

## **BIOLOGICAL RHYTHMS:**

A biological rhythm is any cyclic change in the level of a bodily chemical or function. Biological rhythms are molecular, physiological, or behavioural events that recur and are a ubiquitous property of all living organisms. Rhythmicity coordinates biological systems and synchronizes them with the external environment.

Biological rhythms can be:

1. **Internal (endogenous)** - controlled by the internal biological clock e.g., body temperature cycle etc.
2. **External (exogenous)** - controlled by synchronizing internal cycles with external stimuli e.g., sleep/wakefulness and day/night. These stimuli are called zeitgebers -- from the German meaning "time givers". These stimuli include environmental time cues such as sunlight, food, noise, or social interaction. Zeitgebers help to reset the biological clock to a 24-hour day.

The branch of biology that deals with the study of biological rhythms is called **chronobiology**.

### **TYPES OF BIOLOGICAL RHYTHMS:**

1. Circadian rhythm,
2. Circa-tidal rhythm,
3. Lunar rhythm,
4. Semilunar rhythm,
5. Circannual rhythm.

### **CIRCADIAN RHYTHM:**

- Circadian rhythms are physical, mental, and behavioural changes that follow a 24-hour cycle.
- These natural processes respond primarily to light and dark and affect most living things, including animals, plants, and microbes.
- Chronobiology is the study of circadian rhythms.
- One example of a light-related circadian rhythm is sleeping at night and being awake during the day.

### **BIOLOGICAL CLOCKS:**

- **Biological clocks are organisms' natural timing devices, regulating the cycle of circadian rhythms.**

- They're composed of specific molecules (proteins) that interact with cells throughout the body.
- Nearly every tissue and organ contain biological clocks.
- Researchers have identified similar genes in people, fruit flies, mice, plants, fungi, and several other organisms that make the clocks' molecular components.

### **CIRCADIAN RHYTHMS WITH EXAMPLES:**

- Regularly occurring daily cycle of light and dark (day and night) have been known to exert a far-reaching influence on behaviour and metabolism of many organisms.
- The response of different organisms to environment rhythms of light and darkness is termed as **photoperiodism**.
- The phase with light and without light are termed as **photo-phase** and **scato-phase** respectively.
- Animals are not active continuously throughout day (24 hours).
- The animals that are active during light phase or day time are called **diurnal animals**. Ex: honey bees, ants etc.
- The animals that are active especially during the absence of natural light are termed as **nocturnal animals**. Ex: Cockroach etc.
- There are few animals that are active during sunrise and sunset (dawn and dusk) are called Crepuscular animals. Ex: Rabbit.
- Thus, the 24-hour cycle is marked by alternating periods of walking, feeding during daylight and resting or sleeping at night in diurnal animals and vice versa in nocturnal animals.
- These repeatable rhythms correlate with the Earth's 24-hour rotation called **Circadian rhythm** or **circadian clock**.

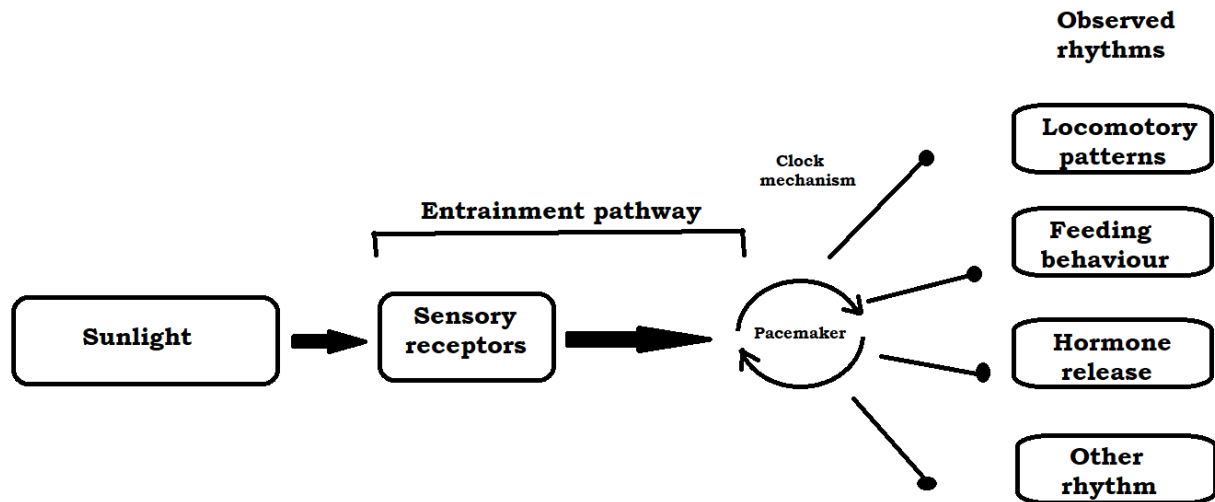
### **Examples:**

1. Algae and phytoplankton photosynthesize during daylight hours in upper regions of a lake or ocean. At midday, these are seen well below the surface and as darkness approaches, these creatures swim upwards to feed upon the each other. These sink back into deep waters after sunrise.
2. Female crickets usually hide in burrow or under litter during the day and move about only after dusk to search for mates. In response, males start calling to attract mates in the evening of each day.

### **CIRCADIAN RHYTHM IN INSCETS:**

- Circadian rhythm in insects is influenced by the presence or absence of light in the environment.

- Presence of light in environment triggers certain behaviours like locomotion, feeding, hormonal cycle etc.
- Absence of light induces behaviours like mating, etc in few insect species. Ex: Crickets.



#### **SCHEMATIC REPRESENTATION OF CIRCADIAN RHYTHM IN INSECTS:**

- In the presence of sunlight, the photoreceptors of the eyes sense the presence of light.
- Sensory receptors of the body are activated and which enhance the speed of metabolic activities of the body.
- The pacemaker (master clock or brain) stimulates the functions such as locomotion, feeding, hormonal release etc.
- In the absence of light, photoreceptors of eyes do not sense any light and therefore the pacemaker do not activate any vital activities of the body.
- Hence, by this its experimentally concluded that in the presence of light in environment decides many activities in the animals.
- Therefore, it can be concluded that day and light phase of Earth decides the circadian rhythm of an individual.

#### **BIOLOGICAL CLOCK WITH EXAMPLE:**

Biological clocks are natural timing devices of the animal that regulate the circadian cycle. These clocks have direct role in determining the type of activity that has to be performed by an individual.

Few scientists claim that both circadian rhythm and biological clocks are one and the same.

- Humans too have specification in the activities that are to be performed in presence or in absence of light in the environment.
- Man performs various activities like physical work, metabolic work, mental activities in the presence of light and in the absence of light, he tends to rest or relax.
- Therefore, humans can be called as **diurnal animals**. But unique feature in man is that **he can manipulate the biological clock of him as per the need**.
- The biological clock in humans is under neural control and it is in control of suprachiasmatic nucleus (SCN) of hypothalamus.
- SCN is a pair of cell clusters in the hypothalamus that receive inputs from nerve fibres originating in the retina.
- SCN acts as master clock in regulation biological clock of humans.
- When the light is present in the atmosphere, the retina senses the light and the impulses are carried to SCN in hypothalamus.
- SCN being central pacemaker, sends signal to pineal gland.
- The pineal gland cyclically changes the production of melatonin hormone (dark hormone) and it's produced in least in the presence of light.
- This triggers other fundamental activities of the body such as walking, feeding, working etc.
- In the absence of light, the melatonin is secreted in large volumes that trigger the resting phase of the humans.
- Hence, presence and absence of light determines the biological actions in humans.

#### **IMPORTANCE OF CIRCADIAN RHYTHM AND BIOLOGICAL CLOCK:**

- Circadian rhythmicity is present in the sleeping and feeding patterns of animals, including human beings.
- There are also clear patterns of core body temperature, brain wave activity, hormone production, cell regeneration, and other biological activities.
- In addition, photoperiodism, the physiological reaction of organisms to the length of day or night, is vital to both plants and animals, and the circadian system or biological clock plays a role in the measurement and interpretation of day length.
- Timely prediction of seasonal periods of weather conditions, food availability, or predator activity is crucial for survival of many species.
- Although not the only parameter, the changing length of the photoperiod ('daylength') is the most predictive environmental cue for the seasonal timing of physiology and behavior, most notably for timing of migration, hibernation, and reproduction.

### Effect of light–dark cycle

- The rhythm is linked to the light–dark cycle.
  - Animals, including humans, kept in total darkness for extended periods eventually function with a free-running rhythm.
  - Their sleep cycle is pushed back or forward each "day", depending on whether their "day", their endogenous period, is shorter or longer than 24 hours.
  - The environmental cues that reset the rhythms each day are called zeitgebers.
  - Totally blind subterranean mammals, e.g., blind mole rat *Spalax* sp., are able to maintain their endogenous clocks in the apparent absence of external stimuli. Although they lack image-forming eyes, their photoreceptors (which detect light) are still functional; they do surface periodically as well.
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