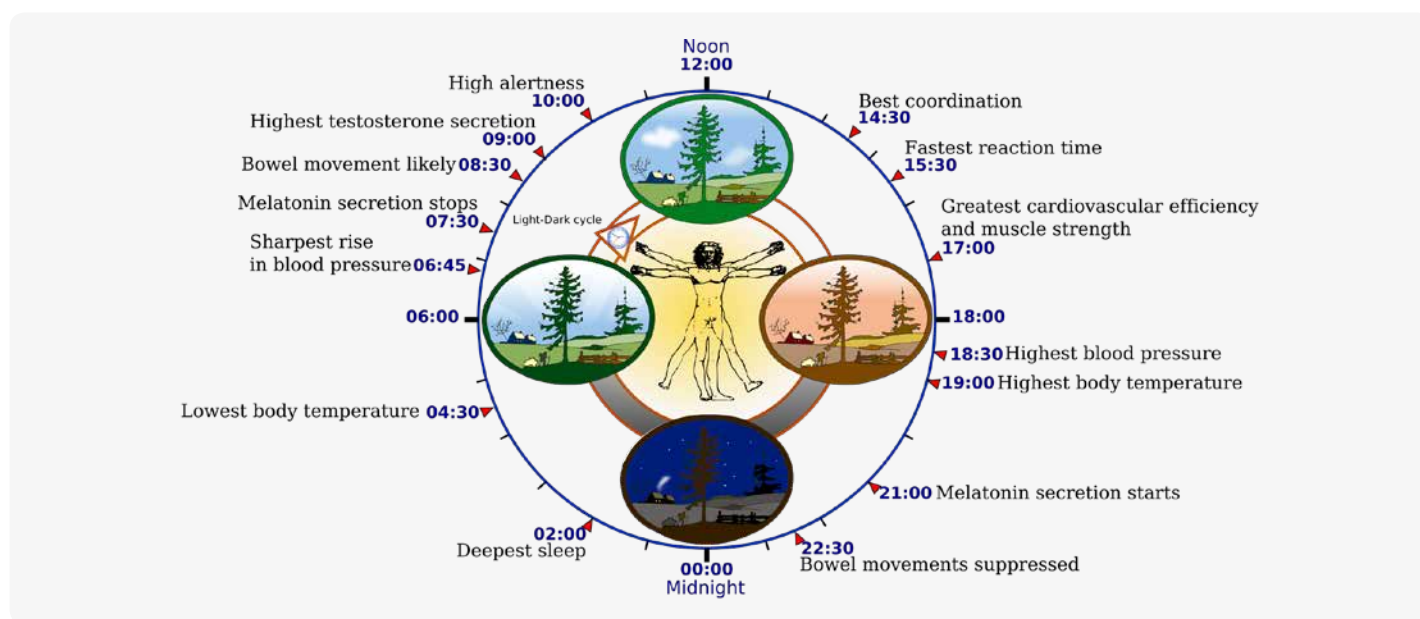


The Nobel Prize and its implication for mariners' health and performance

In 2017, the Nobel Prize in physiology/medicine was awarded to the discoveries of molecular mechanisms controlling the circadian rhythm. The circadian rhythm, mostly affected by light, controls our alertness and sleepiness during the day. We can all benefit from knowing how to use light to maximise our performance, but it is even more important for mariners who are working and living 24 hours a day in a harsh environment where good recovery is important for safe operation and health. Among all the factors on board that affect sleep and alertness, the impact of light may be less known. SSPA performed an overview, funded by the Swedish Mercantile Marine Foundation, about the effects of light and with a greater insight; mariners can adapt new routines to affect their well-being.



"Overview of biological circadian clock in humans" by Yassine Mrabet.

Life at sea

Being a mariner is a dangerous profession with high risks of experiencing both accidents and health issues. Not enough good sleep certainly increases the risk of personal injuries or even the vessel running aground or colliding with other vessels. Poor recovery is also affected by working shift hours, which is common on board. Chronic sleep disorder is associated with cardiovascular disease, diabetes, depression and other health issues.

The circadian rhythm

Our daily rhythm, the so-called circadian rhythm, controls many of our important body functions such as temperature, hormone secretion, metabolism and not least alertness and sleep.

One of the most important external factors, so-called zeitgeber (German for timer), that

controls the circadian rhythm is light. But there are also other zeitgebers such as temperature changes, food intake and social stimuli. It is only recently that we have found out the mechanism of how light affects human circadian rhythm. For 150 years, however, we have had a predominant model of eye function with cones and rods that form receptors for light and the formation of vision. It was not until the late 1990s that a new type of light receptors was discovered, special ganglion cells (pRGCs) that are sensitive to the blue part of the light spectrum wavelength at $\lambda_{max} \sim 480 \text{ nm}$.

Melatonin

One of the more interesting hormones directly associated with sleep is melatonin, which is secreted while we are asleep. The secretion is governed by the circadian rhythm controlled

in a part of the brain called the suprachiasmatic nucleus (SCN) located in the hypothalamus about three centimetres behind the eyes. The most potent external influence on the SCN comes from light through the ganglion cells in the eye.

Daylight

The most obvious and natural way to have a good circadian rhythm with a good night's sleep is to work outside during the daytime. Even short periods outside at lunchtime are beneficial. Note that we should never look into the sun.

There are also other benefits of exposure to sunlight. A recently published study on the overall mortality rate for those who spend a lot of time in the sun showed that their life expectancy is 0.6–2.1 years longer than those who avoid sunlight.



The demanding 24-hour operation of vessels. Photo courtesy of Lars Markström.

Blue wavelength in artificial lighting

However, many tasks onboard are performed inside the ship and the mariners do not get enough exposure to natural daylight. This can be counteracted with illumination which includes the vital blue wavelength. In order to compare light sources with each other, a relative ratio have been employed where a standard fluorescent lamp with a colour temperature of 3000 K, warm white, has a value of 1 and a higher value gives more blue circadian light.

Full-spectrum light sources

There are also specialised full spectrum light sources. Among the terms used by manufacturers, we find full spectrum or daylight type, but this does not guarantee that the proportion of blue light is satisfactory, as there seems to be no uniformly agreed definition for this. These names are more likely to be regarded as marketing terms. In order to determine whether a light source emits a useful proportion of blue light, it is necessary to examine the manufacturer's specifications. It should also be noted that efficiency may often be lower in full spectrum lamps, i.e. the number of lumens per watt is lower and that this may need to be compensated for to achieve sufficient light intensity for a possible light source replacement.

Brightness

The amount of circadian light exposure is determined not only by the ratio in the light

spectrum but also by the brightness. To affect the circadian rhythm, true daylight or at least 1,000 lux of artificial light is needed. Electrical lighting in homes, offices, schools, factories, etc., rarely exceeds 1,000 lux, and is unfortunately often significantly lower. Outdoors, the brightness from sunrise is already between 2,000 and 10,000 lux, even on a cloudy day.

Blue light at the right time

In previous sections, it was described how important light, and specifically blue light, is for the circadian rhythm, provided that it is exposed to the light at the right time, i.e. usually during daytime. But the reverse also applies.

Melatonin, the hormone that is important for sleep and the circadian rhythm, can be suppressed by only small amounts of light, especially blue light. At levels as low as 8 lux, something easily exceeded by a standard table lamp, has an impact.

Some tips for reducing blue light exposure:

- If possible, use a dimmed red light in the evening.
- Avoid watching electronic screens 2–3 hours before bedtime.
- Use glasses that block blue light if you still want to watch screens before bedtime.
- There are also apps available that reduce the blue light content from PCs and other devices.

Blue light blocking

One way to reduce unwanted exposure may be wearing glasses that block blue light. Regular cheap sunglasses with yellow or orange lenses block blue light, but have the unwanted effect that colour rendition is also reduced, which does not suit all work tasks. There are special glasses that block only blue light, but these are significantly more expensive and may not be as effective.

There are also apps for PCs and smartphones that will reduce the blue light from the screen. Although much is written about these in newspapers and blogs etc., specific research in the field seems to be almost non-existent so far.

Light management onboard merchant vessels

If you work outdoors, it will be a part of the usual daily rhythm to get light and darkness at the right time. This will be much more complex when work and rest patterns do not follow the normal daily rhythm, such as several jobs onboard ships.

The United States Coast Guard (USCG) Research and Development Center has prepared a guide on how to improve crew capacity and safety on board merchant ships. The guide is called "Crew Endurance Management Practices: A Guide for Maritime Operations" and is available for download from the USCG website. It describes techniques for adjusting your rhythm for working at night and different shifts, as well as advice on combining this with good night vision.



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He has more than 15 years' experience of industry R&D in the private sector. He joined SSPA in 2012 and manages research projects from multiple disciplines within maritime innovation.

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Examples of our most common light sources:

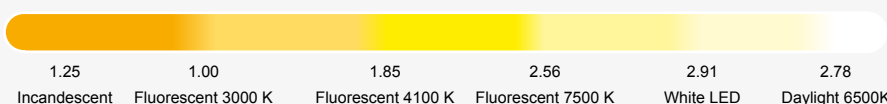


Illustration by SSPA.