Conclusion
CONCLUSIONS

Living organisms have remarkable sense of time. All living organisms exhibit a structured organization in time as well as space. Mammals are no exception and express rhythmicity in their behavior, physiology and biochemistry. These rhythms are of various periods, the 24 hr rhythm perhaps being one of the most important one. These 24 hr rhythms, known as circadian rhythms are endogenous in nature and are generated and entrained to the environmental cues by the suprachiasmatic nucleus (SCN) in the brain. Though the suprachiasmatic nuclei has been identified as the locus of the biological clock, how it functions has not been elucidated as yet.

Though light is not the only external cue that entrains the endogenous circadian rhythms to the external environmental rhythms - it has been long recognized as the most important time cue or zeitgeber. In this study how light affects the circadian system has been examined. This has been done by adopting the following procedures -

[a] studying the the effects of continuous light exposure for 24 consecutive days
[b] studying the effects of light pulses

c) studying, in contrast, the effects of darkness - both dark pulses as well continuous exposure to darkness.

d) and comparing the above three with animals which were exposed to LD 12:12.

It was observed that:

1. Multiple unit activity recorded from the SCN showed a circadian rhythm that persisted under LD 12:12, as well as both LL and DD.

2. The activity peaked during the day or the subjective day while the trough was during the night or the subjective night.

3. This rhythm was $180^\circ$ out of phase with the rhythm of the multiple unit activity recorded from other brain areas.

4. Rats exposed to continuous darkness (till they became free running) and given a light pulse showed an increase in electrical activity of the SCN which gradually decreased
and stabilized within 20 minutes.

5. Dark pulses given to animals, previously exposed to continuous light (till they became free running) produced a decrease in electrical activity of the SCN by 40%.

6. Serotonin content of the SCN showed a circadian rhythm which persisted under constant conditions.

7. Under LD 12:12 serotonin content was maximum just after midnight while the minimum was at about ZT 16.

9. Under constant conditions the profile of the serotonin rhythm was altered.

10. Nitric oxide levels in the SCN showed a circadian rhythm that persisted under constant illumination.

11. The peak concentration was around ZT 12 or CT 12.

12. Light always produced an increase in the nitric oxide level of the SCN. This change was also showed a circadian variability - with light pulses increasing the nitric oxide content by 22.7% at CT 12 and by 38% at CT 24.

13. Spermine and spermidine levels in the SCN showed
circadian rhythms which persisted under not only LD 12:12 but also LL and DD. The maxima were observed at night or subjective nights.

14. Spermine and spermidine levels in the whole brain also showed circadian rhythms which persisted under constant light or constant darkness. The profile of the rhythms of spermine and spermidine in the whole brain were very similar to that of the SCN though the absolute values were slightly different.

15. Petruscine levels were not detectable - neither in the SCN nor in the whole brain.

16. Dark pulses increased the polyamine levels and these increases were dependent on the circadian period.

17. Na, Ca, K and Mg did not show any circadian variability either in the SCN or in the whole brain.

From the above observations it is quite apparent that:

A. Serotonin plays an important role in modulating light information in the SCN and in the overall SCN output.
DIAGRAM SHOWING THE CIRCADIAN SYSTEM IN MAMMALS

B. Nitric oxide also plays an important role in modulating light information in the SCN.

C. But most probably they act at different levels as their peaks (as well as the overall profiles of the rhythms) occur at different times (both CT and ZT).

D. Spermine and spermidine do not show any clear cut relationship with the SCN electrical output and therefore most probably does not have any role in entrainment or rhythm generation. It seems that the circadian variation of these two polyamines is a product of rhythms generated by the biological clock.

E. Calcium, which has been shown to have a number of functions in the SCN is not released by any of the inputs to the SCN. Rather than the Ca fluxes are essentially between intra and extra cellular spaces.

Thus it is clear the effects of light and darkness or the process of entrainment is mediated by a number of factors of which serotonin and nitric oxide are two very important factors.