I've Got Rhythm, You've got Rhythm, All God's Children Got Rhythm

By, Robert H. Jordan, Jr., Ph.D.

When I came to, I was gazing through bleary eyes into the face of Tommy Nyntoyia, our host in Thailand and the man who had put the trip together. I had only been asleep for about 10 minutes, but during that time, I had fallen into a deep, coma-like, semi-consciousness that gripped me as though an anesthesiologist had knocked me out.

This was day three of my group's visit to beautiful Thailand. Our first two days had been in Bangkok and now we were in Chang Mei getting fitted for bargain-priced, tailor-made, silk suits at a craftsman Tommy had recommended. Ten days later on our return to

Bangkok, after touring Thailand, we would pick up our suits on the way back to the US.

While my friends had gone-in to be measured, I had slumped into a heap on a comfortable couch, outside the fitting room, waiting for my turn. But my problem that day was, not my bulging waistline, it was my invisible energy level. I couldn't keep my eyes open. It was as if I had been drugged or had taken ill.

Tommy, looking concerned, said, "You're sick – just jet lag.. Not enough sleep at the right time." I had heard of jet-lag, but thought it was more of a myth or only applied to weaklings or pilots who jumped around from time zone to time zone. It had never happened to me before and I was almost immobilized by the extreme need for sleep.

As I got to my feet, I felt groggy and dazed. All I wanted to do was go lie down and nap. A simple nap seemed like such a divine pleasure – if only I could steal 20 minutes. That was all I wanted. But, we had a full day ahead of us: lunch - next, then riding elephants, and later a tour of one of the most famous Temples or Wats., as they are called, in the city: a tour of **Wat Phra That Doi Suthep,** which is the most famous, perched high up in the mountain that overlooks Chang Mei – 365 steps to the top.

So, I slept in the cab all the way to the game preserve where the elephants were located. It was just as I had desired, spending 20-minutes, with my eyes closed – even in a bumpy taxi, rolling through the traffic-clogged streets, jammed with motorcycles, bicycles, Tuks Tuks, which are motorized rickshaws, and buses, spewing thick, black, noxious, diesel smoke – I

slept like a baby. And much to my surprise, when I woke up, I felt much better – refreshed and energized for the rest of the day.

I realized that I actually had been ill from jet-lag. My body had truly reacted negatively to the disruption in my sleep pattern - or more correctly a resetting of my Circadian Rhythm. Your Circadian rhythm (also known as your sleep/wake cycle or body clock) is a natural, internal system that's designed to regulate feelings of sleepiness and wakefulness over a 24-hour period.[1]

All animals and plants have a built-in circadian rhythm, which is adjusted or entrained to the environment by **external cues**, known as Zeitgebers (a German word meaning "time-givers"), the most important of which is **daylight**. The brain's internal circadian

clock (also known as the **biological clock**, **body clock**, **circadian pacemaker**, **circadian system**, **circadian oscillator**, etc.), which is centered in the hypothalamus region of the basal forebrain, uses these Zeitgebers to naturally synchronize or reset itself each day to within just a few minutes of the Earth's 24-hour rotation cycle (the word "circadian" comes from the Latin words meaning "about a day").[2]

Probably the first animal you think of when considering examples of Circadian Rhythm is the Cicada. We had a huge infestation of broods in 2003 and the 14-year cicadas returned last Summer with their piercing, ear-splitting noises. The 17-year broods, the largest are due to visit us again in 2021.

Some people get confused by the two words Circadian and Cicadia. Even a spell-checker

might give you one when you really want the other. **Circadian** (pronounced “sir-kay-dee-ann”) is an adjective. It means the biological cycles that repeat every 24 hours. **Cicada** (pronounced “si-kay-duh”) is a noun. It means a very large flying insect with a trademark hissing call that it emits during the morning and evening hours of summer in warm climates.

The name Cicada is actually Onomatopoeia – a word that is pronounced like it sounds; zoom, Bam, pop, and cicada – are all examples and si-cadia mimics the sound the insect emits.

One of the nagging mysteries surrounding cicadas is how they calibrate their internal clocks. The great cicada invasion of 2013 is now a memory. Brood II emerged from the ground, created quite an enormous amount of noise in some parts of the Midwest and Northeast,

found a mate and bred and then began to die off, leaving their carcass everywhere to be crushed underfoot giving off a sound resembling a ball of crackling cellophane.

When we reflect on the cycle of Cacadiae, it is indeed an incredible feat. Imagine what it would be like- as advanced as we humans are - to be placed deep into a dark cave without a clock or calendar and being told to come out after exactly 17 years. Few other insects — or any species, for that matter — have such a long and precise ability to gage time so accurately.

Many scientists have speculated about the "why" of the cicada life cycle. Coming out together, in a huge horde, diminishes the possibility that predators could wipe out an entire generation of cicadas. There are simply too many of them.[3]

It’s also possible that the life cycles involve prime numbers (17 years, or 13 years for some other broods) — because they might prevent predators, most of which live shorter lives, from synchronizing their own generations around the cicadas.

For example, a predator that lived for six years couldn’t rely on a bumper crop of cicadas at the beginning or ending of any generation. Data from ornithologists suggest that birds, which feed on cicadas, suffer dips in their population right around the time the cicadas appear. The mass emergence of cicadas may somehow cause a die-off of their predators, although the mechanism is unknown. (Such patterns are common in nature: The snowshoe hare population, for example, rises and falls in a 10-year cycle.)

Entomologists have, however, learned a great deal about how insects measure smaller units of time, such as days and seasons, and those findings may be relevant to the cicada's 17-year cycle.

"Insects have internal biological clocks," says Colin Steel, a biologist at York University in Toronto. "They are mostly located in specialized cells in the brain, known as clock cells, used for measuring 24-hour cycles of time." Further research has shown that clock cells are present in the brains of other animals, including humans.

Steel's research has helped reveal the genetic basis of time measurement. Genes in the clock cell produce proteins at varying concentrations throughout the day. The rhythmic nature of the

rise and fall of protein concentration enables the animal to know the time.

Since only a few cells in the brain are responsible for time measurement, the animal needs a messenger to transmit the time to the rest of the body. There appears to be some direct communication between the clock cells and the nervous system, but more of the communication happens through hormones. We see this phenomenon, not only in insects, but also in mammals, which release corticosteroids into the bloodstream at varying concentrations depending on the time of day.

It's important to note that any animal's internal time estimate is just that — an estimate.

"Without something to synchronize the clock, it will drift further and further from the correct time of day," explains Steel. "That's why they're

called ‘circadian rhythms,’ from the Latin for ‘approximately a day.’ ” Even a bug has a circadian rhythm.

You’ve probably noticed that mosquitoes have an annoying tendency to come out around dusk to feed on human blood. There’s a rather obvious cue for that behavior: the setting of the sun. But researchers have shown that mosquitoes don’t need that cue. If you place a mosquito in a light-free laboratory for several days, it will still begin searching for food at about the same time. On the first day, it may emerge a few minutes later, though, on account of the inaccuracy of its internal clock. On Day Two, it will become active a few minutes later, and so on. In fact, one of the perplexing things about biological timing mechanisms is the consistency of their inaccuracy. All individuals belonging to the

same species are mis-calibrated by almost exactly the same amount in each 24-hour cycle.

Of course, the error in the internal clocks isn't a problem in nature, because all animals have methods for correcting their clocks. For day-to-day rhythms, they use the rising or setting of the sun. When a mosquito perceives the sunset, it resets its clock. One of the mysteries of cicadas is how they calibrate their internal clocks. They live long periods without the benefit of the sun, yet their life cycle still progresses like clockwork.

Animals' biological clocks don't just assess time of day; they also perceive the time of year. When the animal's clock cells synchronize themselves to the rising and setting of the sun, they take note of the changing length of the day during the season. The rhythm of the

seasons is thus recorded in the animal's brain. (Animals on the equator, revealingly, tend not to alter their behavior based on time of year.)

So how does all of this relate to the cicadas? As noted above, no one has figured out exactly how these incredible insects manage to measure a 17-year period so reliably. (As with all animals, the cicadas are imperfect. Some stragglers jump the gun, emerging from the ground four years ahead of schedule.) Based on his study of other insects, Steel has a theory, although he's quick to insist it's merely conjecture.

"I would guess that the larvae of the cicada goes through a number of different life stages in the ground," he says, "and it seems likely that each of the life stages is controlled by a clock, and it can go into an overwintering stage

at the end of each of these larval stages, according to the day length."

It's possible that the cicada doesn't have to measure 17 years. All it needs to do is measure one year, which is the length of time it takes to go from one larval stage to the next. Perhaps the progression from birth to adult happens in 17 stages, until the perfected adult is ready to climb above ground, breed and die. And, of course, raise an incredible din.

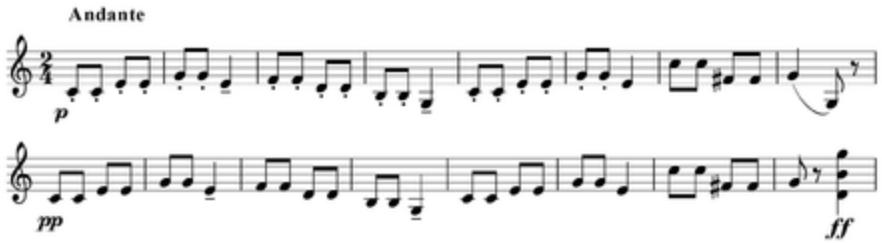
Circadian Rhythms are important to us all for a number of reasons. Our bodies are regulated by our internal clocks which begin adjusting themselves at an early age.

Your circadian rhythm causes your level of wakefulness to rise and dip throughout the day. Most people feel the strongest desire to sleep between 1:00pm and 3:00pm (a.k.a. the post-

lunch, afternoon crash) and then again between 2:00am and 4:00am, but this can vary from person to person. That's why some people are "morning people," while others function best in the evening. Your circadian rhythm can also change as you age. When you were a teenager, for example, your body was programmed (so to speak) to sleep for more total hours, as well as go to bed and wake up later.

The fact that people tend to become drowsy after lunch or in the early afternoon has been known for centuries. Speakers and composers of music have known that a tough audience to entertain is the post-meal listeners who are not only feeling the drop in circadian rhythm, but also have a full stomach which also slows the metabolic process so the body can concentrate on digestion.

Franz Joseph Haydn wrote his Symphony # 94 – which is called the Surprise Symphony in a manner that would wake-up sluggish audiences. It is called the surprise because of a very loud fortissimo chord that would wake up a slumbering audience that had been lulled to sleep by the melodic first movement. Like much of Haydn's music, it is lively, fun, and full of quirks, but not much more so than any other of Haydn's works. That name actually refers to moments in the second movement when the pace is gradual, peaceful, and tranquil. The melodies are passive and unencumbered, listing lazily along in a quiet *pianissimo* when out of nowhere BAM! The audience is hit with a jarring and unexpected *fortissimo* G-major chord that crescendos without warning. Surprise!



In German, the work is referred to as the Symphony *mit dem Paukenschlag*, or, with the kettledrum stroke.

Whether Haydn composed the piece to jar nodding spectators into consciousness or not, the Surprise Symphony does the job of making sure everyone in the audience is awake.

If you follow your body's natural cues regarding when to go to sleep and wake up, your circadian rhythm should stay balanced, but a change in your schedule (like if you stay up late pulling long hours at work one day or sleep in one Saturday), can disrupt your body clock. But, you can follow these three tips to keep your circadian rhythm functioning as it should.[4]

1. Stick to a Consistent Sleep Schedule. A regular bedtime is one part of the equation, but waking up at the same time daily will also help keep your circadian rhythm in check. It may be tempting to grab some extra shut-eye on weekends, but doing so can throw off your body clock during the week.

2. Go for an A.M. Walk. In the morning, exposure to the sun (or indoor light), won't just give you an energy boost—it can also reset your circadian rhythm. A quick outdoor stroll in the morning will give you enough sun exposure to signal to your brain that it's time to start the day. No time to walk? Simply raise the blinds or switch on your brightest light instead.

3. Limit Evening Tech. Bright lights in the evening hours can throw off your body clock by confusing your brain into thinking it's still

daytime. Artificial blue light (the type that laptops, tablets and cell phones emit) is the worst culprit, so try to power-down tech devices at least two to three hours before bed.

Over the years, we have learned a lot about our inner-clocks and how they are regulated by sunlight.

The term ***"circadian"*** stems from the Latin *"circa"* (which means "around") and *"diem"* (which means "day").

In 2010, there was a terrible mining disaster at the Copiapó mine, also known then as the "Chilean mining accident." It began on Thursday, 5 August 2010 with a cave-in at the San José copper–gold mine, located in the Atacama Desert. Thirty-three workers were rescued after being trapped underground when the mine collapsed. The workers were

entombed 2,300 feet deeper than the Willis tower is tall, beneath the surface for 69 days—a very, very long time to be without natural light![5]

To survive, they had to endure constant 90 percent humidity, avoid starvation, battle thirst, guard against fungus and bacteria, and stay sane enough to safely do the work necessary to aid their own rescue. Yet even if they accomplished all that, they faced another danger: the constant darkness.

While engineers worked on a rescue solution, workers above ground were able to rig systems to get required staples to the miners: food, vitamins, reading material, a portable music player (that was shuttled up and down to be charged). The trapped group was even able to watch a football game (Soccer) projected onto

a cave wall. What couldn't be passed down, however, was sunlight. While there were some portable light sources available, being without natural light for such a long time posed many potential health hazards because our bodies depend on an awareness of natural light to keep our "internal clocks" regulated.

This internal clock is related to "circadian rhythm" which tells our bodies when to "do" certain things each day. At the most basic level, our bodies are trained to sleep when it's dark and be up and about in the light. Almost all living things, even microbes, show evidence of circadian rhythm, and this rhythm controls a huge number of physical, mental, and behavioral processes, changes, and fluctuations, including things like body temperature, bowel movements, sleep, and the ability to stabilize one's emotional mood.

The trapped miners faced an extended period of circadian rhythm disruption, but this is an area of study that has impact for astronauts, airline pilots (who often fly across multiple time zones) and even workers who routinely work a night-shift, as well.

Hospital workers are not the only ones who suffer because of shift work that puts them at odds with their internal clocks. Journalists who work the early morning programs will tell you strange stories about the struggles they endure when they go from their day schedules to early morning.

My daughter, Karen Jordan Farr, a weekend news anchor at ABC, WLS TV, Channel-7, told me about a time when she was was scheduled to replace the regular morning show anchor, Judy Hsu, when Judy left work for maternity

leave. Karen was scheduled to spend 6-weeks going in to work at 4-AM, getting up at 2:30 AM, which meant that she had to go to bed at 8:30 each night. This was a schedule that was on the opposite end of the clock, from what was normal for her – an 8-4 day shift. Karen, told me that the 6-week period she spent working mornings is now just a blur – she can't remember anything about that time – it's a dark hole in her memory. "I was a Zombie," she said – "that I remember."

So, scientists have studied this phenomenon of memory loss tied to sleep disruption. Biologists have shown that a functioning circadian system is critical to hamsters' ability to remember what they have learned. Without it, in fact, they can't remember anything. Hamsters who had their circadian system disabled consistently failed to

remember their environment, unlike hamsters with normally functioning circadian systems.

Until now, it has never been shown that the circadian system is crucial to learning and memory. But, the change in learning retention appears to hinge on the amount of a neurochemical called GABA, which the circadian clock uses to control the daily cycle of sleep and wakefulness. A Stanford University study, demonstrated that your circadian system – or internal body clock -- must be in optimal condition in order for you to learn new information and remember it.

One of the worst things you can do to disrupt your body clock is to engage in regular night shift work. As my daughter, Karen or other temporary or replacement anchors will tell you

- working the early morning shift never gets easy – they say, you’re always sleepy.

Life on Earth is adapted to the rotation of our planet. For many years we have known that living organisms, including humans, have an internal, biological clock that helps them anticipate and adapt to the regular rhythm of the day. But how does this clock actually work? Getting to the bottom of that question was the work of three scientists who won the Nobel Prize for Medicine in 2017. Jeffrey C. Hall, Michael Rosbash and Michael W. Young were able to peek inside our biological clock and explain its inner workings. Their discoveries explain how plants, and animals, including humans, adapt their biological rhythms so that they are synchronized with the Earth's revolutions.

Using fruit flies as a model organism, the Nobel laureates isolated a gene that controls the normal daily biological rhythm. They showed that this gene encodes a protein that accumulates in the cell during the night, and is then degraded during the day. Subsequently, they identified additional protein components of this machinery, exposing the mechanism governing the self-sustaining clockwork inside the cell. We now recognize that biological clocks function by the same principles in cells of multicellular organisms, including humans.

With exquisite precision, our inner clocks adapt our physiology to the dramatically different phases of the day. The clock regulates critical functions such as behavior, hormone levels, sleep, body temperature and metabolism. Our wellbeing is affected when there is a temporary mismatch between our external environment

and this internal biological clock. We see this disparity when we travel across several time zones and experience "jet lag". There are also indications that chronic misalignment between our lifestyle and the rhythm dictated by our inner timekeeper is associated with increased risk for various diseases.

Our inner clock

Most living organisms anticipate and adapt to daily changes in the environment. During the 18th century, the astronomer Jean Jacques d'Ortous de Mairan studied mimosa plants, and found that the leaves opened towards the sun during daytime and closed at dusk. He wondered what would happen if the plant was placed in constant darkness. He found that independent of daily sunlight the leaves continued to follow their normal daily

oscillation. The plants seemed to have their own biological clock.

Other researchers found that not only plants, but also animals, including humans, have a biological clock that helps to prepare our physiology for the fluctuations of the day. But just how our internal circadian biological clock works has remained a mystery.[6]

When I crashed on the couch in Chaing Mei, the jet-lag I was suffering made me feel ill. But what about workers who go against the grain and become Robots – sleeping during the day and working the night shift – for prolonged periods of time? As a medic in the army, I worked changing shifts in hospitals all the time: Seven to three for a few weeks, then three to eleven and finally the dreaded shift of 11 to seven. After being on the hated overnight shift

– just when you became kind of used to it, after a few weeks, it was time to change again – keeping workers from acclimating to the upsetting schedule.

Over-the-road truck drivers are also easy victims of an out-of-whack inner clock. If you have ever fought sleep while driving you know that it is a battle you will certainly lose. Sleepiness is an inexorable force that is overwhelming. Outside of torture is impossible to counteract progressive drowsiness.

I remember that just as I was getting slightly accustomed to the night shift, it was time to change back to working days. That variation in schedule was often difficult to adjust to and I found myself sleepy and irritable all the time. Now, I know why. My inner clock was trying to

regulate my habits while I was going against the flow of nature.

In the medical profession, working night shifts is the name of the game. Whether you are an oncology resident who drew the short straw or a nurse who is staffed to permanent night shifts, at some point you will get to know your hospital after midnight.

So, beyond fatigue, is there an inherent danger to this work style? Some researchers believe when it comes to cancer risk and proliferation, the answer is yes.

In 2001, a Fred Hutchinson Cancer Research Center study showed nurses who regularly worked the night shift were more likely to be diagnosed with cancer (*J Natl Cancer Inst* 2001;93(20):1557-1562). Ten years ago, the International Agency for Research on Cancer

identified working a night shift as a probable human carcinogenic (*Lancet Oncol*2007;8(12):1065-1066). While studies have shown there is a correlation between night shift employment and cancer risk, the question remains as to why that was happening on a molecular level.

Today, Parveen Bhatti, PhD, Associate Member of Epidemiology at the Fred Hutchinson Cancer Research Center, studies the potential for a correlation between working the night shift and the cellular repair process.

In the study, Bhatti's team looked at urine specimens from regular night shift hospital employees, collected both when they slept during the day and at night (*Occupational and Environ Medicine* 2016;73(8):537-544).

“I wanted to see if melatonin suppression, among night shift workers, led to a decreased ability to repair oxidative DNA damage, which is a type of damage that has been associated with an increased risk of cancer,” said Bhatti.

Melatonin regulates the body's circadian rhythms. Levels are lowest during the daytime hours before peaking around 1 or 2 a.m. Light exposure, signals to the pineal gland to produce less of the hormone.

Sleeping in a dark environment at night, as our bodies are programmed to do, is essential for melatonin production that, in turn, improves the cells' abilities to repair oxidative DNA damage. If such damage is left unrepaired, it can generate mutations that can lead to cancer. When doctors, nurses, and other hospital staff are exposed to lights when working overnight,

their systems' melatonin secretion is suppressed.

In Bhatti's study, subjects who slept during the day while working at night showed lower levels of biomarker 8-hydroxydeoxyguanosine in their urine. A high presence of the compound is an indication that cells have been repairing DNA damage. The lower presence shown in these subjects is a sign their cells could be more susceptible to cancer-causing mutations.

Can shift workers counteract this damage by taking melatonin supplements? Bhatti warned that over-the-counter melatonin supplements are not regulated by the FDA and may contain additives. The purpose of the hormone is to regulate sleep at night. Supplements are not sleep aids and when taken during the day, they

might have no effect on sleep patterns and, therefore, DNA repair.

"In addition to measuring urinary levels of the DNA damage marker, as was done in the recently published study, we would measure cellular levels of DNA damage," Bhatti said.

Some 3,000 miles away, Thales Papagiannakopoulos, PhD, Assistant Professor of Pathology at NYU Langone Medical Center, is also studying the circadian rhythm disruption common to shift workers. Using mouse models, his research specifically centers on the occurrence and growth of lung cancer.

Cancer Progression

"It is still early days but there is evidence emerging from several models that clock integrity can have an effect on cancer

progression," said Papagiannakopoulos, speaking of course, of the internal clock.

Papagiannakopoulos and his team initiated small cell lung cancer in mice. Some of the mice were placed in light conditions that mimic shift work, where their exposure to light was altered every 2-3 days. This is similar to how clinicians who work night shift might have variable exposure to light at night, based on work schedule. After 8 weeks, those animals' tumors were larger and had grown at a faster rate. The mice in the night shift light model succumbed to the cancer quicker than the other study subjects.

Beyond the sleep-wake cycle, circadian rhythms control when immune cells are most active and control cell metabolism, a process that is necessary for tumors to grow

“Over the last 10 years, there's been a better explanation of how our bodies' clocks work genetically,” said Papagiannakopoulos.

To tie it back to shift work: Did night shift and the subsequent variable light exposure cause the disruption? The question needs further examination, but it is one that the scientific community has a growing interest in answering. Some scientists who study circadian rhythms are actively working to help cancer researchers better incorporate the role of circadian rhythms into research.

Protect Against Personal Cancer Risk

Yet with still many uncertainties surrounding the effect of working night shift on disease, including cancer, how can those on the overnight shift protect their health?

In cancer patients, there are times of day when the circadian rhythms compel the body to produce more immune cells. Papagiannakopoulos wondered whether chemotherapy doses could be given at specific times for maximum impact. This might be especially beneficial to night shift patients whose tumor-growth mechanisms are already growing too fast.

The best advice for shift workers who are concerned about their cancer risk is the same for anyone.

“Night shift workers need to be extra vigilant about living a healthy lifestyle, including trying to get enough sleep, not smoking, and drinking alcohol in moderation,” said Bhatti.

Patients cannot control all genetic factors for their personal cancer risk. And working the

night shift is unavoidable for certain parts of the population. Future research may suggest ways to reverse the DNA damage from altered sleep-wake cycles. Working the late night shift will never be fun, but perhaps one day it will not be damaging to the body's genes

Yet, while research continues to link Circadian Rhythms to understanding cancer progression, scientists in the field of geriatrics are learning more about The link between circadian rhythms and aging. An MIT study found that a gene associated with longevity also regulates the body’s circadian clock.

The MIT study shows that a gene called SIRT1, previously shown to protect against diseases of aging, plays a key role in controlling these circadian rhythms. The researchers found that circadian function decays with aging in normal

mice, and that boosting their SIRT1 levels in the brain could prevent this decay. Conversely, loss of SIRT1 function impairs circadian control in young mice, mimicking what happens in normal aging.[7]

Leonard Guarente is the Novartis Professor of Biology at MIT. Since the SIRT1 protein itself was found to decline with aging in the normal mice, the findings suggest that drugs that enhance SIRT1 activity in humans could have widespread health benefits, says Guarente.

“If we could keep SIRT1 as active as possible as we get older, then we’d be able to retard aging in the central clock in the brain, and health benefits would radiate from that,” Guarente says.

Staying on schedule

In humans and animals, circadian patterns follow a roughly 24-hour cycle, directed by the circadian control center of the brain, called the suprachiasmatic nucleus (SCN), located in the hypothalamus.

“Just about everything that takes place physiologically is really staged along the circadian cycle,” Guarente says. “What’s now emerging is the idea that maintaining the circadian cycle is quite important in health maintenance, and if it gets broken, there’s a penalty to be paid in health and perhaps in aging.”

So, if circadian rhythms are so important to the regulation of everything we do – if the sunlight-darkness cycle is so important to resetting our internal clocks, then what happens when we are blind? What happens to blind cave fish who

have lost their eyeballs over millions of years of disuse? What about marine organisms that live miles down underneath the sea in total darkness? These questions nagged at me because it indicated that some organisms can operate without light to regulate their internal clocks?

You may have seen the commercials on television aimed at people who are blind – asking them if they have Non-24? In most people, the master body clock runs slightly longer than 24 hours. What this means is that rather than cycle on a 24-hour day, most people's natural rhythms actually cycle a tiny bit longer – 24-hours and 30-minutes or 24-hours and 50-minutes. Whether the cycle runs two minutes or 30 minutes longer, if you have Non-24, these minutes add up day after day, a few one day, adding in a few more the next,

and eventually it causes a noticeable change in the times during the day when your body expects to sleep and expects to be awake.[8]

Though Non-24 may appear to be a sleep disorder, it isn't. It's actually a serious, chronic circadian rhythm disorder, very common in people who are totally blind, and it can arise at any age. Currently, there are 1.3 million people who are legally blind in the United States. Of the legally blind, 130,000 have no light perception (i.e., totally blind), and as many as 70% suffer from Non-24.

For people who are totally blind, the master body clock runs its natural course. This means that if your body clock runs on a 24.5-hour schedule, today you're 30 minutes behind and tomorrow your body clock will be an hour behind. The next day will be 90 minutes, and so

on. Day by day, this time adds up until you're many hours behind, creating a rhythm that's out of sync with the typical day-night cycle. Eventually, your body operates as if night is day and day is night. While you could try to maintain your usual schedule, more often than not you have a hard time sleeping at night and then feel an overwhelming urge to sleep during the day. In time, you once again reach the point when your body clock is in sync with the typical day-night cycle. But then, just as quickly, it moves out of sync again.[9]

Finally, after looking at all of the issues surrounding the importance of keeping our internal body clocks in sync – it becomes apparent that a smooth-running circadian rhythm is important to overall body health. Scientists are now finding it tempting to speculate that re-synchronization of metabolic

and physiological functions by the circadian clock may actually slow down the aging process.[10]

If you confuse the rhythmic situation by staying up very late, or depriving yourself of enough hours of sleep, or eating meals at odd hours (times at which your internal clock expects you to be sleeping), you send conflicting signals to your body. In response, your body will produce ‘sleep chemicals’ during times when you need to be awake and alert, and ‘awake chemicals’ when you need to be resting.[11]

I realize that many people may not have a choice in the selection of their jobs and thus their work shifts, but it is vital to understand that when you regularly alter your sleep patterns because of a job like police, fire, news anchor or ER doctor, or taxi driver, or air traffic

controller, then, researchers say, you are simply sacrificing your longevity. Because they say if you engage in this abnormal shifted sleep pattern, for many years, you can easily knock ten or more years off your lifespan. Which means that working overnight for extended periods is literally being on the “graveyard shift.”

[1] **Circadian Rhythm and Your Body Clock, National Sleep foundation. "Understanding your body's internal clock—or circadian rhythm—is the first step to better sleep." Sleep.Org**

[2] CIRCADIAN RHYTHMS – HOW SLEEP WORKS. HowSleepworks.Com

[3] **Washington Post, By Brian Palmer, July 8, 2013, "Cicadas are going, but they'll be back, like clockwork"**

[4] Sleep.org, **Circadian Rhythm and Your Body Clock,** Circadian Rhythm / Body Clock, Sleep Science

[5] Science Buddies, "Trapped Below Ground: The Importance of Circadian Rhythm." Amy Cowen on October 26, 2010

[6] The Nobel Assembly at Karolinska Institutet, Press Release.
[7] MIT News, "The link between circadian rhythms and aging." Anne Trafton, MIT News Office
June 20, 2013

[8] NON-24, A Circadian Rhythm disorder. "What is Non-24?" http://www.non-24.com/about-non-24.php
[9] Ibid.
[10] US National Library of Medicine, National Institutes of Health. Frontiers in Neurology, **Impact of the Circadian Clock on the Aging Process. Sara S. Fonseca Costa and Jürgen A. Ripperger, 2015 Mar 6.**

[11] Mercola, "Your Circadian Clock is Critical to Your Memory" November 01, 2008, https://articles.mercola.com/sites/articles/archive/2008/11/01/your-circadian-clock-is-critical-to-your-memory.aspx