

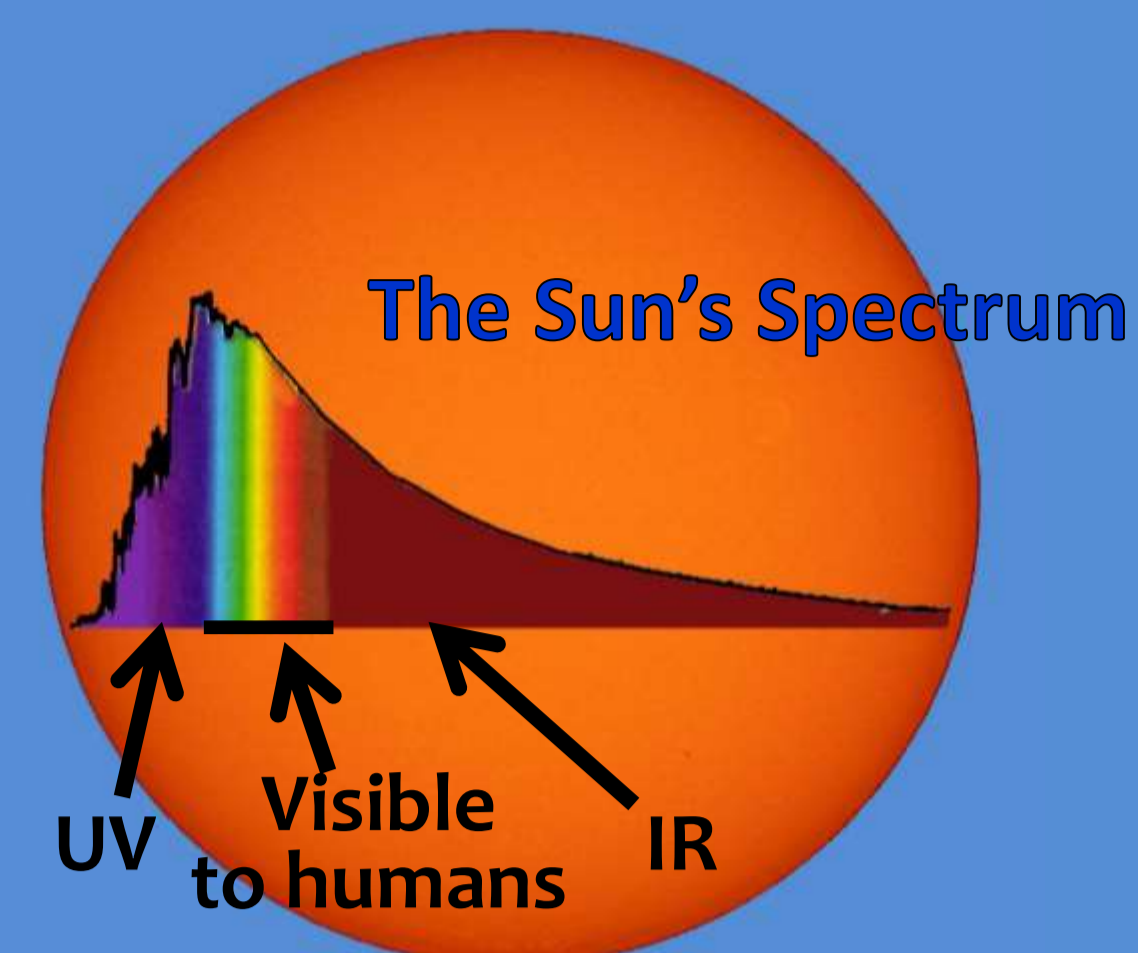
A Brief History of Chronobiology and Light

Chronobiology The study of **biological rhythms** and their adaptation to solar, lunar, and seasonal cycles
(*Chrónos* "time" (ancient Greek) + biology (the science of life))

Light The visible part of the electromagnetic spectrum



- 4.7 billion years ago: Birth of Solar System
- 3.8 billion years ago: First organisms
- 3.4 billion years ago: Sun light for photosynthesis
- 3.2 billion years ago: First Biological Clock
- ~1 million years ago: Pre-historic people tame FIRE (yellow light)



21st Century – Biorhythms Awry - Fractured Ecosystems

2002 discovery: The photosensitive Retinal Ganglion Cells (pRGCs) that synchronize the Circadian Clock with day length are maximally sensitive to deep **Blue Light**.

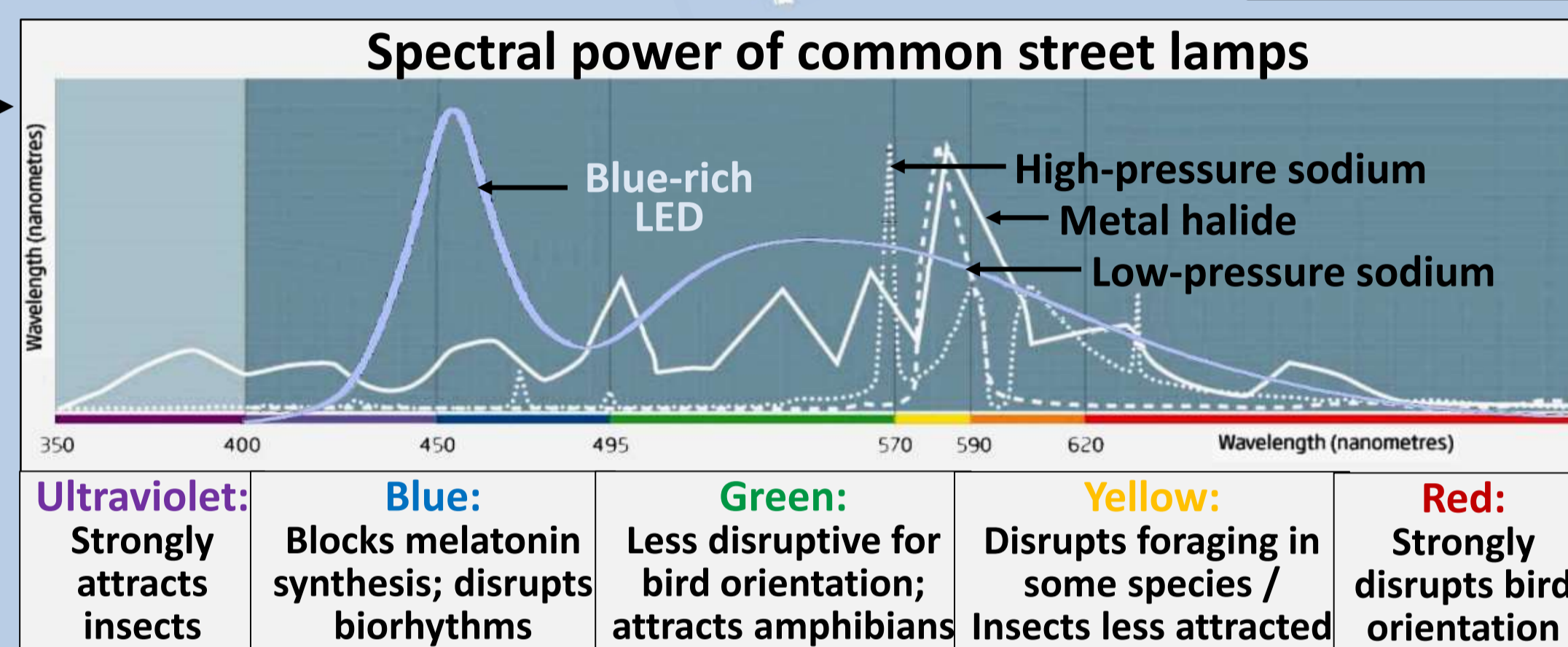
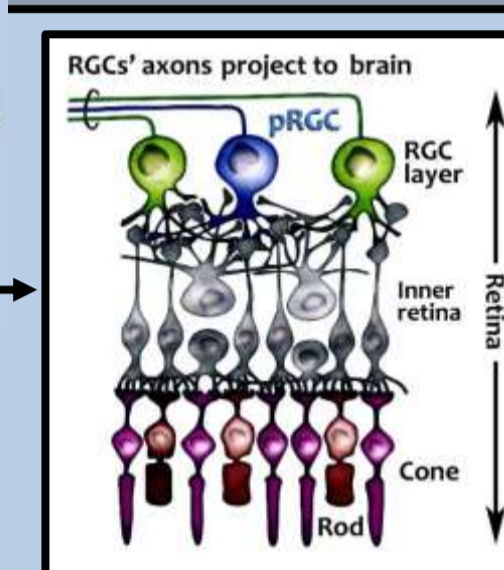
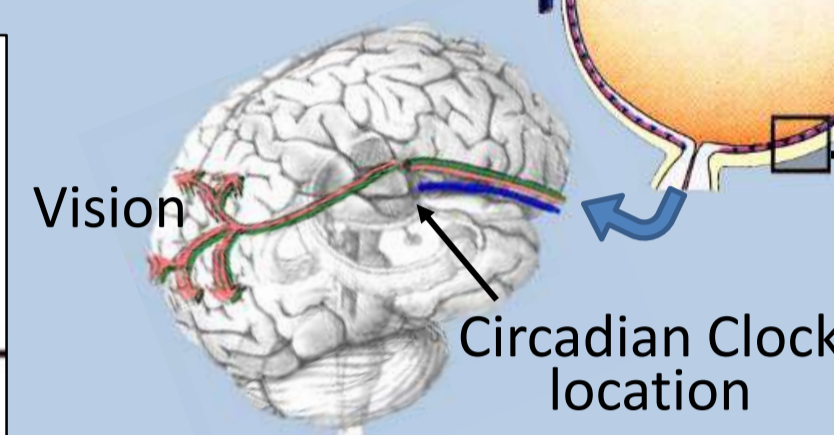
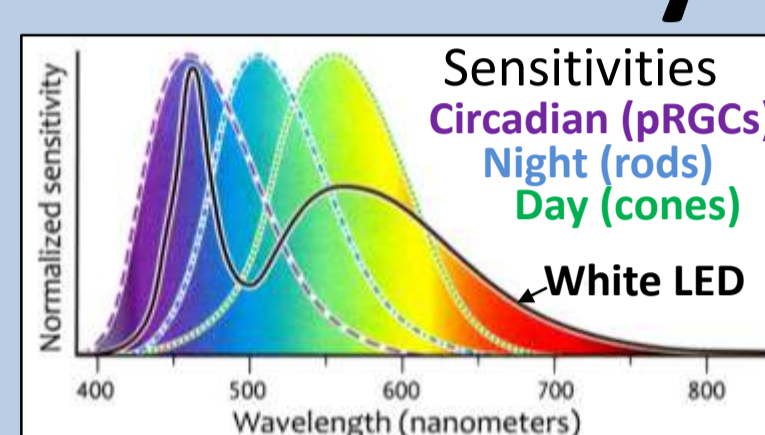
2009 Physicians identify **Light Pollution** as hurtful for wildlife and ecosystems as well as human health and safety.

White LEDs emit abundant blue light - the worst, most harmful light at night for wildlife and humans alike.

The future? Will light pollution continue increasing?

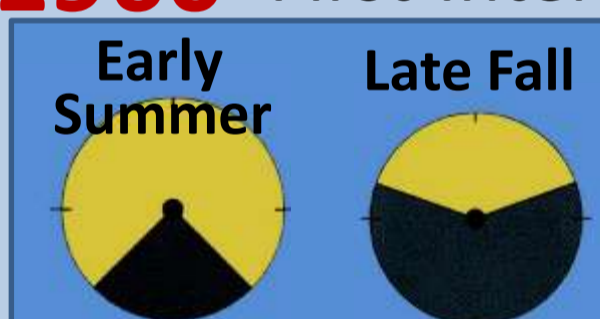
Or, will we change our habits and direct outdoor lighting to the ground, use **amber** LEDs (590 nm peak emission), and mount lamps in sharp cut-off fixtures to prevent blinding glare and light trespass?

Amber LEDs best for seeing at night and least harmful to wildlife

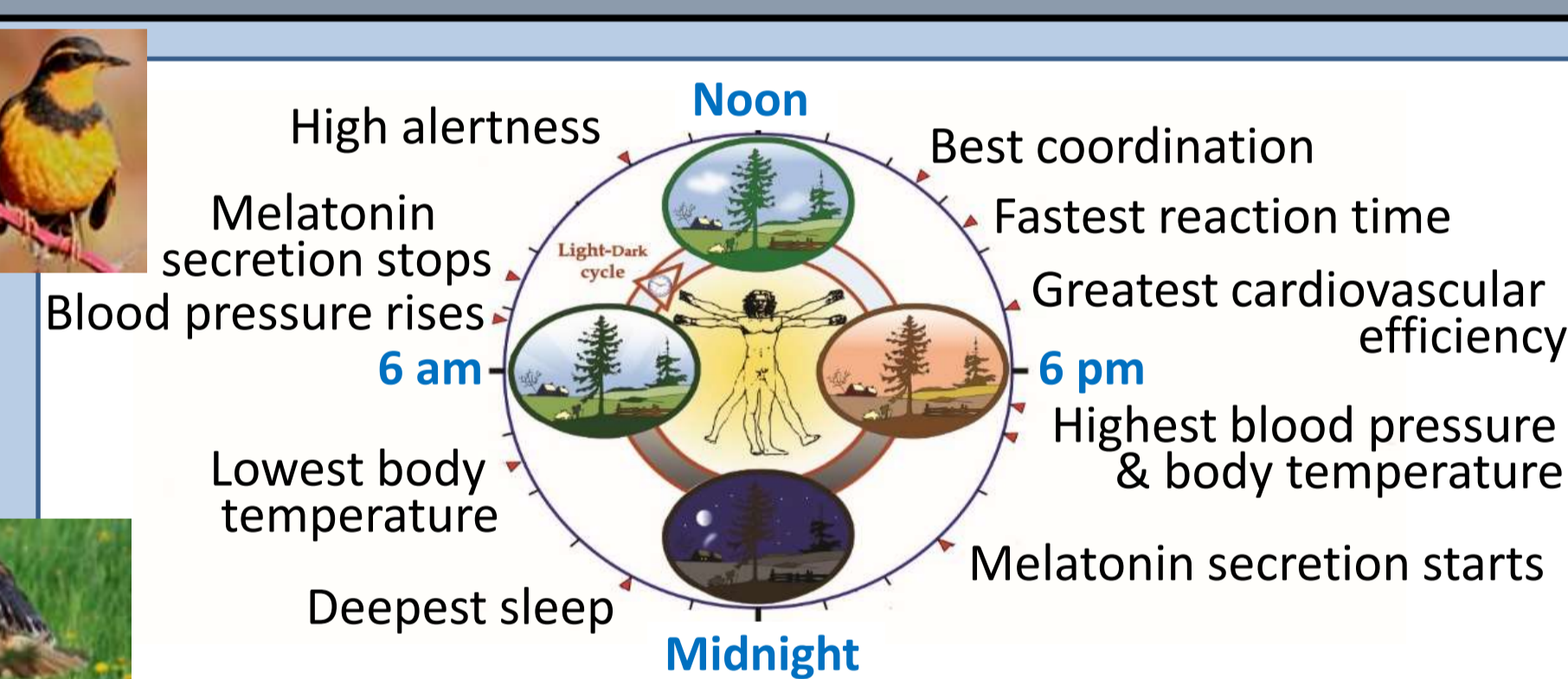


20th Century - Circadian Clock elucidated

1960 First International Symposium on **Chronobiology: Circadian Clocks** in plants and animals control fluctuations in metabolism and behaviour that are tied to the planet's 24 hr day. **Natural light** keeps these biological clocks in tune with the light-dark cycle as it changes through the year.

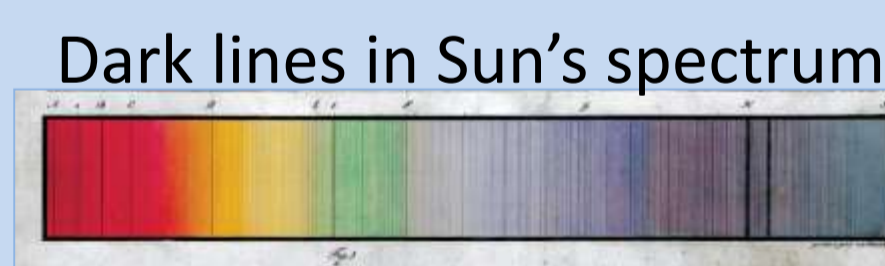


All species, diurnal and nocturnal, depend on darkness at night to navigate by star light, avoid predators, find prey, or sleep.

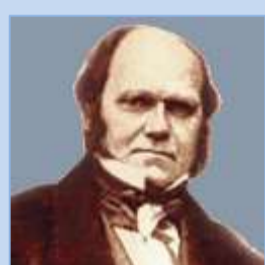


19th Century - Physics / Biology / Technology

1814 Joseph von Fraunhofer builds a **spectroscope** that reveals dark lines in colour spectra produced by elements present in the source; this is now a basic research tool in astronomy and biology.



1859 Charles Darwin: *The Origin of Species by Means of Natural Selection*; **1840 Photography:** Film supplements glass plates for making permanent records of light



1879 Thomas Edison invents the **incandescent light bulb** - White light at the flip of a switch!



18th Century - Foundations of Chronobiology

1729 Jean-Jacques d'Ortois de Mairan, astronomer and **father of chronobiology** discovers the first **internal circadian clock** that keeps time without signals from the environment! In constant darkness, the leaves of *Mimosa* spread (daytime behaviour) and fold (night time behaviour) in a 24-hour rhythm!

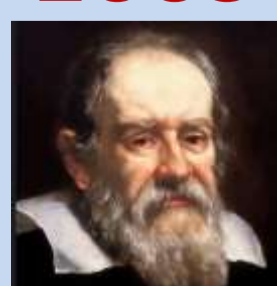


1751 Carolus Linnaeus designs 24-hour **Floral Clock** which marks the hours by arranging plants in a circle according to the opening and closing times of their flowers.



17th Century - Foundations of modern Astronomy & the Study of Light

1609 Galileo Galilei builds a refractor **telescope** to look at the night sky. He discovers the Milky Way's light is from a myriad of stars and watches 4 large moons orbit Jupiter!
Here is proof that Earth is not the centre of all celestial motion.



1610 *Sidereus Nuncius (The Starry Messenger)* - the 1st modern scientific treatise

1668 Isaac Newton builds practical reflector telescope.



1672 *Theory of Light and Colors*

1704 *Opticks; or a Treatise on the Reflexions, Refractions, Inflexions and Colours of Light*



White (sun) light dispersed by prism into colours of spectrum

