

Neuroplasticity in Aging

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UMN Retirees Association

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Main Points

- 1) **Synaptic changes (plasticity) are the basis for learning**
- 2) How plasticity changes with age
- 3) Ways to stimulate and maintain plasticity as we age.

Exercise

Sleep

Social Interaction

Maintain health

Seek new experiences, challenges, learning opportunities



Let's get to know each other!

These links are in the CHAT

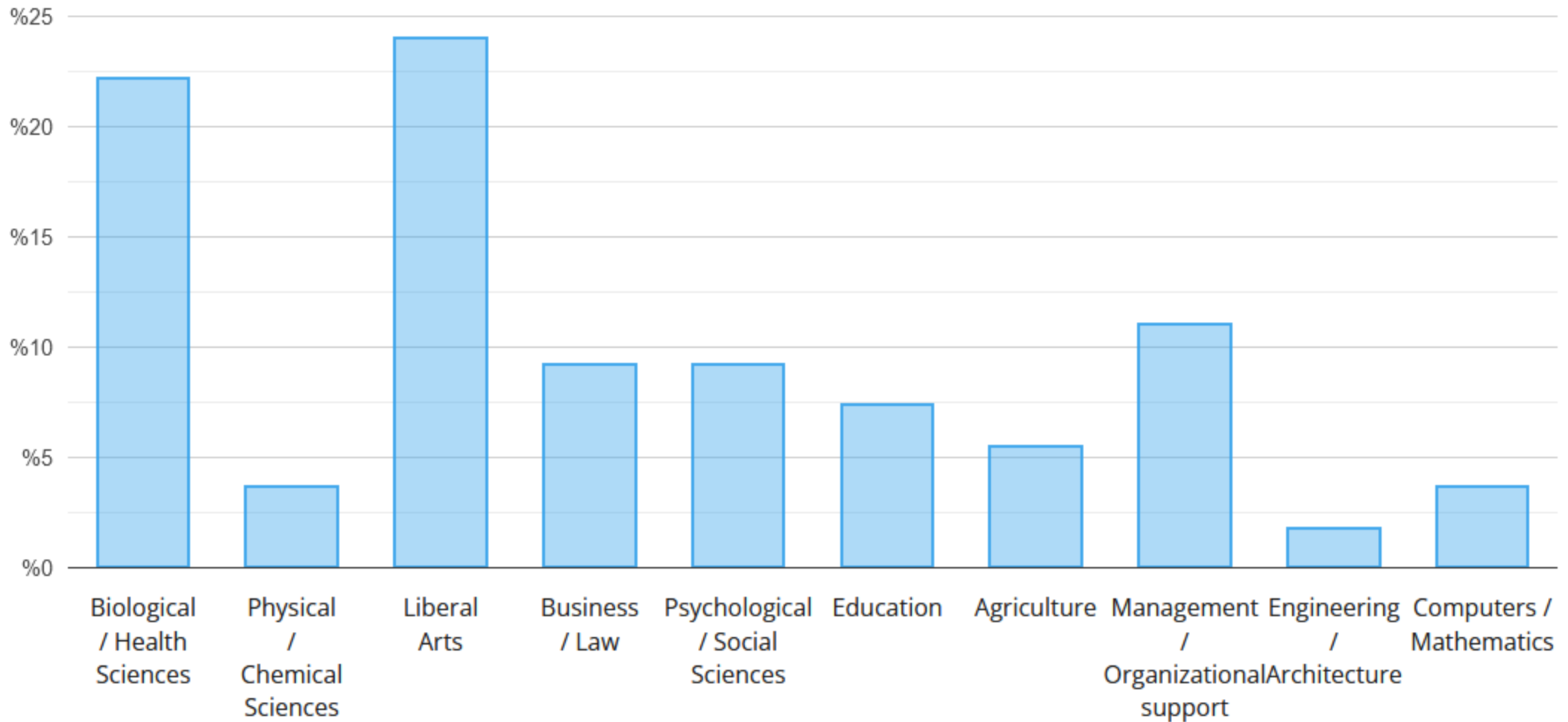
- Go to the Chat.
- Exit full screen
- Open a new tab in your browser
- Go to: <https://chimein2.cla.umn.edu/join/741704>
- Or: visit chimein2.cla.umn.edu and enter **741-704**

- Please answer the 2 questions.

- Let's see who we are today & what we already do for brain health.

Which category best matches your UMN experience?

All ▼



Synapses Make Things Happen

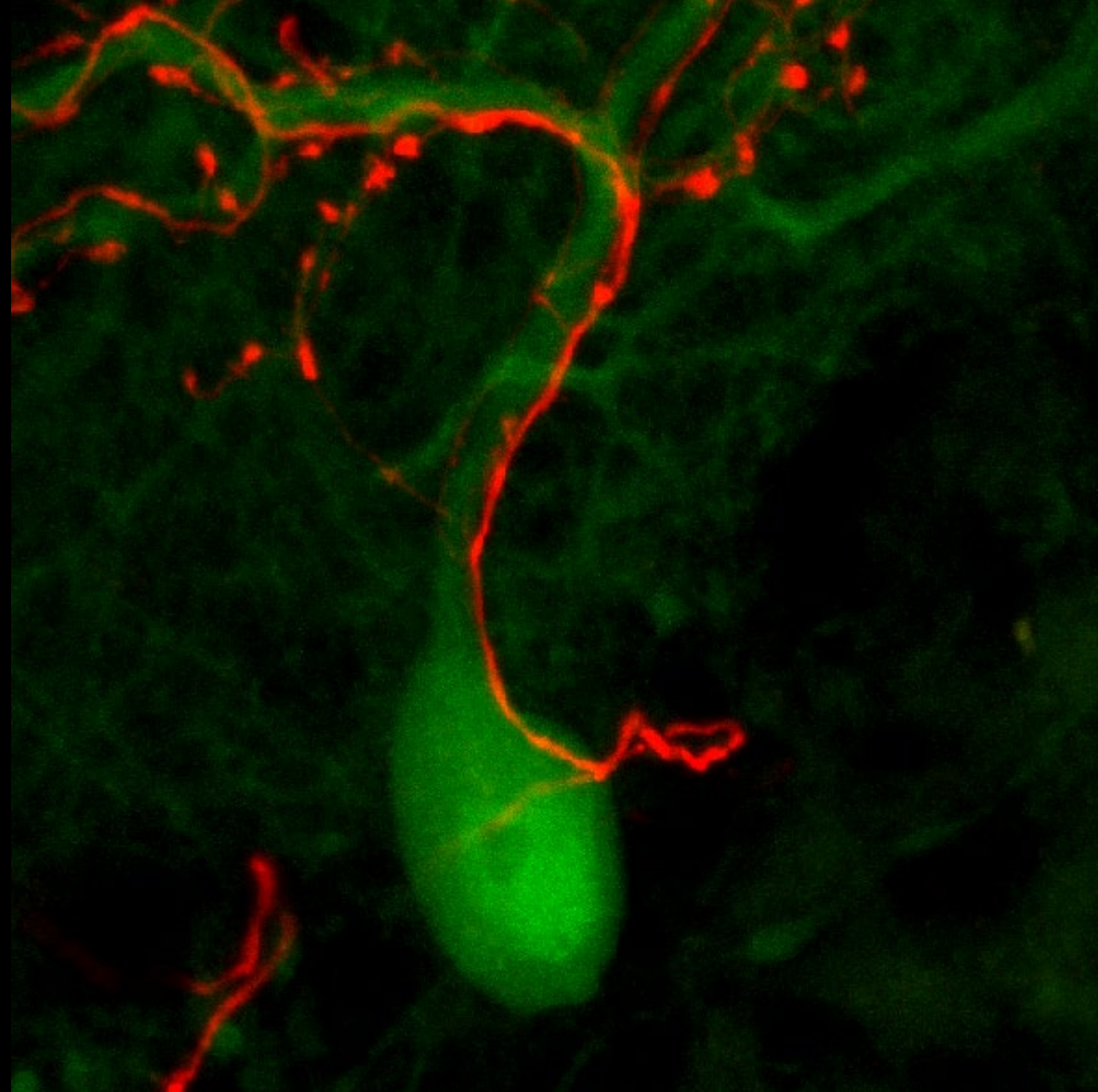
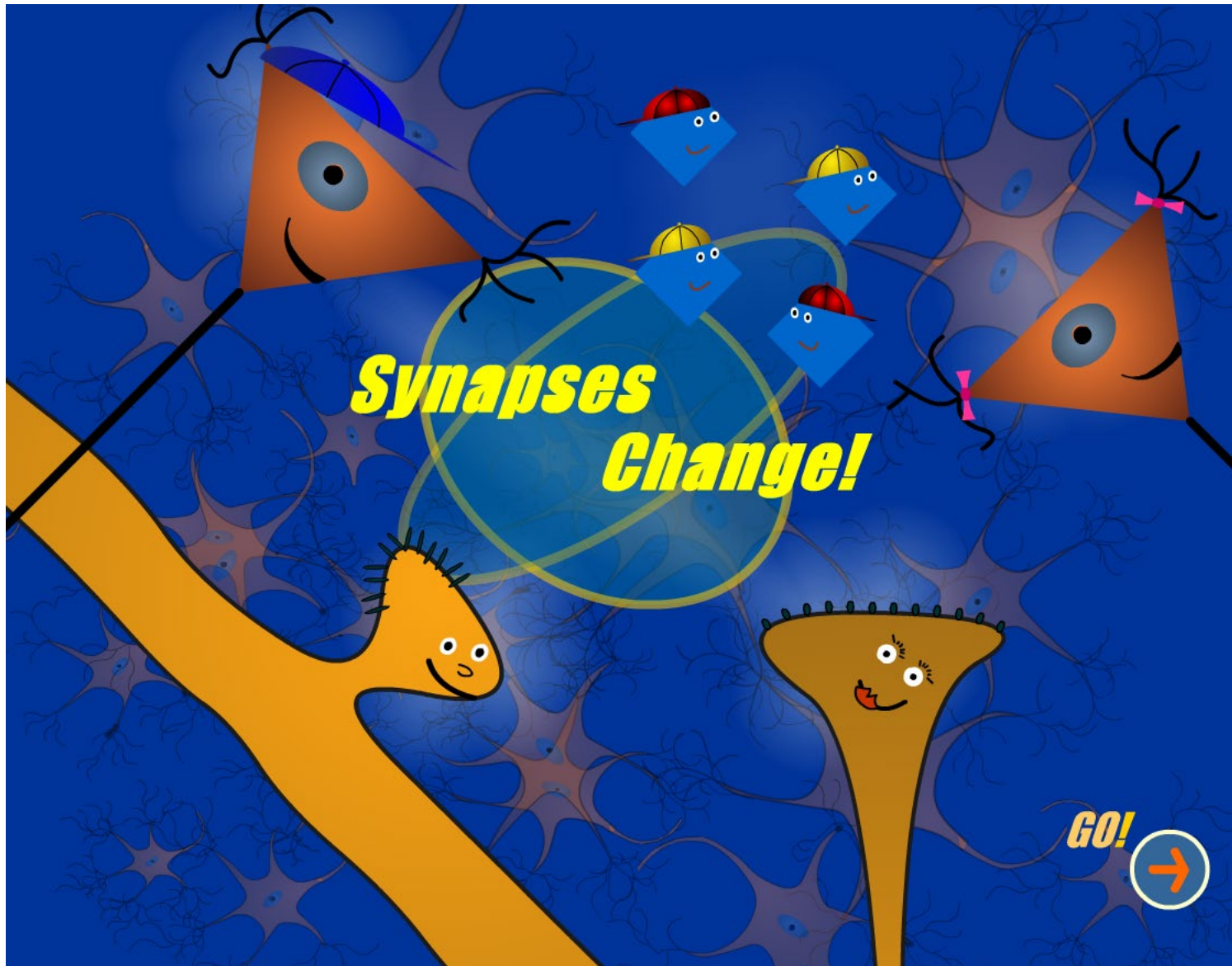


Image courtesy B. Ebner & H. Orr

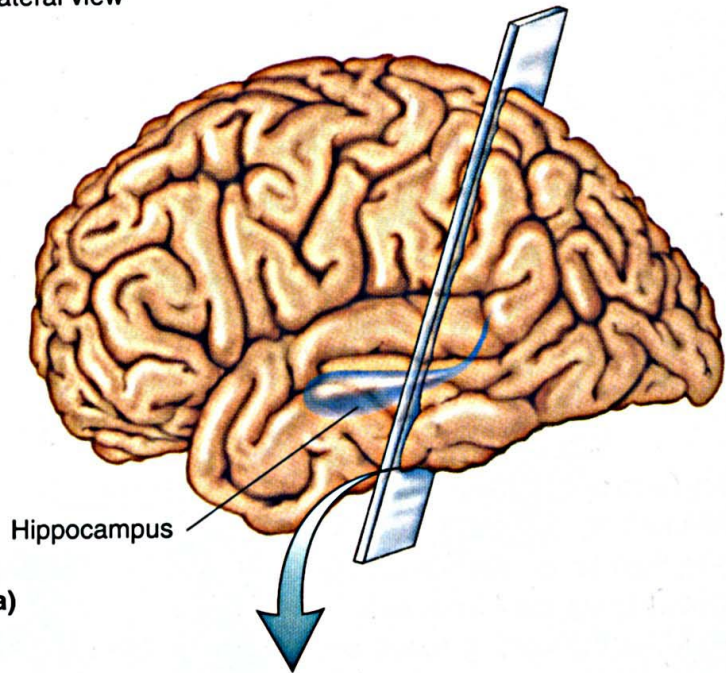


Synapses Change video on Youtube

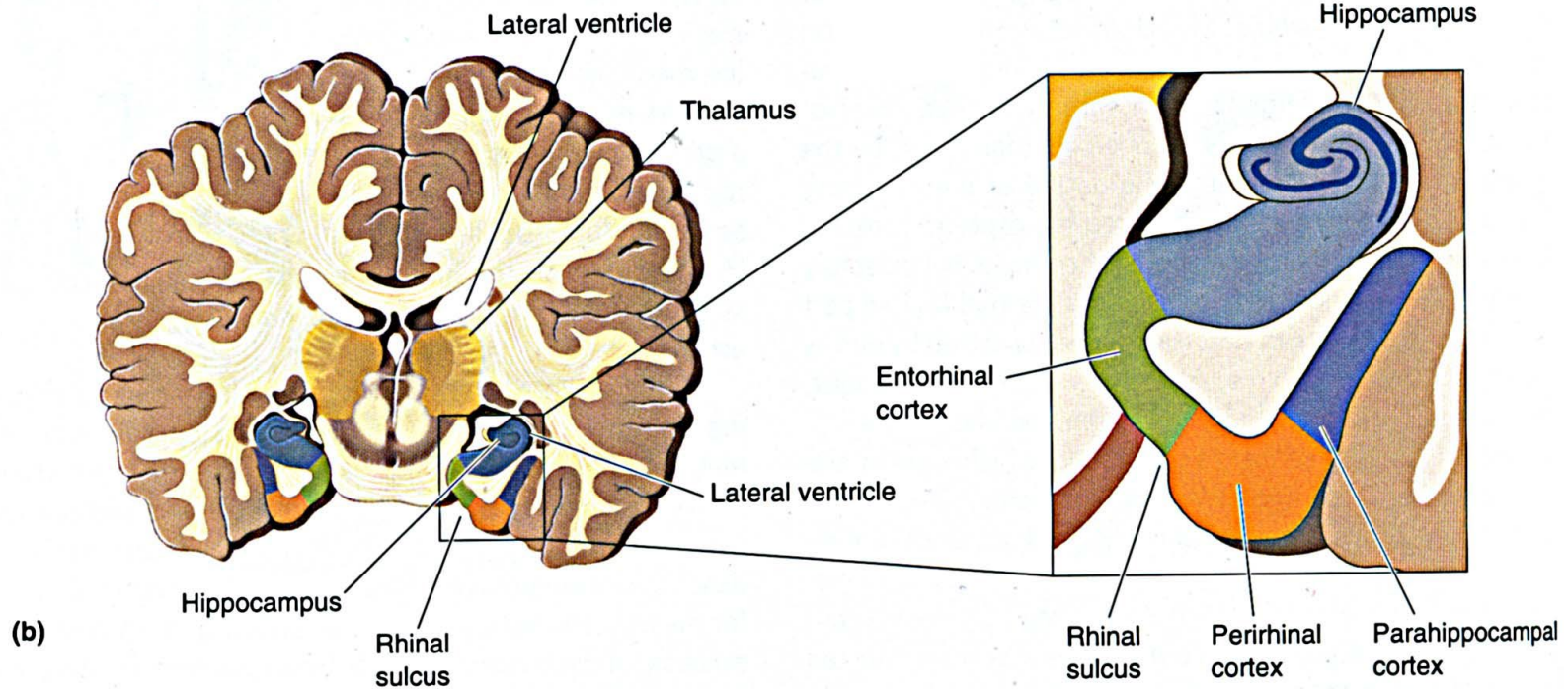
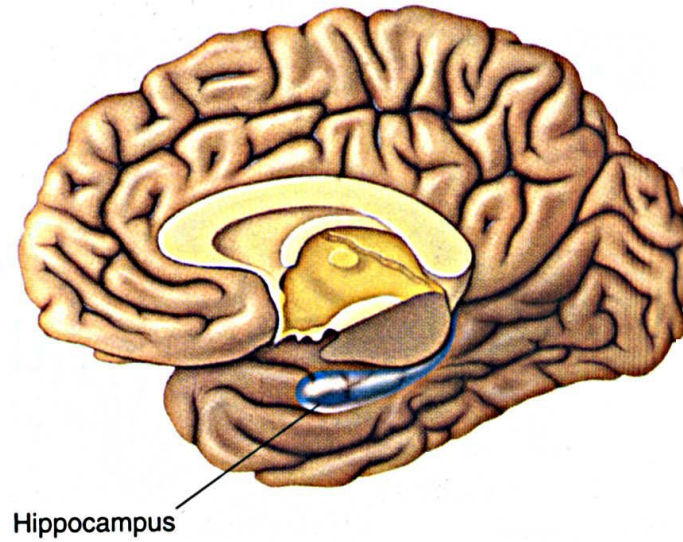
- Explanation of how synapses change
- Play 1:57 to 6:10

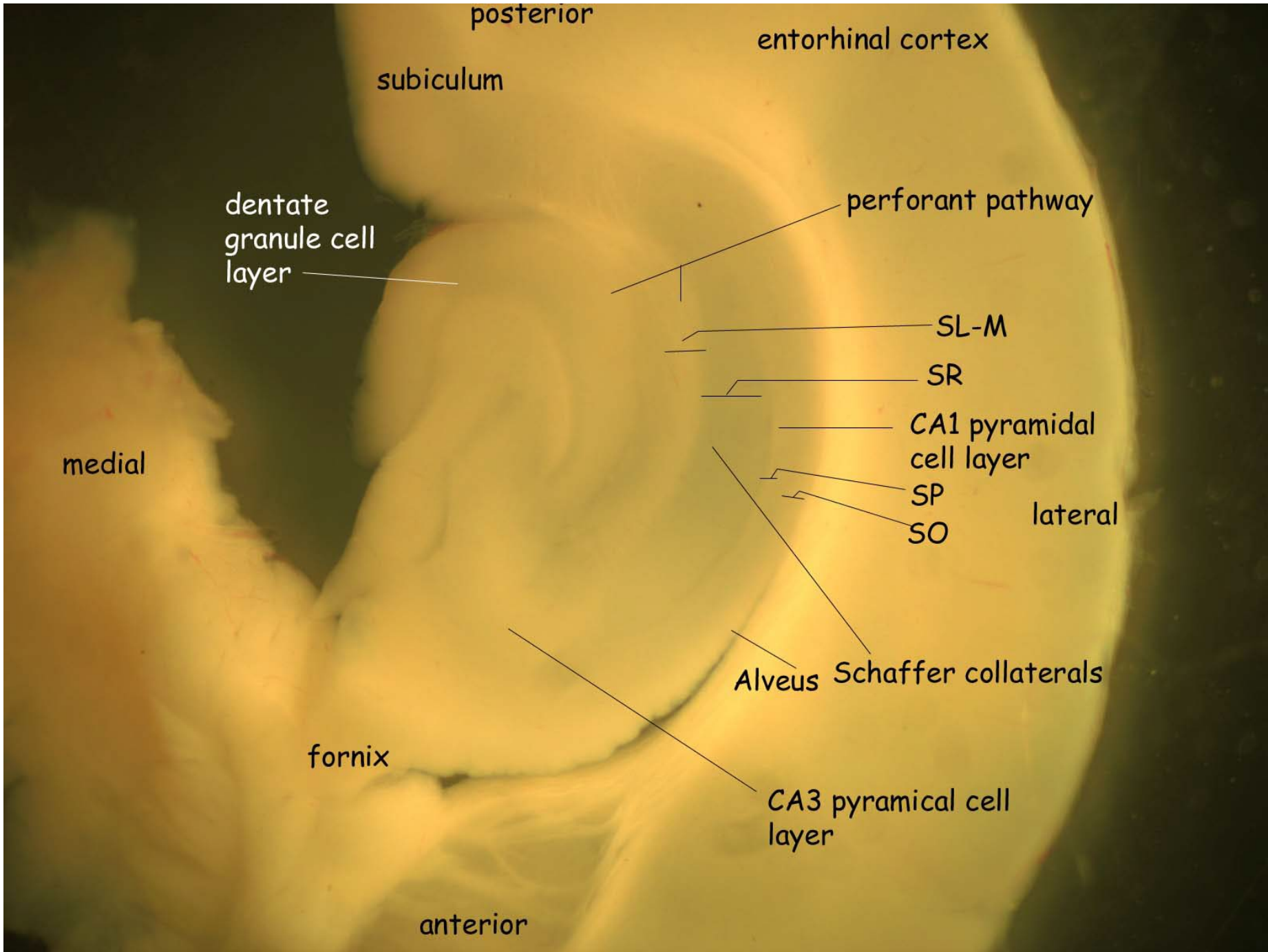


Lateral view

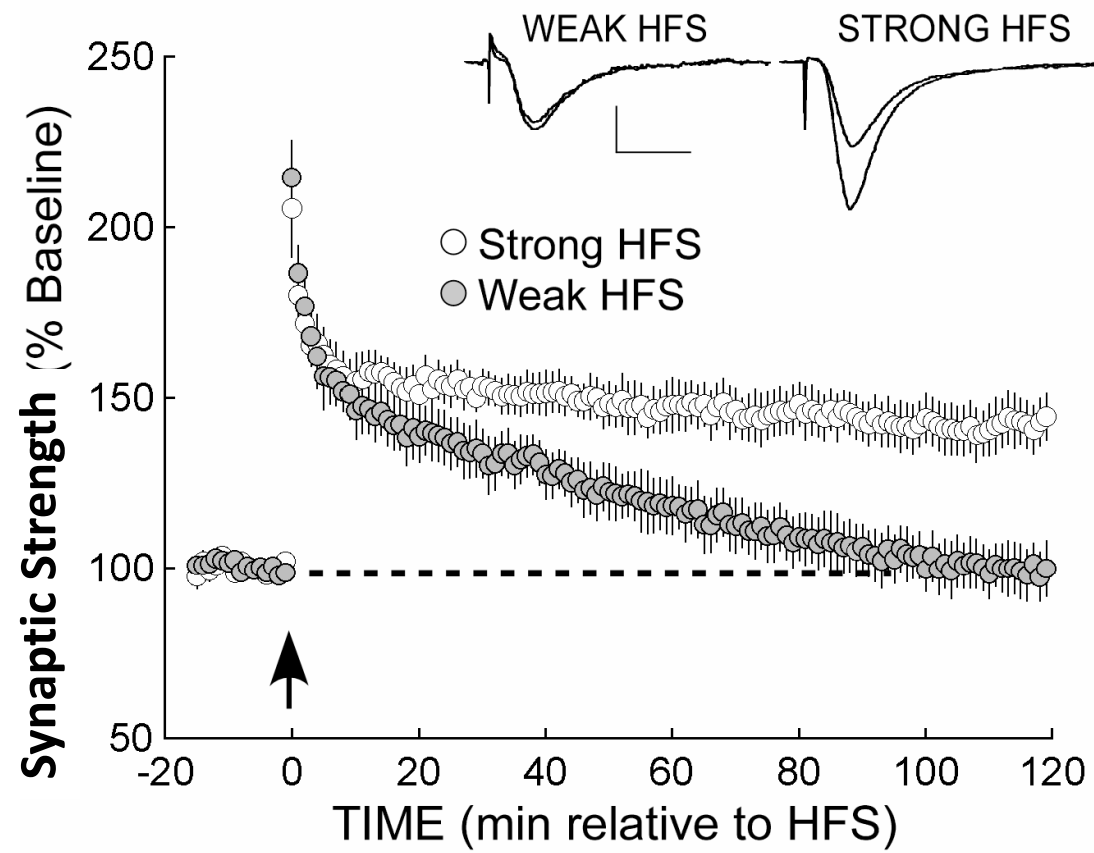
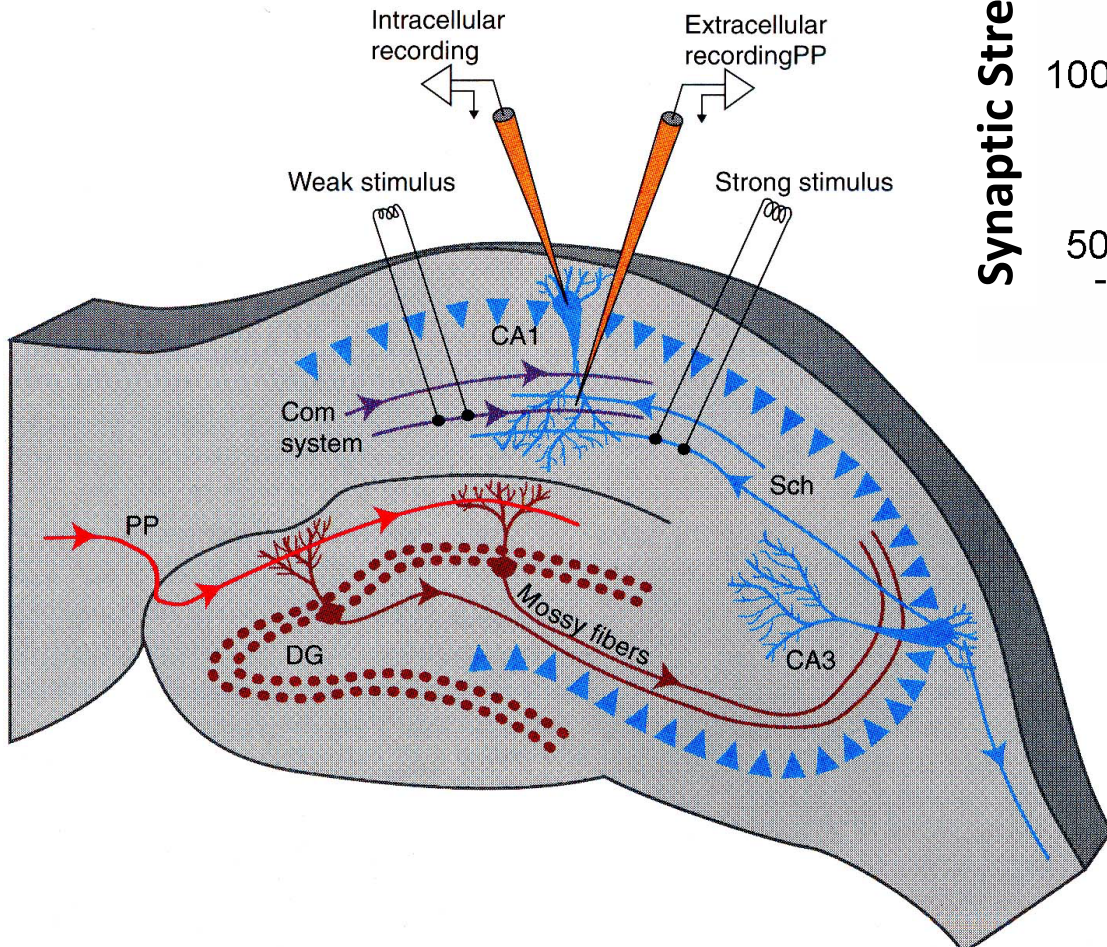


Medial view





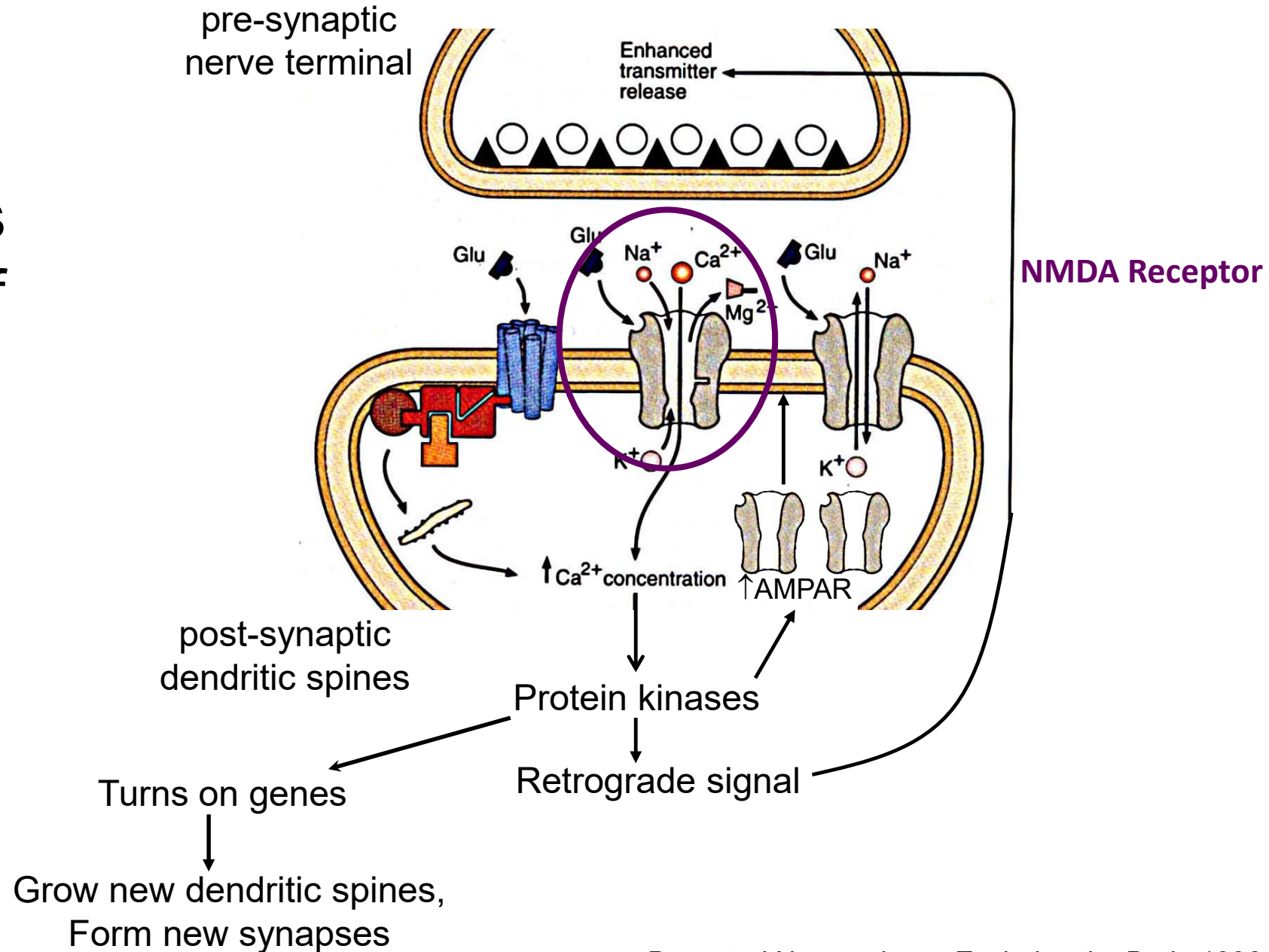
Long Term Potentiation LTP Changes at synapses



Tsokas et al., *J. Neurosci.* **25**:5833 (2005)

Kandel & Schwartz 1995

Learning (LTP) changes synapses through a series of biochemical steps leading to gene transcription



With different experiences,
with a different history of activity,
the strength of sets of synapses CHANGE!

Memories are formed from sets of synapses

Neuronal Connections are Plastic!

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- 2) **How plasticity changes with age**
- 3) Ways to stimulate and maintain plasticity as we age.

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What happens with Aging?

- Normal aging does NOT include loss of neurons.
- Normal aging may includes loss of **synaptic function**.

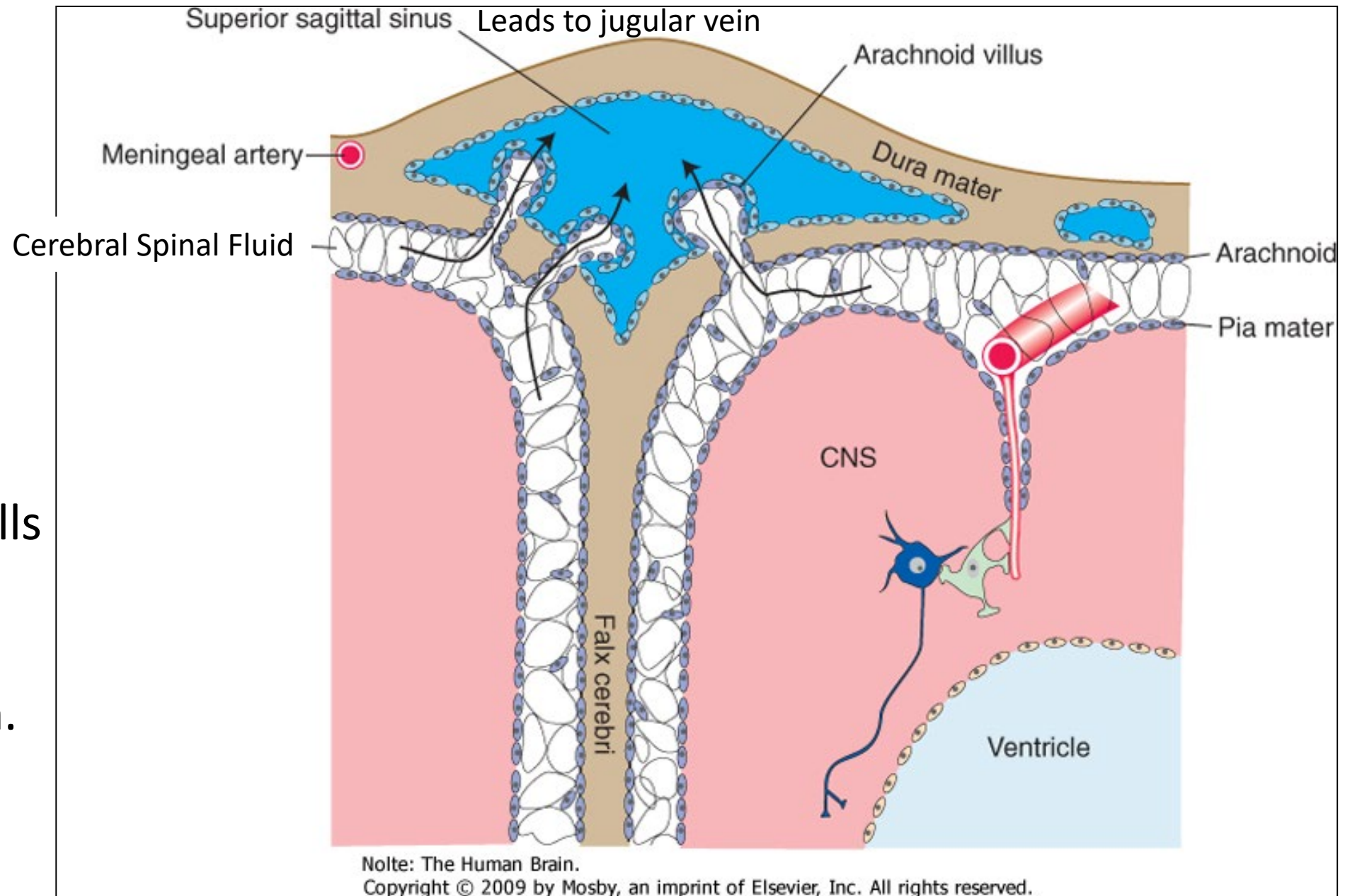
All body systems slow down, including

- Collection of biochemical trash
- Replacing cellular proteins
 - especially Growth Factors, Hormones & DNA repair proteins
 - **BDNF**
 - **Estrogen**
 - Gene transcription for replacing proteins at synapses
- Energy Production

Blood Flow in the Brain

Arteries deliver nutrition: O_2 and glucose to brain cells.

Biochemical Trash moves from the space between cells into the Cerebral Spinal Fluid to get to the jugular vein.

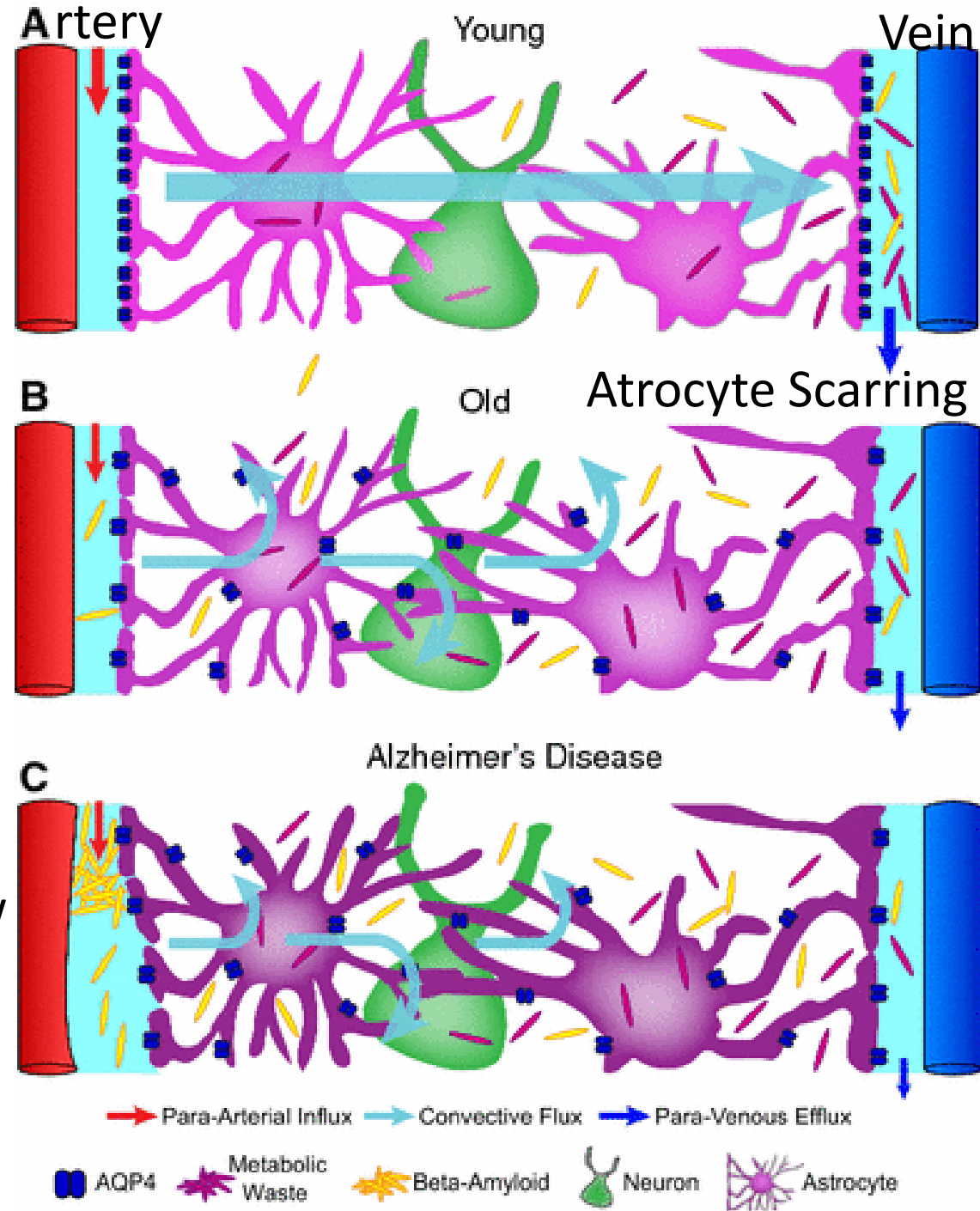




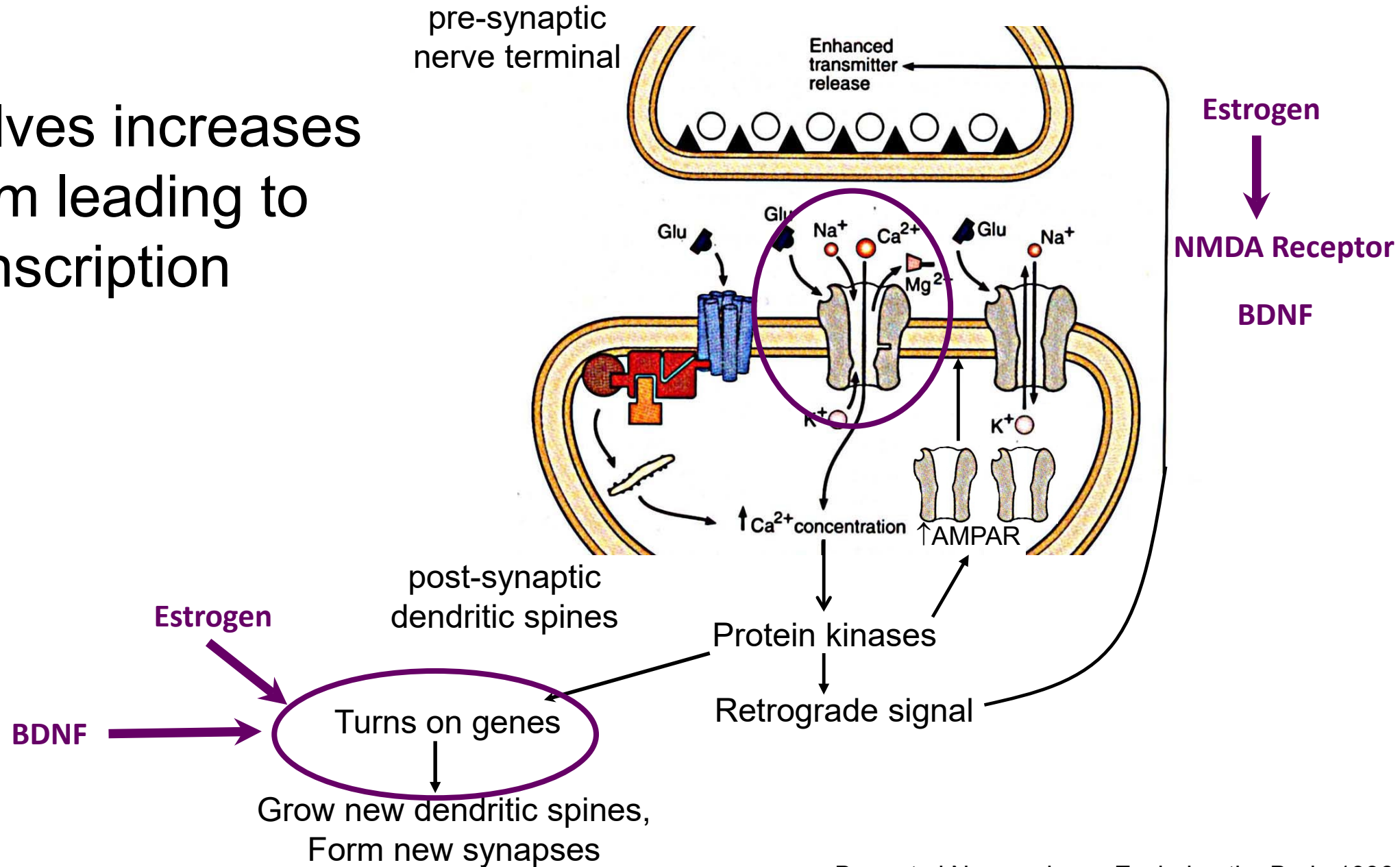
CSF flow decreases with age and disease

→ more biochemical trash accumulates

Beta-Amyloid Blocks CSF flow



LTP involves increases in Calcium leading to gene transcription



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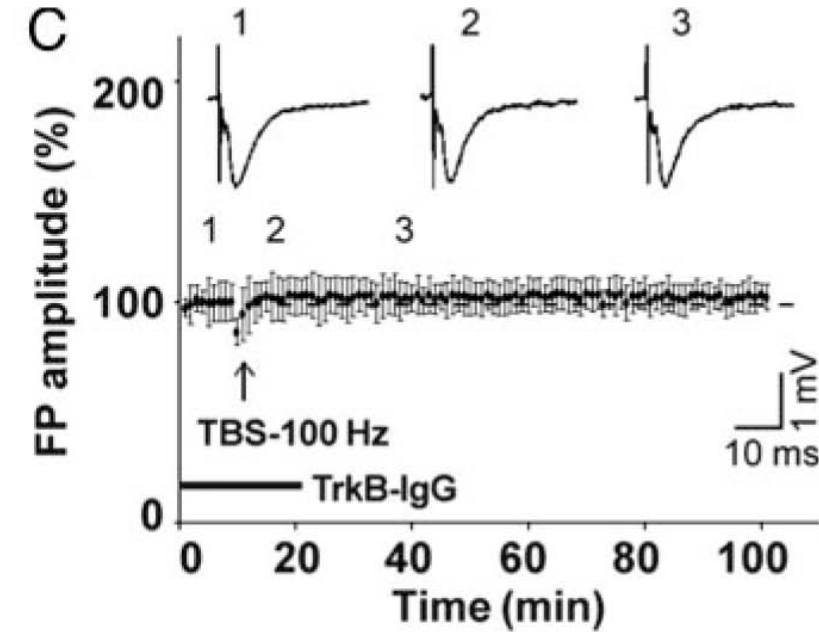
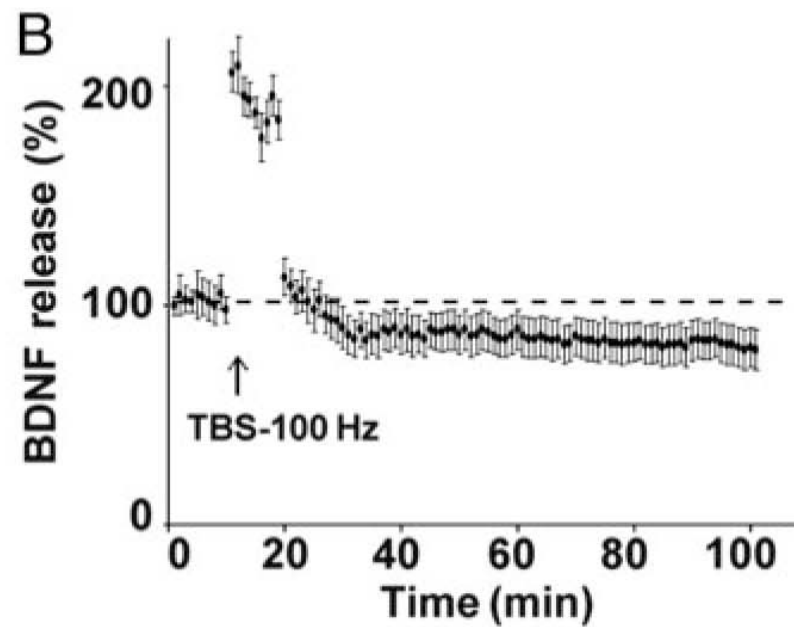
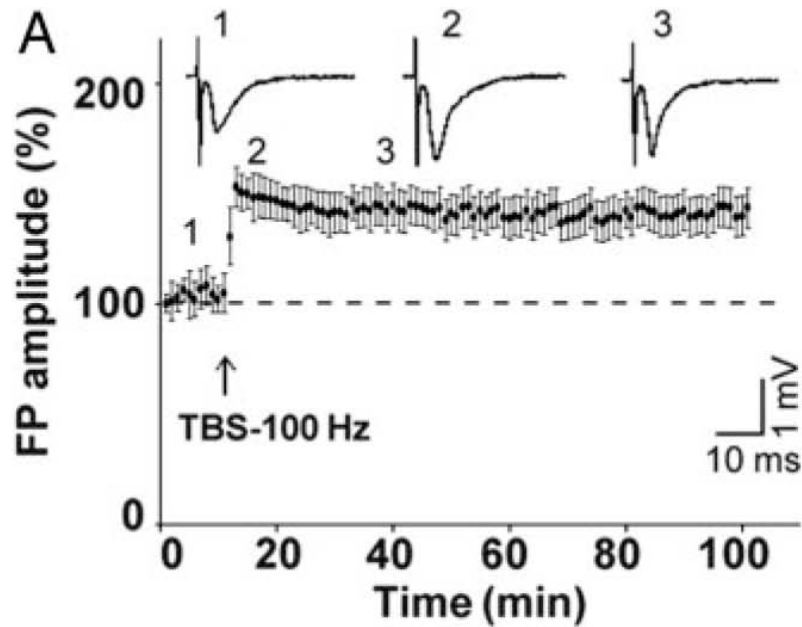


Maintain health



Seek new experiences, challenges, learning opportunities

BDNF is released during & shortly after LTP generation & is required for LTP induction

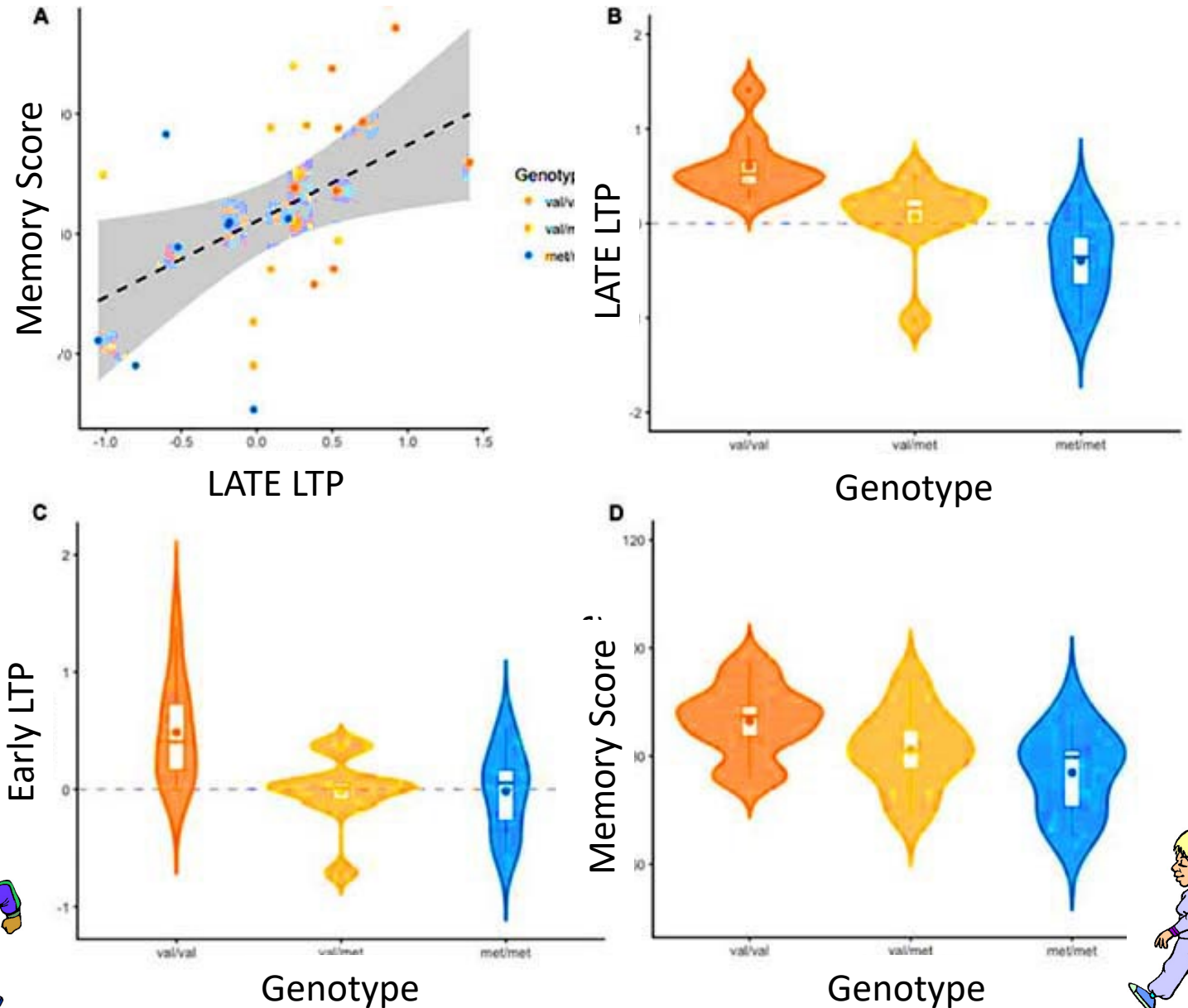




In humans, LTP correlates with memory score & BDNF phenotype

More BDNF →
 More synapse growth →
 More memories

BDNF decreases
 with age

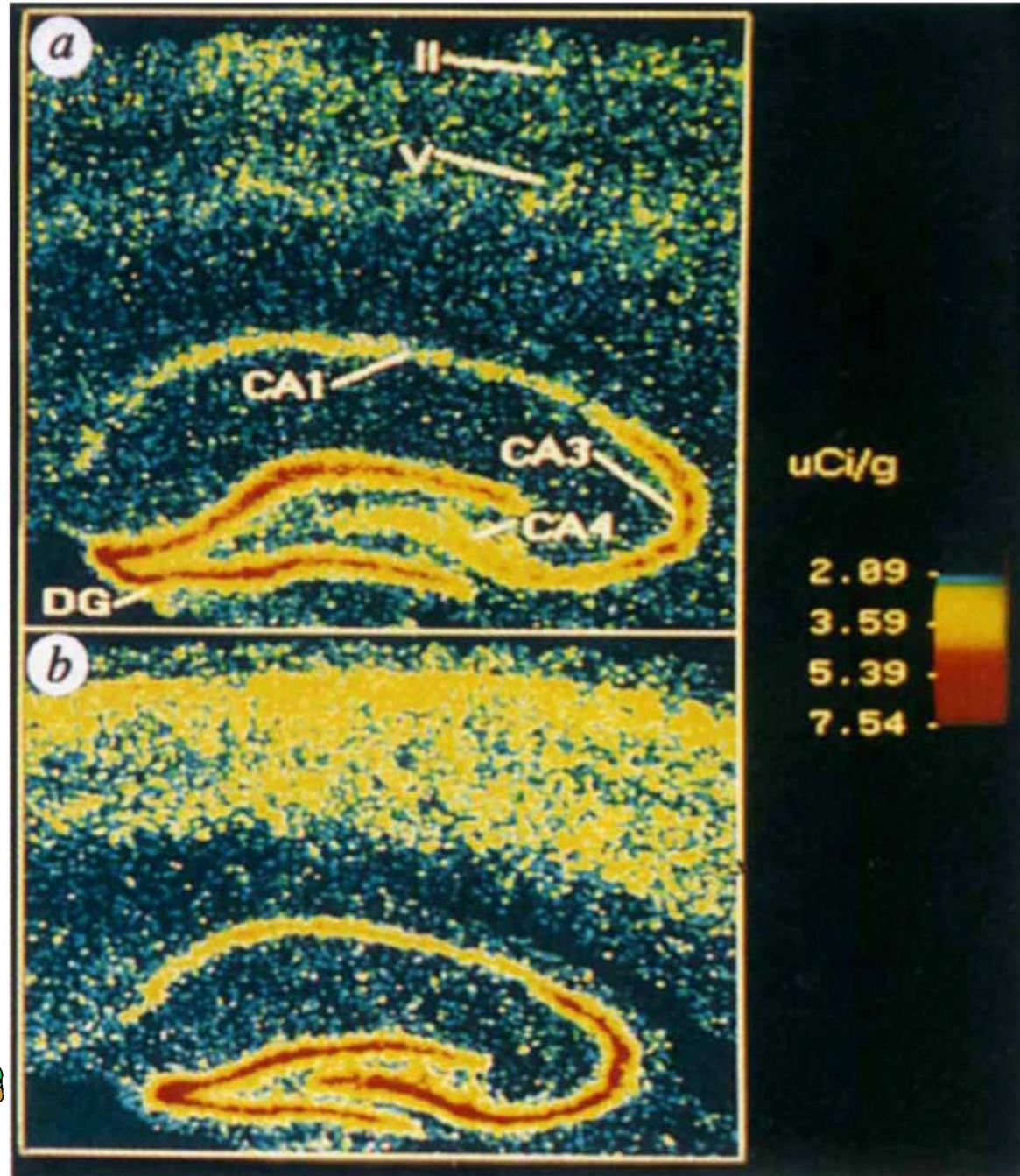


BDNF is generated by exercise.

Exercise increased BDNF mRNA in rat HC & Cortex.

Control

After 7 nights of running



Neeper...Cotman 1995 Science

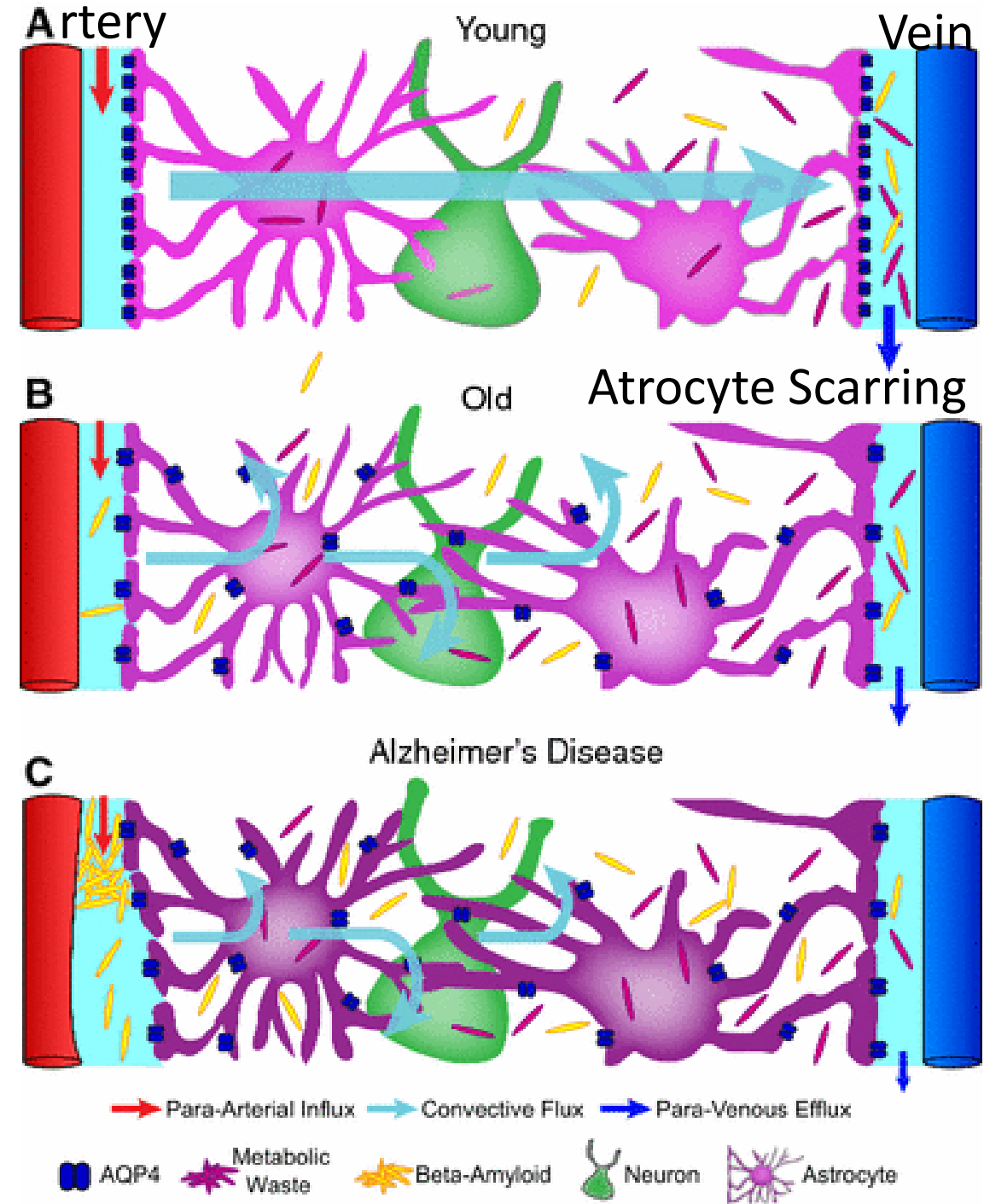




CSF flow increases with SLEEP!!!

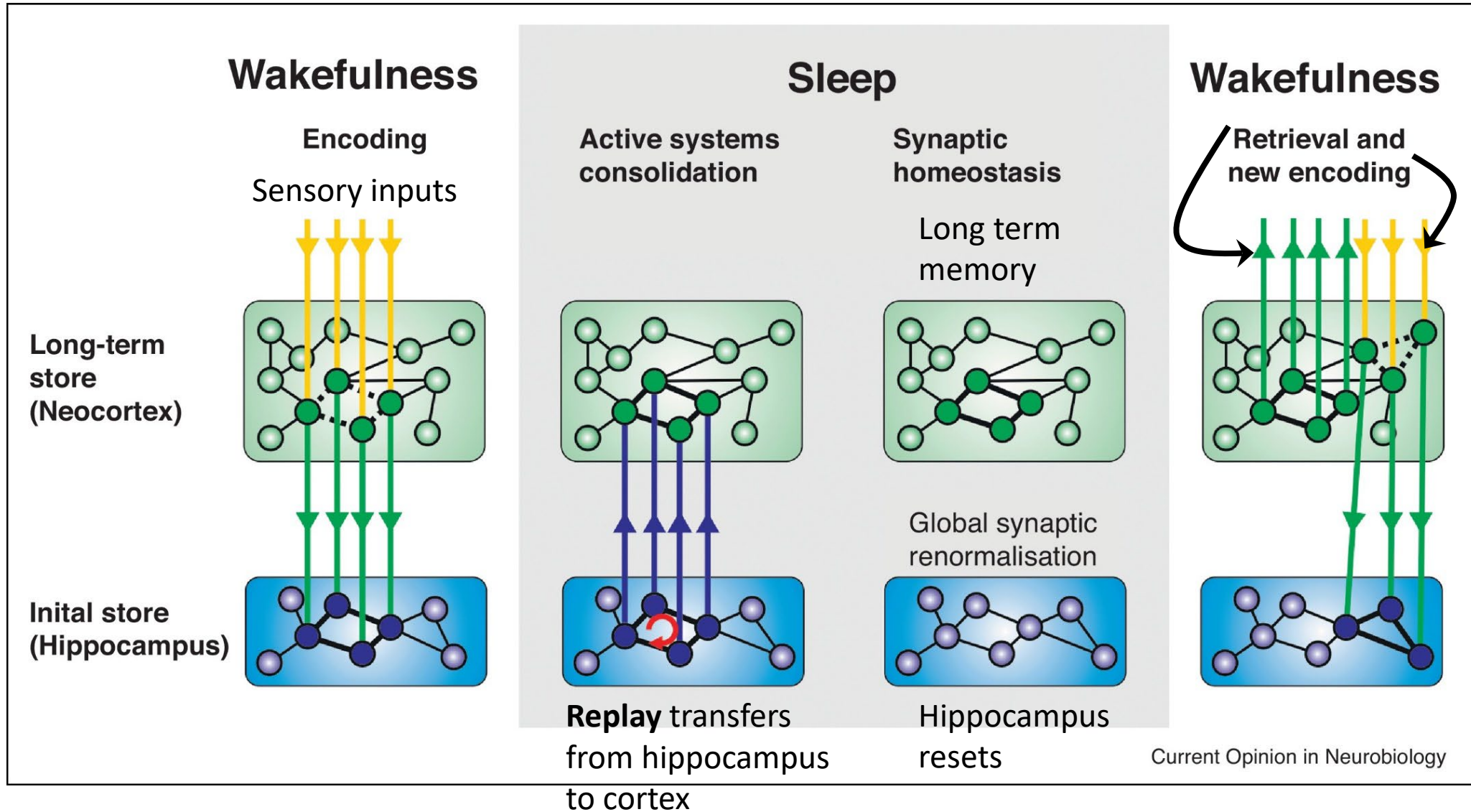
More sleep → More trash collection

Beta-Amyloid Blocks CSF flow





Active replay during sleep transfers important memories to cortical synapses & resets the hippocampus for new learning.



Current Opinion in Neurobiology



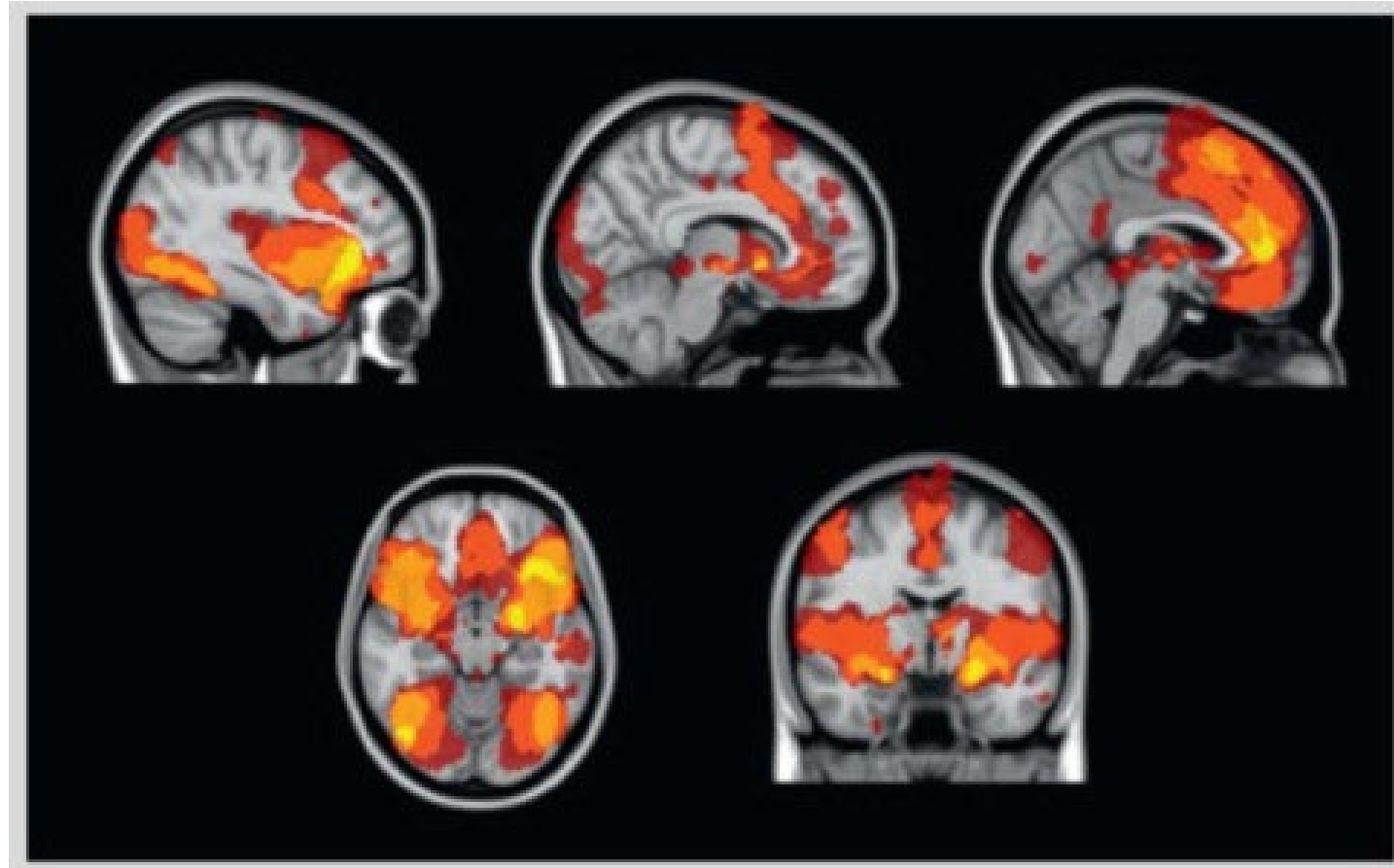


Brain is mainly concerned with processing social information.

Be social to use your brain more!

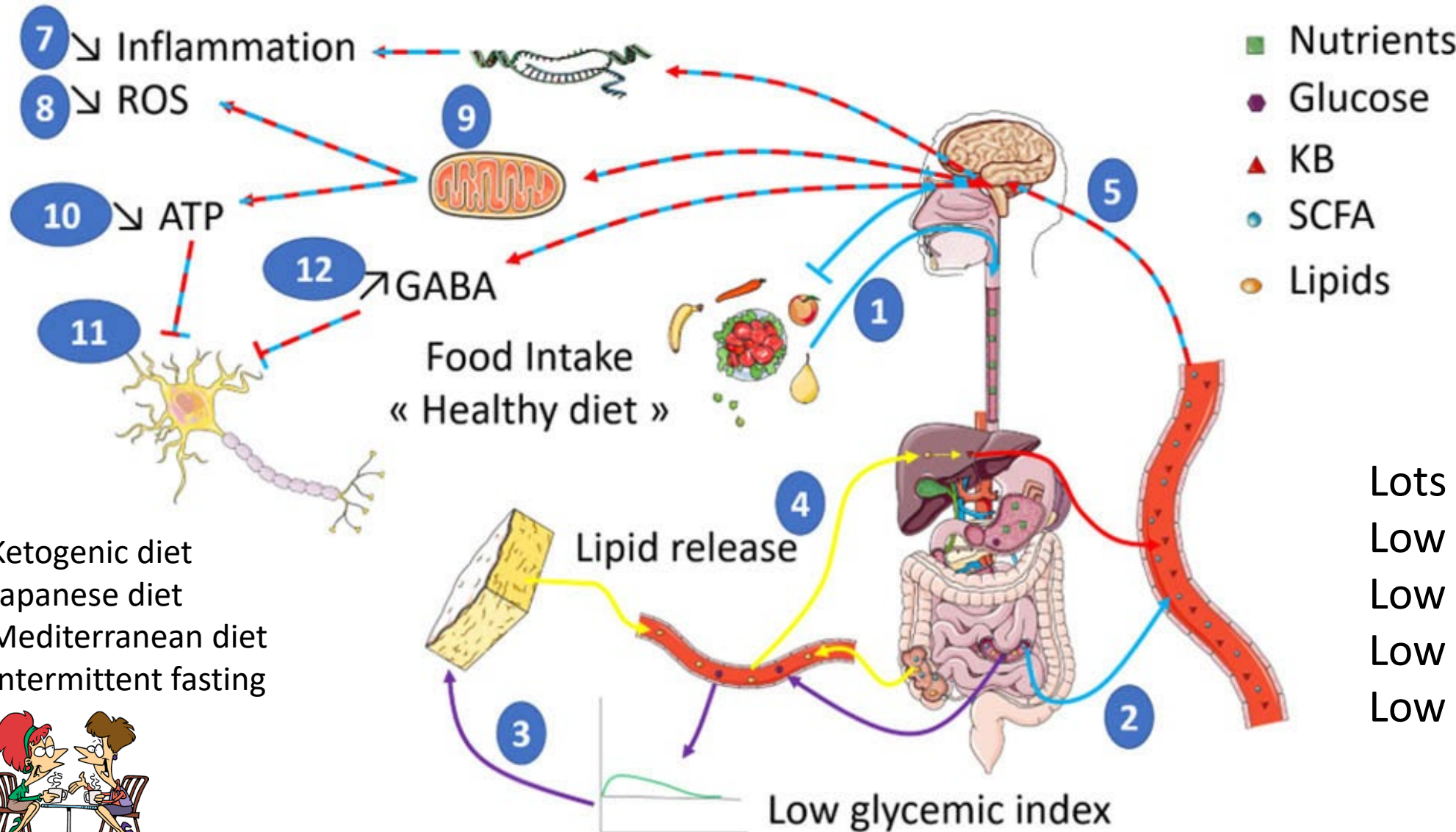


How one person's mind creates the perception of another person as having intentions, beliefs, morals, traits, etc. involves LOTS of brain networks simultaneously.



Network for processing negative emotions: anger, disgust, fear, sadness

Diet effects brain health – including plasticity

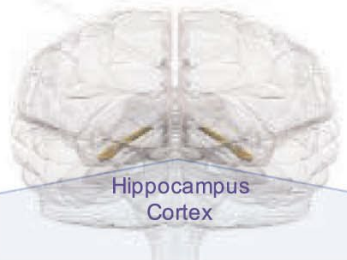




Diet → Sleep

Intermittent Fasting

Adaptive stress response
Metabolic switching

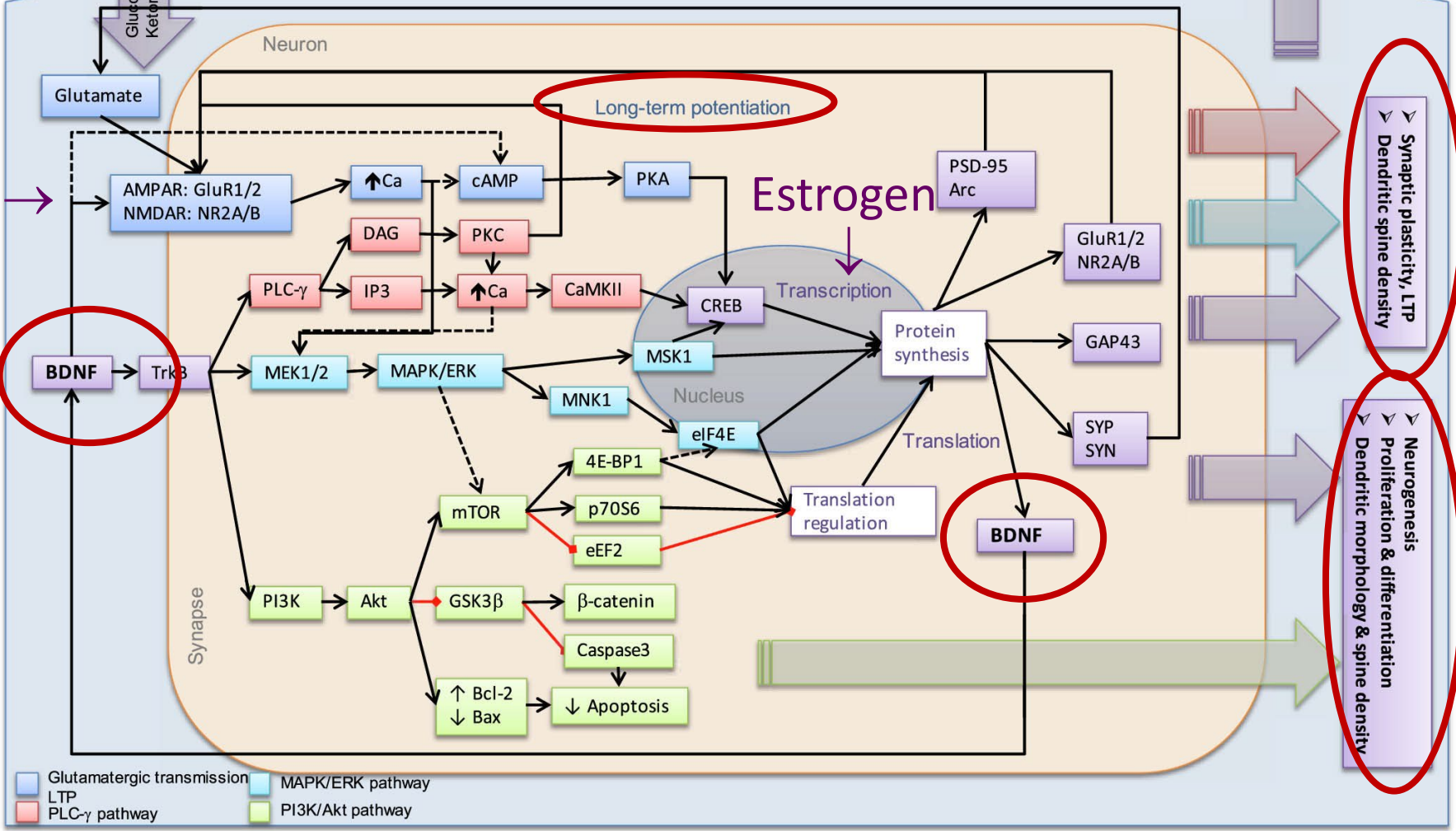


Cognitive Function
Learning & Memory

Exercise →

Estrogen →

Exercise → → →



Synaptic plasticity, LTP
Dendritic spine density

Neurogenesis
Proliferation & differentiation
Dendritic morphology & spine density



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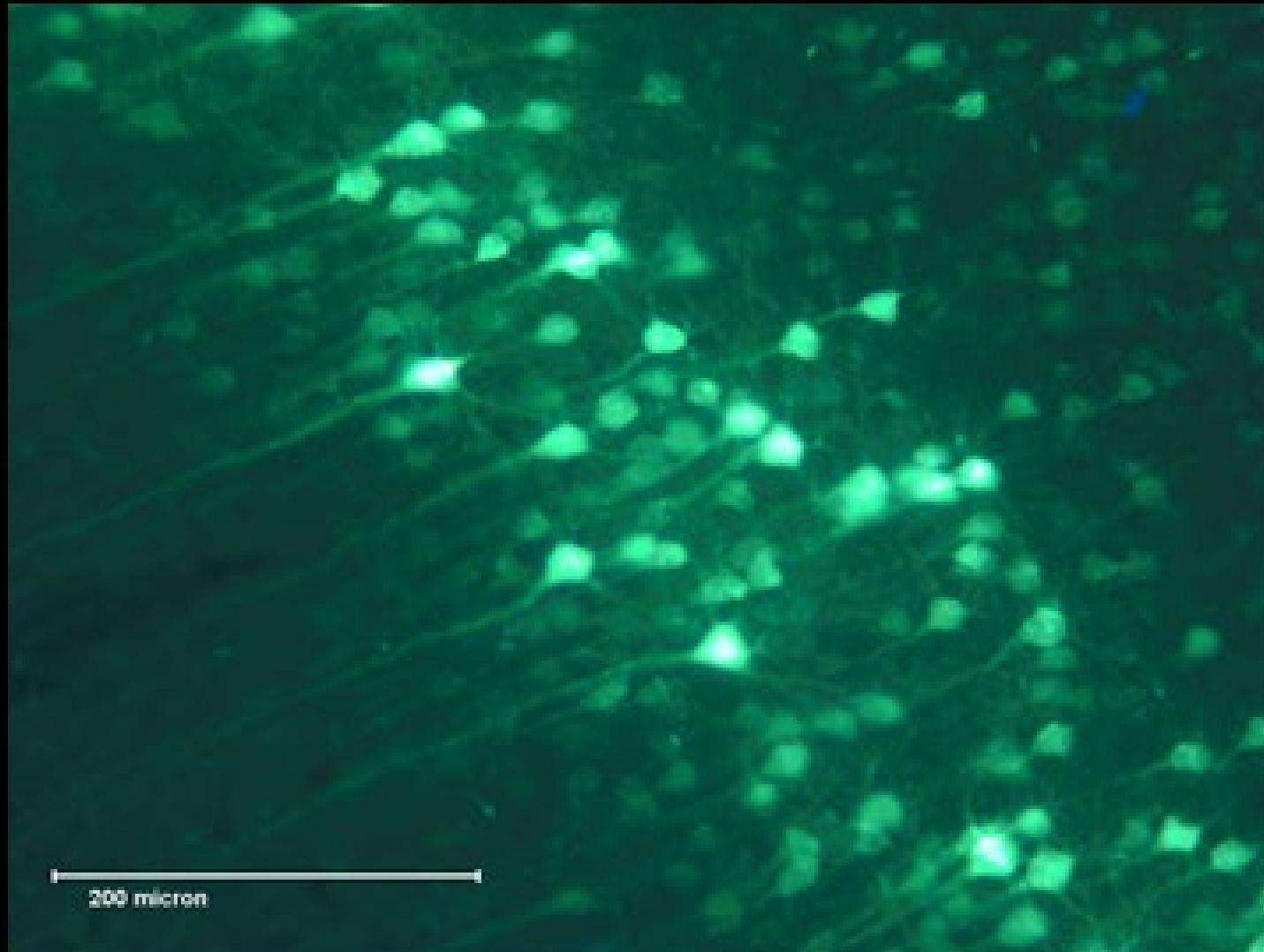


Let's see what you've learned

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-
- Please answer the 3rd Question.

Thank you!





Sleep consolidates learning

in children more than adults.

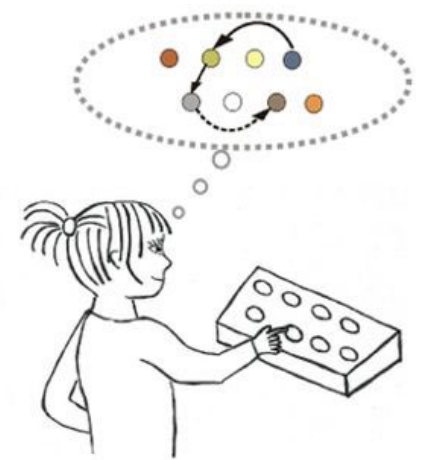
a



Implicit learning

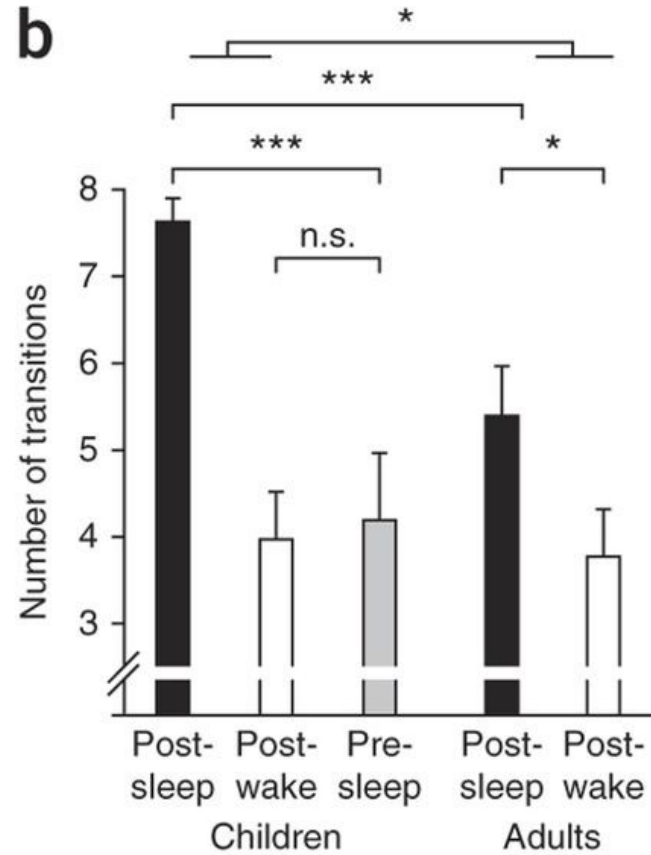


Retention interval



Explicit recall

b



c

