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.

4.5.1 Homeostasis — Why the Body Needs to Stay Stable

The human body works within very narrow ranges of conditions. Enzymes (which control almost every chemical reaction in the body) only function properly at specific temperatures and pH values. Cells need the right concentration of water and salts. If any of these drift outside acceptable ranges, cells malfunction and the organism dies.

Homeostasis is the set of automatic processes that detect and correct any deviation from these optimal conditions. It works through a negative feedback system: a change triggers a response that opposes (reverses) the change, restoring the original condition.

■ ***Think of it like this:*** *A thermostat in a central heating system is the classic example of negative feedback. If the room gets too cold, the thermostat turns the heating on. Once the room reaches the set temperature, the thermostat turns the heating off. The response (heating) opposes the change (getting cold).*

4.5.2 The Nervous System — Rapid Communication

The nervous system allows the body to respond rapidly to changes in the environment. It consists of the central nervous system (CNS) — the brain and spinal cord — and the peripheral nervous system — all the nerves running to and from the rest of the body.

How Nerve Signals Travel

Neurones (nerve cells) are highly specialised for rapid communication. They carry electrical signals called impulses along their length. Neurones are very long (some stretch from your spinal cord to your toes — over a metre!) and are insulated by a myelin sheath, which speeds up signal transmission.

■ **Why does this happen?** Why do some people have slower reaction times than others? The speed of nerve impulses varies — myelinated neurones transmit signals much faster than unmyelinated ones. Multiple sclerosis (MS) is a disease where the myelin sheath breaks down, drastically slowing or stopping nerve signals.

Synapses — Bridging the Gap Between Neurones

Neurones do not touch each other. Between them is a tiny gap called a synapse. When an electrical impulse reaches the end of a neurone, it triggers the release of chemical neurotransmitters that diffuse across the gap and bind to receptors on the next neurone, triggering a new electrical impulse.

■ ***Think of it like this:*** *A synapse is like a ferry crossing a river. The electrical signal (impulse) can travel on land (along the neurone) but must cross the river (synapse) by ferry (neurotransmitter). The ferry takes a moment to cross — this is why synapses slightly slow signal transmission.*

The Reflex Arc — Faster Than Thought

Reflex actions are automatic, rapid responses to stimuli that do not require conscious thought. The signal travels through the spinal cord (not the brain) — this is what makes them so fast. By the time you are consciously aware of touching something hot, your hand has already moved away.

> ■ **Real-life example:** The knee-jerk reflex used by doctors is a monosynaptic reflex — the signal goes directly from sensory neurone to motor neurone without a relay neurone. Doctors test this to check the spinal cord is functioning correctly.

4.5.3 Hormonal Control — Slower but Longer Lasting

The endocrine system uses chemical messengers called hormones, which are secreted directly into the blood by endocrine glands. Hormones travel to all parts of the body but only affect target organs — cells that have specific receptors for that hormone. Hormonal responses are slower than nervous responses but last much longer.

Blood Glucose Control — A Perfect Example of Negative Feedback

Blood glucose must be kept between about 4 and 8 mmol/L. The pancreas constantly monitors blood glucose levels and releases hormones to correct any deviation.

Step 1	**Blood glucose rises**	After eating a carbohydrate-rich meal, glucose is absorbed from the gut into the blood. Levels rise above normal.
Step 2	**Insulin released**	Beta cells in the pancreas detect high glucose and release insulin into the blood.
Step 3	**Cells respond to insulin**	Insulin causes cells throughout the body (especially liver and muscle cells) to take up glucose. In the liver, excess glucose is converted to glycogen (insoluble storage polysaccharide) — this is glycogenesis.
Step 4	**Blood glucose falls**	As glucose leaves the blood, levels fall back towards normal. Insulin secretion decreases.
Step 5	**If glucose falls too low**	Alpha cells in the pancreas release glucagon. This signals the liver to break glycogen back down into glucose (glycogenolysis) and release it into the blood.

"Insulin destroys glucose."

✓ **Actually:**
convert it to
glucagon tri

Homeostasis	Maintenance of a stable internal environment despite external changes
Negative feedback	A control mechanism where a change triggers a response that opposes the change, restoring normal conditions
Neurone	A specialised nerve cell that carries electrical impulses
Synapse	A junction between two neurones — signal crosses using chemical neurotransmitters
Reflex arc	The pathway of a reflex: receptor → sensory neurone → relay neurone → motor neurone → effector
Hormone	A chemical messenger secreted by a gland into the blood, affecting specific target organs

Insulin	Hormone from pancreas that lowers blood glucose by stimulating glucose uptake and glycogen storage
Glucagon	Hormone from pancreas that raises blood glucose by stimulating glycogen breakdown in the liver
Type 1 diabetes	Autoimmune condition — pancreas cannot produce insulin — requires insulin injections
Type 2 diabetes	Body cells become resistant to insulin — linked to obesity — managed with diet, exercise and medication