SIGNIFICANCE OF THE CHRONOBIOLOGICAL APPROACH IN CARRYING OUT AGING STUDIES*

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INTRODUCTION

Chronobiology is the branch of science that explores mechanisms of biological time structure, including important rhythmic manifestations of life.

Rhythms of many frequencies, at most levels of animal and plant life, and from all levels of biological organization have been demonstrated. Oscillation is firmly established as a fundamental property of all life. Because of the regularity of these rhythms, some refer to them as biological or physiological clocks.

The range of frequencies that has been found in the living system extends from cycles of less than a second to cycles of a year or more. It is noteworthy that many, but not all, clearly correspond to physical and environmental frequencies, such as the natural light-dark cycle. There is strong evidence that many rhythms are adaptive and serve to adjust the organism to periodic changes in its environment.

This presentation will concentrate on the frequencies corresponding to the 24-hour day or the circadian (circa, about; dies, day). The adjective "diurnal" is sometimes used synonymously with circadian, but diurnal is better used to describe animals active by day as opposed to nocturnal animals which are active by night. Circadian rhythms are ubiquitous in eukaryotic, unicellular, and multicellular organisms. Recent data on the growth rate of

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bacteria suggest that circadian as well as higher frequency rhythms (ultradian) also characterize the prokaryotic cell (Halberg and Conner, 1961; Sturtevant, 1973).

Fluctuations of most physiological variables are not apparent to us in the same sense that the respiratory or menstrual rhythm is; they only become overt when they are properly measured at frequent intervals over the 24-hour time scale. Because of their somewhat "invisible" nature, there is a tendency on the part of some investigators to slight or ignore them in experimental design. In spite of all that is known, they simply are not being accorded the attention they deserve. This undoubtedly is due in large part to the fact that the science is young (Scheving, 1974).

Overall Objective

The objective of this paper will be to present some data obtained from studies done on elderly human beings as well as from a comparative study of several rhythmic variables in the serum of rodents measured at successive life stages using a chronobiological approach. Such an approach implies that the basic circadian rhythmic nature of the variable under study was considered.

Before presenting these results, I will show first some data on healthy young human beings, and secondly a few examples of rhythms in standardized rodents. Such examples will illustrate what can be expected in young individuals. I will also present some data obtained from a more heterogeneous population of patients with the disease leprosy.

ILLUSTRATIVE EXAMPLES OF RHYTHMS

One of the earliest documented and most extensively studied hormonal rhythms in mammals is the serum steroid rhythm (Pincus, 1943). This rhythm, illustrated in Fig. 1 for both rat and man, will be used to demonstrate some of the basic properties of rhythms and the special terminology used to describe their behavior.

In the diurnally active man, serum steroids begin to be secreted from the adrenal gland prior to awakening, and reach their peak of secretion shortly after he arises. In the nocturnally active rat, the peak occurs shortly before the active period begins (Scheving and Pauly, 1974). The four-fold or greater variation (amplitude) seen along the 24-hour time scale clearly shows that such variation is not a minor fluctuation around the 24-hour mean that could be ignored in experimental design (Scheving, 1974). It should also be noted that rhythms with higher than circadian frequencies (ultradian) (Berson and Yalow, 1968) and lower frequencies