

## Dr. Mario Motta, MD, FACC

- Will present AMA Lighting Policy on Human health effects, 2009, 2012, 2016
- Practicing physician board certified in cardiology
- Associate professor of medicine at Tufts University School of Medicine
- Fellow of the American College of Cardiology and of the American Society of Nuclear Cardiology
- Past president of the Massachusetts Medical Society
- Current Trustee of American Medical Association (governing board)
- Past IDA Board member



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# Dark and Quiet Skies for Science and Society II

Implementing the recommendations

La Palma, Canary Islands, Spain

3 - 7, October, 2021

## AMA lighting policy, 2009, 2012, and 2016 : glare, human health effects, and LED lighting

2009 policy: advocates for full shielding on streetlights for driving safety

2012 human health report:

CSAPH Rep. 4-A-12. "Light Pollution: Adverse Health Effects of Nighttime Lighting". Action of the AMA House of Delegates 2012 Annual Meeting: Council on Science and Public Health Report 4 Recommendations Adopted as Amended (June 20, 2012), and Remainder of Report filed.

2016 LED report :

- The American Medical Association (AMA) supports the proper conversion to community-based Light Emitting Diode (LED) lighting, which reduces energy consumption and decreases the use of fossil fuels. (New HOD Policy)
- The AMA encourages minimizing and controlling blue-rich environmental lighting by using the lowest emission of blue light possible to reduce glare. (New HOD Policy)
- **The AMA encourages the use of 3000K or lower lighting for outdoor installations such as roadways. All LED lighting should be properly shielded to minimize glare and detrimental human and environmental effects, and consideration should be given to utilize the ability of LED lighting to be dimmed for off-peak time periods. (New HOD Policy)**

David Blask, PhD, MD  
(Tulane)

George Brainard, PhD  
(Jefferson)

Ronald Gibbons, PhD  
Virginia Tech)

Steven Lockley, PhD  
(Harvard)

Richard Stevens, PhD  
(Uconn)

Mario Motta, MD  
(Tufts)

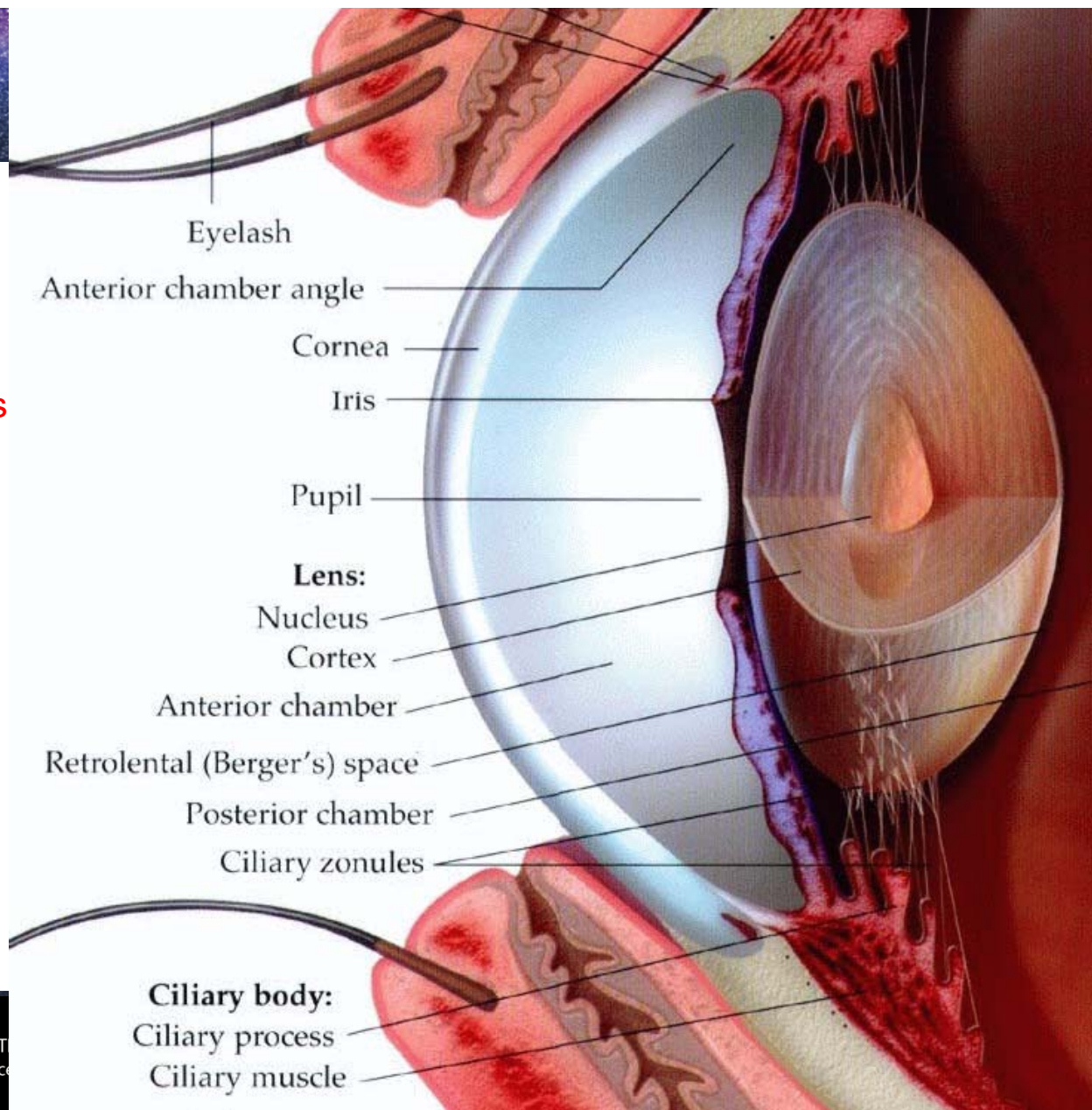
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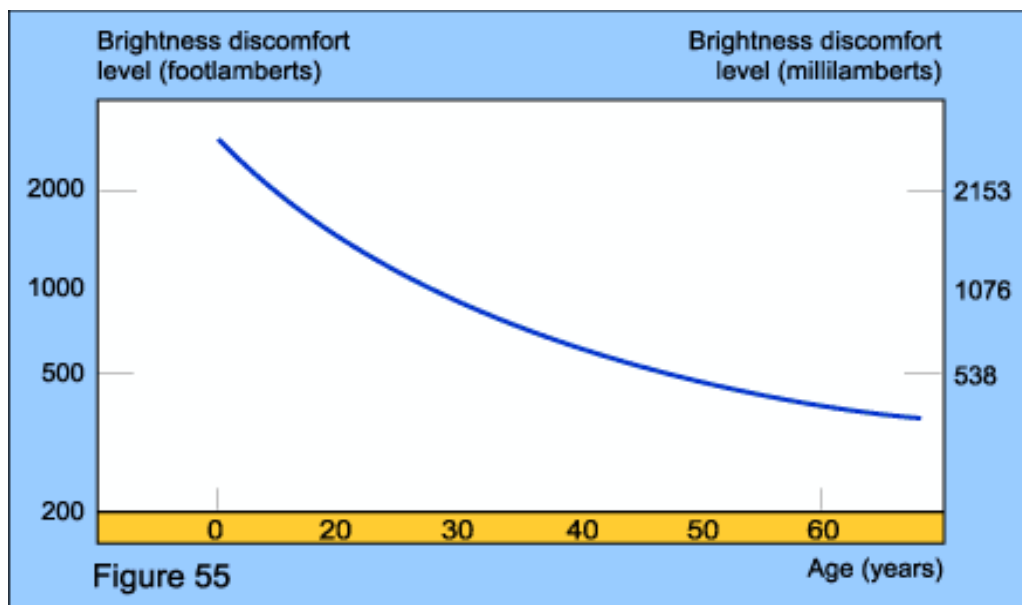
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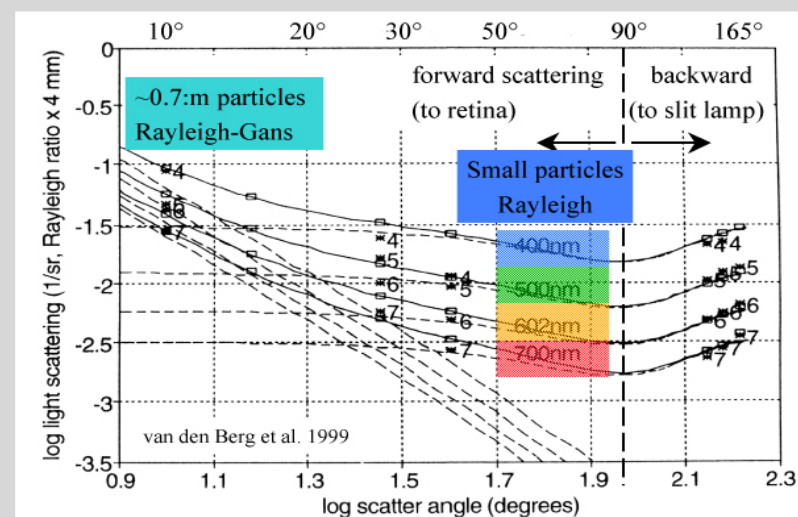
## Biology of the aging human lens



## Glare: Disability and discomfort

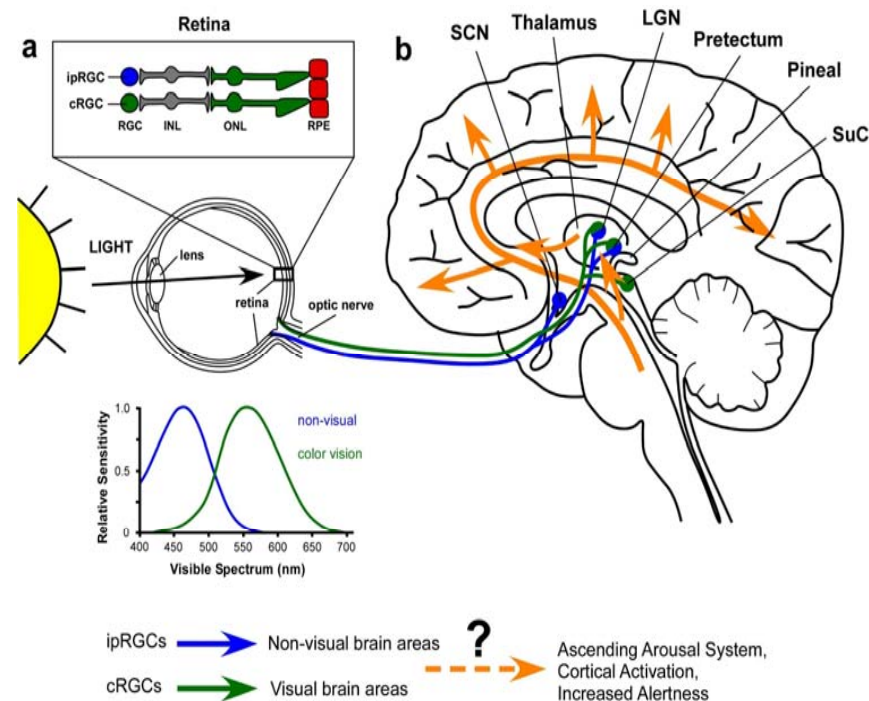


Light scattering by isolated donor lenses (here 50 year old donor)



## Blue-Rich Light: A Health Risk

- Blue light suppresses melatonin, a hormone that influences circadian rhythms.\*
  - Even dim light can interfere with a person's circadian rhythm and melatonin secretion.
  - Melatonin an "immune system adjuvant"
- Eyes exposed to blue light experience decrease in visual acuity since blue light scatters in eye.\*
- Also disrupts circadian rhythm of wildlife.



\*<http://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side>



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## Blue LED



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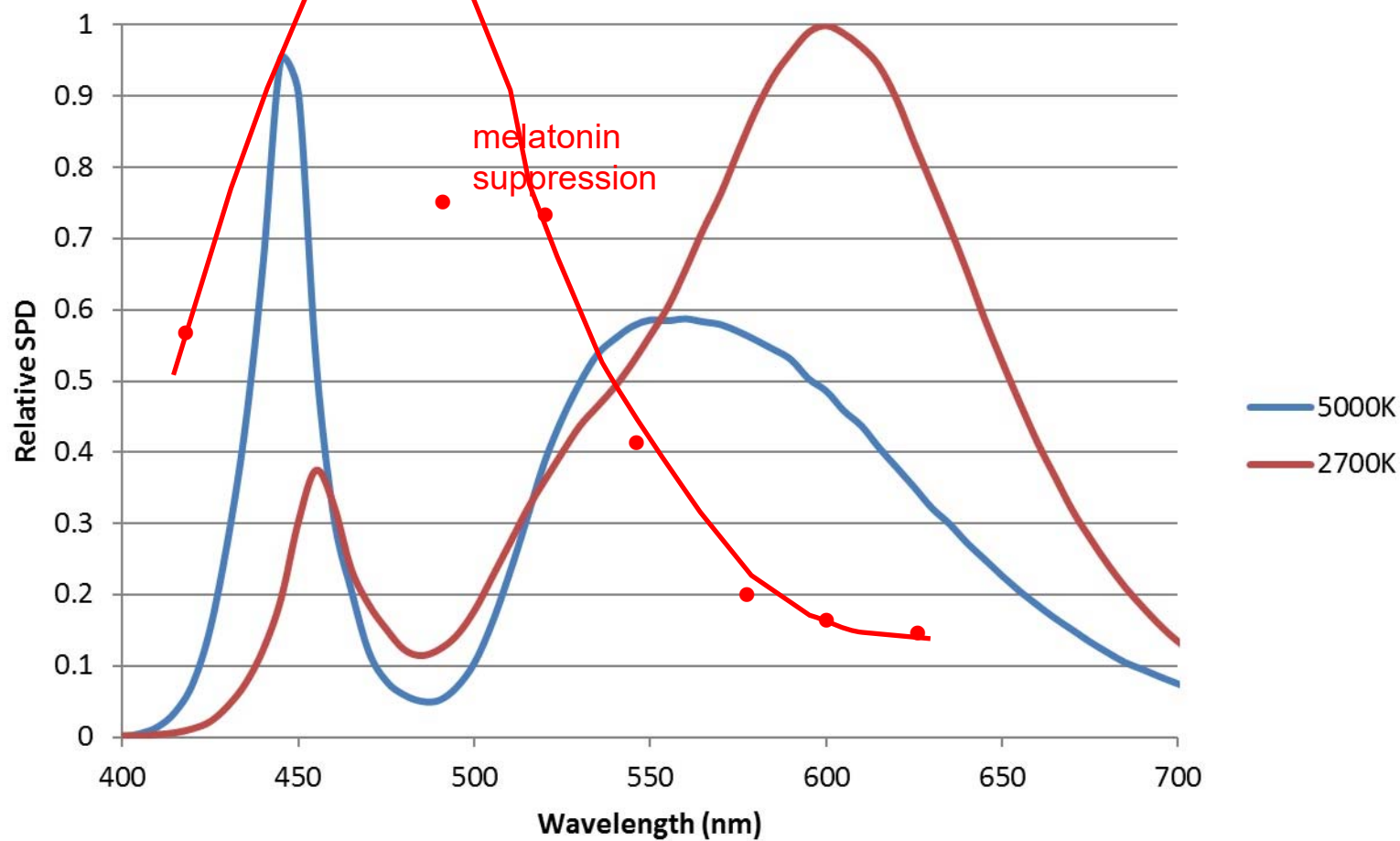


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EXCELENCIA  
SEVERO  
OCHOA





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5000K



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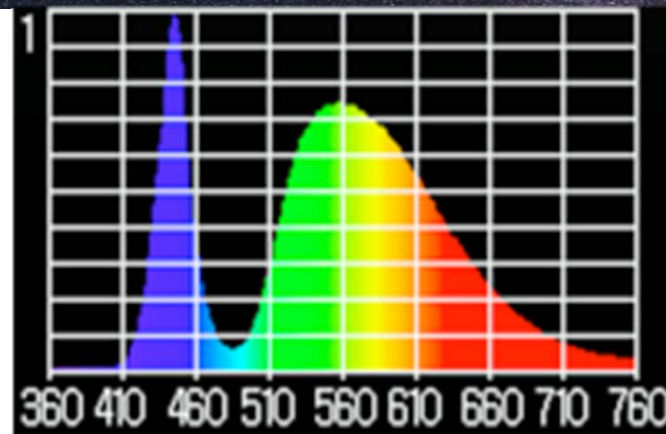
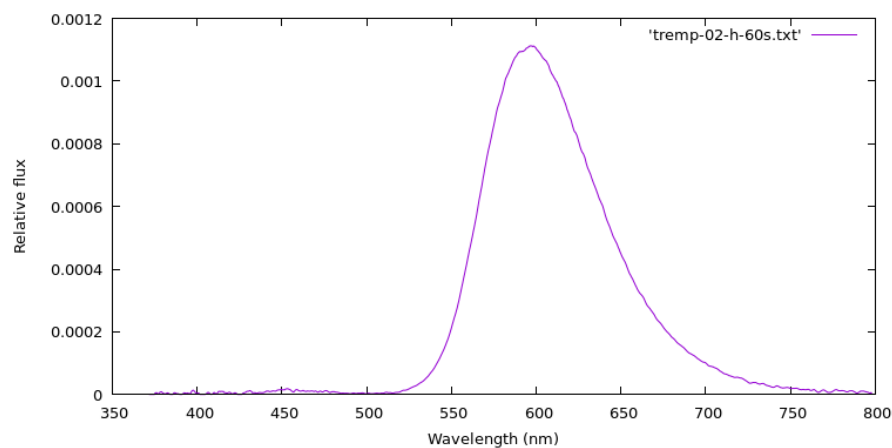
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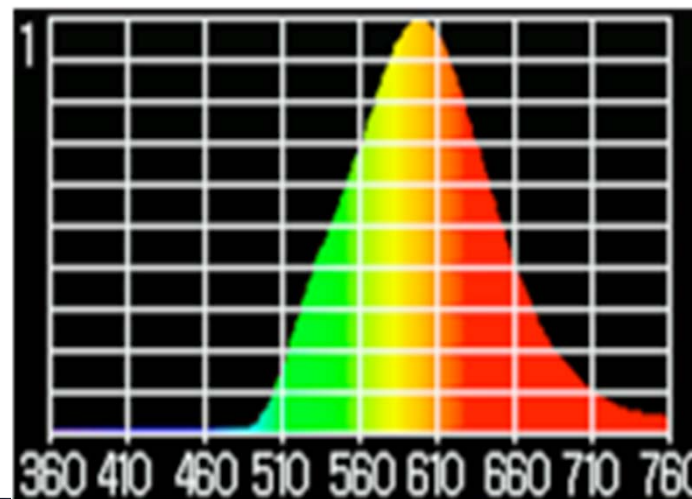
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Sherbrooke, CA  
Amber LED



4000K  
LED  
spectrum

Instead,  
Use Low  
CCT,  
amber, or  
blue  
filtered



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Amber LED spect



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## Circadian Disruption and human health effects

- Adverse effects on sleep and cognition
- WHO has declared circadian disruption a class 2 carcinogen
- evidence is strong for adverse human health effects (multiple peer reviewed research publications):
- cancer – breast and prostate, maybe others
- obesity – altered leptin and ghrelin
- diabetes – glucose metabolism
- mood disorders – depression, bipolar

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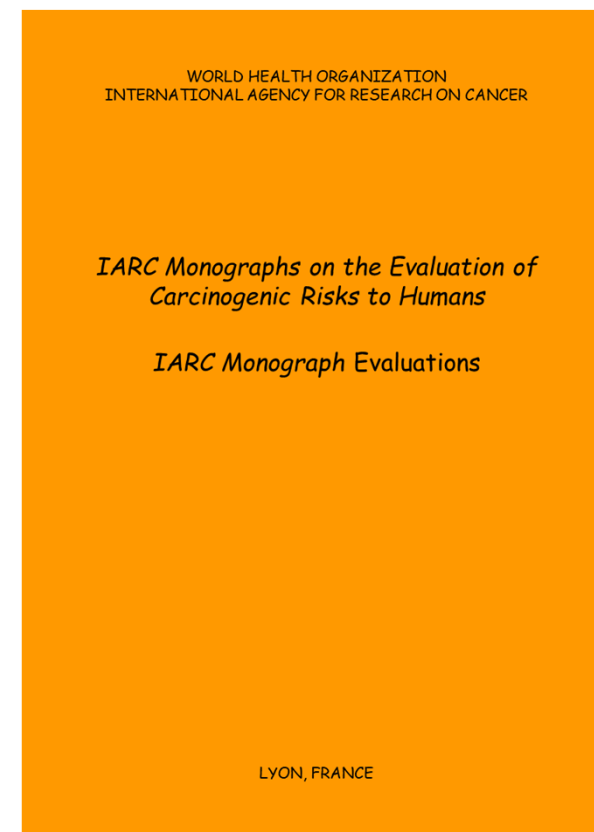
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## IARC: shift workers at higher risk

Straif K, et al. Lancet Oncology, December 2007  
page 1065

“On the basis of ‘limited evidence in humans for the carcinogenicity of shift-work that involves nightwork’, and ‘sufficient evidence in experimental animals for the carcinogenicity of light during the daily dark period (biological night)’, the Working Group concluded that ‘shift-work that involves circadian disruption is probably carcinogenic to humans’ (group 2A).”



## American Cancer Society

The American Cancer Society agrees night work is a cancer risk factor. Their web page has the following statement:

### Night Work

Several studies have suggested that women who work at night -- for example, nurses on a night shift -- may have an increased risk of developing breast cancer. This is a fairly recent finding, and more studies are looking at this issue. Some researchers think the effect may be due to changes in levels of melatonin, a hormone whose production is affected by the body's exposure to light, but other hormones are also being studied.

<http://www.cancer.org/Cancer/BreastCancer/DetailedGuide/breast-cancer-risk-factors>

## The National Institute for Occupational Safety and Health (NIOSH) 2019

### The Color of the Light Affects the Circadian Rhythms

- **Blue light** has the strongest impact. (Blue 10x red) Exposure to blue light (and white light, which contains blue light) during the sensitive period can make it difficult for you to fall asleep and stay asleep.
- Exposure to white light during the day can have positive effects, including boosting alertness and mood.
- **Red light** has no effect on the circadian clock, so you can use a dim red light at night.
- **Yellow** and **orange** light have little effect on the clock so you can use a very dim yellow or orange light at night.

Based on a Metanalysis study of 128 peer reviewed articles show better sleep with amber LED

The literature search resulted to 128 articles which were subjected to a data collection and analysis. Melatonin secretion was studied in 122 articles and REM sleep in 13 articles.

Leena Tähkämö, Timo Partonen & Anu-Katriina Pesonen (2019) Systematic review of light exposure impact on human circadian rhythm, Chronobiology International, 36:2, 151-170, DOI: [10.1080/07420528.2018.1527773](https://doi.org/10.1080/07420528.2018.1527773)

## The Circadian Clock: clock-controlled genes regulated by melatonin

- cell cycle regulation crucial to normal and malignant cell growth (e.g., cyclin D1)
- The 2017 Nobel Prize in Physiology or Medicine is awarded to **Jeffrey C. Hall, Michael Rosbash and Michael W. Young** for their discoveries of molecular mechanisms that control circadian rhythms.
- 5-10% of all mammalian genes are clock controlled
- among these are genes for the key regulators of cell-cycle progression and apoptosis (e.g., cyclins and caspases)
- light-dark cycle strongest circadian cue, ALAN disrupts this

## Breast Cancer and 'Light-at-Night'

- Mechanism: light-at-night alters hormones, suppressing melatonin production, and thereby explains some of the higher risk in industrialized societies from ALAN (**melatonin is an immune system adjuvant**)
- Multiple peer reviewed studies show:
  - shift workers at higher risk
  - blind women at lower risk (including twins)
  - lighted bedrooms at night increase risk (such as from streetlight trespass), the higher the level of trespass, the higher the risk
  - longer sleep lowers risk

- Comprehensive Longitudinal study 1989 – 2013
- 110K women NURSES STUDY (Harvard, multiple sites)
- Women exposed to the highest levels of outdoor light at night—those in the top fifth—had an estimated **14% increased risk of breast cancer** during the study period, as compared with women in the bottom fifth of exposure...As levels of outdoor light at night increased, so did breast cancer rates.- <https://www.hsph.harvard.edu/news/press-releases/outdoor-light-night-breast-cancer/>
- The study found a **direct relationship between a woman's neighborhood nighttime light level** before diagnosis and her later risk of developing breast cancer: The higher the light level, the higher the risk. These findings held even when taking into account many other factors that may also affect risk such as age, number of children, weight, use of hormone medications and a long list of additional potential confounders.

Peter James, Kimberly A. Bertrand, Jaime E. Hart, Eva Schernhammer, Rulla M. Tamimi, Francine Laden, Outdoor ( 2017 ) **Light at Night and Breast Cancer Incidence in the Nurses' Health Study II,** *Environmental Health Perspectives*, August doi: 10.1289/EHP935

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## Evaluating the Association between Artificial Light-at-Night Exposure and Breast and Prostate Cancer Risk in Spain (MCC-Spain Study), Environmental Health Perspectives, April 2018

\*Qian Xiao, Peter James, Patrick Breheny, Peng Jia, Yikyung Park, Dong Zhang, Jared A. Fisher, Mary H. Ward, Rena R. Jones. Outdoor light at night and postmenopausal breast cancer risk in the NIH-AARP diet and health study. International Journal of Cancer, 2020; USA

\*Kloog, I., A. Haim, R. G. Stevens, M. Barchana, and B. A. Portnov. 2008. Light at night co-distributes with incident breast but not lung cancer in the female population of Israel. Chronobiology International 25:65–81

\*Kloog, I., A. Haim, and B. A. Portnov. 2009. Using kernel density function as an urban analysis tool: investigating the association between nightlight exposure and the incidence of breast cancer in Haifa, Israel. Computers, Environment and Urban Systems 33:55–63.

\*Kloog, I., R. G. Stevens, A. Haim, and B. A. Portnov. 2010. Nighttime light level co-distributes with breast cancer incidence worldwide. Cancer Causes & Control 21:2059–2068.

Li Q, Zheng T, Holford TR, Boyle P, Zhang Y, Dai M. Light at night and breast cancer: results from a population-based case-control study in Connecticut, USA. Cancer Causes Control. 2010;21:2281-2285.

\*Rybnikova N, Haim A, Portnov BA. 2015. Artificial light at night (ALAN) and breast cancer incidence worldwide: A revisit of earlier findings with analysis of current trends. Chronobiol Int 32(6):757–773,

\*Keshet-Sitton A, Or-Chen K, Huber E, Haim A. 2016a. Illuminating a risk for breast cancer: A preliminary ecological study on the association between streetlight and breast cancer. Integr Cancer Ther,

\*Anbalagan M, Dauchy RT, Xiang S, et al. Disruption of the circadian melatonin signal by dim light at night promotes bone-lytic breast cancer metastases. Presented at: ENDO 2019; March 23-26, 2019

\*Kim YJ, Lee E, Lee HS, Kim M, Park MS. 2015. High prevalence of breast cancer in light polluted areas in urban and rural regions of South Korea: An ecologic study on the treatment prevalence of female cancers based on National Health Insurance data. Chronobiol Int 32(5):657–667,

\*One negative study from Canada has been published (Rittonja, 2020), possibly explained by higher use of blackout shades for northern summer sleeping. "Outdoor light at night at residences and breast cancer risk in Canada." European Journal of Epidemiology (2020)1-11

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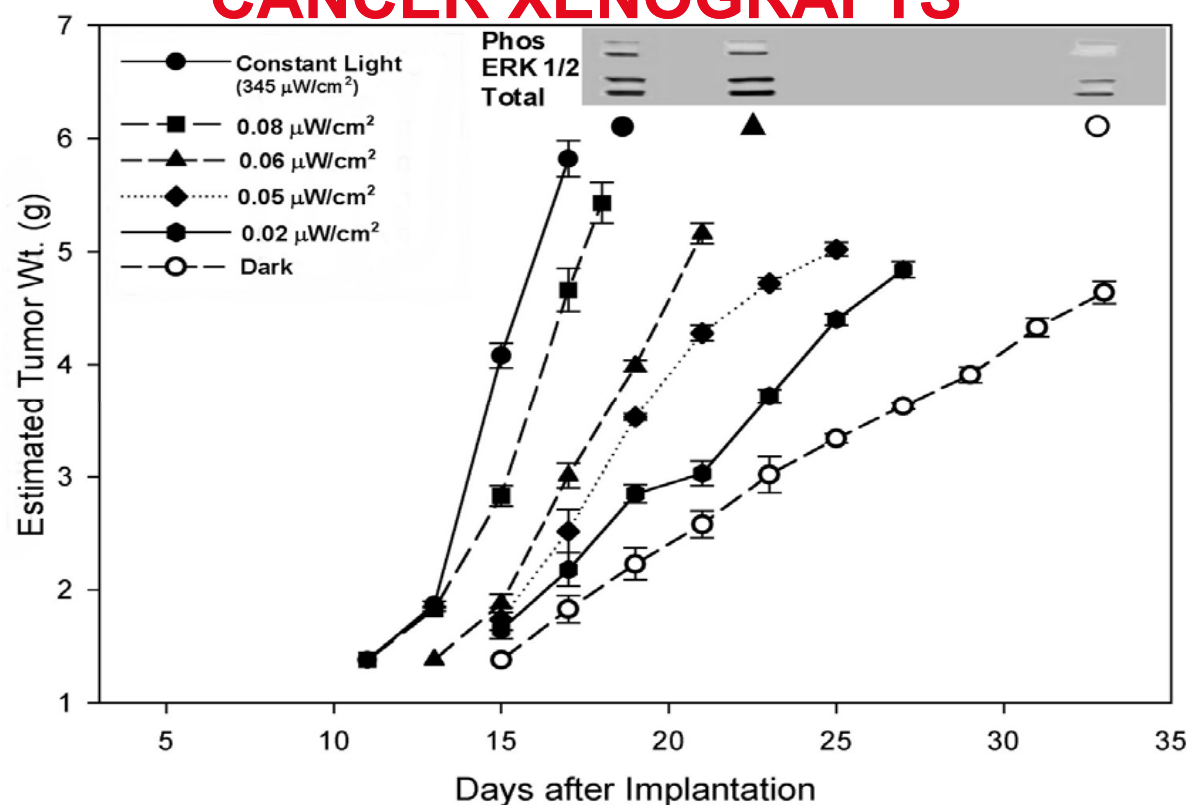


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## GROWTH RATES vs. LIGHT INTENSITY FOR HUMAN BREAST CANCER XENOGRAFTS



Blask, et al  
(Tulane)

## Environmental Impacts from LAN

- Plants (trees, soy beans, budding, crop yields)
- Insects (reproduction, disruption, pollination)
- Birds (migration, foraging, sleep cycle disruption)
- Fish( predation, reproduction and life cycle disruptions)
- Faint skyglow affects 60% invertebrates, 30% vertebrates

“If a lighting environmental effect on a particular species has not yet been documented its probably because it has not yet been studied. In every case where a study has been performed, an effect has been determined !!” *Nature, Jan 16,2018, Travis longcore*

## Ways to Mitigate Light Pollution

- Use LEDs of the lowest possible CCT. (never above 3000K)
- Consider amber LED or blue filtered
- Employ luminaires that minimize glare.
- Filter out light at wavelengths  $\leq 500$  nm.
- Use the right amount of light. Don't over-illuminate.
- Direct the light to the ground only where it is needed.
- Reduce street light illumination levels where possible after a cut-off point in the evening.



Thank you for your  
attention!



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