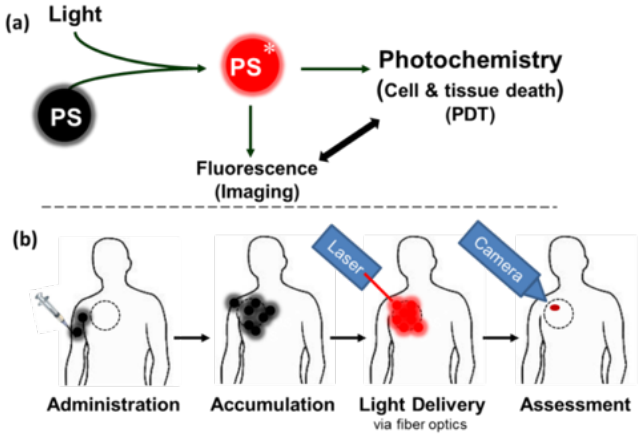
PHOTOMEDICINE

JUNE 2018 TECH BRIEF FOR LIFE SCIENCES TALENT NETWORK



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Photodynamic Therapy (PTD)

The medicinal use of light is now an important tool to treat cancer, heart disease, skin diseases and several types of infections. Photomedicine uses laser and non-laser light for diagnostics and medicinal purposes. Now well beyond the research stages, companies are developing and conducting clinical trials on light-based therapies for safe and effective treatment for skin cancer and other diseases.

This tech brief will focus on photodynamic cancer therapy (PTD). Light therapy has many advantages, yet one obvious limitation over traditional chemotherapy: PDT can only treat areas where light can reach. Light waves do not penetrate as far into tissue as higher wavelengths such as X-rays. So PTD is mainly used to treat skin or the lining of organs during surgery and to activate oncology drugs. It will not be effective on large or spreading tumors.

Corporations developing and supporting photomedicine are not plentiful in New Jersey. A few researchers are publishing in the field. Even so, this is an area in which startups can move quickly. The closely related technologies of medical lasers and ablation devices, though, ***are*** developed by NJ corporations: **Bard Medical**, now part of BD, J&J (by acquisition) and **Stryker Corporation**.

Labor Force Takeaway

The field of photomedicine is expected to grow at compound annual growth rate (CAGR) **4.7% for the period of 2016-2021**. The **global market for medical lasers** is expected to increase to ~$11.5 billion in 2022 at 15.3% CAGR for 2017-2022. Jobs will be created in health care, life sciences and high-end cosmetology.

Given the expected market growth, a review of the basics of photonics, the reaction of human tissue to various wavelengths of light/radiation, and updates in the therapeutic use of visible light and UV is warranted. Classes should cover the therapeutic use of light to treat cancer, heart disease, skin diseases and several types of infections. Also examples of how laser and non-laser light is being used for diagnostics should be discussed. Scientific explanation of photosensitizing agents and how they produce a form of oxygen that kills nearby cells when exposed to a specific wavelength of light should be covered.

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Photodynamic Therapy = Photochemotherapy

Photodynamic therapy starts with a photosensitizer or a photosensitizing drug. Depending on the part of the body being treated, the photosensitizer is either injected into the bloodstream or applied to skin. The drug is absorbed by cancer cells. The period between the drug being given and when the drug is activated can range from a couple of hours to a couple of days, depending on the photosensitive agent used.

Each photosensitizer is activated by light of a specific wavelength. The wavelengths needed to activate most photosensitizers cannot pass through more than about one-third of an inch of tissue (1 centimeter). The photosensitizer – wavelength combination must be varied to treat different areas of the body.

Finally, light is applied to the cancerous area, usually via a fiber optic laser. The light energizes the drug, producing singlet oxygen or another chemical that kills cells. In addition to directly killing cancer cells, PDT appears to shrink or destroy tumors in two other ways. The singlet oxygen kills non-specifically, hence can damage blood vessels in the tumor, thereby preventing the cancer from receiving necessary nutrients. Secondly, PDT may activate the immune system to attack the tumor cells.

When it can be used, PDT delivers very small complication rates and survival curves similar to surgery.

Between PDT and ablation therapies, costs for certain medical treatments may be reduced.

The Photomedicine Society has convened a day-long meeting annually for 27 years. Meetings are usually held just prior to the American Academy of Dermatology's conference. The president-elect, Steven Q. Wang, is based in NYC. For more information on the state of PTD and other aspects of the photomedicine market in New Jersey and to network for contacts within companies:

- Shuang Fang Lim, Robert H. Austin; Princeton University; Department of Physics. 2015 paper: Upconverting nanoparticle-based multi-functional nanoplatform for enhanced photodynamic therapy: Promises and perils
- Hongjun Wang; Stevens Institute of Technology, Department of Biomedical Engineering. 2016 paper: Targeting Antitumor Immune Response for Enhancing the Efficacy of Photodynamic Therapy of Cancer: Recent Advances and Future Perspectives
- Yuanwei Zhang; New Jersey Institute of Technology, Chemistry and Environmental Science 2017 paper: Enhancing Photodynamic Therapy through Resonance Energy Transfer Constructed Near-Infrared Photosensitized Nanoparticles

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Worth mentioning as an aside: ablation technologies overlap with photomedicine. These techniques use electromagnetic energy to kill cells directly. Imagine microwaving cells; they're going to die in seconds. Light frequencies are used to ablate cells. The more widespread techniques though, use radio frequencies due to the low cost of RF components and lasers. Ablation technologies are undergoing a next-generation upgrade, the details of which would be worth incorporating into a skills upgrade course.

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