LED

Introduction

LED stands for Light Emitting Diode. Now it has become a house hold name because light bulbs using this technology are superior in brightness n more economical than traditional bulbs. Today we are going to focus on the regenerative applications of LED. We call this biological effect on cells photobiomodulation. Light ,based on its wave length has varied and specific effect on cells.

Light Therapy

- is also commonly referred to as…
  - Light Emitting Diode Therapy (LEDT)
  - LED Light Therapy
  - Photo Biostimulation
  - Cold Laser
  - Photo Biomodulation
  - Low Power Laser Therapy (LPLT)
  - Low-Level Laser Therapy (LLLT)

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of photons. The term “laser” originated as an acronym for light amplification by stimulated emission of radiation. In essence, LLL brings energy into cells as photons. An “energized” cell we know, functions and regenerates itself better. We will review studies that demonstrates the healing effects of LLL. The key to this end result however depends on many factors some we have not absolutely figured out.

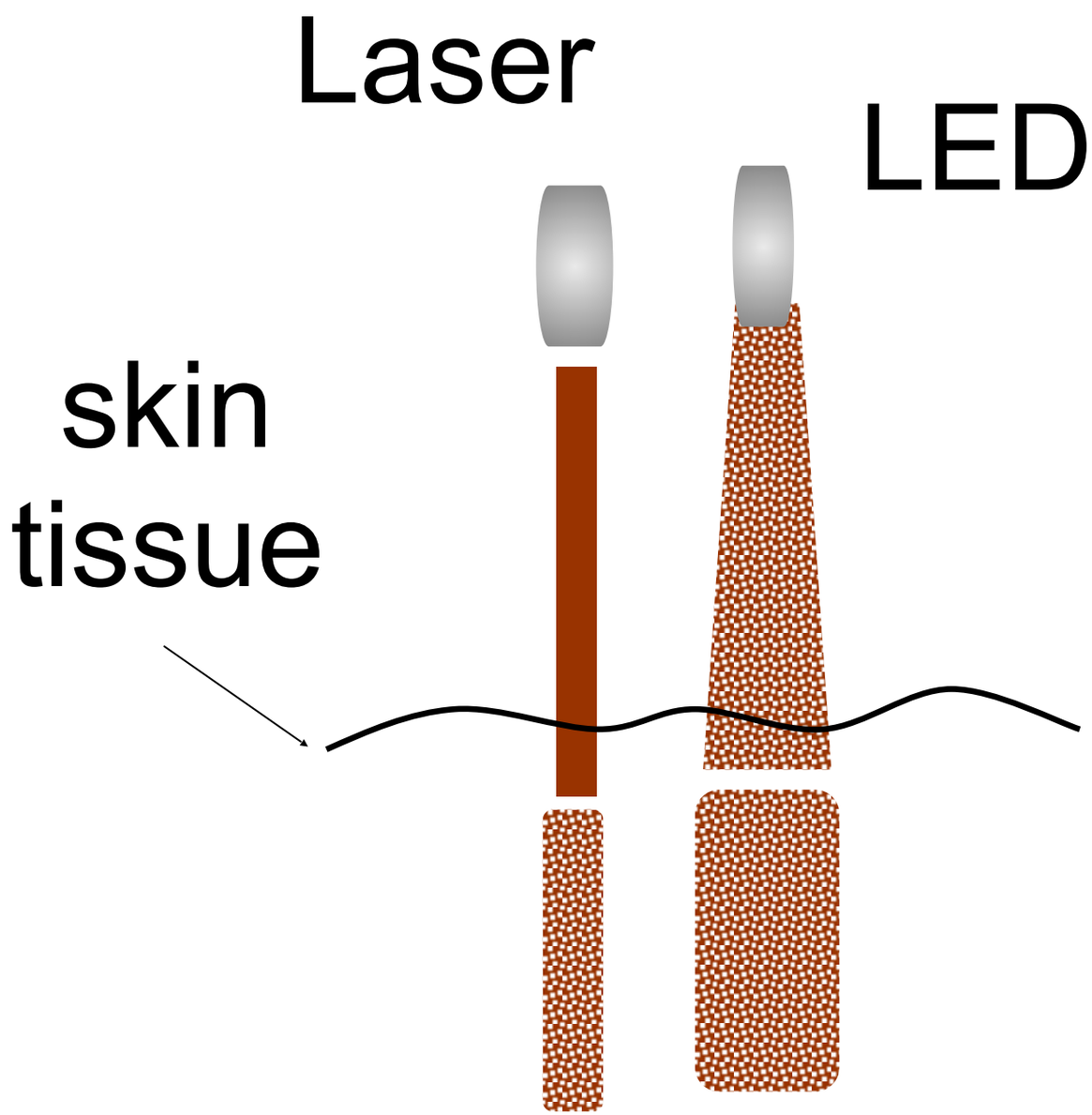
Low level laser therapy (LLLT),or photobiomodulation, caught the attention of scientists as far back as the mid 1960's. We consider Endre Master who worked at the Semmelweis University to be one of the pioneer investigators of cellular effects of light. He brought the effects of low level light to the attention of the medical world. He was the first to demonstrate its effect by demonstrating improved hair growth, reduced inflammation/edema. Consistently over the years other researchers have shown LED to slow down joint deterioration, improve bone health, aid in wound healing, repair neurological disorders and pain. *

*The Nuts and Bolts of Low-level Laser (Light) Therapy -

Ann Biomed Eng. Author manuscript; available in PMC 2013 Feb 1.
Published in final edited form as:
Ann Biomed Eng. 2012 Feb; 40(2): 516–533.
Published online 2011 Nov 2. doi: 10.1007/s10439-011-0454-7

PMCID: PMC3288797
NIHMSID: NIHMS339992

Lasers vs. LED



Before a laser penetrates tissue, it is collimated and coherent. An LED is scattered particles of light which is non-collimated and non-coherent.

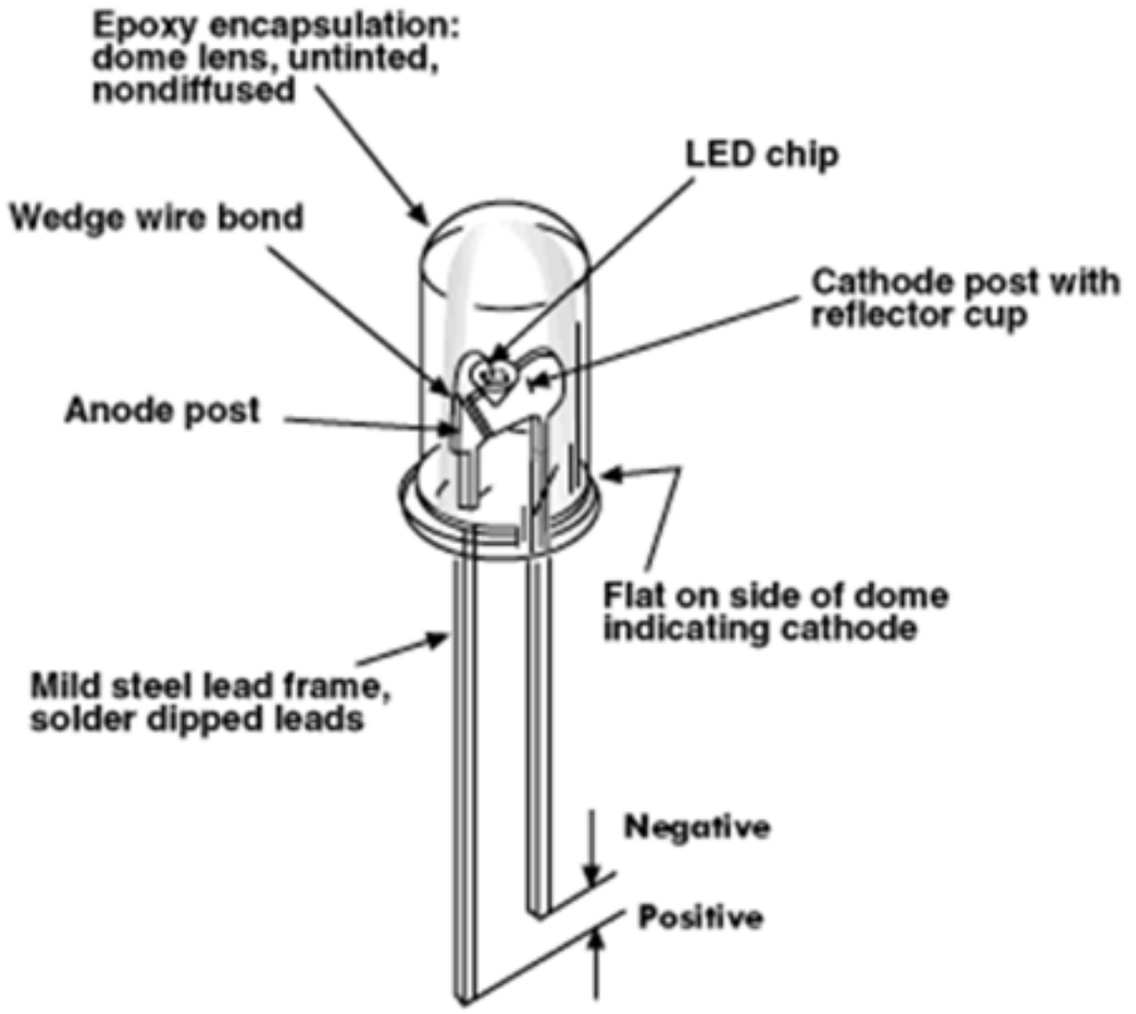
Once light from a laser passes through the first millimeter of tissue, it becomes scattered and losses it collimated and coherent properties.

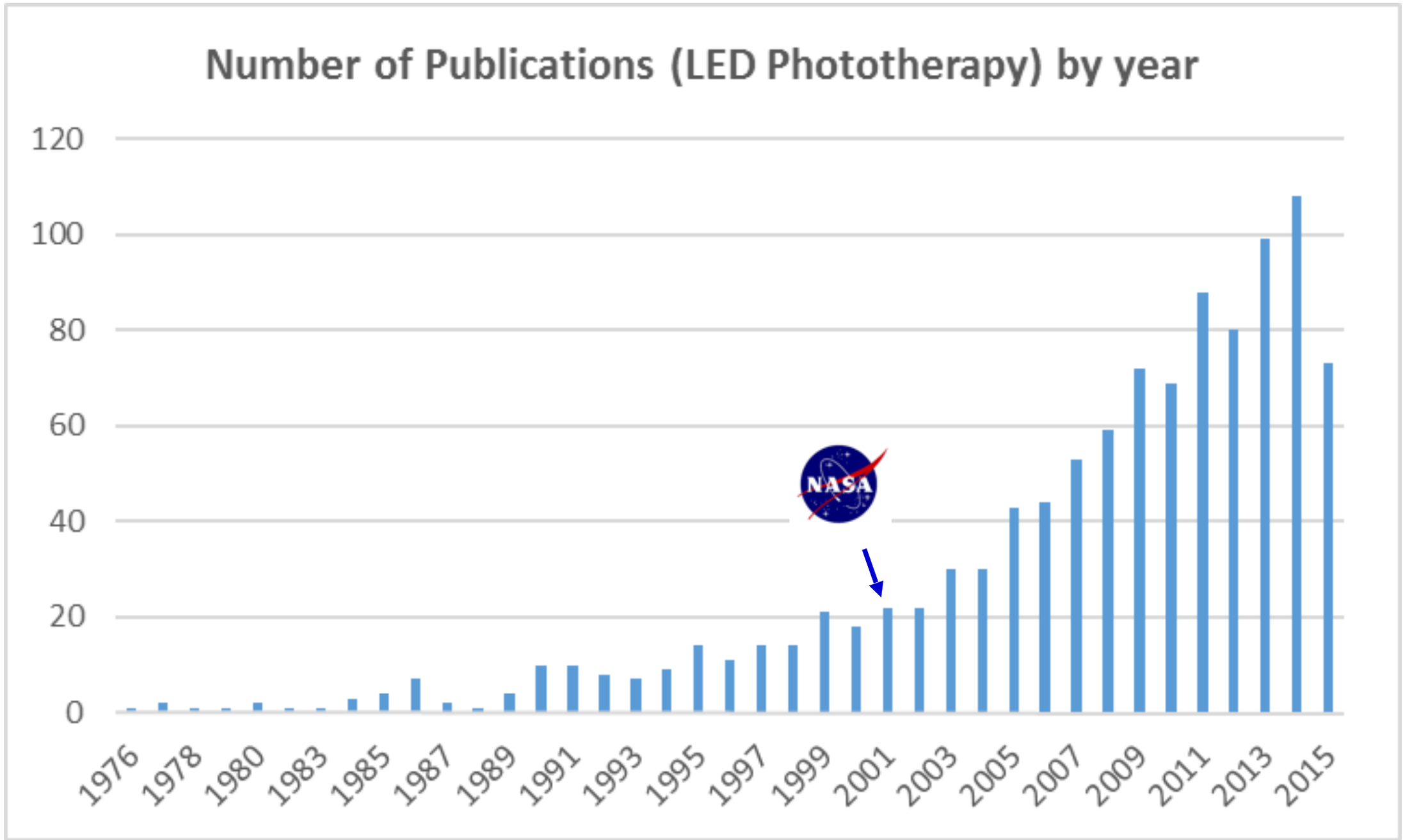
Light Emitting Diodes

- A semiconductor light source that emits photons of light when an electric current passes through it.
- In basic terms, LED's are small light bulbs that emit narrowband, low intensity light energy from the ultraviolet, visible and infrared part of the light spectrum.

- As LED's do not use filaments for illumination this minimises loss of energy as heat -providing a safe, non-thermal skin care treatment.

- They allow hands free, uniform irradiation of large areas of the body

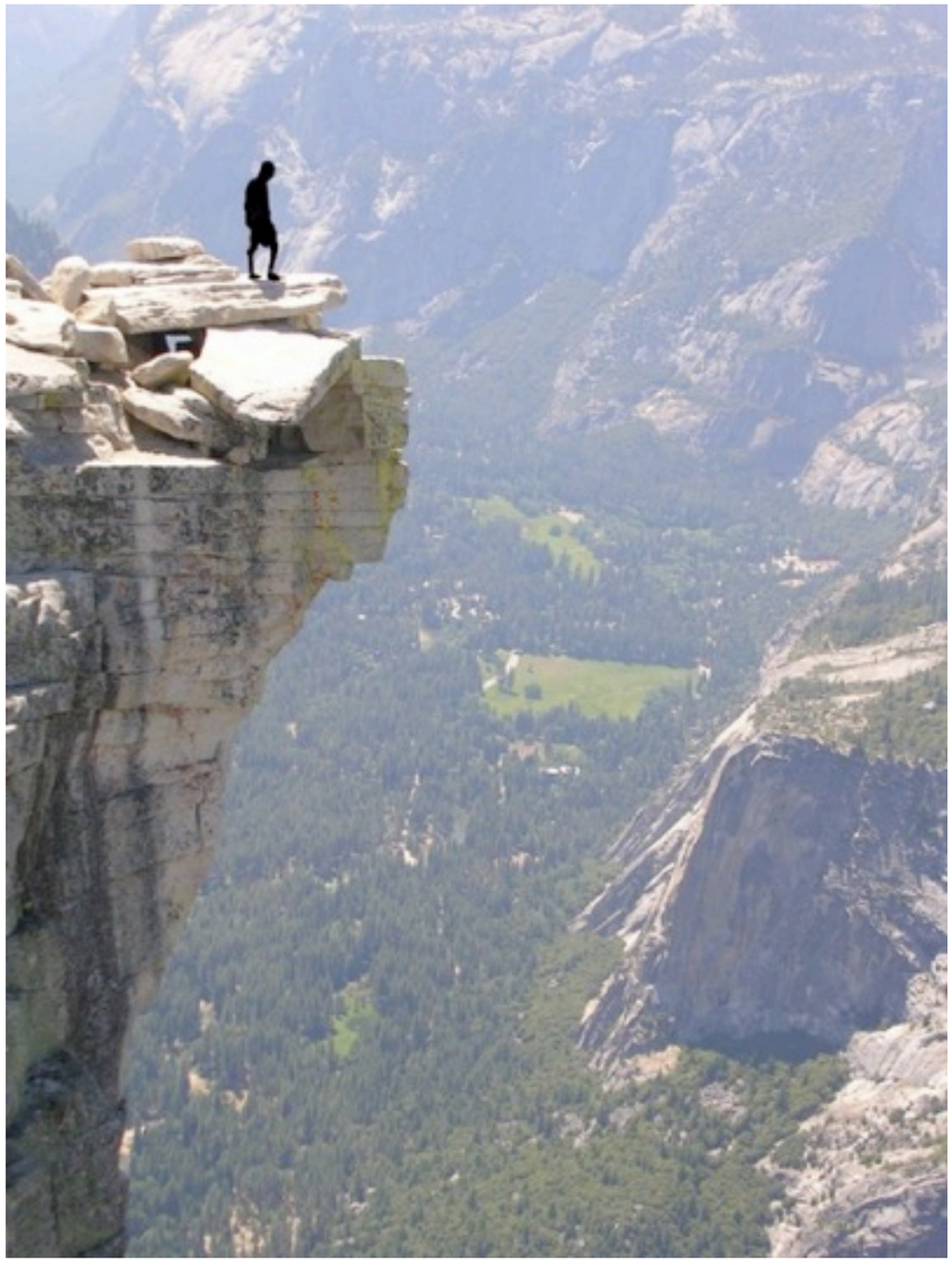




NASA - examined the use of light in space to encourage plant growth and discovered that it stimulated cellular repair helping to promote wound healing and human tissue growth.

Whelan, Harry T., et al. "Effect of NASA light-emitting diode irradiation on wound healing." Journal of clinical laser medicine & surgery 19.6 (2001): 305-314.

Light Therapy – Poised on the fringes



Light Therapy appears to be currently poised as a fringe science moving toward true legitimacy as photoscience that should eventually with continued research progress to mainstream science.

Ravindra Arany P.
Photomedicine and laser surgery Vol 30, 9.2012

Is it Time to Consider Photobiomodulation
As a Drug Equivalent?
Photomedicine & Laser Surgery.
Trina Karu,PhD,drSci Vol 31, Number 5, 2013

Laser Photobiomodulation of Gene Expression and Release of Growth Factors and Cytokines from Cells in Culture: A Review of Human and Animal Studies
Philip V. Peplow, Tzu-Yun Chung, Brigid Ryan, and G. David Baxter. Photomedicine and Laser Surgery. May 2011, 29(5): 285-304.

Understanding Light Therapy Parameters

In order for light therapy to work for anti aging, photon energy must be able to **penetrate** into the body and be **absorbed** by the target tissue and cells within the body.

Penetration and **absorption** are dependent upon many factors including:



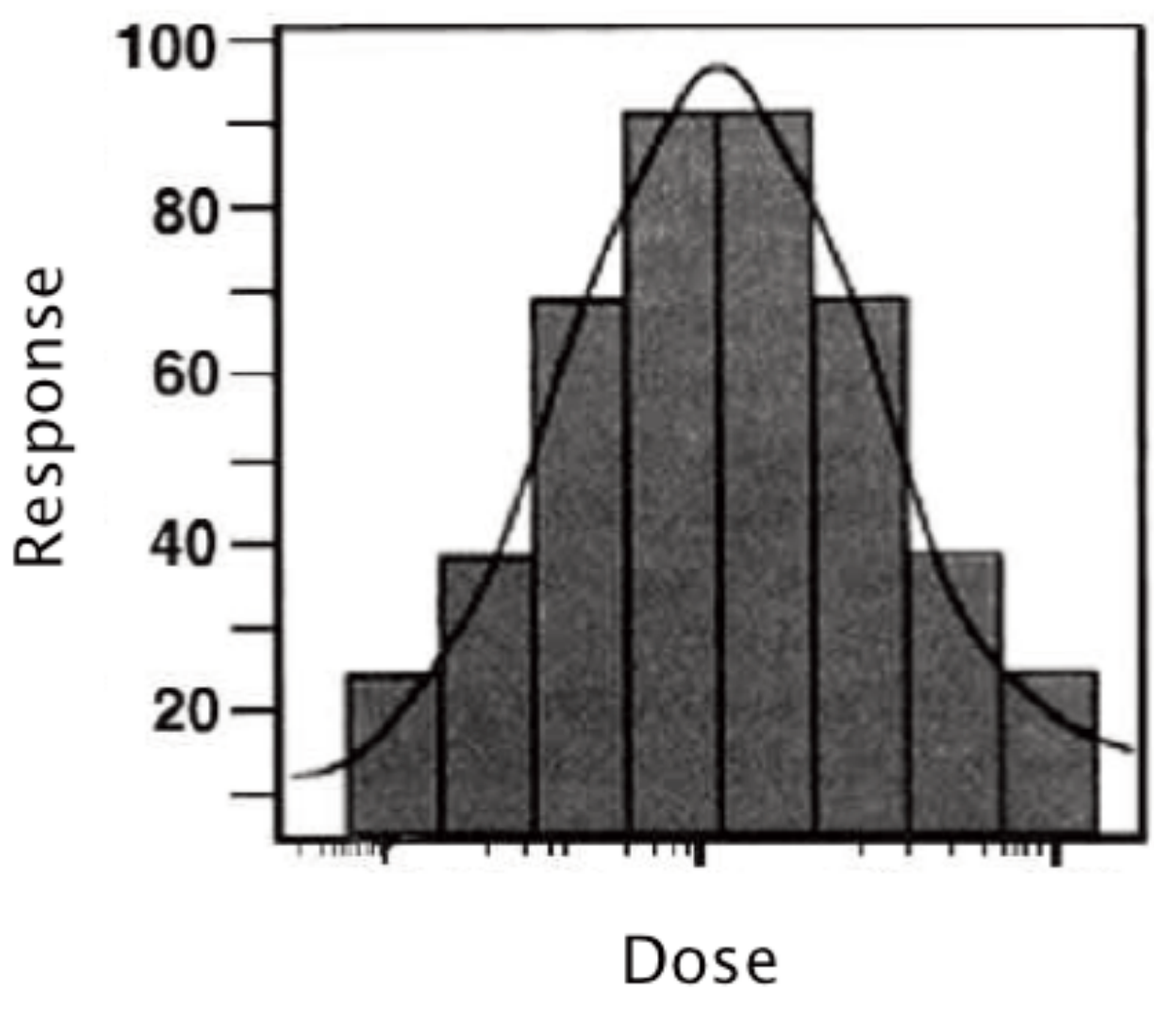
- Wavelength
- power output/treatment time
- design and delivery of the light therapy system
- Distance of light source from tissue
- Duration of light exposure and frequency of treatment

No penetration or absorption = no change

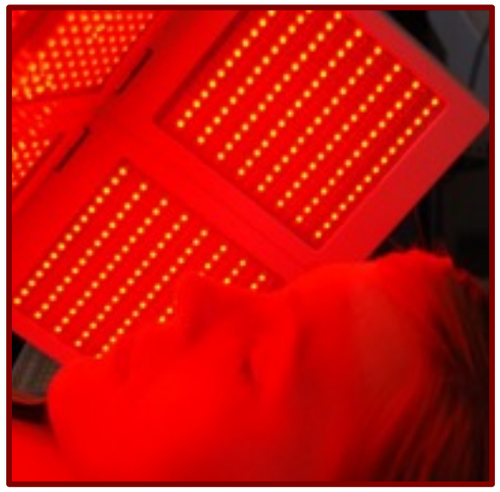
Phototherapy reaches a threshold point at which increases in dose inhibit biological systems.

Arndt-Schulz curve

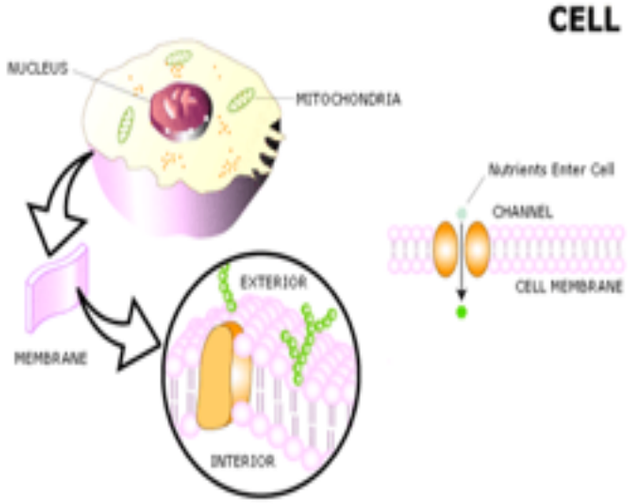
Sommer, Andrei P., et al. "Biostimulatory windows in low-intensity laser activation: lasers, scanners, and NASA's light-emitting diode array system." Journal of clinical laser medicine & surgery 19.1 (2001): 29-33.



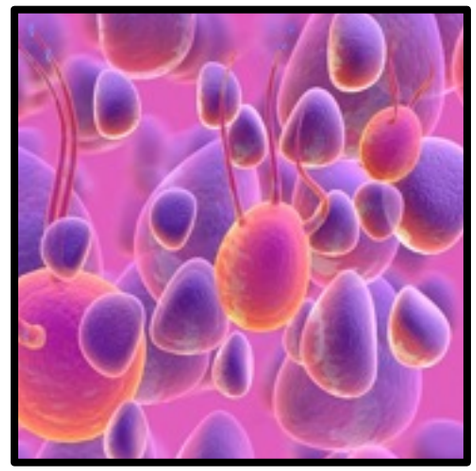
Light Therapy Overview



First, the body is exposed to light energy known as photons.



Next, the biological systems within the body come in contact with these photons. Then the photons may either be absorbed, reflected, or pass right through.



Finally, if the photons are absorbed, the Mitochondria is activated to stimulate ATP production augmenting cell regeneration and angiogenesis.

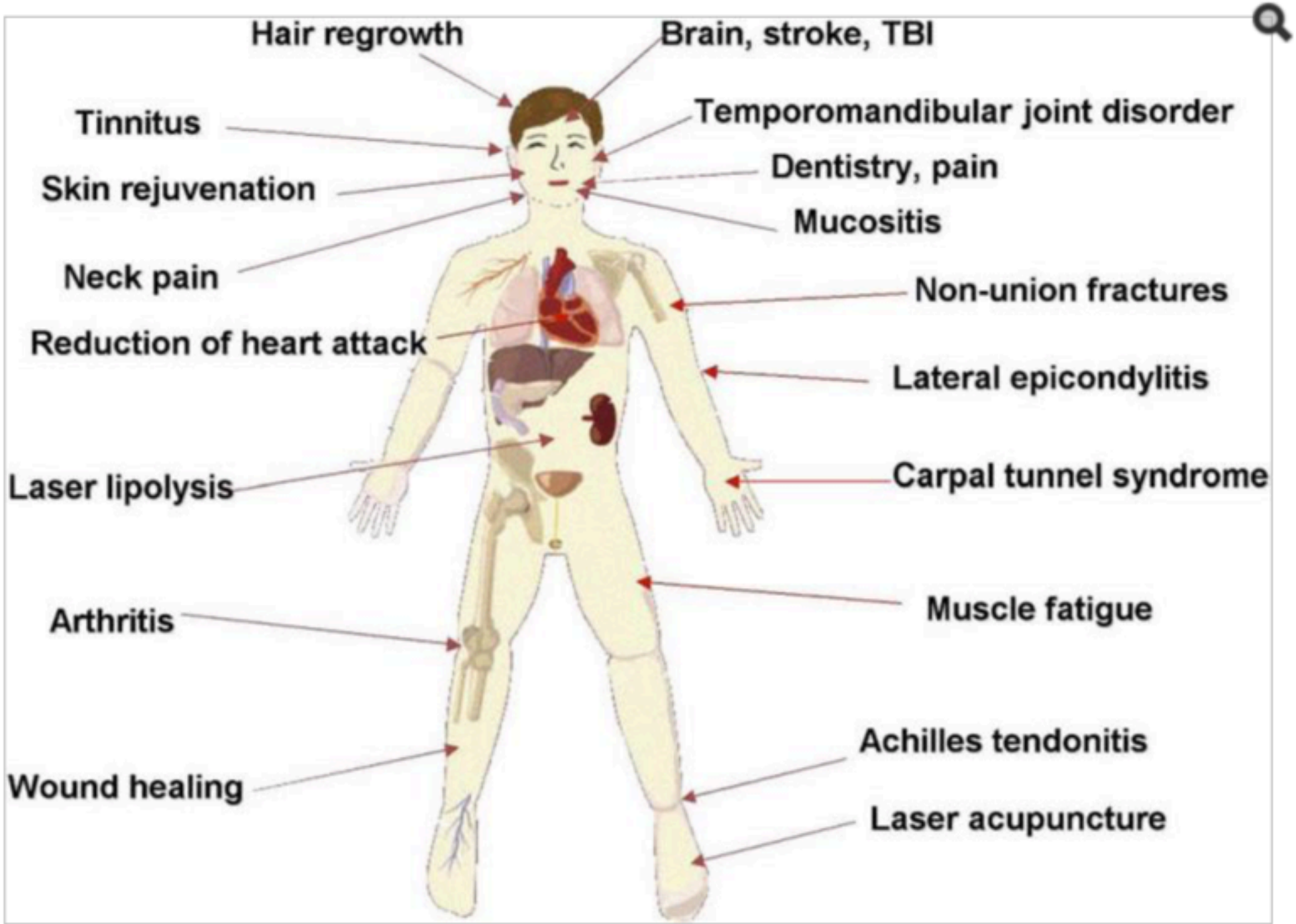


Diagram of the various medical applications of low-level light therapy.

PM R. 2010 Dec;2(12 Suppl 2):S292-305. doi: 10.1016/j.pmrj.2010.10.013.

Role of low-level laser therapy in neurorehabilitation.

Hashmi JT[1], Huang YY, Osmani BZ, Sharma SK, Naeser MA, Hamblin MR.

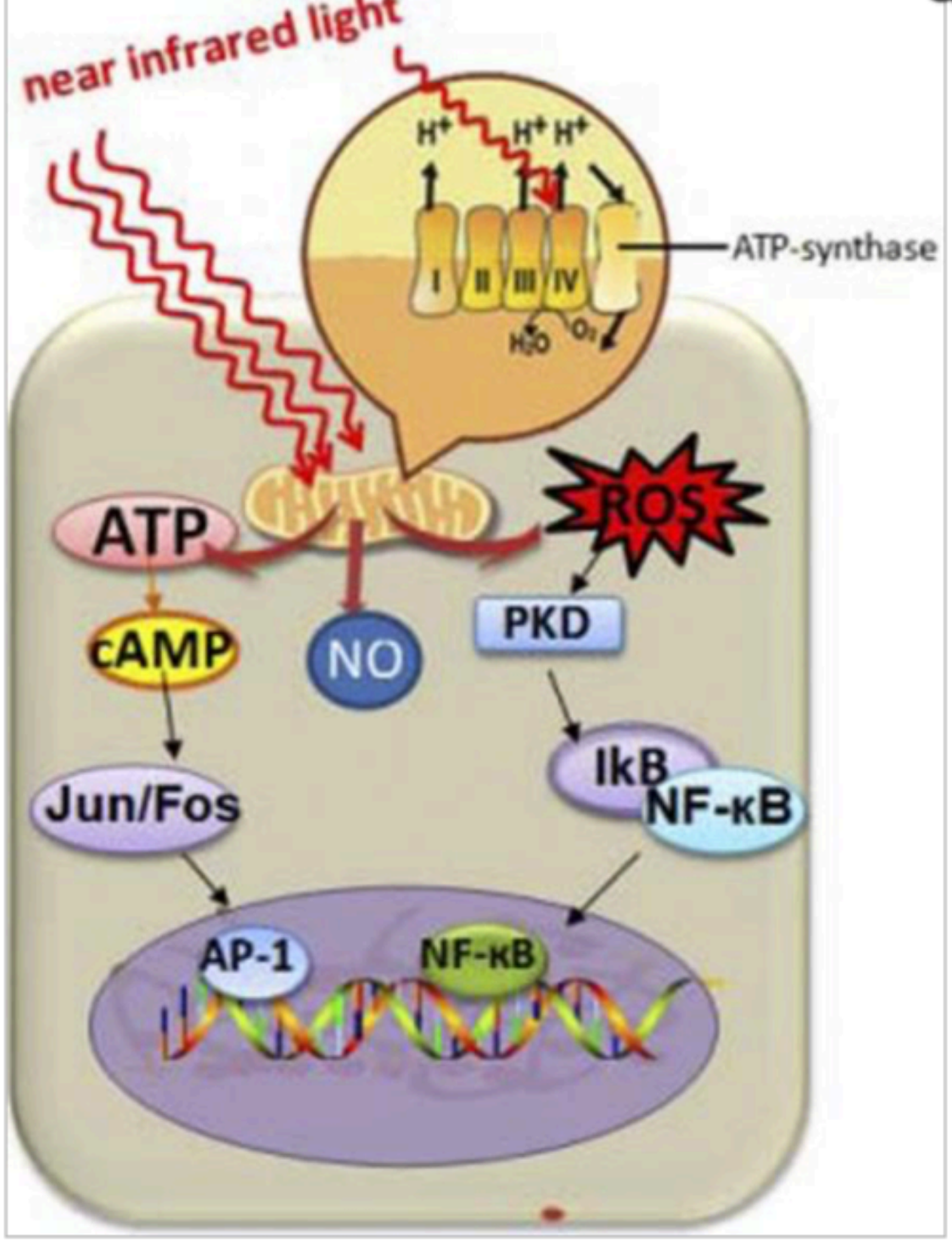


Diagram that illustrates LLLT is absorbed by the mitochondria, causing up regulation of the cellular respiratory chain. This causes a cascade of other chemical reactions that produce NO, reactive oxygen species, cyclic adenosine monophosphate and other cell healing molecules .

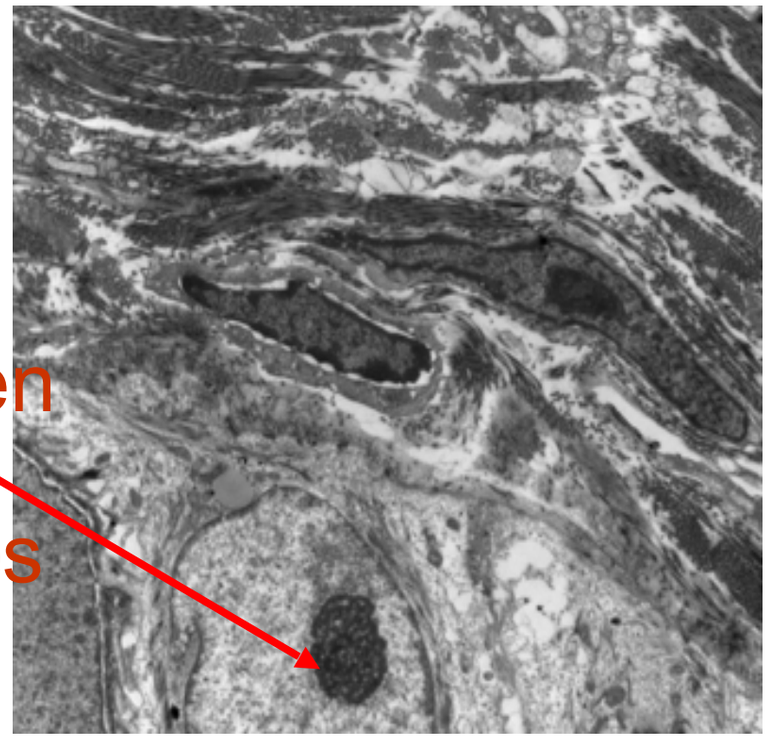
PM R. 2010 Dec;2(12 Suppl 2):S292-305. doi: 10.1016/j.pmrj.2010.10.013.

Role of low-level laser therapy in neurorehabilitation.

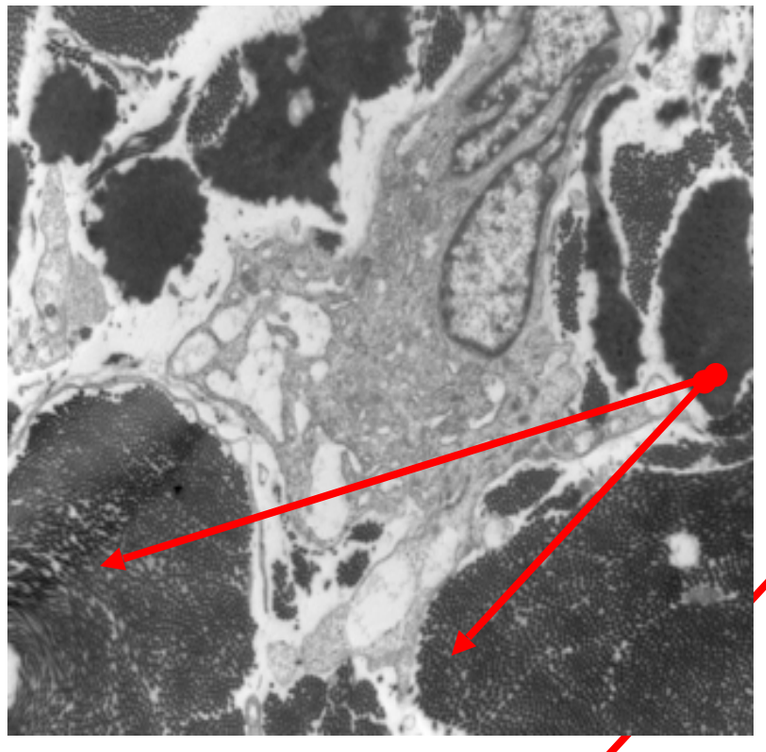
Hashmi JT[1], Huang YY, Osmani BZ, Sharma SK, Naeser MA, Hamblin MR.

PRODUCTION OF ATP

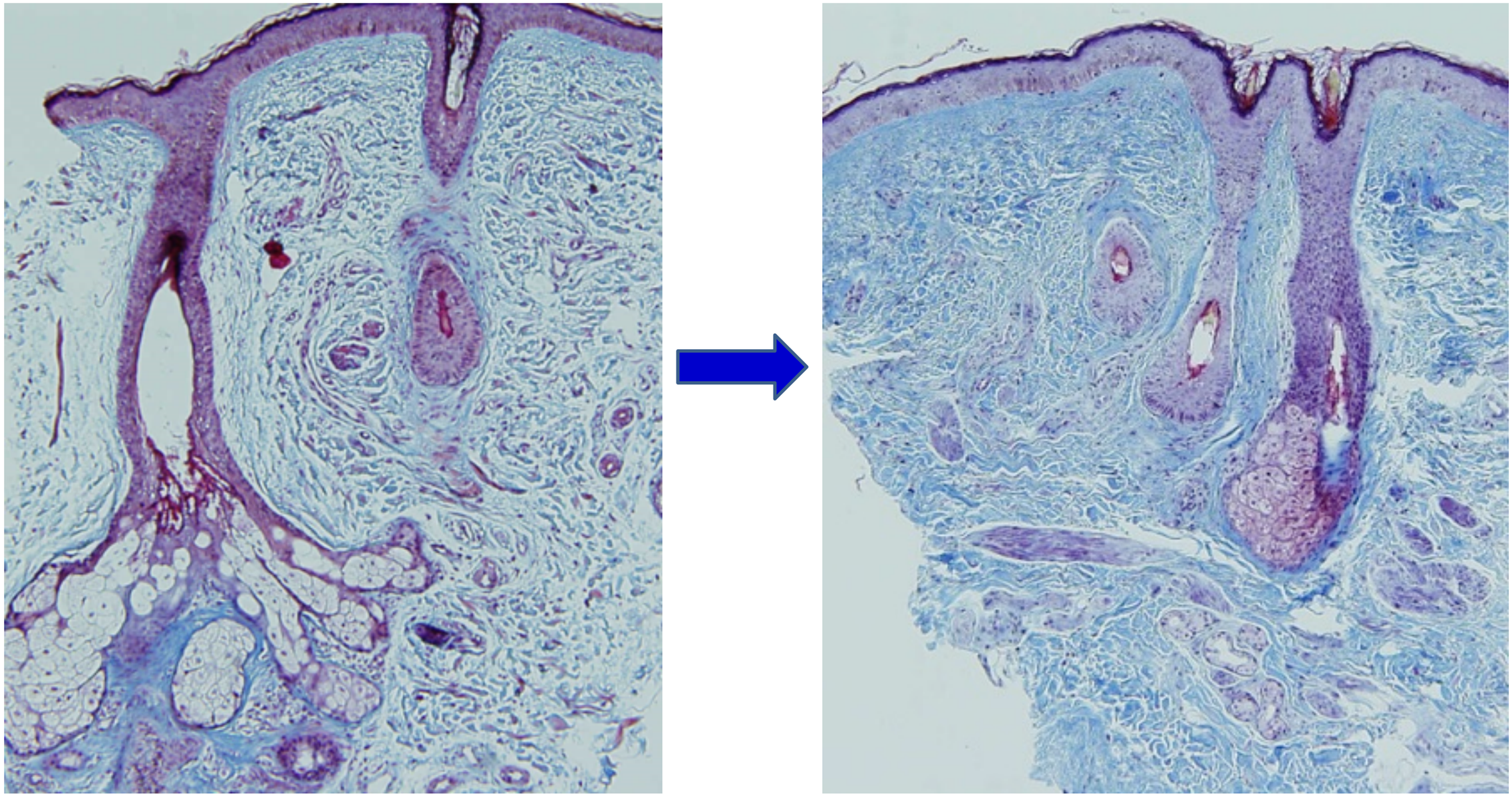
ATP increases the activity of cells. This increases cell productivity, the healing process, and collagen formation.



Before light therapy



6 months following light therapy sessions

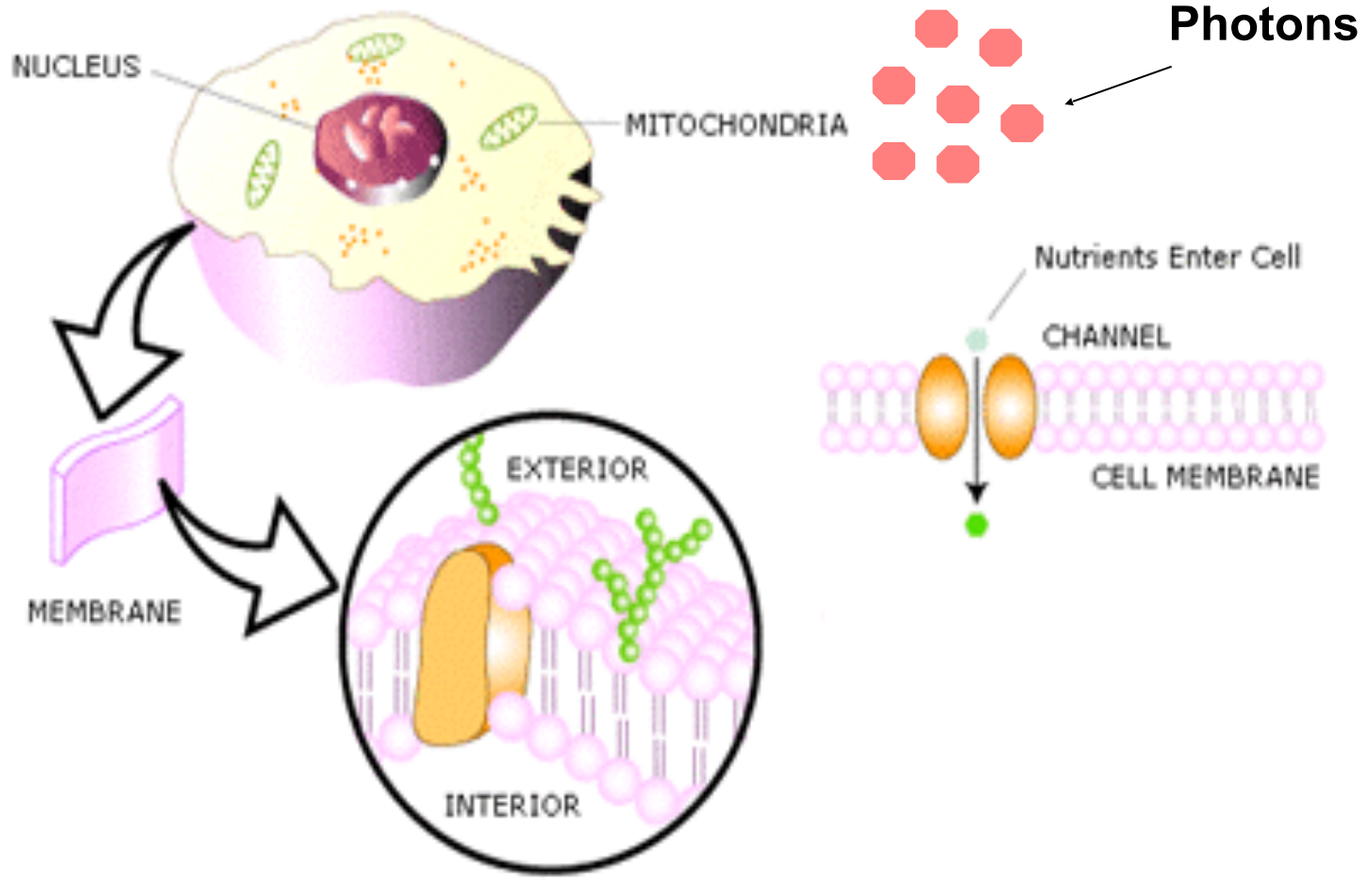


Ultrastructural changes in skin @ 6 weeks. Particular emphasis on collagen deposition. Increases in tighter better organized collagen

Lee SY et al. ‘A prospective, randomized, placebo-controlled, double-blinded, and split-face clinical study on LED phototherapy for skin rejuvenation: Clinical, profilometric, histologic, ultrastructural, and biochemical evaluations and comparison of three differenttreatment settings.’ Journal of Photochemistry and Photobiology B: Biology 88; (2007): 51–67

Understanding Wavelength

All cells have a unique absorption spectrum which determines which wavelengths (color) of energy will be absorbed, reflected or pass right through.



Light must be absorbed by the body to produce a biological response. No absorption = No change

Basic Understanding of Light Therapy

WAVELENGTH	Skin Cytogenic Effect on P.acnis	Fibroblast Connective Tissue and collagen	Mast Wound healing Anti-inflammatory Anti-edema	Macrophage Digest bacteria and other excess material	Scalp Hair restoration by increased NO
Blue Light 420nm	XX				
Red Light 630-670nm		XXX	XX	XX	XX
IR Light 830-880nm		X	XXX	XXX	

Infrared LLLT has been shown to also alleviate myofascial pain *1 and osteoarthritis *2

*1 PubMed

Clin J Pain. 1989 Dec;5(4):301-4.

Diode laser in cervical myofascial pain: a double-blind study versus placebo.

Ceccherelli F[1], Altafini L, Lo Castro G, Avila A, Ambrosio F, Giron GP.

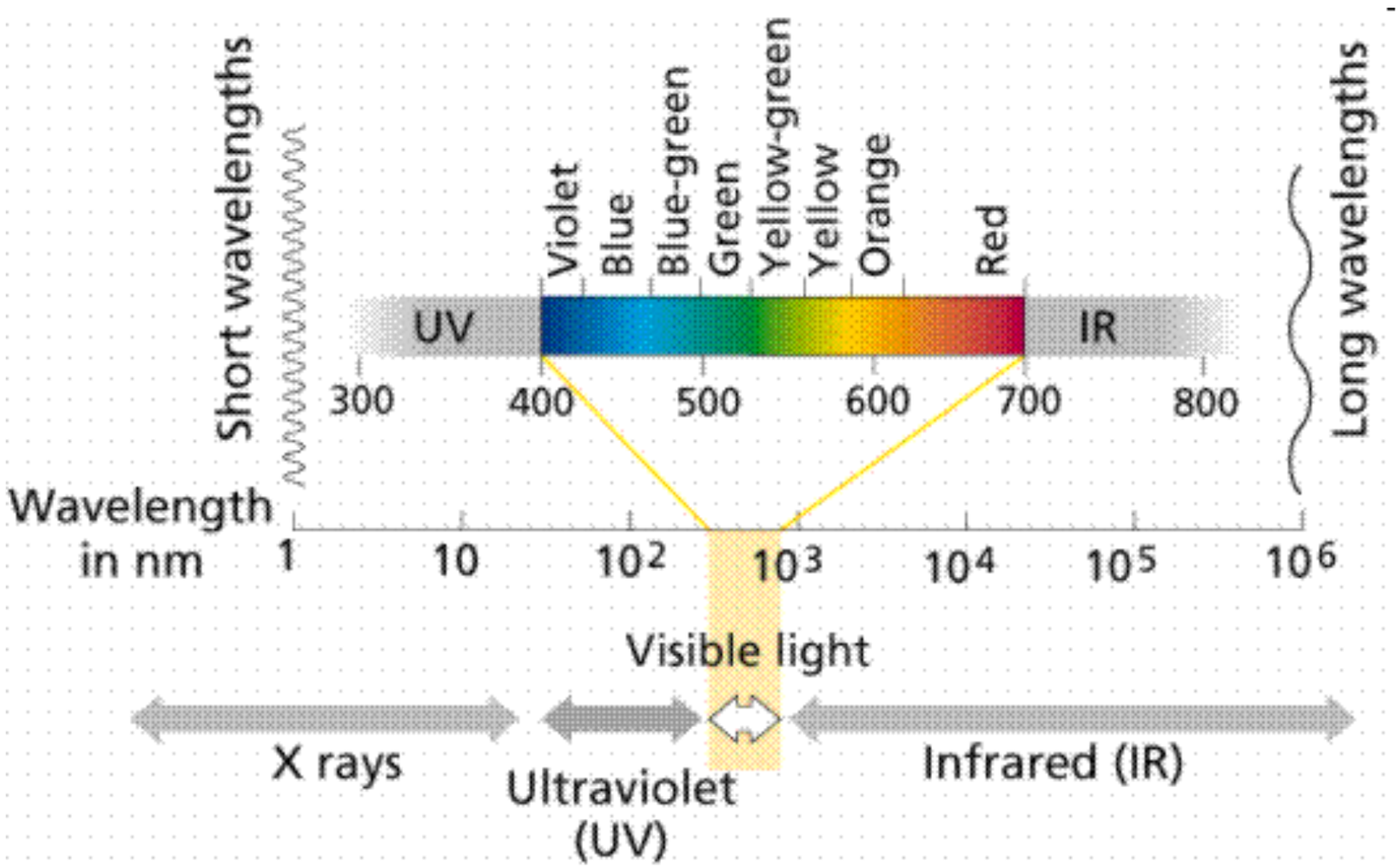
*2 PubMed

J Am Geriatr Soc. 1992 Jan;40(1):23-6.

Improvement of pain and disability in elderly patients with degenerative osteoarthritis of the knee treated with narrow-band light therapy.

Stelian J[1], Gil I, Habot B, Rosenthal M, Abramovici I, Kutok N, Khahil A.

Wavelength and depth of penetration



Generally, the shorter the wavelength the less it penetrates and the quicker it is absorbed by the body.

Light must <u>penetrate</u> into the body to produce a response.

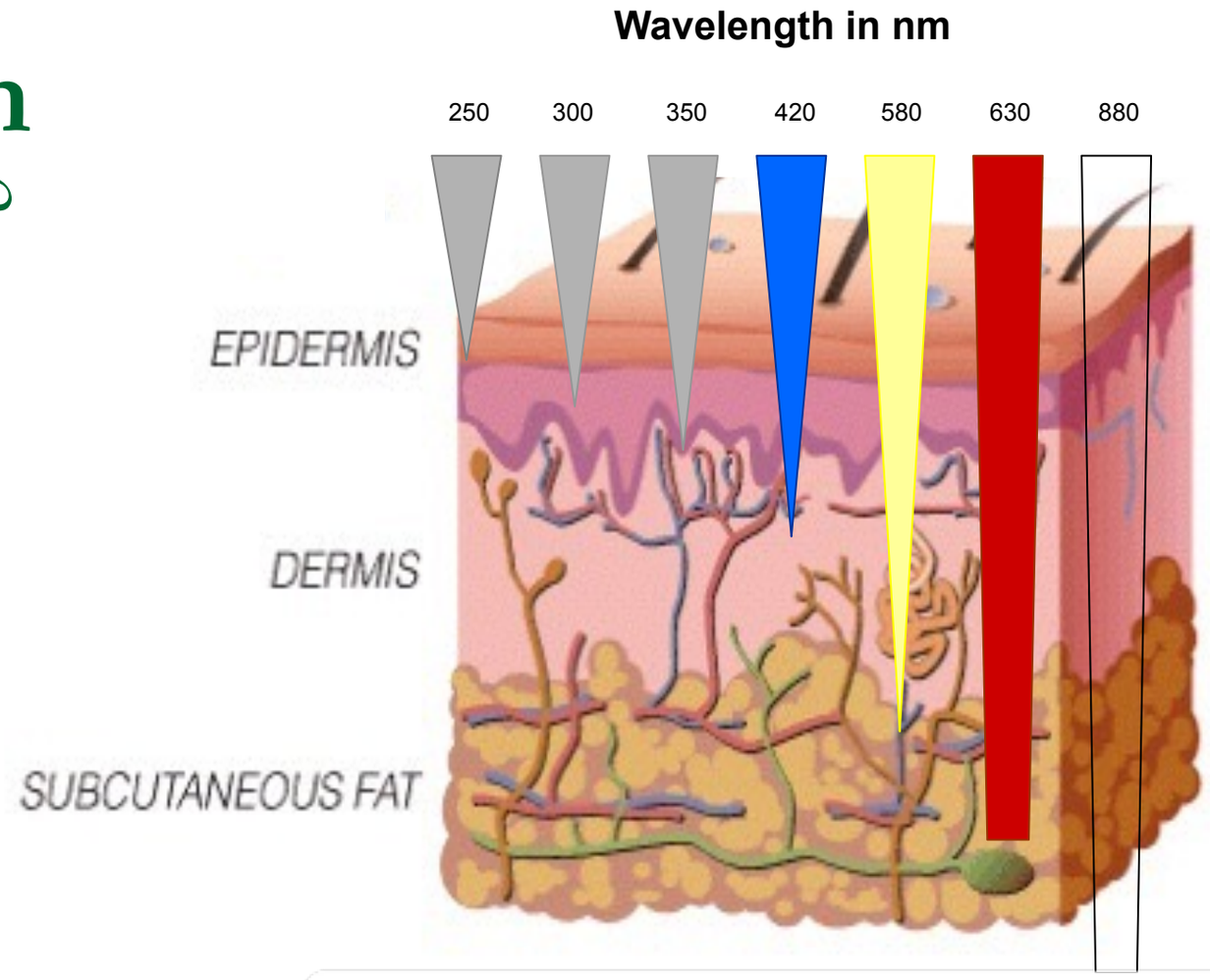
Wavelength

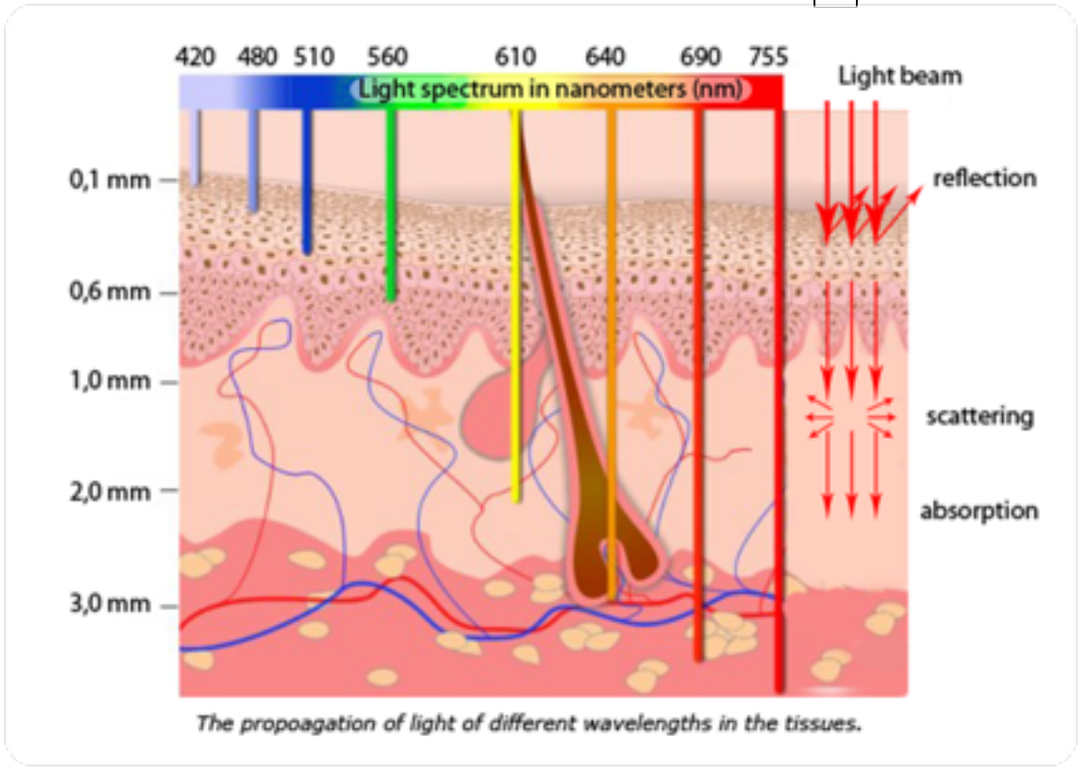
How to Choose?

❖ ***Blue-light energy*** (wavelength 420nm) is primarily absorbed in the epidermis.

❖ ***Red-light energy*** (wavelength 630nm) is primarily absorbed by the blood vessels within the dermis and subcutaneous tissue. Approximately 80% of the energy is absorbed in the first 2 cm.

❖ ***Infra-red light energy*** (IR) (wavelength 880nm) is primarily absorbed by proteins found in cell membrane helping to increase cell permeability. Approx. 50% penetrates to 8cm (per *NASA* study).

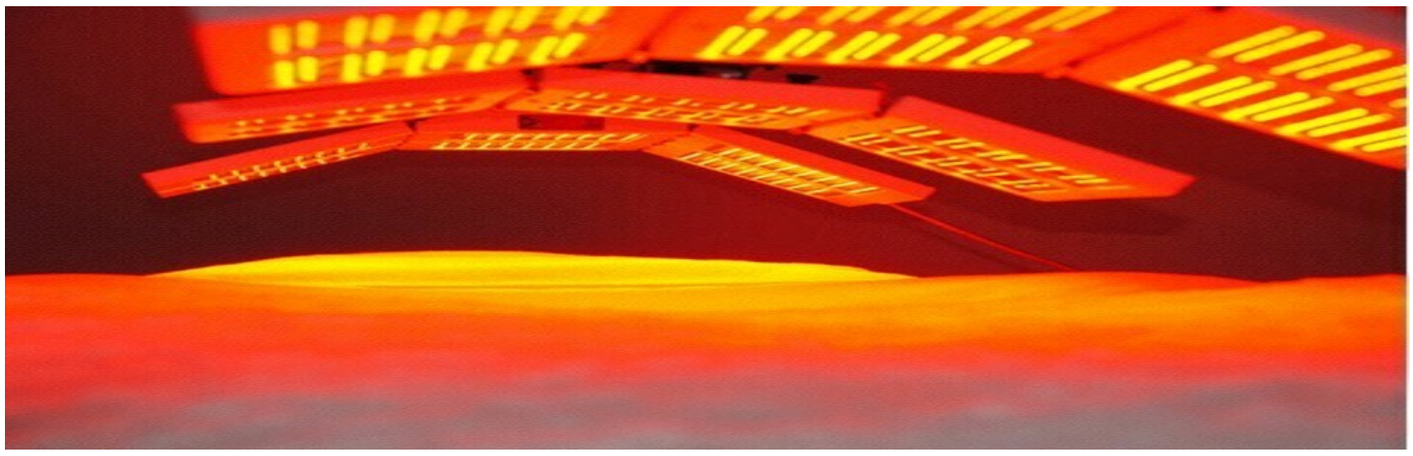




The propoagation of light of different wavelengths in the tissues.

Scientifically Proven Wavelengths

- **420nm (Blue light) targets the P. Acnes**
- **630nm (Red light) primarily absorbed by mitochondria; penetration superficial.**
- **880nm (Infra-Red Light) primarily absorbed by proteins found in the cell membrane increasing permeability; deep penetration.**



Blue and Red Light Therapy for Acne Vulgaris



“Blue Light gets at the core of what causes acne eruptions: P. acnes, the bacterial responsible for causing acne inflammation, pumps out tiny molecules called porphyrins. When those porphyrins are exposed to certain wavelengths of light, they produce free radicals that kill the bacteria. Without P. acnes around to cause inflammation, acne clears up.”
-American Academy of Dermatology

Acne

Acne vulgaris is a common skin condition affecting 70 percent of adolescents[2] and frequently continues into adulthood.[5–7] The mainstay of treatment of acne is the use of topical or systemic antibiotics, benzoyl peroxide preparations, and topical or systemic retinoids.[7]

The rapid increase in the incidence of antibiotic resistance in the causative bacterium *P. acnes* is of concern and there is a pressing need for effective, nonantibiotic treatments.[8]

Acne often improves after exposure to sunlight or artificially produced solar radiation. *P. acnes* produce mainly coproporphyrin III, which has an absorption spectrum peak at 415nm.[9] *In-vitro* irradiation of *P. acnes* colonies with blue visible light leads to photo-excitation of endogenous bacterial porphyrin, singlet oxygen production, and bacterial destruction.[10]

It has been shown both *in vivo* and clinically that acne may be treated successfully with blue visible light phototherapy.[10]

J Dermatolog Treat. 2005;16(4):219-23.

J Cosmet Laser Ther. 2006 Apr;8(1):31-3.

J Cosmet Laser Ther. 2006 Jun;8(2):71-5.

Br J Dermatol. 2013 May;168(5):1088-94. doi: 10.1111/bjd.12186.

J Cosmet Laser Ther. 2009 Jun;11(2):125-8. doi: 10.1080/14764170902777349.

Arch Dermatol Res. 2015 Apr;307(3):265-73. doi: 10.1007/s00403-015-1547-1. Epub 2015 Feb 18.

The Role of Photo Therapy for Treatment of Acne

- Blue light intensifies immune functions and Red light increases cellular activities to exert an anti-inflammatory effect and normalizes cellular function

- Stimulates fibroblast activity, attachment and synthesis of collagen and procollagen, and growth factor production

- Effective means of treating acne vulgaris of mild to moderate severity, with no significant adverse effects; 70% clearance from LED only

- Enhances healing of acne lesions to help prevent acne scars from forming.

Immediate Effects of LED Therapy

Mitochondria in the cells absorb photon energy and convert it to biochemical energy known as Adenosine triphosphate (ATP) resulting in increased cellular activity and mitosis. Both visible red and infrared light have been shown to promote at least 24 different positive changes at the cellular level.Some of the clinical manifestations are:

- Release of endorphins
- Increases blood circulation and arterial flow
- Reduces inflammation and affects arthritic changes
- Begins to restore normal cellular function affecting fibroblasts,keratinocytes, melanocytes , hair follicles ,nerve tissue, retina ,bone and malignant cells
- Protection against cell damage. Assists in exercise or traumatic muscle recovery

Established Indications

Acne

Bone Disease

Burns

Circumferential Reduction

Dental Implants

Gum Disease

Hair Regrowth

Pain

Photodynamic Therapy

Skin Discoloration

Skin Rejuvenation

Skin Ulcerations

TMJ

Vitiligo

Wound Healing

*Future Applications May Include Retinal anomalies , Intracranial trauma/ anoxic incidents.



- Kim JW. ‘Clinical trial of Non thermal 633nm LED array for renewal of Photoaging : Clinical Surface Profilometric Results.‘ *Journal of the Korean society for Laser Medicine and Surgery. Vol 9: 1; 69-76*
- Russell B et al; ‘A study to determine the efficacy of combination LED light therapy (830 nm and 633 nm) in facial skin rejuvenation’. - *Journal of Cosmetic and Laser Therapy volume 7 issue ¾ (2005).*
- Lee *SY et al*. ‘A prospective, randomized, placebo-controlled, double-blinded, and split-face clinical study on LED phototherapy for skin rejuvenation: Clinical, profilometric, histologic, ultrastructural, and biochemical evaluations and comparison of three different treatment settings.’ Journal of Photochemistry and Photobiology B: Biology 88; (2007): 51–67
- Takezaki, Shinichiro, et al. "Ultrastructural observations of human skin following irradiation with visible red light-emitting diodes (LEDs): a preliminary in vivo report." *Laser Therapy 14.4 (2005): 153-159.*

- Two treatments weekly for 4 weeks.
- Combination of 830 Near infra red and 633nm visible red – more effective than the individual wavelengths alone.
- Statistically significant reduction in wrinkles using profilometry.
- Statistically significant improvements in skin elasticity.
- Skin brightening seen in phototypes III & IV.
  - Studies have shown that the combination wavelengths reduces pigmentation (both global improvements and targeted brown spots)
- Appearance of vascular lesions/telangiectasia appear to lessen.





Appearance of vascular lesions/telangiectasia appear to lessen.

Lee SY et al. ‘A prospective, randomized, placebo-controlled, double-blinded, and split-face clinical study on LED phototherapy for skin rejuvenation: Clinical, profilometric, histologic, ultrastructural, and biochemical evaluations and comparison of three different treatment settings.’ Journal of Photochemistry and Photobiology B: Biology 88; (2007): 51–67

Long Term Results of LED Therapy

- Repairs damaged tissues
- Increases moisture retention
- Increases lymphatic system drainage-detoxifying the skin tissue
- Corrects melanin production
- Improves thickness, elasticity and collagen in skin
- Increases arterial circulation through NO
- Increases oxygenation and mitochondrial function
- Increases vascularity
- Increases lymphatic system activity
- Reduces excitability of nervous tissue
- Increases RNA and DNA synthesis
- Stimulates fibroblasts activity
- Increases cell permeability and cellular communication accelerating regional healing
- Stimulates tissue granulation which accelerates the healing process .
- Affects P.Acnes and MRSA

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J Cosmet Laser Ther. 2006 Jun;8(2):71-5.

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Irradiation at 634nm releases nitric oxide from human monocytes - Article in Journal of Photochemistry and Photobiology. B, Biology March 201

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Pre-Conditioning with Low-Level Laser (Light) Therapy: Light Before the Storm
Dose Response. 2014 Dec; 12(4): 619–649.
Published online 2014 Sep 22. doi: 10.2203/dose-response.14-032.Agrawal

PMCID: PMC426745

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a Wellman Center for Photomedicine, Massachusetts General Hospital, b Department of Dermatology, Harvard Medical School, c Harvard-MIT Division of Health Sciences and Technology,

The role of nitric oxide in low level light therapy (PDF Download Available). Available from: https://www.researchgate.net/publication/237089612_The_role_of_nitric_oxide_in_low_level_light_therapy [accessed Oct 16 2017].

J Am Geriatr Soc. 1992 Jan;40(1):23-6.
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PMCID: PMC3288797
NIHMSID: NIHMS339992

Additional Sources Cited Continued..

ResearchG

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/49758044

Low intensity light stimulates nitrite–dependent nitric oxide synthesis but not oxygen consumption by cytochrome c oxidase: Implications for phototherapy

ARTICLE in JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY. B, BIOLOGY · MARCH 2011
Impact Factor: 2.96 · DOI: 10.1016/j.jphotobiol.2010.12.002 · Source: PubMed

A conservative approach for deep dermal burn wounds using polarised-light therapy*

Author links open overlay panel
MD, PhD, FCCPStan J.Monstrey(Professor and Chief)H.HoeksemaH.SaelensK.DepuydtMoustaphaHamdiMD, FCCPKoenread VanLanduyt(Associate Professor)Phillip N.Blondeel
Show more
https://doi.org/10.1054/bjps.2002.3860

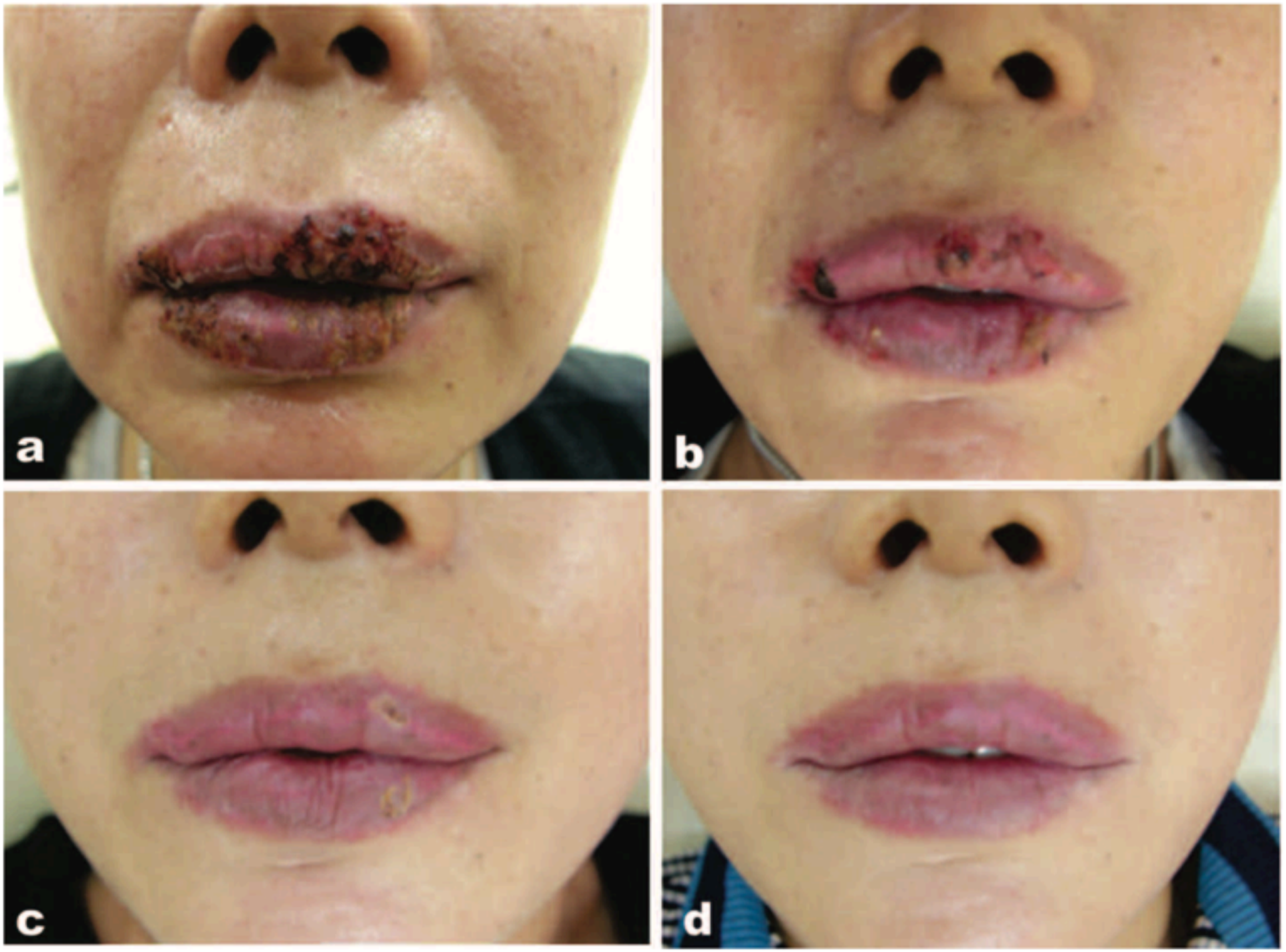


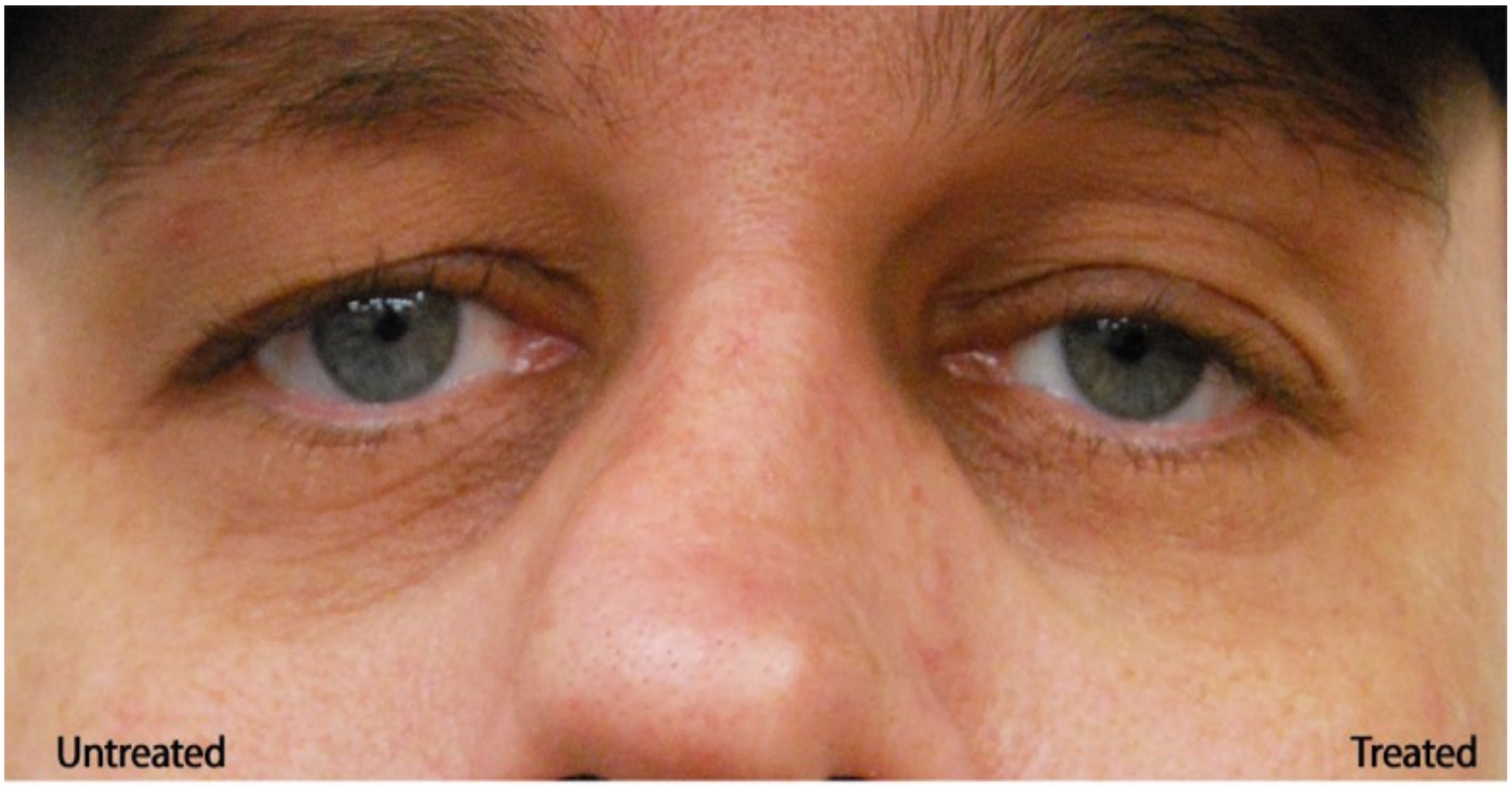
Fig. 6: An adverse reaction was seen in a 54-year-old female following an illegal cosmetic lip tattoo. (a) at baseline, swelling of the lips with secondary bacterial infection and herpes zoster can be seen. (b) Findings 1 week after start of treatment (4 sessions). (c) 2 weeks post-baseline, improvement is noted. (d) The final excellent results 3 weeks from baseline after 12 LED-LLLT treatment sessions. Improvement in the overall skin condition should also be noted.

DermaKinetics Before and After
Chin: 8 LWDK Treatments



Treated with DK Anti-Aging Series Step 1 and Step 2

DermaKinetics Before and After
Eye: 8 treatments with LWDK



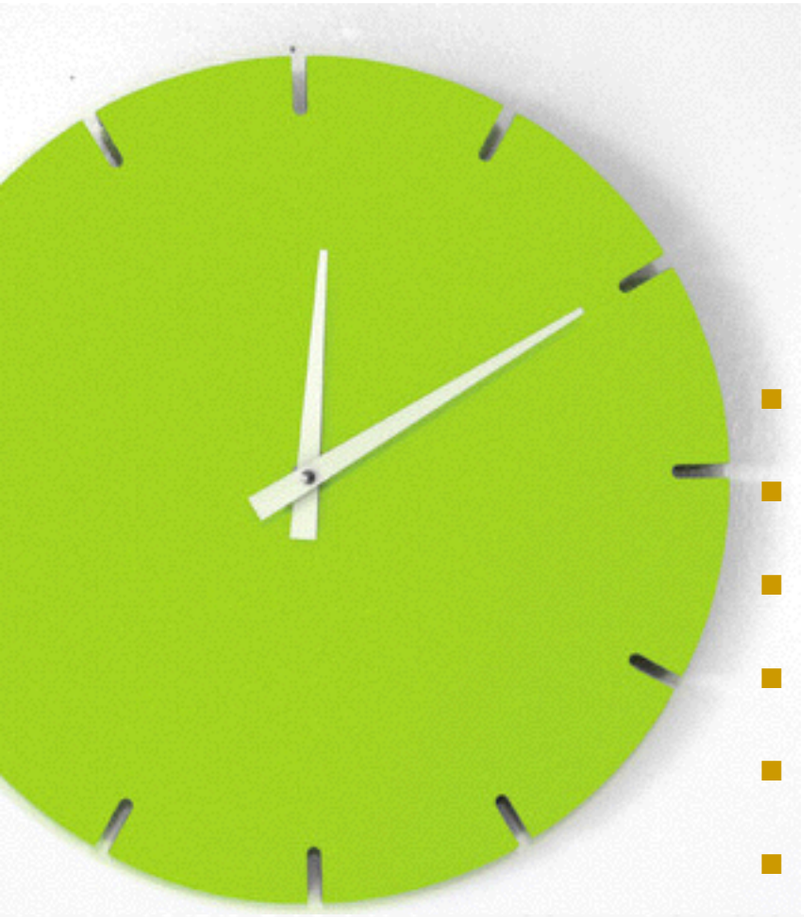
Under Eye and Eye Lid Area-Right Side Only Treated with DK Anti-Aging

Cumulative Effects of LED Light Therapy

- Stimulates fibroblasts activity
- Increases moisture retention
- Increases lymphatic system drainage
- Down regulates melanocyte over production
- Thickens and firms skin
- Increases production of collagen and elastin
- Enhances cellularATP production
- Increases circulation

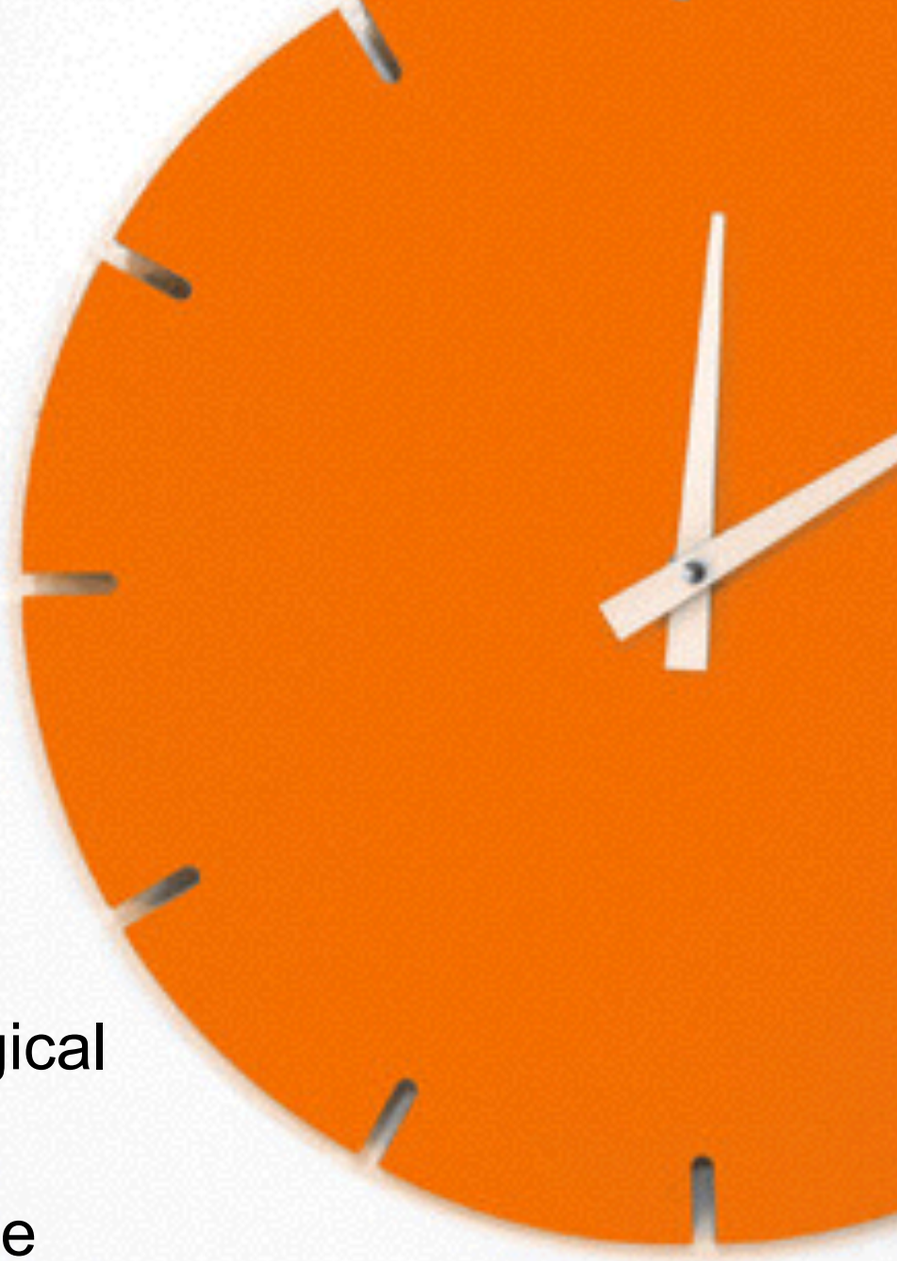
- Reduces excitability of nervous tissue

- Has bactericidal effects on MRSA and P.Acnes



Advantages of LED Therapy

- No thermal damage
- No discomfort
- No down time
- No scarring
- No discoloration
- No side effects
- All Skin Types



- Safe
- Painless
- Non-surgical
- Effective
- Affordable
- Non-evasive
- Year Round



Results…significant and Long Lasting!

Hair Restoration…A Chronic Progressive Condition









Lasers in Surgery Medicine 46: 601 - 607 (2014)

Lasers Surgery and Medicine 2014 Apr; 46(4):373.

Women's Clinical Study

The Growth of Human Scalp Hair in Females Using Visible Red Light Laser and LED Sources

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Title

The Growth of Human Scalp Hair Mediated By Visible Red Light Laser and Led Sources In Males. Lanzafame RJ, Blanche RR, Bodian AB, Chiacchierini RP, Fernandez-Obregon A, Kazmirek ER

Abstract

Background and Objectives

Low-Level Light Therapy (LLLT) has been used to promote hair growth. A double-blind randomized controlled trial was undertaken, to define the safety and physiologic effects of LLLT on males with androgenic alopecia.

Methods

Forty-four males (18-48 yo, Fitzpatrick I-IV, Hamilton-Norwood IIa-V) were recruited. A transition-zone scalp site was selected; hairs were trimmed to 3 mm height; the area was tattooed and photographed. The active group received a "TOPHAT655" unit containing 21, 5 mW lasers (655 +/- 5 nm), and 30 LEDS (655 +/- 20 nm), in a bicycle-helmet like apparatus. The placebo group unit appeared identical, containing incandescent red lights. Patients treated at home every other day for 16 weeks (60 treatments, 67.3 J/cm(2) irradiance/25-minute treatment), with follow-up and photography at 16 weeks. A masked 2.85 cm(2) photographic area was evaluated by another blinded investigator. The primary endpoint was the percent increase in hair counts from baseline.

Results

Forty-one patients completed the study (22 active, 19 placebo). No adverse events or side effects were reported. Baseline hair counts were 162.7 +/- 95.9 (N = 22) in placebo and 142.0 +/- 73.0 (N = 22) and active groups respectively (P = 0.426). Post-treatment hair counts were 162.4 ± 62.5 (N = 19) and 228.7 +/- 102.8 (N = 22), respectively (P = 0.0161). A 39% percent hair increase was demonstrated (28.4 +/- 46.2 placebo, N = 19; 67.2 +/- 33.4, active, N = 22) (P = 0.001) Deleting one placebo group subject with a very high baseline count and a very large decrease, resulted in baseline hair counts of 151.1 +/- 81.0 (N = 21) and 142.0 +/- 73.0 (N = 22), respectively (P = 0.680). Post-treatment hair counts were 158.2 +/- 61.5 (N = 18) and 228.7 +/- 102.8 (N = 22) (P = 0.011), resulting in a 35% percent increase in hair growth (32.3 +/- 44.2, placebo, N = 18; 67.2 +/- 33.4, active, N = 22) (P = 0.003).

Conclusions

LLLT of the scalp at 655 nm significantly improved hair counts in males with androgenetic alopecia.