

Biological Clocks, Aging and Dis-ease: A Chronobiology Primer



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The timing of certain actions can be critical--just a fraction of a second can make a difference when avoiding a collision with a car or hitting a ball with a bat. In contrast, the sense of time going away can be wonderful, such as when reading a good book or article (such as this one!), watching a movie or having a massage.

The ability of an Olympic gymnast to land backward on a balance beam requires coordination of billions of processes. Computer graphics and robotics strive for the elegance of human movement.

Besides coordination with the outer world, internal processes such as sleep, digestion, heart rhythm, and hormonal rhythms require proper synchronization for optimal health.

Rhythms and Chronobiology

A rhythm is a pattern in time. Chronobiology is the science of biological rhythms. Virtually every activity and treatment has an optimal timing. For example, 30 years ago insulin was given only once a day; now it is given by a pump all day long, peaking with meals. In Chinese Medicine each system has a peak that lasts 2 hours and a lull 12 hours later.

Many systems work on a diurnal or 24 hour cycle, the most obvious being sleep; while other processes, such as digestion may have several peaks over the day. Other important peaks, such as the liver function between 11pm and 2am, or hormones such as testosterone and cortisol, are not obvious but equally critical. There are also seasonal cycles that affect sleep, mood and appetite. We often feel the peaks and valleys of function via alertness, anxiety, fatigue, clarity, hunger, and pain.

Sleep, Melatonin, the Hypothalamus and Signal Systems

The dominance of sleep forces us to surrender one third of our lives to its demand. However, if we cheat it by sleeping less than 7-9 hours, we age more rapidly and increase the risk of diseases such as obesity, diabetes, depression, Alzheimers, heart disease and cancer.

The pineal gland, in the back of the brain, produces the hormone melatonin. Melatonin's function is to coordinate the various clocks and virtually every cell of the body. It is one of the oldest hormones in evolution, even present in reptiles. Some frogs have a clear membrane over their pineal gland to detect sunlight directly.

The hypothalamus, a nerve center deep in the brain, is the "CPU" of our nervous system. It controls and coordinates sleep and arousal, hormones, hunger, emotion, and all bodily functions. It receives light information to tell the pineal gland when to make melatonin. Just a small amount of light in our bedrooms can disrupt the peak of melatonin at 11 pm. A newly discovered part of the hypothalamus called the orexin/ hypocretin system also has powerful effects on sleep and awake, and is involved in some sleep disorders.

There are specific signal systems in the digestive

system, endocrine system, brain, heart, and virtually every cell of the body. They are in constant communication with the hypothalamus via email messages through nerves, and snail mail via melatonin and other signal molecules.

Applications

The optimal time to eat, take medications, think and exercise varies by activity, agent and by individual. Some

people are extremely sensitive to changes in timing. Altering the sleep-wake cycle for travel or work is known to harm health and performance, for which there is growing regulation (drivers, pilots, doctors). "Sleep hygiene", a deliberate practice of healthy sleep, is a simple, effective and inexpensive practice that is under-utilized.

The rhythm of the adrenal glands create a burst of energy that wakes us at 6-7 am with a peak in the hormone cortisol. If this peak occurs too early, we wake up in the middle of the night, and if too late we have trouble waking and then can get irritable, anxious or panicky later in the day.

Regarding diet, it's not just the carbs, fats and proteins that we emphasize or avoid, it's also when they are eaten and in what order. "Intermittent fasting" is a method of timing when we don't eat.

The question of how often to exercise, and what type is subject to intense debate. Yoga greets the day with "sun salutations."

For the last 100 years, the light bulb has enabled us to separate from the rhythms of the day and seasons; while convenient there are downsides to this change in human life.

The health care crisis and growing incidence of brain dysfunction in our children will require that we all share cost, risk and responsibility to find simple preventative solutions to chronic problems, rather than complex high-tech, expensive, risky medications and procedures. Chronobiology will grow as an important strategy for health care.

IMPORTANT NOTES:

1. **This educational material may not be used to influence medical care without supervision by a licensed practitioner.**
2. These contents are ©2015 by Michael Cheikin MD and may not be reproduced in any form without express written permission.
3. Dr. Cheikin's website has related articles such as "BioRhythms", Sleep, Adrenal Fatigue and many others.
4. Epigenes are the software that modify DNA expression, which can take effect in a huge range of time, from seconds, to decades.

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Rhythms of the body	
Duration of cycle	Description
1 second	Heart contraction
5 seconds	Breath cycle, 12 breaths per minute
45-90 minutes	Changes in alertness and internal activities
Diurnal	24 hours, coordinated with the sun
3 days to decades	Epigenetic modulation and DNA induction ⁴
Weekly	An arbitrary rhythm based on 7 days
Monthly	Coordinated with the moon (and other members of our species)
Seasonal	Changes every 3 months in daylight, temperature, foods, activity
Annual	Based on the orbit of the earth around the sun
7 year	Cycles of change such as puberty, brain skills and menopause
20 years	Each generation represents a change in genes and physiology