

Biorytmy, cirkadiánní rytmy

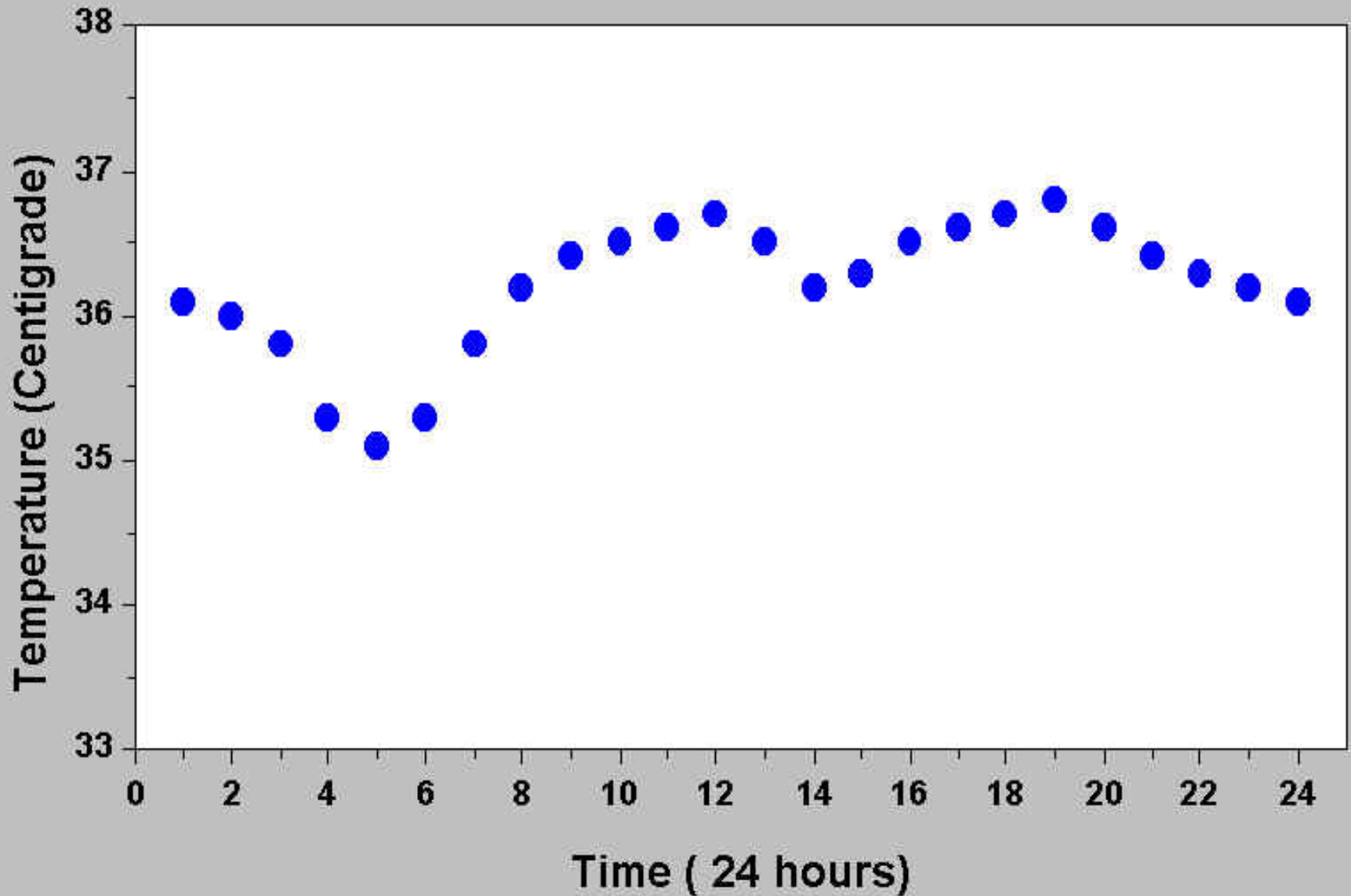
doc. MUDr. Jindřich Fiala, CSc.



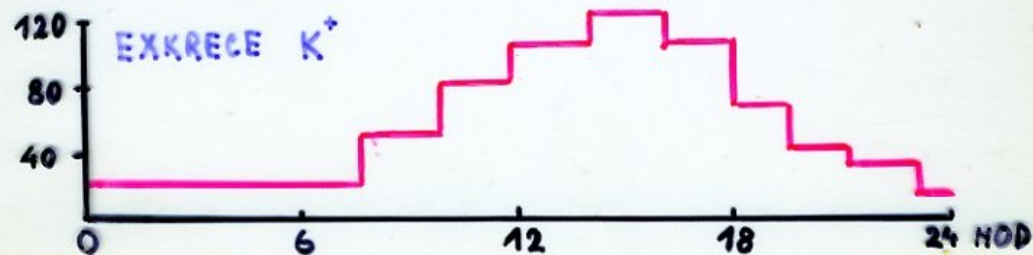
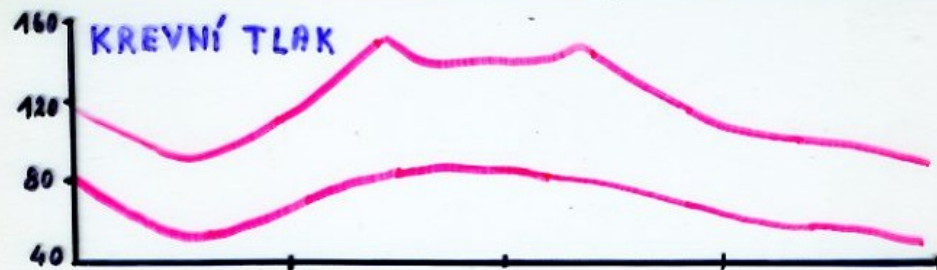
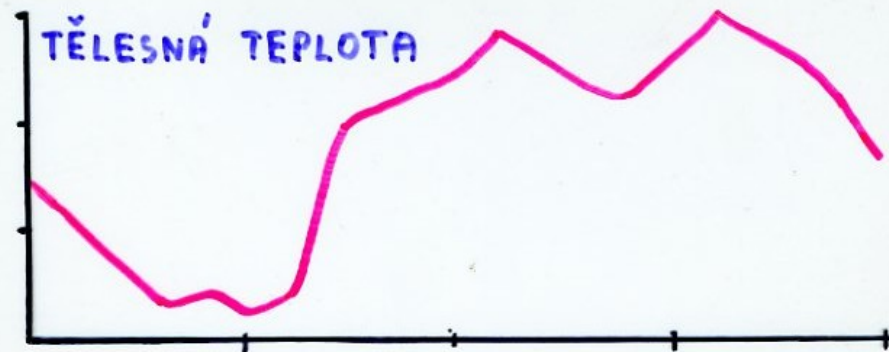
Ústav ochrany a podpory zdraví

LF MU Brno



Core Body Temperature



CIRKADIÁNNÍ VARIACE NĚKTERÝCH FYZIOL. HODNOT

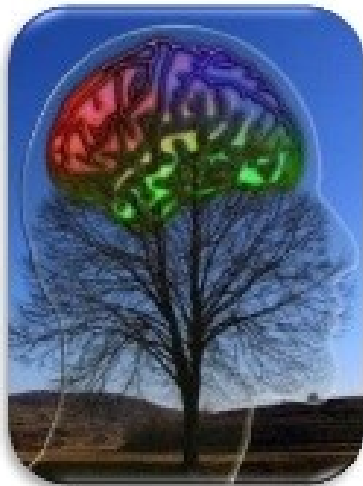


Historie:

Date	Literature/contributor	Comment
1918	J.S. Szymanski	Showed that animals are capable of maintaining 24-hour activity patterns in the absence of external cues such as light and changes in temperature
1959	Franz Halberg (University of Minnesota-Father of American Chronobiology)	Coined the term "Circadian" 
20th Century	Auguste Forel, Oskar Wahl	Circadian rhythms were noticed in the rhythmic feeding times of bees
1967	Erwin Bunning	Described physiological clock in plant
1970s	Ron Konopka, Seymour Benzer  	Isolated the first clock mutant in Drosophila and mapped the "period" gene, the first discovered genetic component of a circadian clock
1994	Joseph Takahasi	Discovered the first mammalian 'clock gene' (CLOCK) using mice

Introduction of Chronobiology

- ❑ Study of biological time in relation with cyclic rotation of the earth in it's axis which is completed within 24 hrs.
- ❑ Biological rhythm varies from milliseconds in ocular field potential to years
- ❑ Circadian rhythm is the most extensively studied and best understood biological rhythm.
- ❑ Chronobiology comes from the ancient Greek (*chrónos*, meaning "time"), and biology, which means "the study, or science, of life"



Biorytmy - definice:

- *Cyklické, pravidelné funkční kolísání fyziologického funkčního stavu organismu*

Kritéria:

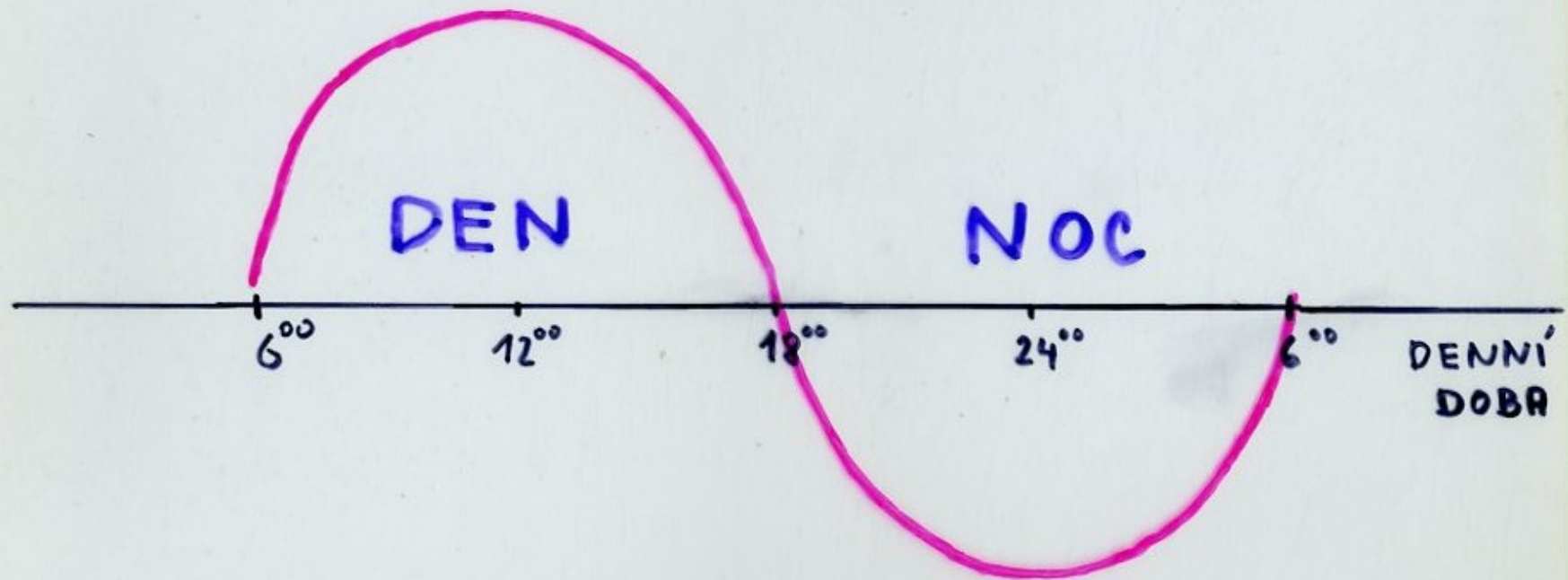
- *Přetrvává v konstantních podmínkách*
- *Nezávislý na teplotě (perioda)*
- *Může být „resetován“, změněn a řízen vnějšími vlivy*

Základní pojmy

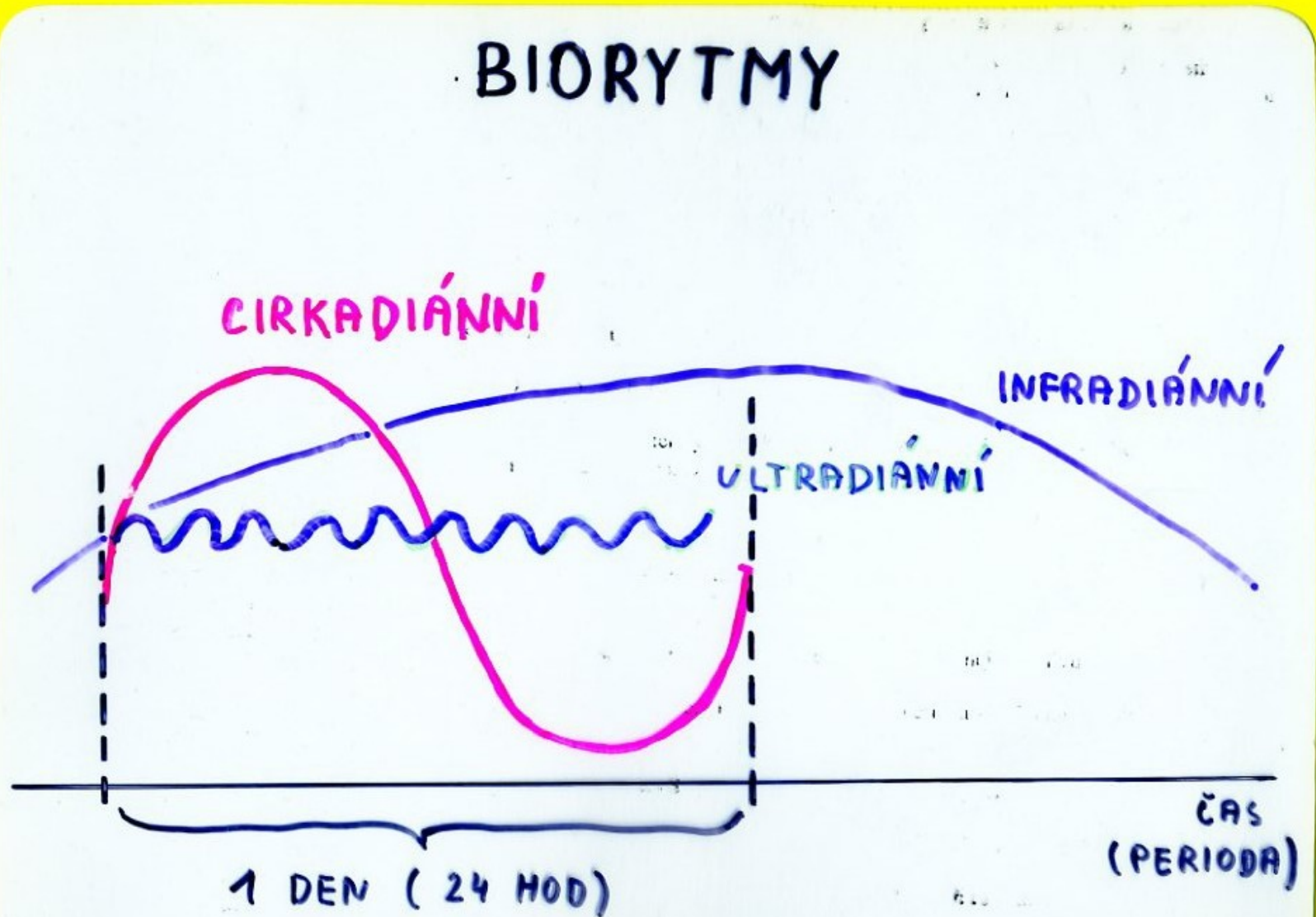
Term	Definition
Melatonin	A hormone produced rhythmically in vertebrates by the pineal gland, a pea sized organ at the center of the human brain.
Nocturnal activity	Activity performed mainly at night
Oscillator	Internal and therefore unseen, or endogenous oscillator (the biological clock) that produces an overt measurable biological rhythm in the organism.
Period	The length of one complete cycle of a rhythm
Phase	A particular reference point in the cycle of a rhythm, e.g. the daily onset of locomotor activity, or the light-to-dark transition in a zeitgeber cycle.
Phase shift	Shift in a biological rhythm along its time axis so whilst the period remains the same the time at which the rhythm occurs changes
Zeitgeber “time giver”	Periodic environmental signal that entrains some biological rhythm , for example a natural or artificial day-night cycle for a circadian rhythm

Základní parametry biorytmu

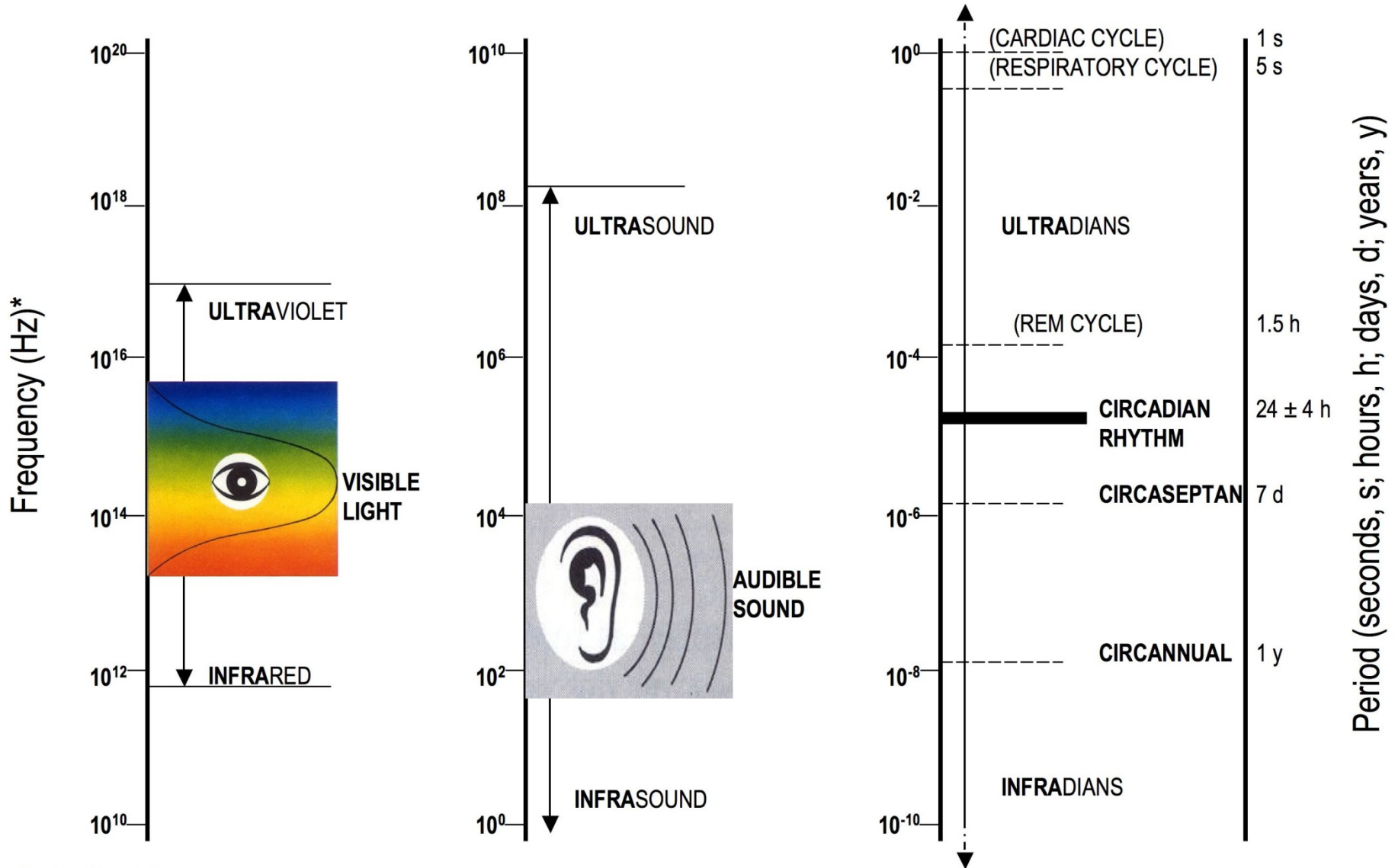
- *Délka periody*
- *Průběh, tvar* (nemusí být pravidelná sinusovka)
- *Amplituda*
- *Fázový posun*



Základní rozdělení biorytmů – dle délky periody



CHRONOBIOLOGIC TERMINOLOGY FOLLOWS THAT USED IN PHYSICS BASED ON FREQUENCY (f; RECIPROCAL PERIOD: $\tau = 1/f$)



*1 Hz = 1 cycle/sec

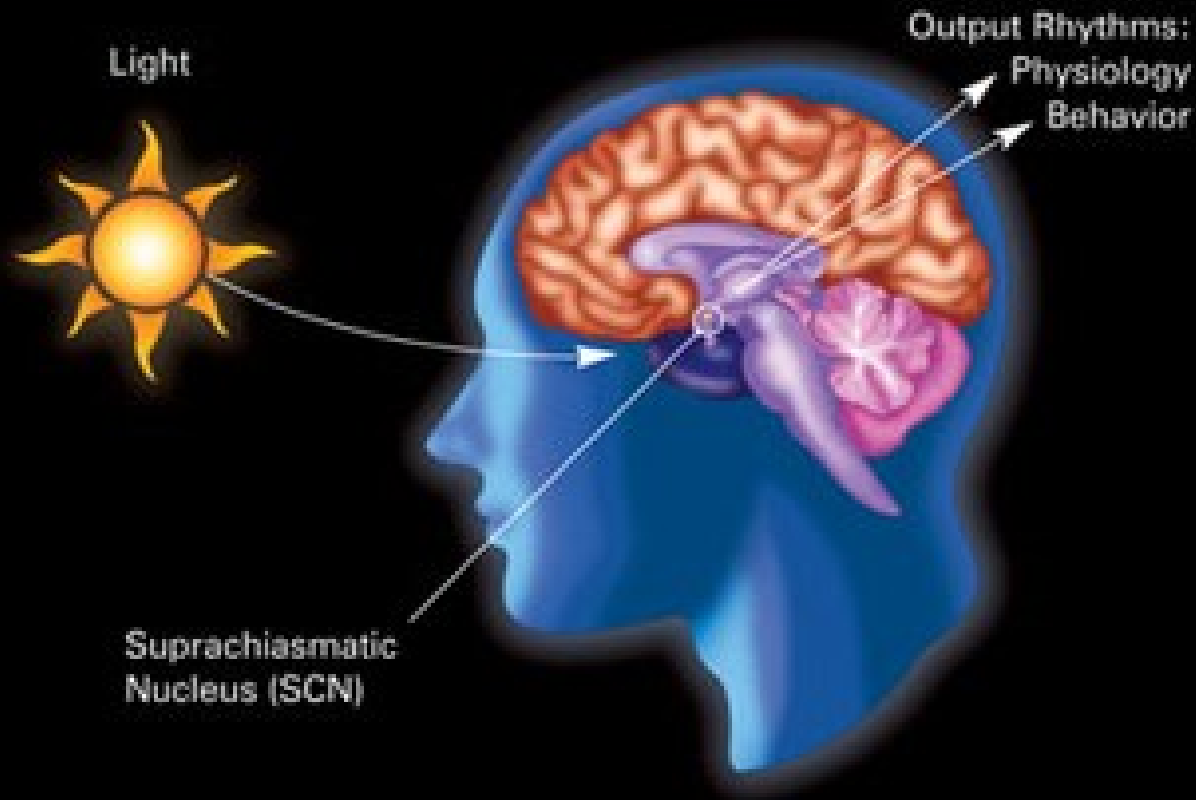
biological rhythms



Circadian rhythms

- ❑ Latin word circa means about and dies means days, which has the periodicity of one day.
- ❑ Such rhythms persist in the absence of time cues
- ❑ Self sustained biological rhythms characterized by a free-running period of about 24 hours (circa diem)
- ❑ Circadian rhythm may be
 - ❖ Diurnal: organisms active during daytime
 - ❖ Nocturnal: organisms active in the night
 - ❖ Crepuscular: animals primarily active during the dawn and dusk hours (ex: white-tailed deer, some bats)

Cirkadiánní biorytmy



Cirkadiánní biorytmy – vliv vnější rytmicity

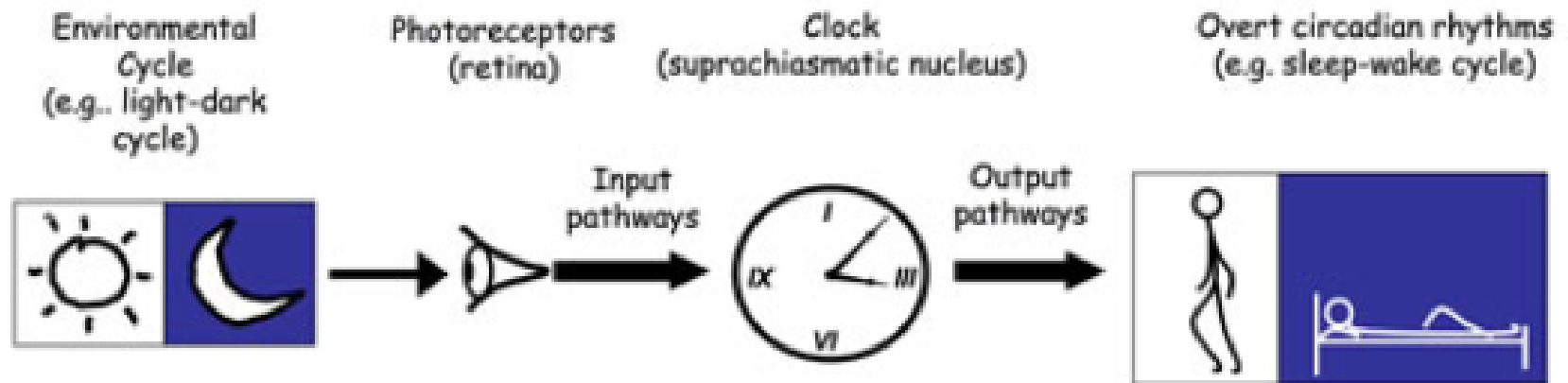


Figure 1: Schematic representation of the basic components of a circadian system. One or more biological clocks have the ability to oscillate in a self-sustained manner and to sustain biological rhythms through output pathways. The clocks, in turn, are synchronized to the solar day through input pathways. In mammals, many of these components are characterized. The master clock that regulates all circadian rhythms is located within the suprachiasmatic nucleus of the hypothalamus (SCN). Synchronization to the light-dark cycle is through direct neuronal projections from the retina to the SCN.

Vztah mezi variabilitou prostředí, homeostázou a rytmičitou

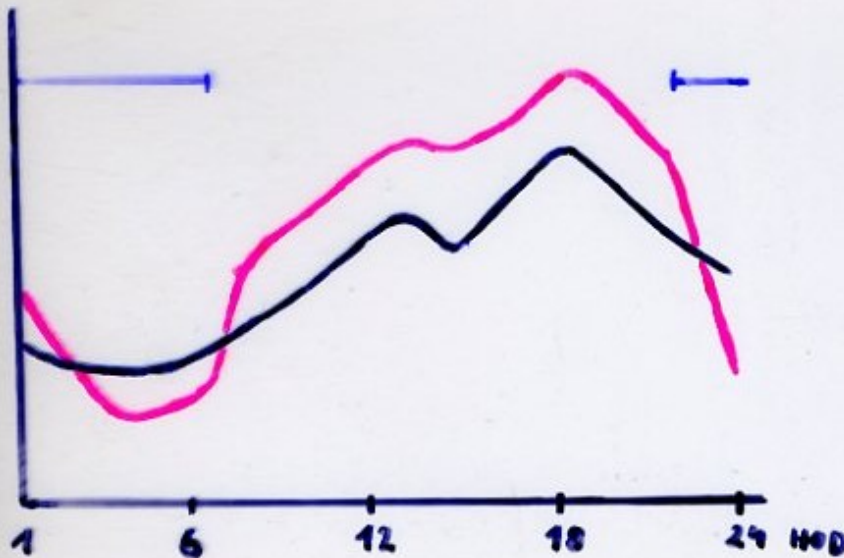
VNĚJŠÍ RYTMICITA

OVLIVNĚNÍ AMPLITUDY
(= VNĚJŠÍ SLOŽKA CIRK. RYTMU)

ZEITGEBER

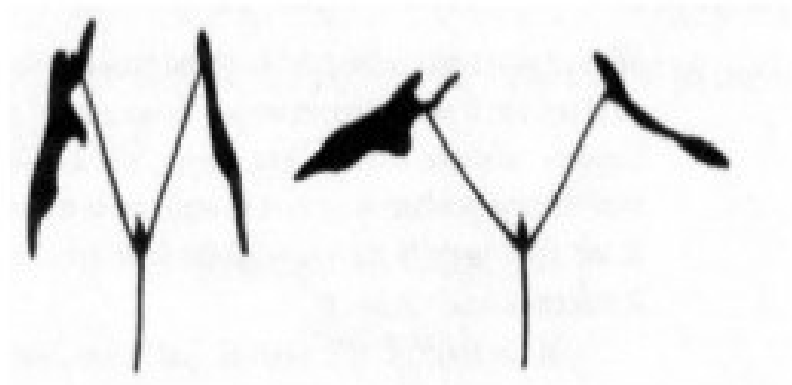
SYNCHRONIZACE
BIOLOGICKÝCH HODIN

(AUTONOM. PERIODA \approx 25 HOD.)

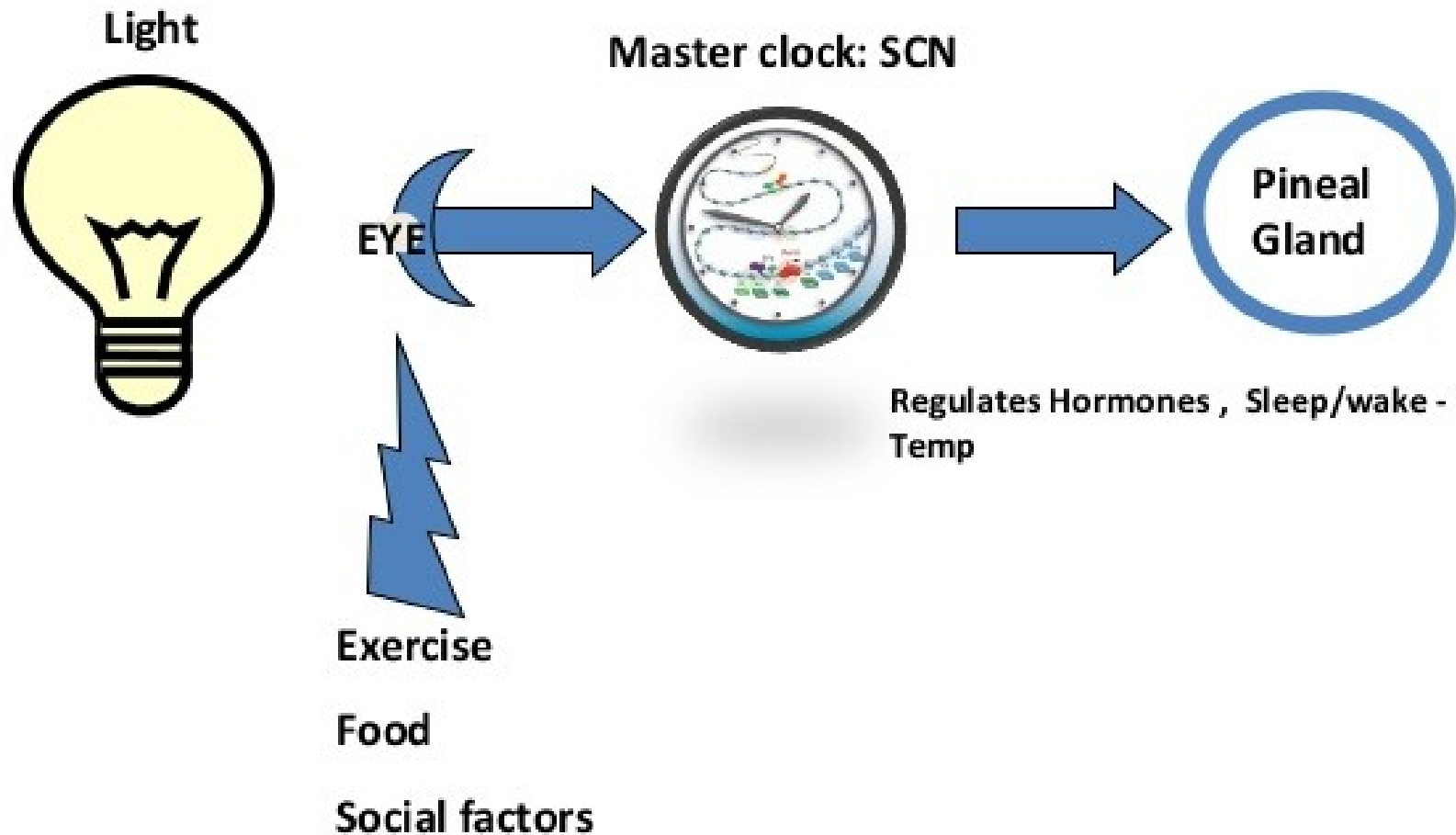


zeitgeber

- ❑ An environmental agent or event (as the occurrence of light or dark) that provides the stimulus for setting or resetting a biological clock of an organism
- ❑ Any external or environmental cue that entrains, or synchronizes, an organism's biological rhythms to the earth's 24-hour light/dark cycle and 12 month cycle.
- ❑ The term "zeitgeber" (German for "time giver" or "synchronizer") was first used by Jurgen Aschoff , one of the founders of Chronobiology
- ❑ Common zeitgeber
 - ❖ Temperature
 - ❖ Social interactions
 - ❖ Pharmacological manipulation
 - ❖ Exercise
 - ❖ Eating/drinking patterns



**“Zeitgeber” (time givers)
“entrain” clock**



Cirkadiální rytmy = fylogenetická adaptace na střídání dne a noci

diurnal

nocturnal

dawn

day

dusk

night

matutinal

(ranní)

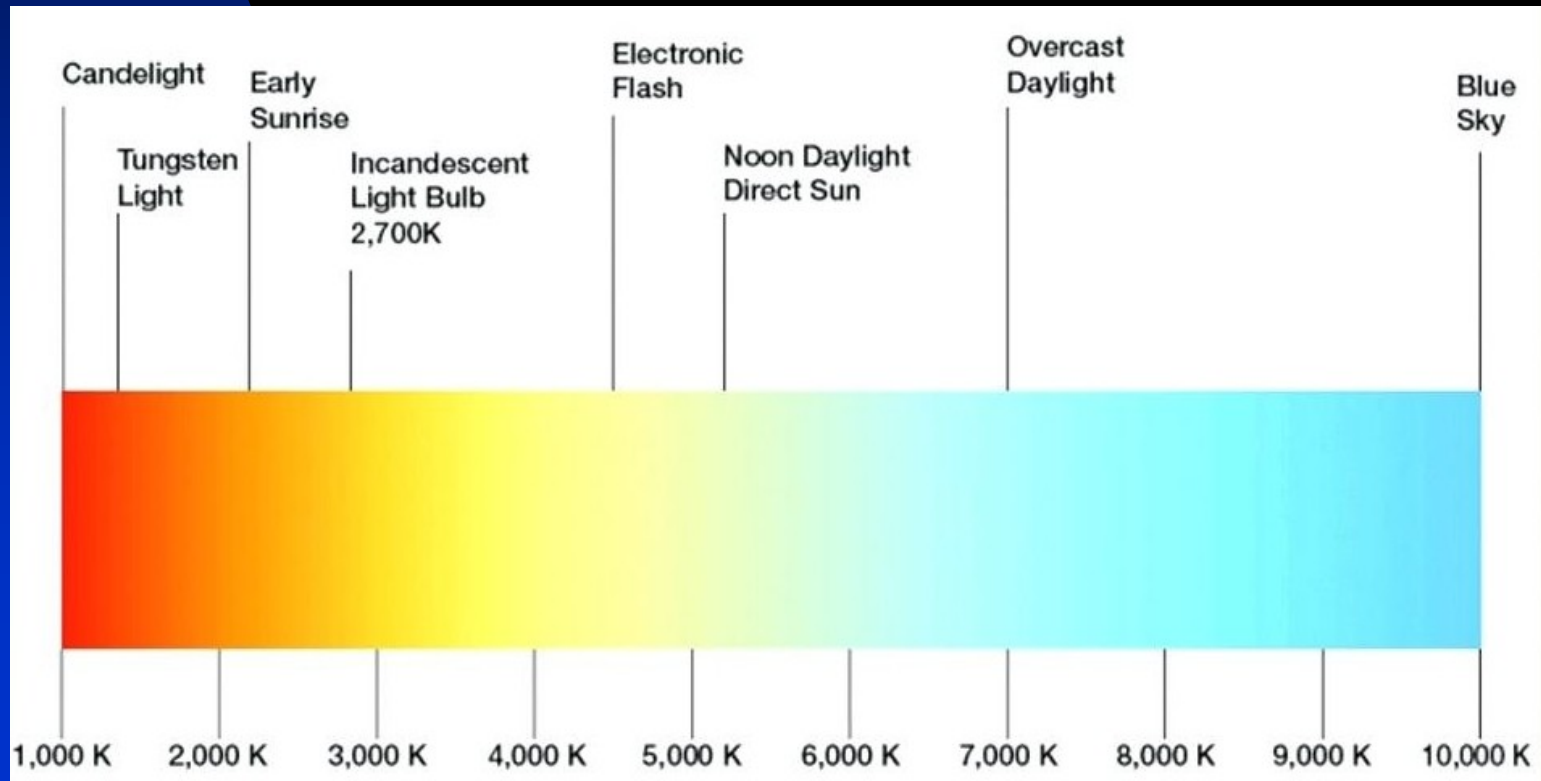
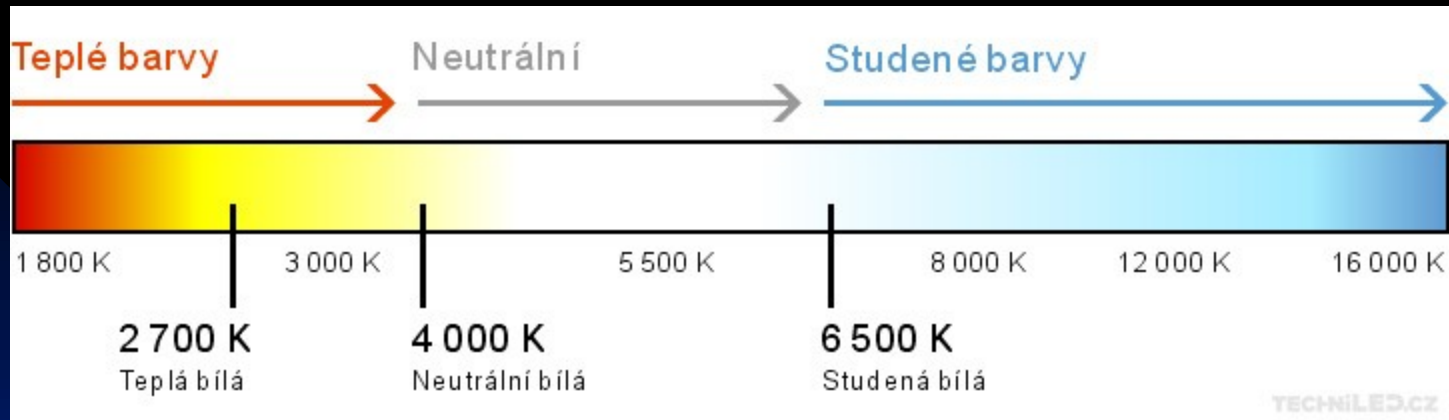
vespertine

(večerní)

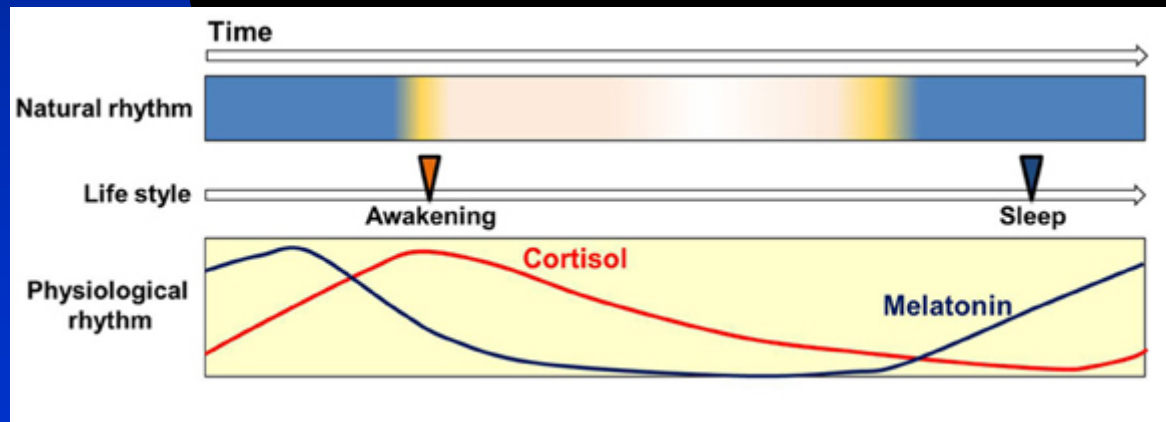
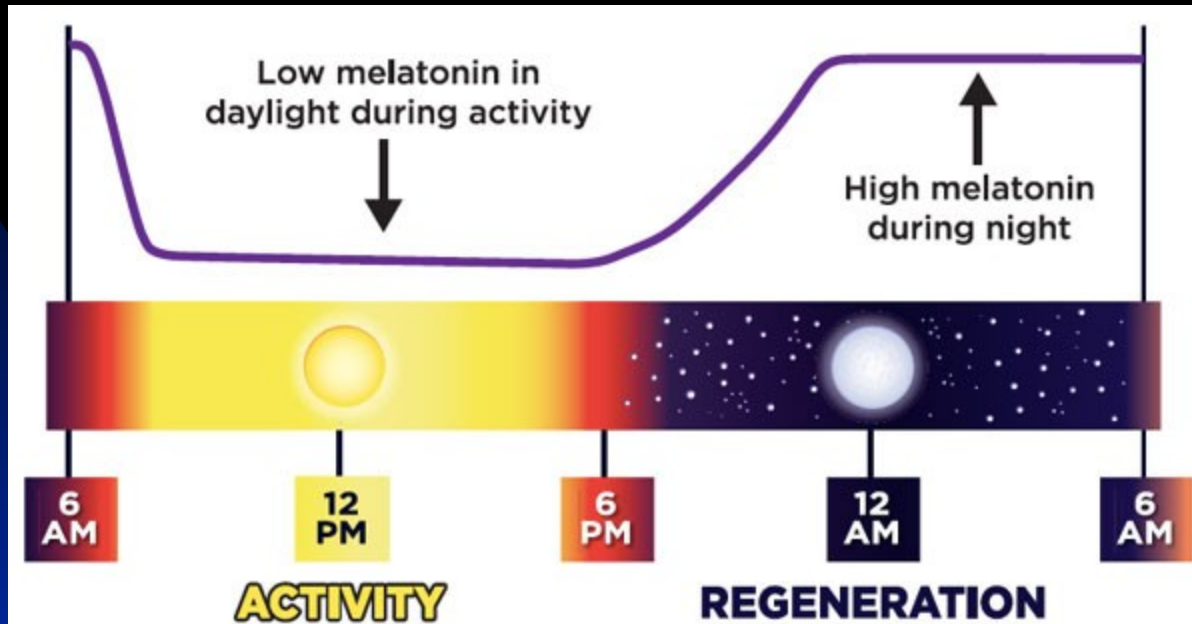
crepuscular
(soumrační)

time →

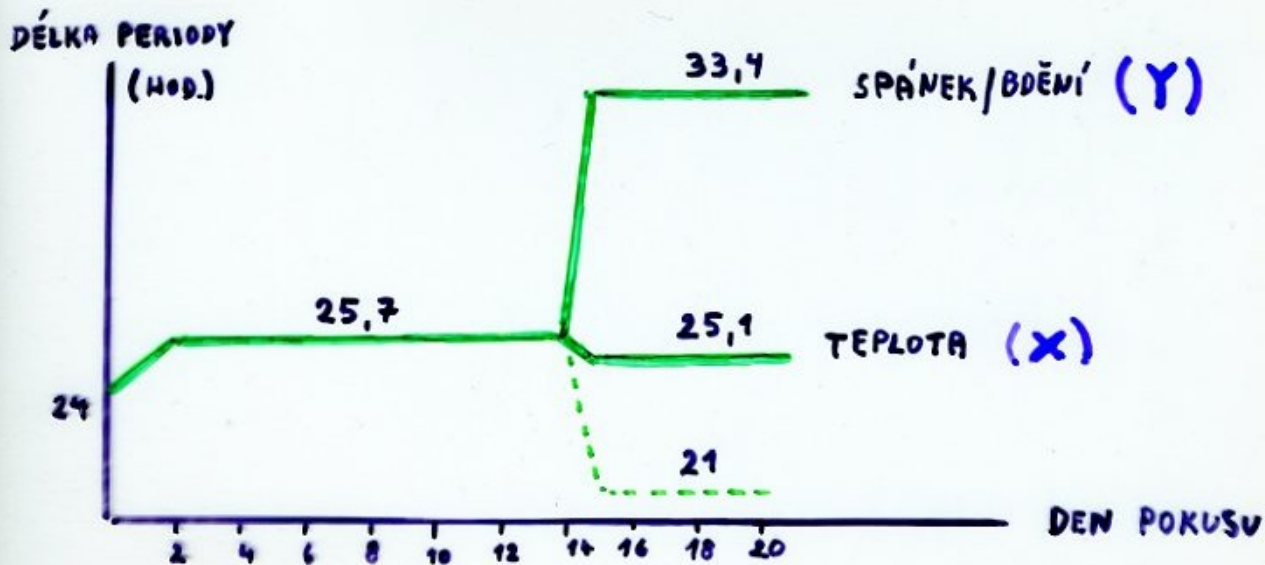
Barevná teplota



Melatonin



Vnitřní desynchronizace



OSCILÁTOR X (I) : SILNÝ, MĚNĚ OVLIVNITELNÝ, T.J. MENŠÍ ŠKÁLA MOŽNÉ SYNCHRONIZACE (22,3 - 26,9 h.)

OSCILÁTOR Y (II) : SLABŠÍ, VÍCE OVLIVNITELNÝ (SYNCHRONIZACE 12 - 65 h.)

OSCILÁTOR „ČILOSTI“ ?

Circadian rhythm disorders can be caused by many factors, including:

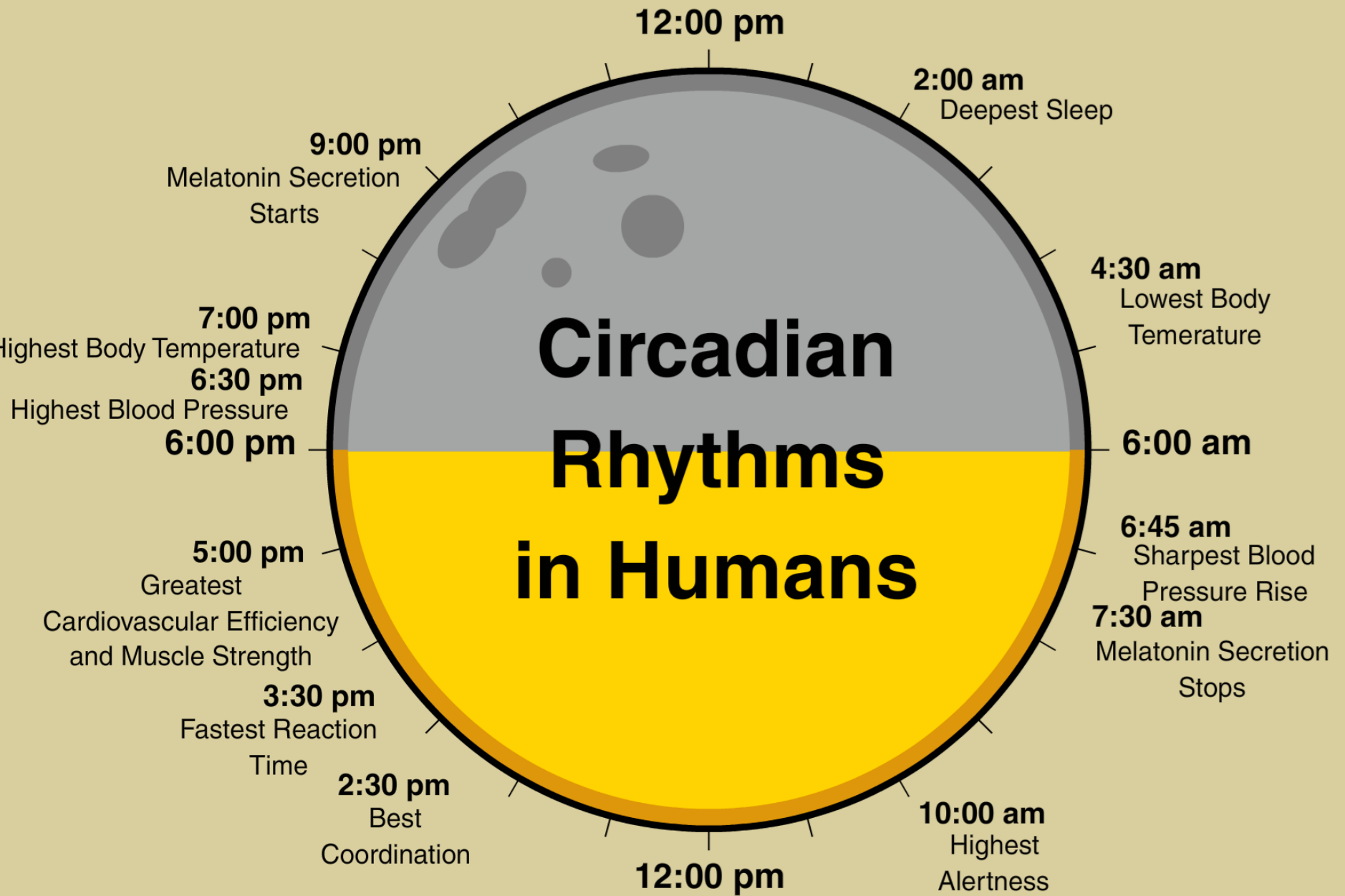
- ❖ Shift work
- ❖ Pregnancy
- ❖ Time zone changes
- ❖ Medications
- ❖ Changes in routine

Kde se s cirkadiánními rytmy setkáváme (potýkáme) nejčastěji

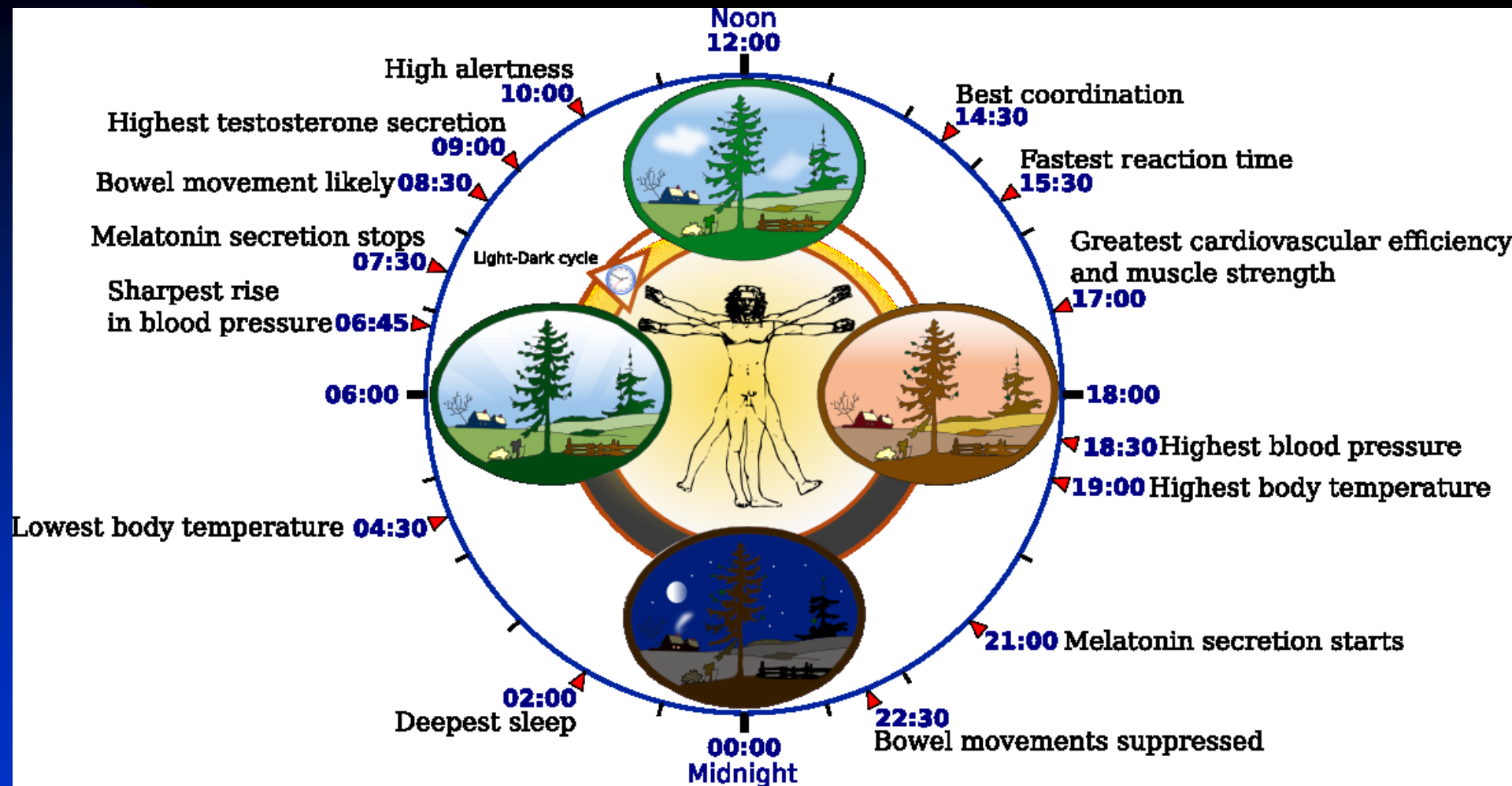
- *Letní čas*
- *Jet lag*
- *Seasonal affective disorders, zimní deprese*
- *Poruchy spánku*
- *Uspořádání pracovní doby, režim práce a odpočinku*
- *Směnná a noční práce*
- *Individuální rozdíly – ranní a večerní typy*
- *Interpretace klinických měření (např. těl. teplota)*

Common Circadian Rhythm Disorders

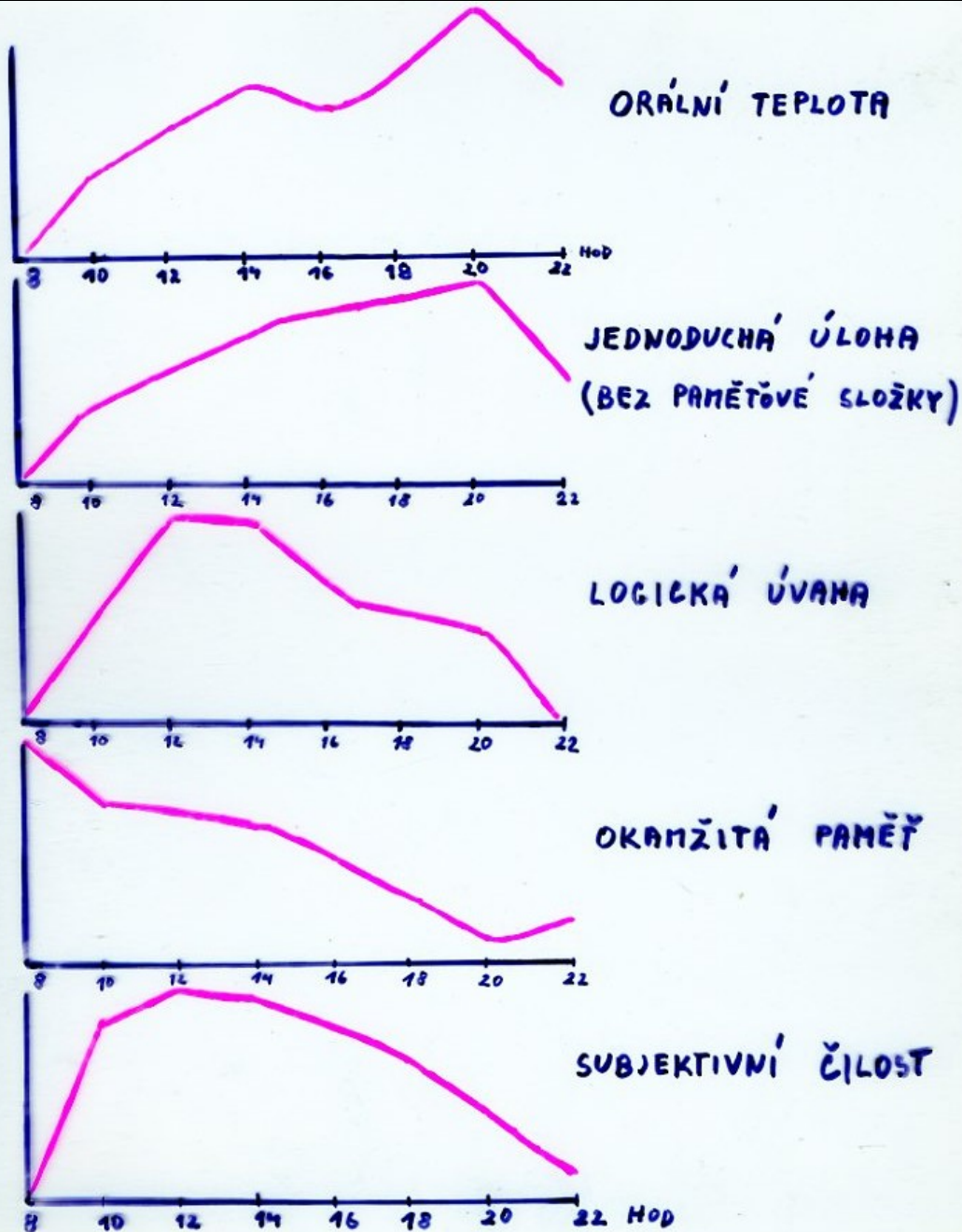
- ❖ **Jet Lag or Rapid Time Zone Change Syndrome:** This syndrome consists of symptoms that include excessive sleepiness and a lack of daytime alertness in people who travel across time zones.
- ❖ **Shift Work Sleep Disorder:** This sleep disorder affects people who frequently rotate shifts or work at night.
- ❖ **Delayed Sleep Phase Syndrome (DSPS):** This is a disorder of sleep timing. People with DSPS tend to fall asleep very late at night and have difficulty waking up in time for work, school, or social engagements.
- ❖ **Advanced Sleep Phase Syndrome (ASPD):** This is a disorder in which a person goes to sleep earlier and wakes earlier than desired. ASPD results in symptoms of evening sleepiness, going to bed earlier (for example, between 6 p.m. and 9 p.m.), and waking up earlier than desired (for example, between 1 a.m. and 5 a.m.)
- ❖ **Non 24-Hour Sleep Wake Disorder:** This is a disorder in which an individual has a normal sleep pattern, but lives in a 25-hour day. Throughout time, the person's sleep cycle will be affected by inconsistent insomnia that occurs at different times each night. People will sometimes fall asleep at a later time and wake up later, and sometimes fall asleep at an earlier time and wake up earlier.



Cirkadiánní rytmy



Průběh výkonnosti



Pracovní doba

- FIXNÍ
- ROTUJÍCÍ (STRÍDÁNÍ SMĚN)
- „NETRADIČNÍ SYSTÉMY“:
 - PRUŽNÁ (POHYBLIVÁ)
 - VOLNÁ
- + JEDNORÁZOVÉ NOČNÍ SLUŽBY (OJEDINĚLÉ - PRAVID.)

POTENCIÁLNĚ NEPŘÍZNIVÉ SYSTÉMY:

- ZAHRNUTÍ NOČNÍ SMĚNY
- ROTUJÍCÍ

HLAVNÍ SFÉRY NEG. OVLIVNĚNÍ NOČNÍ PRACÍ

- CIRKADIÁNNÍ RYTMY

PRAČE V DOBĚ ÚTLUMU,
SPÁNEK V DOBĚ AKTIVACE

PROČ NEDOCHÁZÍ K ADAPTACI:

- NEZMĚNĚNÉ VNĚJŠÍ SYCHRONIZÁTORY
- VÍKEND (NEBO JINÉ VOLNO)

- SPÁNEK

- VIZ. CIRK. RYTMY
- HLUK
- RODINA

- PSYCHOSOCIÁLNÍ ASPEKTY

- STRAVOVÁNÍ

OPATŘENÍ:

- CO NEJMÉNĚ SUKCESIVNÍCH NOČNÍCH
- NE PŘI SOUČASNÉM DALŠÍM RIZIKU
- NE PRO ŽENY
- INDIV. VÝBĚR (KONTRAINDIKACE)

Negativní působení směnné práce

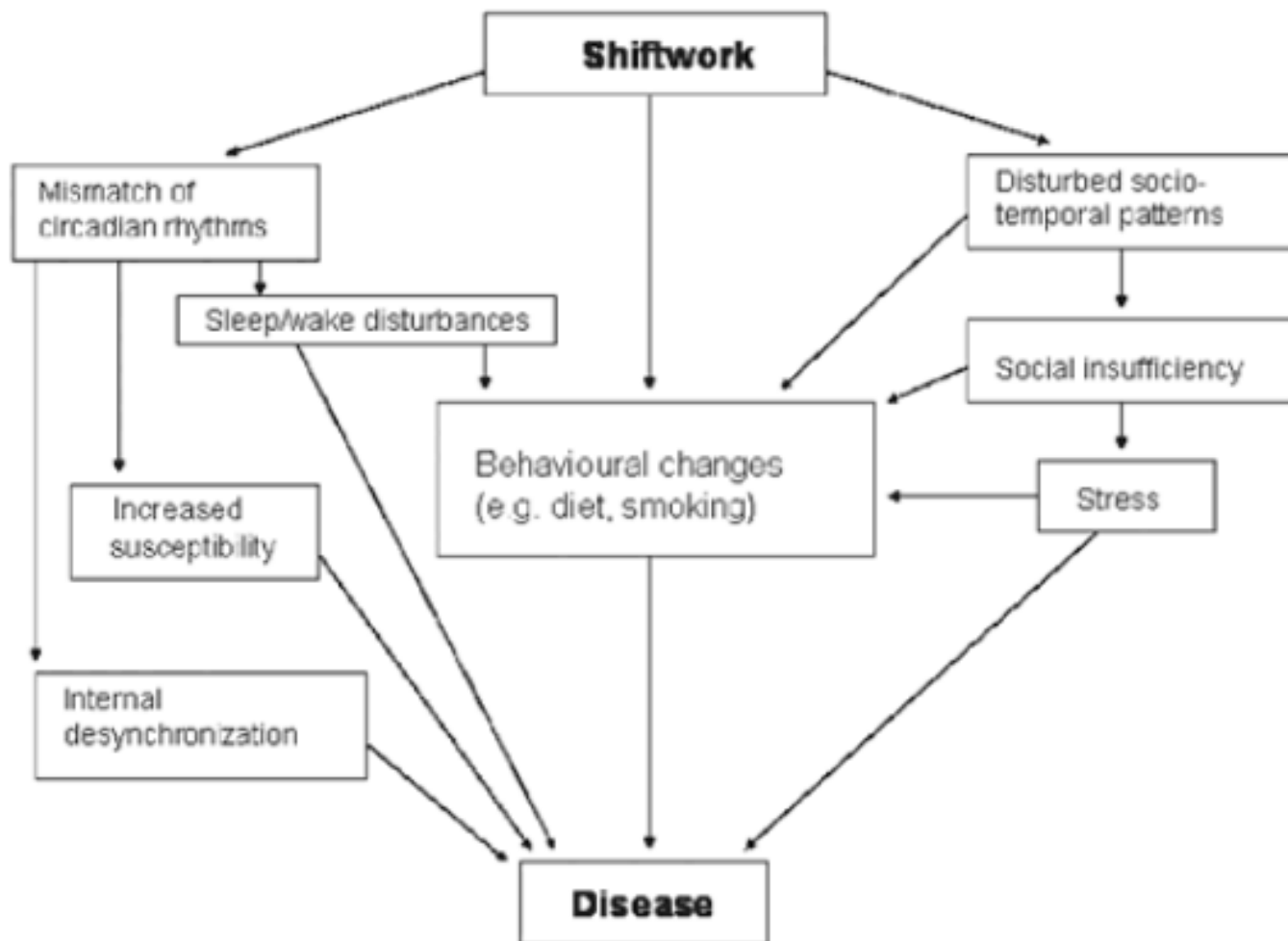


Figure 2: Exposure to unusual light-dark cycles produces diverse pathologies. Schematic representation of the direct consequences of exposure to unusual light-dark cycles that can be experienced by people under shift work schedules or exposed to chronic jet-lag. These direct consequences could be involved in disease etiology. Figure from [1].

Kontraindikace pro směnnou a noční práci

- *Poruchy spánku*
- *Deprese, jakékoliv psychické poruchy*
- *Epilepsie*
- *Diabetes*
- *Poruchy zažívání*
- *Kardiovaskulární onemocnění*