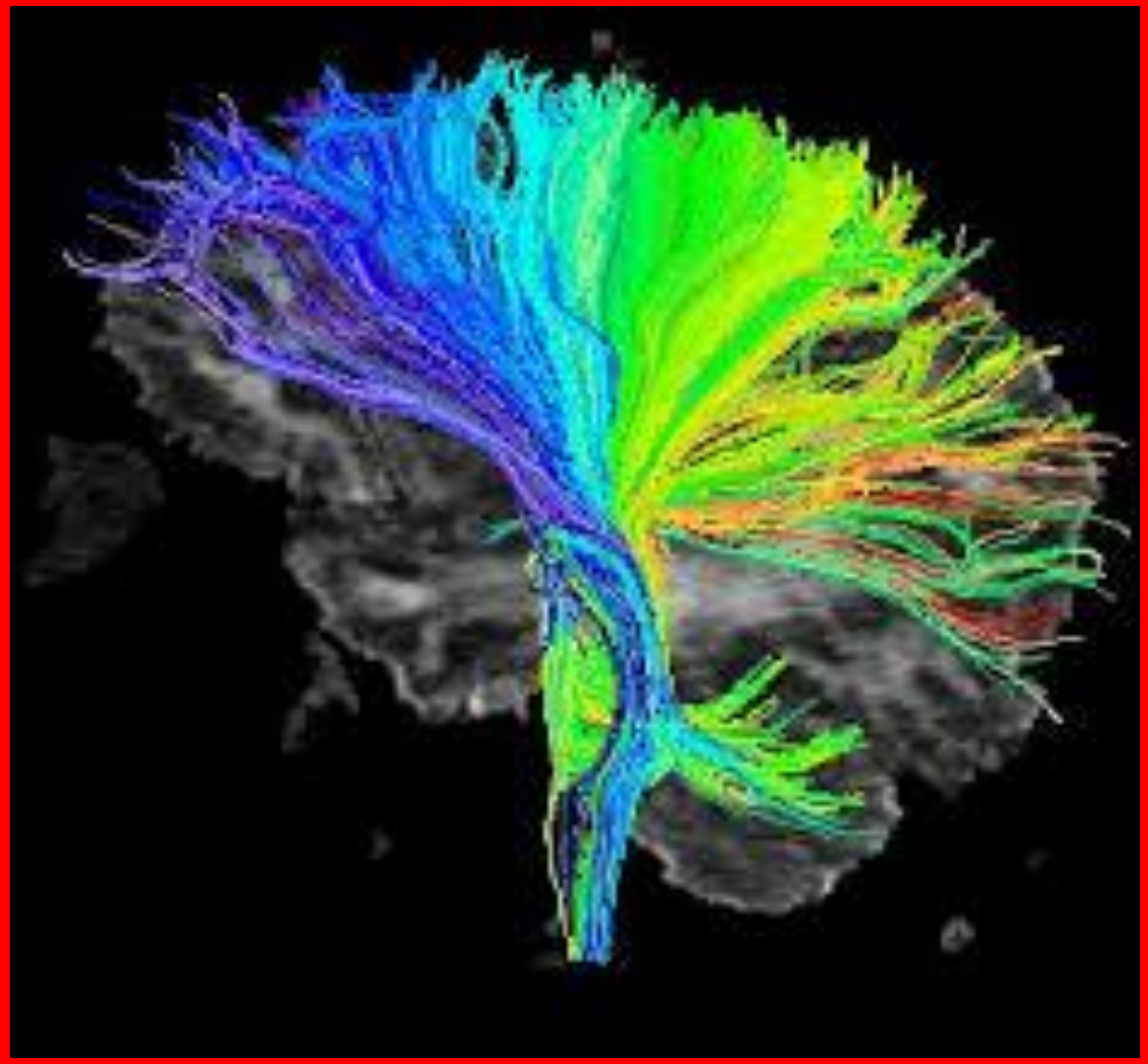
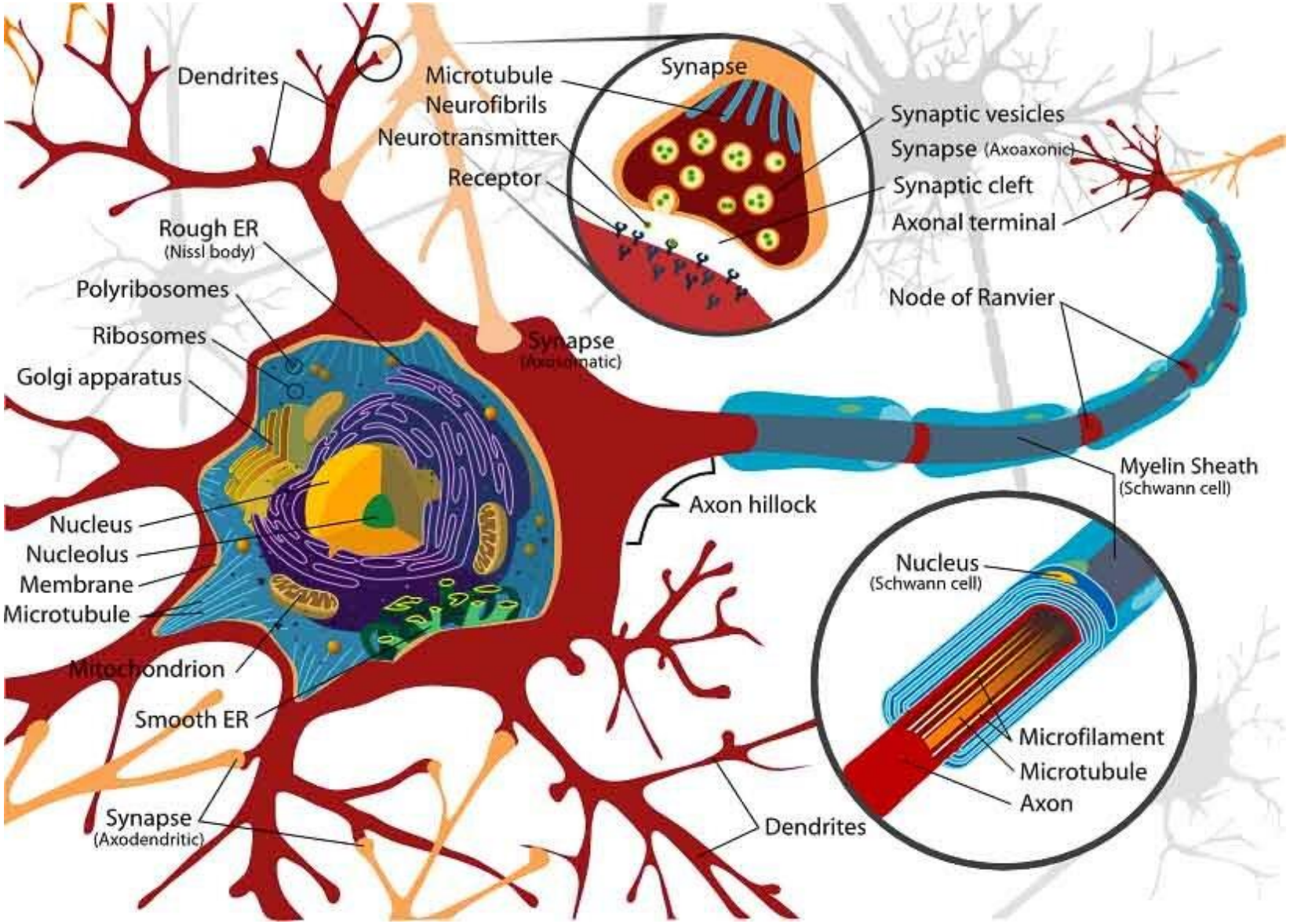
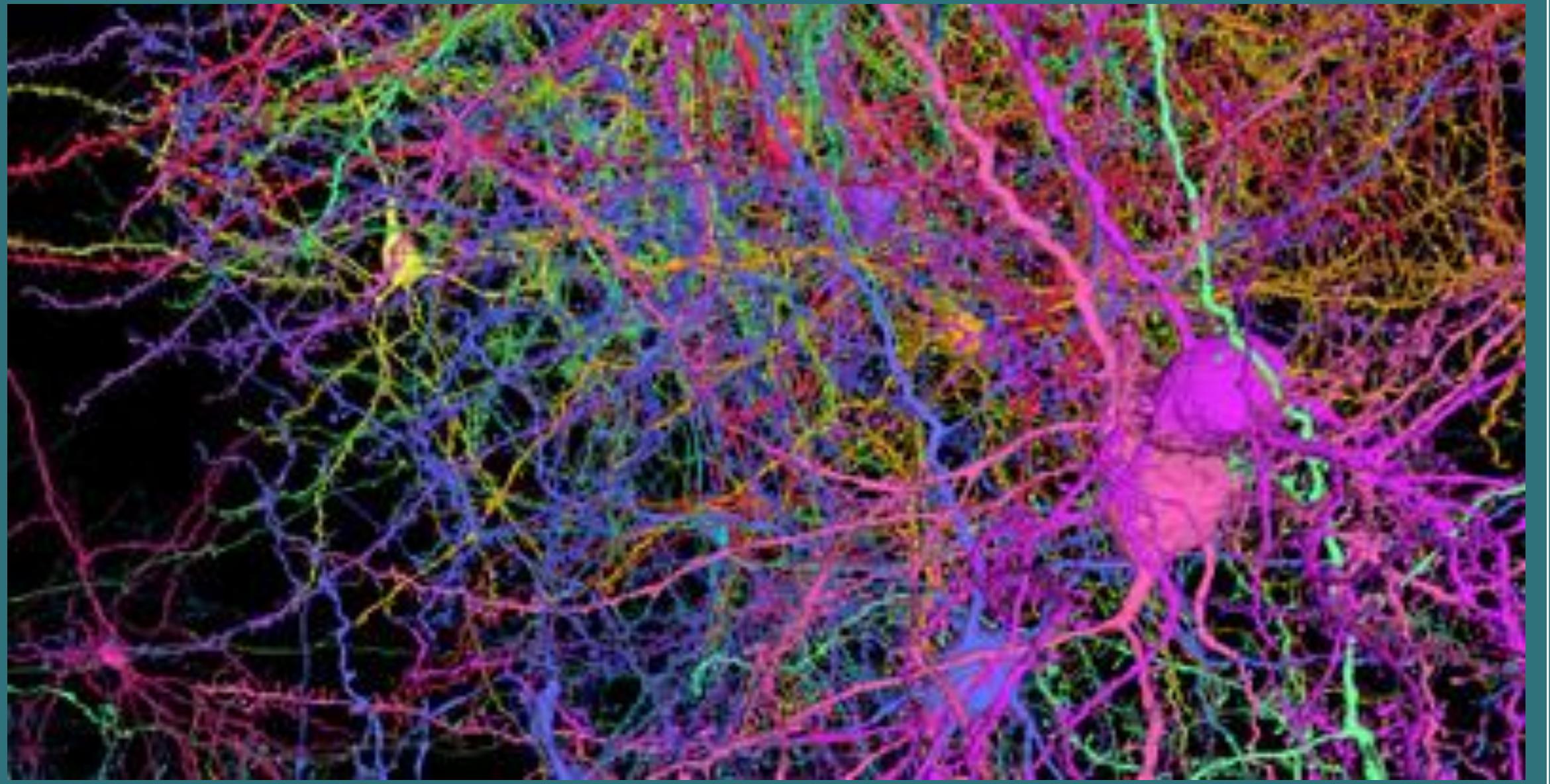
Jeffrey E. Hansen, Ph.D.
Center for Connected Living, LLC

Neuroscience Images and the Story They Tell



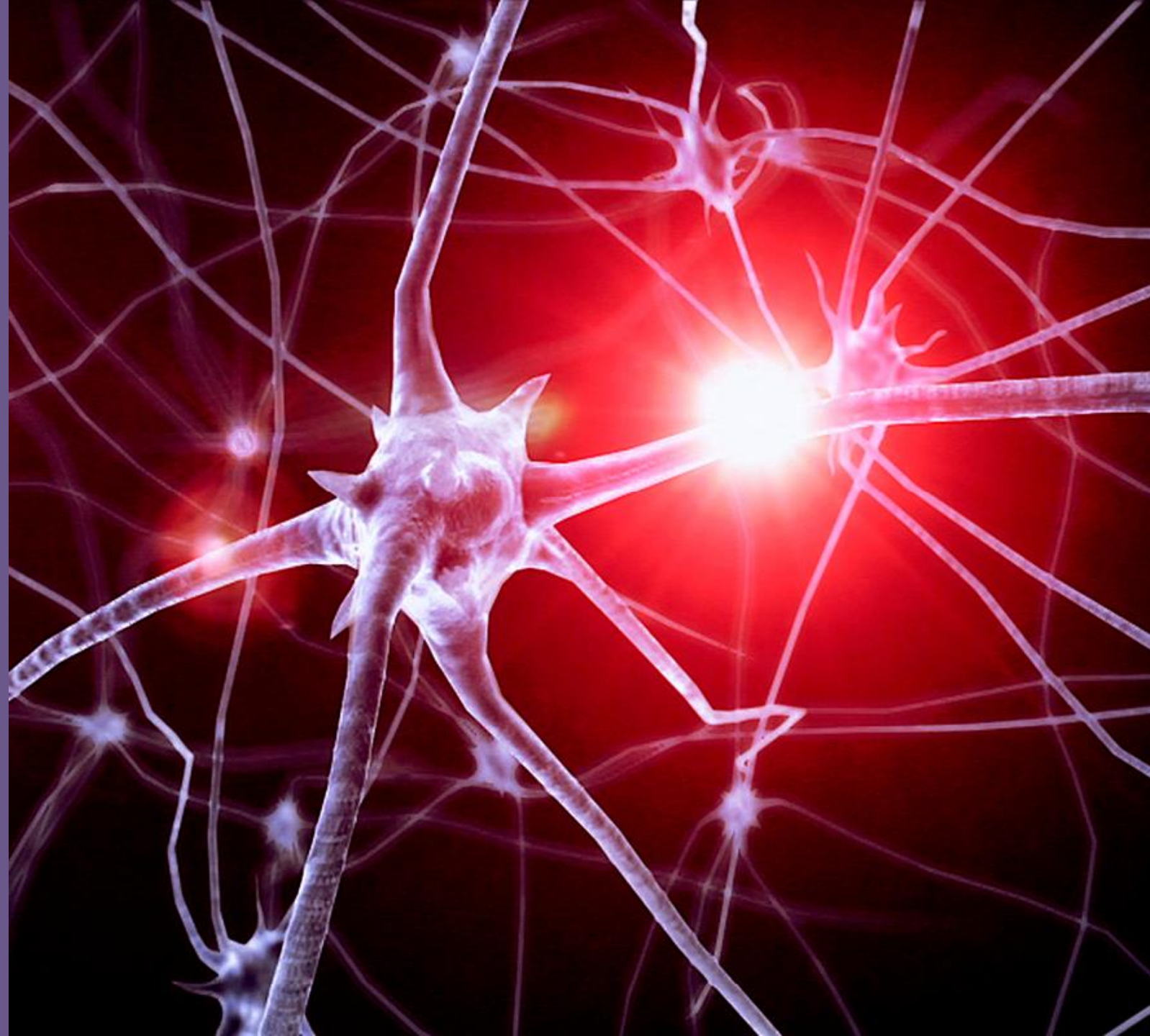

Dendrites
Microtubule
Neurofibrils
Neurotransmitter
Receptor
Synapse
Synaptic vesicles
Synapse (Axoaxonic)
Synaptic cleft
Axonal terminal
Rough ER
(Nissl body)
Polyribosomes
Ribosomes
Golgi apparatus
Synapse
(Axosomatic)
Node of Ranvier
Myelin Sheath
(Schwann cell)
Axon hillock
Nucleus
Nucleolus
Membrane
Microtubule
Mitochondrion
Smooth ER
Synapse
(Axodendritic)
Nucleus
(Schwann cell)
Microfilament
Microtubule
Axon
Dendrites



Neural pathways are like superhighways of nerve cells that transmit messages. You travel over the superhighway many times, and the pathway becomes more and more solid. You may go to a specific food or cigarettes for comfort over and over, and that forms a brain pathway. The hopeful fact, however, is that the brain is always changing, and you can forge new pathways and create new habits. That's called the neuroplasticity of the brain (Lifexchange, 2022).

Well, you might recall our recent post on the basic building blocks of your brain – brain cells called neurons. We all have 100 billion or so of them, and they can each connect with 250 000 surrounding neurons because they are senders/receivers of information in your brain. And, if neurons are the transmitters, neural pathways are what give the information they send in our brains meaning (Lifexchange, 2022).

https://lifexchangesolutions.com/neural-pathways/



There are many technical types of pathways with big names, but for understanding how the brain impacts behaviour in business, all we need to know is that there are dominant (well-formed) pathways and lesser (fragile new pathways).

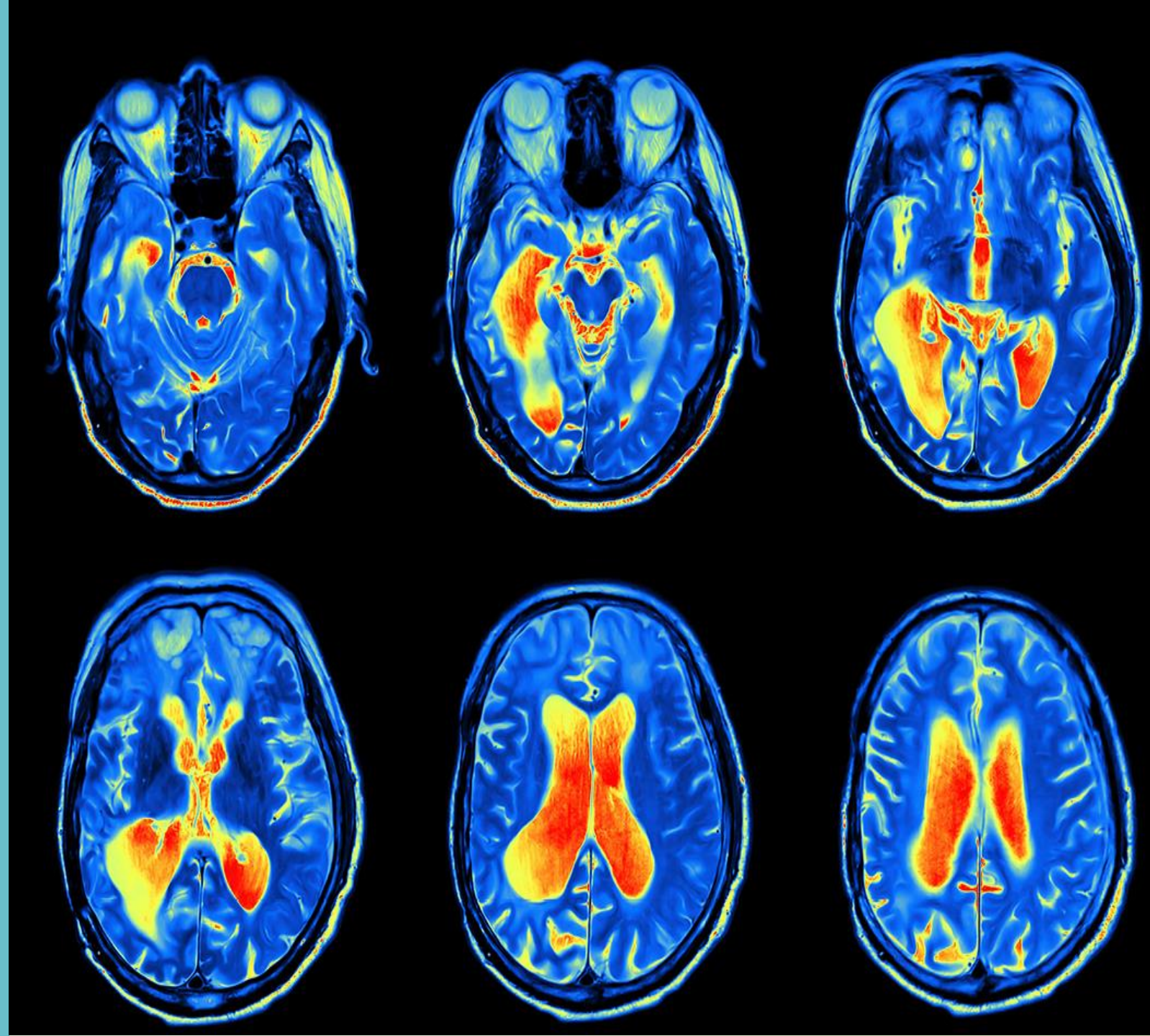
When your brain processes a new thought, it starts off as a lesser pathway. Like a baby trying to walk for the first time (neurons connecting from the brain to muscles, for balance etc.) and battling a bit. But the more you do it over and over again in the same way, the stronger and more dominant the neural pathway becomes. And now, today, as an adult, you don't need to think about walking anymore, it's a well-formed dominant neural pathway in your brain. Now, it's the same with every thought that you have. Those you have over and over again become dominant. And new ones that you don't practice often get deleted by glial cells after about 48 hours (Lifexchange, 2022).

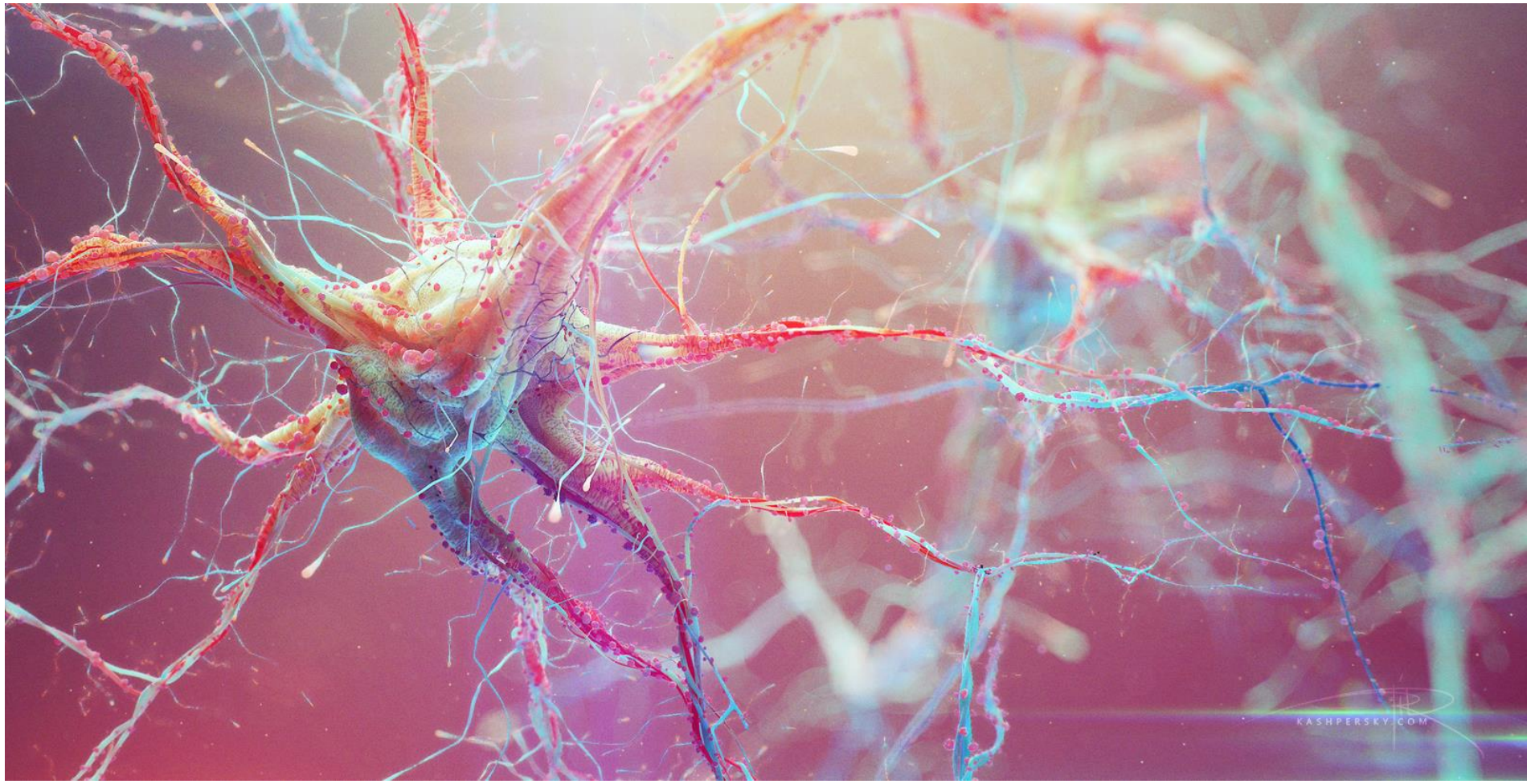
https://lifexchangesolutions.com/neural-pathways/

Neural pathways are the connections that form between the neurons in your brain. And you can think of them as a pattern that represents any thought about anything you've ever had – as simple as an apple, as complicated as love and integrity, every thought is a neural pathway.

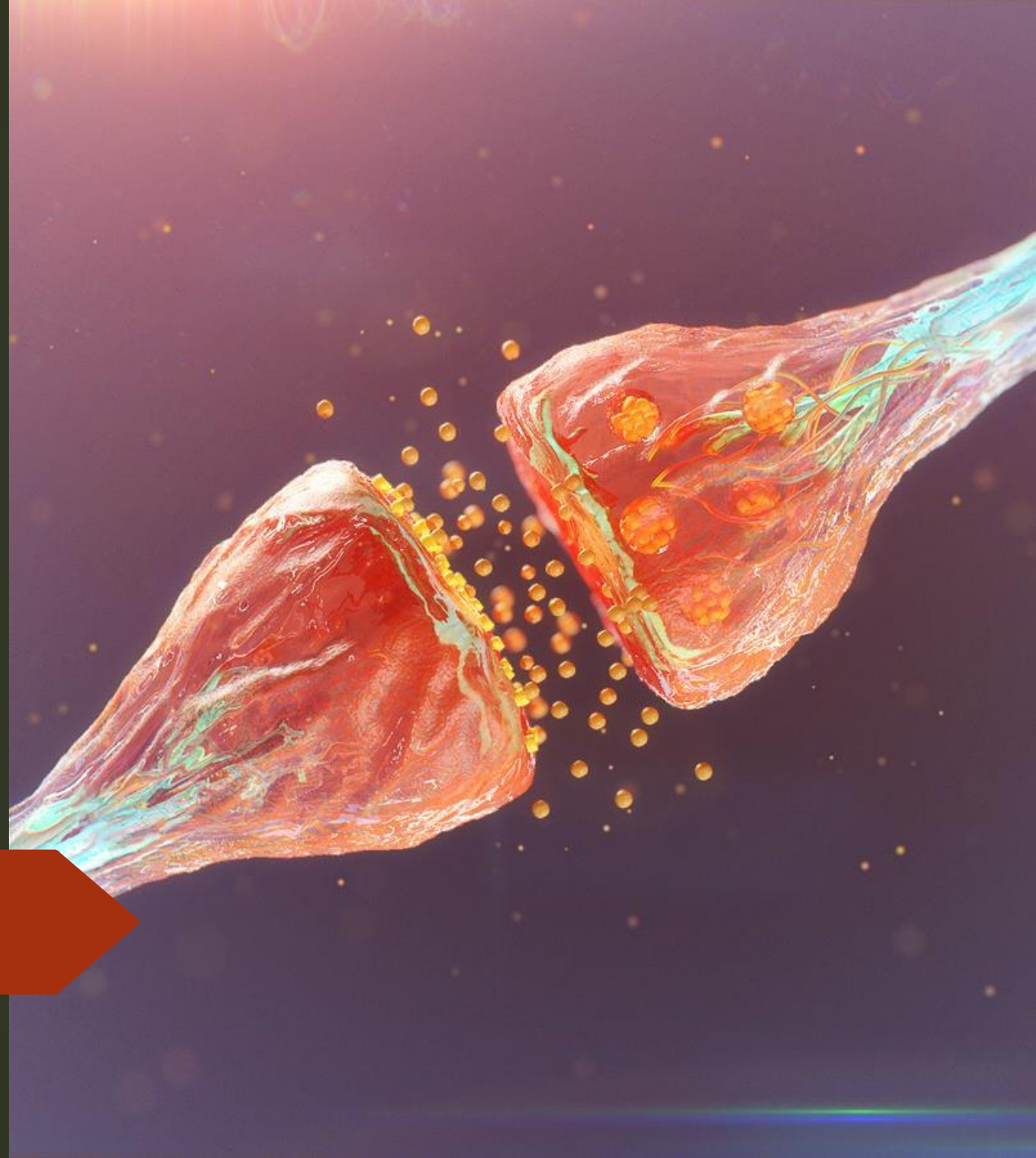
Now, we're often taught to think of our brains as computers, a storeroom with boxes or ROM that your brain can fetch (recall) when you need it. But that's not accurate. Your thoughts are more like patterns than boxes. Neural pathways are the connections between neurons that light up when you think of something for the first time, and the connections form a pattern in your brain. Your brain has now attached meaning to that specific pattern.

https://lifexchangesolutions.com/neural-pathways/

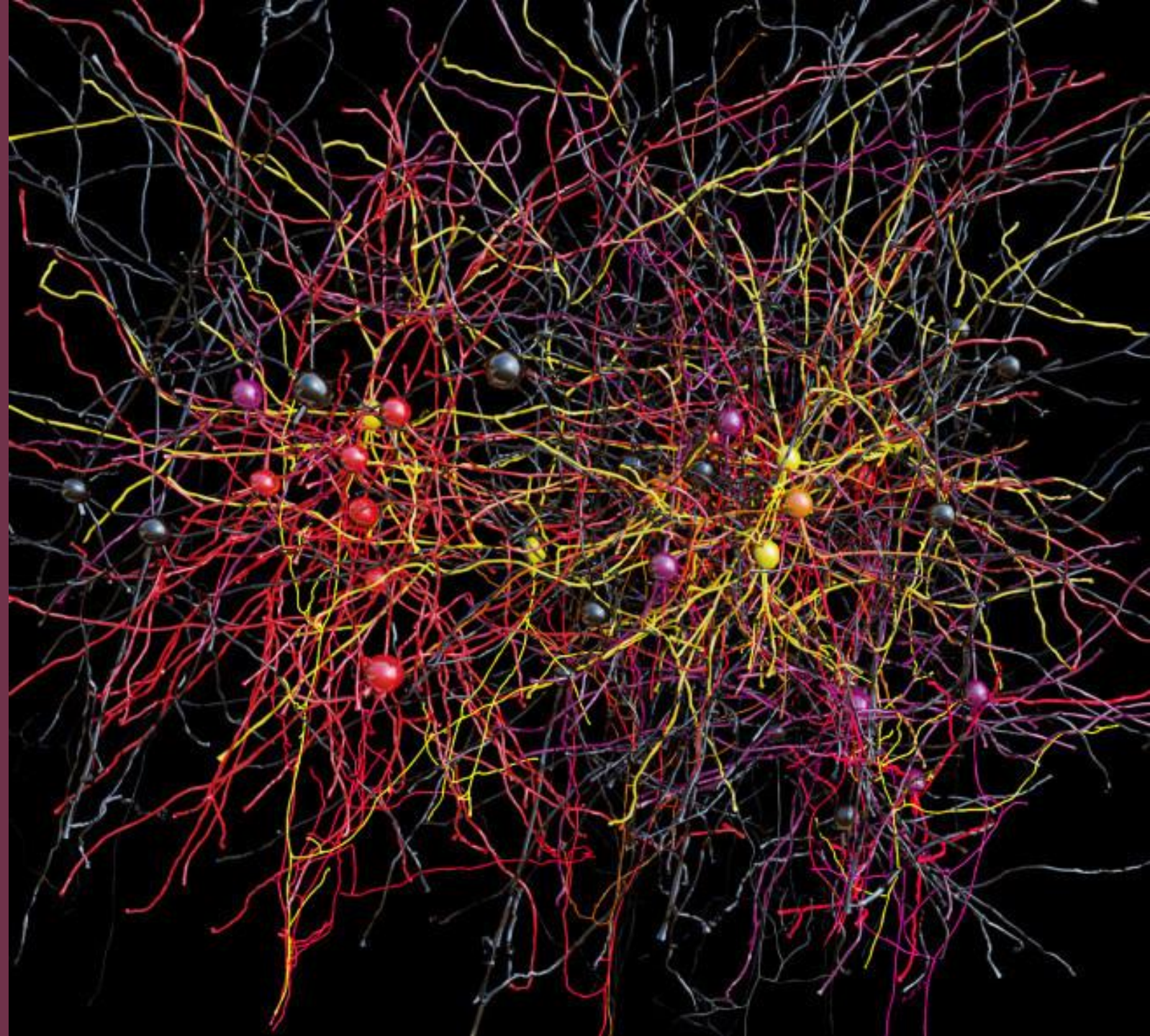



KASHPERSKY.COM

The Synapse: In a chemical synapse, the electrical activity in the presynaptic neuron triggers the release of chemical messengers, the neurotransmitters. The neurotransmitters diffuse across the synapse and bind to the specialized receptors of the postsynaptic cell.



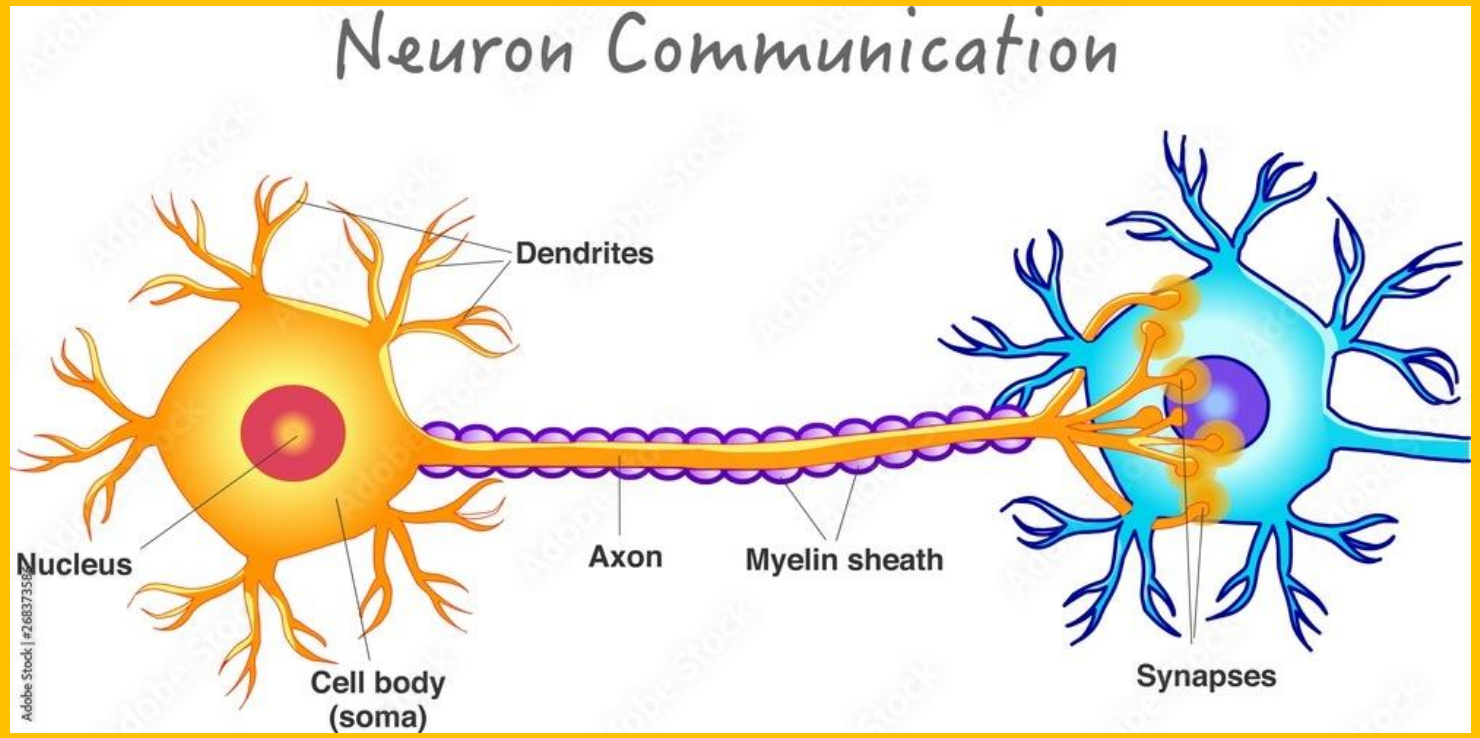
This graphic traces a network of cortical neurons from a trillions of bytes' worth of 3-D data. Some of the neurons are color-coded according to their activity patterns in the living brain. (Credit: Clay Reid, Allen Institute; Wei-Chung Lee, Harvard Medical School; Sam Ingersoll, graphic artist)

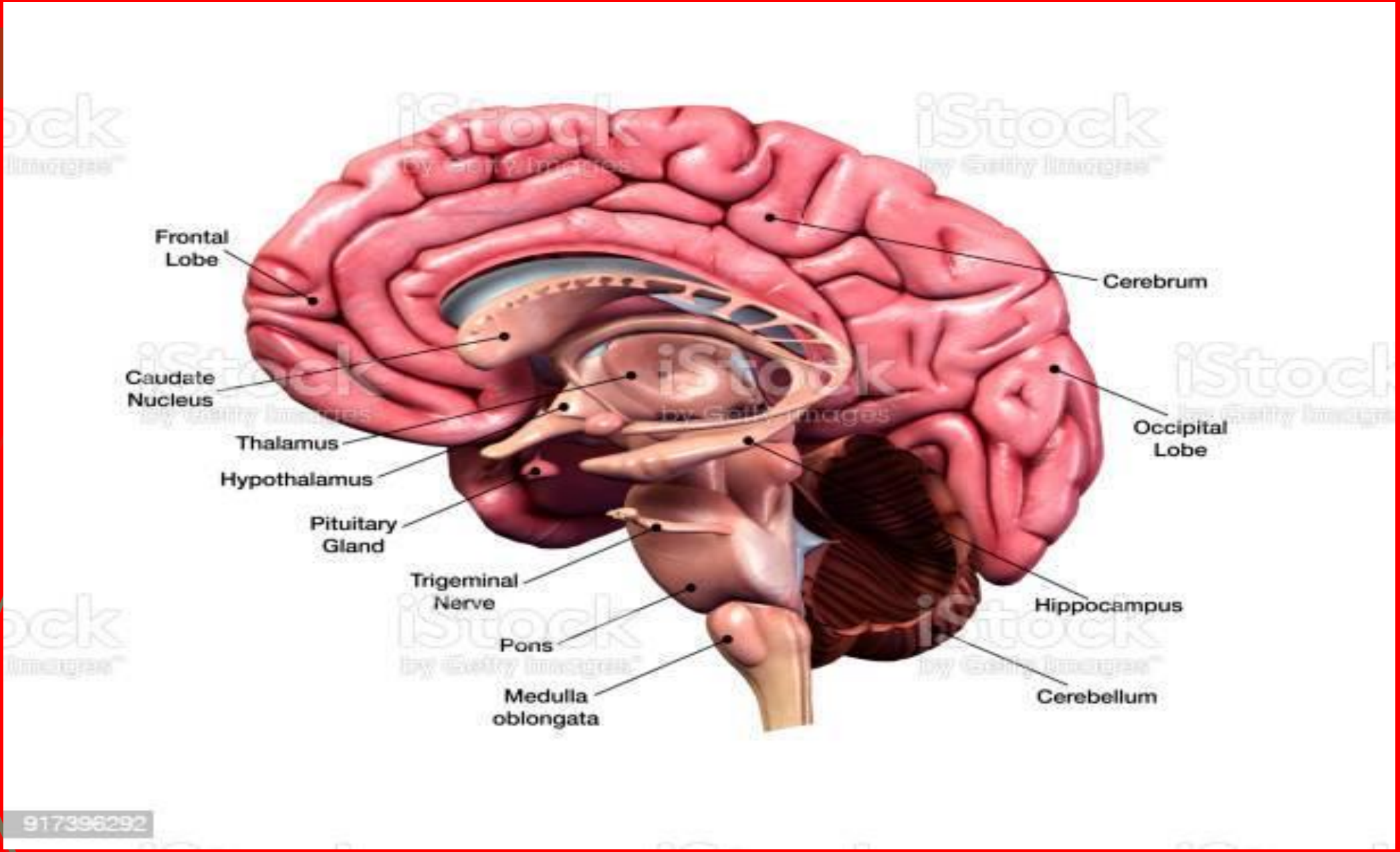


How Neurons Communicate

Click here for a short video with nicely describes how neurons communicate to one another.

https://courses.lumenlearning.com/wmopen-psychology/chapter/outcome-neurons/




Frontal Lobe
Cerebrum
Caudate Nucleus
Occipital Lobe
Thalamus
Hypothalamus
Pituitary Gland
Trigeminal Nerve
Hippocampus
Pons
Cerebellum
Medulla oblongata

Functional Areas of the Cerebral Cortex

1 Visual Area:
- Sight
- Image recognition
- Image perception

2 Association Area
- Short-term memory
- Equilibrium
- Emotion

3 Motor Function Area
- Initiation of voluntary muscles

4 Broca's Area
- Muscles of speech

5 Auditory Area
- Hearing

6 Emotional Area
- Pain
- Hunger
- "Fight or flight" response

7 Sensory Association Area

8 Olfactory Area
- Smelling

9 Sensory Area
- Sensation from muscles and skin

10 Somatosensory Association Area
- Evaluation of weight, texture, temperature, etc. for object recognition

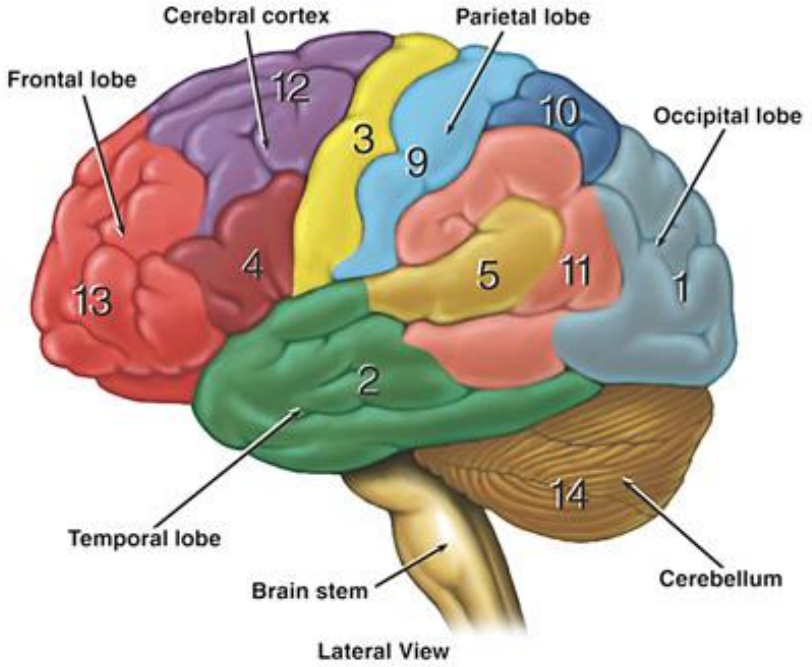
11 Wernicke's Area
- Written and spoken language comprehension

12 Motor Function Area
- Eye movement and orientation

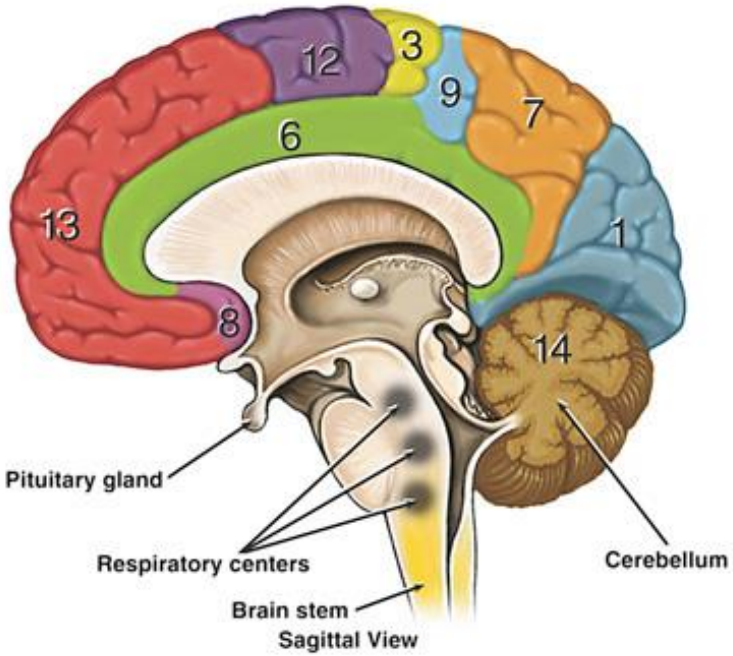
13 Higher Mental Functions
- Concentration
- Planning
- Judgment
- Emotional expression
- Creativity
- Inhibition

Functional Areas of the Cerebellum

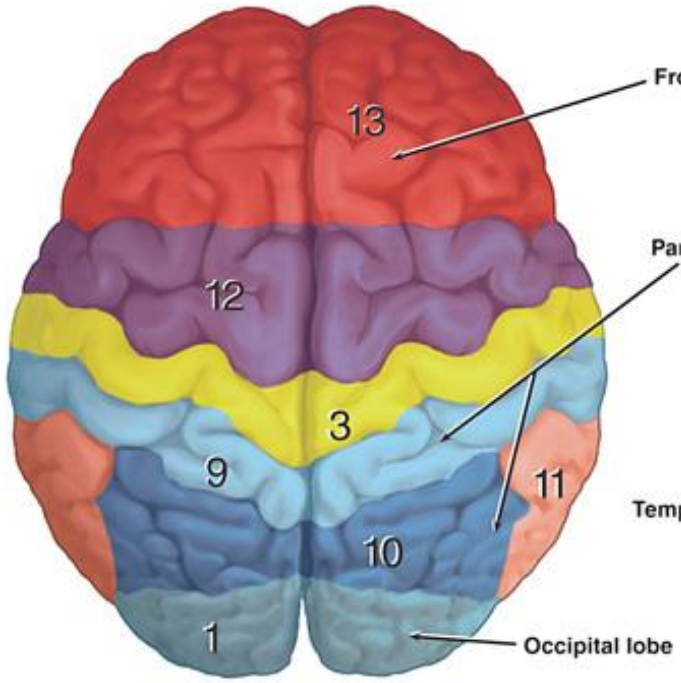
14 Motor Functions
- Coordination of movement
- Balance and equilibrium
- Posture



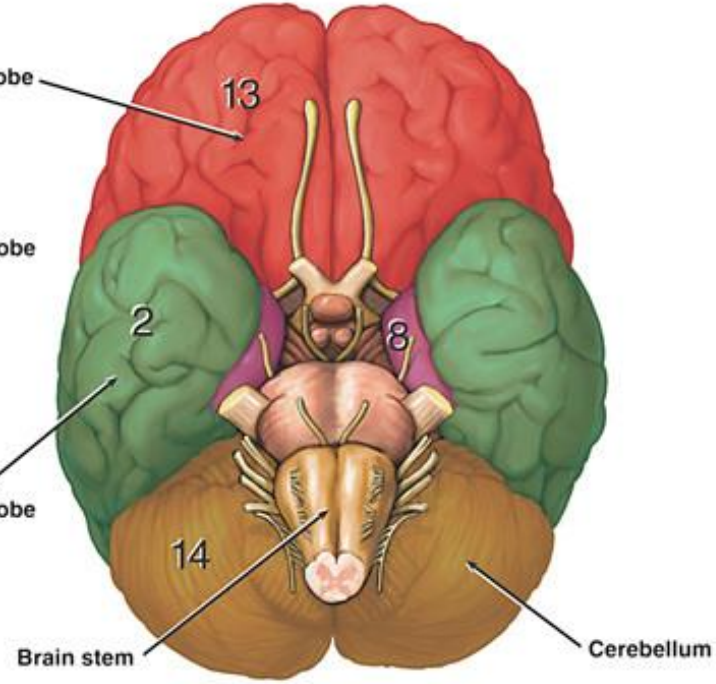
Lateral View



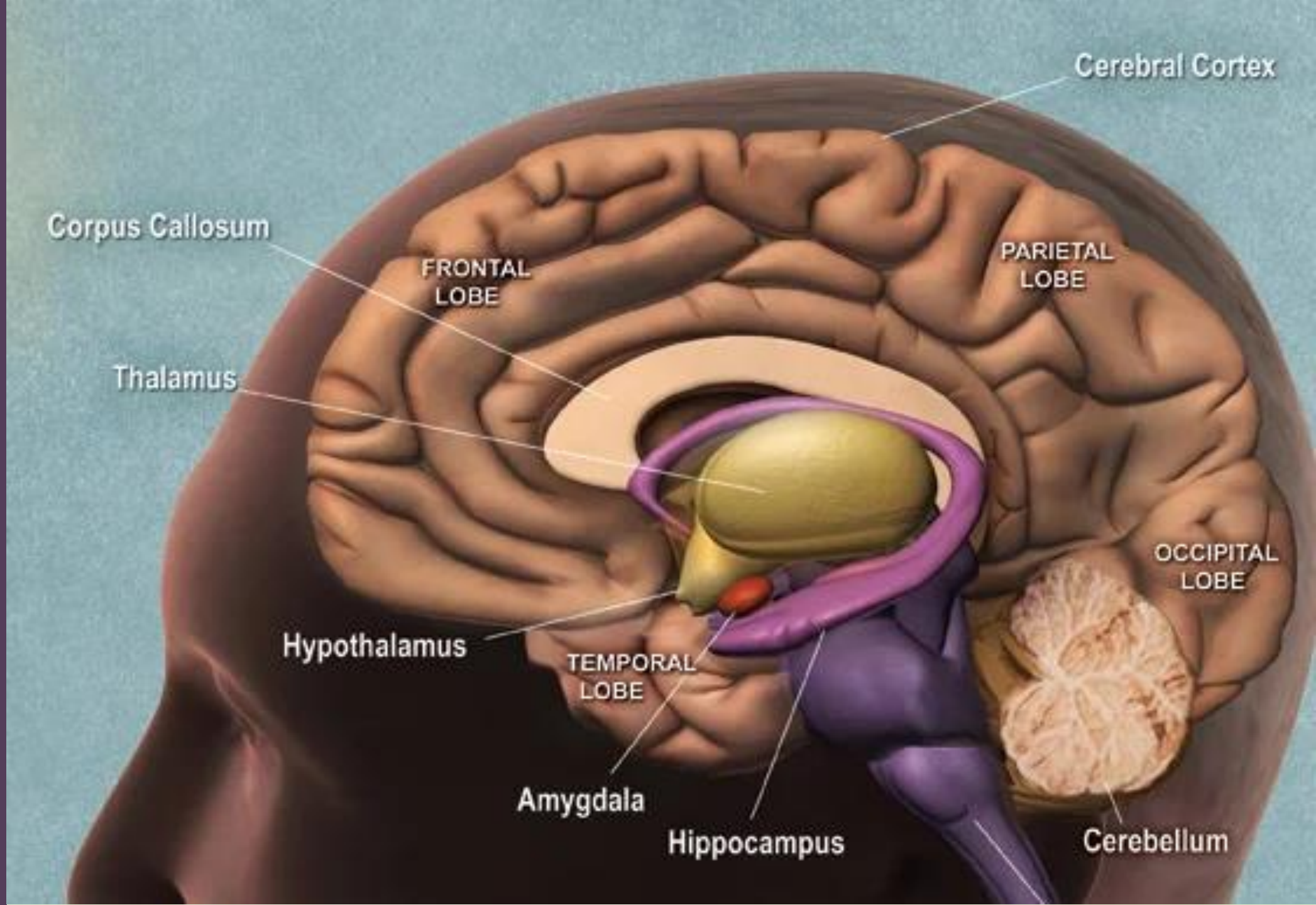
Sagittal View



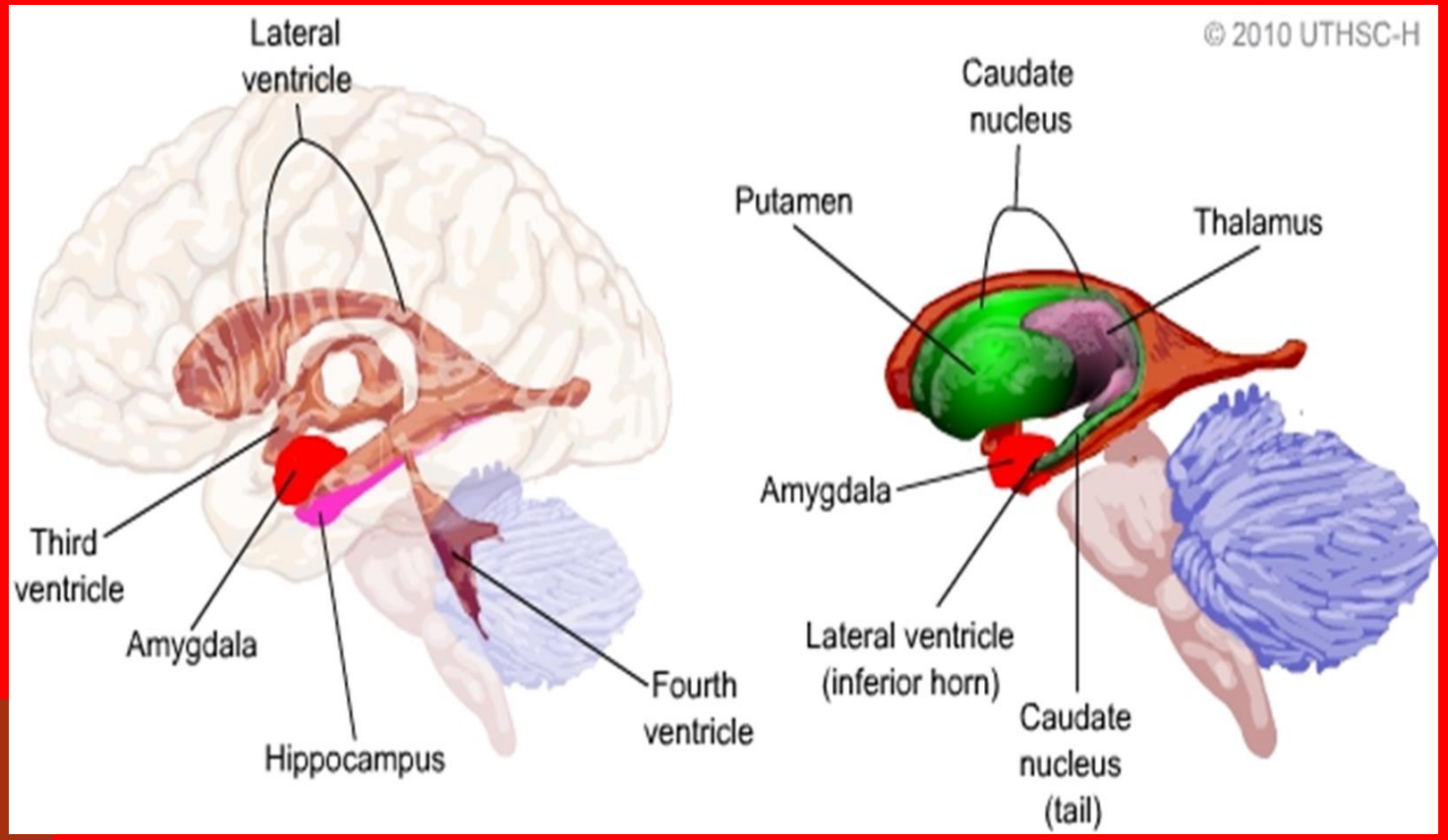
Superior View



Inferior View

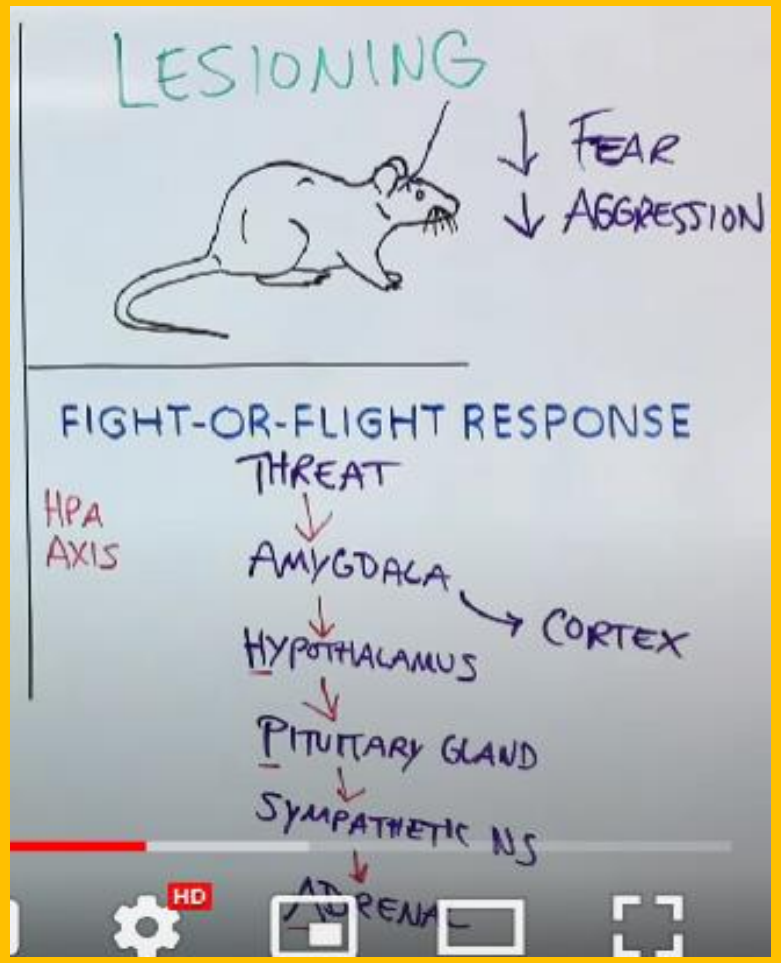

Cerebral Cortex
Corpus Callosum
FRONTAL LOBE
PARIETAL LOBE
Thalamus
OCCIPITAL LOBE
Hypothalamus
TEMPORAL LOBE
Amygdala
Hippocampus
Cerebellum

The Amygdala



How the Amygdala Works

- Amygdala is the integrative center for emotions, emotional behavior, and motivation. If the brain is turned upside down the end of the structure continuous with the hippocampus is called the uncus. If you peel away uncus you will expose the amygdala which abuts the anterior of the hippocampus. Just like with the hippocampus, major pathways communicate bidirectionally and contain both efferent and afferent fibers.
- The amygdala receives inputs from all senses as well as visceral inputs. Since the amygdala is very important in emotional learning it is not surprising that visceral inputs are a major input source. Visceral inputs come from the hypothalamus, septal area, orbital cortex, and parabrachial nucleus. Olfactory sensory information comes from the olfactory bulb. Auditory, visual and somatosensory information comes from the temporal and anterior cingulate cortices.

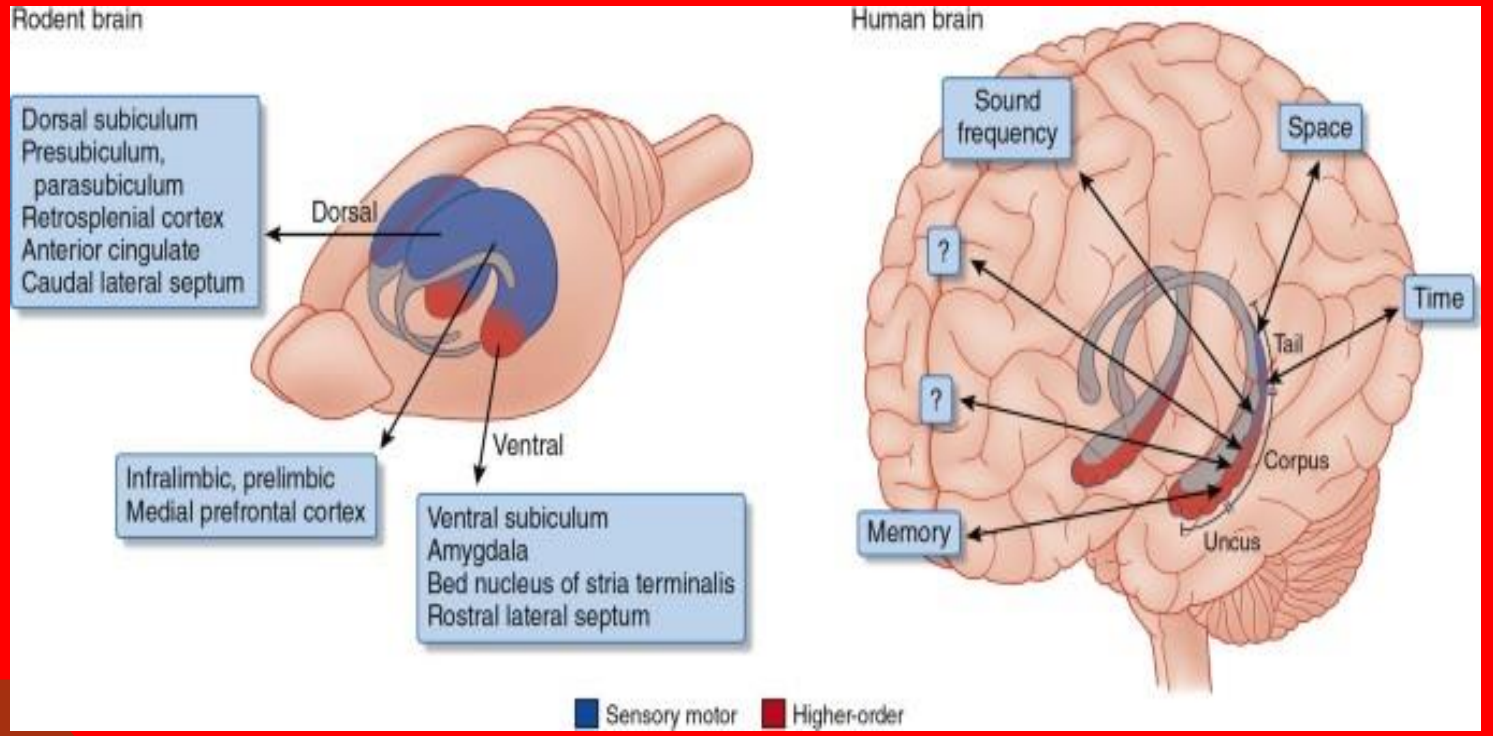


Click here for short videos on how the amygdala works:

https://www.youtube.com/watch?v=JVvMSwsOXPw&ab_channel=NeuroscientificallyChallenged

https://www.youtube.com/watch?v=KMQIuLQG09o&ab_channel=PSYCHEXPLAINED

The Hippocampus



How the Hippocampus Works

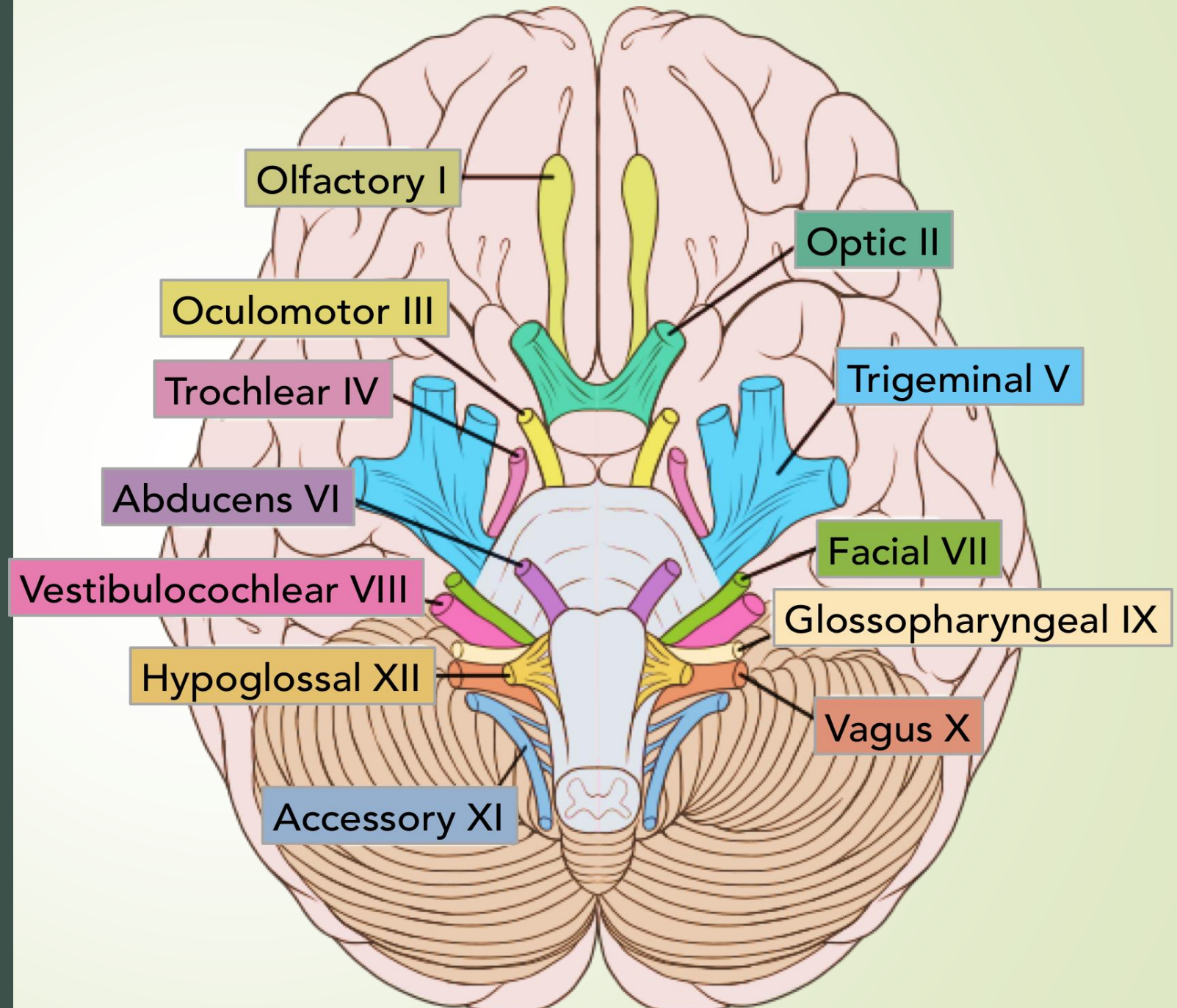
- The hippocampus is a curved-shaped structure in the temporal lobe associated with learning and memory. The name being derived from the Greek words for ‘sea monster’ but is more commonly recognizable for being shaped like a seahorse.
- The hippocampus is considered to be a part of the limbic system, a group of structures involved in the processing and regulating of emotions and memories. The hippocampus, is most strongly associated with the formation of memories, is an early storage place for new long-term memories, and is involved in the transition of these long-term memories to more permanent memories.
- The hippocampus is important in the organization and storage of new memories, especially those which are declarative memories (e.g., memories relating to facts and events).
- This area is also responsible for making memories stronger by connecting sensations and emotions to these memories. For instance, the hippocampus has links with, and is approximate to the amygdala, a structure associated with emotions, especially fear.

- Click here for two short video on how the hippocampus works:

https://www.youtube.com/watch?v=2K3GAaC2SEI&ab_channel=BioBrainBuddies

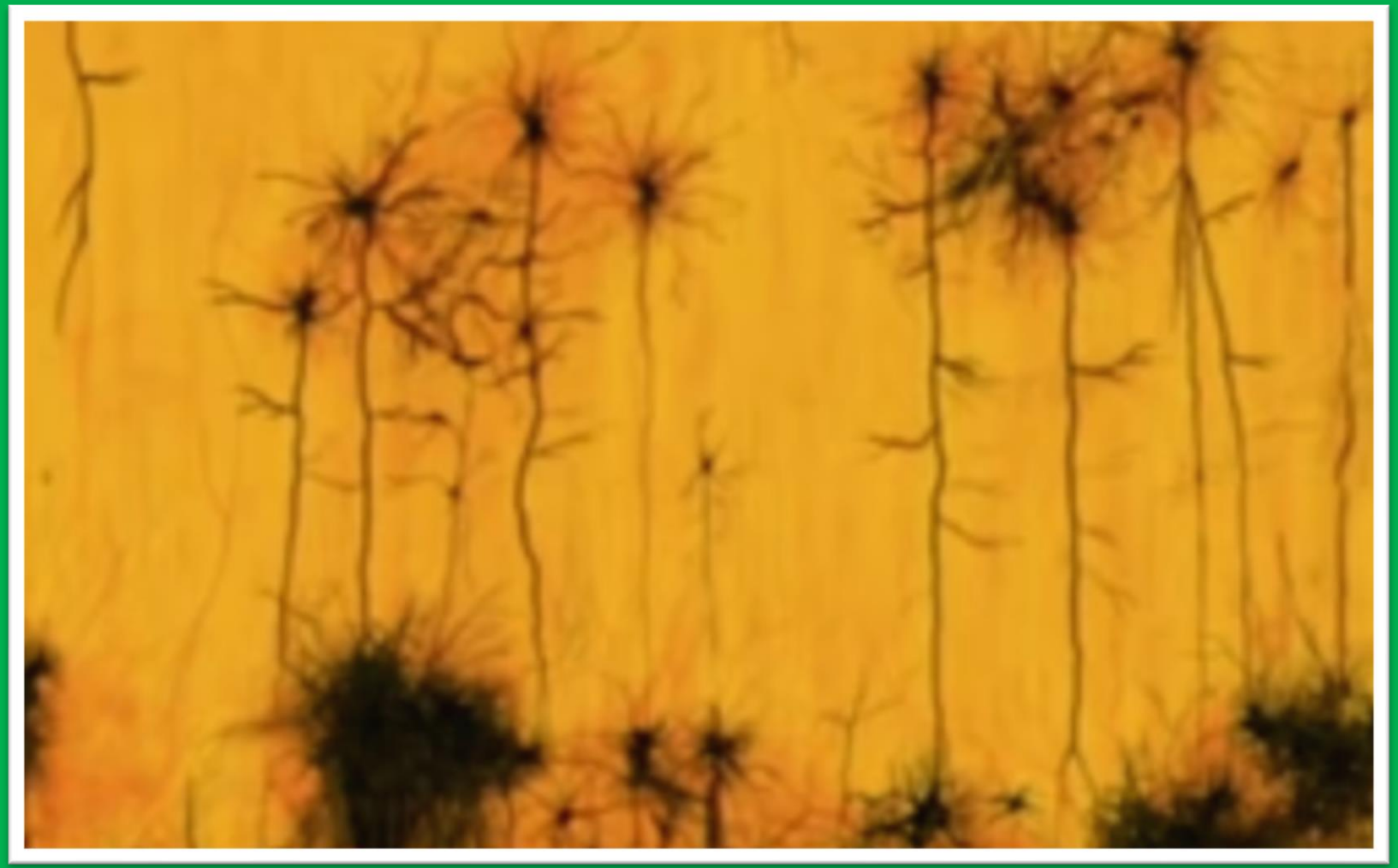
https://www.simplypsychology.org/hippocampus.html

The 12 Cranial Nerves

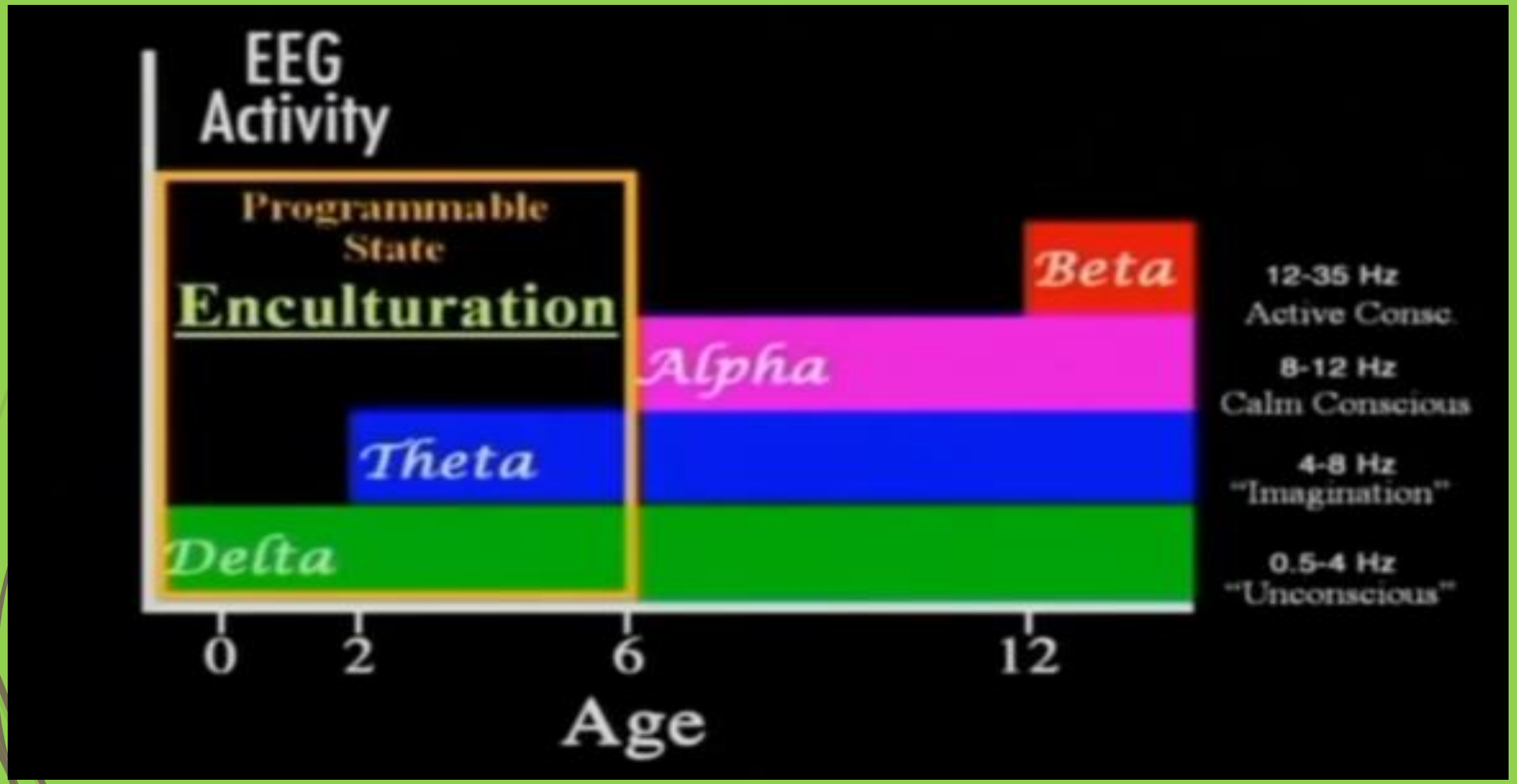


Dendritic Wiring of Neurons

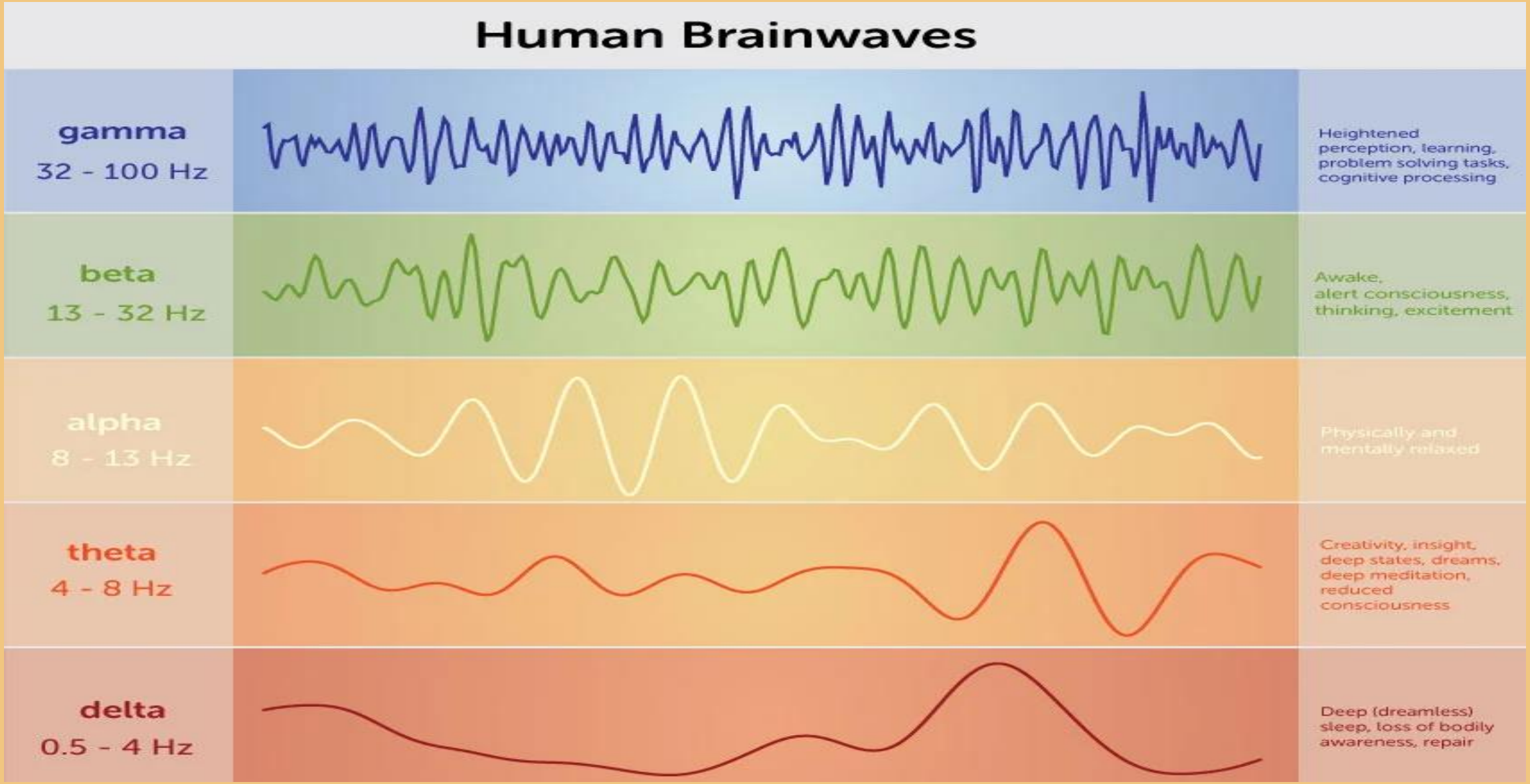
- As Hebb said, neurons that fire together, wire together. This slide nicely shows increased density of dendrites (the dark areas) in neurons that fire frequent and much less density in the neurons that don’t fire as often.



Brain wave activity and age



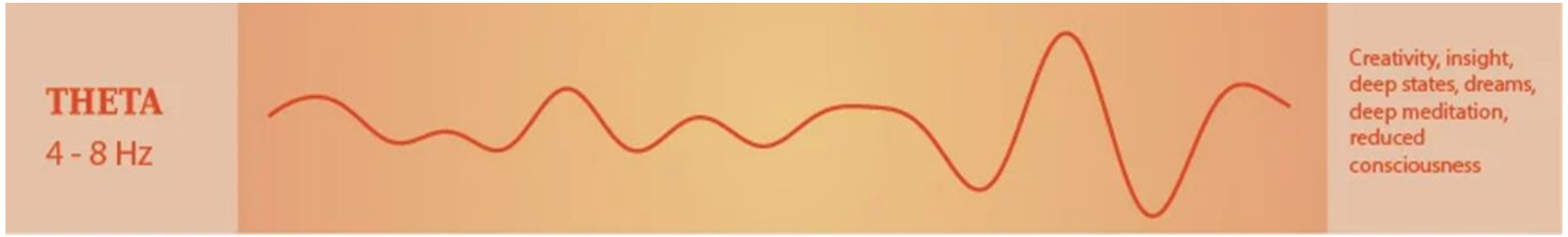
Human Brainwaves



Delta Brainwaves

- Frequency: 0.5-4 Hz
- State: Sleep, dreaming

These are the slowest of all brainwaves and are strongest when we are enjoying restorative sleep in a dreamless state. This is also the state where healing and rejuvenation are stimulated, which is why it's so crucial to get enough sleep each night.



Theta Brainwaves

- Frequency: 4-8 Hz
- State: Creativity, insight, dreams, reduced consciousness

According to Professor **Jim Lagopoulos** of Sydney University, "previous studies have shown that theta waves indicate deep relaxation and occur more frequently in highly experienced meditation practitioners. The source is probably frontal parts of the brain, which are associated with monitoring of other mental processes."

Most frequently, theta brainwaves are strongly detectable when we're dreaming in our sleep (think, the movie *Inception*), but they can also be seen during :

- Deep meditation
- Daydreaming

Alpha Brainwaves

- Frequency: 8-13 Hz
- State: Physically and mentally relaxed

Alpha brainwaves are some of the most easily observed and were the first to be discovered. They become detectable when the eyes are closed and the mind is relaxed. They can also often be found during activities such as:

- Yoga
- Just before falling asleep

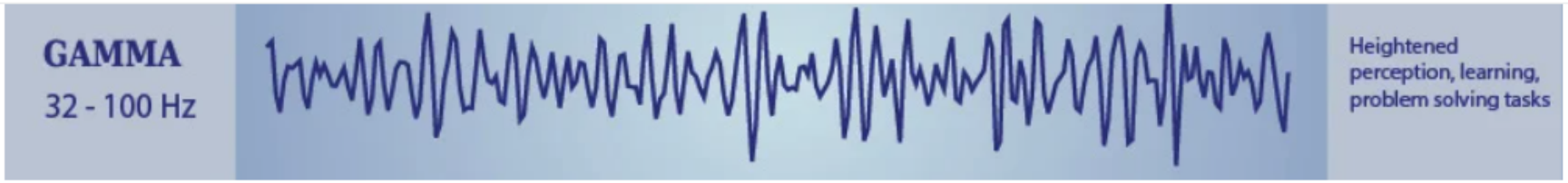
Beta Brainwaves

- Frequency: 13-32 Hz
- State: Alert, normal alert consciousness, active thinking

For example:

- Active conversation
- Making decisions
- Solving a problem
- Focusing on a task
- Learning a new concept

Beta brainwaves are easiest to detect when we're busy thinking actively.



Gamma Brainwaves

- Frequency: 32 – 100 Hz
- Associated state: Heightened perception, learning, problem-solving tasks

Gamma brainwaves are the fastest measurable EEG brainwaves and have been equated to 'heightened perception', or a 'peak mental state' when there is simultaneous processing of information from different parts of the brain. Gamma brainwaves have been observed to be much stronger and more regularly observed in very long-term meditators including Buddhist Monks.

DNA