Detox the Brain with Deep Sleep

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SIU MEDICINE
FORWARD. FOR YOU.

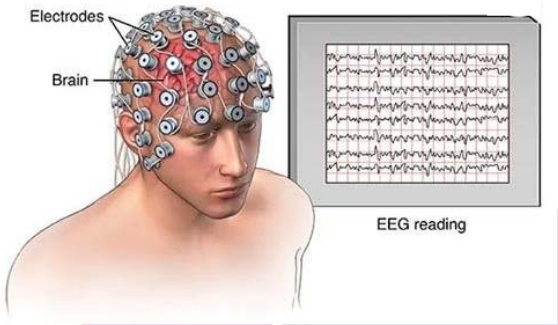
Why Sleep?

- Function unknown
  - Neuronal communication
  - Toxin removal
  - Memory consolidation
  - Immune system
- Sleep Deprivation
  - Death (Animal study)
  - Mood
  - Safety
- Poor Sleep
  - Heart Disease
  - Diabetes
  - Depression
  - Cancer
  - Colds
  - Dementia

Does sleep change with age?

- Total Sleep Time
- Sleep Latency
- Hrs Asleep/ Hrs in Bed
- Wake after Sleep Onset
- Sleep Architechture
- # Naps Duration Daytime sleepiness
- Qualitative Reports

How to measure sleep?



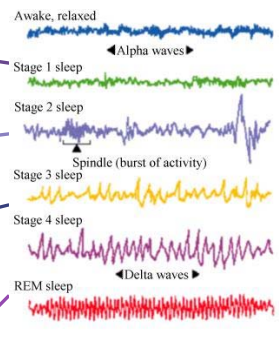
Electroencephalography

NREM
Wake Easily
Feel like no sleep
⇩ HR, RR, BP
Hypnotic Jerks

NREM
Most common 50%
Harder to wake
⇩ HR, RR, BP

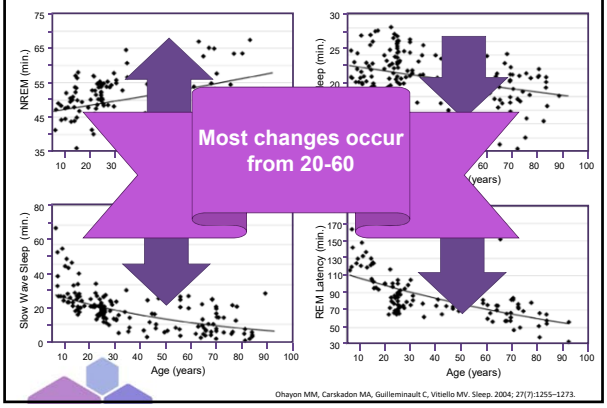
NREM Deep Sleep
35-45 min after onset
Disorient on wake
⇩ HR, RR, BP

Rapid Eye Movement
Dreaming, sleepwalking
Disoriented on wake
⇧ HR, RR, BP
⇩ Regularity
⇧ Throughout night



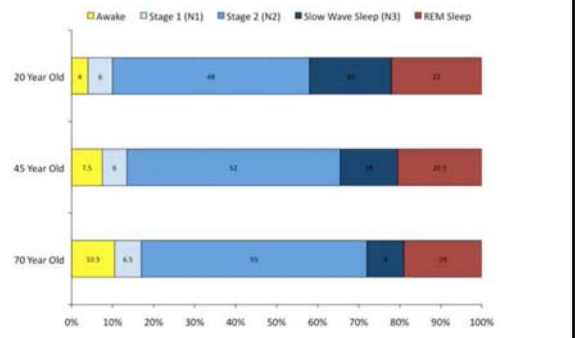
Electroencephalography (EEG)

Sleep Architecture - Aging



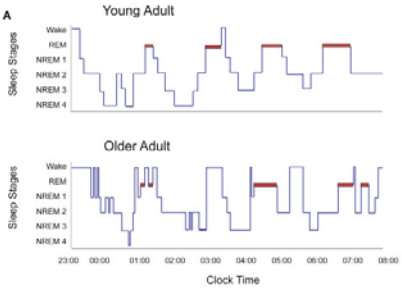
Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Sleep. 2004; 27(7):1255–1273.

Sleep Architecture

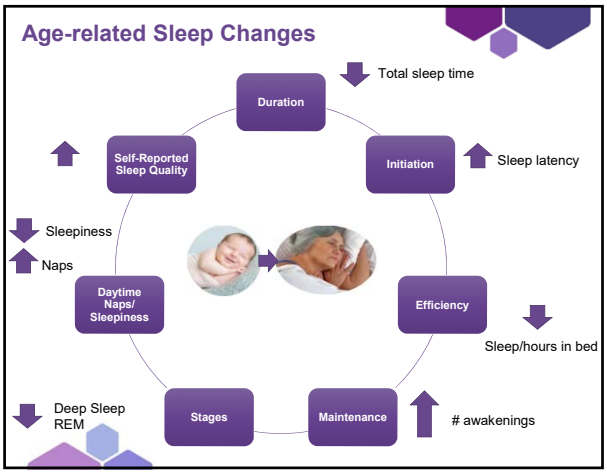


Scullin MK, Bliwise DL. Perspect Psychol Sci. 2015;10(1):97–137.

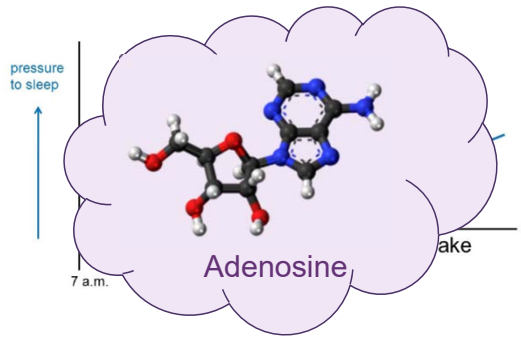
Sleep Architecture



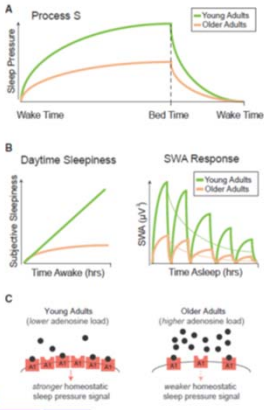
Age-related Sleep Changes



Homeostatic Sleep Drive



Homeostatic Sleep Drive



Sleep Pressure

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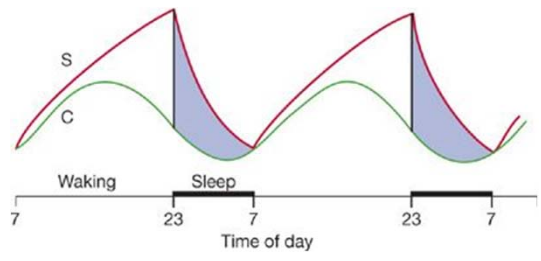
Daytime Sleepiness

&

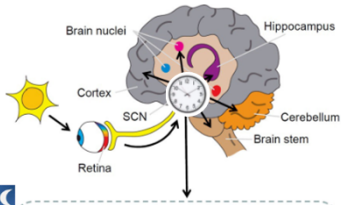
Awakenings

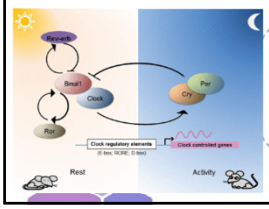
Mander BA, Winer JR, Walker MP. Neuron. 2017 Apr 5;94(1):19-36

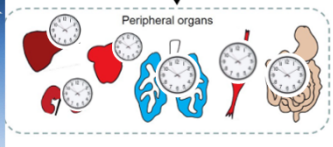
Physiological Control of Sleep/Wake Cycles



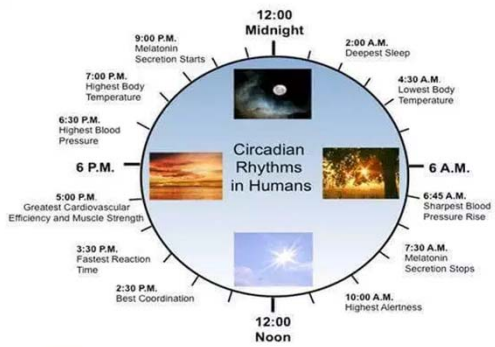
Circadian Rhythms



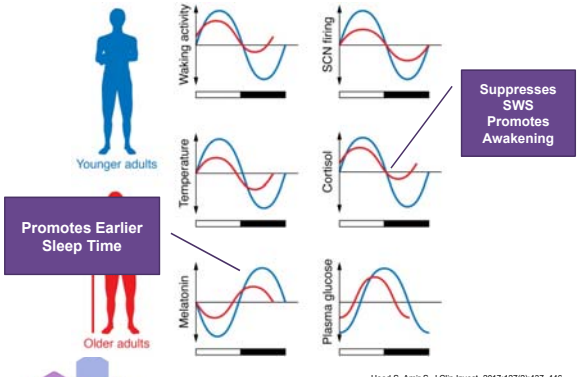




Circadian Rhythms

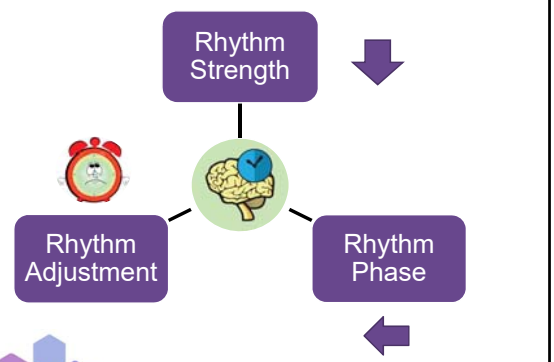


Rhythm Change - Aging

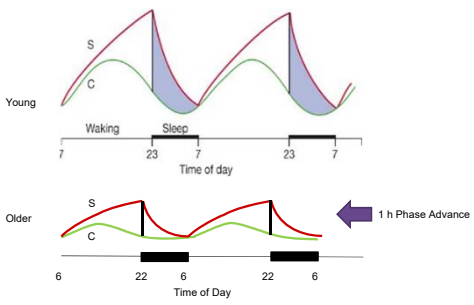


Hood S, Amir S. J Clin Invest. 2017;127(2):437–446.

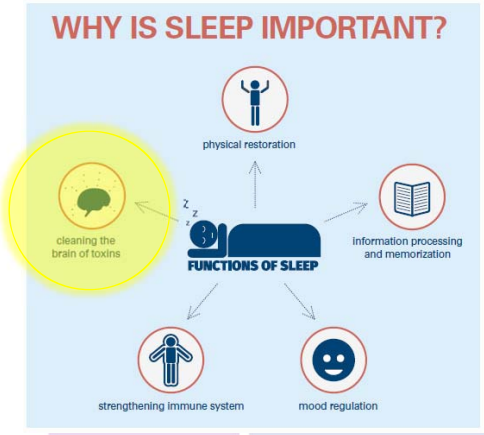
Circadian Rhythms - Aging



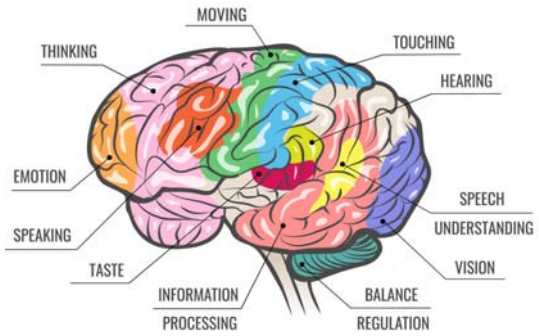
SLEEP/WAKE CYCLES



WHY IS SLEEP IMPORTANT?



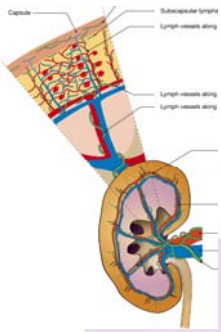
Brain Metabolic Activity



Lymphatics

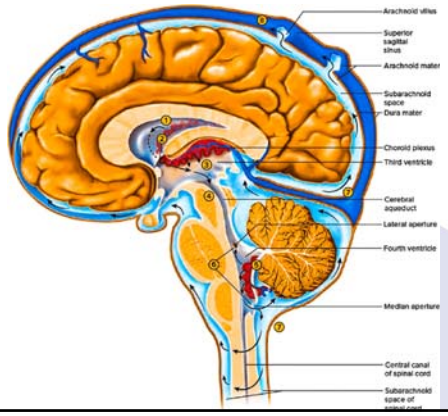
Waste Removal

Lymph System Anatomy

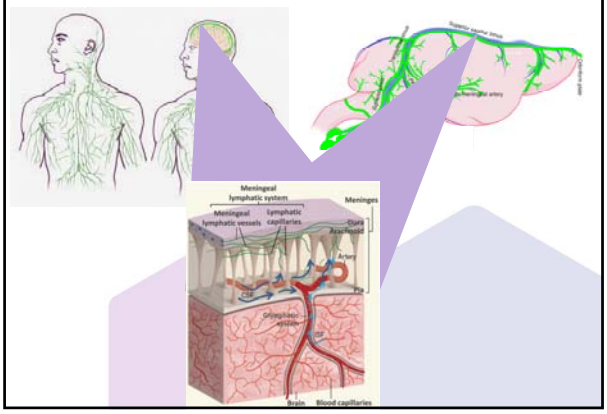


How does the brain handle waste?

CSF – the brain's lymphatic system?



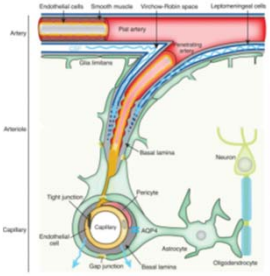
Meningeal Lymphatics

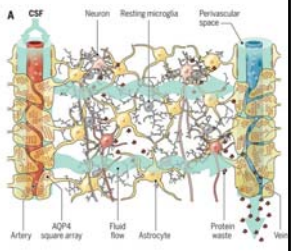


The Glymphatic System

Glial-derived lymphatic-like function

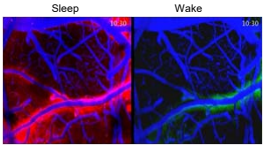
Maiken Nedergaard, MD, DMSc

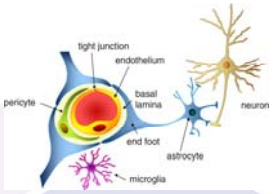


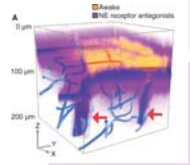


Nedergaard M, Goldman SA. Science. 2020 Oct 2;370(6512):50-56.

Glymphatic Flow during Sleep

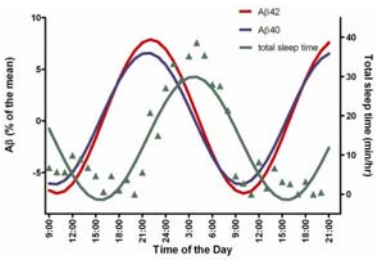






Xie L, Kang H, Xu Q, et al. Science. 2013;342(6156):373-377.

Sleep Removes Aβ from CSF



Aβ production = wakefulness due to increased neuronal activity

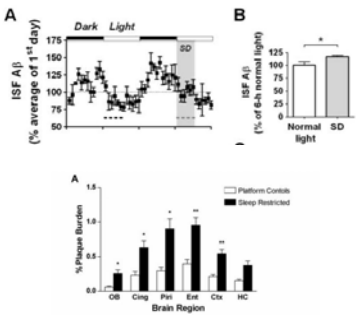
Aβ production reduced during SWS

Aβ cleared by glymphatic flow during sleep

Huang Y, Potter R, Sigurdson W, et al. Arch Neurol. 2011;69(1):51–58.

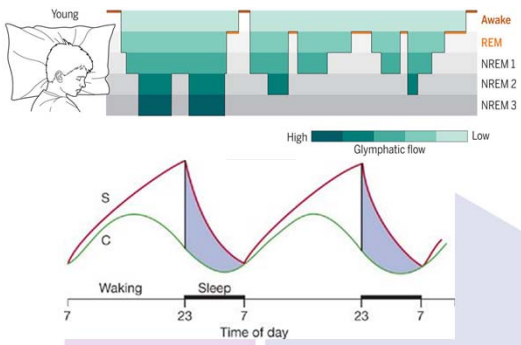
Sleep Deprivation Increases Plaque Burden and CSF Aβ

- Tg2576 Mice
- 5-fold increase in Aβ40 and a 10- to 15-fold increase in Aβ42/43
- 6 h sleep deprivation



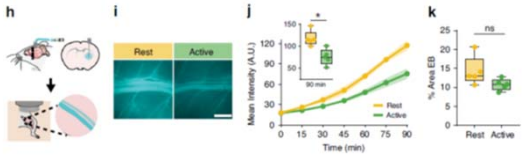
Kang JE, Lim MM, Bateman RJ, et al. Science. 2009;326(5955):1005–1007.

Sleep Promotes Glymphatic Flow



Nedergaard M, Goldman SA. Science. 2020 Oct 2;370(6512):50-56

Circadian Control of Glymphatics



Hablitz LM, Plá V, Giannetto M, Vinitsky HS, Stæger FF, Metcalfe T, Nguyen R, Benrais A, Nedergaard M. Nat Commun. 2020 Sep 2;11(1):4411.

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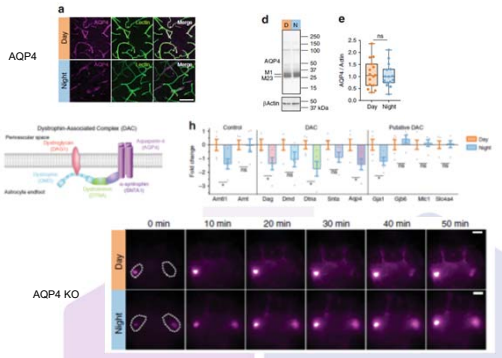

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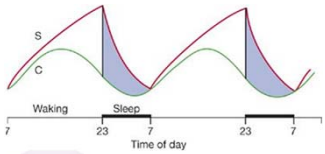
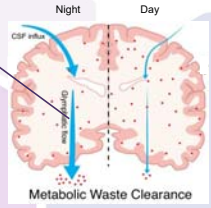
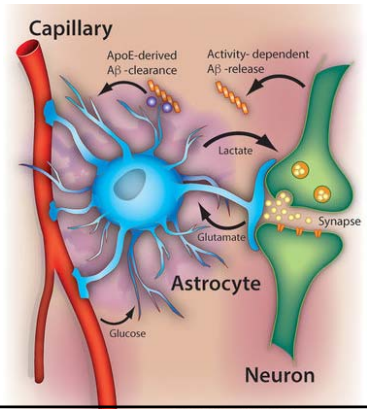


AQP4



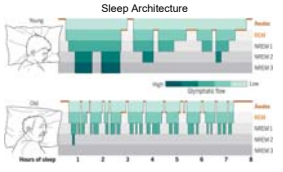
Hauglund, N., Pavan, C. & Nedergaard, M. 2020. Current Opinion in Physiology, 15: 1-6.

Sleep and Circadian Regulation of Astrocytes



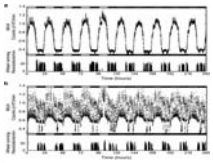
Glymphatics and Aging

Sleep Architecture

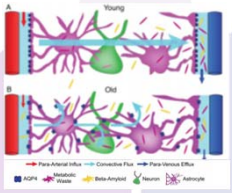


Nedergaard M, Goldman SA. Science. 2020 Oct 2;370(6512):50-56. doi: 10.1126/science.abb8739.

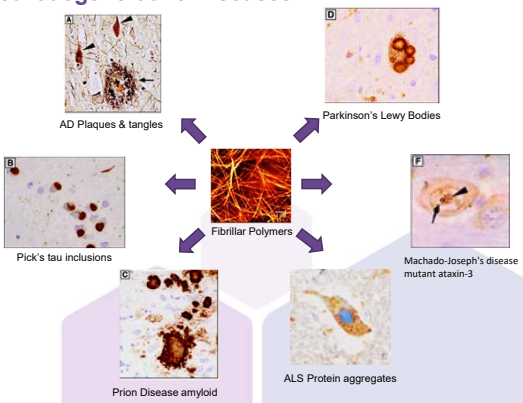
Circadian Clock Function



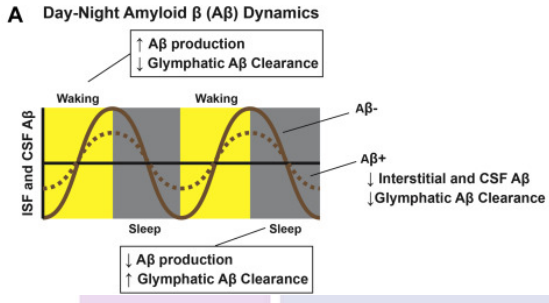
Nakamura, T.J., Takasu, N.N. & Nakamura, W. 2016. J Physiol Sci 66, 367–374



Neurodegenerative Diseases

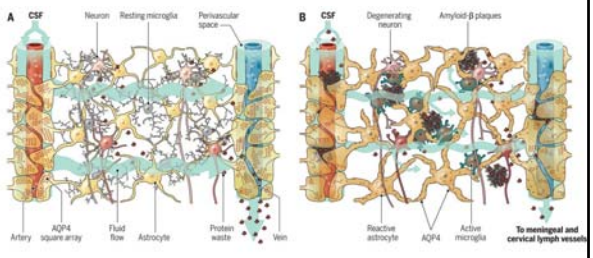


Amyloid Beta Dynamics



Boespflug EL, Iliff JJ. Biol Psychiatry. 2018 Feb 15;83(4):328-336.

Fluid Transport in Alzheimer's Disease



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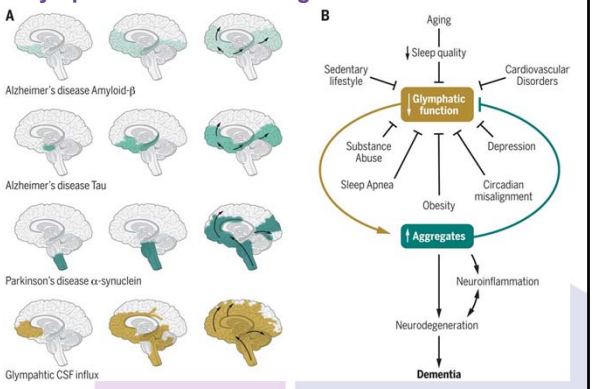
Glymphatics and Neurodegenerative Disease



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- Nedergaard EuroPhysiology conference talk: https://www.youtube.com/watch?v=He6HMnMbxAc