Photodynamic therapy (PDT) is an emerging cancer treatment modality based on the interaction of light, a photosensitizing drug, and oxygen. PDT has been approved by the US Food and Drug Administration for the treatment of microinvasive lung cancer, obstructing lung cancer, and obstructing esophageal cancer. Studies have shown some efficacy in the treatment of a variety of malignant and premalignant conditions including head and neck cancer, lung cancer, mesothelioma, Barrett's esophagus, prostate, and brain tumors. Unlike radiation therapy, PDT is a non-ionizing radiation that can be used repeatedly without cumulative long-term complications since it does not appear to target DNA.

Various photosensitizer drugs have been developed. Most of the drugs are so called Type II photosensitizers, where the active agent of phototoxicity is induced by the production of singlet oxygen or active oxygen derivatives through light activation. The first-generation photosensitizer, haematoporphyrin derivative (HPD), is a mixture of porphyrin monomers and oligomers that is partially purified to produce the commercially available product, Photofrin®. HPD is photochemically activated by the absorption of tissue-penetrating light at λ 630 nm (red) and is the only FDA approved photosensitizer. HPD-mediated PDT has several clinical disadvantages, including prolonged skin photosensitivity (4 weeks), relatively low quantum yield of singlet oxygen, and a limited depth of associated tissue damage of 2-5 mm. Second generation photosensitizers (e.g., mTHPC, TOOKAD, and MLu) overcome these shortcomings with higher quantum yield, lower skin toxicities, and deeper penetration.

There has been tremendous progress in photodynamic therapy dosimetry. The simplest clinical light dose prescription is to quantify the incident fluence for patients treated with a given photosensitizer injection per body weight. However, light dose given in this way do not take into account the light scattering by tissue and usually underestimate light fluence rate. Techniques have been developed to characterize the tissue optical properties and the light fluence rate in-vivo. Other optical spectroscopic methods have been developed to characterize tissue absorption and scattering properties, which in term provide information about tissue oxygenation and drug concentration. Fluorescence techniques can be used to quantify drug concentration and potentially photobleaching rate of photosensitizers.

The objective of this course is to present a brief review of the issues related to the application of photodynamic therapy. In particular, we review the current start of art of techniques to quantify light fluence, drug concentration, and tissue oxygenations, and PDT outcome.

Educational Objectives:

1. To explain the basic principle of photodynamic therapy.
2. To discuss the various photosensitizer drugs.
3. To review techniques for PDT light delivery for surface and interstitial applications.
4. To review current state of art in PDT in-vivo light dosimetry, light-tissue interaction, and the light fluence distributions in turbid medium.
5. To review PDT dosimetry techniques to characterize tissue optical properties, drug concentration, tissue oxygen concentration, and PDT efficacy.