Cardiovascular disease and health risks

Atherosclerosis, blood clotting, risk factors, cholesterol and lipoproteins, vitamin C and antioxidants, analysing health data, perception of risk, and treatments.

Atherosclerosis

Atherosclerosis is the build-up of fatty deposits in the walls of arteries. The sequence of events is:

1. **Endothelial damage**: the inner lining of the artery is damaged (by high blood pressure, smoking or other factors).
2. **Inflammatory response**: white blood cells (monocytes becoming macrophages) move into the wall and take up **LDL cholesterol**, forming foam cells.
3. **Plaque (atheroma) formation**: cholesterol, dead cells, fibrous tissue and calcium build up and form a plaque that bulges into the lumen. The wall hardens and loses its elasticity.
4. The **lumen narrows**, so blood pressure rises and flow decreases. The raised blood pressure damages the endothelium further (a positive feedback).

Consequences: reduced blood supply to tissues, a **thrombus** (clot) and, in the coronary arteries, **angina** or a **myocardial infarction** (heart attack). In the brain a blockage causes a **stroke**.

Blood clotting

When a blood vessel is damaged (including a ruptured plaque), clotting follows:

1. Damaged tissue and **platelets** release **thromboplastin**.
2. Thromboplastin, with calcium ions, catalyses the conversion of **prothrombin** (inactive) to **thrombin** (an enzyme).
3. Thrombin catalyses the conversion of soluble **fibrinogen** to insoluble **fibrin**.
4. Fibrin forms a **mesh** of fibres that traps platelets and red blood cells, forming a clot.

> **NOTE**
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> A clot that forms inside a vessel without an injury (a **thrombus**) can block a coronary artery and cause a heart attack. It is a positive feedback system, so the clotting is fast.

Risk factors for cardiovascular disease (CVD)

Factors that **increase** the risk include:

- **Genetics** (family history, genes affecting cholesterol or blood pressure)

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- **Diet** high in saturated fat and salt, and low in fruit and vegetables
- **Age** (the risk rises as arteries lose elasticity)
- **Gender** (higher for men, and for women after the menopause)
- **High blood pressure**
- **Smoking** (carbon monoxide damages endothelium; nicotine raises blood pressure and heart rate)
- **Inactivity** and **obesity**

Cholesterol and lipoproteins

Cholesterol is carried in the blood in **lipoproteins**.

- **Low-density lipoproteins (LDL)** carry cholesterol to tissues and deposit it in artery walls. A high LDL level **raises** the risk of CVD.
- **High-density lipoproteins (HDL)** carry cholesterol from tissues back to the liver. A high HDL level **lowers** the risk.

Evidence for a causal link between blood cholesterol and CVD comes from **epidemiological** studies (people with higher total or LDL cholesterol have more CVD), from the genetic condition of **familial hypercholesterolaemia**, and from trials showing that **lowering** LDL (with statins) reduces CVD.

Antioxidants

Free radicals damage cells and promote atherosclerosis by oxidising LDL. **Antioxidants** (vitamins C and E, and others in fruit and vegetables) neutralise free radicals, so a diet rich in antioxidants may reduce the risk of CVD.

Core Practical 2: vitamin C

Vitamin C (ascorbic acid) is found in fruit and vegetables.

1. Use **DCPIP** (blue) which turns **colourless** when reduced by vitamin C.
2. Add the food extract to a fixed volume of DCPIP **drop by drop** until it just goes colourless.
3. Compare with the volume needed for **vitamin C standards** (a dilution series) to estimate the concentration.

The more extract needed, the **lower** the vitamin C concentration. Control the volume of DCPIP, the extraction method, and the stirring. DCPIP is affected by light and heat, so carry out the test at the same temperature.

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Analysing health data

- **Correlation does not prove causation.** A correlation between two factors may be due to a third factor, so look for a **plausible mechanism**, a **dose-response** relationship, and evidence from controlled trials.
- **Conflicting evidence** may arise from differences in sample, method or confounding factors.
- Calculate and compare **rates** (per 100 000 people) and use relative risk.

Evaluating the design of studies

A good study has:

- a **large sample size**, so the results are more reliable and chance has less effect,
- a **representative** sample (age, sex, background) selected without bias, so the results are valid,
- control of **confounding variables** (matching groups or statistical adjustment),
- **repeated** results, and a clear definition of what is measured.

Perception of risk

People's perception of risk often differs from the actual risk. They may **underestimate** risks from familiar or voluntary activities (diet, smoking, inactivity) because the effects are delayed, and **overestimate** rare or dramatic risks. Media coverage and personal experience influence perceptions.

Reducing the risk

Knowledge of risk factors is used to reduce the risk of coronary heart disease:

- Diet: lower saturated fat, salt and calories; more fibre and antioxidants.
- Maintain a healthy weight, measured by **body mass index (BMI)** or **waist-to-hip ratio**, with the waist-to-hip ratio better at showing abdominal fat.
- Take **exercise**, and **do not smoke**.

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Treatments for CVD

Drug	Action	Benefit	Risk
Antihypertensives (e.g. beta blockers, ACE inhibitors)	Lower blood pressure	Reduce risk of stroke and heart attack	Dizziness, other side effects
Statins	Reduce LDL cholesterol production in the liver	Lower risk of atherosclerosis	Muscle pain, liver effects
Anticoagulants (e.g. warfarin)	Prevent clotting	Reduce risk of a thrombus	**Bleeding**, as the blood does not clot well
Platelet inhibitors (e.g. aspirin)	Make platelets less sticky	Reduce risk of clots	Bleeding, stomach irritation

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