Model systems to study sleep

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Caenorhabditis elegans

Drosophila melanogaster

Danio rerio

Mus musculus

Disclaimer and Disclosure

- **Disclaimer:** Views expressed in this presentation are my own and do not reflect the policy of my institution or my funding agencies.
- **Disclosure:** I have no financial relationship relevant to the subject of this presentation.

Studying sleep in diverse species can inform both the function (WHY?) and mechanism (HOW?) of sleep



Defining sleep

EEG approach



Behavioral approach





Defining sleep



• Behavioral quiescence—no feeding or moving



Weak stimuli—reduced responsiveness

But, also true of





• Strong stimuli—reversibility



• Homeostasis—the longer you don't, the more you need to.



• Episodic—regulated by internal timer



Studying sleep in diverse species can inform the core function(s) of sleep



Anafi, Kayser, and Raizen, Nature Reviews Neuroscience 2017

Comparison between model systems for sleep research

Wu and Raizen, 2017

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	Throughput	Simple nervous system	Temporal niche	Genetic tools	Immediate relevance to humans	Special features
	++++	++++	-	++++	+	connectome, imaging
Caste	+++	++	diurnal	++++	++	circadian mechanisms
	++	+	diurnal	++	+++	imaging, drug screens
	+	-	nocturnal	++	++++	EEG

Immediate Relevance to humans



experimental power

KIN-29/SIK promotes sleep

The EGL-4 PKG Acts With KIN-29 Salt-Inducible Kinase and Protein Kinase A to Regulate Chemoreceptor Gene Expression and Sensory Behaviors in *Caenorhabditis elegans* Genetics 2008

Alexander M. van der Linden,* Scott Wiener,* Young-jai You,[†] Kyuhyung Kim,* Leon Avery[†] and Piali Sengupta^{*,1}





Forward-genetics analysis of sleep in randomly mutagenized mice Nature 2016

Hiromasa Funato^{1,2}, Chika Miyoshi^{1*}, Tomoyuki Fujiyama^{1*}, Takeshi Kanda^{1*}, Makito Sato^{1,3*}, Zhiqiang Wang¹, Jing Ma¹, Shin Nakane⁴, Jun Tomita⁴, Aya Ikkyu¹, Miyo Kakizaki¹, Noriko Hotta-Hirashima¹, Satomi Kanno¹, Haruna Komiya¹, Fuyuki Asano¹, Takato Honda¹, Staci J. Kim¹, Kanako Harano¹, Hiroki Muramoto¹, Toshiya Yonezawa¹, Seiya Mizuno⁵, Shinichi Miyazaki¹, Linzi Connor¹, Vivek Kumar^{6,7}, Ikuo Miura⁸, Tomohiro Suzuki⁸, Atsushi Watanabe⁹, Manabu Abe¹⁰, Fumihiro Sugiyama⁵, Satoru Takahashi⁵, Kenji Sakimura¹⁰, Yu Hayashi^{1,11}, Qinghua Liu^{1,12}, Kazuhiko Kume⁴, Shigeharu Wakana⁸, Joseph S. Takahashi^{1,6,13} & Masashi Yanagisawa^{1,3,13,14}



A salt-induced kinase is required for the metabolic regulation of sleep PLOS BIOLOGY 2020

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Two types of sleep

- Healthy (two-process) sleep
 - Regulated by clock and homeostatic processes
 - S C WAKING SLEEP 7 23 7 TIME OF DAY

- Sickness sleep/lethargy
 - During illness (cellular stress)
 - Infection
 - Inflammatory disease
 - Cancer or cancer treatment
 - Traumatic brain injury
 - May not obey 2-process "rules"



worms for high throughput gene discovery





Kerry Lecure (one yr of data)

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Postdoctoral positions available