Photodynamic Therapy: Killing Cancer with Light

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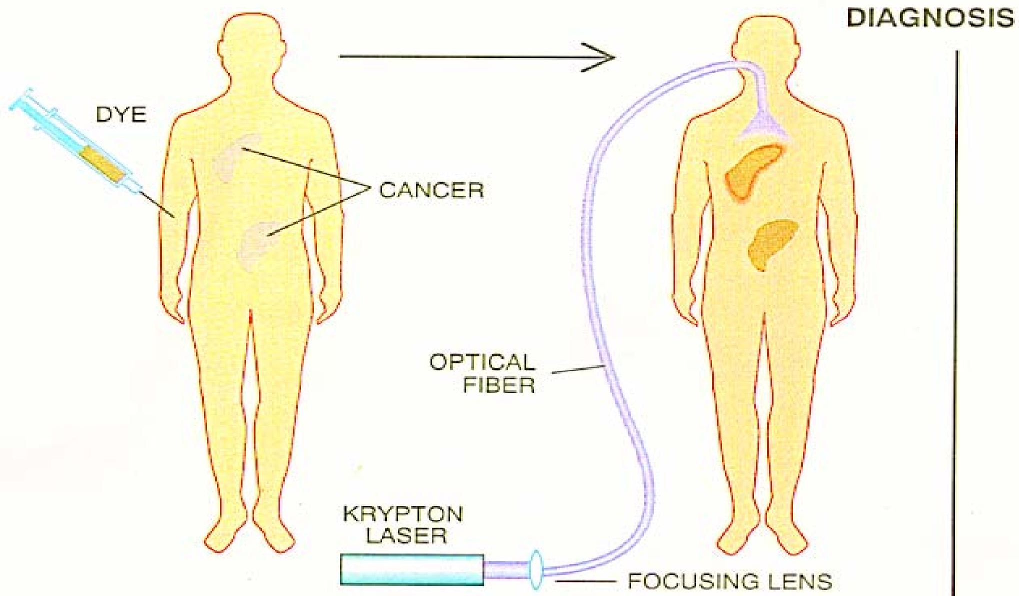
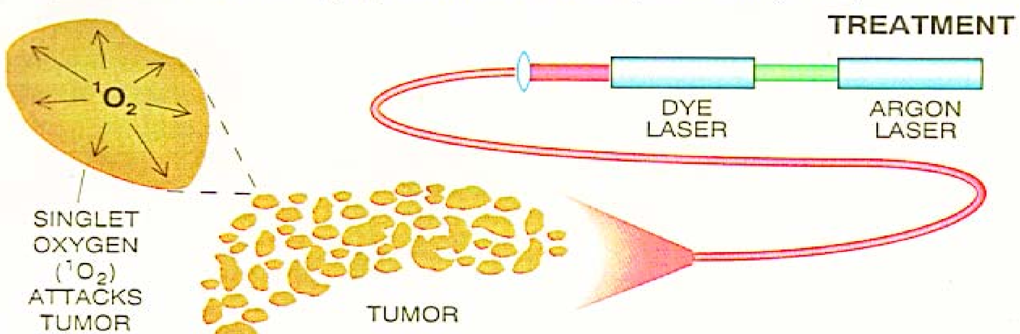
Photodynamic Therapy for Cancer



A dye selectively concentrates in cancerous tissue 48 to 72 hours after it is injected. Blue-violet light from the krypton laser, administered through an optical fiber, causes the dye-laden growth to fluoresce so it can easily be observed and diagnosed. The optical fiber then delivers laser light of another wavelength, which destroys the tumor. In this case, an argon laser drives a second light source: the red dye laser. Energy from the laser excites dye molecules in the tumor; these molecules, in turn, pass the energy to molecular oxygen. The excited oxygen, called singlet oxygen because of its spin state, becomes highly reactive and destroys the malignancy.



Oral Sarcoma Tumor Treatment in a Dog

Immediately after treatment

1 day later

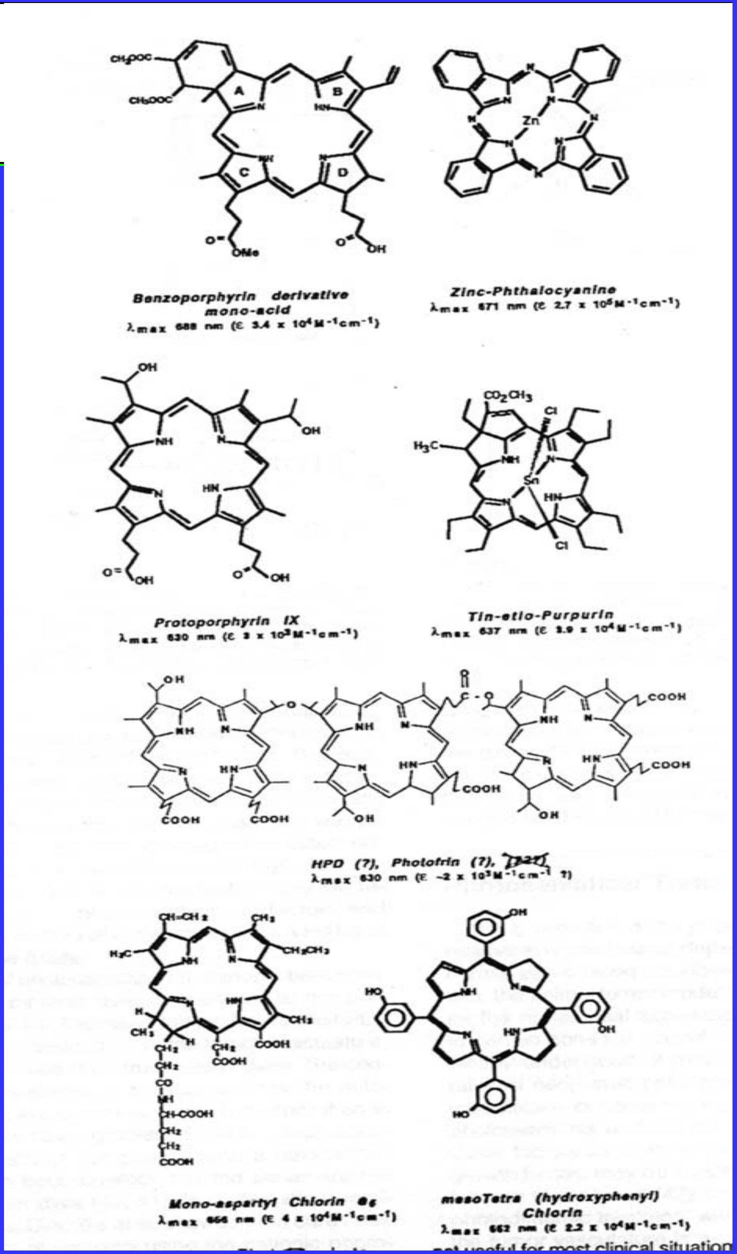
3 days later

5 days later

Current Clinical Uses of PDT in USA are

- Late stage esophageal cancer with photofrin (FDA approval 1996)
- Age related macular degen. with verteporfin (BPD) (FDA approval 2000)
- Kaposis-sarcoma with ALA (FDA approval 2000)
- Clinical trials in : prostate, head and neck, glioma, Barrett’s esophagus, tumor bed treatment, photodetection of cancer.

Photosensitizers

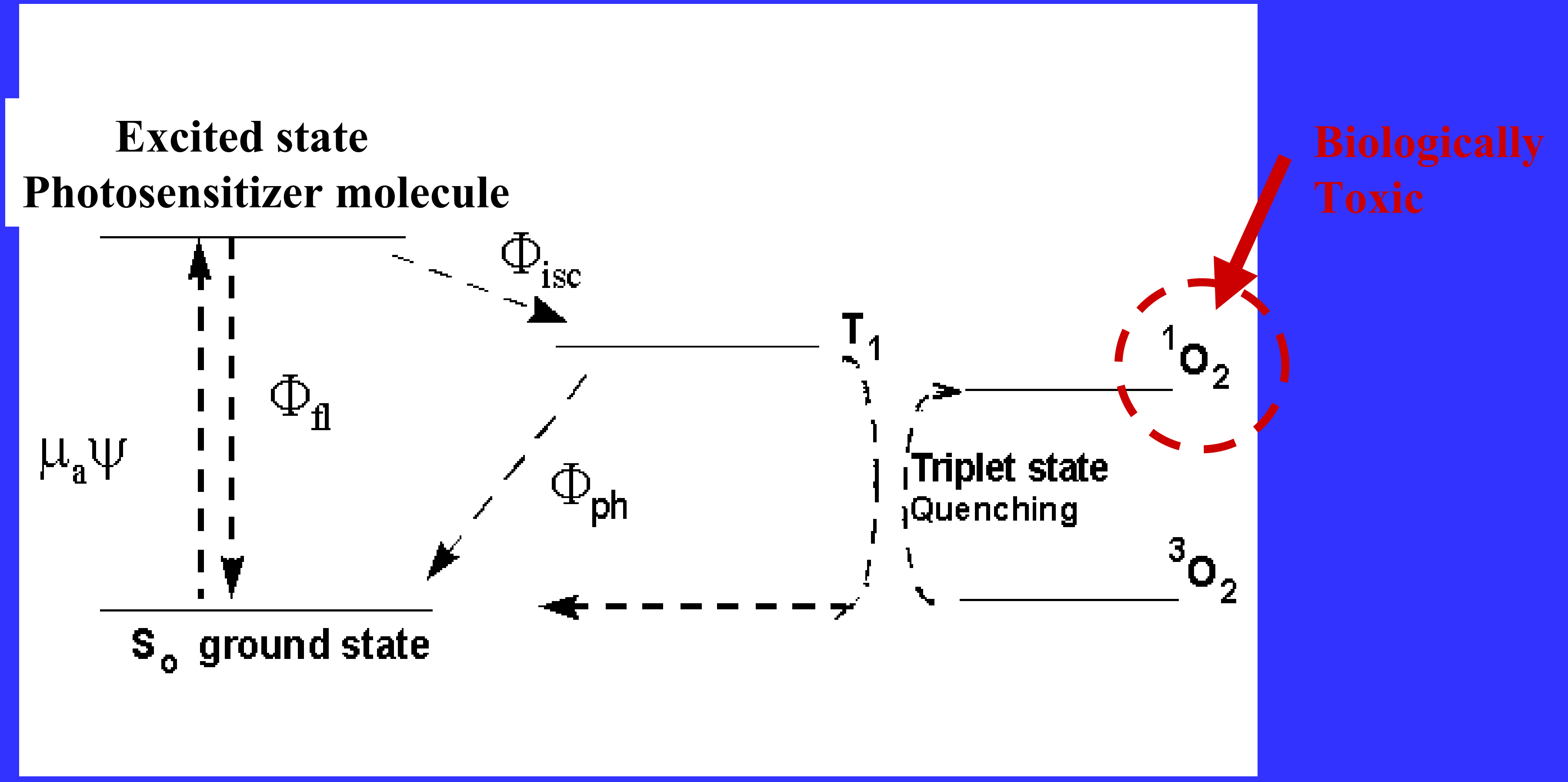


Each of these molecules is designed to:

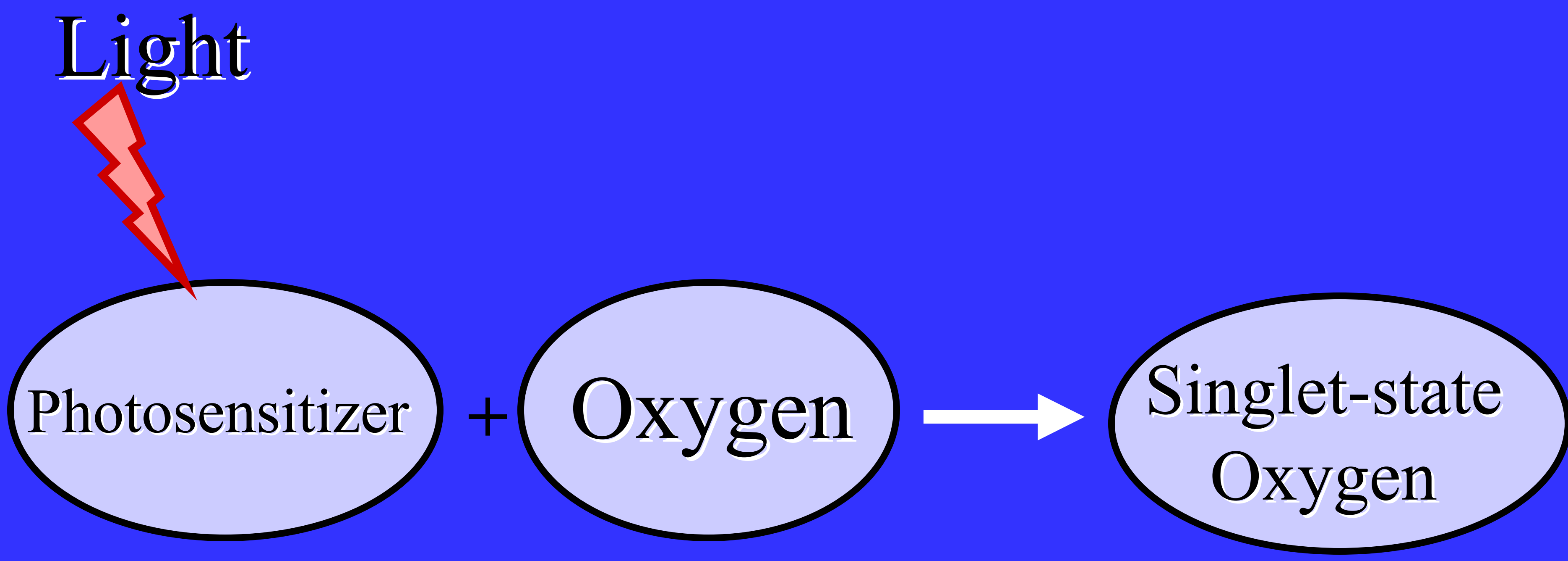
1) **Be biologically inert**
2) **Localize in tumors**
3) **Absorb red light**
4) **Generate singlet state oxygen**

Jablonski Energy-level diagram

showing the pathway for generation of singlet oxygen from photosensitizer

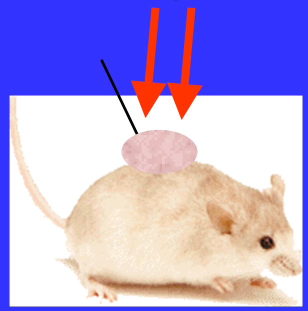


Estimation of the delivered Dose to tissue requires understanding three input parameters:



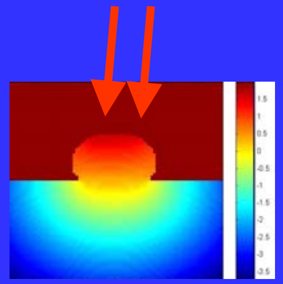
Measurement and Modeling of Light in Tissue

light



Mouse tumor treatment

light



Light field simulation

Iteratively match measurements by fitting optical properties

Determine optimal
Fit to data

Determine treatment
Plan specifications

Measurement of Photosensitizer in Tissue: academic/industry collaboration

Photosensitizer measurement is achieved
With a microsampling fiber bundle, developed
at Thayer School of Engineering and
commercialized by Aurora Optics Inc.
Hanover NH.

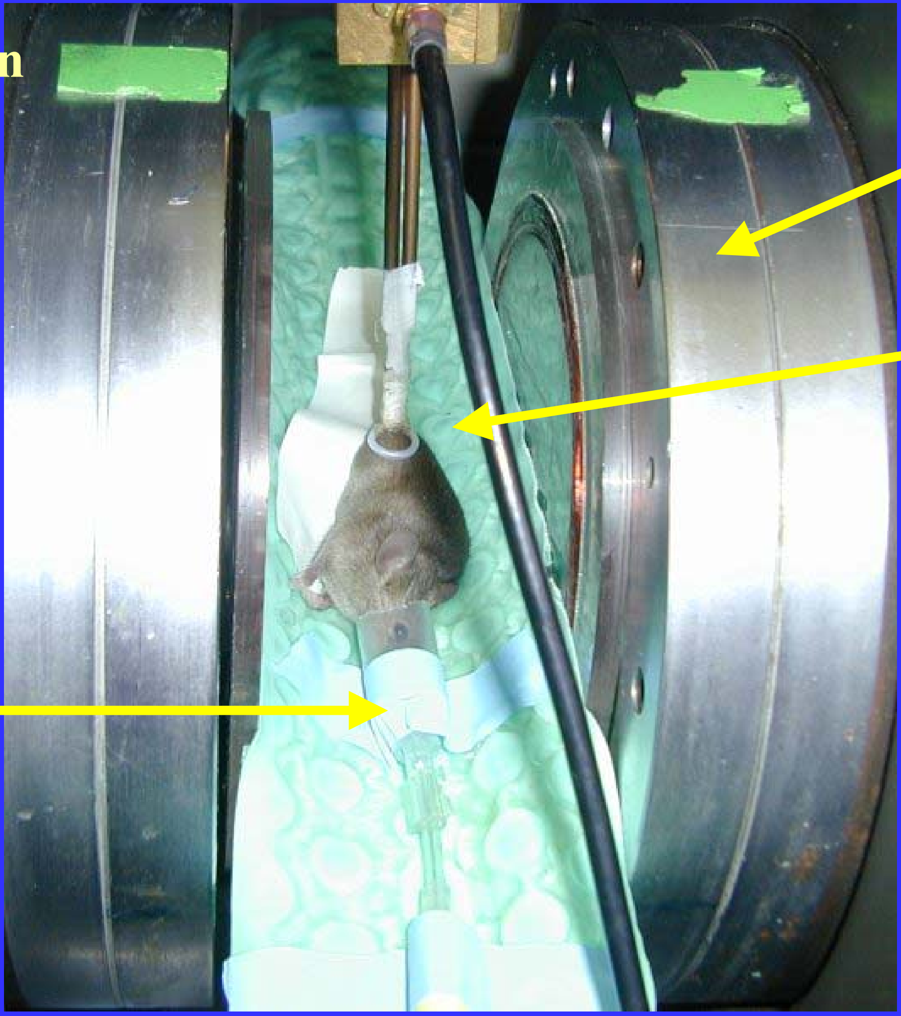
Measurement and Modeling of Oxygen in Tissue:
Using the Dartmouth Center for EPR Oximetry

implanted 50 micron crystal of char in tumor 2-3 mm below the surface

High field magnet

RF pickup coil placed over mouse tumor

mouse anesthesia



Current Research at Thayer in PDT

- development of instrumentation
- vascular versus cellular-targeting therapy
- combination PDT with radiation therapy
- tumor models and veterinary treatment

Participants

• Brian W. Pogue	(Thayer)
• Bin Chen	(Thayer)
• P. Jack Hoopes	(Surgery, Thayer)
• Keith Paulsen	(Thayer)
• Julia A. O'Hara	(Radiology)
• Chao Sheng	(Thayer)
• Xiaodong Zhou	(Thayer)
• Gregory Burke	(Aurora Optics, Inc.)

More details can be seen at:
www.dartmouth.edu/~biolaser