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Study: Nighttime LED light increases risk of cancer

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LAST UPDATED: 09/13/2011 03:29

University of Haifa research shows "light pollution" suppresses melatonin, said to be beneficial against cancer.

Increasing concern that “light pollution” caused by artificial lighting that reduces the production of the hormone melatonin by the brain’s pineal gland can cause cancer and other diseases has led to new research into which types of electric bulbs cause less potential risk.

Now a University of Haifa researcher and his colleagues who are participating in an international study of the subject have found that nighttime exposure to white-light-emitting diode bulbs – which are actually blue light on the spectrum – commonly used both in outdoor and some indoor lighting suppresses the beneficial hormone’s production five times more than does high-pressure sodium bulbs that emit an orange-yellow light.

Prof. Abraham Haim, with scientists from Italy and the US, just published findings on the subject in the *Journal of Environmental Management* in an article titled “Limiting the impact of light pollution on human health, environment and stellar visibility.”

Sent the paper by *The Jerusalem Post*, Health Ministry public health chief Prof. Itamar Grotto said on Sunday that it will discuss the recommendations with other factors including the Standards Institution and other regulatory bodies.

The researchers said that since civilization is obviously unwilling to return to the caveman era and live in darkness when the sun goes down, efforts can be made to minimize exposure at night to types of illumination that reduce melatonin production.

“Just as there are regulations and standards for ‘classic’ pollutants, there should also be regulations and rules for pollution stemming from artificial light at night,” said Haim, head of the University of Haifa’s Center for Interdisciplinary Chronobiological Research and the Israeli partner in the research.

The Israeli government has, like others abroad, been in recent years encouraging the public to purchase and use other types of bulbs that use significantly less electricity and last longer than the old-style incandescent bulbs based on

filaments; increasingly, they are not sold in stores.

LED bulbs are found on thousands of products from cellular phones and computer monitors to toothbrushes, operating room equipment and bright tiny bulbs in indoor lighting fixtures.

The new research included a comparison between HPS bulbs, which emit orange-yellow light and are often used for street and road lighting, to other bulbs.

From this comparison, it became clear that the metal halide bulb, which gives off a white light and is used for stadium lighting and many other uses, suppresses melatonin at a rate more than three times greater than the HPS bulb, while the LED bulb, which also gives off a white light, suppresses melatonin at a rate more than five times higher than the HPS bulb.

“The current migration from the now widely-used sodium lamps to white lamps will increase melatonin suppression in humans and animals,” the researchers say. Melatonin, a compound that adjusts our biological clock and is known for its antioxidant and anti-cancerous properties, is sold freely in the US and other countries, especially to relieve ‘jet lag,’ but the Health Ministry in Jerusalem allows its sale only by doctor’s prescription, arguing that it is a drug that must be controlled.

“White” artificial light is emitted at wavelengths of between 440 and 500 nanometers, according to the international team of astronomers, physicists and biologists from ISTIL - Light Pollution Science and Technology Institute in Italy, the US National Geophysical Data Center in Boulder, Colorado, and the University of Haifa.

Their research was the first to examine differences in melatonin suppression in a various types of light bulbs, primarily those used for outdoor illumination, such as streetlights, road lighting and mall lighting.

“Blue light” receptors in the retina of the eye affect melatonin production but are independent of the visual system, meaning that we don’t ‘see’ with them.

The team calculated wavelength and energy output of bulbs that are generally used for outdoor lighting and then compared that information with existing research regarding melatonin suppression to determine how much each type of bulb used at night suppresses melatonin production.

The researchers offered some concrete suggestions that could reduce nighttime suppression of melatonin production – to limit the use of “white” light to those instances where it is absolutely necessary; adjust lampposts so that their light is not directed beyond the horizon, thus significantly reducing light pollution; using only the amount of light needed for a task; and turning off the lights when not in use.

They stressed that there is no harm using artificial light during the day, as the pineal gland does not produce much melatonin then.

“Unless legislation is updated soon, with the current trend toward sources as white LEDs, which emit a huge amount of blue light, we will enter a period of elevated negative effects of light at night on human health and environment. Lamp manufacturers cannot claim that they don’t know about the consequences of artificial light at night,” says Dr. Fabio Falchi of ISTIL.

“As a first step in Israel, for example, the Standards Institution of Israel should obligate bulb importers to state clearly on their packaging what wavelengths are produced by each bulb. If wavelength indeed influences melatonin production, this is information that needs to be brought to the public’s attention, so consumers can decide whether to buy this lighting or not,” Haim added.

The University of Haifa researcher declared in 2008 that exposure to light at night is the most powerful factor in breast cancer besides genetic defects.

Other studies have implicated it in prostate cancer and the development of nearsightedness in children, eyestrain, headaches and sleep disorders.

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Blue light has a dark side

MAY 2012

Light at night is bad for your health, and exposure to blue light emitted by electronics and energy-efficient lightbulbs may be especially so.

Until the advent of artificial lighting, the sun was the major source of lighting, and people spent their evenings in (relative) darkness. Now, in much of the world, evenings are illuminated, and we take our easy access to all those lumens pretty much for granted.

But we may be paying a price for basking in all that light. At night, light throws the body's biological clock—the circadian rhythm—out of whack. Sleep suffers. Worse, research shows that it *may* contribute to the causation of cancer, diabetes, heart disease, and obesity.

But not all colors of light have the same effect. Blue wavelengths—which are beneficial during daylight hours because they boost attention, reaction times, and mood—seem to be the most disruptive at night. And the proliferation of electronics with screens, as well as energy-efficient lighting, is increasing our exposure to blue wavelengths, especially after sundown.

Daily rhythms influenced by light

Everyone has slightly different circadian rhythms, but the average length is 24 and one-quarter hours. The circadian rhythm of people who stay up late is slightly longer, while the rhythms of earlier birds fall short of 24 hours. Dr. Charles Czeisler of Harvard Medical School showed, in 1981, that daylight keeps a person's internal clock aligned with the environment.

The health risks

Study after study has linked working the night shift and exposure to light at night to several types of cancer (breast, prostate), diabetes, heart disease, and obesity. It's not exactly clear why nighttime light exposure seems to be so bad for us. But we do know that exposure to light suppresses the secretion of melatonin, a hormone that influences circadian rhythms, and there's some experimental evidence (it's very preliminary) that lower melatonin levels might explain the association with cancer.

A Harvard study shed a little bit of light on the possible connection to diabetes and possibly obesity. The researchers put 10 people on a schedule that gradually shifted the timing of their circadian rhythms. Their blood sugar levels increased, throwing them into a prediabetic state, and levels of leptin, a hormone that leaves people feeling full after a meal, went down.

Even dim light can interfere with a person's circadian rhythm and melatonin secretion. A mere eight lux—a level of brightness exceeded by most table lamps and about twice that of a night light—has an effect, notes Stephen Lockley, a Harvard sleep researcher. Light at night is part of the reason so many people don't get enough sleep, says Lockley, and researchers have linked short sleep to increased risk for depression, as well as diabetes and cardiovascular problems.

The power of the blues

While light of any kind can suppress the secretion of melatonin, blue light does so more powerfully. Harvard researchers and their colleagues conducted an experiment comparing the effects of 6.5 hours of exposure to blue light to exposure to green light of comparable brightness. The blue light suppressed melatonin for about twice as long as the green light and shifted circadian rhythms by twice as much (3 hours vs. 1.5 hours).

In another study of blue light, researchers at the University of Toronto compared the melatonin levels of people exposed to bright indoor light who were wearing blue-light–blocking goggles to people exposed to regular dim light without wearing goggles. The fact that the levels of the hormone were about the same in the two groups strengthens the hypothesis that blue light is a potent suppressor of melatonin. It also suggests that shift workers and night owls could perhaps protect themselves if they wore eyewear that blocks blue light. Inexpensive sunglasses with orange-tinted lenses block blue light, but they also block other colors, so they're not suitable for use indoors at night. Glasses that block out only blue light can cost up to $80.

Less-blue light

If blue light does have adverse health effects, then environmental concerns, and the quest for energy-efficient lighting, could be at odds with personal health. Those curlicue compact fluorescent lightbulbs and LED lights are much more energy-efficient than the old-fashioned incandescent lightbulbs we grew up with. But they also tend to produce more blue light.

The physics of fluorescent lights can't be changed, but coatings inside the bulbs can be so they produce a warmer, less blue light. LED lights are more efficient than fluorescent lights, but they also produce a fair amount of light in the blue spectrum. Richard Hansler, a light researcher at John Carroll University in Cleveland, notes that ordinary incandescent lights also produce some blue light, although less than most fluorescent lightbulbs.

What you can do

- Use dim red lights for night lights. Red light has the least power to shift circadian rhythm and suppress melatonin.
- Avoid looking at bright screens beginning two to three hours before bed.
- If you work a night shift or use a lot of electronic devices at night, consider wearing blue-blocking glasses.
- Expose yourself to lots of bright light during the day, which will boost your ability to sleep at night, as well as your mood and alertness during daylight.

The Dangers of Using Electronics at Night and What We Can Do About It

The dark side of light at night

Published on May 4, 2012 by Sherrie Bourg Carter, Psy.D. in High Octane Women

While the discovery of artificial light certainly has made us a more productive and efficient society, there is a dark side to light that many high achievers would do well to consider. According to the May, 2012 issue of *Harvard Health Letter*, the light that sets us aglow at night as we work well past "quitting time," check email, send texts, share information on social media sites, and flip through pages on e-readers puts us at risk for serious health problems, and this is especially true when it comes to types of light emitted by electronics and energy-efficient lightbulbs. According to the article, although blue wavelengths are beneficial during daylight hours because they boost our attention, reaction times, and mood, they can be quite disruptive to our health and well being at night, particularly in today's high-powered electronic age where screens rule—day and night.

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The Costs

The average circadian cycle is twenty-four and a quarter hours, but it is daylight that keeps our internal clocks aligned with our environment. When we upset the balance with repeated exposure to light at night, it can throw our rhythm off and wreak havoc on our health. This effect has been demonstrated through numerous experiments showing that certain types of cancer (breast and prostate) are associated with night shift work and exposure to light at night.

Although researchers are not yet certain exactly why night light exposure has such a negative impact, they believe it's at least partly related to the fact that exposure to light suppresses the secretion of melatonin, a hormone that affects circadian rhythms (some preliminary research suggests that lower melatonin levels may explain the association with cancer). In fact, one researcher, Professor Abraham Haim at the University of Haifa, believes that light at night is a carcinogenic environmental pollutant that will continue to negatively impact our health and well being until the world recognizes its harmful effects and makes important changes to how and when we use light.

Harvard researchers also have found a possible link between disruptions in circadian rhythms and diabetes and obesity. When subjects were put on a schedule which gradually shifted their circadian rhythms, their blood sugar levels increased and their levels of leptin, a hormone that causes people to feel full after a meal, decreased.

Furthermore, sleep experts have long contended that exposure to light at night interferes with sleep, and this view has found support from research. For example, a 2011 study published in the EndocrineSociety's *Journal of Clinical Endocrinology & Metabolism* (JCEM) revealed that exposure to artificial light between sunset and bedtime strongly suppresses melatonin levels, which can negatively impact physiological processes that are regulated by melatonin including sleep, thermoregulation, blood pressure, and glucose levels.

Types of Light and their Impact

According to the Harvard article, "While light of any kind can suppress the secretion of melatonin, blue light does so more powerfully." In an experiment comparing the effects of 6.5 hours of exposure to blue light to exposure to green light of comparable brightness, Harvard researchers and their colleagues discovered that blue light suppressed melatonin for about twice as long as the green light and shifted circadian rhythms by twice as much (3 hours versus 1.5 hours).

In another study out of the University of Toronto, researchers compared the melatonin levels of people exposed to bright indoor light who were wearing blue-light–blocking goggles to those exposed to regular dim light without goggles and discovered that melatonin levels in both groups were about the same, supporting the hypothesis that blue light suppresses melatonin secretion.

Haim's research has found similar results, showing that white LED light (which is blue light on the spectrum) suppresses the production of melatonin five times more than the orange-yellow light given off by traditional high-pressure sodium (HPS) bulbs and that metal halide bulbs, often used for stadium lighting, suppress melatonin at a rate more than three times higher than the HPS bulb.

According to Dr. Luis Arrondo of Foundational Healing, examples of light sources high in melatonin-suppressing blue light include:

- LED light bulbs
- Computer monitors
- Laptop computers
- iPads, iPhones and similar devices
- Hand-held video games
- Electronic gadgets
- LED televisions
- LED digital clocks

What You Can Do

1) Although glasses that block out blue light can be rather expensive, if you do a lot of work at night, it might be worth it to invest in them.

2) Consider trying f.lux, a free download that adjusts the lighting on your computer depending on the time of day. (See review by Digital Dojos and user comments on YouTube).

3) If you must use a night light, use dim red lights. According to the*Harvard Health Letter*, "Red light has the least power to shift circadian rhythm and suppress melatonin."

4) Avoid the melatonin-suppressing light sources described above, beginning two to three hours before bed.

5) Expose yourself to bright light during day time hours, which should not only improve your mood and alertness during the day, but also help you sleep at night.

6) Reconfigure lighting in your home so that it mimics fire light, which is rich in red and yellow wavelengths. Dr. Arrondo says, "This could mean shutting off the overhead lights and using floor and table lamps with orange and yellow bulbs in the evening. Of course, it also means forgoing computer and television use, especially just before bedtime. It may sound drastic, but for the person with persistent insomnia, these changes can help."

7) Reduce stress as much as possible. Stress increases our body's production of cortisol, which lowers melatonin levels.

Light From Self-Luminous Tablet Computers Can Affect Evening Melatonin, Delaying Sleep
New LRC research can aid in the development of "circadian-friendly" electronic devices

A new study from the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute shows that a two-hour exposure to electronic devices with self-luminous "backlit" displays causes melatonin suppression, which might lead to delayed bedtimes, especially in teens.

The research team, led by Mariana Figueiro, associate professor at Rensselaer and director of the LRC's Light and Health Program, tested the effects of self-luminous tablets on melatonin suppression. In order to simulate typical usage of these devices, 13 individuals used self-luminous tablets to read, play games, and watch movies. Results of the study, titled "Light level and duration of exposure determine the impact of self-luminous tablets on melatonin suppression," were recently published in the journal Applied Ergonomics.

"Our study shows that a two-hour exposure to light from self-luminous electronic displays can suppress melatonin by about 22 percent. Stimulating the human circadian system to this level may affect sleep in those using the devices prior to bedtime," said Figueiro.

The actual melatonin suppression values after 60 minutes were very similar to those estimated using a predictive model of human circadian phototransduction for one-hour light exposures. "Based on these results, display manufacturers can use our model to determine how their products could affect circadian system regulation," said Figueiro.

The results of this study, together with the LRC predictive model of human circadian phototransduction, could urge manufacturers to design more "circadian-friendly" electronic devices that could either increase or decrease circadian stimulation depending on the time of day—reducing circadian stimulation in the evening for a better night's sleep, and increasing in the morning to encourage alertness. In the future, manufacturers might be able to use data and predictive models to design tablets for tailored daytime light exposures that minimize symptoms of seasonal affective disorder, and sleep disorders in seniors. Individuals would be able to receive light treatments while playing games or watching movies, making light therapy much more enjoyable than just sitting in front of a light box.

Along with Figueiro, co-authors of the study are LRC Director and Professor Mark S. Rea, LRC Research Specialist Brittany Wood, and LRC Research Nurse Barbara Plitnick.

Melatonin is a hormone produced by the pineal gland at night and under conditions of darkness in both diurnal and nocturnal species. It is a "timing messenger," signaling nighttime information throughout the body. Exposure to light at night, especially short-wavelength light, can slow or even cease nocturnal melatonin production. Suppression of melatonin by light at night resulting in circadian disruption has been implicated in sleep disturbances, increased risk for diabetes and obesity, as well as increased risk for more serious diseases, such as breast cancer, if circadian disruption occurs for many consecutive years, such as in nightshift workers.

"Technology developments have led to bigger and brighter televisions, computer screens, and cell phones," said Wood, who used the study as the basis for her master's thesis. "To produce white light, these electronic devices must emit light at short wavelengths, which makes them potential sources for suppressing or delaying the onset of melatonin in the evening, reducing sleep duration and disrupting sleep. This is particularly worrisome in populations such as young adults and adolescents, who already tend to be night owls."

In the study, the participants were divided into three groups. The first group viewed their tablets through a pair of clear goggles fitted with 470-nm (blue) light from light emitting diodes (LEDs). This was a "true positive" condition because the blue light is known to be a strong stimulus for suppressing melatonin. The second group viewed their tablets through orange-tinted glasses, capable of filtering out the short-wavelength radiation that can suppress melatonin; this was the "dark control" condition. The third group did not wear glasses or goggles. Each tablet was set to full brightness.

In order to accurately record personal light exposures during the experiment, each subject wore a Dimesimeter close to the eye. The Dimesimeter is a small calibrated light meter device developed by the LRC that continuously records circadian light and activity levels. Last year, international magazine The Scientist named the LRC's Dimesimeter as one of the "Top 10 Innovations of 2011."

The research team established that duration of exposure and the distance between the eye and the display, which determines the amount of light reaching the back of the eye, affects melatonin levels. Melatonin suppression after a one-hour exposure to the tablet was not significantly affected. However, after a two-hour exposure there was significant

suppression.
The type of task being performed on the tablets also determines how much light is delivered to the cornea and, therefore, the impact on evening melatonin levels. As shown by the team's Dimesimeter measurements, the range of photopic illuminance levels at the cornea from the tablets alone varied from 5 lux, which is not likely to affect melatonin, to over 50 lux, which would result in measurable melatonin suppression after a two-hour exposure. Therefore, before any generalizations can be made, it is important to measure how much light one is receiving from these self-luminous devices. Until manufacturers develop more "circadian-friendly" electronic devices that increase or decrease light exposure based on time of day, Figueiro has several recommendations to reduce their effects on sleep. "We recommended dimming these devices at night as much as possible in order to minimize melatonin suppression, and limiting the amount of time spent using these devices prior to bedtime."
The study was funded by Sharp Laboratories of America.
Published August 27, 2012

Dangers of LED TVs
By Robert Godard, eHow Contributor

Most claims about the dangers of LED TVs are unsubstantiated

After LED TVs were initially introduced, they were found to have some inherent dangers in them caused by the overuse of this new technology. Since then, there have been significant improvements made to the design of these LED TVs so that they are safe for use by the average consumer.

1. The Cause
   - Several studies have found that the main cause of health issues associated with LED technology comes from improper use of blue LED lights. The blue LED is unfortunately one of the most commonly used color in television technology, even in simple applications such as the power button on the TV.

2. The Reason
   - The reason that blue LEDs cause some minor health problems is something known as the Purkinje shift. The Purkinje shift describes the way our eyes are more sensitive to blue light. This is especially true in dark environments, where our eyes are more likely to single out blue or green light. Think about the way a blue light may catch your eye and distract you when you are trying to go to sleep. This is a consequence of the Purkinje shift.

3. Effects
   - Most of the effects that are caused by the blue LED are both mild and temporary. This can include headaches or a temporary worsening of vision and in some cases slight nausea may occur. As with any technology, these effects only result from overuse of this technology, they are by no means instantaneous. Though the effects are intensified in LED televisions, they are common in other televisions where blue LEDs are used for backlighting.

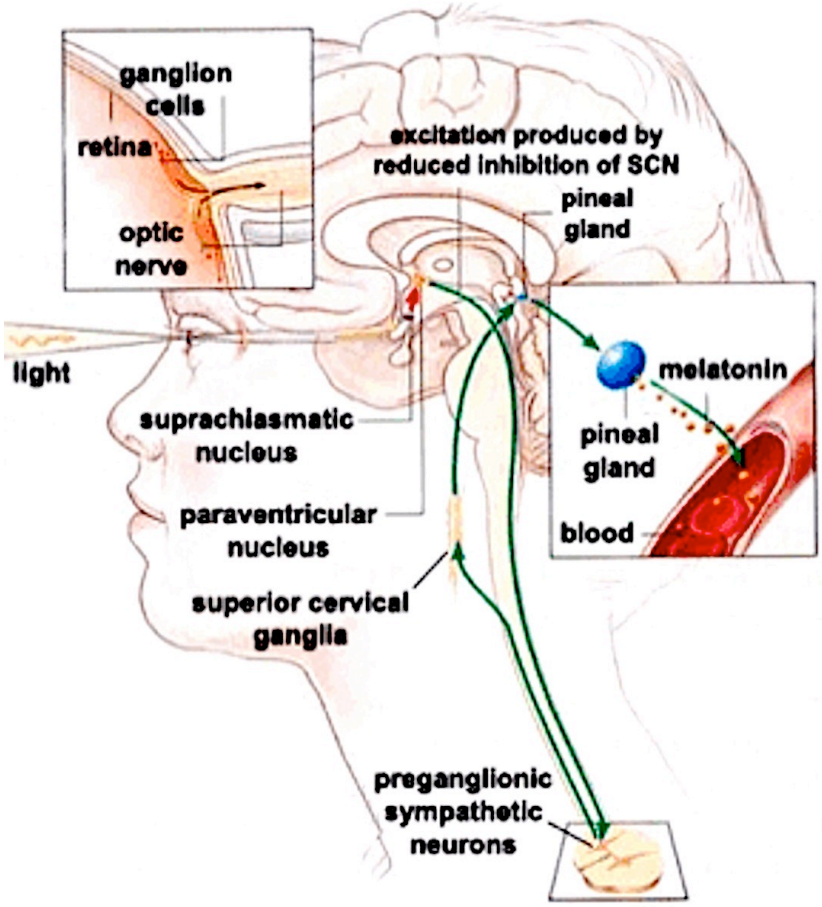
4. Myths
   - There have been some claims that LED technology can cause serious health problems, including cancer. While there is definitive evidence that suggests LED lights may interrupt sleep cycles and cause headaches, there is none to suggest that there is a link between LED lights and cancer. However, it has been found that blue LED lights lower melatonin levels, which can weaken a body's immune system. Whether or not this has any link to cancer is uncertain, but most companies have reduced the use of blue light in their technology to avoid these negative effects.

Blue light, sleep, mental alertness and health
Posted on 27. February 2012 by Vincent Giuliano
By Vince Giuliano
We are being exposed to a lot more blue and ultraviolet light in recent years, especially at night. This is due to 1. fluorescent bulbs replacing incandescent bulbs in homes and workspaces, especially "daytime" spectrum bulbs, 2. Flat LED TV screens replacing the old big-box tube fluorescent screens, 3. flat LED computer screens replacing the old fluorescent ones, and 4. White-light LED streetlamps replacing yellow-light sodium vapor lamps. In each case the light emitted is significantly shifted to the blue and even to the ultraviolet. And giant TV and big computer screens pre-empt larger and larger parts of the total field of vision. The result of greater exposure to blue light is inhibition of expression of melatonin, changes in our circadian sleep rhythms, changes in alertness and possible psychological and disease-susceptibility disturbances. These "blue light" effects have received significant research attention recently and have been discussed in the popular press. Some have even opined that lighting has become a public health issue.

Further, with aging, natural human lenses tend to be yellow and less sensitive to blue and UV. Having such lenses may inhibit melatonin suppression and the natural circadian rhythms. How do these factors interact? The purpose of this blog is to review the relevant research and to summarize the major issues and findings to date.

There is much more that meets the eye than what we see.

Besides providing visual images, inputs from the eye to other body systems impact on mood, alertness, sense of wellbeing and on the integrity of circadian rhythms related to health. Essentially all vertebrates are subject to a circadian regulatory system where the body adjusts dynamically to the daily cycle of light and dark as well as to how this cycle is affected by season. Key to this process is a small group of hypothalamic nerve cells in the brain, the suprachiasmatic nucleus (SCN), which serves as a master circadian pacemaker. The SCN controls the timing of the sleep-wake cycle and coordinates this with other circadian rhythms to enhance behavioral and environmental adaptation.



"Diagram of various neurological structures, including the suprachiasmatic nucleus (SCN), that are involved in human circadian rhythm control." *Image credit: http://thebrain.mcgill.ca*

A starting orientation for this blog is provided by the 2004 publication *Human pineal physiology and functional significance of melatonin*. "Descriptions of the pineal gland date back to antiquity, but its functions in humans are still poorly understood. In both diurnal and nocturnal vertebrates, its main product, the hormone melatonin, is synthesized and released in rhythmic fashion, during the dark portion of the day-night cycle. Melatoninproduction is controlled by an endogenous circadian timing system and is also suppressed by light. In lower vertebrates, the pineal gland is photosensitive, and is the site of a self-sustaining circadian clock. In mammals, including humans, the gland has lost direct photosensitivity, but responds to light via a multisynaptic pathway that includes a subset of retinal ganglion cells containing the newly discovered photopigment, melanopsin. The mammalian pineal also shows circadian oscillations, but these damp out within a few days in the absence of input from the primary circadian pacemaker in the suprachiasmatic nuclei (SCN). The duration of the nocturnal melatonin secretory episode increases with nighttime duration, thereby providing an internal calendar that regulates seasonal cycles in reproduction and other functions in photoperiodic species. Although humans are not considered photoperiodic, the occurrence of seasonal affective disorder (SAD) and its successful treatment with light suggest that they have retained some photoperiodic responsiveness. In humans, exogenous melatonin has a soporific effect, but only when administered during the day or early evening, when endogenous levels are low. Some types of primary insomnia have been attributed to diminished melatonin production, particularly in the elderly, but evidence of a causal link is still inconclusive. Melatonin administration also has mild hypothermic and hypotensive effects. A role for the pineal in human reproduction was initially hypothesized on the basis of clinical observations on the effects of pineal tumors

on sexual development. More recent data showing an association between endogenous melatonin levels and the onset of puberty, as well as observations of elevated melatonin levels in both men and women with hypogonadism and/or infertility are consistent with such a hypothesis, but a regulatory role of melatonin has yet to be established conclusively. A rapidly expanding literature attests to the involvement of melatonin in immune function, with high levels promoting and low levels suppressing a number of immune system parameters. The detection of melatonin receptors in various lymphoid organs and in lymphocytes suggests multiple mechanisms of action.Melatonin has been shown to be a powerful antioxidant, and has oncostatic properties as well, both direct and indirect, the latter mediated by its effects on reproductive hormones. Finally, there are reports of abnormal daily melatonin profiles in a number of psychiatric and neurological disorders, but the significance of such abnormalities is far from clear."

The role of melatonin in the process is further explained in the 2006 publication*Melatonin: Nature's most versatile biological signal?* "Melatonin is a ubiquitous molecule and widely distributed in nature, with functional activity occurring in unicellular organisms, plants, fungi and animals. In most vertebrates, including humans,melatonin is synthesized primarily in the pineal gland and is regulated by the environmental light/dark cycle via the suprachiasmatic nucleus. Pinealocytes function as 'neuroendocrine transducers' to secrete melatonin during the dark phase of the light/dark cycle and, consequently, melatonin is often called the 'hormone of darkness'. Melatonin is principally secreted at night and is centrally involved in sleep regulation, as well as in a number of other cyclical bodily activities. Melatonin is exclusively involved in signaling the 'time of day' and 'time of year' (hence considered to help both clock and calendar functions) to all tissues and is thus considered to be the body's chronological pacemaker or 'Zeitgeber'. Synthesis of melatonin also occurs in other areas of the body, including the retina, the gastrointestinal tract, skin, bone marrow and in lymphocytes, from which it may influence other physiological functions through paracrine signaling. Melatonin has also been extracted from the seeds and leaves of a number of plants and its concentration in some of this material is several orders of magnitude higher than its night-time plasma value in humans. Melatonin participates in diverse physiological functions. In addition to its timekeeping functions, melatonin is an effective antioxidant which scavenges free radicals and up-regulates several antioxidant enzymes. It also has a strong anti-apoptotic signaling function, an effect which it exerts even during ischemia. Melatonin's cyto-protective properties have practical implications in the treatment of neurodegenerative diseases. Melatonin also has immune-enhancing and oncostatic properties. Its 'chronobiotic' properties have been shown to have value in treating various circadian rhythm sleep disorders, such as jet lag or shift-work sleep disorder. Melatonin acting as an 'internal sleep facilitator' promotes sleep, and melatonin's sleep-facilitating properties have been found to be useful for treating insomnia symptoms in elderly and depressive patients. A recently introduced melatonin analog, agomelatine, is also efficient for the treatment of major depressive disorder and bipolar affective disorder. Melatonin's role as a 'photoperiodic molecule' in seasonal reproduction has been established in photoperiodic species, although its regulatory influence in humans remains under investigation. Taken together, this evidence implicates melatonin in a broad range of effects with a significant regulatory influence over many of the body's physiological functions."

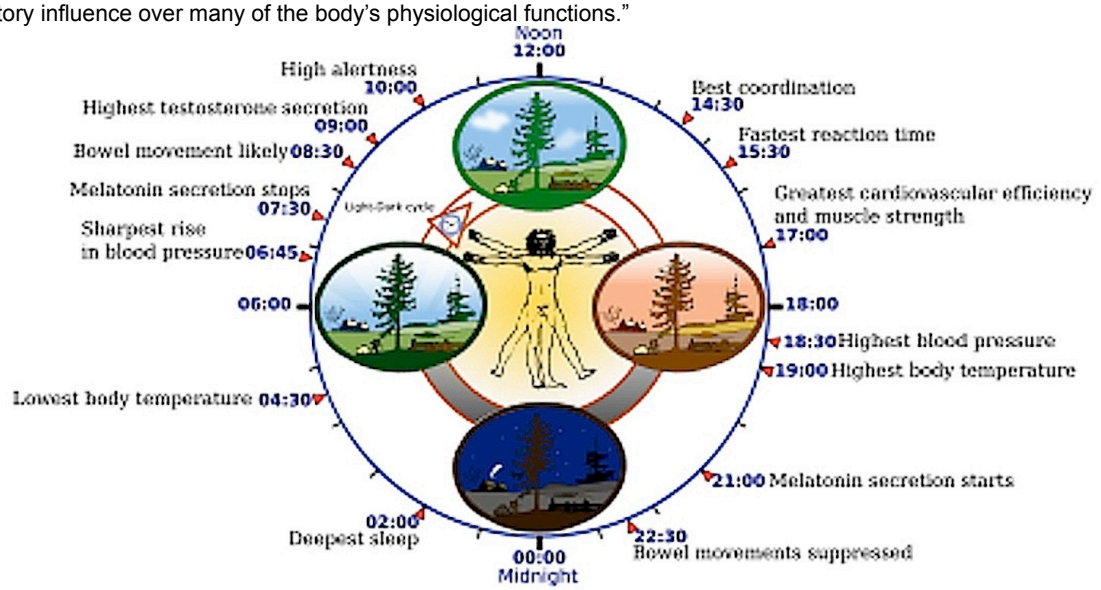


Image source: http://en.wikipedia.org/wiki/Circadian_rhythm

The natural changes in blue light in day and night drives an important aspect of the 24 hour circadian cycle involving the suprachiasmatic nuclei in regulating pineal melatonin synthesis and secretion. In the evenings there is no blue light to inhibit expression of melatonin. Melatonin secretion starts. Melatonin promotes sleep and performs a number of natural antioxidant and other restorative functions(ref)(ref)(ref). Comes daytime, blue light leads to melatonin secretion stopping. Clearing of melatonin resulting in sharper cognitive and memory functions. Artificial blue light at night, possibly generated by LEDs and especially not on a consistent basis, disrupts this cycle. Further, total daily melatonin production may be decreased due to the night work.

There are multiple body clocks. Light at night inhibits melatonin, getting the SCN out of synchronization with the other clocks leading to negative or possibly pathological consequences.

The 2010 publication *Circadian dysfunction in disease* reports: "The classic view of circadian timing in mammals

emphasizes a light-responsive 'master clock' within the hypothalamus which imparts temporal information to the organism. Recent work indicates that such a unicentric model of the clock is inadequate. Autonomous circadian timers have now been demonstrated in numerous brain regions and peripheral tissues in which molecular-clock machinery drives rhythmic transcriptional cascades in a tissue-specific manner. Clock genes also participate in reciprocal regulatory feedback with key signaling pathways (including many nuclear hormone receptors), thereby rendering the clock responsive to the internal environment of the body. This implies that circadian-clock genes can directly affect previously unforeseen physiological processes, and that amid such a network of body clocks, internal desynchronization may be a key aspect to circadian dysfunction in humans. Here we consider the implications of decentralized and internally responsive clockwork to disease, with a focus on energy metabolism and the immune response."

Quoting from Victor's recent blog entery *Circadian Regulation, NMN, Preventing Diabetes, and Longevity*: "Circadian clock functions are ubiquitous and impacted by aging, dietary, lifestyle and environmental conditions. They play important roles with respect to metabolism, health and disease susceptibilities. A key link between circadian regulation and metabolism appears to be the sirtuin SIRT1. Age or disease related-dysregulation of circadian metabolic control can lead to multiple kinds of havoc including type 2 diabetes."

Blue light seems to be particularly important in driving the daily SCN clock by inhibiting the expression of melatonin.

The fact that the spectral composition of light can impact on the expression of melatonin has been studied since the mod 80s. The effect was discussed in the 1984 publication *The influence of different light spectra on the suppression of pineal melatonin content in the Syrian hamster*, the 1985 publication *Photoperiodic and light spectral conditions which inhibit circulating concentrations of thyroxine in the male hamster*, and the 1986 publication *[Effect of UVA on biosynthesis of melatonin in the retina]*. From the latter: "Although exposure to UVA light affects the visual process only slightly, melatonin biosynthesis was shown to be influenced significantly. Since melatonin is said to play an important role in light adaptation processes, it may be suggested that an imbalance between visual process and light adaptation may occur, predominantly in the aphakic eye."

The 2001 publication *An action spectrum for melatonin suppression: evidence for a novel non-rod, non-cone photoreceptor system in humans* provided a more detailed report:

1. "Using the ability of light to suppress nocturnal melatonin production, we aimed to investigate its spectral sensitivity and produce an action spectrum. Melatonin suppression was quantified in 22 volunteers in 215 light exposure trials using monochromatic light (30 min pulse administered at circadian time (CT) 16-18) of different wavelengths (λmax 424, 456, 472, 496, 520 and 548 nm) and irradiances (0.7-65.0 μW cm−2).
2. At each wavelength, suppression of plasma melatonin increased with increasing irradiance. Irradiance-response curves (IRCs) were fitted and the generated half-maximal responses (IR50) were corrected for lens filtering and used to construct an action spectrum.
3. The resulting action spectrum showed unique short-wavelength sensitivity very different from the classical scotopic and photopic visual systems. The lack of fit ($r2 < 0.1$) of our action spectrum with the published rod and cone absorption spectra precluded these photoreceptors from having a major role. Cryptochromes 1 and 2 also had a poor fit to the data. Fitting a series of Dartnall nomograms generated for rhodopsin-based photopigments over the λmaxrange 420-480 nm showed that rhodopsin templates between λmax 457 and 462 nm fitted the data well ($r2 \geq 0.73$). Of these, the best fit was to the rhodopsin template with λmax 459 nm ($r2 = 0.74$).
4. Our data strongly support a primary role for a novel short-wavelength photopigment in light-induced melatonin suppression and provide the first direct evidence of a non-rod, non-cone photoreceptive system in humans."

From the 2011 publication *Non-Visual Effects of Light on Melatonin, Alertness and Cognitive Performance: Can Blue-Enriched Light Keep Us Alert?* "The differential spectral sensitivity of non-image forming responses to visual responses [6], [7] has challenged the classical involvement of rod and cone photopigments in responses to light. Since Berson and co-workers [1] detected intrinsic photosensitive retinal ganglion cell (ipRGC) in the mammalian retina, it began to emerge that the eye plays a dual role in detecting light for a range of behavioral and physiological responses apart from the classical visual responses. Melanopsin-containing ipRGCs have a specialized non-visual retino-hypothalamic tract which provides direct neuronal connections to the suprachiasmatic nucleus (SCN), as well as direct and indirect (via SCN) projections to brain areas implicated in the regulation of arousal [32]. Furthermore, the SCN has connections to the pineal gland, which is responsible for the regulation of melatonin, as well as with many areas that share input from the visual photoreceptor system, such as the lateral geniculate nucleus, pretectum, and superior colliculus [33]. However, very recent findings suggest that cone photoreceptors also contribute substantially to non-visual responses at the beginning of a light exposure and at low irradiances, whereas melanopsin may be the primary circadian photopigment in response to long-duration light exposure and at high irradiances [8]." And yes, it does appear that blue light can keep us alert.

The non-visual impacts of light received by eyes is mediated by retinal ganglion cells which express melanopsin.

These cells are different than the rods and cones which enable us to see objects, and they respond to differently to light spectra, with response peaking in the blue. Discovered in 2000 and as reported in *A novel human opsin in the inner retina,* "Here we report the of a novel human opsin, melanopsin, that is expressed in cells of the mammalian inner retina. The human melanopsin gene consists of 10 exons and is mapped to chromosome 10q22. This chromosomal localization and gene structure differs significantly from that of other human opsins that typically have four to seven exons. A survey of 26 anatomical sites indicates that, in humans, melanopsin is expressed only in the eye. In situ hybridization histochemistry shows that melanopsin expression is restricted to cells within the ganglion and amacrine cell layers of the primate and murine retinas. Notably, expression is not observed in retinal photoreceptor cells, the opsin-containing cells of the outer retina that initiate vision. The unique inner retinal localization of melanopsin suggests that it is not involved in image formation but rather may mediate nonvisual photoreceptive tasks, such as the regulation of circadian rhythms and the acute suppression of pineal melatonin. The anatomical distribution of melanopsin-positive retinal cells is similar to the

pattern of cells known to project from the retina to the suprachiasmatic nuclei of the hypothalamus, a primary circadian pacemaker."
Also from the 2011 publication *Non-visual effects of light on melatonin, alertness and cognitive performance: can blue-enriched light keep us alert?* "The non-visual effects of ocular light at short wavelengths strongly impinge on the human circadian timing system [1], [2], most probably via novel photoreceptors with the photopigment melanopsin [3], [4], [5]. Maximal response of this non-image-forming (NIF) system to light occurs between 446 and 483 nm for melatonin suppression [6], [7]. Furthermore, circadian phase shifts seem to be more sensitive to 460-nm light compared to 555-nm light at high irradiances [8]. Repercussions on human physiology include increased heart rate and core body temperature after blue (460 nm) but not after green light (550 nm) of equal photon density when administered in the evening [9], together with decreased electroencephalographic (EEG) slow-wave activity in the first cycle of non- rapid eye (NREM) sleep and shortened rapid eye movement (REM) sleep duration in the first two cycles [10]."
Light peaked at 6500K appears to have the highest bioactive effect for melatonin suppression.
The same publication reports "Comparison of salivary melatonin levels across different light conditions indicated that light at 6500K, 3000K and 2500K resulted, respectively, in an increase of 29.5±5%, 49±7.6% and 42±8.6% in comparison to pre-light exposure (1-way ANOVA, F2,17=2.1, p=0.03). –Here we demonstrate that the alerting response to polychromatic light in the evening is wavelength-dependent, such that light at 6500K is more effective than light at 2500K and 3000K in reducing subjective sleepiness and enhancing cognitive performance, specifically associated with tasks of sustained attention. — In our study, light exposure caused a wavelength-dependent suppression of salivary melatonin, such that light at 6500K resulted in a significant attenuated melatonin secretion, particularly after 90 minutes of light exposure, and which persisted during post-light exposure. This stands in agreement with recent findings suggesting that the human circadian pacemaker is highly sensitive to short wavelength light [6], [7], as indexed by action spectra for human melatonin suppression and assessment of human circadian phase resetting[30], [31]."
A trend in street lighting is replacing sodium vapor bulbs with more energy-efficient LED lighting, shifting the spectrum of such light from the yellow toward the blue.
This is happening throughout the country. For example on Feb 22, 2012, the Dothan Eagle reported *Energy-efficient street lights being installed* reported*: "*New energy-efficient streetlights are going up on West Main Street, reducing energy consumption and greenhouse gas emissions. — Richard Ash, electric operations supervisor for Dothan Utilities, said the street lights were purchased for the city through a grant from the U.S. Department of Energy, aimed at pursuing energy efficiency to reduce greenhouse gas emissions. The grant was for $600,000. About $100,000 of that is being used for the streetlights. — The new streetlights are 157-watt LED lights and replace 250-watt high pressure sodium bulbs. Ash said the new lights use less electricity and will last longer than the old sodium bulbs. According to Lighting Orient, an LED light manufacturer, LED lights provide 50 to 60 percent energy savings over traditional sodium bulbs. They may also appear brighter than the old bulbs because they emit white, rather than yellow light. — Dothan Utilities workers are currently installing about 68 lights from the intersection of West Main Street at Ross Clark Circle to Montana Street. Lights have also been installed on Westgate Parkway and Honeysuckle Road. Installation should be complete in about two weeks."
Flat-screen LED TV sets and backlit LED computer monitors have already largely displaced the older fluorescent CRT TV sets and monitors. These new displays often display light whose frequency peak is more in the blue. Blue light from light-emitting diodes at night can cause significant suppression of expression of melatonin in humans with consequent disruption of the daily circadian rhthym with possible negative health consequences.
The May 2011 publication *Evening exposure to a light-emitting diodes (LED)-backlit computer screen affects circadian physiology and cognitive performance* ***reports:*** *"*Many people spend an increasing amount of time in front of computer screens equipped with light-emitting diodes (LED) with a short wavelength (blue range). Thus we investigated the repercussions on melatonin (a marker of the circadian clock), alertness, and cognitive performance levels in 13 young male volunteers under controlled laboratory conditions in a balanced crossover design. A 5-h evening exposure to a white LED-backlit screen with more than twice as much 464 nm light emission {irradiance of 0,241 Watt/(steradian × m(2)) [W/(sr × m(2))], 2.1 × 10(13) photons/(cm(2) × s), in the wavelength range of 454 and 474 nm} than a white non-LED-backlit screen [irradiance of 0,099 W/(sr × m(2)), 0.7 × 10(13) photons/(cm(2) × s), in the wavelength range of 454 and 474 nm] elicited a significant suppression of the evening rise in endogenous melatonin and subjective as well as objective sleepiness, as indexed by a reduced incidence of slow eye movements and EEG low-frequency activity (1-7 Hz) in frontal brain regions. Concomitantly, sustained attention, as determined by the GO/NOGO task; working memory/attention, as assessed by "explicit timing"; and declarative memory performance in a word-learning paradigm were significantly enhanced in the LED-backlit screen compared with the non-LED condition. Screen quality and visual comfort were rated the same in both screen conditions, whereas the non-LED screen tended to be considered brighter. – Our data indicate that the spectral profile of light emitted by computer screens impacts on circadian physiology, alertness, and cognitive performance levels. The challenge will be to design a computer screen with a spectral profile that can be individually programmed to add timed, essential light information to the circadian system in humans."
So, for people like myself who tend to work at night in front of a large bluish LED screen, compared to working on an old smaller and yellower screen: 1.On the one hand, alertness, cognitive and memory performance and feeling of wellbeing are improved, sleepiness is diminished and productivity is improved, and 2. On the other hand evening expression of melatonin is inhibited, the nighttime circadian sleep cycle is delayed, depth and quality of sleep may be impaired, and there could be additional negative consequences.
The December 2011 publication *Blue light from light-emitting diodes elicits a dose-dependent suppression of melatonin in humans* points out the importance of light frequency on LED inhibition of melatonin. This document reports: "Light suppresses melatonin in humans, with the strongest response occurring in the short-wavelength portion of the spectrum between 446 and 477 nm that appears blue. Blue monochromatic light has also been shown to be more effective than longer-wavelength light for enhancing alertness. Disturbed circadian rhythms and sleep loss have been described as risk

factors for astronauts and NASA ground control workers, as well as civilians. Such disturbances can result in impaired alertness and diminished performance. Prior to exposing subjects to short-wavelength light from light-emitting diodes (LEDs) (peak λ = 469 nm; 1/2 peak bandwidth = 26 nm), the ocular safety exposure to the blue LED light was confirmed by an independent hazard analysis using the American Conference of Governmental Industrial Hygienists exposure limits. Subsequently, a fluence-response curve was developed for plasma melatonin suppression in healthy subjects (n = 8; mean age of 23.9 ± 0.5 years) exposed to a range of irradiances of blue LED light. Subjects with freely reactive pupils were exposed to light between 2:00 and 3:30 AM. Blood samples were collected before and after light exposures and quantified for melatonin. The results demonstrate that increasing irradiances of narrowband blue-appearing light can elicit increasing plasma melatonin suppression in healthy subjects (P < 0.0001). The data were fit to a sigmoidal fluence-response curve (R(2) = 0.99; ED(50) = 14.19 μW/cm(2)). A comparison of mean melatonin suppression with 40 μW/cm(2) from 4,000 K broadband white fluorescent light, currently used in most general lighting fixtures, suggests that narrow bandwidth blue LED light may be stronger than 4,000 K white fluorescent light for suppressing melatonin."

One negative consequence of inhibition of melatonin production by exposure to blue LED light at night could be elevated risk of breast cancer.

The October 2011 publication *Circadian regulation of molecular, dietary, and metabolic signaling mechanisms of human breast cancer growth by the nocturnal melatonin signal and the consequences of its disruption by light at night* reports; "This review article discusses recent work on the melatonin-mediated circadian regulation and integration of molecular, dietary, and metabolic signaling mechanisms involved in human breast cancer growth and the consequences of circadian disruption by exposure to light at night (LAN). The antiproliferative effects of the circadian melatonin signal are mediated through a major mechanism involving the activation of MT(1) melatonin receptors expressed in human breast cancer cell lines and xenografts. In estrogen receptor (ERα+) human breast cancer cells, melatonin suppresses both ERα mRNA expression and estrogen-induced transcriptional activity of the ERα via MT(1) -induced activation of G(αi2) signaling and reduction of 3′,5′-cyclic adenosine monophosphate (cAMP) levels. Melatonin also regulates the transactivation of additional members of the steroid hormone/nuclear receptor super-family, enzymes involved in estrogen metabolism, expression/activation of telomerase, and the expression of core clock and clock-related genes. The anti-invasive/anti-metastatic actions of melatonin involve the blockade of p38 phosphorylation and the expression of matrix metalloproteinases. Melatonin also inhibits the growth of human breast cancer xenografts via another critical pathway involving MT(1) -mediated suppression of cAMP leading to blockade of linoleic acid uptake and its metabolism to the mitogenic signaling molecule 13-hydroxyoctadecadienoic acid (13-HODE). Down-regulation of 13-HODE reduces the activation of growth factor pathways supporting cell proliferation and survival. Experimental evidence in rats and humans indicating that LAN-induced circadian disruption of the nocturnal melatonin signal activates human breast cancer growth, metabolism, and signaling provides the strongest mechanistic support, thus far, for population and ecological studies demonstrating elevated breast cancer risk in night shift workers and other individuals increasingly exposed to LAN."

Photo-triggering of circadian rhythms may be impaired in older people because of yellowing of their natural lenses which blocks blue light.

"The December 2011 publication *Short wavelength light filtering by the natural human lens and IOLs – implications for entrainment of circadian rhythm* reports: "*Purpose*: Photoentrainment of circadian rhythm begins with the stimulation of melanopsin containing retinal ganglion cells that respond directly to bluelight. With age, the human lens becomes a strong colour filter attenuating transmission of short wavelengths. — The purpose of the study was to examine the effect the ageing human lens may have for the photoentrainment of circadian rhythm and to compare with intraocular implant lenses (IOLs) designed to block UV radiation, violet or bluelight. *Methods*: The potential for photoentrainment of circadian rhythm was computed for 29 human donor lenses (18-76 years) and five IOLs (one UV, two violet and two bluelight blocking) based on the transmission properties of the lenses and the spectral characteristics of melanopsin activation and two of it's physiological outcomes; melanopsin-driven pupillary light reponse and light-inducedmelatonin suppression. *Results*: The potential for melanopsin stimulation and melatoninsuppression was reduced by 0.6-0.7 percentage point per year of life because of yellowing of the natural lens. The computed effects were small for the IOLs and did not exceed that of a 22.2-year-old natural lens for the blue-blocking IOLs. *Conclusion*: The results show that photoentrainment of circadian rhythm may be significantly impaired in older subjects because of the colour filtering characteristics of the human lens, whereas the effects were small for all three types of IOLs studied. Consequently, the ageing process of the natural lens is expected to influence the photoentrainment of circadian rhythm, whereas IOLs are not expected to be detrimental to circadian rhythm."

So, one would think that yellowed lenses would protect older people against LED-originated blue light at night as well as inhibiting light-activated clearance of melatonin in the morning. This is not necessarily the case for people who have had cataract surgery since artificial replacement lenses may readily transmit bluish light. I have had cataract surgery and have an implanted replacement lense only in my left eye. When I look at things with only one eye open, scenes and objects are brighter and bluish seen from the left eye, darker and yellowish when seen from the right eye.

Research has been conducted on intraocular implants with different spectral characteristics. Some are blue-blocking. See these publications. Some researchers feel there are detriments but no health benefits to blue blocking. See the 2010 publication *Blue-blocking IOLs decrease photoreception without providing significant photoprotection*.

On a personal note

Relevant to the above, typically: 1. I work until 9-10:30 PM on a 26" backlit LED computer monitor or watch TV on a 47" flat LED screen, 2. I take 2mg of melatonin together with other supplements about 10:45PM, 3. I go to bed at 11:30PM, 4. I have no trouble going to sleep or sleeping, 5. When I get up at 7:30 or 8:00 AM, I am often still quite sleepy. Exposing myself to bright light and exercising help shake this off as well as does going back to work in front of the LED monitor. It seems my melatonin supplement has a 10-hour impact.

Can't Sleep? Blame Your LED Backlit Screen
Posted on **2012 April 14**

A lot of studies have explored the potential negative effects of light pollution and overexposure to light. Some studies suggest excess exposure is related to insomnia (this might come as a shock…not) and diseases like Alzheimer's or Breast Cancer. With regard to light wavelengths, the blue wavelength is one of particular interest, especially for those of us who use mobile electronics on a daily basis.

Melatonin & Blue Light

The New York Times published an article that quotes researchers who discuss some of the effects blue light has on our eyes and the chemical imbalance of***melatonin***. Melatonin is a hormone that responds directly to any kind of light. As night approaches and the amount of light decreases, the body releases melatonin, which "promotes sleep and alerts a variety of biological processes to the approximate hour of the day." However, when light strikes the *retina*, or back of the eye, melatonin is suppressed.

…there lies the rub. In this modern world, our eyes are flooded with light well after dusk, contrary to our evolutionary programming. Scientists are just beginning to understand the potential health consequences. The disruption of circadian cycles may not just be shortchanging our sleep, they have found, but also contributing to a host of diseases.

Scientists like George Brainard, a neurologist at Thomas Jefferson University in Philadelphia, have observed that blue light is especially effective at suppressing melatonin. Why is this relevant? ***Many backlit electronic screens implement LED technology that uses blue wavelength emitting diodes***.

The Experiments

A group of researchers at the University of Basel in Switzerland conducted a study using 13 men that were asked to sit in front of different types of computer screens before retiring to bed. During one week, they spent five hours in front a fluorescent, red-based screen that emitted little blue light. During another week, they spent five hours in front of a LED, blue-based screen that emitted twice as much blue light. Notice the first screen emitted barely any blue, so twice as much blue light is significantly more, but it doesn't mean the screen was screaming blue. This is significant to me because it seems to indicate that the study was more realistic and not taken out of context from the kinds screens people actually look at. So what were the results?

Melatonin levels in volunteers watching the LED screens took longer to rise at night, compared with when the participants were watching the fluorescent screens, and the deficit persisted throughout the evening.

And this is the most intriguing part:

The subjects also scored higher on tests of memory and cognition after exposure to blue light, Dr. Cajochen and his team reported in the May issue of The Journal of Applied Physiology. While men were able to recall pairs of words flashed across the fluorescent screen about half the time, ***some scores rose to almost 70 percent when they stared at the LED monitors***.

My first impression after reading that was that I'll continue to study for tests using my computer. Maybe that explains higher tests scores when I do use my computer? I haven't looked into it but it's an interesting thought.

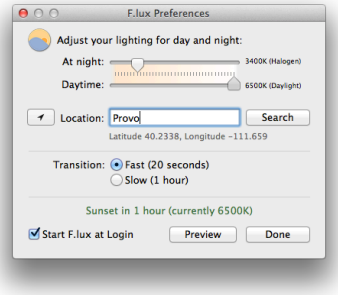
Takeaways

Again, why is this relevant? Because we are readily replacing old red light technology like incandescent bulbs with new energy-efficient blue light technology like LEDs. Most of our new electronic screens use LED technology (TVs, laptops, flat screen monitors, mobile phones, etc.).

Research isn't absolutely conclusive since this is a relatively immature field of study, but the findings are starting to lead scientists to more concrete conclusions. Health agencies are starting to make statements. The World Health Organization concluded that irregularities in biological clock patterns "can alter sleep-activity patterns, suppress melatonin production and disregulate genes involved in tumor development." The Journal of the American Medical Directors Association made conclusions regarding the boost in cognitive processes made by subjects exposed to blue light as opposed to red light.

Technological Solutions

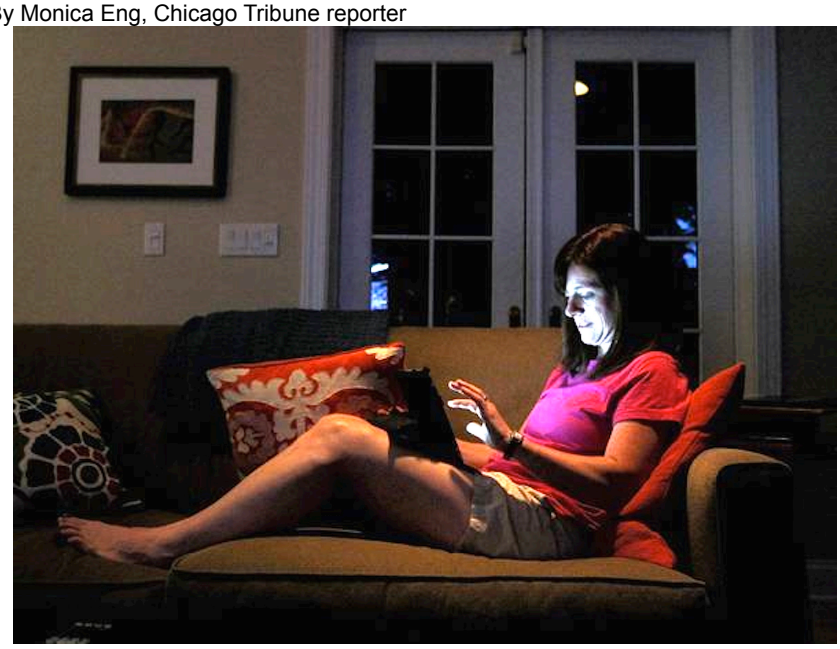
If you're a little paranoid about your health, or maybe you want to ensure you're sleeping your best, there are some technological solutions. flux (Mac, iPhone/iPad, Windows & Linux) is a ***free program that automatically adjusts the amount of blue light emitted by your screen depending on the time of day***. So in the evening the screen changes to redder tones. During morning hours, screen color is designed to emulate natural sunlight. Don't worry, your whole screen won't turn red; you'll just notice a it feels a bit warmer with regard to color temperature. You can also customize it for the best experience by adjusting how fast it transitions, how much the color changes and what kind of lighting you are surrounded with.
I suggest you give flux a try as today's mini-app of the day. I've found it rests my eyes a bit more in the evening if nothing else.
Another Mac only alternative is a prefpane app called Shades.



Examples of Other Light Related Studies
If you're interested in learning a bit more you can check out the articles listed on Stereopsis's research link (the group that developed f.lux) or read some of the studies listed below.

- The impact of light from computer monitors on melatonin levels in college students
- Non-Visual Effects of Light on Melatonin, Alertness and Cognitive Performance: Can Blue-Enriched Light Keep Us Alert?
- Short-Wavelength Light Sensitivity of Circadian, Pupillary, and Visual Awareness…
- High sensitivity of the human circadian melatonin rhythm to resetting by short wavelength light
- Melatonin rhythmicity: effect of age and Alzheimer's disease
- Effect of Light Wavelength on Suppression and Phase Delay of the Melatonin Rhythm

Light from electronic screens
at night linked to sleep loss
American Medical Association recognizes problem with tablets and e-readers
July 08, 2012|By Monica Eng, Chicago Tribune reporter



(Chris Sweda, Chicago Tribune)

Like a lot of Americans, Amalie Drury has grown very attached to her smartphone.
The 33-year-old Chicago writer checks the device multiple times a day for Facebook updates and email messages. She

brings it into the bathroom when she brushes her teeth. And she often totes it to bed, "just to check email one more time and play a few more rounds of Words With Friends."

If Drury wakes up in the middle of the night, she reaches for her phone again. "My first thought is to pick up the iPhone to see what's happening in the news," she said. "I'll ... sometimes read long features and not really be able to go back to sleep."

Drury's "terrible habits," as she calls them, reflect those of millions who bring their phones, tablets, e-readers and laptops to bed each night, according to consumer research. The trend is causing increasing concern in the medical community based on mounting evidence that the type of light produced by our portable electronic screens can contribute to sleep loss.

Last month the American Medical Association issued a policy recognizing "that exposure to excessive light at night, including extended use of various electronic media, can disrupt sleep or exacerbate sleep disorders, especially in children and adolescents."

Any light at night can be disruptive, researchers say, but in recent years studies have zeroed in on the particularly potent "blue light" emitted abundantly from the energy-efficient screens of smart-phones and computers as well as many fluorescent bulbs.

Because blue light is especially prominent in daylight, our bodies associate it with daytime, which may be why exposure to blue light can make us more alert and improve our response times. It also has been shown to suppress melatonin, a hormone that helps regulate sleep and is not produced during the day.

In May 2011, Swiss researchers at the Basel reported that subjects who spent time at night in front of an LED computer screen, as opposed to a screen emitting a variety of colors but little blue light, experienced "a significant suppression of the evening rise in endogenous melatonin and … sleepiness."

Over the last decade, neuroscientists have discovered novel light-sensitive cells in the eye that detect light. These cells are separate from those we use for vision and contain a photopigment called melanopsin that is particularly sensitive to blue light. Scientists think this light-detecting mechanism, which regulates our sense of night and day and time of year, evolved before the ability to see. "Blue light preferentially alerts the brain, suppresses the melatonin and shifts your body clock all at the same time," said Harvard Medical School sleep researcher Steven Lockley. "Your brain is more alert now and thinks it's daytime because we have evolved to only see bright light during the day."

Compounding the problem, Lockley and others said, is that unlike TV (which also emits blue light), these newer electronic screens are positioned close to our faces, increasing the intensity and effects of the blue light on our brains.

"The closer you have a light source to the face, the more intense it is," said Lockley, co-author of "Sleep: A Very Short Introduction." "And the further you go away, it falls off quite quickly. So having things close to the face is much worse than having a TV that's 10 feet away."

The researcher stressed that these types of screens are not all bad. When used during the day, they can help stabilize circadian rhythms and increase alertness and reaction time.

Increasingly, however, consumers are using devices that emit blue light well into the night. A recent poll by Rosetta marketing consultants indicated that today almost 1 in 3 Americans who use the Internet own a tablet and that 68 percent of them report taking the device to bed. While tablet manufacturers remain generally quiet about the blue light issue — neither, which makes the Nook Simple Touch with GlowLight, nor Amazon, maker of the Kindle Fire, responded to requests for interviews — industry watchers and scientists confirm that some manufacturers are already developing new features to automatically modulate or remove blue light emissions at night. Representatives of Apple note that blue light emissions can be reduced on the iPad by adjusting brightness and switching to white on black mode at night through the "settings" feature.Other companies also are working on technical solutions. In 2005, after conducting early studies on the effects of blue light on sleep, **researchers at John Carroll University in Ohio formed a spinoff company called Photonic Developments to market products that can mitigate blue light exposure. These include orange-tinted glasses, screen filters and blue-light-free bulbs, all sold at LowBlueLights.com.**

"We have many people talking about the problem," said Richard Hansler, one of the scientists who developed the products, "but I'm surprised that so few have come up with solutions for it."

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