GCSE Biology

Edexcel Topic 5 – Health, disease and the development of medicines.

Overview

Health, disease and the development of medicines.

Health and disease

- Definition of health
- Difference between communicable and non-communicable diseases
- Common infections, pathogens and how they are spread
- Lifecycle of a virus

Plant disease

- Plant defence mechanisms
- Detection and identification of plant diseases (Higher Tier)

Human body defence responses

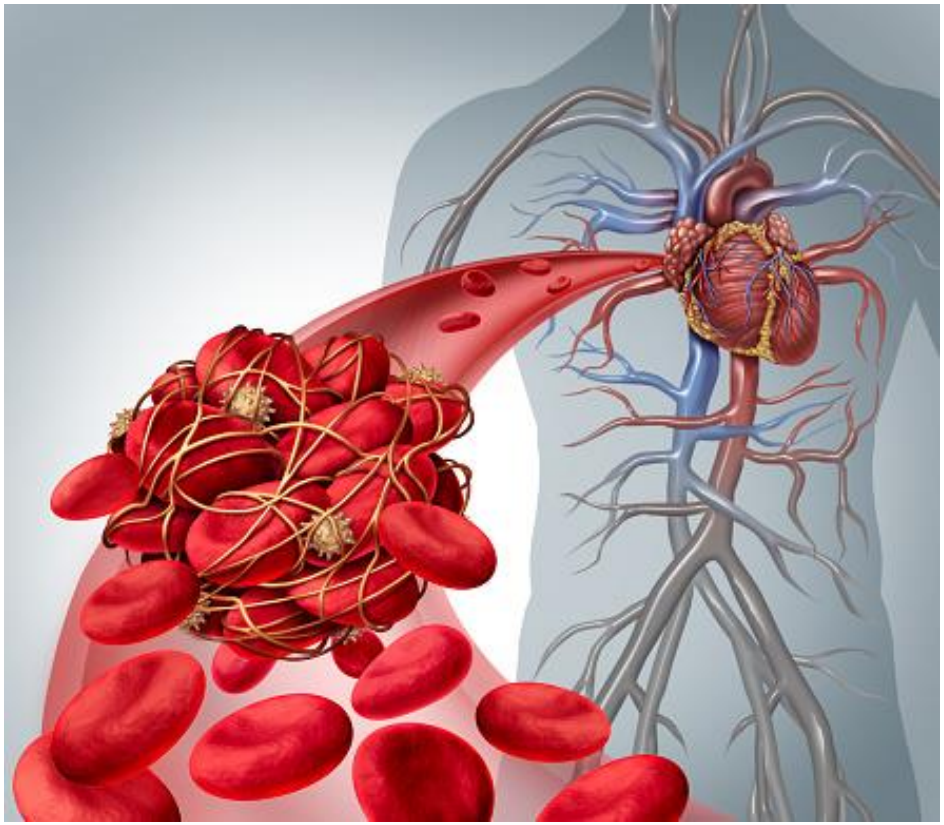
- Physical barriers and chemical defences
- Role of the specific immune system
- Immunisation
- Antibiotics
- Culturing microorganisms

Development of new medicines

- Production and use of monoclonal antibodies

Effect of lifestyle

- Exercise, diet and BMI
- Alcohol on liver disease
- Smoking on cardio vascular disease
- Evaluation of treatments for cardiovascular disease



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Health and Disease
Part 1 (5.1 – 5.8)

- Definition of health
- Difference between communicable and non-communicable diseases
- Common infections, pathogens and how they are spread
- Lifecycle of a virus (biology)

The World Health Organisation definition:

Health is a state of complete **physical**, **mental** and **social well-being** and not merely the absence of disease or infirmity.

Disease can be:

- **Communicable** – these are **infectious** diseases caused by viruses, bacteria, protists and fungi and are **spread** in animals (and plants) e.g. malaria, measles, athletes foot
- **Non-communicable** – these diseases are not caused by **infection** and cannot be **spread** e.g. heart disease, diabetes, Alzheimer's, asthma

Different **types of disease** may **interact** (work together) to make a person more **susceptible** to other diseases.

- **Defects in the immune system** mean that an individual is more likely to suffer from infectious diseases
- **Viruses** living in cells can be the trigger for cancers to form
- **Immune reactions** initially caused by a pathogen can trigger allergies such as skin rashes and asthma
- **Severe physical ill health** can lead to depression and other mental illness

Pathogens are **micro organisms** that cause **infectious disease.**

Pathogens may **infect** **plants or animals** and can be **spread** by **direct contact** or **indirect contact.** Indirect contact happens when microorganisms are **carried** to the person by **water** or by **air** or by **animal vectors.**

Pathogens **depend** on the **host** to provide the suitable **conditions and nutrients** that they need to **grow and reproduce.**

Pathogens can be **bacteria, viruses, fungi** or **protists.**

Viral diseases

- **Viruses may reproduce rapidly**
- **Viruses live and reproduce inside cells causing damage**

Bacterial diseases

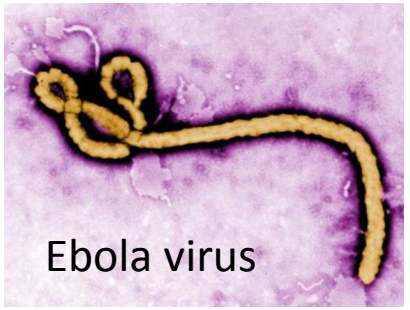
- **Bacteria may reproduce rapidly**
- **Bacteria may produce toxins that damage tissues and make us feel ill**

Pathogens may **infect** **plants or animals** and can be **spread** by **direct contact (D), by water (W)** or **by air (A)**or **animal vectors (V).**

Examples of Viral Diseases

HIV (human immunodeficiency virus)

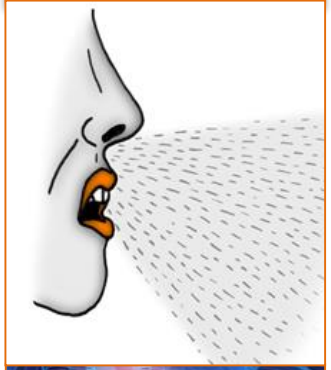
- HIV is a sexually transmitted infection (STI)
- Initially causes a **flu-like** illness and spread by **sexual contact** or exchange of body fluids such as blood when drug users share needles.
- Unless HIV is successfully controlled with **antiretroviral** drugs, the virus will destroy white blood cells leading to the onset of AIDS.
- Late stage HIV or **AIDS** occurs when the body's immune system can no longer deal with other infections or cancers.


Ebola virus

Ebola virus (biology only)

- People are infected when they have **direct contact** through broken skin with the **bodily fluids** of a person with Ebola.
- Initial symptoms of Ebola include fever and joint pain.
- The symptoms develop into **haemorrhagic fever** which includes **internal** and **external bleeding** causing multiple organ failure.

Examples of Bacterial Diseases



Cholera

- Cholera is a disease which is spread via contaminated drinking water.
- Cholera causes diarrhoea and can kill if left untreated.
- Cholera is often a consequence of a humanitarian crisis.
- Clean drinking water and good sanitation reduces the spread of cholera.

Tuberculosis

- Tuberculosis (TB) bacteria are spread through the air in tiny droplets when an infected person sneezes or coughs.
- It can cause lung damage.
- A vaccination programme is in place to reduce the spread.

Helicobacter (biology only)

- The presence of Helicobacter has been found to be a contributory factor in development of **stomach ulcers**.
- It is transmitted **orally** through saliva.
- To **reduce the spread**: do not share food / cutlery or cups, avoid saliva exchange with an infected person.

Example of a Fungal Disease

Chalara ash dieback

- Chalara causes **leaf loss** and **lesions** in the bark. Trees usually die from the infection or become weakened to attacks by other pests or pathogens.
- There is **no cure** known for this disease.
- Chalara ash dieback is spread through **airborne** transmission of **fungal spores**.
- Infected **leaves fall** to the ground during autumn and spores are carried on the **wind** and deposited on healthy ash trees.

To **reduce the spread** of the pathogen:
✓**Clean** machinery, tools, vehicles and footwear when moving between sites.
✓ **Burn or compost** infected leaves on site.
✓ Warn all land users so they can also **take precautions**.

Example of a Protist Disease

Malaria

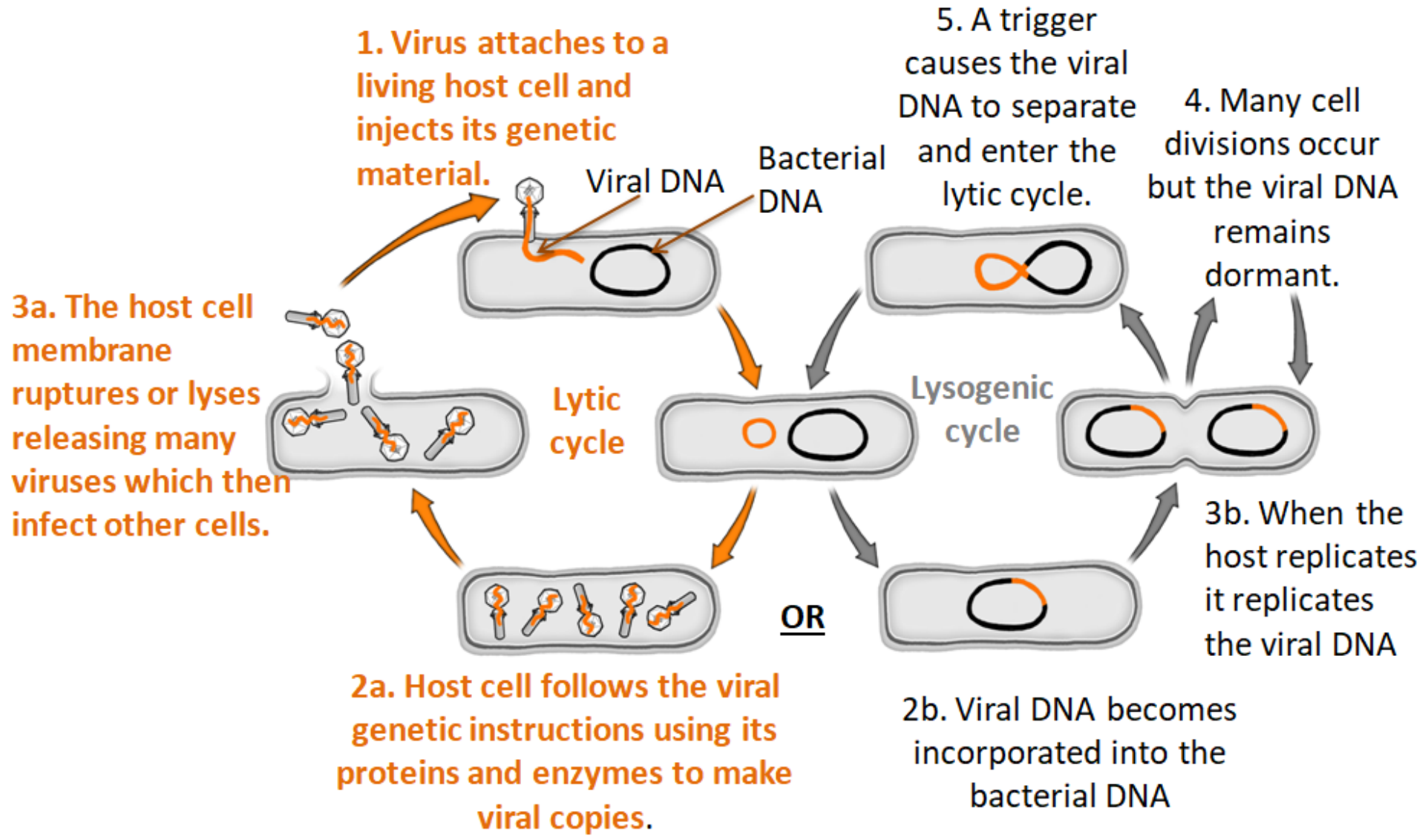
- The malaria causing **protist** is spread by **mosquitoes** feeding on infected blood and then biting a human.
- Mosquitoes are animal **vectors** as they pass on malaria but do not suffer themselves.
- Malaria causes damage to blood and the liver. It **can be fatal**.
- Control the **spread** by preventing mosquitoes **breeding** and use mosquito **nets** to avoid being bitten.

Health, disease and the development of medicines part 1- Health and disease

Disease	Symptom	Method of transmission	Control spread of disease by:	Caused by:
Malaria	Recurrent fever	Animal vector	Preventing breeding of mosquitoes or use of a net to prevent being bitten.	Protist
Chalara ash dieback	Leaf loss and bark lesions	Airborne	Remove infected leaf litter. Clean all tools, vehicles and footwear.	Fungus
Cholera	Diarrhoea	Waterborne	Clean drinking water and good hygiene and sanitation.	Bacteria
Tuberculosis	Lung damage	Airborne	Vaccination programme. Treat infection with antibiotics.	Bacteria
HIV	Flu like illness	Sexual contact or bodily fluids. Direct contact.	Use of condoms / clean needles. Treat infection with antiretroviral drugs.	Virus
Ebola *(biology only)*	Haemorrhagic fever	Bodily fluid - direct contact	Avoid contact with people infected with Ebola.	Virus

Health, disease and the development of medicines part 1- Lifecycle of a virus (Biology)

Viruses are not living organisms and cannot reproduce without a host cell.



Health, disease and the development of medicines part 1- Health and disease

Sexually transmitted infections (STI) are passed from one person to another through **unprotected sex** or **genital contact**. **HIV** is an STI which is spread via infected **bodily fluids**. Spread can be reduced by wearing a **condom**, not sharing needles if a drug user and use of medication to prevent an infected person passing on the STI to another e.g. a mother to her unborn child.

Chlamydia is the most common STI in the UK. It is a **bacterial** infection. The bacteria are spread through infected **bodily fluids**. To **reduce** the chance of catching Chlamydia, people should use **barrier methods of contraception** such as a condom.

Most people have no symptoms and so do not know they are infected. In **women**, Chlamydia can cause **pain** or a **burning sensation** when **urinating**, vaginal **discharge**, **pain** in the lower abdomen and **heavy periods**.

In **men**, Chlamydia can cause pain or a **burning sensation** when **urinating**, a **discharge** from the tip of the penis and **pain** in the **testicles**.

Chlamydia can be **detected** using a **urine test** or a **swab** of the affected area. It can be **treated with antibiotics**. Chlamydia can be passed by an infected pregnant woman to her unborn baby.

If left **untreated**, Chlamydia can cause **long term health problems** and infertility.

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QuestionIT!

Health and disease Part 1

- Definition of health
- Difference between communicable and non-communicable diseases
- Common infections, pathogens and how they are spread
- Lifecycle of a virus (biology)

1. Complete the table by filling in the missing information.

Disease	Symptom	Method of transmission	Control spread of disease by:	Caused by:
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Cholera	Diarrhoea	Waterborne		Bacteria
HIV	Flu like illness			Virus
Ebola (biology only)	Haemorrhagic fever	Bodily fluid - direct contact		

Health, disease and the development of medicines part 1 – **QuestionIT**

2. Define the word health.

3. What are communicable diseases?

4. What are non-communicable diseases?

5. What does the term ‘susceptible to other diseases’ mean?

6. What is the definition of a pathogen?

7. How can the spread of Chlamydia be reduced?

8. What disease does HIV cause eventually if it is not successfully managed?

9. What type of pathogen causes Chlamydia?

Health, disease and the development of medicines part 1– QuestionIT

Biology Only

10. What are the two pathways involved in the lifecycle of a virus?

11. Which pathway involves the assimilation of lots of new active viral particles?

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AnswerIT!

Health and disease
Part 1

- Definition of health
- Difference between communicable and non-communicable diseases
- Common infections, pathogens and how they are spread
- Lifecycle of a virus (biology)

1. Complete the table by filling in the missing information.

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Chalara ash dieback	Leaf loss and bark lesions	Airborne	**Remove infected leaf litter. Clean all tools, vehicles and footwear.**	Fungus
Cholera	Diarrhoea	Waterborne	**Clean drinking water and good hygiene and sanitation.**	Bacteria
HIV	Flu like illness	**Sexual contact or bodily fluids. Direct contact.**	**Use of condoms / clean needles. Treat infection with antiretroviral drugs.**	Virus
Ebola	Haemorrhagic fever	Bodily fluid - direct contact	**Avoid contact with people infected with Ebola.**	**Virus**

Animal tissues, organs and organ systems Part 3 – AnswerIT

2. Define the word health. **A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.**

3. What are communicable diseases? **Infectious diseases caused by microbes that can be spread.**

4. What are non-communicable diseases? **Diseases not caused by infections and cannot be spread.**

5. What does the term 'susceptible to other diseases' mean**? An increased likelihood of developing other diseases.**

6. What is the definition of a pathogen? **A disease causing organism including bacteria, viruses, fungi and protists.**

7. How can the spread of Chlamydia be reduced? **Wearing a condom, being tested to see if a person has the disease and can be treated or avoiding sex.**

8. What disease does HIV cause eventually if it is not successfully managed? **AIDS**

9. What type of pathogen causes Chlamydia? **Bacterium**

Animal tissues, organs and organ systems Part 3 – QuestionIT

Biology Only

10. What are the two pathways involved in the lifecycle of a virus?

Lytic

Lysogenic

11. Which pathway involves the assimilation of lots of new active viral particles?

Lytic

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Plant disease

Part 2 (5.9B- 5.11B)

- Plant defence mechanisms (biology)
- Detection and identification of plant diseases (biology higher Tier)

Health, disease and the development of medicines part 2-Plant disease (Biology)

video

Plants have several ways of defending themselves from pathogens and to deter herbivores.

Physical

Bark, thick waxy **cuticles**, tough **cellulose cell walls** **defend** the plant from **pathogen entry.**

Mechanical

Touch can make Mimosa leaves suddenly curl which **frightens** animals.

Chemical

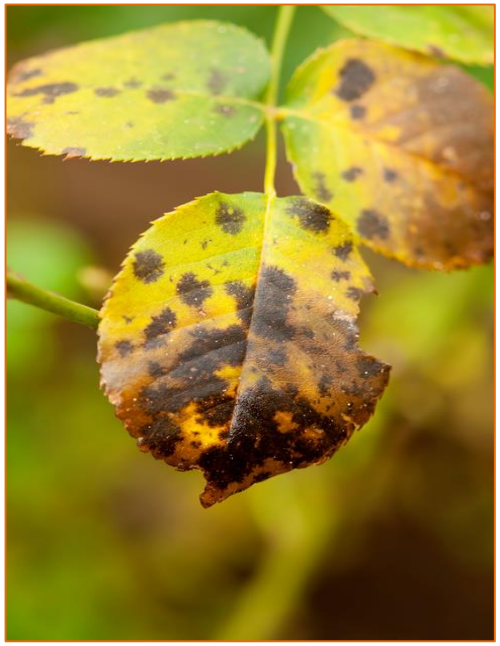
Antibacterial and other **toxic** chemicals come from plants e.g. menthol from mint, digoxin from foxgloves, aspirin from willow. **Humans** use these to **treat disease** and **relieve symptoms.**

Mechanical

Thorns make plants **painful** if eaten by herbivores.

Plants suffer from a range of infections caused by pathogens or insect pests. We can **detect** a plant is **diseased** by **observing** these visible signs in the field:

Unusual **growths**



Spots or discoloured leaves

Malformed leaves or stems

Health, disease and the development of medicines part 2-Plant disease (Biology Higher tier)

The presence of **pests**

Stunted growth

Areas of **decay** (rot)

If a plant disease is suspected then it may be **identified** using:

- ✓Gardening manuals
- ✓Gardening websites
- ✓ Test kits containing **monoclonal antibodies**
- ✓Taking infected plants to a **laboratory** to identify the pathogen

Health, disease and the development of medicines part 2-Plant disease (Biology Higher tier)

Plants can often **appear** to be **diseased** because they look unhealthy e.g. yellow leaves, stunted growth.
This can be **due to environmental causes** such as ion deficiencies in the soil that the plants have been grown in.

Nitrate ions = healthy growth

Lack of nitrate = stunted growth

Magnesium = healthy chlorophyll

Lack of magnesium = chlorosis (yellowing of leaves due to lack of chlorophyll)

Health, disease and the development of medicines part 2-Plant disease (Biology Higher tier)

Pathogens can be spread in different ways.

A scientist specialising in plant disease is called a **plant pathologist**.

Plant pathologists analyse the **distribution** of **plants with a disease** to identify the likely pathogen.

Air borne pathogens often cause a **random** distribution of diseased plants.

If plants in a very **localised** area have become diseased, then the **pathogen** responsible is more likely to be found in the **soil**.

When a plant is infected by a pathogen, the **pathogen's DNA** can be identified from plant tissue samples sent for **diagnostic testing** in the laboratory.

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QuestionIT!

Plant disease

Part 2 (5.9B- 5.11B)

- Plant defence mechanisms (Biology only)
- Detection and identification of plant diseases (Biology higher tier only)

1. List three ways a plant can defend itself against the attack of pests and pathogens.

2. Name two chemicals produced by plants which humans can use to relieve disease symptoms.

Higher tier

3. What information might a distributional analysis of a plant disease produce?

4. List two other ways plant diseases can be identified.

5. What ion is needed for healthy growth in plants?

6. If a plant had yellow leaves what mineral ion is likely to be absent?

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AnswerIT!

Plant disease
Part 2

- Plant defence mechanisms (Biology only)
- Detection and identification of plant diseases (Biology higher tier only)

Plant disease (Biology) – AnswerIT

1. List three ways a plant can defend itself against the attack of pests and pathogens.

   Thick cell wall
   Thick leaf cuticle
   Producing chemicals
   Prickly spines

2. Name two chemicals produced by plants which humans can use to relieve disease symptoms.

   Aspirin
   Digoxin
   Menthol

Higher Tier

3. What information might a distributional analysis of a plant disease produce?

   The pattern of plants which have become diseased may indicate if the pathogen is air borne or in the soil.

Plant disease (Higher tier biology)– AnswerIT

4. List two other ways plant diseases can be identified.

Visible symptoms

Diagnostic testing

5. What ion is needed for healthy growth in plants?

Nitrate

6. If a plant had yellow leaves what mineral ion is likely to be absent?

Magnesium

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Human body defence responses.
Part 3 (5.12- 5.19B)

- Physical barriers and chemical defences
- Role of the specific immune system
- Immunisation
- Antibiotics
- Culturing microorganisms (biology)

Health, disease and the development of medicines part 3 – Human body defence responses

The human body has several **non specific** ways of defending itself from pathogens getting in.

nose

Physical barriers

Nasal hairs, sticky **mucus** and **cilia** prevent pathogens entering through the nostrils.

stomach

Chemical defence

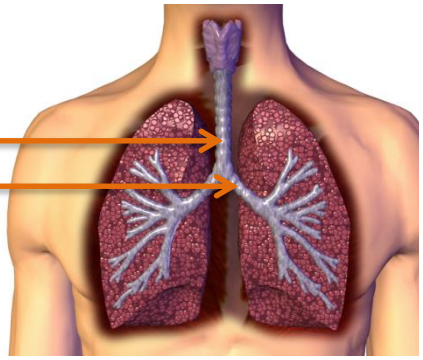
Hydrochloric acid (pH1) kills most ingested pathogens.

Chemical defence

Tears, saliva and mucus contain an **enzyme** called **lysozyme** which destroys microorganisms.

trachea / bronchus

[video]

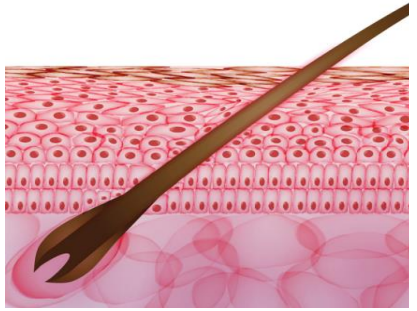


Physical barriers

Respiratory system is lined with **mucus** to trap dust and pathogens. **Cilia** move the mucus upwards to be **swallowed**.

skin

Physical barriers



Hard to **penetrate** **waterproof** barrier. **Glands** secrete **oil** which kill microbes.

The **specific immune system** defends the human body against disease by:

Detection

- The body is **exposed** to the pathogen which enters the body. **Antigens** (foreign proteins on the surface of the pathogen) are **detected** by the immune system.

Activation

- The antigens **trigger** an **immune response** which causes the **lymphocytes** to produce **specific antibodies** which destroy the pathogens.

Memory

- The antigen triggers the production of **memory lymphocytes**. If the body is **re-infected** with the **same pathogen** the memory lymphocytes respond by producing **antibodies** much more **rapidly**. This is called the **secondary response** to the antigen.

Health, disease and the development of medicines part 3 – Human body defence responses

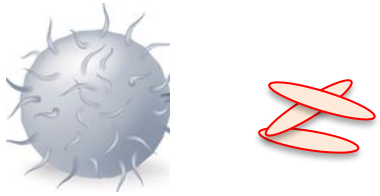
Communicable diseases can be dangerous leading to epidemics or pandemics. **Vaccination** can be used to **enhance** the immune system and reduce the chances of this happening. A vaccine contains a small amount of **dead or inactive** form of the pathogen that can be introduced into the body and cause an immune response.

Lymphocyte

pathogen

White blood cells detect inactive pathogens from the vaccine. → Antibodies are released into the blood. → Pathogens are destroyed by antibodies.

If the body becomes **re-infected** with the same pathogen then the white blood cells are prepared.
The white blood cells can respond much more **quickly** and make **more** of the right type of **antibodies** much more quickly.



White blood cells detect pathogens.

Antibodies are made and released into the blood much faster and in larger amounts.

Pathogens are destroyed by the antibodies much faster.

This means that the person is **unlikely to suffer** the symptoms of the harmful disease.
Infection has been prevented by **enhancing** the immune system.

Health, disease and the development of medicines part 3 – Vaccinations (biology)

Advantages of vaccinations:

- The **chances of falling ill** or dying from a disease might be far **greater** than the chance of experiencing a **side effect**.
- Vaccination is **cheaper** than treating a seriously ill person.
- When fewer people are vaccinated the number of cases of the disease increases.
- If enough people in a community are vaccinated against a pathogen it makes it **difficult** for the disease to **spread** because there are so few susceptible people left to infect.
- This is called **herd immunity**. It is crucial for **protecting** people who cannot be vaccinated such as very **young** children, people with **immune system problems** and those who **are too ill** such as cancer patients.

Disadvantages of vaccinations:

- There are risks that come with vaccinations. Some people have **side effects**.
- People do not like having vaccinations.

Immunisation means that a person has become **resistant** to a pathogen. Immunisation can be a result of **natural** exposure to a pathogen or **artificial** by being given a vaccination containing the pathogen. These both require the **body** to react by **producing antibodies** and so are called **active** immunity. **Passive** immunity can also occur when a **baby receives antibodies** in the mothers **milk** or when an injection contains antibodies.

Health, disease and the development of medicines part 3 – Antibiotics

An **antibiotic** is a drug that helps to cure a bacterial disease by only **inhibiting cell processes** in the infective bacteria **inside** the body, without affecting the host organism.

Different bacterial infections need a **different** antibiotic.

Antibiotics **cannot** be used to **treat viral** pathogens.

Penicillin is a well known antibiotic medicine.

Using antibiotics has greatly **reduced** deaths.

It is difficult to develop **drugs** to kill **viruses** without harming body tissues because viruses live and reproduce inside cells.

A doctor will **not prescribe** antibiotics for a **viral infection** as they do not work.

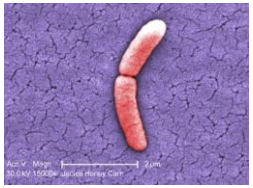
Antibiotics can only be used for **bacterial infections**

Painkillers, steroids or anti inflammatory medicines can be used to **relieve** the **symptoms** of viral infections. Symptoms may include: fever, muscle ache, headache or a runny nose.

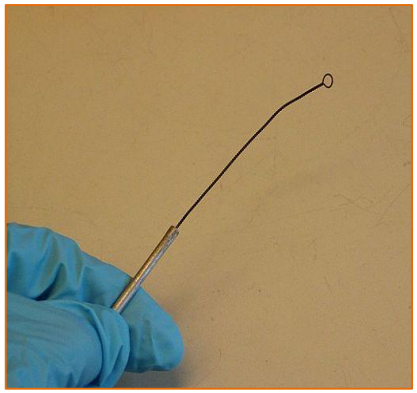
Painkillers **do not** kill pathogens.

Health, disease and the development of medicines part 3 – Culturing microorganisms (Biology)

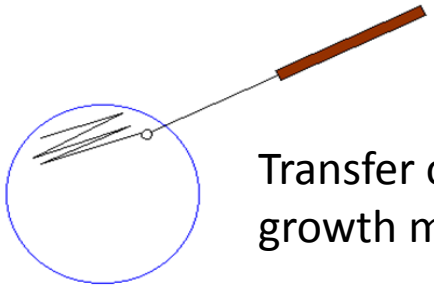
Bacteria multiply by binary fission (a type of cell division where two identical cells are formed). In the right conditions, cells can divide as often as every 20 minutes.



An autoclave



An inoculating loop



Transfer of bacteria to the growth medium

Bacteria can be grown in the lab using <u>aseptic (sterile)</u> techniques.

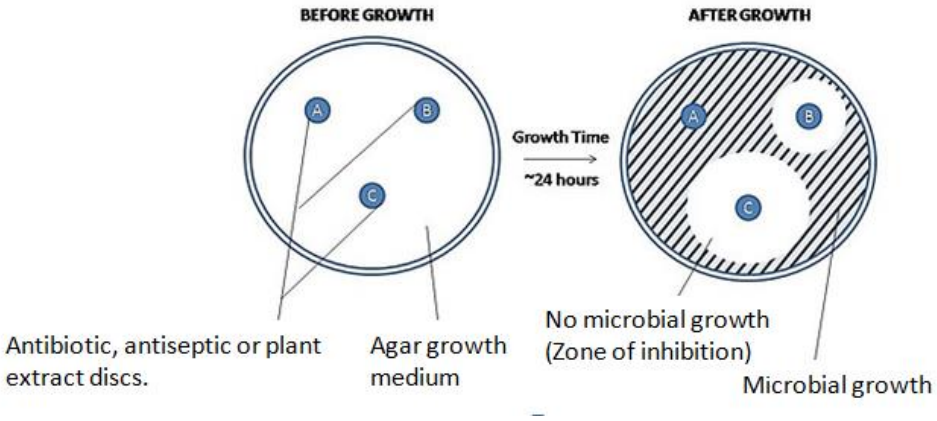
- A **growth medium (agar)** used containing an *energy* source (carbohydrate) and minerals.
- Petri dishes and agar must be **sterilised in an autoclave before use to kill microorganisms.**
- **Inoculating loops** used to transfer bacteria after being heated in a Bunsen flame to **sterilise** them.
- The lid of the Petri dish should be **sealed** with **tape to stop other microorganisms** getting in (must **not be fully sealed so oxygen** can get in). All Petri dishes and vials must be **kept covered** when not in use to reduce the risk of contamination.
- In school, Petri dishes are **incubated at 25°C to reduce risk** of growth of **pathogens** that might be **harmful.**

Health, disease and the development of medicines part 3 – Culturing microorganisms (biology)

Core practical : Effectiveness of antiseptics, antibiotics or plant extracts on microbial cultures experiment.

- Use **aseptic** techniques.
- **Sterile** agar **growth medium** inoculated with **microorganisms**.
- **Paper discs** containing **antiseptics**, **antibiotics or plant extracts** placed on **microbial culture** and **left to grow.**
- **Water disc used as a CONTROL.**
- If **microorganisms don't grow** around the disc then the chemical is **effective** at killing the microorganism.
- **Area** where **bacteria don't grow** is called **ZONE OF INHIBITION**.

Video



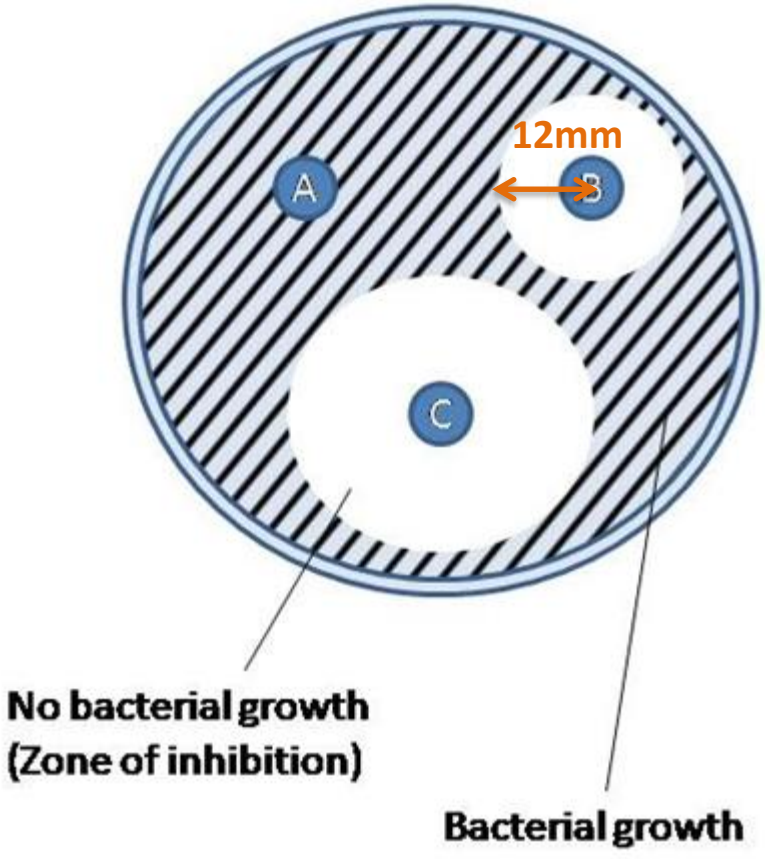
Calculating the cross sectional area of the zone of inhibition.

Measure the radius of the clear zone.

Use the formula πr^2 to calculate the cross sectional area.

If the radius of the zone of inhibition for disc B was 12mm, then the cross sectional area is:

$3.14 \times 12^2 = 452mm^2$



Bacteria can **mutate**.

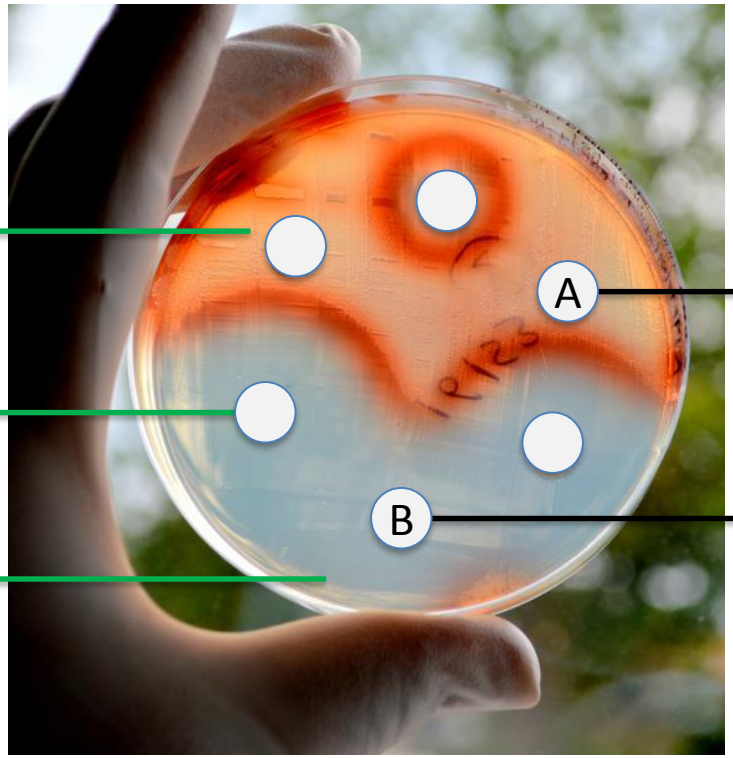
Sometimes this makes them **resistant** to antibiotic drugs.

The **mutated** bacteria are **not killed**. Increasing numbers of different bacteria are becoming resistant and this is **of concern**.

Red = bacteria colonies

Disc soaked in antibiotic

Clear = no bacterial colonies



Bacteria are resistant to antibiotic A

Bacteria are killed by antibiotic B

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QuestionIT!

Human body defence responses. Part 3 (5.12- 5.19B)

- Physical barriers and chemical defences
- Role of the specific immune system
- Immunisation
- Antibiotics
- Culturing microorganisms (biology)

Human body defences – QuestionIT

1. Name three physical barriers of the human body which protect the body from pathogens.
2. What is lysozyme?
3. Name the chemical found in the stomach which acts as a chemical defence against pathogens.
4. What is an antigen?
5. What is an antibody?
6. What does a memory lymphocyte do?
7. What is meant by the secondary response to an antigen?
8. What does a vaccine contain?

9. Which type of pathogen would doctors treat with antibiotics?

Biology only

10. What does the term herd immunity mean?

11. What does aseptic mean?

12. What does an autoclave do?

13. Why should Petri dishes and culture vials be kept covered?

14. What formula is used to calculate the cross sectional area of a bacterial culture?

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AnswerIT!

Human body defence responses. Part 3 (5.12- 5.19B)

- Physical barriers and chemical defences
- Role of the specific immune system
- Immunisation
- Antibiotics
- Culturing microorganisms

Human body defences – QuestionIT

1. Name three physical barriers of the human body which protect the body from pathogens.

   Skin

   Mucus

   Cilia

2. What is lysozyme? **An enzyme secreted in tears which destroys pathogens.**
3. Name the chemical found in the stomach which acts as a chemical defence against pathogens. **Hydrochloric acid.**
4. What is an antigen? **An antigen is a substance which stimulates the production of antibodies.**
5. What is an antibody? **A protein which is produced in response to an antigen which it then neutralises.**

Human body defences – AnswerIT

6. What does a memory lymphocyte do?

   This type of white blood cell remain in the blood for a long time. These will rapidly trigger the production of antibodies if the body is re-infected.

7. What is meant by the secondary response to an antigen?

   A secondary response occurs when a second exposure to the antigen triggers an immune response. Antibodies are made in a much shorter period of time meaning the body has a rapid response to the pathogen the second time around.

8. What does a vaccine contain?

   A weakened or dead form of the pathogen

9. Which type of pathogen would doctors treat with antibiotics?

   Bacteria

Human body defences – AnswerIT

Biology only

10. What does the term herd immunity mean? **Herd immunity is an indirect protection from communicable diseases which occurs when a large percentage of the population has become immune to the disease through vaccination.**

11. What does aseptic mean?
    Sterile

12. What does an autoclave do? **Sterilises equipment or substances using steam and high pressure.**

13. Why should Petri dishes and culture vials be kept covered? **To reduce the chance of contamination of the culture medium from the air.**

14. What formula is used to calculate the cross sectional area of a bacterial culture?

    πr^2

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LearnIT!

KnowIT!

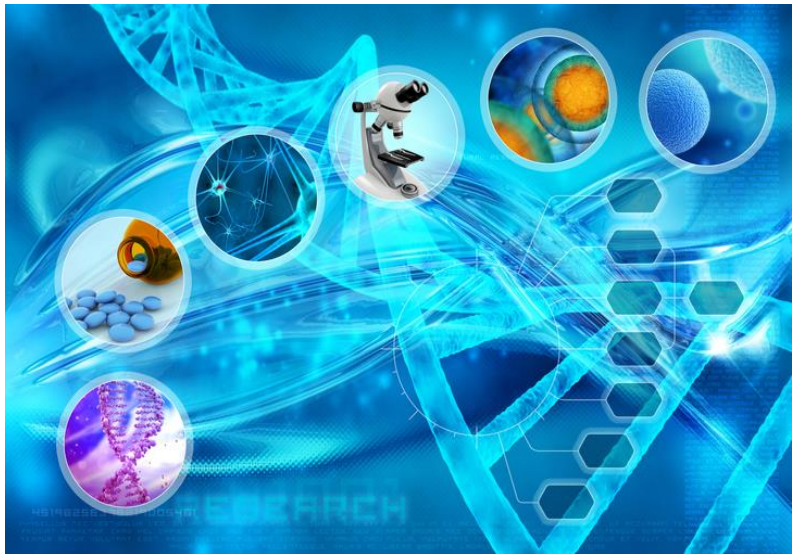
Development of new medicines

Part 4 (5.20 - 5.22B)

- Process of developing new medicines
- Monoclonal antibodies (biology HT)

Health, disease and the development of medicines part 4 – Development of new drugs

The initial chemical used to make a drug may have been **discovered** from a plant. Most new drugs are **developed** and **synthesised (made)** in a laboratory by chemists in the pharmaceutical industry.



New drugs must be tested and trialled to check:

- ✓ **Efficacy** - that the drugs work
- ✓ **Toxicity** - that the drug is not poisonous
- ✓ **Dose** - the most suitable **amount** to take

Preclinical tests must be carried out before humans are allowed to take the drug.

These preclinical tests are done on **cells**, **tissue** samples and live **animals**.

If successful the new drug will proceed to **clinical testing**.

The stages of a clinical trial are:

Stage 1
- Healthy volunteers try small doses of the drug to check it is **safe** and has **no side effects**

Stage 2
- A small number of **patients** try the drug at a **low dose** to see if it works

Stage 3
- A larger number of patients take the new drug and different doses are trialled to find the **optimum dose**

Stage 4
- **A double blind trial** will occur to see how effective the new drug is. The patients are divided into groups

video

Health, disease and the development of medicines part 4 – Development of new drugs

A **double blind trial** is carried out on **patients** who **have** the **disease** to make sure that it is actually the drug which is having an effect on the patients and not anything else.

The details of everyone taking part in the trial is entered into a computer database. The computer groups people **randomly**.

Each person receives a unique code and they receive the medicine which is labelled with the matching code.

No-one knows who is receiving the real drug or a **placebo** until the end of the trial.

The **placebo** is often the drug the patient was originally taking so they still receive medical treatment.

Health, disease and the development of medicines part 4 – Monoclonal antibodies (biology HT)

Monoclonal antibodies are identical copies of **one** type of **antibody** produced in a laboratory.

How to produce monoclonal antibodies:

1. A mouse is **injected** with a pathogen.

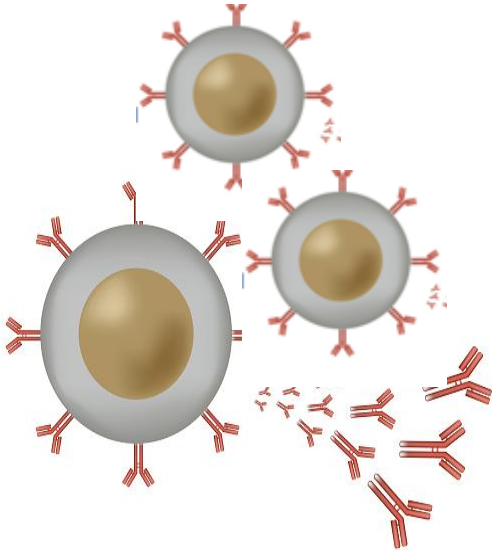
2. White blood cells called **lymphocytes** produce **antibodies** but they do not divide.

3. Lymphocytes are removed from the mouse and **fused** with rapidly dividing mouse **tumour cells.**

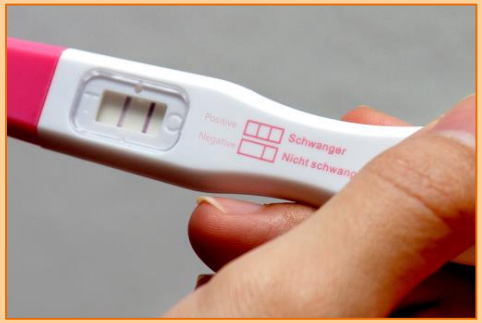
4. The new cells are called **hybridomas**.

5. The **hybridomas divide** rapidly and release lots of **antibodies** which are then collected.

Mono = one



Monoclonal antibodies are **specific** to one **binding site** on the **antigen**. This means that we can use monoclonal antibodies to **target** a specific **chemical** or specific **cells** in the body. They can be used to locate blood clots and cancer cells.



During pregnancy, a **hormone called HCG** is released into the blood. **Monoclonal antibodies** can detect the presence of this chemical at low levels and are used in **pregnancy testing kits.**

Development of new medicines part 4 – Monoclonal antibodies (Biology HT)

Monoclonal antibody research has raised some concerns about their **ethical** use.

Mice are injected with pathogens and so they will **experience** the **disease** symptoms.

Mice provide antibody producing cells and tumour cells. Mice are **induced** with **cancer** to get the tumour cells.

Monoclonal antibodies have been **successful** in treating some cancers and diabetes. But there have been **deaths** when used to treat patients with **multiple sclerosis** (MS).

Herceptin is used for breast cancer. It is **not toxic** and is **specific** to breast cancer cells so **few side effects**. But it is **costly**.

Health, disease and the development of medicines part 4 – Monoclonal antibodies (biology HT)

Monoclonal antibodies are used in **diagnosis** to locate blood **clots** and cancer cells. They are used in treating some **cancers**. They **target** specific cells causing **minimal damage** to the rest of the body cells around the tumour **unlike** other **drugs** or **radiotherapy.**

- The monoclonal antibodies are **specific** to the antigen on the cancer cells.
- A chemical which **stops cells dividing** can be bound to the monoclonal antibodies.
- The patient is given the monoclonal antibodies and they attach to **receptors** on the cancer cells.
- The chemical **stops** the cancer cells growing and dividing.

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QuestionIT!

Development of new medicines. Part 4 (5.20 - 5.22B)

- Process of developing new medicines
- Monoclonal antibodies (biology HT)

Development of new medicines – QuestionIT

1. Any potential new drug has to go through a series of tests.

   What is meant by the following terms?

   a) Efficacy b) Toxicity c) Optimum dose

2. Number these statements to show how drugs are tested.

   Drugs are trialled on live animals

   Drugs are trialled on people with the disease the drug is for

   Drugs are trialled in laboratories on cells and tissue cultures

   Drugs are trialled on healthy volunteers

3. Drugs companies often use a placebo in their trials.

   a. What is a placebo? b. Why is it used?

Questions for Biology HT only

4. Place the statements in the correct order to show how monoclonal antibodies are produced.

- ❑ Mouse lymphocytes produce antibodies.
- ❑ The antibodies are collected and purified.
- ❑ Mouse lymphocytes are collected.
- ❑ Mouse is injected with a pathogen.
- ❑ Hybridoma cells are separated and cultured to form a clone.
- ❑ Mouse lymphocyte and mouse tumour cell are fused.
- ❑ The clone produces large quantities of antibody.

5. What are the applications of monoclonal antibodies?

6. Why do some people feel the use of monoclonal antibodies is unethical?

7. Why would a test kit containing monoclonal antibodies be useful to detect plant disease?

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AnswerIT!

Development of new medicines.

Part 4 (5.20 - 5.22B)

- Process of developing new medicines
- Monoclonal antibodies (biology HT)

Development of new medicines– AnswerIT

1. What is meant by the following terms?

   a) Efficacy **how effective the drug is**

   b) Toxicity **how poisonous the drug is**

   c) Optimum dose **minimum amount of the drug which provides the best response**

2. Number these statements to show the process of drug testing.

   2. *Drugs are trialled on live animals*

   4. *Drugs are trialled on people with the disease the drug is for*

   1. *Drugs are trialled in laboratories on cells and tissue cultures*

   3. *Drugs are trialled on healthy volunteers*

Development of new medicines– AnswerIT

3. Drug companies often use a placebo in their trials.

a. What is a placebo?

A medicine that does not contain the drug that is being trialled.

b. Why is it used?

A placebo is used to check that there are no other factors which may cause the patient's condition to improve without the drug.

Development of new medicines– AnswerIT

Questions for Biology HT only

4. Place the statements in the correct order to show how monoclonal antibodies are produced.

2. Mouse lymphocytes produce antibodies.

7. The antibodies are collected and purified.

3. Mouse lymphocytes are collected.

1. Mouse is injected with a pathogen.

5. Hybridoma cells are separated and cultured to form a clone.

4. Mouse lymphocyte and mouse tumour cell are fused.

6. The clone produces large quantities of antibody.

Development of new medicines – AnswerIT

5. What are the applications of monoclonal antibodies?

Pregnancy testing

Used to measure levels of hormones and other chemicals in blood

Treat some cancers by delivering a toxic drug to the cancer cells

To find various molecules in cells or tissues by binding to them with a fluorescent dye

6. Why do some people feel the use of monoclonal antibodies is unethical?

Mouse has to suffer the disease deliberately

Mouse is induced to have cancer

Treatment not always safe

It's very expensive and money could be better used

Development of new medicines – AnswerIT

7. Why would a test kit containing monoclonal antibodies be useful to detect plant disease?

   The monoclonal antibodies can be used to detect a particular chemical which is only present in one type of pathogen. This would then show whether the plant was infected with this disease or not.

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LearnIT!

KnowIT!

Effect of lifestyle

Part 5 (5.23 – 5.25)

- Exercise, diet and BMI
- Alcohol on liver disease
- Smoking and cardio vascular disease
- Evaluation of treatments for cardiovascular disease

Health, disease and the development of medicines part 5 – Effect of lifestyle

Non-communicable diseases (NCDs) can have a significant **human** and **financial** cost for individuals, local communities, nationally and globally. Video - NCDs

WHO Factsheet data link

- Non-communicable diseases (NCDs) kill **40 million** people each year, equivalent to **70% of all deaths globally**
- Each year, **15 million** people die from a NCD between the ages of 30 and 69 years; over **80%** of these "premature" deaths occur in low- and middle-income countries
- **Cardiovascular diseases** account for **most** NCD deaths, or **17.7 million people** annually, followed by **cancers** (8.8 million), **respiratory diseases** (3.9million), and diabetes (1.6 million)

Human cost: lower quality of life, shorter lifespan and the families of the sufferer are also affected due to caring responsibilities, parental/partner death etc.

Financial cost: cost of health care, research into diseases, awareness campaigns. Reduced income due to inability to work, personal care costs, adaptations to the home and buying specialist equipment e.g. wheelchairs, mobility scooters etc.
Also if many people are unable to work due to NCDs the economy can be affected.

Health, disease and the development of medicines part 5 – Effect of lifestyle

There are **lifestyle factors** that can also affect health and increase the risk of getting a non communicable disease, these can be:

- **aspects of a persons lifestyle**
  - e.g. lack of exercise, stress levels, exposure to too much sunlight, exposure to ionising radiation (e.g. X-rays, gamma rays)
- **substances (chemicals) taken**:
  - **into a persons body** – e.g. high fat/sugar diet, cigarette smoke, alcohol
  - **in their environment** - e.g. air/water pollution, asbestos, ionising radiation

These are called **RISK FACTORS**

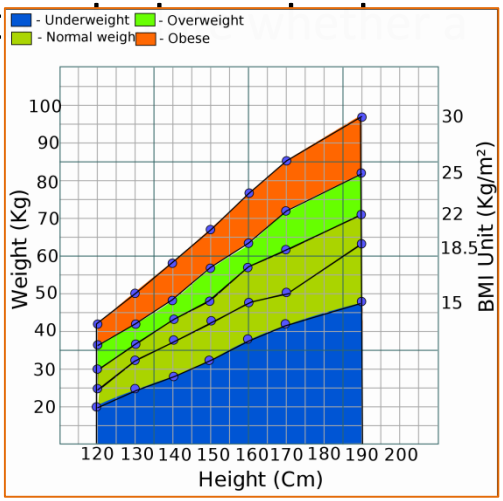
HAZARD	RISK FACTOR	HARM
The potential source of harm e.g. smoking, lack of exercise	The combination of the chances of the hazard causing harm and the severity of that harm	The damage to health or a disease that can occur

MANY DISEASES ARE CAUSED BY THE INTERACTION OF A NUMBER OF RISK FACTORS

Health, disease and the development of medicines part 5 – Effect of lifestyle

Excess weight (obesity) can make a person at **risk of cardiovascular disease**, a stroke and Type 2 diabetes. If there are no underlying health concerns then obesity is best tackled through a combination of a **healthy balanced diet** and **exercise**.

A tool called the **Body Mass Indicator** (BMI) can be used t[illegible] whether a persons weight lies within a healthy range.



[BMI calculator]

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

Being **underweight** (malnourished) can also be **of concern**. This can indicate a person is not getting sufficient food of a good nutritional quality or indicate medical problems such as an overactive thyroid gland.
A person who is suffering from **malnutrition** may have a **weakened immune system** and be at risk of developing **fragile bones**, **fertility** problems and a lack of **energy**.

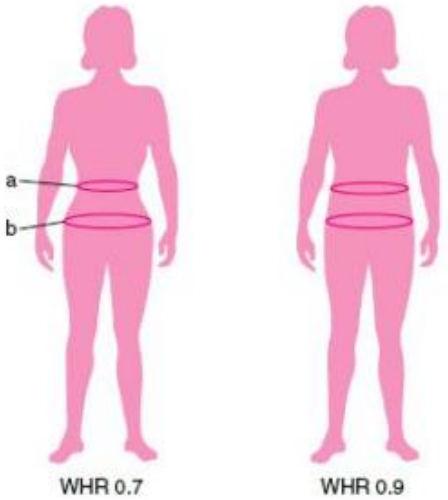
Health, disease and the development of medicines part 5 – Effect of lifestyle

The use of **BMI** has **limitations** because it simply shows if a person is carrying too much weight. It does not calculate if this is excess fat, muscle or bone.

Very muscular adults and athletes may be classed as overweight or obese even though their body fat is low.

The **waist to hip ratio** should be considered alongside the BMI figure.

Male (waist : hip ratio)	Female (waist : hip ratio)	Health risk based on Waist : hip ratio
0. 95 or below	0.80 or below	Low risk
0.96 to 1.0	0.81 to 0.85	Moderate risk
1.1 or more	0.86 or more	High risk

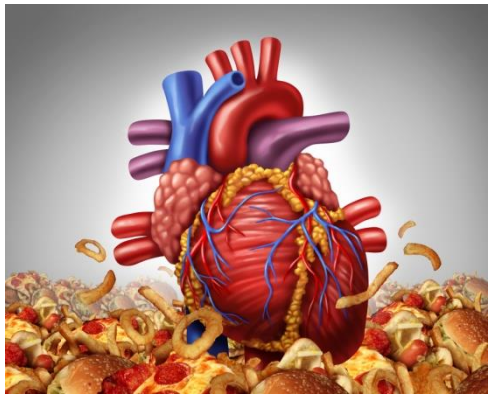


Health, disease and the development of medicines part 5 – Effect of lifestyle

Many non communicable diseases are caused by the interaction of a number of factors.

CARDIOVASCULAR disease can be affected by a number of lifestyle risk factors:

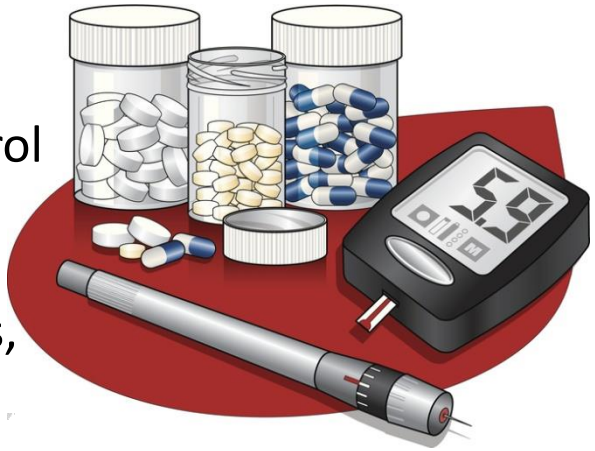
- **Diet** – a diet high in saturated fats can increase the levels of LDL (low density lipoproteins – cholesterol plus a protein that can cause atherosclerosis).
- **Smoking** – tobacco smoke **damages** the lining of the arteries leading to atherosclerosis, **carbon monoxide** in tobacco smoke reduces the amount of oxygen in the blood so the heart has to pump harder, the **nicotine** in tobacco smoke causes the heart to beat faster and raises blood pressure.
- **Lack of exercise** – exercising regularly lowers blood pressure and stress.



Effect of lifestyle Part 5 - non-communicable diseases

Many non-communicable diseases are caused by the interaction of a number of factors:

OBESITY is a lifestyle risk factor for Type 2 diabetes:

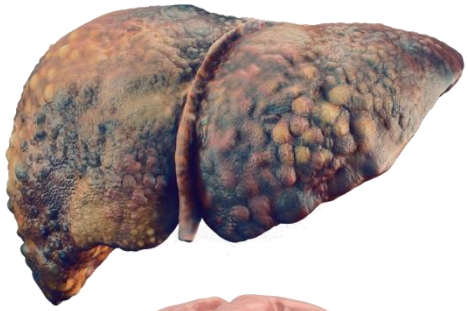


- **Type 2 diabetes** – is where the cells in the body are less sensitive or resistant to insulin so the body cannot control the concentration of glucose in the blood correctly.

  Video - Type 2 Diabetes

- **Obesity** increases the risk of developing Type 2 diabetes, the more fat you have around your abdomen

Alcohol is a lifestyle risk factor for Liver disease and Brain damage:



- **Liver disease** – the liver breaks down toxins in alcohol. If you have too much alcohol, the first stage of liver disease is when the liver becomes fatty. Eventually **cirrhosis** of the liver develops if you continue to drink too much alcohol.
- **Brain function damage** – alcohol affects the way the nerve cells in the brain work and the cells then become damaged. The brain mass may also shrink Video

Health, disease and the development of medicines part 5 – Effect of lifestyle

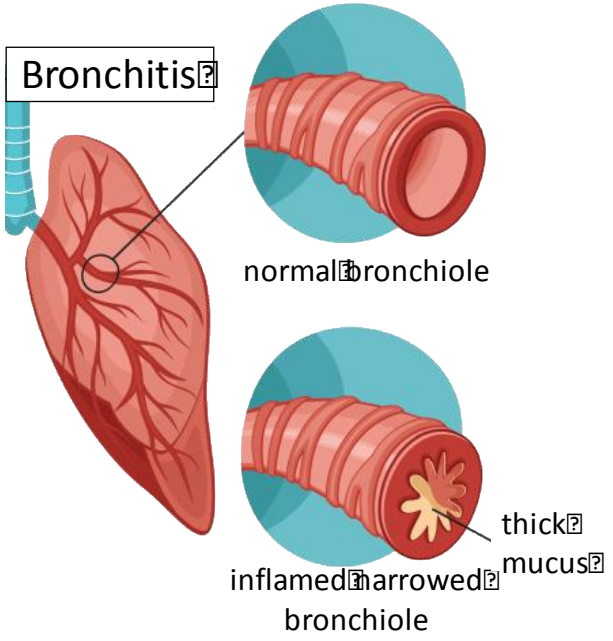
Many non-communicable diseases are caused by the interaction of a number of factors:

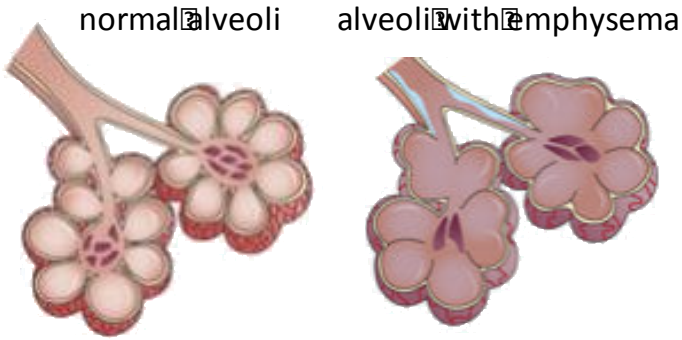
SMOKING is a lifestyle risk factor for Lung disease:

- **COPD** – describes a group of lung diseases that make it difficult for people to move air in and out of the lungs

Two examples of these are:

- **Bronchitis** – the bronchi and bronchioles are **inflamed** (swollen) and excess **mucus** is produced
- **Emphysema** – this affects the **alveoli.** The walls are **broken down** and they then trap excess air





COPD **narrows** the airways and makes it difficult to get rid of CO_2 and get in the O_2 needed for respiration. **Smoking** is the main cause of COPD and is responsible for 9 out of 10 cases. Video - COPD

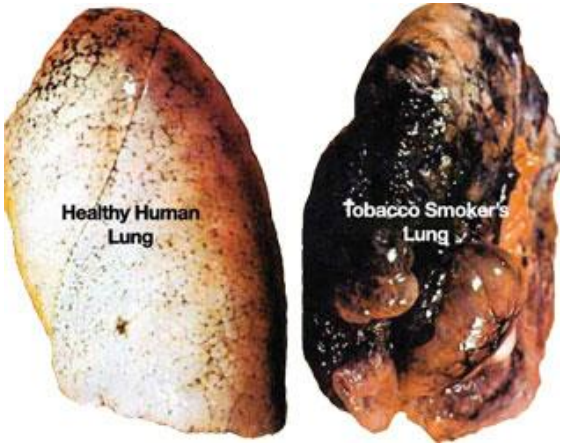
Health, disease and the development of medicines part 5 – Effect of lifestyle

Many non-communicable diseases are caused by the interaction of a number of factors:

SMOKING is a lifestyle risk factor for Lung cancer:

- **Lung cancer -** is one of the **most common** and serious types of cancer. Around 44,500 people are diagnosed with the condition every year in the UK (NHS)
- **Symptoms include**:
  - a persistent cough
  - frequent chest infections
  - coughing up blood
  - breathlessness
- **Causes**: **most** cases of lung cancer are linked to **smoking 85%** (NHS). Tobacco smoke contains over **60 toxic chemicals** and some of these substances are known to be **carcinogenic** (cancer causing)

If you smoke more than **25 cigarettes a day**, you are **25 times** more likely to get lung cancer than a non-smoker. Some people who have never smoked can get lung cancer too.



All cigarettes must now by law be sold in plain packaging and with graphic images and health warnings.

Health, disease and the development of medicines part 5 – Effect of lifestyle

20 minutes: heart rate and blood pressure reduce

Within 2-12 weeks the circulation and lung function begin to improve.

Between 5 to 15 years, the risk of a stroke falls to be approximately the same as someone who has never smoked.

Benefits of stopping smoking on cardio vascular disease.

Within 12 hours the levels of carbon monoxide in the blood fall.

After 1 year of stopping smoking, the risk of CVD falls to approximately half that of a smoker.

After 10 years the risk of lung cancer falls to about half that of a smoker.

Health, disease and the development of medicines part 5 – Effect of lifestyle

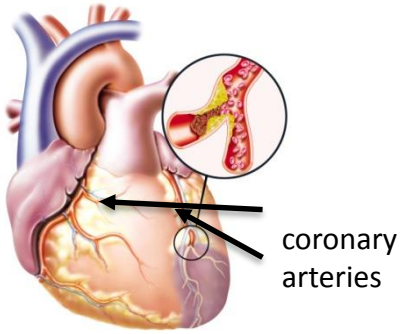
Many non-communicable diseases are caused by the interaction of a number of factors:

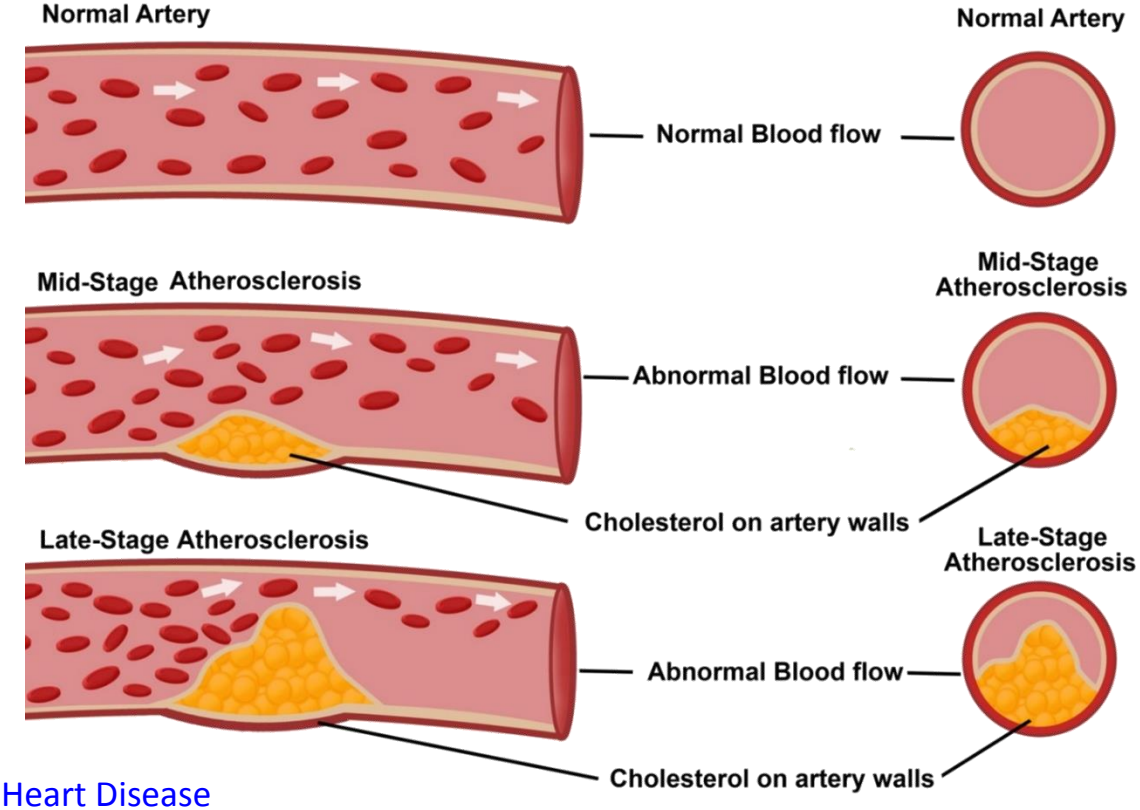
CARCINOGENS increase the risk for cancer:

- **Carcinogen** - a **substance** or form of **radiation** that can **cause cancer**. Some carcinogens cause cancer by damaging the DNA directly, others can speed up cell division making mutations more likely
- **Tobacco** - smoke can cause cancers in the lungs, oesophagus, larynx (voice box), mouth, throat, kidney, bladder, pancreas, stomach and cervix
- **Alcohol** - is a risk factor in the following cancers - mouth, larynx, oesophagus, liver and breast
- **Occupational carcinogens** – there are over 40 known carcinogens in the work environment and these need to be carefully controlled so that workers don't get too exposed to them e.g. asbestos causes lung cancer

Health, disease and the development of medicines part 5 – Effect of lifestyle

Cardiovascular disease (CVD) is a general term for disease which involve the **heart** or **blood vessels. Atherosclerosis** is a cause of **coronary heart disease** where **layers** of **fatty material** build up inside the coronary arteries, **narrowing** them. This **reduces** the flow of blood through the coronary arteries, resulting in a **lack of oxygen** for the **heart muscle.**

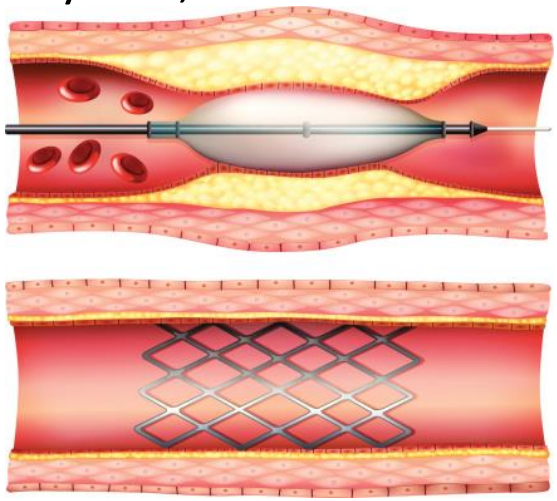




Video - Coronary Heart Disease

Health, disease and the development of medicines part 5 – Effect of lifestyle

Atherosclerosis can be **treated** in two main ways by placing a **stent** in the coronary artery and/or using **lifelong medication** called **statins**. Lifestyle changes such as a healthy diet, exercise and no smoking are also vital in reducing the risk of CVD.



Stents are metal cylinder grids which can be **inserted** into an artery to maintain blood flow by **keeping the artery open** so that the heart continues to receive **enough oxygen** to function effectively.

Video - Stent Insertion Animation

Statins are drugs that lower harmful **cholesterol** in the blood and stop the **liver** producing too much cholesterol and reduce the rate at which it is deposited. Patients should change their **lifestyle** and have a healthy **diet**. This **reduces** the risk of heart disease.

Health, disease and the development of medicines part 5 – Effect of lifestyle

Heart disease can lead to **heart failure**. Patients with heart failure can be given **heart** or **heart and lung transplants**. Donor hearts come from a **person who has died.** These only have a **few hours** to get to the person needing the heart. Often hearts and lungs are transplanted together. In this country you have to give **consent** for your organs to be donated.

Video - Heart Transplant (graphic)

Conditions that may require a heart transplant include:

- **Atherosclerosis** (coronary heart disease) – a build-up of fatty substances in the arteries supplying the heart
- **Cardiomyopathy** – where the walls of the heart have become stretched, thickened or stiff
- **Congenital heart disease** – birth defects that affect the normal workings of the heart

Artificial hearts are occasionally used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest as an aid to recovery. Artificial hearts can only be used as a **short term** measure.

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QuestionIT!

Effect of lifestyle

Part 5 (5.23 – 5.25)

- Exercise, diet and BMI
- Alcohol on liver disease
- Smoking and cardio vascular disease
- Evaluation of treatments for cardiovascular disease

Effect of lifestyle part 5 – QuestionIT

1. How do you calculate BMI?
2. What other information could also be used to indicate if a person is overweight?
3. Name a lifestyle risk factor for developing liver disease.
4. List three lifestyle risk factors which are likely to increase the chance of developing cardiovascular disease.
5. Name three methods of treatment for cardiovascular disease.
6. What is a statin?
7. What is a stent used for?

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AnswerIT!

Effect of lifestyle

Part 5 (5.23 – 5.25)

- Exercise, diet and BMI
- Alcohol on liver disease
- Smoking and cardio vascular disease
- Evaluation of treatments for cardiovascular disease

Effect of lifestyle part 5 – AnswerIT

1. How do you calculate BMI?

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

2. What other information could also be used to indicate if a person is overweight? **Waist: hip ratio**
3. Name a lifestyle risk factor for developing liver disease.
   Alcohol
4. List three lifestyle risk factors which are likely to increase the chance of developing cardiovascular disease.
   Smoking
   Unhealthy diet
   Lack of exercise
5. Name three methods of treatment for cardiovascular disease.
   Lifestyle change
   Lifetime medication
   Surgery

Effect of lifestyle part 5 – AnswerIT

6. What are statins? **Statins are drugs that lower harmful cholesterol in the blood and stop the liver producing too much cholesterol and reduce the rate at which it is deposited.**

7. What is a stent used for?
   Stents are metal cylinder grids which can be inserted into an artery to maintain blood flow by keeping the artery open so that the heart continues to receive enough oxygen to function effectively.