Brain Basics and the Social Brain

Why do people behave the way they do?

BRAIN WAVE Centre
Mind, Brain and Education

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Welcome

Please allow me to introduce myself.

I 'm Dr. Kim Calder Stegemann. I am an author, a university professor, a therapist, researcher, and I hold designations for neuromodulation and neurofeedback. I have dedicated my professional career to helping others make positive changes in their lives and feel better about themselves.

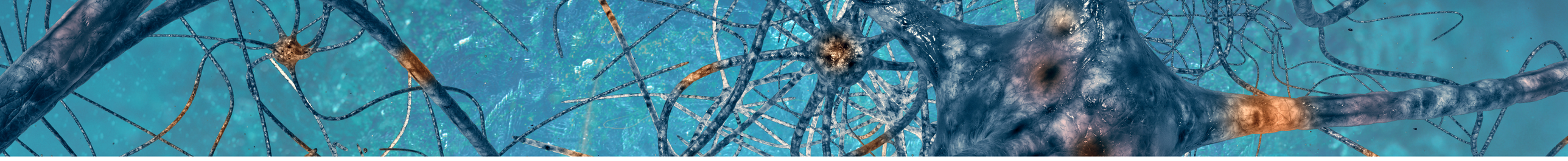
How do I do that? I use a wholistic approach — I look at brain activity, body functioning, external behaviour, social context, and a person's emotional well-being.

Every thought, sensation, and emotion that we have is ultimately a function of our brain and our nervous system, and the interaction with our environment. When your brain and body work right, you work right. That is why it is so crucial to better understand the brain — whether you are in the fields of education, psychology, or the corporate world. Knowledge about brain health allows us to help our students, clients, and employees.

This e-book will provide the reader a basic understanding of the brain, key structures and functions, and also how the brain learns and develops — it's plasticity!! Of course, the book is no replacement for a neurological textbook and/or a consultation with a neurologist. But, it will provide you with a good grounding for more learning about this amazing machine!!

Dr. Kim Calder Stegemann

PH.D., CCC, QEEG-D, BCN



What's going on?

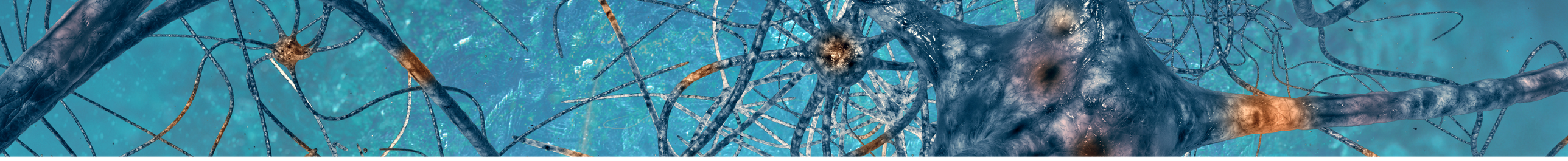
- Do you feel like you need more information about the brain to best help your students, clients, or employees?
- Are you curious why people behave and act the way they do?
- Do you ever wonder why some people function as if they were “programmed"?

THEN THIS E-BOOK IS FOR YOU!

In this e-book we will delve into the parts of the brain, how our brains develop and what happens to the brain when in a highly emotive state. You will also learn more about neuromodulation and why quantitative EEG's (QEEG) are so important to fully understand a person's individual brain waves and how best to help them.

The best part about this? It is now affordable to get a glimpse into the brain without invasive procedures and million dollar machines! With the knowledge we now possess, it is possible to modify brain (and body) activity to enhance performance and achieve desirable results.

Neuroscience is now available to EVERYONE!



How do I know this will help?

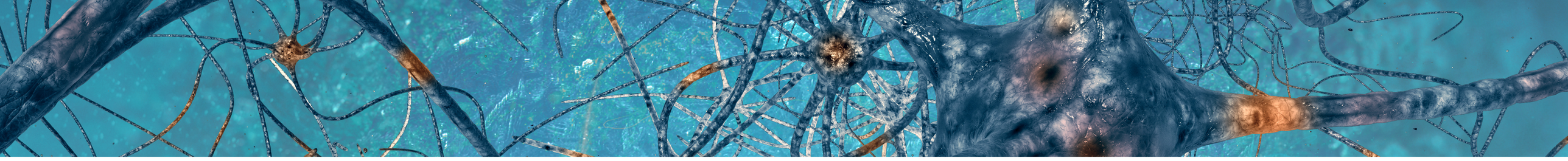
Because I've been where you are.

When I was a teacher of those with special learning needs, I always wondered what was going on "inside the heads" of my students, rather than just relying on observations for assessments, program plans, or teaching. I wanted solid facts, graphs, and science to support my observations.

I needed a comprehensive assessment of those children so I could help them in the best way(s) possible. I wanted the whole picture.

However, I was limited in what I could do as a teacher.

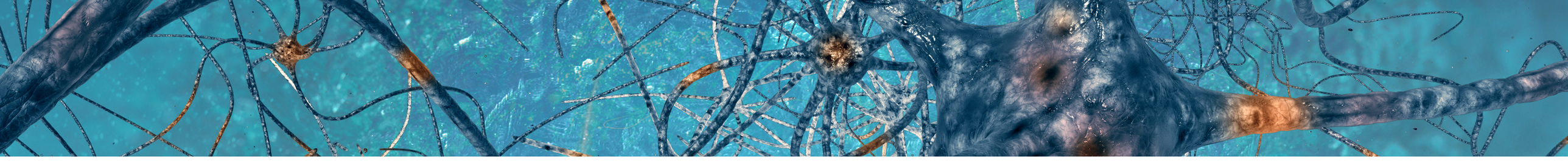
One of the best things I did was to gain certifications in psychotherapy, QEEG (quantitative evaluation of the EEG recordings), neurofeedback, and EMDR (eye movement desensitization and reprocessing). Now, I'm not suggesting you do this as well ... but I'd like to share some of what I have learned over the years working with many different types of people.



“The human brain has 100 billion neurons, each neuron connected to 10 thousand other neurons. Sitting on your shoulders is the most complicated object in the known universe.”

T-Mobile, 2019

Dr. Michio Kaku, Theoretical Physicist

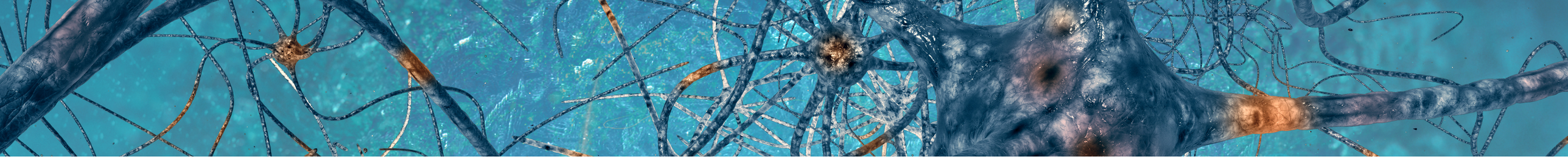


Real life stories of change

I had a top executive come to me because of **OCD** symptoms. She was a “tapper” and also someone whose brain was so busy that she would count the number of words that I was using, AND THE NUMBER OF SYLLABLES, all while listening to me and totally comprehending! She only came for five or six sessions and quickly figured out a few strategies to bring down the extremely large amounts of hi-beta (very fast brainwaves) in the frontal lobe and above the anterior cingulate. The compulsive tapping decreased, as did the counting of words and syllables. It was important for her to keep practicing her strategies. She also had to be sure to keep up her exercise routine (aerobics 3 x/week), follow a strict sleep schedule, and maintain a balanced diet.

One patient was a veteran who was suffering from **PTSD**, **anxiety**, and **depression**. He had sustained brain injury from multiple blast injuries. We used stimulation and neurofeedback to help heal and settle his brain. He also was very careful about his diet, consumption of alcohol, and sleep hygiene. It wasn’t a quick fix, but he was able to establish a much happier and balanced life.

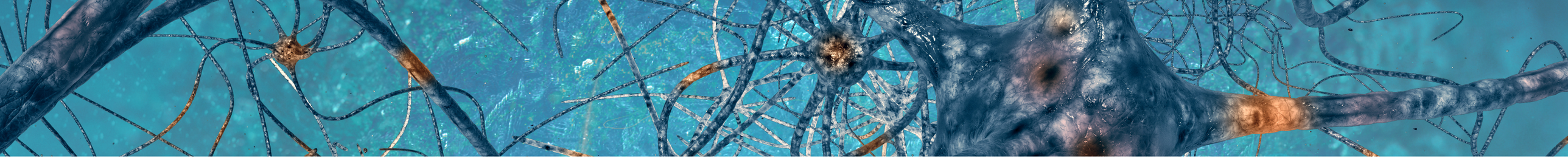
A **Native elder** came to me to help her with **trauma** she had suffered as a result of being in a residential school. We used neurofeedback and some neurostimuatlion to reset the brain, and also allow her to release trauma that seemed to have been “trapped” in her mind and body.



I KNEW I found the right combination of assessments and interventions to best help people.

SO, HOW CAN I HELP YOU?

In the following pages, I will hopefully provide you with an in-depth look into the brain, it's development, and how different modulations can have positive effects on behaviour. For a more comprehensive understanding, please register for my BrainWave Academy course. It is a course designed for those who are interested in knowing what's really going on inside the brain.



Brain myths

The human brain is amazing — made of 100 billion neurons that control everything from your movement to your personality. But it's also often misunderstood. Here are 10 myths you may have heard about the brain.

1) You only use 10% of your brain.

2) Brain size affects intelligence.

3) Alcohol kills brain cells.

4) Babies exposed to classical music end up smarter.

5) Left-brained people are more analytical and methodical, while right-brained people are creative or artistic.

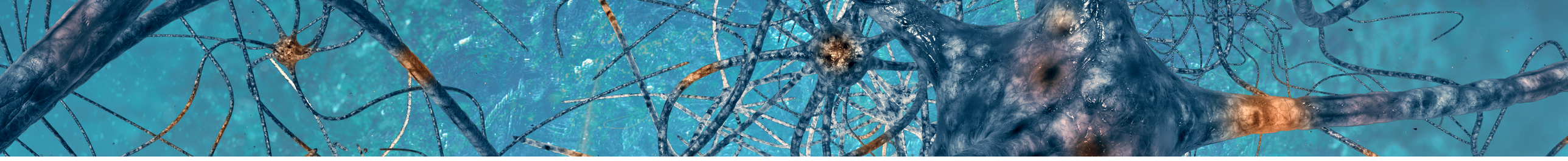
6) Brain size declines as you get older.

7) People have different learning styles.

8) Brain games improve your memory and reasoning skills.

9) Your IQ stays the same throughout your life.

10) Your brain works better under pressure.

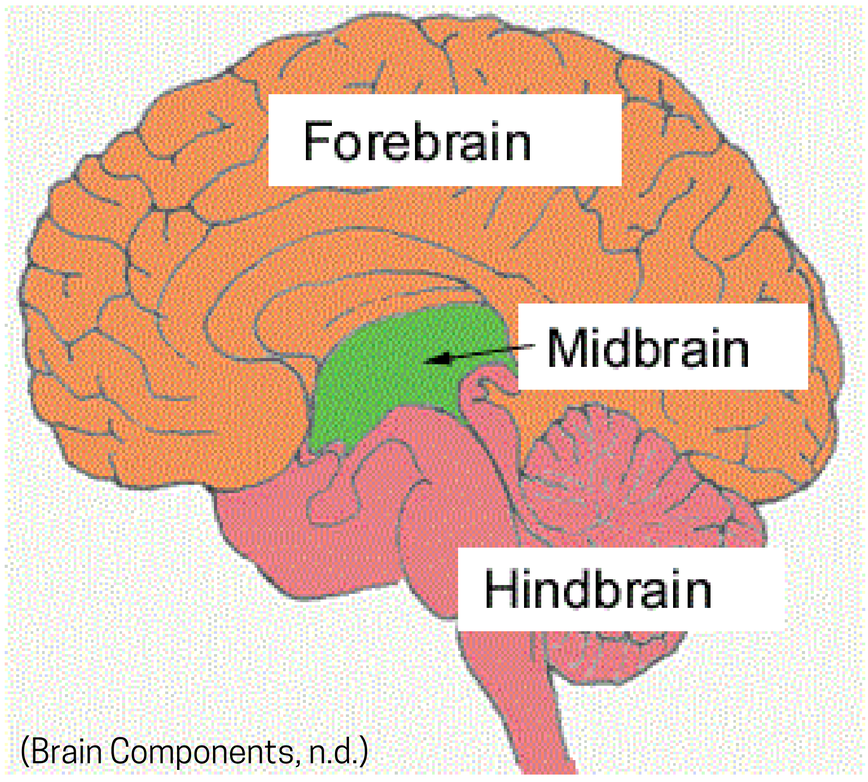


Parts of the brain

Evolutionarily our brains developed from the bottom up, beginning with the brain stem and cerebellum. It is only as we became homo-sapiens that our forebrain, and in particular the pre-frontal cortex, developed.

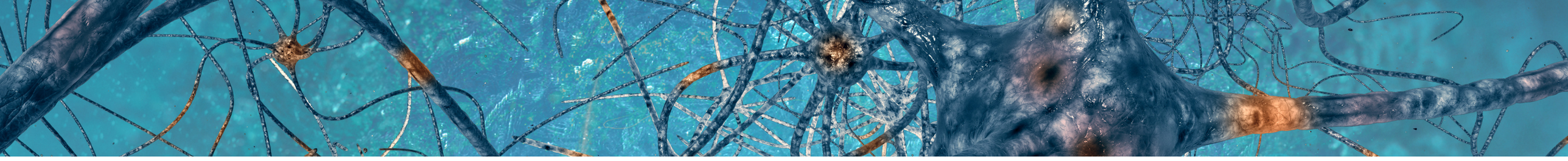
Let's look at the fully formed human brain, starting with the THREE main regions: **hind-brain**, **mid-brain**, and **forebrain**.

The **hind-brain** consists of the brain stem and cerebellum (the small cauliflower shape at the back and base). The brain stem connects to the spinal cord, which is the major highway to all organs and peripheral parts of the body. The cerebellum, sometimes referred to as the "primitive brain" or the "lizard brain", is responsible for basic bodily functions such as heart rate and respiration. It is also the part of the brain that enacts the "fight, flight, freeze, or feign" response. Because it was key to the survival of our primitive ancestors, it got the name "primitive brain". The "lizard brain" moniker came about because, if you consider that we may have evolved from the more basic of creatures, including lizards, the very basic survival instincts are housed in the "lizard brain".

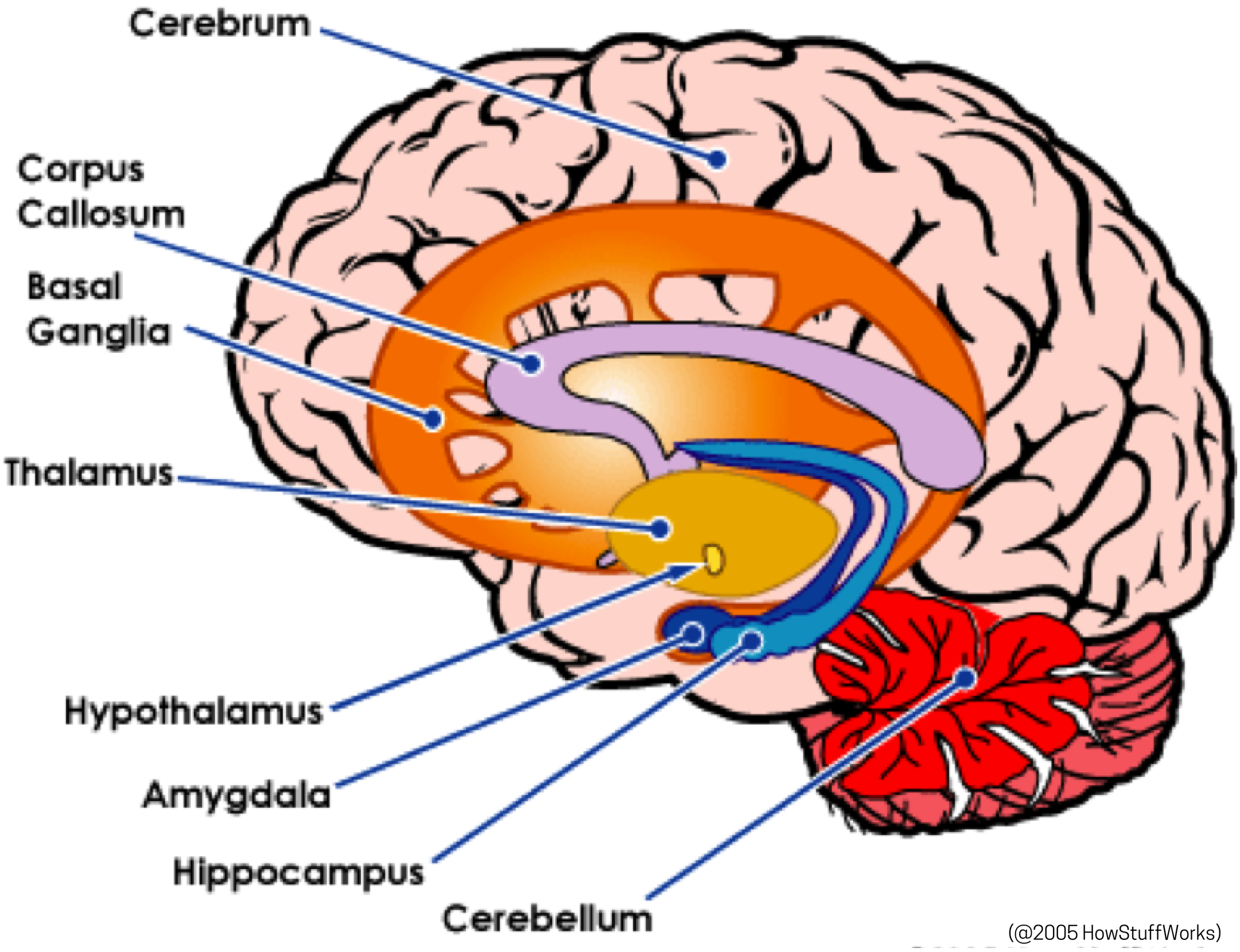


(Brain Components, n.d.)

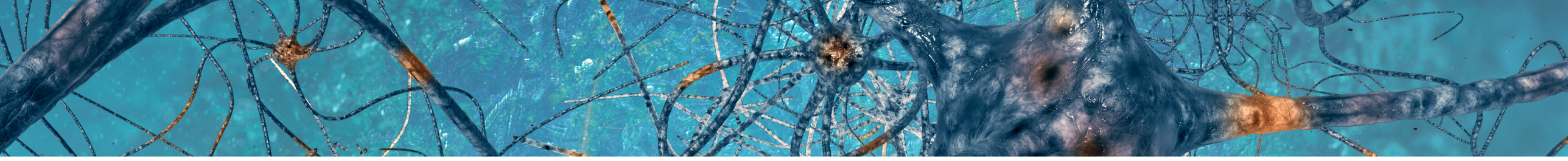
For simplicity purposes, I'm going to refer to the **mid-brain** as composed mainly of the limbic system. (Detailed neurology textbooks will include different brain structures here, but I am trying to keep it simple!) The **limbic system** is far from simple, however. You might know it to be responsible for emotions, which is true. But, it does a lot more than that. It is a key system that processes and interprets messages from the forebrain to the hindbrain and visa versa. It is also where you find the thalamus, which is the main generator of such brainwaves as delta, theta, and alpha. (We'll talk more about brainwaves later.)



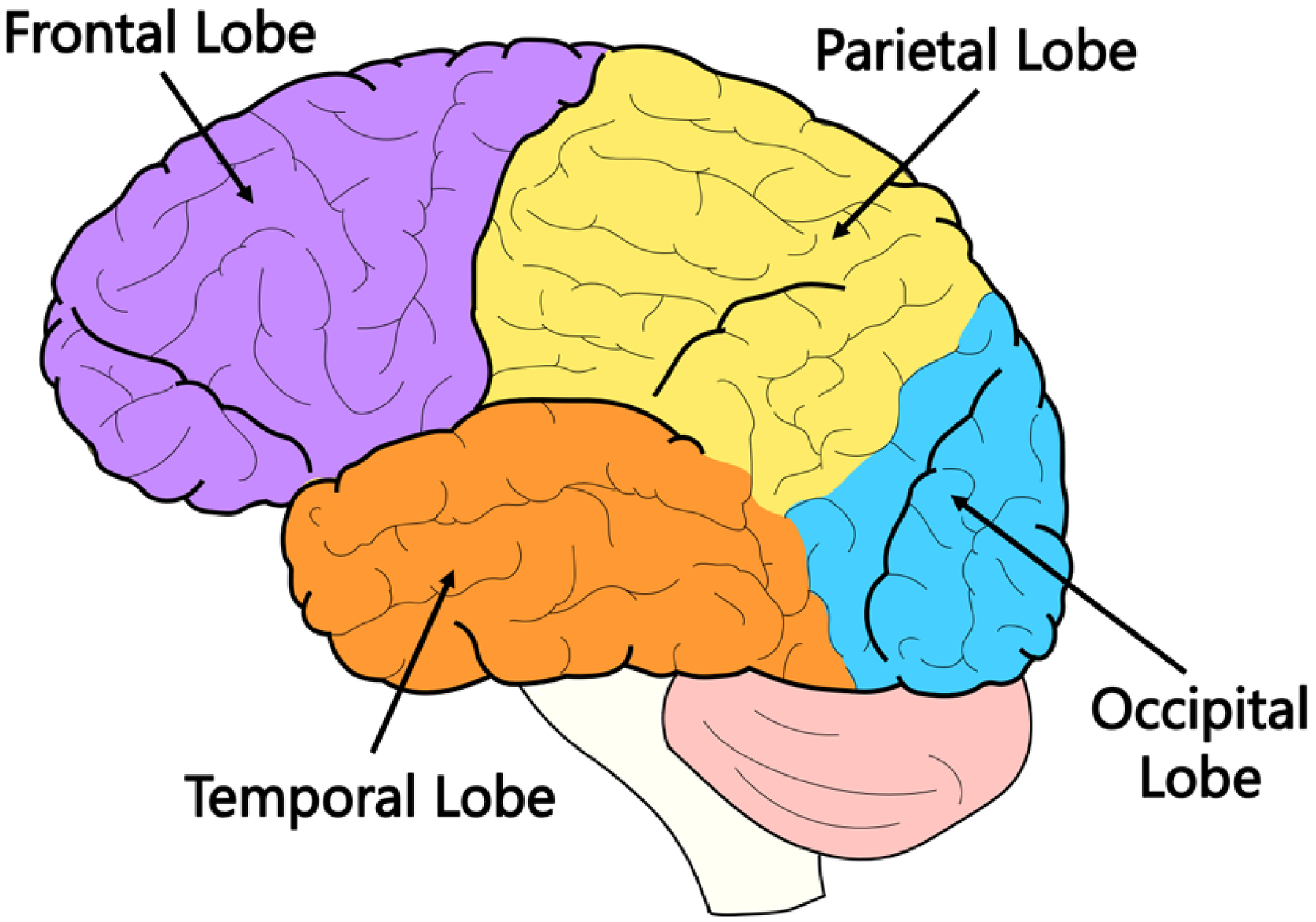
The **limbic system** is also comprised of such structures as the hippocampus (partly responsible for storing memories), the amygdala (which is the alarm system alerting us of potential danger), the hypothalamus (which in part controls the release of important hormones), and the basal ganglia and striatum (these are important parts which are in charge of motivation, adjusting motor behaviour, and integrating feelings). When the basal ganglia is overactive, an individual may "struggle with anxiety and physical stress symptoms, such as headaches, intestinal problems, and muscle tension" (Amen, 2008, p. 59).



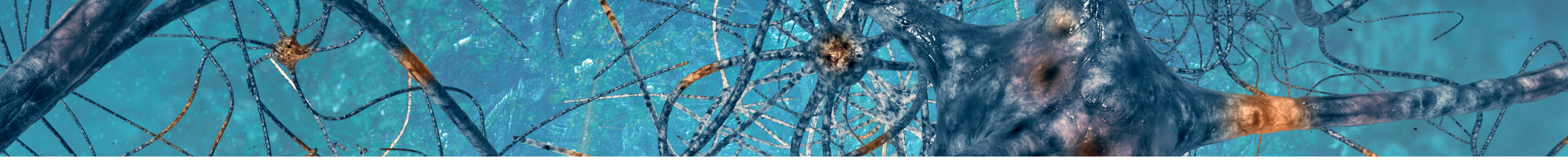
(@2005 HowStuffWorks)



Now let's move to the biggest part of the brain — the **forebrain** which consists of all of the four lobes of the cortex — frontal, parietal, temporal, and occipital. That's a lot of real estate just for the forebrain, but it is one of the features that distinguish us from other animals. While we are talking about the forebrain, we should talk about the typical functions of each of these lobes.



(Brainframe-Kids, 2020)

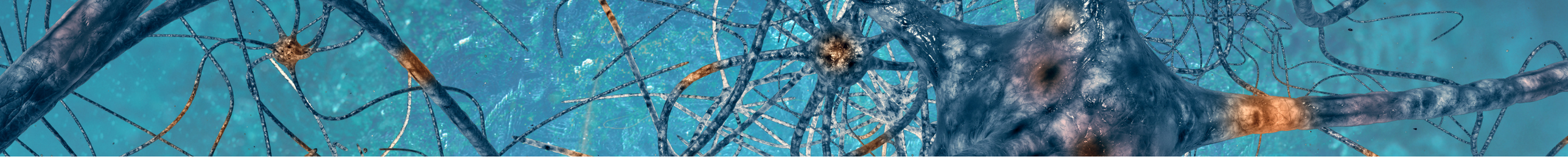


The **frontal lobe** is like the CEO (Chief Executive Officer). It's responsible for planning, evaluating, reasoning (sometimes referred to as executive functions.....which might help you to remember what this key executive actually does). It is also responsible for impulse control and error identification, and is the last part of the brain to fully develop. Some say that the frontal lobe does not fully mature until around the age of 25, a fact that most car insurance companies are well aware of! Because the forebrain is so late in developing, it is a huge worry when we see teens and young adults using drugs, alcohol, or even excess caffeine. All of these substances impair the development of the still fragile brain.

Another part of the forebrain is the **parietal lobe**. It is the strip of the brain beginning just behind and above the ears, stretching over the top to the other side. The parietal lobe is involved in processing sensory information and memory retrieval. The parietal lobe has garnered a lot of attention with those studying Autism Spectrum Disorder (ASD) because mirror neurons are at at the bottom part of the strip. Mirror neurons interpret the emotions of others and are typically impaired in individuals living with ASD.

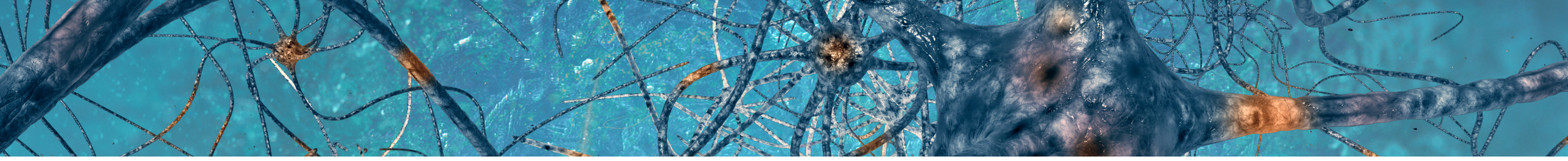
The **temporal lobes** are located on each side of the head and they are important for processing auditory information and also for storing and retrieving memories.

The part at the back of the brain is called the **occipital lobe**. It is in charge of generating and processing visual information. As we learn more about Post Traumatic Stress Disorder (PTSD), we have focused, in part, on the occipital lobe. Some individuals have impaired functioning when closing their eyes because they are trying to block out any visual memories of traumatic events. Of course, other key areas are also involved in PTSD, such as the limbic system.



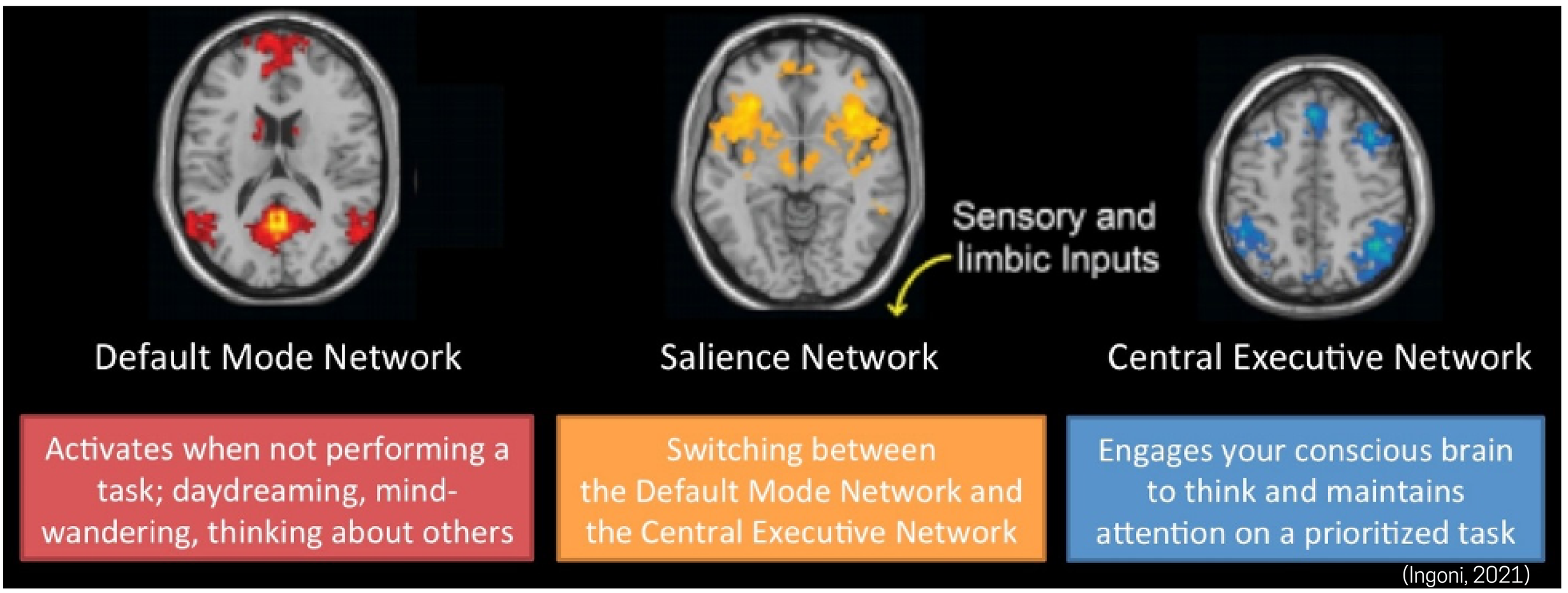
Two hemispheres

Last, I should mention that the brain has two hemispheres, left and right, connected by a tissue called the corpus collosum. The corpus collosum doesn't get a lot of attention, but you can imagine how important it is for the brain to share and process information from one hemisphere to the other. In basic terms the left hemisphere is responsible for language and logical, linear functions, while the right brain deals with creative, emotional, and non-linear functions. We used to characterize people as left- or right-brained, depending on their abilities with certain tasks. For example, an artist might be considered to be more right-brained; however, we now know that there are different networks in the brain which encompass both hemispheres and several different parts at once. As you will continue to learn, the brain is too complex to boil it down into just left- or right-brain dominant.



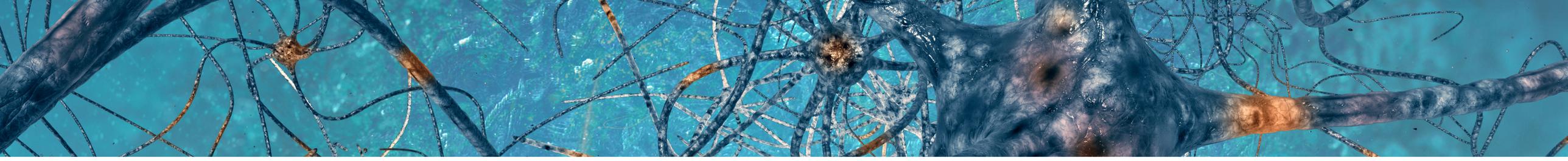
Networks and nodes

New forms of neuroimaging have allowed us to see the workings of these networks. By doing so we have discovered that there are key nodes or hubs within the brain, kind of like major intersections, connecting multiple pathways. If signals can travel at over 250 mph (roughly 300 km/h) (Amen, 2008), you wouldn't want to be a distracted pedestrian in these intersections!



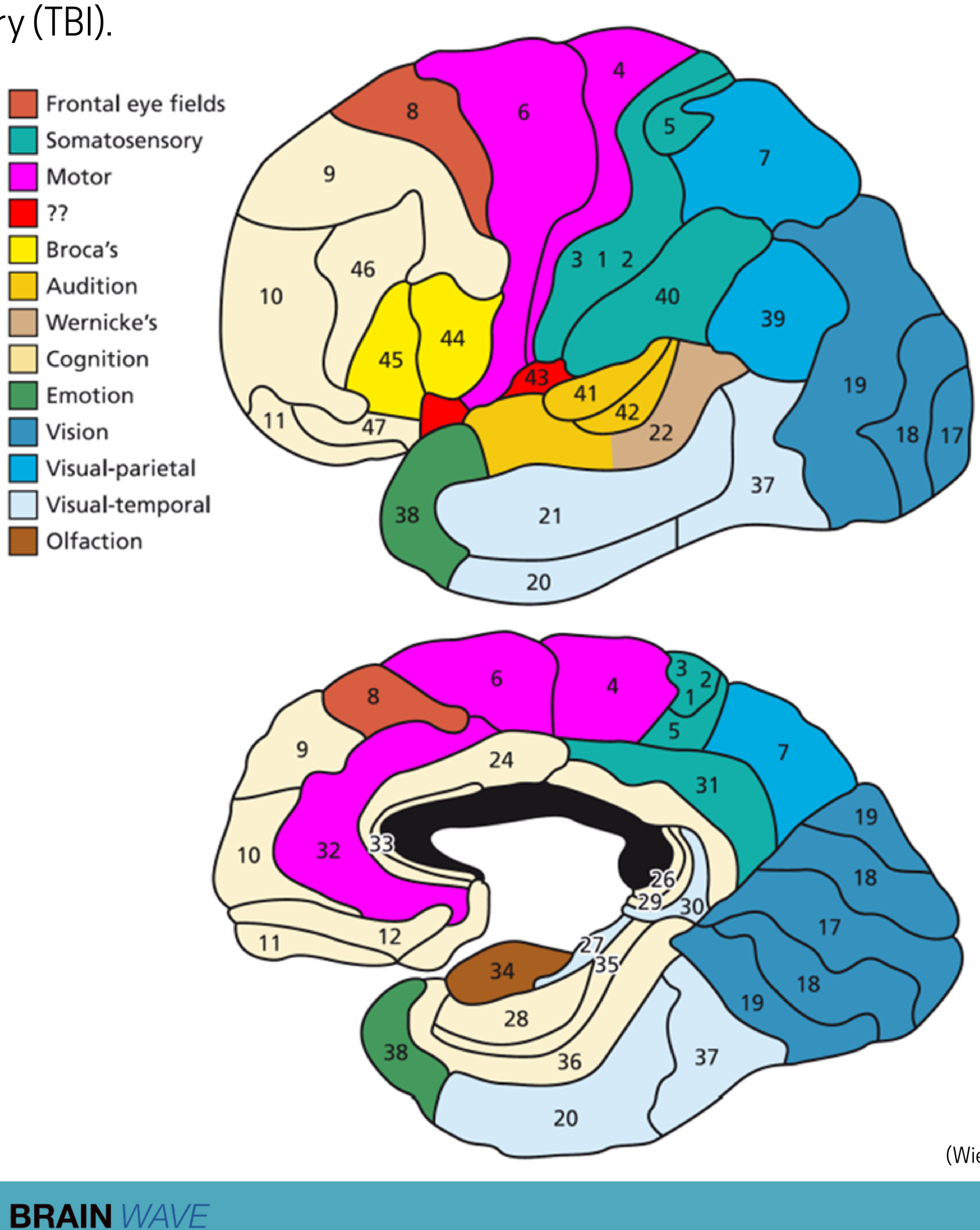
There are many different networks within the brain, but THREE main ones are the Default Mode Network (DMN), the Salience Network (SN), and the Central Executive Network (CEN).

You can probably guess what the Salience and Central Executive networks do, based just on the name, but the Default Mode Network is a bit different. The DMN is active when your brain isn't actively processing any specific information, like when you are daydreaming. But it is important because you want it to be revving at a good speed so that when a major task is at hand, it can kick in quickly. I have seen some people with a DMN that is both revving too high in one part and also revving too slow in another part, like having your foot on the gas pedal and the brake at the same time. Not only is this exhausting, it leaves the brain being far less efficient than it could be.

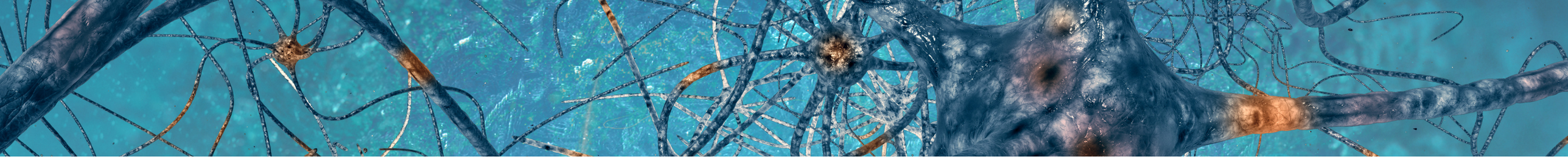


Brodmann areas

While we are talking about parts of the brain and specific functions, we should give a nod to a scientist from the late 1800 and early 1900s. Dr. Korbinian Brodmann was a German neurologist who dissected the brains of corpses to examine the structure of the tissues. Based on these very thin slices of the fore-, mid-, and hind-brain regions, he was able to separate the brain into even finer areas. We call them Brodmann areas (BAs), and there are roughly 50 odd BAs, each which have been further examined for specific functions for which they are typically responsible. It is not an exact science, again because the brain is far too sophisticated to be broken down into 50 areas of function, but it does provide a beginning point to examine when an individual is experiencing some particular mental ailments such as stroke, PTSD, or even traumatic brain injury (TBI).



(Wiese et al., 2017)

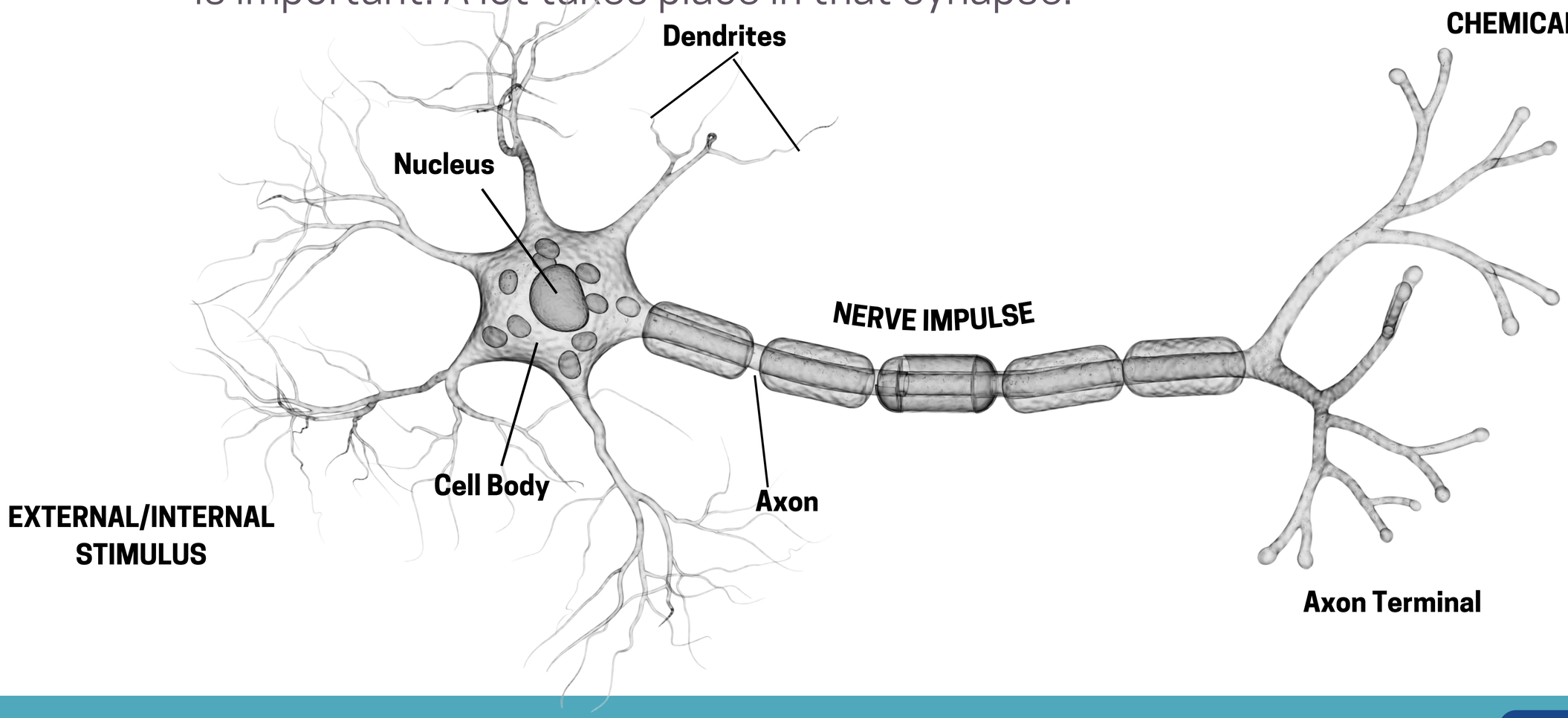


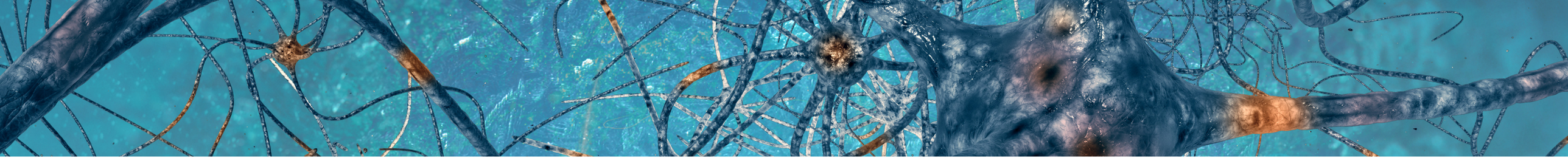
Neurons – Where do they fit in?

We have moved from the three regions of the brain to the lobes and limbic system, to networks that connect the various areas, and then to Brodmann areas. Now let's find out what is happening within each of those areas. The brain is made up of different types of cells such as glia, astrocytes, and neurons. You probably have heard of neurons, since they are the types of cells that do the communicating in the CNS (central nervous system) and PNS (peripheral nervous system). Yes, there are neurons in areas other than the brain! Let's focus on the neurons.

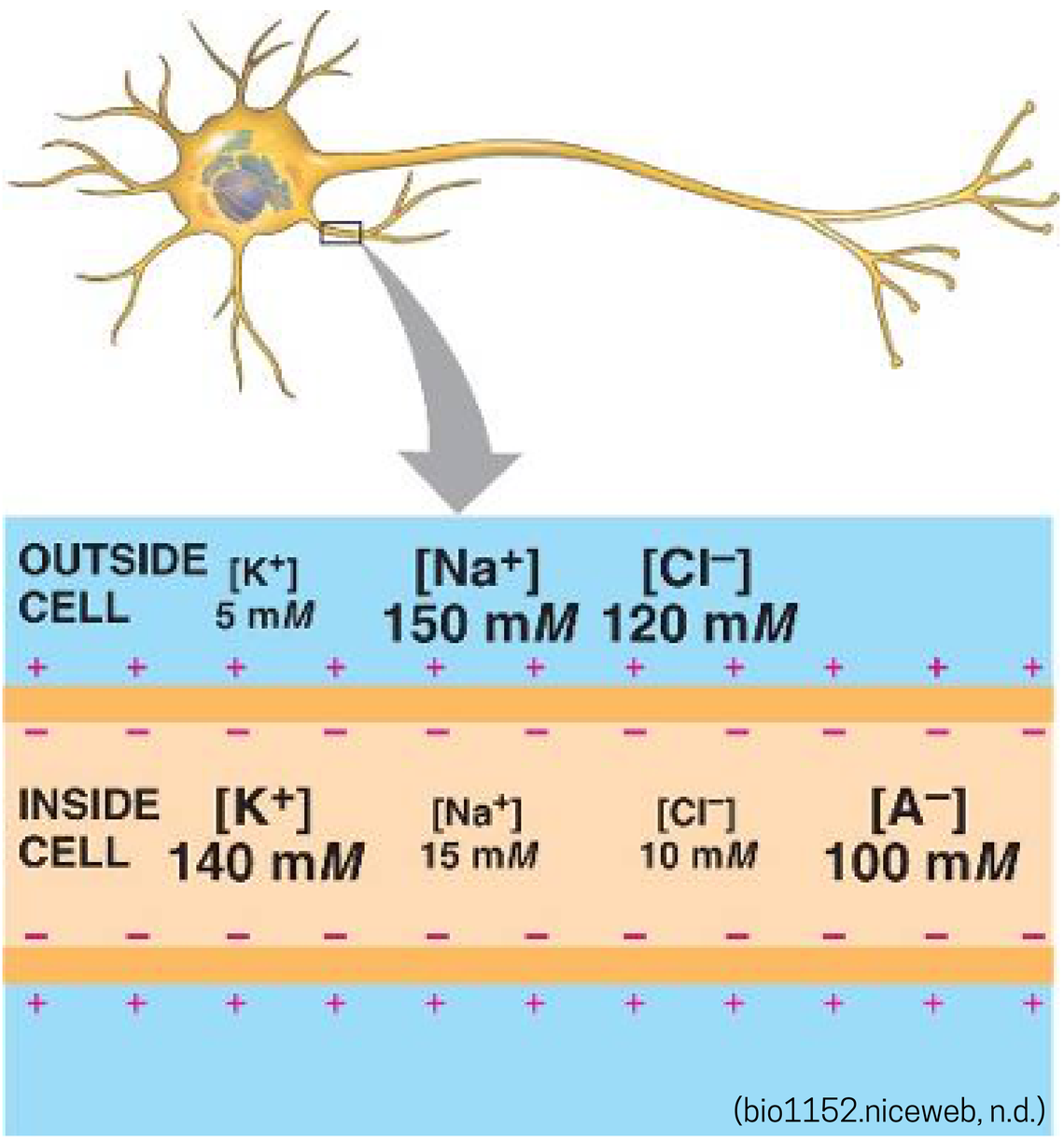
Each neuron has three main parts — nucleus in the **cell body**, **dendrites**, and **axons**. Dendrites are the arms and fingers extending out from the cell body. They want to try to connect to other neurons, kind of like shaking hands. The axon is the long tail extending from the cell body, and the end of which you have toes, each with **axon terminals**. The axon terminals of these toes reach out to connect to other neurons, at the fingers, body, or even axon. Visualize five neurons, each with dozens of fingers and toes, trying to communicate with the other neurons. What a jumble of pathways! In fact, the human brain has over 100 billion neurons and over 10 trillion connections.

The neurons connect to each other leaving a small space in between, which is called the **synapse**. It is space, and not really a physical part of the neuron, but it is important. A lot takes place in that synapse!

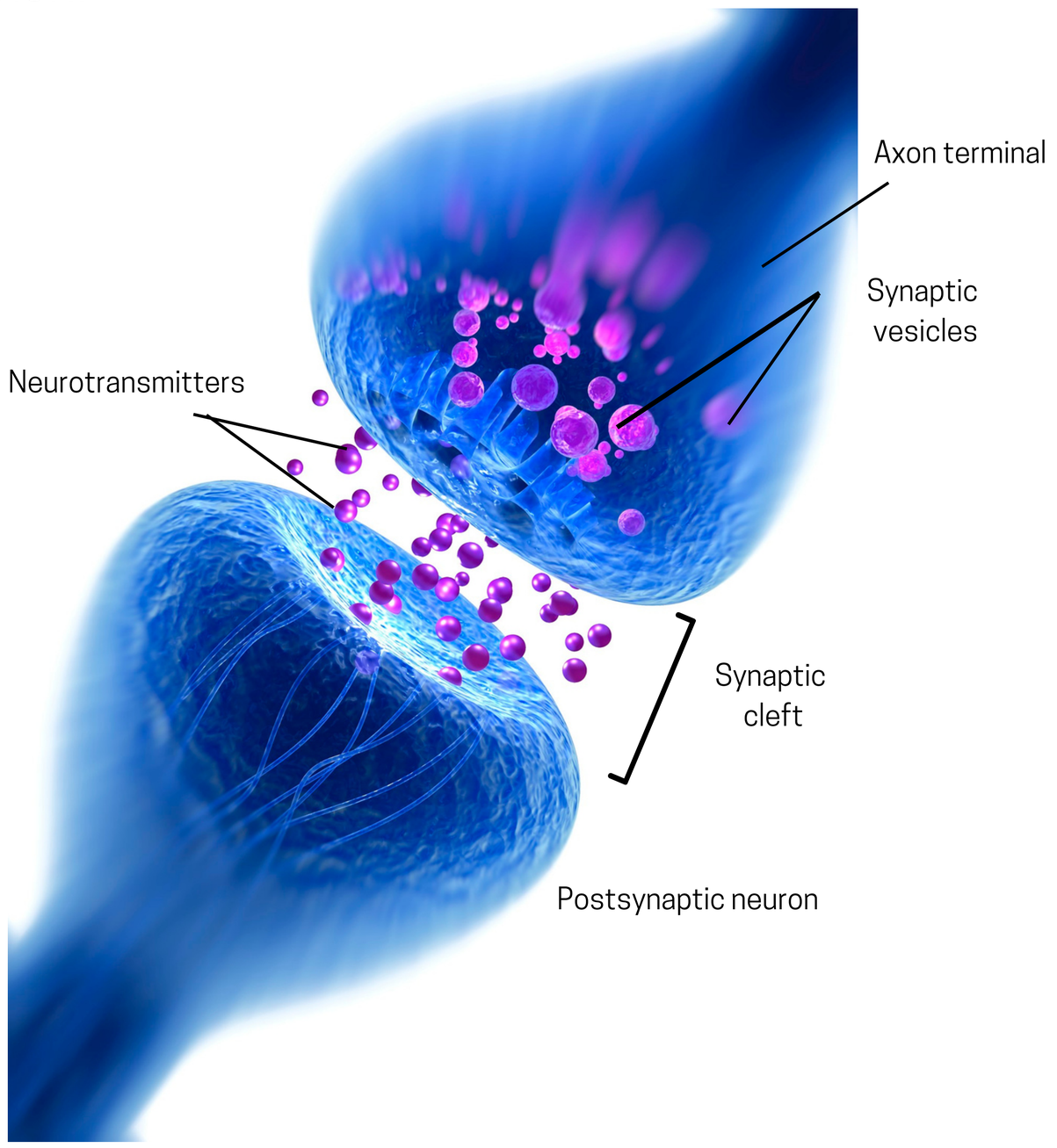




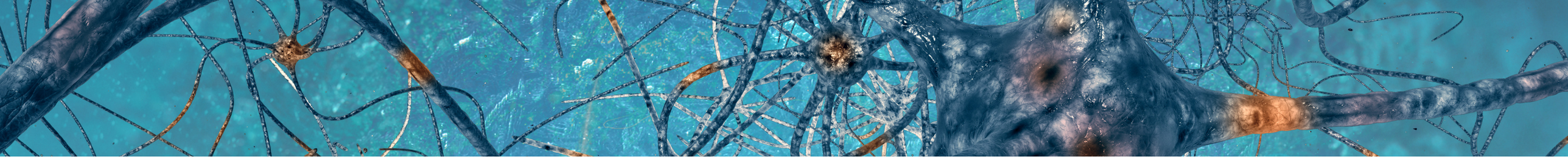
Let’s go back up to the cell body. Remember back to high school chemistry when you learned about the different elements, each with a particular valance or charge? Some are positively charged, like Calcium (Ca+), Sodium (Na+) and Potassium (P+) and some are negative, such as Chlorine (Cl-), and others are neutral, such as Oxygen (O). These ions flow in and out of the cell body and when they do, they change the electrical balance. The brain is always seeking balance, so it sends a flood of ions in and out to get back to its resting state. All of this rush of charged ions causes an electrical signal to be generated. **Boom!** An **electrical signal** fires and travels down the axon to the axon terminals. When the axon is nicely wrapped in a fatty substance called myelin, the signal can travel even faster down the axon.



(bio1152.niceweb, n.d.)

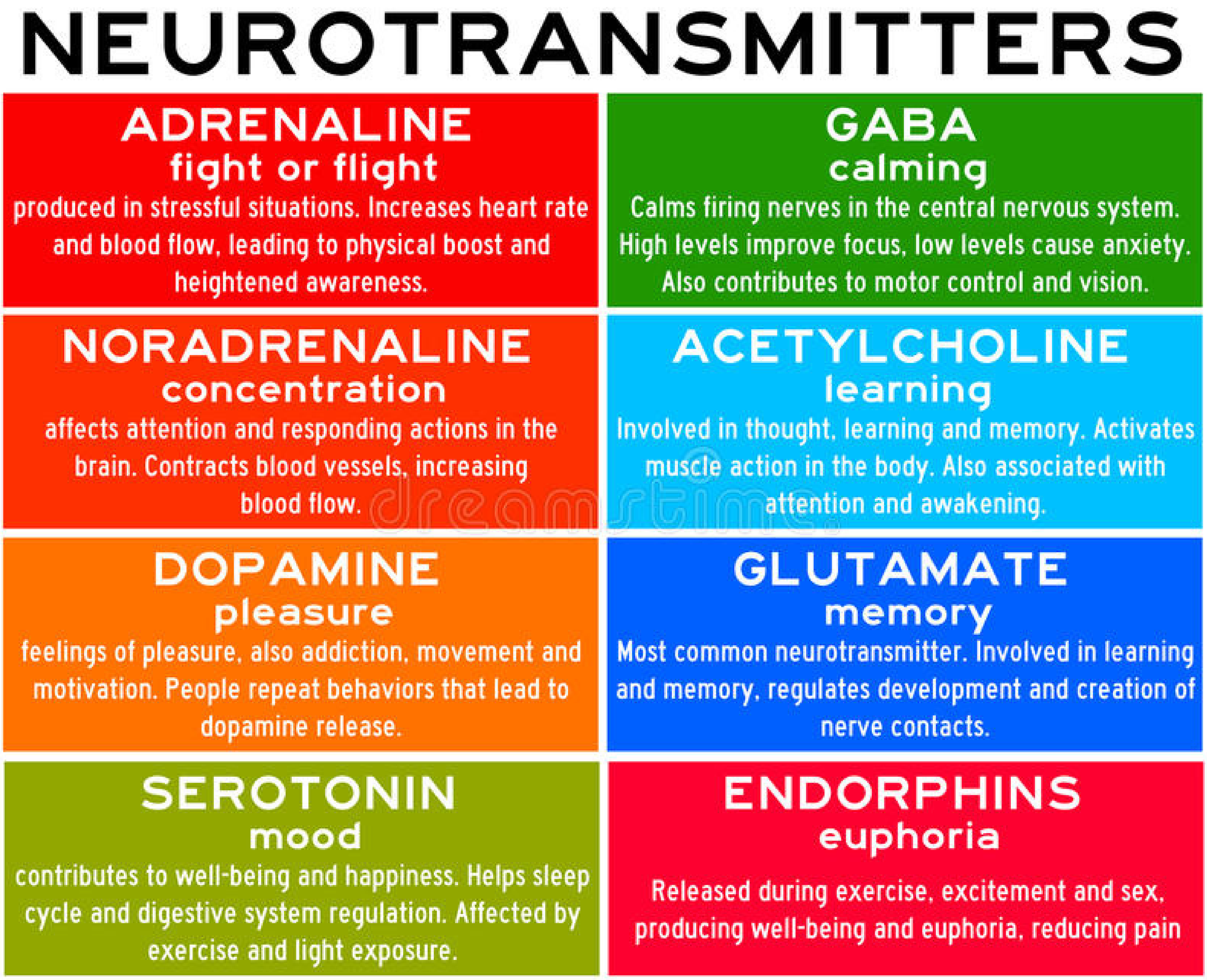


At the axon terminal yet another process takes place. More ions or particular chemicals called **neurotransmitters** are released (depending on the type of axon terminal). The neurotransmitters or elements are released into the synapse, looking for a place to land. Some will find a space and fit into a receptor at the neighbouring dendrite. Others get pulled back to the axon terminal. You might have heard of SSRIs (Selective Serotonin Reuptake Inhibitors), a medication used to treat depression. It works by preventing the serotonin (neurotransmitter) from being pulled back into the releasing axon terminal too soon, allowing it to float around longer in the synapse.

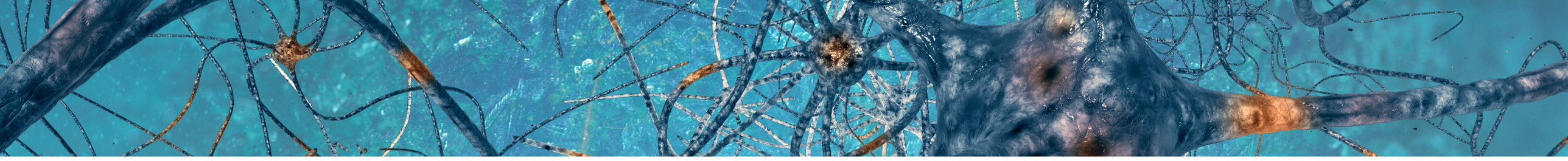


Neurotransmitters

There are a number of different neurotransmitters that move between neurons, facilitating communication. Serotonin is well known for mood modulation (it has many other functions, however). Other neurotransmitters are: dopamine (often associated with the high you get from doing a cardiovascular workout), acetylcholine, and epinephrine (sometimes also called adrenaline). The brain has specialized pathways for each of these neurotransmitters. The axon terminal can also release hormones such as estrogen and testosterone, which also serve to communicate to the receiving neuron.

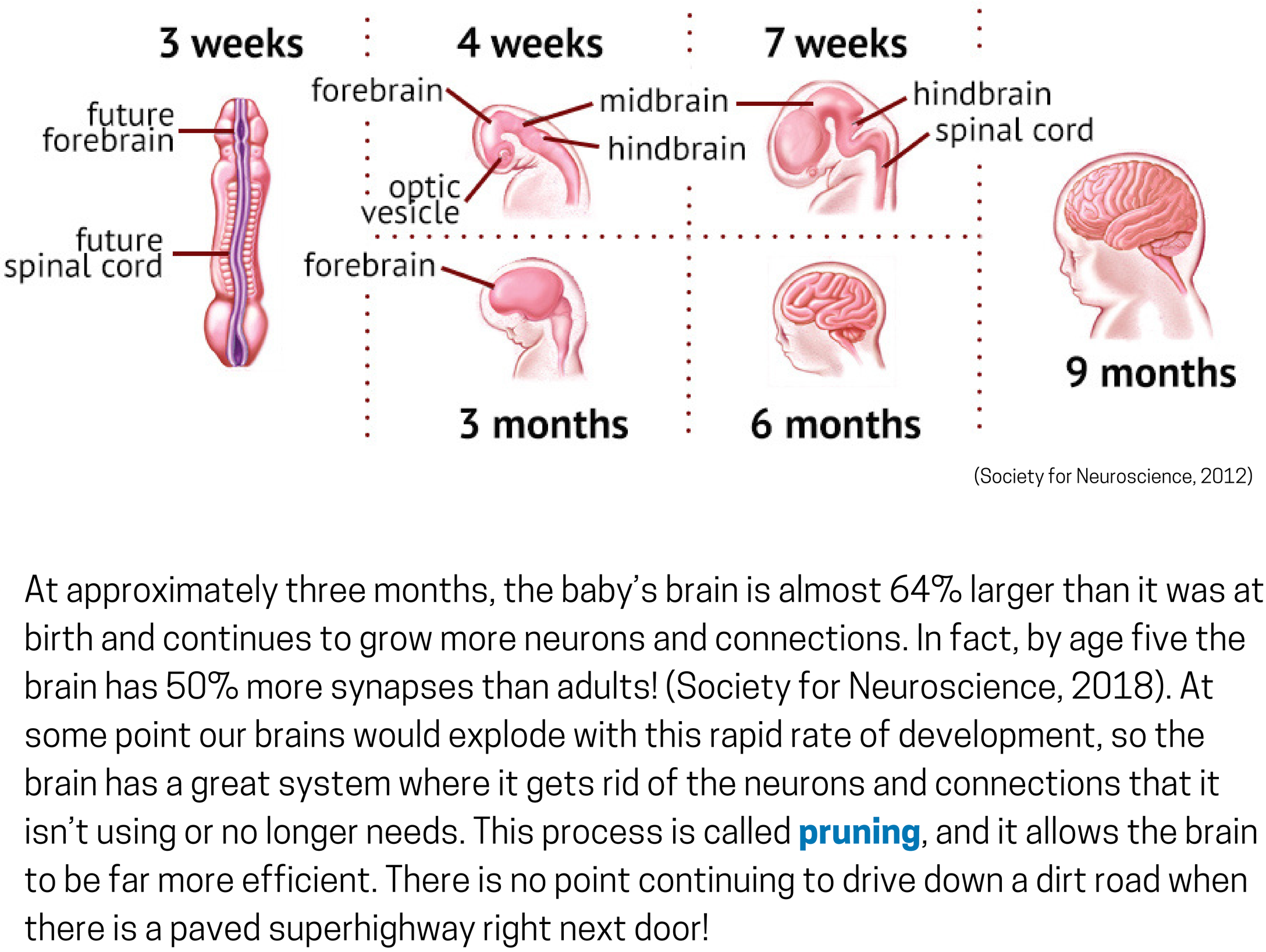


(dreamstime, 2021)



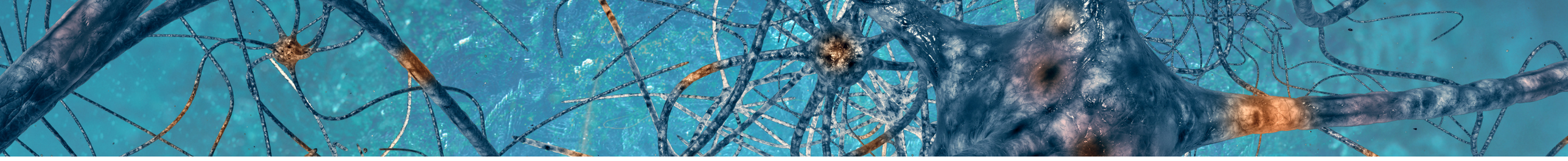
Development

Development is the natural unfolding of the growth process, usually in very typical patterns. For example, after conception, the brain transitions through the same phases — from cell birth to migration (where the neurons and other cells migrate to particular areas of the brain and body), to forming the dendrites and axons of the neurons, to forming the synaptic receptors, and then on to myelination (where a fatty substance encases the axon and helps to speed up communication) (Kolb & Whishaw, 2009).



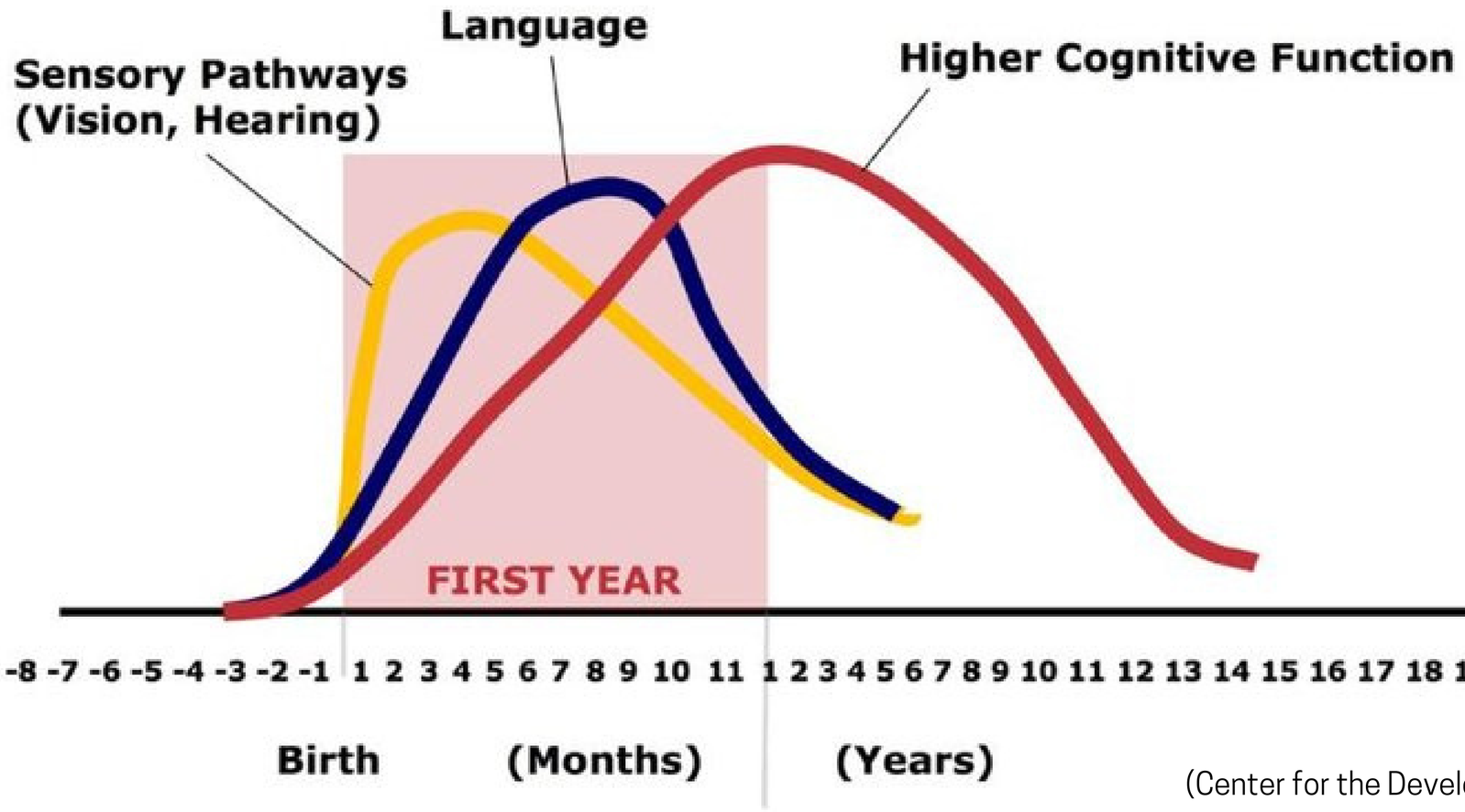
(Society for Neuroscience, 2012)

At approximately three months, the baby's brain is almost 64% larger than it was at birth and continues to grow more neurons and connections. In fact, by age five the brain has 50% more synapses than adults! (Society for Neuroscience, 2018). At some point our brains would explode with this rapid rate of development, so the brain has a great system where it gets rid of the neurons and connections that it isn't using or no longer needs. This process is called **pruning**, and it allows the brain to be far more efficient. There is no point continuing to drive down a dirt road when there is a paved superhighway right next door!



Human Brain Development

Neural Connections for Different Functions Develop Sequentially



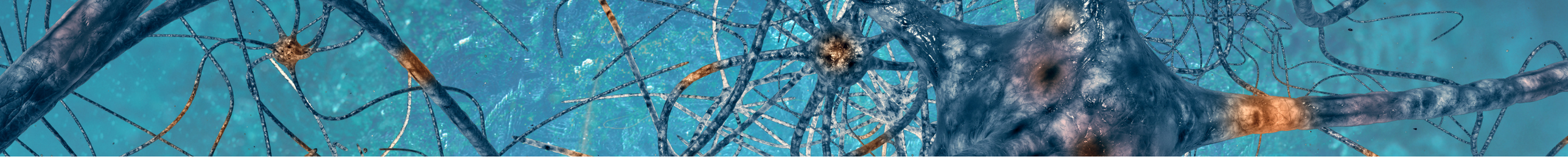
(Center for the Developing Child, n.d.)

We do know that there are **"critical periods"** when the brain undergoes huge changes, for example in the early childhood years. That is why we focus so much on providing appropriate stimulation during this period, as a way to ensure development during the period when the child is learning to walk, acquiring language, and beginning to learn to self-soothe. We once believed that a lost critical period meant that the brain and body could never catch up. That has become a point of debate, after all, we have discovered the remarkable capacity of the brain to modify itself — be plastic.

Not only do we need meaningful experiences for our brain to develop, we also must have safe, close relationships with others, like our main caregivers (typically our parents). Multiple things happen in the brain when we connect with others, particularly as infants (enough for an entire book!).

Optimal sculpting of key neural networks through healthy early relationships allows us to think well of ourselves, trust others, regulate our emotions, maintain positive expectations, and utilize our intellectual and emotional intelligence in moment-to-moment decision making (Cozolino, 2013).

So, development is a lot about growing and pruning neurons and ensuring that key structures are built, and acquiring the ability to be resilient in the face of adversity. Learning is similar, but based almost exclusively on the individual's interaction with the environment.

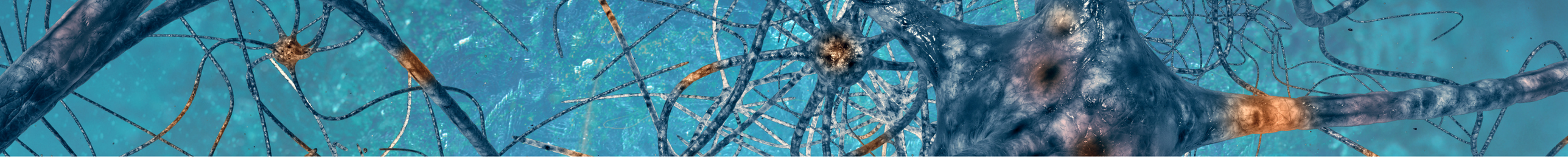


Learning

At a neuronal level, there are four main ways that verify learning.

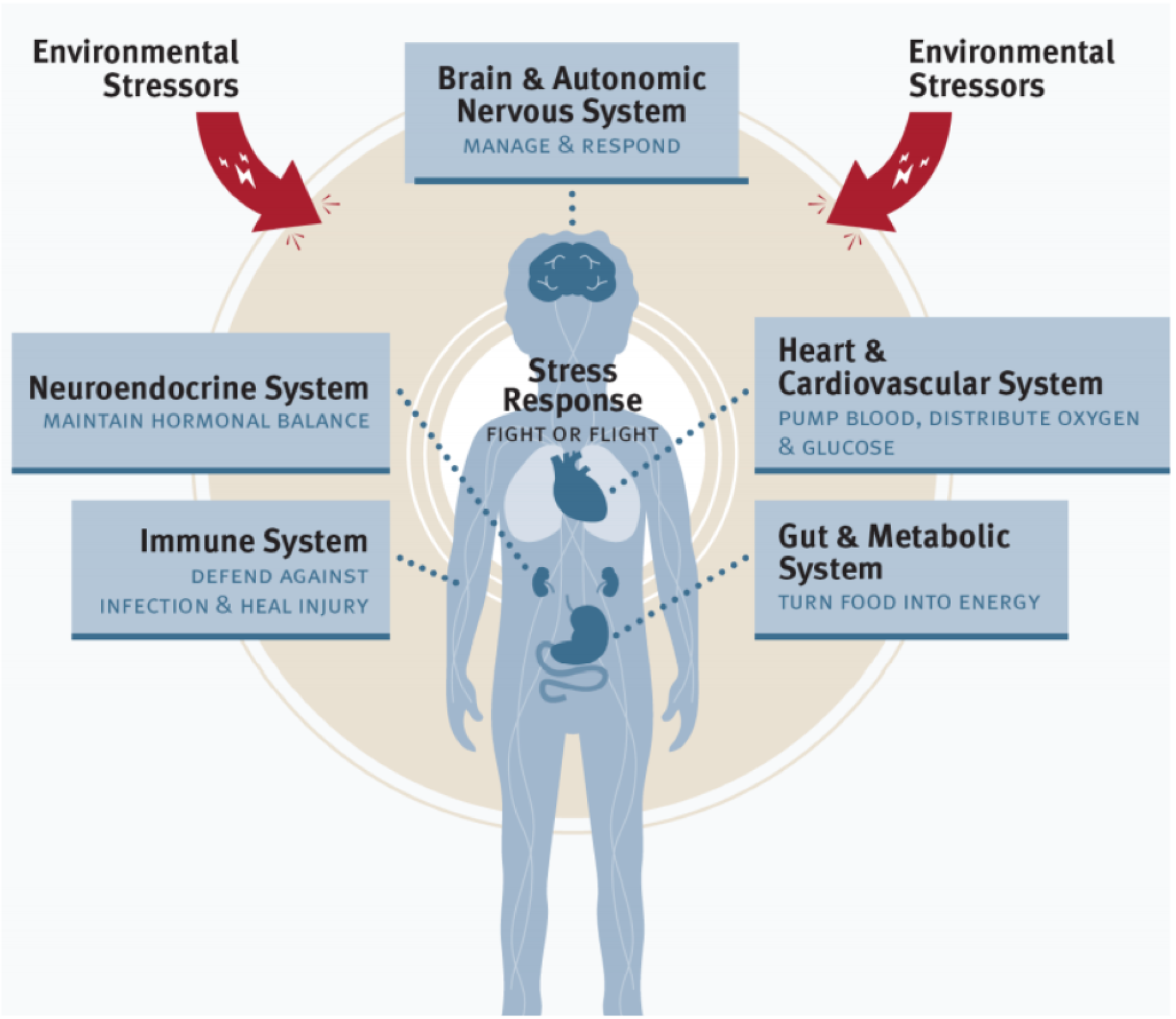
- First, the receiving neuron may develop bigger receptors to grab onto those neurotransmitters or ions quicker.
- Another evidence of learning is an increase in the amount of neurotransmitter that is released from the axon terminal.
- The receiving neuron (and its post-synaptic membrane) may also become more sensitive to the neurotransmitter, reacting sooner.
- Yet one more evidence of learning is when there are more connections between various neurons, just like new roadways being paved.

However, learning does not occur if a person is in a state of stress. In fact, Harvard University has done an amazing job of explaining the necessary requirements for a child to develop AND learn, key among them are **stimulating environments** with **safe, nurturing relationships.**

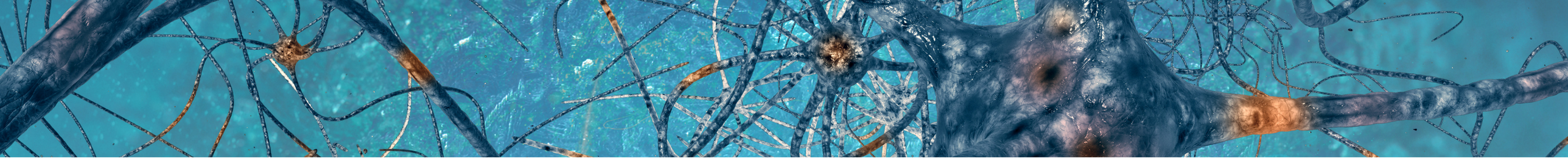


Common brain ailments

Our **genes** play a huge role in the type of person that we become. There are several brain or body impairments which are directly linked to our genes, such as Down Syndrome and Cystic Fibrosis. However, we are products of more than just our genetics. The **environment** has a huge impact not just on our learning, but on how our genes express themselves, and also how our brains and bodies change over the life span.



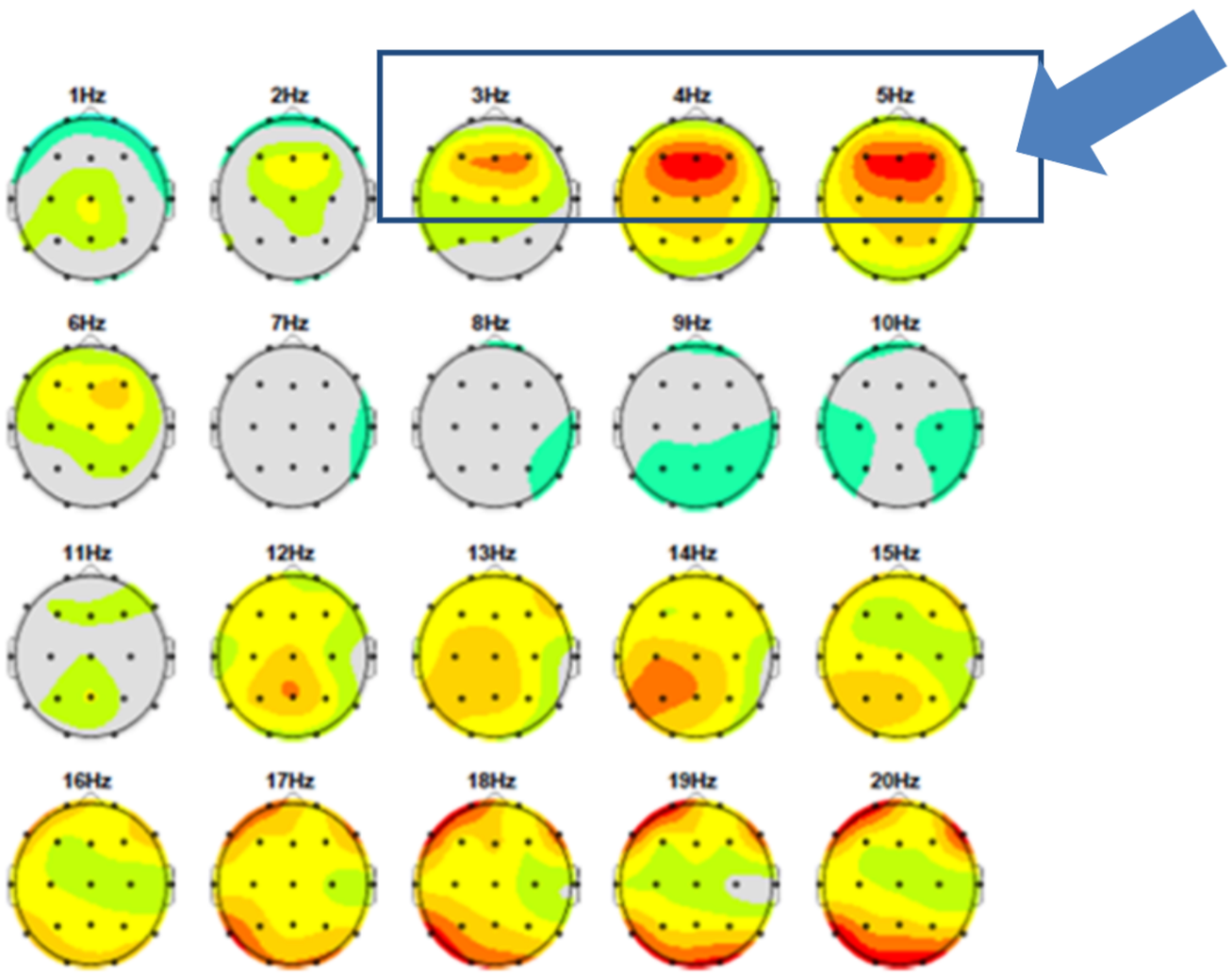
(National Scientific Council on the Developing Child, 2020)

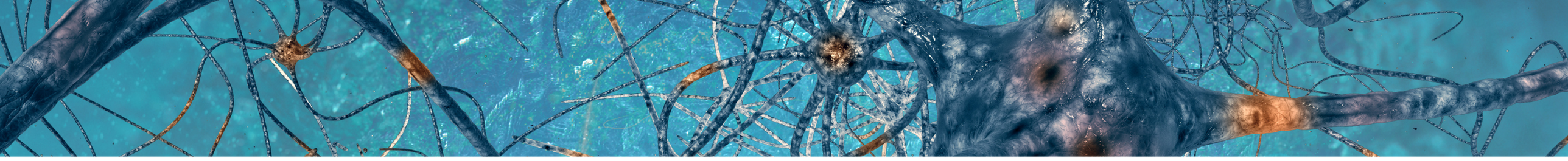


For example, **toxins** or **injury** (before, during, or after birth) can negatively impact the developing brain and body. Other environmental impacts, such as early traumatic experiences can have a profound impact on how a child's brain and body develop; even though all of the structural parts are there, the way that they function is different. Children who have lived with **chronic stress** don't develop the ability to listen, feel, and interpret internal signals like fear, hunger, and fatigue. Further, key body systems (brain and autonomic nervous system, gut and metabolic system, endocrine system, and even the heart and cardiovascular system) can become over- or under-active (National Scientific Council on the Developing Child, 2020), leading to life-long disruptions in functioning (see image on previous page).

The degree of impairment is in part dependent on age at onset, location in the brain of injury or tumour, and the duration of assault. Even though the brain tries to re-organize and regenerate after an injury or negative experience, the way that the brain functions changes.

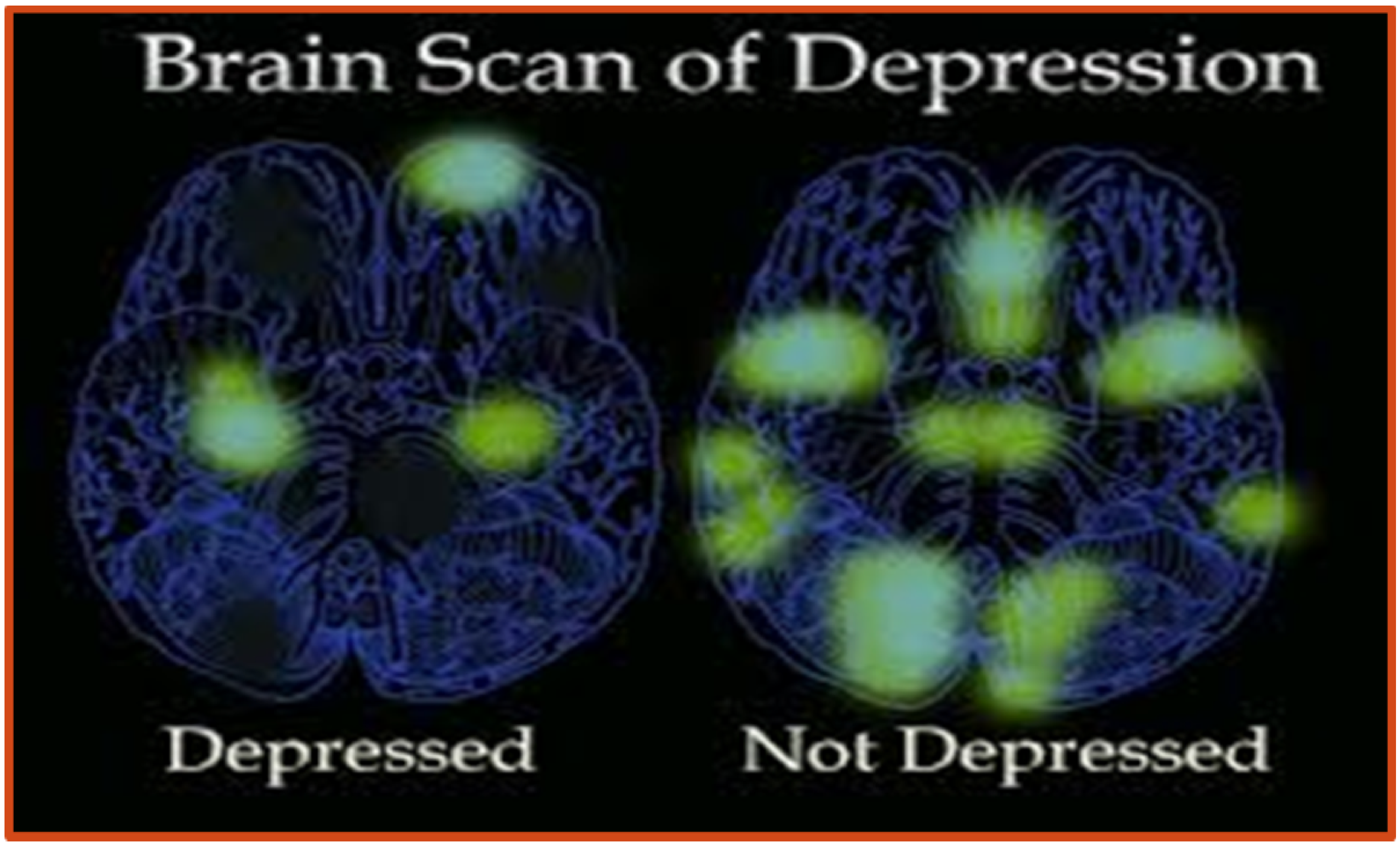
One of the most exciting aspects of neuroscience is our ability to SEE these changes. The science is improving every day and we are able to identify what we call phenotypes or biomarkers of particular mental issues based on brain activity. For example, we can see patterns associated with one type of ADHD (excess theta/beta ratio at top of head). (Arns, Heinrich, & Strehl, 2014; Thompson & Thompson, 2006).



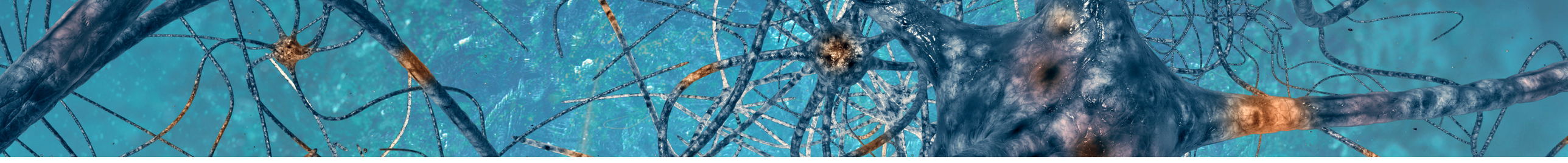


Another example is of one type of depression where we can see decreased prefrontal cortex activity at rest, especially on the left side, and increased limbic system activity (thalamus, amygdala, cingulate gyrus and deep temporal lobes) (Thompson, Thompson, Reid, Thompson, & Hagedorn, 2013; Swingle, 2008). There are multiple other examples, from alcoholism, to anxiety, to trauma, and obsessive compulsive disorder. As technology advances, the precision will, no doubt increase. There is a BUT here ...the brain is so incredibly complex that these profiles are not 100% predictive. A brain may be compensating for a particular pattern, meaning that the individual may not experience the symptoms that are typically associated with the illness.

As with all brain ailments, I believe a wholistic understanding of the person is the key to ultimately helping them change their life. It's critical to look at their brain activity using a quantitative EEG (QEEG), and understand their emotional state and how their environment has affected their behaviour to this point. Often a combination of therapy and neuromodulation are necessary to provide real change; essentially rewiring or reprogramming their brain to achieve the desired behaviour.



(Thompson et al., 2013)



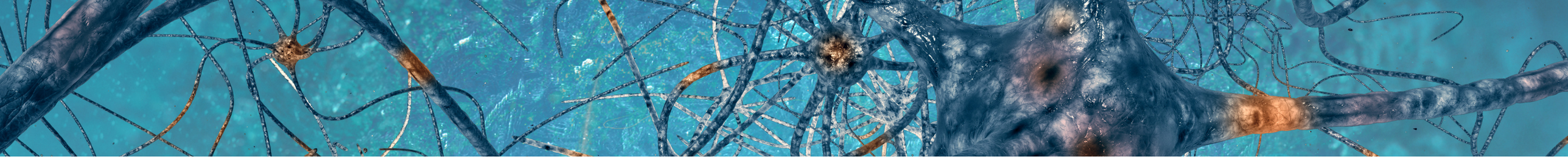
Regulating behaviour & brain functioning

You might be wondering what someone can do to change brain and body functioning. That area of study is also experiencing a renaissance of sorts! Again, with the advances in technology, we can SEE what is happening in the brain and body when there is an internal or external stimulus or change.

Even with technology, I always like to start with the **basics**. Believe it or not, moderating your diet, exercise, and sleep patterns can make a huge difference to your brain and body functioning. Scientists are finding more and more research to support the brain-gut connection and what impact certain foods can have on the health of the brain and other systems within the body.

- **Diet and blood sugar regulation** — take a look at your nutrition. Are you eating the rainbow of fruits and vegetables, healthy fats, proteins from meat, and legumes and beans? The old adage, *you are what you eat*, is especially true with brain health.
- **Exercise** — we need to move our bodies to promote good health. Are you moving at least 120 minutes a week? Good heart health is also good brain health!
- **Sleep hygiene** —our cells repair while we are sleeping so it's important to get between 7-9 hours of sleep each night. Also important, is not looking at your phone or computer for at least one hour before going to sleep — the blue light affects your pineal gland which controls wakefulness.

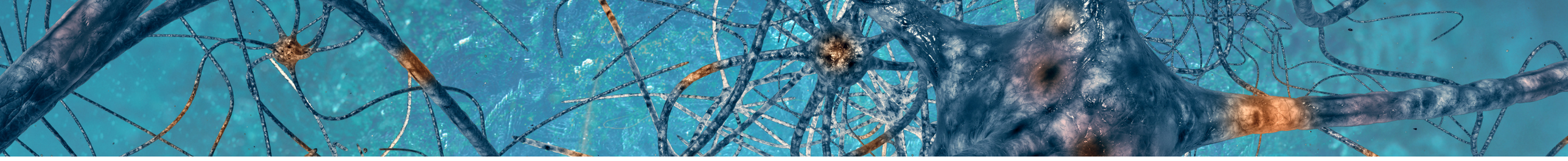
There are numerous strategies that improve brain function, including but not limited to: intermittent fasting, hormone regulation, stress management, and meditation. The idea of treating the whole body rather than isolated parts has really evolved into a field with robust, research-based strategies.



Regulating behaviour & brain functioning continued

Simple adaptations can be made just by changing the amount of **sensory information** that is assaulting the body. Some people are very sensitive to fluorescent lights, loud sounds, or even the types of fabric on the body. Certainly, any parent of child with Autism Spectrum Disorder (ASD) is well aware of the need to adjust environmental inputs as a way to help regulate their child's behaviours and mood.

Ideally, we want our children (and ourselves) to begin to sense when they are becoming overstimulated or stressed in some way (and even when we are under-aroused). Then they can learn to make adjustments or use strategies to help calm (or arouse) the brain and body. Self-regulation is ultimately what we are after! If you do an internet search for self-regulation tools or self-regulation strategies, you will find a ton of information. But **buyer beware**. With the growth of the industry, there are many tools, devices, or approaches that don't necessarily have any scientific grounding. **Check out the research** whenever you can.



Now what?

You've read all this and still you want to know more about neuroscience, as it directly relates to your career, private practice, and for home life.

You're in luck! I have a brand new online course just for you!

This course is for persons interested in pursuing educational leadership, administration, and counselling careers, as well as educators, employers and mental health professionals, all of whom need to be knowledgeable about **brain health.**

You can work in a semi-paced format, online, and earn continuing education credit as well.

We offer three options for your convenience and level of interest. Choose to learn a little bit or a lot — pick what stream is right for you. See our pricing and CE credit options on the next page.

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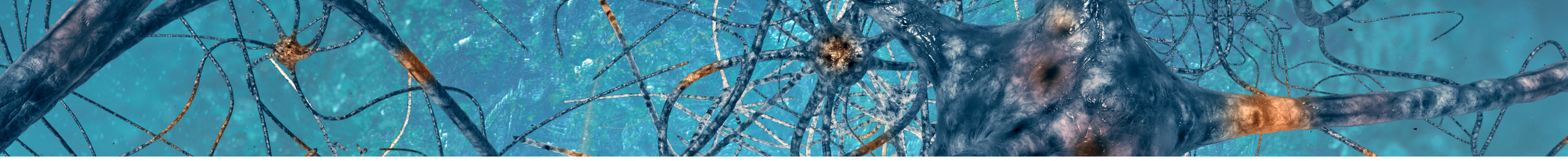

3 Pricing options

Fundamental Stream: 6 CE credits $150 + GST

This course is for individuals who just want a brief overview of the content, with minimal reading or assignments, and only requiring quizzes as evaluation.

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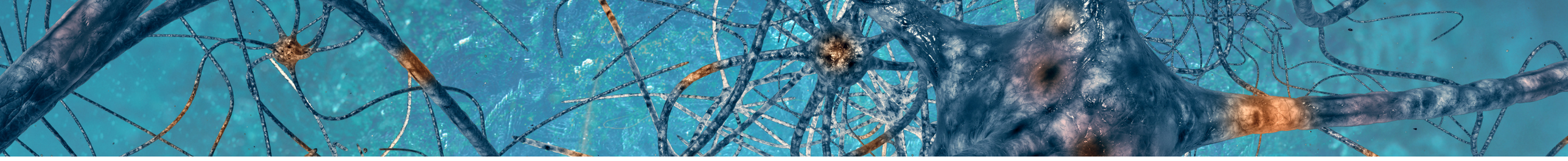
If you're a clinic or practice and you have several clinicians or therapists wanting to take our course, you will get a 15-30% discount.

Register today!

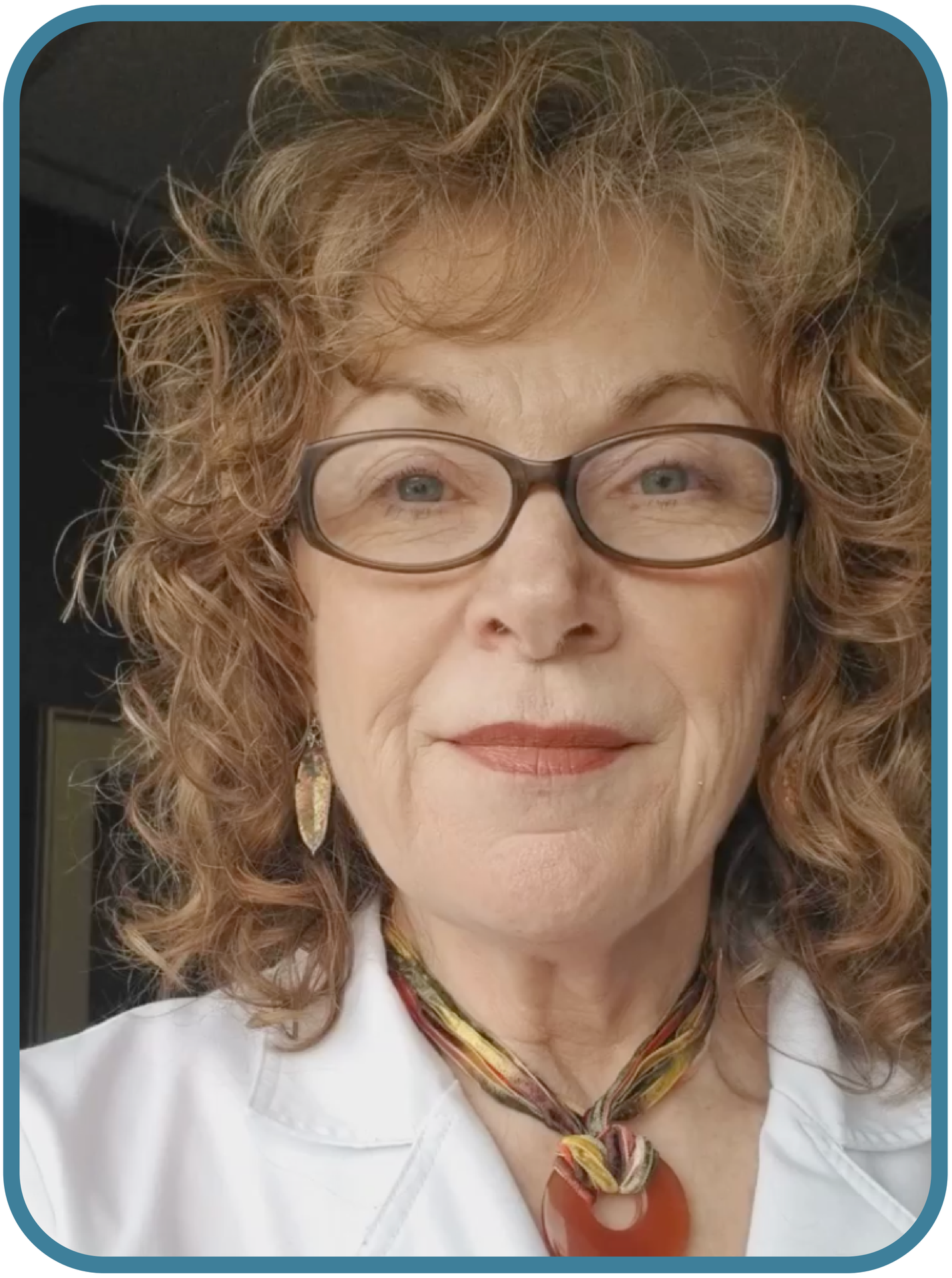


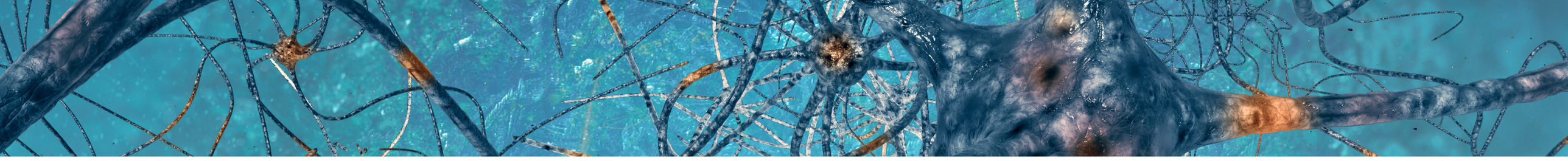
Thank you!

Whatever you choose to do, I want to wish you all the best! It is a very exciting time in the study of the brain and body wellness!

Please reach out if you are curious about therapy, assessments, and neuromodulation -- I offer all of these services.

Dr. Kim Calder Stegemann
PH.D., CCC, QEEG-D, BCN





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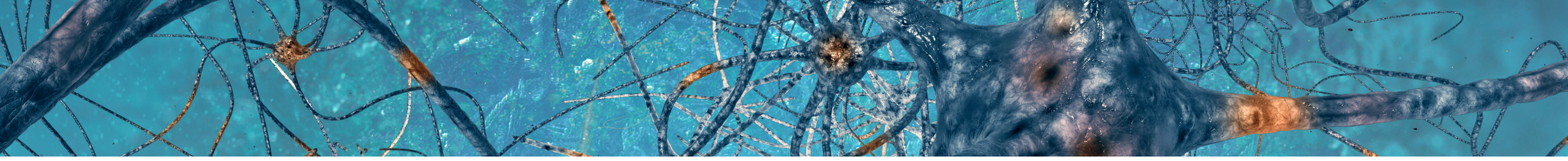

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