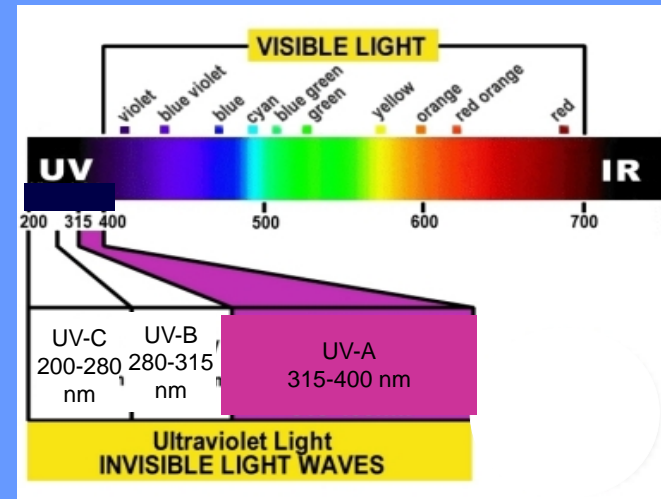


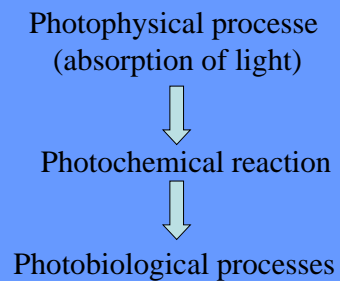
## Biological effects of light



## Optical region of EM spectrum

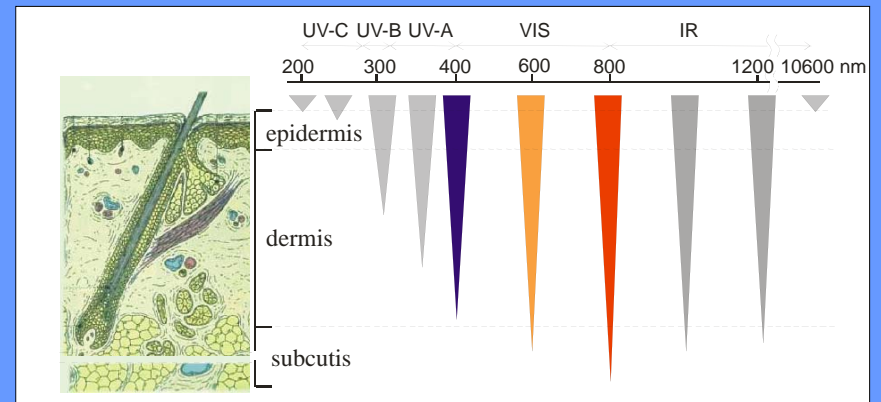


## Steps leading to the photobiological alterations



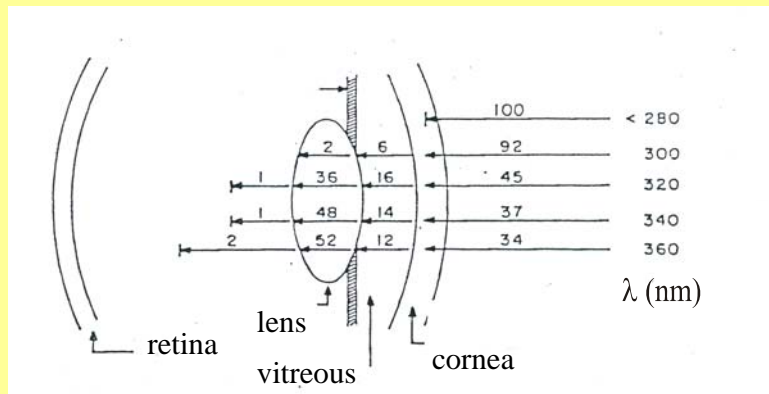
*Absorption of light is a prerequisite of photobiological processes*

## Penetration distance of light into skin



*Penetration depth is wavelength dependent*

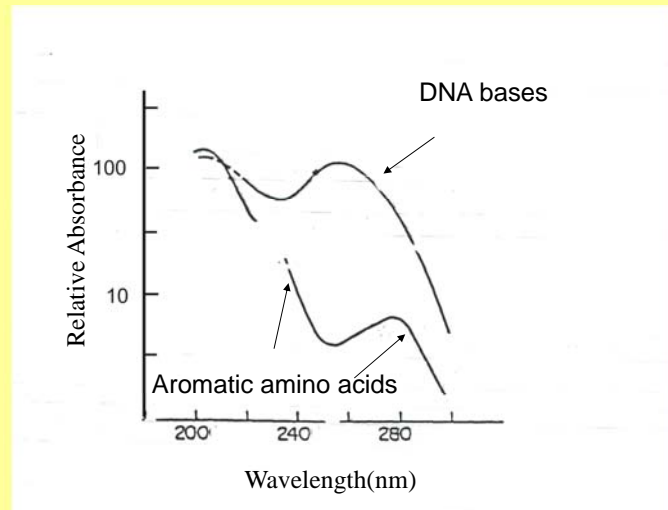
## Penetration distance of light into eye



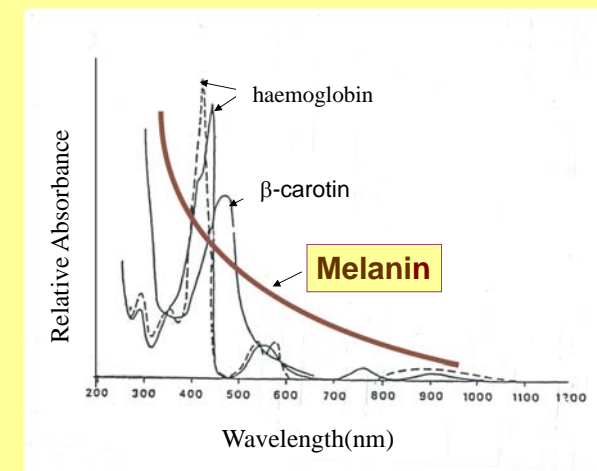
## Light absorbers (chromophores) in human tissues

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

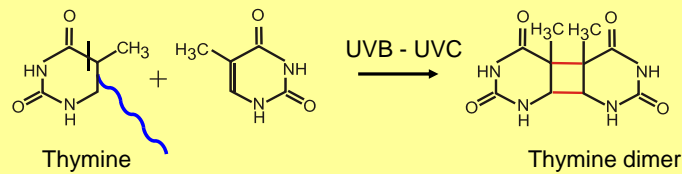
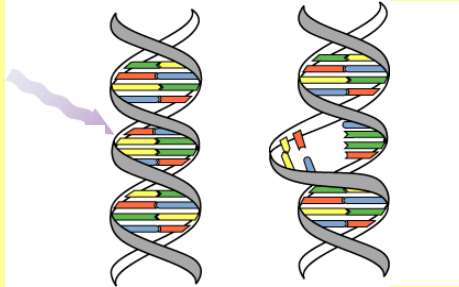
## Absorption spectra of endogenous chromophores (1)



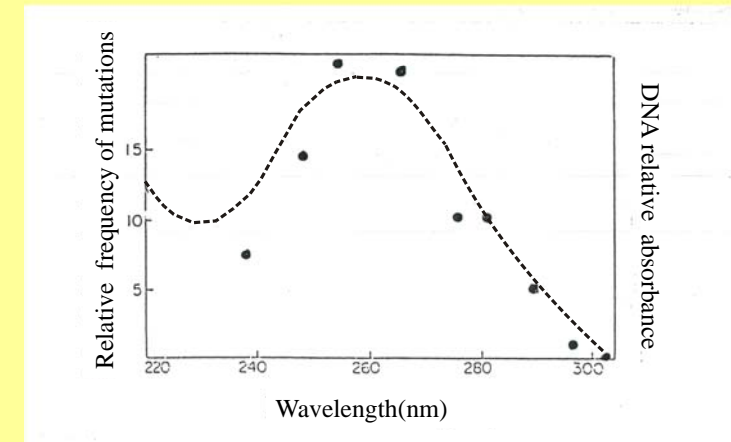
## Absorption spectra of endogenous chromophores (2)



## 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

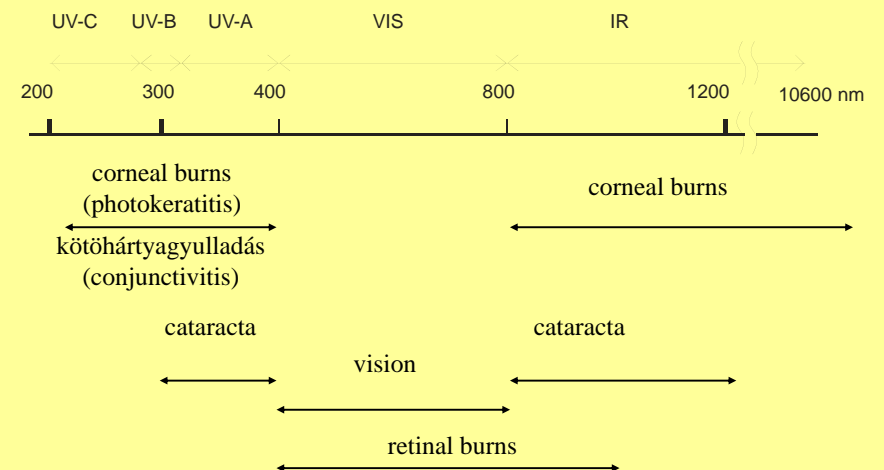
*Short term:* sunburn  
immuno-suppression

*Long terme:* age related wrinkles  
age related pigmentation  
skin Cancer

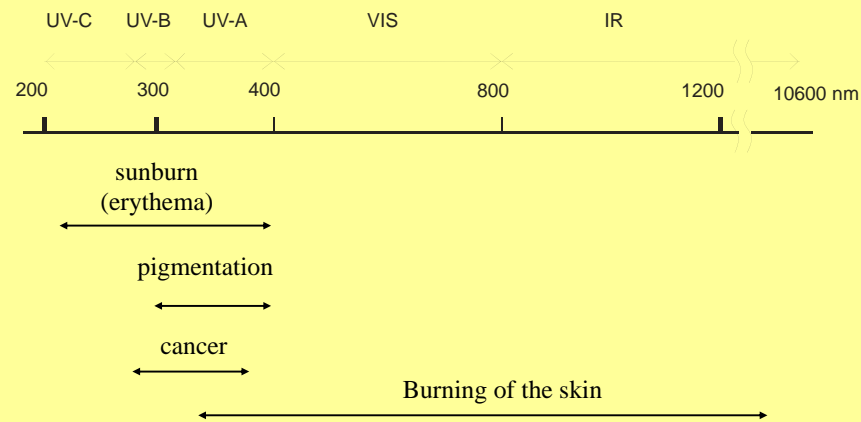


## Penetration distance and localization of damages

in the eye

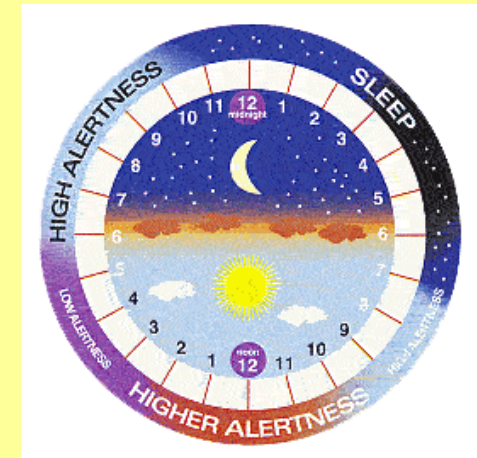


in the skin

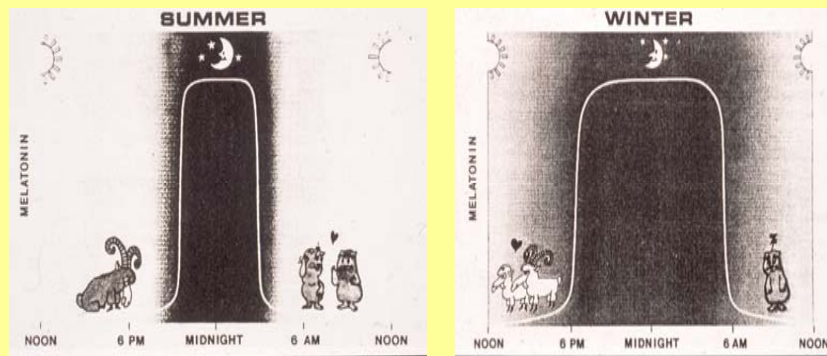


## Daily and annual rhythms

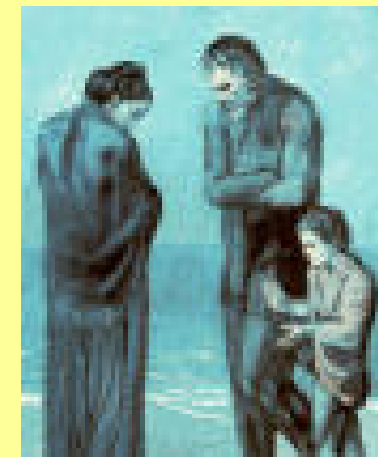
e.g. temperature  
hormon production  
digestion  
sleeping / wake



Light may play a role on the circadian rhythm



Seasonal Affective Disorder (SAD)  
fényhiányos depresszió

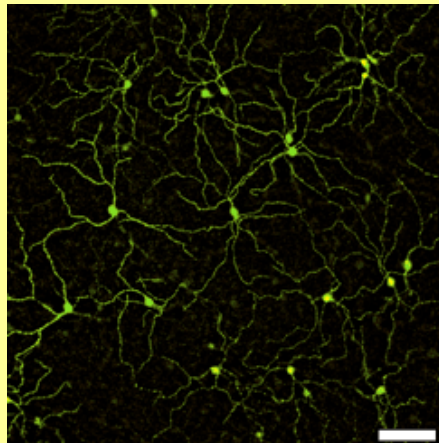
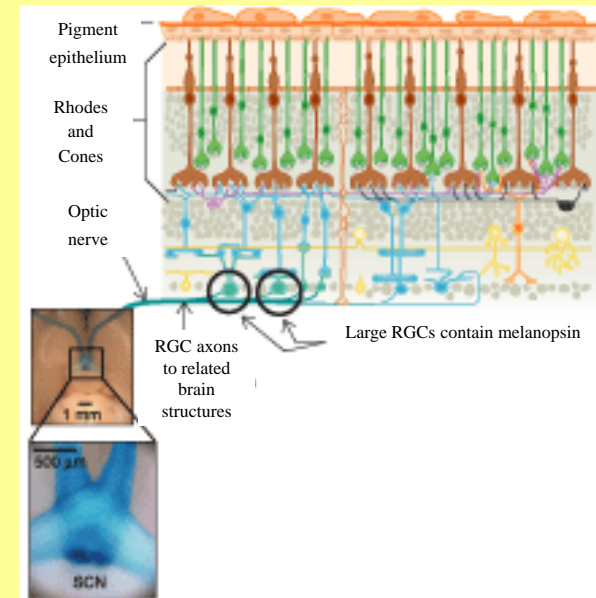


## Background of SAD : hight serum level of melatonin

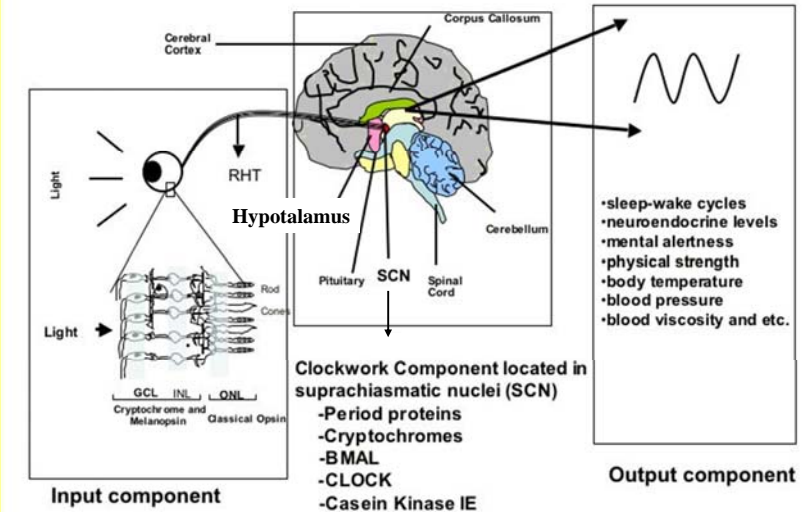
Melatonin level is regulated by the intensity, wavelength and time period of the incident light into the eye

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 living organisms. Which macromolecule is responsible for these processes? Why?

*Damjanovich, Fidy, Szöllősi: Medical Biophysics*

II. 2.3.3

II. 2. 3.4.

IX.2.