IMA EMERGING TRENDS IN MEDICINE

PHOTOBIOMODULATION PBM

Dr. Ryan Cole
IMA Head of Medical and Scientific Affairs

INDEPENDENT™ MEDICAL ALLIANCE

EMERGING TRENDS IN MEDICINE

PhotoBioModulation PBM

Current Evidence, Proposed Mechanisms, & Clinical Applications

With

Dr. Ryan N. Cole

AP/CP, IMA Head of Medical and Scientific Affairs

CONFLICTS OF INTEREST

- NONE
- NOT SPONSORED BY “BIG SUN”

THANK YOU

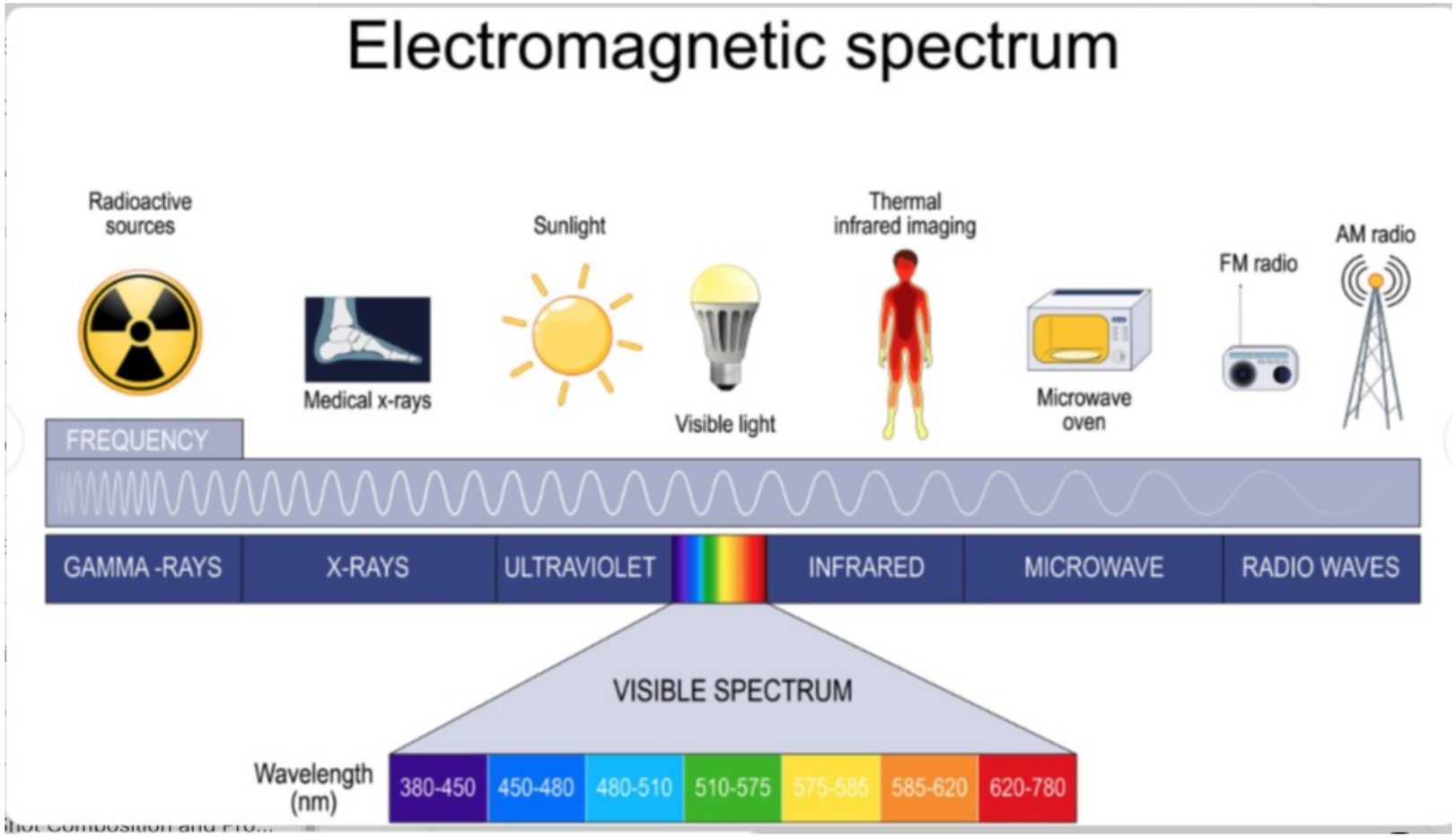
COUNTLESS GREAT RESEARCHERS AND TEACHERS

- MICHAEL HAMBLIN, MD
- ROGER SEHEULT, MD
- MARTIN MOORE-EDE, MD PHD
- RICHARD WELLER, MD
- DR. GLEN JEFFREY
- DOUGLAS WALLACE, MD
- NICK LANE, PHD
- DR. ROBERT FOSBURY
- DR. RUSSEL REITER
- SCOTT ZIMMERMAN - ENGINEER
- JACK KRUSE, MD
- MAX GULHANE, MD
- THE GUY FOUNDATION
- VLADIMIR HEISKANEND (PBM DATABASE)
- SO MANY OTHERS

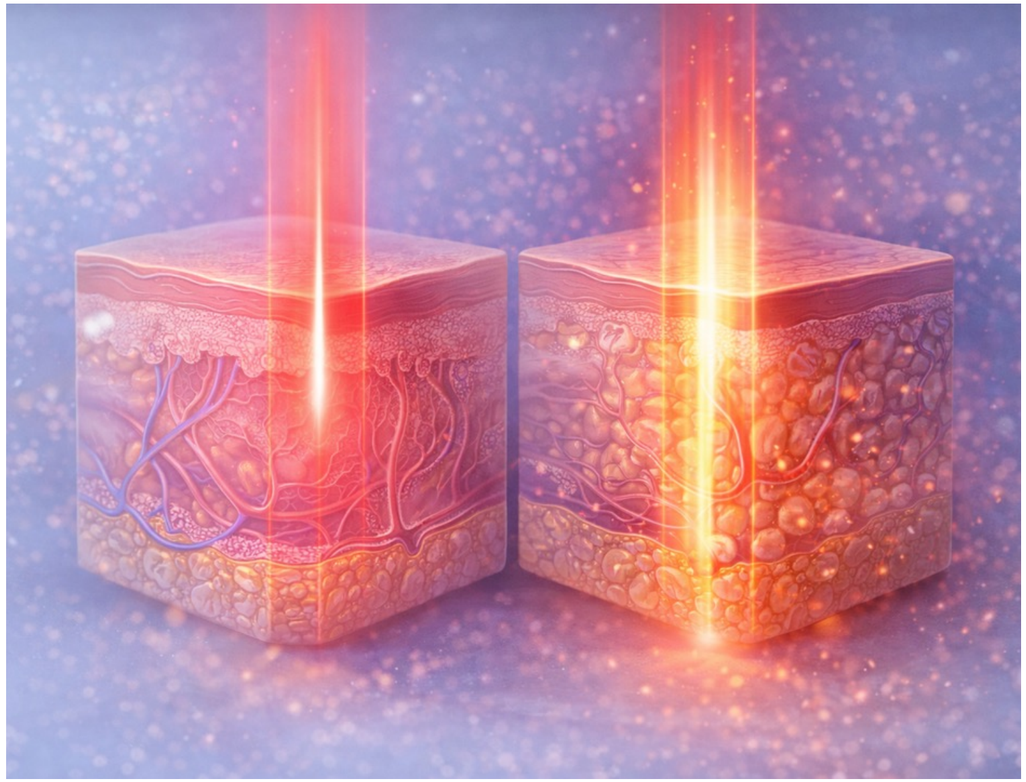

Remember to drive with your highbeams on...
If you want to arrive at your destination quicker.

THIS IS A STORY ABOUT SHINING LIGHT ON SOMETHING WE SEEM TO HAVE FORGOTTEN...

ONLY ABOUT 10% OF THE EMS IS VISIBLE LIGHT



LIGHT SPECTRUM



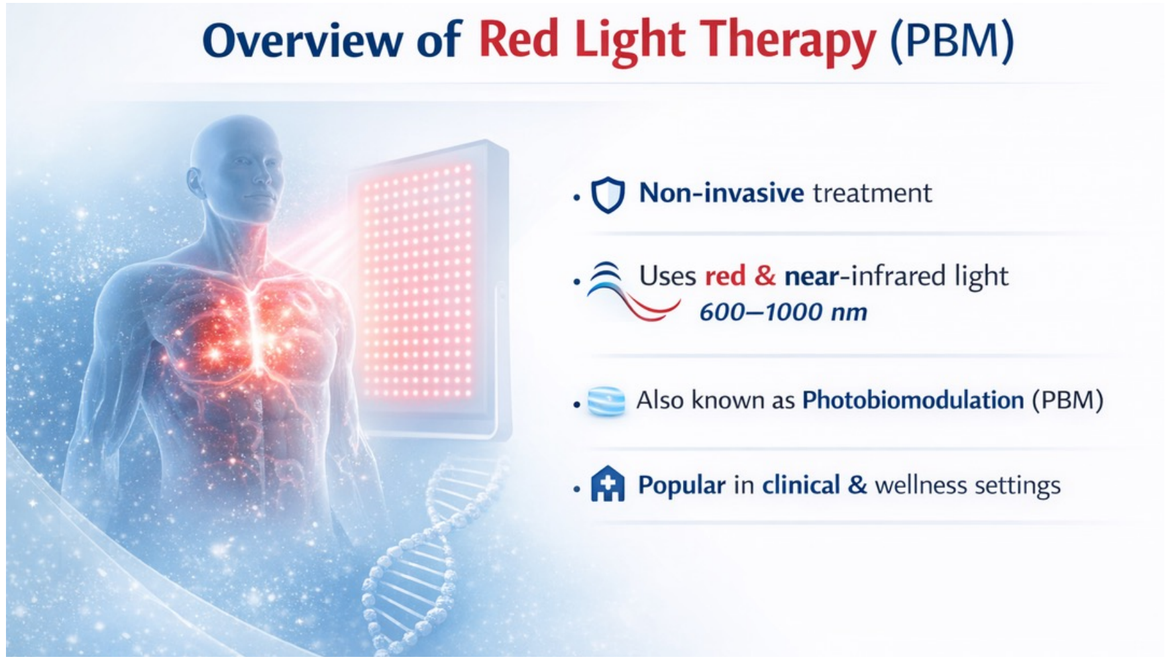
- Red light: ~600–700 nm
- Near-infrared light: ~700–1000 nm
- Different penetration depths
- Both used therapeutically

Karu TI. Mitochondrial signaling in mammalian cells activated by red and near-IR radiation. Photochem Photobiol. 2008;84(5):1091–9.

PHOTOBIOMODULATION (PBM)

PHOTO - LIGHT
BIO - LIFE
MODULATION – SHIFTING
/ALTERING/ CHANGINING

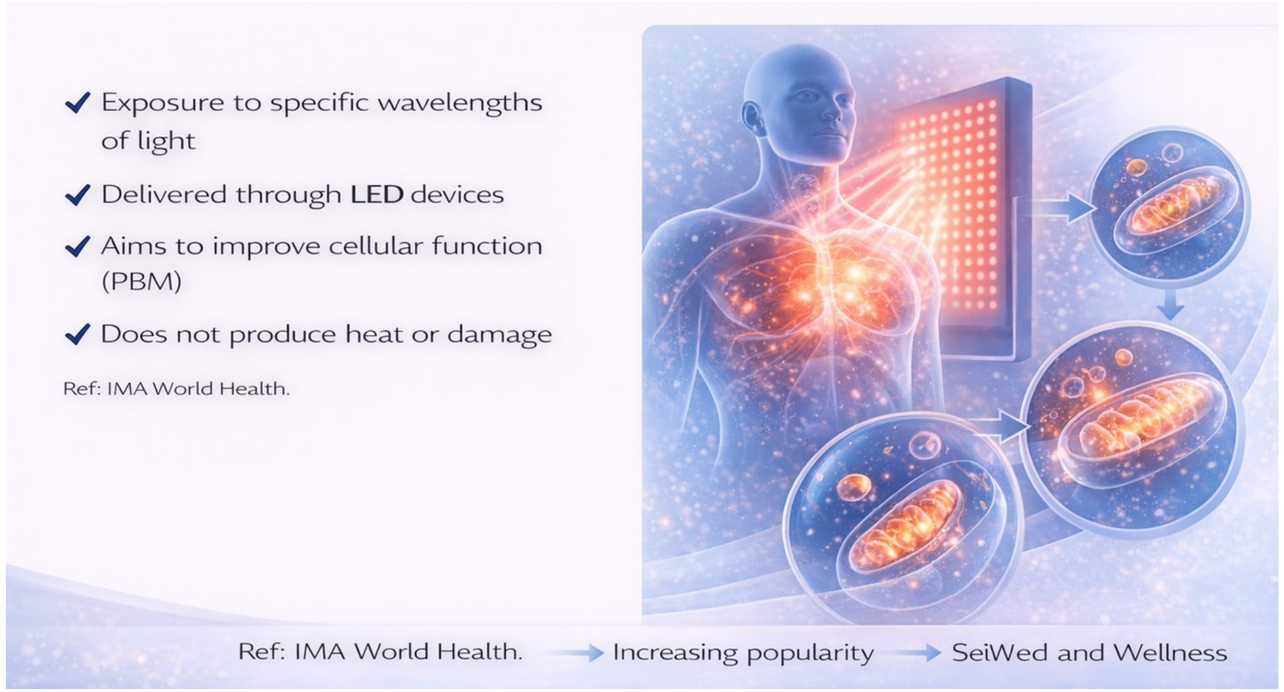
Uses red and near-infrared light
Increasing popularity in clinical and wellness settings



Hamblin MR. Photobiomodulation or low-level laser therapy. J Biophotonics. 2016;9(11-12):1122–4.

Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012;40(2):516–33.

WHAT IS RED LIGHT THERAPY?

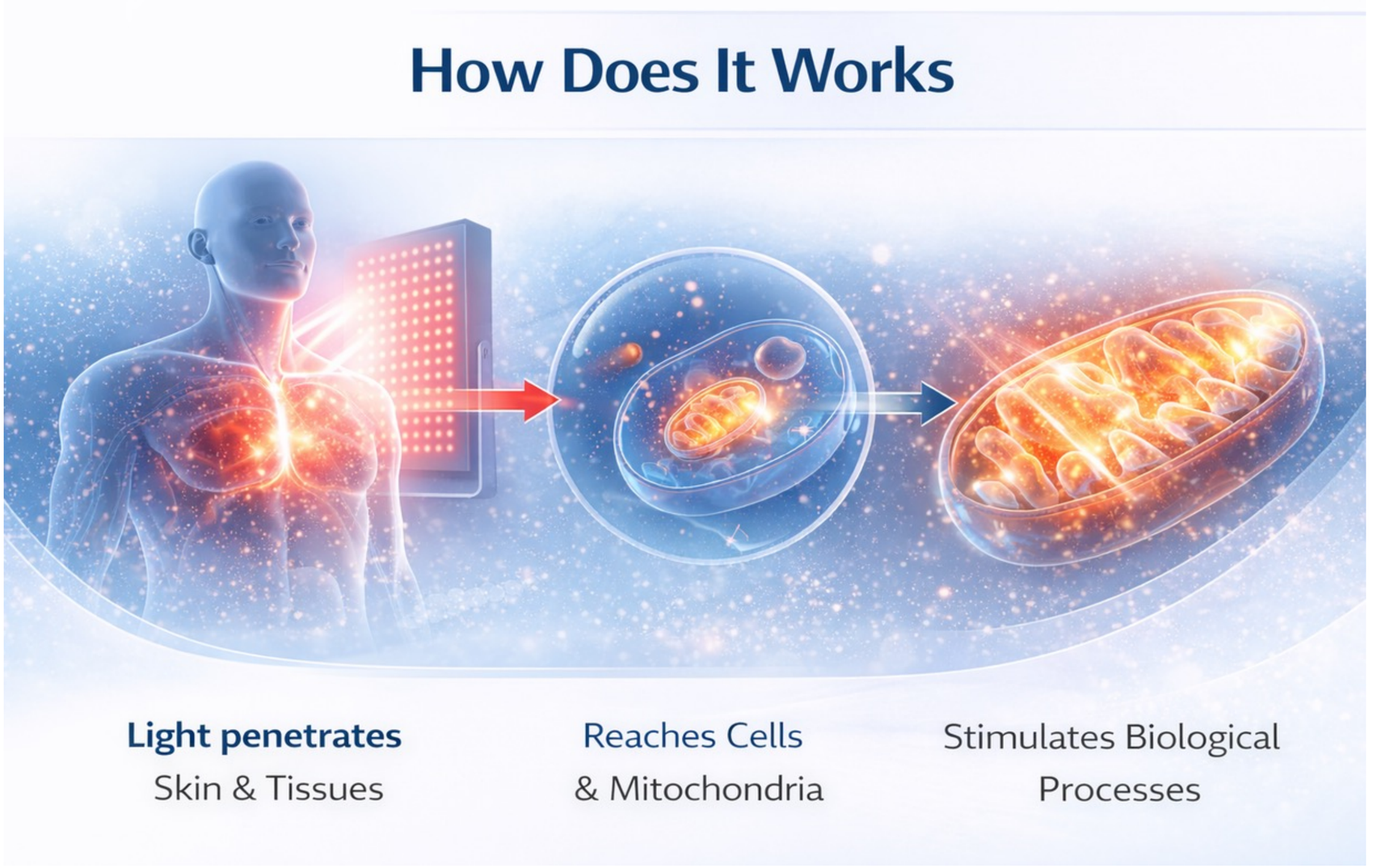


- Exposure to specific wavelengths of light
- Delivered through LED devices
- Aims to improve cellular function
- Does not produce heat or damage

Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012;40(2):516–33.

HOW DOES IT WORK?

- Light penetrates skin and tissues
- Reaches cells and mitochondria
- Stimulates biological processes
- Enhances cellular performance



de Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE J Sel Top Quantum Electron. 2016;22(3):7000417.

ALL THE LIGHT WE CANNOT SEE CAN ALTER BIOLOGY IN MANY WAYS

WHY DOES LIGHT MATTER AS A TOPIC?

- WE EVOLVED UNDER BRIGHT DAYS AND DARK NIGHTS
- MODERN LIFE HAS COMPRESSED DAYLIGHT AND HAS EXTENDED ARTIFICIAL LIGHT EXPOSURE
- PBM - GAINING CLINICAL ATTENTION ACROSS MANY MEDICAL DOMAINS, WOUND, RETINA, NEUROLOGY, ETC.
- INTEREST IS RISING FASTER THAN STANDARDIZATION
- PHYSICIANS NEED A BIOLOGICALLY COHERENT FRAMEWORK

SUNLIGHT

“THERE IS NO ALTERNATIVE (TINA)”

- DR. JACK KRUSE

WE ARE NOW ON AN ARTIFICIAL “JUNK” LIGHT DIET

- NORTH AMERICANS NOW SPEND 93% OF THEIR TIME INDOORS (WORK OR HOME), 87% INDOORS, 6% DRIVING
- LIGHT EFFECTS CHRONOBIOLOGY, NEUROBIOLOGY AND MITOCHONDRIAL ENERGY
- PBM CAN HAVE BENEFICIAL EFFECTS, BUT WAVELENGTHS, DOSE AND TIMING MATTERS

LEARNING OBJECTIVES

“LETS BE ENLIGHTENED”

- HISTORY
- VISIBLE AND NON VISIBLE SPECTRUM IN HEALTH
- RETINAL AND CIRCADIAN PATHWAYS
- MITOCHONDRIA AND LIGHT
- IMMUNE SYSTEM AND LIGHT
- CLINICAL EVIDENCE, OPPORTUNITIES AND LIMITATIONS

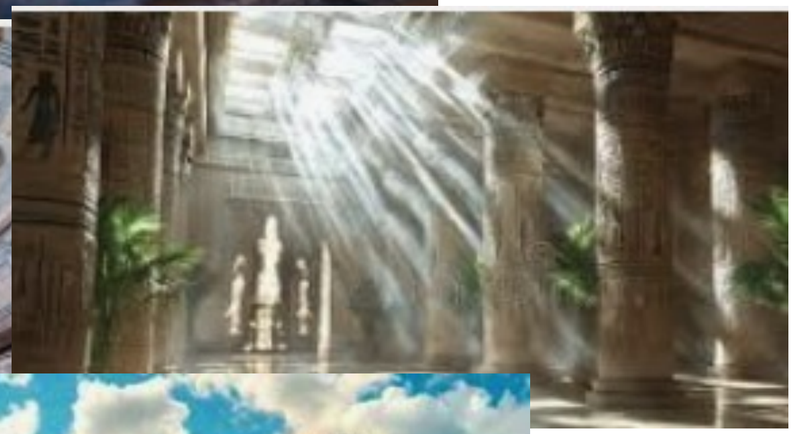
HISTORY OF LIGHT AS THERAPY


“Let There Be Light”

ANCIENT USE

PREDATES MODERN MEDICINE

- ASSYRIANS, BABYLONIANS, EGYPTIANS, GREEKS, INCAS, ROMANS, INDIANS, CHINESE
- HELIOTHERAPY - SUNLIGHT AS THERAPY (GREECE HELIOPOLIS)
- TEMPLES, ARCHITECTURE, ORIENTATION



It is the unqualified result of all my experience with the sick that, second only to their need of fresh air, is their need of light; that, after a close room, what hurts them most is a dark room and that it is not only light but direct sunlight they want.

-FLORENCE NIGHTINGALE

“WATER IS GOOD, AIR IS BETTER, BUT LIGHT IS BEST OF ALL”

- 1855 LAKE BLED, SLOVENIA

ARNOLD RIKLI - SWISS HEALER

BLUE LIGHT

UNOPPOSED

- SPIKES BLOOD SUGAR
- SLOWS MITOCHONDRIA
- ALTERS CIRCADIAN SIGNALS

SANATORIUMS

LATE 19TH, EARLY 20TH CENTURIES

- GERMANY
- DAVOS, SWITZERLAND
- LAKE PLACID, NEW YORK
- USED FOR TB PATIENTS FOR ISOLATION AND HEALING

NOBEL PRIZE

1903

- DR. NIELS RYBERG FINSEN, DANISH PHYSICIAN
- HEALING LUPUS VULGARIS (CUTANEOUS TB) WITH UV AND SMALLPOX SCARRING WITH RED LIGHT
- CARBON ARC LAMPS
- “FATHER OF PHOTOTHERAPY”

KELLOGS

MICHIGAN

- DR JOHN HARVEY KELLOG AND BROTHER MERRIT KELLOG
- BATTLE CREEK MICHIGAN CLINICS 1891
- INTRODUCED LIGHT BOXES INTO HOSPITALS 1903

LIGHT THERAPY

1930s - 1950s to PRESENT

- EXTENSIVE USE OF UV AND FAR INFRARED 1930s, HOME USE
- TOO MANY BURNS, RESTRICTED TO HOSBITALS
- UVB USED WIDELY SINCE THE 1950s in DERMATOLOGY THROUGH THE PRESENT
- 1959 PHOTOTHERAPY INTRODUCED FOR INFANTILE BILIRUBINEMIA

LOW LEVEL LASER THERAPY LLLT

- 1960 - DR. THEODORE MAIMAN CREATED FIRST LASER BASED ON EINSTEIN'S WORK OF 1917
- 1962 FIRST LIGHT EMITTING DIODE (LED) AND RED DIODE LASER, DR NICK HOLONYAK
- TECHNICALLY FIRST LED 1927 BY OLEG LOSEV
- 1962 FIRST INFRARED LIGHT LASER DR ROBERT HALL, ET AL

LOW LEVEL LASER THERAPY
LLLT

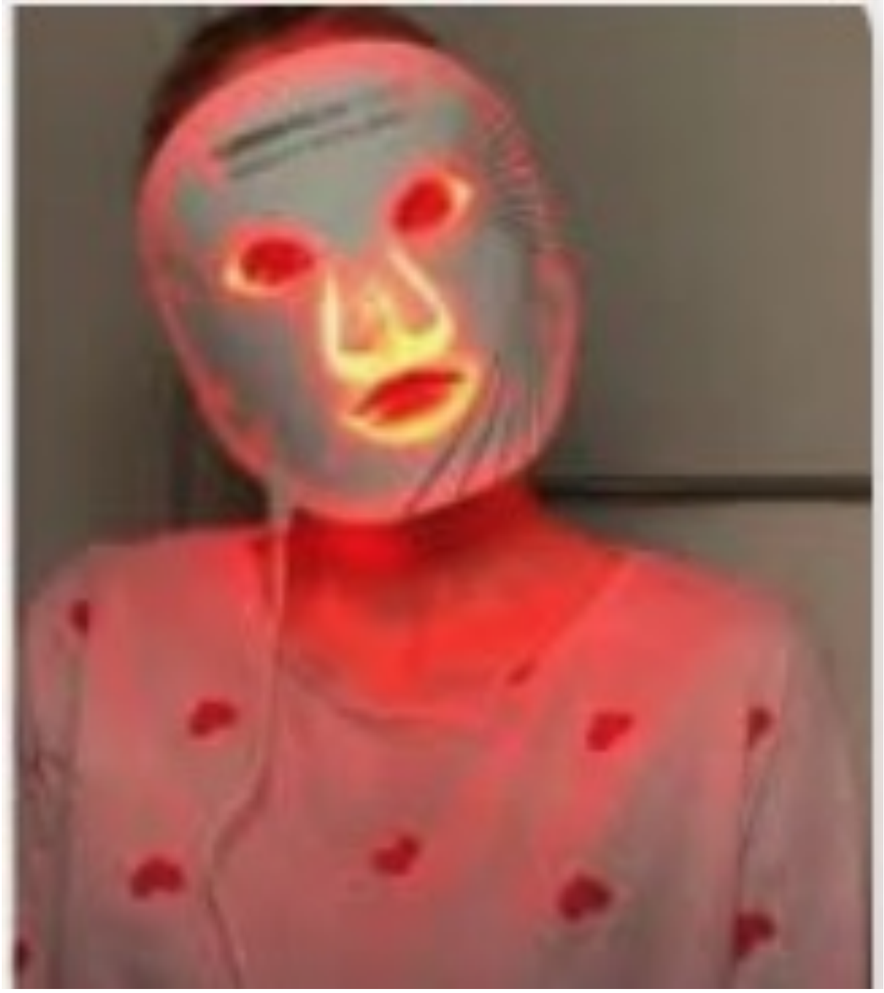
- 1964 NOBEL PRIZE, NIKOLAJ BASOV AND ALEXANDER PROKHOROVE, CHARLES TOWNES FOR QUANTUM ELECTRONICS LEADING TO MASER-LASER TECHNOLOGY
- 1967 LLLT DISCOVERED DR ENDRE MESTER
- 1971 LLLT REPORTED BENEFICIAL IN WOUND HEALING
- 1974 LLLT INCORPORATED AS STANDARD OF CARE IN RUSSIA

LLLT TO LED TO PBM

- 1992 POURREAU-SCHNEIDER FIRST APPLICATION OF LLLT FOR ORAL MUCOSITIS
- 1998 NASA LED INVENTED, HARRY WHELAN, ET AL
- 1999-DR TIINA KARU, PROPOSED CCO IN THE MITOCHONDRIA AS THE RED AND NIR LIGHT REGION

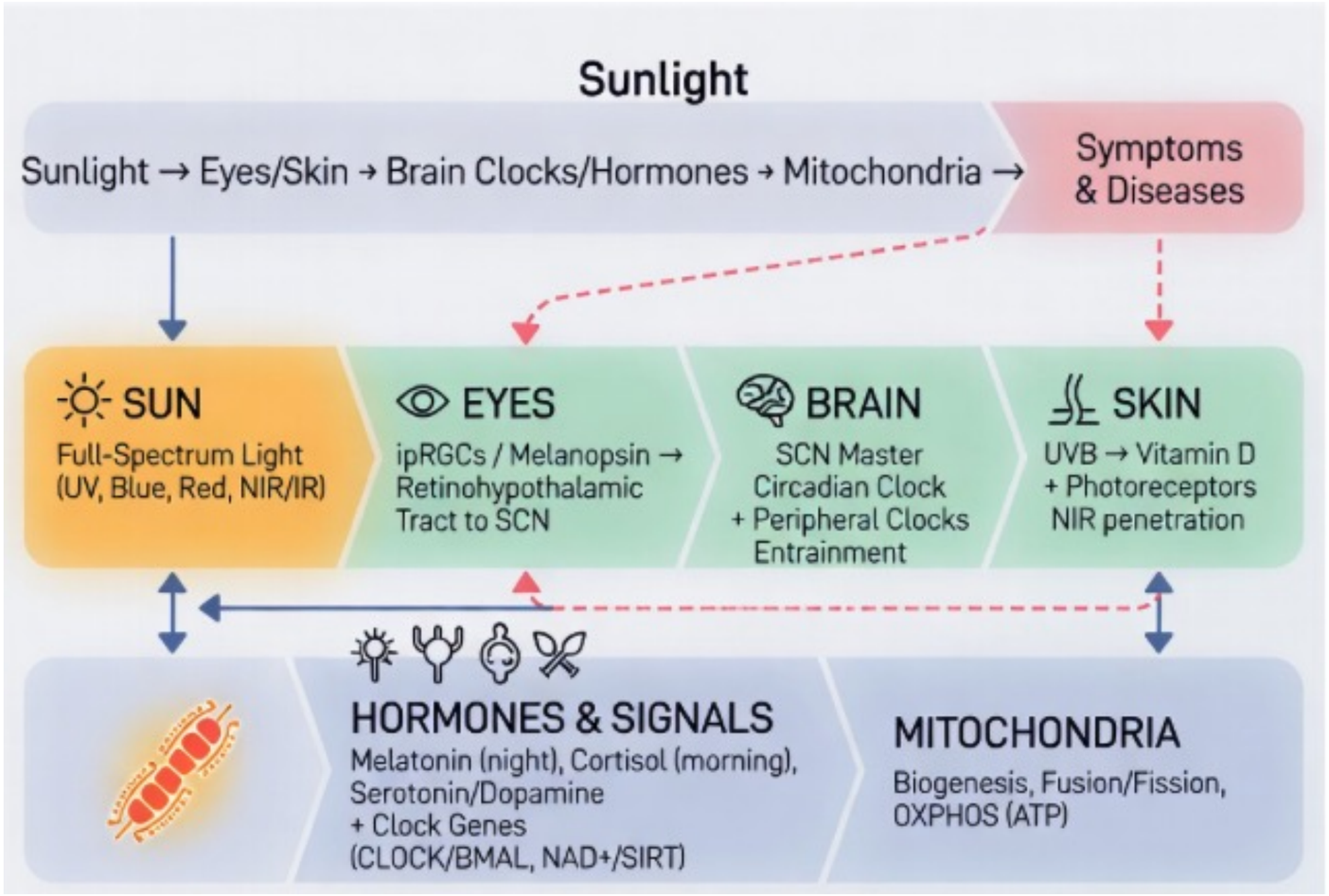
LLLT TO LED TO PBM

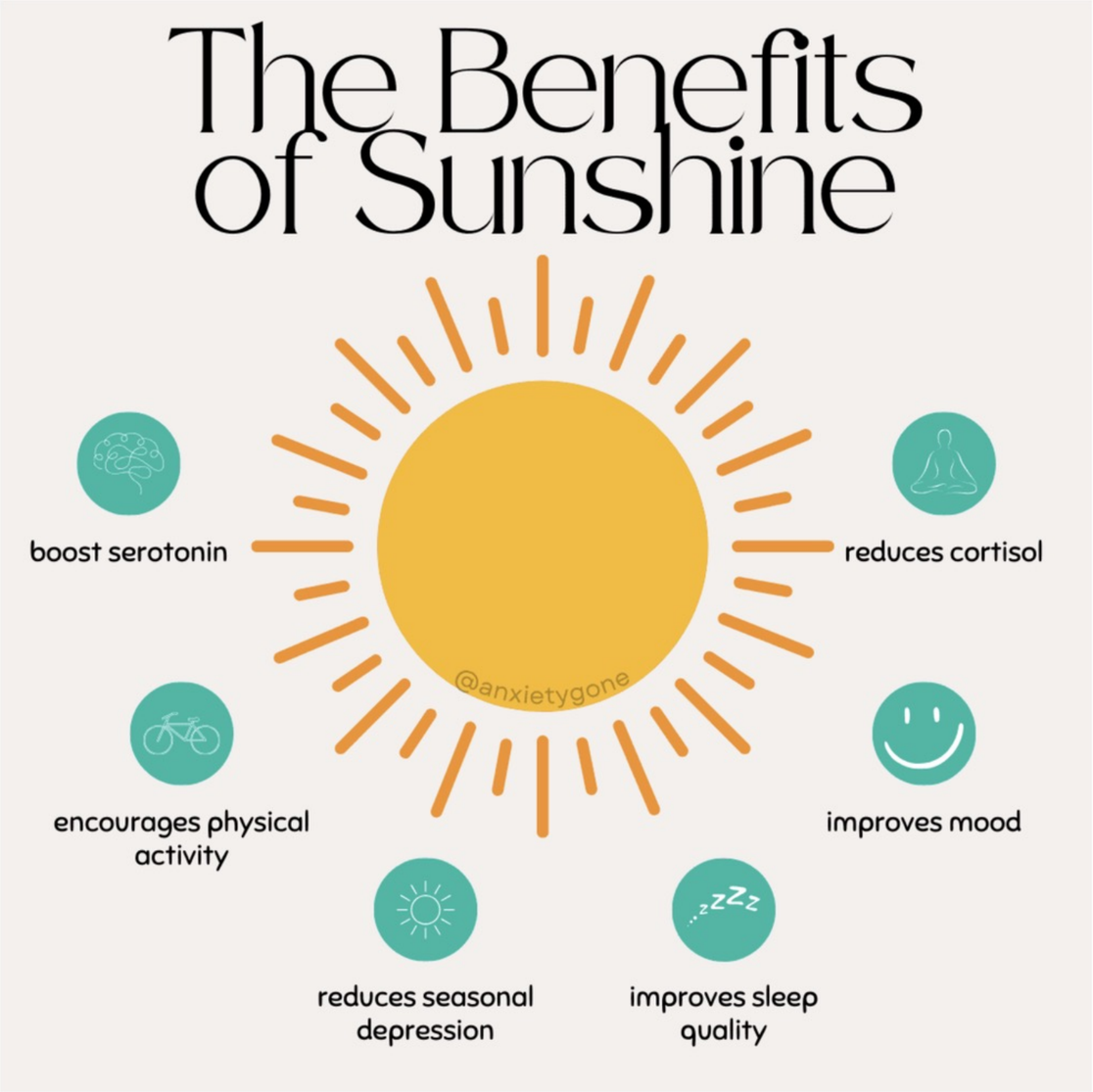
- 2002 WHELAN, LED USED TO TREAT ORAL MUCOSITIS
- 2003 LED USED TO RESTORE ROD AND CONE FUNCTION IN ANIMAL MODELS
- 2007 FIRST FDA APPROVED PBM DEVICE
- 2012 NIR DISCOVERED TO PENETRATE THE SKULL, JARED JAGDEO, ET AL
- 2014 PBM ACCEPTED AS THE TERM FOR PHOTOTHERAPY OVER LLLT
- 2016 THE TERM PBM ADDED TO THE NATIONAL LIBRARY OF MEDICINE DATABASE
- BY 2020 32 HOME USE DEVICES APPROVED BY THE FDA

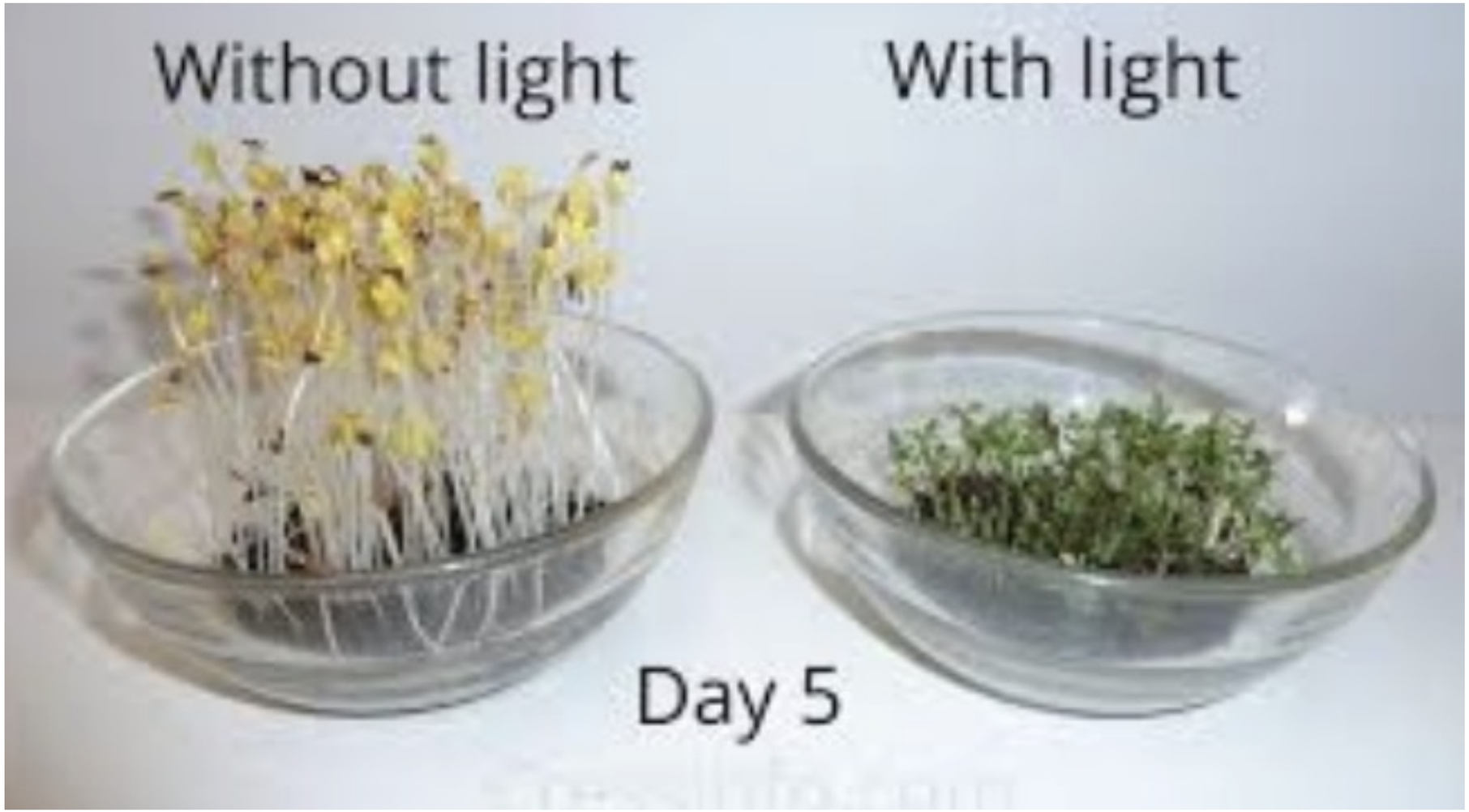


HOW DID MEDICINE FORGET OR NEGLECT LIGHT? LET'S SHINE SOME LIGHT ON THE SUBJECT

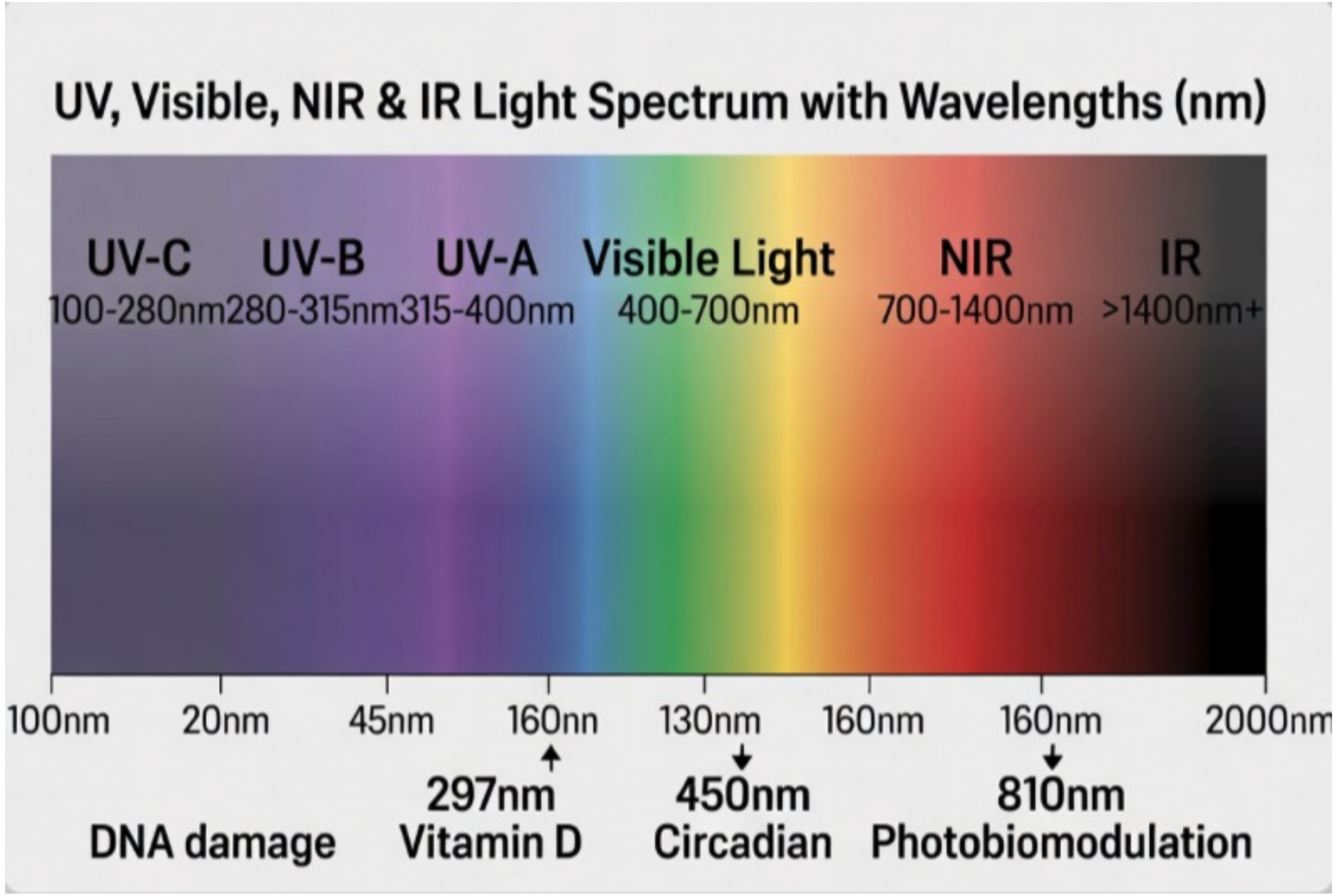
WHY DOES LIGHT MATTER?




The Benefits of Sunshine
boost serotonin
reduces cortisol
@anxietygone
encourages physical activity
improves mood
reduces seasonal depression
improves sleep quality


Without light
With light
Day 5

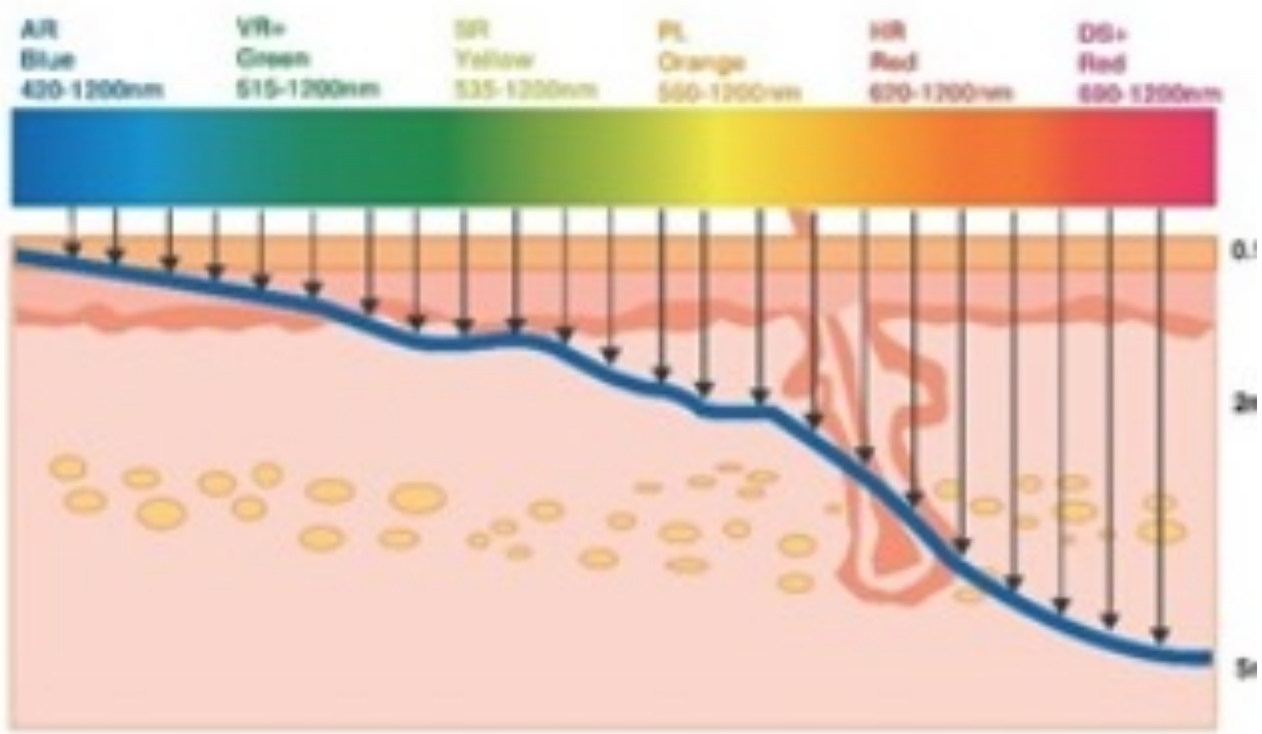

Don't forget to drink water and go out in the sun. You are basically a houseplant with complicated emotions



Karu TI. Mitochondrial signaling in mammalian cells activated by red and near-IR radiation. Photochem Photobiol. 2008;84(5):1091–9.

HUMAN CHROMOPHORES
ABSORBERS OF LIGHT

- DNA
- UROCANIC ACID
- AMINO ACIDS
- FLAVINS
- HEMOGLOBIN
- MELANIN (AND ITS PRECURSORS AND METABOLITES)
- WATER (PRIMARY CHROMOPHORE IN BIOLOGY)



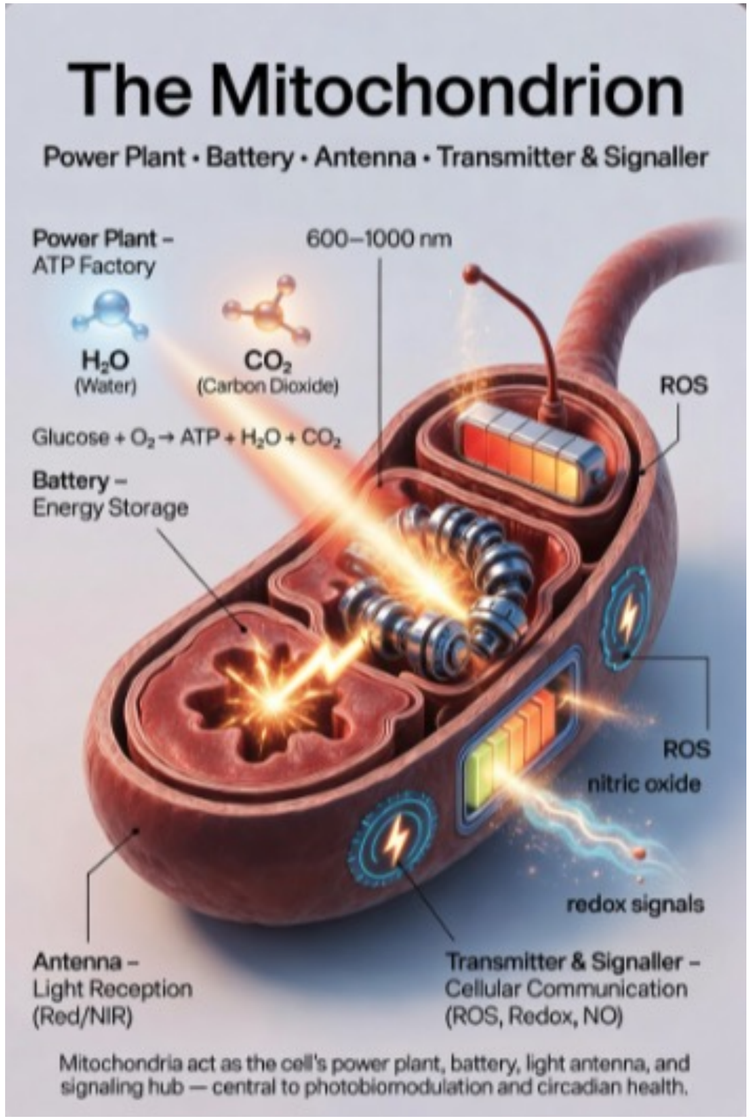
Chromophores	Absorption Wavelengths (nm)
Nucleic acid	260-280
Protein	280-300
Hemoglobin	400, 542, 554, 576
Melanin	400-800
Water	1400-10000
Flavins	420-500
Cytochrome oxidase	620-900

Various Types of Tissue Chromophores and Their Main Absorption Wavelengths

MITOCHONDRIA

POWER PLANTS?

- JUST A POWER PLANT?
- BATTERY
- ANTENNAS
- SIGNALERS
- DISTANT COMMUNICATORS



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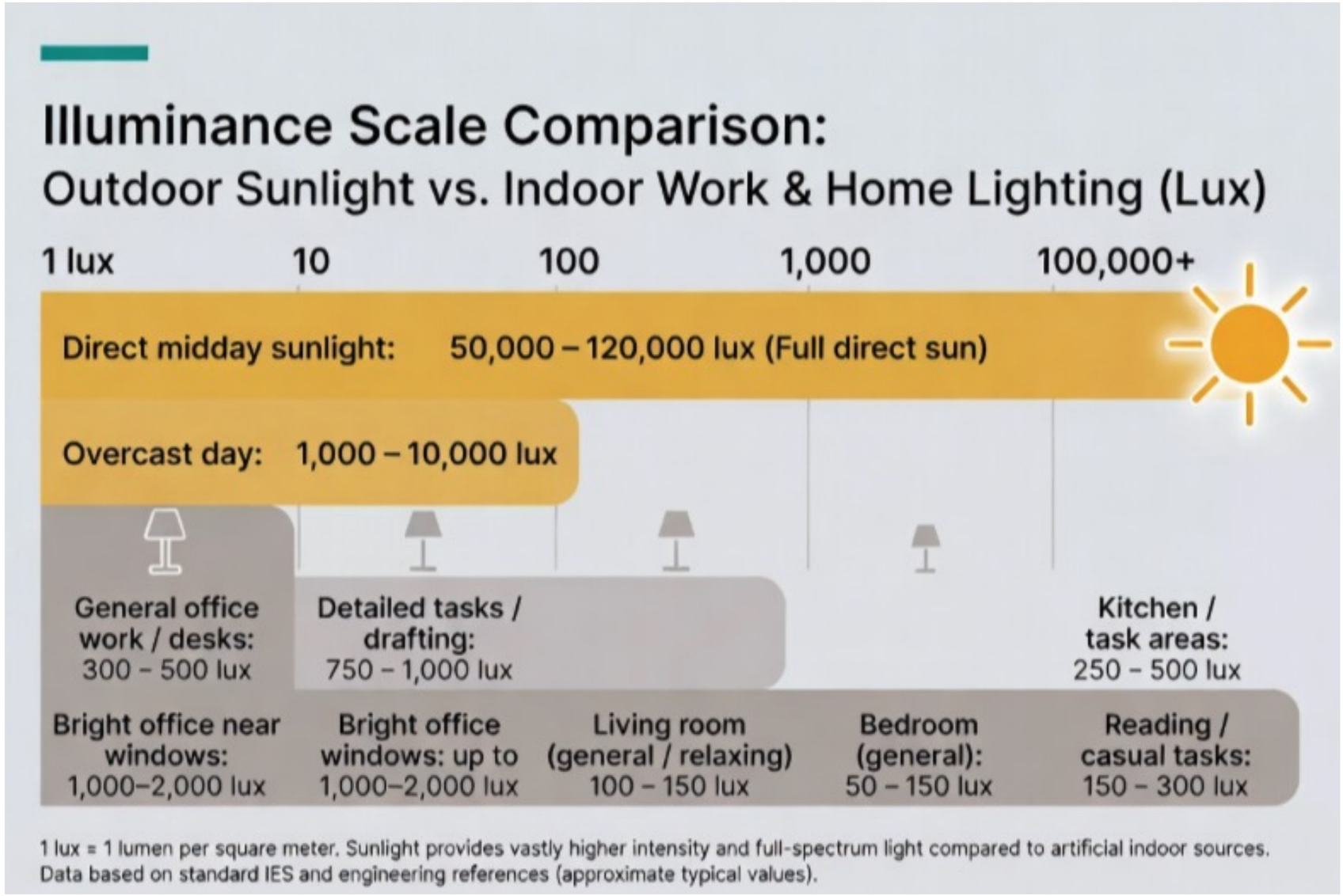
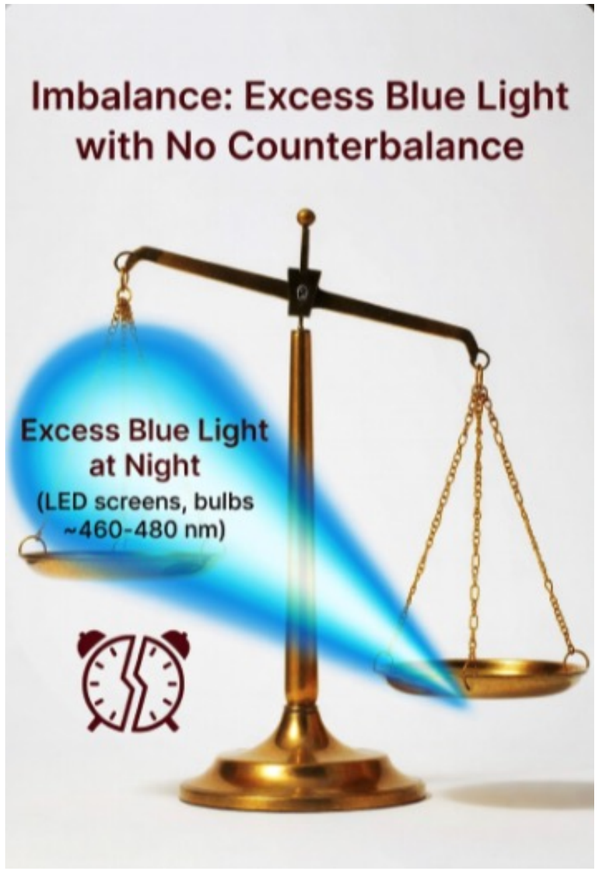
Hamblin MR. Mechanisms and applications of the anti-inflammatory effects of photobiomodulation. AIMS Biophys. 2017;4(3):337–61.


Illuminance Scale Comparison:
Outdoor Sunlight vs. Indoor Work & Home Lighting (Lux)
1 lux
10
100
1,000
100,000+
Direct midday sunlight: 50,000 – 120,000 lux (Full direct sun)
Overcast day: 1,000 – 10,000 lux
General office work / desks: 300 – 500 lux
Detailed tasks / drafting: 750 – 1,000 lux
Kitchen / task areas: 250 – 500 lux
Bright office near windows: 1,000–2,000 lux
Bright office windows: up to 1,000–2,000 lux
Living room (general / relaxing) 100 – 150 lux
Bedroom (general): 50 – 150 lux
Reading / casual tasks: 150 – 300 lux
1 lux = 1 lumen per square meter. Sunlight provides vastly higher intensity and full-spectrum light compared to artificial indoor sources.
Data based on standard IES and engineering references (approximate typical values).

BLUE LIGHT IS BALANCED IN NATURE BY RED AND NEAR INFRARED

UNOPPOSED BLUE LIGHT CAN HAVE BIOLOGICAL CONSEQUENCES

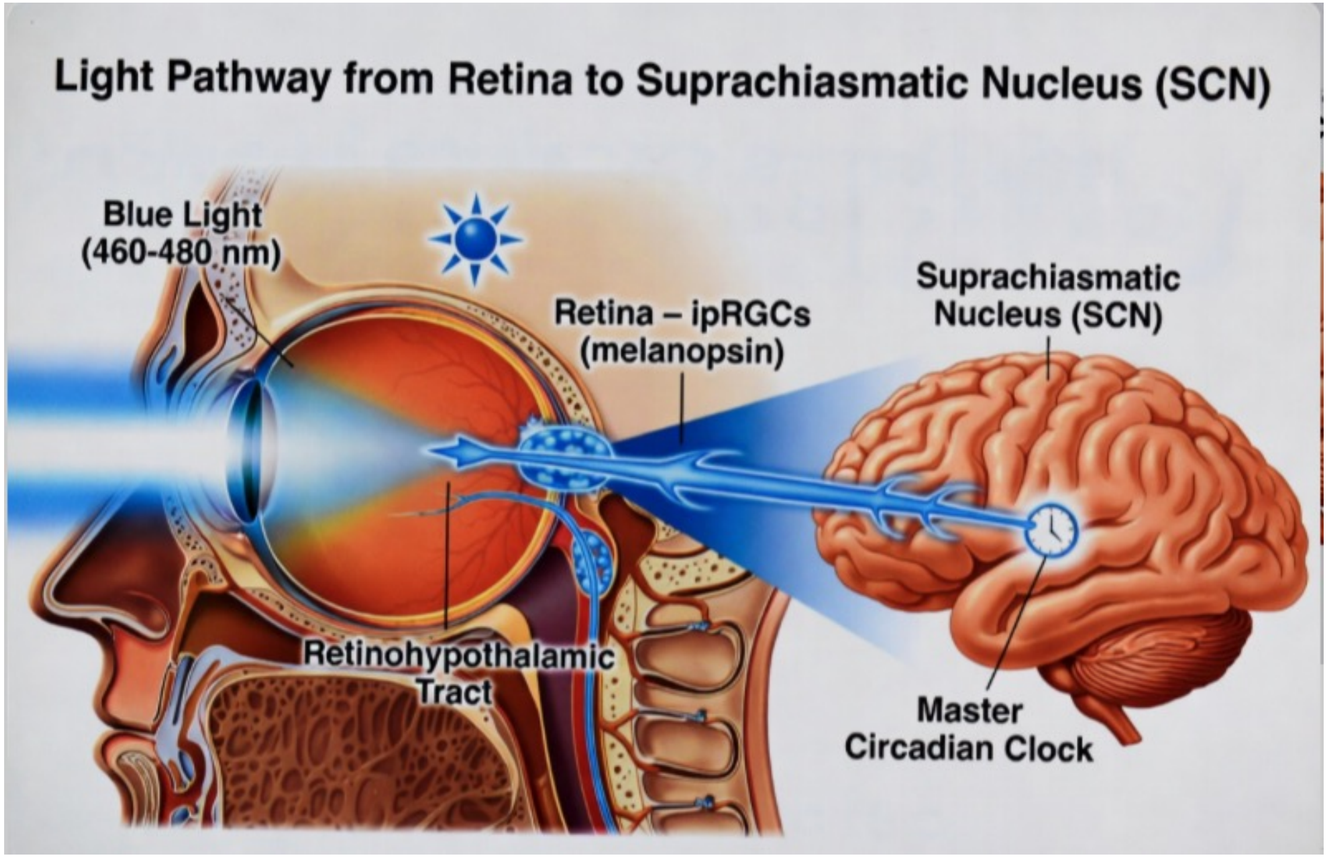
LIGHT TIMING CAN POTENTIALLY BE VIEWED AS A DRUG/MEDICATION



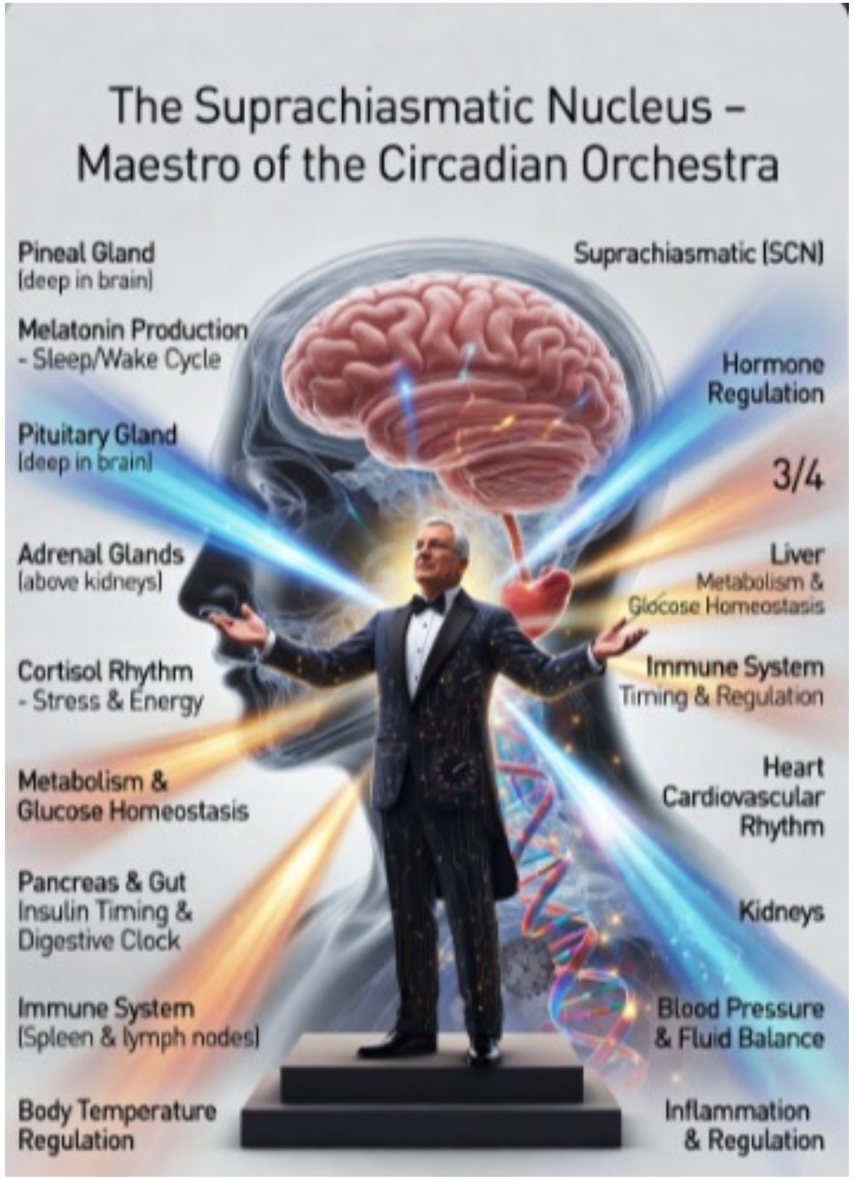
MORNING LIGHT -

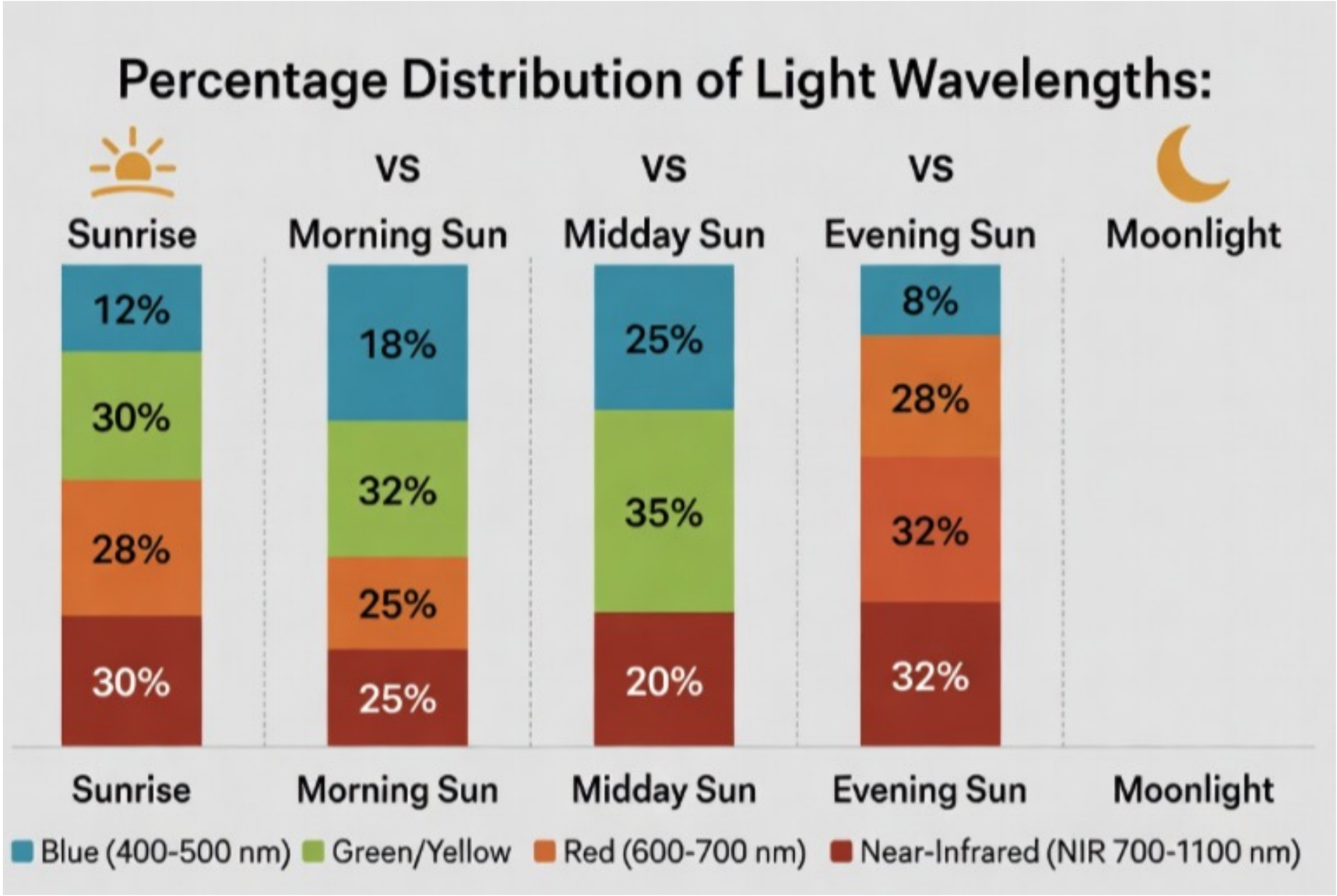
ZEITGEBER-“TIME GIVER”

- MORNING LIGHT SETS OUR CENTRAL CLOCK AND CLOCK GENES
- ANCHORS OUR CIRCADIAN PHASE
- SUPPORTS EVENING SLEEP TIMING
- IMPROVES ALERTNESS AND CIRCDADIAN AMPLITUDE
- OUTDOOR LIGHT IS FAR MORE INTENSE THAN INDOOR

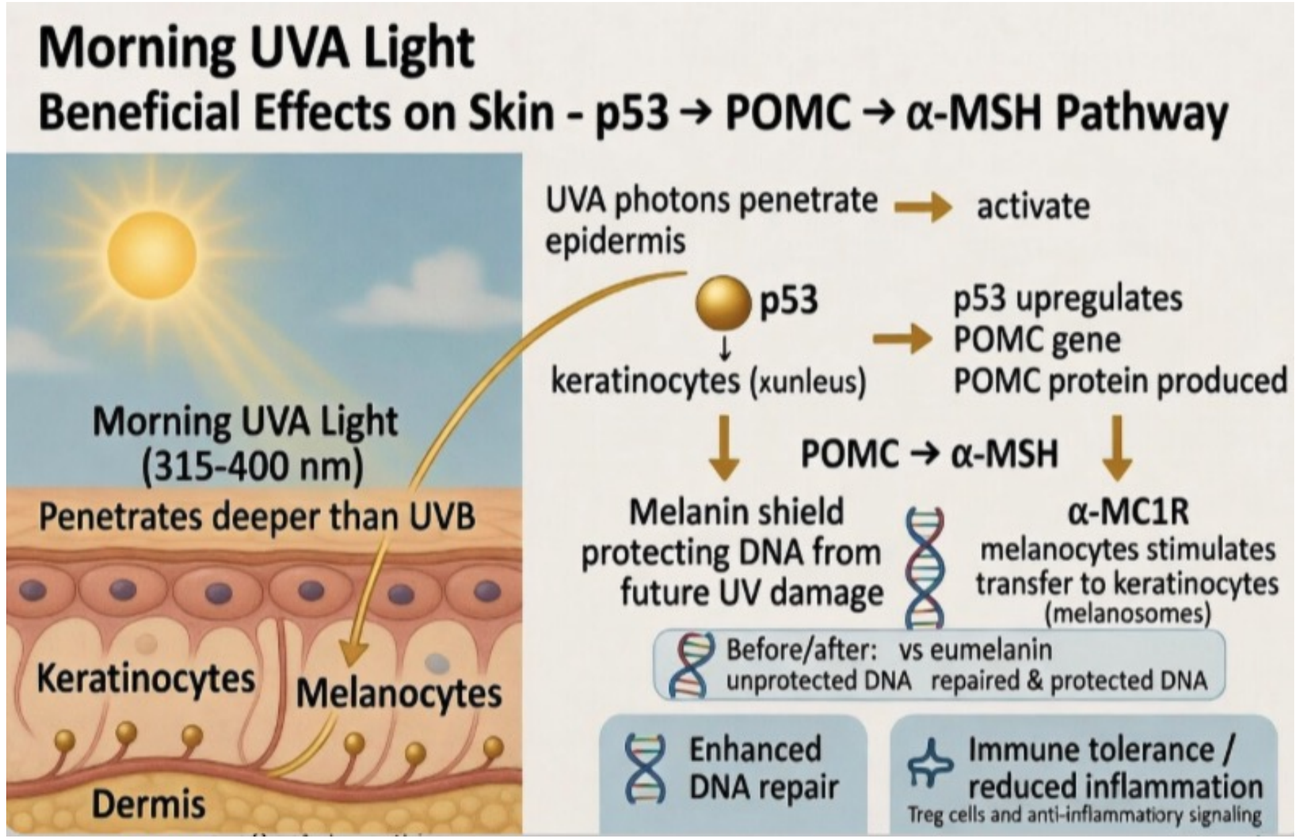


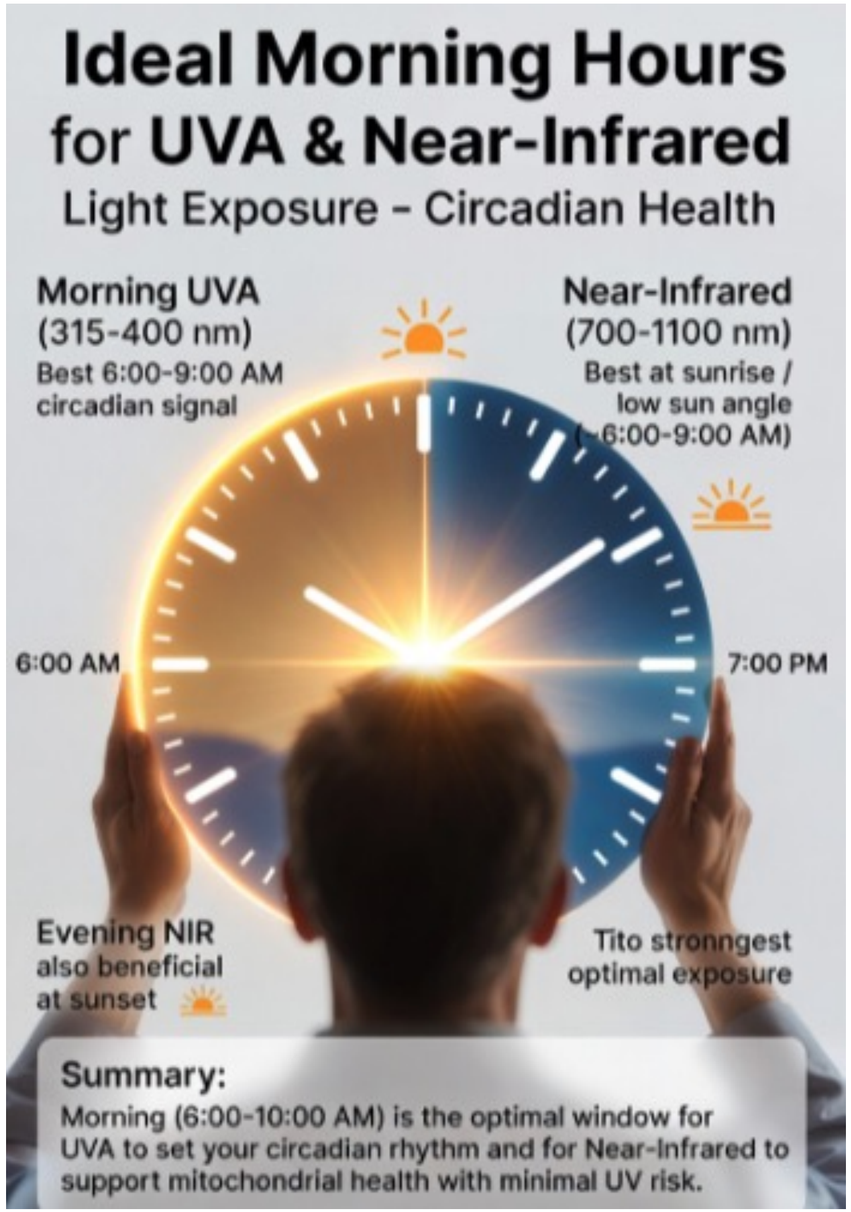
THE RETINA IS NOT ONLY SENSORY, BUT ALSO BIO-REGULATORY
ipRGCs (intrinsically photosensitive retinal ganglion cells)


The Suprachiasmatic Nucleus –
Maestro of the Circadian Orchestra
Pineal Gland
(deep in brain)
Melatonin Production
- Sleep/Wake Cycle
Pituitary Gland
(deep in brain)
Adrenal Glands
(above kidneys)
Cortisol Rhythm
- Stress & Energy
Metabolism &
Glucose Homeostasis
Pancreas & Gut
Insulin Timing &
Digestive Clock
Immune System
(Spleen & lymph nodes)
Body Temperature
Regulation
Suprachiasmatic (SCN)
Hormone
Regulation
3/4
Liver
Metabolism &
Glucose Homeostasis
Immune System
Timing & Regulation
Heart
Cardiovascular
Rhythm
Kidneys
Blood Pressure
& Fluid Balance
Inflammation
& Regulation

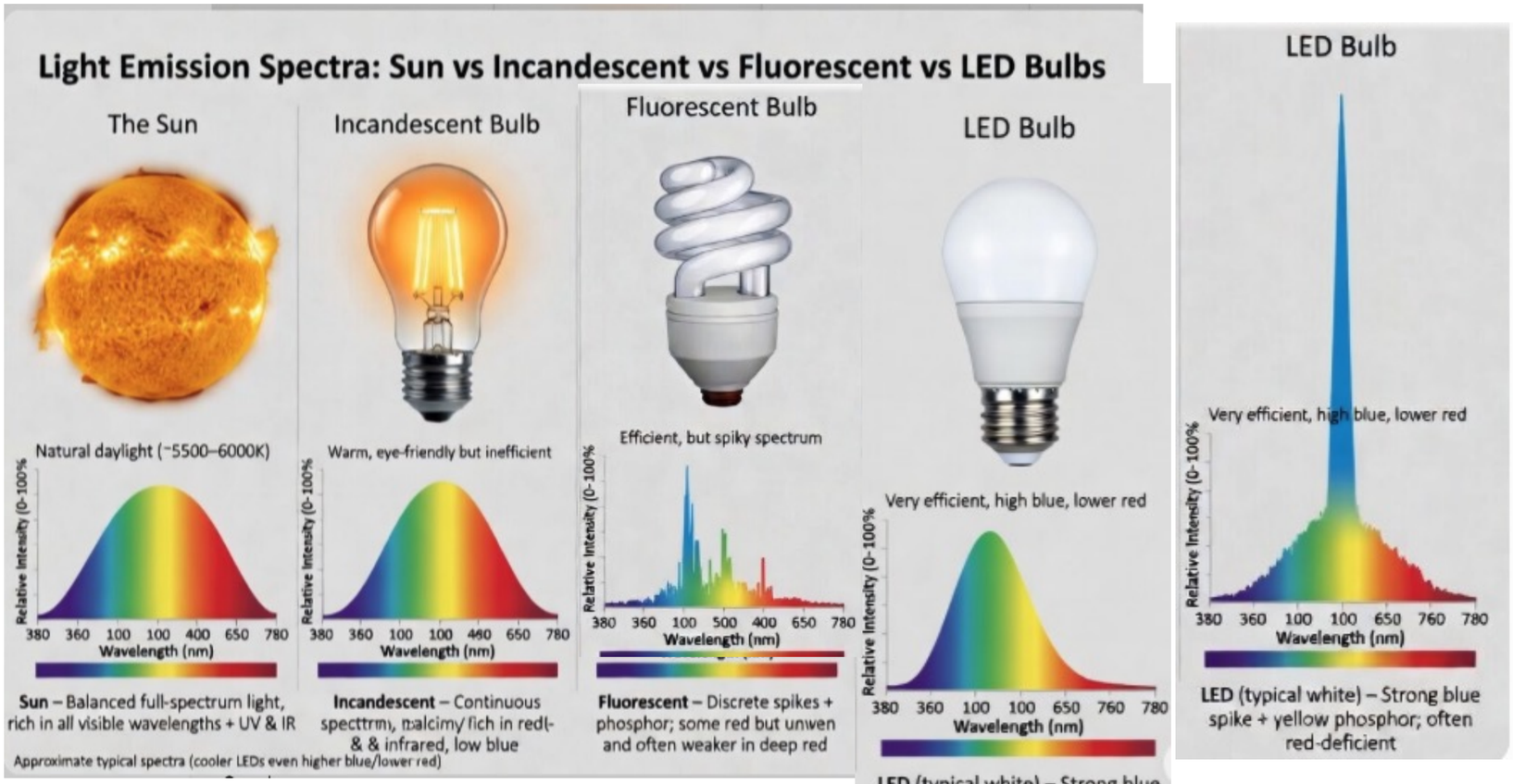

Percentage Distribution of Light Wavelengths:
Sunrise
vs
Morning Sun
vs
Midday Sun
vs
Evening Sun
Moonlight
12%
30%
28%
30%
18%
32%
25%
25%
25%
35%
20%
8%
28%
32%
32%
Sunrise
Morning Sun
Midday Sun
Evening Sun
Moonlight
Blue (400-500 nm)
Green/Yellow
Red (600-700 nm)
Near-Infrared (NIR 700-1100 nm)

MORNING UV-A LIGHT ALSO SETS OUR SKIN PROTECTION CLOCK



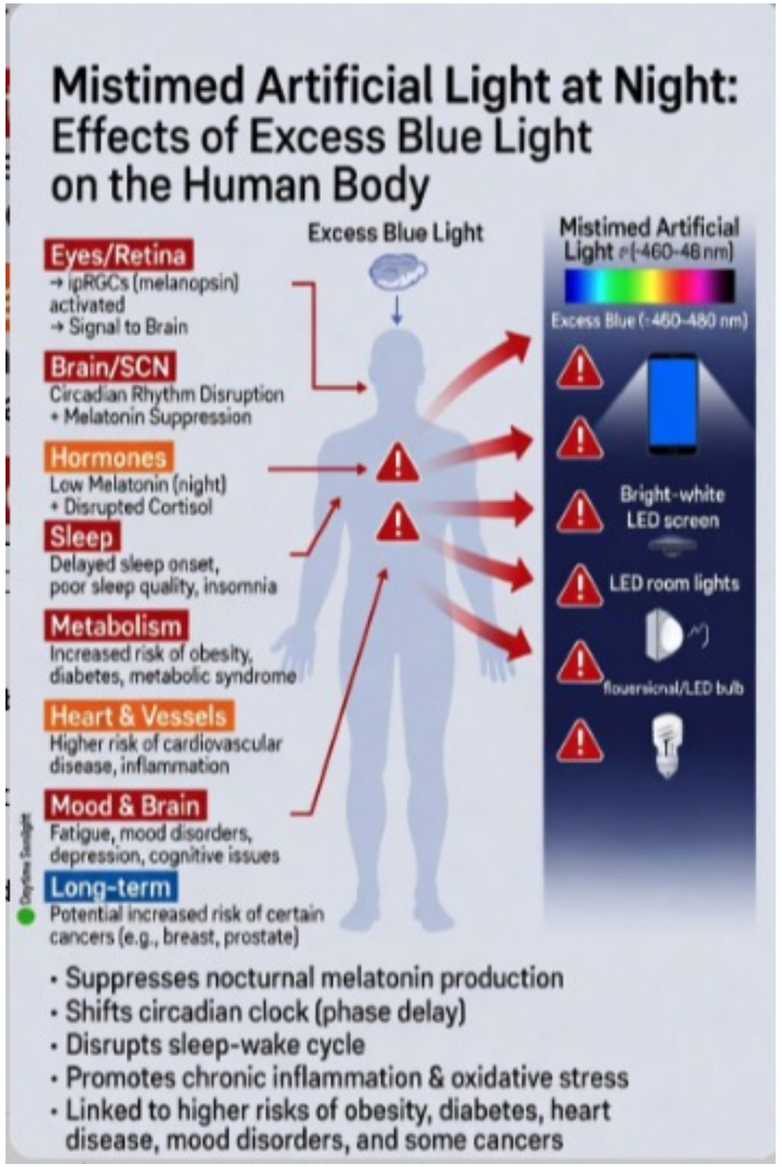

Ideal Morning Hours
for UVA & Near-Infrared
Light Exposure - Circadian Health
Morning UVA
(315-400 nm)
Best 6:00-9:00 AM
circadian signal
Near-Infrared
(700-1100 nm)
Best at sunrise /
low sun angle
(6:00-9:00 AM)
6:00 AM
7:00 PM
Evening NIR
also beneficial
at sunset
Tito stronngest
optimal exposure
Summary:
Morning (6:00-10:00 AM) is the optimal window for
UVA to set your circadian rhythm and for Near-Infrared to
support mitochondrial health with minimal UV risk.

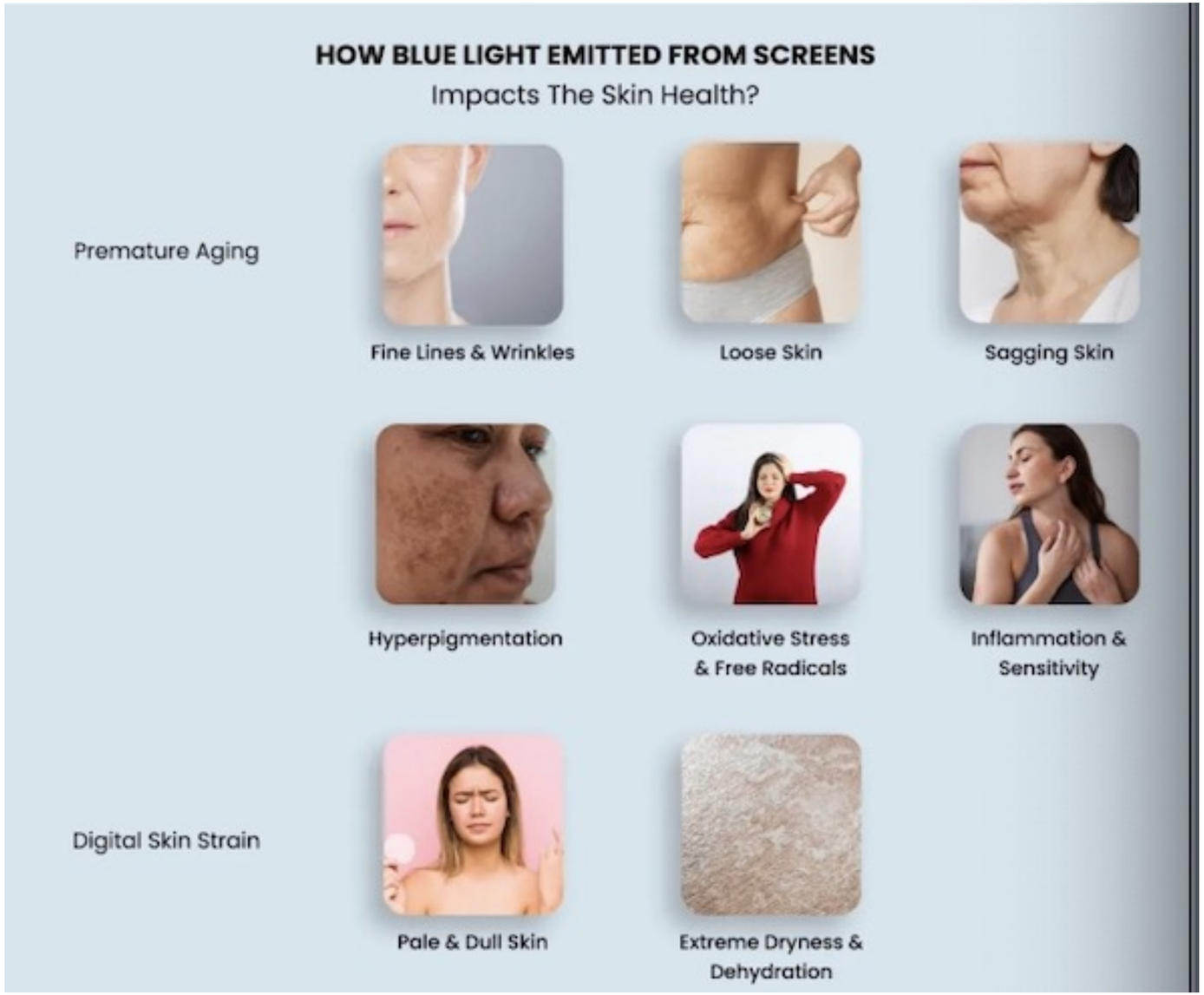
MODERN LIGHT DEFICIENCY



POTENTIAL EXCESS/MIS-TIMED BLUE LIGHT EFFECTS ON BIOLOGY

- SUPRESSES MELATONIN PRODUCTION (SLEEP DISRUPTION), CIRCADIAN DISRUPTION
- POTENTIAL CONTRIBUTOR TO NEURODEGENERATION
- SPIKES IN BLOOD SUGAR, DIABETES, HEART DISEASE
- OBESITY RISK
- EYE FATIGUE, MACULAR DEGENERATION
- CAN INCREASE ROS BURSTS IN MITOCHONDRIA
- INCREASED CANCER RISK (PROSTATE AND BREAST)
- DEPRESSION AND ANXIETY


Mistimed Artificial Light at Night:
Effects of Excess Blue Light
on the Human Body
Excess Blue Light
Eyes/Retina
→ ipRGCs (melanopsin) activated
→ Signal to Brain
Brain/SCN
Circadian Rhythm Disruption
+ Melatonin Suppression
Hormones
Low Melatonin (night)
+ Disrupted Cortisol
Sleep
Delayed sleep onset, poor sleep quality, insomnia
Metabolism
Increased risk of obesity, diabetes, metabolic syndrome
Heart & Vessels
Higher risk of cardiovascular disease, inflammation
Mood & Brain
Fatigue, mood disorders, depression, cognitive issues
Long-term
Potential increased risk of certain cancers (e.g., breast, prostate)
Daytime Sunlight
Mistimed Artificial Light e(460-48 nm)
Excess Blue (~460-480 nm)
Bright-white LED screen
LED room lights
fluorescnal/LED bulb
• Suppresses nocturnal melatonin production
• Shifts circadian clock (phase delay)
• Disrupts sleep-wake cycle
• Promotes chronic inflammation & oxidative stress
• Linked to higher risks of obesity, diabetes, heart disease, mood disorders, and some cancers


HOW BLUE LIGHT EMITTED FROM SCREENS
Impacts The Skin Health?
Premature Aging
Fine Lines & Wrinkles
Loose Skin
Sagging Skin
Hyperpigmentation
Oxidative Stress & Free Radicals
Inflammation & Sensitivity
Digital Skin Strain
Pale & Dull Skin
Extreme Dryness & Dehydration

TIMING OF SUNLIGHT AND LEPTIN
HUNGER HORMONE

SUNLIGHT CONTROLS LEPTIN VIA THE LEPTIN MELANOCORTIN PATHWAY

MORNING LIGHT RAISES LEPTIN AND DECREASES APPETITE

EVENING LIGHT LOWERS LEPTIN AND INCREASES APPETITE

IT IS A HORMONE THAT CONTROLS FAT STORES, APPETITE, METABOLISM AND IMMUNE FUNCTION

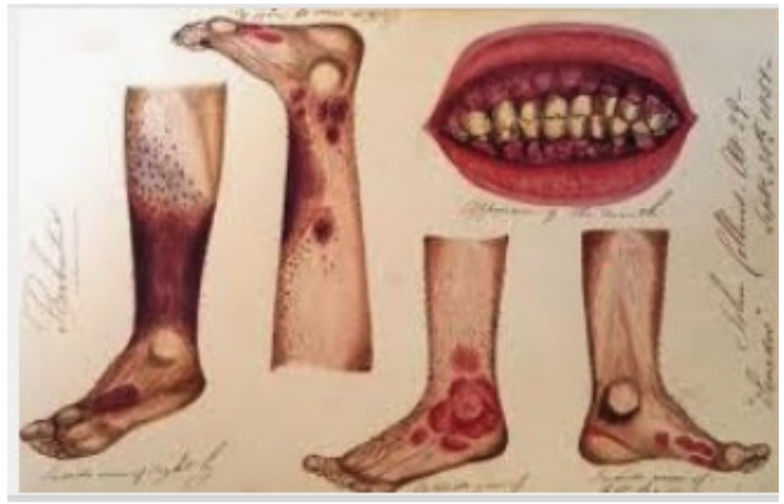
PROPER LIGHT TIMING AND DOSE MAY BE MORE IMPORTANT THAN DIET

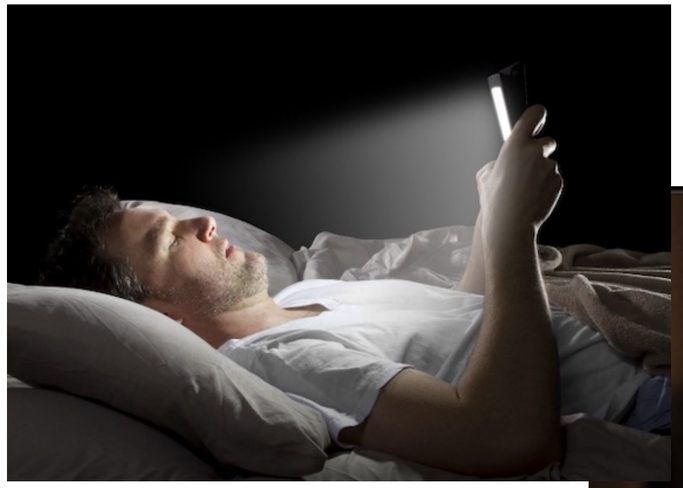
LIGHT DEFICIENCY LEADS TO LEPTIN RESISTANCE AND OBESITY

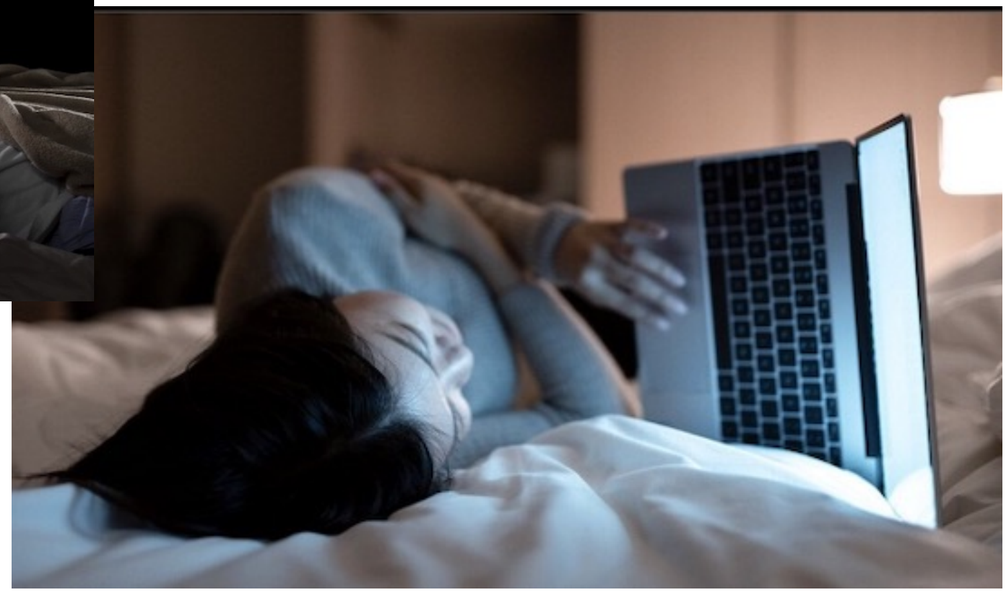
“MODERN LIGHTING IS POTENTIALLY THE SCURVY OF THE CURRENT ERA”

(paraphrase)

-ROBERT FOSBURY, PHD








GROG
IS NOW A
MODERN
MAN!

Blue Light Exposure vs. Recommended Sunlight Dose

Artificial Blue Light

(~460–480 nm)

Rx: Morning Sunlight Exposure

Recommended Dose: 10–30+ minutes of full-spectrum natural sunlight daily (especially morning UVA + balanced visible light)

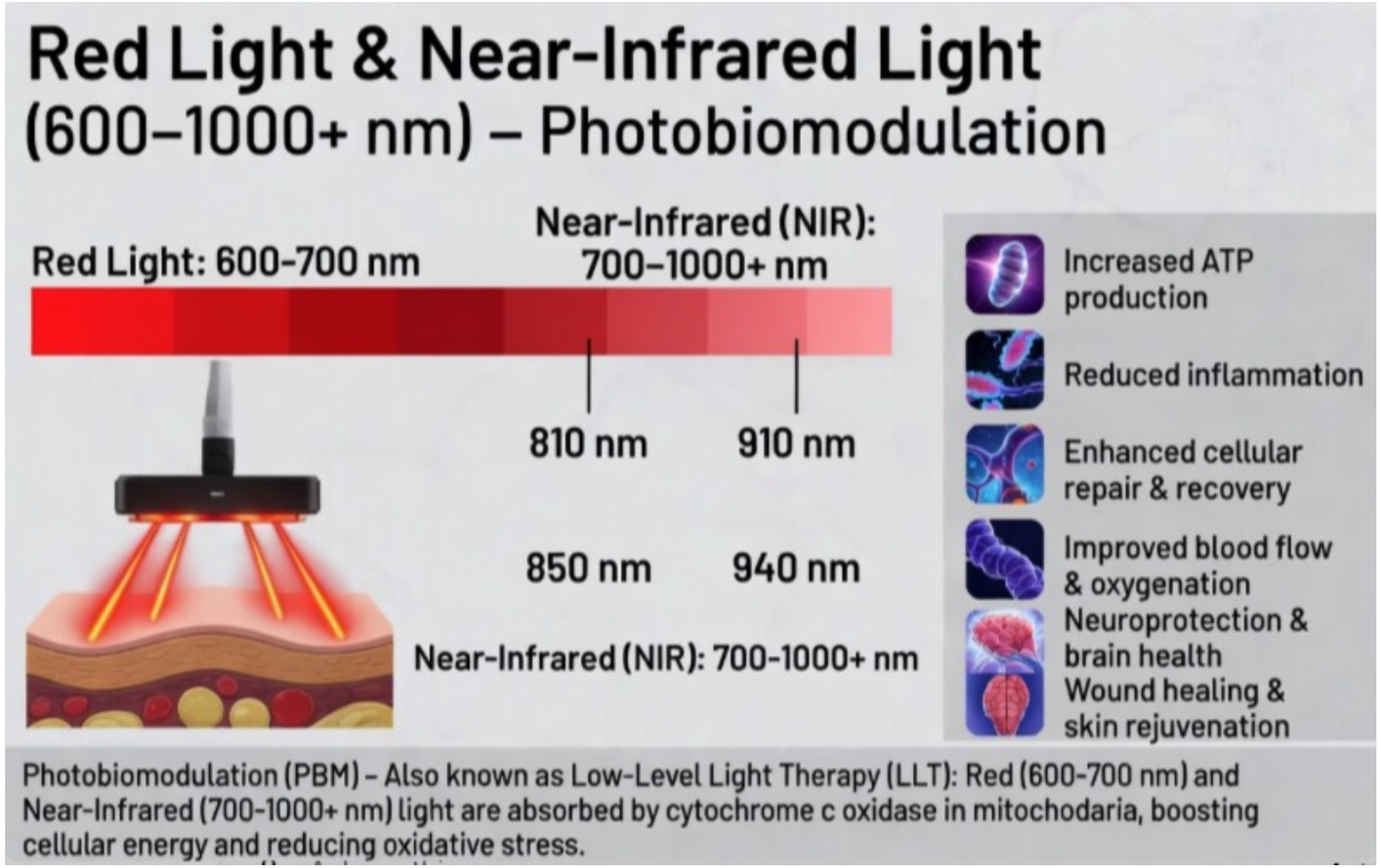
Artificial blue light at night disrupts circadian rhythm. Natural sunlight is the body's preferred "prescription" for healthy circadiand signaling, vitamin D, and mood.

SUNLIGHT - “THERE IS NO ALTERNATIVE (TINA)”

- DR. JACK KRUSE


I'M CHANGING THE LIGHT BULB

PHOTOBIOMODULATION PBM



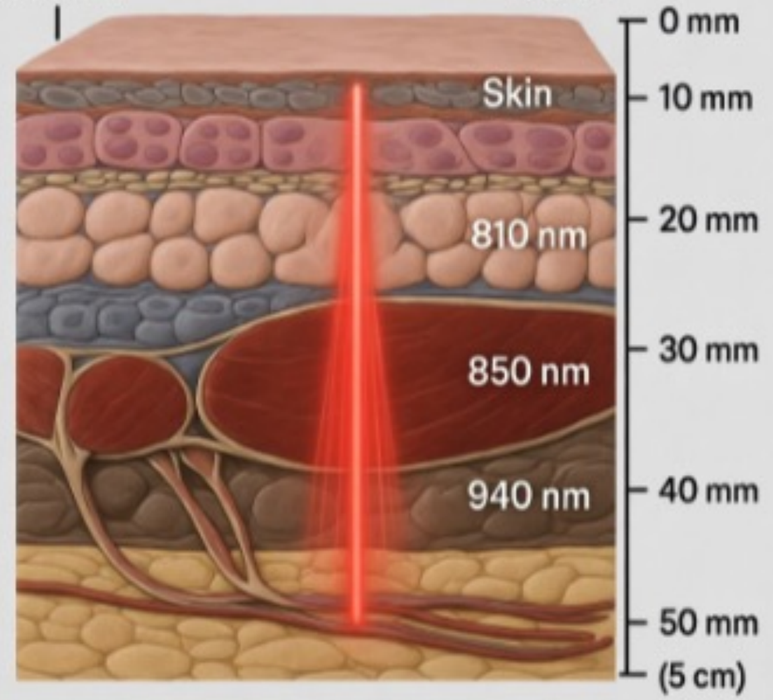
de Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE J Sel Top Quantum Electron. 2016;22(3):7000417.

Depth of Penetration: Red Light vs Near-Infrared (NIR) Light in Human Tissue

Red Light
(600-700 nm) –
Superficial penetration
(mostly absorbed in
epidermis & dermis)

Near-Infrared
(700-1000+ nm) –

Deep penetration



NIR wavelengths penetrate significantly deeper than visible red light due to lower scattering and absorption in tissue. Longer NIR wavelengths generally reach deeper structures (muscle, joints, bone)

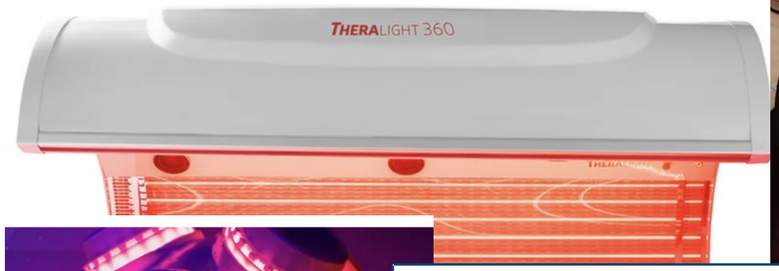
scientific reports

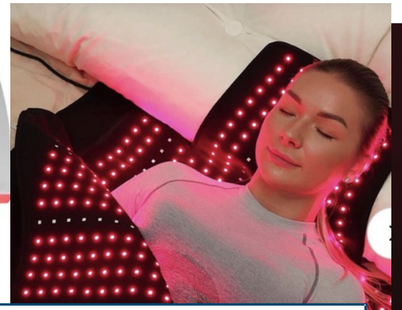
Article | Open access | Published: 08 July 2025

Longer wavelengths in sunlight pass through the human body and have a systemic impact which improves vision

Glen Jeffery ✉, Robert Fosbury, Edward Barrett, Chris Hogg, Marisa Rodriguez Carmona & Michael Barry Powner

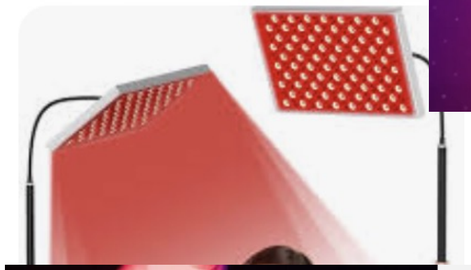
Scientific Reports **15**, Article number: 24435 (2025) | Cite this article

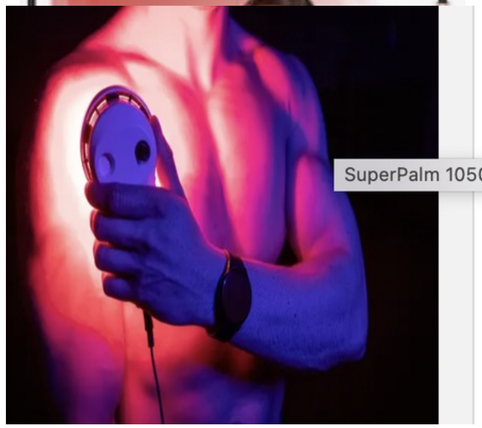




TYPES OF DEVICES:

- LED Panels
- Single spectrum lasers
- Wearable devices
- Handheld units
- Full-body systems





Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012;40(2):516–33.

DEVICE CONSIDERATIONS

- Power density
- EMF exposure
- Treatment goals

Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012;40(2):516–33.


ROXANNE!
YOU DON'T HAVE TO PUT ON THE RED LIGHT!

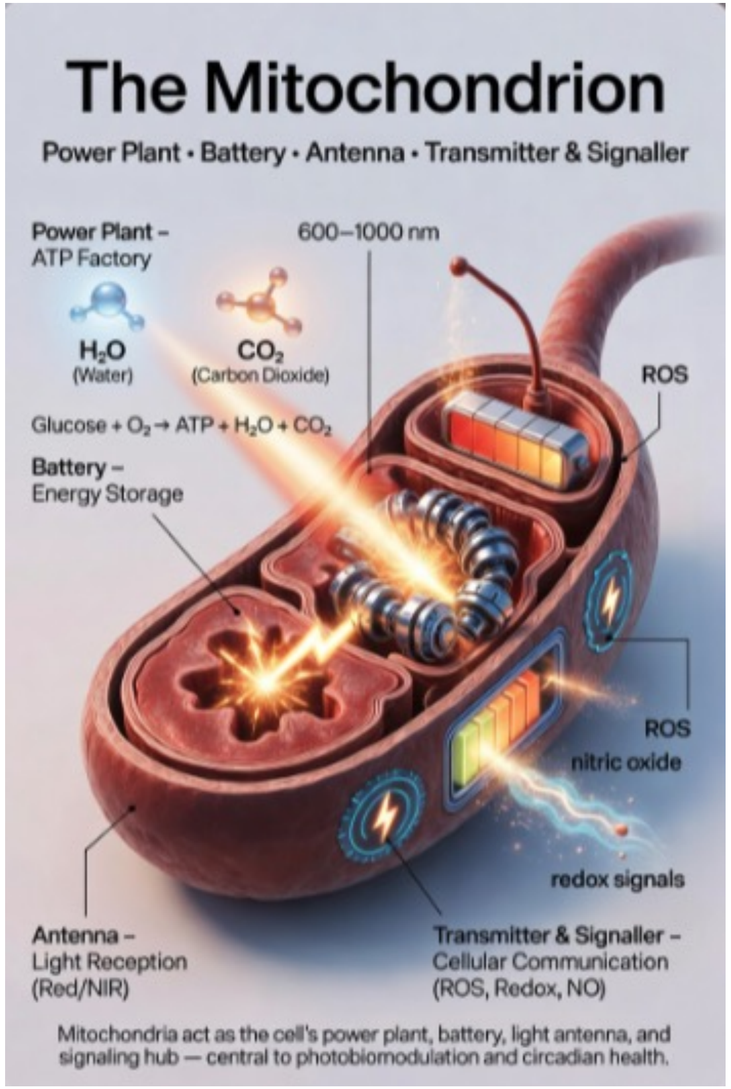
LEAVES AND GRASS REFLECT NEAR INFRARED LIGHT

MITOCHONDRIAL EFFECTS OF PBM

MITOCHONDRION

AN ANCIENT HITCH HIKER?

- PRODUCES ENERGY ATP, WATER AND CO2
- IS LIGHT SENSITIVE TO BLUE, RED, GREEN AND NIR
- COMMUNICATES WITH THE NUCLEUS
- DYSFUNCTION CONSIDERED TO BE RESPONSIBLE FOR MANY MANIFESTATIONS OF CHRONIC DISEASE AND AGEING



Karu TI. Mitochondrial signaling in mammalian cells activated by red and near-IR radiation. Photochem Photobiol. 2008;84(5):1091–9.
Hamblin MR. Mechanisms and applications of the anti-inflammatory effects of photobiomodulation. AIMS Biophys. 2017;4(3):337–61.

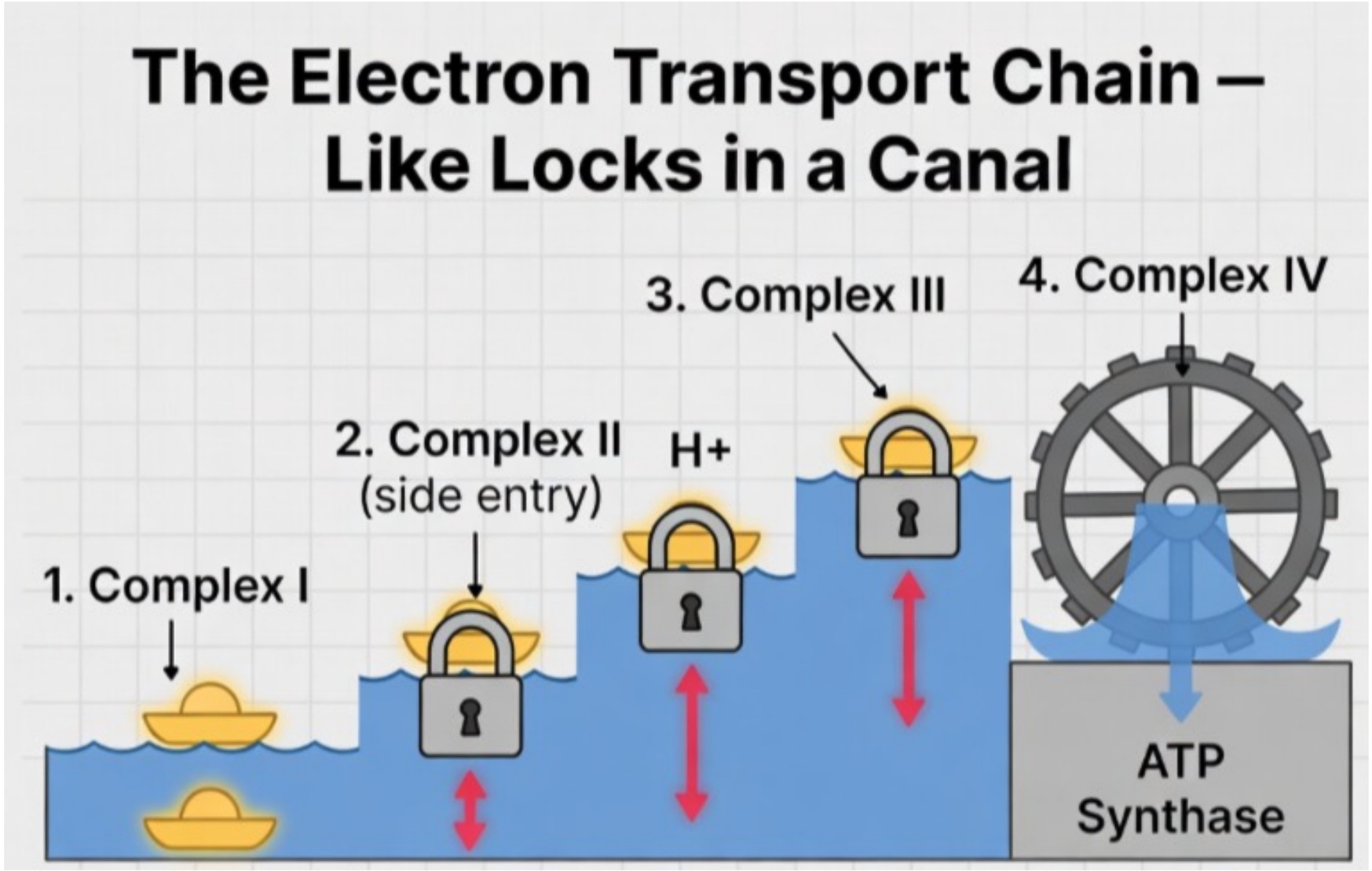
Mitochondrial Density in Human Cells & Tissues (Highest to Lowest)

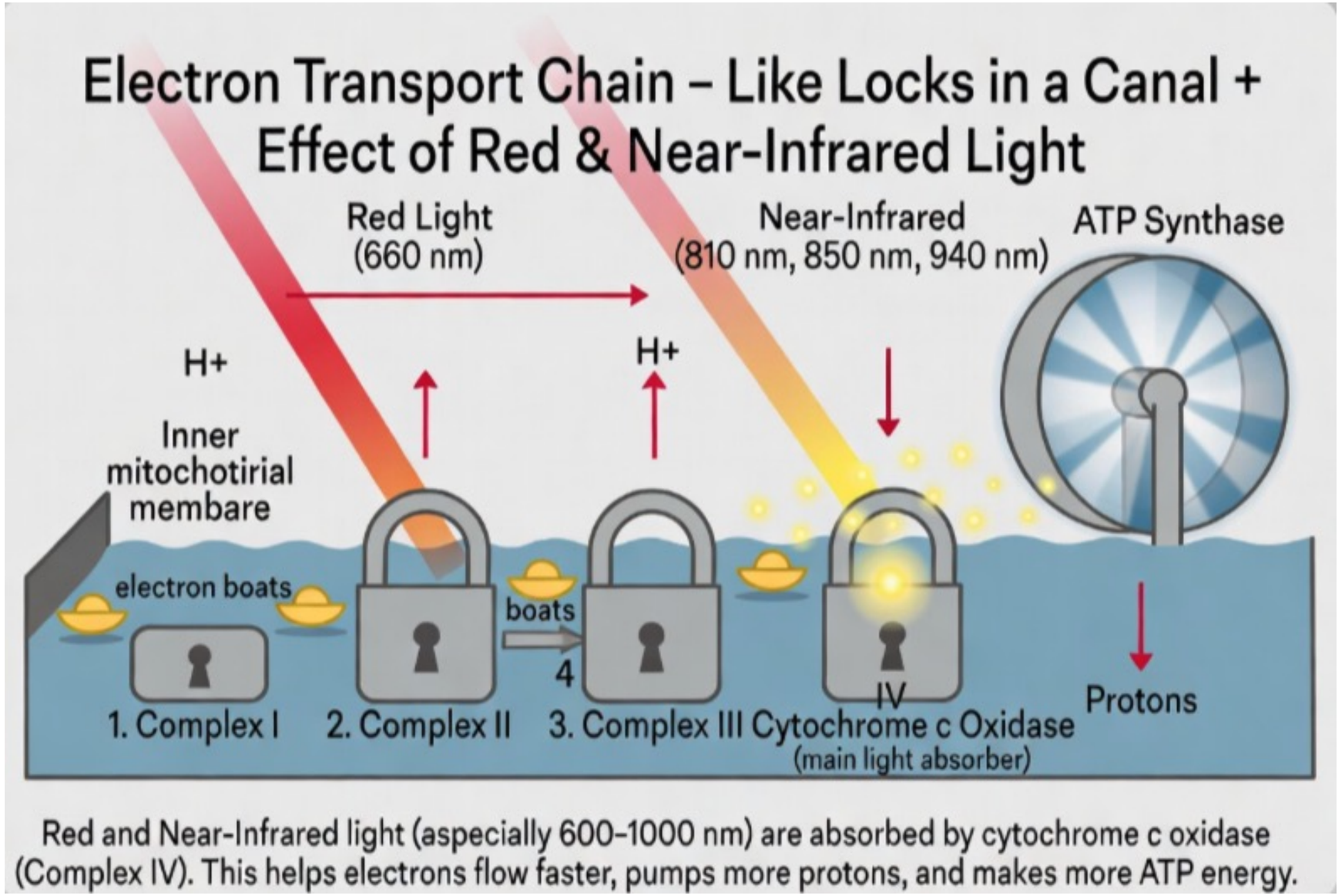
	volume	Approximate average
Retina (Photoreceptor inner segments / ellipsoid zone)	50-70%	~5,000 - 10,000+ mitochondria per cell
Heart muscle (Cardiomyocytes)	35-40%	~5,000 - 8,000 per cell
Slow-twitch skeletal muscles	20-30%	~2,000 - 5,000 per cell
Liver hepatocytes	20-25%	~1,000 - 2,000 per cell
Kidney proximal tubule cells	15-20%	~1,500 - 2,500 per cell
Brain neurons	10-15%	~1,000 - 2,000 per cell
Pancreatic beta cells	8-12%	~500 - 1,500 per cell
Fast-twitch skeletal muscle	5-10%	~500 - 1,000 per cell
Lung epithelial cells	4-8%	~300 - 800 per cell
Skin keratinocytes	2-5%	~100 - 500 per cell
White fat cells (adipocytes)	1-3%	~50 - 200 per cell
Mature red blood cells	0%	0 mitochondria

MITOCHONDRIA

FACTOIDS

- WE PRODUCE OUR BODY WEIGHT IN ATP EVERYDAY
- THE MEMBRANE POTENTIAL IS -150 TO -180 MV IN HEALTHY MITOCHONDRIA (LOWER IN UNHEALTHY MTC) SIMILAR TO LIGHTNING IN RELATIVE FIELD STRENGTH
- WE HAVE CIRCULATING, CELL FREE, INTACT MITOCHONDRIA ABOUT 1 TO 10 MILLION
- PLATELETS CONTAIN MITOCHONDRIA
- VITAMIN D RECEPTORS PRESENT, CONTROLLING RESPIRATORY ACTIVITY


The Electron Transport Chain –
Like Locks in a Canal
1. Complex I
2. Complex II
(side entry)
H+
3. Complex III
4. Complex IV
ATP
Synthase



Red and Near-Infrared light (aspecially 600–1000 nm) are absorbed by cytochrome c oxidase (Complex IV). This helps electrons flow faster, pumps more protons, and makes more ATP energy.

ATP PRODUCTION

- Increases ATP synthesis
- ATP = cellular energy source
- Enhances repair and regeneration
- Improves overall cell efficiency

de Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE J Sel Top Quantum Electron. 2016;22(3):7000417.

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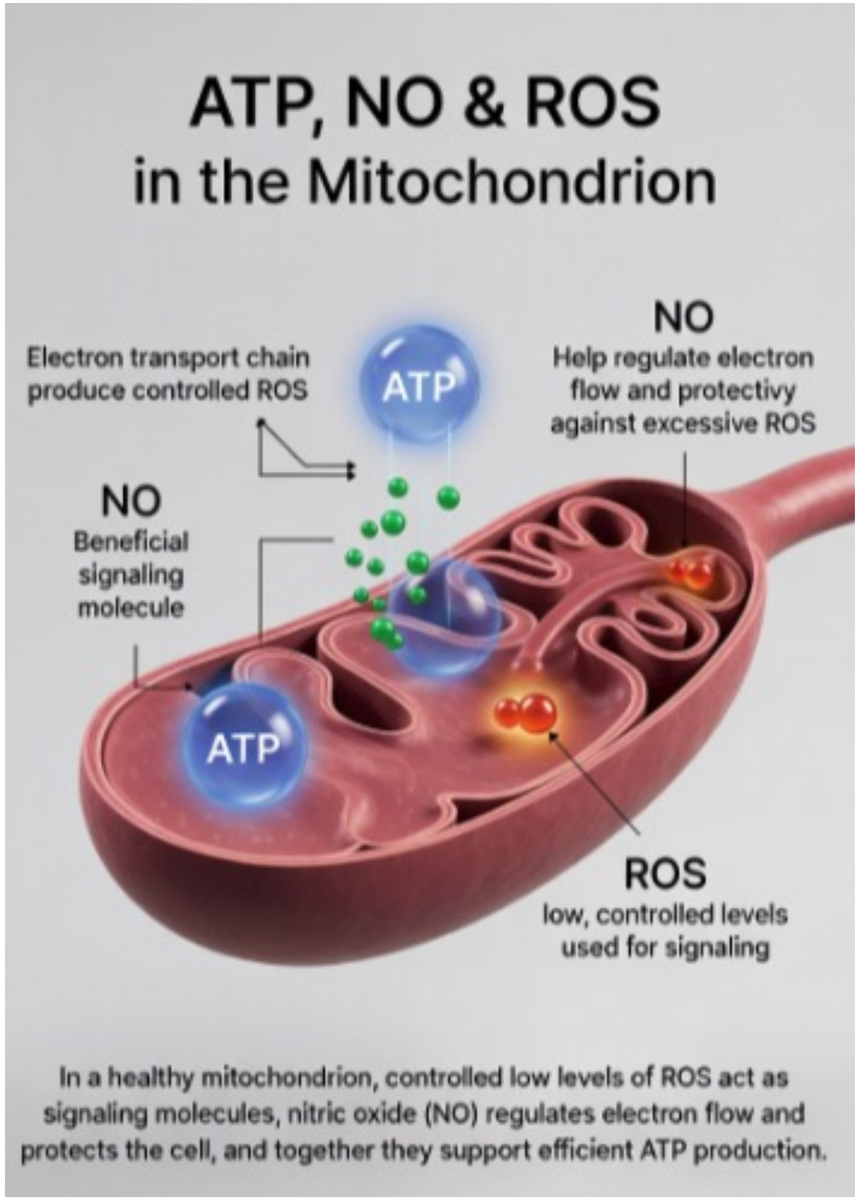
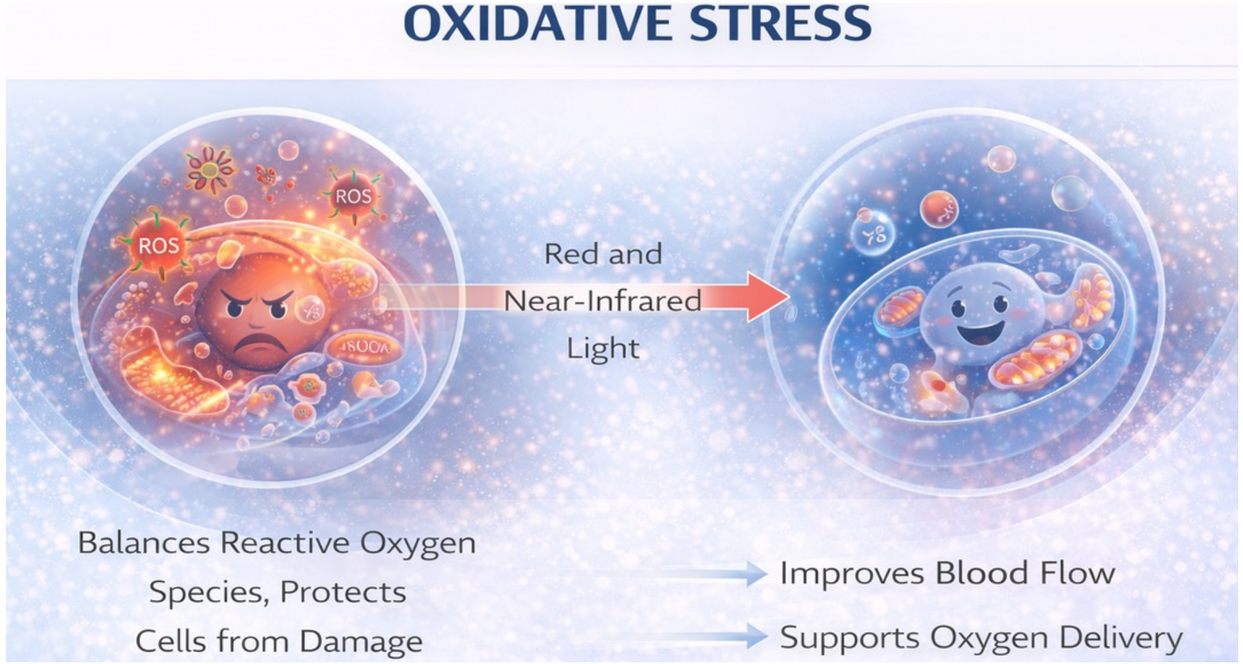


de Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE J Sel Top Quantum Electron. 2016;22(3):7000417.

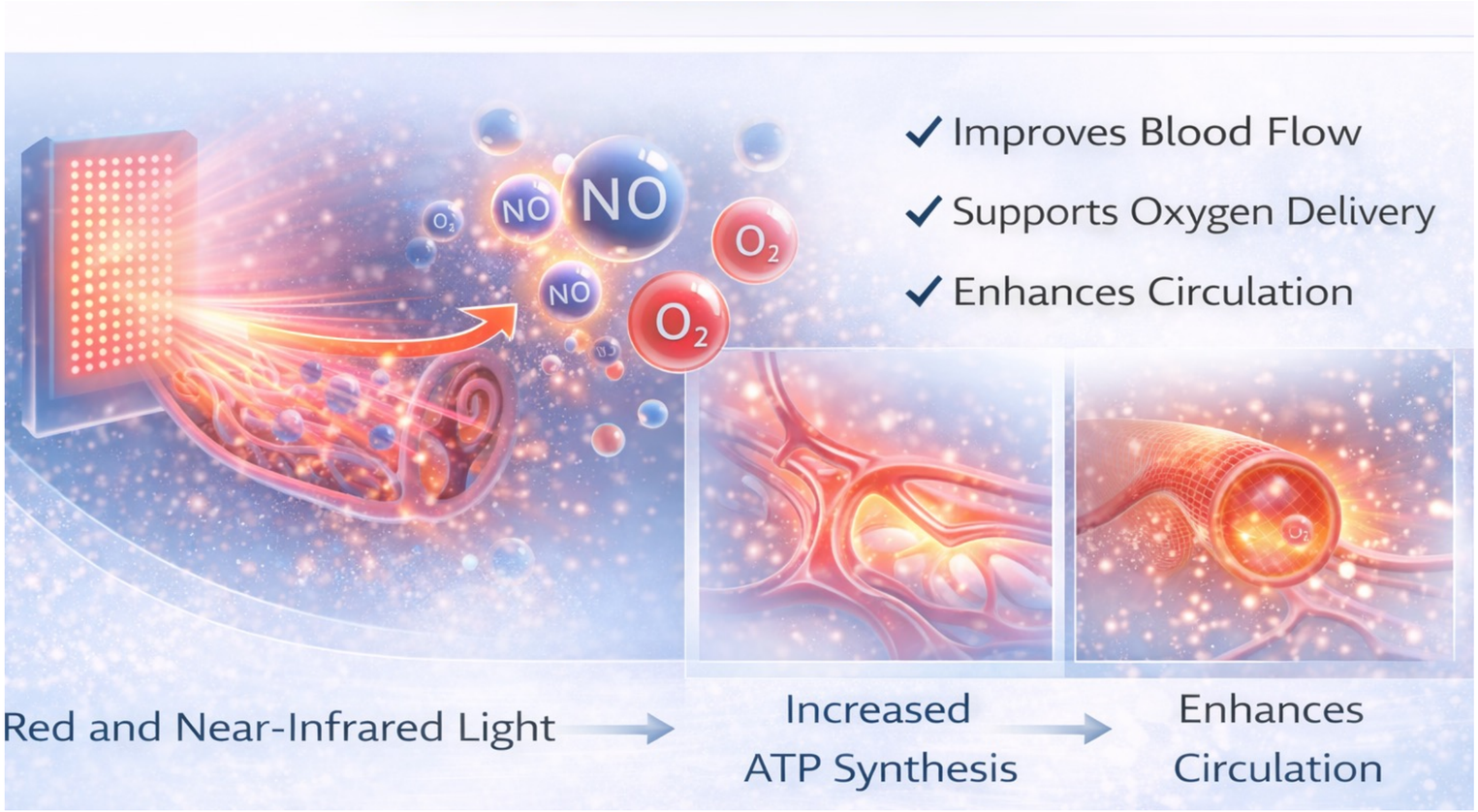
OXIDATIVE STRESS

- Helps reduce oxidative stress
- Balances reactive oxygen species
- Protects cells from damage



Hamblin MR. Mechanisms and applications of the anti-inflammatory effects of photobiomodulation. AIMS Biophys. 2017;4(3):337–61.

NITRIC OXIDE EFFECTS



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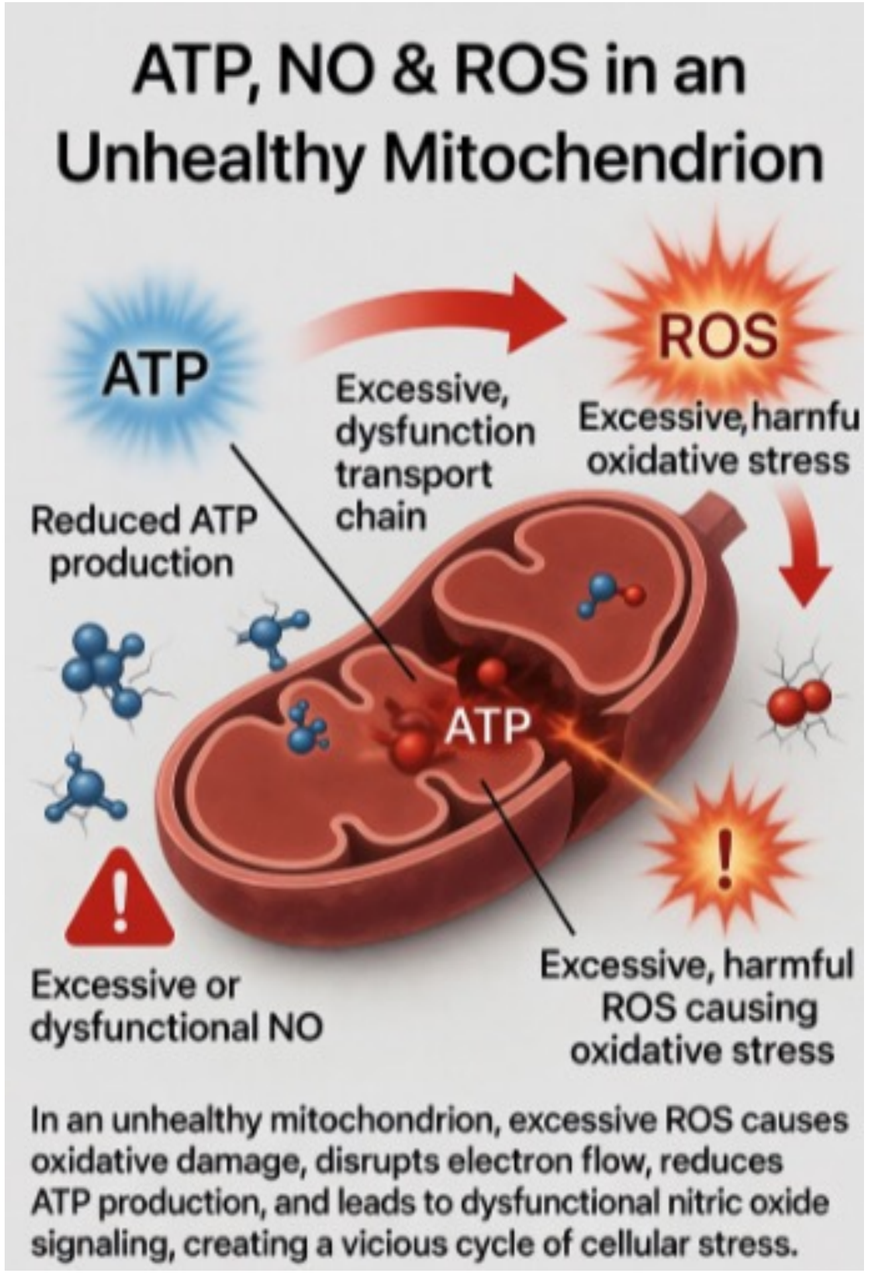
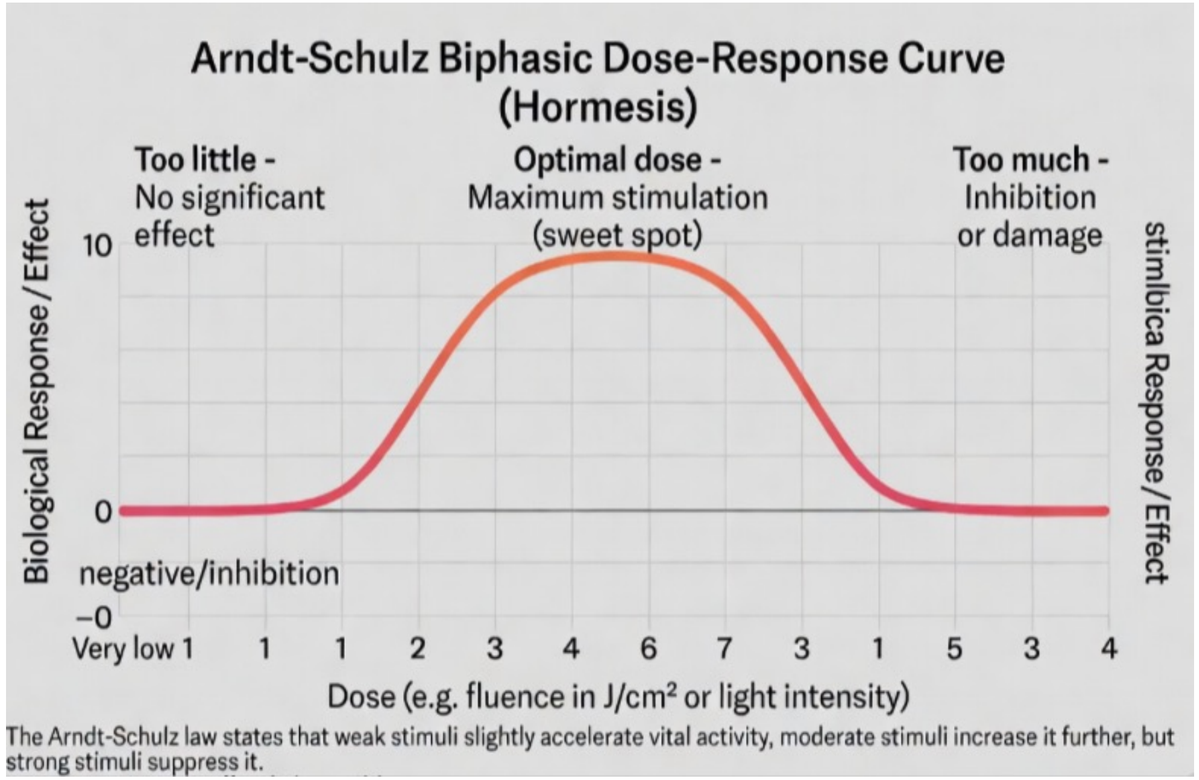

ATP, NO & ROS in an Unhealthy Mitochendrion
ATP
ROS
Excessive, dysfunction transport chain
Excessive,harmfu oxidative stress
Reduced ATP production
ATP
Excessive or dysfunctional NO
Excessive, harmful ROS causing oxidative stress
In an unhealthy mitochondrion, excessive ROS causes oxidative damage, disrupts electron flow, reduces ATP production, and leads to dysfunctional nitric oxide signaling, creating a vicious cycle of cellular stress.

DON'T OVERUSE PBM

BIPHASIC DOSE RESPONSE

- MORE IS NOT BETTER
- TOO LITTLE ENERGY MAY DO TOO LITTLE
- TOO MUCH MAY IMPAIR RESPONSE
- DOSE INCLUDES IRRADIANCE, FLUENCE, PULSE STRUCTURE (HERTZ) AND TREATMENT INTERVALS
- CLINICAL PROTOCOLS MAY FAIL IF DOSIMETRY IS IGNORED

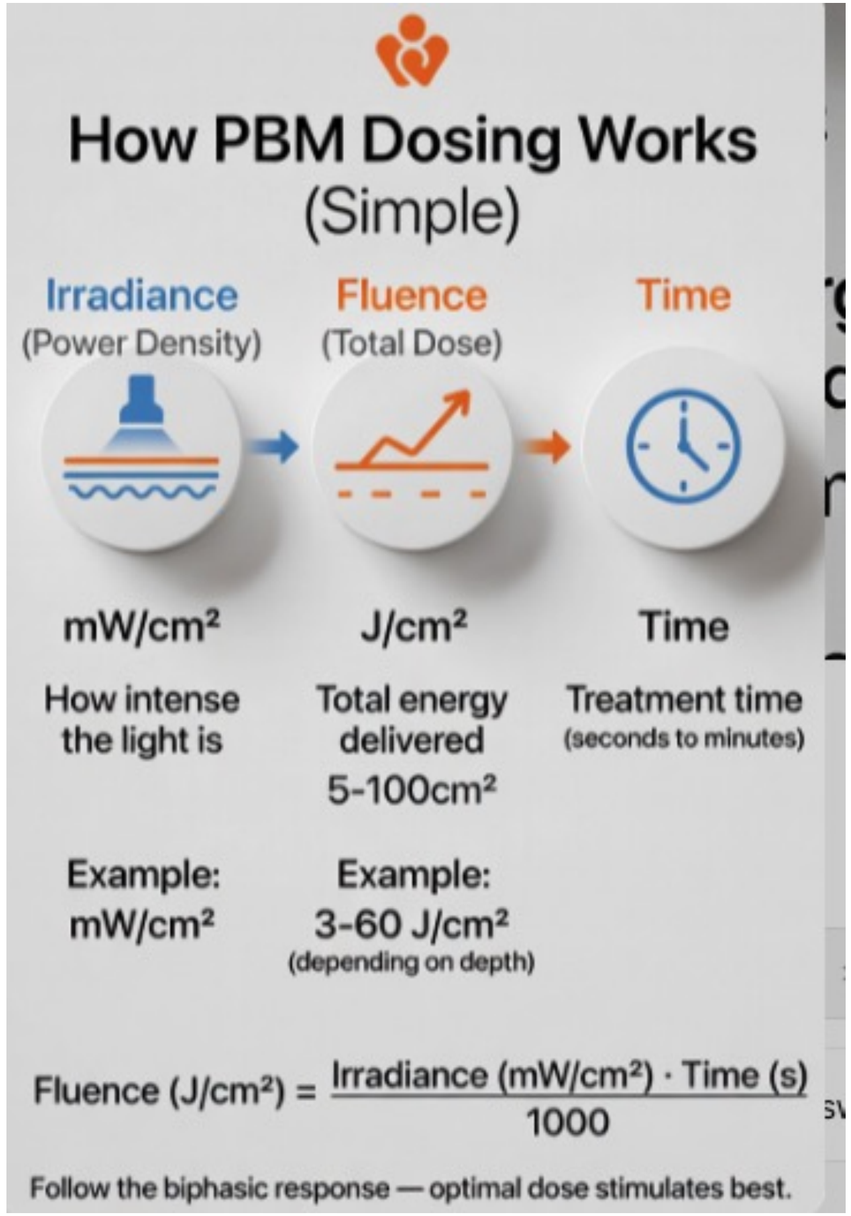


The Arndt-Schulz law states that weak stimuli slightly accelerate vital activity, moderate stimuli increase it further, but strong stimuli suppress it.

PBM DOSIMETRY

IT DEPENDS

- IRRADIANCE (POWER DENSITY) MEASURED IN mW/cm2, MILLIWATTS PER SQUARE CENTIMETER
- FLUENCE (ENERGY DENSITY, “DOSE”): MEASURED IN J/cm2 JOULES PER CENTIMETER SQUARED IT IS CALCULATED BY mW/cm2 x time (seconds)/1000 = J/cm2
- FUTURE MEASUREMENT MAY CONSIDER NUMBER OF PHOTONS DELIVERED



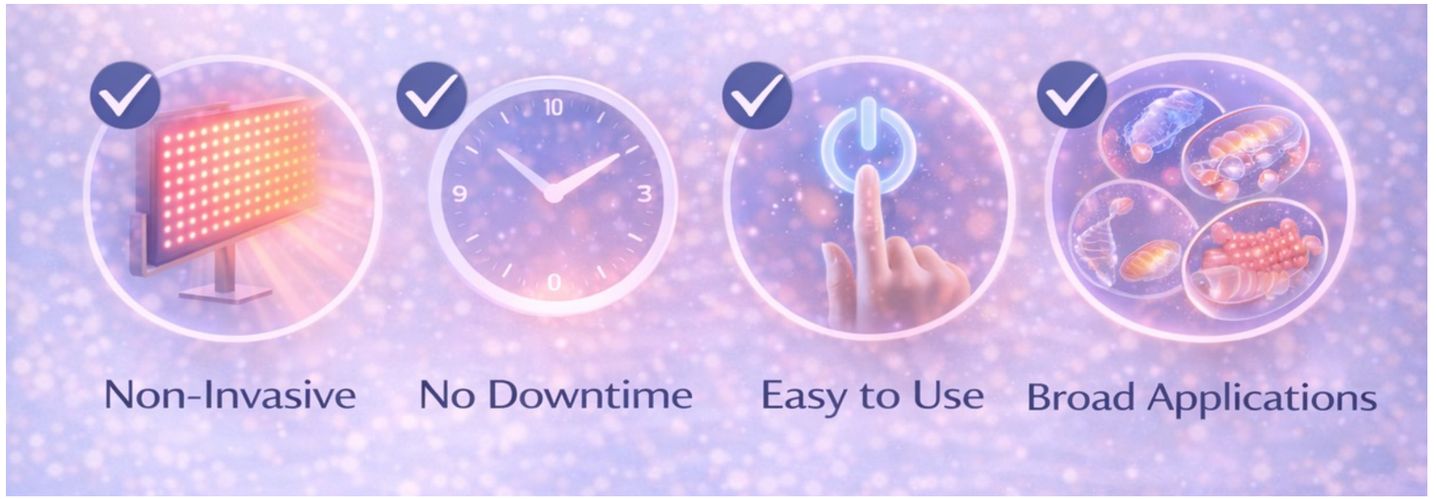
TREATMENT PROTOCOL

- Start slowly
- Short sessions
- Monitor response

Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser (light) therapy. Ann Biomed Eng. 2012;40(2):516–33.

CONSISTENCY

- Regular use > long sessions
- Cumulative effects



Hamblin MR. Photobiomodulation or low-level laser therapy. J Biophotonics. 2016;9(11-12):1122–4.

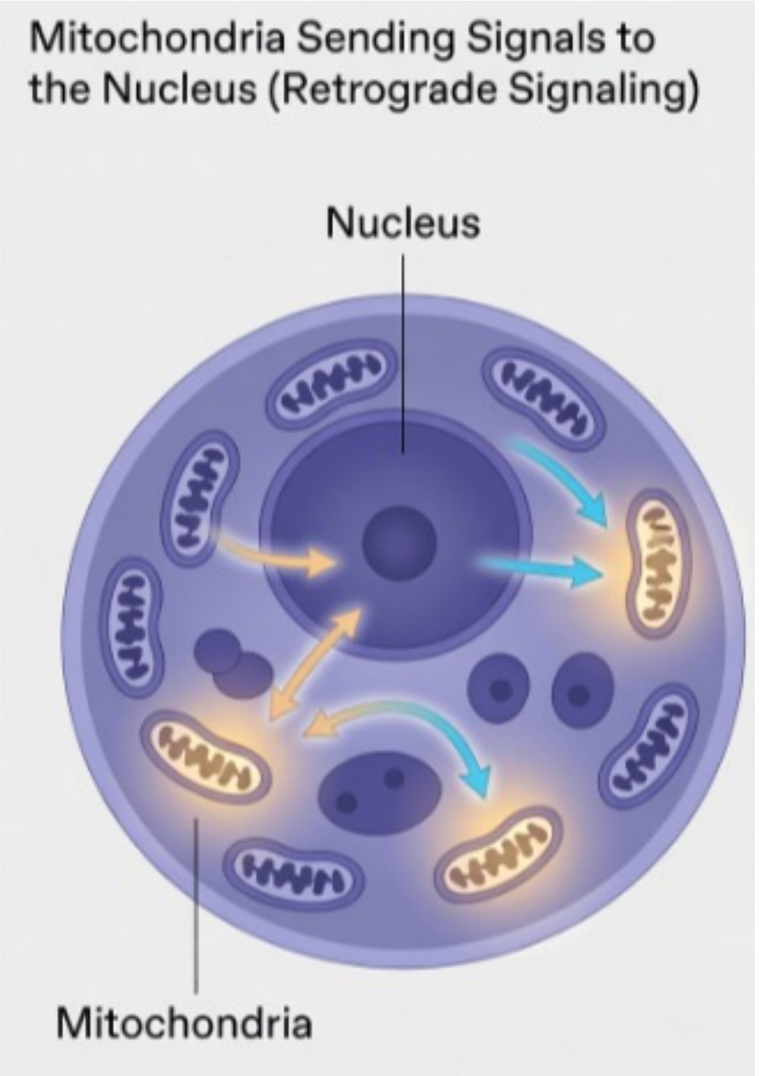
PBM Dosing Chart: 10 Most Common Applications

Application	Typical Wavelength)	Irradiance (mW/cm^2)	Fluence (J/cm^2)	Session Duration	Frequency (per week)
Skin Rejuvenation	630-850	20-50	3-10	10-20	2-3x
Hair Regrowth	650-670	5-20	3-6	10-20	3-5x
Wound Healing	630-850	30-100	5-20	5-15	3-5x
Osteoarthritis / Joint Pain	800-1000	50-100	20-50	10-20	3-5x
Muscle Recovery	800-1000	50-100	30-60	10-20	3-5x
Chronic Low Back Pain	800-1000	50-100	20-50	15-25	3-5x
Transcranial (Brain Health)	810-1064	20-50	20-60	10-20	2-3x
Oral Mucositis / TMJ	630-850	20-60	2-8	5-10	3-3x
Thyroid (Hashimoto's)	630-850	20-50	20-40	10-20	2-3x

PBM MECHANISMS BEYOND MITOCHONDRIA

SIGNALS

- MAY ALTER INFLAMMATION SIGNALS, SURVIVAL PATHWAYS, REPAIR PROGRAMS
- GENE EXPRESSION CHANGES IN EXPERIMENTAL SYSTEMS HAVE BEEN REPORTED
- VASODILATION, INCREASED BLOOD FLOW
- PROPOSED TO UPREGULATE MITOCHONDRIAL, INTRACELLULAR MELATONIN (POWERFUL ANTIOXIDANT)



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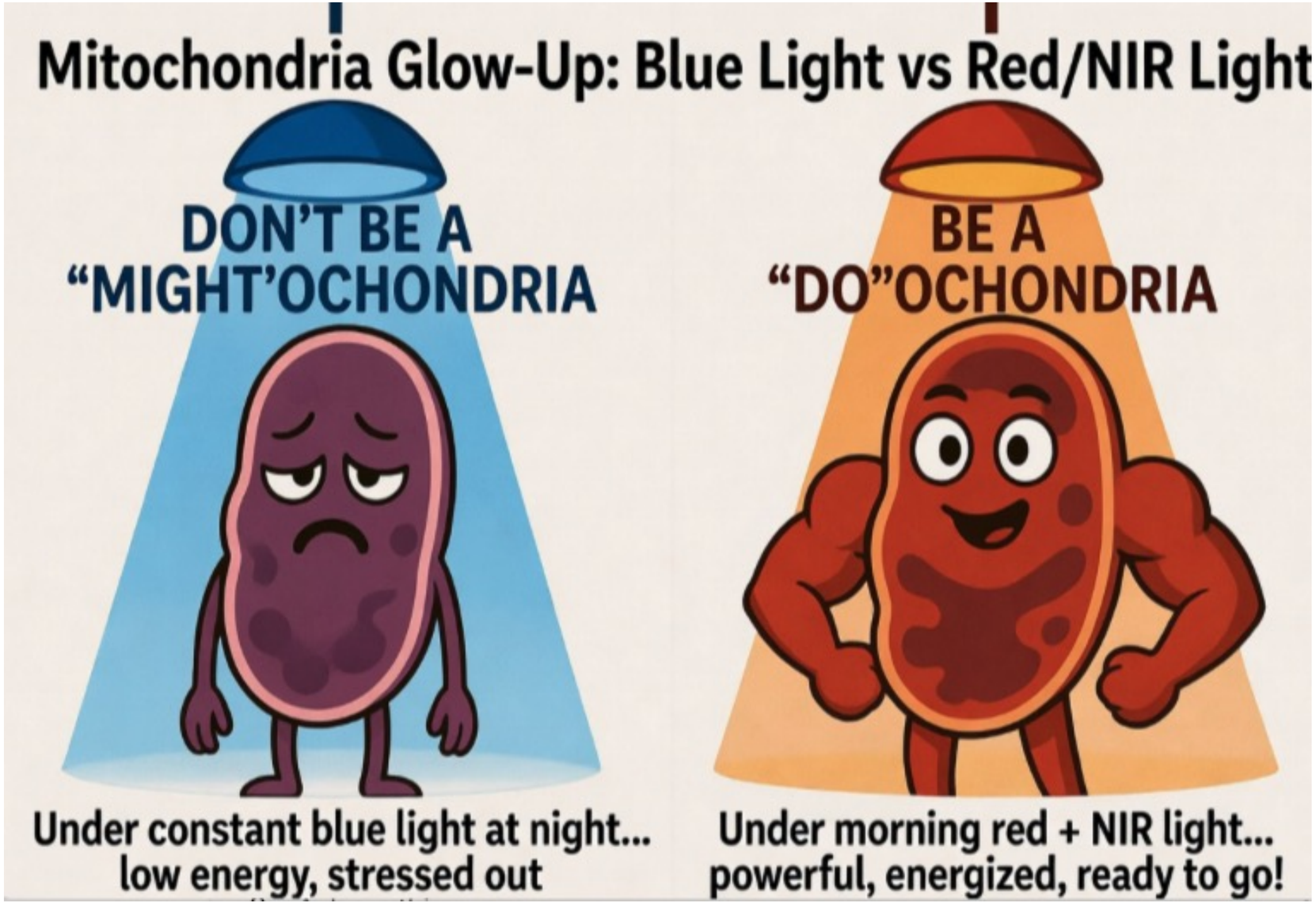
MITOCHONDRIAL PBM BENEFITS ABOUND

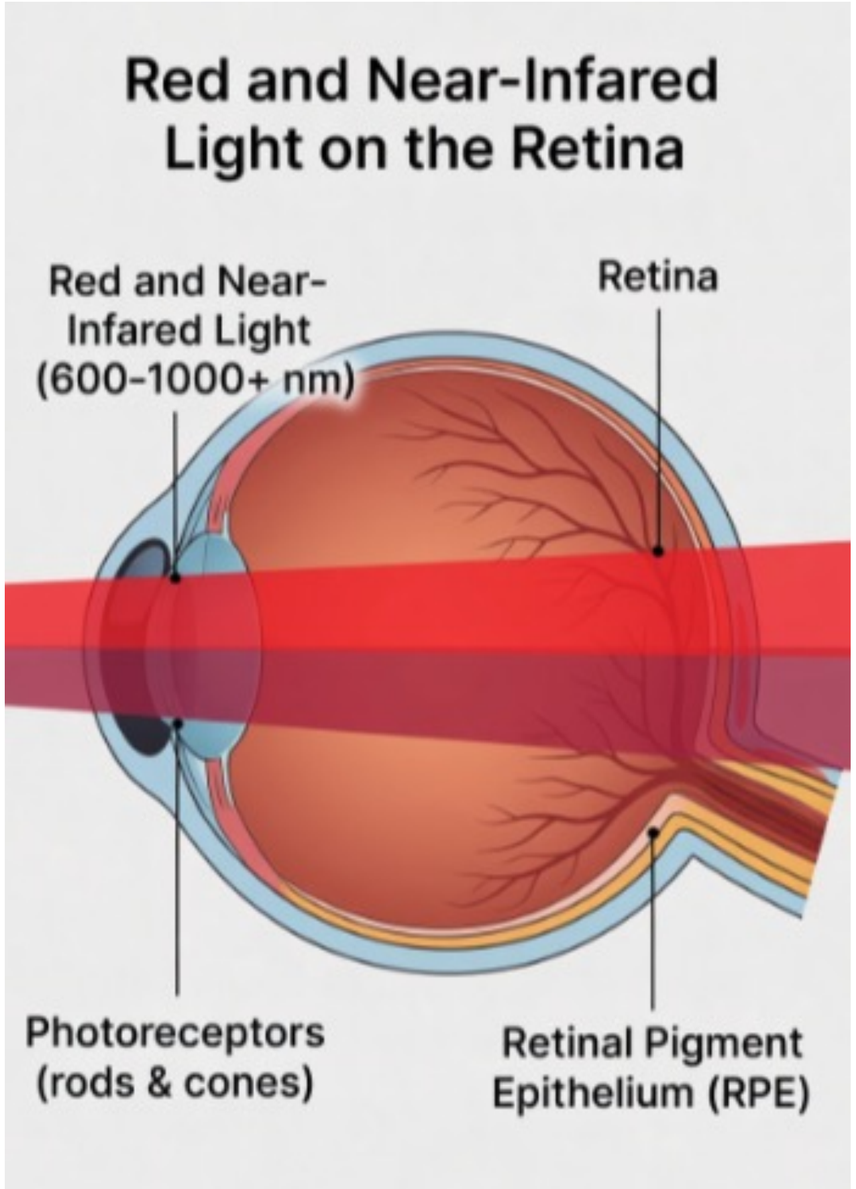

Mitochondria Glow-Up: Blue Light vs Red/NIR Light
DON'T BE A
"MIGHT'OCHONDRIA
BE A
"DO"OCHONDRIA
Under constant blue light at night...
low energy, stressed out
Under morning red + NIR light...
powerful, energized, ready to go!

PBM POTENTIAL BENEFITS

RETINAL MODELS

PBM

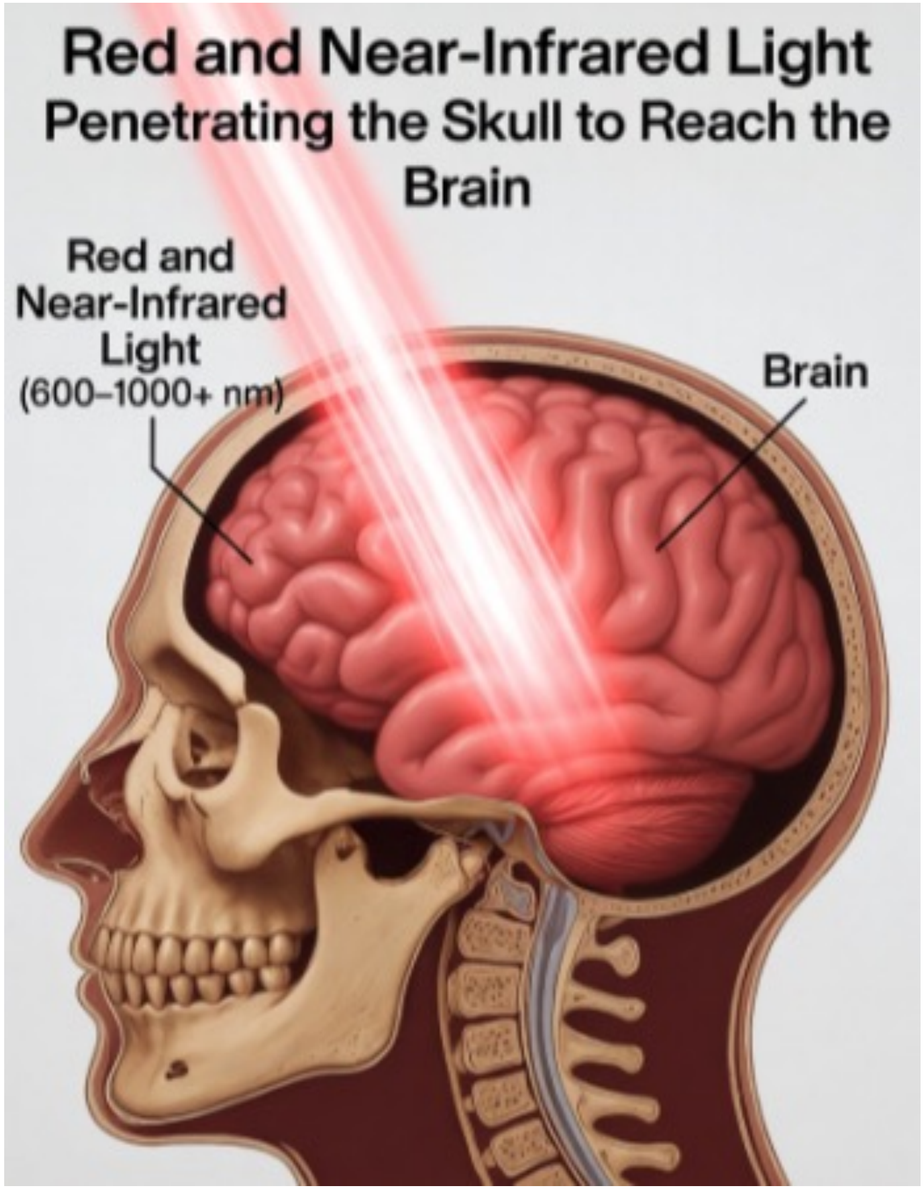
- MAY PROTECT STRESSED RETINAL TISSUE
- DECREASES NEGATIVE INFLAMMATION
- PROMISING FINDINGS IN MACULAR DEGENERATION, GLAUCOMA



NEURODEGENERATIVE CONDITIONS

PBM

- MAY INFLUENCE CEREBRAL METABOLISM AND SIGNALING (THINK MITOCHONDRIA AND VASODILATION)
- ENTHUSIASM EXCEEDS STANDARDIZATION
- POTENTIAL IN TBI, ALZHEIMERS, PARKINSON'S, DEMENTIA, SEIZURE DISORDERS (CASE REPORTS) AND ANIMAL MODELS

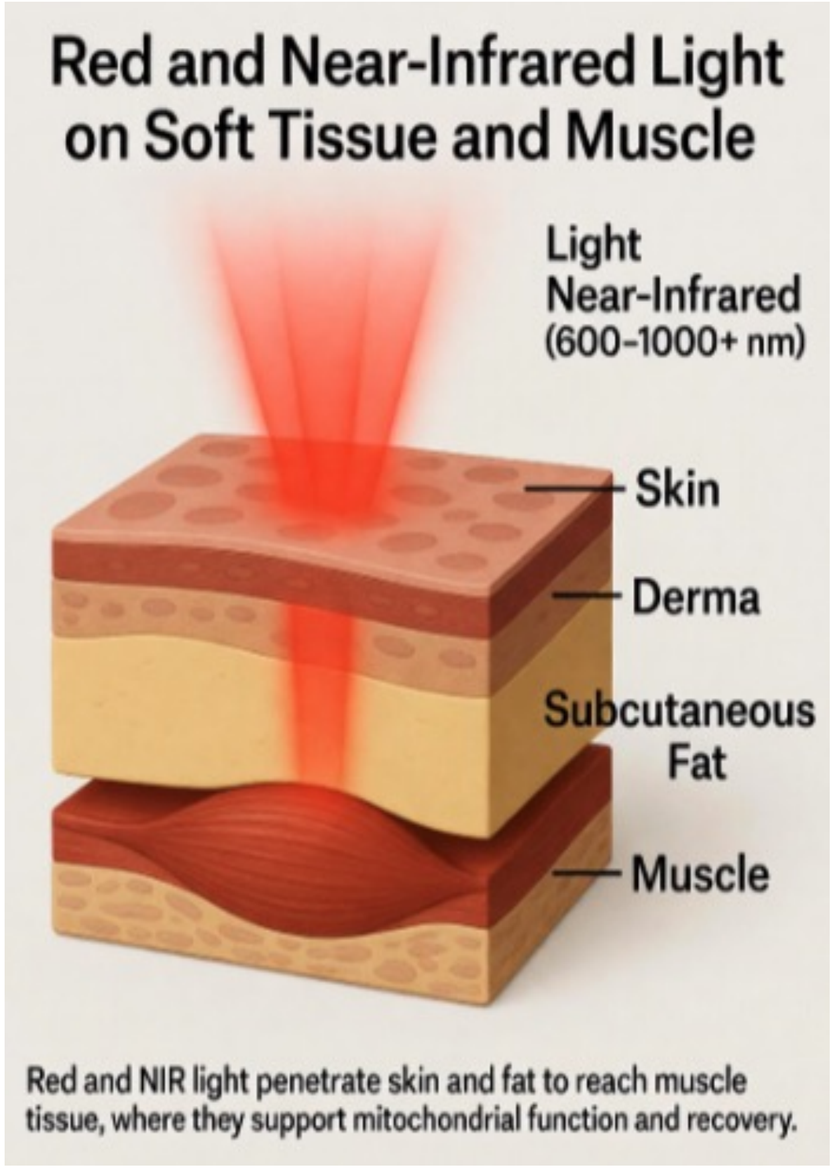


Hamblin MR. Shining light on the head: photobiomodulation for brain disorders. BBA Clin. 2016;6:113–24.

PAIN MODULATION

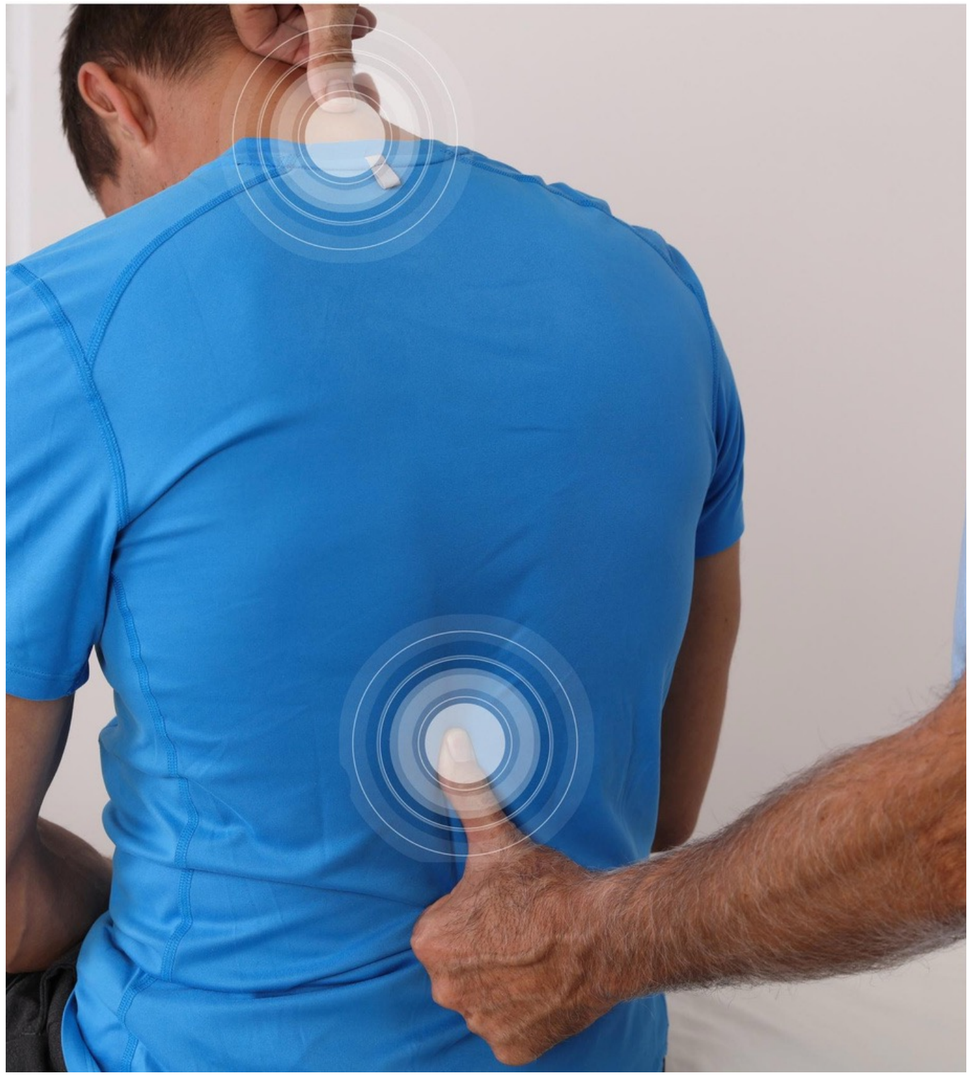
PROPOSED MECHANISMS

- LONGSTANDING USE IN MUSCULOSKELETAL AND REHAB (PERSONAL STORY)
- ANTI-INFLAMMATORY EFFECTS
- MITOCHONDRIAL AND VASODILATION



PAIN RELIEF

- Significant pain reduction vs placebo (~70% in some studies)
- Sustained clinical improvement over time
- Effective in chronic musculoskeletal conditions

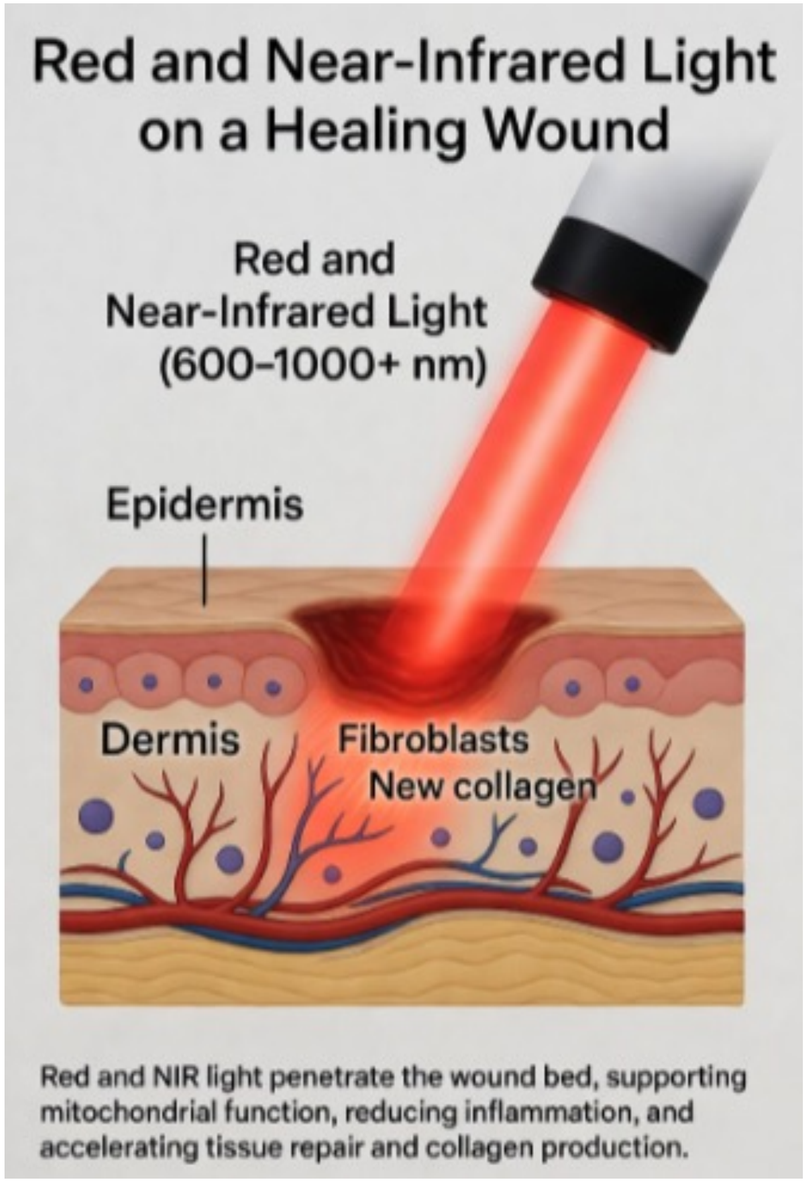


Chow RT, Johnson MI, Lopes-Martins RA, Bjordal JM. Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis. Lancet. 2009;374(9705):1897–908.

WOUND REPAIR

PROPOSED MECHANISMS

- MAY IMPROVE TISSUE ENERGY AND METABOLISM
- ANTI-INFLAMMATORY EFFECTS
- PLAUSIBLE BIOLOGIC MODELS
- MANY STUDIES ON FIBROBLASTS AND DECREASED SCARRING



Avci P, Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, et al. Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring. Semin Cutan Med Surg. 2013;32(1):41–52.

WOUND HEALING

- Accelerated wound closure compared to control
- Enhanced tissue regeneration
- Improved healing outcomes in clinical studies

Posten W, Wrone DA, Dover JS, Arndt KA, Silapunt S, Alam M. Low-level laser therapy for wound healing: mechanism and efficacy. Dermatol Surg. 2005;31(3):334–40.

SKIN HEALTH

- Improved skin texture and elasticity
- Reduction in wrinkles and fine lines
- Clinical improvement in dermatologic conditions

Avci P, et al. Semin Cutan Med Surg. 2013;32(1):41–52.

IMMUNE MODULATION

CYTOKINES PROPOSED MECHANISMS

- MAY DECREASE IL-6, IL-1B, IL18, TNF ALPHA IN MANY MODELS (660NM-810NM)
- MAY INCREASE IL-10 AND TGF BETA
- INTERFERON GAMMA RESPONSE IS VARIABLE

Hamblin MR. Mechanisms and applications of the anti-inflammatory effects of photobiomodulation. AIMS Biophys. 2017;4(3):337–61.

COVID STUDY BRAZIL

PBM

- RCT
- 300 LEDS, 940NM
- 15 MIN/DAY X 7 DAYS
- HOSPITAL STAY SHORTENED BY 4 DAYS (STATISTICALLY SIGNIFICANT)
- IMPROVED SPO2, TIDAL VOLUME, RESPIRATORY RATE, HEART RATE, BLOOD PRESSURE VS CONTROL GROUP

Randomized Controlled Trial > J Photochem Photobiol B. 2023 Jan:238:112619.
doi: 10.1016/j.jphotobiol.2022.112619. Epub 2022 Dec 5.

Cardiopulmonary and hematological effects of infrared LED photobiomodulation in the treatment of SARS-COV2

Pâmela Camila Pereira [1], Carlos José de Lima [2], Adriana Barrinha Fernandes [2], Renato Amaro Zângaro [2], Antonio Balbin Villaverde [3]

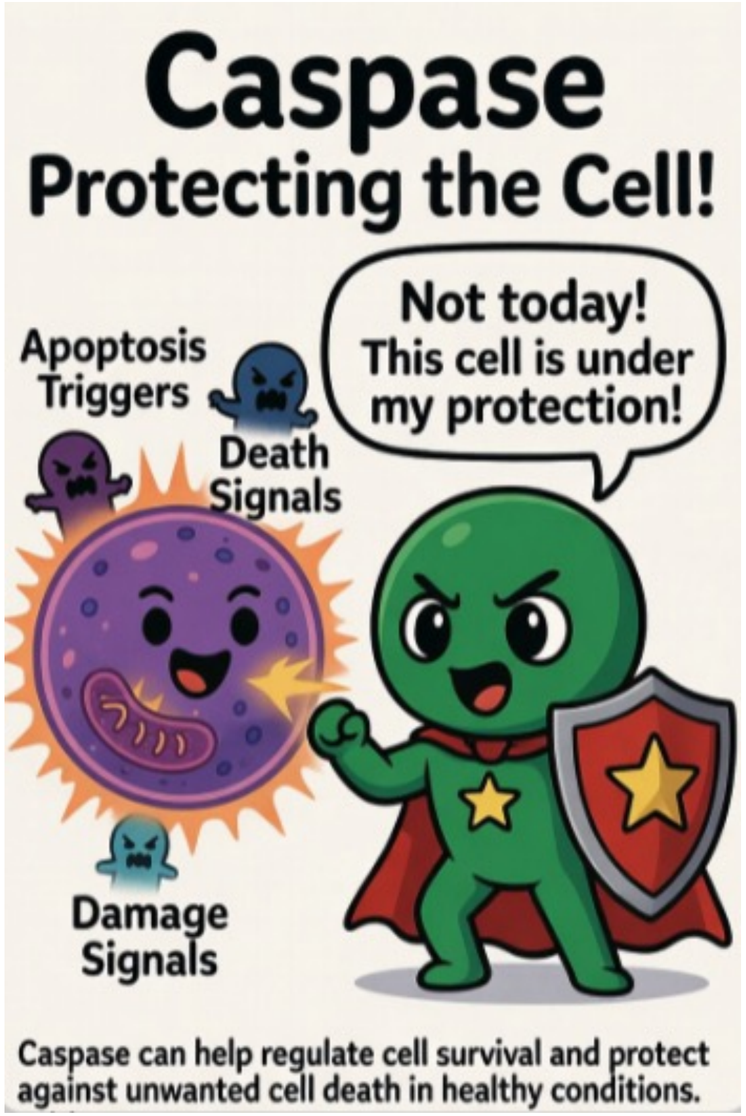
Affiliations + expand

PMID: 36495670 PMCID: PMC9721157 DOI: 10.1016/j.jphotobiol.2022.112619

CELL PROTECTION

CASPASES

- CASPASES CAN BE ANTI APOPTOTIC
- PBM IN MODELS UPREGULATES CASPASE 3,7,8,9
- ALSO UPREGULATES BCL-2 (ANOTHER ANTI APOPTOTIC PROTEIN)
- POTENTIAL FOR STUDIES IN CARDIAC AND NEUROPROTECTION IN ACUTE EVENTS
- ALSO PLAYS A ROLL IN WOUND HEALING



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IMMUNE CELL MODULATION

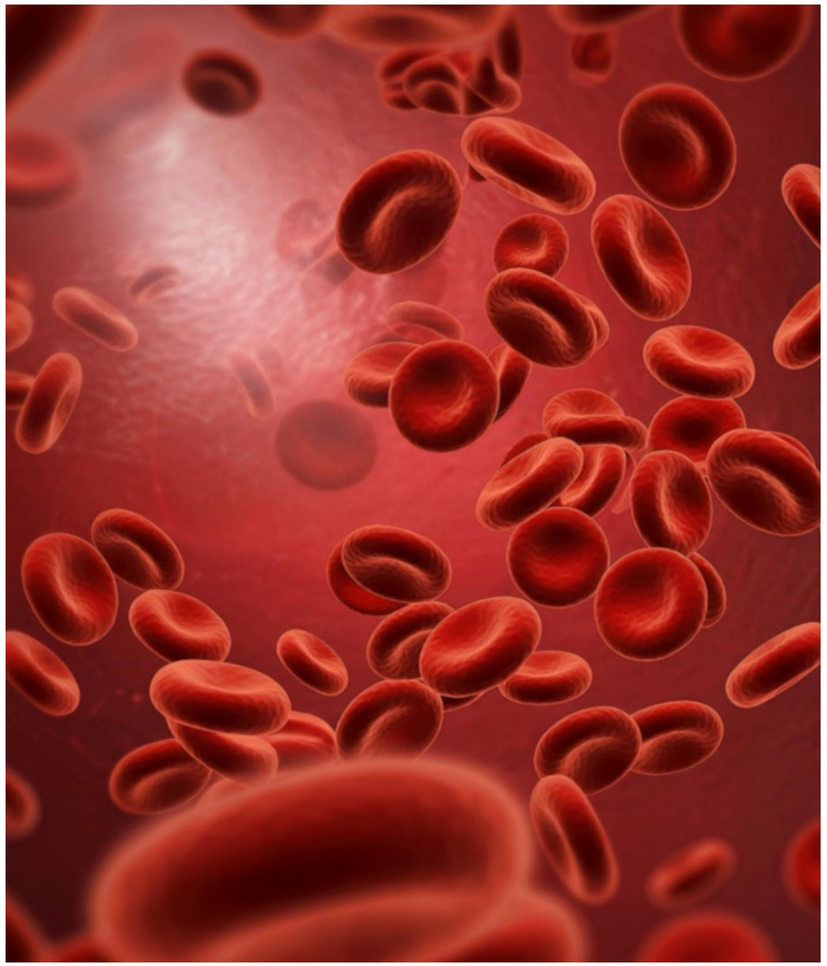
PBM

- MAY BENEFICIALLY SHIFT TH1/TH2 BALANCE IN MODELS
- INDUCES M2 MACROPHAGE POLARIZATION
- AFFECT TH17/T REG CELL BALANCE
- MAY DECREASE EFFECTOR CD4 PROLIFERATION VIA IL-10 UPREGULATION
- LUNG MODELS - DECREASED EDEMA AND NEUTROPHIL INFLUX
- IN MODELS MAY SUPPORT CD8 FUNCTION AND PROLIFERATION (POTENTIAL VIRAL AND CANCER FIGHTING EFFECTS)

Hamblin MR. Mechanisms and applications of the anti-inflammatory effects of photobiomodulation. AIMS Biophys. 2017;4(3):337–61.

CIRCULATION

- Improves blood flow
- Enhances oxygenation
- Supports tissue health



Karu TI. Mitochondrial signaling in mammalian cells activated by red and near-IR radiation. Photochem Photobiol. 2008;84(5):1091–9.

STEM CELLS

PBM

- 660NM AND 810NM INCREASED ATP IN STEM CELLS BY 15-20% IN ONE STUDY

- INCREASES VIABILITY, REDUCED AGEING MARKERS, INCREASED MIGRATION AND PROLIFERATION (BOTH ADIPOSE AND BONE MARROW SCs)

METABOLIC/ ENDOCRINE EFFECTS
PBM

- PRE MEAL PBM DECREASED POST MEAL GLUCOSE SPIKE BY 27%, COVERING THE AREA OF A 4X6INCH NOTE CARD. - STUDY BY GLEN JEFFREY, UK
- HAS IMPLICATIONS FOR DIABETES
- SOME EVIDENCE IN HASHIMOTO'S THYROIDITIS

SLEEP & RECOVERY

- May improve sleeps quality
- Supports circadian rhythm
- Enhances recovery

Hamblin MR. Shining light on the head: photobiomodulation for brain disorders. BBA Clin. 2016;6:113–24.

NEURO PSYCHIATRIC
PBM

- PROMISING HARVARD STUDIES ON DEPRESSION
- MAY TAKE WEEKS TO MONTHS OF CONSISTENCY

Review > Psychiatr Clin North Am. 2023 Jun;46(2):331-348. doi: 10.1016/j.psc.2023.02.013. Epub 2023 Mar 25.

Photobiomodulation: An Emerging Treatment Modality for Depression

Willians Fernando Vieira [1], Dan V Iosifescu [2], Kayla Marie McEachern [3], Maia Gersten [3], Paolo Cassano [4]

Affiliations + expand

PMID: 37149348 DOI: 10.1016/j.psc.2023.02.013

HAIR GROWTH

PBM

Review > Photodermatol Photoimmunol Photomed. 2021 Mar;37(2):91-98.
doi: 10.1111/phpp.12649. Epub 2021 Jan 13.

Photobiomodulation for the management of hair loss

Angeli Eloise Torres [1], Henry W Lim [1]

Affiliations + expand

PMID: 33377535 DOI: 10.1111/phpp.12649

- DEMONSTRATED IN MANY MODELS AND CASE STUDIES
- FOLLICLE STEM CELLS MUST STILL BE PRESENT
- MAY HAVE IMPLICATIONS IN FOLLICLE PROTECTION IN CHEMOTHERAPY
- HELPFUL IN ANDROGENIC ALOPECIA AND TELOGEN EFFLUVIUM

MUSCLE RECOVERY

- Reduction in pain and inflammation
- Improved recovery after acute injury
- Favorable outcomes in inflammatory conditions

Bjordal JM, Johnson MI, Iversen V, Aimbire F, Lopes-Martins RA. Low-level laser therapy in acute pain: a systematic review. Lancet. 2006;368(9543):2080–6.

PBM TIMING

- MORNING OR DAYTIME APPEARS TO BE MORE EFFECT BASED ON CIRCADIAN CLOCKS
- PREMEAL TREATMENT CAN DECREASE BLOOD SUGAR SPIKES
- INTERVENTION IMMEDIATELY AFTER INJURY MAY PRESERVE TISSUE
- AFTER SUNSET MAY BE DISRUPTIVE
- NOT WELL STUDIED
- CHRONOBIOLOGY? ALSO EAT DURING HOURS OF LIGHT. YOUR MITOCHONDRIA BECOME STRESSED AFTER SUNSET.

Review > Photobiomodul Photomed Laser Surg. 2025 Mar;43(3):81-82.
doi: 10.1089/photob.2024.0154. Epub 2025 Jan 29.

Optimal Timing of Photobiomodulation Therapy for Retinal Diseases: Leveraging Circadian Mitochondrial Rhythms

Rubens Camargo Siqueira [1 2]

Affiliations + expand

PMID: 39876708 DOI: 10.1089/photob.2024.0154

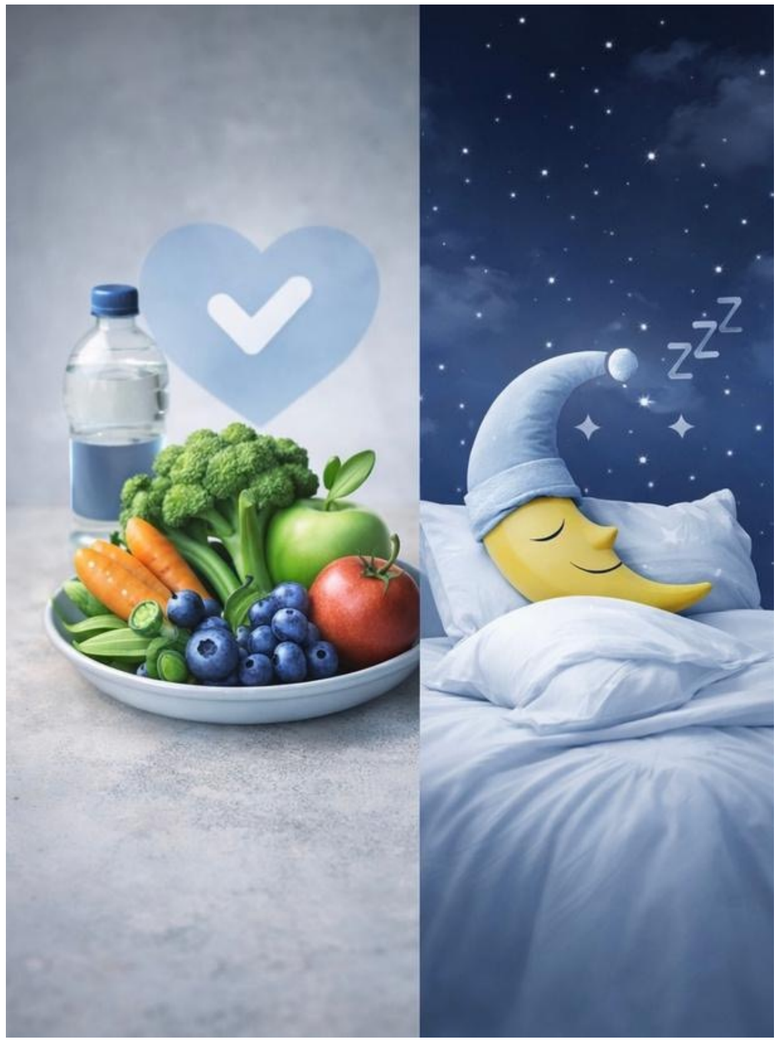
PBM STRONGEST EVIDENCE

- BIOLOGIC FOUNDATION FOR CIRCADIAN SIGNALING STRONG
- MECHANISMS PLAUSIBLE AND SUPPORTED BY EXPERIMENTAL LITERATURE
- MEANINGFUL CLINICAL TRACTION IN PAIN, WOUND, ORAL AND OPTHAMALOGIC SETTINGS
- EVIDENCE VARIES GREATLY BY INDICATION
- NOT MARKETED YET AS EVIDENCE BASED

HOLISTIC INTEGRATION

- Adjunct, non-invasive therapeutic modality
- May complement standard medical treatments
- Most evidence supports use in pain and dermatologic conditions
- Should not replace evidence-based therapies

Diet, Sleep, Exercise, & Sunlight



Hamblin MR. Photobiomodulation or low-level laser therapy. J Biophotonics. 2016;9(11-12):1122–4.

Chow RT, Johnson MI, Lopes-Martins RA, Bjordal JM. Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis. Lancet. 2009;374(9705):1897–908.

CLINICAL EVIDENCE OF PHOTOBIOMODULATION

>Significant pain reduction vs placebo (~70% in some studies)

>**Improved outcomes in musculoskeletal and inflammatory conditions**

>Accelerated wound healing and tissue repair

>Increased collagen production and skin improvement

Chow RT, Johnson MI, Lopes-Martins RA, Bjordal JM. Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis. Lancet. 2009;374(9705):1897–908.

Bjordal JM, Johnson MI, Iversen V, Aimbire F, Lopes-Martins RA. Low-level laser therapy in acute pain: a systematic review. Lancet. 2006;368(9543):2080–6.

Avci P, Gupta A, Sadasivam M, Vecchio D, Pam Z, Pam N, et al. Low-level laser (light) therapy (LLLT) in skin: stimulating, healing, restoring. Semin Cutan Med Surg. 2013;32(1):41–52.

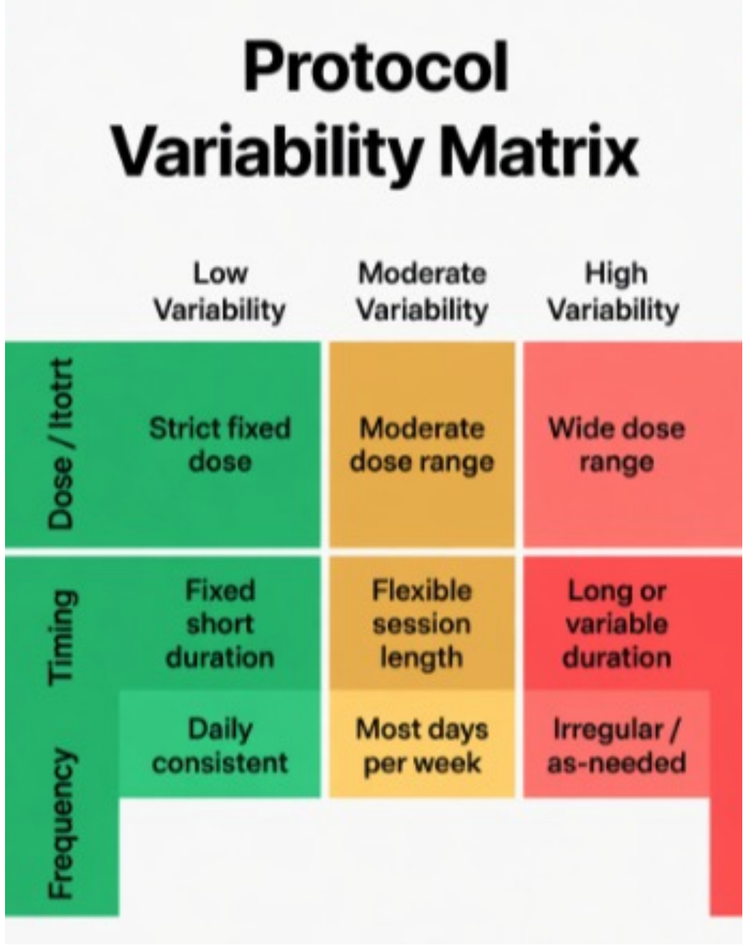
Posten W, Wrone DA, Dover JS, Arndt KA, Silapunt S, Alam M. Low-level laser therapy for wound healing: mechanism and efficacy. Dermatol Surg. 2005;31(3):334–40.

PBM PRELIMINARY

- NEUROLOGIC AND SYSTEMIC CLAIMS ARE EARLY STAGE
- SMALL SAMPLE SIZES
- PUBLICATION CAN OUTPACE REPLICATION
- LACK OF PROTOCOL AND DEVICE STANDARDIZATION

PBM EVIDENCE CONFLICTS

- DIFFERENT WAVELENGHTS
- DIFFERENT IRRADIANCE AND FLUENCE
- DIFFERENT PULSE (HZ) STRUCTURES AND TREATMENT INTERVALS
- DIFFERENT TISSUES AND DISEASE STATES
- DIFFERENT ENDPOINTS AND FOLLOW UP PERIODS



Chow RT, et al. Lancet. 2009;374(9705):1897–908.

LIMITATIONS

- Variability in treatment protocols
- Heterogeneity across studies
- Limited standardization in clinical trials
- Need for larger randomized studies

Chow RT, et al. Lancet. 2009;374(9705):1897–908.

CONTROVERSIES

- Overhyped claims
- Lack of standardization
- Need for more trials

Bjordal JM, Johnson MI, Iversen V, Aimbire F, Lopes-Martins RA. Low-level laser therapy in acute pain: a systematic review. Lancet. 2006;368(9543):2080–6.

FUTURE DIRECTIONS

- Expanded clinical trials
- Standard protocols
- Integration in medicine

de Freitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE J Sel Top Quantum Electron. 2016;22(3):7000417.

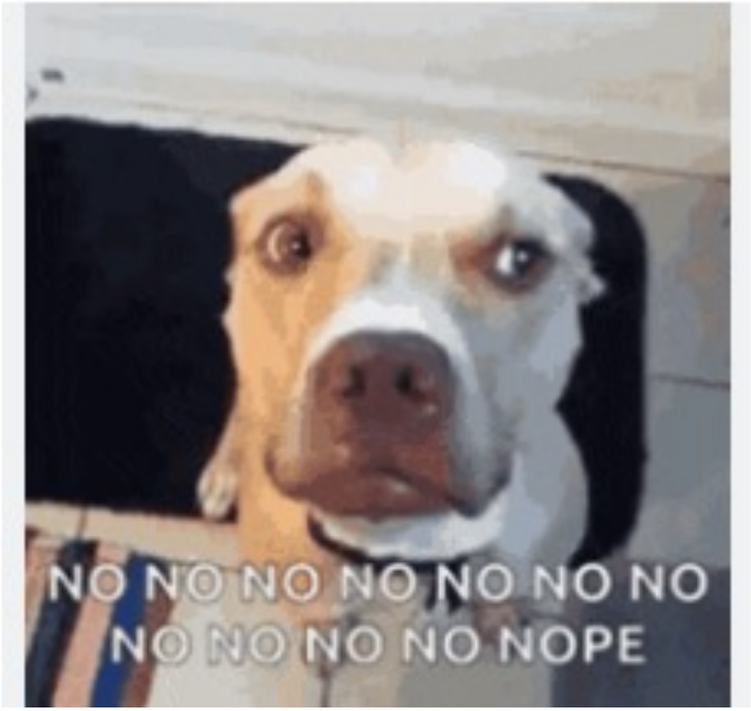
SAFETY, CAUTIONS, OVERSTATEMENT

- NON THERMAL DOES NOT MEAN RISK FREE
- DON'T USE LASERS IN EYES
- PHOTOSENSITIVITY, MALIGNANCY CONCERNS, DEVICE MISUSE REQUIRE JUDGEMENT
- MORE ENERGY IS NOT ALWAYS BETTER (GOLDILOCK ZONE)
- MARKETING LANGUAGE MAY EXCEED EVIDENCE

Bjordal JM, Johnson MI, Iversen V, Aimbire F, Lopes-Martins RA. Low-level laser therapy in acute pain: a systematic review. Lancet. 2006;368(9543):2080–6.

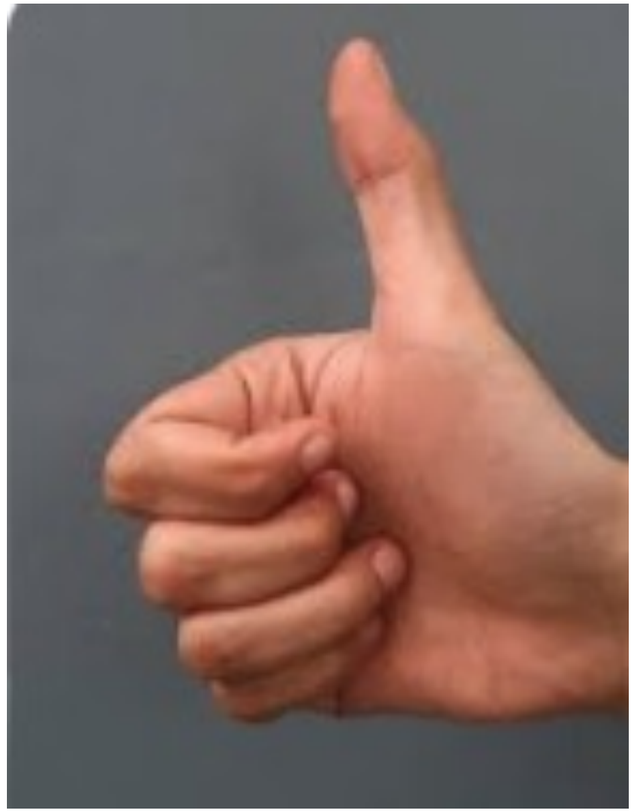
PBM - WHAT IT IS NOT

- IT IS NOT UV THERAPY (THAT IS ANOTHER LONG LECTURE) SEE THE PUBLICATIONS OF RICHARD WELLER, MD DERMATOLOGIST
- IT IS NOT TANNING
- IT IS NOT SIMPLY WARMTH
- IT IS ABSOLUTELY NOT A SUBSTITUE FOR GOOD CIRCADIAN LIGHT HYGIENE
- IT IS NOT A JUSTIFICATION FOR PAN-DISEASE CLAIMS



PBM PRACTICAL CLINICAL TAKEAWAYS

- RESTORE DAYLIGHT FIRST, ESPECIALLY MORNING LIGHT EXPOSURE
- REDUCE MISTIMED EVENING MELANOPIC EXPOSURES
- USE PBM WITH ATTENTION TO WAVELENGTH, DOSE, TISSUE AND TIMING
- MATCH CLAIMS TO EVIDENCE
- THINK IN SYSTEMS: RETINA, CLOCK, MITOCHONDRIA, BEHAVIOR, METABOLISM
- THINK OF PBM AS COMPLEMENTARY NOT COMPETITIVE



CONCLUSION

- Promising but evolving therapy
- Strong cellular basis
- Best used as adjunct treatment

Hamblin MR. Photobiomodulation or low-level laser therapy. J Biophotonics. 2016;9(11-12):1122–4.

DON'T FORGET THESE

- LIGHT IS A BIOLOGIC REGULATOR, NOT JUST AN ENVIRONMENTAL BACKDROP
- THE EYE IS THE GATEWAY TO CIRCADIAN AND NEUROENDOCRINE CONTROL
- RED AND NIR MAY MODULATE MITOCHONDRIA IN USEFUL WAYS
- TIMING, DOSE, AND TISSUE CONTEXT DETERMINE OUTCOMES
- THE FUTURE IS INTEGRATIVE, BUT MUST BE EVIDENCE BASED, WITH MUCH RESEARCH YET TO BE DONE

SUNLIGHT - “THERE IS NO ALTERNATIVE (TINA)”

- DR. JACK KRUSE

OTHER VISIBLE AND NON-VISIBLE WAVELENGTHS OF INTEREST

- GREEN
- BLUE (YES, I SAID BLUE)
- AMBER/YELLOW/ORANGE
- UVA/UVB


Light Therapy by Color:
Wavelengths, Penetration & Uses
Epidermis
0.5-1 mm
Dermis
Subcutaneous
Blue Light (405-470 nm)
Penetration: Epidermis only (~0.5-1 mm)
Main Uses: Acne (kills P. acnes bacteria, reduces inflammation & oil)
Green Light (495-570 nm)
Penetration: Upper to mid Dermis (~1-2 mm)
Main Uses: Migraines (reduces frequency/intensity/photoyhobia), chronic pain
Yellow/ Amber Light (570-590 nm)
Penetration: Mid Dermis (~2 mm)
Main Uses: Redness, rosacea, flushing, sensitive skin, post-procedure calming
Orange Light (590-620 nm)
Penetration: Mid Dermis (~2-3 mm)
Main Uses: Skin radiance, mild discoloration, improved circulation, glow
Blue + Red Combination (415-470 nm) (630-660 nm)
Penetration: Epidermis + Dermis
Main Uses: Moderate/severe acne (bacteria killing + healing)
UVB Narrowband (311-313 nm)
Penetration: Epidermis only
Main Uses: Psoriasis, vitiligo, eczema (medical phototherapy)
Bright White / Full-Spectrum (broad visible, high intensity)**
Penetration: Eyes & circadian system (not skin)
Main Uses: Seasonal Affective Disorder (SAD), mood, circadian rhythm


EASY BEING GREEN. IT IS NOT.


FINALLY
SUNSHINE


HELLO SUNSHINE MY OLD FRIEND...


Dont let
ANYONE
take your
sunshine!


I have seen the light!


THANK YOU!

Thank you

For more medical education visit
www.IMAhealth.org

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