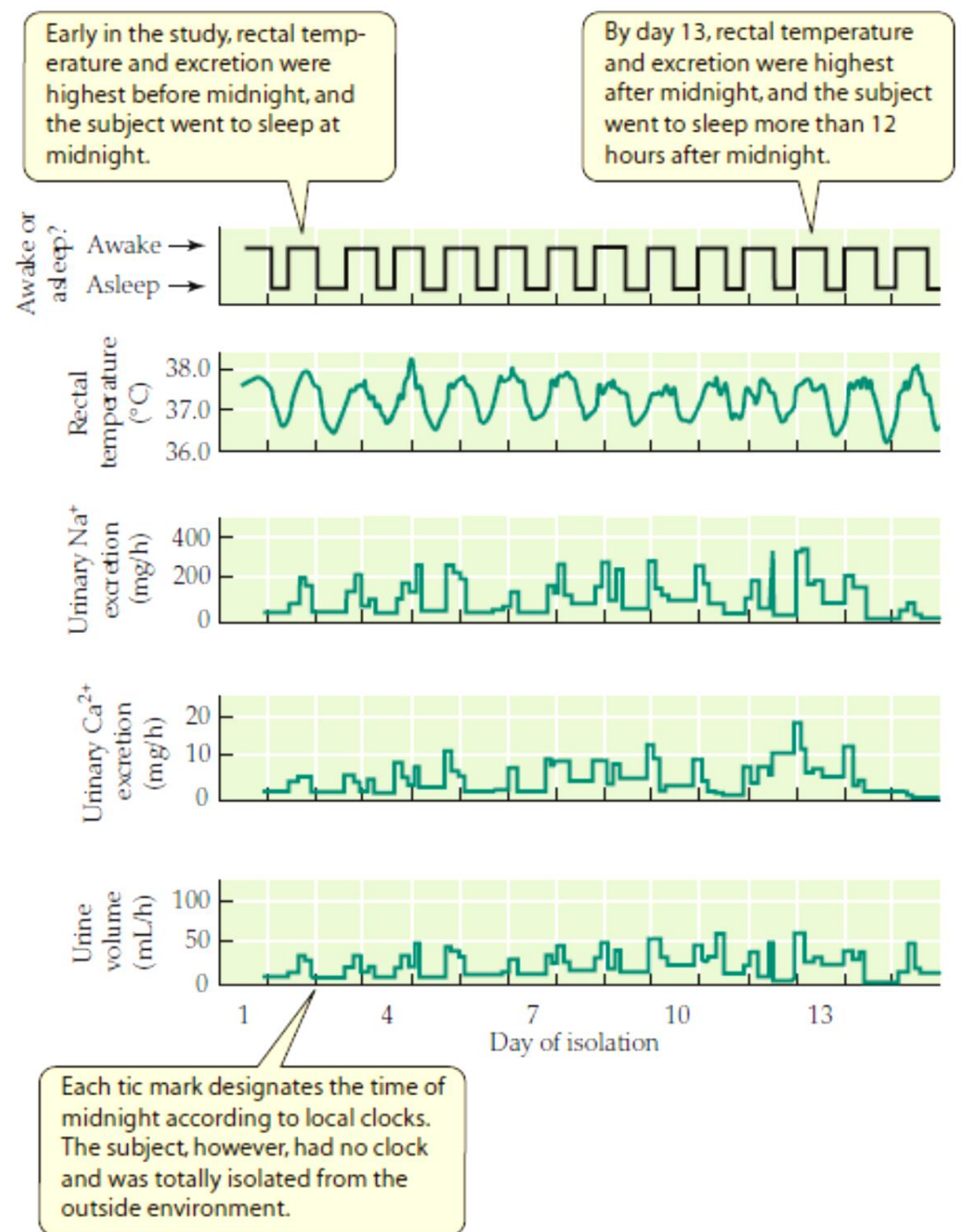


Biological Clock

UG 1, CBCS

Daily rhythm

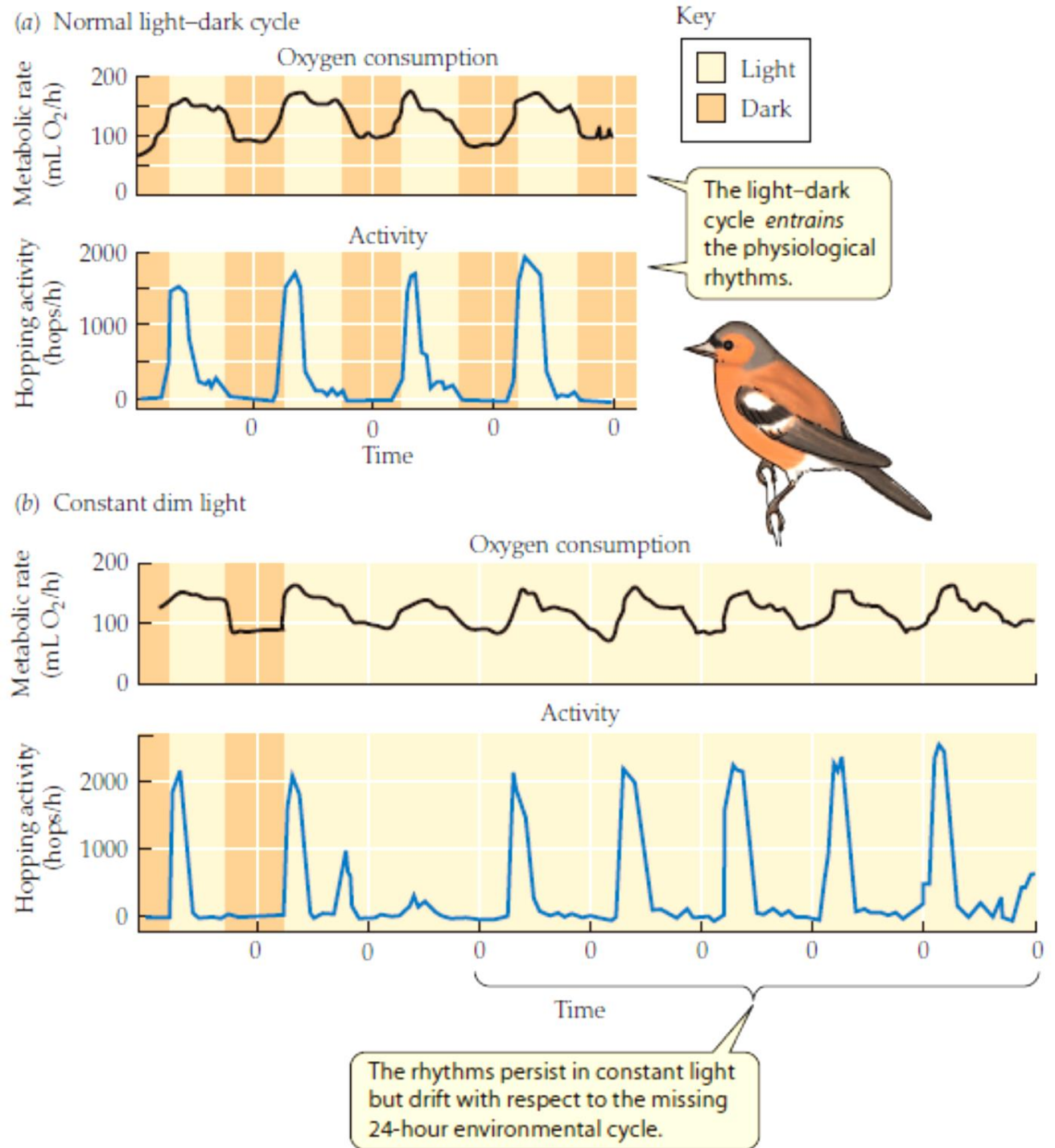
Or
Biological rhythm



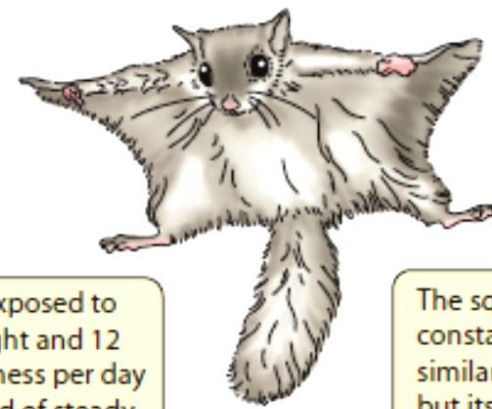
Circadian rhythm

circa, “about”; *dies*, “a day”

The process by which a biological rhythm is brought into phase with an environmental rhythm is called entrainment.



Free running rhythm

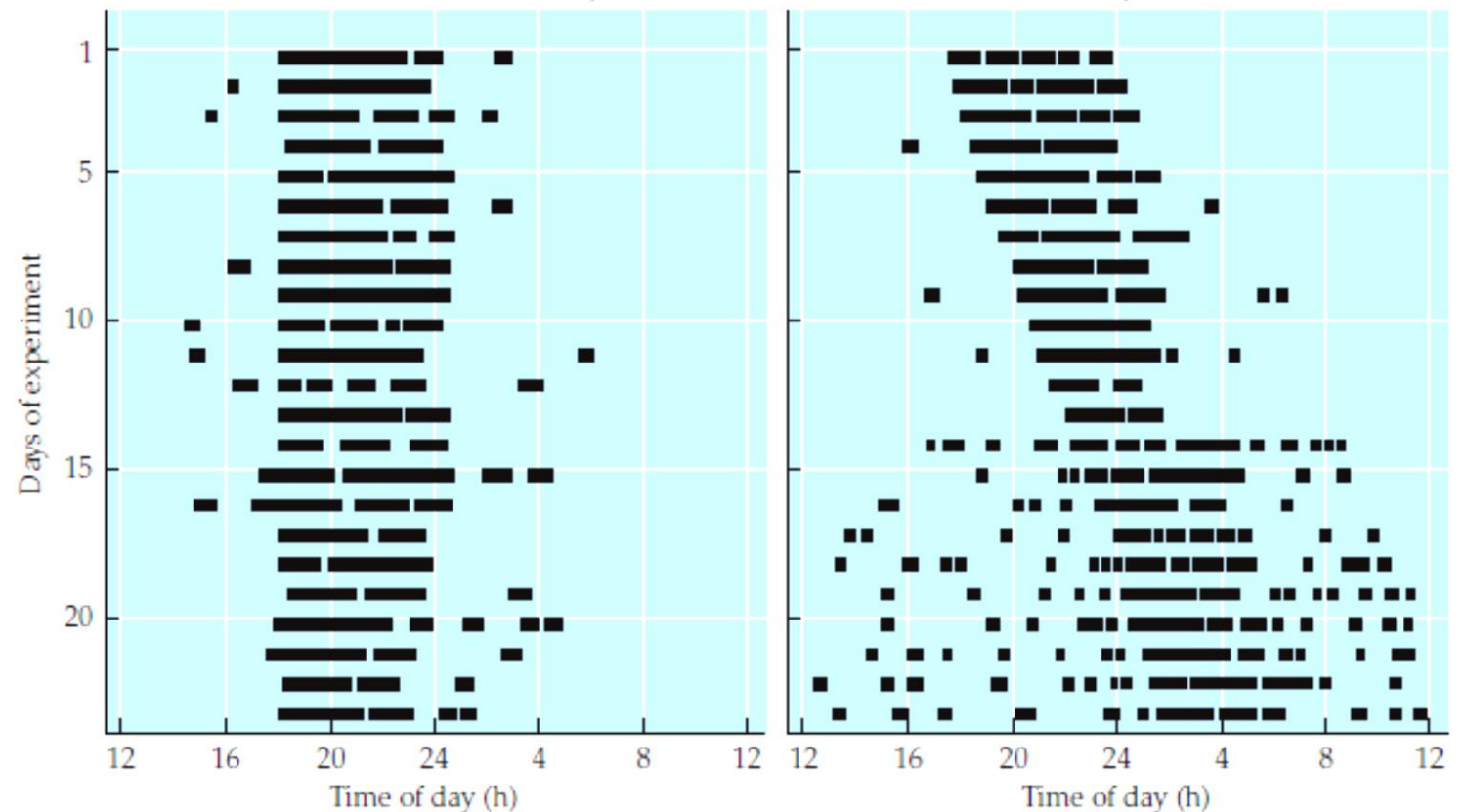


The squirrel exposed to 12 hours of light and 12 hours of darkness per day began a period of steady running each night near the onset of darkness.

The squirrel exposed to constant darkness had similar patterns of activity, but its activity periods drifted, starting later with each passing day.

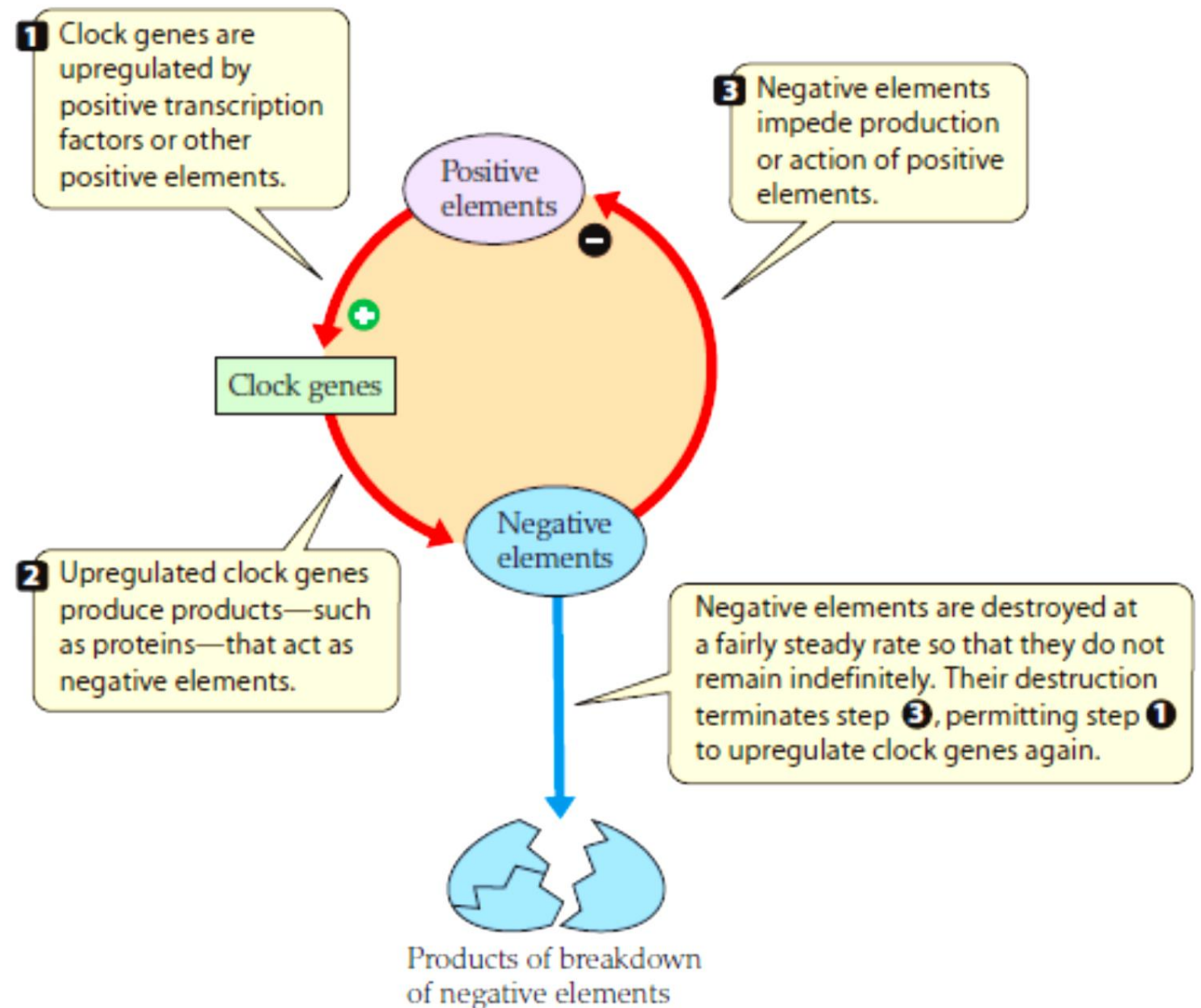
(a) 12 hours of darkness per day

(b) Constant darkness



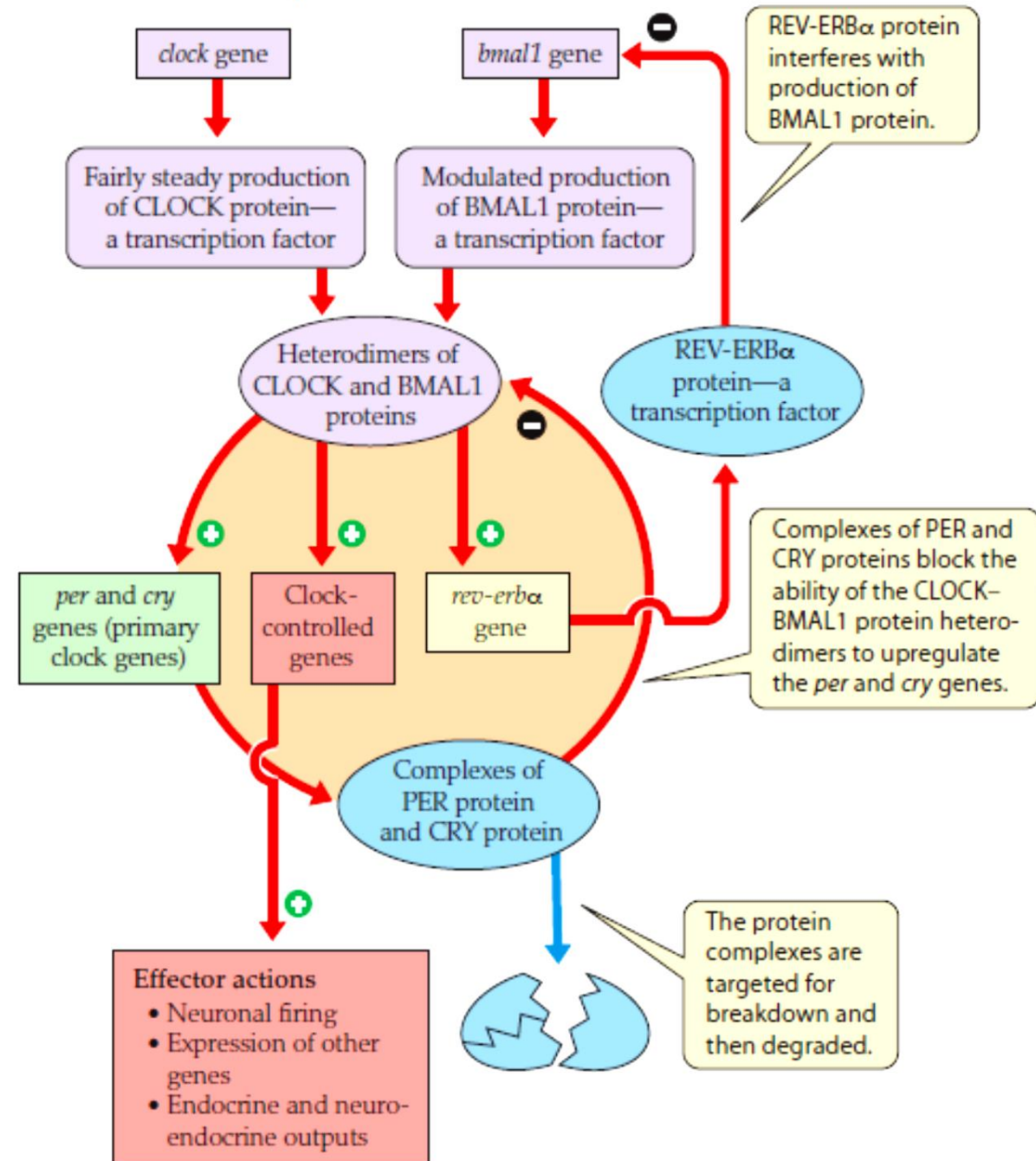
Model of mechanism

(a) A universal model of the mechanism of biological timekeeping



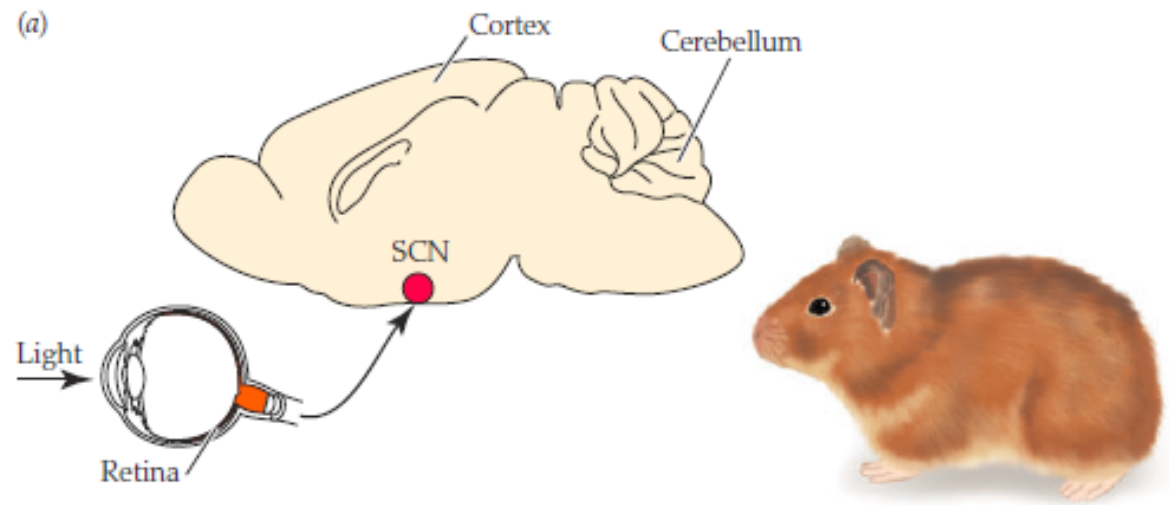
Abbreviated mechanism

(b) Some aspects of the timekeeping mechanism in neurons of the mammalian suprachiasmatic nuclei

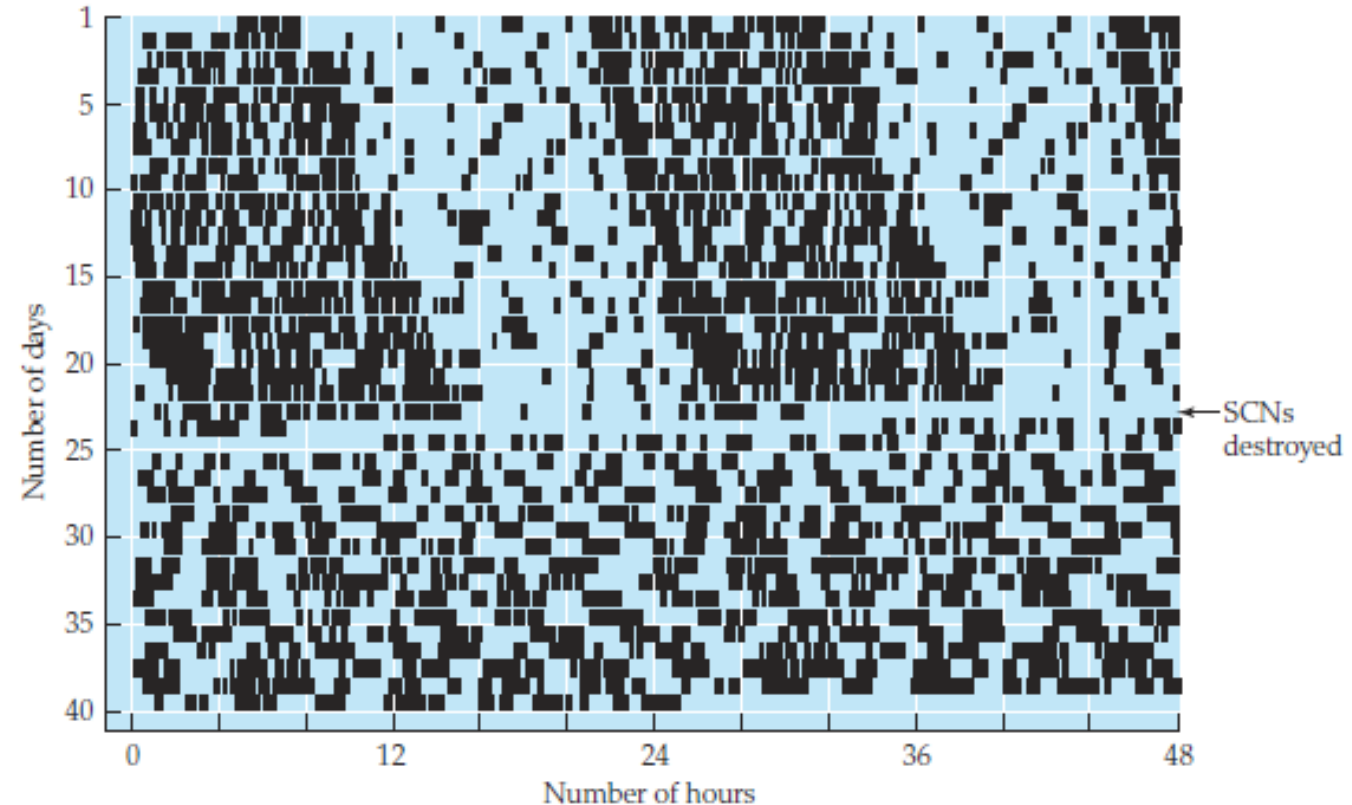


Suprachiasmatic nuclei (SCN)

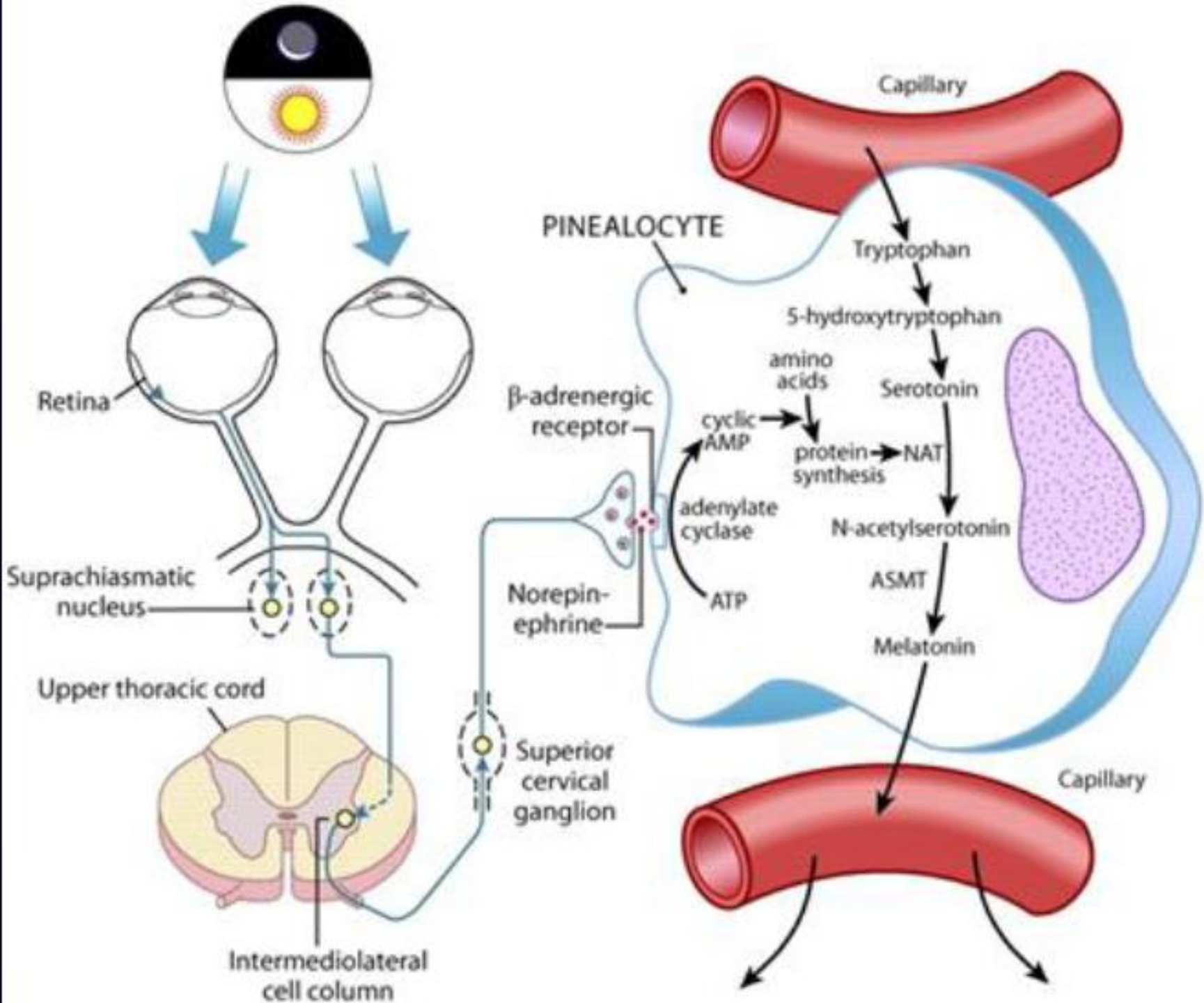
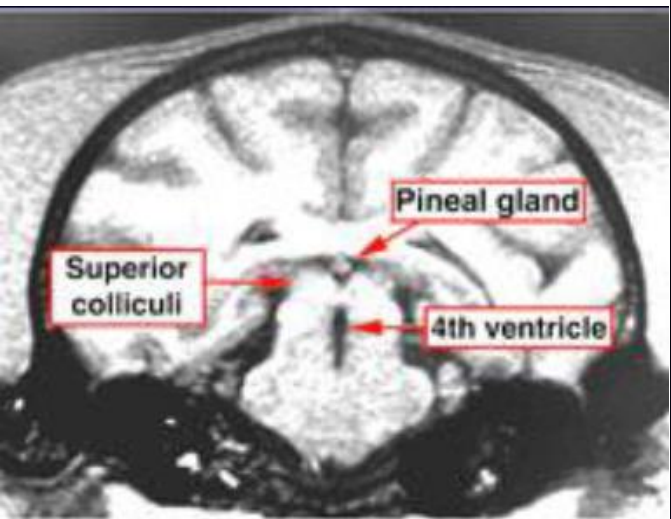
In mammals, the master circadian clock resides in the paired suprachiasmatic nuclei of the hypothalamic region of the diencephalon. Each *suprachiasmatic nucleus* (SCN) is just dorsal to the optic nerve at the optic chiasm



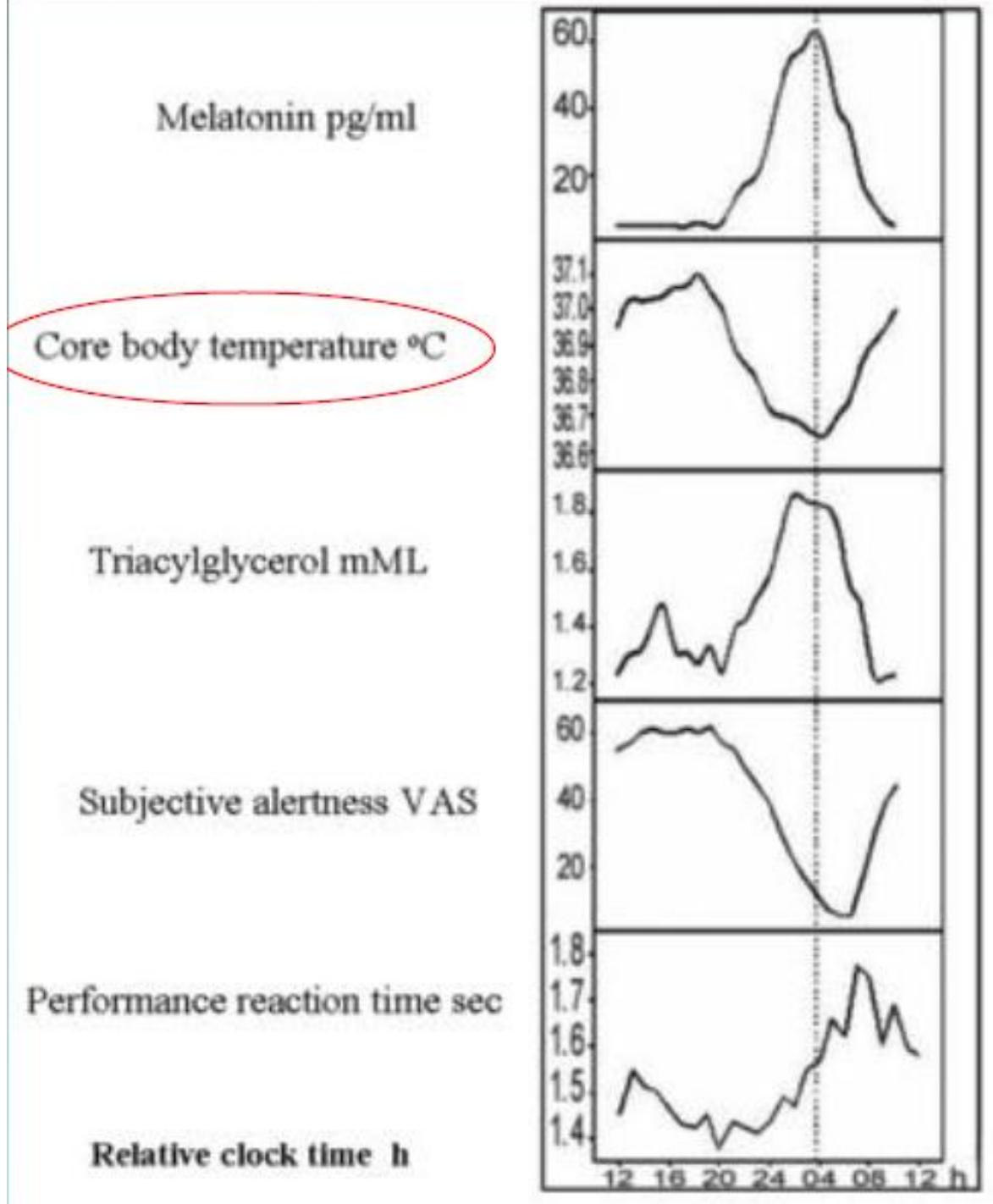
(c) Loss of free-running rhythms upon destruction of the SCNs



Pineal gland



Melatonin and sleep



Endocrine output of circadian clock

1) Free-running circadian clock

2) clock entrained to melatonin

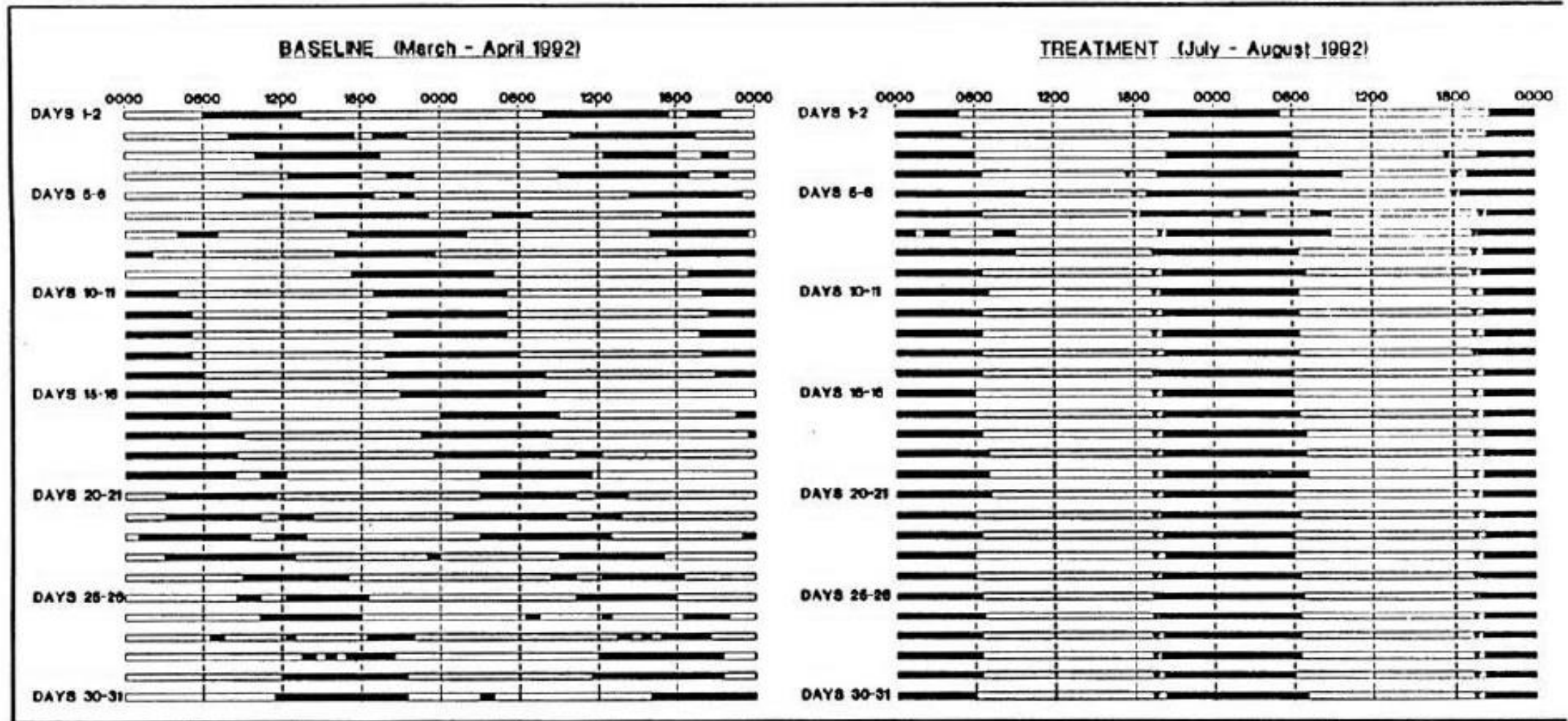
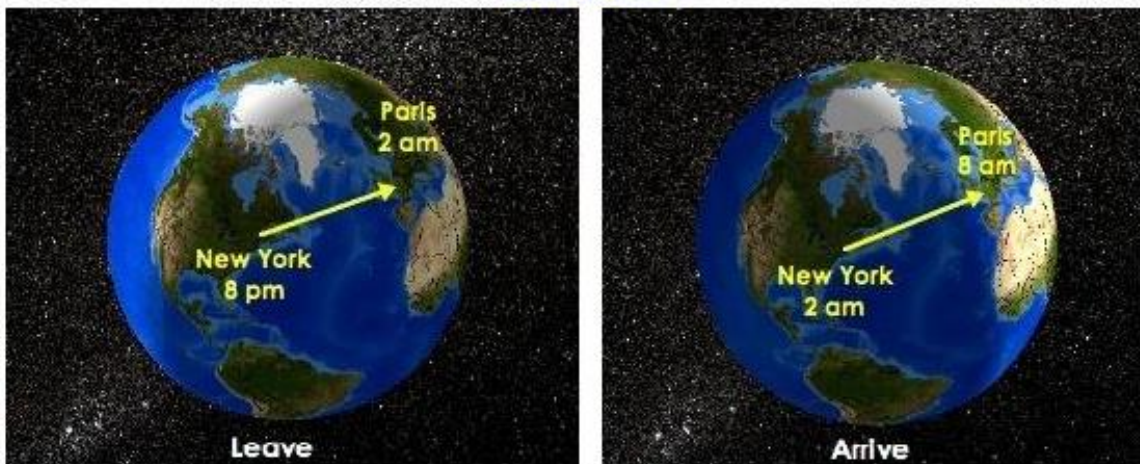


Figure 1. Sleep diary data, double-plotted for 30 days. Black bars represent times when the child was asleep, as reported by the parents. The left panel presents baseline data, collected in March–April, 1992. The right panel presents the first 27 days of melatonin treatment (July–August, 1992). Treatment was initiated on Day 4. Triangles represent the time of melatonin administration.

Jet Lag

Jet Lag

West to East



East to West

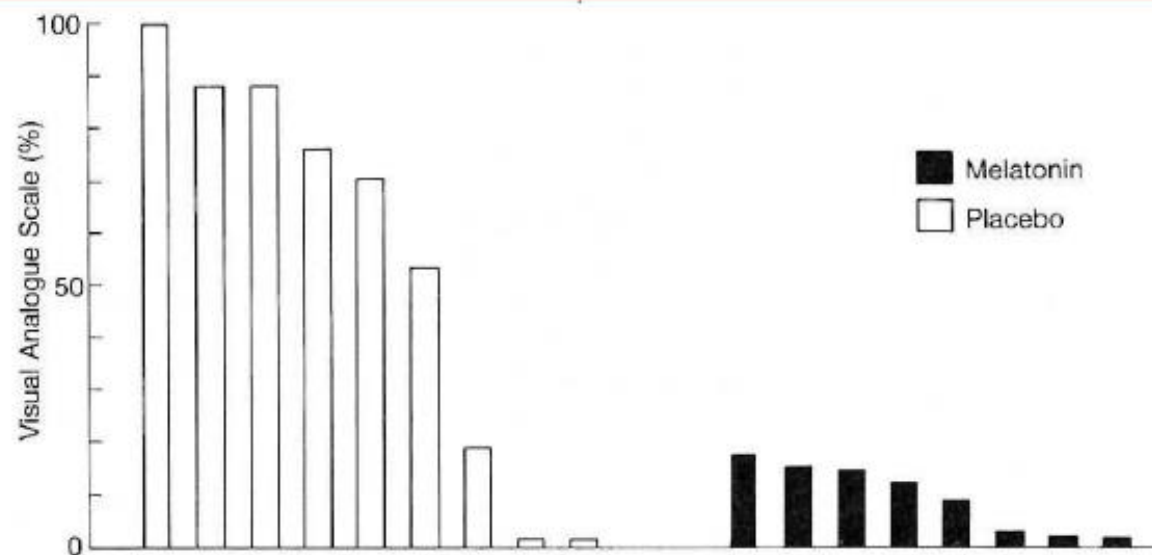
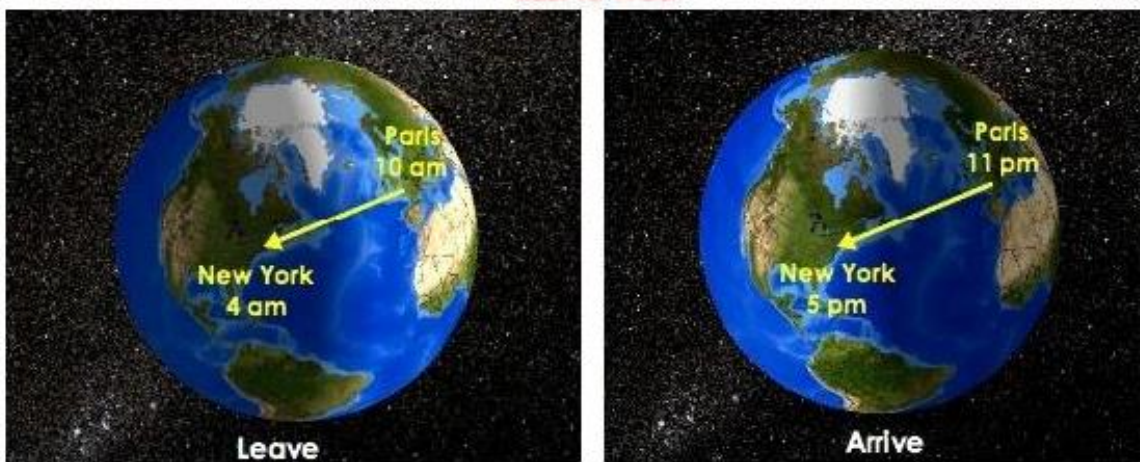


Fig. 2.8. Individual ratings of 'jet-lag' (0=insignificant, 100=very bad) on a 10-cm visual analogue scale in 17 subjects taking either melatonin (■) or placebo (□) in a precisely timed protocol (see text) before and after an 8 time-zone flight from San Francisco to London. The study design was double-blind. Subjects were in San Francisco time zone for 14 days prior to flight. (From Arendt *et al.* 1986, with permission.)

Seasonal Affective Disorder (SAD)

- Seasonal Affective Disorder (SAD) is a type of depression that comes and goes with the seasons, typically starting in the late fall and early winter and going away during the spring and summer. Depressive episodes linked to the summer can occur, but are much less common than winter episodes of SAD.
- **Signs and Symptoms**
- Seasonal Affective Disorder (SAD) is not considered as a separate disorder. It is a type of depression displaying a recurring seasonal pattern. To be diagnosed with SAD, people must meet full criteria for major depression coinciding with specific seasons (appearing in the winter or summer months) for at least 2 years. Seasonal depressions must be much more frequent than any non-seasonal depressions.
- **Symptoms of Major Depression**
 - Feeling depressed most of the day, nearly every day
 - Feeling hopeless or worthless
 - Having low energy
 - Losing interest in activities you once enjoyed
 - Having problems with sleep
 - Experiencing changes in your appetite or weight
 - Feeling sluggish or agitated
 - Having difficulty concentrating
 - Having frequent thoughts of death or suicide.

SAD cont.....

- Symptoms of the Winter Pattern of SAD include:
 - Having low energy
 - Hypersomnia
 - Overeating
 - Weight gain
 - Craving for carbohydrates
 - Social withdrawal (feel like “hibernating”)
- Symptoms of the less frequently occurring summer seasonal affective disorder include:
 - Poor appetite with associated weight loss
 - Insomnia
 - Agitation
 - Restlessness
 - Anxiety
 - Episodes of violent behavior

SAD cont....

- **Risk Factors**
- Attributes that may increase your risk of SAD include:
 - **Being female.** SAD is diagnosed four times more often in women than men.
 - **Living far from the equator.** SAD is more frequent in people who live far north or *south of the equator*. For example, 1 percent of those who live in Florida and 9 percent of those who live in New England or Alaska suffer from SAD.
 - **Family history.** People with a family history of other types of depression are more likely to develop SAD than people who do not have a family history of depression.
 - **Having depression or bipolar disorder.** The symptoms of depression may worsen with the seasons if you have one of these conditions (but SAD is diagnosed only if seasonal depressions are the most common).
 - **Younger Age.** Younger adults have a higher risk of SAD than older adults. SAD has been reported even in children and teens.

Hormonal Circadian Rhythm

- **Cortisol:** Highest in the morning (wake up), lowest during onset of sleep. Fluctuations can be >100%. Complete reversal requires 1-3 weeks → low dependency on sleep cycles.
- **Growth Hormone:** Large diurnal differences (100pg/ml → 800pg/ml), with close dependency on sleep cycles. During sleep, GH levels increase and decrease during wakeful state.
- **Prolactin:** resembles the growth hormone cycle.
- **Aldosterone:** Secretion is modified by postural changes. For lying-down subjects, it peaks at morning just before awakening, and lowers in the afternoon. It follows ACTH rhythm. Subjects that assume upright position and are active throughout the day, aldosterone secretion rapidly increases upon assuming upright position, peaks during the afternoon and declines in the evening (even if upright position is maintained).
- **Testosterone:** Follows a low-amplitude circadian rhythm (no large diurnal differences). Lowest during the afternoon, gradually increasing during the night, with episodic bursts of secretion. Maximal values are reached at awakening.

Snowshoe hares



Seasonal colour change

- Snowshoe hares can change the colour of their fur from brown in the summer to white in the winter. The process occurs over about 10 weeks, with the white fur appearing first on the ears and feet and gradually moves towards the body. During the spring, brown fur replaces the white fur in the reverse process.
- Since snowshoe hares do not hibernate and are active in the nighttime, they are positioned to detect these changes in the light cycle over the seasons (ie, the photoperiod).
- When the days are long and the nights are short, the hypothalamus and suprachiasmatic nucleus receives stimulation from melanopsin-containing retinal ganglion cells, which in turn stimulates melanin production in the fur. When the days become shorter, the brain receives less stimulation from these cells, and melanin production slows, resulting in all new growth of fur lacking pigment (white).