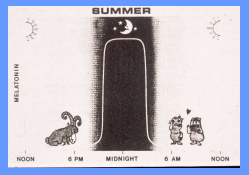
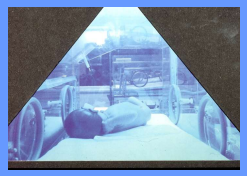
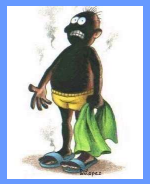
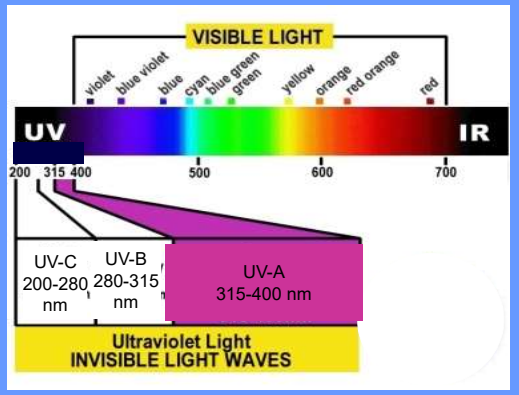


Biological effects of light





Optical reagon of EM spectrum



Steps leading to the photobiological alterations

Photophysical processe
(absorption of light)

⇩

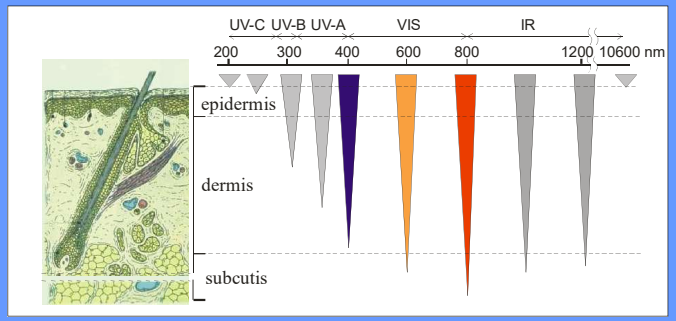
Photochemical reaction

⇩

Photobiological processes

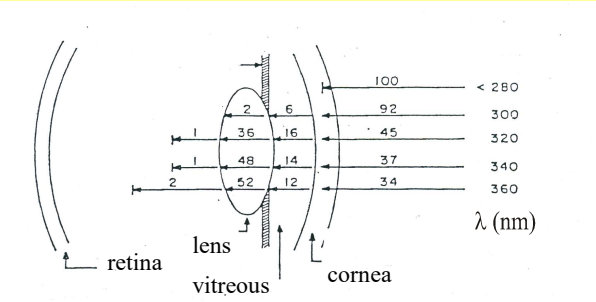
Absorption of light is a prerequisite of photobiological processes

Penetration distance of light into skin



Penetration depth is wavelength dependent

Penetration distance of light into eye



Ligth absorbers (chromophores) in human tissues

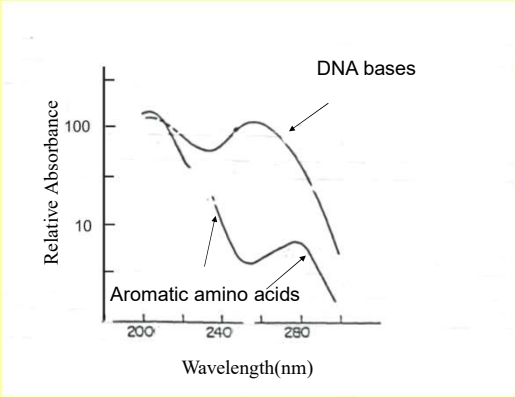
Endogenous

e.g. nucleic acids
proteins
melanin
opsins

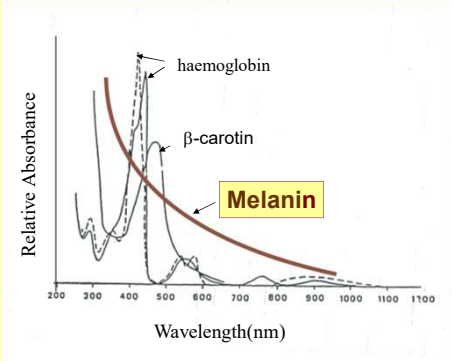
Exogenous

e.g. food coloring dyes
cosmetics
drugs

Absorption spectra of endogenous chromophores (1)

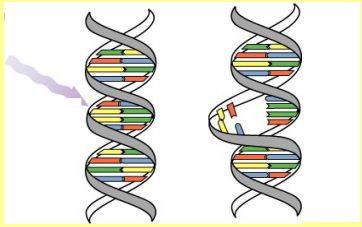


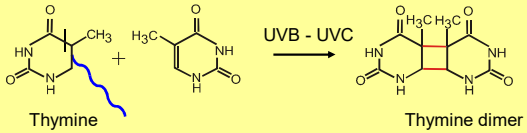
Absorption spectra of endogenous chromophores (2)



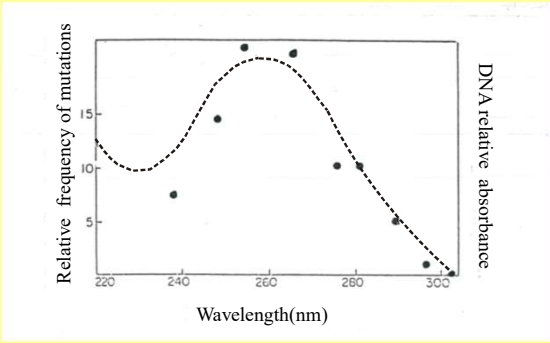
Direct photochemical reactions

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?

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

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 photobiolgical effects of light

Beneficial vs detrimental effects

examples

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

examples

Sunburn
Wrinkles
Age related pigmentation
Skin cancer
Immuno-suppression

Spatial distribution of alterations

Local effects

in the skin

in the eye

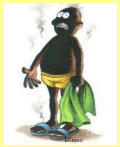
target regions of therapies

Systemic effects

Temporal distribution of alterations

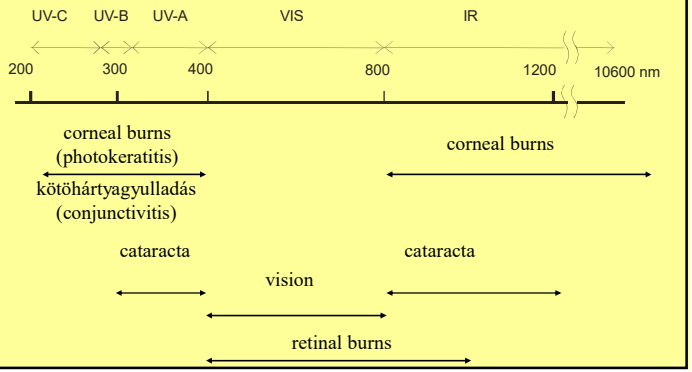
Short term: sunburn
immuno-suppression

Long terme: age related wrinkles
age related pigmentation
skin Cancer

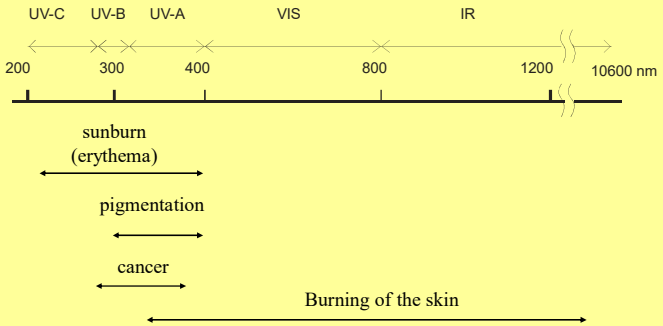


Penetration distance and localization of damages

in the eye

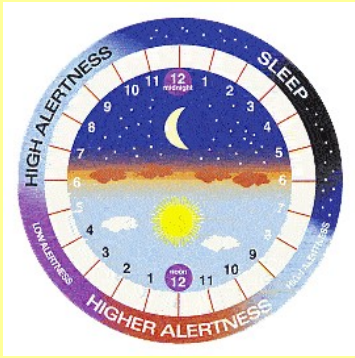


in the skin

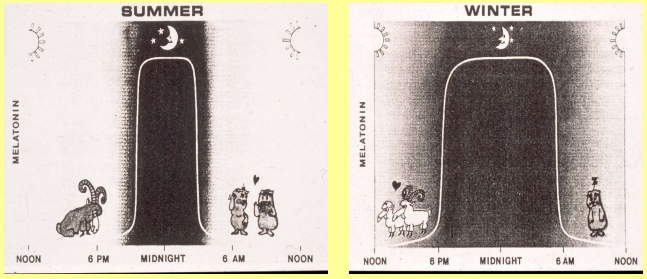


Daily and annual rhythms

e.g. temperature
hormon production
digestion
sliping / wake



Light may play a role on the circadian rhythm



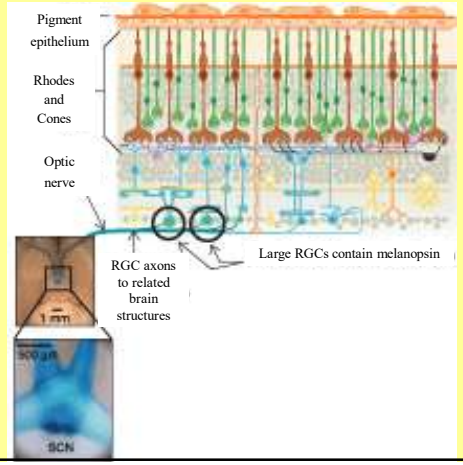
Seasonal Affective Disorder (SAD)
fényhiányos depresszió

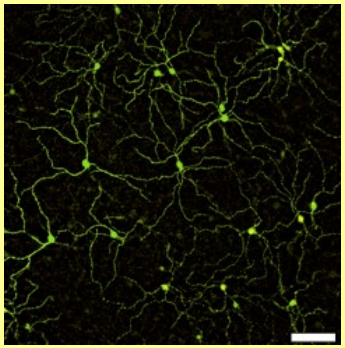
Background of SAD : hight serum level of melatonin

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

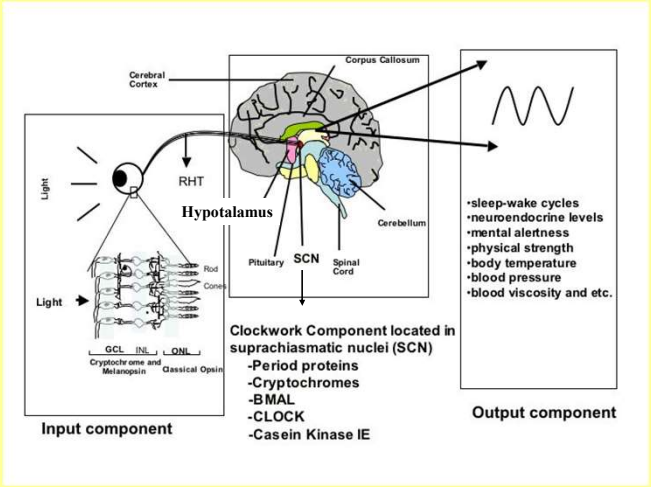
Melatonin level regulation is independent of vision – blindness do not oppose this process

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 (λ_{max} = 580 nm)
with UV filter
(Sun: about 6000 K, λ_{max} = 480 nm)

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

Therapeutical application of light

Phototherapy : light + endogenous chromophores

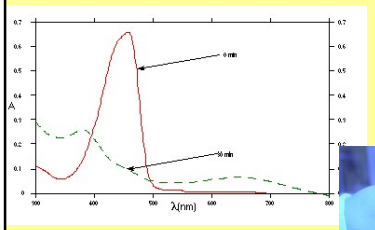
Photochemotherapy: light + exogenous chromophores (drugs)

Neonatal jaundice (hyperbilirubinemia)

Inceased bilirubin production

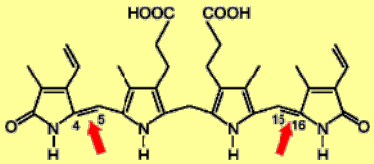
Decreased bilirubin clearence

Absorption spectrum of bilirubin → Blue light therapy



Bilirubin cis - trans isomerization

due to light absorption



PDT

Photodynamic therapy

Short history

Raab *1900*: akridin + napfény - papucsállatka pusztulása

Tappeiner *1903-1904*: eozin + napfény + oxigén - sejtkultúrákban sejtinaktiváció

– *fotodinamikus* szó használata

Hausman *1908*: klorofillal szenzibilizált vvs hemolizise

1911: hematoporfirinnel szenzibilizált egér

Meyer-Betz 1912: próbálkozások különböző porfirinekkel

Meyer-Betz 1913: 3 mg/kg porfirint injektál magába és kimegy a napra

Dougherty *1978*: humán in vivo alkalmazás malignus tumorokon

Mi a PDT?

Fény és fényérzékenyítő anyag

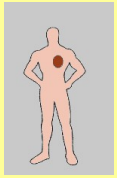
kombinált használata

oxigéndús környezetben

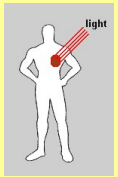
T. Dougherty: Activated dyes as antitumor agents. J. Natl. Cancer. Inst. 1974

A typical PDT session

The photosensitizer is applied

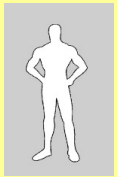


Localization of photosensitizer in the tumor



The photosensitizer is activated by light

The tumor is selectively destroyed



Mechanism of PDT (1)

Indirect photochemical reaction

Electron transfer

$$D \xrightarrow{h\nu} D^*$$

$$D^* + A \longrightarrow D^+ + A^-$$

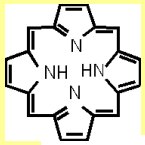
Free radical production

Energy transfer

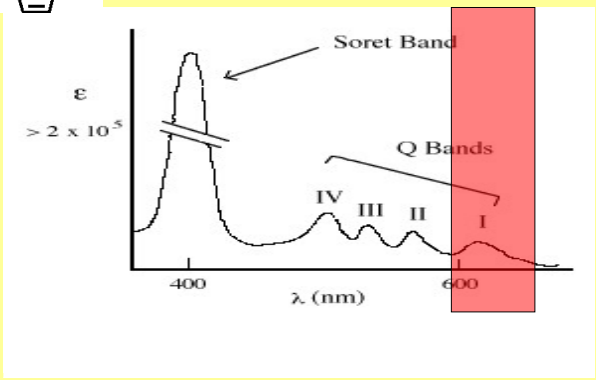
$$D \xrightarrow{h\nu} D^*$$

$$D^* + A \longrightarrow D + A^*$$

Singlet oxygen production



Typical absorption spectrum of porphyrins



Application fields of PDT

- ***Tumour therapy***
  - non-pigmented skin cancer
  - head-neck tumours
  - lung cancer
  - bladder carcinoma
- ***Non-malignant skin desorders***
- ***Inactivation of microbial cells and viruses***
  - inactivation of bacteria and biofilms – ORAL DESINFECTION
  - cleaning of acnes
  - sterilization of blood products
  - desinfection of water

Treatment of scamus cell carcinoma (by PDT

m-THPC PDT 24 óra

m-THPC PDT 7 nap

m-THPC PDT 4 hónap

file:///C:/Users/felhasználó/Documents/Asztal2/csik2017/IRODALOM/dentalpdt/wilson.pdf

FULL PAPER

PPS www.rsc.org/pps

Lethal photosensitisation of oral bacteria and its potential application in the photodynamic therapy of oral infections

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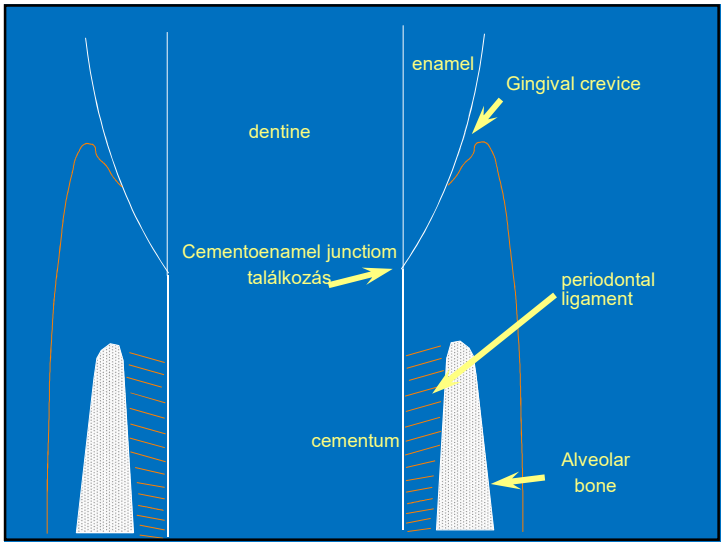
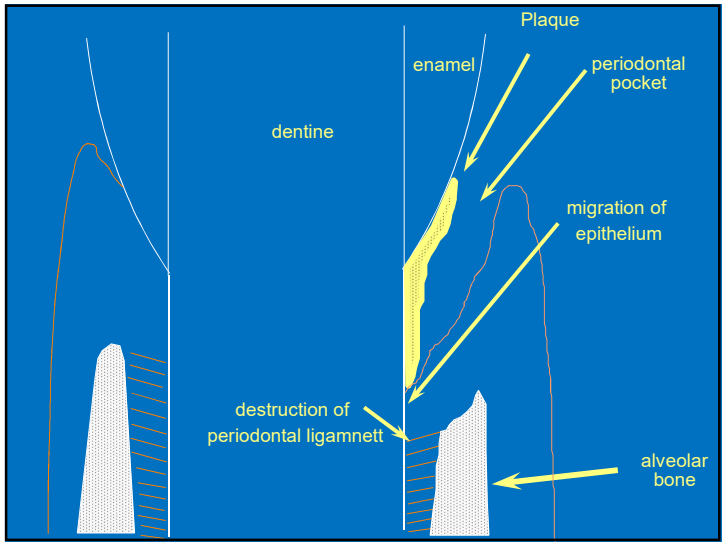
Chemical antibacterial agents are increasingly being used in prophylactic and therapeutic regimes for dental plaque-related diseases, which are among the most common human infections. As these agents are difficult to maintain at a therapeutic concentration in the oral cavity and can be rendered ineffective by resistance development in the target organisms, there is a need to develop alternative antimicrobial approaches. Bacteria and other microbes can be sensitised to light through prior treatment with a chemical photosensitising agent. Lethal photosensitisation of a wide range of bacteria responsible for caries, periodontal diseases and root canal infections has been demonstrated using red light in conjunction with a number of photosensitisers, including Toluidine Blue, phthalocyanines and chlorins. The advantages of this approach are that bacteria can be eradicated in very short periods of time (seconds or minutes), resistance development in the target bacteria is unlikely and damage to adjacent host tissues and disruption of the normal microflora can be avoided. This approach may be a useful alternative to antibiotics and antiseptics in eliminating cariogenic and periodontopathogenic bacteria from disease lesions and for the disinfection of root canals. Not only would this be of benefit for the treatment of these diseases but, by replacing the antimicrobial agents that are currently used for such purposes, it would help to conserve our dwindling supply of antimicrobial agents that are effective in the treatment of serious systemic infections.

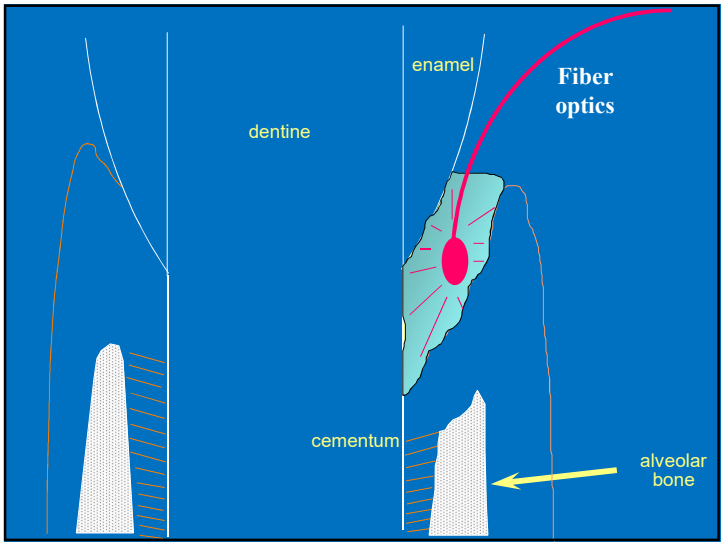
1 Introduction

The oral cavity of man is colonised by very large numbers of a highly diverse community of bacteria (as many as 1000 different species have been detected) collectively known as the "normal oral microflora".[1,2] While the vast majority of the members of this complex community are harmless, some have been identified as the aetiological agents of a variety of diseases both within and outside of the oral cavity (Table 1).[3] These diseases range from those with a very high prevalence but which are not

The accumulation of these bacterial biofilms on tooth surfaces results in some of the most prevalent bacteria-induced diseases of man—caries and inflammatory periodontal diseases. The former is due to the accumulation of the biofilm supragingivally (*i.e.* above the level of the gingival margin) and involves the progressive dissolution of enamel and, eventually, the underlying dentine (Fig. 2). It has been reported that in the USA, as many as 58.6% of children between the ages of 5 and 17 have dental caries.[3] The periodontal diseases stem from a build-up of plaque at and below the gingival margin and the







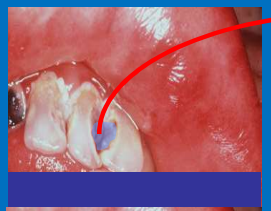
fogágygyulladás kezelése #1
fényérzékenyìtő alkalmazása

fogágygyulladás kezelése #2
iny alatti régió besugárzása

Treatment of caries #1

Application of photosensitizer

Treatment of caries#2



Irradiation

Reconstructive filling

Damjanovich, Fidy, Szöllősi: Medical Biophysics

II. 2.3.3

II. 2. 3.4.

IX.2.