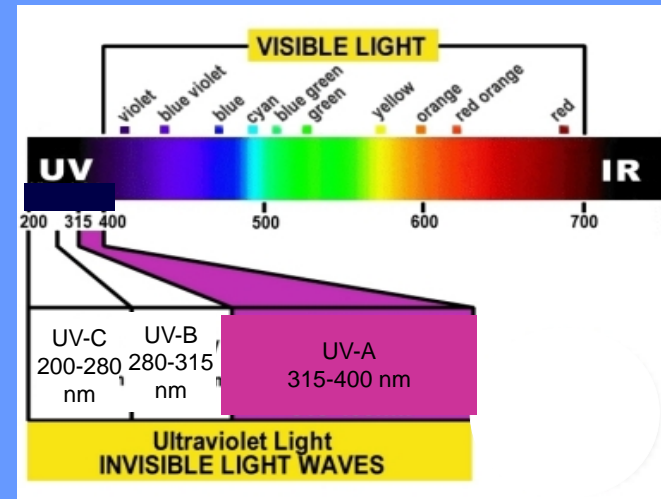


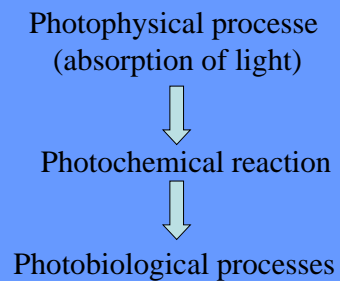
Biological effects of light



Optical region of EM spectrum

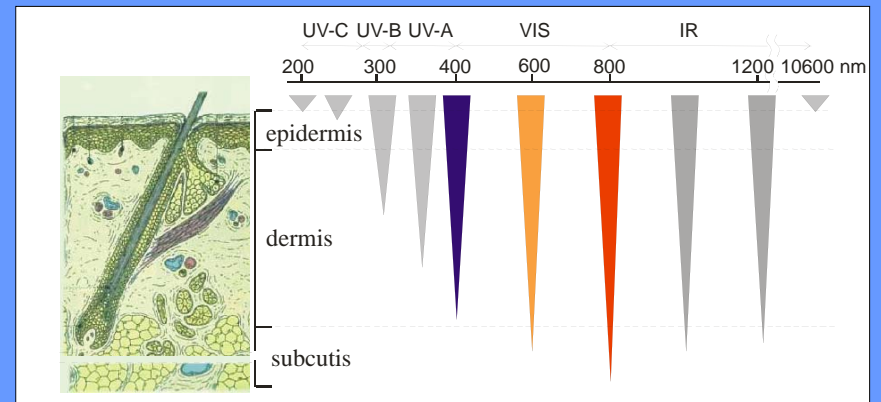


Steps leading to the photobiological alterations



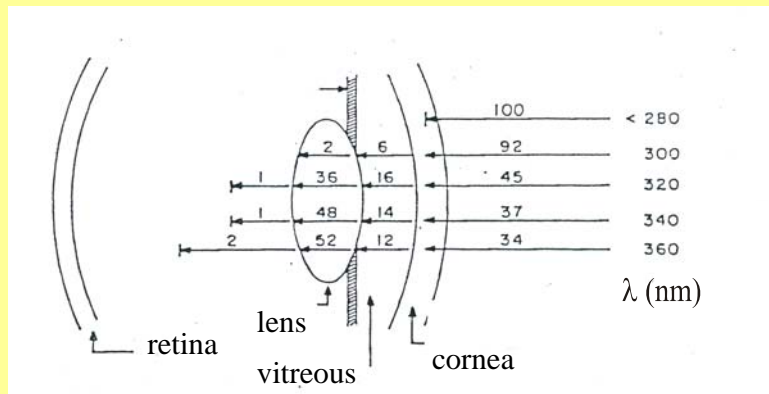
Absorption of light is a prerequisite of photobiological processes

Penetration distance of light into skin



Penetration depth is wavelength dependent

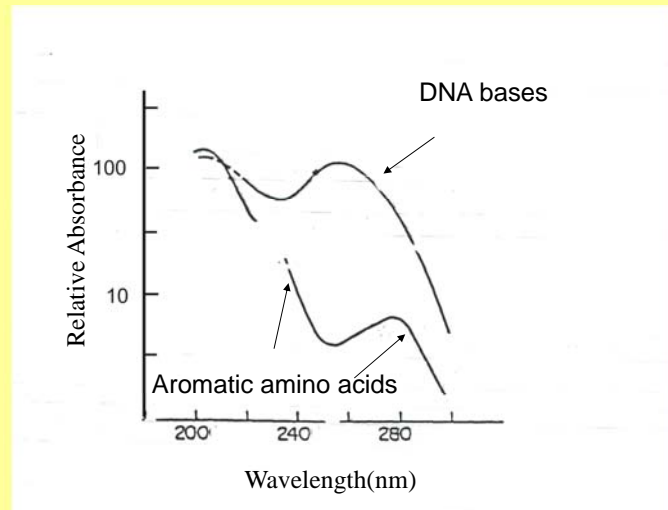
Penetration distance of light into eye



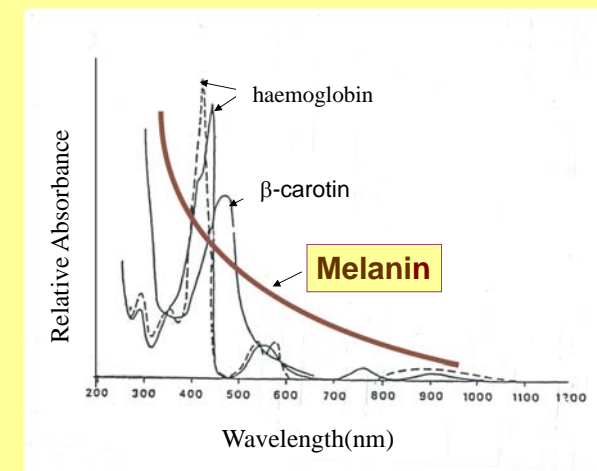
Light absorbers (chromophores) in human tissues

| Endogenous | Exogenous |
|---|---|
| e.g. nucleic acids proteins melanin opsins | e.g. food coloring dyes cosmetics drugs |

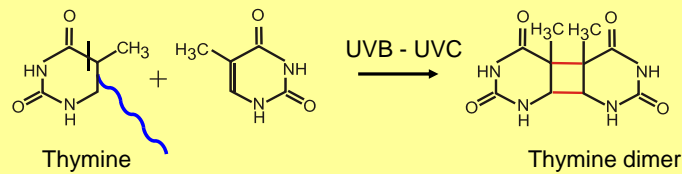
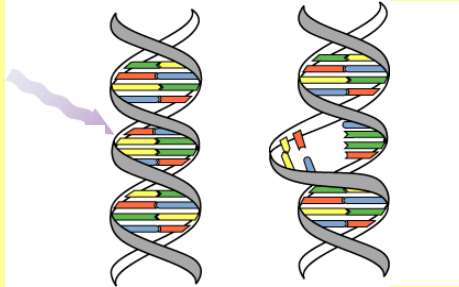
Absorption spectra of endogenous chromophores (1)



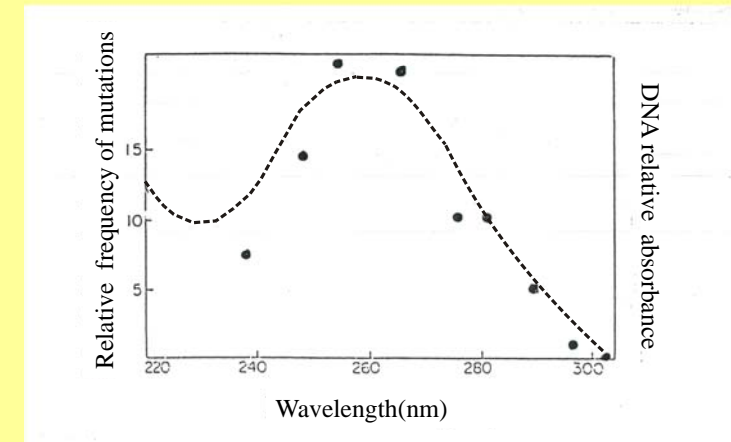
Absorption spectra of endogenous chromophores (2)



Direct photochemical reactions e.g. Formation of DNA damages



Biological consequences of DNA damages in E. coli



Efficiency varies with the wavelength

Mutations are induced by the photons absorbed in DNA

Reciprocity?

$$J_{(\lambda)} [\text{J} / \text{s m}^2] \times t [\text{s}] = D_{(\lambda)} [\text{J} / \text{m}^2]$$

The results depends only on the incident dose ($D_{(\lambda)}$)
or

on J and on t separately

Reciprocity is valid for photochemical reactions but not for photobiological results.

Examples for the photobiological effects of light

Beneficial vs detrimental effects



examples

Vision
Vitamin-D production
Pigmentation
Daily and annual rhythms
Therapeutic applications



examples

Sunburn
Wrinkles
Age related pigmentation
Skin cancer
Immuno-suppression

Spatial distribution of alterations

Local effects

in the skin

in the eye

target regions of therapies

Systemic effects

Temporal distribution of alterations

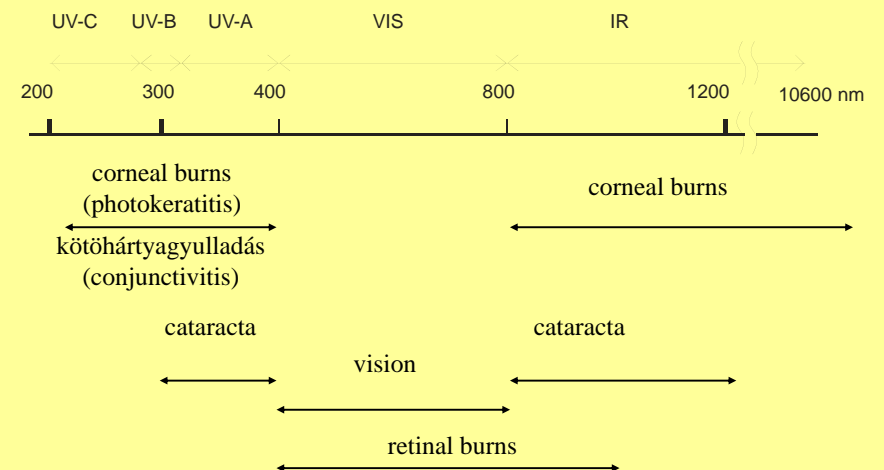
Short term: sunburn
immuno-suppression

Long terme: age related wrinkles
age related pigmentation
skin Cancer

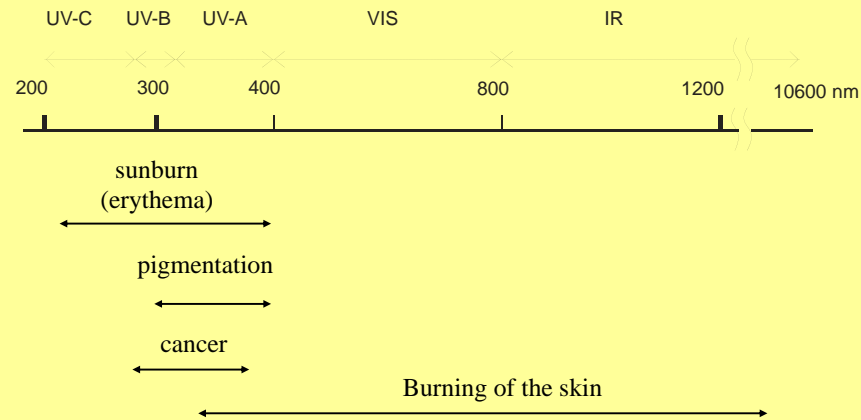


Penetration distance and localization of damages

in the eye

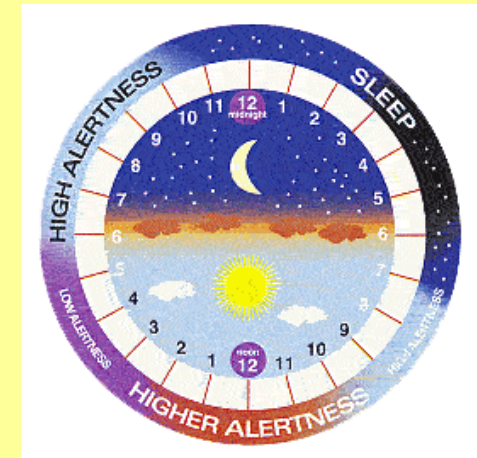


in the skin

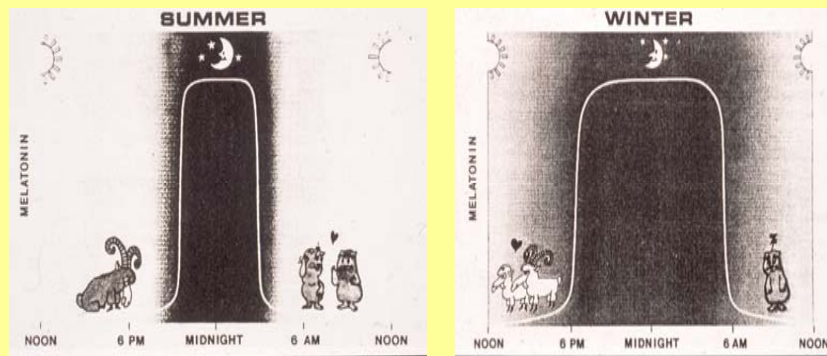


Daily and annual rhythms

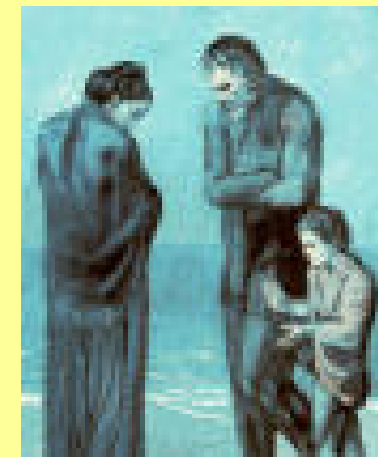
e.g. temperature
hormon production
digestion
sleeping / wake



Light may play a role on the circadian rhythm



Seasonal Affective Disorder (SAD)
fényhiányos depresszió

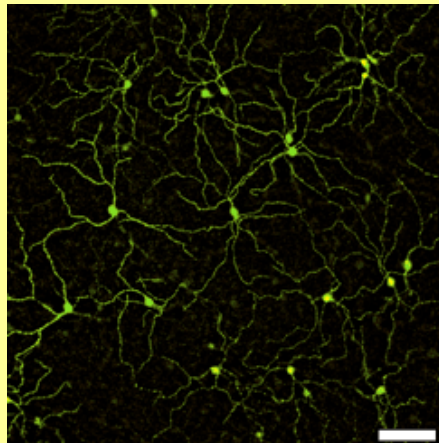
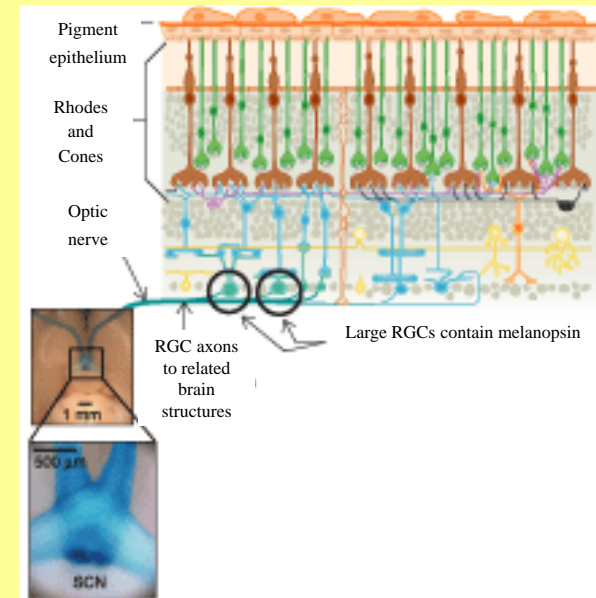


Background of SAD : hight serum level of melatonin

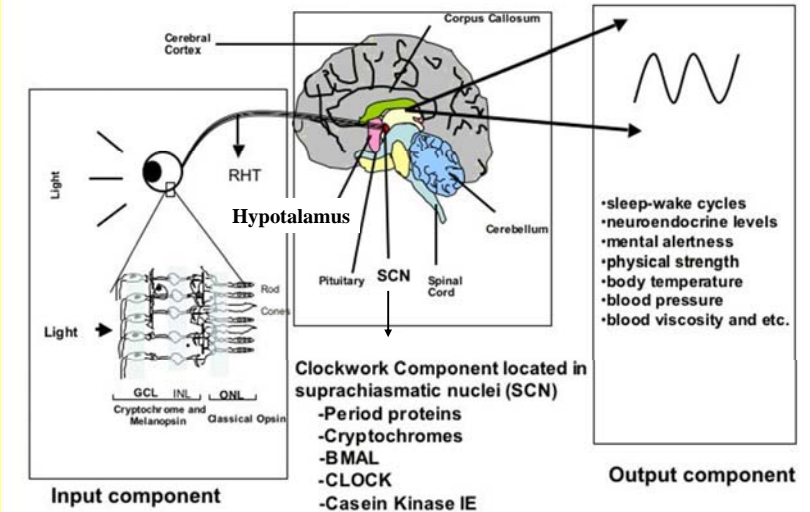
Melatonin level is regulated by the intensity, wavelength and time period of the incident light into the eye

Melatonin level regulation is independent of vision – blindness do not oppose this process

A new type of photosensitive cells (RGC) in retina



Network of retinal ganglion cells



Seasonal Affective Disorder (SAD)

Treatment

Light source: 5000 K incandescent lamp ($\lambda_{\max} = 580 \text{ nm}$)
with UV filter
(Sun: about 6000 K, $\lambda_{\max} = 480 \text{ nm}$)



max . 5 – 10 000 lux
(normal indoor is about 50-100 lux
bright sunlight is about 105 lux)
10 – 15 minutes / day

Question of the week

Absorption of UV-C and UV-B radiation leads to photobiological damages in genetic material. Which macromolecule is responsible for these processes? Why?

Damjanovich, Fidy, Szöllősi: Medical Biophysics

II. 2.3.3

II. 2. 3.4.

IX.2.