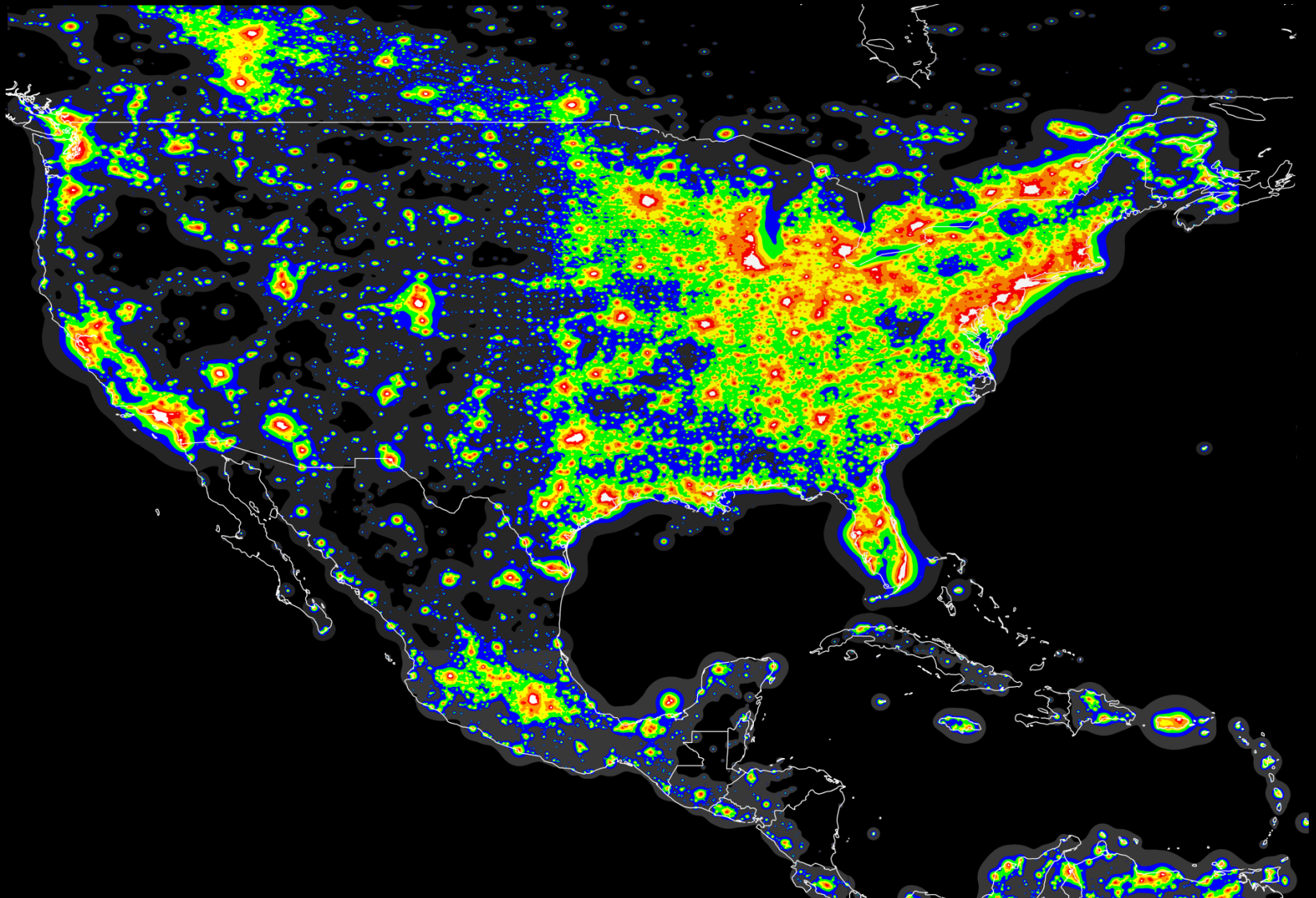


TRUE NIGHT HAS DISAPPEARED IN MUCH OF NORTH AMERICA

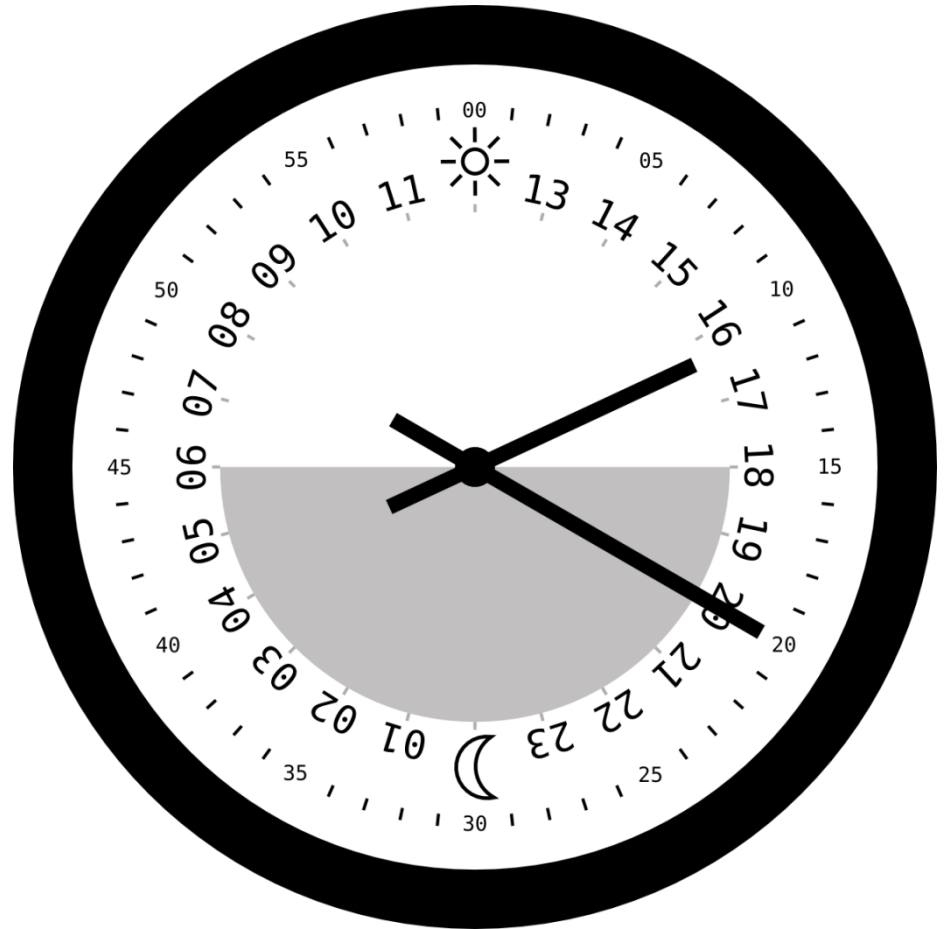


120 YEARS AFTER COMMERCIAL ELECTRIC LIGHTING IS DEVELOPED



CIRCADIAN RHYTHMS

- SCN: a clock in your brain
- SCN controls circadian rhythms
 - Sleepiness & Alertness
 - Body Temperature
 - More than 1/3 of all genes
 - Metabolism

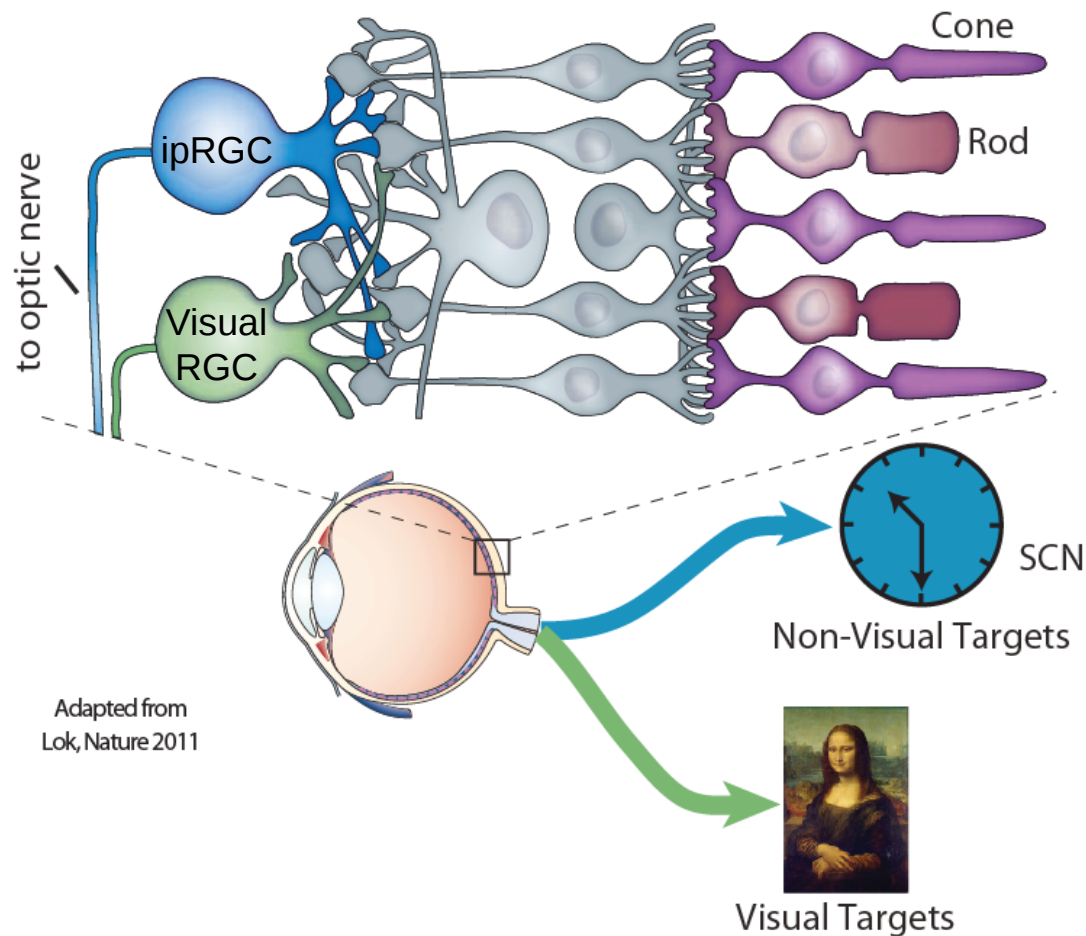


CIRCADIAN PHOTOENTRAINMENT

- We need to set our internal clock!
 - timing of sunrise and sunset changes
 - jet lag
- cues that tell us what time it is
 - eating & drinking
 - exercise
 - temperature
 - **LIGHT!**



ipRGCs: PHOTORECEPTORS FOR CIRCADIAN PHOTOENTRAINMENT



- Rods and cones are not required for photoentrainment
- **ipRGCs are 3rd type of photoreceptor**
- most sensitive to **blue light**
- wire directly to SCN
- control circadian rhythms
- regulate melatonin levels
- control alertness
- impact sleep onset

CHRONODISRUPTION: ALAN & HUMAN HEALTH



Disrupted Sleep



Obesity/Diabetes



Depression



Heart Disease



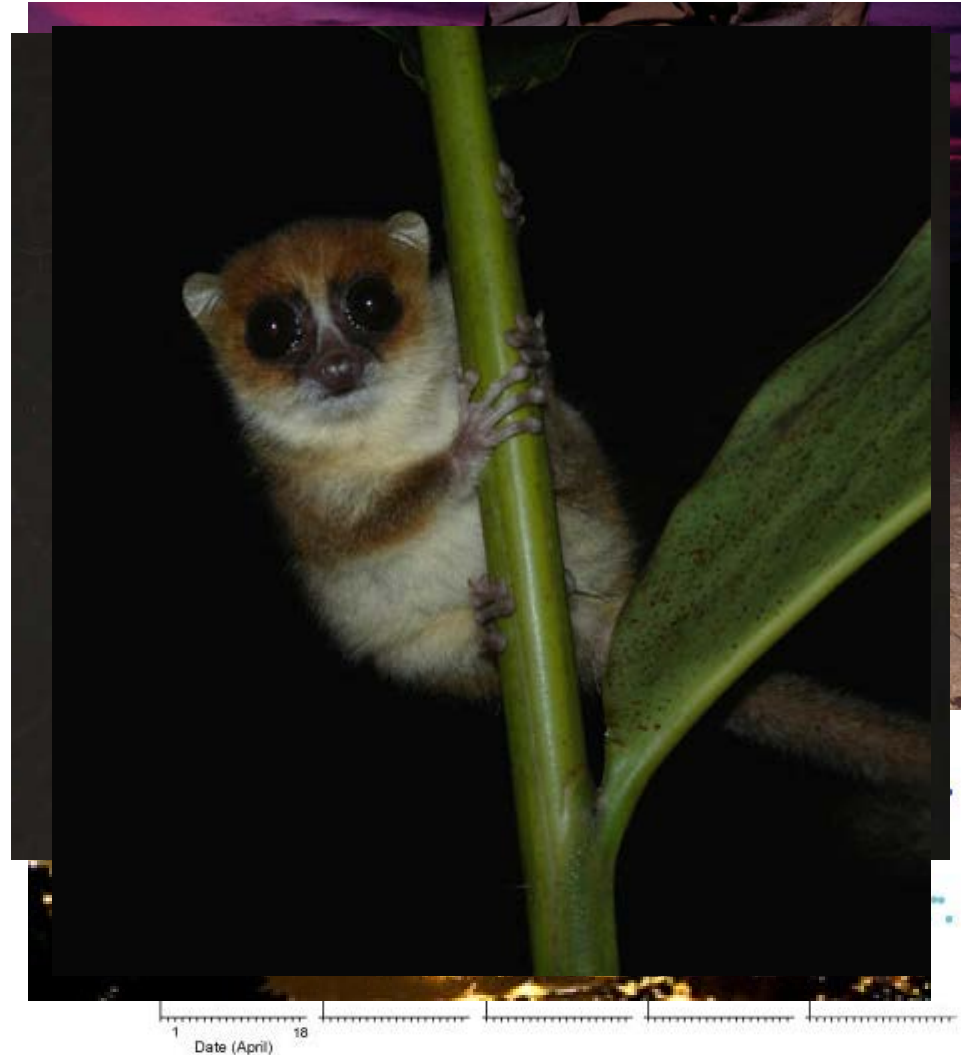
Cancer



Impaired
Immune System

ECOLOGICAL IMPACT OF ALAN

- migration
- navigation
- biomass
aggregation
- habitat
destruction
- circadian
disregulation



2014 NOBEL PRIZE IN PHYSICS

Isamu Akasaki, Hiroshi Amano,
and Shuji Nakamura

"for the invention of efficient blue
light-emitting diodes which has
enabled bright and energy-saving
white light sources"

LEDs: BRIGHTER & LONGER LASTING

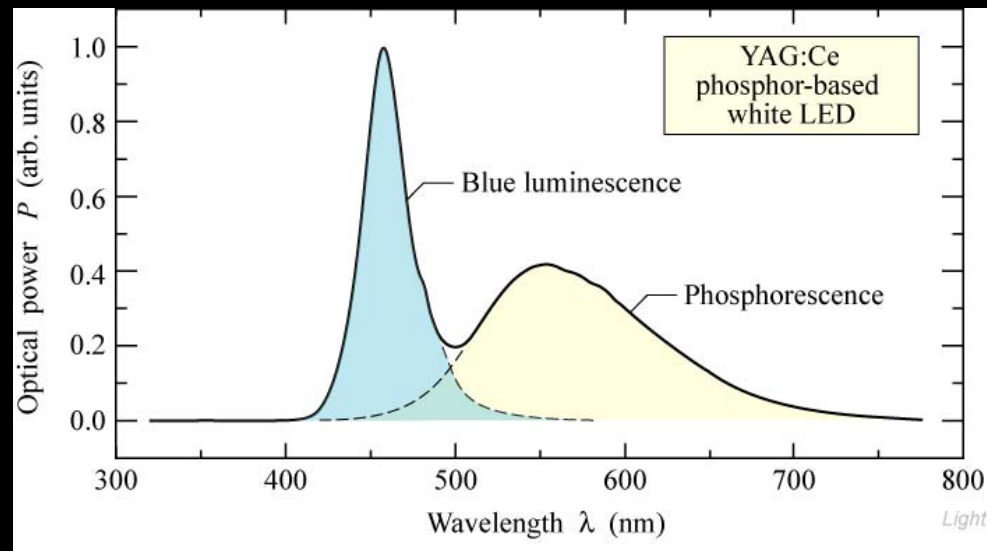
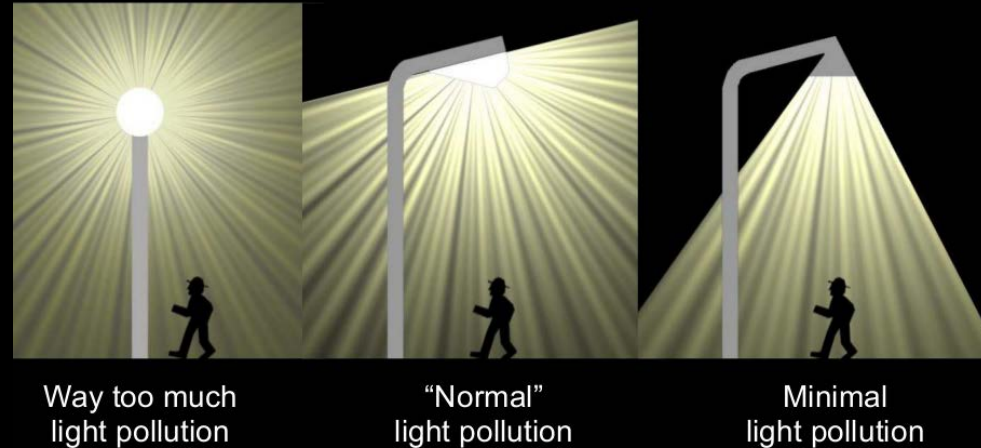
UNINTENDED CONSEQUENCES: LED LIGHTING WARS

- Bright lighting attracts customers
- LEDs lower lighting costs → more light
- Vision depends on contrast → nearby businesses are forced to respond
- Many LEDs emit more **blue light** than older technologies



BEST LIGHTING PRACTICES

- **fully shielded fixtures & targeted lighting**
- **“warm-white” or filtered LEDs (CCT < 3,000 K)**
- **adaptive controls:** dimmers, timers, and motion sensors
- **avoid the temptation to over-light**



SELECTED RESOURCES

- **International Dark Sky Association (www.ida.org)**
- “The End of Night: Searching for Natural Darkness in an Age of Artificial Light” by Paul Bogard
- “Outdoor Light at Night and Breast Cancer Incidence in the Nurses’ Health Study II” by James et al. in *Environmental Health Perspectives* (2017)
- “Does artificial light-at-night exposure contribute to the worldwide obesity pandemic?” by Rybnikova et al. in *International Journal of Obesity* (2016)
- “Global rise of potential health hazards caused by blue light-induced circadian disruption in modern aging societies” by Hatori et al. in *Aging and Mechanisms of Disease* (2017)
- “Ecological Light Pollution” by Longcore and Rich in *Frontiers in Ecology and the Environment* (2004)
- “How ecological communities respond to artificial light at night” by Sanders and Gaston in *Journal of Experimental Zoology-A: Ecological and Integrative Physiology* (2018)