

Fra lys til fotobiomodulasjon?

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M. Sc. Havbruksbiologi / Daglig leder Laksesystemer AS

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Oppdretternes førstevalg



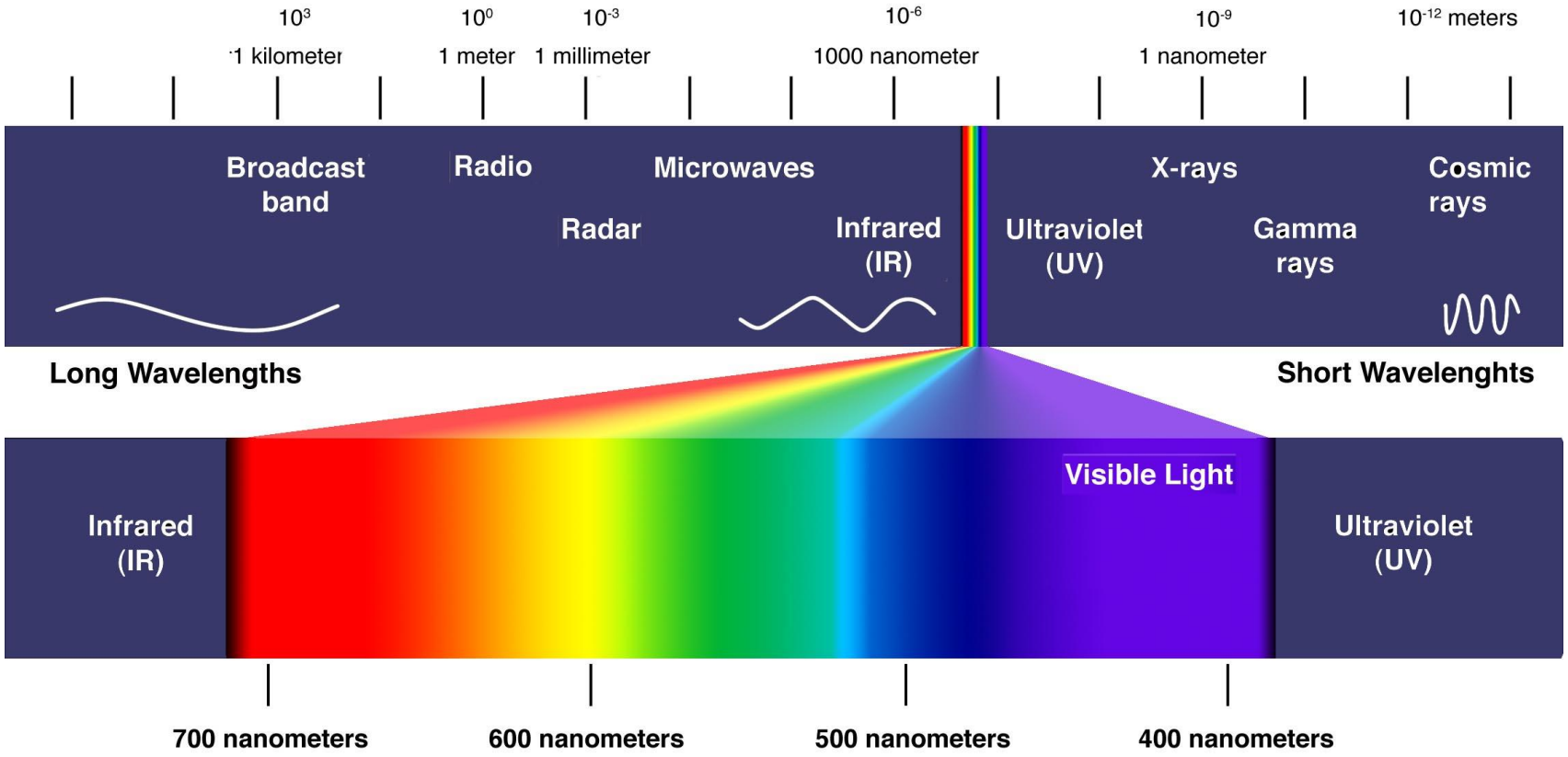


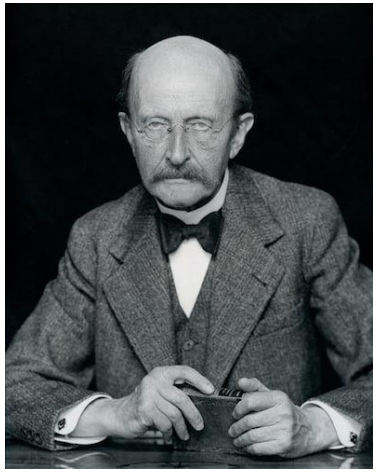
LYS ER LYS?

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Oppdretternes førstevalg

Ulike bølgelengder har ulik energi og gir ulik biologisk effekt

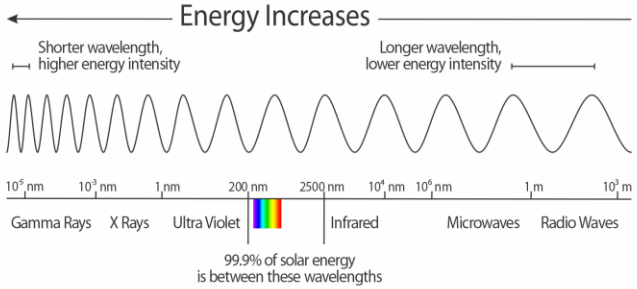




MAX PLANCK • KVANTETEORI

$$E = hc/\lambda$$

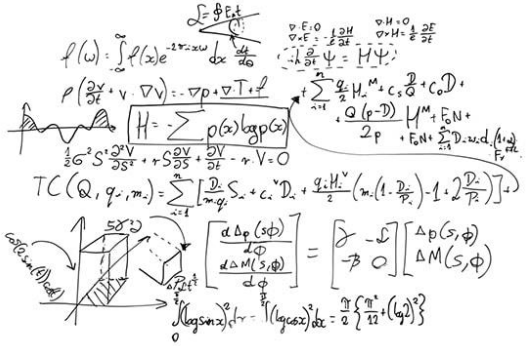
Kortere bølgelengde
= høyere fotonenergi



Kilder: Astronomers Group, EM Spectrum • All About Circuits, Max Planck

Hvordan måler vi lys?

Kategori	Mål	Enhet	Hva måler det?
Optisk energi (hvor mye lys som produseres)	Strålingseffekt	W	Optisk energi per sekund
	Irradians	W/m^2	Optisk effekt per areal
	Strålingsenergi	J	Total optisk energi
Fotoner (antall lyspartikler)	Fotonfluks	mol/s eller µmol/s	Antall fotoner per sekund
	Fotonflukstetthet (PPFD)	$\mu mol/m^2/s$	Fotoner per areal per sekund
	Foton dose	$\mu mol/m^2$	Totalt antall fotoner per areal over tid
Spektralt lys (hvilke bølgelengder)	Spektral irradians	$W/m^2/nm$	Optisk effekt fordelt på bølgelengder
	Spektral fotonfluks	$\mu mol/m^2/s/nm$	Fotoner per areal per sekund, fordelt på bølgelengder
Menneskeøyets oppfattelse (hvordan vi ser lyset)	Lysstyrke	candela (cd)	Lys i en bestemt retning
	Belysningsstyrke	lux (lm/m^2)	Hvor mye menneskeoppfattet lys som treffer en flate
	Lysfluks	lumen (lm)	Total menneskeoppfattet lysfluks
	Luminans	cd/m^2	Hvor lyssterk en overflate ser ut

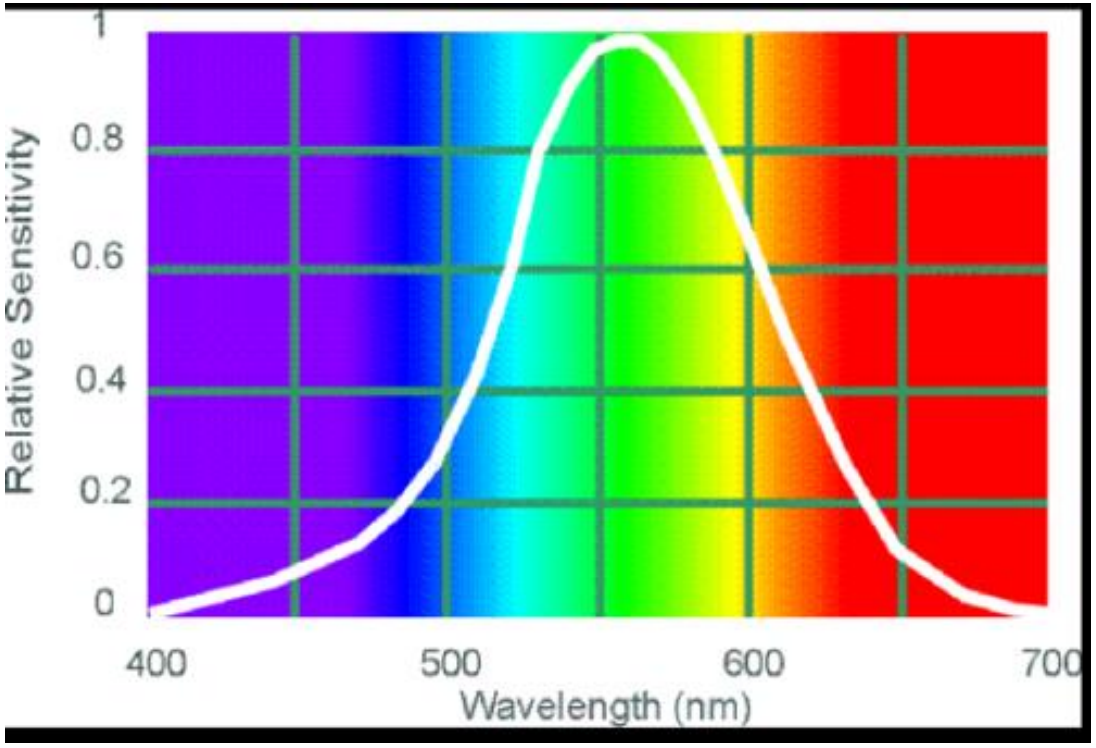


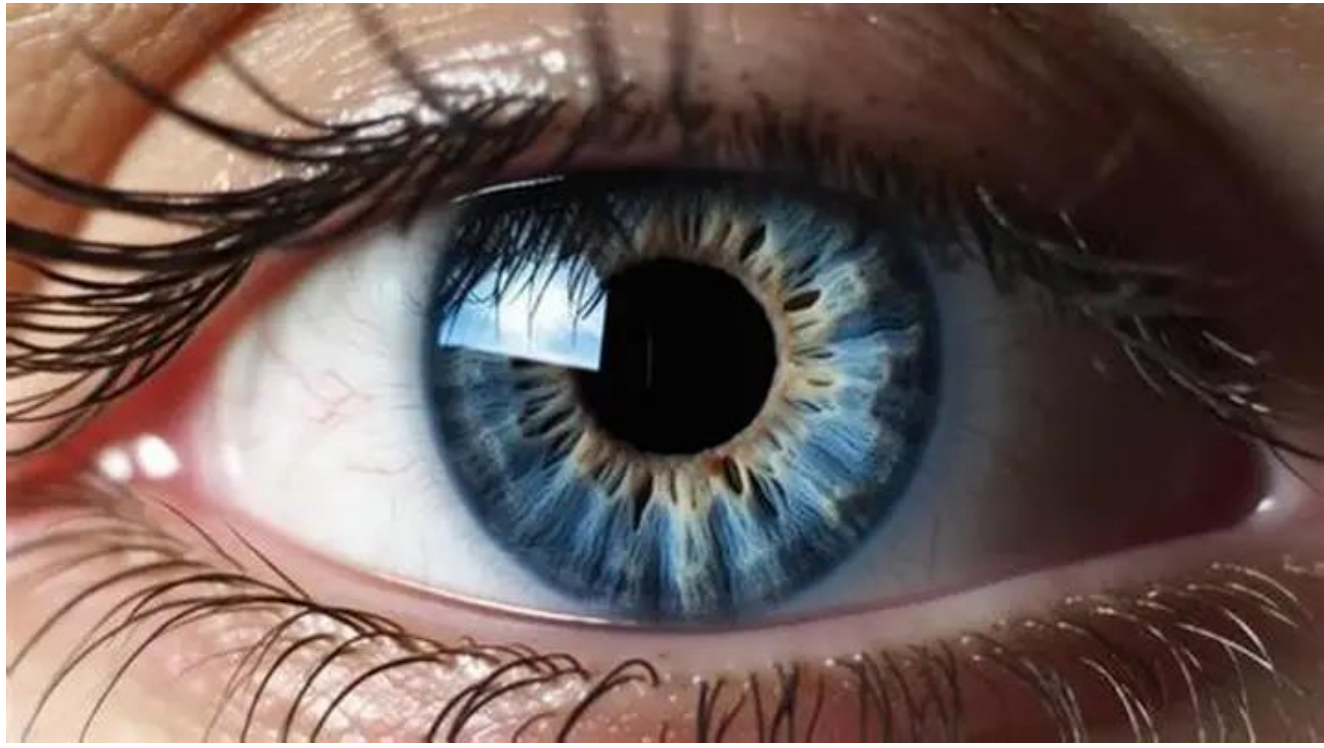


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“Lumen is for human”

- Lumen eller Lux er målemetoder laget for mennesker – estimerer hvor mye av lysenergien som treffer innenfor menneskets øyes spektralsensitivitet







250 Watt
7500 Lumen



250 Watt
35 000 Lumen
Er denne lampen mest effektiv?



250 Watt
5 000 Lumen

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250 Watt
~ 470 µmol/s



250 Watt
~ 500 µmol/s



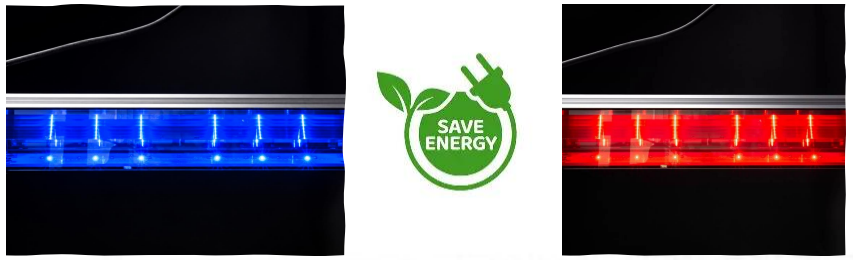
250 Watt
~ 690 µmol/s
Er denne lampen mest effektiv?

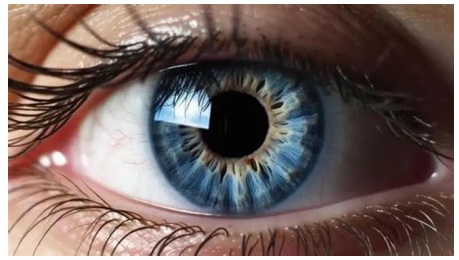
Kommer an på hva vi ønsker å oppnå…

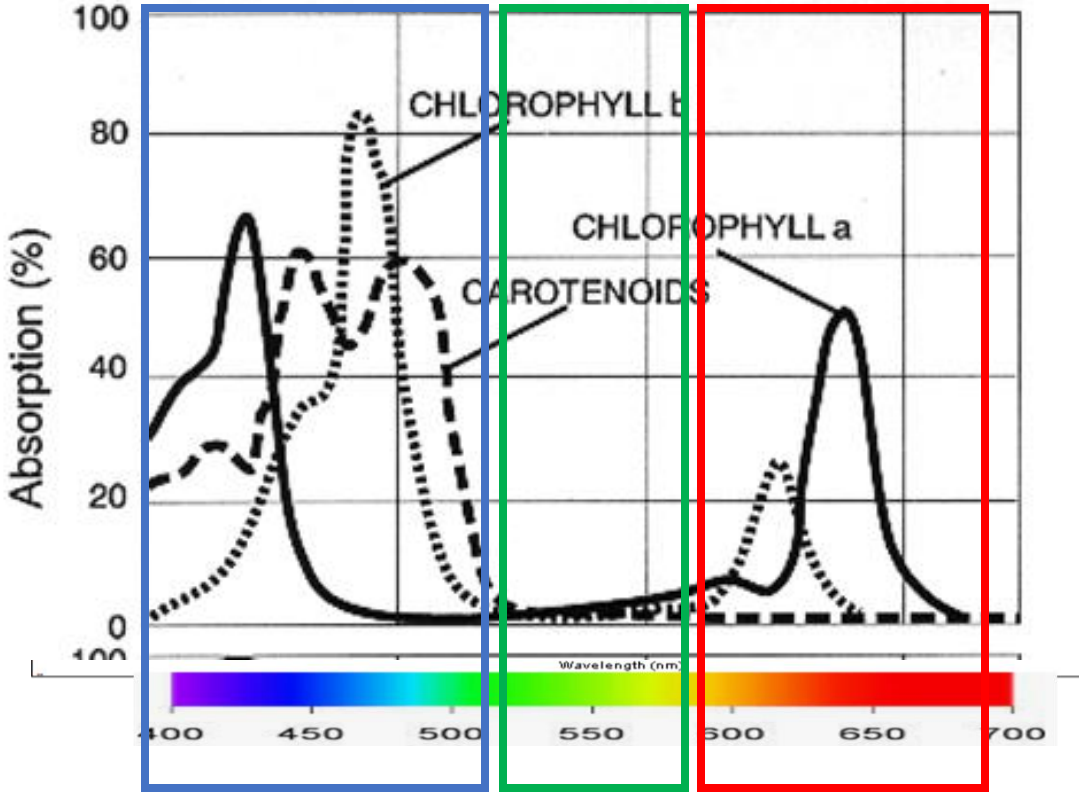
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Fotobiomodulasjon i planteproduksjon







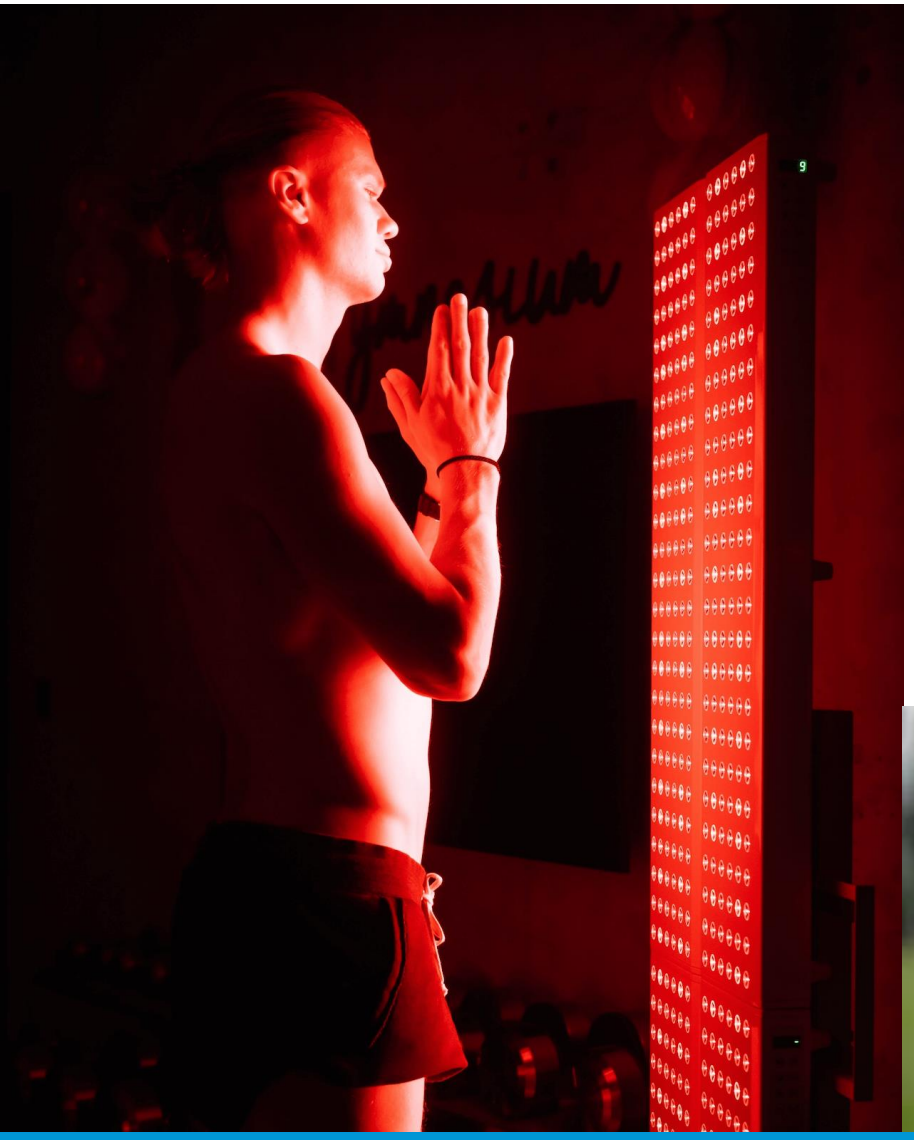


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Fotobiomodulasjon mennesker?

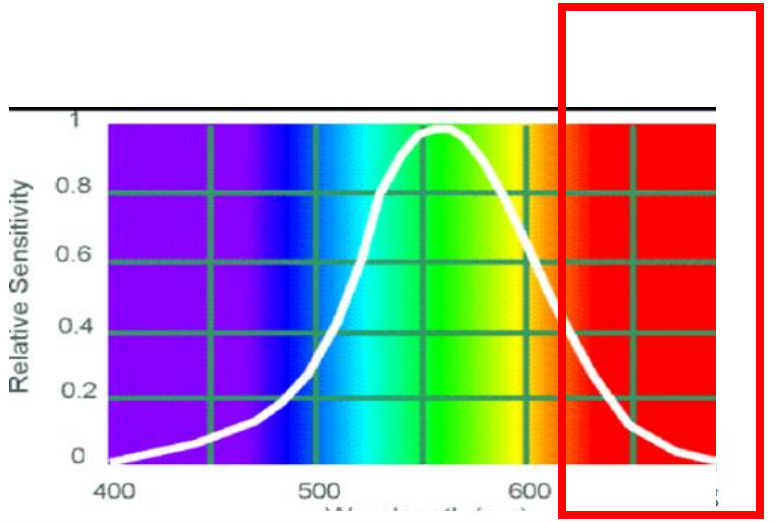




Photobiomodulation Therapy Improves Performance and Accelerates Recovery of High-Level Rugby Players in Field Test: A Randomized, Crossover, Double-Blind, Placebo-Controlled Clinical Study

Henrique D Pinto [1], Adriane A Vanin, Eduardo F Miranda, Shaiane S Tomazoni, Douglas S Johnson, Gianna M Albuquerque-Pontes, Ivo de O Aleixo Junior, Vanessa Dos S Grandinetti, Heliodora L Casalechi, Paulo de Tarso C de Carvalho, Ernesto Cesar Leal-Junior





Fotobiomodulasjon kylling

Application of Ultraviolet Light for Poultry Production: A Review of Impacts on Behavior, Physiology, and Production


Md. Sohel Rana [1,2,3*]

Dana L. M. Campbell [1,2]

1. School of Environmental and Rural Science, University of New England, Armidale, NSW, Australia
2. Agriculture and Food, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Armidale, NSW, Australia See more

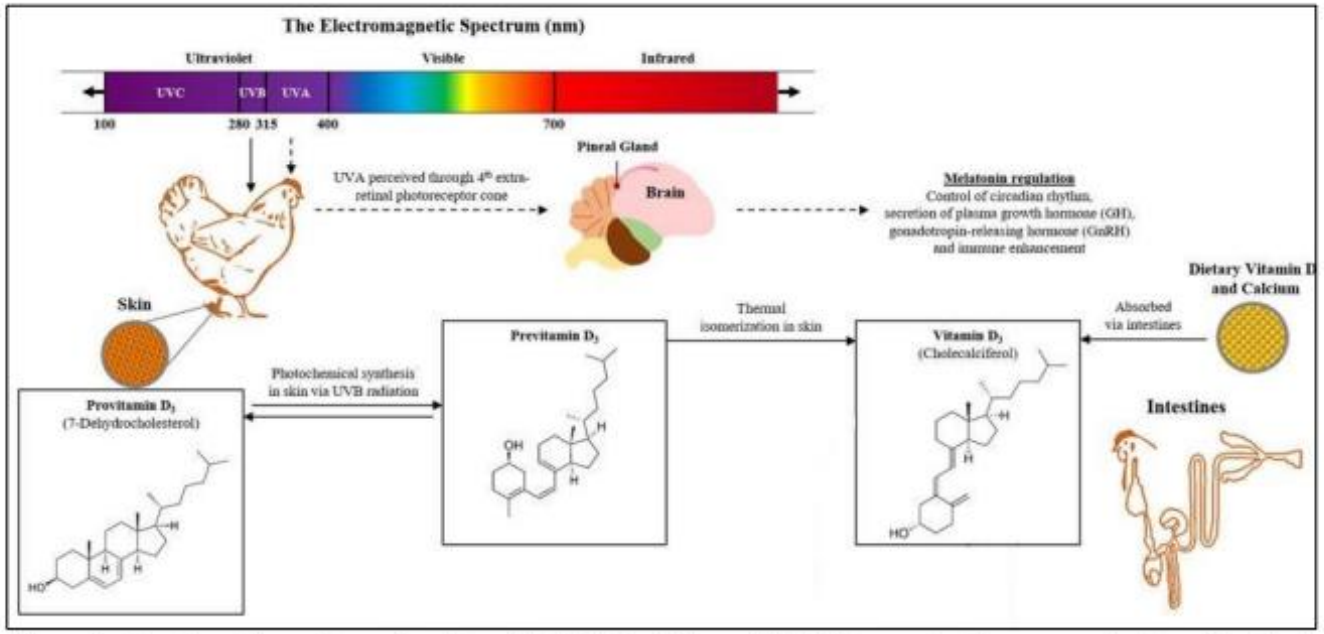


Figure 2. The absorption pathways for ultra-violet light in chickens. UV-A light wavelengths are perceived by UV retinal photoreceptors, but also through extra-retinal photoreceptors in the pineal gland, which regulates the production of melatonin. UV-B light is absorbed through the skin in chickens and is responsible for the endogenous synthesis of vitamin D that supplements vitamin D obtained through the diet (Source: Rana and Campbell, 2021).





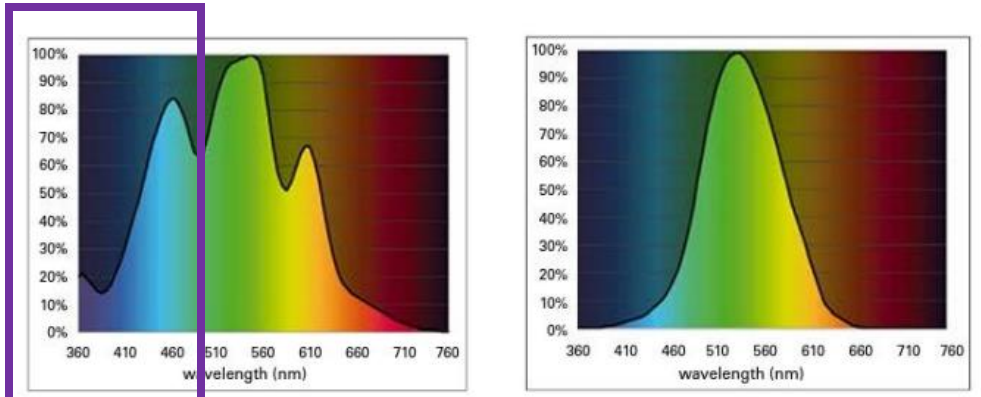


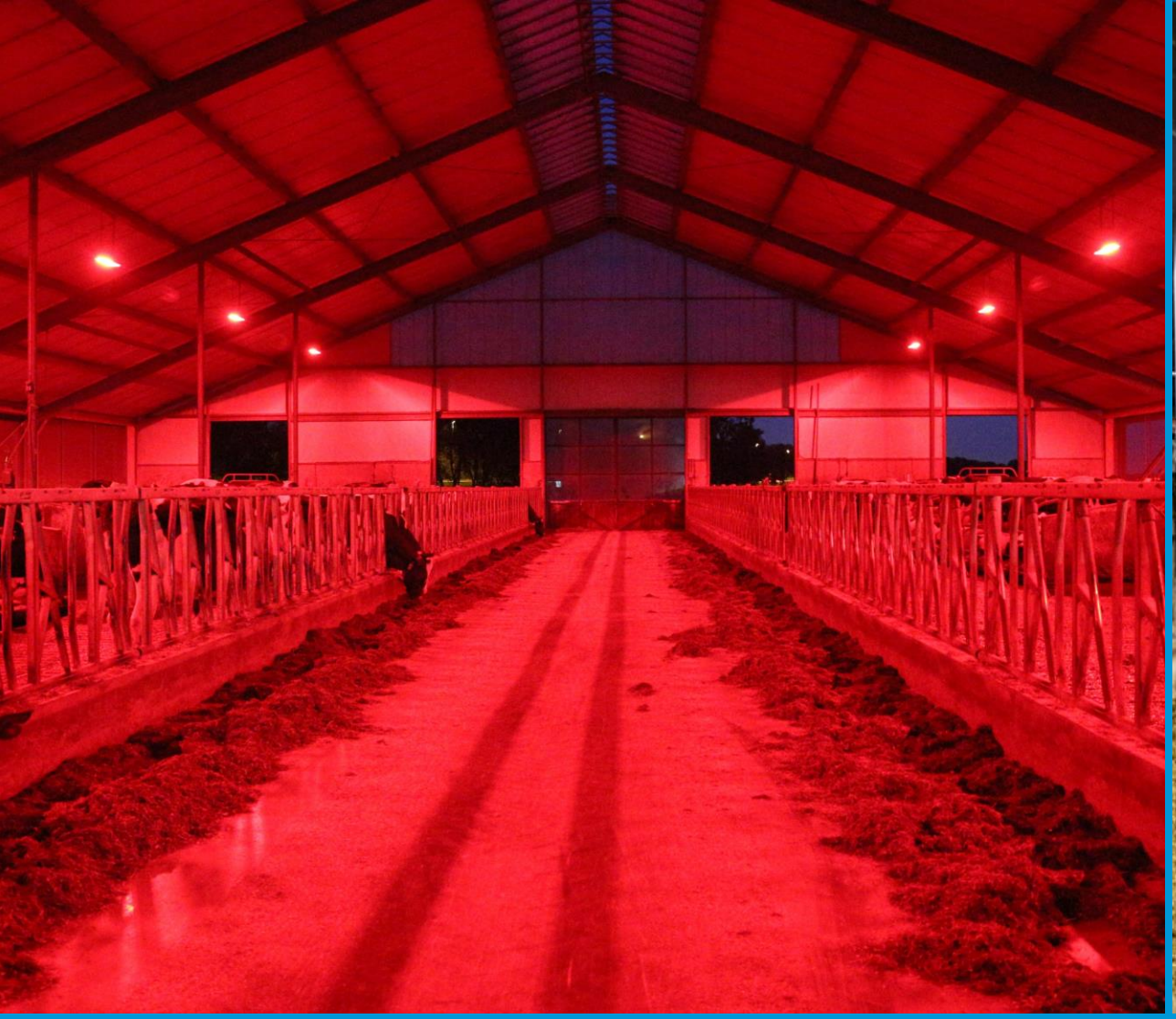
Figure 1. (a) The visible light spectrum of domestic chickens (*Gallus gallus domesticus*) and **(b)** humans (*Homo sapiens*) showing the photosensitivity peaks of each species at different light wavelengths (Source: Hy-Line International, 2017).





FOTOBIOMODULASJON I PRAKSIS

Blått lys beroligende før flytting eller slakt





FOTOBIOMODULASJON I PRAKSIS

Rødt nattlys gir kontrollert lysstyring uten stress

Fotobiomodulasjon fisk?

Blått lys:

- ✓ Mest effektiv inhibering av melatonin fra pinealorgan (Vera et al., 2010)
- ✓ Økning i cortisol og glukose (Migaud et al., 2007)

UV-B lys:

- ✓ Stimulerer produksjon av vitamin D (Fossen et al., 2026)

Differential light intensity and spectral sensitivities of Atlantic salmon, European sea bass and Atlantic cod pineal glands *ex vivo*

L.M. Vera, A. Davie, J.F. Taylor, H. Migaud Show more

The effect of spectral composition and light intensity on melatonin, stress and retinal damage in post-smolt Atlantic salmon, *Salmo salar*

Herve Migaud, Mairi Cowan, John Taylor, Hugh W. Ferguson Show more

Cite Add to Mendeley Share 10.1016/j.aquaculture.2007.04.064



UV-B light stimulates the production of Vitamin D_3 in Atlantic salmon

Inge Fossen [a], Tobias Backström [b], Tomas Holte [c], Øystein Klakegg [b,*]

[a] Salmon Evolution ASA, Torget 5, 6440 Elnesvågen, Norway
[b] Faculty of logistics, Molde University College, Campus Kristiansund, Fosnagata 12, 6509 Kristiansund, Norway
[c] Salmon Evolution Dale AS, Dalsbygdvegen, 6120 Falkestad, Norway

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Fotobiomodulasjon fisk?

Grønt lys:

- ✓ Redusert cortisol (Choi et al., 2012) stress hormon
- ✓ Redusert Norepenephrine (Choi et al., 2021)

<u>= Fisk håndterer stress bedre</u>

- ✓ Økt Melanine concentrating hormone (MCH1)
- ✓ Økt Neuropeptide Y (NPY)
- ✓ Økt Insuline-like growth factor 1 (IGF-1)

Hormoner kjent for å være orexogene (appetittstimulerende)

<u>= Fisk med bedre immunitet, bedre vekst og bedre fôrutnyttelse</u>

Aquaculture Reports
Volume 19, March 2021, 100605

Effect of green wavelength light on stress and appetite responses of olive flounder (*Paralichthys olivaceus*) following feed deprivation and re-feeding

Cheol Young Choi [a], Jin Ah Song [a], Tae Ho Lee [a], Young-Su Park [b]

General and Comparative Endocrinology
Volume 271, 15 January 2019, Pages 82-90

Effects of green light on the growth of spotted halibut, *Verasper variegatus*, and Japanese flounder, *Paralichthys olivaceus*, and on the endocrine system of spotted halibut at different water temperatures

Daisuke Shimizu [a], Satoshi Kasagi [b], Ryota Takeuchi [b], Tomoki Maeda [a], Sumihisa Furufuji [c], Kanta Mizusawa [b], Tadashi Andoh [d], Akiyoshi Takahashi [b]

Aquaculture Reports
Volume 19, March 2021, 100605

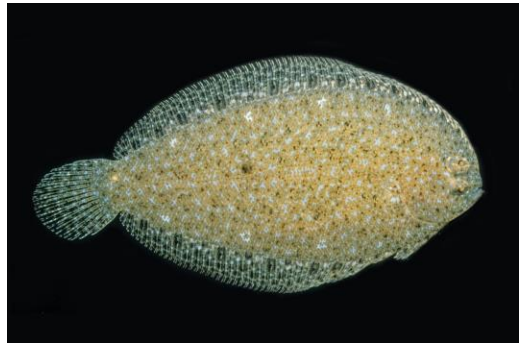
Effect of green wavelength light on stress and appetite responses of olive flounder (*Paralichthys olivaceus*) following feed deprivation and re-feeding

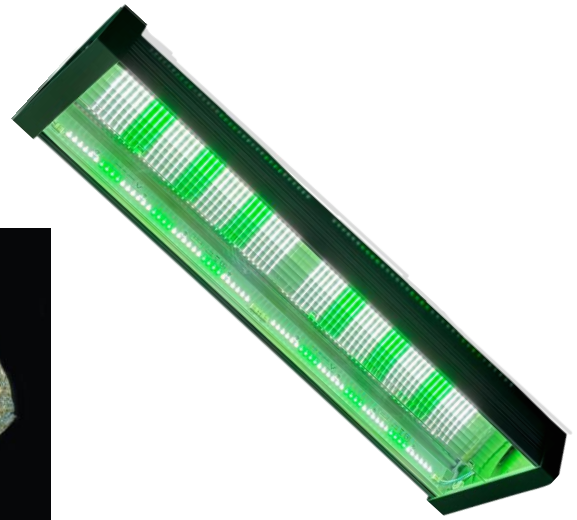
Cheol Young Choi [a], Jin Ah Song [a], Tae Ho Lee [a], Young-Su Park [b]

Aquaculture
Volume 546, 15 January 2022, 737275

The stimulation effects of green light on the growth, testicular development and stress of olive flounder *Paralichthys olivaceus*

Yuxia Zou [a b], Zhuangzhuang Peng [a b], Wenxiang Wang [a b c], Shaoshuai Liang [a b], Changbin Song [d], Lijuan Wang [a b], Zhihao Wu [a b], Qiaowan Wu [a b c], Xungang Tan [a b], Feng You [a b]

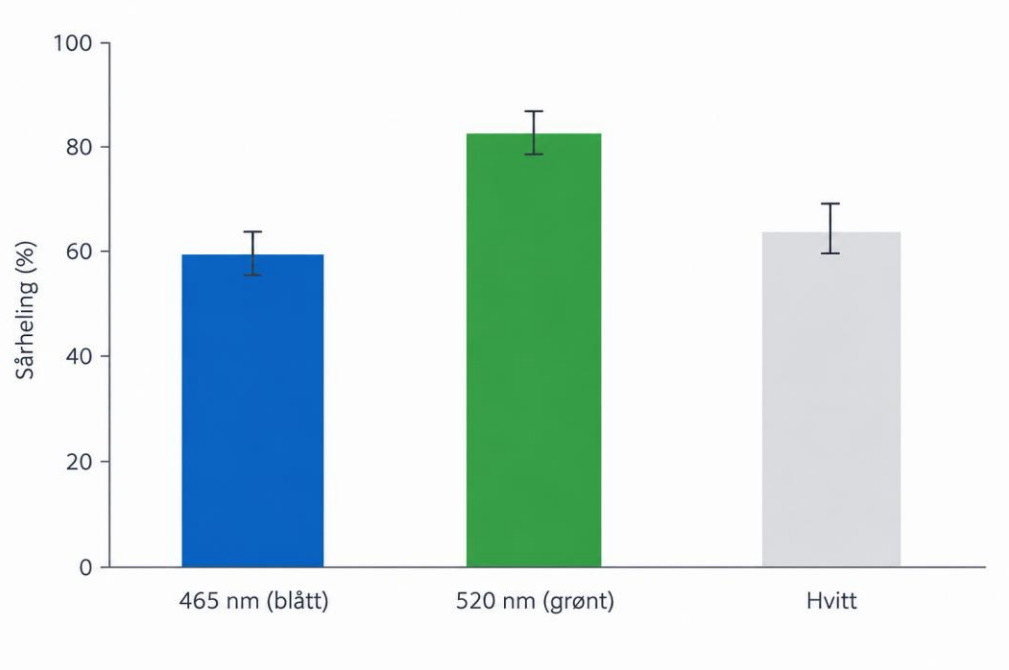




Fotobiomodulasjon fisk

Grønt lys:

- ✓ Stimulerte proliferasjon av celler (Lee et al., 2025)
- ✓ Reduserte sår / akselererte sårheling (Roh et al., 2021)
- ✓ Reduserte DNA skade etter termisk stress (Kim et al., 2016)
- ✓ Reduserte dødelighet etter skade




Molecular mechanisms of green LED-accelerated wound healing in olive flounder (*Paralichthys olivaceus*)


Cell proliferation and wound healing effects of LEDs in the olive flounder, Paralichthys olivaceus

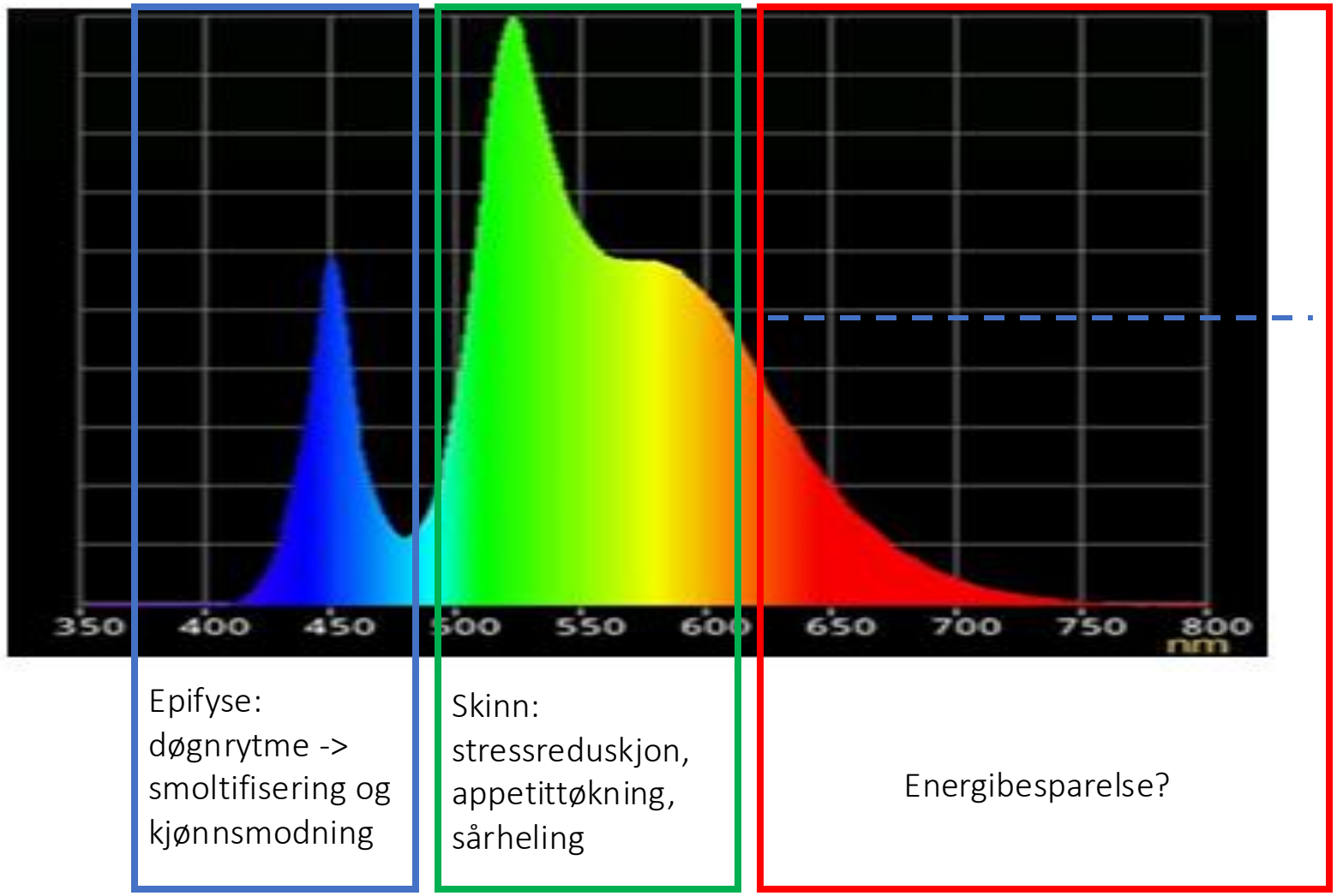

Effects of different light wavelengths from LEDs on oxidative stress and apoptosis in olive flounder (*Paralichthys olivaceus*) at high water temperatures



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Oppdretternes førstevalg

Maks fiskebiologisk effekt per watt»?



Epifyse:
døgnrytme ->
smoltifisering og
kjønnsmodning

Skinn:
stressreduskjon,
appetittøkning,
sårheling

Energibesparelse?

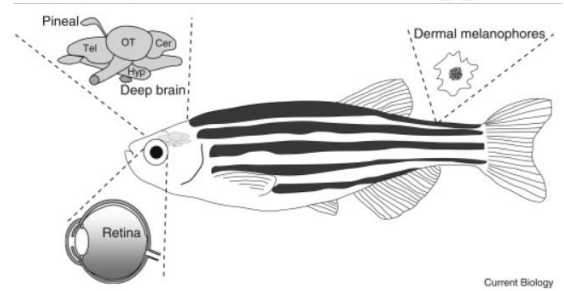
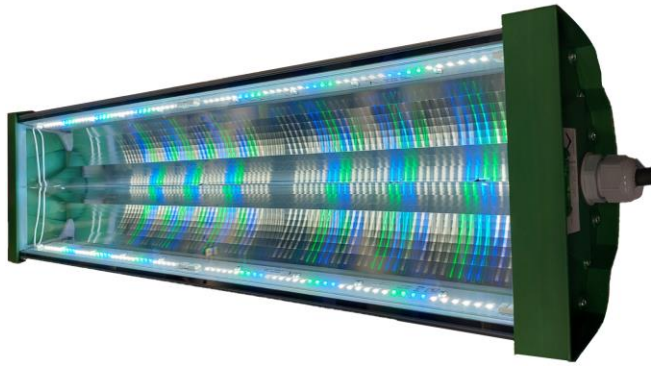
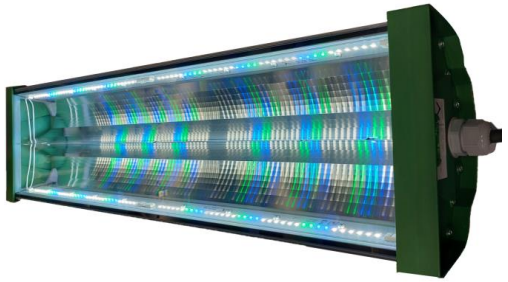
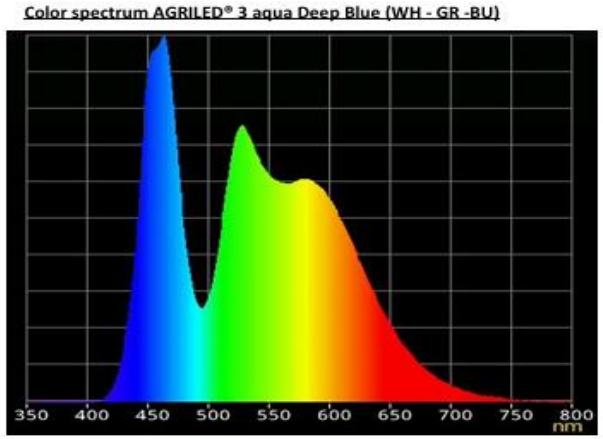


Figure 1 Photosensitive structures in nonmammalian vertebrates.



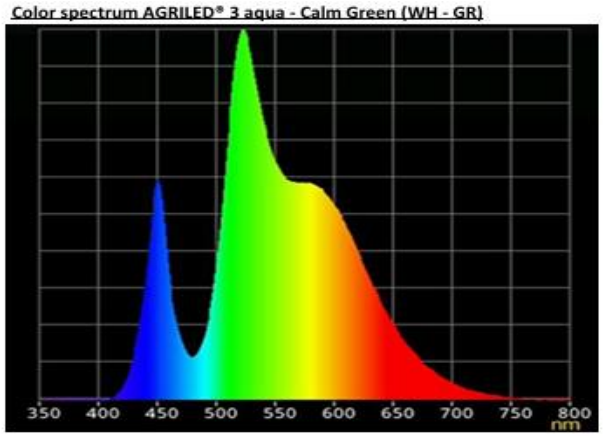
DEEP BLUE





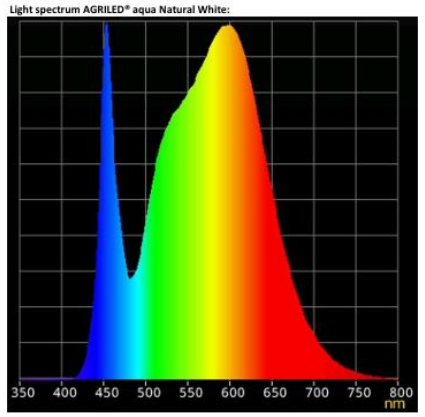
CALM GREEN





NATURAL WHITE



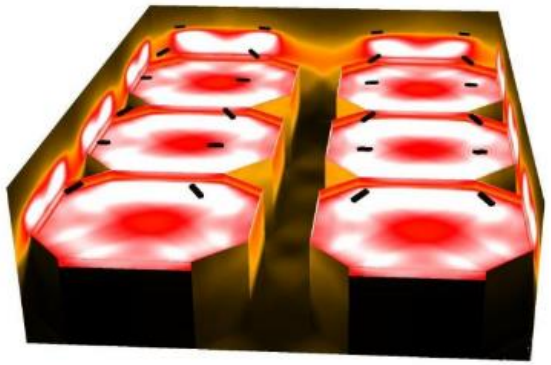


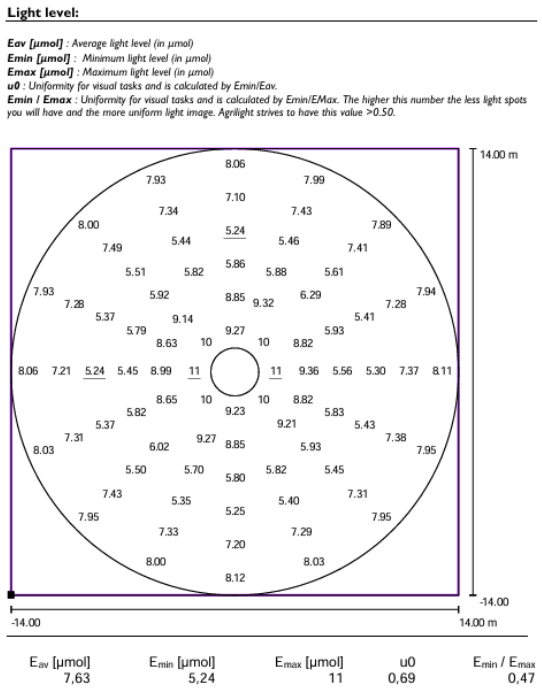
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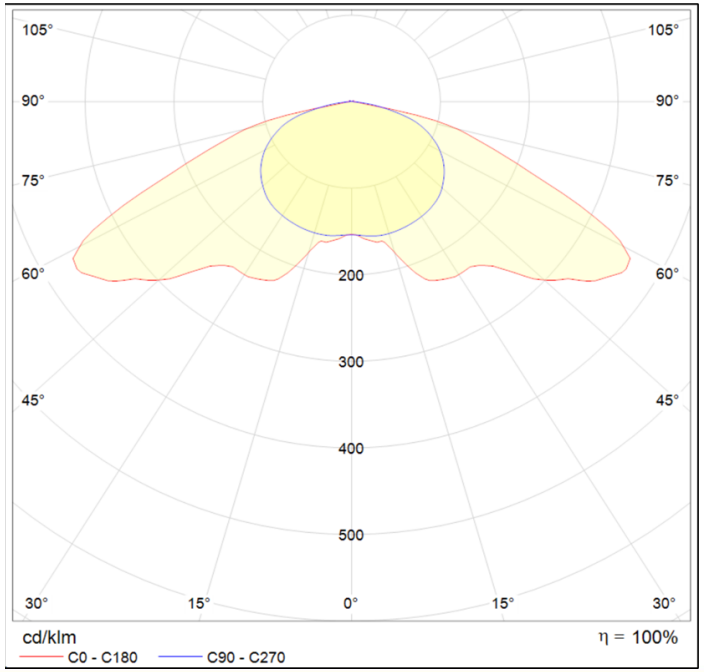
Ulik lysprofil til ulike biologiske oppgaver

Spredning av lys

- Tilpassing av selve armaturen for å sende mer lys ut i kantene for at man skal få et jevnt teppe av lys der dyrene er

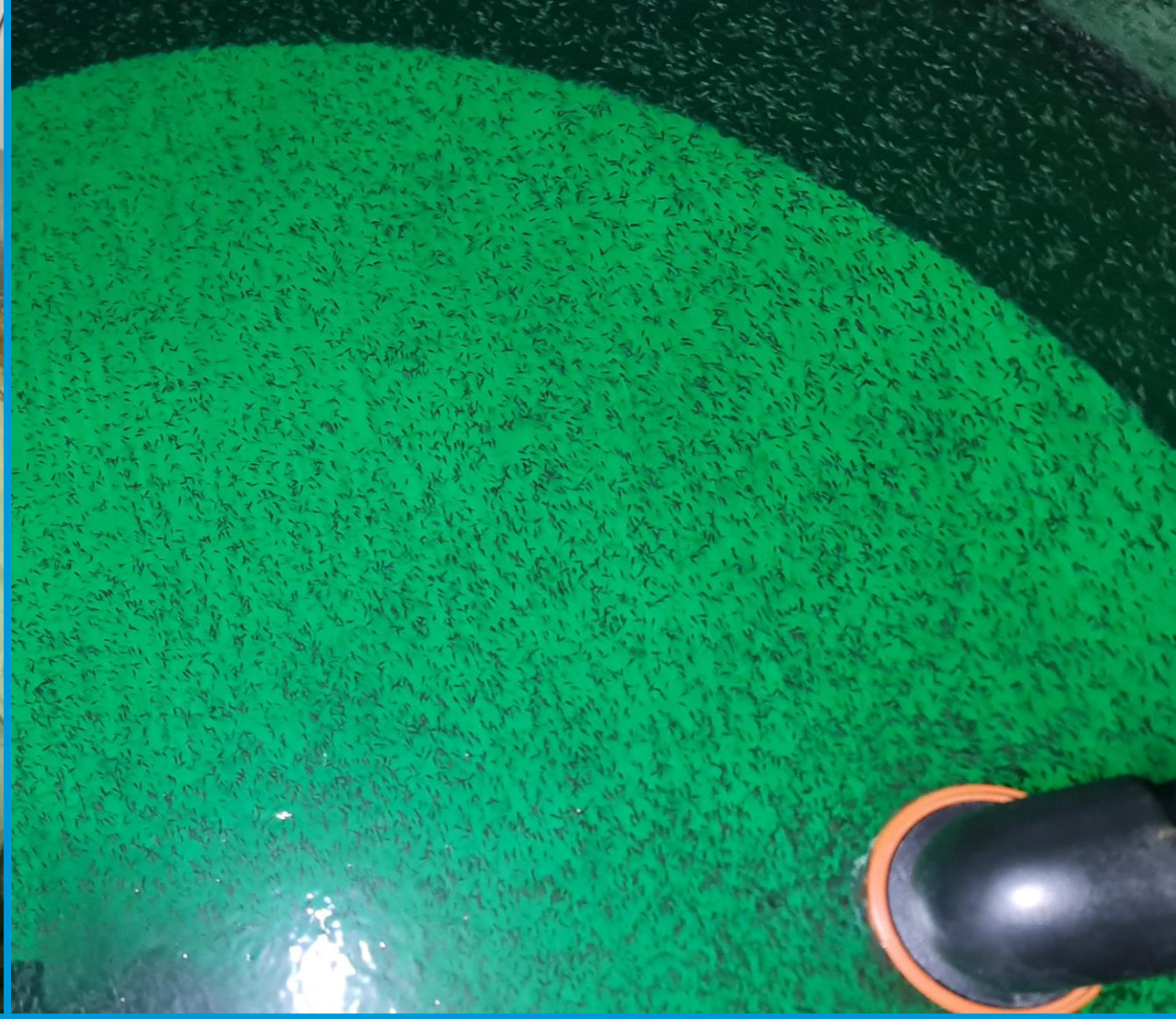






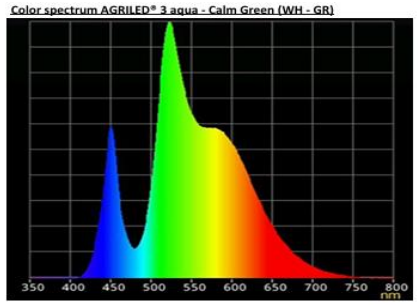






VIKTGHETEN AV LYSSPREDNING

Calm Green – Redusert dødelighet



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