Scientists Discover Key to Melatonin Production and Regulation of Circadian Rhythms

Neuroscientists at Jefferson Medical College have clarified how the human eye uses light to regulate melatonin production, and in turn, the body's biological clock. Their observations are published in the August 15 issue of the ***Journal of Neuroscience.***

The scientists discovered what appears to be a fifth human "photoreceptor," which is the main one to regulate the biological - and non-visual - effects of light on the body. They have identified a novel photopigment in the human eye responsible for reacting to light and controlling the production of melatonin, which plays an important role in the body's circadian rhythms. They also discovered that wavelengths of light in the blue region of the visible spectrum are the most effective in controlling melatonin production.

"We have strong evidence for a novel, fifth photoreceptor and it appears to be independent of the classic photoreceptor for vision. It influences the biological effects of light. It regulates circadian rhythms and hormones in the body. We've also shown the fingerprint of wavelength sensitivity for the regulation of the hormone melatonin," said George Brainard, Ph.D., professor of neurology at Jefferson Medical College of Thomas Jefferson University in Philadelphia.

"This discovery will have an immediate impact on the therapeutic use of light for treating winter depression and circadian disorders," he adds. "Some makers of light therapy equipment are developing prototypes with enhanced blue light stimuli.

Four cells in the human retina capture light and form the visual system. One type, rod cells, regulates night vision. The other three types, called cone cells, control color vision. It's known that exposure to light at night can disrupt the body's production of melatonin, which is produced by the pineal gland in the brain and plays a vital role in resetting the body's daily biological clock.

Earlier this year, Dr. Brainard and his group showed that the combined three-cone system didn't control the biological effects of light, at least not for melatonin regulation. But subsequent work led to the surprising discovery that a novel receptor was responsible for the effect.

"We didn't anticipate this at all," he says.

In the study, they looked at the effects of different wavelengths of light on 72 healthy volunteers, exposing them to nine different wavelengths, from indigo to orange. Subjects were brought into the laboratory at midnight, when melatonin is highest. The subjects' pupils were dilated and then they were blindfolded for two hours. Blood samples were drawn.

Next, each person was exposed to a specific dose of photons of one light for 90 minutes, and then another blood sample was drawn. Wavelengths of blue light had the highest potency in causing changes in melatonin levels, he explains.

In theory, he says, "If a clinician wants to use light therapeutically, the blue wavelengths may be more effective. If you wanted built-in illumination that would enhance circadian regulation, you might want this wavelength region emphasized. In contrast, if you wanted something that doesn't produce biological stimulation, you might steer the light more toward the red wavelengths." But controlled clinical trials will be needed, he adds. Next, Dr. Brainard's team would like to study the next step in how light regulates not just melatonin, but all of the body's circadian rhythms, including body temperature, cortisol and performance rhythms. The National Institute of Neurological Disorders and Stroke, the National Space Biomedical Research Institute and NASA funded the research.