



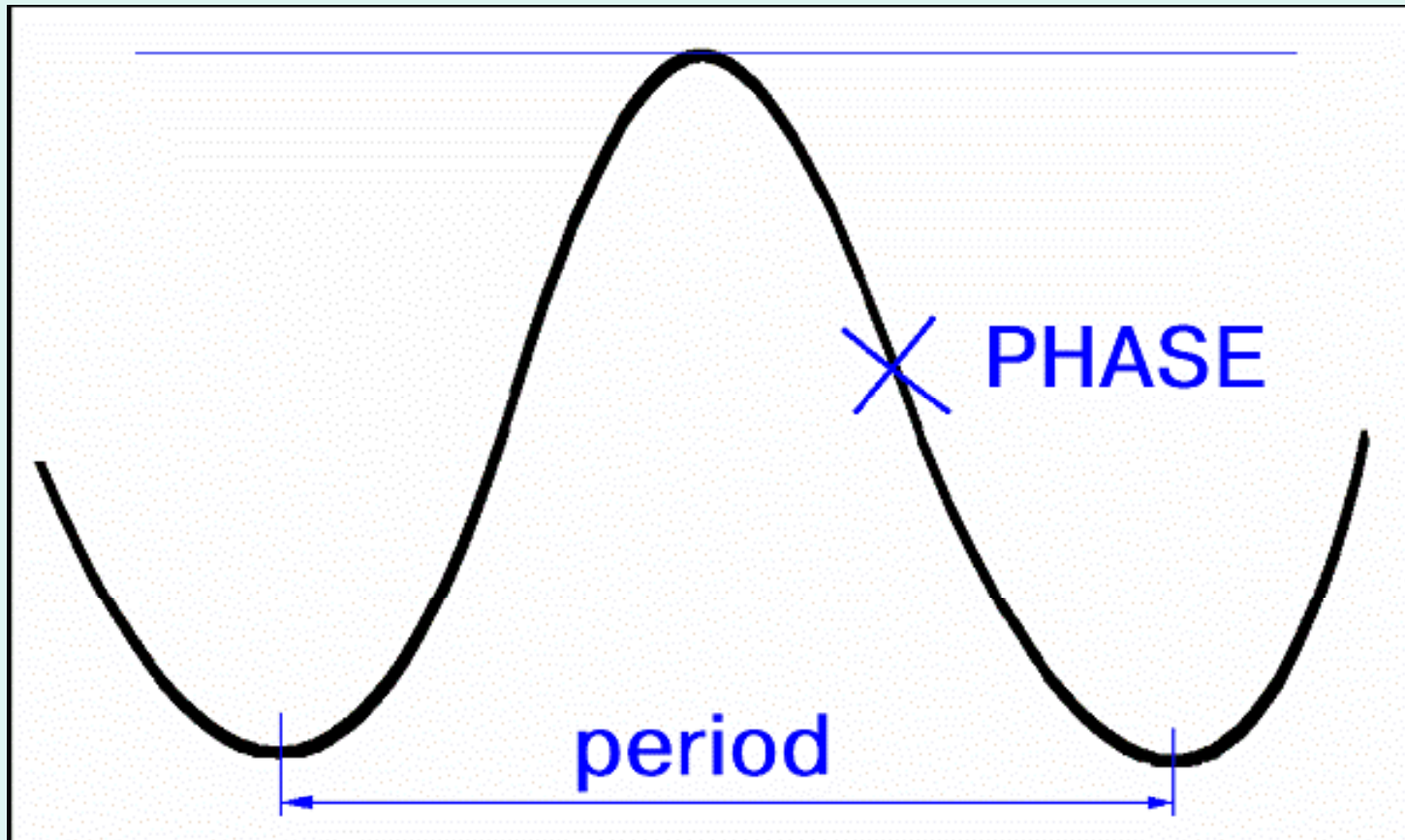
Jennifer Swann PhD
Lehigh university
Bios 90/95

Circadian rhythms

The following have a common link in circadian rhythms.

- Three mile island, Exxon Valdez, Chernobyl
- Jet lag
- Anesthetics

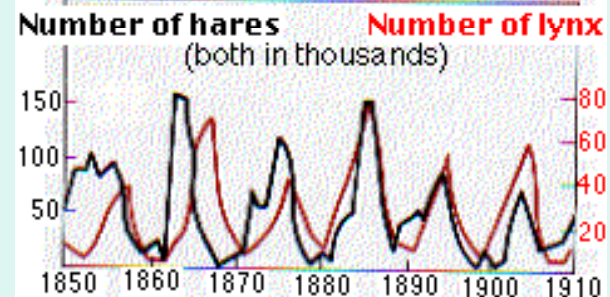
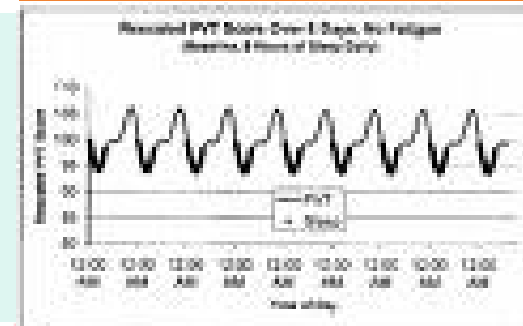
What is rhythm?



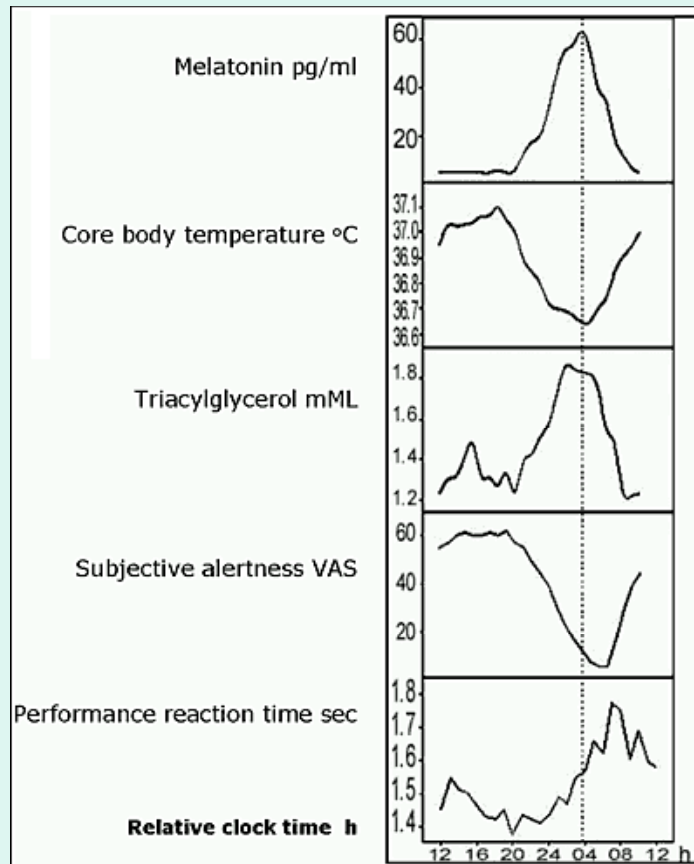
Circadian rhythms are a subset of biological rhythms

- Any measurable parameter in a living organism with a regular interval.
- Biological rhythms have periods that range from 8 seconds to several years.

Cardiac rhythm $\tau = 8$ seconds



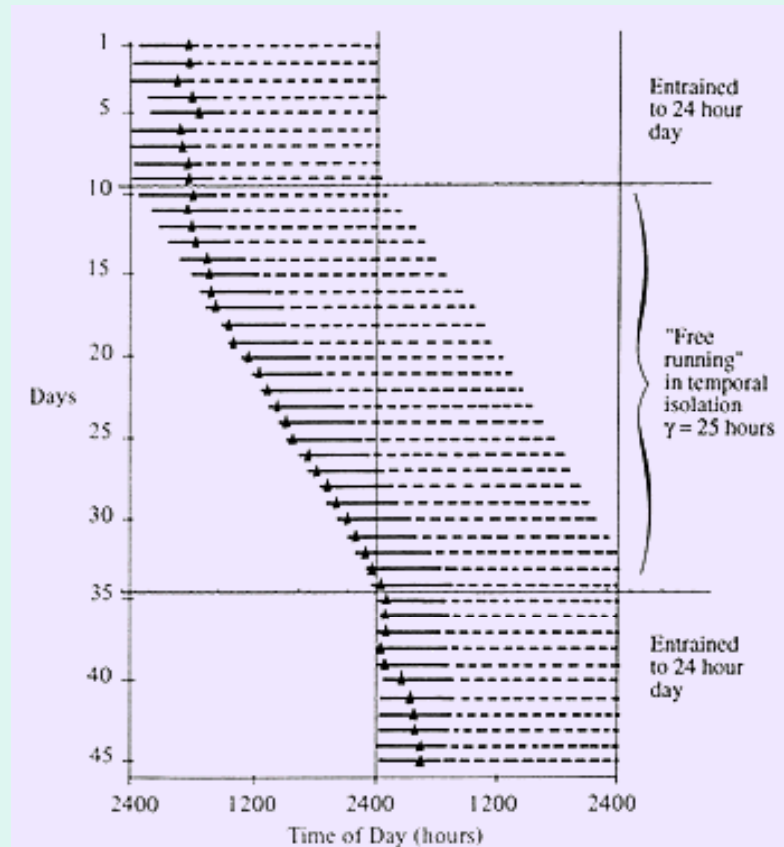
What is a circadian rhythm?



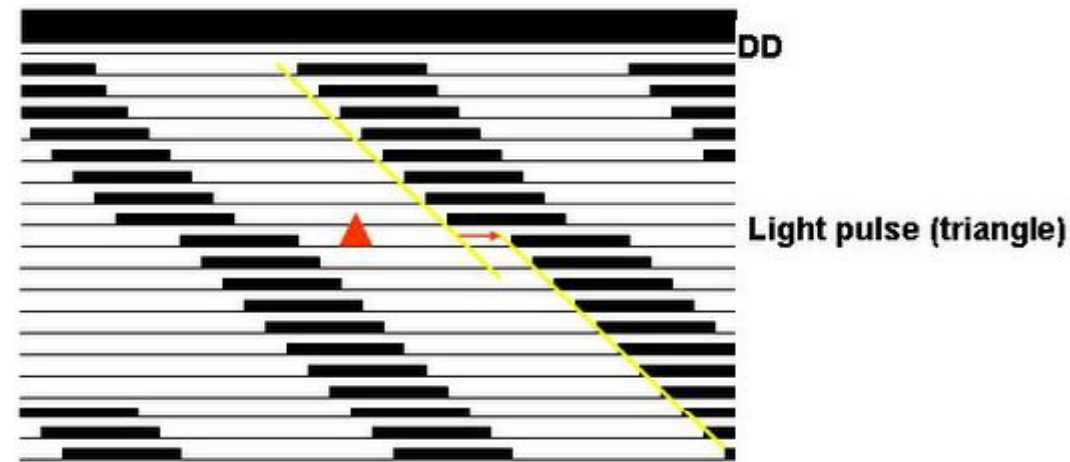
1. Period of about 24 hours
2. Endogenously generated
3. Entrained by external signals

Free running rhythms

- This figure shows the rhythms of a human male during exposure to external cues (first and last 10 days) and in the absence of cues.
- Note that the rhythms “entrain” to the external cues and persist in the absence of cues with a period slightly greater than 24 hours.

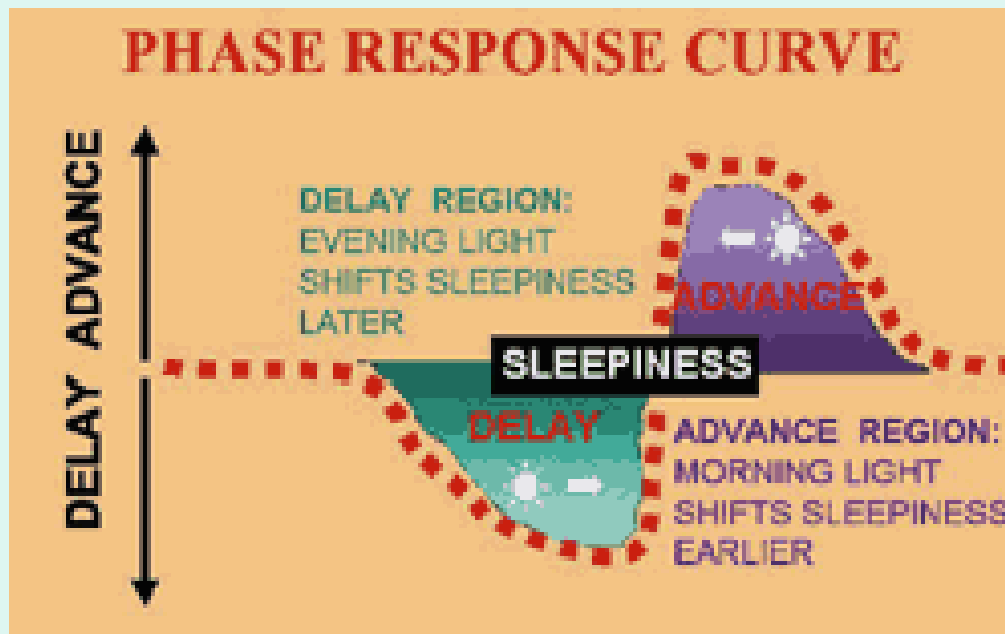


Entrainment



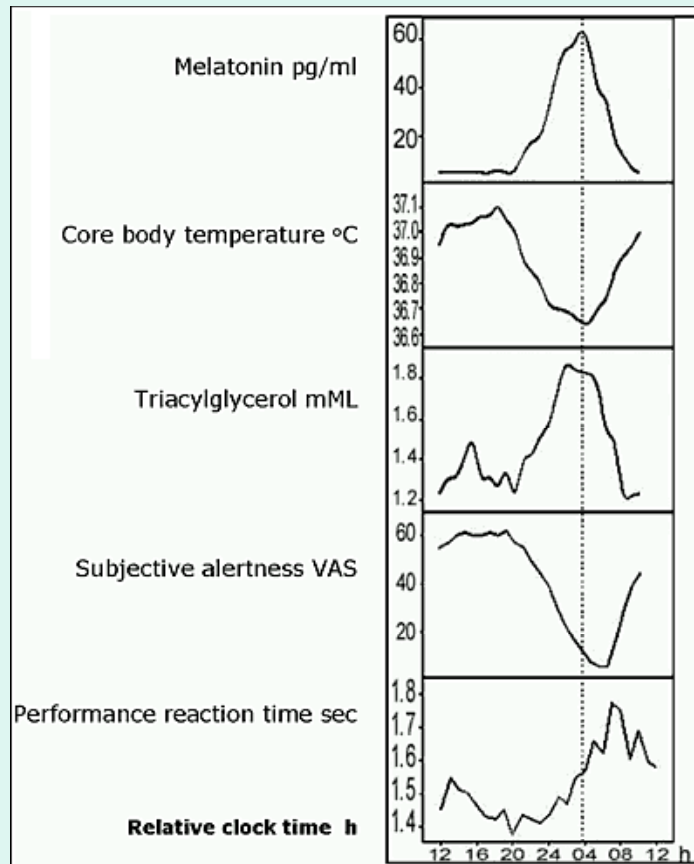
- Circadian rhythms synchronize with their environment by responding to light cues.
- scienceblogs.com

Phase Response Curve



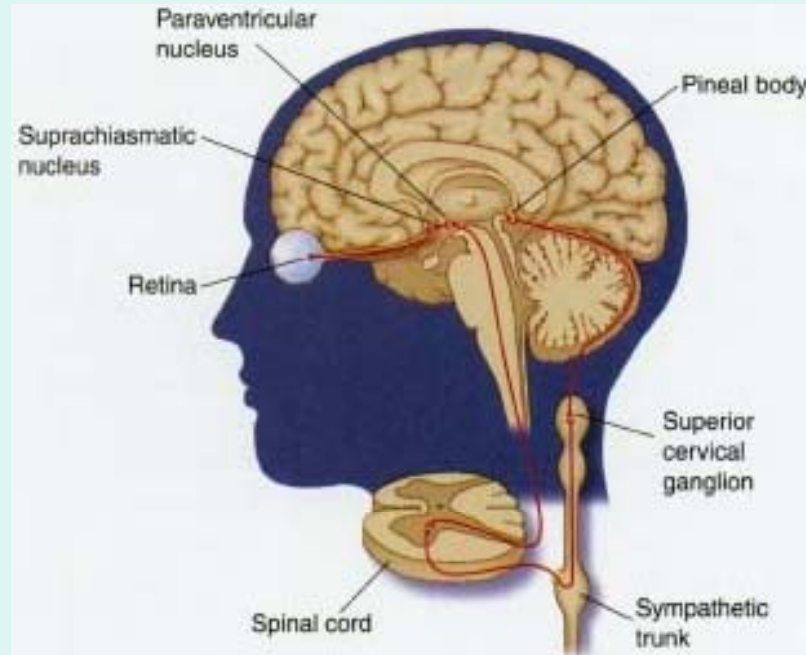
- The phase response curve dictates how a rhythm entrains to external cues.

Every aspect of physiology has a circadian rhythm



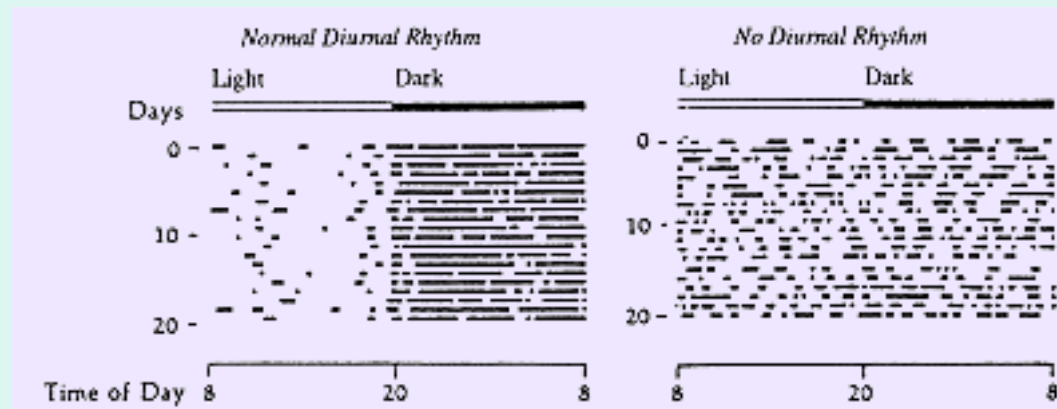
- Period close to 24 hours
- Not all are in the same phase with each other

The SCN controls circadian rhythms



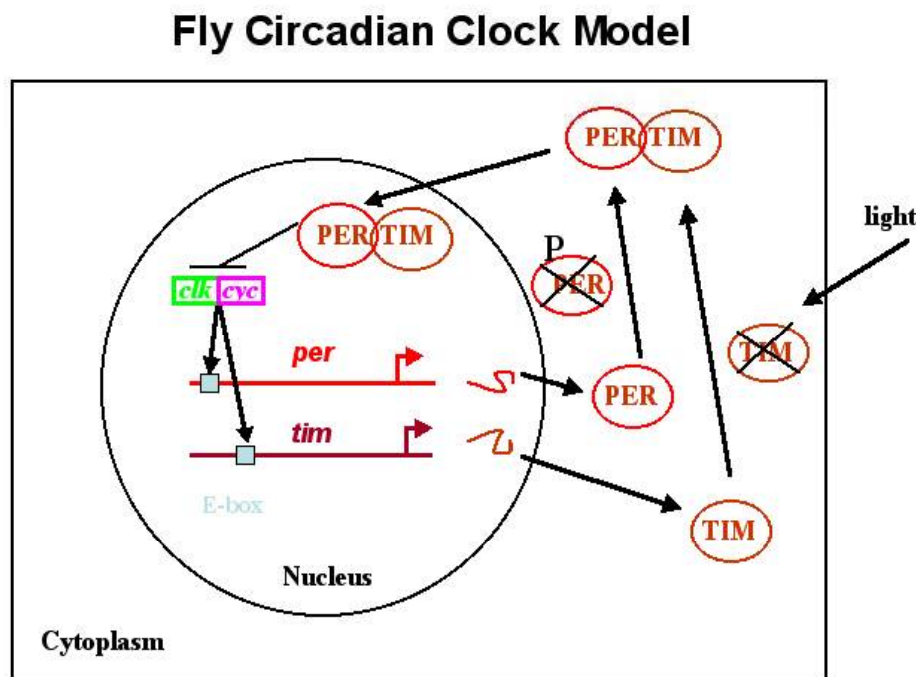
- The suprachiasmatic nucleus is the “Master oscillator”.
- Sits above the optic chiasm and receives light from special receptors in the retina

Lesions of the SCN eliminate circadian rhythms.



- Left-hand diagram: normal 24 hour rhythm of a rat. The animal is active mainly at night (in darkness). Right-hand diagram: after elimination of the suprachiasmatic nucleus, the rhythm disappears completely. The thick horizontal lines indicate times when the rodent (a rat in this case) is running on a running wheel. Successive days are plotted one below the other. Thus, the points which are adjacent on any vertical line are exactly 24 hours apart. Rest and activity are randomly distributed throughout the day.

The molecular basis for circadian rhythms



- The proteins PER and TIM form heterodimers which block the clock gene form transcribing more of these proteins

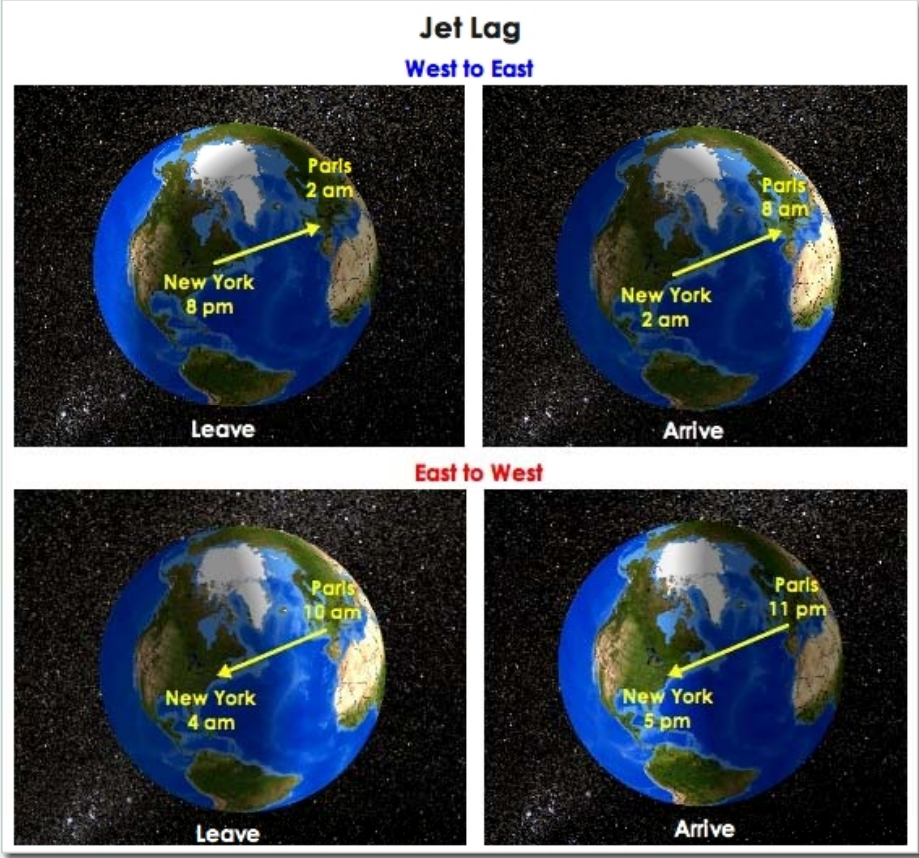
Shift work

Table 1. COMPARISON OF TYPICAL JET-LAG AND SHIFT LAG SYMPTOMS

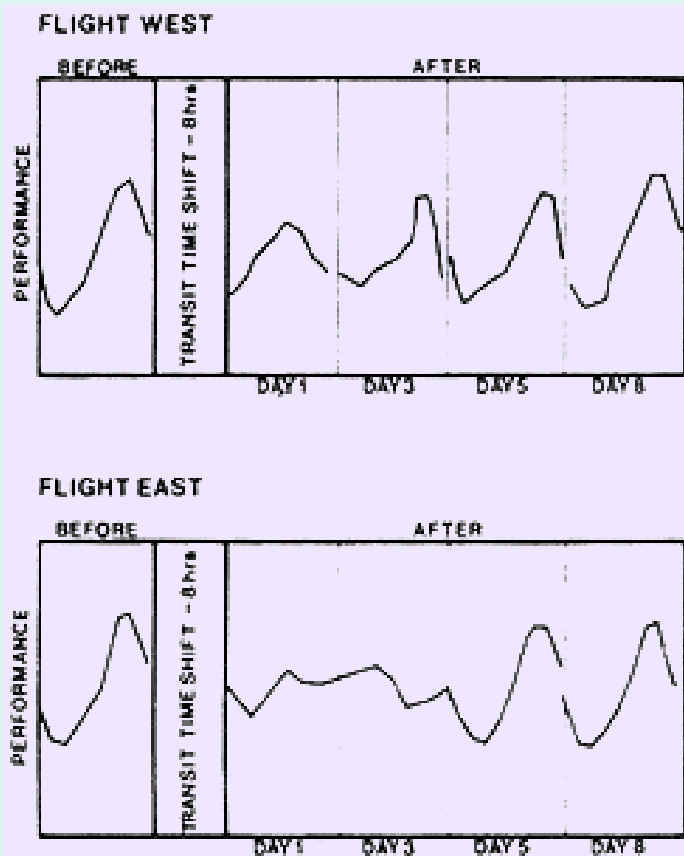
JET-LAG	SHIFT-LAG
Daytime sleepiness	Sleepiness,/sleeping at work
Insomnia at night	Sleep disruption during day time sleep
Impaired concentration	Decreased vigilance/attention
Slow physical responses	Impaired performance
Irritability	Irritability
Digestive system disturbance	Gastrointestinal dysfunction
Depressive symptoms	Depression and apathy

- Shift workers experience the same symptoms as jet lag.

Jet lag

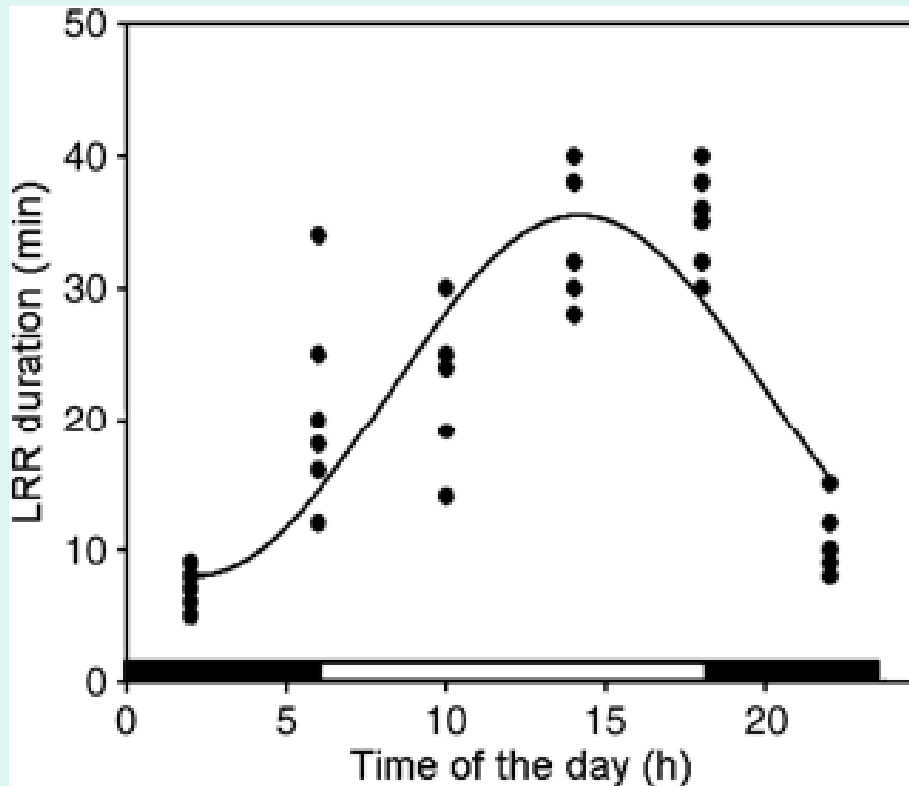


Jet lag



- “Jet lag” refers to the delay in the shift of circadian rhythms after a long flight to the east or west.
- Flights west are easier to adjust to than flights east.

Anesthetics have a circadian rhythm



- Susceptibility to drugs depends on when they are given!

Duration of the loss of righting reflex (LRR) following propofol injection (100 mg/kg) in rats at different times of the day.