Human Circadian Rhythms and Sleep-Wake Cycle

Knowledge about the process of normal sleep will help in cultivating healthy sleep-wake behavior. Every living being has an innate desire to sleep as their survival depends on it. There are two types of sleep:

- 1. *Circadian sleep.* It is the rejuvenating sleep brought about by hormone melatonin. Light (photic) signals from sunlight/daylight stimulate the brain clock, which in turn sends a message to the pineal gland located near it. The mood-elevating hormone serotonin gets synthesized in the pineal gland first in response to the brain clock signal. Melatonin, in turn, is manufactured from the serotonin. Since the sleep hormone melatonin and mood-elevating chemical serotonin are interrelated, poor sleep leads to depression, and the depression, in turn, leads to insomnia.
- 2. Deficit sleep. The desire for sleep which gets built up at the end of a day's activity is called sleep deficit or sleep debt. The metabolic activity during the wakeful state produces accumulation of a chemical substance called adenosine in the brain. Adenosine is the chemical driver of the sleep. The longer the body is awake and active, the more will be the accumulation of adenosine, and the more intense will be the drive for rest and sleep.

How the Circadian and Deficit Sleep Work Together to Regulate Normal Sleep

The first and foremost function of the brain clock is to keep the body awake during the daylight hours. The deficit sleep drive of adenosine keeps building the sleep drive with each accumulating awake hour. As the dark of night approaches, the awake signal from the brain clock dampens, and the sleep driver (adenosine) takes over to initiate the process of sleep. Rejuvenating sleep follows the deficit sleep. Melatonin hormone release from the pineal gland starts at around 9 PM and is responsible for the rejuvenating sleep. Two hours before morning wake up time, the brain clock begins with the alert signals, and the melatonin release from the pineal gland stops. Cessation of the melatonin secretion coincides with a fully awake state of the morning.

"It must be noted that the normal wake up process which follows the rejuvenating sleep in an individual is a spontaneous phenomenon. It does not require an alarm clock. The need for an alarm clock daily to wake up in the morning is an indicator that the sleep-wake cycle is not in natural harmony, and there is residual sleep debt."

How Much Sleep Does a Human Need?

Sleep needs change over the lifetime of the human. Infants under one year need up to 16-18 hours of sleep. Seep hours then decrease steadily as the child grows. For optimal health, an adult needs 7-8 hours of sleep. Of these 7-8 hours:

- The first 20-30 minutes get spent in the process of falling asleep. The sleep onset time longer than 30 minutes suggests insomnia.
- First four hours of the sleep go towards paying back sleep debt or sleep deficit created during the day's activity.
- The final 3 hours of the daily sleep cycle are rejuvenating sleep, which is under the control of the sleep hormone melatonin. The rejuvenating sleep is a critically important part of the sleep

process as creativity, memory consolidation, repair of body tissues, and the hormone secretion occurs during this phase.

For the majority of the adults, 7 hours of sleep is a good guideline. The sleep duration of fewer than 7 hours creates sleep debt. There are, however, exceptions to this rule. If someone sleeps little less than this duration but feels refreshed, not tired or sleepy during the day, and does not require an alarm clock to wake up daily, he/she can be considered to be getting required hours of sleep.

Health Problems Associated with Perpetual Sleep Debt

Perpetual sleep debt day after day is also called the state of chronic sleep deprivation. The sleep debt is the amount of sleep one needs, minus the amount of sleep one gets.

For every hour one stays awake, he/she will accumulate sleep debt of 20-30 minutes. Over 16 hours of the awake cycle, the sleep debt of 7-8 hours gets accumulated. A state of the sleep debt is a significant problem in the modern urban population who stay perpetually engaged with work or social activities going late into the night. Two or three hours of sleep debt for a day or two is easy to catch up in the following few days. However, longer sleep debt accumulated day after day is hard to pay back. The perpetual sleep debt or sleep deprivation leads to many health problems, such as:

- a) Headache, migraine
- b) Mood disorders such as anxiety, irritability, anger, hostility, and depression
- c) Lack of concentration—attention deficit disorder
- d) Poor memory

A constant feeling of being tired and sleepy