

Photodynamic effect of halogenated porphyrin against Paramecium. New laboratory class for interdisciplinary education

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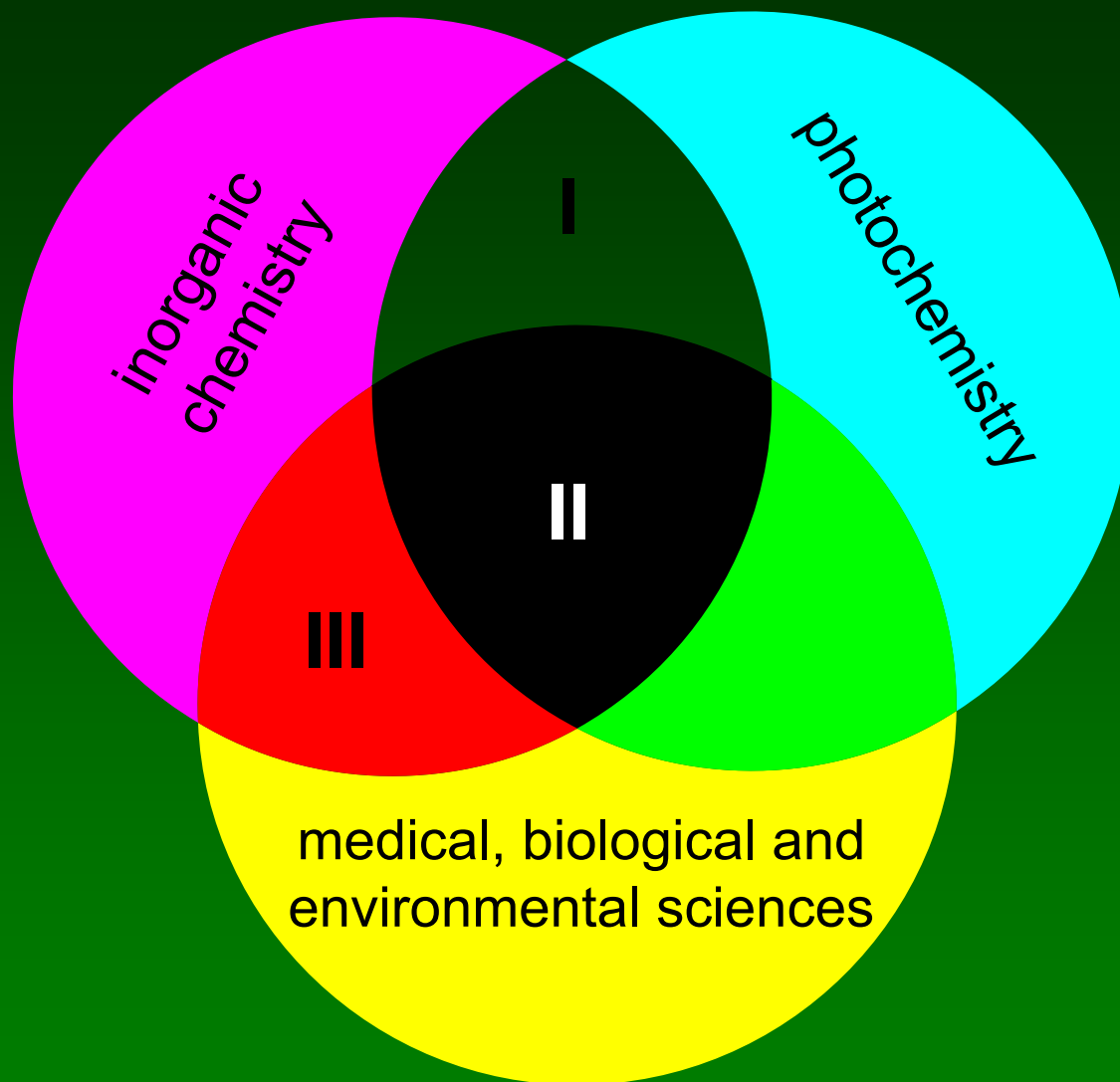
Jagiellonian University

Faculty of Chemistry

Faculty of Biochemistry, Biophysics and
Biotechnology

Reasons

- Doctoral students at the Faculty of Chemistry (Jagiellonian University) are obliged to take up a 360-hour teaching load during their studies
- The course “Chemistry at Tertiary (University) Education Level’ for doctoral students
- The propositions of scenarios of classes run by the students are introduced and presented in a broader way e. g. at the conference Variety on Chemistry Education
- New courses such as Photochemistry in biology and medicine, Bioinorganic Photochemistry

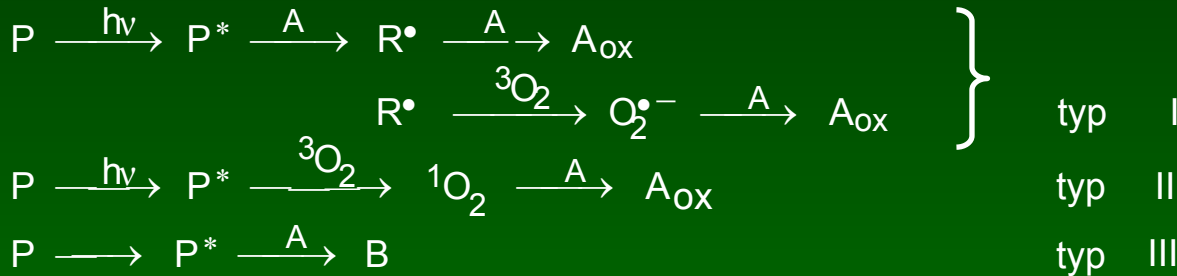


Bioinorganic *photochemistry* (II), as a part of bioinorganic chemistry (II + III) connects inorganic photochemistry (I + II) with biological, medical and environmental sciences.

PHOTODYNAMIC THERAPY (PDT)

Photodynamic therapy is a treatment modality involving administration of a **photosensitizer (P)**, accumulation of sensitizer molecules in the target cells, followed by selective irradiation of lesion with visible or infrared **light** in the presence of molecular **oxygen**. Drug and light individually are non-toxic, in combination destroy tissues.

Mechanism:

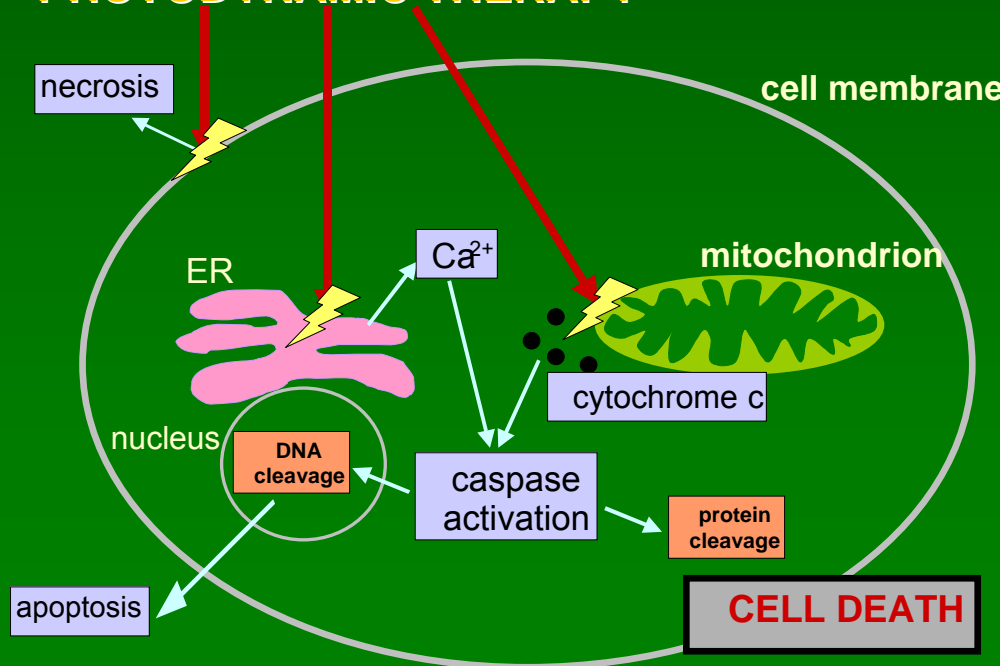


Main biological targets are:

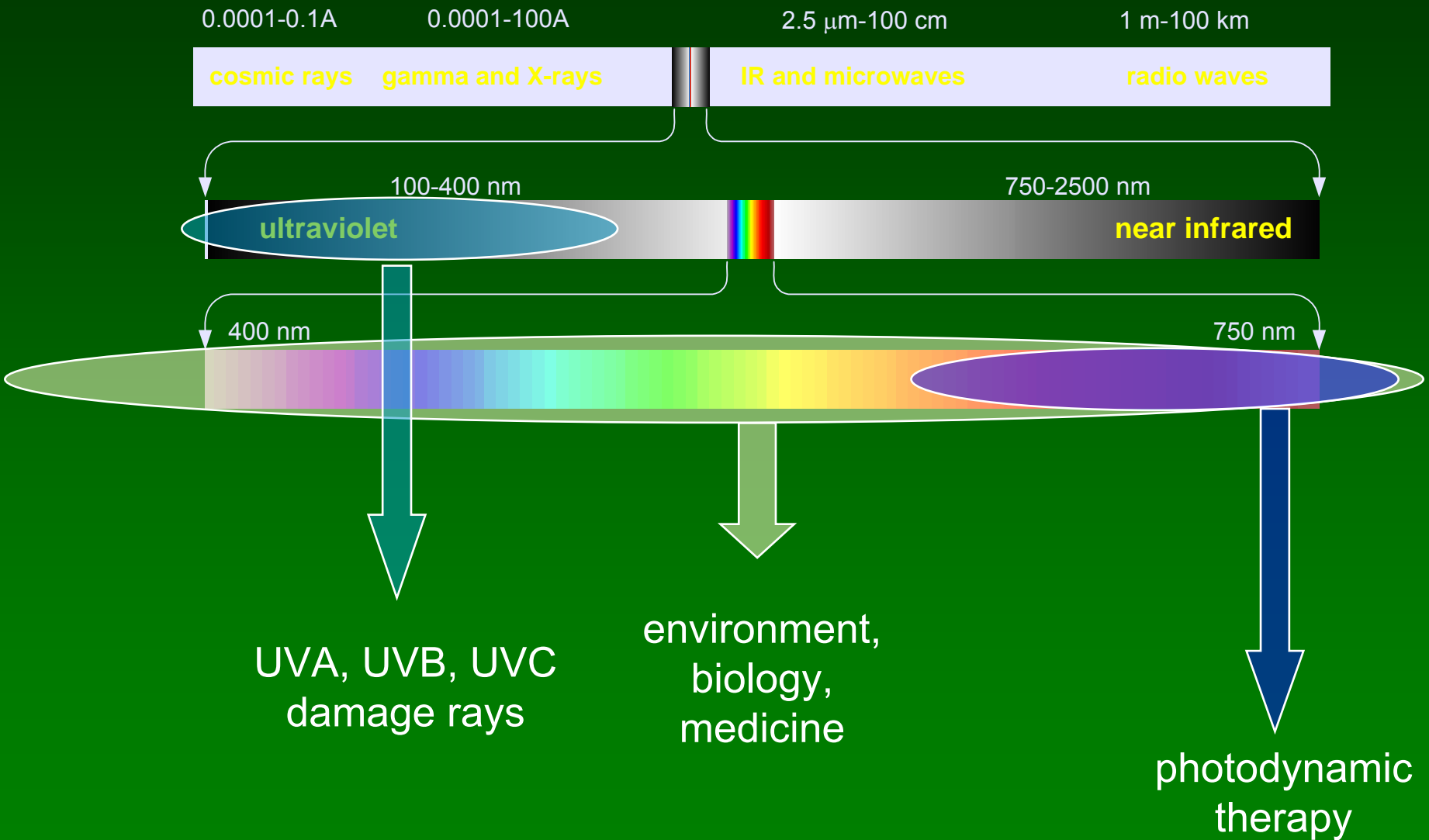
cell membrane and membranous organelles such as **mitochondria**, **lysosomes** and **nuclei**.

Hydrophobic drugs attack and annihilate tumour cells mainly by direct interactions. Hydrophilic drugs kill neoplastic cells indirectly by damaging blood vessels and interrupting the supply of oxygen and other nutrients.

PHOTODYNAMIC THERAPY



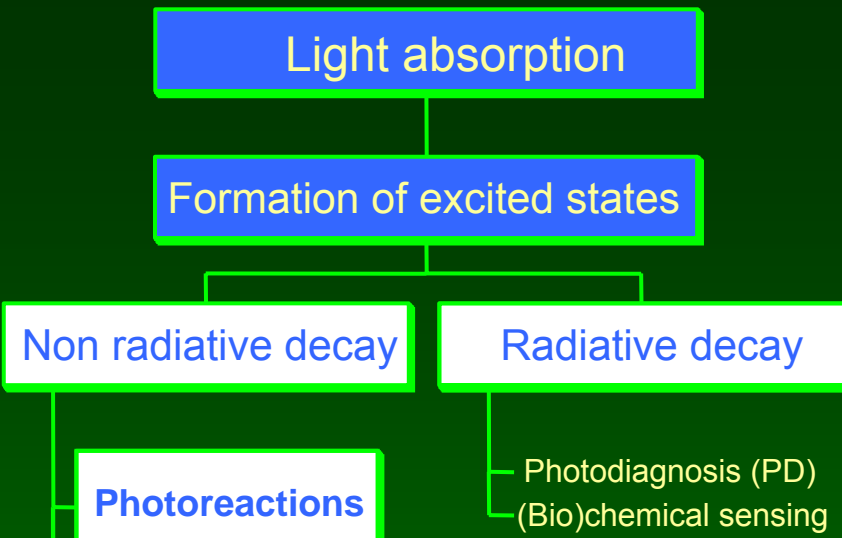
Electromagnetic radiation



LIGHT SOURCES

	Wavelength(s) (nm)	Bandwidth (nm)	Power	Light delivery
Therapy laser processor (PMC-018)	670 830	Monochrome 5 – 10	Up to 200 mW	Optical fibre
Diode Laser Opal, Coherent	689	Monochrome 5 – 10	Up to 300 mW	Optical fibre
Halogen lamp (OSM-20)	300 – 1100	200	Up to 45 mW	Optical fibre
Halogen lamp (Optel, HOP 250)	300 - 1100	10-100 (depending on the filter used)	Up to 1,2 W	Optical fibre
Nd-YAG Laser	255	6	0.75 W	Directly
	355	6	1.00 W	
	532	6	2.45 W	
	1064	7	4.5 W	

Application of photophysical and photochemical processes in photomedicine

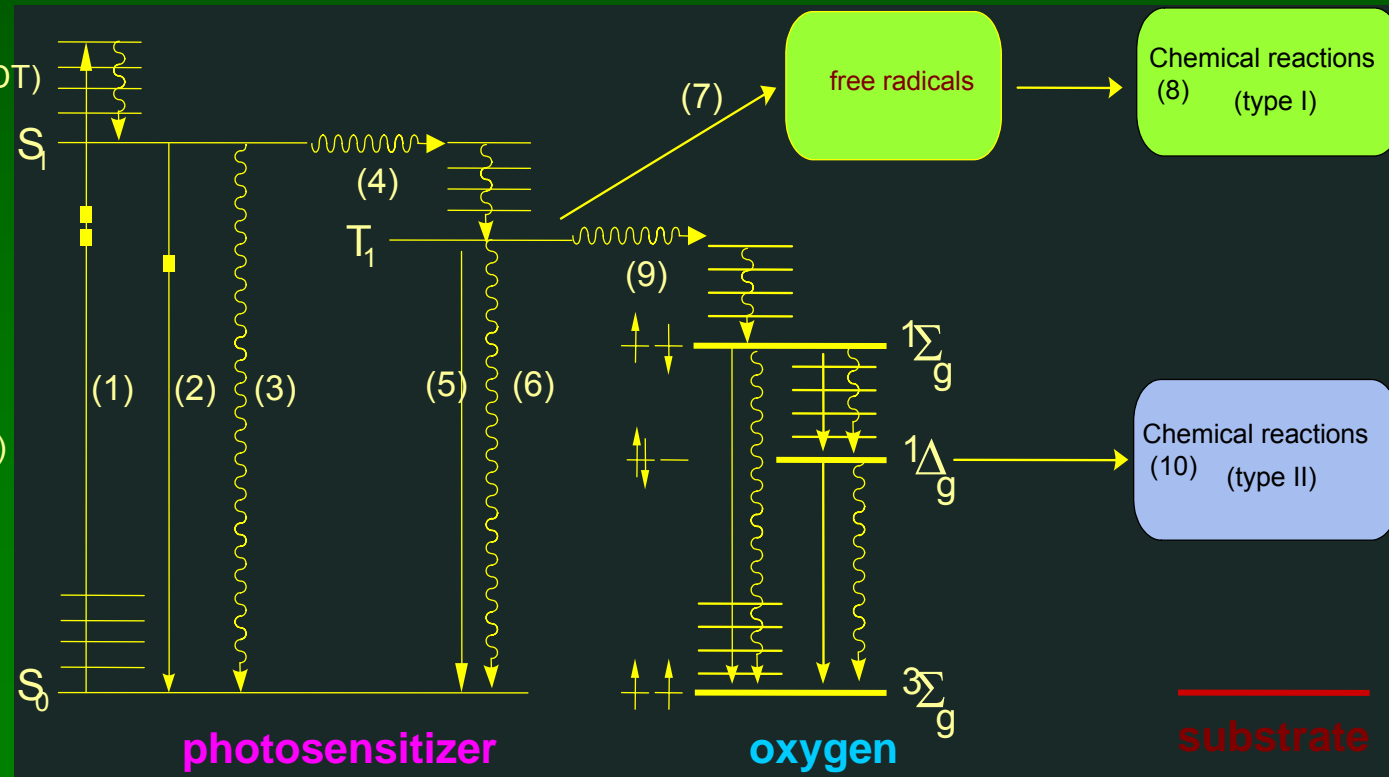


Photoreactions

- Photodynamic therapy (PDT)
- Photoactivation
- Photodelivery
- Phototoxicity

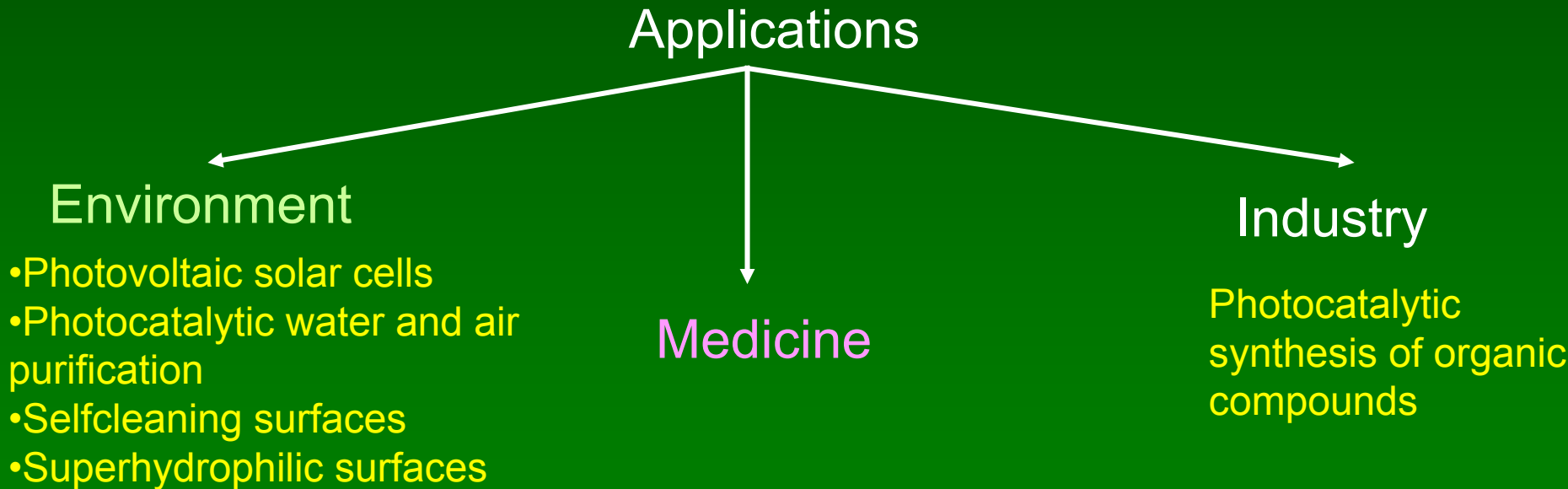
Internal conversion to the ground state

- Photothermal therapy (PT)
- Photoprotection



PHOTOSENSITIZERS

- Organic compounds (dyes, aromatic hydrocarbons)
- Tetrapyrrole macrocycles and their derivatives (porphyrins, chlorins, phthalocyanines)
- Transition metals complexes
- Semiconductors
- Inorganic or organic compounds immobilized on semiconductors



PHOTOSENSITIZERS for PDT

- **FIRST GENERATION:**
HEMATOPORPHYRIN
DERIVATIVE (HPD) AND ITS
ANALOGUES
- **SECOND GENERATION:**
STRUCTURALLY DISTINCT
COMPOUNDS WITH LONG-
WAVELENGTH ABSORPTION
- **THIRD GENERATION:**
SECOND GENERATION
PHOTOSENSITIZERS
BOUND TO CARRIERS FOR
SELECTIVE
ACCUMULATION IN THE
TUMOUR

IDEAL PHOTOSENSITIZER

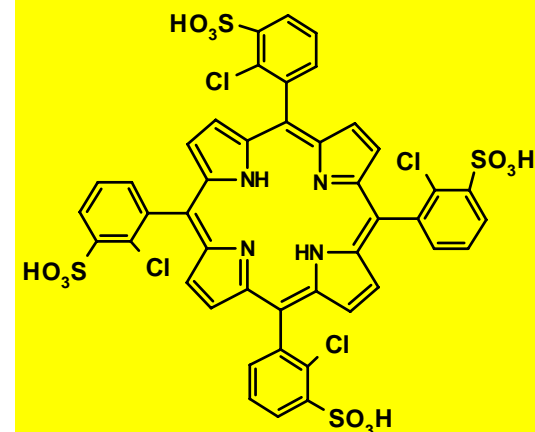
A. Biological aspects

1. Little or no dark toxicity
2. Selective accumulation and prolonged retention in tumour tissues
3. Controlled photofading to reduce the unwanted skin photosensitivity side effects and increase light penetration during therapy

B. Chemical and photochemical aspect

1. Stability, purity and homogeneity
2. High absorption coefficient in the phototherapeutic window (600-1000 nm)
3. High quantum yield for singlet molecular O₂ (¹Δ_g) sensitisation.

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Synthesis, Photophysical Studies and Anticancer Activity of a New Halogenated Water-Soluble Porphyrin

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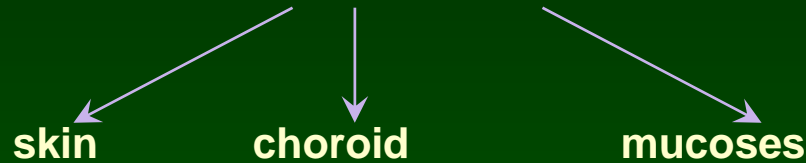
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MELANOMA

Etiopatogenesis



A = (asymmetry)

B = (border)

C = (color)

D = (diameter)

E = (elevation)

IMPORTANT MELANOMA PROPERTIES

- Resistance to various treatments
- Endogenous chromophore - melanin

Alternative model

Paramecium

in the chemical and physical departments usually there is no possibility to perform the experiments on neoplastic cells

Equipment



Nikon Eclipse TS-100 F inverted microscope
Equipped with Nikon digital camera Coolpix 8400



Halogen lamp

New laboratory class designed for those with a general interest in the biomedical application of photochemistry

The presented laboratory class will enable students to:

Understand basic concepts of photochemistry and photosensitization

Connect these physico-chemical concepts to biomedical applications

Understand the relation between chemical structure, photophysical properties and biological activity

The main emphasis of this class

- ◇ planning chemical, biological and physical experiments together
- ◇ dosimetry methods for monitoring the amount of photosensitizer, the amount of light, and the amount of oxygen

The interdisciplinary setting of this topic is definitely able to attract students much more so than a typical program in Chemistry

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