes a named disease.

Common infections Spec 5.5

Infections you need to know		
Disease	Pathogen type	Effect on the host
Cholera	Bacterium	Causes diarrhoea
Tuberculosis	Bacterium	Causes lung damage
Chalara ash dieback	Fungus	Causes leaf loss and bark lesions in ash trees
Malaria	Protist	Causes damage to the blood and liver
HIV	Virus	Destroys white blood cells, leading to the onset of AIDS

Triple only

Triple only infections

Disease	Pathogen type	Effect on the host
Stomach ulcers (<i>Helicobacter</i>)	Bacterium	Causes stomach ulcers
Ebola	Virus	Causes haemorrhagic fever

Triple only

Haemorrhagic fever means a fever with bleeding.

How pathogens spread and how to control them Spec 5.6

To explain how to reduce the spread of a disease, first state how it is spread, then say how that route can be blocked.

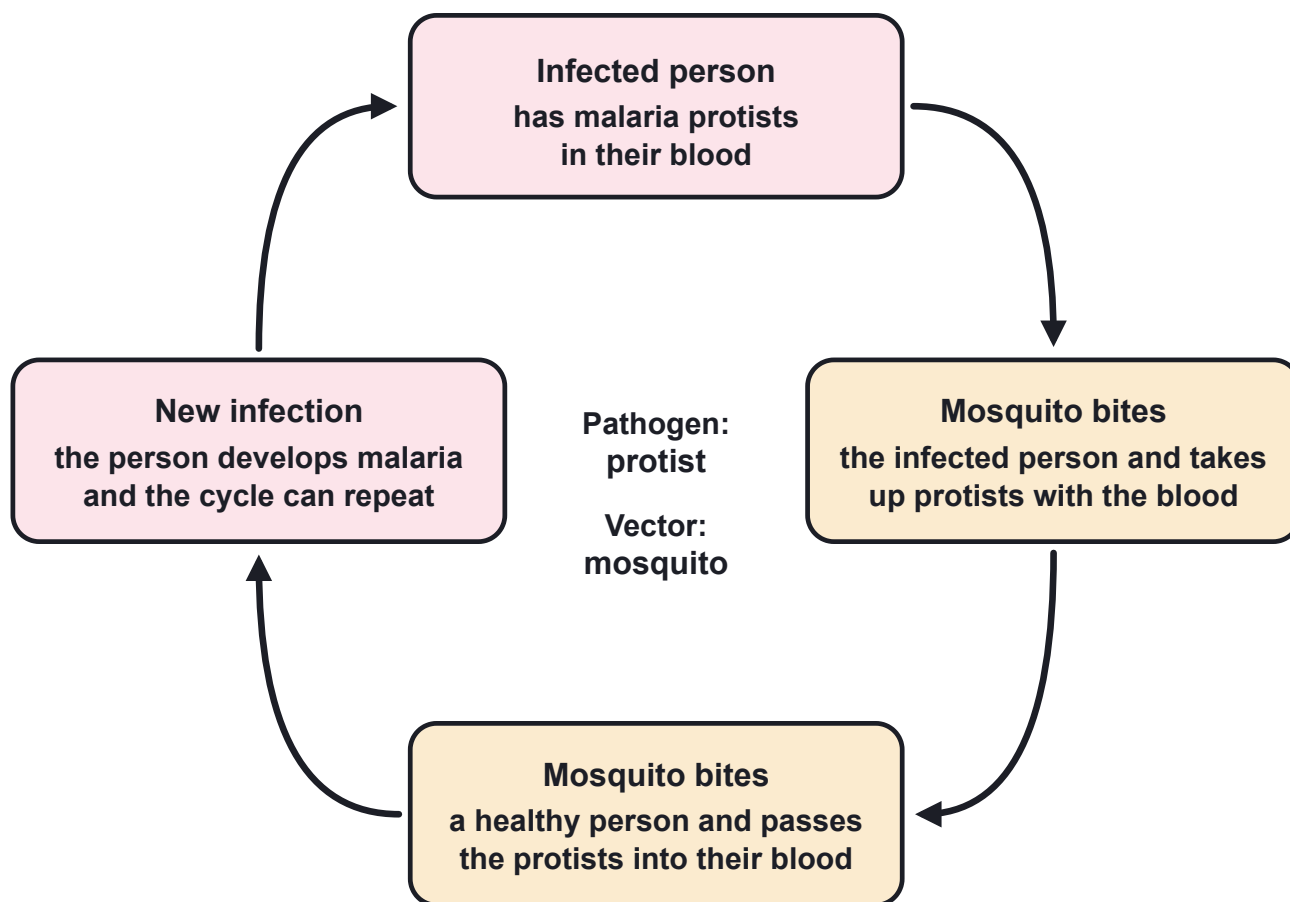
Spread and control of named diseases		
Disease	How it spreads	How spread can be reduced or prevented
Cholera (bacteria)	In water contaminated with sewage containing the bacteria	Provide clean drinking water; treat sewage; wash hands and cook food thoroughly
Tuberculosis (bacteria)	Airborne : droplets from coughs and sneezes	Isolate infected people; cover the mouth when coughing; good ventilation; vaccination
Chalara ash dieback (fungi)	Airborne spores carried by the wind	Destroy infected trees; restrict movement and import of ash plants
Malaria (protists)	By an animal vector: the mosquito, which carries the protist from person to person	Control mosquitoes (drain standing water, use insecticides); mosquito nets; insect repellent

Triple only

Spread and control of Triple only diseases		
Disease	How it spreads	How spread can be reduced or prevented
Stomach ulcers, <i>Helicobacter</i> (bacteria)	Oral transmission : swallowing the bacteria in food, water or from saliva	Good hygiene; handwashing; clean water and food preparation
Ebola (virus)	Contact with infected body fluids	Isolate patients; wear protective clothing; avoid contact with body fluids, including safe handling of bodies

A **vector** is an organism that carries a pathogen from one host to another without usually being harmed itself. The malaria vector is the mosquito. Killing or avoiding the vector breaks the chain.

Common mistake: Mosquitoes do not cause malaria. The protist causes it. The mosquito is only the vector that carries the protist.



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The mosquito is the **vector**: it carries the malaria protist from one person to the next.

Sexually transmitted infections Spec 5.8

Sexually transmitted infections (STIs) are spread by sexual contact. You need two examples: chlamydia and HIV.

Chlamydia and HIV		
	Chlamydia	HIV
Pathogen	Bacterium	Virus
How it spreads	Unprotected sexual contact	Unprotected sexual contact; sharing needles; contact with infected blood; from an infected mother to her baby
Effects	Often no symptoms; can cause infertility	Destroys white blood cells and can lead to AIDS
How spread can be reduced	Use condoms; screening and testing; treating infected people with antibiotics; informing partners	Use condoms; do not share needles; screen donated blood; drug treatment to lower the amount of virus

Condoms act as a **barrier** that stops body fluids passing from one person to another. Using a condom, having fewer partners and being tested regularly all reduce the spread.

Exam tip: A good answer to 'how can the spread of an STI be reduced' names the method and says how it works, for example 'use a condom, which prevents body fluids passing between partners'.

Quick check

- 1 . Name the four types of pathogen.
- 2 . How is cholera spread, and how can its spread be reduced?
- 3 . What is the vector for malaria?
- 4 . Triple only: what happens to the host cell in the lytic pathway?
- 5 . Name a bacterial STI and a viral STI.

3 Human defences and immunity Spec 5.12–5.15B

Physical barriers and chemical defences Spec 5.12

The body has first lines of defence that try to stop pathogens getting in or kill them before they can cause harm.

Human physical barriers and chemical defences		
Defence	Type	How it protects
Skin	Physical barrier	Forms a barrier that pathogens cannot easily pass through
Mucus	Physical barrier	A sticky liquid in the nose and airways that traps pathogens
Cilia	Physical barrier	Tiny hairs on the cells lining the airways that move the trapped mucus up and away from the lungs
Lysozymes	Chemical defence	Enzymes in tears and other secretions that break down the cell walls of bacteria
Hydrochloric acid	Chemical defence	Acid in the stomach that kills pathogens swallowed with food and drink

Common mistake: Cilia do not trap pathogens; mucus does. Cilia move the mucus.

The specific immune system Spec 5.13

If a pathogen gets past the first defences, the **specific immune system** responds. It is called specific because the response is aimed at one particular pathogen.

Antigen	A molecule, usually on the surface of a pathogen, that the immune system recognises as foreign and that triggers an immune response.
Antibody	A protein made by white blood cells (lymphocytes) that binds to a specific antigen.
Memory lymphocyte	A white blood cell that stays in the body after an infection and can respond quickly if the same antigen returns.

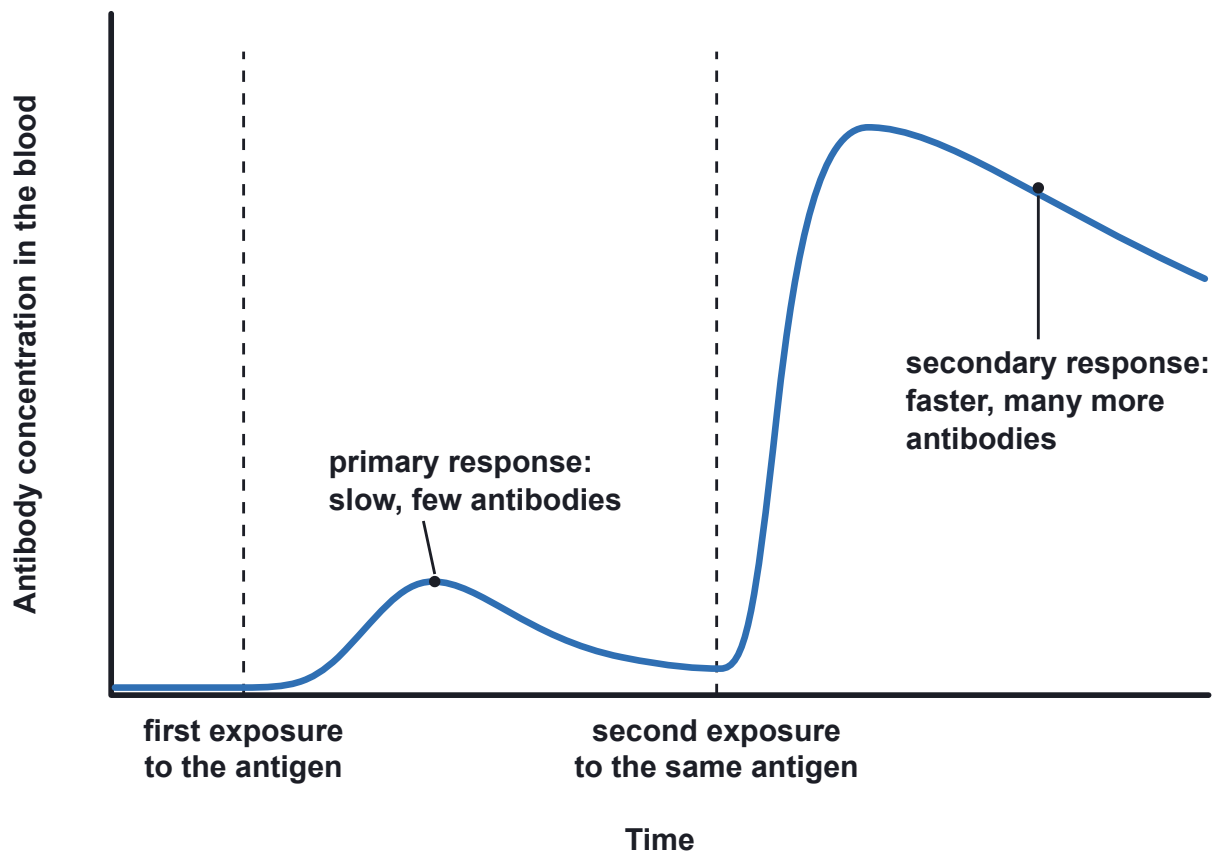
The primary response

1. The body is exposed to a pathogen.
2. The **antigens** on the pathogen trigger an immune response.
3. Lymphocytes with antibodies that fit the antigen divide, and the response causes the production of **antibodies**.
4. The antibodies bind to the antigens on the pathogen and help to destroy it.
5. The antigens also trigger production of **memory lymphocytes**.

The secondary response

If the same pathogen enters the body again, the memory lymphocytes recognise its antigens. They respond **faster** and make more antibodies than the first time, so the pathogen is destroyed before it can make the person ill. The person is now immune to that pathogen.

Exam tip: For the secondary response, write three things: it is quicker, more antibodies are made, and memory lymphocytes are responsible.



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Memory lymphocytes make the **secondary response** faster and bigger than the primary response.

Immunisation Spec 5.14

Immunisation gives protection from a disease without having to catch it. A person is given an **inactive** form of the pathogen, for example a dead or weakened one, usually by injection.

1. The inactive pathogen is put into the body. It cannot cause the disease, but its antigens are still present.
2. The antigens trigger an immune response and antibodies are made.
3. Memory lymphocytes are produced.
4. If the live pathogen enters later, the memory lymphocytes carry out a fast secondary response. Large numbers of antibodies are made quickly and the person does not become ill.

Immunisation and the immune response		
	Natural infection	After immunisation
Pathogen present	Live pathogen	Inactive pathogen, which cannot cause the disease
Memory lymphocytes made?	Yes	Yes
Person becomes ill?	Yes, during the first (primary) response	No

Doctors sometimes give a second injection, called a booster, to increase the number of memory lymphocytes made.

Common mistake: Immunisation does not put antibodies into the body. It makes your own body produce antibodies and memory lymphocytes.

Quick check

- 1 . Name two physical barriers in the human body.
- 2 . What do lysozymes do?
- 3 . What is an antigen?
- 4 . Why is the secondary response better than the primary response?
- 5 . Triple only: what is herd immunity?

4 Antibiotics, culturing microorganisms and new medicines

Spec 5.16–5.22B

Antibiotics Spec 5.16

Antibiotics are medicines that treat bacterial infections. They work by **inhibiting cell processes** in the bacterium. They do not harm the host organism's own cells, because the host's cells work differently.

Antibiotics can **only** be used to treat bacterial infections. Viruses are not cells. They live and reproduce inside host cells, so the cell processes that antibiotics inhibit are not present in a virus. Antibiotics therefore do not work on viral diseases such as HIV or Ebola.

Common mistake: Antibiotics do not 'kill viruses', and they cannot treat a cold or flu. State that they act on processes in bacterial cells but not host cells.

Developing new medicines Spec 5.20

Developing a new medicine, including a new antibiotic, takes many stages. Each stage checks that the medicine is safe and that it works.

1. **Discovery**: finding a chemical that might treat the disease. These may come from natural sources, such as plants or microorganisms, or be designed in a laboratory.
2. **Development**: the chemical is studied and improved, and a way to make it as a medicine is worked out.
3. **Preclinical testing**: the medicine is tested in the laboratory on cells and tissues, and then on live animals, to find out if it is toxic and whether it works.
4. **Clinical testing**: the medicine is tested on people. It is first given to a small number of healthy volunteers to check it is safe, then to patients to check that it works and to find the right dose.

Only a medicine that passes all the stages can be used to treat patients. The testing protects people from harmful or ineffective medicines.

Exam tip: Learn the four stages in order: discovery, development, preclinical, clinical. Preclinical comes before any testing on humans.

Quick check

1. Why can antibiotics not be used to treat viral infections?
2. Triple only: why is an inoculating loop heated in a flame before use?
3. Triple only: in the core practical, what does a larger clear zone show?
4. Name the four stages in developing a new medicine in order.
5. Triple only, Higher tier: what is a hybridoma cell?

5 Non-communicable diseases Spec 5.23-5.25

Causes of non-communicable diseases Spec 5.23

Many non-communicable diseases are caused by the **interaction of a number of factors**. No single factor usually explains why one person gets the disease and another does not.

Non-communicable diseases and some linked factors	
Type of disease	Examples of factors involved
Cardiovascular disease	Diet, lack of exercise, smoking, alcohol, inherited factors
Many forms of cancer	Smoking, harmful radiation, certain chemicals, inherited factors
Some lung diseases	Smoking, air pollution
Some liver diseases	Drinking too much alcohol
Diseases influenced by nutrition	Too much or too little of certain foods; obesity and malnutrition

Factors can be **lifestyle** (what a person chooses to do), **environmental** (what a person is exposed to) or **inherited** (passed on in genes). Having several of these together increases the chance of disease more than having one alone.

Lifestyle factors and non-communicable diseases Spec 5.24

Lifestyle choices affect the risk of non-communicable diseases. Their effects are seen at three levels.

Effects at different levels		
Level	What it means	Example
Local	A community, town or region	Local access to affordable healthy food and sports facilities affects obesity rates
National	A whole country	The cost to a country's health service of treating cardiovascular disease; government campaigns
Global	Around the world	Obesity and malnutrition are both found around the world; the WHO monitors and responds to them

Exercise and diet: obesity and malnutrition

Malnutrition is a diet that does not contain the right balance of nutrients. It can mean too little food or too much. **Obesity** is having too much body fat, often because energy taken in from food is greater than energy used in exercise. Obesity increases the risk of cardiovascular disease and other diseases influenced by nutrition. Regular exercise and a balanced diet reduce the risk.

Two measurements are used to assess body size:

$$\text{BMI} = \text{mass (kg)} \div \text{height (m)}^2$$

$$\text{waist : hip ratio} = \text{waist circumference} \div \text{hip circumference}$$

A high BMI suggests a person is overweight or obese. A high waist : hip ratio means more fat is stored around the waist, which is linked to a higher risk of cardiovascular disease. You will be given the values to compare with.

Calculating BMI

A person has a mass of 72 kg and a height of 1.80 m. Calculate their BMI.

1. $\text{height}^2 = 1.80 \times 1.80 = 3.24 \text{ m}^2$
2. $\text{BMI} = \text{mass} \div \text{height}^2 = 72 \div 3.24$
3. $\text{BMI} = 22.2$

Answer: BMI = 22.2 (to 1 decimal place)

Calculating waist : hip ratio

A woman has a waist circumference of 81 cm and a hip circumference of 90 cm. Calculate her waist : hip ratio.

1. $\text{waist : hip ratio} = \text{waist circumference} \div \text{hip circumference}$
2. $= 81 \div 90$
3. $= 0.90$

Answer: 0.90 (a ratio has no units, as long as both measurements are in the same unit)

Maths skill: Square the height before dividing. Dividing by the height without squaring gives a much larger answer than the real BMI.

Alcohol and liver disease

The liver breaks down alcohol. Drinking too much over a long time damages liver cells and can cause liver diseases such as a fatty liver, inflammation and scarring (cirrhosis), which can lead to liver failure.

Smoking and cardiovascular disease

Chemicals in tobacco smoke damage the lining of arteries, which increases the build-up of fatty deposits and narrows the arteries. Nicotine also increases heart rate and blood pressure. Together this increases the risk of cardiovascular disease. Smoking is also a risk factor for lung diseases and lung cancer.

Exam tip: A correlation between a lifestyle factor and a disease does not prove that one causes the other. A large sample and a mechanism that explains the link make a causal link more likely.

Treating cardiovascular disease Spec 5.25

Cardiovascular disease is disease of the heart or blood vessels. In an evaluate question you must give advantages and disadvantages of each treatment, then reach a conclusion.

Evaluating treatments

Treatment	Advantages	Disadvantages
Life-long medication , for example statins to lower cholesterol, or drugs that lower blood pressure or stop blood clotting	Reduces risk; no operation needed; can be effective for many years	Must be taken every day for life; possible side effects; ongoing cost; may be forgotten
Surgical procedures , for example stents, bypass surgery, valve replacement or a heart transplant	Can quickly restore blood flow or heart function; effective for serious cases	Risks of surgery such as infection and bleeding; recovery time; cost; a transplant needs a donor and may be rejected
Lifestyle changes , such as stopping smoking, eating a balanced diet and exercising	Cheap; no side effects; also reduces the risk of other diseases	Needs long-term effort; results take time; not enough alone for severe disease

The best choice depends on the patient. Lifestyle changes are suitable for most people to reduce risk. Medication is used to manage existing disease. Surgery is usually used when disease is severe or has caused a blockage.

Exam tip: To get full marks on an evaluate question, finish with a justified conclusion, such as which treatment you would recommend for a particular patient and why.

Quick check

1. What does it mean that many non-communicable diseases are caused by an interaction of factors?
2. Write the BMI equation.
3. How does smoking increase the risk of cardiovascular disease?
4. Which disease is linked to drinking too much alcohol?
5. Give one advantage and one disadvantage of life-long medication.

Quick check answers

Health and disease

1. A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.
2. Communicable diseases are caused by pathogens and can be passed on; non-communicable diseases cannot be passed on.
3. HIV destroys white blood cells, so the immune system is weakened and cannot fight off other pathogens.
4. As one variable increases, the other also increases.

Pathogens and infections

1. Viruses, bacteria, fungi and protists.
2. Through contaminated water; provide clean water and treat sewage.
3. The mosquito.
4. It bursts open (lyses), releasing new viruses.
5. Chlamydia (bacterial) and HIV (viral).

Human defences and immunity

1. Any two of: skin, mucus, cilia.
2. They are enzymes that break down the cell walls of bacteria.
3. A molecule, usually on the surface of a pathogen, that triggers an immune response.
4. Memory lymphocytes make it faster and produce more antibodies.
5. When a large proportion of the population is immune, so the pathogen cannot spread easily and non-immune people are protected.

Antibiotics, culturing microorganisms and new medicines

1. Antibiotics inhibit cell processes in bacteria; viruses are not cells and reproduce inside host cells.
2. To sterilise it by killing any microorganisms on it.
3. The substance is more effective at stopping bacteria growing.
4. Discovery, development, preclinical testing, clinical testing.
5. A cell made by fusing an antibody-producing lymphocyte with a tumour cell; it divides and produces antibodies.

Non-communicable diseases

1. Several factors, such as lifestyle, environmental and inherited factors, act together to cause the disease, rather than one factor alone.
2. $BMI = \text{mass (kg)} \div \text{height (m)}^2$
3. It damages artery linings, so fatty deposits build up and arteries narrow; nicotine raises heart rate and blood pressure.
4. Liver disease, for example cirrhosis.
5. It reduces risk without surgery; it must be taken for life and may have side effects.