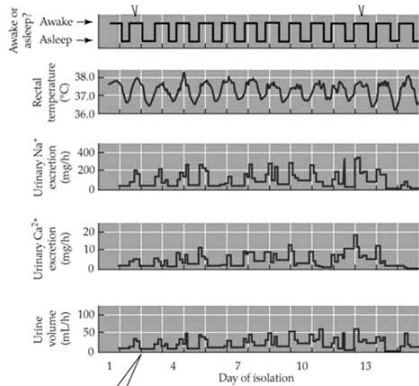


Biological Clocks
Chapter 14

1. Endogenous (internal) rhythms
 - A. continue in the absence of environmental cues.
 - B. synchronize the internal environment with the external environment
2. Rhythms are in phase if they occur synchronously.

Fig 14.12 Daily rhythm of several physiological functions in a human



Biological clock controls

1. Biological clocks control a suite of behaviors.
2. Biological clocks are predictive.
3. Period = amount of time between a particular part of the rhythm between 2 cycles
 - A. Circatidal rhythms affect organisms along seashore
 - B. Circannual clocks are set by photoperiod
 - C. Circadian rhythms: range over a day.

TABLE 14.3 Some processes that show circadian rhythmicity in animals and other eukaryotes

Locomotor activity in many vertebrates and invertebrates
 Sleep-wake cycles in many animals
 Metabolic rate in many animals
 Variations of body temperature (including torpor) in birds and mammals
 Urine output and drinking in mammals
 Adrenocortical hormone secretion and epidermal mitosis in mammals
 Integumentary color change in fish and crabs
 Oviposition, mating, and emergence of adults from pupae in insects
 Female pheromone release and male pheromone sensitivity in insects
 Mating in *Paramecium*
 Bioluminescence and photosynthetic capacity in dinoflagellate algae

Figure 14.13
 Circadian rhythm of metabolic rate (O₂ consumption) and motor activity for a chaffinch

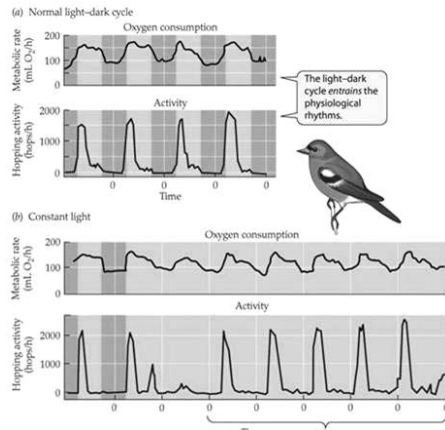
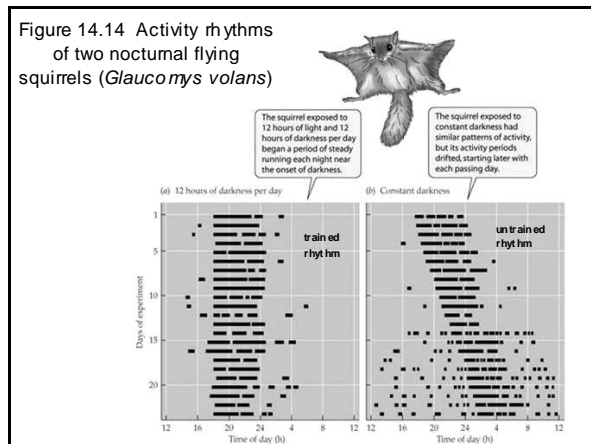


Fig. 14.13b. Oxygen consumption and activity remains cyclical in finches after being exposed to constant light, and thus is endogenous (and circadian).

BIOLOGICAL CLOCKS

1. The physiological rhythms maintained by biological clocks are trained by environmental conditions but do not depend upon them.
2. Endogenous biological clocks maintain circadian rhythms in isolation but don't necessarily remain in phase with the environment.

Figure 14.14 Activity rhythms of two nocturnal flying squirrels (*Glaucomys volans*)



Circadian rhythms

1. When environmental cues are absent the endogenous rhythm is free running.
2. A free-running animal maintains its cycle with no external cues.
3. Entrainment is an environmental cue used to synchronize a biological rhythm.
4. The cue is called a **zeitgeber** or phasing factor

Endogenous clocks and compensation

1. Timing of circadian clocks is insensitive to temperature.
2. The clock does not speed up at higher temperatures or slow down at low temperatures.
3. Biological clocks are functions of the nervous and neuroendocrine systems

Fig 14.16 The paired suprachiasmatic nuclei constitute the major circadian clock of mammals

1. Suprachiasmatic nuclei (SCN) control the pineal gland
2. Pineal gland can be the clock in other organisms.
3. Eyes and associated structures in insects and mollusks
4. Pineal
 - A. Produces Melatonin
 - B. Regulation of patterns of eating, sleeping, and reproduction
 - C. onset of puberty
 - D. female reproductive cycle

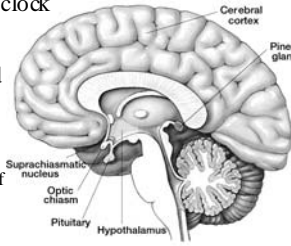
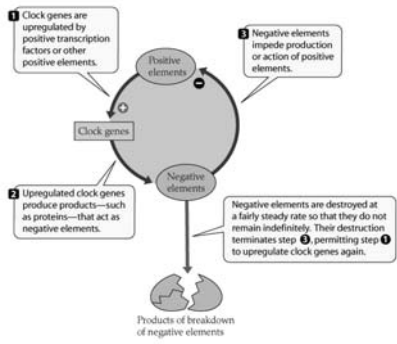


Fig 14.15 Cellular mechanisms of circadian timekeeping

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



Mammalian Clocks

