These notes explain the **why** behind every concept, not just the what. They include **analogies**, **real-life examples**, and explanations of **common mistakes**. Use these alongside your revision notes for full understanding.

4.2.1 Principles of Organisation

Multicellular organisms are not just random collections of cells. They are organised in a precise hierarchy where each level serves a purpose. Understanding this hierarchy helps you understand how our bodies function as a coordinated whole.

Step 1	**Cells**	The basic unit of life — each type is specialised for a specific job (e.g. muscle cell contracts)
Step 2	**Tissues**	Groups of similar cells working together (e.g. muscle tissue = many muscle cells)
Step 3	**Organs**	Groups of DIFFERENT tissues working together for one function (e.g. heart contains muscle, nerve, epithelial tissue)
Step 4	**Organ systems**	Groups of organs that together perform a major body function (e.g. digestive system)
Step 5	**Organism**	The whole living thing, made up of all its organ systems working together

■ ***Think of it like this:*** *Think of it like a school. Individual students (cells) sit in classrooms (tissues) which are in departments (organs) which make up the whole school (organism). Each level works because of the level below it.*

4.2.2 The Digestive System — Breaking Food Down

The digestive system breaks large, insoluble food molecules into small, soluble ones that can be absorbed into the bloodstream. Without digestion, the starch in bread, the proteins in meat, and the fats in cheese could never get into your cells.

Why Does Food Need to Be Digested?

■ **Why does this happen?** Large molecules like starch, proteins and fats cannot pass through the walls of the small intestine into the blood — they are simply too big. Digestion breaks them into smaller units (glucose, amino acids, fatty acids) that are small enough to be absorbed by diffusion and active transport.

- **Mouth:** Teeth mechanically break food into smaller pieces (increasing surface area). Salivary amylase begins digesting starch into sugars.
- **Oesophagus:** Food is pushed down by peristalsis — wave-like muscle contractions. No digestion occurs here.
- **Stomach:** Muscular walls churn food into a liquid (chyme). Pepsin (a protease) digests proteins. Hydrochloric acid kills bacteria and creates the acidic pH pepsin needs.
- **Small intestine:** Receives bile from the liver and enzymes from the pancreas. Most digestion and ALL absorption happens here.

- **Large intestine:** Absorbs water from undigested material. Remaining material becomes faeces.
- **Liver:** Produces bile — not an enzyme, but an emulsifier that breaks fat into tiny droplets, dramatically increasing surface area for lipase.
- **Pancreas:** Produces amylase (breaks down starch), protease (breaks down proteins) and lipase (breaks down fats). These flow into the small intestine.

Enzymes — The Molecular Scissors of the Body

Enzymes are protein molecules that act as biological catalysts. They speed up reactions without being used up themselves. Each enzyme is specific to one substrate — the substrate must fit perfectly into the enzyme's active site.

■ ***Think of it like this:*** *An enzyme is like a specific-shaped key and its substrate is the lock. Only the right key can open the right lock. When the key is in the lock (the enzyme-substrate complex is formed), the reaction happens. The key (enzyme) comes out unchanged and can be used again.*

The induced fit model (more accurate than the older lock and key model) suggests the active site is not perfectly rigid — it slightly changes shape to accommodate the substrate, like a glove moulding around a hand.

Temperature and pH Effects on Enzymes

As temperature rises, particles move faster, collisions between enzyme and substrate become more frequent, and the reaction rate increases. However, above the optimum temperature (around 37°C for human enzymes), the bonds holding the protein in shape begin to break. The enzyme denatures — its active site permanently changes shape and can no longer bind its substrate.

pH affects the charges on amino acids in the active site. Extreme pH values disrupt these charges, again denaturing the enzyme. Different enzymes have different optimum pHs: pepsin works best at pH 2 (stomach acid), amylase at pH 7 (mouth).

"Enzymes are destroyed by high temperature."

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■ **Real-life example:** Washing powder with "biological" enzymes works better at lower temperatures because the enzymes digest stain proteins and fats. Non-biological powder uses chemicals that need higher temperatures. Biological powder cannot be used above about 40°C or the enzymes denature.

4.2.2 The Heart and Circulatory System

The heart is a double pump. The right side receives deoxygenated blood from the body and pumps it to the lungs to pick up oxygen. The left side receives oxygenated blood from the lungs and pumps it to the rest of the body. These are two separate circuits — the pulmonary circulation (heart ↔ lungs) and the systemic circulation (heart ↔ body).

■ **Why does this happen?** Why does the left ventricle have thicker, more muscular walls than the right ventricle? Because it has to pump blood all the way around the body — a much longer journey at higher pressure than the right ventricle's short trip to the nearby lungs.

Coronary Heart Disease — When the Heart's Own Blood Supply Fails

The heart muscle itself needs a blood supply to stay alive. The coronary arteries sit on the surface of the heart and supply it with oxygen and glucose. In coronary heart disease (CHD), fatty deposits called plaques build up inside these arteries, narrowing them. If a plaque ruptures, a blood clot can form and completely block the artery — causing a heart attack (myocardial infarction).

- Lifestyle risk factors: smoking, high saturated fat diet (raises LDL cholesterol), physical inactivity, stress, obesity, high blood pressure.
- Statins: drugs that reduce blood LDL cholesterol — lower the risk of plaque formation.
- Stents: small metal mesh tubes inserted into narrowed coronary arteries to keep them open.
- Bypass surgery: a blood vessel from elsewhere in the body is used to route blood around the blocked section.

4.2.3 Plant Organisation — Transport Without a Heart

Plants do not have a heart, yet they manage to transport water from roots 30 metres up to the leaves of a tall tree. They do this using the properties of water itself and the structure of xylem.

■ **Why does this happen?** Water evaporates from leaves through stomata (transpiration). This creates a negative pressure at the top of the xylem column that literally pulls water up from the roots — like drinking through a straw. The cohesion of water molecules (they stick to each other) means the entire column moves upward as one.

Enzyme	A biological catalyst — a protein that speeds up chemical reactions without being used up
Active site	The specific region of an enzyme where the substrate binds
Denaturation	Permanent change in enzyme shape due to high temperature or extreme pH — active site is destroyed
Peristalsis	Wave-like muscular contractions that push food along the digestive system
Emulsification	Breaking large fat droplets into smaller ones — bile does this, increasing surface area for lipase
Coronary arteries	Blood vessels supplying the heart muscle with oxygen and glucose
Atherosclerosis	Build-up of fatty plaques inside arteries — leads to coronary heart disease