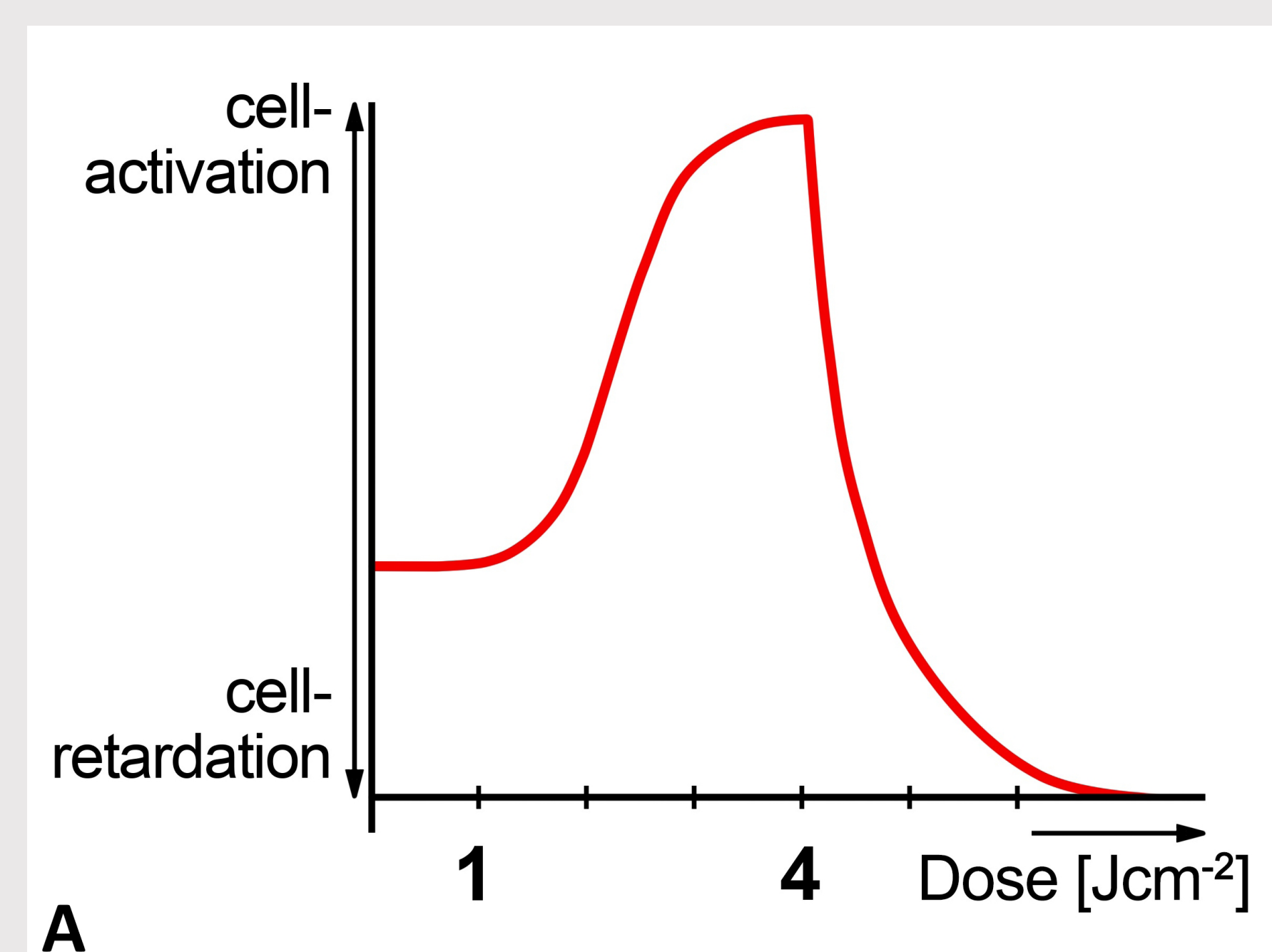


Mitochondrial photo field-effect transistor: quantum tunneling & photo sensitivity – model explaining the brain death dogma challenge

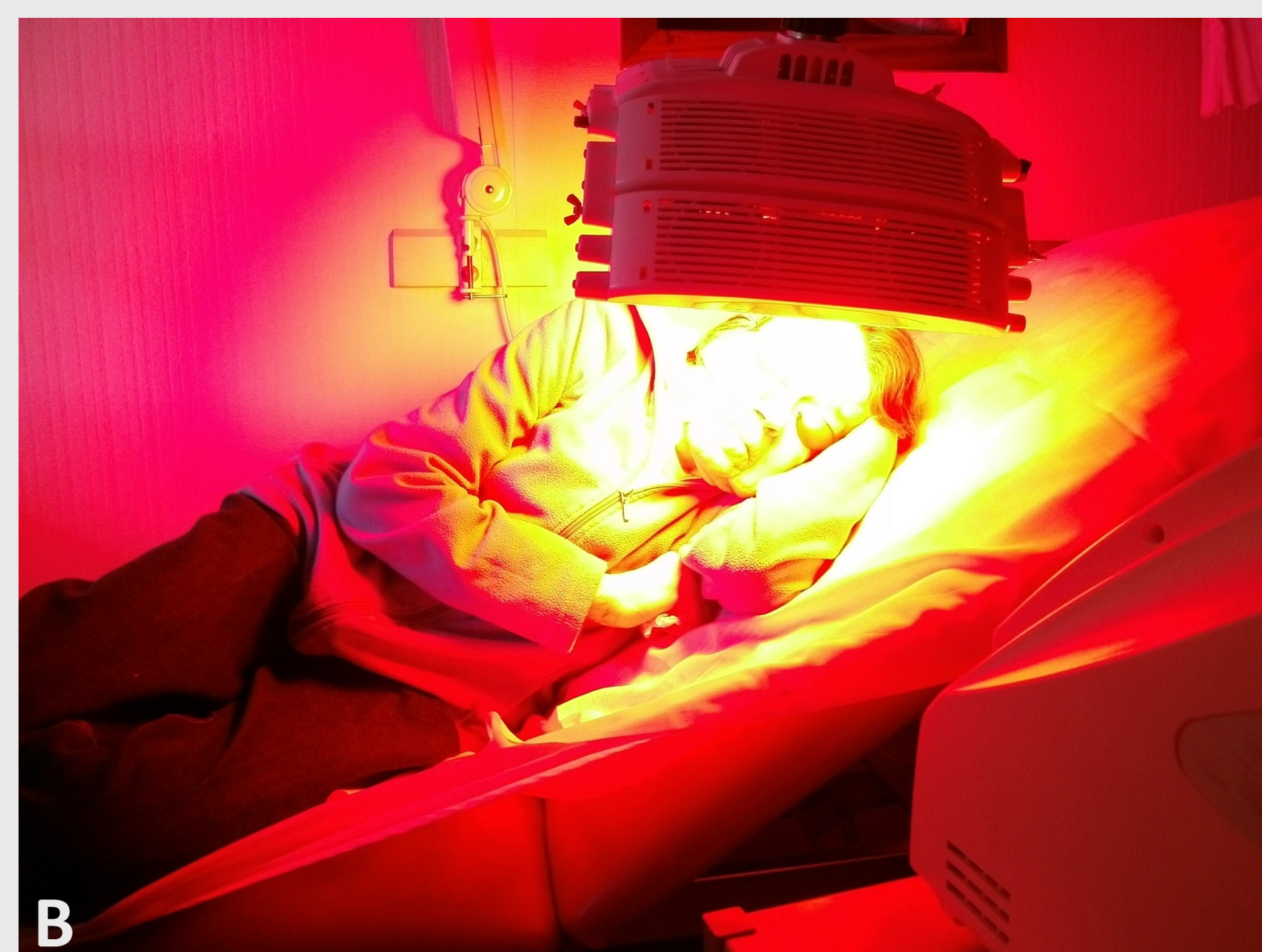
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BRIDGING BETWEEN LLLT AND NANOMEDICINE

Low level light therapy (LLLT) uses moderate light intensities delivered by red to near infrared (R-NIR) lasers or light emitting diodes (LED) operating in the 1- 4 J/cm² dose window, effective in vitro and in vivo. Pulsed LLLT forces cells and tissues to uptake nanoparticles (1).



A: Classical biostimulatory dose window in LLLT, where light intensities are comparable to the solar constant (ca. 1 kW/m²).

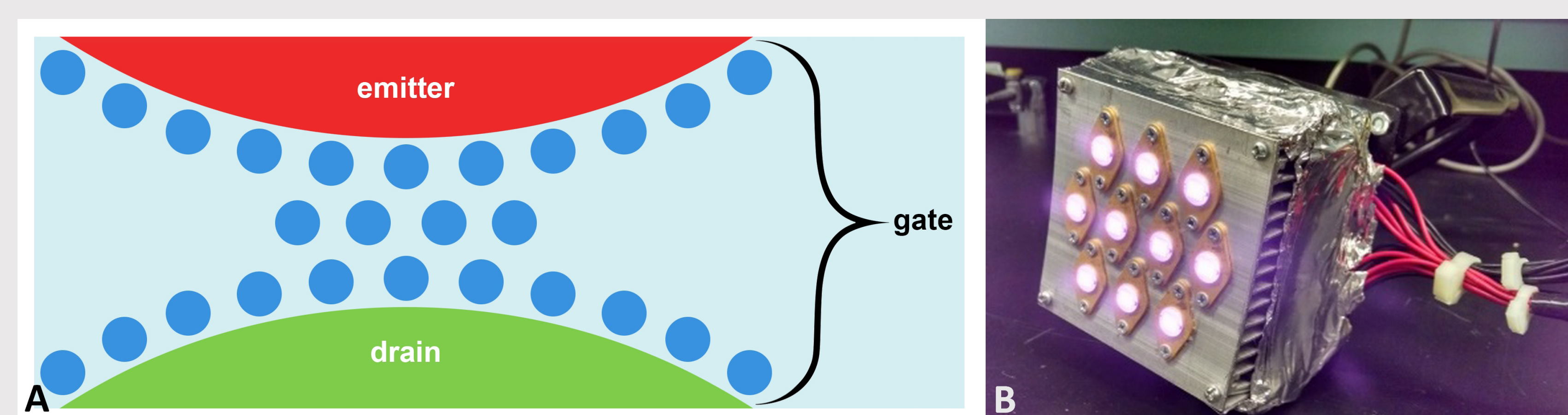


B: Rapid wound healing and minimal scar formation after cosmetic surgery.

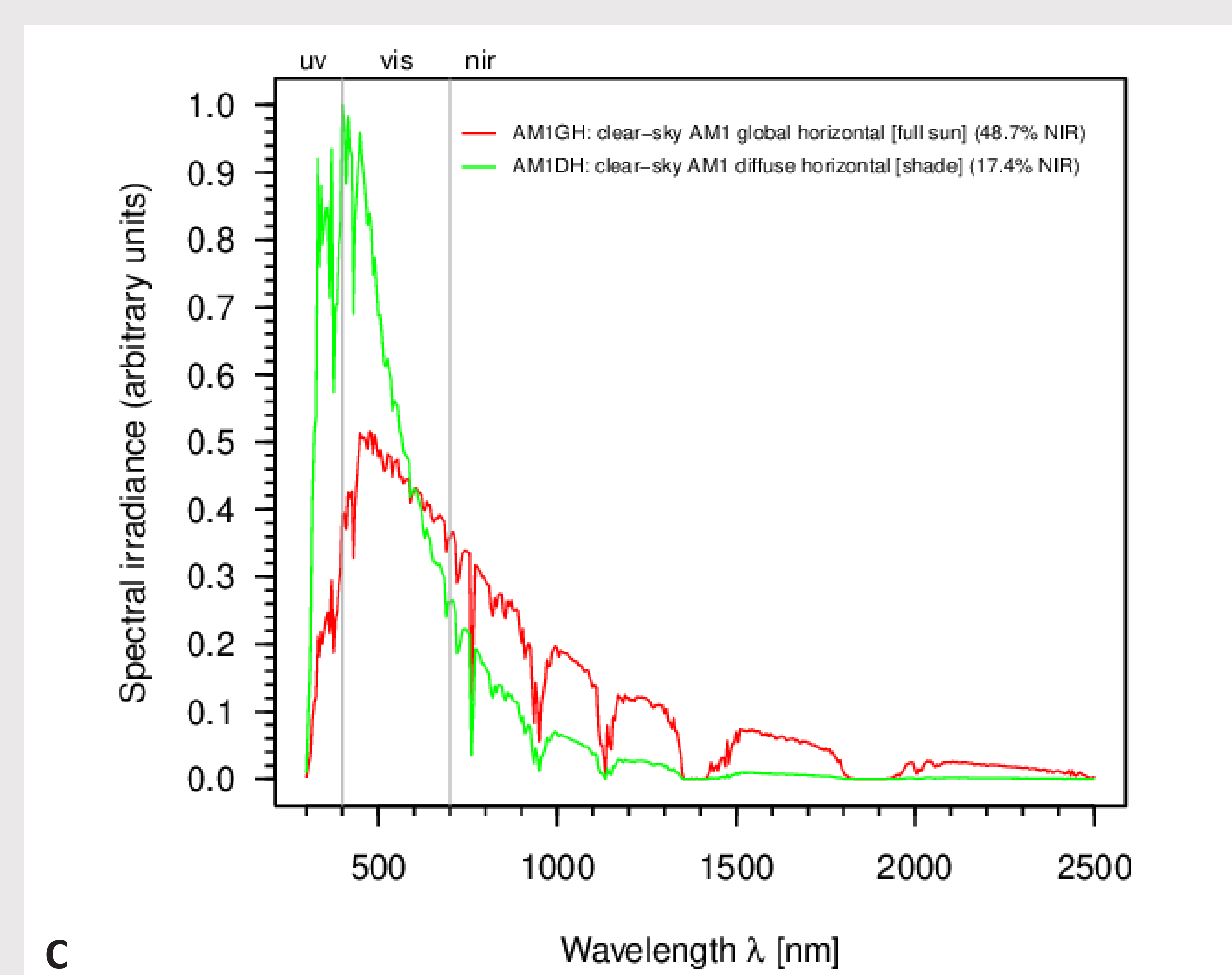
APPLICATIONS: treatment of diabetic ulcers, dementia, depression, stroke, TBI, peripheral neuropathy, retinal disorders, oral mucositis, burns, inflammatory processes, infertility, cosmetic surgery. In viral infections LLLT can be used to upregulate the immune system, kill viruses and help cells to get rid of internal amyloid- β deposits (2). Except for the antiviral action, the therapeutic effects are explicable via ATP upregulation in mitochondria (3).

MITOCHONDRIAL PHOTO FIELD-EFFECT TRANSISTOR: The biological photo-FET model provides an intuitive explanation to the discovery that the frequencies 750 and 950 nm reduced the activity of COX (via inhibition of the reaction of CYTc and COX) and limited ROS generation in irradiated brains. The model explains the recovery of pigs 13.5 minutes post cardiac arrest, resuscitation and irradiation of the foreheads for 2 hours with an intensity of 2W/cm² distributed on 10 powerful LEDs – 5 operating at 750 and 5 at 950 nm (Mike Hüttemann, personal communication). What is so special about the wavelengths 750 and 950 nm?

MITOCHONDRIAL SOLAR SENSITIVITY: There are 2 pronounced minima in the R-NIR sector of the spectral solar irradiance, at 750 and 950 nm (C). During evolution mitochondria were not exposed to light except the sun. The simplest argument is that the mitochondrial photo-FET apparatus had no opportunity to adapt to these wavelengths. It is plausible that lack of adaptation to 750 and 950 nm results in a stronger perturbation of the H₂O barrier than for other wavelengths of the solar spectrum, inhibiting electron tunneling from CYTc to COX (6). Together with the findings of the Hüttemann group (7) this holds the promise to change the accepted brain death dogma.

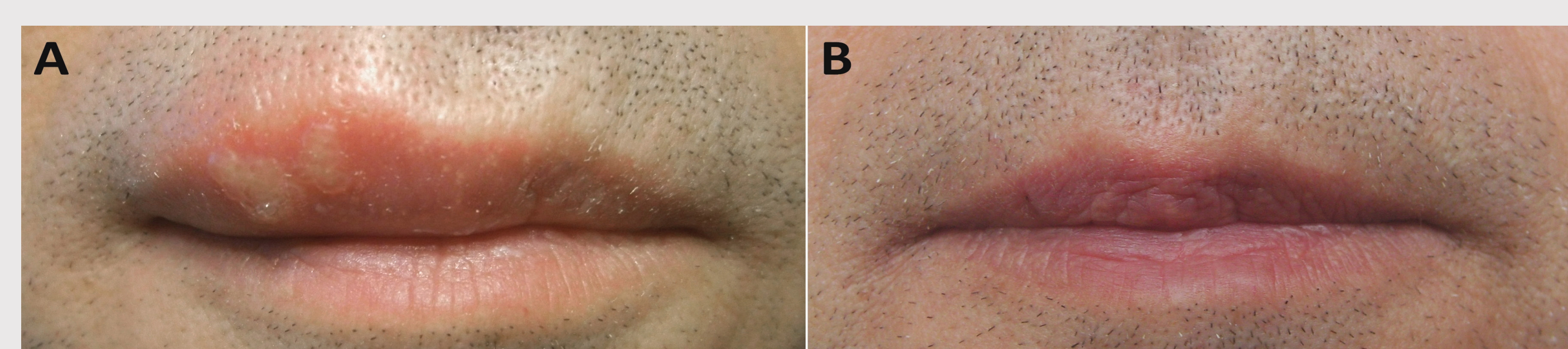


A: Biological photo-FET. Tunneling of electrons across 3 monolayers of H₂O between CYTc and COX is controlled by R-NIR light. Image: ref. 4. Probability for an electron incident on a potential U-E to cross a barrier of width L is $T = e^{-2\kappa L}$, where $\kappa = \sqrt{2m(U-E)}/\hbar$, with m and $\hbar$ standing for the electron mass and Planck constant $\hbar$ divided by 2π respectively.
B: Powerful LEDs used to rescue pigs from terminal brain damage 13.5 minutes post cardiac arrest. Courtesy: Maik Hüttemann.



C: Solar spectral irradiances incident on a horizontal terrestrial surface in full sun (red) or shade (green) (5). Courtesy: Ronnen Levinson, Heat Island Group, Lawrence Berkeley National Laboratory.

HERPES LABIALIS: NO MORE CREAMS



A: Herpes labialis treated with Acyclovir, 8 days after manifestation of first symptoms. B: Herpes labialis treated with red laser light, 4 days after manifestation of first symptoms. Laser intensity ca. 15 times that of the solar constant. No inflammation, no pain, no bleeding, only a mild warm sensation.

Infection with HSV-1 is suspected to be a risk factor in the formation of Alzheimer's disease. Irradiation of the affected area at the time of the manifestation of the first symptoms with 650 nm laser light (2 W/cm²) for 5 min, twice a day for 2 consecutive days, prevented the outbreak. Assumption: the virus was killed by mitochondrial ROS, triggered by the high laser intensity.

COVID-19 COULD TRIGGER ALZHEIMER'S

During a severe infection with all the lead symptoms of Covid-19, LLLT has been used to treat a painful frontal sinusitis (8). Could LLLT be extended to treat further manifestation of Covid-19? Recently, Ezzat et al. identified the viral protein corona as a critical factor for viral–host interactions and showed that that respiratory syncytial virus (RSV) and HSV-1 accumulate a protein corona in biological fluids, and that HSV-1 triggers amyloid- β aggregation (9). Possible involvement of SARS-CoV-2 in the etiology of Alzheimer's disease is sufficient motivation for further research efforts: While the moderate light doses used in LLLT are instrumental to support the immune defense via ATP upregulation – as could be useful in Covid-19 – ROS generation via higher light doses based on higher intensities could be used to destroy the corona-virus, in this case using pulsed light to prevent overheating and by avoiding the wavelengths 750 and 950 nm – shield and sword against SARS-CoV-2.

1. Sommer AP, Zhu D, Scharnweber T. J Control Release 2010;148:131-134.
2. Sommer AP, et al. Photomed Laser Surg 2012;30:54-60
3. Sommer AP, Haddad MKh, Fecht HJ. Sci Rep 2015;5:12029.

4. Shimada S, et al. EMBO J 2017;36:291-300.
5. Levinson R, Akbari H, Berdahl P. Solar Energy 2010;84:1717-1744.
6. Sommer AP. Ann Transl Med 2020;8:161.

7. Strubakos CD, et al. J Cereb Blood Flow Metab 2020;40:833-844.
8. Sommer AP, Försterling HD, Naber KG. Precis Nanomed 2020;3:541-548.
9. Ezzat K, et al. Nat Commun 2019;10:2331.