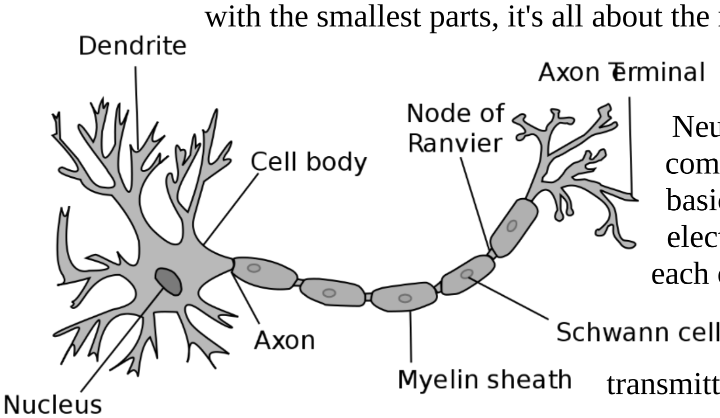
**The Chemical Mind: Crash Course Psychology #3**

Say it's late at night, you're home alone drifting off to sleep, just, entering that dream about Fritos, and then suddenly there's a banging at the door! Suddenly you're wide awake and it feels like your heart's gonna explode. You jump up, ready to run out the back door, possibly grab a **Phillips head screwdriver** and stab it into the darkness until it sticks into something.

Now whether it's a **Weeping Angel** or your neighbor looking to borrow a can of beans, it doesn't really matter because when you heard that sudden noise, your startled brain released an icy typhoon of chemicals. And everything that's now going through your mind, like your urge to flee, your urge to defend yourself, that internal debate about whether Weeping Angels are even real and "Woah! Where's the cat?" All that? Is just a result of those chemicals.

Our brains and our nervous systems and the substances they produce and are always bathed in are amazingly complex nuanced systems. And even though we're always talking about our mental activities being somehow separate from all the biological stuff going on in our bodies, in reality, the moods, ideas, impulses, that flash through our minds are spurred by our biological condition. As psychologists like to say, "Everything psychological is biological."

So, one way to understand how your mind works is to look at how the chemistry of your body influences how you think, sense, and feel about the world around you. To do that, we begin at the simplest level, the system with the smallest parts, it's all about the neuron, baby.




Neurons, or nerve cells, are the building blocks that comprise our nervous systems. Neurons share the same basic makeup as our other cells, but they have electrochemical mojo that lets them transmit messages to each other. Your brain alone is made up of billions of neurons, and to understand why we think or dream or do anything, you gotta first understand how these little transmitters work.

You actually have several different types of neurons in your body, from ones that are less than a millimeter long in your brain to ones that run the whole length of your leg! Yes, you have cells as long as your legs, which is nothing compared to the hundred and fifty feet the nerve cells of some dinosaurs had to be, I'm getting off topic, sorry.

No matter how big a nerve is, they all have the same three basic parts: the soma, dendrites, and axon. The soma, or cell body, is basically the neuron's life support; it contains all that necessary cell action like the nucleus, DNA, mitochondria, ribosomes, and such. So, if the soma dies, the whole neuron goes with it.

The dendrites, as bushy and branch-like as the trees they're named after, receive messages and gossip from other cells. They're the listeners, whispering what they hear back to the soma.

The axon is the talker. This long, cable-like extension transmits electrical impulses from the cell body out to other neurons or glands or muscles. Whereas the dendrites are short and bushy, the axon fiber is long, and, depending on what type of neuron it is, is sometimes encased in a protective layer of fatty tissue, called the myelin sheath.

It's almost like an insulated electrical wire, the myelin sheath speeds up the transmission of messages, and if it degrades, as it does with those affected with multiple sclerosis, those signals are degraded as well, eventually leading to lack of muscle control.

Neurons transmit signals either when stimulated by sensory input or triggered by neighboring neurons. The dendrites pick up the signal and activate the neuron's action potential, or firing impulse, that shoots an electrical charge down the axon to its terminals and towards the neighboring neurons.

The contact points between neurons are called synapses. All those bushy little dendrites are decorated with synapses that almost but don't quite touch the neighboring axon in the tiniest game of "I'm not touching you!" of all time. They're less than a millionth of an inch apart. And that microscopic cleft is called the synaptic gap.

So, when an action potential runs down to the end of an axon, it activates the chemical messengers that jump that tiny synaptic gap, flying like that little air kiss and landing on the receptor sites of the receiving neuron. Those messengers are neurotransmitters.

Although neurotransmitters slide right into their intended receptors like a key into a lock, they don't stay bonded to the receiving neuron. They just sort of pop out, having excited or inhibited the receiving neuron's trigger, then the extras immediately get reabsorbed by the neuron that released them in the first place in a process called reuptake.

Kinda like, "Here you go, oh, psych!"

So, neurons communicate with neurotransmitters which in turn cause motion and emotion; they help us move around, **make jazz hands**, learn, feel, remember, stay alert, get sleepy, and pretty much do everything we do. Some of them just make you feel good, like the endorphins we get flooded with after running ten miles or falling in love or eating a really good piece of pie.

We've got over 100 different kinds of these brilliant neurotransmitters -- some are excitatory, and others are inhibitory, and all are good reminders that everything psychological is, also, biological. Excitatory neurotransmitters rev up the neuron, increasing the chances it will fire off an action potential. Norepinephrine is one you're probably familiar with, it helps control alertness and arousal. Glutamate is another, involved in memory, but an over-supply of it can wig out the brain and cause seizures and migraines which is why some people are sensitive to all that MSG, or monosodium glutamate, in their **Ramen.**


Inhibitory neurotransmitters on the other hand, chill neurons out, decreasing the likelihood that the neuron will jump into action. GABA– gamma-aminobutyric acid– is a major inhibitory neurotransmitter, and you've probably heard of serotonin which affects your mood and hunger and sleep. Low amounts of serotonin are linked to depression, and a certain class of antidepressants help raise serotonin levels in the brain.

Some neurotransmitters, like acetylcholine and dopamine, play both sides and can both excite or inhibit neurons depending on what type of receptors they encounter. Acetylcholine enables muscle action and influences learning and memory; Alzheimer's patients experience a deterioration of their acetylcholine producing neurons. Dopamine, meanwhile, is associated with learning, movement, and pleasurable emotions, and excessive amounts of it are linked to schizophrenia as well as addictive and impulsive behavior. So, neurotransmitters are basically your nervous system's couriers.

But they aren't the only chemical messengers delivering the news; they've got some competition brewing in the endocrine system. And if you've been through puberty, you know what I'm talking about: hormones. Like neurotransmitters, hormones act on the brain, and indeed some of them are chemically identical to certain neurotransmitters.

Hormones affect our moods, arousal, and circadian rhythm, they regulate our metabolism, monitor our immune system, signal growth, and help with sexual reproduction. You could say that most of them boil down to the basics: attraction, appetite, and aggression. Whereas neurons and synapses flick on and off, sending messages with amazing speed, the endocrine system likes to take its time, delivering the body's slow chemical communications through a set of glands that secrete hormones into the bloodstream where they're ferried to other tissues, especially the brain.

So, while the nervous and endocrine systems are similar, in that they both produce chemicals destined to hit up certain receptors, they operate at very different speeds. It's like, if the nervous system wants to get in touch with you, it sends you a text. But if the endocrine system has a message, it will like lick the stamp, and put it on, and write your address, and then a note and a pen on paper, and then fold it up and put and mail it to you with the Post Office.

But fast isn't always better, and your body will remember that letter longer than the text. Hormones, they linger. Which helps explain why it takes some time to simmer down after a moment of severe fright or anger. And our endocrine systems have a few important hormone brewing glands. We've got a pair of adrenal glands snuggled up against our kidneys that secrete adrenaline, that famous fight or flight hormone that jacks up your heart rate, blood pressure and blood sugar, giving you that tidal wave of energy preparing you to run like heck or punch that charging baboon in the throat; the pancreas sits right next to the adrenal gland and oozes insulin and glucagon hormones that monitor how you absorb sugar, your bodies main source of fuel. Your thyroid and parathyroid glands at the base of your throat secrete hormones that regulate your metabolism and monitor your body's calcium levels; if you have testicles, they're secreting your sex hormones like estrogen and testosterone, and if you've got ovaries, they're doing that job.

And all those glands are super important, but there is **one gland that rules them all, and in the darkness binds them: the pituitary gland**. Although it's just a little pea-sized nugget hidden deep in the bunker of the brain, it is the most influential gland in this system. It releases a vital growth hormone that spurs physical development and that love hormone, oxytocin, that promotes warm, fuzzy feelings of trust and social bonding.

What really makes the pituitary the master gland is that its secretions boss around the other endocrine glands, but even the pituitary has a master in the hypothalamus region of the brain, which we will talk more about next episode.

So, AHHHHHHHHH! if I managed to scare you, sorry, but I'm illustrating a point.

You have no control over being scared, but maybe now you do understand a little more clearly how your nervous and endocrine systems worked together to call the shots. First, the sensory input from your eyes and ears went to your brain, the simplest bits of your hypothalamus without even letting you analyze it and were like ahhhh, and then, that ran down the chain of command from your pituitary to your adrenal glands, to the hormone adrenaline, to the rest of your body and then back to your brain, which then realized that I was just messing with you and told everybody to just calm down for once!

The whole deal is a feedback loop: your nervous system directs your endocrine system which directs your nervous system, brain, gland, hormone, brain. And, of course, each of these systems is fantastically complex. Way more than we can get into here.

So, in our next lesson, we're gonna get all up in your brain, and delve deeper into the different components of your nervous system, find out what your old brain is, and learn about how much of your brain you actually use.