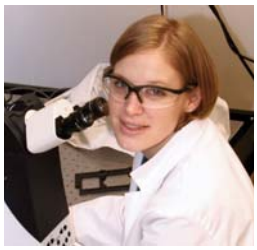
Georgia Tech ChBE

School of Chemical & Biomolecular Engineering

Cancer Research



Julie Champion: Novel Strategies for Treatment of Breast Cancer

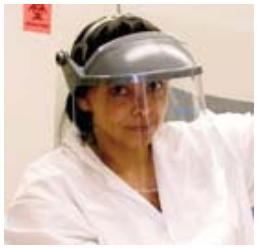
Breast cancer cells undergo a variety of molecular changes leading them to escape normal cell cycle control, proliferate, and metastasize. We have identified bacterial proteins, normally secreted during infection, as an innovative approach towards the eradication of breast cancer. Some of these proteins block cell pathways and mechanisms that are also crucial to cancer progression. Our lab is identifying bacterial proteins that decrease proliferation and metastasis and increase cell death when introduced in breast cancer cell lines. In order to translate these proteins into actual therapeutics, they must be packaged and delivered to cancer cells in the body. Protein nanoparticles are an ideal platform since the therapeutic load can be combined with targeting and immune-avoidance strategies to deliver high levels of protein inside cancer cells. We are investigating fabrication of bacterial protein nanoparticles and their therapeutic capacity in vitro and in vivo. This approach attacks cancer cells differently than existing chemotherapies and could be especially valuable to patients with chemotherapy-resistant breast cancer.

Mark Prausnitz: Transdermal Immunotherapy Using Microneedles and Other Technologies

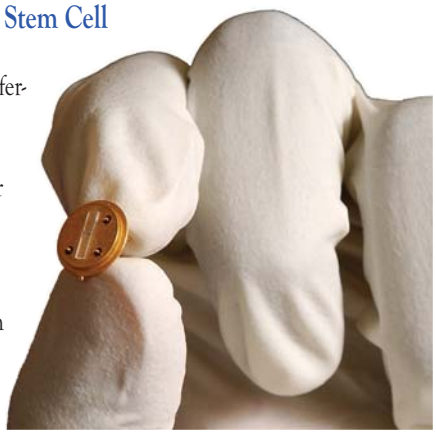
We are developing methods to deliver vaccines and immunotherapeutics into the skin in a minimally invasive manner and thereby target immune cells. Microneedles are assembled into patches that pierce the upper layers of the skin and deposit compounds. This delivery method is simpler and more reliable than conventional injection with a hypodermic needle and much more effective than transdermal patches. We are also developing a heat-based method involving thermal ablation to create microchannels in the skin surface and thereby allow penetration of compounds into the skin. Our work will further set the stage for delivery of therapeutic cancer vaccines, including peptide- and DNA-based vaccines, and for immunotherapies involving monoclonal antibodies and other compounds. Our dermal delivery methods are also suitable for targeted delivery to the skin to treat skin cancers, such as melanoma.

Intracellular Delivery Using Ultrasound and Laser-nanoparticle Interactions for Improved Gene-based Therapy

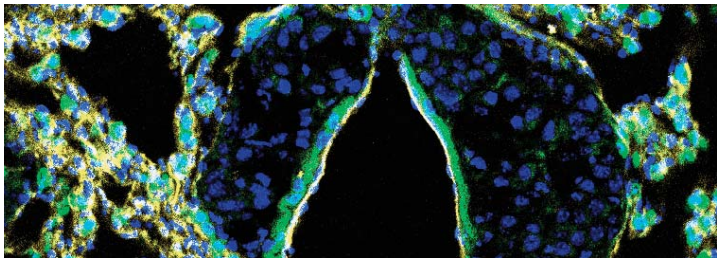
Gene-based therapy has tremendous promise for the treatment and cure of cancer. We offer physically based methods, such as ultrasound and laser excitation of carbon nanoparticles, to generate shock waves. These shock waves temporarily break open the cell membrane and thereby permit entry of DNA, RNA, and other molecules for cancer gene therapy.



Michelle Dawson: Genetically Engineered Mesenchymal Stem Cell (MSC) Gene Delivery Systems

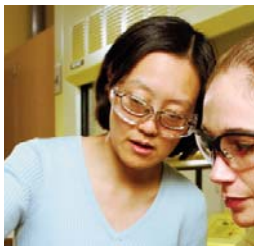


MSCs are multipotent progenitor cells that can self-renew and differentiate even upon ex vivo culture and expansion. MSCs spontaneously migrate from the bone marrow and infiltrate wounded tissues and tumors; however, the majority of MSCs reinfused after ex vivo culture and genetic manipulation become trapped in the lungs. The identification of soluble growth factors that stimulate their migration in the wound bed or tumor may be a key element in the development of MSC-based therapeutics that can overcome these transport limitations. Our research seeks to explain the rheological properties of MSCs before and after treatment with soluble growth factors, and to correlate these findings to cell migration and, ultimately, to MSC accumulation in breast, lung, or pancreatic tumors.



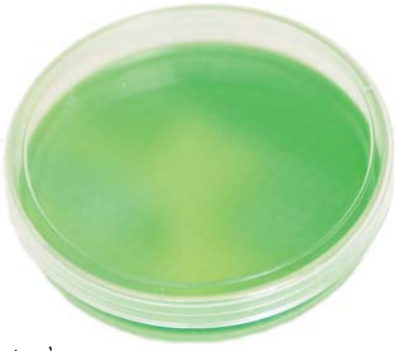
Bone-Marrow-Derived Cells (BMDCs) in Tumor Growth and Metastasis

The bulk of the enormous public health burden associated with cancer is attributed to metastatic disease, a condition often regarded as incurable. The recruitment of BMDCs to tumors, which is thought to be mediated by the secretion of proangiogenic chemokines, is a critical step in tumor growth and metastasis. Our studies focus on investigating the effect of proangiogenic chemokines, including VEGF and SDF-1, on the migration of myeloid or mesenchymal stem cells isolated from whole bone marrow. We are also looking for these same populations of BMDCs in tissues from tumor-bearing mice. These studies will be used to develop new strategies for preventing BMDC accumulation in tumor tissues.



Hang Lu: Cancer Prognosis and Basic Biology

The goal of our work is to develop a series of high-throughput microfluidic assays based on biochemical and mechanical manipulations and measurements of tumor cells for improved cancer prognosis. We are interested in the mechanisms of tumor metastasis and in using patient samples (from serum or urine) to predict the tumor metastatic potential and patient outcome in prostate and bladder cancers. Microfluidic assays not only require minute amounts of samples but also provide precise and quantitative measurements that bench-scale assays cannot. This work is in collaboration with Dr. Leland Chung (Emory) and Dr. Cheng Zhu (Georgia Tech). The potential impact of the proposed studies is to enable physicians and patients to receive state-of-the-art prognostic information at the time of clinical diagnosis, thereby allowing them to determine timing and strategies for therapeutic intervention.



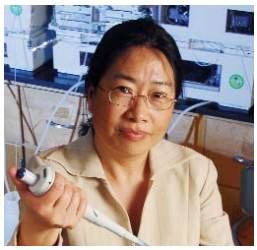
Adoptive Transfer of T Cells is a promising clinical cancer therapy that relies on enhancing the adaptive immune response to target tumor cells in patients. Our long-term objective is to understand how T cell activation is dampened in vivo by the tumor milieu and to be able to evaluate the responsiveness of ex vivo-expanded T cells accurately for cancer therapy. This research is expected to expand the toolbox of cancer therapy and other related quantitative biosciences and medical technologies. Our work is in collaboration with Dr. Melissa Kemp (Georgia Tech) and currently funded by the National Cancer Institute.

Carson Meredith: Bioinformatics for Personalized Medicine

The future of cancer treatment lies in personalized medicine, in which a patient's tumor is treated based upon its unique molecular profile: the gene and protein signature of diseased cells. This profile varies considerably from one person to another, leading to variability in patient responses to treatment. The ability to predict and monitor the treatment for each patient in real time would be a giant step forward in cancer care. Unfortunately, molecular profiling is currently not available to most patients because of its manual, time consuming, and cost-intensive nature. We are applying bioinformatics to automate the molecular profiling of cancer to make this revolutionary new approach accessible to all patients. Our work integrates bioinformatics algorithms into automated profiling of ovarian and pancreatic cancers, as these are treatment-resistant diseases that vary significantly from one person to another.

Mark Styczynski: Cancer Metabolism

We use techniques from cutting-edge mass spectrometry in the profiling of small molecule metabolites (known as metabolomics) combined with advanced computational biology to study cancer metabolism and improve the detection of existing cancers. A specific challenge is unraveling the "Warburg effect," a hallmark of most forms of cancer that is characterized by rapid proliferation but altered (and suboptimal) production of cellular energy. We study this phenomenon in a yeast model system and in cancer cell lines, integrating metabolomic and microarray data to understand cancer metabolism and identify new potential targets for therapeutic intervention. We also use metabolomic techniques to discover metabolite biomarkers that are diagnostic or prognostic of cancer. By identifying metabolites that are differentially or uniquely present in cancerous and control samples (tissues and bodily fluids), we discover biomarkers of cellular metabolism dysfunction that can be used for rapid and potentially noninvasive clinical testing and diagnoses with a direct impact on patient treatment and survival.



Rachel Chen: Synthesis of Carbohydrates for Therapeutic Applications

Although carbohydrates are well known for their roles in structure and energy storage, it is only recently that their crucial functions as information carriers have been uncovered. Carbohydrate antigens overexpressed by cancer cells can be exploited for therapeutics. Several carbohydrate-based cancer vaccines are in clinical trials, but the difficulty associated with carbohydrate synthesis hampers further development. Microbe-based synthesis represents an emerging technology that has the potential to simplify synthesis processes. Over the past several years, our laboratory has developed metabolic engineering strategies to derive microbial catalysts for efficient synthesis of complex carbohydrates.

Lakeshia Taite: Biologically Responsive Materials

Our work focuses on the development of novel biologically responsive materials for use as combined imaging and drug-delivery systems for breast cancer diagnostic and therapeutic applications. Novel thermally responsive dendrimers are prepared on the surface of near infrared (NIR) absorbing nanoshells. The ability to switch drug delivery from the dendrimer on and off through light exposure will provide unprecedented control, and the temperatures enabling drug release will be below uncomfortable ablation temperatures. Together, these factors improve patient quality of life and reduce cancer recurrence.

Local Treatment of Cancerous Lesions

The targeted delivery of nitric oxide (NO) is a strategy that could have an enormous impact in the treatment of aggressive brain tumors. NO has long been implicated in both tumoricidal and tumorigenic activity, suggesting that there is a carefully modulated balance of NO within the local microenvironment to allow tumor progression. NO has been shown to inhibit glioma cell growth and increase cell sensitivity to radiation and chemotherapeutics. We are developing a targeted system for NO delivery using glioma-specific peptides to study the efficacy of using NO to sensitize gliomas and improve patient prognosis. These highly biocompatible materials will be translated easily from bench to bedside therapies that can greatly increase brain cancer survival rates through efficient tailoring of treatment modalities.

WANT MORE INFORMATION?

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