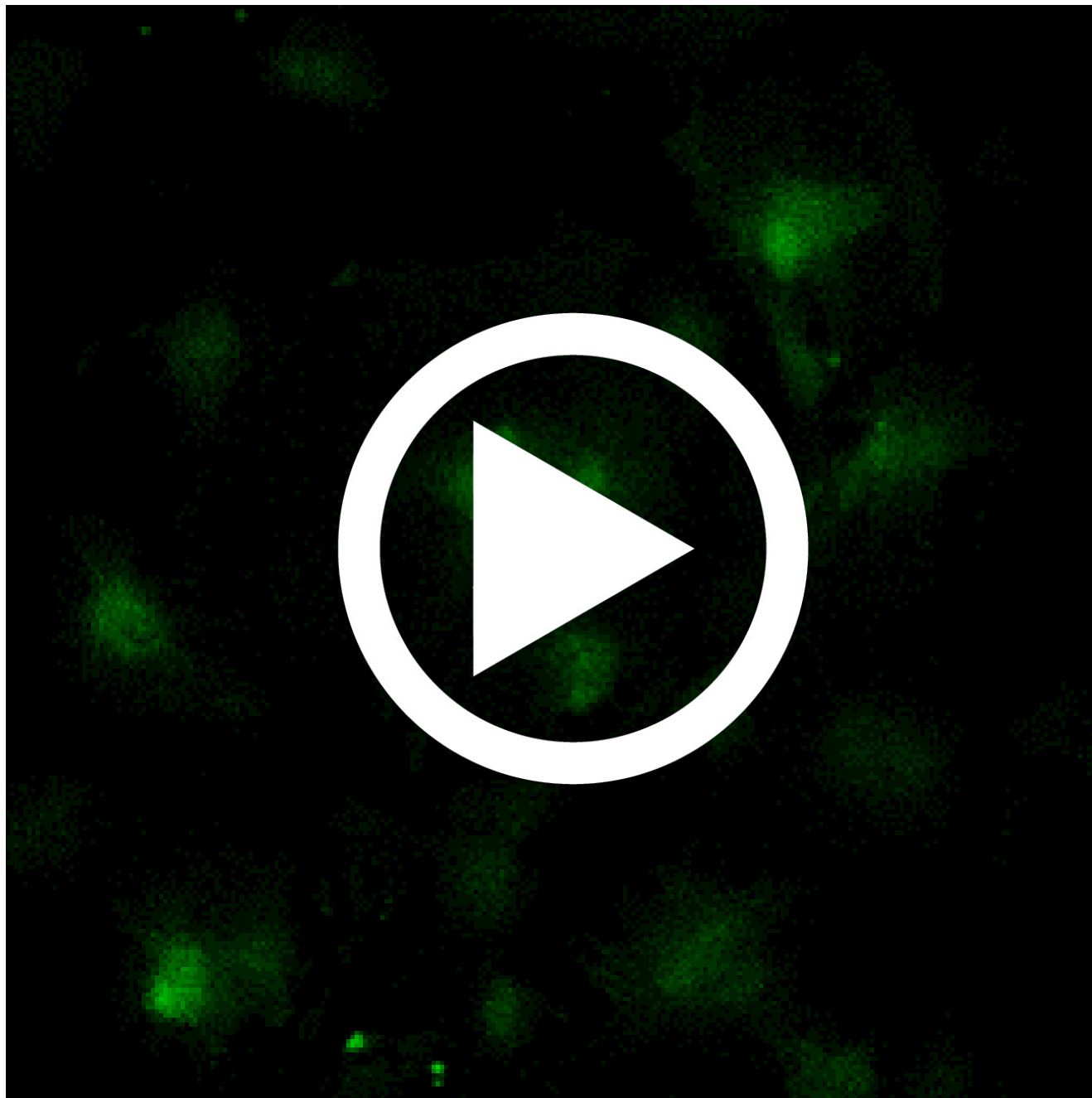


**WHAT'S IN A BRAIN?
MORE THAN MATTER!**

PROMISE

SANFORD[®]
RESEARCH

WATCH THIS!



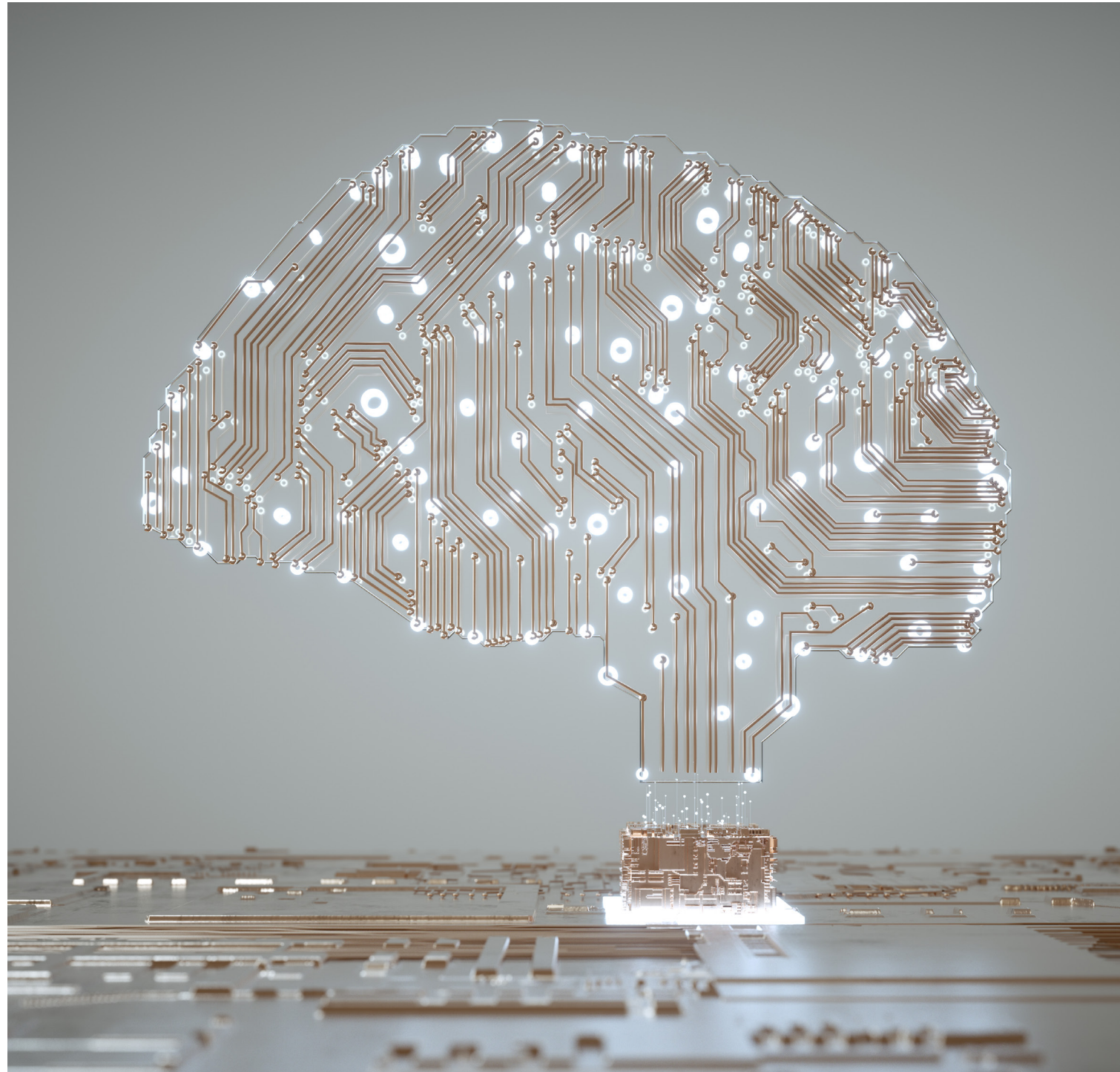
Watch the video.
What do you see
happening? Green
spots? Alien
invasion? Glowing
algae? What do
you think?

BRAIN POWER

The brain sends and receives signals through special cells called neurons.

There are about 86 billion neurons in your brain.





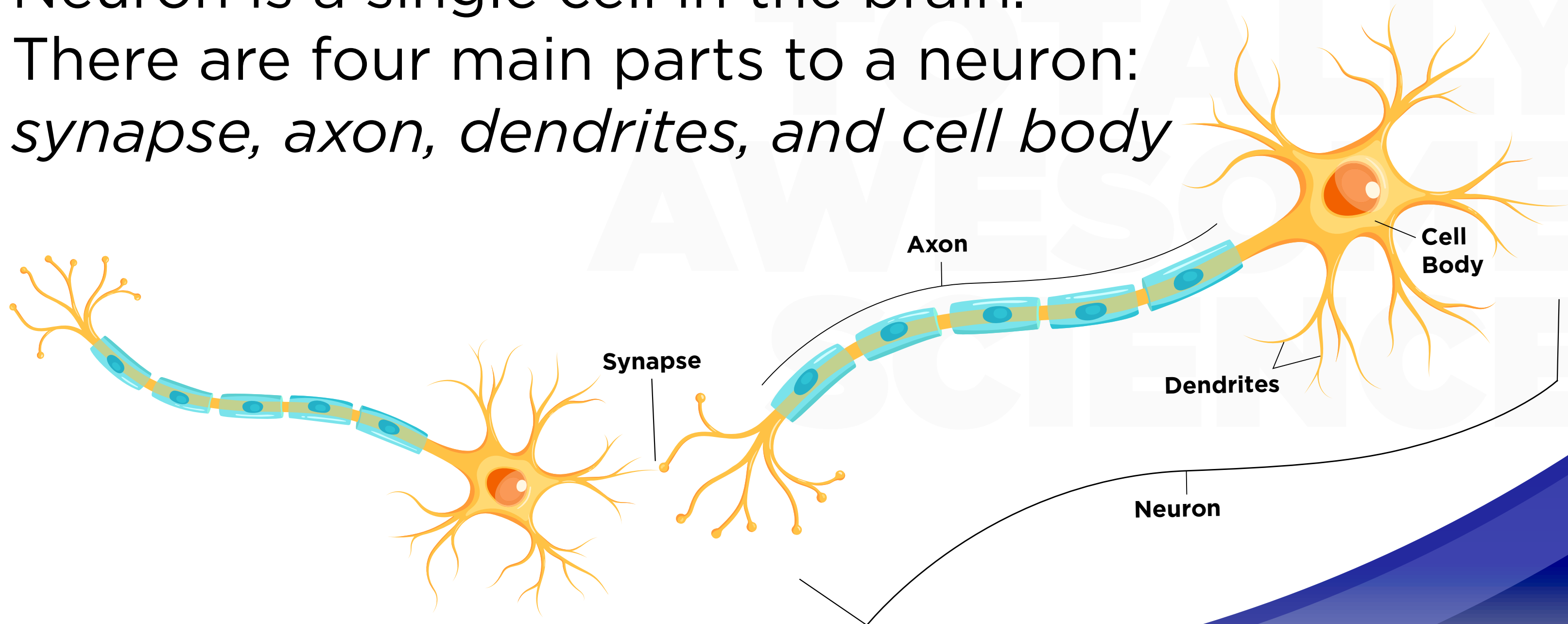
BRAIN POWER

These neurons act like a computer processor to allow you to learn and help your body function.

WHAT IS A NEURON?

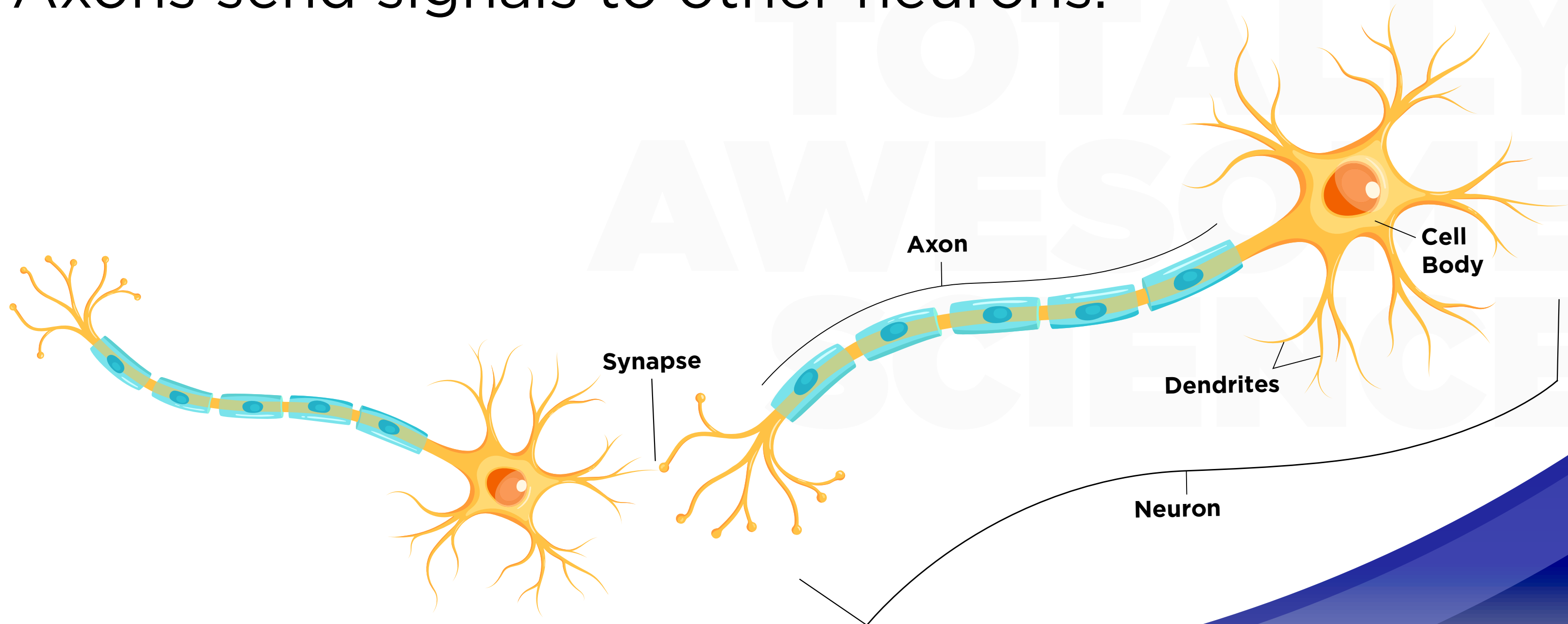
Neuron is a single cell in the brain.

There are four main parts to a neuron:
synapse, axon, dendrites, and cell body



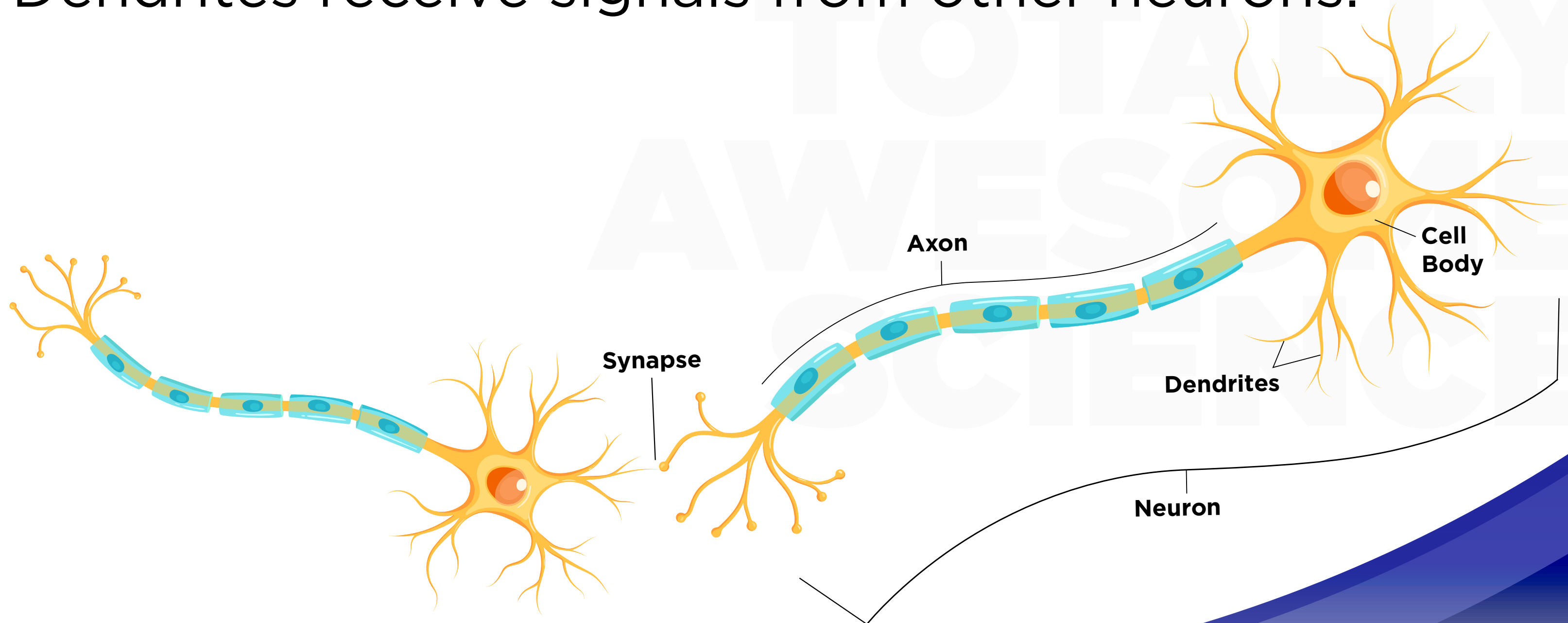
AXON

Axons send signals to other neurons.



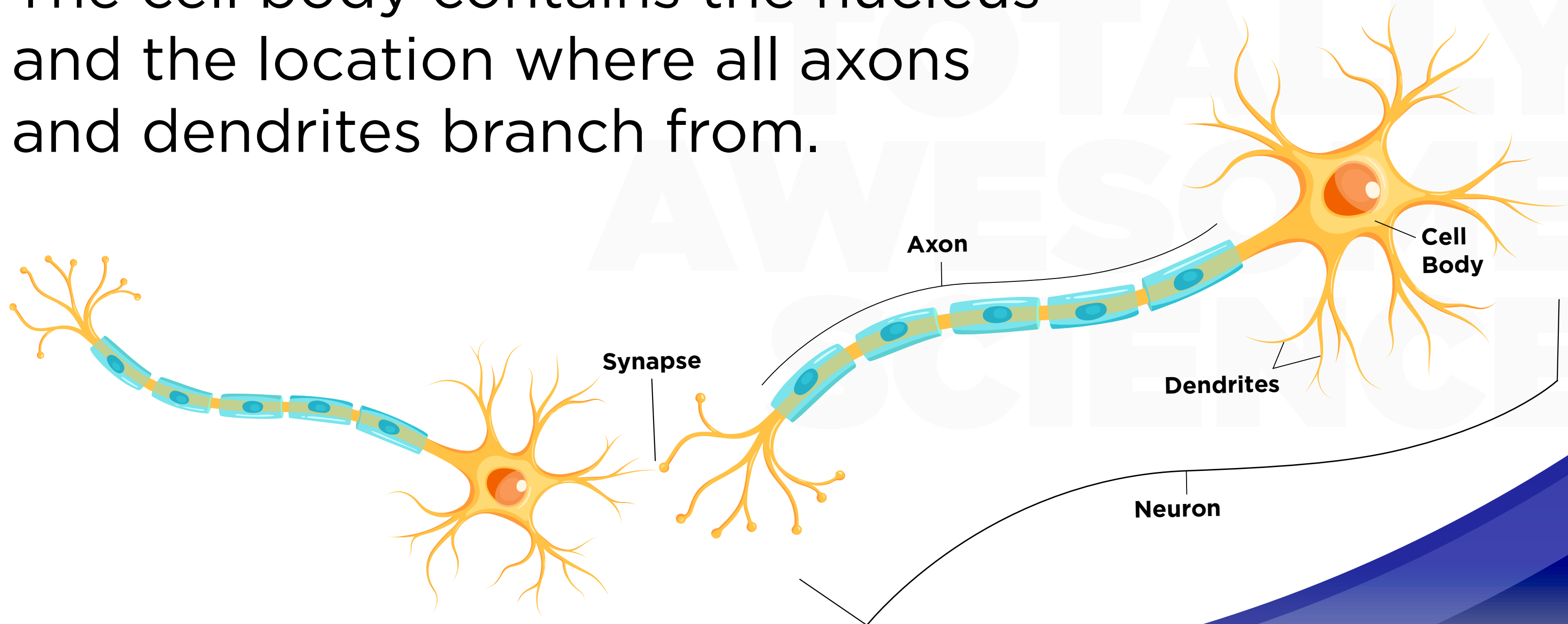
DENDRITES

Dendrites receive signals from other neurons.



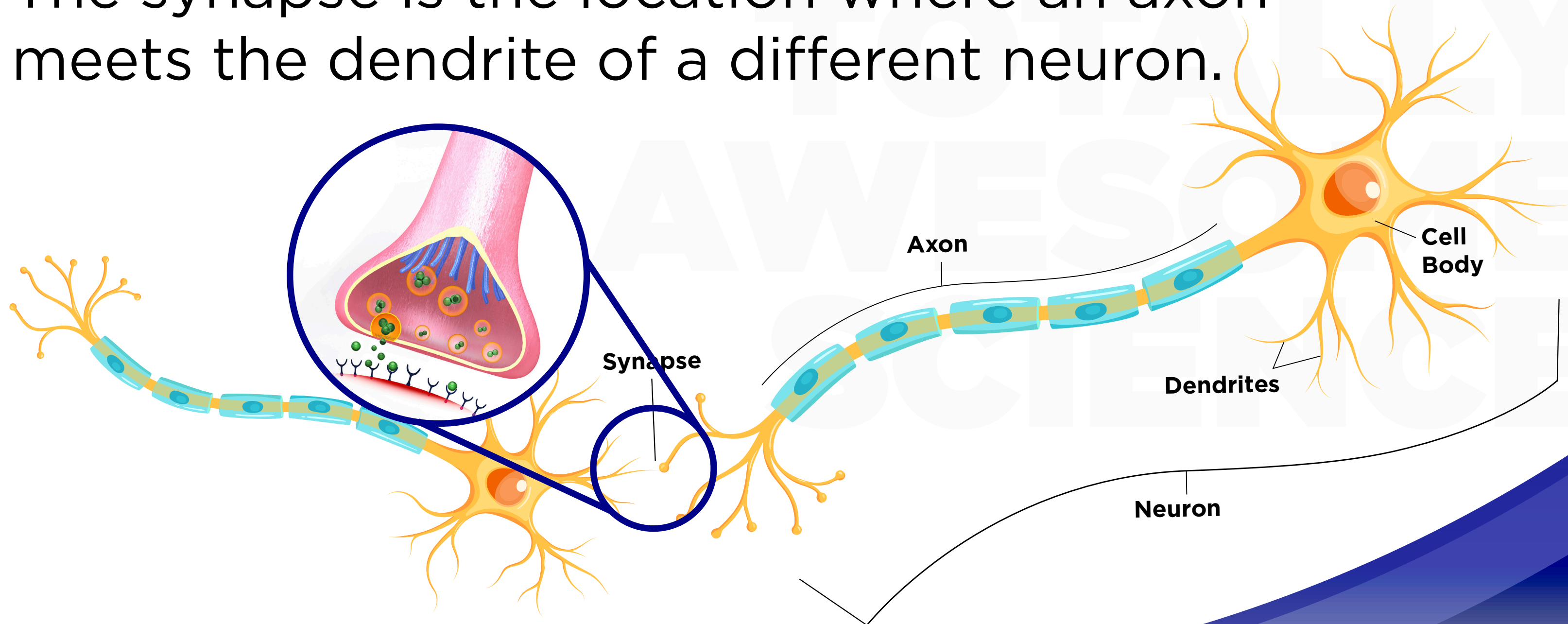
CELL BODY

The cell body contains the nucleus and the location where all axons and dendrites branch from.



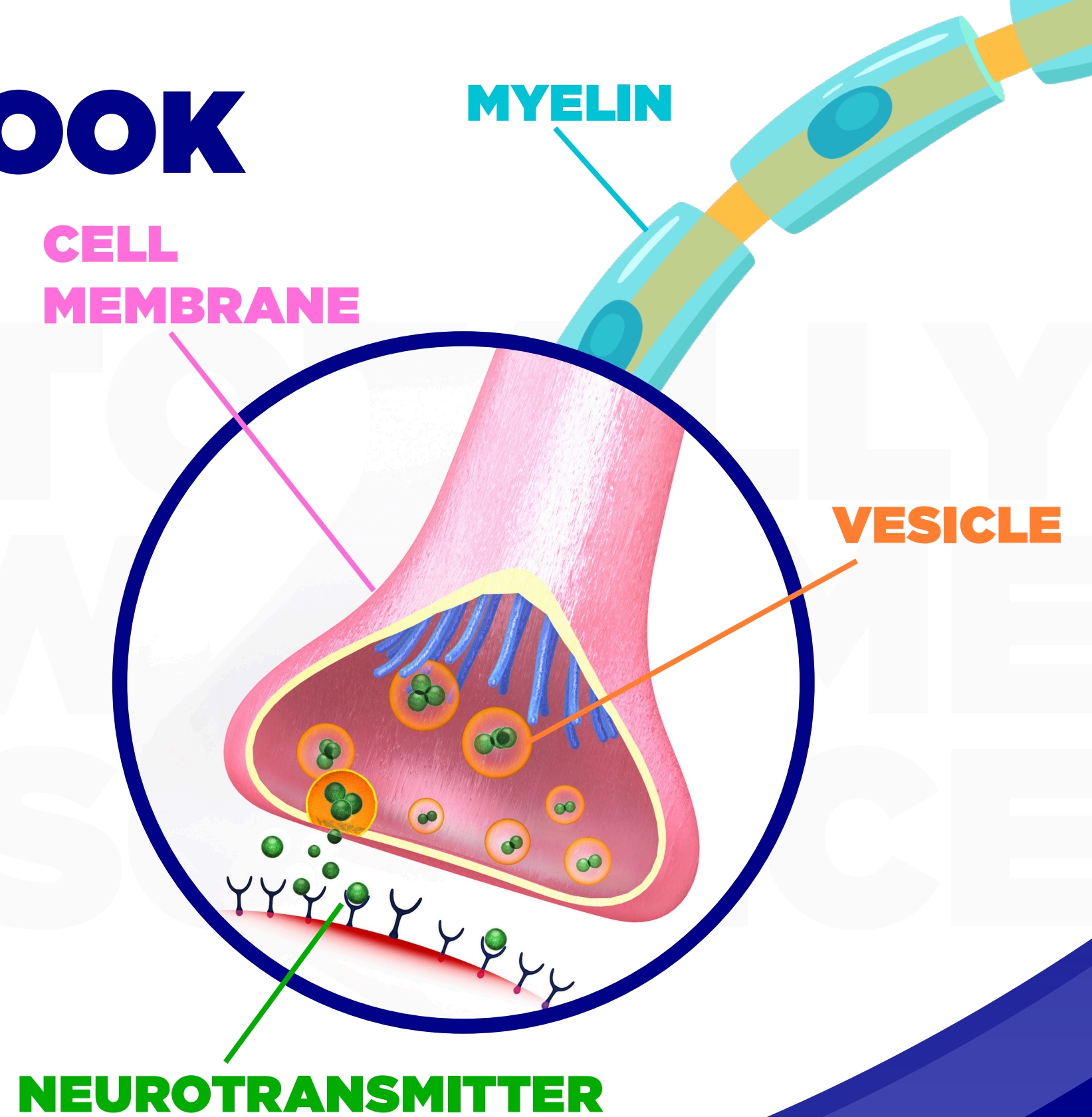
SYNAPSE

The synapse is the location where an axon meets the dendrite of a different neuron.



TAKE A CLOSER LOOK

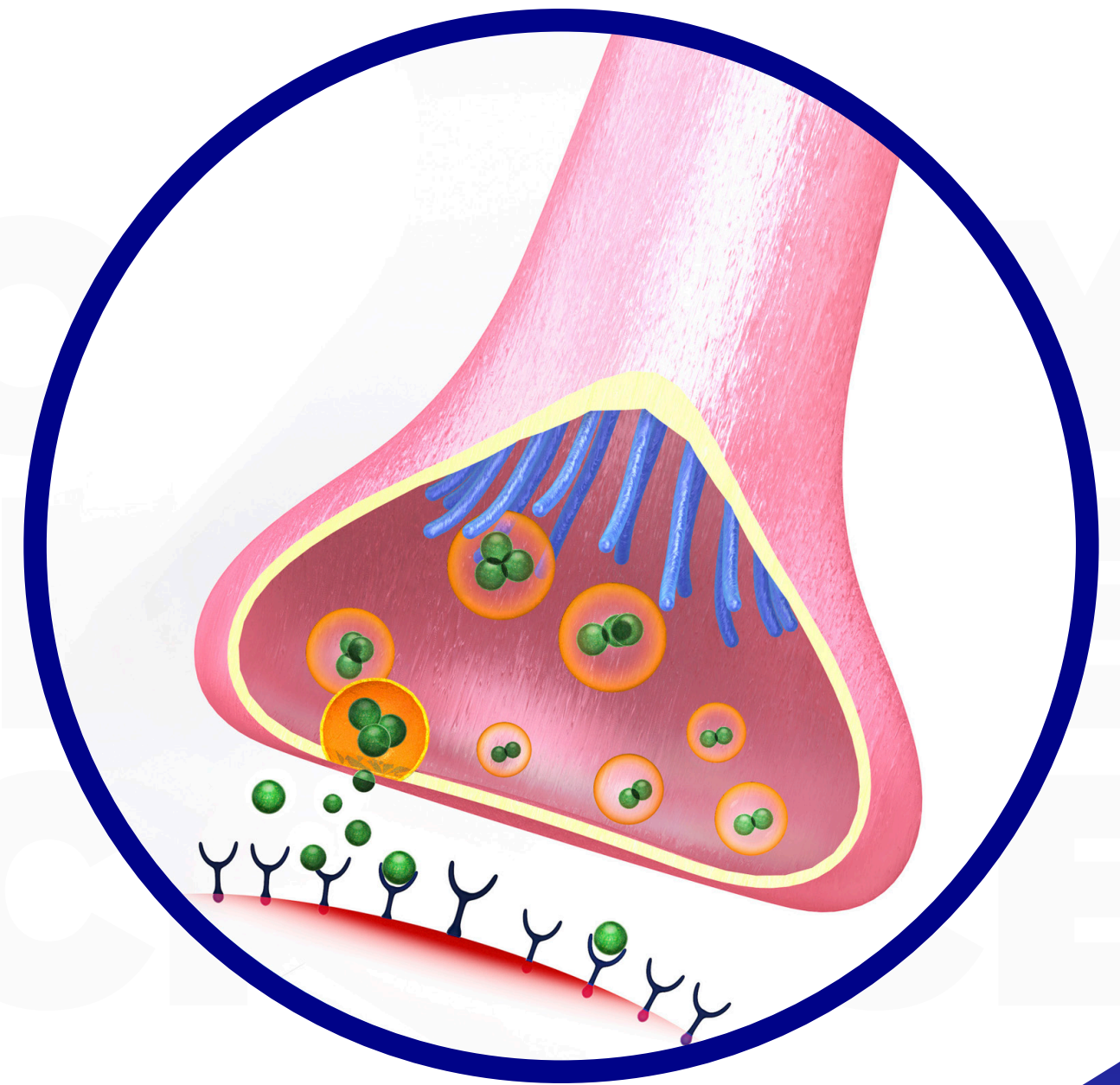
- **Neurotransmitters:** Molecules responsible for sending signals
- **Vesicles:** Transport packages within a cell
- **Cell membrane:** A double layer of phospholipids that encapsulates a cell
- **Myelin:** A fatty coating over some axons and dendrites that helps signals travel faster



Neurotransmitters relay signals from an axon to a dendrite.

Dendrites have special receivers.

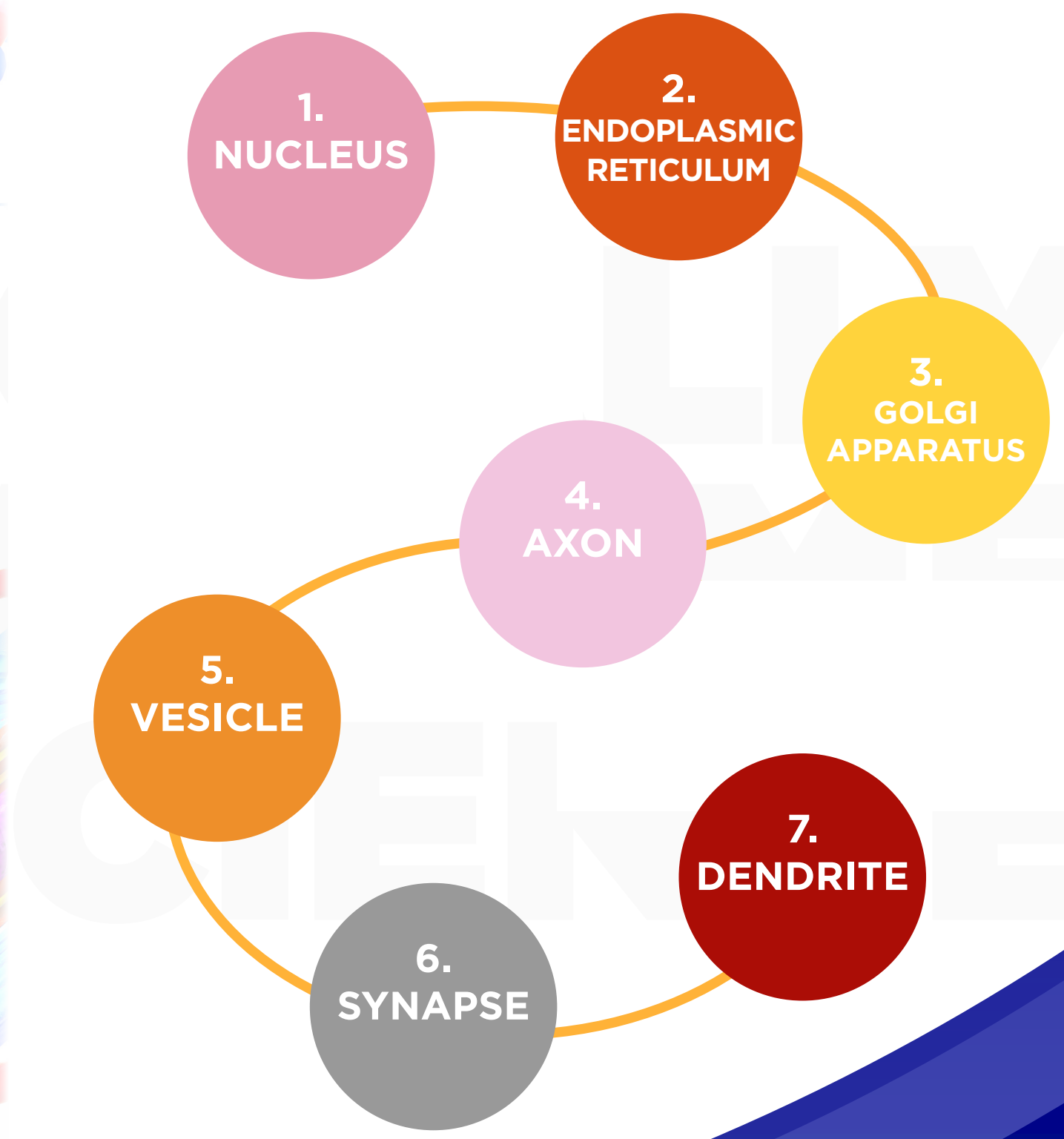
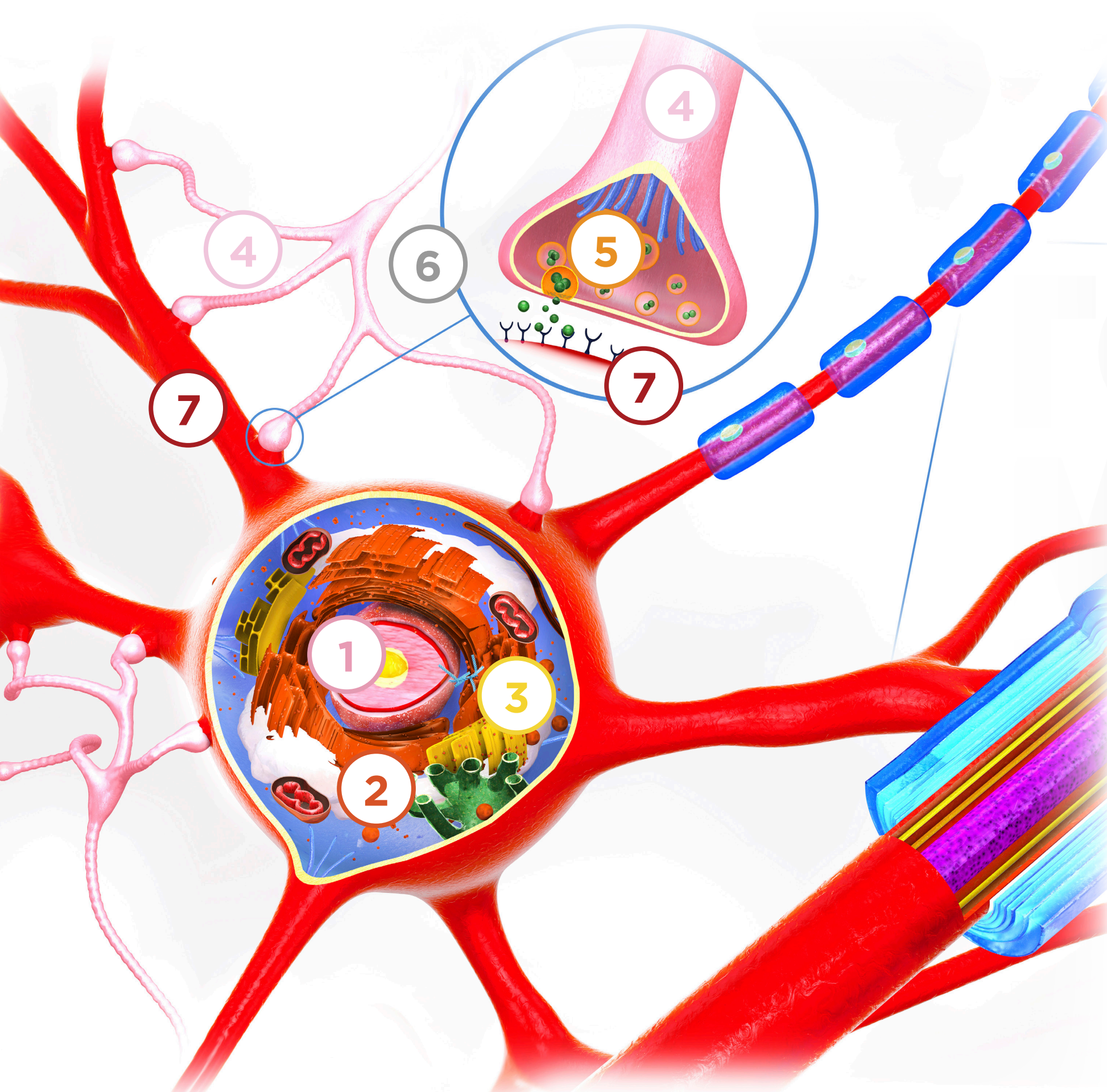
Dopamine is an example of a neurotransmitter that transmits a signal to reward certain behaviors thus making you want to repeat the behaviors.

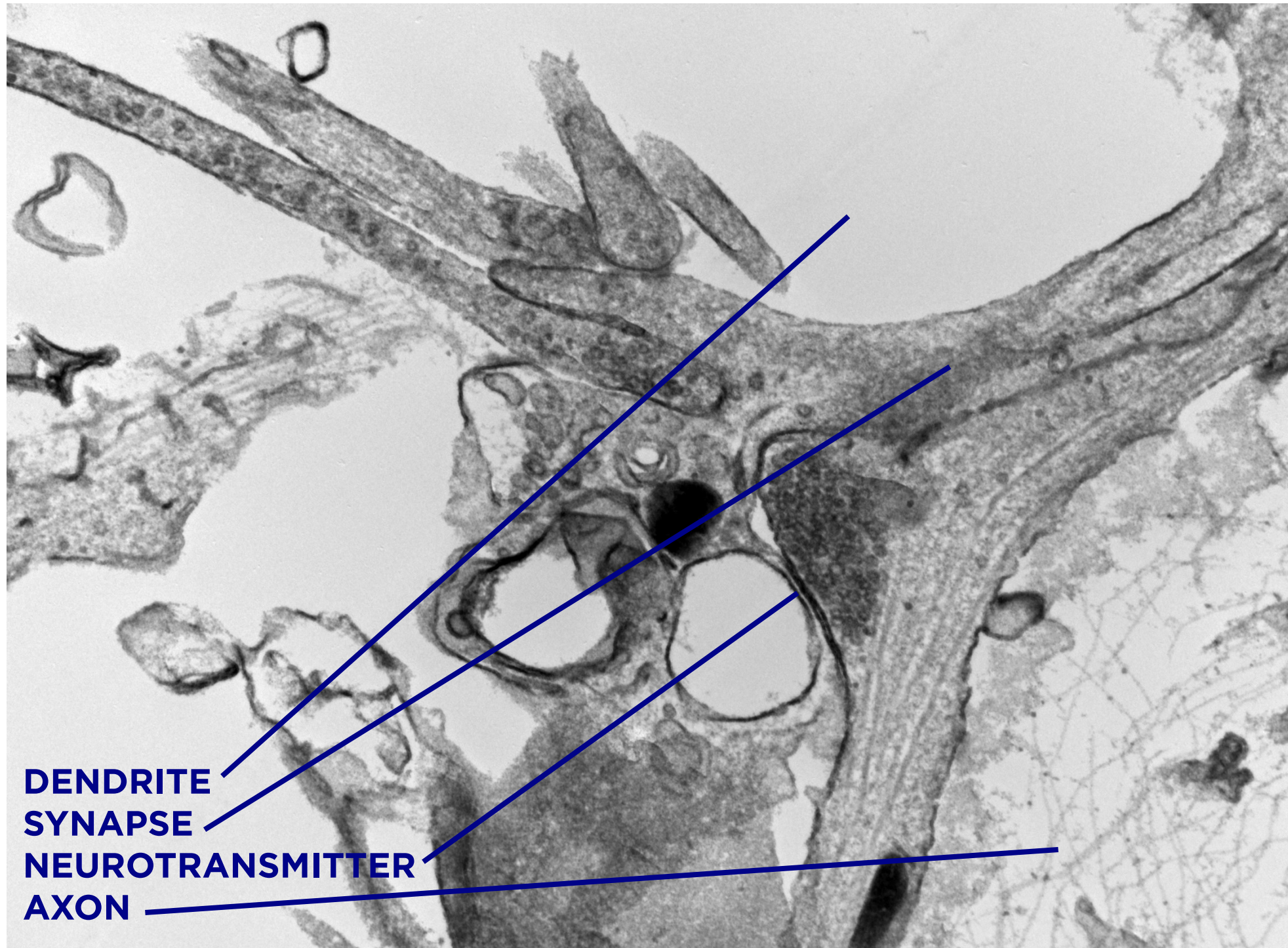


SYNTHESIS & MOVEMENT OF DOPAMINE



1. Dopamine starts as DNA in the nucleus.
2. The DNA is transcribed and translated into a polypeptide.
3. The golgi apparatus marks the protein for delivery to the axons.
4. Dopamine is placed into vesicles.
5. Calcium causes vesicles to pinch.
6. Dopamine is released to the synapse.
7. Dopamine attaches to receptors on the dendrites.





WHAT DO REAL NEURONS LOOK LIKE?

Image courtesy of Dr. Kevin Francis, Sanford Research

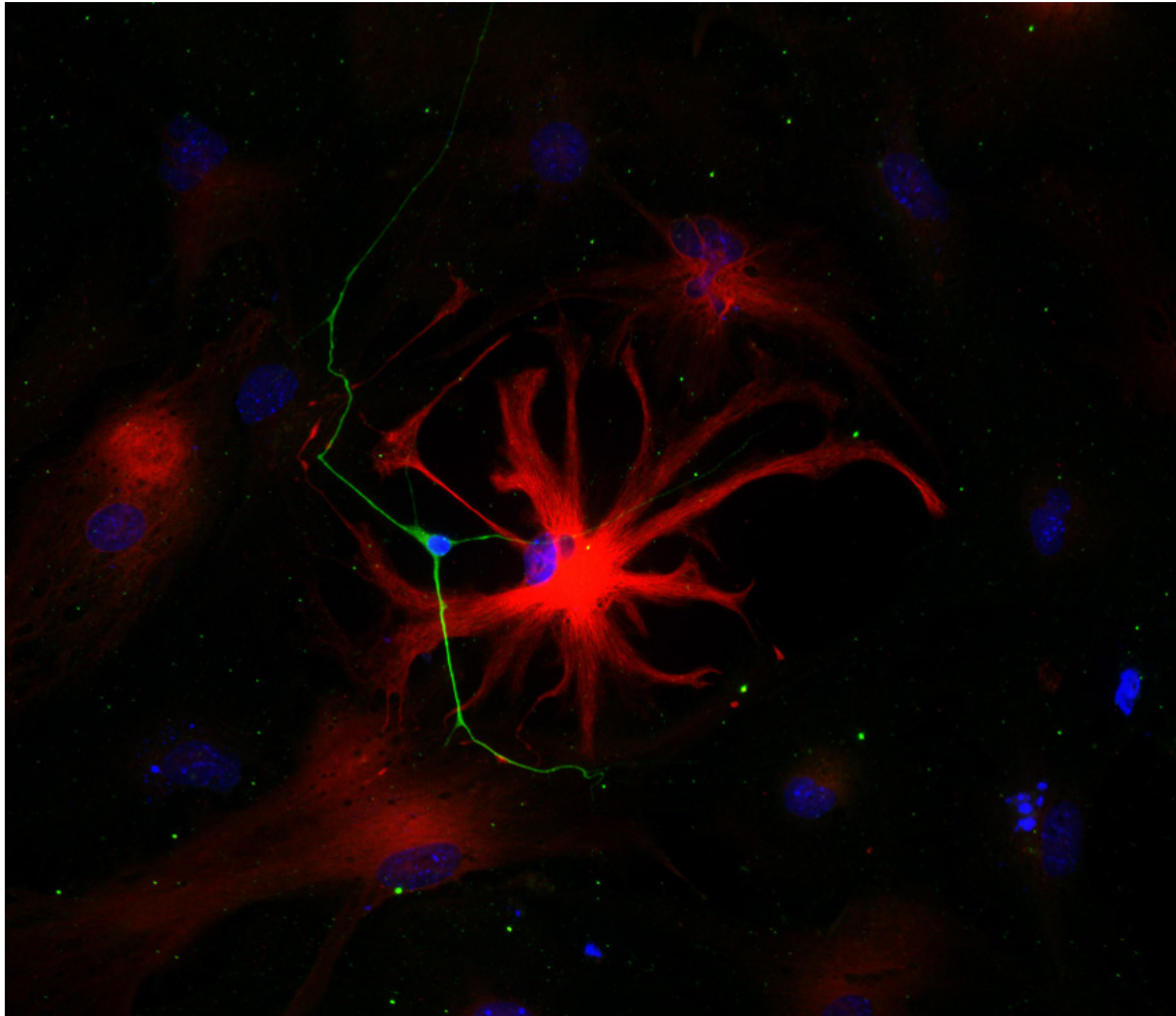


Image courtesy of Dr. Kevin Francis, Sanford Research

MORE THAN NEURONS

Along with all the neurons, there are also about 84 billion glial cells in the brain.

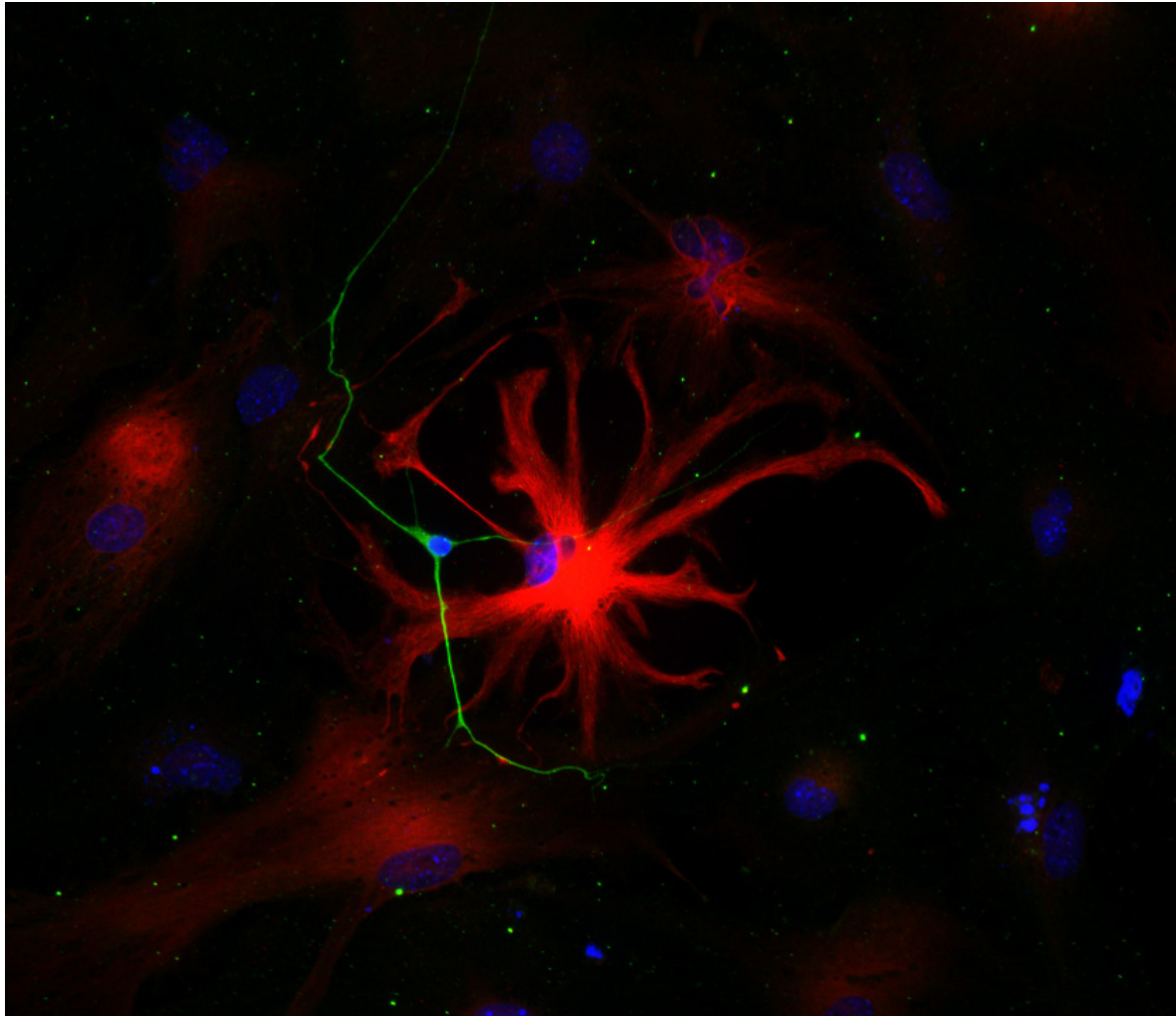


Image courtesy of Dr. Kevin Francis, Sanford Research

Glial cells help neurons fight infection, form myelin, and support the structure of neurons.

Astrocytes are a type of glial cell that act like glue for **neurons** (blue are neuron nuclei).



HOW TO GET SMARTER

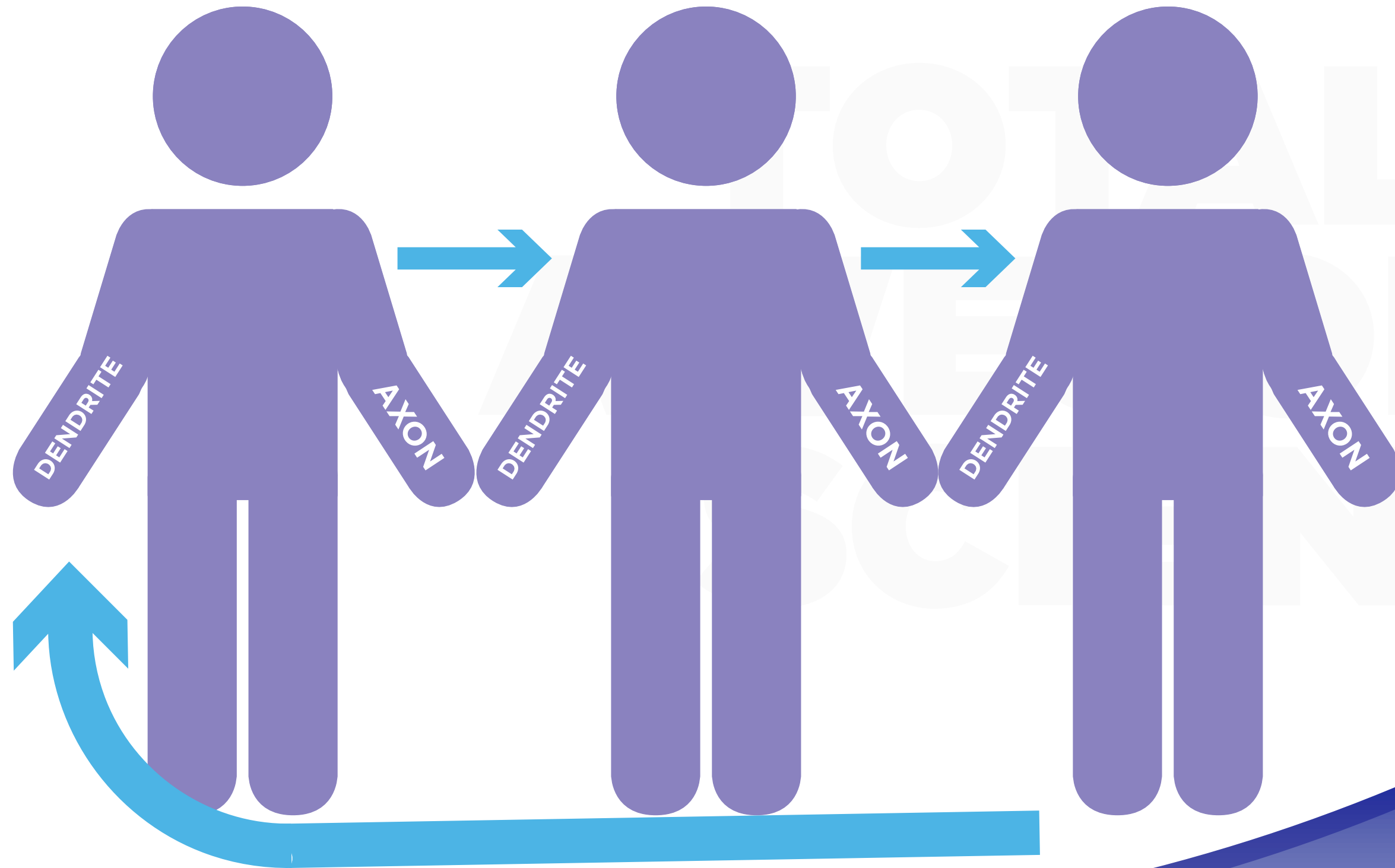
Neurons are one of the few cell types that do not undergo mitosis (cell division).

Instead of dividing, neurons use glial cells to form new synapses and strengthen existing ones.

TRY THIS!

You and your classmates are now neurons! Your mission is to send a top secret code through the brain - AKA to all of your classmates without getting it wrong. But, you only have so much time to send the message. Stop the timer and win the game!

TRY THIS!



HOW DO NEURONS SEND INFO?

You're playing as the goalie in a game of soccer and a ball is thrust at you. Your eyes see the ball coming which causes your legs to jump towards the ball while your arms catch it. This all happens in under a second.

Turn to your neighbor and discuss.

How do you think your brain quickly receives a signal from your eyes and sends that signal to your legs and arms?

HOW DO NEURONS SEND INFO?

Neurons send and receive signals using electricity.

This is not the type of electricity found in a wall socket. It is similar to the static electricity that builds up and is only released when you touch an object.

To better understand electricity and how the brain works, you are going to build a brain of your own.



BUILD A BRAIN EXPERIMENT

The human brain contains billions of cells. One important cell type is neurons. Neurons communicate with one-another by sending signals. When you put billions of neurons into a circuit, you are able to accomplish incredible things. The human brain is made up of ~86 billion neurons. The only animal that has more neurons than humans is elephants. However, humans have more neurons in a special part of the brain called the cerebral cortex. Let's see if you can imitate the brain by using your materials to build a circuit capable of lighting a bulb. Draw out your plan below before you start experimenting with your materials.



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EXPERIMENT TIME!

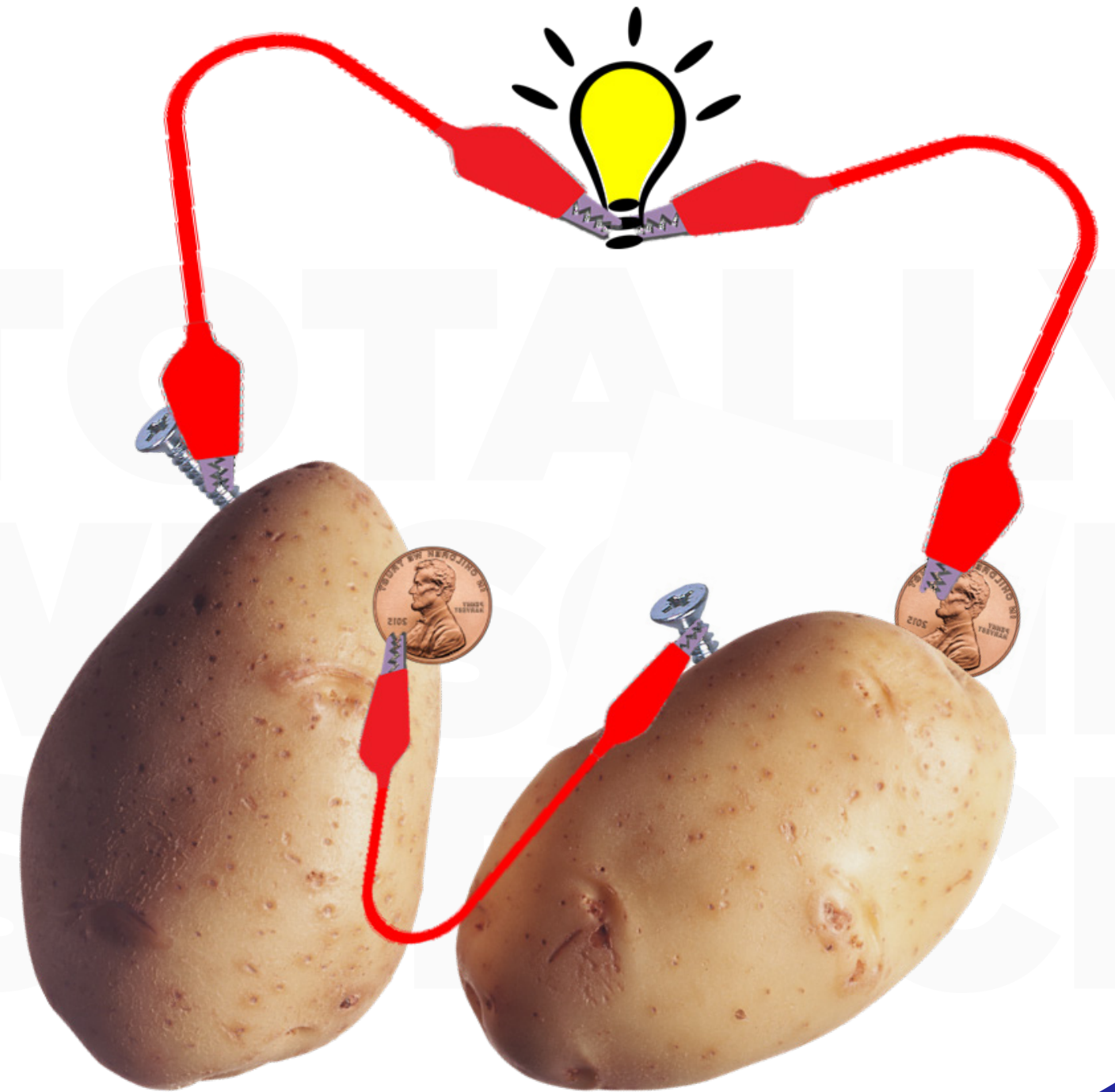
Your job is to use the supplies you are given to light the lightbulb.

Try using the materials in different and unexpected ways.

Can you figure out which parts of your model are the neurons, axons, dendrites, synapses, and eye?

Are there neurotransmitters in your model? How about myelination?

How does the structure of a neuron affect its function (to transmit signals)?



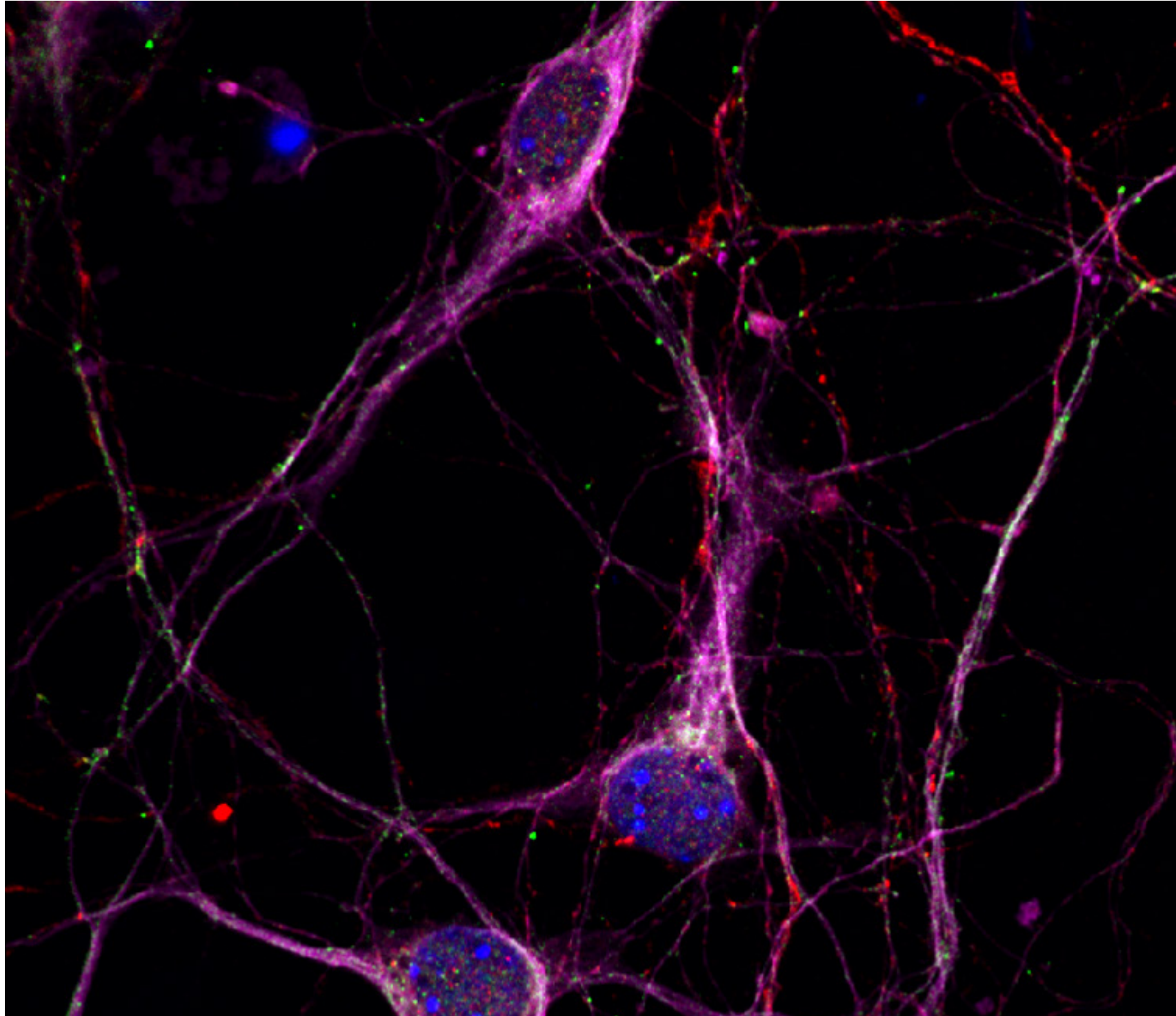


Image courtesy of Dr. Kevin Francis, Sanford Research

At Sanford research scientists are building neuronal networks in petri dishes using stem cells.

A neuronal network is a system with neurons and glial cells working together.

WHAT IS A STEM CELL?

Stem cells are a unique type of cell that is capable of becoming any type of cell.

In 2006 scientists discovered they could take fibroblasts (skin cells) and transform them into stem cells.

Stem cells can then be programmed into any cell type in the body.

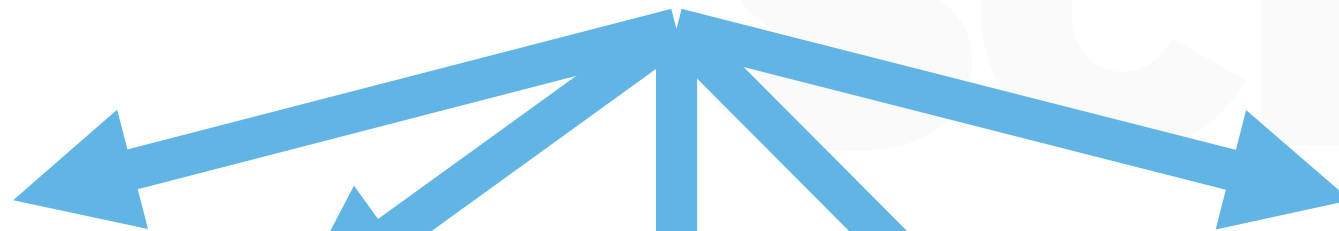
WHAT IS A STEM CELL?

Fibroblast



Stem Cell

Neuron

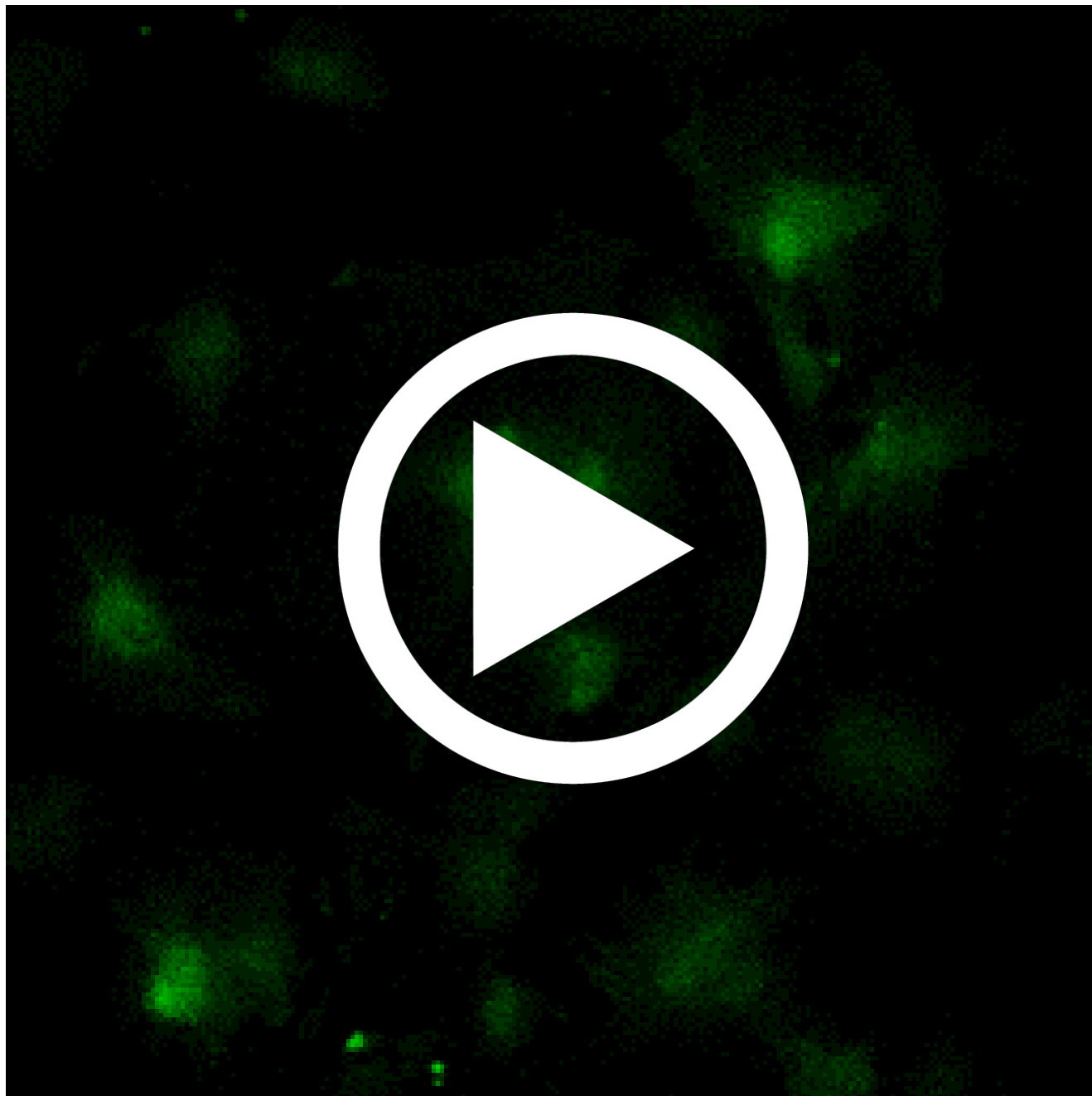


Astrocyte

Any Body
Cell

Fibroblast

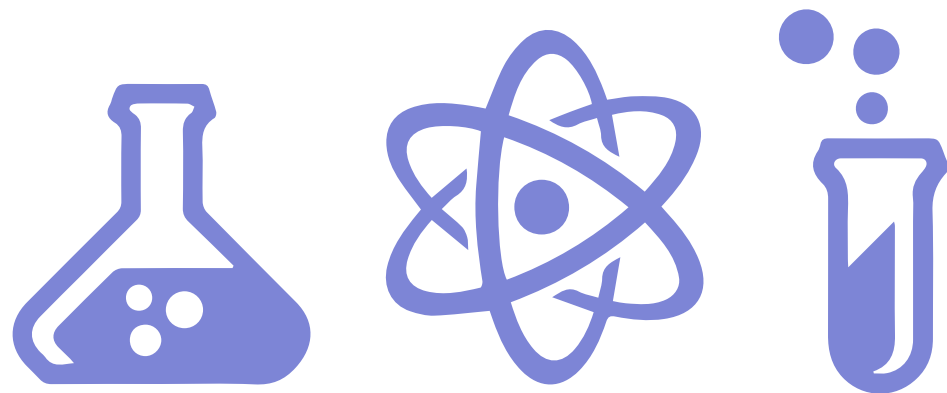
Stem Cell



Rewatch this video.
What do you think is happening now?

What are the pros and cons of scientists being able to grow neurons (or any cell type) in a petri dish?

ANSWER THE REMAINING QUESTIONS IN YOUR LAB NOTEBOOK!



Name: _____

PROMISE

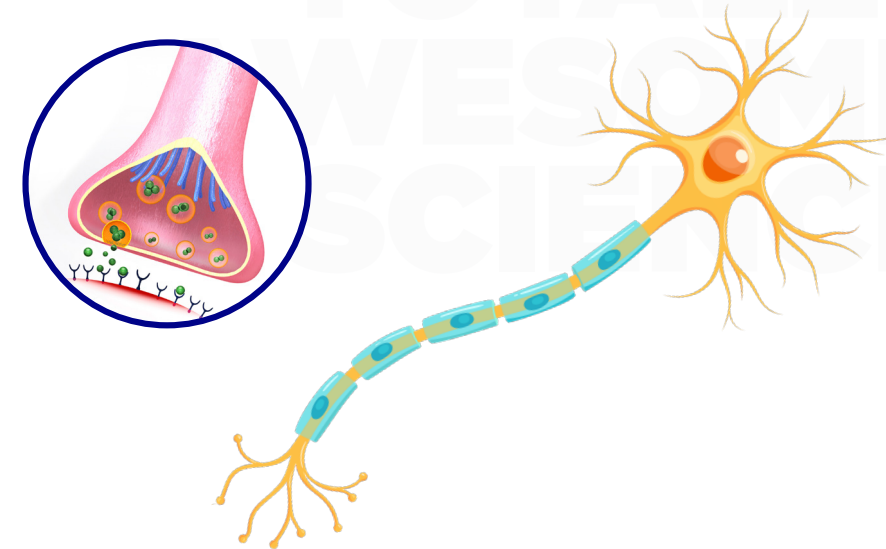
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WHAT'S IN A BRAIN? MORE THAN MATTER!

Answer the questions below as you progress through the What's in a Brain lesson and slideshow.

1. Watch the opening video. What do you see happening?

2. Label this neuron with the following: dendrites, axons, cell body, neuron, vesicle, and neurotransmitter.



3. When you played the brain signaling game, what difficulties did you have when trying to accurately and quickly send the code?