The Microscopic World – The brain

Class 7 – CTYI, DCU

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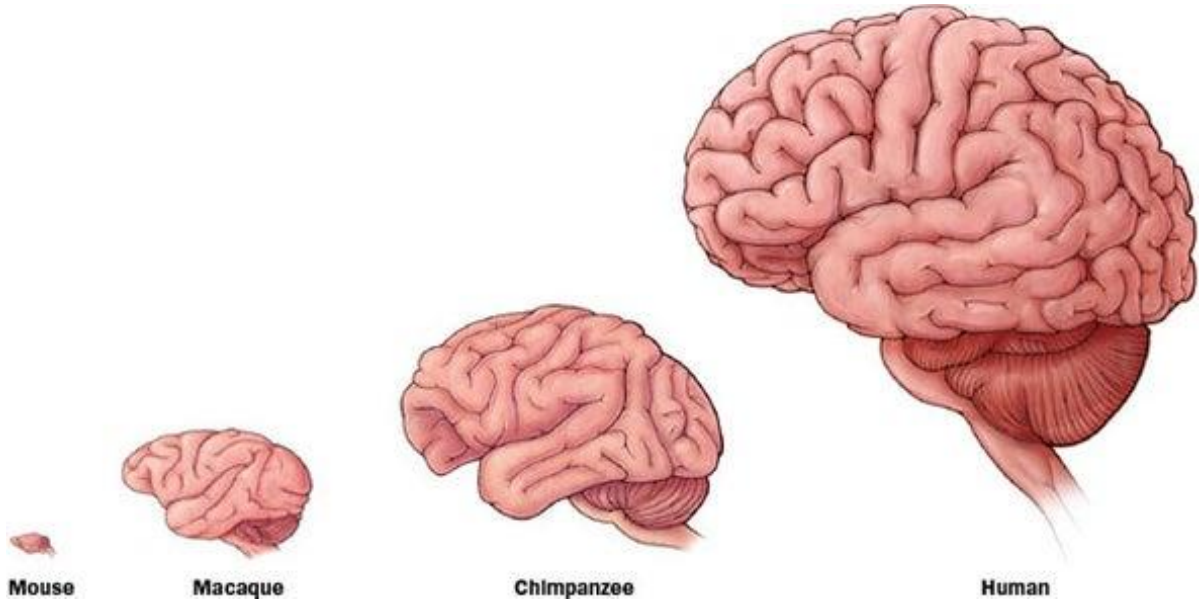
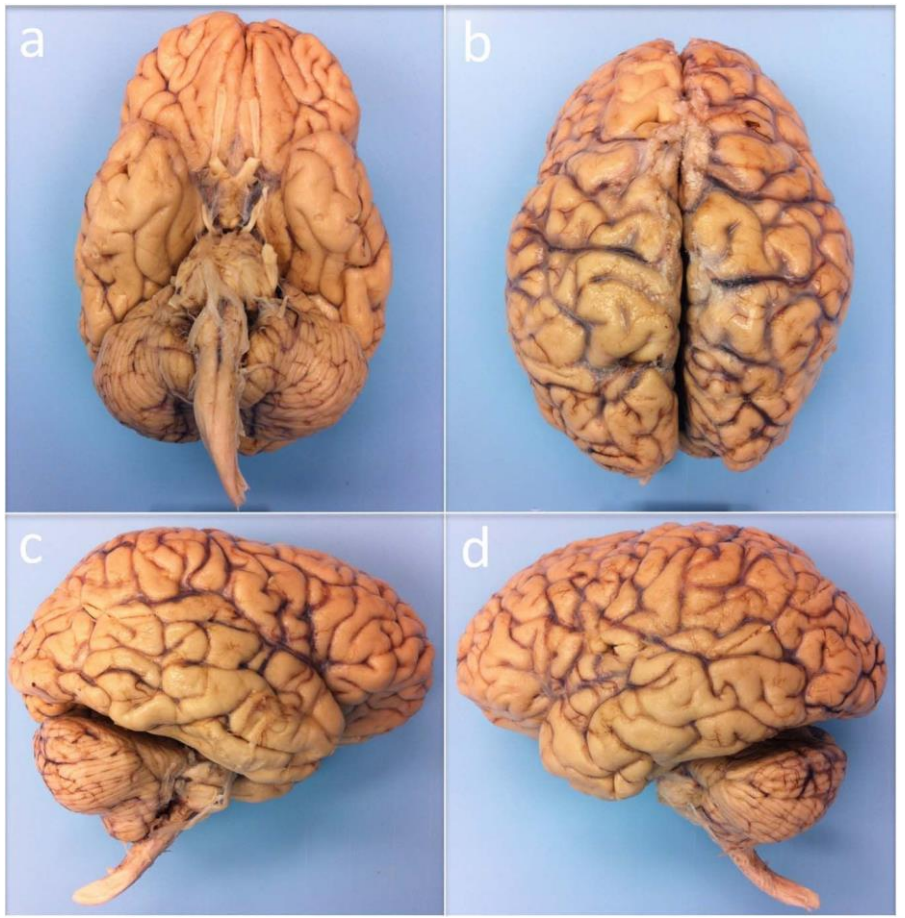
If you have any questions about anything – email me at niamh.kerslake.staff@ctyi.org

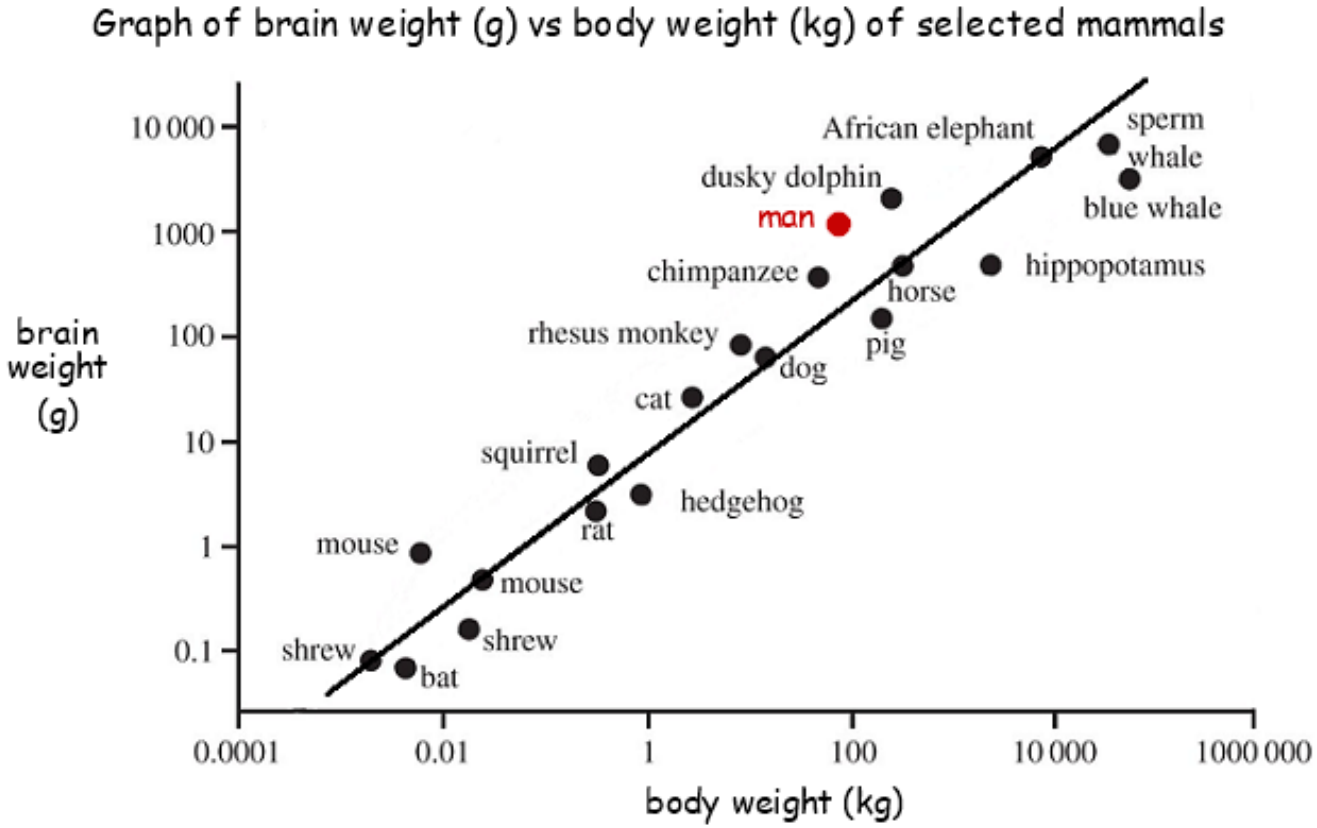
The Human Brain is actually quite impressive





Humans have pretty big brains for our size

- Humans have pretty big brains for our size
- Human (man) brain weigh about 1400 g/1.4 kg
- Woman's brains are about 1300g / 1.3 kg
- This accounts for 2% of our body weight
- Humans evolved from a common ancestor we had with apes and our big brains helped us
- But brains are hungry
- Brain takes 22% of energy



Study of brains is called Neuroscience

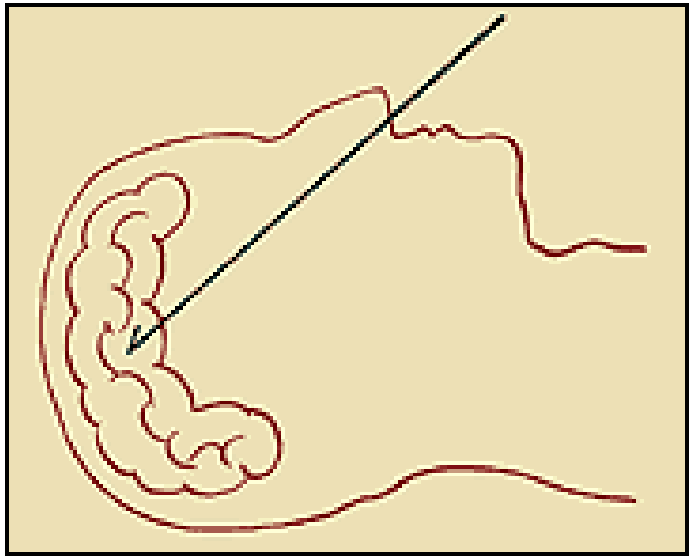
- But our brain is so complex – we need lots of different ways to study it
- Doctors – Neurologists, Psychiatrists, Surgeons
- Psychologists – Behaviour – why humans and animals act the way they do
- Genetics/Geneticists – Look at genes in our brains, how brains develop, wiring of our brains
- Molecular biology/Cell biology – how cells in the brain talk to each other, how wiring in the brain works,

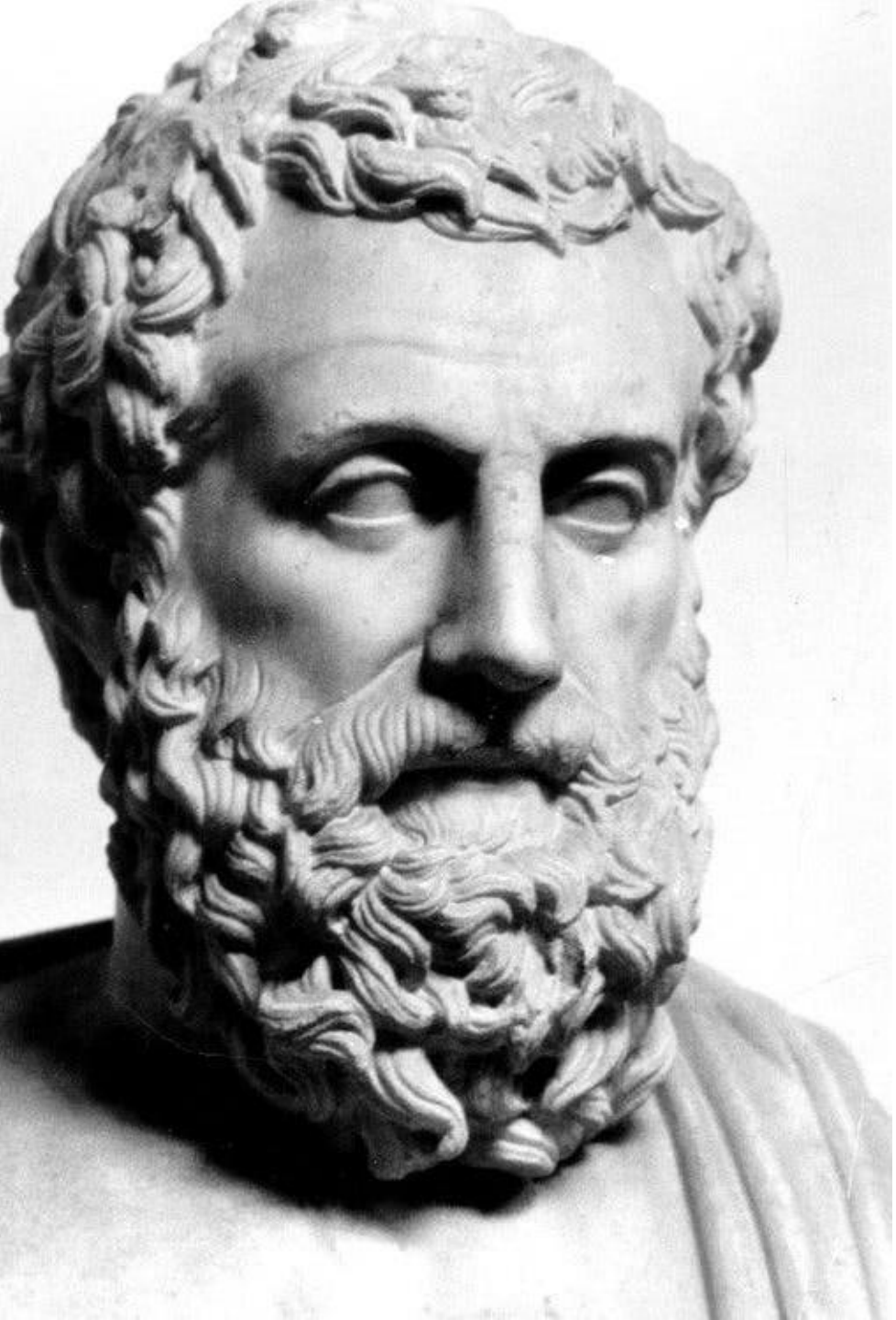
Why should we study the brain?

- To cure disease
- To come up with new drugs and treatments
- To understand why we are the way we are
- Understand the mysteries of the brain

We haven’t always considered the brain to be as important as we do now

- Ancient Egyptians didn’t understand the importance of the brain but they were the first to study it
- During mummification the brain was disposed of
- Edwin Smith Surgical Papyrus
- 1700 BCE but may date back to 3000 BCE
- Based on great Egyptian physician named Imhotep

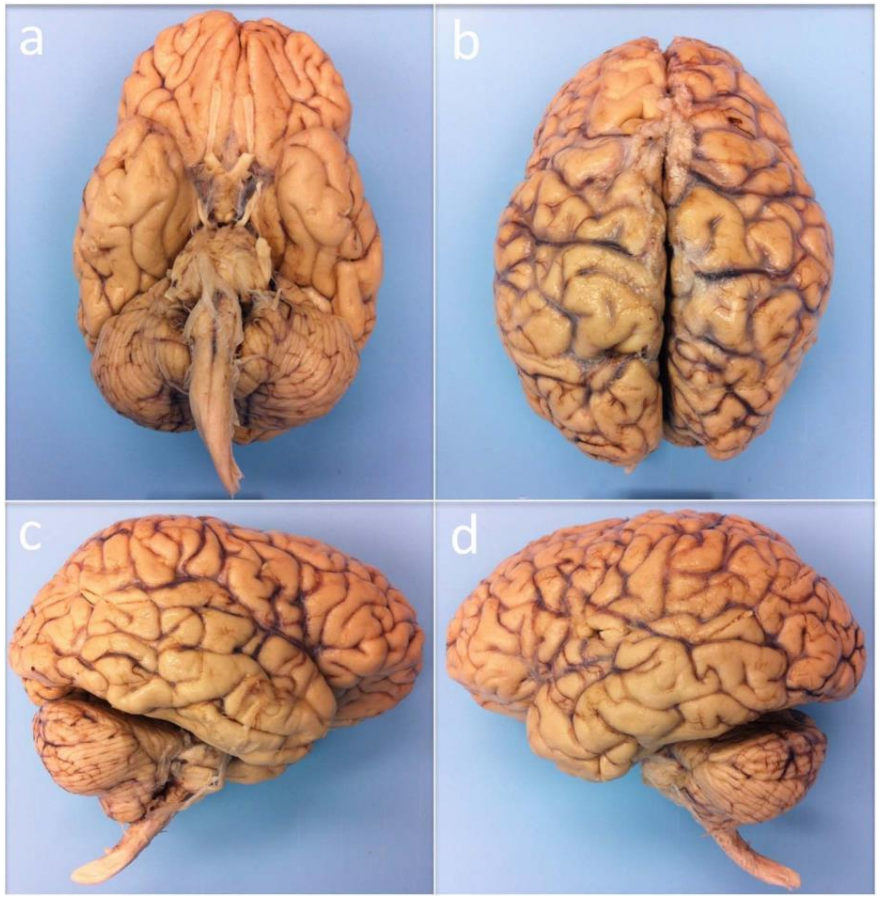




Ancient Greeks

- Hippocrates – Area of sensation but also area of intelligence
- Plato – Rational soul
- Aristotle – Heart was the seat of intelligence (384-322 BCE)
- This became the accepted view for another 500 years
- Microscopes in the 1700s allowed scientists to see individual cells
- Began to use electricity to study brain cells ‘neurons’ and muscles

Different parts of the brain do different jobs



But we tend to find out about these things when they go wrong…

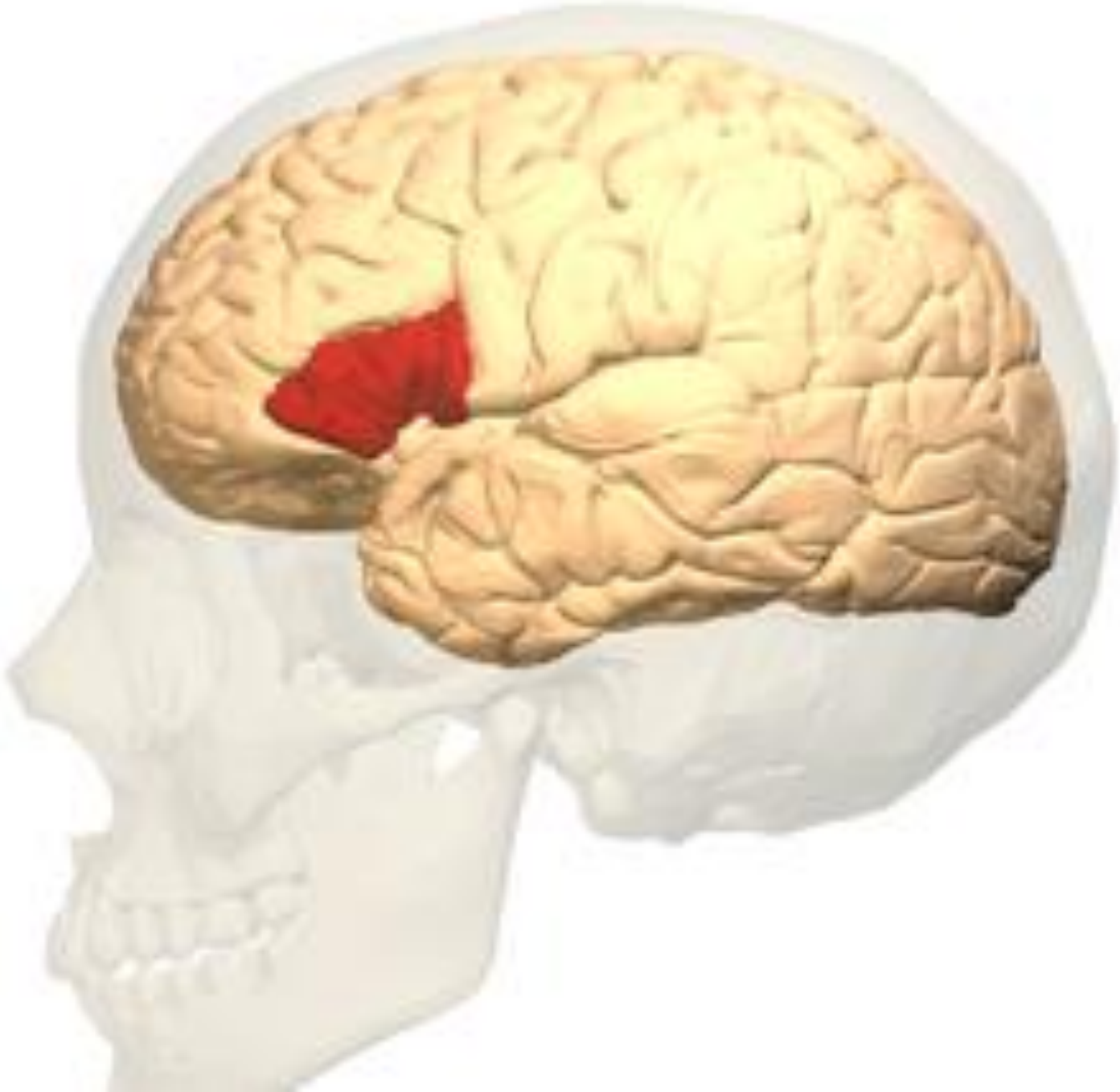
Phineas Gage

Phineas Gage

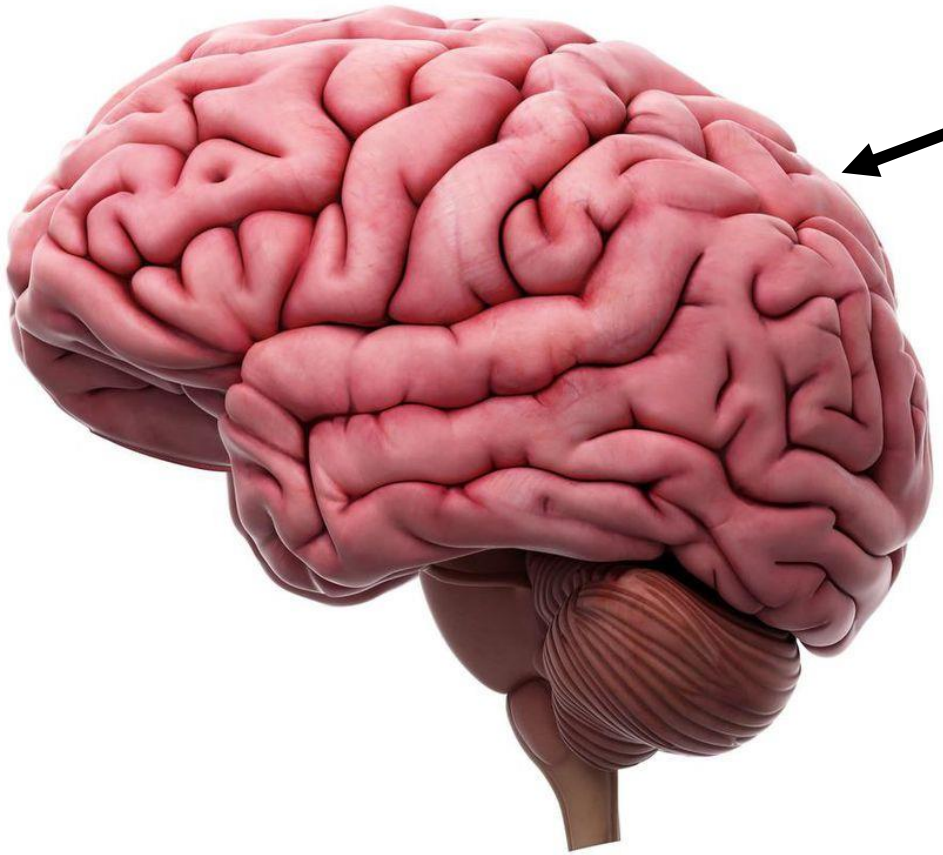
- Phineas was a railroad worker in America
- An accident while laying new track caused this….
- Somehow he survived
- Although Phineas recovered from his injuries – friends and family noted changes about his personality
- Before his accident – described as hard-working and pleasant
- After his injury – reports described him as aggressive, drunk, unable to hold down a job
- Modern analysis of his skull suggests would result in problems with emotional processing and rational decision-making

Broca's Area

- Paul Broca was a French doctor (1824-1880)
- 2 patients made Broca famous
- Louis Victor Leborgne (Tan)
- - Could only say the word 'Tan'
- But it didn't seem to affect his intelligence
- Lelong
- 84 year old man who was treated for dementia
- - Could only say 5 words - Yes, No, Three, always and Lelo
- Both had disease in this area
- Broca believed speech comes from this area



Different parts of the brain do very different jobs



Cortex : Wrinkly bit of the brain
Outermost layer of the Cerebrum

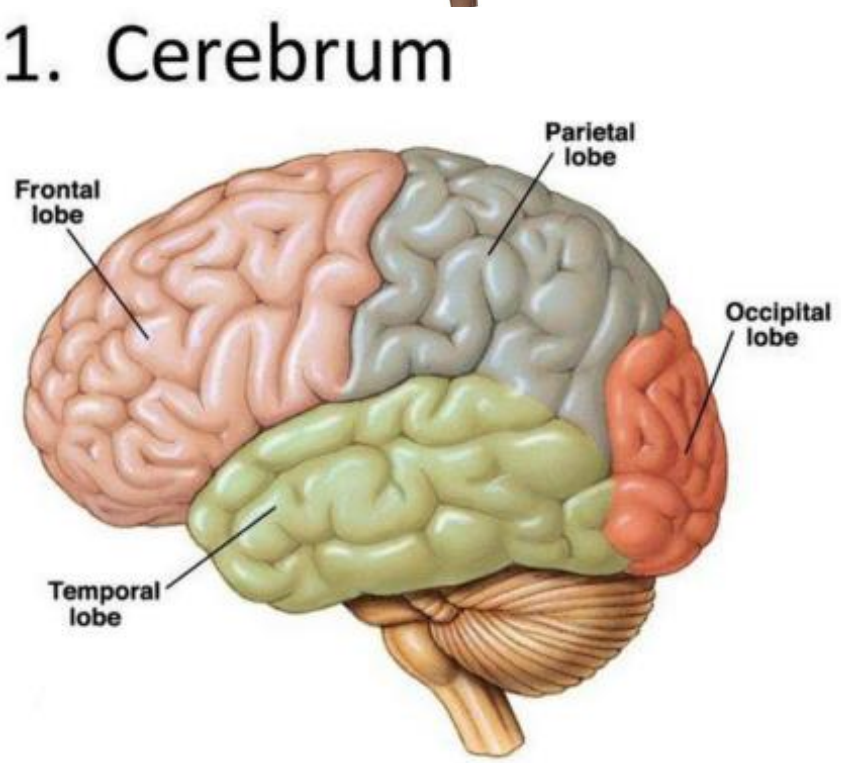
Take a piece of paper and scrunch it into a ball

- What do you notice?
- A: The paper seems to have shrunk
- B: The screwed up paper has got bigger
- C: The paper is the same size

- Have a look at this video: https://video.nationalgeographic.com/video/til/00000152-9dc0-de97-ad5b-bddd25860000
- The wrinkly part of your brain does the majority of higher “thinking”
- The wrinkles give the brain more space (more surface area) without taking up more volume

Cerebrum

- Cortex makes up the **Cerebrum**
- Biggest bit of the brain. Accounts for 2/3 of the weight of the brain
- This is where our thinking goes on
- 2 hemispheres
- Left =
  controls language and speech.
- Right = visual and spatial information.

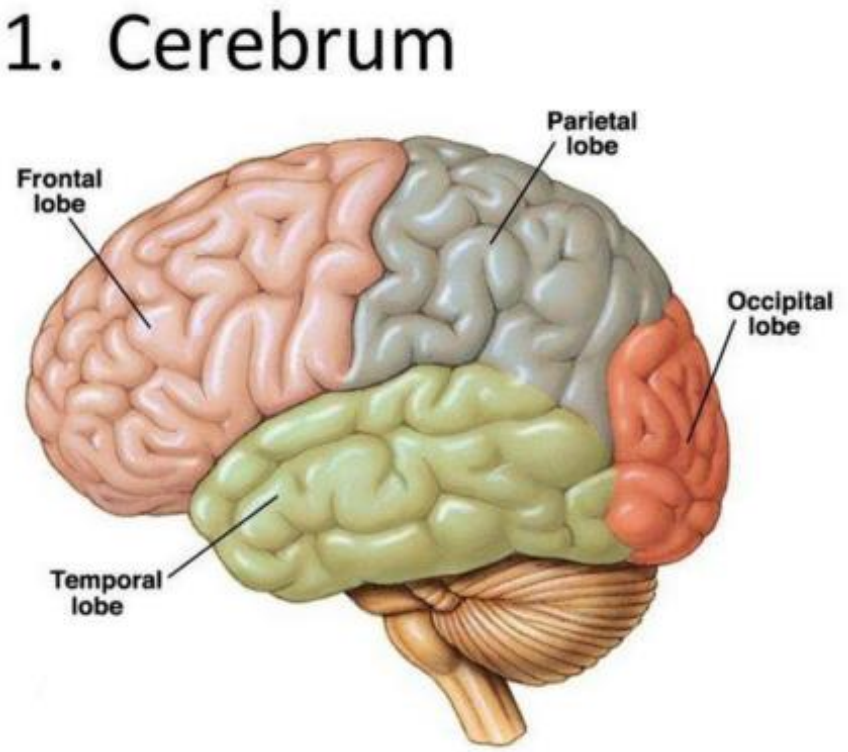


Surface lobes of the cerebrum
- Frontal lobe
- Parietal lobe
- Occipital lobe
- Temporal lobe

Figure 7.

Cerebrum

- 4 lobes
- Frontal lobe – At the front and top of the brain. Highest level of thinking - language, memory, problem solving , planning, judgment, decision making, impulse control, attention
- Parietal lobe – Behind the frontal love. Involved in sensory information and helps an individual understand their position in their environment. Hand eye coordination
- Temporal lobe – Lower front of the brain. Visual memory, language and emotion, hearing
- Occipital lobe – Back of the brain. Vision. Processes visual input from eyes

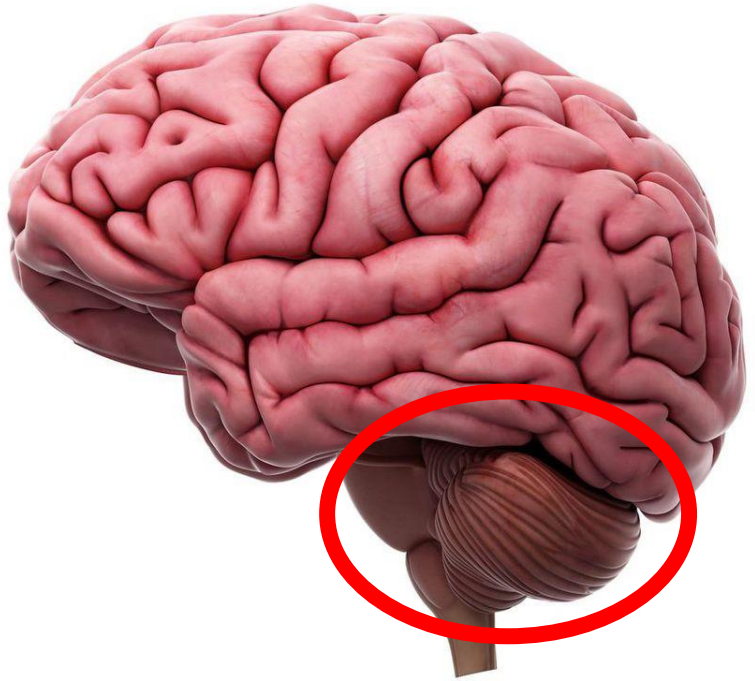


Surface lobes of the cerebrum
Frontal lobe
Parietal lobe
Occipital lobe
Temporal lobe

Figure 7.

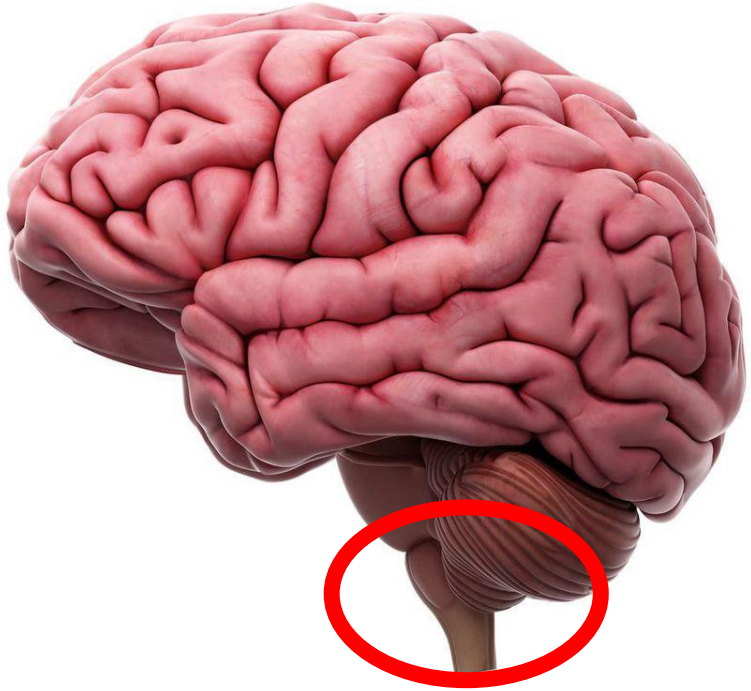
Cerebellum

- Little brain
- Balance and controls movement
- Balance: The cerebellum has special sensors that detect shifts in balance and movement. It sends signals for the body to adjust and move.
- Coordinating movement: Most body movements require the coordination of multiple muscle groups. The cerebellum times muscle actions so that the body can move smoothly.
- Vision: The cerebellum coordinates eye movements.
- Motor learning: The cerebellum helps the body to learn movements that require practice and fine-tuning. For example, the cerebellum plays a role in learning to ride a bicycle or play a musical instrument.



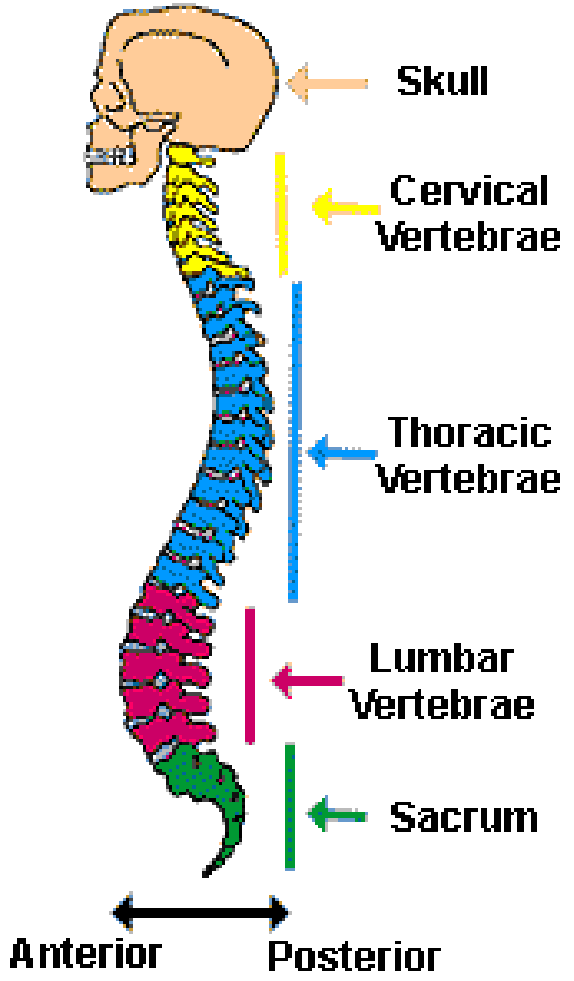
Brain Stem

- The brainstem manages vital automatic functions
- Breathing, circulation, sleeping, digestion and swallowing. These are the involuntar processes
- The brainstem also controls reflexes.
- Mike the headless chicken
- Head was cut off but enough of his brainstem was left so he lived for 18 months



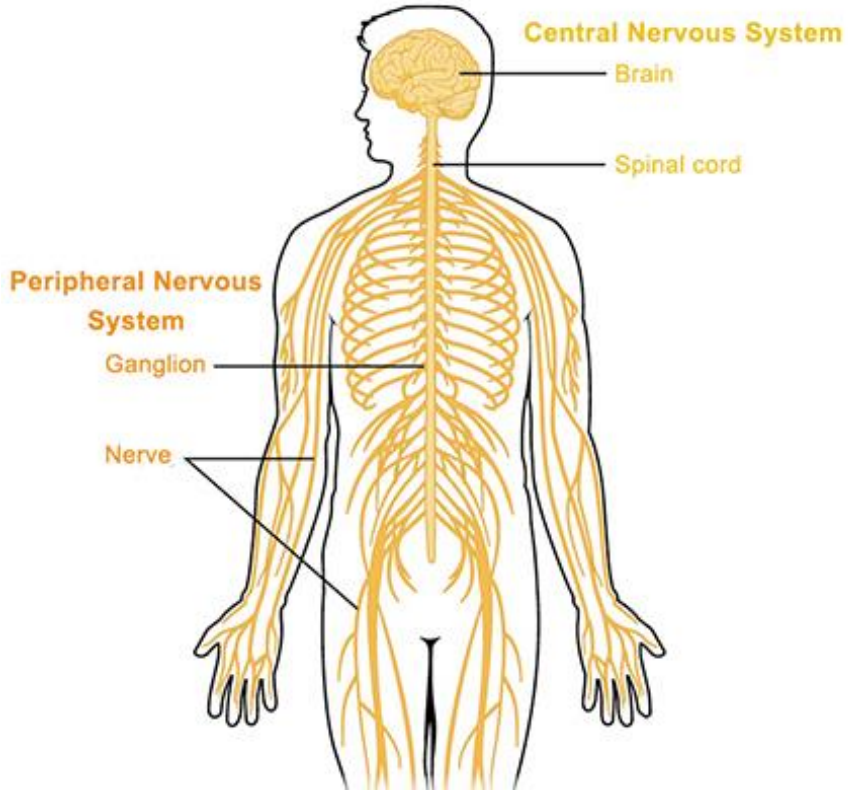
Spinal cord

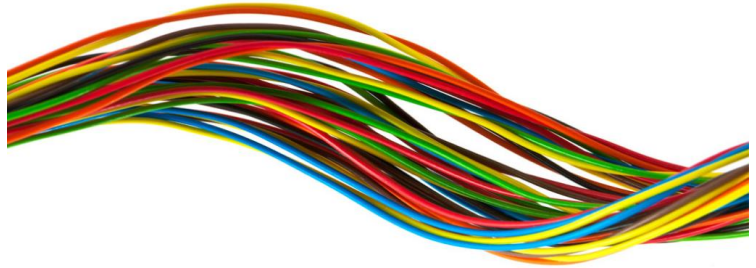
- About 45 cm long
- It carries messages from your brain to the rest of your body and back again
- Nerves carry signals from your senses to your brain and from your brain to your limbs telling your body what to do
- You have over 72 km of nerves in your body
- Unlike other cells, there are some parts of the brain where your nerve cells are never replaced



Neuroscience is the study of the nervous system

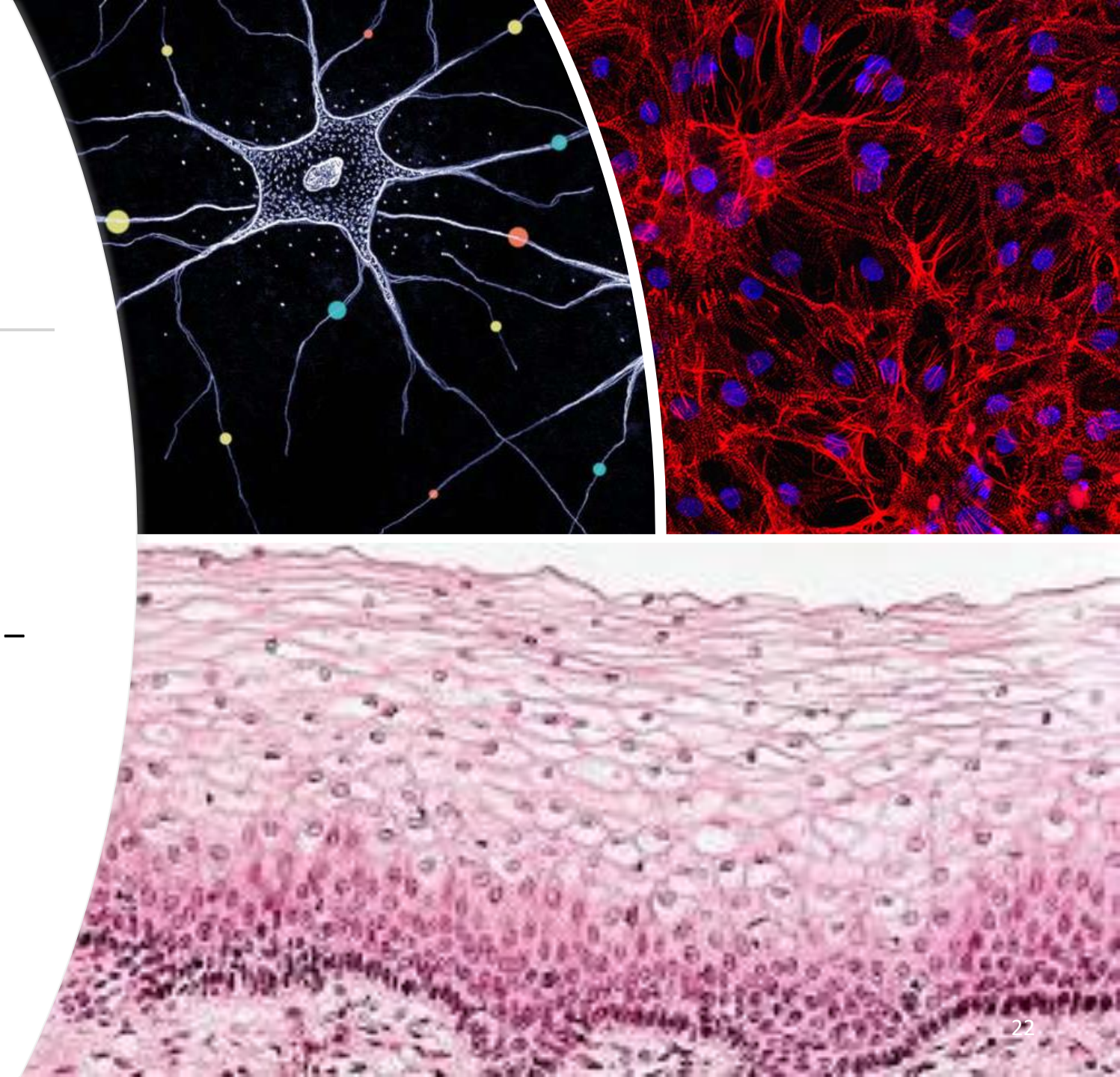
- Nerves carry the message from your brain to the rest of your body and back
- Nerves are made up of bundles of nerve cells called neurons
- Nervous system is made up of 2 sections
- Central nervous system: Brain and spinal cord
- Peripheral nervous system: Everywhere else





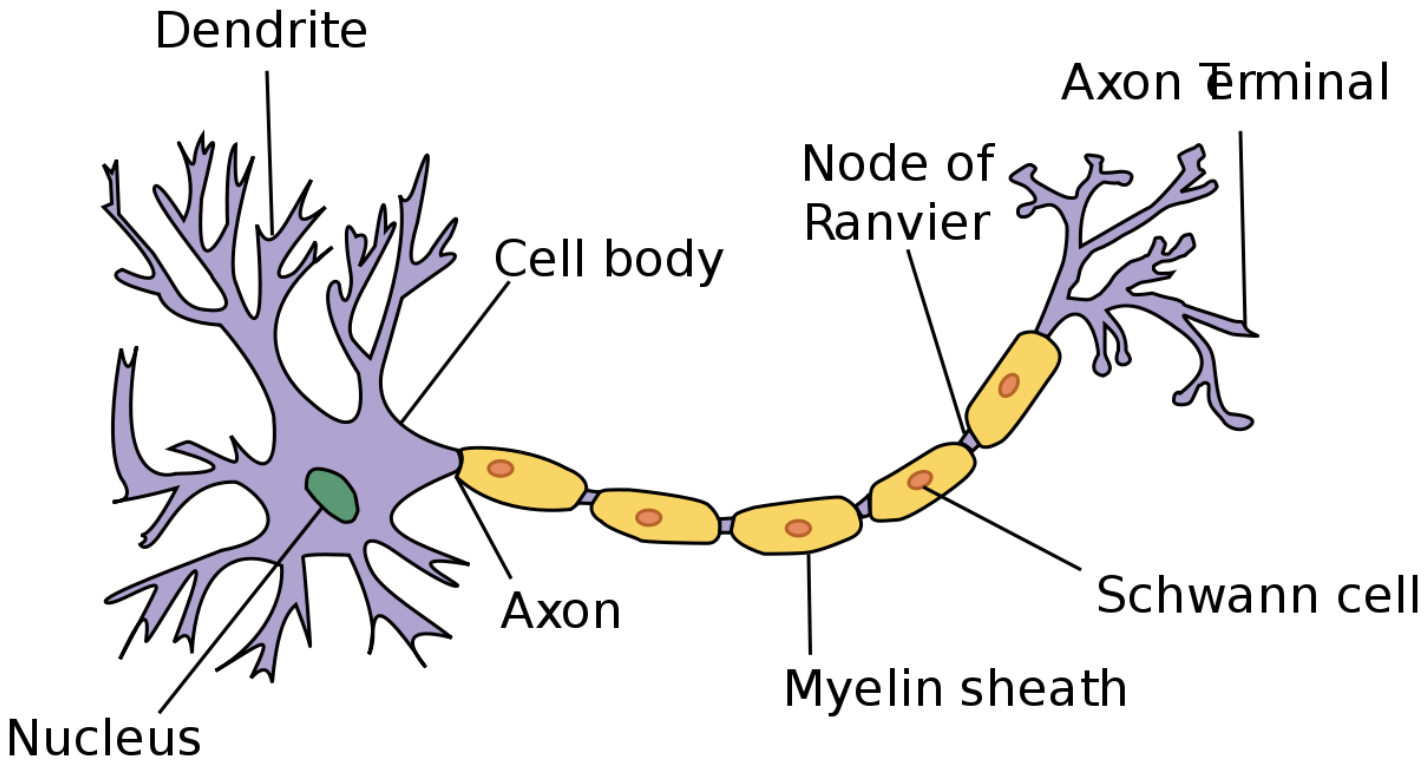
What is a cell

- Cells work together in your body to perform different functions
- These cells working together are called your ‘organs’
- Since each organ has a different job to do – cells look a bit different to get that job done



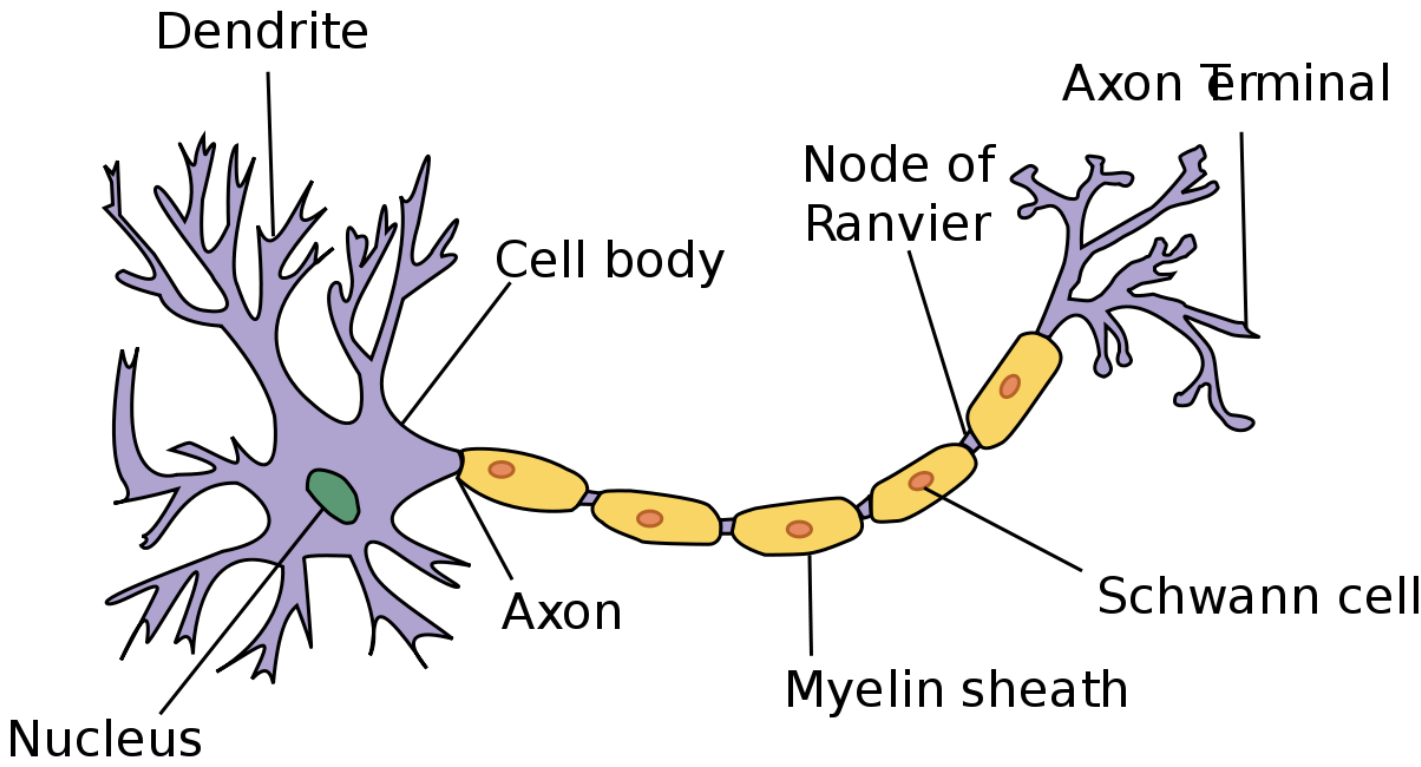
Neurons

- The human brain has approximately 86 billion neurons
- Neurons come in all shapes and sizes
- Some neurons are tiny while some axons can stretch to be more than a metre
- But neurons are still cells – still have a cell membrane, still have a nucleus that contains genes, neurons contain other organelles
- Also some differences – have special things like dendrites and axons, use electricity to talk to one another,



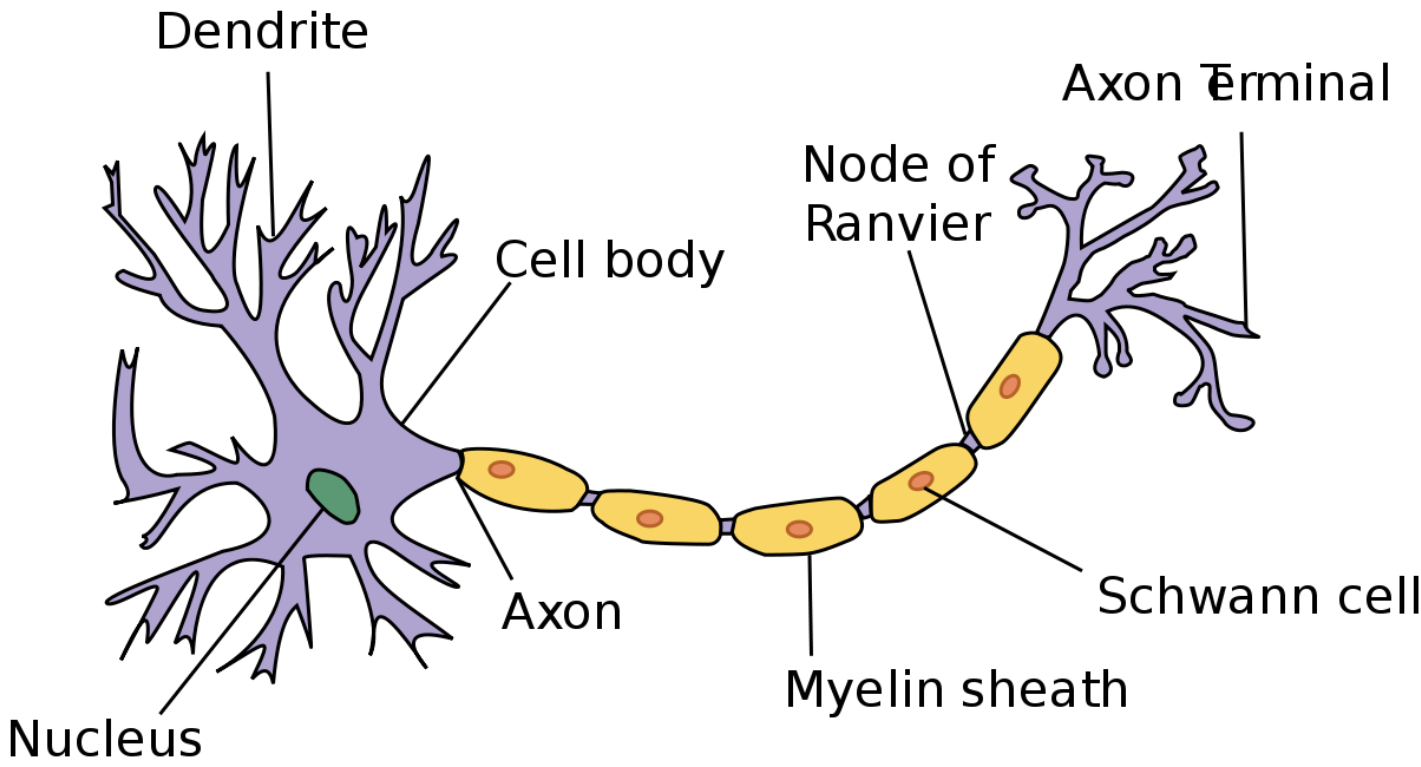
How do neurons work

- Messages travel along neurons are called impulses
- Impulses begin in receptors
- For example – when your fingers touch a rough surface, receptors in your skin sense this and create an impulse.
- They send this impulse or signal through nerves to your brain where it works out this information and what to do
- Impulses are so quick – More than 300 kph to respond to a change



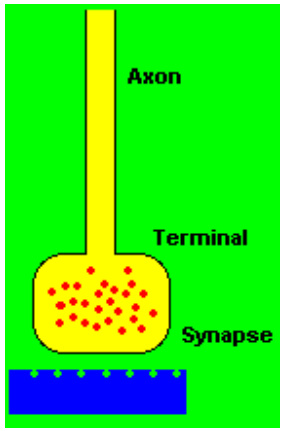
How do neurons work

- Dendrites: Have the receptors. They receive the signal and begin the impulse/message
- Impulse always goes from the dendrite to the axon
- The message gets carried along the neuron
- The Myelin sheath insulates the message and stops it leaking out. Like the rubber on a cable
- Axons: Send the message on. They release chemicals at the end of one neuron that get picked up by another neuron
- And the cycle starts again

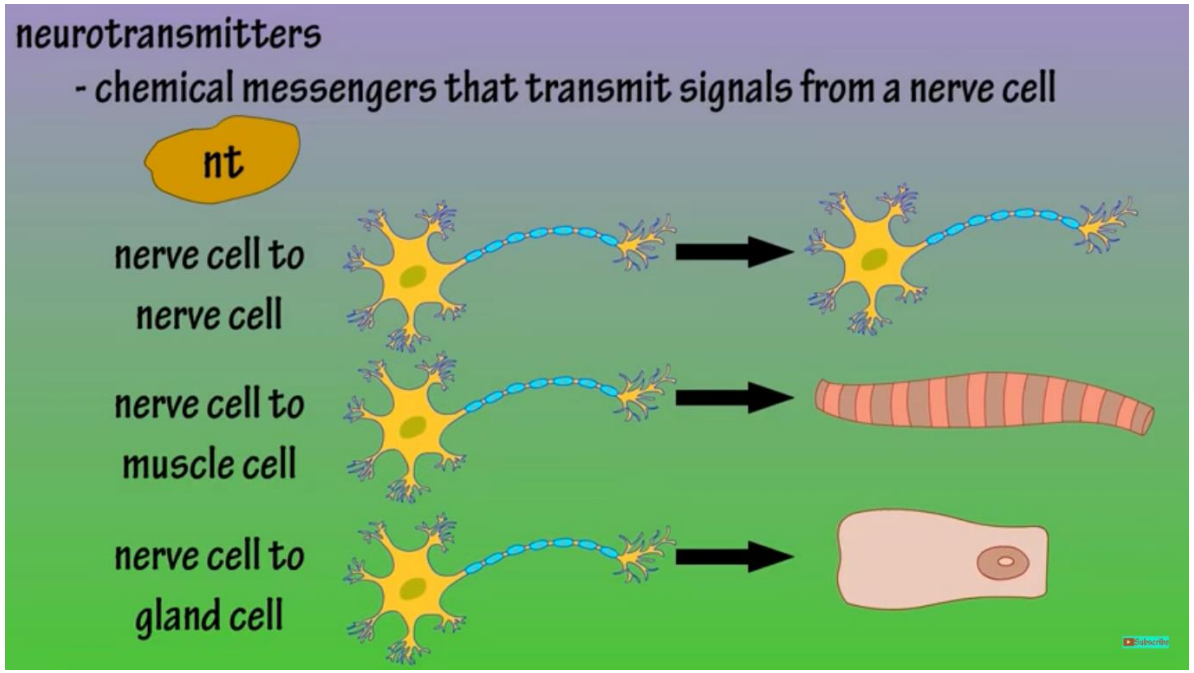


But first let’s make our own! (More instructions in the attached pdf)

Neurotransmitters

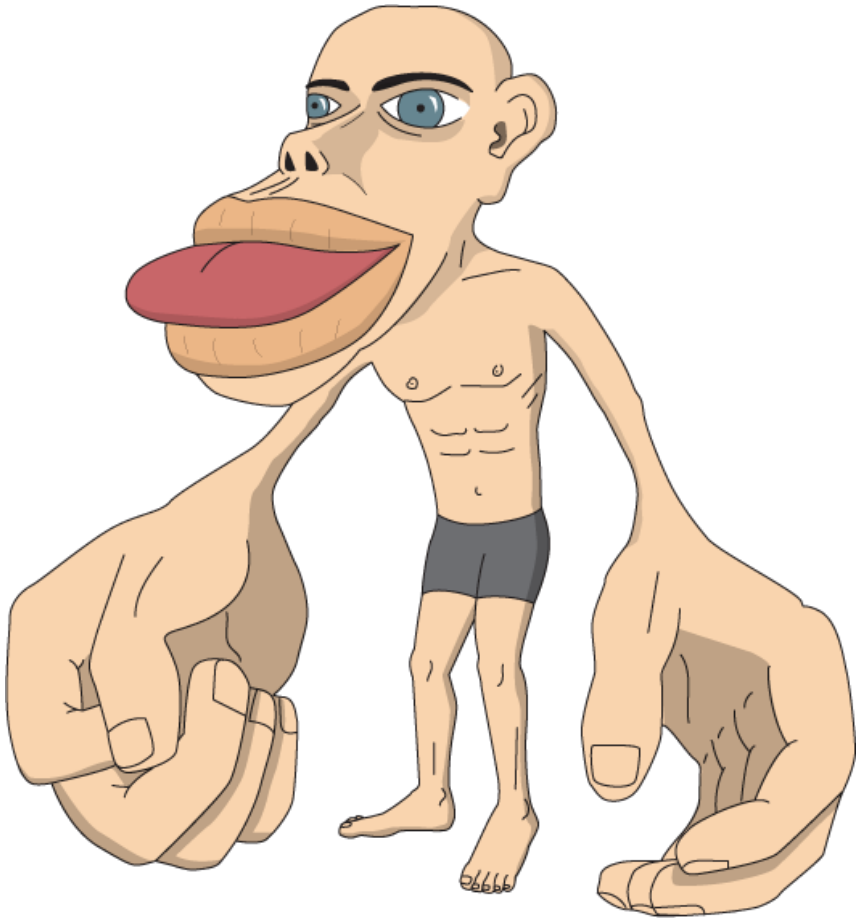


- The chemical that gets released at the end is called a neurotransmitter
- Neurotransmitters pass on the message from a neuron to another neuron, a muscle or a gland and tell it what to do
- Neurotransmitters serotonin, dopamine
- Often when people take drugs – like alcohol, caffeine etc it affects how their neurotransmitters work and cause people to behave differently



Different parts of your body have a different amount of nerve endings

- This is a homunculus
- His body parts are proportional to the amount of nerves that are in the body
- Our hands, lips and mouth are the most sensitive parts of our body to touch so we have more nerves in these parts of our body to detect touch, taste, etc.

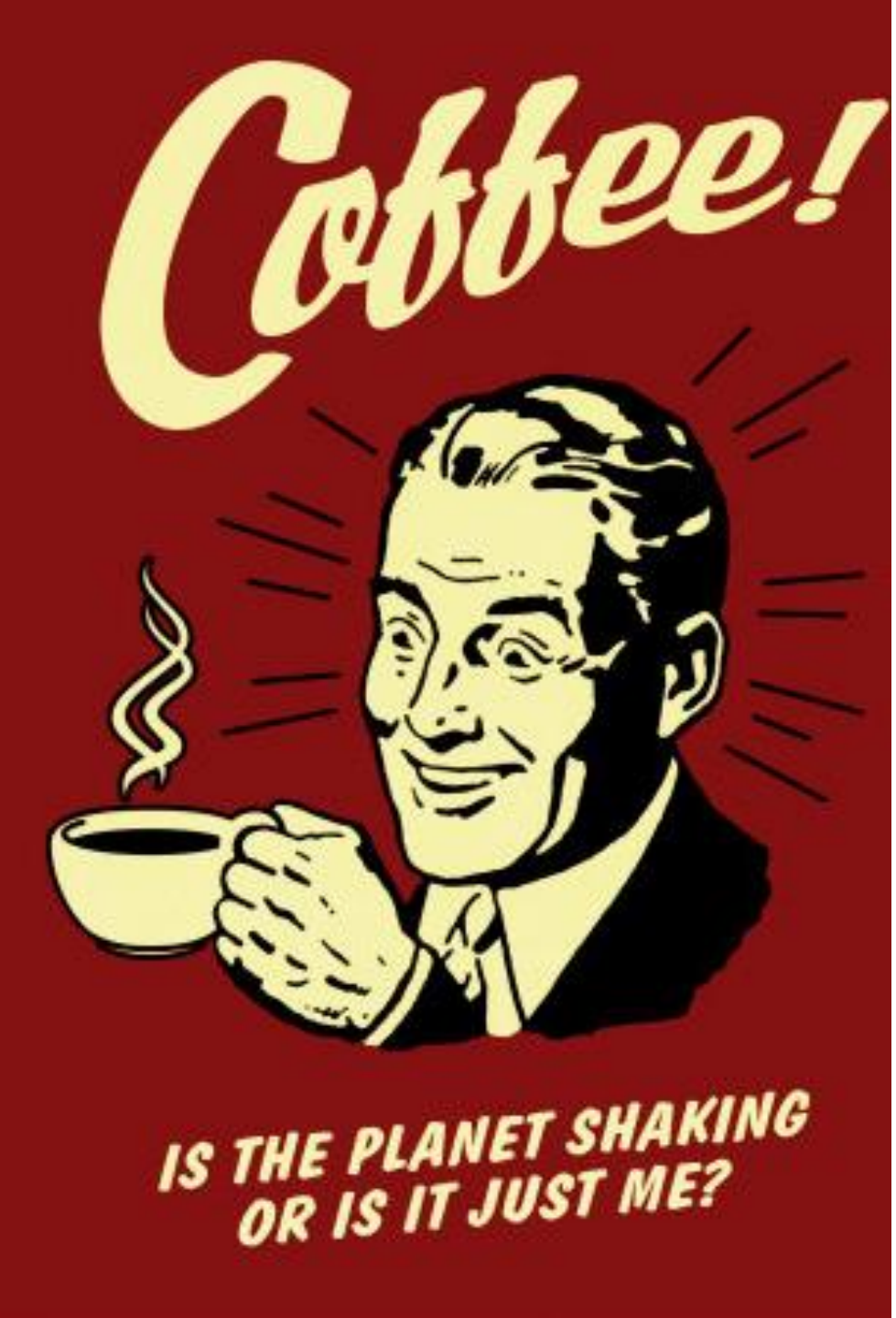


Two touch discrimination test (For more instructions see the PDF)

- You will need toothpicks/cocktail sticks, a ruler and another person
- **Gently,** put two cocktail stick on a volunteer's skin
- Ask them how many cocktail sticks they can feel
- Measure the distance between the two sticks
- Move the sticks closer, can they now feel two or one
- Repeat until they can only feel one and measure the distance between the sticks
- Try different parts of the body (with permission and be gentle)
- Mix it up, a few times try only using one to make sure your volunteer isn't lying
- Try it with different people, try it on yourself

Botox

- Botox is short for **Botulinum toxin**
- It is the most toxic substances known to man
- a millionth of a gram will kill a human
- It comes from a bacteria *Clostridium botulinum*
- Used medically to treat muscles that are overactive or spasm
- In cosmetics, used to reduce appearance of wrinkles
- Botox stops neurotransmitters leaving the neuron
- If it gets into bloodstream, it causes paralysis, difficulty breathing and death



Caffeine

- Caffeine is a central nervous system stimulant.
- In moderate doses, caffeine can: increase alertness, reduce fine motor coordination, cause insomnia, cause headaches, nervousness and dizziness
- In massive doses, caffeine is lethal. A fatal dose of caffeine has been calculated to be more than 10 grams (about 170 mg/kg body weight) - this is the same as drinking 80 to 100 cups of coffee in rapid succession
- Caffeine enters the bloodstream through the stomach and small intestine and can have its effects as soon as 15 minutes after it is consumed. Once in the body, caffeine will stay around for hours: it takes about 6 hours for one half of the caffeine to be eliminated
- Caffeine looks very similar to a neurotransmitter in the brain called adenosine
- Caffeine also acts at other sites in the body to increase heart rate, constrict blood vessels, relax air passages to improve breathing and allow some muscles to contract more easily.

Other resources

- Remember to email me pictures of your neurons and what you found out from your two point touch discrimination experiments – niamh.kerslake.staff@ctyi.org
- Attached map of the brain to colour and try to label
- If you have any questions about anything, send me an email!
- https://faculty.washington.edu/chudler/neurok.html – is a great website for all things neuroscience and lots of good activities
- Why patients are awake during brain surgery – The brain doesn't feel pain so there is no need to use general anaesthetic -2 videos on people undergoing brain surgery while awake https://www.youtube.com/watch?v=AT5-r5LBaTM https://www.youtube.com/watch?v=M_fjiEOb40M