BIOLOGICAL - CLOCK

As a clock is responsible for informing the time of the day and night, a thermometer is responsible for informing the rise and fall of temperature and a barometer is responsible for informing the changes in pressure of the environment, similarly there is an equipment within the body of animals and plants which are existing in this gigantic living universe. This equipment is responsible for resting and active conditions of animals or plants working in response to the environmental factors. This equipment or device is termed as "BIOLOGICAL - CLOCK". This term was first coined by a German plant physiologist named "ERWING BUNNING" in 1929.

This clock regulates the active and resting conditions of animals in response to the external factors. These active or resting conditions in response to external environmental factors are known as rhythms and these rhythms are kept regular or entrained by environment cues known as Zeitgebers.

for example, regular rising and setting of the sun. If the normal Zeitgeber is blocked from the animals there a substitute takes place in the working of the animal to synchronize gradually with the new environment.

The regulatory factors or the basic manifestations of a biological clock may be divided into four groups -

1. **CIRCADIAN RHYTHM** — These rhythms are related with the rise and setting of the sun. It is a cyclic variation in the intensity of metabolic and physiological processes of a day. It is a cyclic variation of some facet of behaviour of about 24 hours.

In other words, in this natural habitat, animals or plants remains in the rest or active during the day hour or photoperiod is called as circadian rhythm. It is generated by the rotation of the earth on its axis.

It may be divided into sub-groups —

(a) **DIURNAL RHYTHM** — It is a rhythm

of biological variations occuring between sunrise and sunset, and

(b) **NOCTURNAL RHYTHM** — It is a rhythm of biological variations occuring between sunset and sunrise.

There are many examples of circadian rhythm. The most common well studied circadian rhythm was given by Aschoff and Weaver in 1966 is "SLEEP" which remains undisturbed even if a human being is kept isolated from all environmental influences.

Babies show a four hour awaking rhythm apparently every hour to four for feeding. So, initially a circadian rhythm of 25 hours develops which gradually becomes synchronized to a 24 hour rhythm with maturation of sense organs. This shows that circadian rhythm is actually of 24 hours and innate.

Daily activity patterns may be changed by learning and may change at different seasons of the year. For example, in nocturnal animals such as bats and deer mice which become active at sunset. Total activity time of these

type of animals tends to be longer in winter season than that of summer season because the duration of winter nights become more than that of summer nights. In diurnal animals, on the other hand it tends to be shorter in winter.

2. **TIDAL RHYTHM** — These rhythms are related with tides and these occur twice a day with the reflex of tide and flowing movement of sea.

For example, in Mussels (i.e. Mytilus edulis and Mytilus californis), rhythmic fluctuations in the rate of water population relating to the tide was observed by K. S. Rao in 1954.

3. **LUNAR RHYTHM** — The correlation of animals with moon is known as lunar rhythm or lunar periodicity. This type of rhythms are mostly present in marine animals. The activity of the animals which shows this type of rhythm is the highest at the full moon and the lowest at the quarter moon.

Grunion fish is the most common example which shows the lunar rhythm. It is affected by the tides. At the time of full moon when the tide becomes high and this fishes come on the sea-shore with the tide and breeding takes place. The higher tide penetrates the eggs in sand. They do not hatch up to two weeks. After two weeks, when the highest tide comes, the small fries come from the eggs and enter the sea.

So, we can say that, the lunar rhythms are associated with 14th/28th day cycle of the moon. In other words, from our point of view, it is the menstrual cycle of women having a periodicity of 28 days. But in some other animals, this corresponds to a cycle of about 29.5 days. The most common example is the Palola worm (i.e. Eunica) in which reproductive activity occurs during the neap or low tides of last quarter moon in October and November. The fresh water guppy (i.e. Paecilia reticulata) has

a rhythm of changes of spatial sensitivity which corresponds to the lunar cycle

4. **CIRCANNUAL OR SEASONAL RHYTHM** ——

These rhythms have a period of about one year under constant laboratory conditions such as sufficient light, temperature, heat etc. when all exogenous influences are shut out. It has been established in birds. In them, migration takes place in a season and after that season these come to their own places. Again in that season after one year, migration takes place. So, a cycle of one year or seasonal periodicity is maintained. The other example is the hibernation of frog of periodicity of about one year. In mammals, for example Western European hedge-hog (i.e. Erinaceus europeans) and also in man there are marked physiological changes which are correlated with the season.

Other examples, such as Garden Warbler and Willow Warbler are long distance migrants which

show seasonal changes.

Except these rhythms, the some other rhythms are the followings —

(a) **ENTRAINED RHYTHM** — These rhythm may persist for sometimes, even in the absence of the entertaining agents, the zeitgebers. For example in White rat, normal estrous cycle continues when it is kept in constant darkness. However, when continuous light is given the rat stops ovulating because ovulatary storage of gonadotro-phins fails to appear.

(b) **PERSISTENT RHYTHM** — It is chara-cterised by persistent factors which are long effectives. It seems to have solar and lunar day effect.

The biological clock which is persistent in the diurnal change in the activity are not persistent with the absence of environmental changes.

Some effects of photoperiodism are seen which are as follows —

(i) It affects the pituitary gland. If the time lengths of light is more

pituitary is more affected and there a more secretion of growth harmones will take place and as a result gonads become increase.

(ii) Due to increase of gonads, animals want to copulate. So, breeding takes place which was observed by Bowen in 1930. Rate of reproduction in birds increase during summer season when light is more.

(iii) The migration of birds is also affected by photoperiodism. Some birds live in cool but in summer that fly at hill. Some birds live in hot region. So, they come to cold region in summer.

(iv) It also affects the stage of development called DIAPAUSE. If photoperiodism increases, it gives an increase in metabolic activities which resist to extreme of climatic factors and thus the development also increases.

Some theories have been given to concern the biological clock in which these two are important —

A. EXOGENOUS THEORY — This explained that some environmental factors

B.

influence the rhythm such as magnetic field. This theory has not been accepted.

B. **ENDOGENOUS THEORY** — It is the modern theory. It explains that biological clock is an endogenous presence inside the animals. But the external factors may also affect internal factors thirdly. It has been accepted by many workers.

CONCLUSION —

Having a bird's eye view on the basis of above discussions it can be concluded or it can be said clear that biological clock which movement or working is based on the interplay of external and internal factors.

Finally, we can say that biological clock is an internal autonomous device of animals and plants.

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