Edexcel GCSE Biology

Your notes

Development of Medicines

Contents

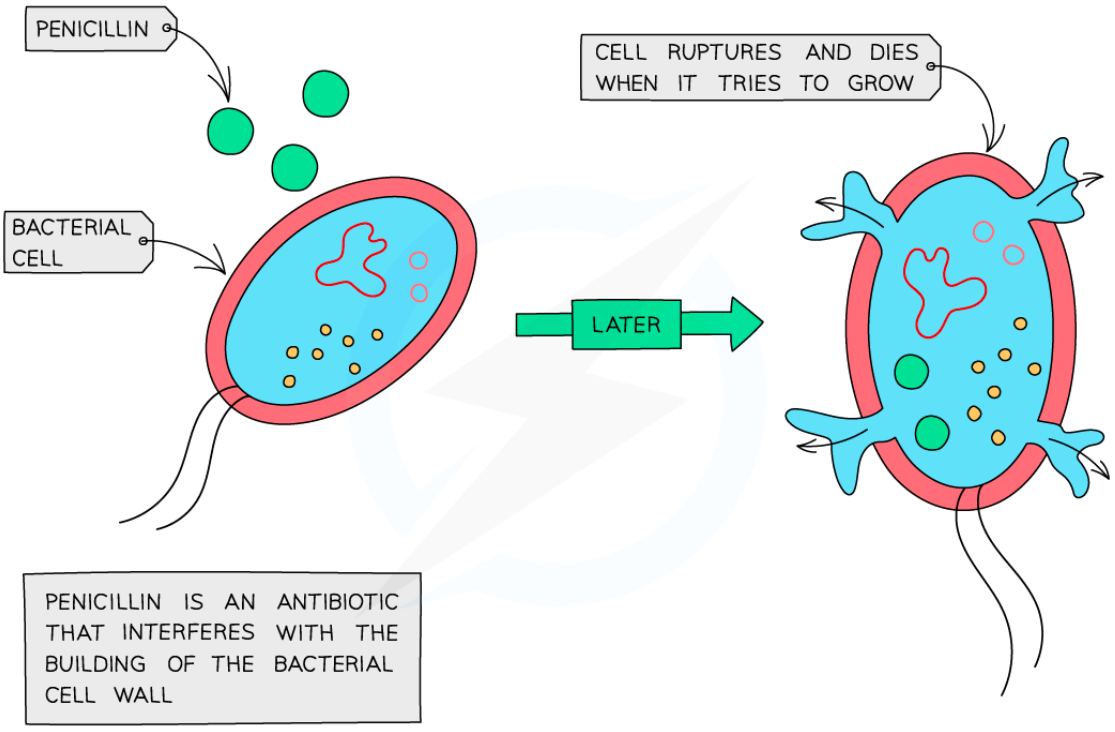
Antibiotics


Your notes

Antibiotics

- When treating a disease there are two types of medication that an individual can take:
  - Medicines that treat the **cause** of the disease – e.g. antibiotics
  - Medicines which treat the **symptoms** of the disease – e.g. painkillers
- **Antibiotics,** such as penicillin, are medicines that help to cure bacterial disease by killing infective bacteria inside the body
- The use of antibiotics has greatly reduced the deaths from infections in the last century
- Only **certain antibiotics will work on certain diseases**, however, so a doctor will prescribe different antibiotics depending on the type of infection
- It is important that specific bacteria should be treated by specific antibiotics that are known to work against them
- Antibiotics work by inhibiting the processes in the bacterial cells, such as the production of the cell wall
  - They affect processes usually only in bacteria so are **not harmful to host cells**

Your notes



Penicillin was the first antibiotic to be discovered and is widely used, although resistance is a problem

- Antibiotics will **not work against viruses**, as viruses reproduce inside cells. It is difficult to develop drugs that kill viruses without also **damaging the host's tissues**

Your notes

Uncontaminated Cultures & Aseptic Techniques

Growing bacterial cultures in the lab

- The effect of **disinfectants** and **antibiotics** on microorganisms can be investigated using cultures of bacteria grown in the lab
- In the right conditions, some species of bacteria can multiply as much as once every **20 minutes**. This is ideal as large cultures of bacteria for study can be grown in relatively short periods of time
- To multiply this quickly, bacteria require an adequate supply of **nutrients** (carbohydrates, proteins, minerals and vitamins) and an **appropriate temperature** (which varies depending on the species being grown)
    - Warmer temperatures promote faster growth, but in a school lab the maximum allowed temperature for growth is 25°C
    - Above this temperature, more harmful pathogens are likely to grow
- Bacteria can be grown in a **nutrient broth solution** or as colonies on an **agar gel plate**

Aseptic conditions

- It is vital that **uncontaminated** cultures of microorganisms are grown in the lab
- The presence of competing species can affect the growth of cultures, as well as the validity of any study performed on them
- Some important aseptic techniques are outlined in the table below:

Uncontaminated Culture Preparation Table

Your notes

STEPS	EXPLANATION
1. WHENEVER WORKING ASEPTICALLY, ALL WORK SHOULD BE CARRIED OUT IN FRONT OF A LIT BUNSEN BURNER WITH A YELLOW FLAME.	THE FLAME CREATES A CONVECTION CURRENT ABOVE THE BENCH, PREVENTING CONTAMINATION OF ANY MICROORGANISMS IN THE AIR.
2. HOT AGAR JELLY IS POURED INTO A STERILISED PETRI DISH. THE AGAR IS LEFT TO COOL AND SET.	THE PETRI DISH AND CULTURE MEDIUM ARE HEATED TO A HIGH TEMPERATURE TO KILL ANY POTENTIAL MICROORGANISMS THAT COULD CONTAMINATE THE EXPERIMENT.
3. AN INOCULATING LOOP IS PASSED THROUGH A HOT FLAME BEFORE IT IS USED TO TRANSFER BACTERIA TO THE CULTURE MEDIUM.	ANY MICROORGANISMS ON THE LOOP ARE KILLED TO PREVENT CONTAMINATION.
4. PETRI DISHES SHOULD ONLY BE OPENED AS LITTLE AS POSSIBLE, AT THE SIDE FACING THE BUNSEN BURNER.	THIS DECREASES THE RISK OF MICROORGANISMS CONTAMI-NATING THE DISH.
5. THE LID OF THE PETRI DISH SHOULD BE SECURED WITH TAPE AT INTERVALS AROUND THE DISH AND STORED UPSIDE DOWN.	THIS PREVENTS DROPS OF CONDENSATION (ANOTHER SOURCE OF CONTAMINATION) FROM DROPPING ONTO THE SURFACE OF THE AGAR.
6. THE CULTURES SHOULD NOT BE INCUBATED ABOVE 25°C IN A SCHOOL LABORATORY.	THIS RESTRICTS THE GROWTH OF HARMFUL PATHOGENS (WHICH ARE MORE LIKELY TO GROW AT HIGHER

	TEMPERATURES).

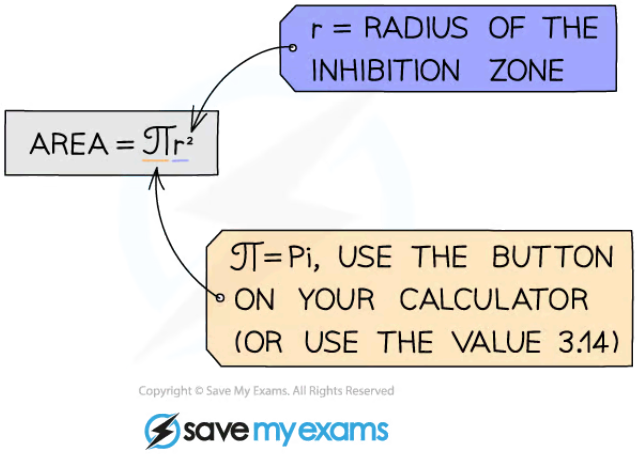
Your notes

Examiner Tips and Tricks

Only lifting the lid of the petri dish a little is vital to reduce the risk of contamination by other microorganisms. It is not to prevent air from entering, as oxygen is still required by bacteria grown in school labs (more harmful bacteria tend to be anaerobic).

Calculating Inhibition Zone Area

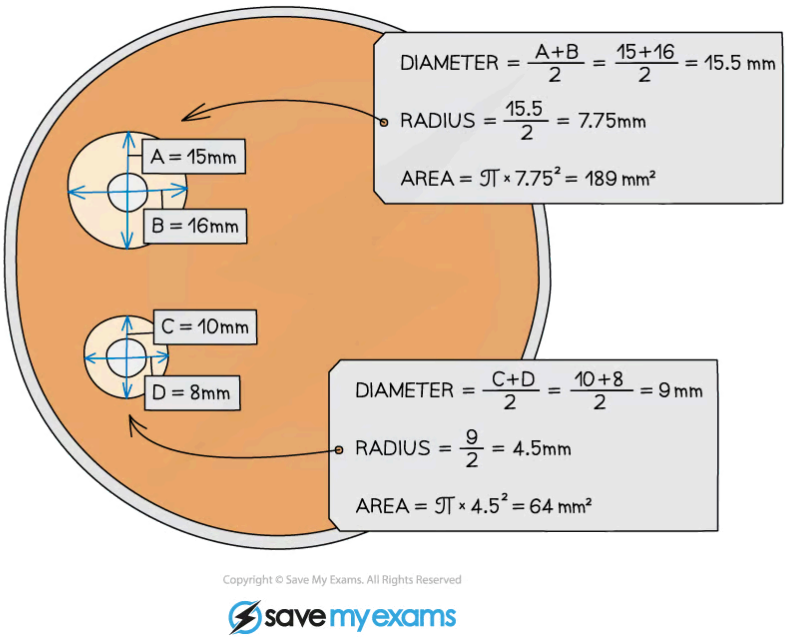
- The effectiveness of different **antibiotics**, **antiseptics** or **disinfectants** can be determined by calculating the area of an **inhibition zone** around a disc of the substance being tested
- To calculate the area of an inhibition zone you should use the equation:



Calculating area

Worked Example

Your notes



Calculating the area of a clear zone is a far more accurate way of comparing the effect of different substances on bacterial growth than trying to judge by sight

Examiner Tips and Tricks

It is far more accurate to measure the diameter of an inhibition zone than its radius but remember to half the diameter before using the area equation above (as this equation uses the radius).If the clear zone is not perfectly circular, you will need to take at least two measurements of the diameter of an inhibition zone and find the mean diameter before calculating the area.


Your notes

Practical: Investigating Bacterial Growth

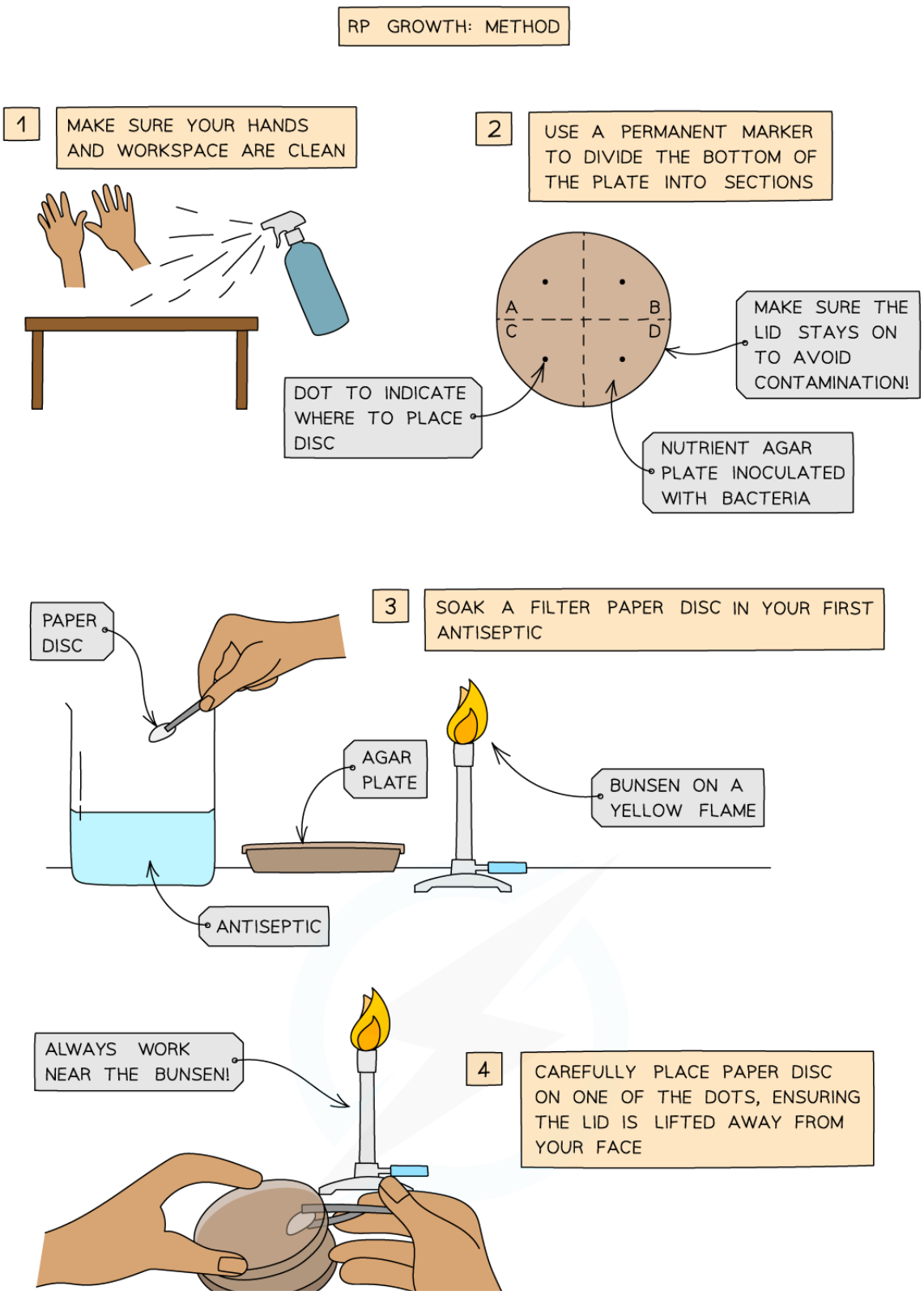
- Aim: To investigate the effect of **antiseptics** or **antibiotics** on bacterial growth using agar plates and **measuring zones of inhibition**
- You will:
  - Use **aseptic technique** to place filter paper discs soaked in different antiseptics or antibiotics onto uncontaminated **agar plates** containing bacteria
  - Measure the zone of inhibition around the growing colonies to compare the effect of different antiseptics and antibiotics
  - Calculate the area of each zone
- In this practical, you are not required to prepare the plates used to investigate bacterial growth but you should be aware of good microbial aseptic techniques
  - **Preventing contamination** is **vital** in any microbiology investigation to ensure that you are only investigating the effect of any antiseptic or antibiotic **on the specific species of bacteria you are studying**

Apparatus

- Petri dish with nutrient agar (pre-prepared)
- Marker pen
- Paper disks soaked in
  - Antiseptic
  - Antibiotics or different types of antiseptic
  - Distilled water (control)
- Tweezers
- Sticky tape
- Bunsen burner
- Incubator

Method

Your notes



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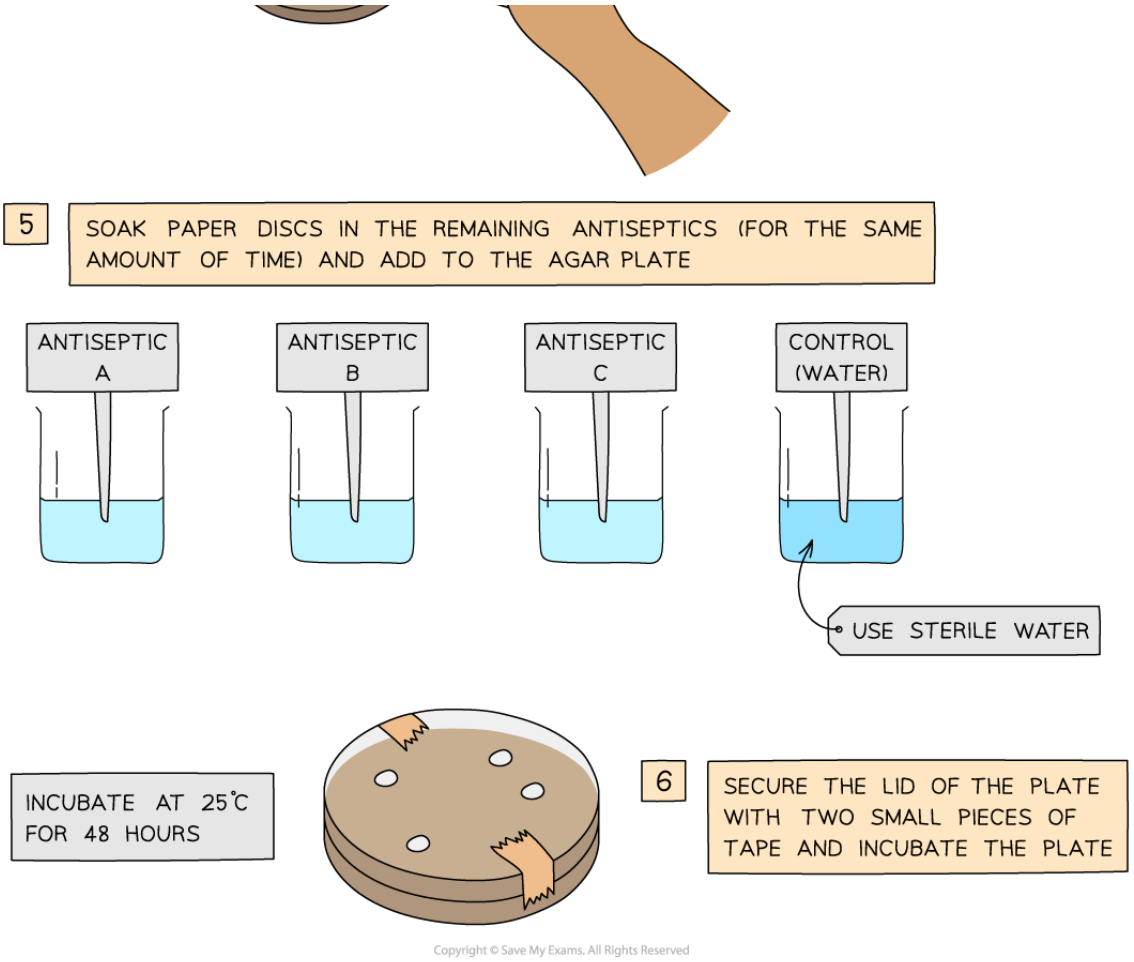


Whilst carrying out this practical you should try to identify the main hazards and be thinking of ways to reduce the risk of accidents

Results

- You may use commercially produced antibiotic discs rather than soaking discs in disinfectants
- Incubating the plates allows the bacteria in the agar to multiply by **binary fission** (this may be visible by the agar darkening or by colonies appearing)
- The antiseptics present in the discs will diffuse out into the agar, with the concentration decreasing with distance from the disc
- Where the concentration is sufficient to prevent bacterial growth or kill bacteria, the agar will remain clear
- It is possible to judge which antiseptic or antibiotic is the most effective by eye, but it is far more accurate to calculate the diameter of each inhibition zone and then use this to calculate the area of each inhibition zone

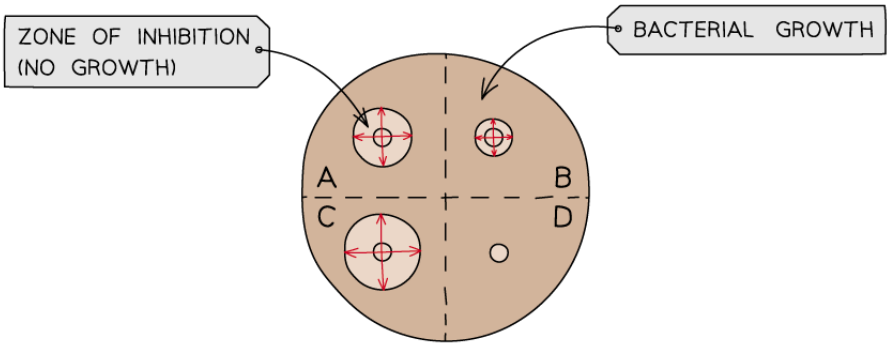

Your notes

- Clear zones of inhibition are not always perfectly circular, so the diameter of each zone should be measured twice at 90° angles to each other) and a mean diameter calculated before calculating the area

Your notes

RP GROWTH: ANALYSIS

1 MEASURE THE DIAMETER OF THE CLEAR ZONE AROUND DISC. REPEAT MEASUREMENT AT A 90° ANGLE



2 CALCULATE THE MEAN DIAMETER OF EACH ZONE AND FROM THESE VALUES CALCULATE THE CROSS-SECTIONAL AREA OF THE CLEAR ZONES AROUND THE BACTERIAL COLONIES

TYPE OF ANTISEPTIC	DIAMETER OF CLEAR ZONE (mm)			MEAN RADIUS (mm)	CROSS SECTIONAL AREA (mm²)
	1	2	MEAN		
A	17.0	15.0	16.0	8.0	201
B	8.0	7.0	7.5	3.75	44
C	21.0	22.0	21.5	10.75	363
D	0	0	0	0	0

REMEMBER AREA = πr^2

3 CONCLUDE WHICH TYPE OF ANTIBIOTIC WAS THE MOST EFFECTIVE AGAINST BACTERIAL GROWTH

THE MOST EFFECTIVE ANTIBIOTIC WAS ANTISEPTIC C BECAUSE IT HAD THE LARGEST CLEAR ZONE AROUND THE DISC WITH AN AREA OF 363 mm²

Record the diameter of each clear zone to the nearest whole millimetre and remember to calculate the area using the radius (taken as half the value of the mean diameter of each zone)

Why use a control?

- It is vital that one of the paper discs placed on the bacterial agar plate is not soaked in antiseptic or antibiotic but is soaked in **sterile water** instead
- This is to be sure that any differences in bacterial growth observed were caused by the presence of the antiseptic or antibiotic used and not some other factor (such as the paper discs themselves)


Your notes

Discovery & Development of New Drugs

Your notes

Discovering New Drugs

- Traditionally, drugs were extracted from **plants** and **microorganisms**
- New drugs are being developed all the time by scientists at universities and drug companies around the world
- Lots of the medications that we use today are based on **chemicals extracted from plants**
  - The heart drug **digitalis** originates from **foxgloves**
  - The painkiller **aspirin** originates from **willow**
  - **Penicillin** was discovered by Alexander Fleming from the *Penicillium* mould
- Most new drugs are synthesised by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant

Drugs From Plants Table

PLANT	DRUG	CONDITION
FOXGLOVE	DIGITALIS	HELP STRENGTHEN THE HEARTBEAT
WILLOW BARK	ASPIRIN (ACETYLSALICYLIC ACID)	PAINKILLER, FEVER AND INFLAMMATION

- **Penicillin** was first discovered by Alexander Fleming in 1928
- He left some Petri dishes that had been **contaminated** with mould and found that **bacteria would not grow near the mould**
- He discovered that the mould (*Penicillium notatum*) was releasing a chemical (penicillin) that killed the bacteria surrounding it
- New drugs are now developed by the pharmaceutical industry. Many of these still have plants as their source

Testing New Drugs

Your notes

- All new drugs need to be tested and trialled before they can be used in patients. They are tested for:
  - **Toxicity** – does it have harmful side effects?
  - **Efficacy** – does the drug work?
  - **Dose** – what dose is the lowest that can be used and still have an effect?
- The results of any testing are then **peer-reviewed** to make sure that the results are described accurately. The results would then be **published** in journals

Developing New Drugs

- **Preclinical** testing is done in a **laboratory** using **cells**, **tissues** and **live animals**
- **Clinical** trials use **healthy volunteers** and **patients**
- Very low doses of the drug are given at the start of the clinical trial
- If the drug is found to be safe, further clinical trials are carried out to find the **optimum dose** for the drug
- In double-blind trials, some patients are given a **placebo**

The three stages of drug development

- **Preclinical testing**
  - The drug is tested on cells in the lab
  - Computer models may also be used to simulate the metabolic pathways that may be taken by the drug
  - **Efficacy** and **toxicity** are tested at this stage
- **Whole organism testing**
  - The drug is tested on animals to see the effect in a whole organism – all new medicines in the UK have to have tests on 2 different animals by law
  - **Efficacy**, **toxicity** and **dosage** are tested at this stage
- **Clinical trials**
  - The drug is tested on human volunteers first, generally with a very low dose then increased. This is to make sure it is safe in a body that is working normally
  - The next stage is to test on patients with the condition.

The patients are often split into two groups; one given the drug the other given a **placebo**. This is called a **double-blind study** – neither the doctor nor the patient knows if the patient is getting the placebo or the active drug

- Once the drug is found to be safe then the lowest effective dose is tested at this stage


Your notes

Future medications

- Pharmaceutical companies are always looking to find new medications these include:
  - **Vaccinations** to different diseases
  - **Antibiotics** that have a different action on the bacteria, so that bacteria are not resistant to them
  - **Painkillers** with fewer side effects
  - **Antiviral drugs** that don't damage the body's tissues
- Sources of these medications may be plants or microorganisms

Examiner Tips and Tricks

You should be able to describe the process of discovery and development of potential new medicines, including preclinical and clinical testing in the exam.

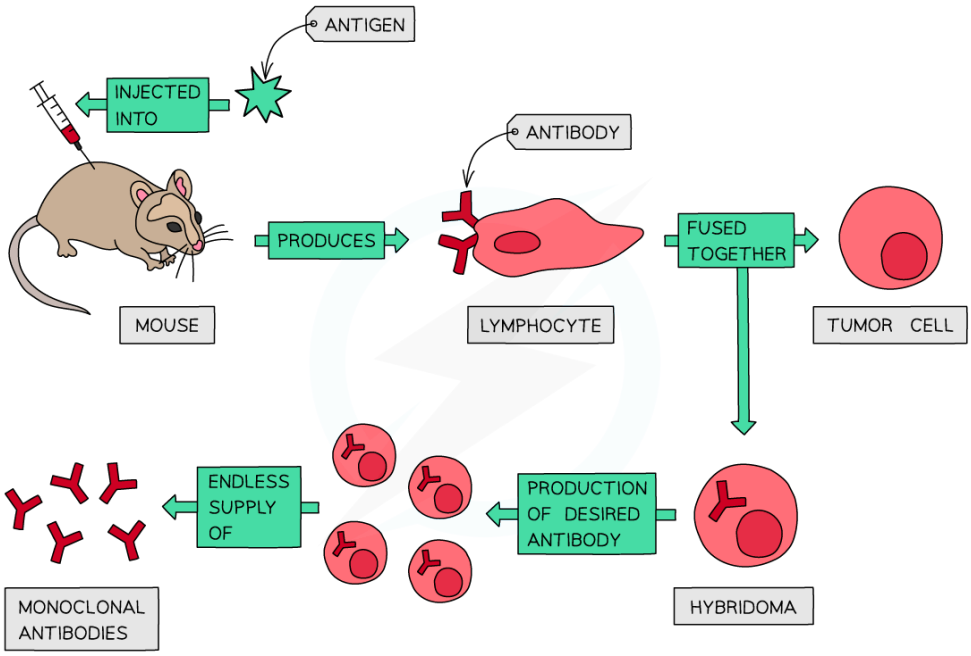
Monoclonal Antibodies

Your notes

Production of Monoclonal Antibodies

Higher tier only

- **Monoclonal antibodies** are **antibodies** that are made by identical immune cells, these identical immune cells are **clones** of the parent cell
- **Antibodies** are Y shaped proteins made by **lymphocytes,** (see Human Defence Systems)
- The antibodies are specific to one binding site on one protein antigen and so are able to target a specific chemical or specific cells in the body
- They are produced by stimulating mouse lymphocytes to make a particular antibody by exposing them to an antigen



The antigen is injected into a mouse and the antibodies combined with a tumour cell to make clones of the antibody

- The **lymphocytes** are combined with a particular type of **tumour cell** to make a **hybridoma cell**

- Tumour cells can divide repeatedly which is why they are used
- The **hybridoma** cell can both divide and produce the antibody
- Single hybridoma cells are cloned, resulting in many divisions, making high quantities of **identical cells** that all produce the **same antibody**
- A large amount of the antibody can be collected and purified ready for use

Examiner Tips and Tricks

The cells produced in this way create only **one** type of antibody, hence the name '**monoclonal antibodies**'.

Uses of Monoclonal Antibodies

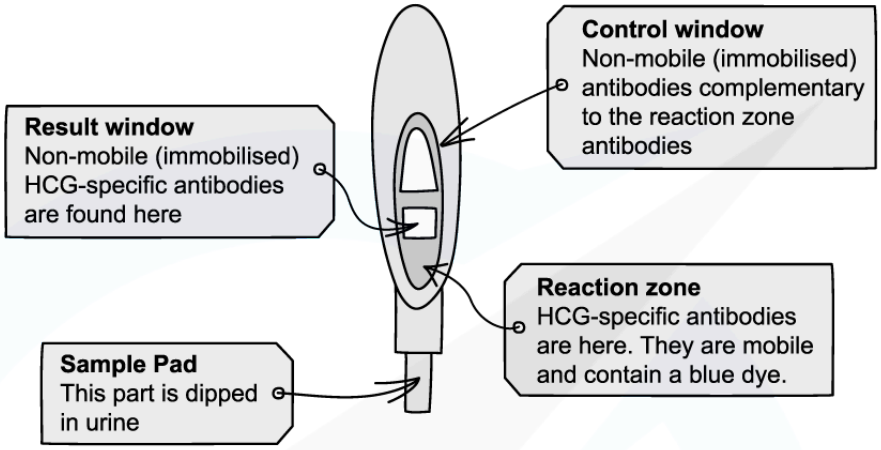
Higher tier only

- The cloned antibodies that are produced can be to a **specific protein** on the cell or a **particular chemical**
- Monoclonal antibodies have a variety of uses. Some examples include:
  - In **pregnancy tests –** monoclonal antibodies with **blue beads** attached bind to the **HCG hormone** (produced during pregnancy) to show a positive test
  - To **diagnose certain diseases** - in laboratories to **measure the levels of hormones and other chemicals in blood** (such as some cancer proteins), or to detect pathogens
  - **To treat some diseases:** for cancer the monoclonal antibody can be bound to a radioactive substance, a toxic drug or a chemical which stops cells growing and dividing. It delivers the substance to the cancer cells without harming other cells in the body
  - **To locate blood clots** - radioactively labelled monoclonal antibodies are used to **bind to proteins** in a blood clot. A special camera can then be used to make an image of the radiation and locate the potentially harmful blood clot

Use of monoclonal antibodies table

Your notes

Your notes

USE	HOW DOES IT WORK?
PREGNANCY TEST	THE MONOCLONAL ANTIBODIES ARE **SPECIFIC** TO A HORMONE PRODUCED IN PREGNANCY, **HUMAN CHORIONIC GONADOTROPIN** (HCG). THEY WILL BIND TO THE HORMONE IF PRESENT AND PRODUCE A COLOUR CHANGE 
DIAGNOSIS OF DISEASE	THE MONOCLONAL ANTIBODIES ARE **SPECIFIC** TO **ANTIGENS** FOUND ON THE SURFACE OF **PATHOGENS, BLOOD CLOTS** OR **CANCER CELLS**. THEY ALSO CONTAIN MARKERS THAT HELP THE DOCTORS TO FIND THE LOCATION OF THEM. IT IS USED IN THE TEST FOR PROSTATE CANCER.
MEASURING AND MONITORING	THEY CAN BE USED TO DETECT NOT ONLY THE **PRESENCE** OF A CHEMICAL OR PATHOGEN BUT THE **QUANTITY**. FOR EXAMPLE DRUG TESTING OF ATHLETES AND SCREENING BLOOD FOR THE PRESENCE OF HIV.
RESEARCH	MONOCLONAL ANTIBODIES WITH A FLUORESCENT DYE ATTACHED CAN BE USED BY SCIENTISTS TO **DETECT SPECIFIC MOLECULES** IN A CELL OR TISSUE.
TREATING DISEASE	MANY TYPES OF CANCER ARE DIFFICULT TO TREAT. MONOCLONAL ANTIBODIES CAN BE USED IN THREE WAYS TO TREAT CANCER: 1. USE OF THE MONOCLONAL ANTIBODIES TO **TRIGGER IMMUNE CELLS** TO DESTROY THEM

	2. USING MONOCLONAL ANTIBODIES TO **BLOCK RECEPTORS**, WHICH STOPS THEM GROWING AND DIVIDING 3. CARRY TOXIC DRUGS, OR **RADIOACTIVE SUBSTANCES** FOR RADIOTHERAPY, TO THE SITE OF THE TUMOUR

Your notes

Examiner Tips and Tricks

You are not expected to recall any specific tests or treatments but given appropriate information, you should be able to explain how they work using the principles of antibody specificity. You should be able to describe some of the ways in which monoclonal antibodies can be used in the exam. You should also appreciate the power of monoclonal antibodies and be considerate of ethical issues as a result of their production and use.

Advantages & Disadvantages of Monoclonal Antibodies

Higher tier only

- Monoclonal antibodies have the potential to make big **improvements to diagnosis and treatment** and when they were first developed there were hopes for their use to become widespread
- However monoclonal antibodies create more **side effects** than expected which has hampered their use

Monoclonal antibodies table

ADVANTAGES	DISADVANTAGES
• THEY ONLY BIND TO SPECIFIC MOLECULES ON DISEASED OR DAMAGED CELL – THEY DO NOT AFFECT HEALTHY CELLS • HIGHLY SPECIFIC SO CAN BE PRODUCED TO TREAT A RANGE OF CONDITIONS • HOPED TO BE A CHEAPER PROCEDURE, AND A TRIED AND TESTED METHOD OF TREATING CONDITIONS	• CAUSED MORE SIDE EFFECTS THAN FIRST EXPECTED. THE USE OF MICE ANTIBODIES CAUSED COMPLICATIONS. NOW HUMANISED ANTIBODIES ARE BEING DEVELOPED • IT IS AN EXPENSIVE PROCESS AT THE MOMENT • PRODUCING SPECIFIC MONOCLONAL ANTIBODIES IS PROVING TO BE MORE DIFFICULT THAN EXPECTED


Your notes

Lifestyle & Non-Communicable Disease

Your notes

Risk Factors

- **Risk factors** can increase the chance of developing many **non-communicable** diseases
- **Non-communicable diseases** may include:
  - Cardiovascular diseases
  - Cancer
  - Lung and liver diseases
  - Obesity and malnutrition
- **Associated risk factors** are things such as:
  - **Lifestyle choices** e.g. alcohol, diet, drugs and exercise
  - **Environmental exposure** e.g. pollution, noise and asbestos
  - **Unavoidable factors** e.g. age, gender and genetics
- These risk factors are usually **not causative** despite the fact that many will show **correlations** with the rate of infection, this is because interactions between **many different factors** all contribute towards the overall **likelihood** that someone will develop a disease
  - For example; someone who smokes regularly isn't guaranteed to develop lung cancer but their risk compared to someone who doesn't smoke is much, much higher
- A **causal** mechanism has been proven for some risk factors, but not in others

Risk Factors & Causal Mechanisms Table

Your notes

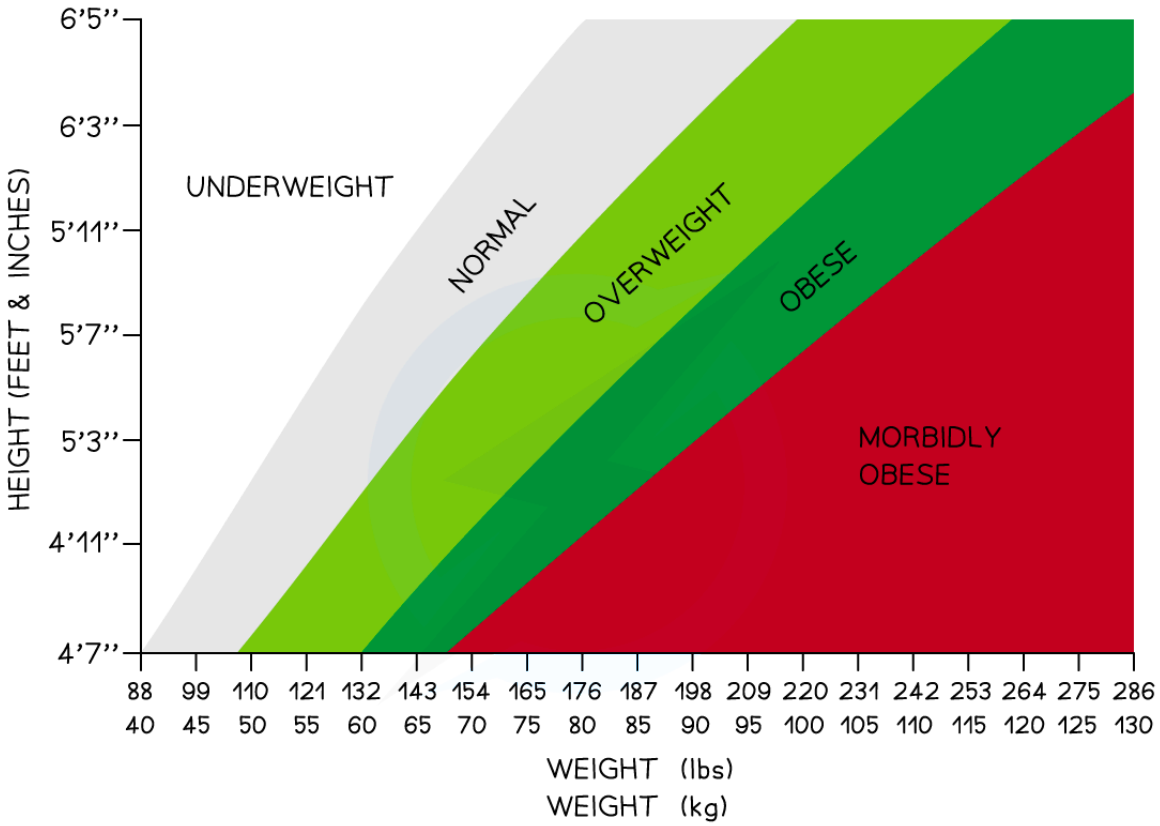
Risk factor	Disease risk factor is linked to	Explanation of how risk factor may cause disease
Smoking	Lung disease, lung cancer and cardiovascular disease	Chemicals in cigarette smoke (such as tar and nicotine) damage the alveoli in the lungs and the endothelial lining of the arteries.
Obesity caused by a poor diet	Type 2 diabetes	Excess consumption of sugar as a result of a poor diet reduces the body's sensitivity to insulin
Consuming alcohol	Liver disease and impaired brain function	The breakdown of alcohol by cells of the liver produces substances which can be toxic to liver cells in high concentrations. The neurones of the brain are also damaged by alcohol, reducing brain function.
Exposure to carcinogens	Cancer	Exposure to ionising radiation (eg. X–rays) or certain chemicals can damage DNA in cells leading to uncontrolled cell division, causing cancer
Smoking and consuming alcohol when pregnant	Poor development of foetus (unborn baby)	Carbon monoxide in cigarette smoke reduces the amount of oxygen transported around the mother's body, reducing the oxygen delivered to the foetus. Substances in alcohol can impair the development of the brain in a foetus.

Your notes

- Some **risk factors** may be associated with multiple diseases e.g. smoking is a risk factor for cardiovascular disease (CVD) and cancer
- Some **diseases** are associated with multiple risk factors e.g. smoking, drinking too much alcohol, poor diet and lack of exercise are all risk factors for cardiovascular disease (CVD)

Obesity and malnutrition

- The key risk factors for both obesity and malnutrition are **exercise** and **diet**
  - Eating more calories than we burn leads to weight gain
  - Significant weight gain can lead to **obesity**
  - Obesity increases the risk of other non-communicable diseases such as
    - Type 2 diabetes
    - Cardiovascular disease
  - Obesity is a national problem and has lead to the introduction of a sugar tax to try and tackle the issue
  - Eating fewer calories than we burn, or having an unbalanced diet can lead to **malnutrition**
  - Malnutrition can lead to many different outcomes depending on the nutrient that is lacking, for example
    - Brittle bones may result if calcium levels are low
    - Anaemia may result from low iron levels
  - Malnutrition is often associated with developing countries as many individuals do not have access to the necessary nutrients
  - **Body Mass Index (BMI)** is a simplistic measurement which uses data about the weight and height of an individual to determine their health status



$$BMI = \frac{\text{WEIGHT IN KILOGRAMS}}{\text{HEIGHT IN METERS}^2}$$

Body mass index can be used to assess the weight of an individual

Liver disease

- Liver disease can result from an **excessively high intake of alcohol** for a prolonged period of time
- Alcoholics, in particular, are prone to liver failure and sometimes cancer as a result of the high alcohol consumption
- Alcoholism also makes individuals at risk of developing other diseases due to vitamin deficiencies which impact their general health
- There is a recommended daily intake level for alcohol to try and guide people towards a sensible level of alcohol consumption
- Advertisements for alcohol in the UK are all delivered alongside the message to "drink responsibly" to try and encourage awareness around the associated health risks

Your notes

Your notes

Lung Disease

- **Smoking** is a key risk factor for lung disease
- Diseases such as **chronic obstructive pulmonary disorder** (COPD), **pneumonia and lung cancer** all develop more commonly in patients who smoke
- This is because there are many disease-causing chemicals present in smoke
  - **Tar** - causes lung cancer
  - **Nicotine** - causes atherosclerosis and high blood pressure
- In the UK, there are rules and restrictions around the sale of nicotine based products including high tax, generic packaging with pictures to deter people and bans on advertising
  - These methods are all aimed at reducing smoking nationally

Cardiovascular disease

- There are many risk factors associated with CVD including
  - **Smoking**
  - **Poor diet**
  - **Lack of exercise**
  - **High alcohol consumption**
- Chemicals in smoke damage the arteries causing **atherosclerosis**
- The issue is amplified by a diet that is high in saturated fats and **cholesterol** which causes the plaques in atherosclerosis to form
- A consequence of these two effects is that the individual will suffer from **high blood pressure** and an increased chance of **blood clots** forming which may lead to a heart attack or a stroke

Other wider impacts of risk factors

- Risk factors not only affect an individual's health but also have an impact on the wider community due to the associated health costs
  - **Society**
    - Particular local areas may have a high incidence of certain cardiovascular diseases due to lifestyle norms e.g. poor diet or high alcohol intake
    - This can put a strain on the local medical resources

- **The economy**
  - There is a huge cost associated with treating and preventing many non-communicable diseases
  - The NHS in the UK provides the resources for treatment
  - Additionally, patients suffering from such diseases may also be unable to work and therefore unable to contribute to the economy of a country
- **International relations**
  - The incidence of non-communicable diseases in a country could be significant enough to reduce the development of that country e.g. a developing country where rates of malnutrition are particularly high will have a reduced workforce
- Considering these categories allows us to establish the impact of risk factors on a national and international level


Your notes


Your notes

Treating CVD

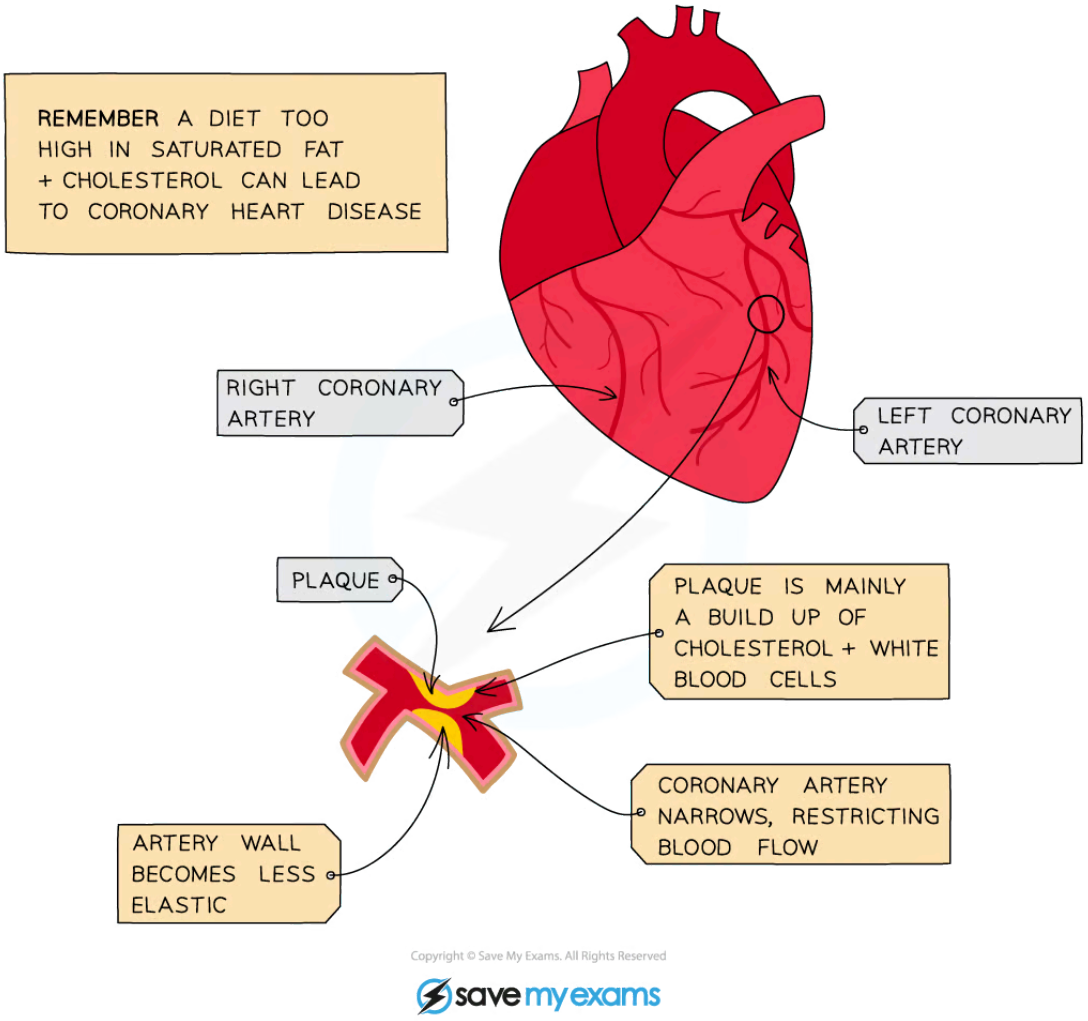
Types of CVD

- Cardiovascular disease includes any long term condition of the **heart or blood vessels**
- CVD usually occurs as a result of **high cholesterol** levels and the build-up of fatty deposits leading to the development of **atherosclerosis**
- There are several categories of CVD which include:
  - **Coronary heart disease** - Angina, heart attacks and heart failure all disrupt the blood flow to the heart
  - **Strokes** - Disruption of blood to the brain
  - **Peripheral arterial disease** - Blockages to (peripheral) arteries in the limbs
  - **Aortic disease** - Conditions associated with the aorta

Cholesterol

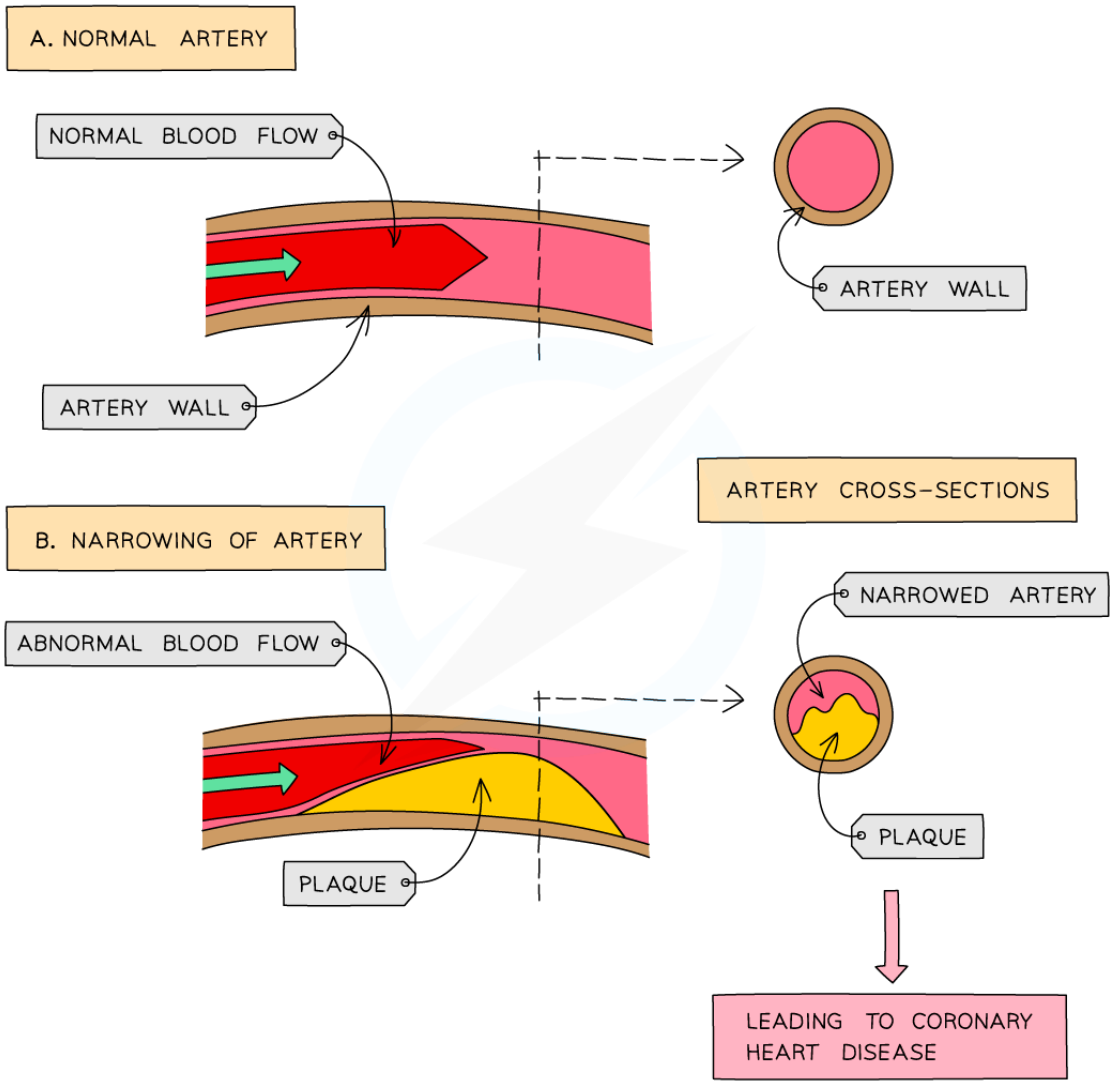
- There are two sources of cholesterol in the body:
  - Dietary cholesterol (from animal products eaten)
  - Cholesterol synthesised by the liver
- In **coronary heart disease** (CHD), cholesterol contributes to the build-up of fatty plaques inside the **coronary arteries**
- **Fatty plaques** reduce the flow of blood through the coronary arteries
  - This is a problem because the **cardiac muscle cells** of the heart are supplied with blood by the **coronary arteries** that branch off directly from the aorta
  - It is vital that this blood reaches these cells in order to supply **oxygen** for constant **respiration**

Your notes



Build-up of plaque in the coronary arteries narrows the lumen

Your notes



The effect of a narrowed lumen in a coronary artery is reduced blood flow to the heart

- If a coronary artery becomes partially or completely blocked by these fatty deposits, it loses its **elasticity** and cannot stretch to accommodate the blood which is being forced through every time the heart contracts
- This reduces the flow of blood through the arteries, resulting in a lack of oxygen for the heart muscle

- **Partial blockage** of the coronary arteries creates a restricted blood flow to the cardiac muscle cells and results in severe chest pains called **angina**
- **Complete blockage** means cells in that area of the heart will not be able to respire aerobically, leading to a **heart attack**


Your notes

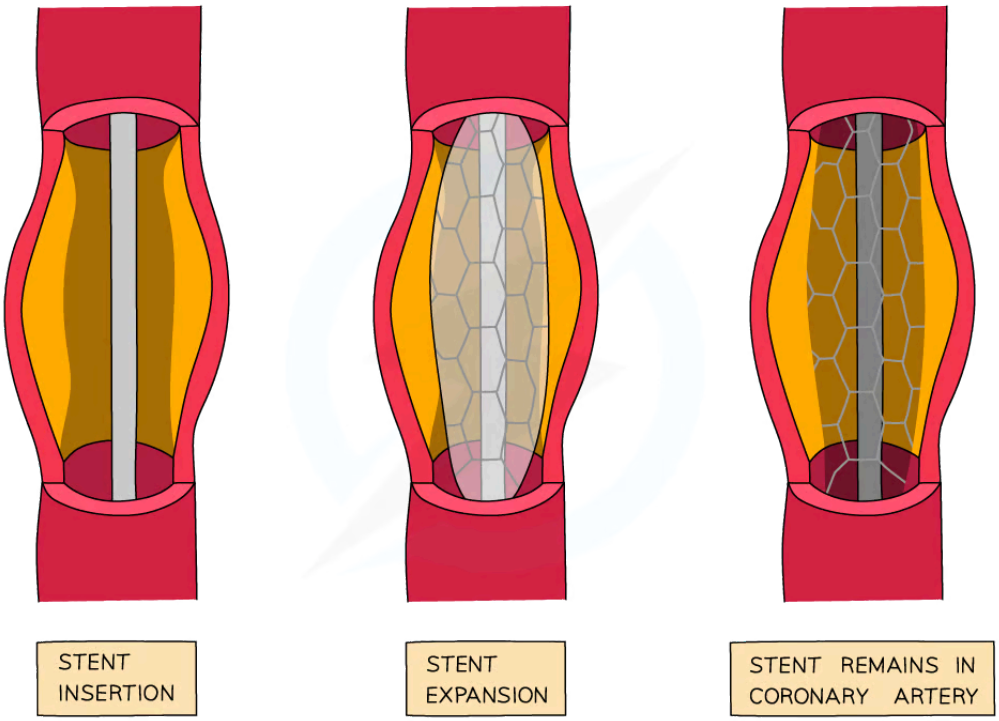
Treatment of CVD

- As cardiovascular diseases usually develop by the same mechanism, they can often be treated in similar ways, including:
  - Surgical procedures
  - Lifelong medication
  - Lifestyle changes

Surgical Procedures

- **Coronary bypass surgery** involves replacing damaged vessels with healthy vessels from elsewhere in the body
  - This allows blocked sections of the heart to be bypassed or replaced
- **Heart transplants** are a more complicated option to treat CVD
  - Transplants carry the risk of rejection and the possibility that the heart will not work at all
  - Patients would need to be on medication permanently
- More commonly, **stents** can be used to keep the coronary arteries open
  - A narrow tube is threaded up through the groin up to the blocked vessel
  - A tiny balloon is then inflated
  - The balloon pushes the metal or plastic stent against the wall of the artery, increasing the width of the lumen
  - The balloon and tube are then removed

Your notes



Inserting a stent into a blocked artery is a relatively simple surgical procedure

- Stents are very effective at reducing the risk of a heart attack as they **widen the lumen to increase blood flow** to the coronary arteries, and the procedure is relatively simple
- Stents also last a long time, which is a positive, however, there is a risk of **blood clots** (thrombosis) occurring around

Treating CVD: Lifelong medication

- **Aspirin** is a drug which is commonly used for pain relief
  - Low levels of aspirin can also be used to reduce CVD
  - It works by inhibiting an enzyme associated with inflammation as well as blocking chemicals required in the formation of blood clots
- **Anti-hypertensives** can be used to reduce blood pressure

- This means less damage caused to arteries and so less build up of fatty plaques

- **Statins** are drugs that are widely used to reduce the levels of fatty deposits (cholesterol) in the blood
  - They **block an enzyme** in the liver which is needed to make **cholesterol**
  - This slows down the rate of fatty material building up in the blood, reducing the risk of CHD occurring
  - There are many advantages and disadvantages of statins:

Statins Advantages & Disadvantages Table

Advantages of Statins	Disadvantages of Statins
Statins reduce the levels of 'bad' (LDL) cholesterol in the blood, reducing the likelihood of plaques building up which lowers the risk of CHD, heart attacks and strokes. Statins can also increase levels of 'good' (HDL) cholesterol in the blood which can remove 'bad' cholesterol circulating around the body.	Statins must be taken regularly and long-term; if someone forgets to take them or doesn't take them regularly then they are less effective. They also take a while to start having an effect. In some people, undesirable side effects such as muscle and joint pain, kidney problems and neurological issues have been reported.

Your notes

Lifestyle changes

- Patients are encouraged to make **lifestyle changes** to reduce the risk of developing or worsening CVD
- Patients should:
  - **Stop smoking** - to reduce the build-up of atherosclerosis
  - **Maintain a balanced diet** including:
    - Low cholesterol to reduce the build-up of atherosclerosis
    - Low salt to reduce the risk of high blood pressure
    - Controlled calories to maintain a healthy weight and reduce strain on the heart

- **Increase exercise** - to maintain a healthy weight and reduce strain on the heart


Your notes