The Role of structural plasticity in producing Non random neural connectivity

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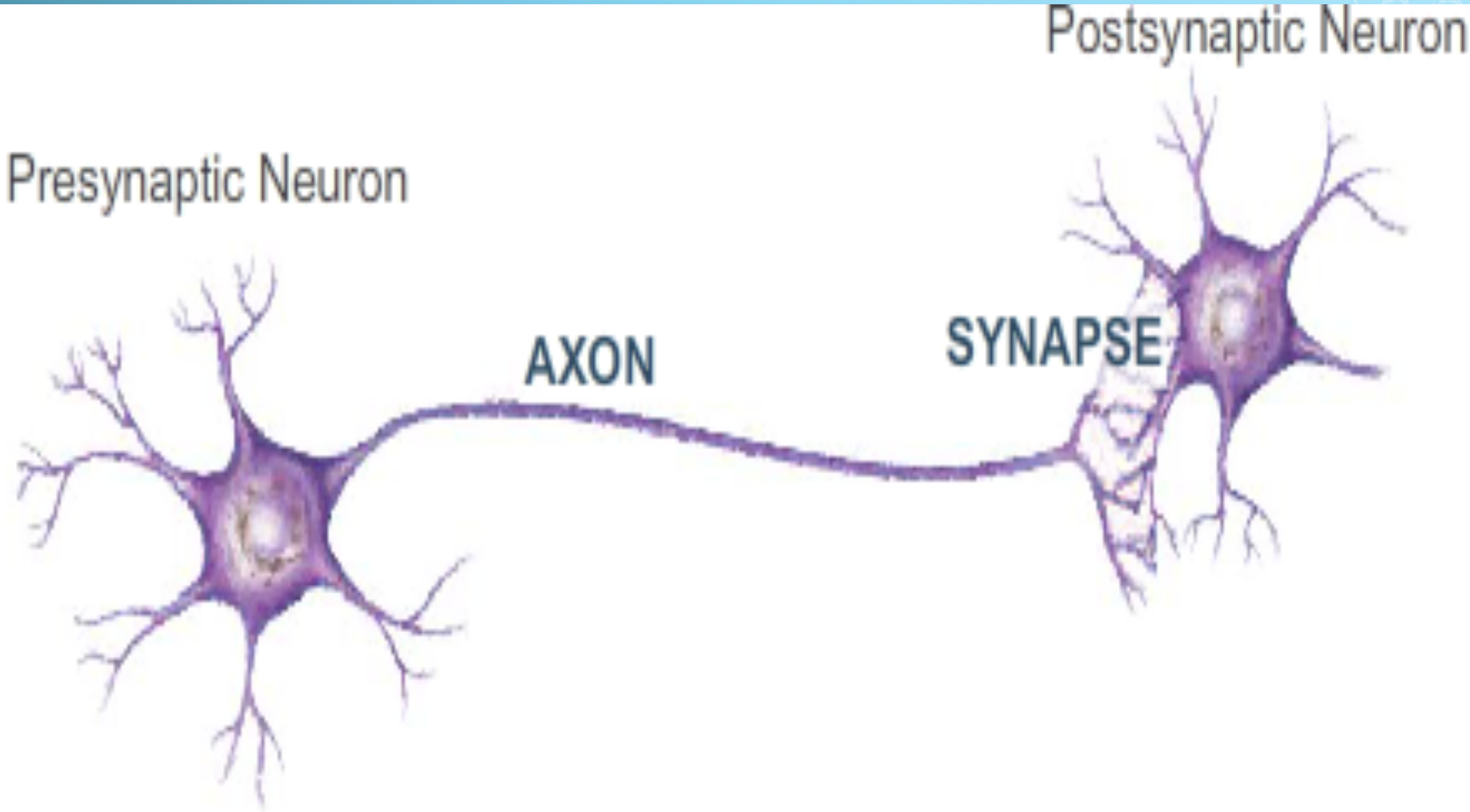
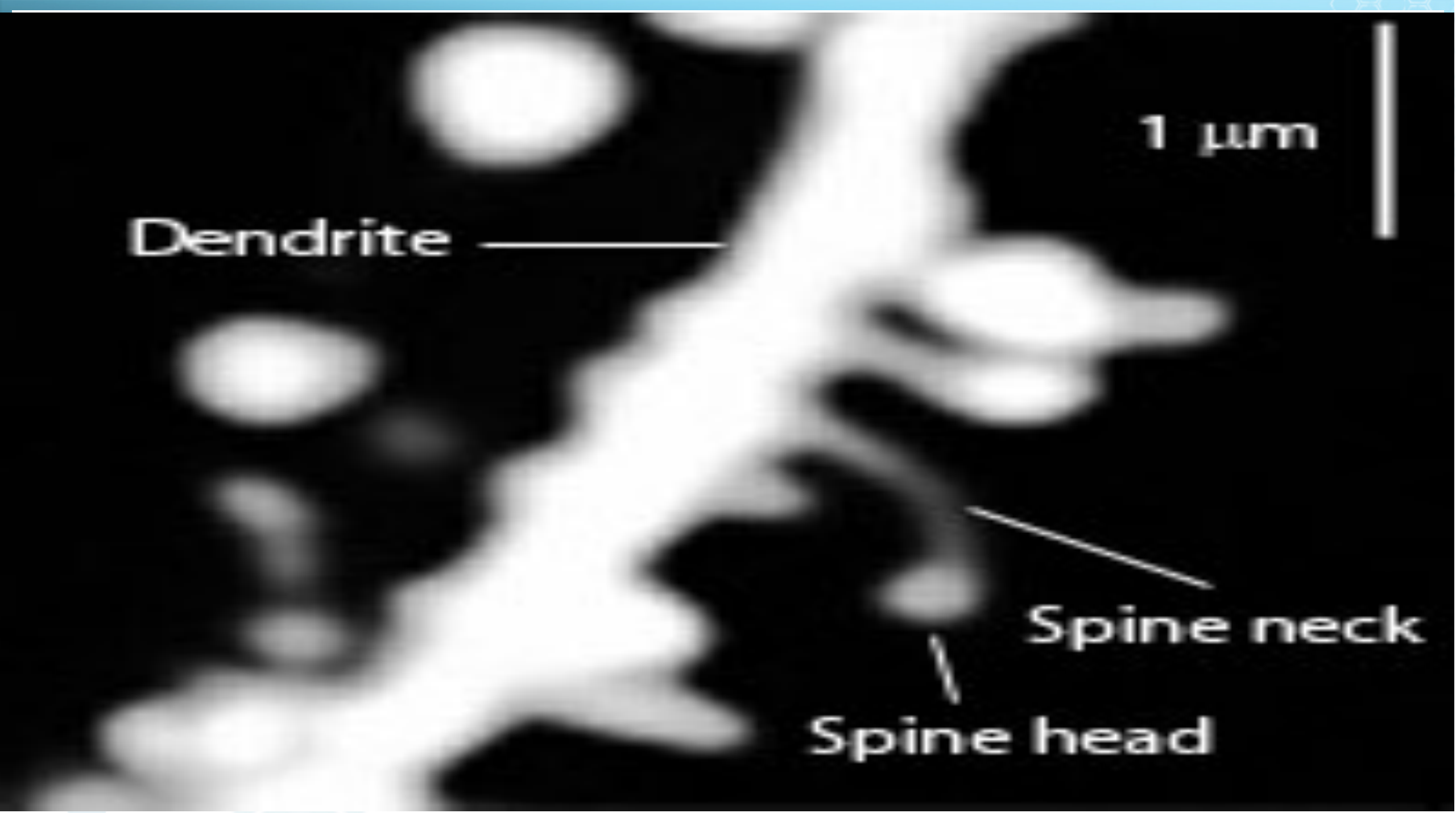
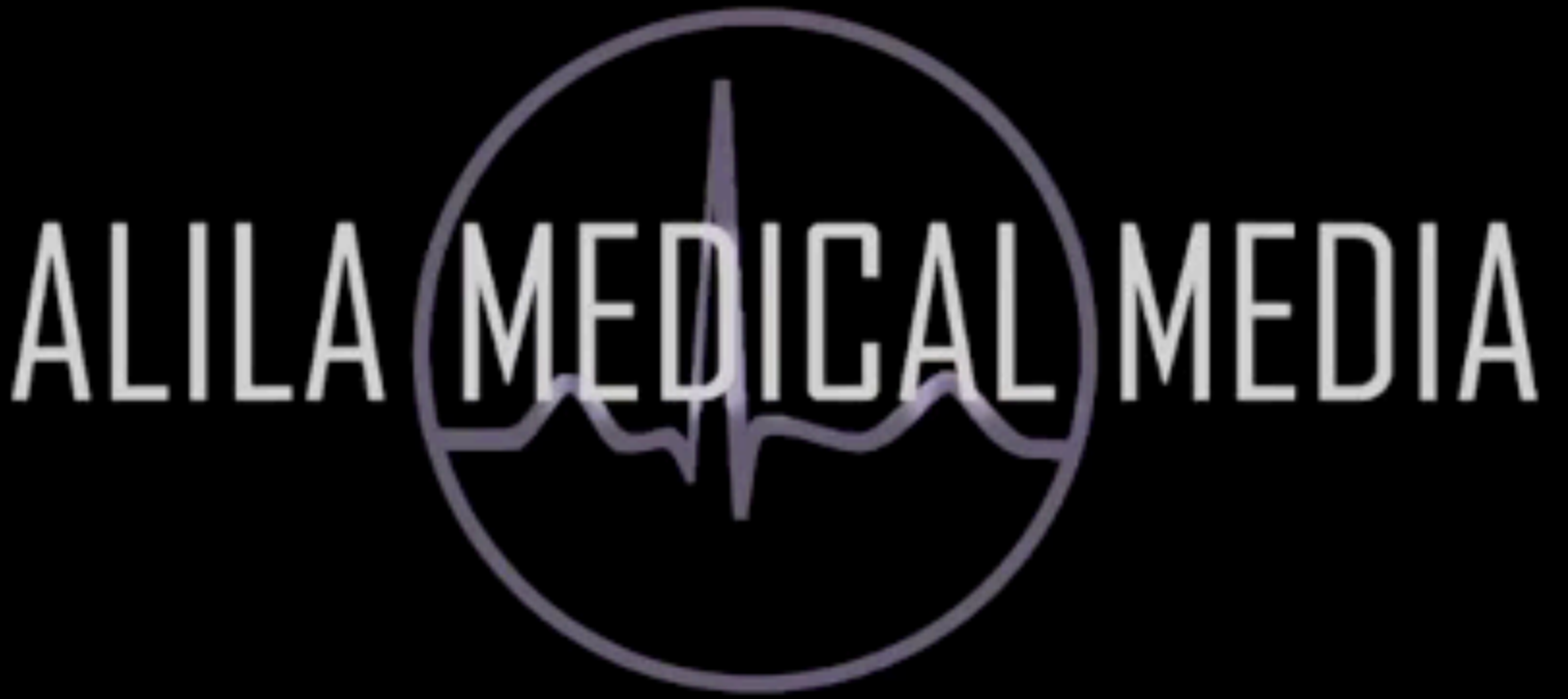

Postsynaptic Neuron
Presynaptic Neuron
AXON
SYNAPSE


1 µm
Dendrite
Spine neck
Spine head

Dendritic Spines

- **What are they?** :small protrusions that emerge from the dendrites - Most excitatory synapses in the brain are found on spine heads
- **What is their Size?** - a spine consists of a bulbous head, volume 0.001–1 μm3, at the end of a thin spine neck, diameter around 0.1 μm. A 100 μm length dendrite can contain several hundred spines.
- **What's in a spine?** - All spines contain a postsynaptic density, an electron-dense thickening where the presynaptic axon contacts the spine
- **Do all spines look alike?** – No
- **Can spines change shape?** Yes! - Over timescales of
  - seconds, spines continuously undergo small changes in shape, powered by dynamic actin filaments.
  - minutes to hours spines can change their shape dramatically or even appear or disappear.
- **What are spines for?** Nobody really knows
- **Can having more spines make us smarter?**



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Neuro Plasticity

- "Organic matter, especially nervous tissue, seems endowed with a very extraordinary degree of plasticity." - Psychologist William_James - "The Principles of Psychology"1890.
- 1920s researcher Karl Lashley provided evidence of changes in the neural pathways of rhesus monkeys
- 1960s, researchers began to explore cases in which older adults who had suffered massive strokes were able to regain functioning, demonstrating that the brain was much more malleable than previously believed.

Characteristics of Neuroplasticity

- Age
- Involves brain cells other than neurons, including glial and vascular cells.
- result of learning, experience, and memory formation or as a result of damage to the brain.
- Genetics and environment also have an influence.
- Psychoactive substances or pathological conditions -

Types of Brain Plasticity

plasticity		
	Structural	Brain damage
		learning
	Functional	Brain damage

- **Functional plasticity:** The brain's ability to move functions from a damaged area of the brain to other undamaged areas.
- **Structural plasticity:** The brain's ability to actually change its physical structure as a result of learning.

Structural synaptic plasticity

- Spine growth - with long-term potentiation (LTP)
- Spine shrinkage - with long-term depression (LTD)
- Actin remodelling - induces structural synaptic plasticity
- The cellular mechanisms controlling the actual re-modeling of the spine – unknown
- Synaptic activity first leads to an immediate increase in spine volume in 30 min. Over the next 1–3 hr, the spine either retracts to its original size or both the spine and presynaptic bouton increase in size as well, leading ultimately to a stably enlarged synapse.

Structural Plasticity

A

Re-routing and rewiring around a lesion

B

Extension of afferents following tool use learning