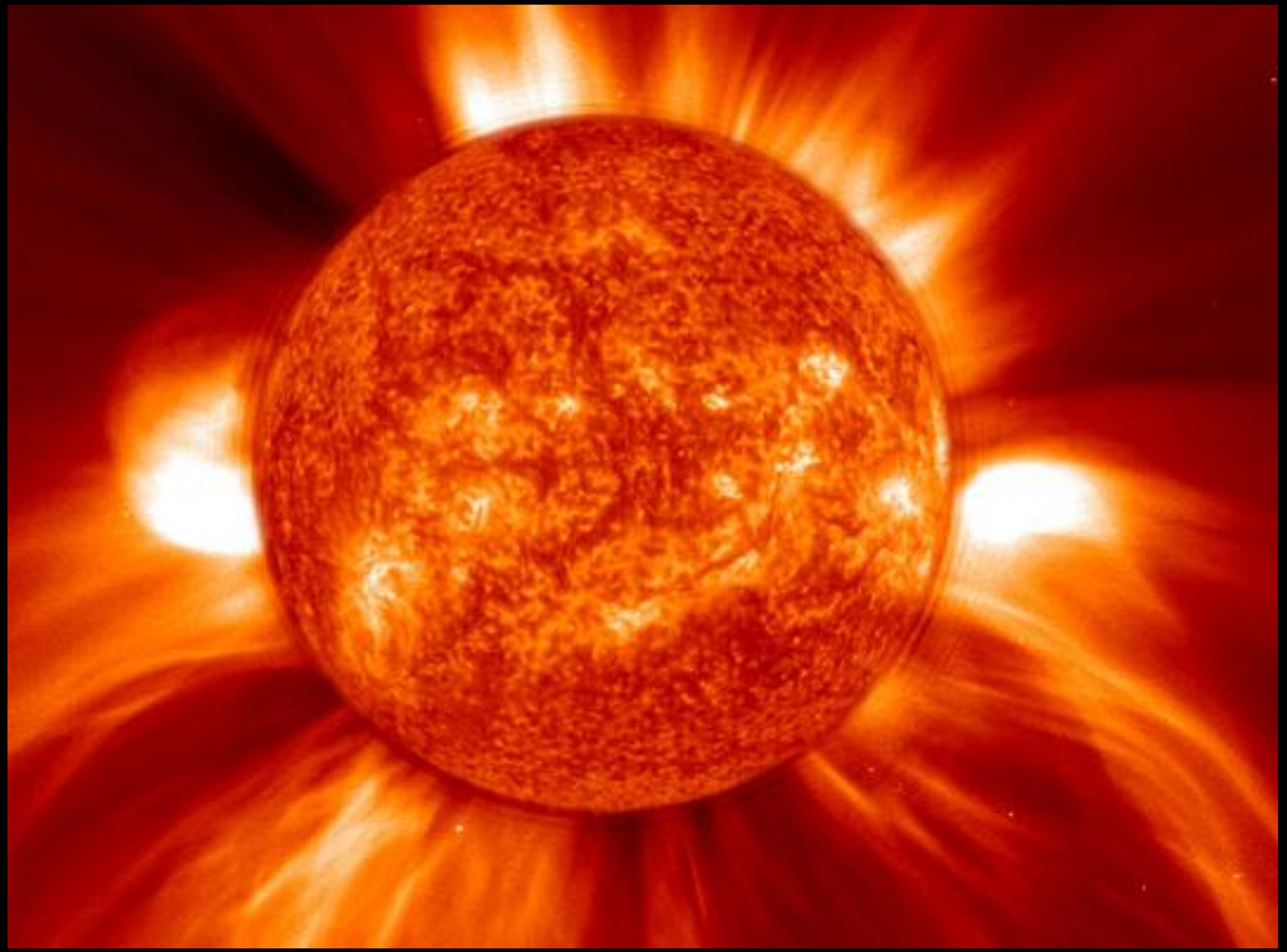
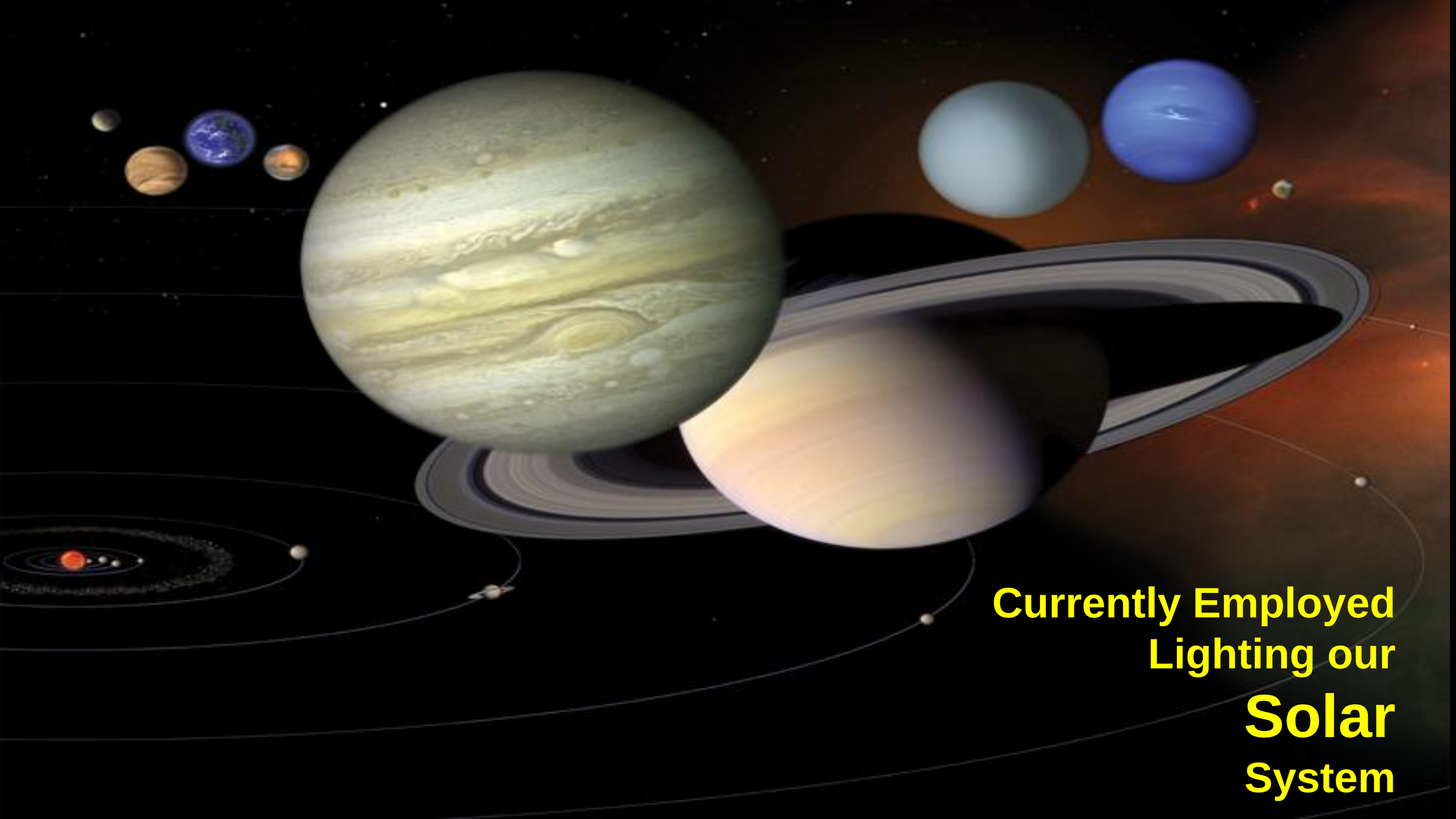
An Introduction to Optimized Building Environments For Health and Energy Efficiency

Content to be Covered

- Mother Nature’s Lighting
- Don’t Try to Light with a Match!
- Optimizing Plant Lighting
- The Gene Comes to Light
- Optimizing Human Performance with Controls

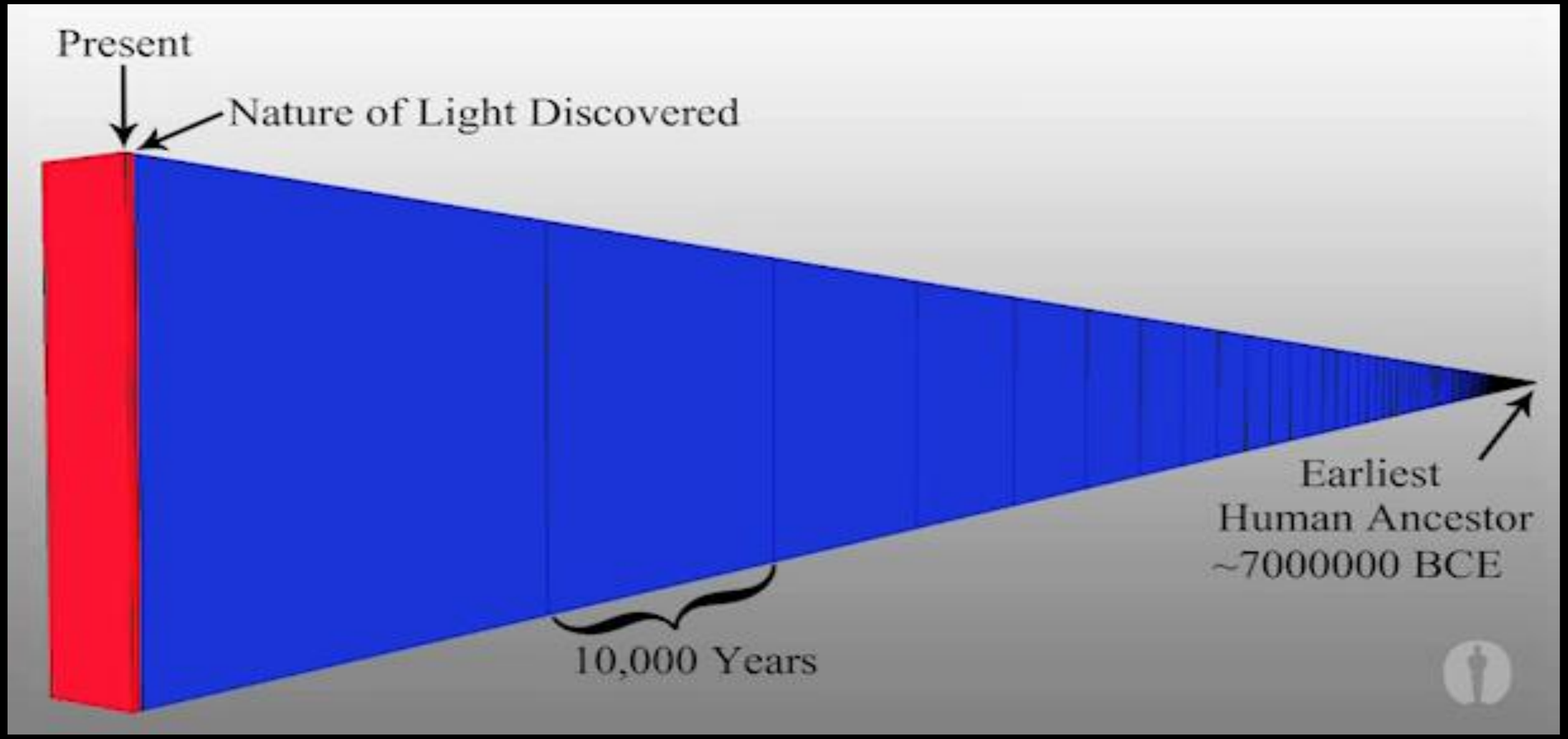
Our SUN




Currently Employed
Lighting our
Solar
System

…and TRAINING us for over 7 Million Years In Full Spectrum Sun Light!

The Nature and Power Of Light Has Only Just Begun to be Realized!



Nature Introduced
Light's Visual
Spectrum
to us by these
Atmospheric
Displays

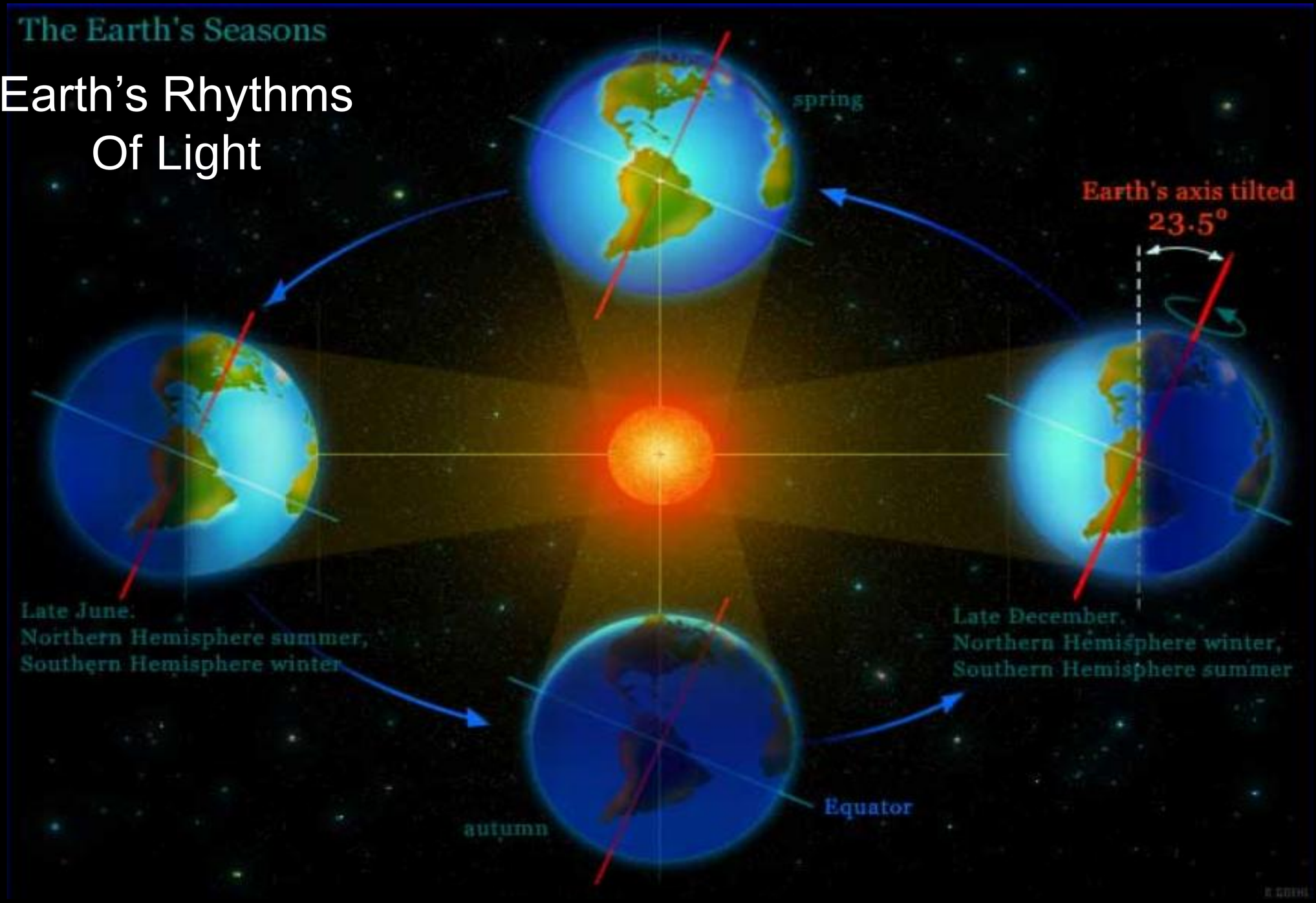
The **COLORS** delivered to earth in the daylight spectrum are….

echoed back to us in the colors we see around us in nature

Nature’s Advanced Analog Lighting Control System Version - 1

Circa 4.5 Billion Years Ago

Earth’s Rhythms Of Light



Nature is full of dynamic functions

- The earth revolves around the sun = Seasons
- The earth rotates on its axis = Day/Night
- Sun rise to sun set = Changing color temperature, outside air temperature, wind, and pressure

Sunlight Creates an Annual Rhythm of Seasons

Sunlight also triggers a biological response of plants and animals to adapt to the seasons

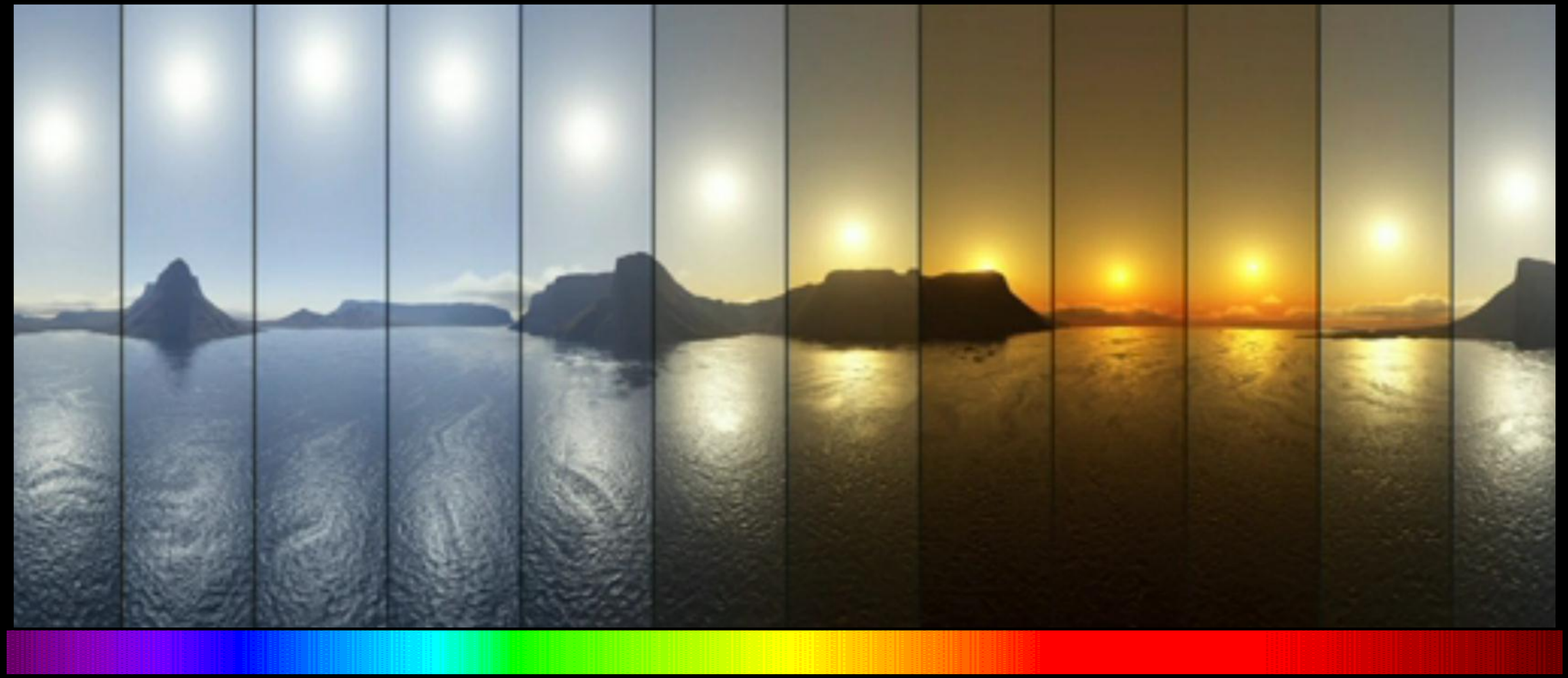
Harvest & Food Storage
Rest Preparation
Migration

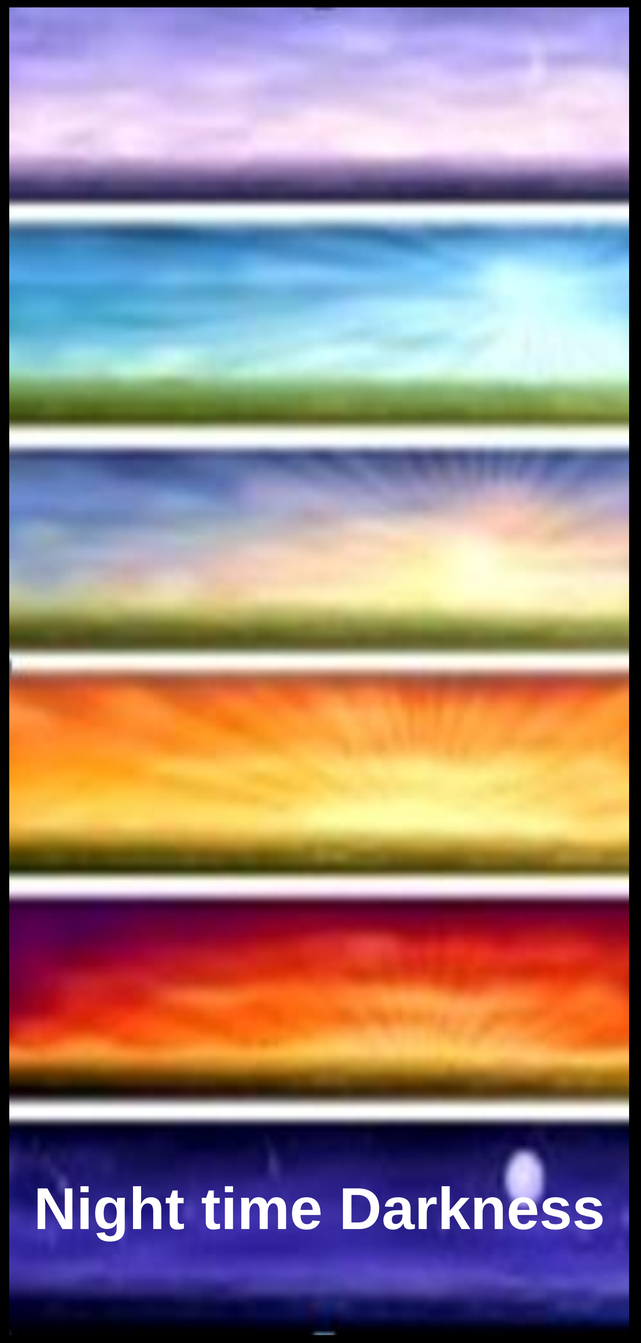
Maximum Activity
Maturity
Color

Awakening
Plant Budding
Breeding & Birth

Restoration
Energy Storage
Hibernation

Sunlight Creates a Daily Rhythm of Light

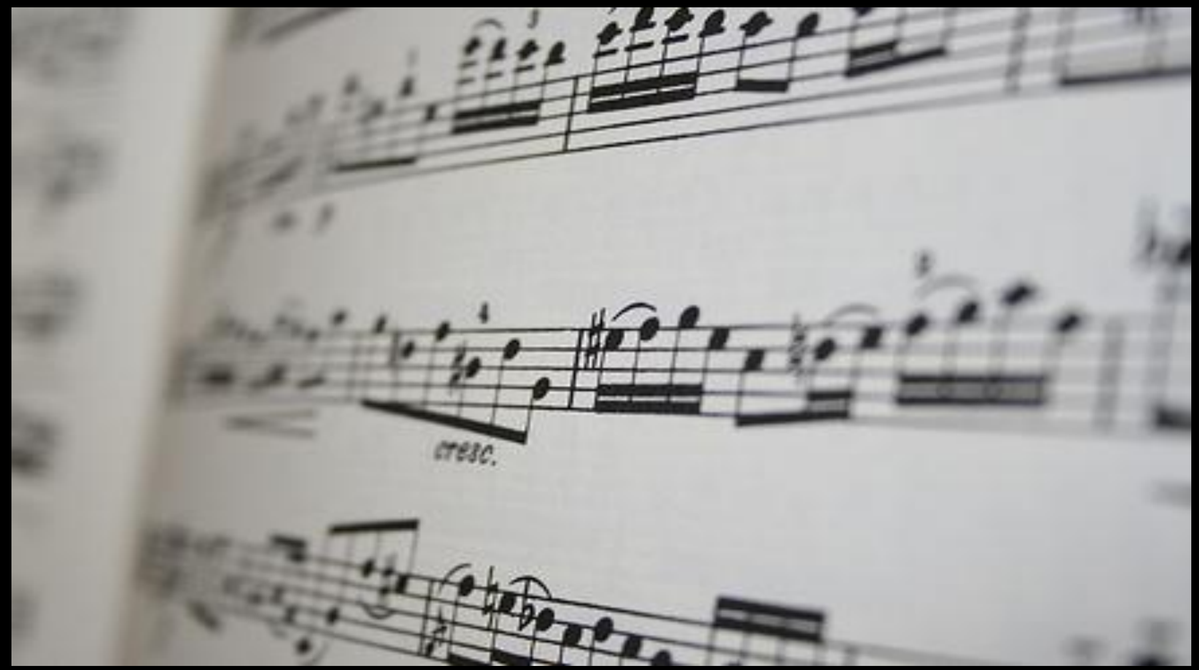




The Sun’s Daily Photo-rhythm of spectral changes from blue dominate daytime to red dominate evening followed by nighttime darkness provides a natural **Seasonal** and **Daily Timing Control System** for biological functions in plants, animals and us!

We dance to the
Biological rhythms of

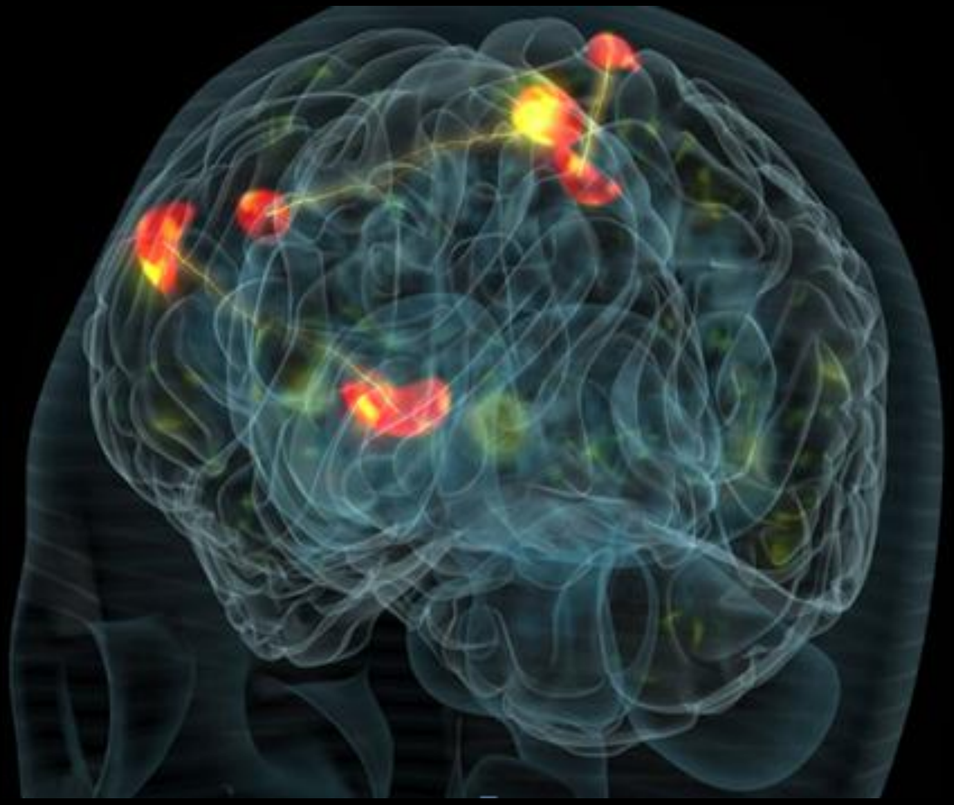
Mother Nature’s
Environmental Music
seasons, days, nights,
hours and minutes



The Circadian Rhythm

The **“internal body clock”** that regulates the 24-hour cycle of biological processes in animals

Directed by signals
we get from our internal and external
built and natural environments



The term Circadian comes from
Latin words that literally mean
(around-the-day).

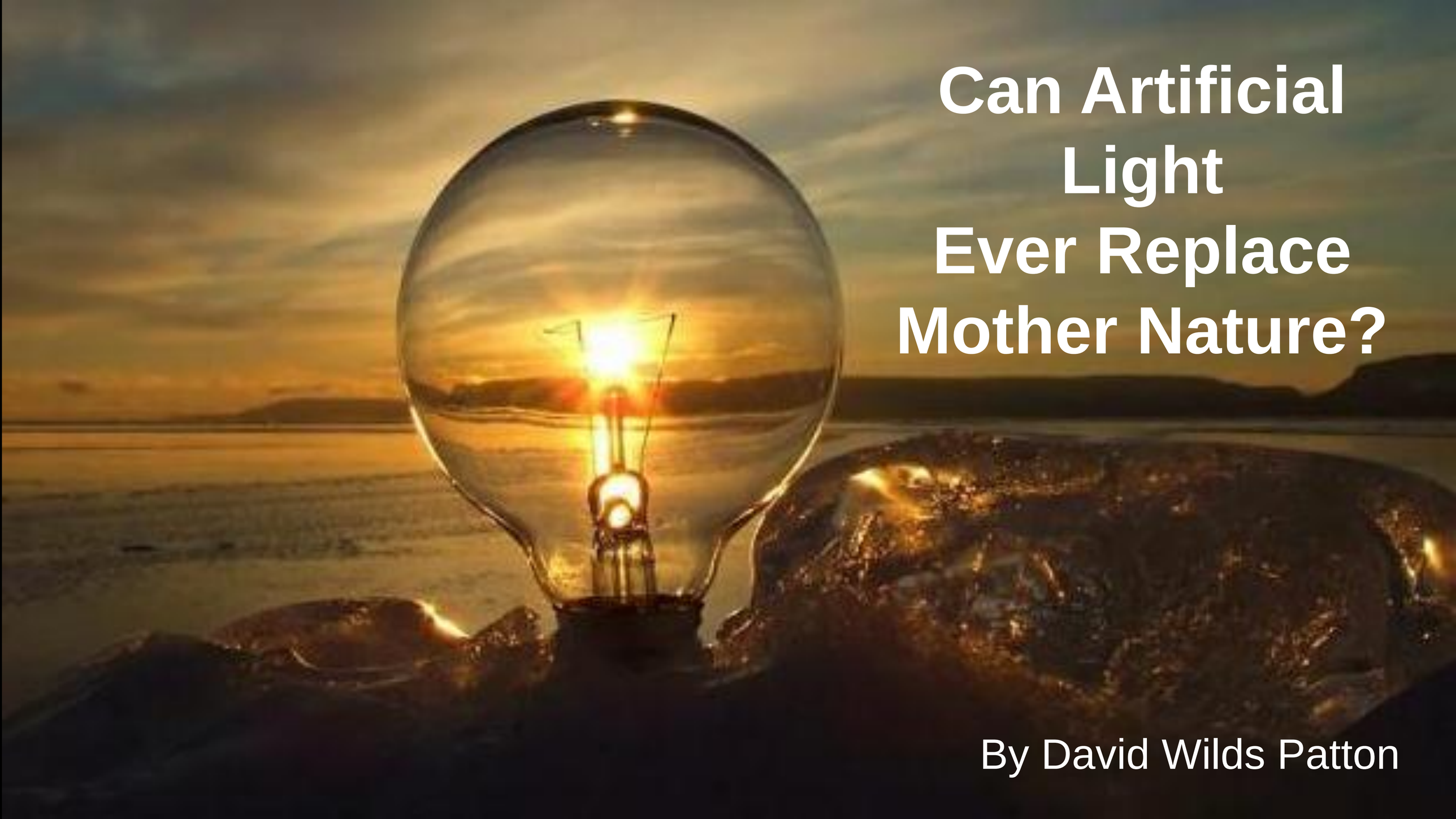
The ***Circadian System***
is comprised of two mechanisms

1. *The Circadian Rhythm*

2. *The Homeo-static Sleep Propensity* (HSP)
   triggering sleep's restorative drive for
   Maintenance & Repair and wakefulness drive for
   full Productive Operation

The Impact of Artificial Light on Our Environment

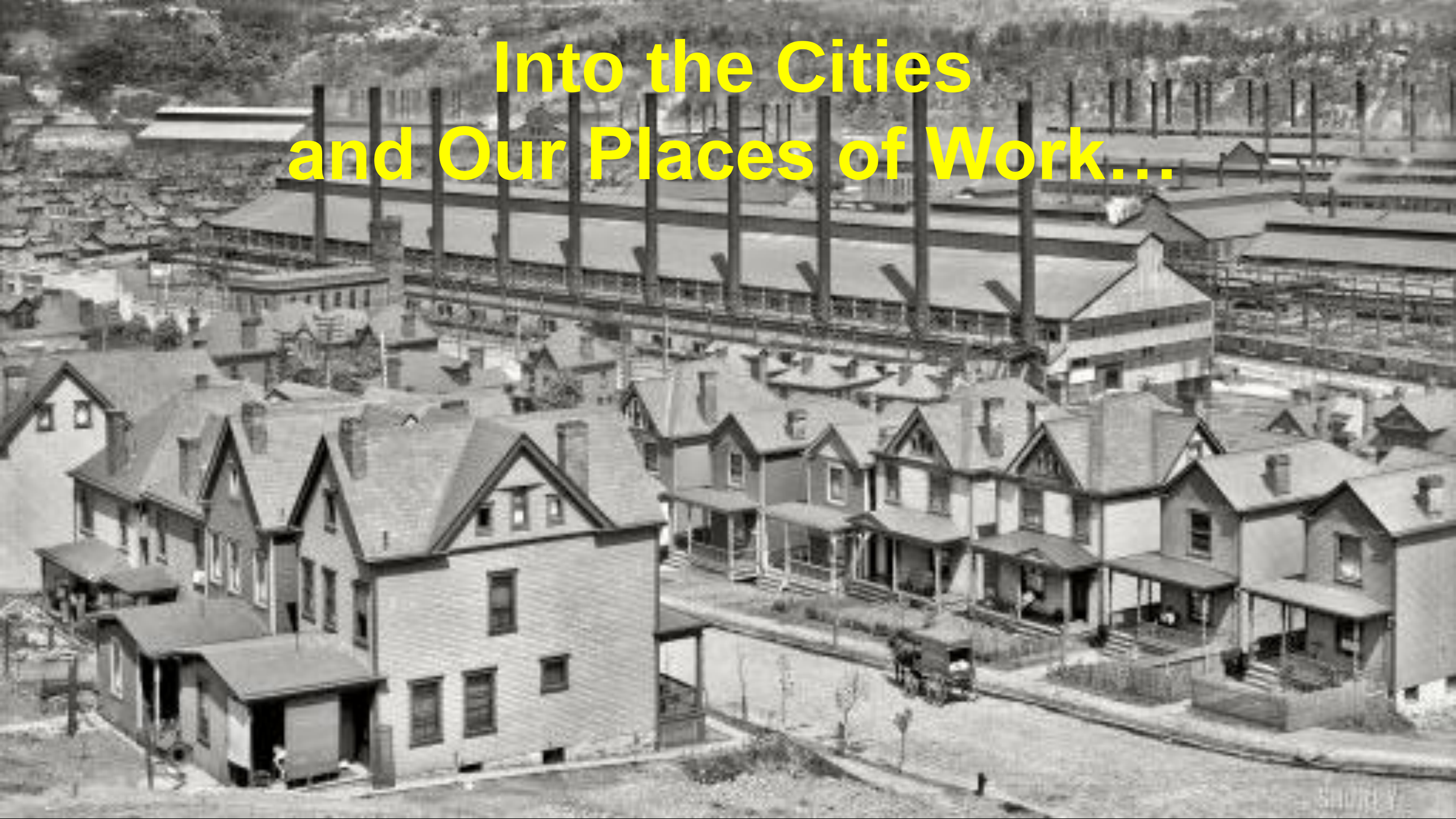
An Optimization Competition with Mother Nature that we are Losing



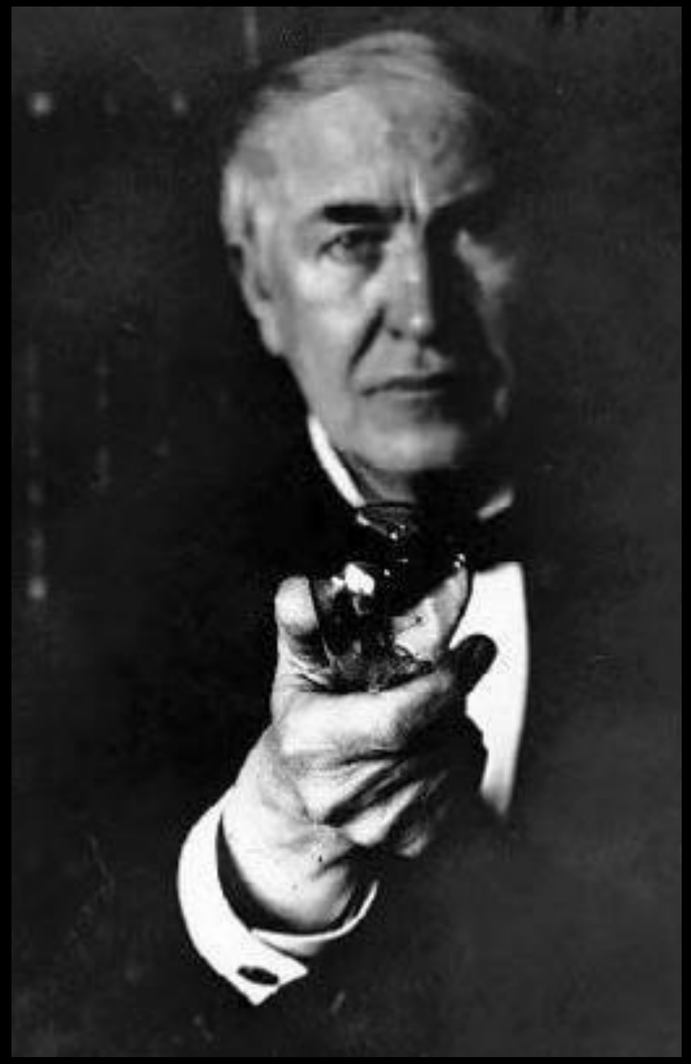
Can Artificial Light Ever Replace Mother Nature?

By David Wilds Patton

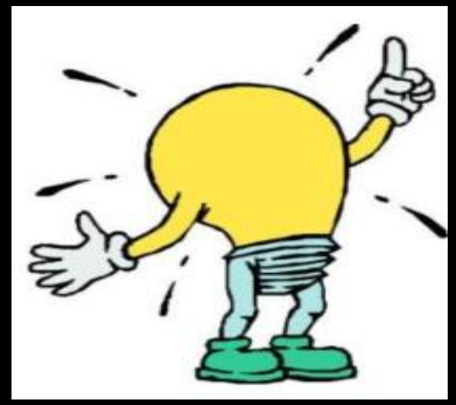

Our First Lighting
Systems Were Combustion Based
Just Like the Sun


Into the Cities
and Our Places of Work…

…and Then Edison Changed Everything!
…Here, you just screw it in and.. “Turn It ON”?

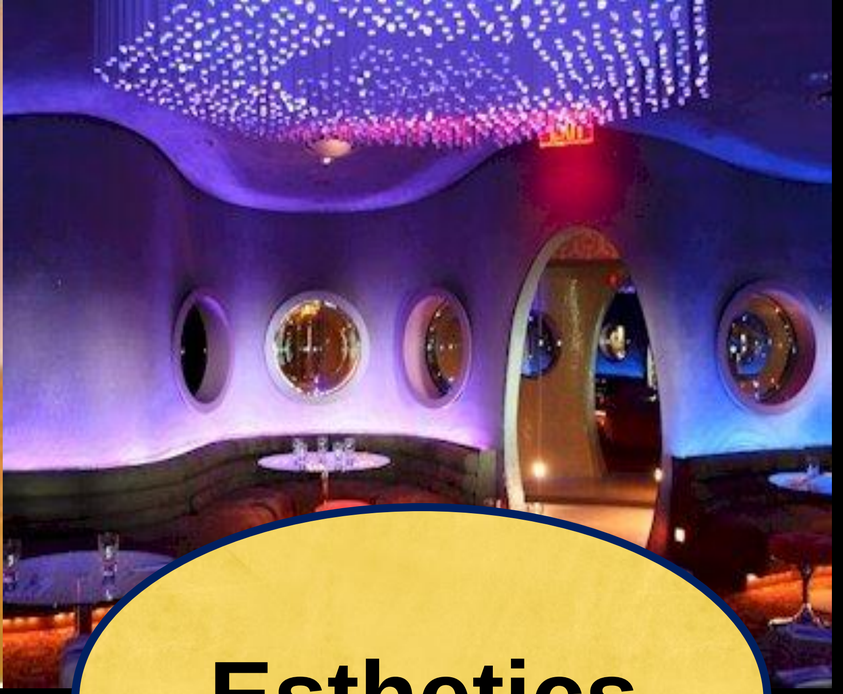


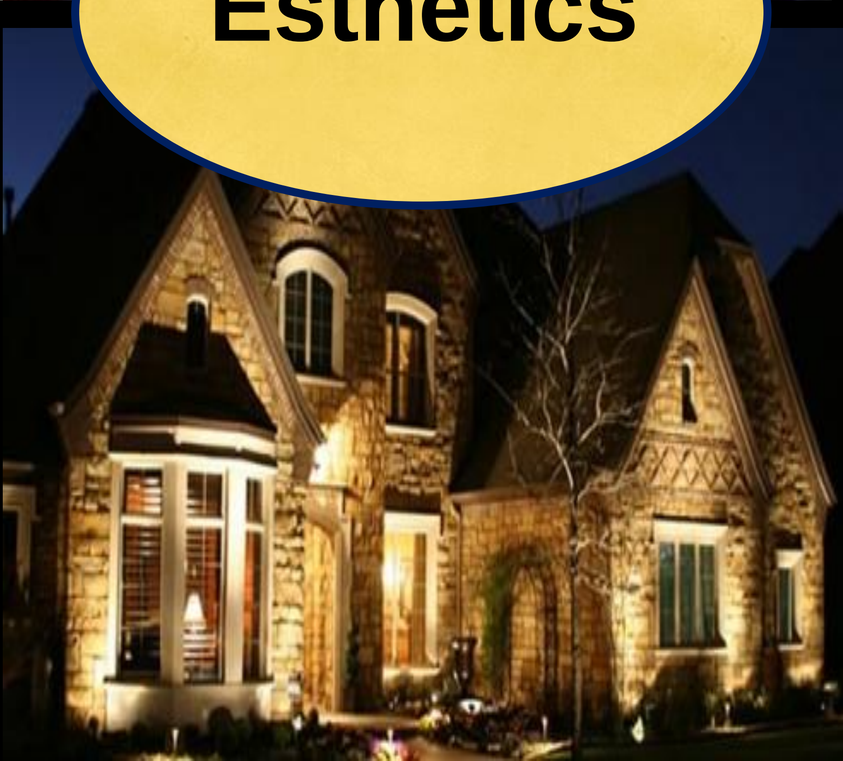

Visibility

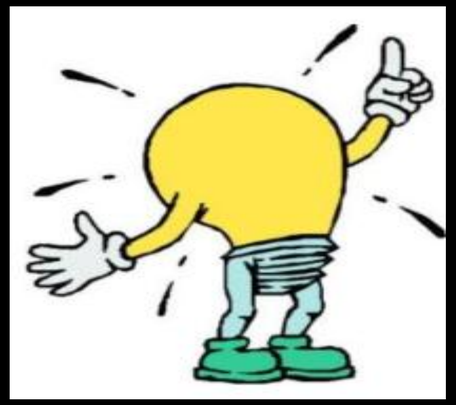


Task Lighting Controllable from the Desk Top… for the Boss

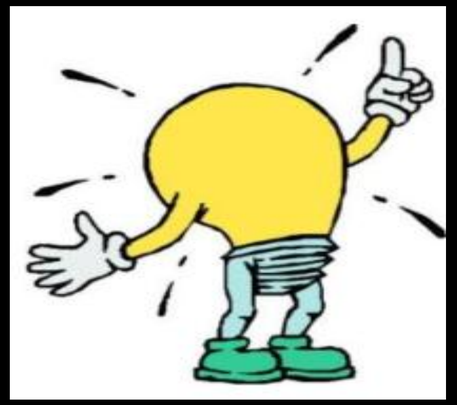

Visibility



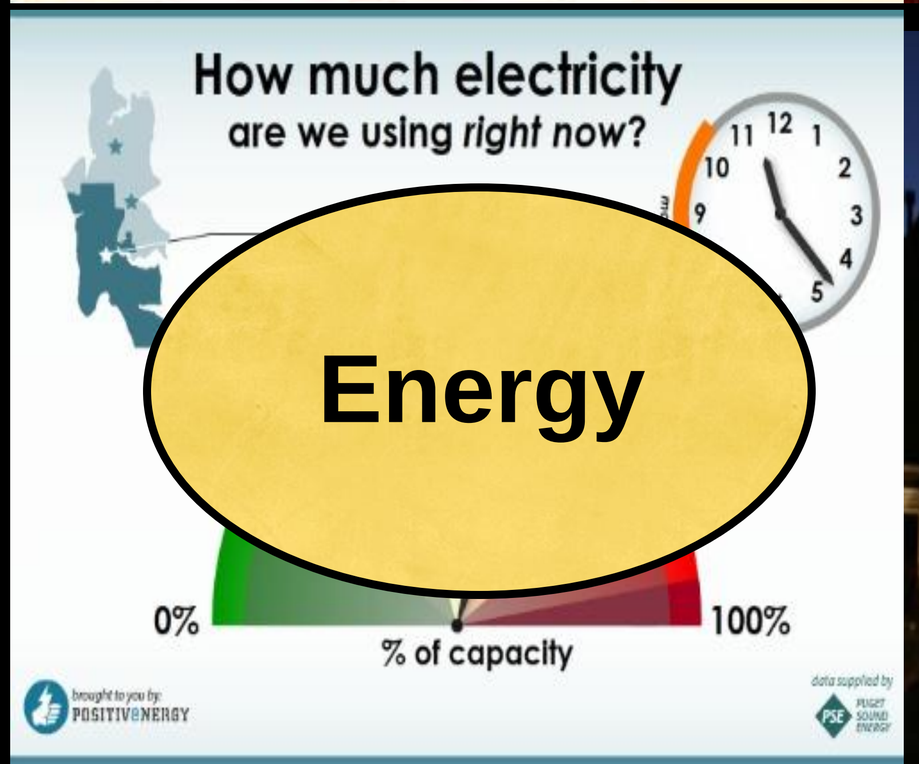

Esthetics

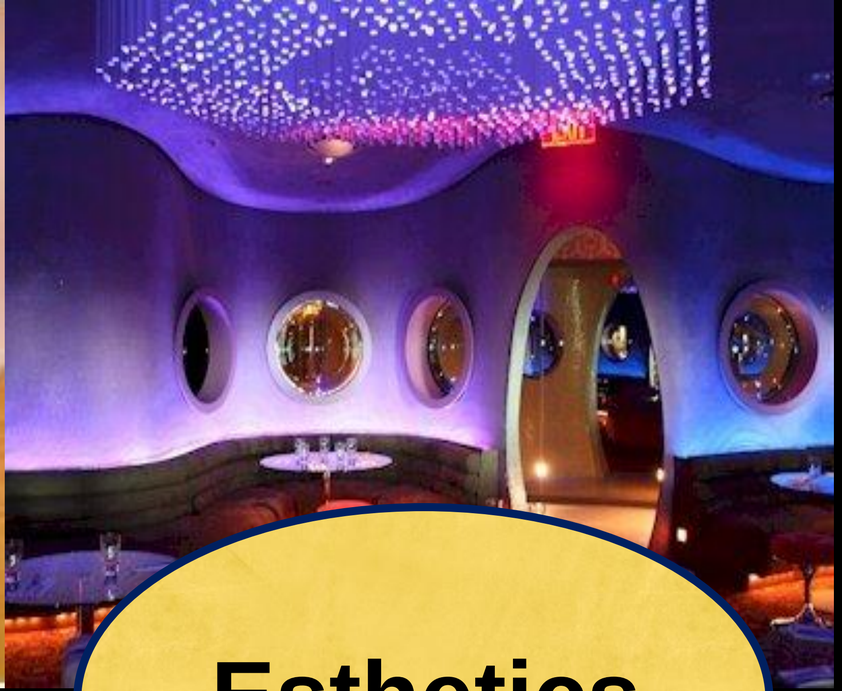


Then for Everyone! Wow! What a Power Bill $$$.

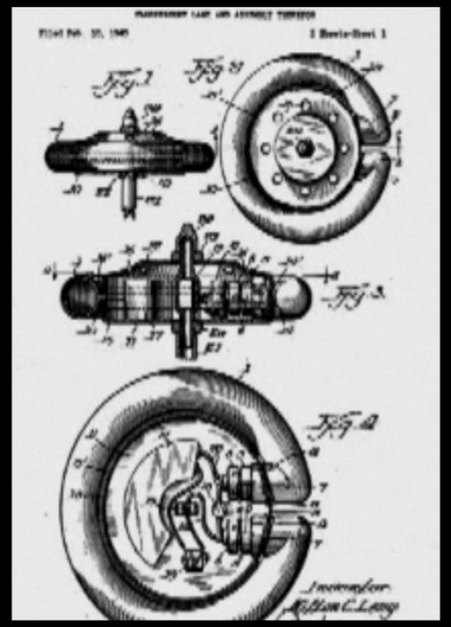


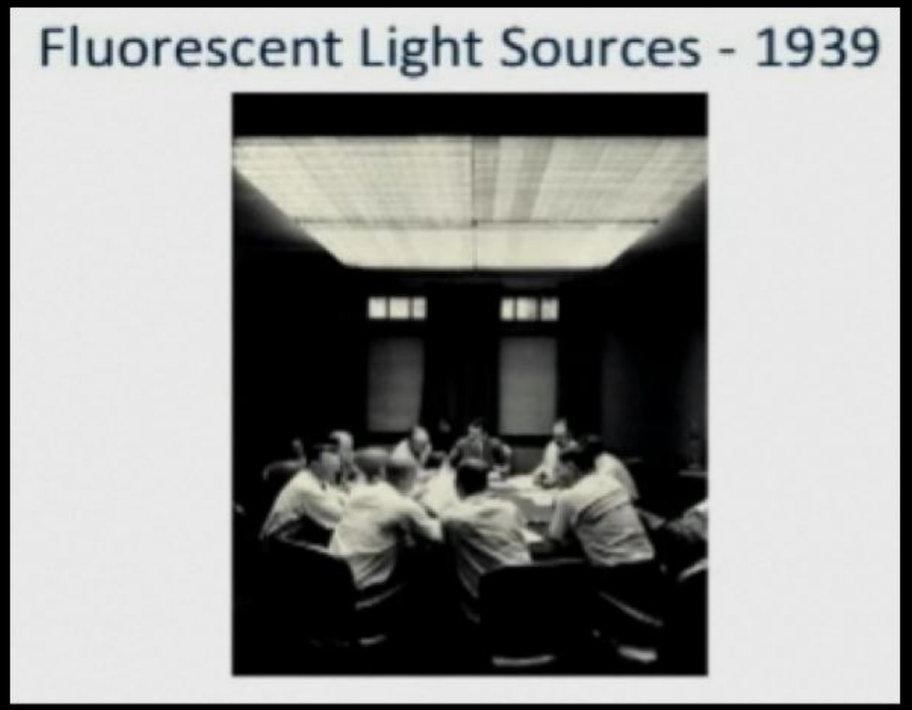

Visibility

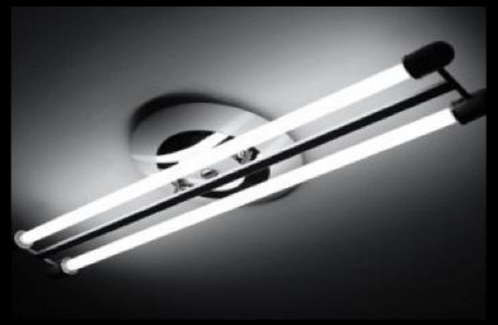

How much electricity
are we using right now?
Energy
0%
100%
% of capacity
brought to you by:
POSITIVEENERGY
data supplied by
PSE
PUGET SOUND ENERGY


Esthetics

and we needed MORE lighting but, LOWER Power Bills so….







..then more Energy Efficient Illumination for everyone!
From Sun Up to Midnight

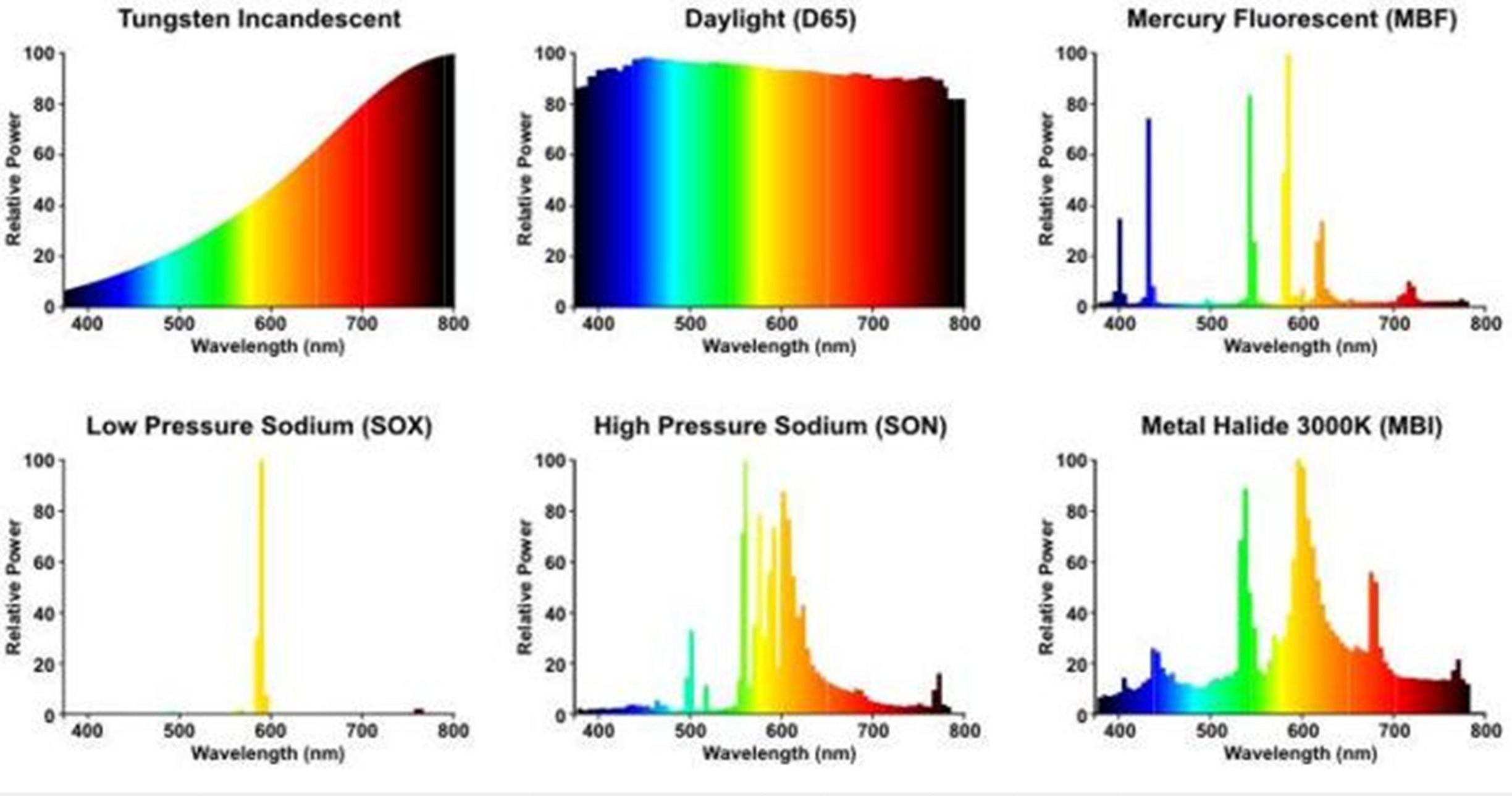
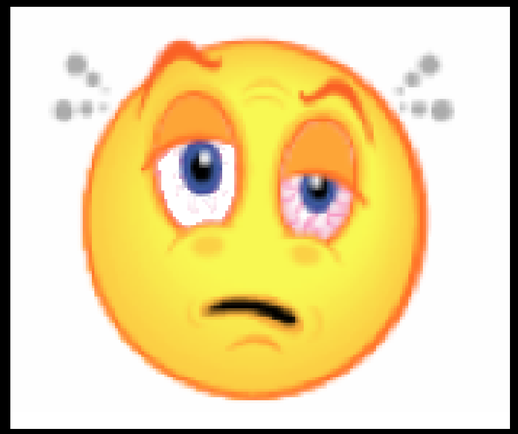


Figure S5 - Spectral Power Distributions of Various Light Sources

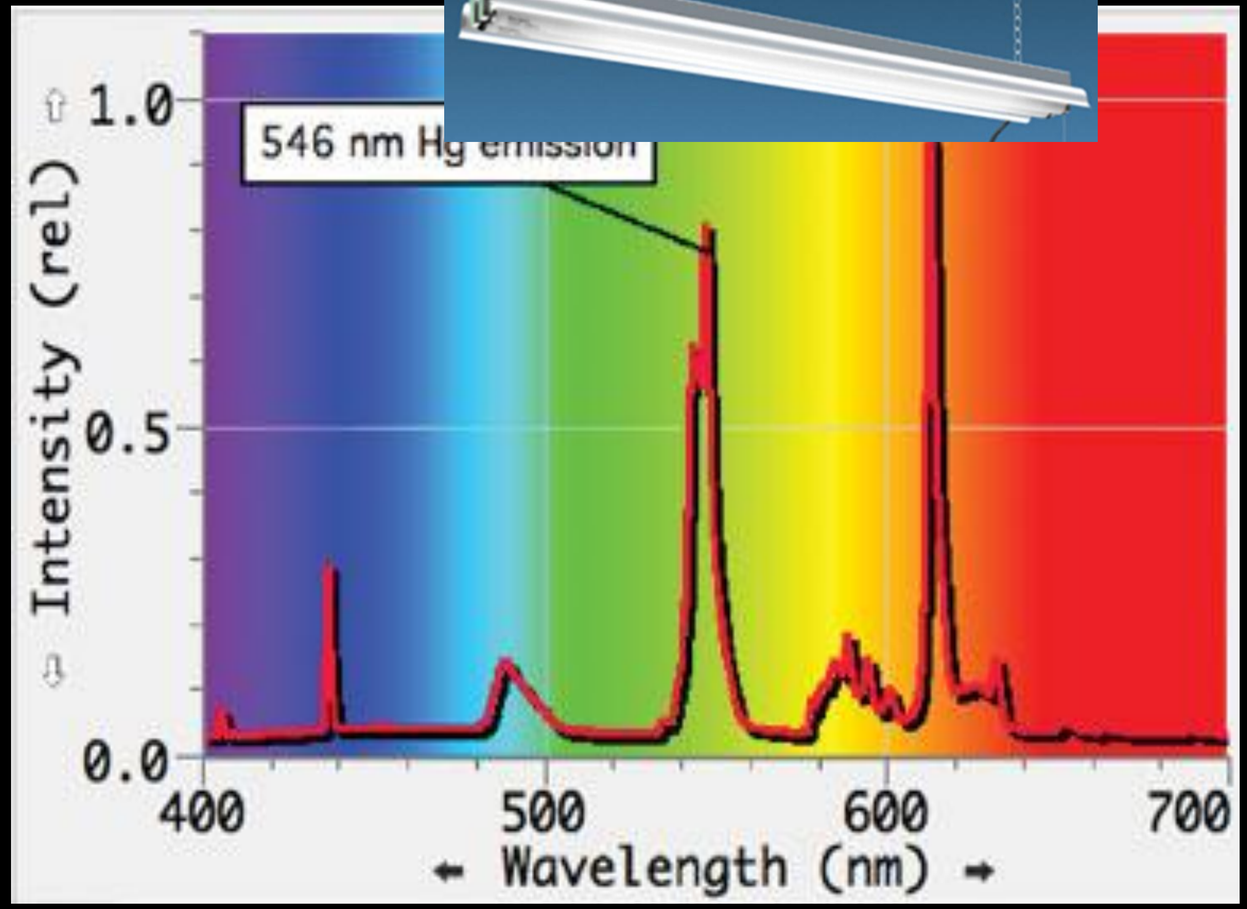
Mal-Nurished Food

Empty Calories
Just Filler



Mal-Nurished Lighting

Empty Foot Candles
Just Illumination

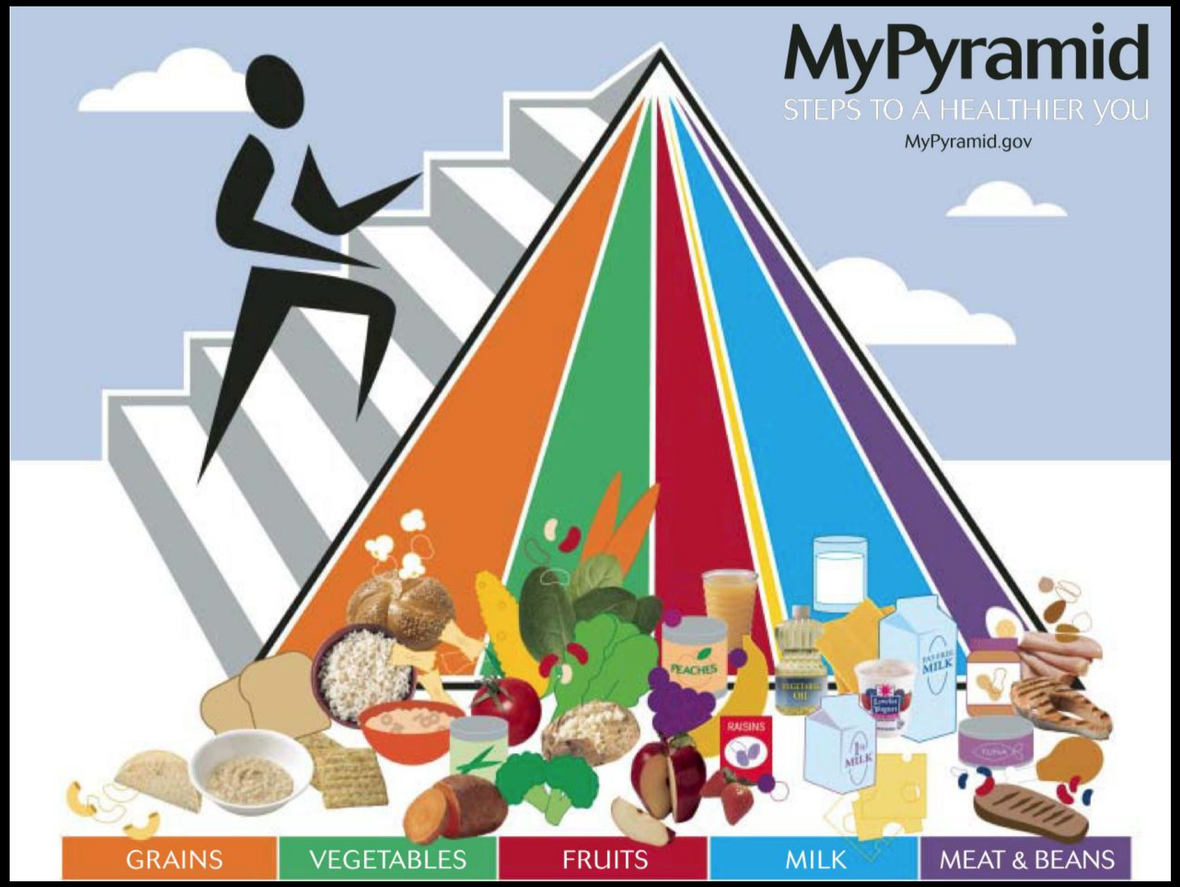


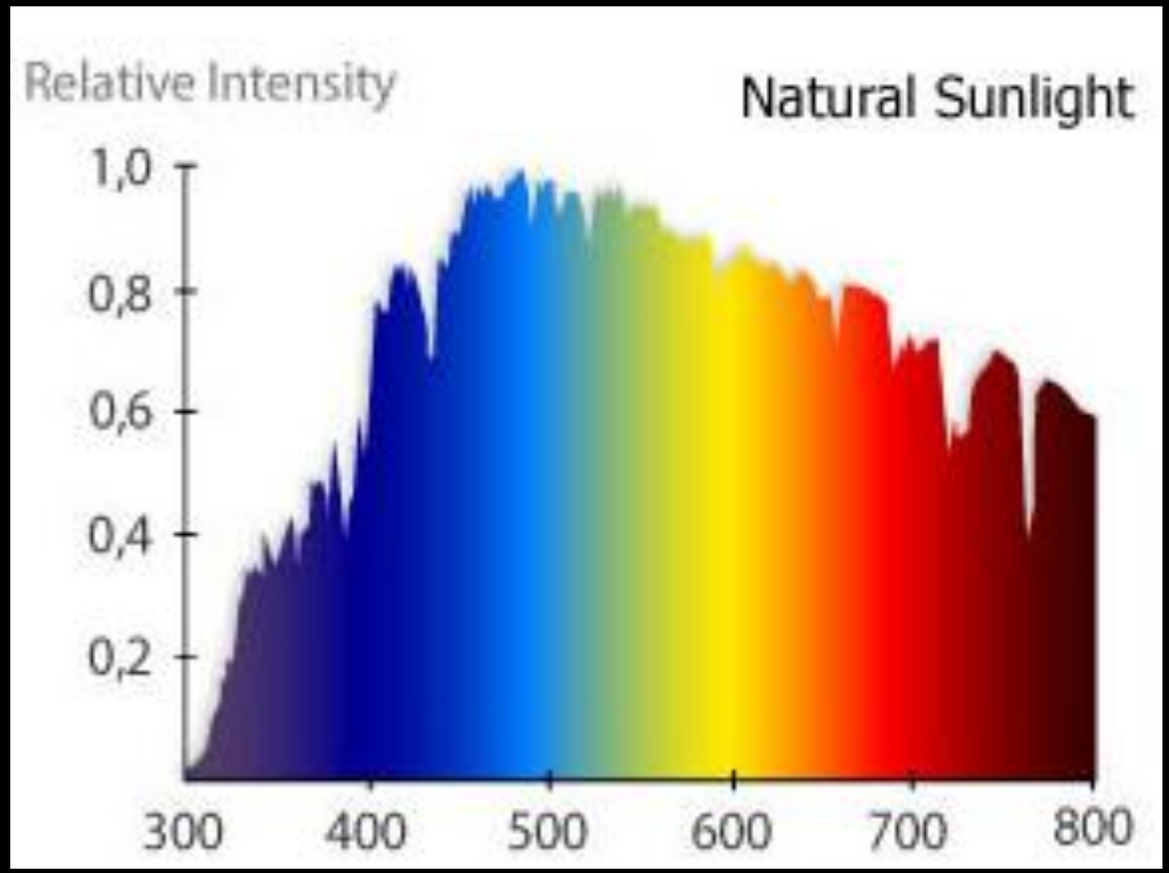
Nutritious Food

Makes you Healthy

Nutritious Light

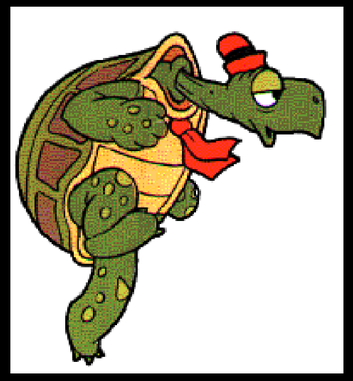
Makes you Healthy





100 Years of Comparative Progress For the Consumer in Terms of Fidelity

Lighting *Fidelity* vs. Sound *Fidelity*



Low Fidelity Sound



















High Fidelity Digital Sound and HD 3D Picture

Low Fidelity Sound

Low to Medium Fidelity Light

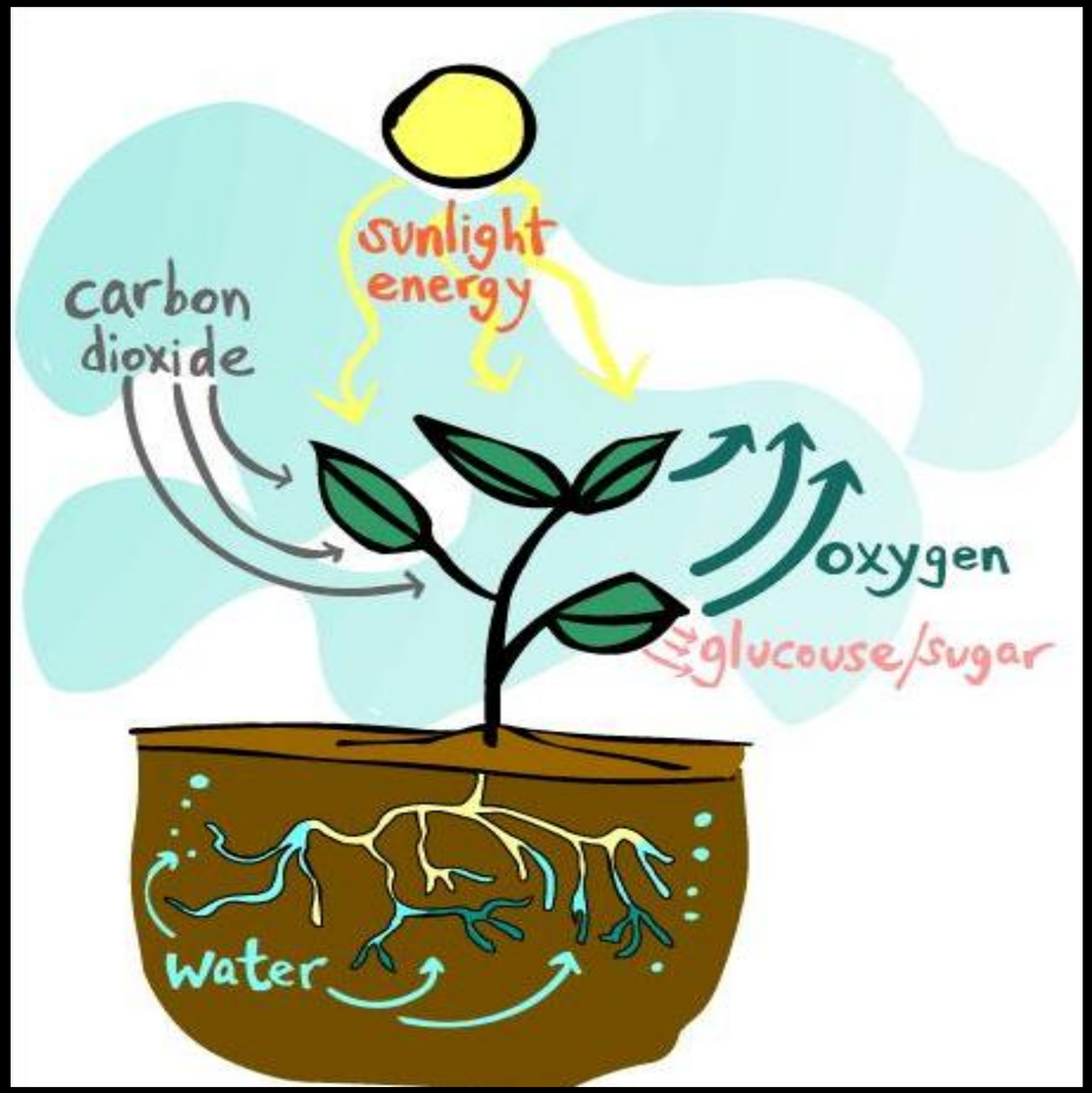
Low Fidelity Light

High Fidelity Digital Sound and HD 3D Picture

In the mid 17th Century Jan van Helmont discovered that the bulk of a plants bio-mass

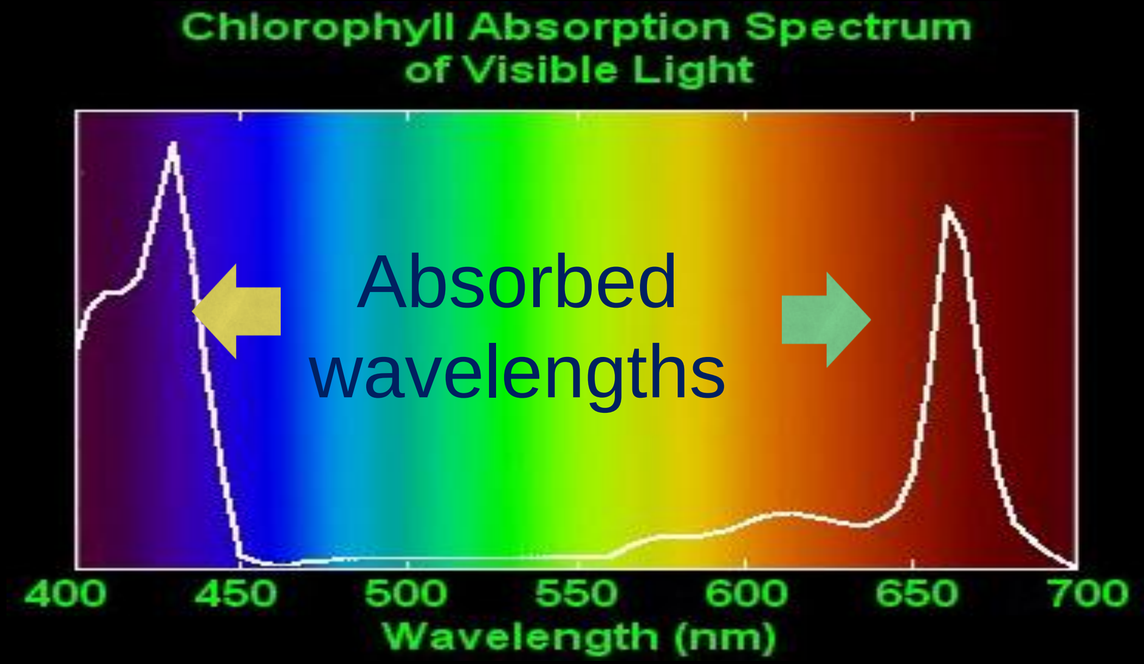
comes from the inputs of **PHOTOSYNTHESIS** and not the soil itself!

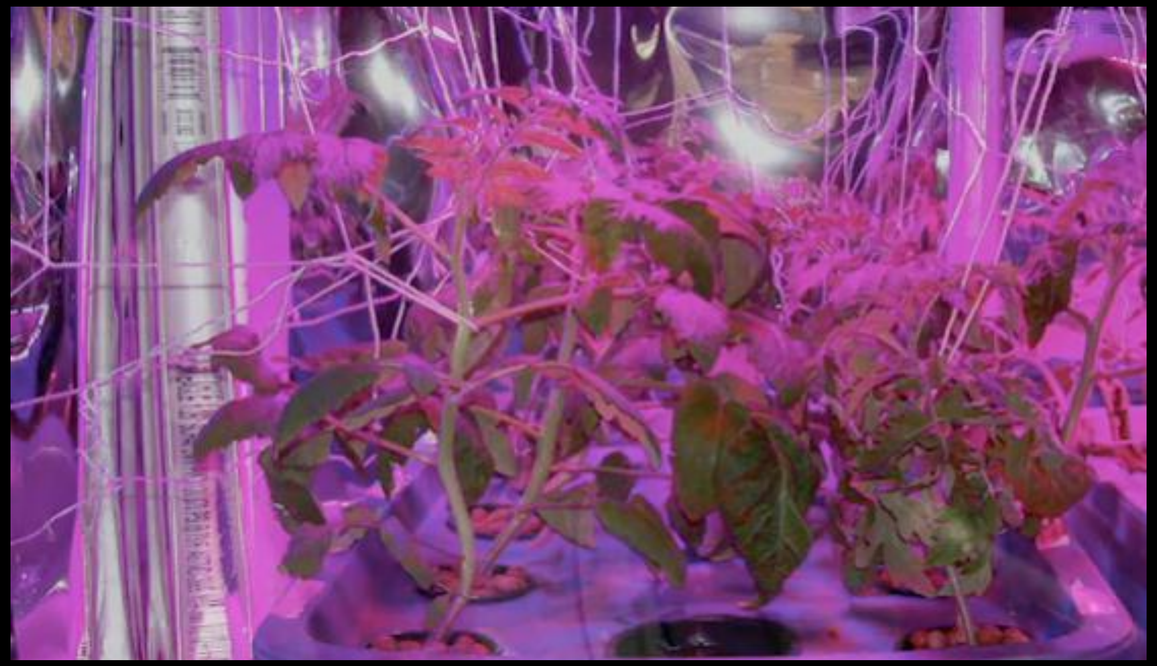
How can we grow more?

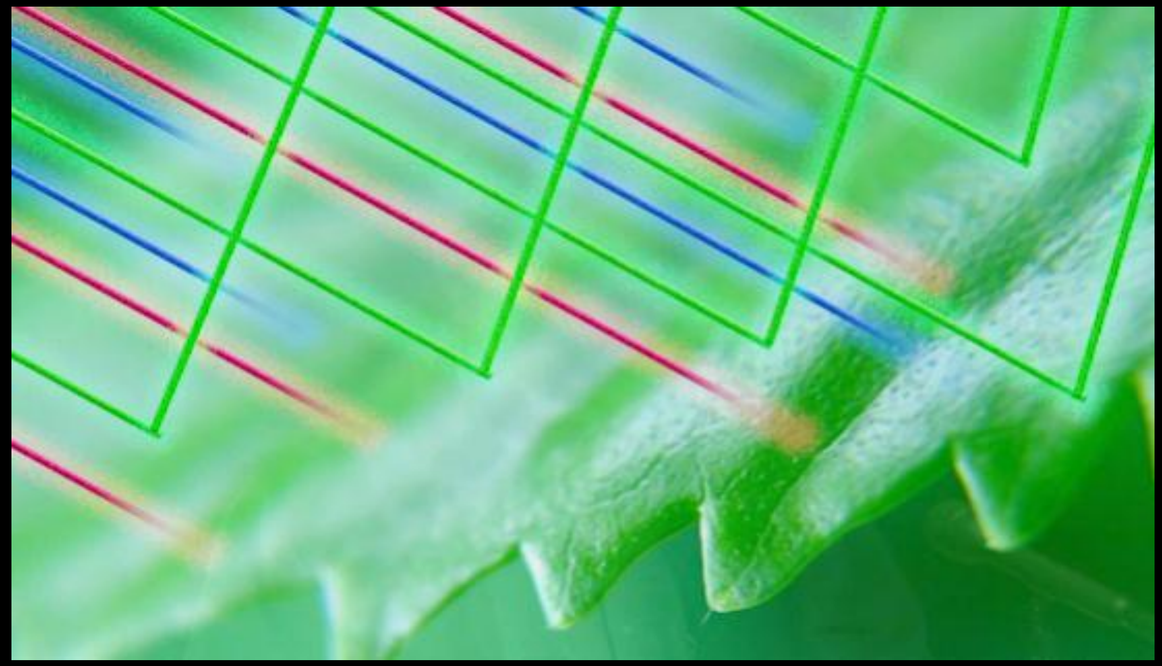


What color of light do plants Love?

Red & Violet







Op – ti- mize

Meaning "to make the most of"

Vegetables grow better in OPTIMIZED *Tuned Spectrum* Lighting

We Learned How to Optimize Plant Growth with Artificially Lighted Environments

But We Need to Learn How to Increase Human Productivity and Health with Artificial Lights As Well

Our Brain Uses Light For Vision,

But, That is Only Part of the Story!

Step 1:
Light rays pass through the eye's clear front cover called the cornea.

Step 2:
Light passes through the eyes pupil, the eye's window to the world. The pupil is surrounded by a sphincter call the iris; the eye's colored ring.

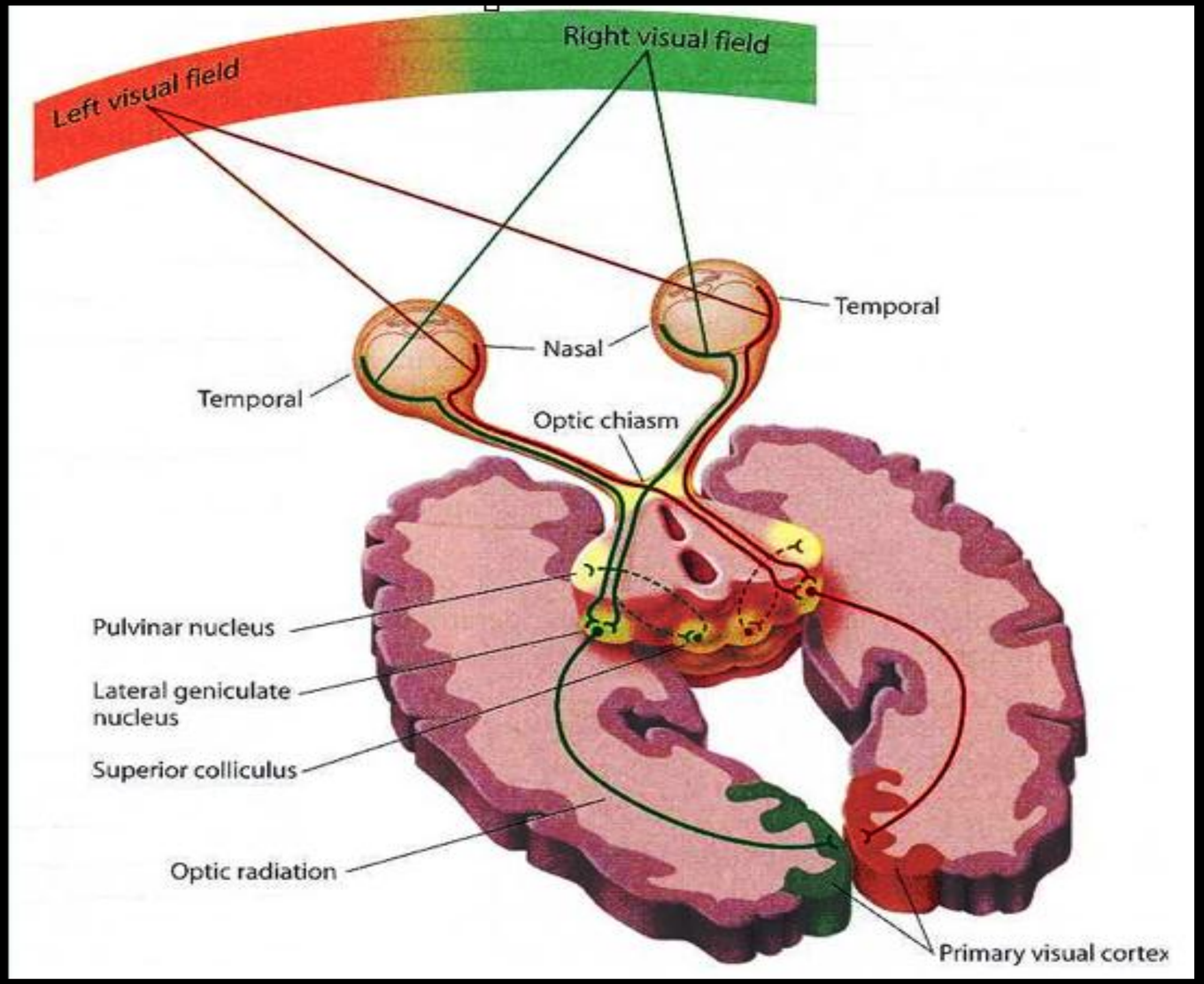
Step 3:
Light passes through the eye's crystalline lens, which constricts to help light rays come to focus at one focal point.

Step 4:
Light rays travel to and come to rest on the retina resulting in clear vision.

Step 5:
Once light rays come to rest on the retina a signal is carried done the optic nerve to the brain.

Step 6:
The brain receives the signals and interprets them into a picture(s).

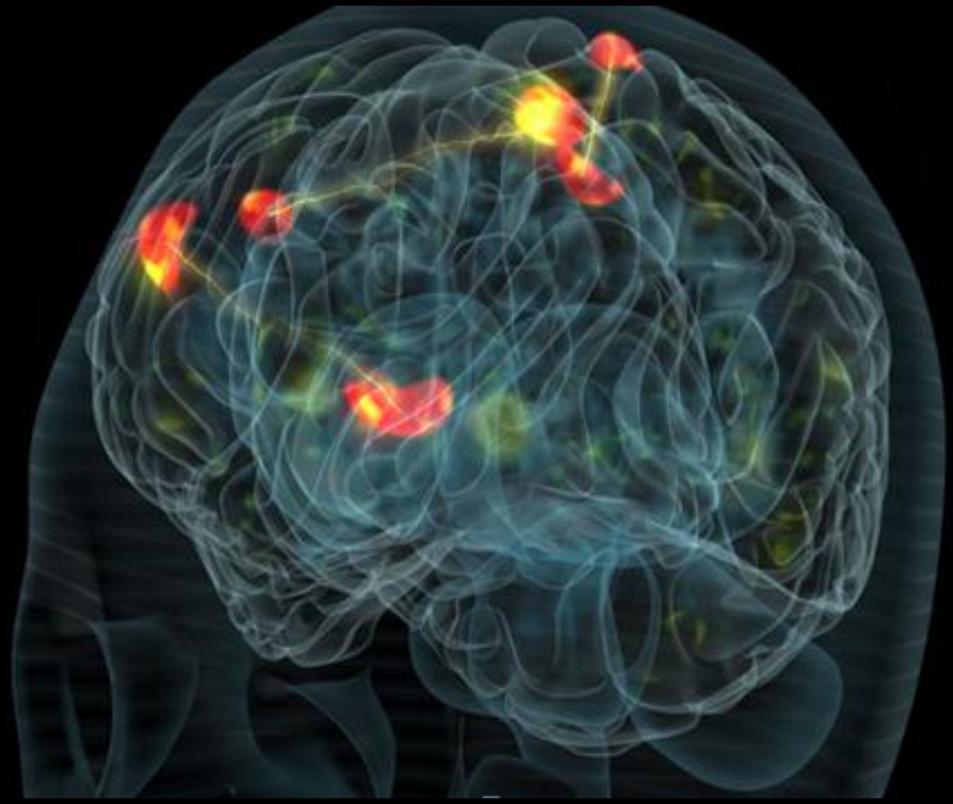
Step7:
The brain tells the eyes what it sees by forming the picture.



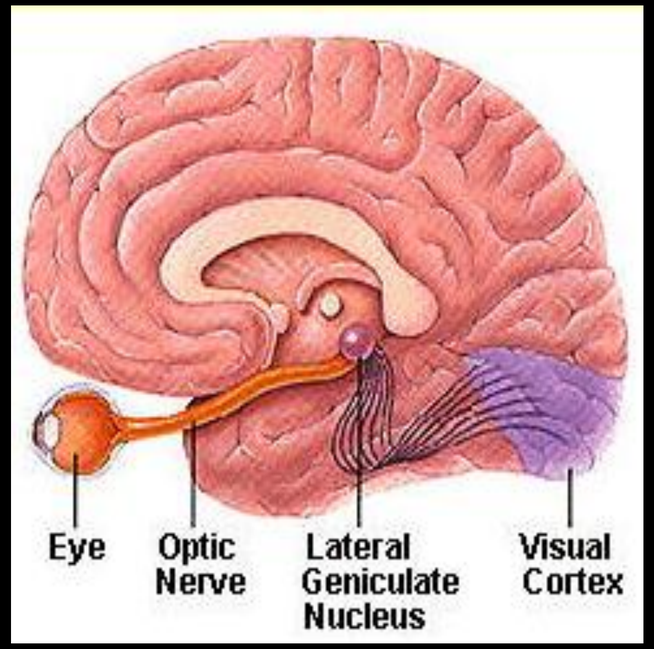
Discovery of the Light Synchronizer

In the late 1990's a discovery was made which identified specialized non-visual retina cells called **(ipRGC)** Intrinsically Photo-sensitive Retinal Ganglion Cells responsible for conveying environmental light signals to the brain.

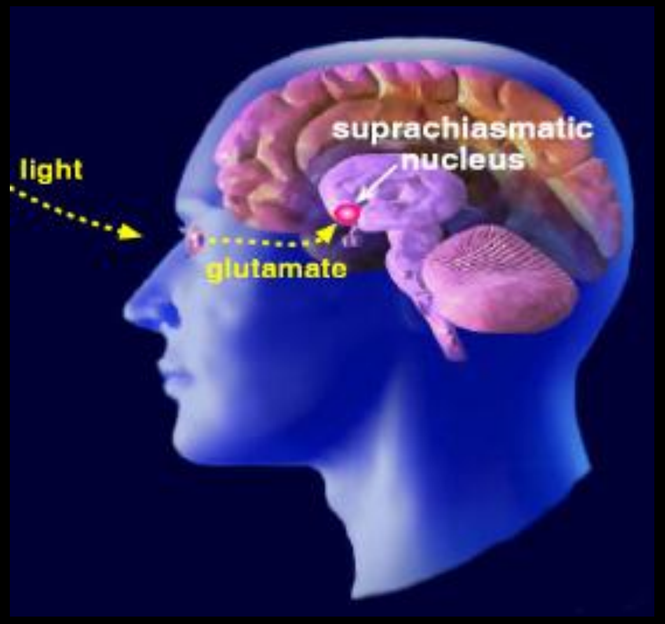
These signals are used for the synchronizing of our master biological clock to an eternal rhythm of sunlight's changing wavelengths, brightness, and darkness throughout the 24 hour day.



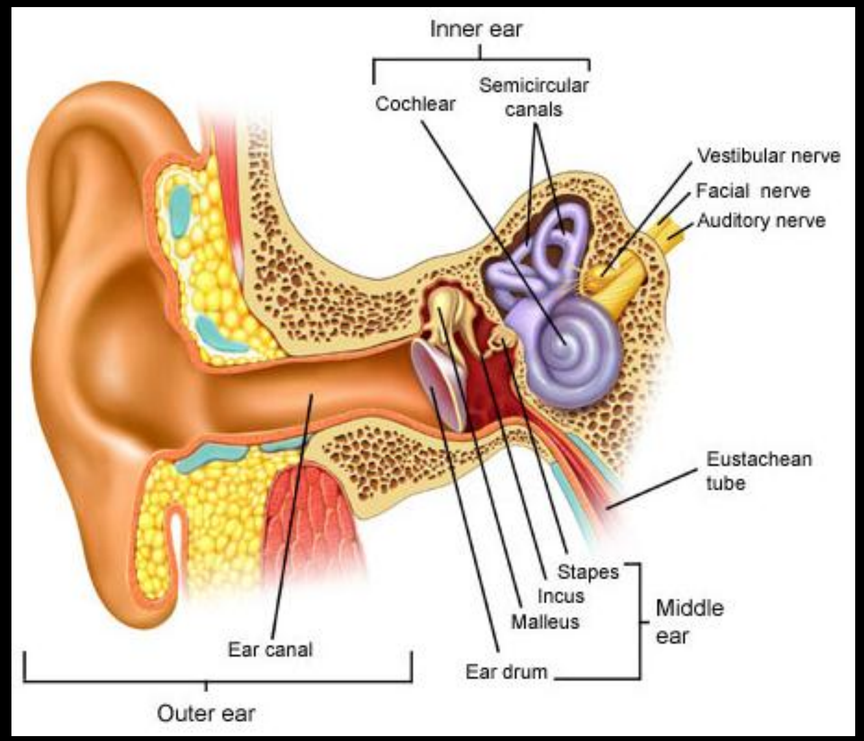
The Eye sense light and our brain sees



The Eye also senses light and color for our brain to adjust our biological rhythms



The ear senses air vibration and our brain ***hears sounds***



It also ***maintains balance*** as it detects our position relative to the pull of gravity

Zeitgeber German time giver or synchronizer

Any external cue that synchronizes an organism's time-keeping system (internal clock) to the earth's 24-hour light/dark cycle.

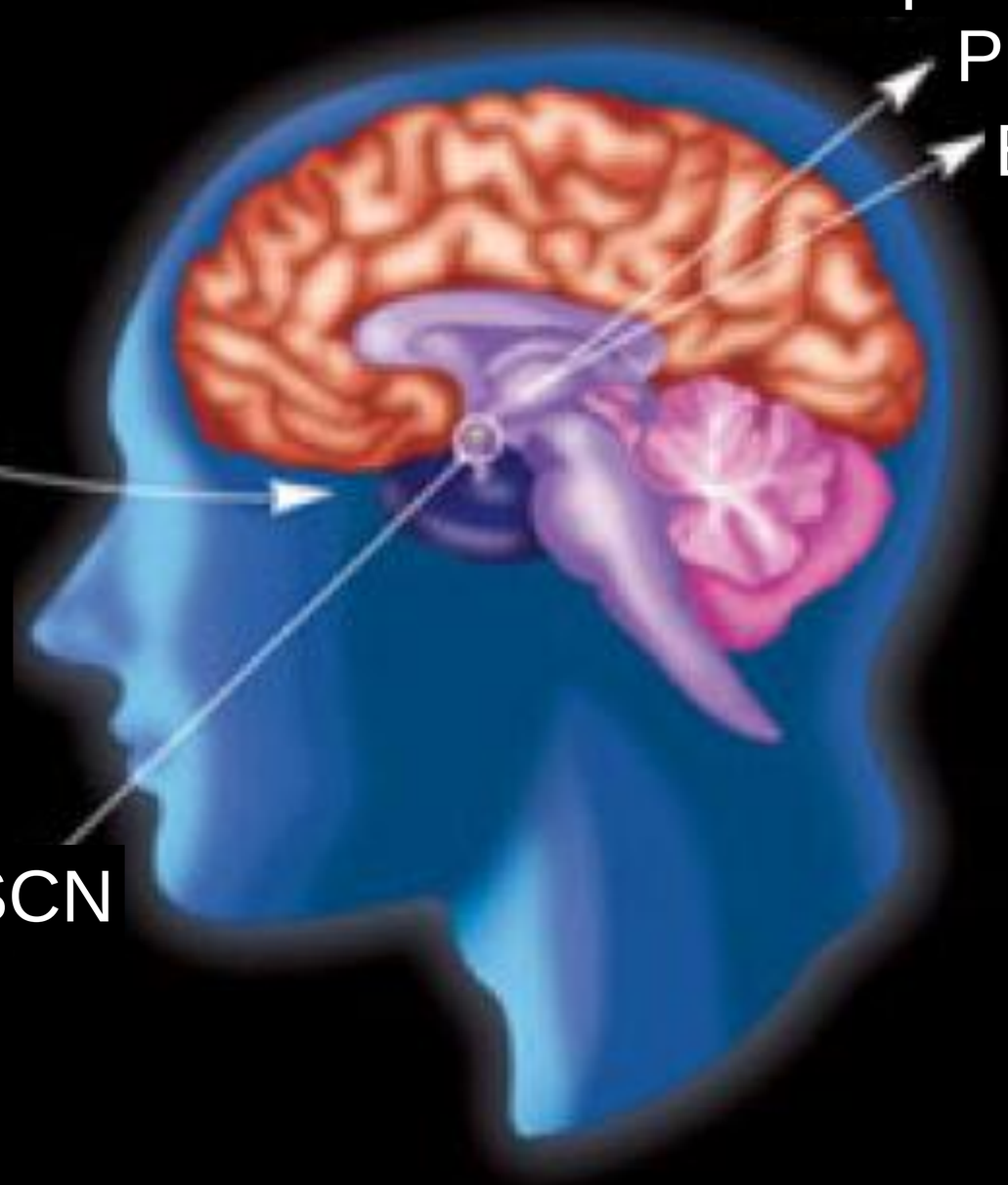
The strongest zeitgeber, for both plants and animals, is *LIGHT!*

Others included temperature, eating & drinking patterns, nutrition, and exercise

So How Does this Control System Function?

LIGHT

Output Rhythms:
Physiology
Behavior

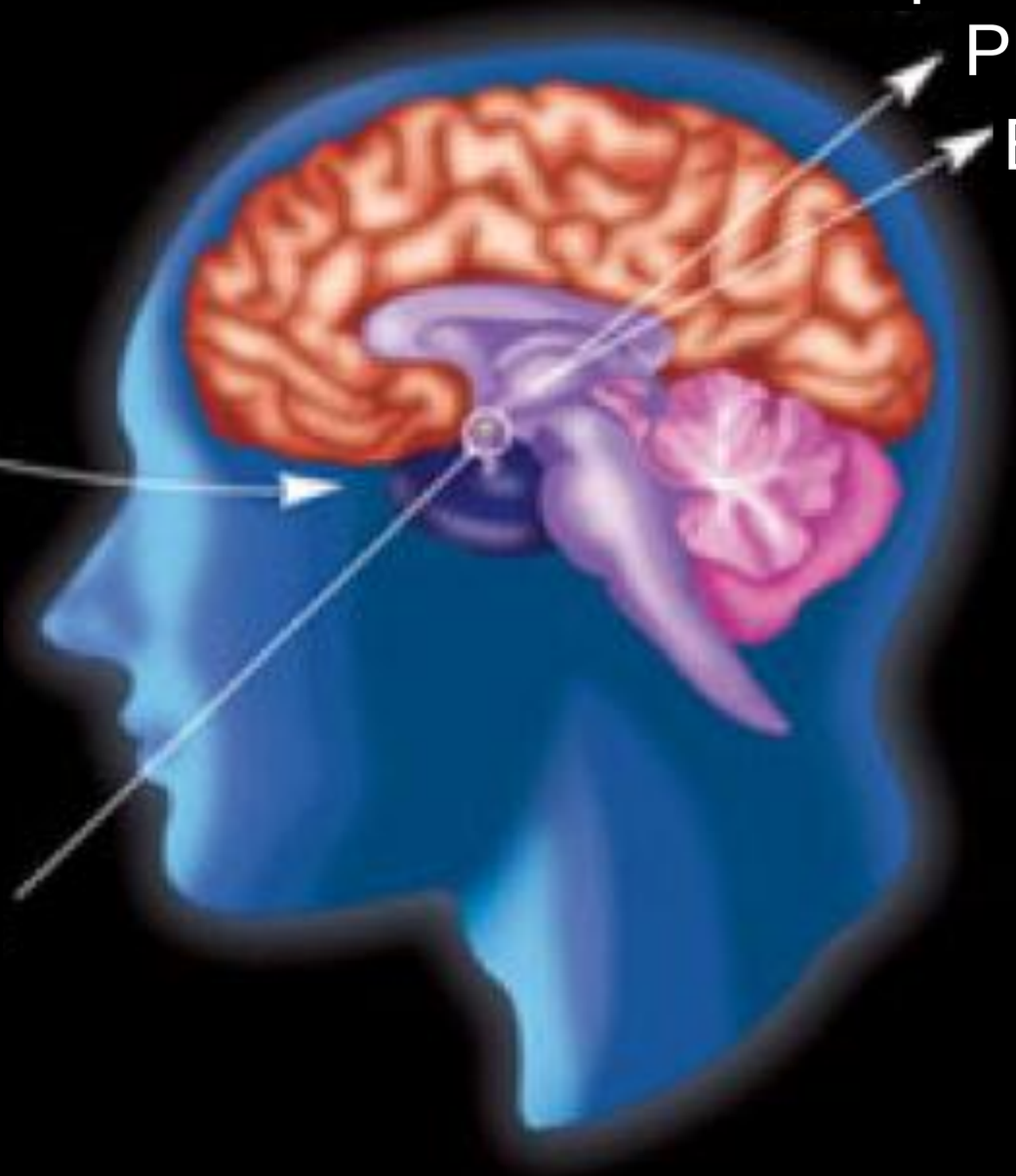


SCN

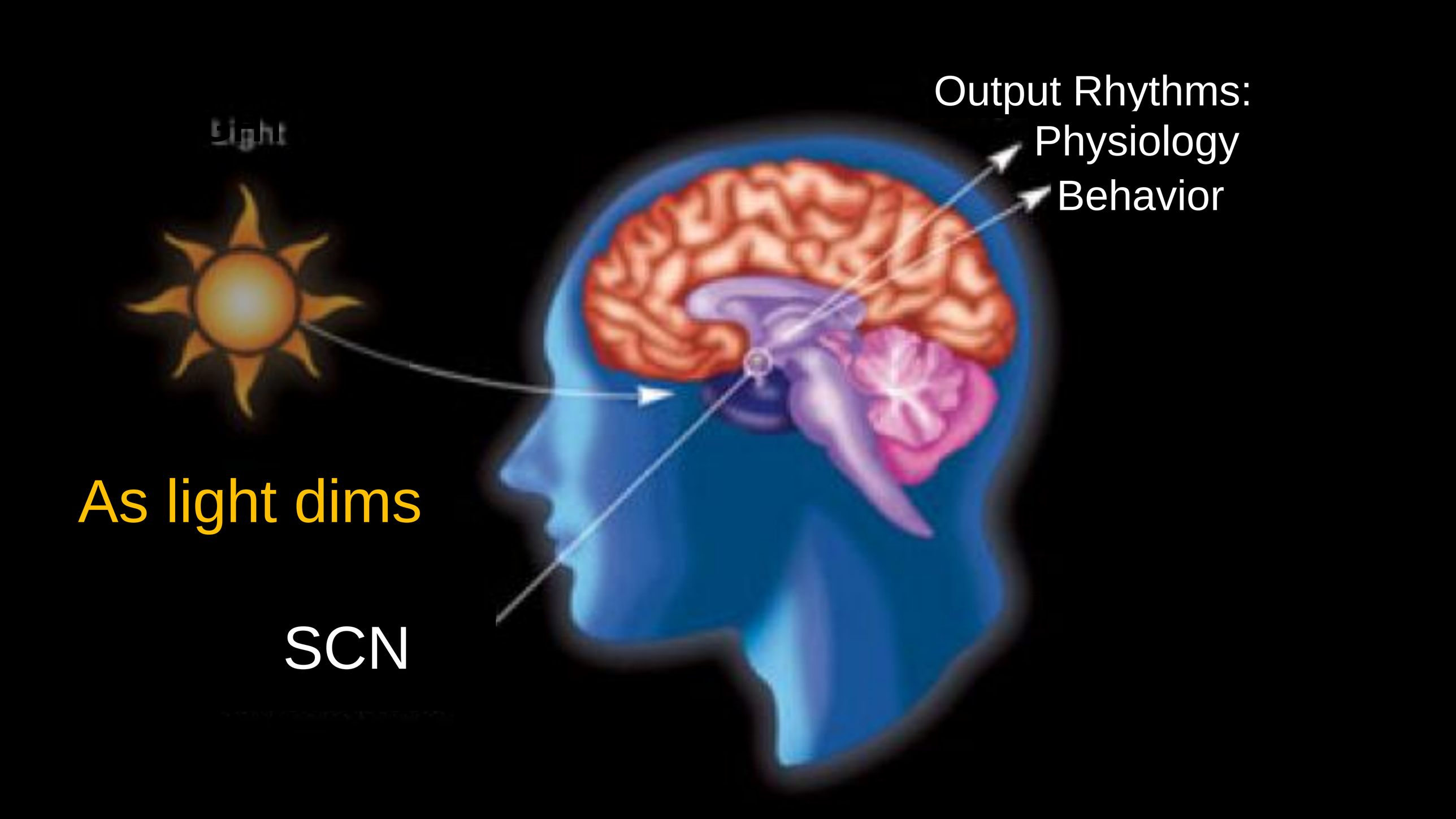
1) Light is detected by **ipRGC** cells in the Retina which detect **blue dominate** light of day, and **red dominate light** of sunset, and darkness, sending signals to the (SCN)

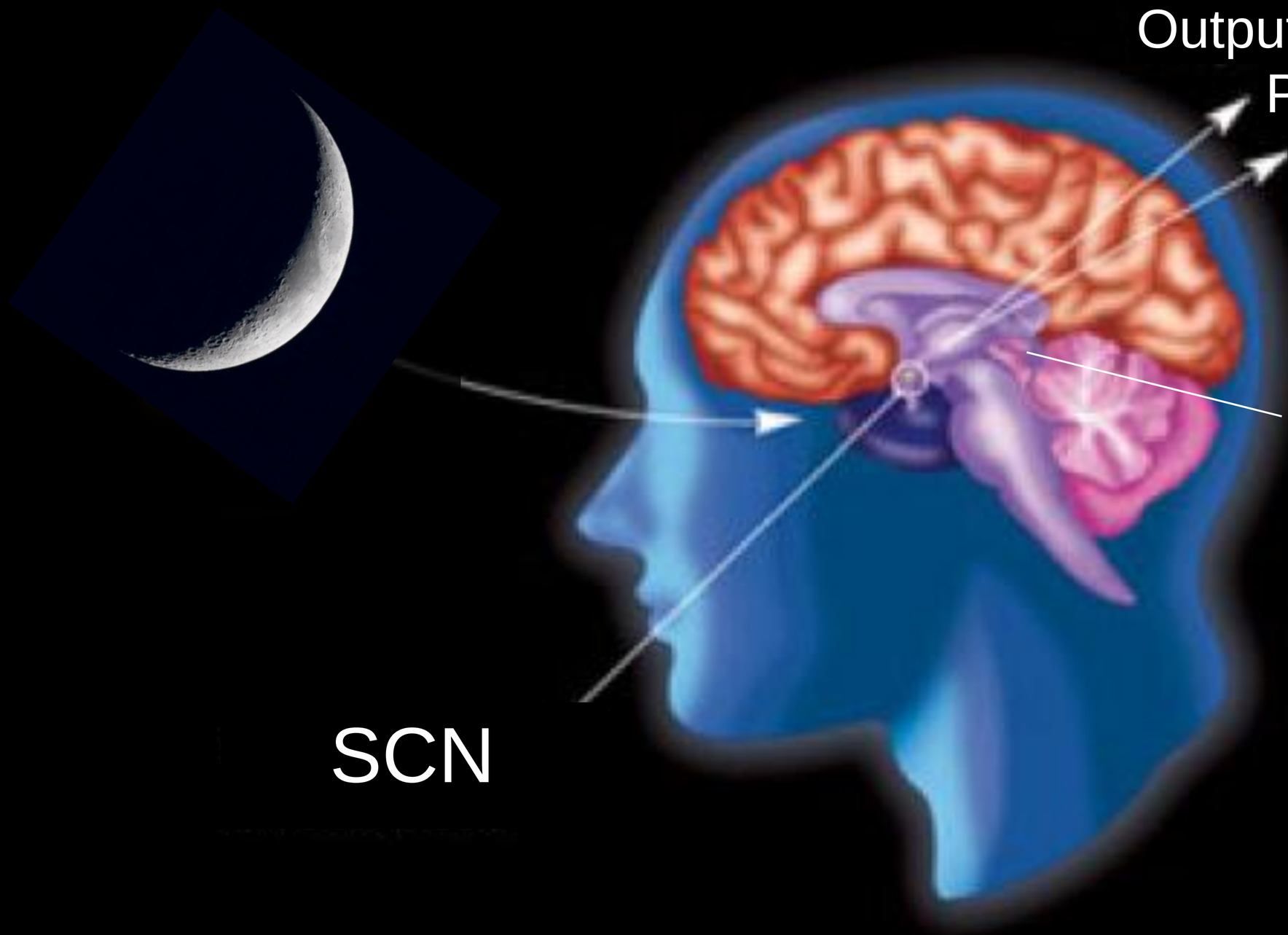
LIGHT

Output Rhythms:
Physiology
Behavior



2) (SCN) Supra-chiasmatic Nucleus - our **Biological Clock,** located in the Hypothalamus, sends signals to the Pineal gland depending on the brightness, time and color of the light


Light
Output Rhythms:
Physiology
Behavior
As light dims
SCN

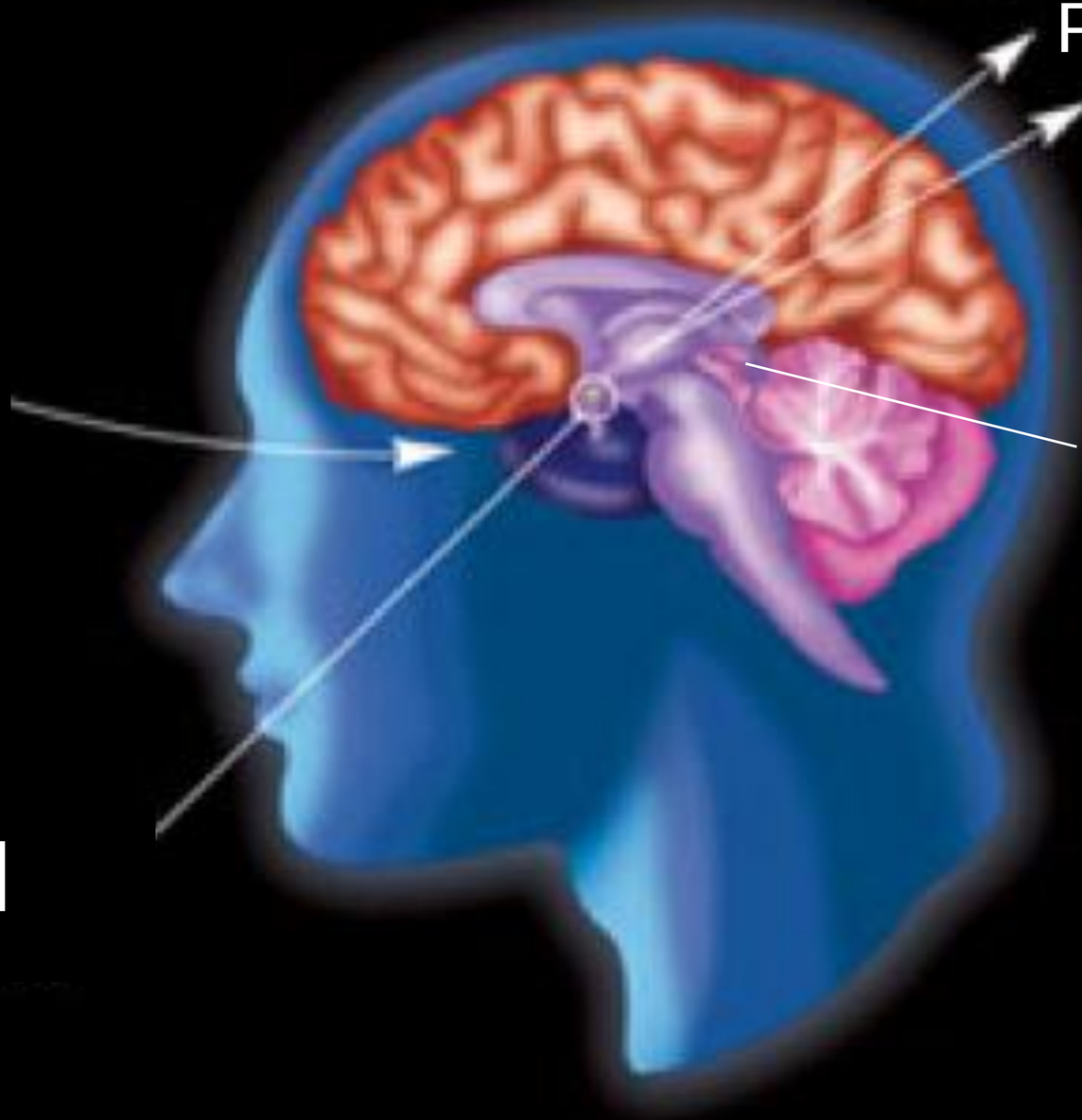


3) The (SCN) directs the Pineal Gland to make and release **Melatonin. our sleep hormone,** in to the blood stream making you **sleepy**

LIGHT

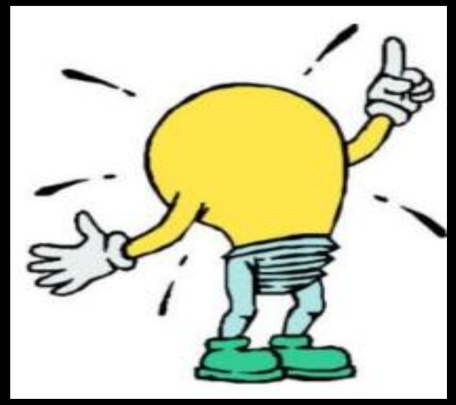
As Bright Artificial Light Turns On

SCN



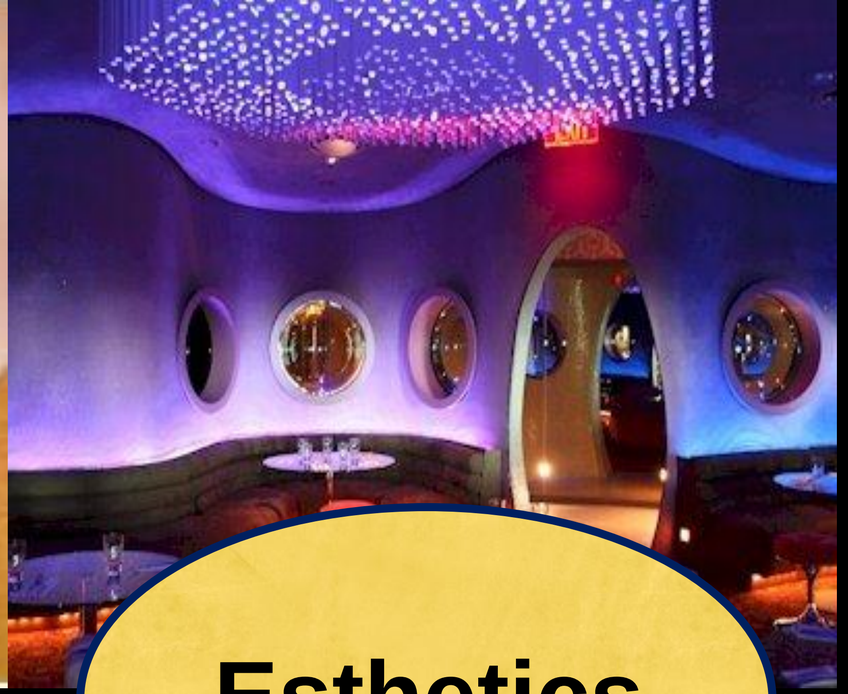
Output Rhythms:
Physiology
Behavior

4) The (SCN) directs the Pineal Gland to reduce or stop **Melatonin** release inhibiting the sleep signal

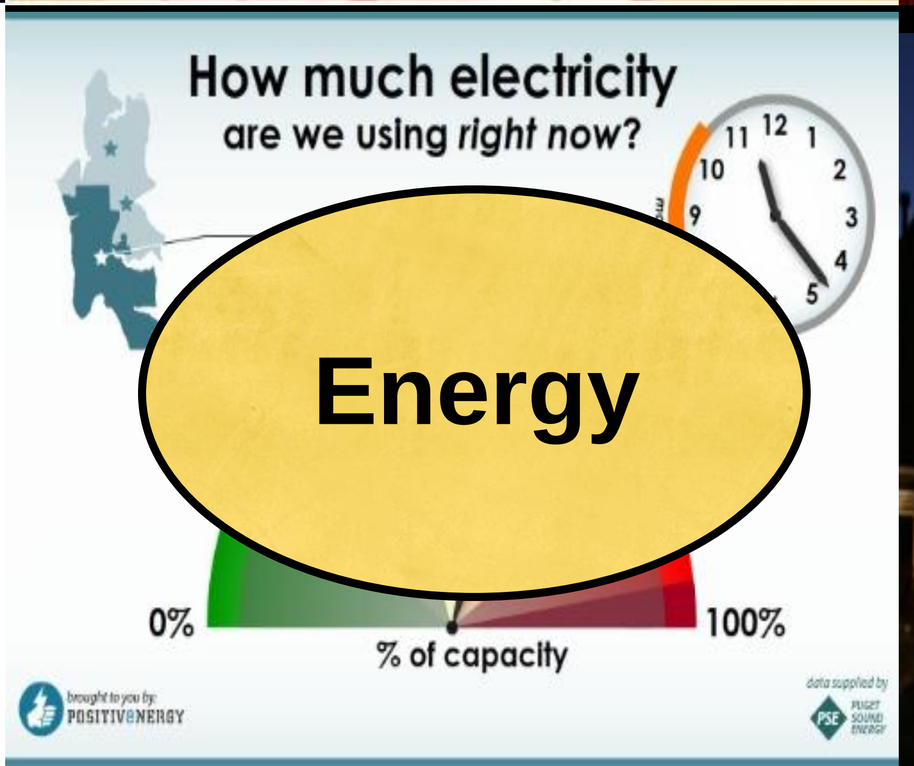


Health

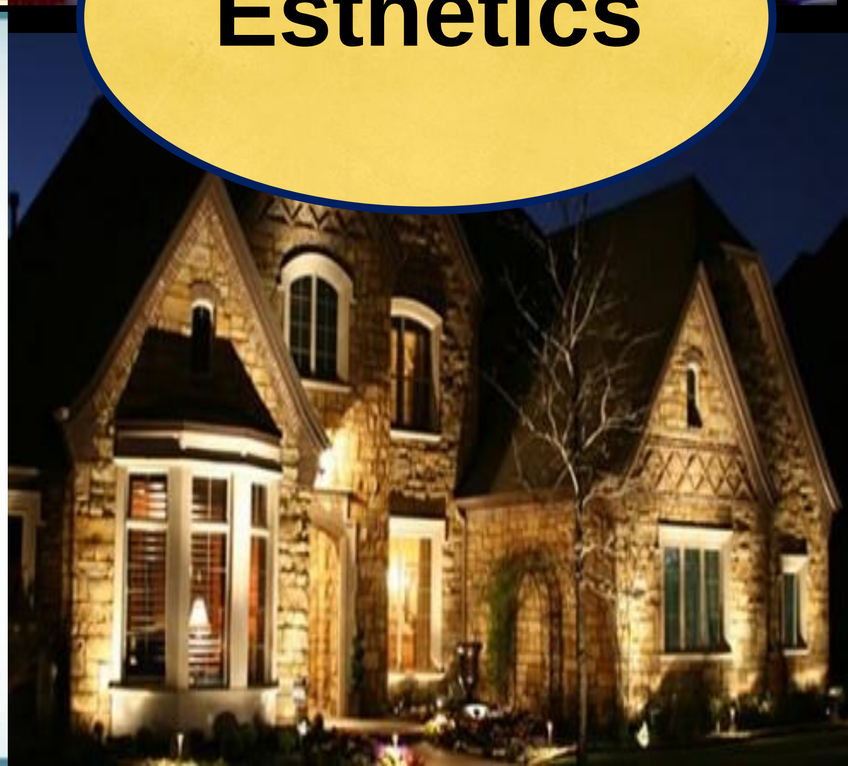
Visibility



Esthetics



Energy



Esthetics

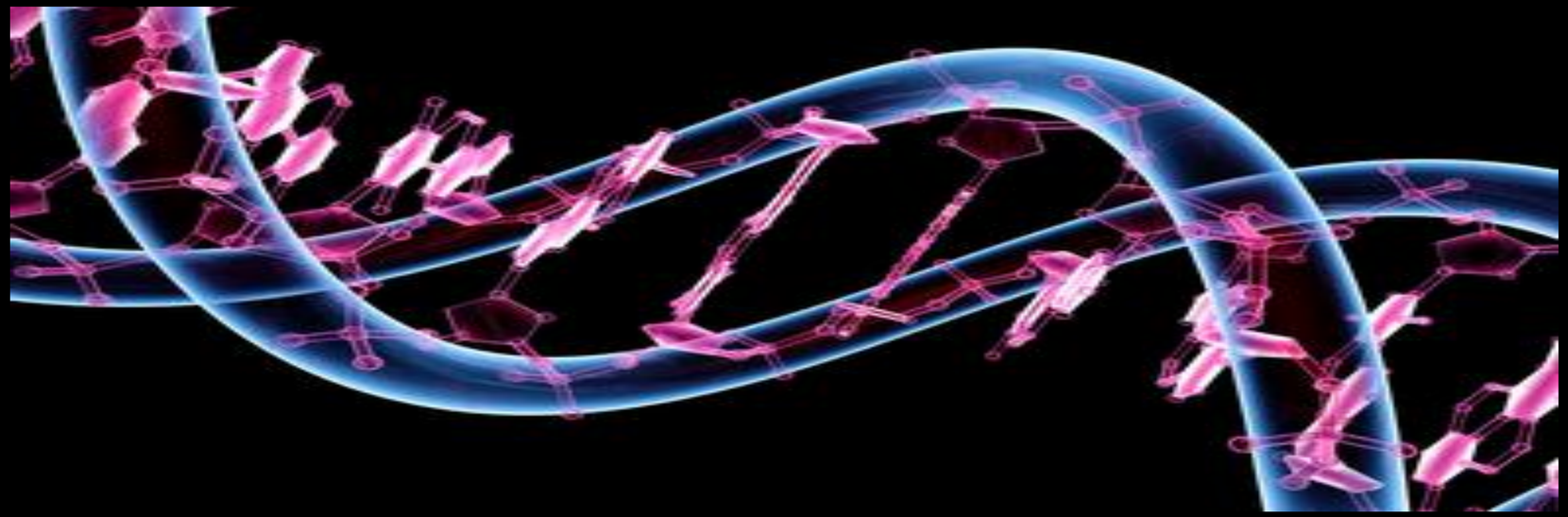
A New Lighting Word
Epigenetics

The foundation of the Human Control System

Epigenetics look at the sources that activate gene expression or suppression

Tracing the signals from outside the cell that tell the genes what to do

What do GENES Have To Do With Our Biological Performance?



What do Relays and Sensors have to do with Lighting Controls?

EVERYTHING!

The Genetic Control System

- Memory, learning, stress and healing are all affected by classes of genes that are Expressed = Controlled in cycles that range from one second to many hours and years

- Our Genes are Automatically Controlled by external and internal environmental cues

External Environment:

Light & Color, sound, air, food toxins and social network

Inner environment:

Emotional, bio-chemical, and spiritual

Some of the Numbers

- We have about 23,000 genes
- 51% are regulatory genes
- 90% of all genes have been educated, programmed, and tested in cooperation with signals from our natural environment for over 6 million years
- Every day our genes are retro-commissonined and optimized by the new days environmental cues in the form of LIGHTING, temperature and nutrition

Human Performance Optimization

- Optimum Human function is **governed by our sleep wake cycle**
  Just like a manufacturing facility, optimum function is governed by its preventative maintenance schedule

- We are finding that the artificial built environments we have constructed to recreate nature, such as a sunny day and 72 degrees from 6 a.m. to11 p.m., is not the same environment that we were optimally designed for

THE HUMAN MAINTENANCE CONNECTION

CONTROLS AND Light

The Sleep & Wake Hormones (signals)

Wake Hormones

- In the pre-dawn hours the body temperature has reached its minimum

- The morning sun rise signals the body clock to stop producing Melatonin

- The body clock also signals the body to begin producing the steroid hormone **Cortisol**, Serotonin a Neurotransmitter and other powerful alertness chemicals. **Cortisol** acts as a ***power surge***, at its highest level around 5 a.m. in the morning.

- About an hour after cortisol levels rise, the body is able to wake up

Melatonin’s Other Effects on our Biology?

Melatonin is a Repair Hormone! demonstrated to be a powerful antioxidant **preventing damage to DNA** by some carcinogens stopping the mechanism by which they cause cancer

Melatonin's antioxidant activity may reduce damage caused by some types of Parkinson's disease, play a role in **preventing cardiac arrhythmia** and **possibly increase longevity**

Younger children hit their peak melatonin production at night, and some researchers believe that the level of melatonin peaks earlier as we get older. This may explain why older adults go to bed earlier, wake up earlier, and have more sleep problems than children do

The World Health Organization in 2007 named late night shift work as a probable cancer-causing agent. Melatonin is an anti-oxidant and suppressant of tumor development.

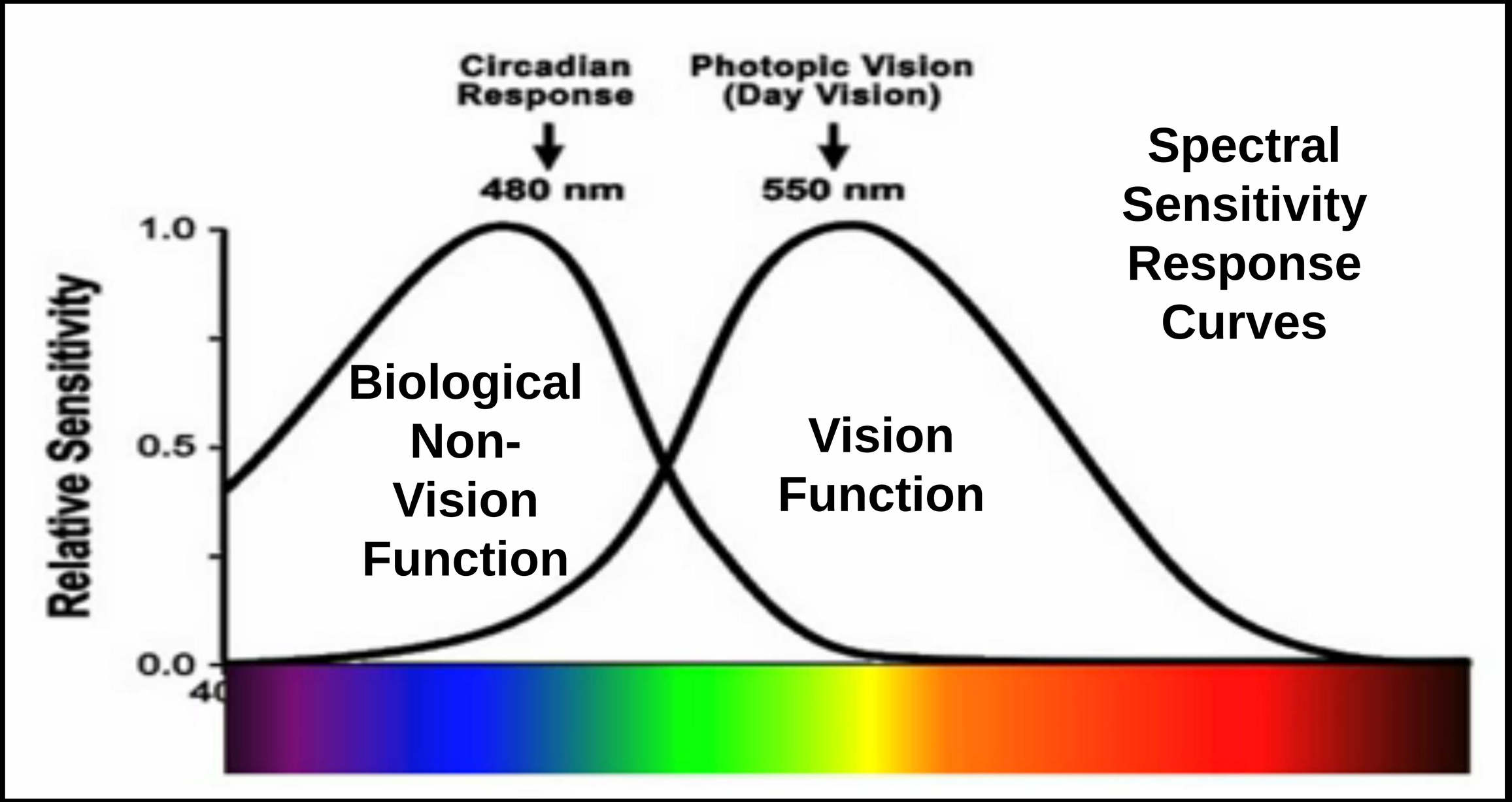
Studies Indicate Sleep is Critical

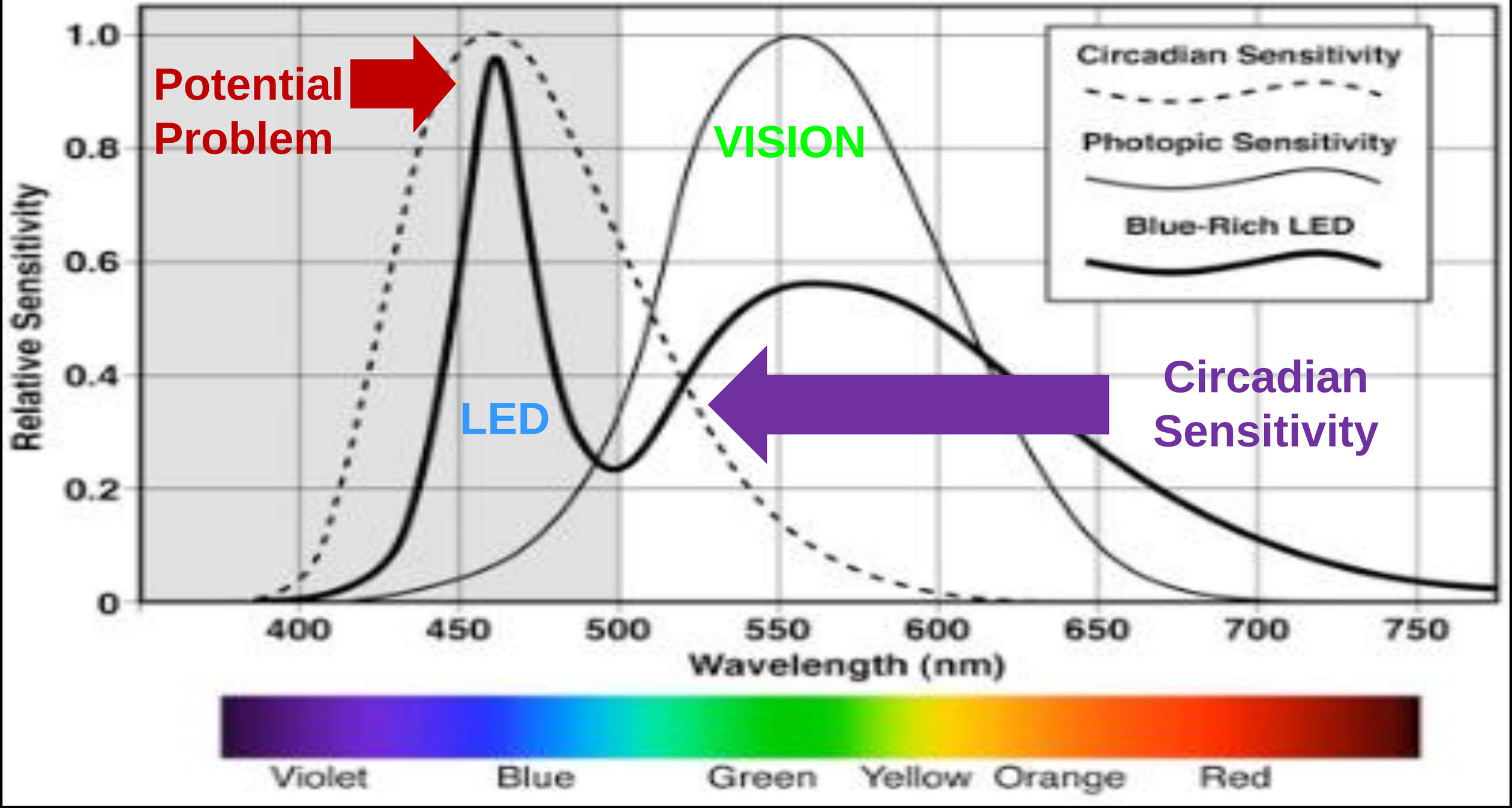
- Melatonin needs to have significant bright light during the day to sufficiently suppress and conserve it for sleep. This conservation allows it to “build up pressure”, so to speak, so that it can return at night with a powerful surge

- Some elderly are not getting sufficient daytime light to suppress melatonin to fully wake up.

- If melatonin is not suppressed sufficiently to build up “sleep pressure” they don’t get as much regenerative rest or, sleep as long, when they go to sleep.

- In addition many retirement homes do not provide proper lighting to allow people to, go and return from, the rest room with out triggering the end of the sleep cycle


Circadian Response
480 nm
Photopic Vision (Day Vision)
550 nm
Spectral Sensitivity Response Curves
Relative Sensitivity
1.0
0.5
0.0
Biological Non-Vision Function
Vision Function


Potential Problem
VISION
LED
Circadian Sensitivity
Circadian Sensitivity
Photopic Sensitivity
Blue-Rich LED
Relative Sensitivity
1.0
0.8
0.6
0.4
0.2
0
400
450
500
550
600
650
700
750
Wavelength (nm)
Violet
Blue
Green
Yellow
Orange
Red

Is Your Body A Biological Clock Watcher?

Our Biological Light Clock

AM Time

PM Time

Noon
12:00

Vitamin D2 Synthesis from UVB

Lowest Day Time Performance

Ghrelin Peak = Lunch

High alertness
10:00

Highest testosterone secretion
09:00

Bowel movement likely
08:30

Melatonin secretion stops
07:30

Sharpest rise in blood pressure
06:45

Ghrelin Rises = Breakfast

Wake Up Body
06:00

Melatonin at Lowest Levels

Cortisol Rising

Lowest body temperature
04:30

Body Phycology (Brain) Repaired 2am to 6am

Body Physically Repaired 10pm to 2am

Dropping Melatonin

Low Cortisol

02:00
Deepest sleep

Ghrelin Small Peak

Peak Melatonin

00:00
Midnight

Highest Cell Regeneration

11:00P Bowel movements suppressed

10:30P

10:00P

Go to Sleep

9:00P **Melatonin Rises**

Warm up lighting

8:00P

Ghrelin Peak = Dinner

Cortisol Falling

7:00P Highest body temperature

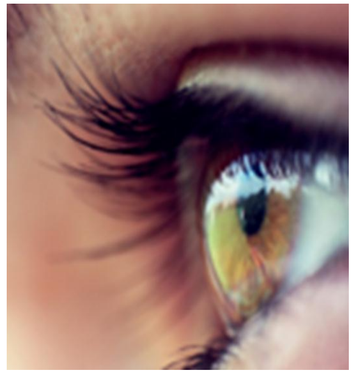
6:30P Highest blood pressure

6:00P

5:00P
Greatest cardiovascular efficiency and muscle strength

3:30P
Fastest reaction time

2:30P
Best coordination



Why are Circadian Rhythms Disorders a Problem?

Why are Circadian Rhythms Disorders a Problem?

Sleep Quality
and
Sleep Deprivation

Why Do We Sleep?

1. To allow the brain and body to repair itself

2. To conserve energy for the next days hunt

Why Do We Sleep?

1. To allow the brain and body to repair itself

2. To conserve energy for the next days hunt

Survival!

What Causes Circadian Rhythm Disorders

Some of the Causes:

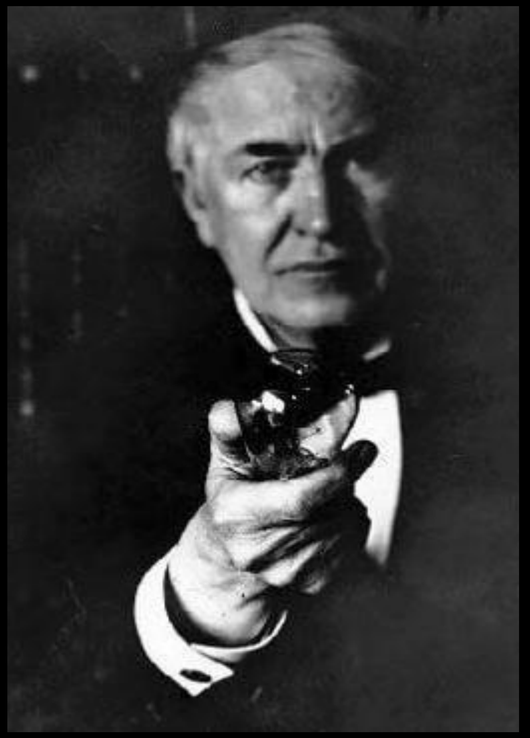
- Time zone changes “Jet Lag”
- Lack of Sunlight and Intensity “Northern Latitudes” SAD
  Seasonal Affected Disorder “SAD”
- Shift work
- Lighting “Lack of Daylight exposure”
- Light Pollution, “Lack of Dark exposure” Artificial Light in and outside
- Lighting “Out of phase Synchronicity with daylight color temperature”
- Pregnancy
- Medications
- Changes in routine

How Much Sleep Do You Really Need?

Age	Sleep Needs
Newborns (0-2 months)	12-18 hours
Infants (3 to 11 months)	14 to 15 hours
Toddlers (1-3 years)	12 to 14 hours
Preschoolers (3-5 years)	11 to 13 hours
School-age children (5-10 years)	10 to 11 hours
Teens (10-17)	8.5-9.25 hours
Adults	7-9 hours

Source: National Sleep Foundation

When the Light Bulb Went On to Help Us See our Eyes Started to Close



The average young adult, **today, reports sleeping about 7 to 8 hours** each night. When we compare this to sleep patterns in 1910, before Edison's modern coiled tungsten filament light bulb, was introduced, we find that the **average person use to sleep 9 hours** each night. This means that today's population **sleeps 1 to 2 hours less** than people did early in the century (Webb & Agnew, 1975).

The effects of sleep loss are cumulative, and regularly **losing one or two hours of sleep** a night can lead to chronic **sleep deprivation.**

Sleep deprivation has been shown to **produce psycho-motor impairments equivalent to** those induced by **alcohol consumption** at or above the legal limit.

66% of all Americans don’t get the sleep that Doctors recommend
70,000,000 have problems sleeping

Our Need for SLEEP

Sleep Deprivation and Workplace Productivity

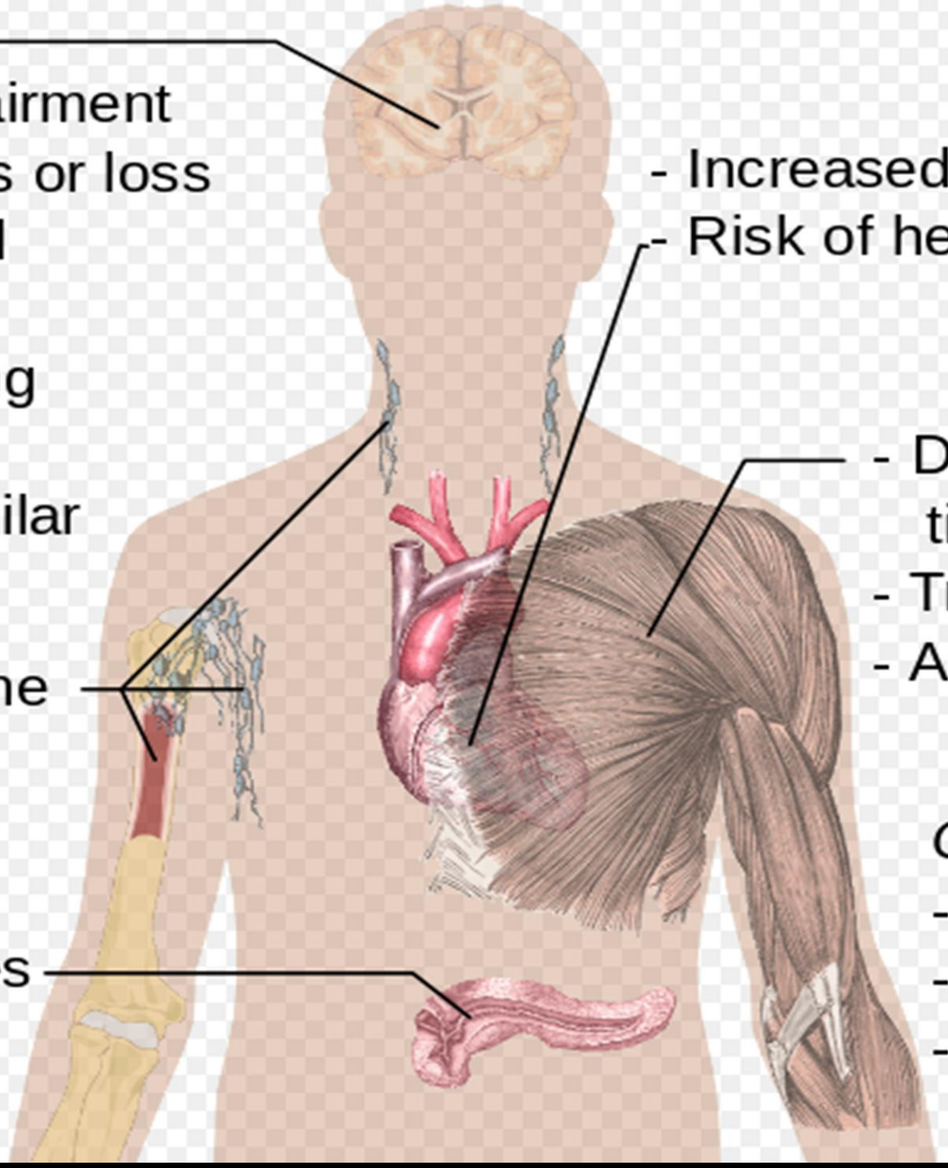
Effects of

Sleep deprivation

- Irritability
- Cognitive impairment
- Memory lapses or loss
- Impaired moral judgement
- Severe yawning
- Hallucinations
- Symptoms similar to ADHD

- Impaired immune system

- Risk of diabetes Type 2



- Increased heart rate variability
- Risk of heart disease

- Decreased reaction time and accuracy
- Tremors
- Aches

Other:
- Growth suppression
- Risk of obesity
- Decreased temperature

- Disasters Where SLEEP DEPRIVATION was a major factor

- Three Mile Island Reactors
- Peach Bottom Reactors
- Chernobyl (50,000 lives)
- Exxon Valdez
- The Challenger Accident

The Cost $$$
Of missing ZZZ's

- **Automotive Crash Estimates vary, these are thought to be underestimated….**
- **100,000 Crashes** Related to Fatigue Annually in U.S per the NHTSA
- **1,550 Sleep Related Traffic Deaths in 1996**
- **71,000 injuries**
- Drowsy Driving represents 10-30% of all crashes worldwide
- Sleep related crashes have fatality and injury rates similar to alcohol related crashes

Sleep Deprivation in Children

- More than two-thirds of children experience one or more sleep problems at least a few nights a week.

- For children with ADHD, poor sleep (too little sleep or symptoms of sleep disorders) may profoundly impact ADHD symptoms.

- **In fact, one study found that treating sleep problems may be enough to eliminate attention and hyperactivity issues for some children.**

- Philips Consumer Lifestyle – announced that…
- **“23 % of office workers admit to taking a nap at work.”**

- “**56 %** of office workers don’t consistently get a good night’s sleep.”

- “**64%** of employees do not wake up before their alarm goes off and more than one-third (37%) are not ready to get up when their alarm goes off

- **“85 % of office workers admit that if they slept more, they would be more productive while on the job.”**

Could Sleep Deprivation Lead to a…

Corporate Train Wreck?

Sleep disturbances contribute to decreased employee productivity at a high cost to employers

$136 billion per year in health-related lost productivity

$101 billion more than for workers without fatigue

$1,967 per employee annually

For a firm with 3,000 employees that’s $6,000,000 annually

Corporate Health Care Costs

- Healthcare costs continue to grow ahead of cost of living raises at over seven percent
- In 2012, companies can be expected to pay almost $12,000 per employee for healthcare costs.
- It is expected that the 2012 costs to be 7.2 percent above their 2011 costs which were 7.4 percent above 2010 costs
- Employers are being much more aggressive in their use of cost-sharing techniques and cost-control programs

Other Light Related Circadian Disorders

Jet Lag or Rapid Time Zone Change Syndrome:

Medically a sleep disorder referred to as ***desynchronosis***…

The inability of our internal circadian clock to make an immediate adjustment to the changes in the external light cues that an individual experiences when rapidly crossing time zones. It effects more than the sleep and wake cycle. Many rhythms are out of sync.

Causes:

- Pre-flight Stress
- Disrupted sleep patterns, red eye flights
- Higher than normal cabin pressure
- Dry cabin air (dehydration)
- Dehydration, Lack of movement
- Disrupted Eating times and appetite
- Recirculated stale cabin air
  causing headaches and drowsiness
- Alcoholic drinks 2-3 x more potent on flight
- Coffee, sodas, juices
- Constant engine noise

Current Aircraft Cabin Design that Reduces Stress and Makes for a More Comfortable Flight

Circadian Restoration Treatment:
Taking long walks during the daylight hours

Doing light therapy using a special fixture with a very bright color corrected fluorescent bulb or…

Using an LED light (10,000 lux) with proper color temperature to mimic light from the sun may also be helpful.

Night Time Darkness is Important Too!

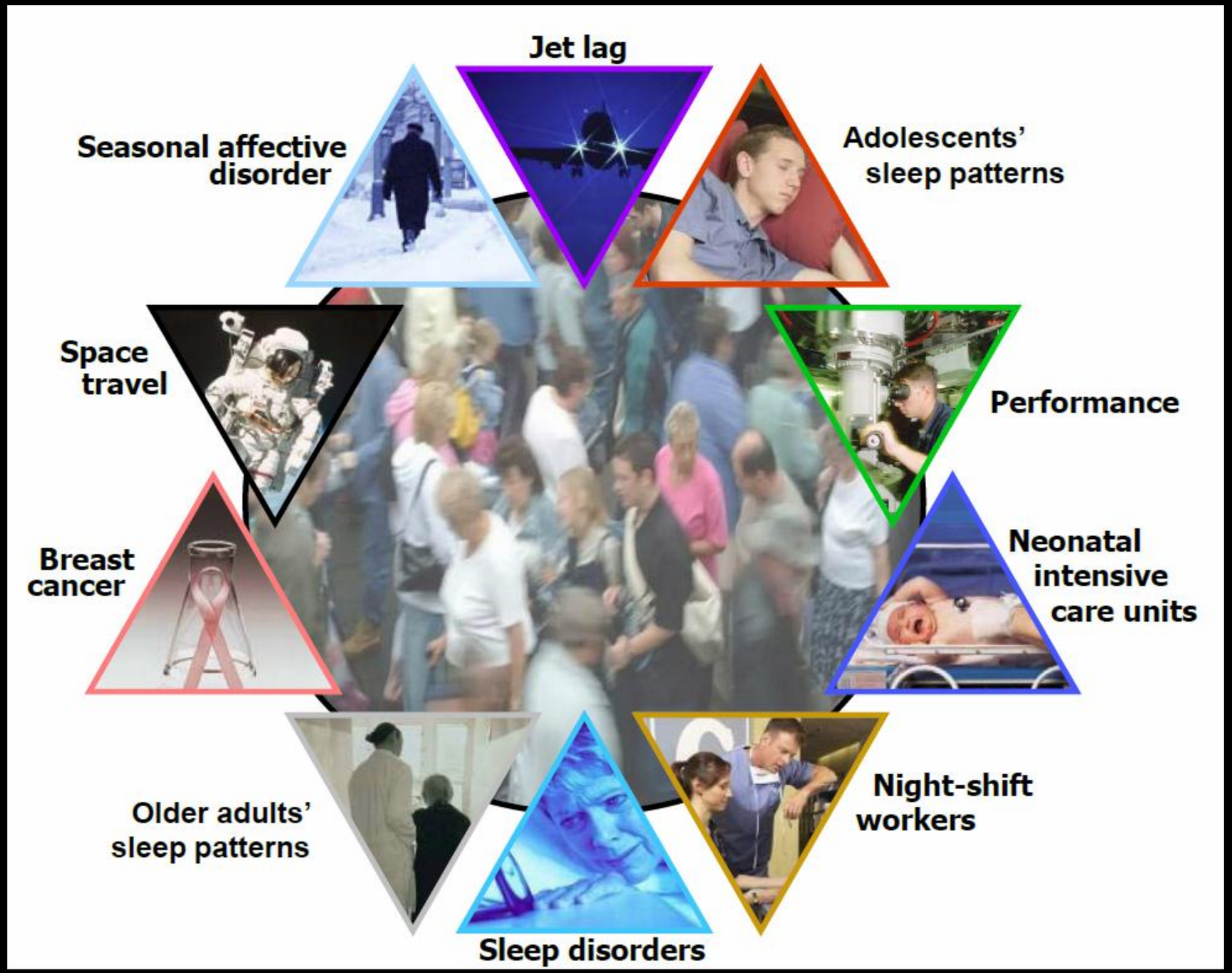
Not only do we need light to fully turn off Melatonin in the day so we can be fully awake,

We need Full Darkness to turn Melatonin ON at night!

Light Pollution…
the Melatonin “OFF” switch to restorative sleep

Conclusion: Lighting Design Must Address

Providing Healthy Illumination for *Non-visual* Function



Circadian Adaptive Lighting

Applied lighting strategy best describing the integration of

natural daylight, artificial light and integrated shading strategies combined with advanced control systems

specifically designed to phase shift, align or enhance the human circadian system in order to elicit or influence physiological and or behavioral response for…

optimized performance and health

Three Types of
Circadian Adaptive Lighting Design

- Circadian Restoration
- Circadian Maintenance
- Circadian Emulation

Circadian Restoration

A medically prescribed light treatment utilizing specific defined dosing protocols and advanced control systems to restore chronically desynchronized circadian rhythms

SAD treatment
    Northern Latitudes
Jaundice
Hospital wards, ICU units
Sleep diagnostic centers
Medically Supervised Athletic Training Facilities
Long term care facilities
Health care treatment rooms

Circadian Maintenance

Enhance natural light levels and to artificially stimulate the circadian system with enhancement of natural light/dark cycles including natural spectrum color shift over the 24 hour day combined with the use of advanced day lighting technologies and automated dynamic lighting and shading systems, **to facilitate sleep.**

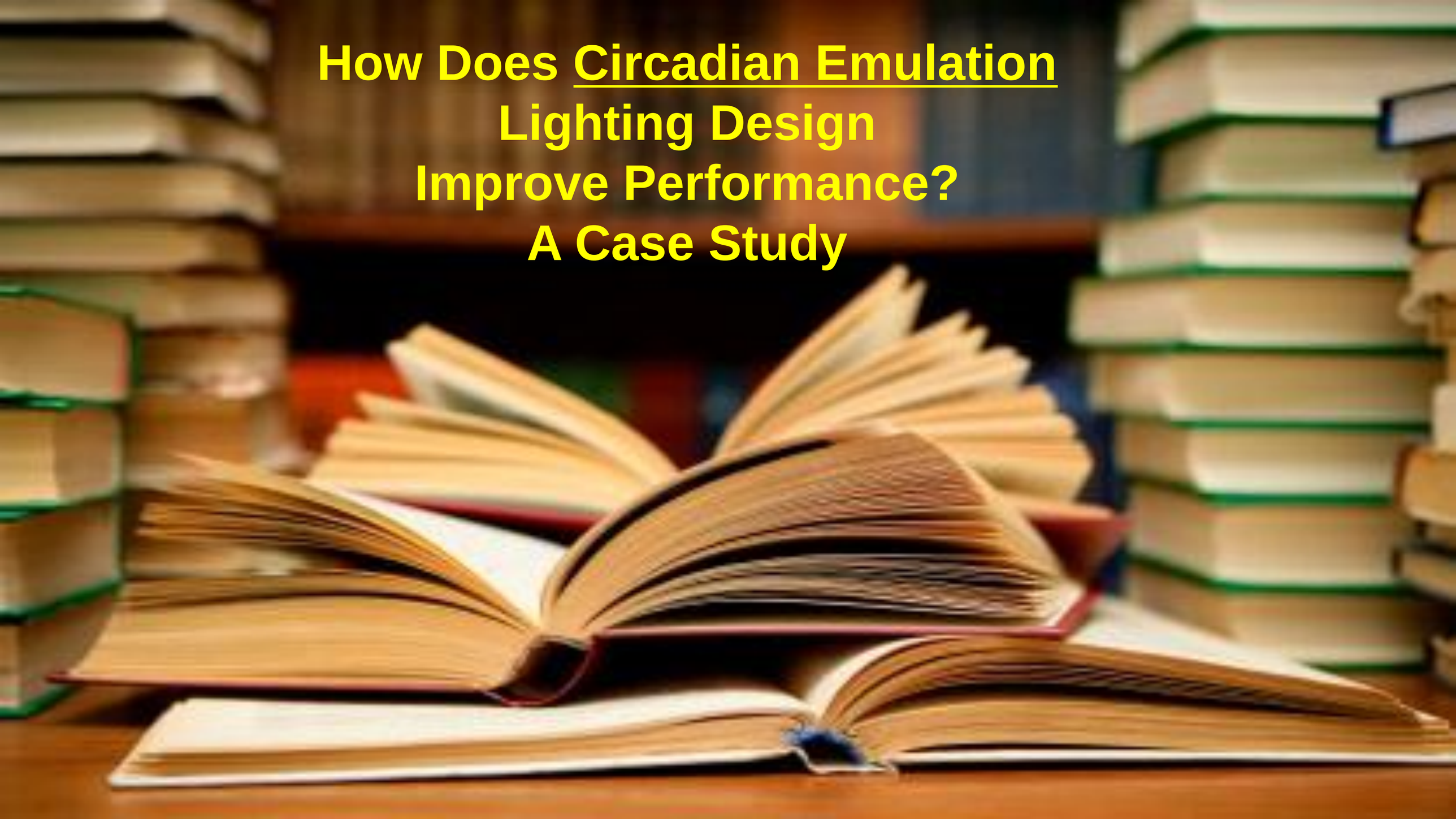
Spas
Hospitality
Medical tourism
Confined populations
ICUs and Neonatal intensive care units
Patient rooms
Non-work related windowless environments
Long Term Residential Quarters, Common Areas, Prisons

Circadian Emulation

Non Clinical application of dynamic lighting in low light or windowless environments to artificially emulate a cycle of dynamic light with natural color shifts timed for circadian support utilizing advanced lighting control systems, for the desynchronized worker or student. It may also be used to provide tunable wavelengths of enhanced blue or white for the purpose of **enhancing performance and eliciting specific behavioral outcomes** by fostering employee and student efficacious sleep periods

Some applications may require medical oversight

Critical Operation Control Rooms, Emergency Response Environments
Nursing stations, Dispensing Pharmacies, Surgical Suites
Windowless Office and School Environments
Night Shift work areas
Submarines
Mining
Residential settings for sleep quality and weight management


How Does Circadian Emulation
Lighting Design
Improve Performance?
A Case Study

Case study
In der Alten Forst

Location	Hamburg, Germany
Philips Lighting	SchoolVision Lighting solution

Date of release: May 2010 / UK
Printed in the Netherlands

PHILIPS
sense and simplicity

The Tools Lights and Controls

Solution SchoolVision surface-mounted T-5 Fixture System TCS477 3x49W/827/452 HFD LE1 ND AC-MLO
 is a Dynamic Lighting luminaire, which can provide the various lighting settings that are needed to give children the best learning experience.

The LRM2095 OccuPlus is a combined sensor and controller. It will dim and switch the lights in a room or area on occupancy and available daylight, with options for local override, parallel operation and network links to Building Management Systems (BMS).

The UID 2096 SchoolVision 4 Scene Controller

Normal Scene

Standard white light levels helps pupils to pay attention and listen to the teacher making it suitable for regular classroom activities

Focus Scene

For more challenging tasks, tests or exams the teacher can switch to the fresh, bright **cool light** to aid concentration

Energy Scene

When pupils need to be more active in the early morning or after lunch, the fresh **very cool light** helps to invigorate them

Calm Scene

When a relaxing ambience for individual work or quiet time is desired a **warm white** light is set

NORMAL

Normal Class Lessons Standard Color Tone

ENERGY

Support Fresh Start (Morning) or (Early Afternoon)
Very Cool Color Tone

FOCUS

Concentration for Testing Cool Color Tone

CALM

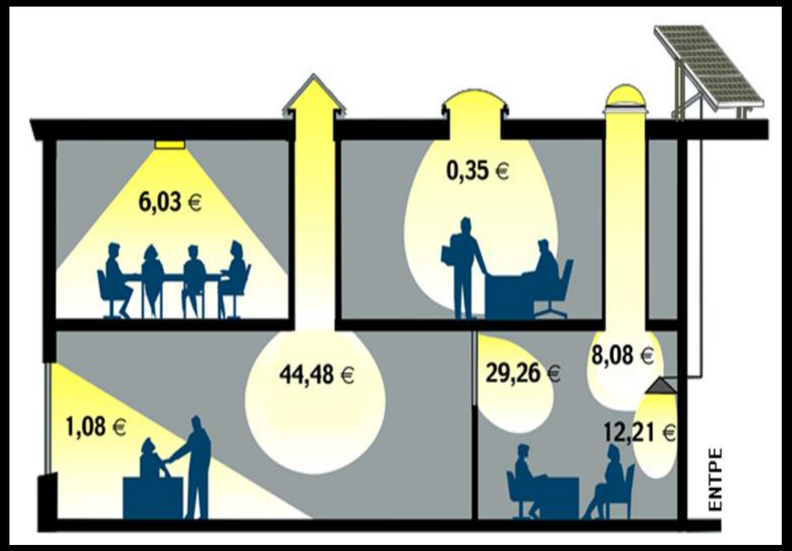
When Class Is Hyperactive Warm Color Tone

Significant Positive Results
Under **TASK OPTIMIZED** color temperature, Quality Spectrum Lighting Conditions:

Reading Speed	35% Increase
Frequency of Errors Made	45% Decrease
Hyperactive Behavior	76% Decrease

The Importance of Controls is Growing in all Areas Especially Artificial and Natural Lighting Applications

Light Pipe Systems with Daylight Control

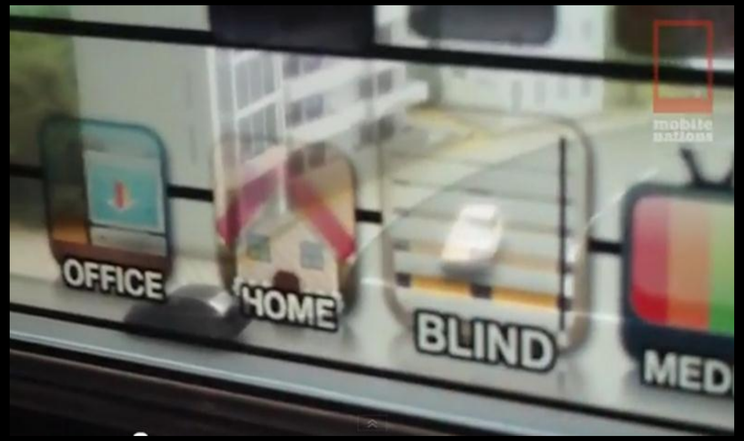


Day lighting Requiring Advanced Shade Control Strategies

OLED Media / Shade Control Window

Transparent to Exterior

Is a Video Display



Computer Screen

Illuminates at Night

Provides Virtual Blinds

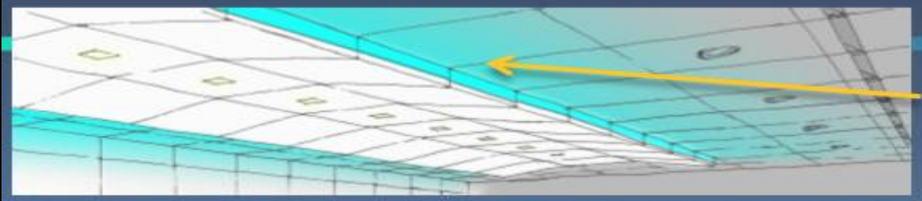
Is a TV Screen

Static & Live Video Virtual Sky

Natural Sky Emulating LED Fixtures

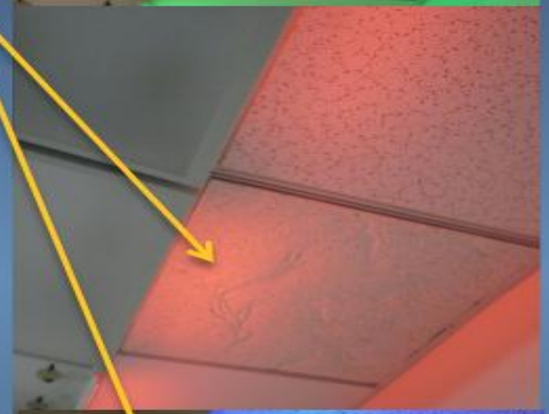
Making Office Environments Enjoyable

Color-changing Halo



Original Vision

Photos of actual tile



Computer model of the upcoming installation
(Courtesy OSRAM SYLVANIA, Inc.)

…and Our Future Dreams

What does all this Human-centric Optimization mean for the Controls Industry?

Dynamics and Interactive Control

- From the latest science about artificial and natural environmental impact on our biology, we are learning that our environments must be more dynamic, interactive and responsive to our biological needs to optimize the performance of the assets that we built the buildings for, PEOPLE

- We shouldn't build smart building and systems just to save energy, we should build them to optimize human performance and health, using only the energy that we need to accomplish it and nothing more!

HUMAN HEALTH OPTIMIZATION =
INCREASED PERFORMANCE AND ASSET ROI

Current Realities

- Sophisticated commercial automation systems for HVAC has matured in the last 10 years, and are capable of providing high degrees of optimization
- Yet, most buildings run poorly, waste energy, and provide less than optimal working environments
- What's missing?

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- What's missing?

"Ongoing" Education and Training

Most Control Systems Without Training

If We Are Truly Smart, Building Design and Operation Must Be Planned to be Effective

For the Life of the Building

Inception To Demolition!

A design that not only provides environmental sustainability, but total building life cycle operational and maintenance sustainability

As the Impact on Our Biology and Performance from Lighting and Environment Systems is Better Understood, Monetized and Disseminated

There will be an Increased Importance for Higher Quality Operation of Systems and Verification of Performance

Financial loss from less than optimal environmental design on insurance, health care costs, productivity, errors, and accidents, will drive demand for human-centric design.

The control systems required will not only need to run correctly on the first day…

but will need to provide evidence based optimized operation for the life of the system to realize the owners ongoing ROI

Educational Goals

Owner Education

Owners must be educated and understand the economics of waste and lack of optimization, and request that their design teams deliver systems that can be effectively optimized providing realization of the ROI they are being sold on.

Architectural Design, Engineering Education

1. Plan from the outset for optimized performance in all systems.
2. Hire a Commissioning, (Cx) Authority at the START of design process to:
   - Establish Owner Performance Requirements (OPR)
   - Help manage the design team in delivering a design that meets the OPR
   - Help guide the creation of design an construction documents that speak Cx, operation and maintenance, and not just construction, for these are the documents that will support the future successful ongoing training, operation, and maintenance of the building systems!

Manufacture and Rep Education

1. Understand the application of their systems in real world environments
2. Understand the measureable performance goals that the owner, Cx, has set for their systems
3. Understand how to integrate their systems with a whole building intelligence systems

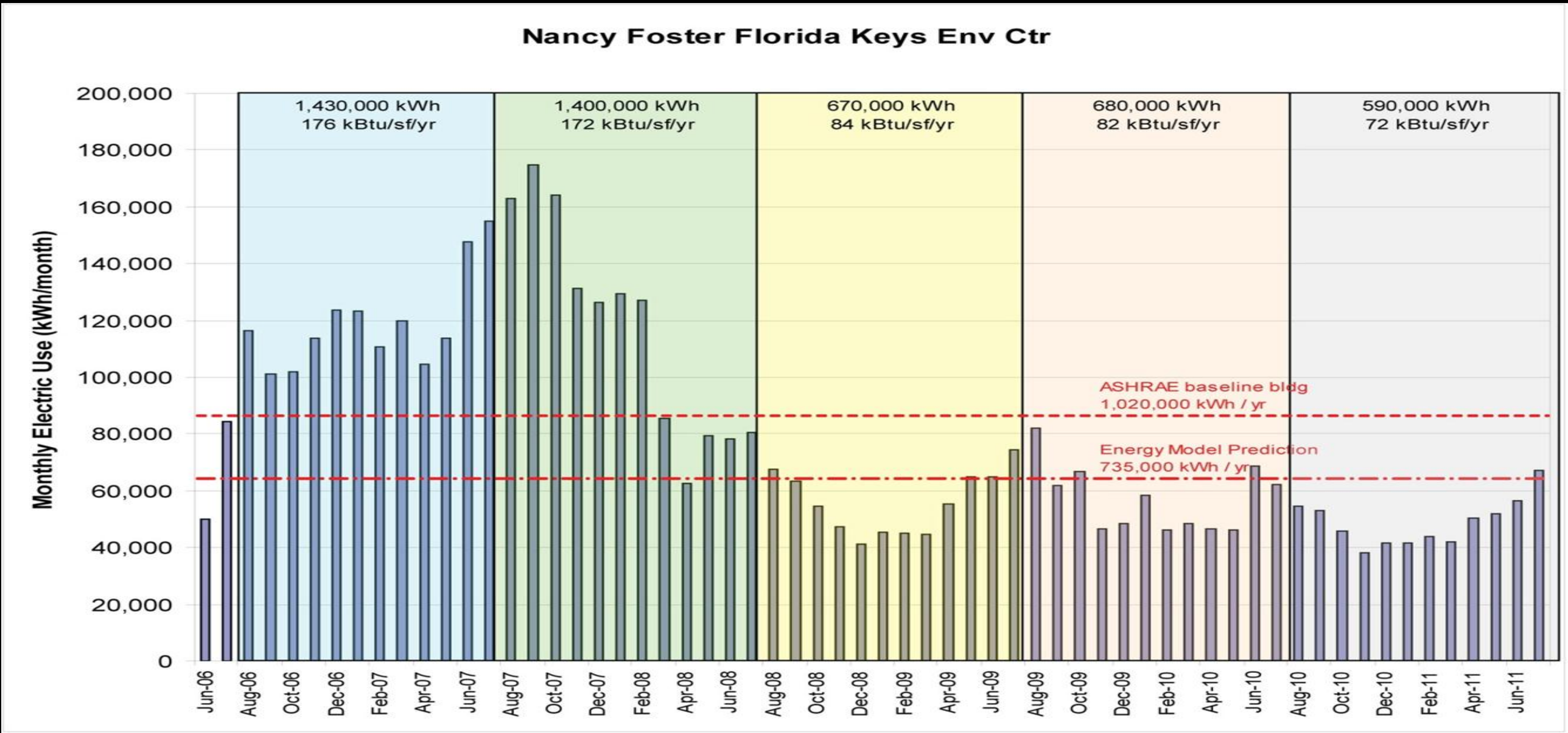
Contractor Education and Training Certification

1. Have expert knowledge and skills to properly install, integrate, and meet the performance goals set
2. Armed with Commissionable construction documents, create as-builts that are accurate
3. Complete pre-functional testing ready for Performance Testing and Commissioning

Commissioning ***The Best ROI Value $$$***

1. Have the As-Built documents complete prior to Commissioning so that they can be also commissioned and verified as accurate
2. Have assets and job plans loaded in to the computerized maintenance management system, (CMMS) for commissioning verification
3. Use the time of commissioning to **ECUCATE AND TRAIN** the building operation and maintenance staff, as this will also be a time of trouble shooting all system to achieve integrated optimized operation.
4. Bench mark ALL settings and values that reflect optimized operation as a reference for all future maintenance and retro-commissioning performance
5. Load all benchmarks into the CMMS
6. Allow for adequate time to commission the project prior to occupancy
7. Re-commission systems prior to the first year warrantee ending using this for additional training

The Case For Training During Commissioning



Recommendations

Hire contractors and manufactures that will support product and system training as this will be an on-going process over the life of the systems installed

Added value would be having maintenance service providers perform remote monitoring and performance based maintenance of the systems to:

- Maintain the operational, energy and human-centric adjectives set down in the design documents
- Assure integration with all building intelligences

New Businesses

In light of the evolving complexity and cost for ongoing education needed to support life time optimized operation of building systems, other business models may evolve.

Such companies could employ continuously trained highly skilled engineers and operators to remotely monitor and direct maintenance responses for multiple clients. Services provided could range from from commissioning, to tiered maintenance alarming and remote maintenance support, to full contracted maintenance.

•

Goals to Accomplish

- Periodically Retro-Commission all systems by a quality **CERTIFIED** commissioning agent, either against the original bench marked performance targets, or in the case of renovations, new benchmarks adjusted for building programming changes

- Constantly compare energy bills to original energy performance benchmarks with the use of user friendly dash boards

- Monitor tenant responses to human-centric system operation, so as to quickly identify any operational deviations degrading personal performance, building system ROI, and total cost of ownership

Call to Action to the Control Industry

While we wait for human-centric optimized lighting science, protocols, and light fixture technology to mature we must begin to re-invent lighting control training, and skilled maintenance practices that will deliver optimized performance over the life of systems.

If we do not respond now, the health and performance benefits that we are, just now discovering, will never be invested in or realized.

Smart People Design Smart Buildings
To be fed from Smart Power Grids

Smart People Design Smart Buildings
To be fed from Smart Power Grids

Smart People must also
Operate Those Buildings to
Realize the Owner’s Investment

Smart People Design Smart Buildings
To be fed from Smart Power Grids

Smart People must also
Operate Those Buildings to
Realize the Owner’s Investment

Education and Training = Reliable ROI
Needed to justify Control Investment

A Step In the Right Direction!

California Advanced Lighting Controls Training Program

- A statewide initiative aimed at increasing the use of lighting controls in commercial buildings.

- CALCTP will educate, train and certify licensed C-10 electrical contractors, state-certified general electricians in the proper programming, testing, installation, commissioning and maintenance of advanced lighting control systems.

- Additionally, CALCTP partners are developing a course for specifiers (Architects, Engineers, Lighting Designers) on advanced lightning controls design and specification.

Major Citations and Related References

Deborah Burnett ASID, CMG, LGC, AASM: Circadian Adaptive Lighting, A Landmark Paradigm Shift with Unprecedented ROI Potential

Frank H. Mahnke: Color, Environment, & Human Response

Jacob Liberman: O. D., Ph. D., Light Medicine of the Future

Philips Lighting, School Vision Case Study, In der Alten Forst

Thank You