Comparative Physiology and Pharmacology of Sleep

Sleep stages (animals)

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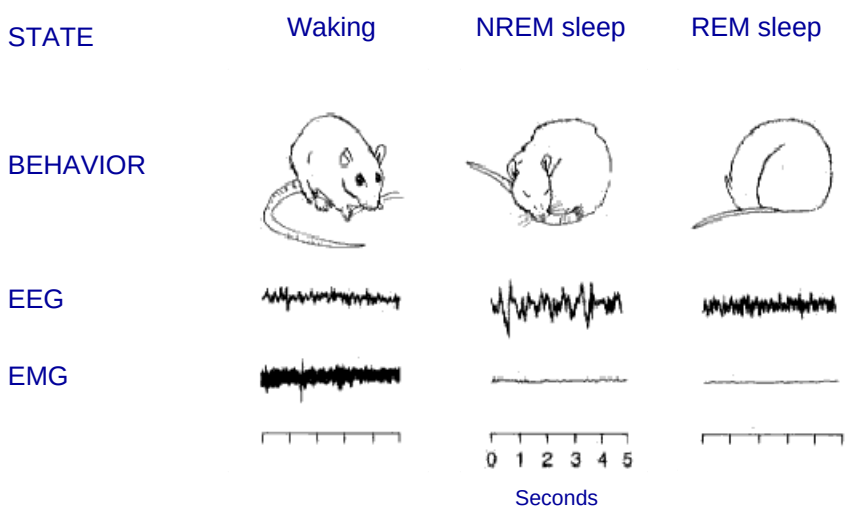
Educational objectives

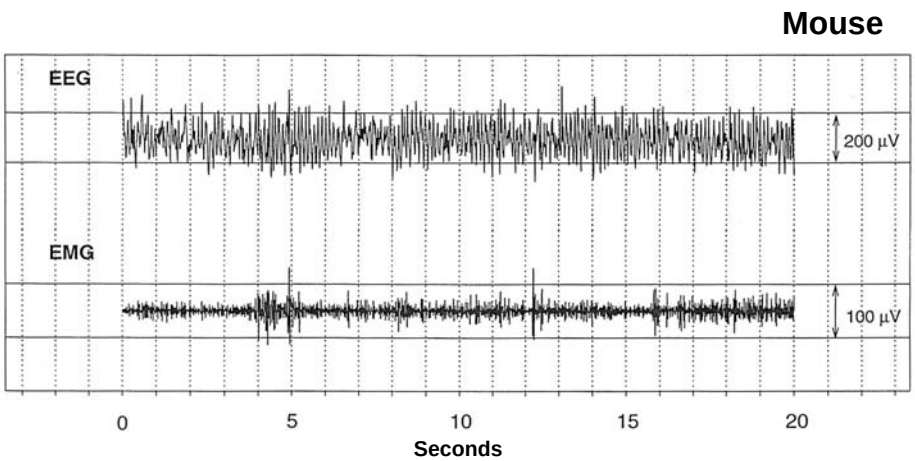
At the end of the lecture you should be able to:

- **Describe the sleep stages and the sleep architecture of mammals**
- **Apply criteria for sleep in different species**

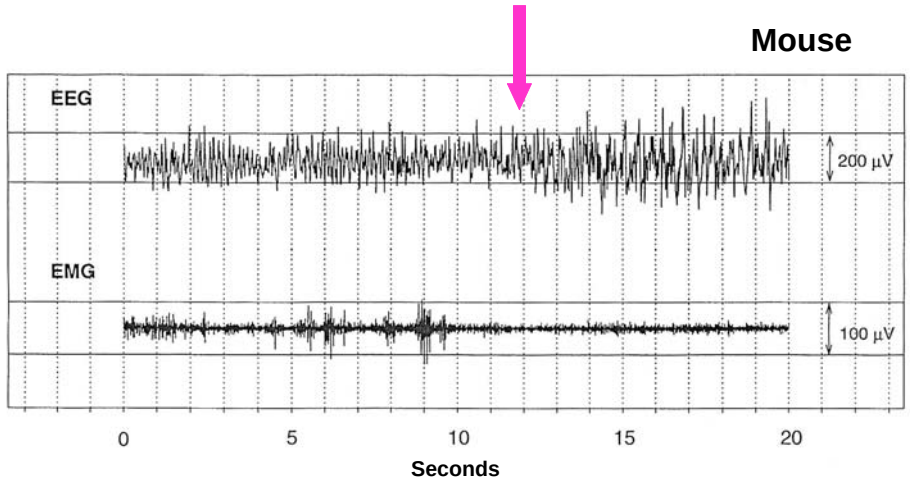
Vigilance states in rodents



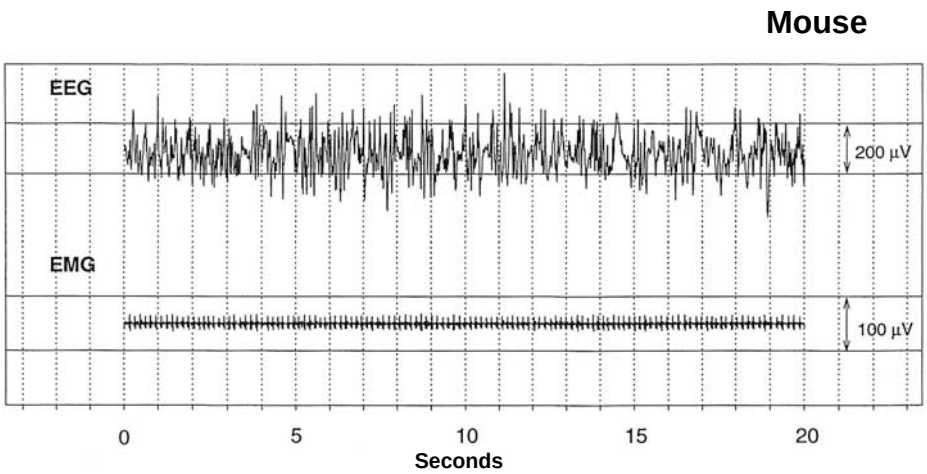
Waking



Waking-NREM sleep transition

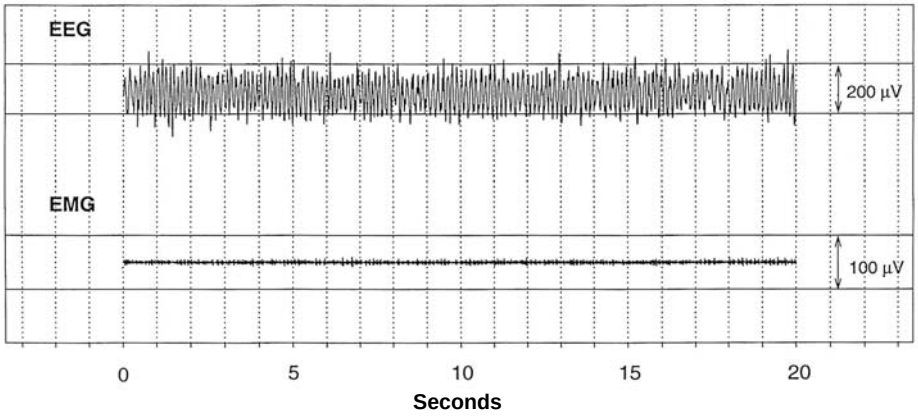


NREM Sleep

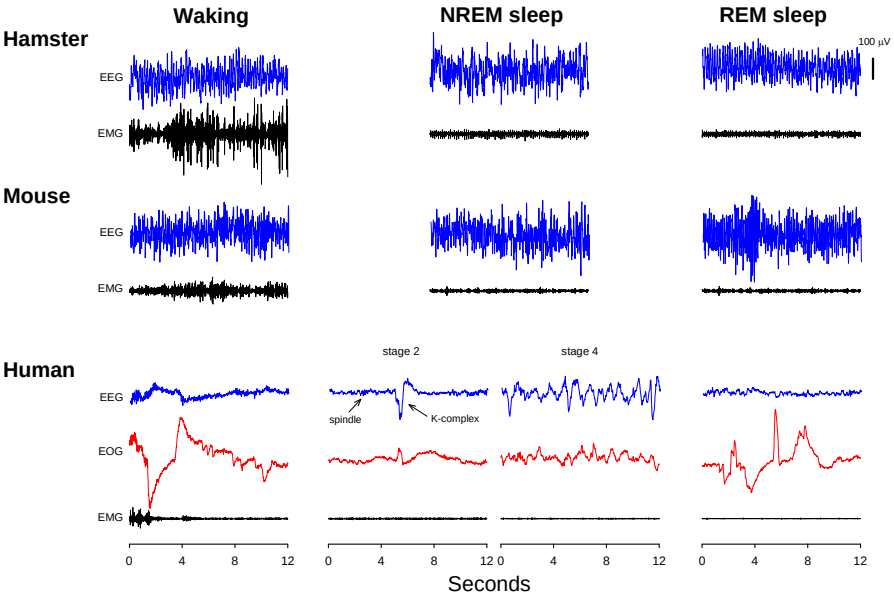


REM sleep

Mouse



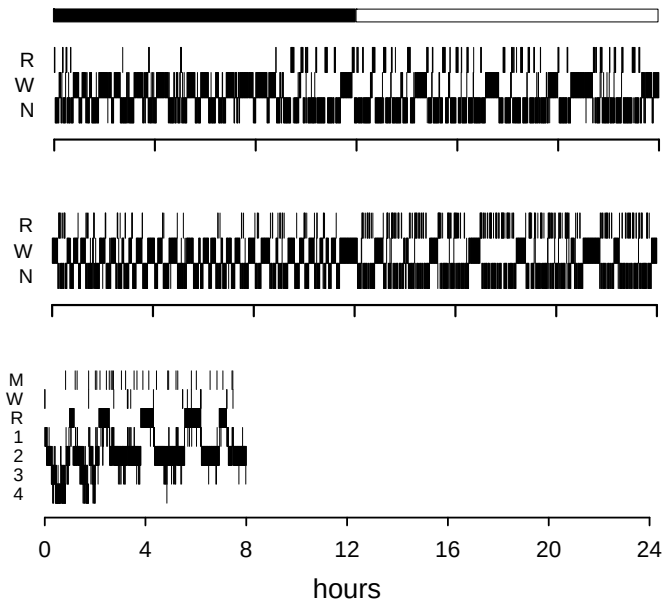
Comparable sleep stages



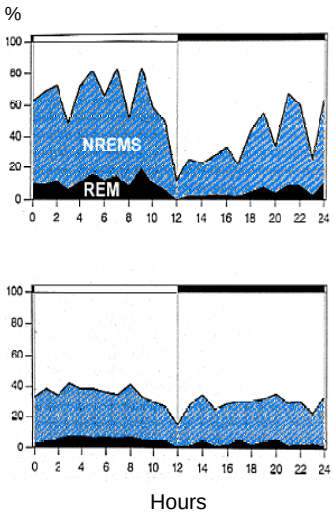
Sleep is neither continuous nor uniform.

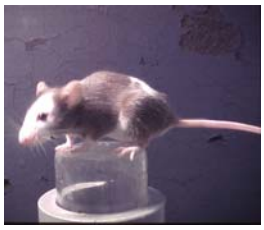
Sleep is a cyclic process (with a seemingly programmed time course).

Distribution of sleep and waking



Day-night distribution of sleep



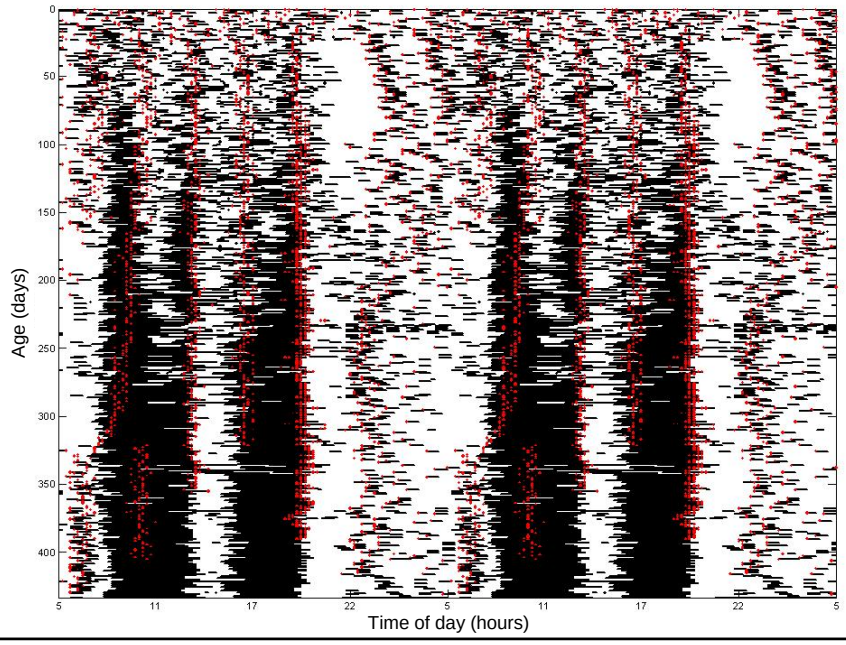


Tobler & Franken, Neurosci Lett, 1993

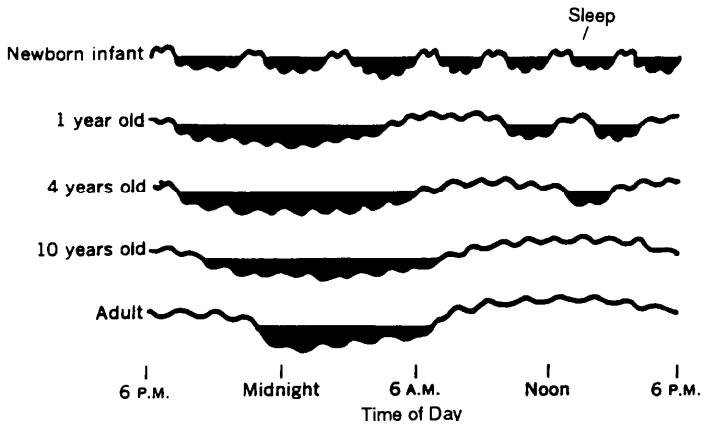
Animals are polyphasic.

Humans are monophasic, with exceptions:
- **Development**
- **Naps/Siesta**

Rest-activity during the first year

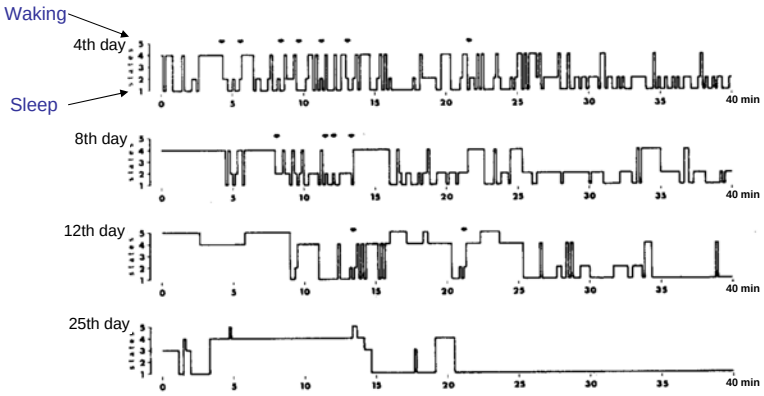


From poly- to monophasic sleep



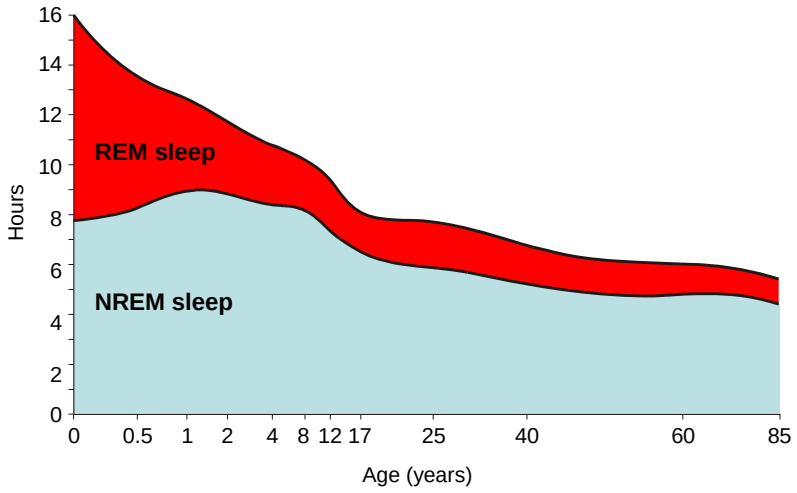
Kleitman, 1954

Development of vigilance states in rats



Gramsbergen, 1970

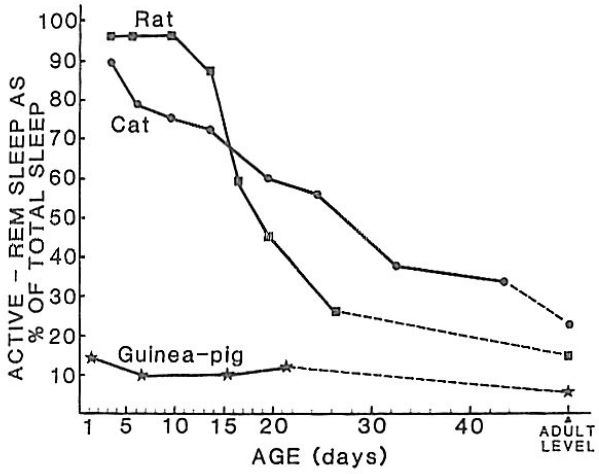
Sleep stages during development



Roffwarg et al. 1956

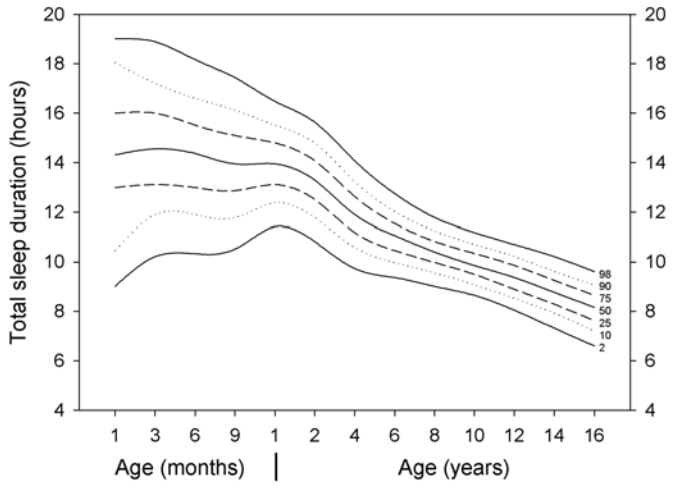
Decrease of the amount of REM sleep

Dependent on the developmental status at birth



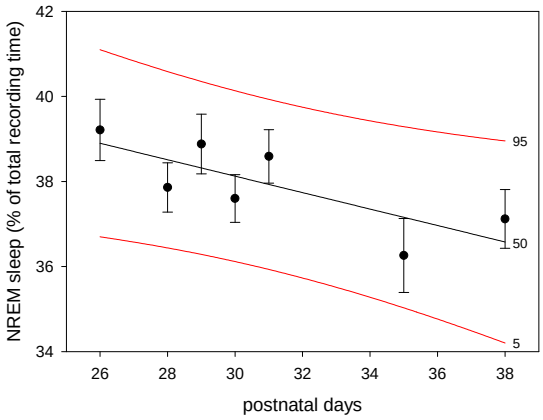
Zepelin, Principles and Practice of Sleep Medicine, 2000

Variability of the sleep duration

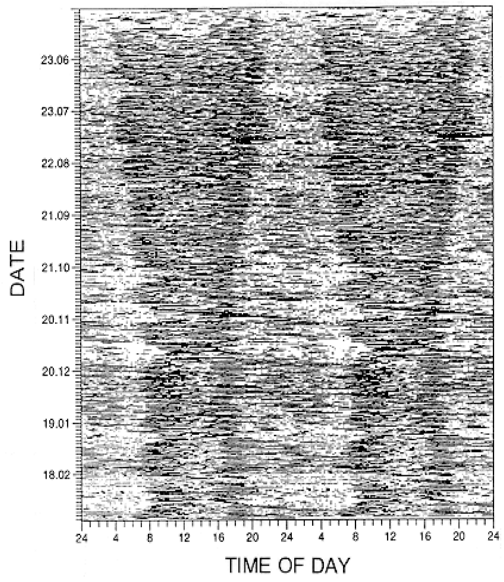


Iglowstein et al., 2003

Sleep duration during development in rats



Rest activity rhythm of the Capricorn

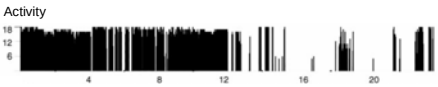


Tobler et al., 1994

The duration, organization, and composition of sleep changes during development.

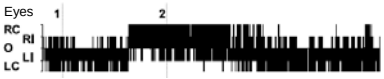
Sleep in different species

Drosophila



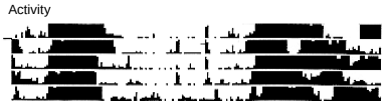
Shaw et al., 2000

Belugawale



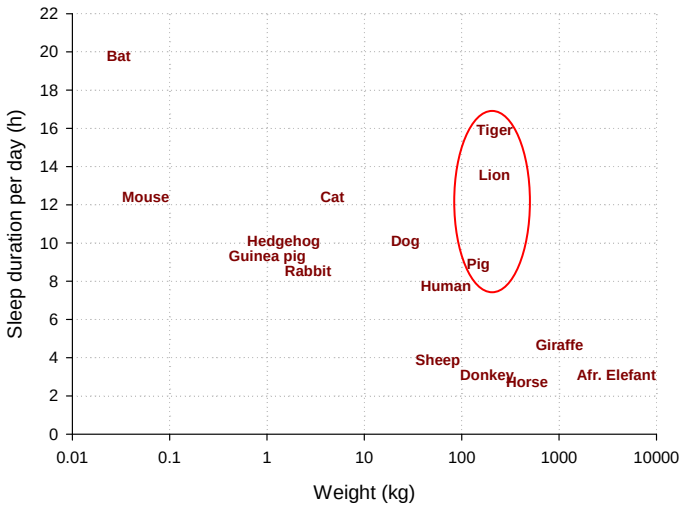
Lyamin et al., 2002

Cow



Tobler et al., Bits of sleep

How much do animals sleep



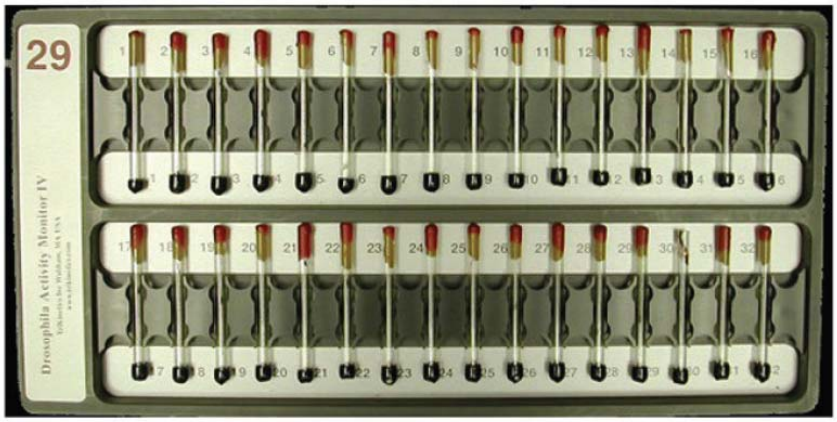
Siegel et al., 2005

Sleep criteria

- **Specific place for sleep**
- **Species specific body position**
- **Immobility**
- **Increased arousal threshold**
- **Fast reversibility**
- **Homeostatic regulation**

Piéron 1913; Flanigan, 1974; Tobler, 1982

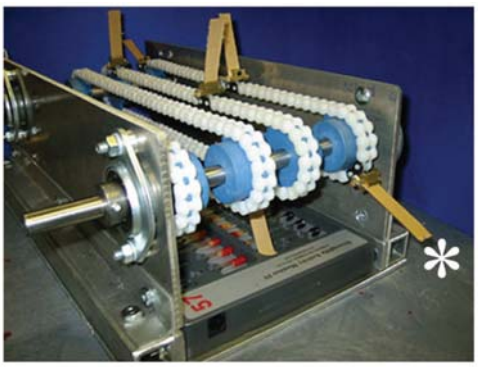
Does a fruit fly sleep?

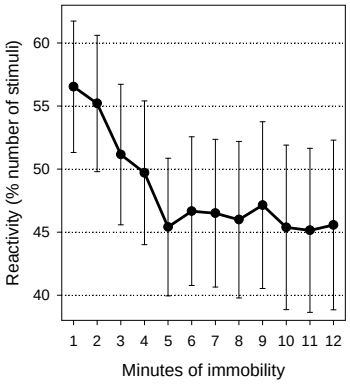


Shaw et al., 2000

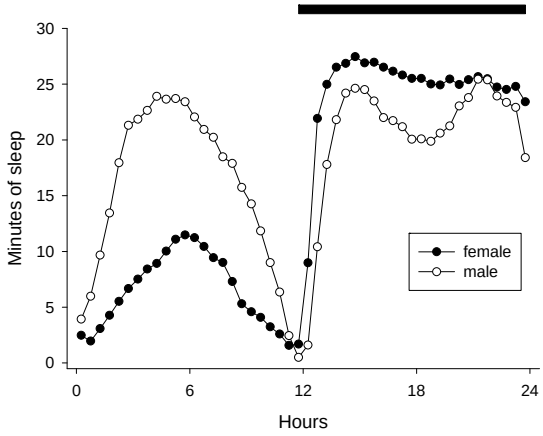
Huber et al., 2004

Definition of sleep in Drosophila

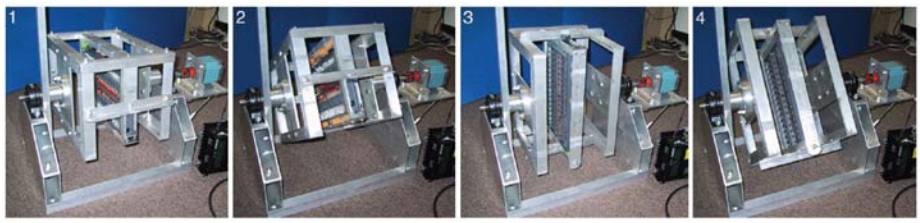


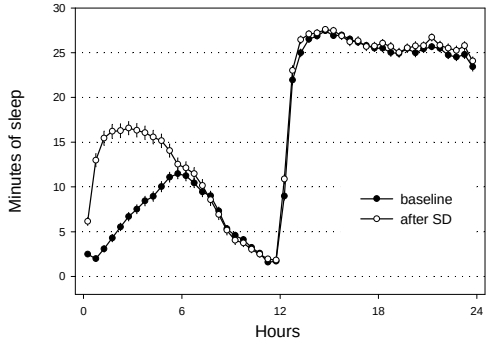


Sleep during 24 hours



Sleep deprivation



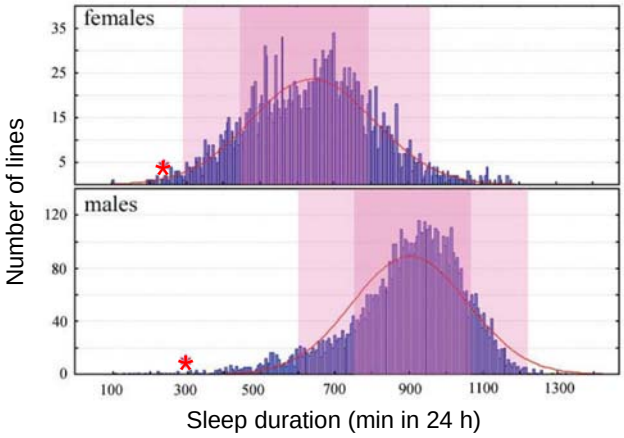


Criteria for sleep in Drosophila

- **Increased arousal threshold**
- **Homeostatic regulation**

- **Young flies sleep a lot, adults less**
- **Stimulants and sleeping aids influence sleep**

Sleep duration in *Drosophila melanogaster*

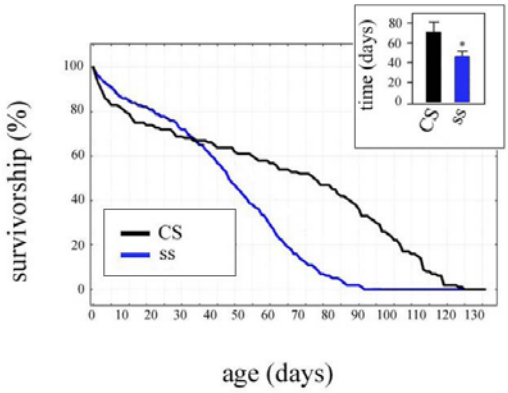


* Potassium channel Knock-out (Shaker)

Cirelli et al., 2005

The Drosophila Shaker mutant

- Sleeps for one-third of the wild-type amount
- Copes well with sleep deprivation
- Shows no signs of performance decrements
- However…



Cirelli et al., 2005