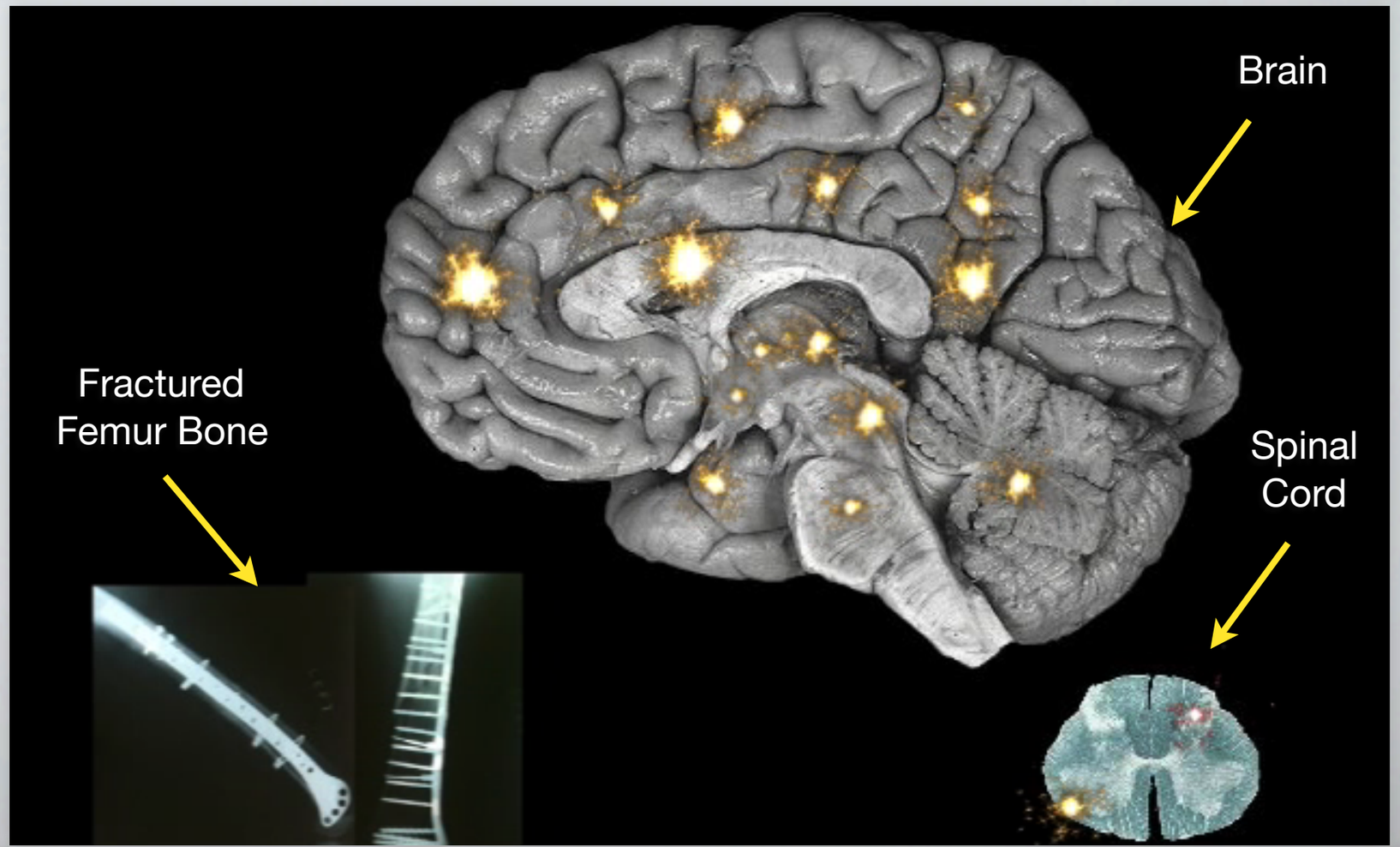
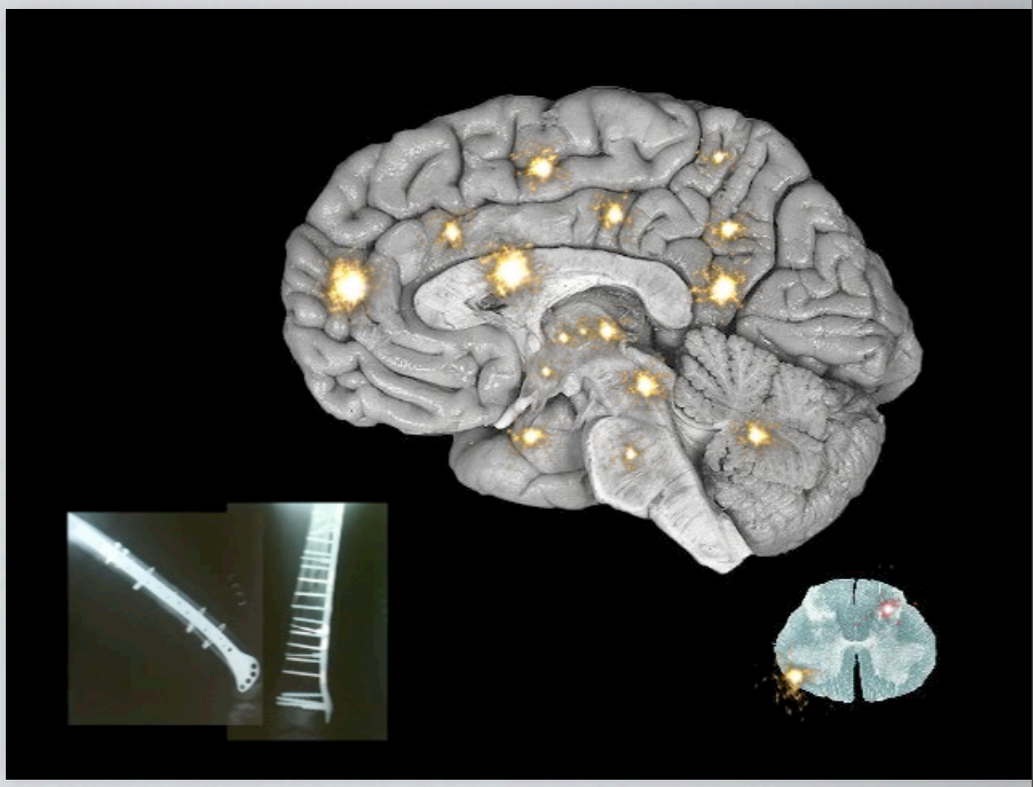
Lecture One:
Brain Basics





How does pain get from here to here

How does the brain work?

- Every cell in your body is wired to send a signal to your brain
- The brain doesn't just receive information, but sends directions back out to every cell in your body
- Nerves act as the circuits that carry information to and from the brain

How does the brain work?

- The brain has to be understood in 7 ways

1. Nerve cells: where genes and signals create chemicals that determine firing
2. Synapses: the connections of nerve cells
3. Anatomy: location of different brain parts
4. Physiology: how the different parts work together

How does the brain work?

- The brain has to be understood in 7 ways

5. Circuits: the electrical pathways in the brain connecting one region to another
6. Functional Regions: in any region of the brain nerve cells and their connection are responsible for several functions
7. Neuroplasticity: What gets fired gets wired; what you don't use you lose; when you make 'em your break 'em, when you break 'em you make 'em

How does the brain work?

- Almost all nerves carrying information to the brain end before they reach it
- Signals are passed by electrical impulses down microscopic nerve filaments called axons
- The first place that these signals go is to nerve cell bodies just outside of the Central Nervous System

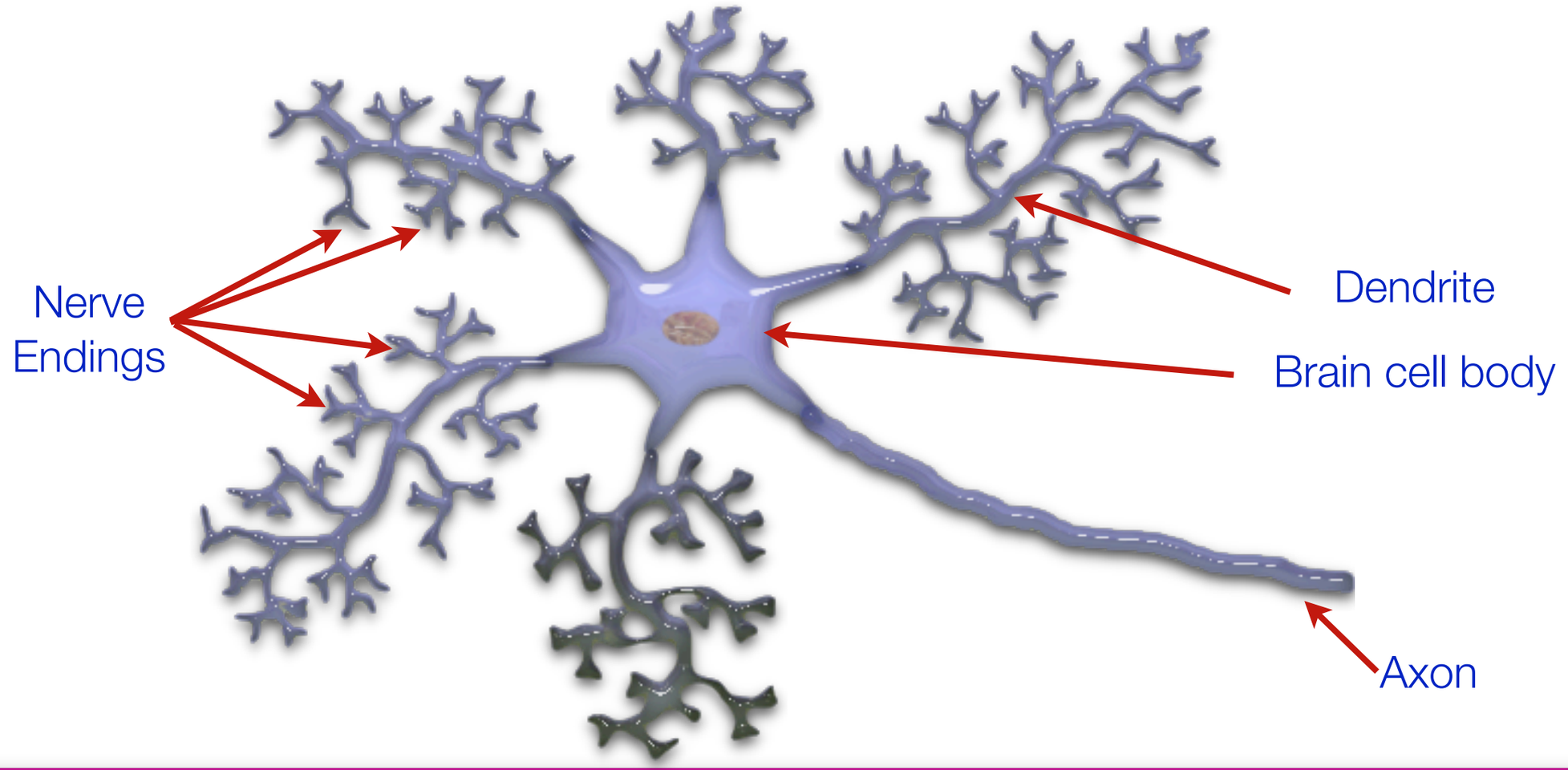
How does the brain work?

- The nerve cells respond to the electricity passing through them by making chemicals
- Some become little packets that transmit information at nerve endings in the spinal cord or the brain
- Some become receptors for receiving that information

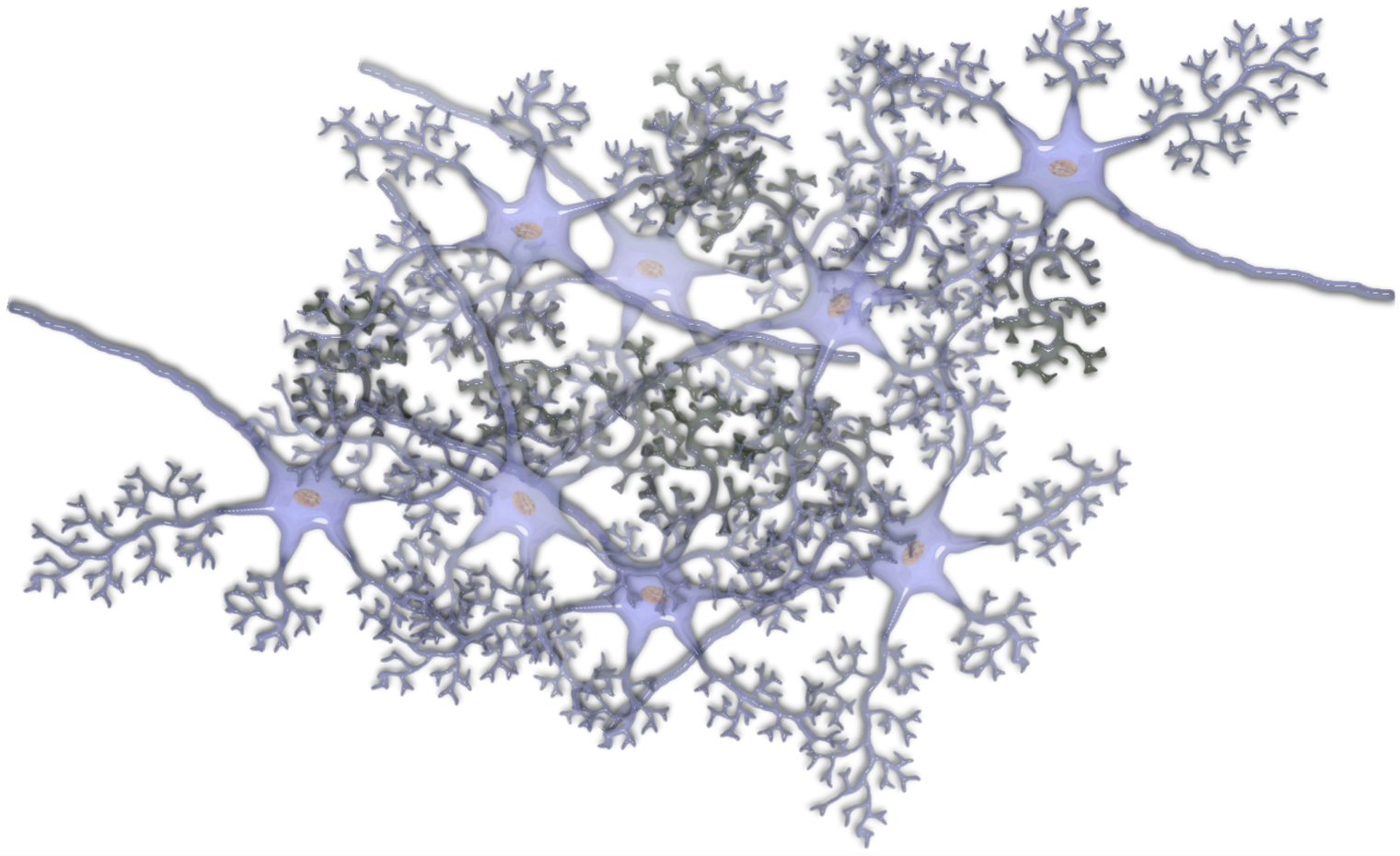
How does the brain work?

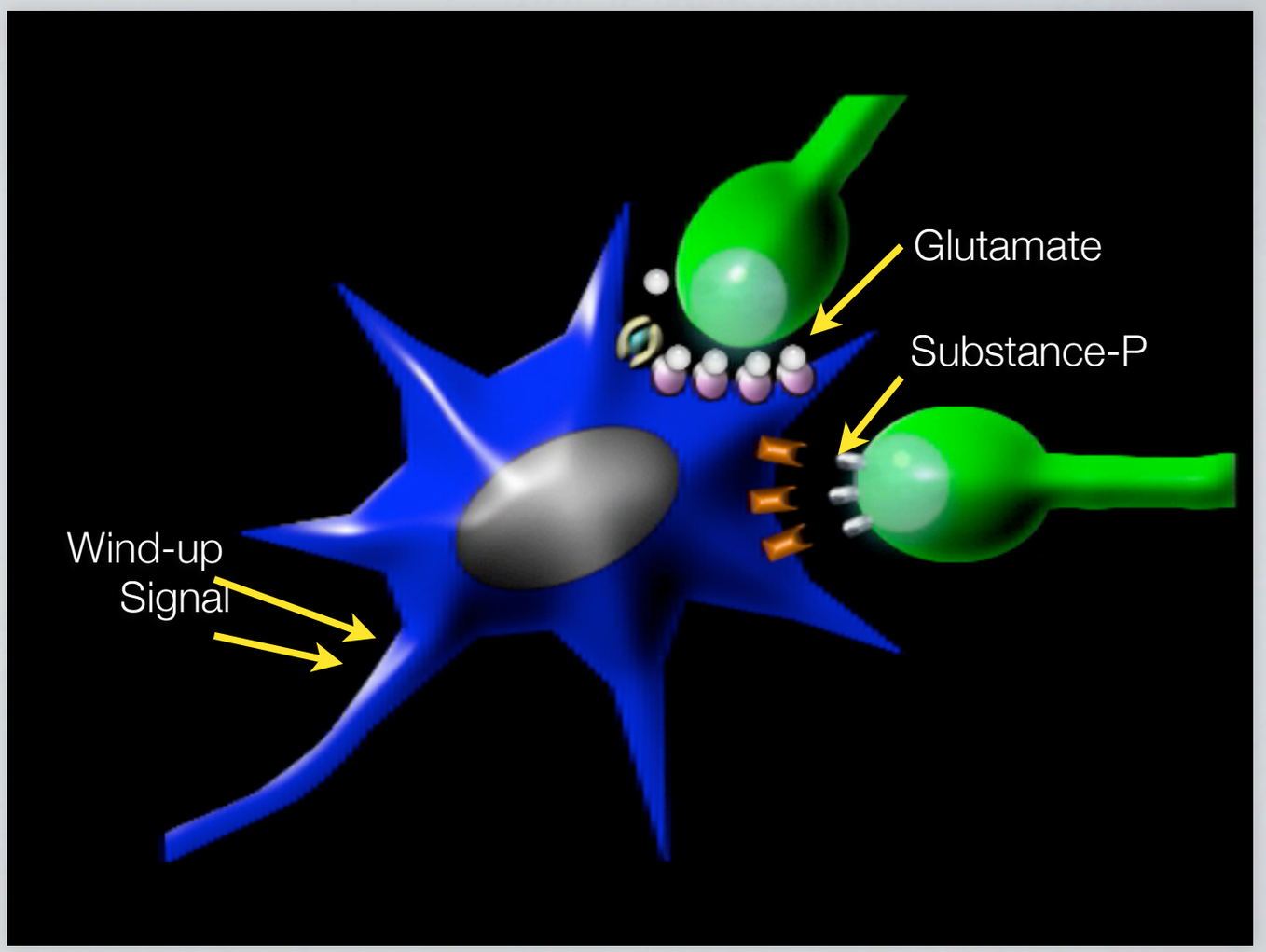
- The place where this information is passed is a gap between nerve endings called a synapse
- It is made up of an incoming nerve ending, a space between and a receptive nerve ending
- Electrical signals are converted to chemical signals, which are received by chemical receptors and are then turned back to electrical signals

Brain Cells



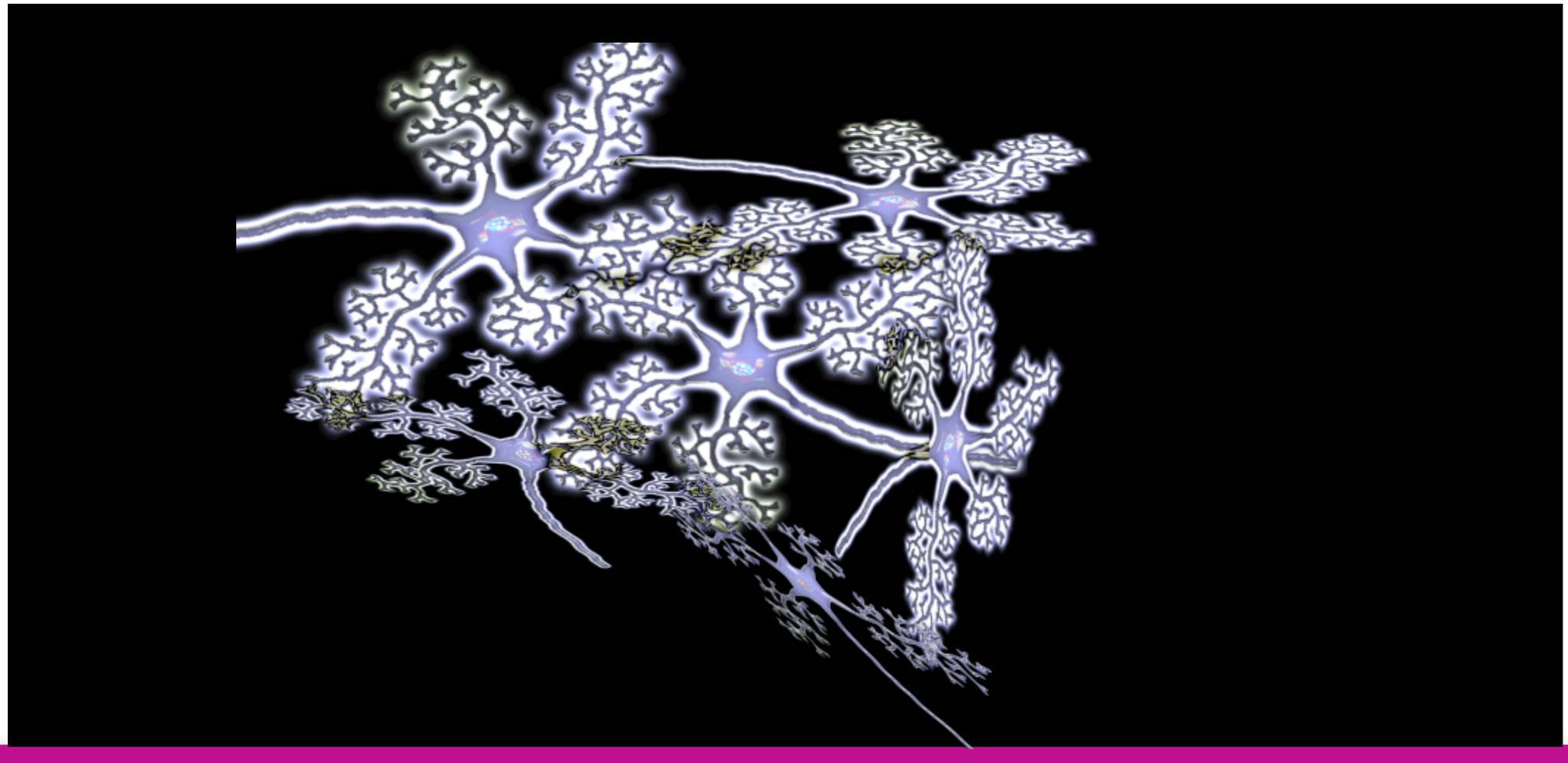
Synapses: Each Brain Cell is Capable of About 10,000 Synapses





Synaptic Transmission:
Substance-P Transmits signal
NMDA calcium activity winds it up

When Information is passed at the synapse brain cells fire



How does the brain work?

- There are 100 billion nerve cells in the brain
- There are 1000 trillion connections (synapses) that pass information from one part of the brain to another
- Every week trillions of connections either form or disappear

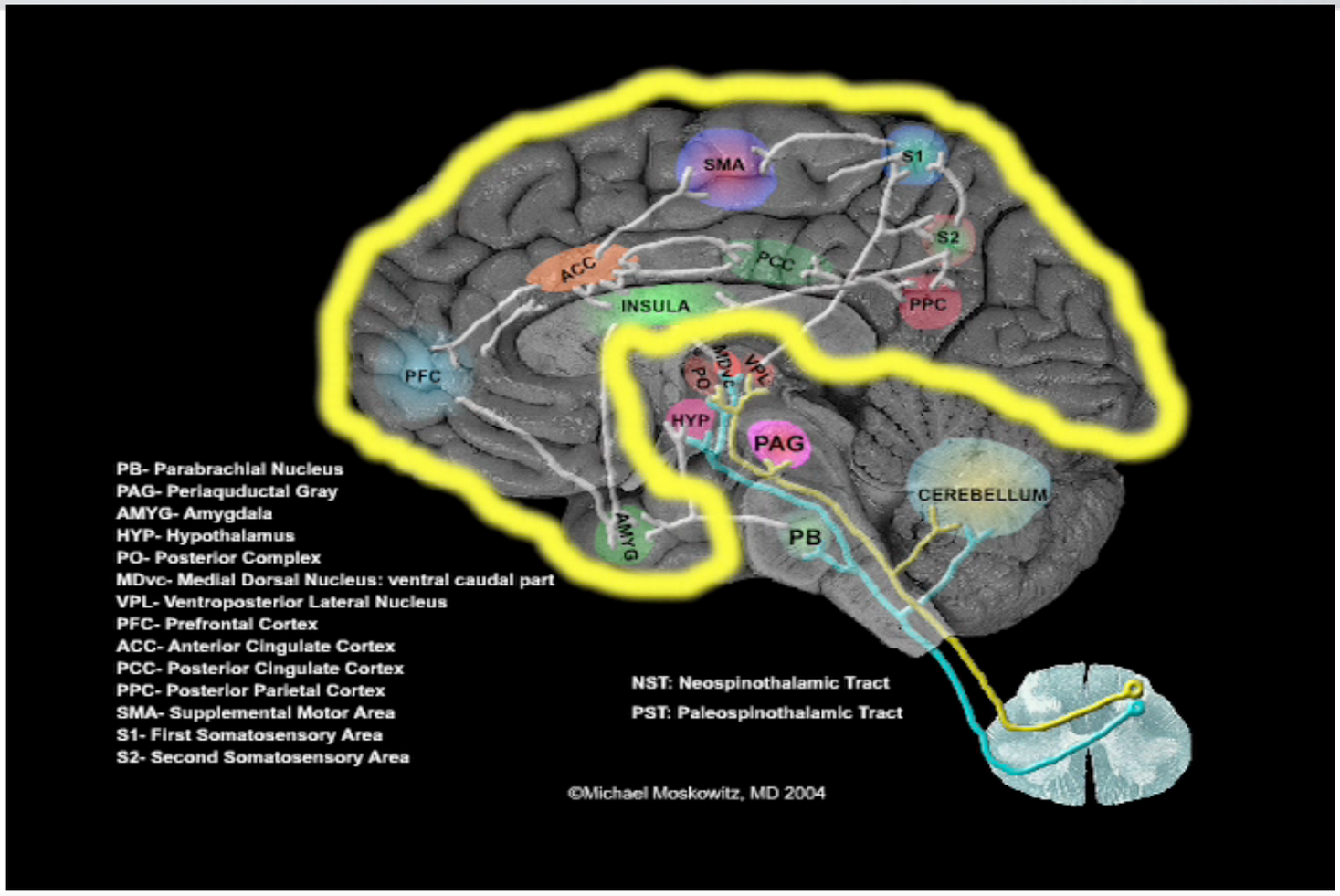
It isn’t pain ‘till it hits the brain

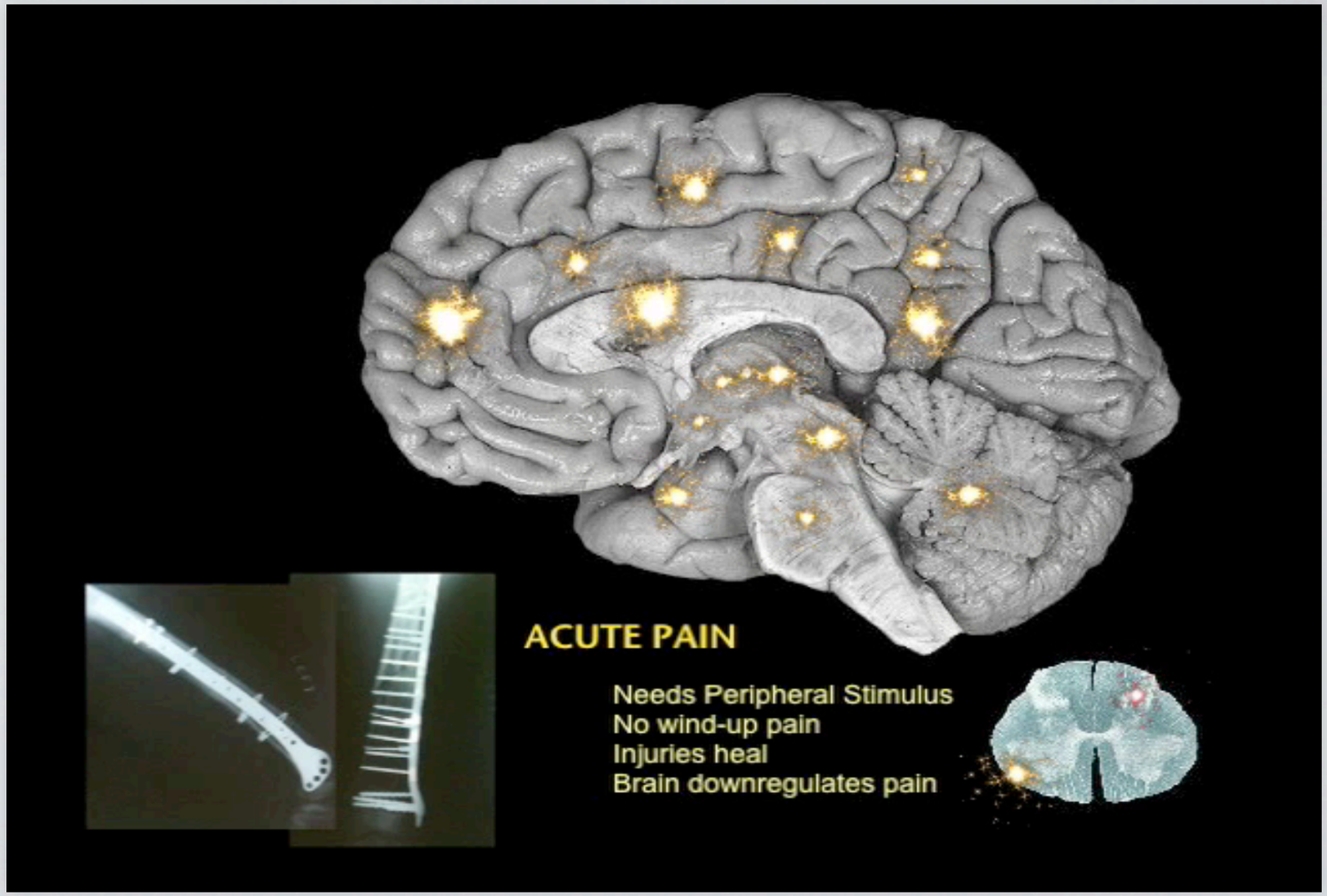
- When you stub a toe, you cannot feel any pain until the signal gets to the thinking part of your brain
- The signal goes from your toe to synapses in the spinal cord and the non-thinking brain and is still not pain
- Only at the thinking brain, does it become pain

It isn’t pain ‘till it hits the brain

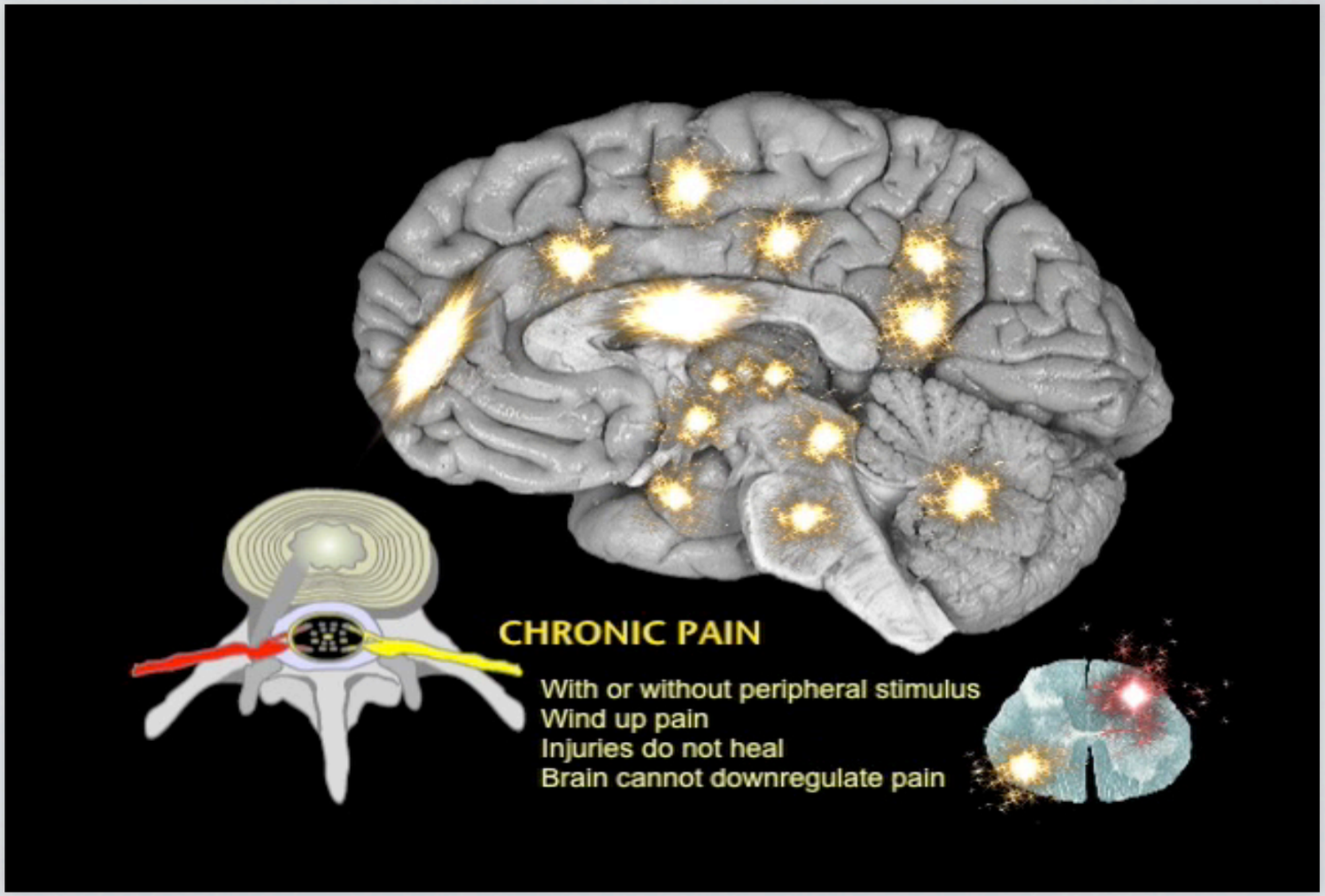
- Once the signal arrives at the thinking brain, 9 areas of it are responsible for how we experience pain
- In acute pain, the highly adaptive brain shuts off the signal when danger from injury passes or we rest the injured part of our bodies, long before healing is complete
- In persistent pain, the signal is amplified and is kept going long past any usefulness, becoming it’s own disease process

Pain in the Brain



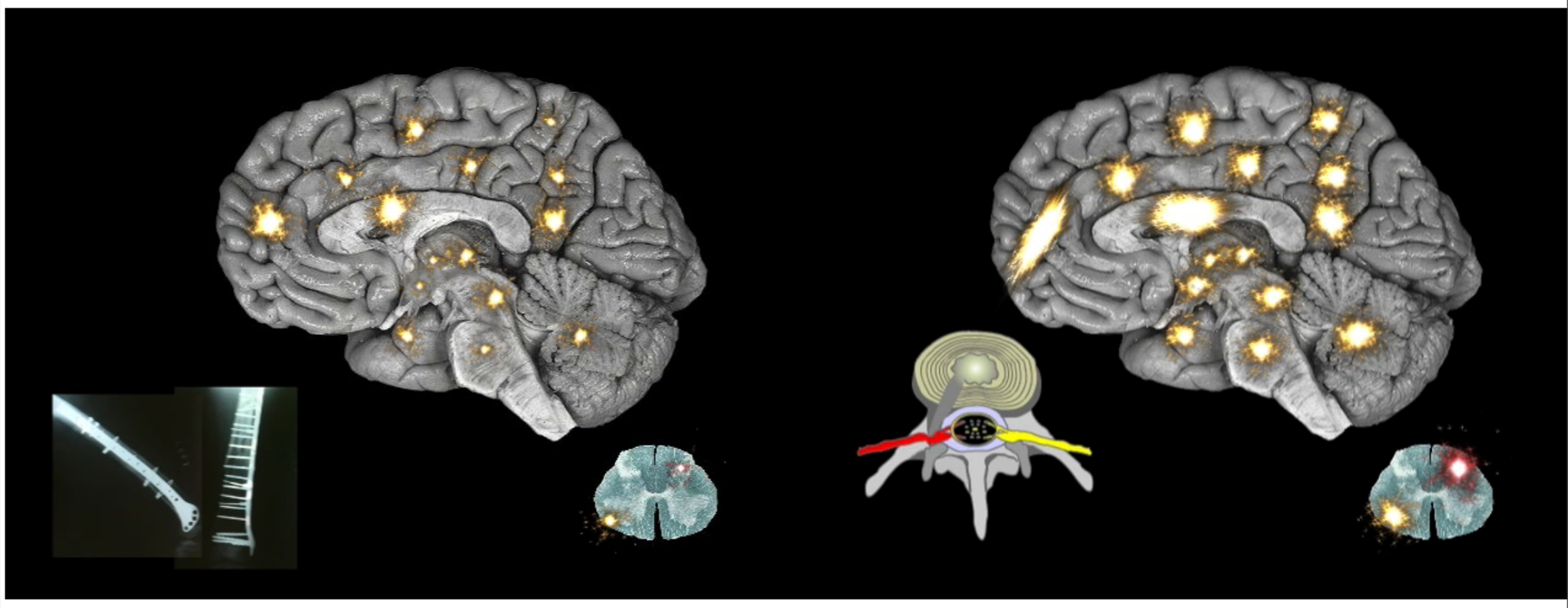


The Brain and Pain: Acute Pain



The Brain and Pain: Chronic Pain

Acute vs Chronic Persistent Pain: Brain Maps



Acute Pain Brain Map

Chronic Pain Brain Map

Brain Pain Maps

- In chronic pain, the brain's pain map is expanded compared to acute pain
- When a brain map expands it steals nerve cells and their synapses from other functions in the area
- In pain, constant input to the brain leads to firing of nerve cells far longer lasting than the incoming pain signal–Long Term Potentiation

Shrink The Pain Map By Flooding The Brain With:

Thoughts.....Images.....Sensations.....Memories.....Soothing Emotions.....Movement.....Beliefs

Prefrontal

Pain, Executive Function, Creativity, Planning, Empathy, Action, Emotional balance, Intuition, Morality

Anterior Cingulate

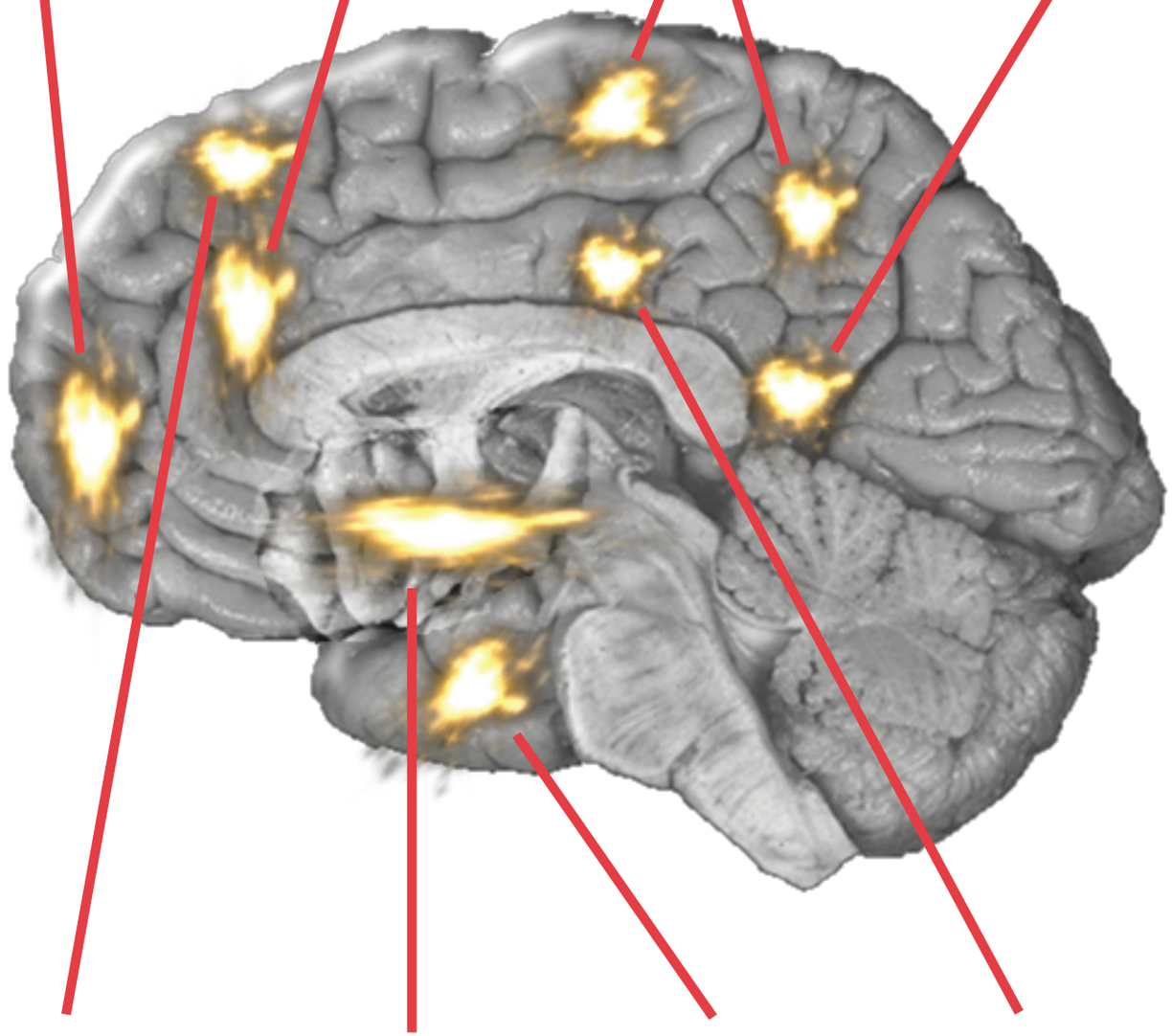
Pain, Emotional self control, Sympathetic control, Conflict detection, Problem solving

Somatosensory 1 & 2

Pain, Temperature, Pressure, Touch, Postion, Vibration, Sensation of movement

Posterior Parietal

Pain, Sensory, Visual, Auditory Perception, Mirror neurons, Internal location of stimuli, Location of external space



Supplementary Motor

Pain, Planned movement, Mirror neurons

Insula

Pain, Temperature, Itch, Empathy, Emotional self Awareness, Quiets the amygdala, Sensual touch, Connects emotion with bodily sensation, Mirror neurons, disgust

Amygdala

Pain, Emotion, Emotional Memory, Emotional response, Pleasure, Sight, Smell, Fight, Flight, Freeze, Emotional extremes

Posterior Cingulate

Pain, Visuospatial cognition, Autobiographical memory retrieval

Scent Circuit

- Nasal mucosa to nerves that penetrate skull bone and synapse with olfactory track
- The next synapse is amygdala, then circuit traces the pain circuit
- Amygdala is the first place we perceive pain– sends signals via neurotransmitter, Substance P and use of Calcium channels to generate signal
- Peppermint blocks Substance P and calcium channels

Scent and Emotional Memory Circuit

Scent and Sensory Circuit

- Scent stimulates the Amygdala
- Insula responds to circuit by either setting off pleasure circuits or disgust
- Sensory areas of the brain are stimulated, selectively identifying the strongest sensation

Scent vs Pain

- The brain tends to identify the strongest sensation
- Other sensations are identified, but are pushed into the background
- This technique can be used to push pain to the background (Peppermint and cold receptors)