FIU Biomedical Engineering
FLORIDA INTERNATIONAL UNIVERSITY

Annual Graduate Research Day

Distinguished Lecture:

Advances in Neurosensory Engineering: Novel Applications in Auditory, Visual and Brain Monitoring and Neurotesting

Ozcan Ozdamar**, PhD**
Professor and Chair, Department of Biomedical Engineering
University of Miami

Presented by:

Department of Biomedical Engineering

Wallace H. Coulter Foundation BME Distinguished Lecture Series
September 28, 2012
Engineering Center, Florida International University, Miami, FL

Annual Graduate Research Day Schedule

Posters :	11:30 pm	Panther Pit
Lecture :	4:00 pm	EC 2300
Awards :	5:30 pm	EC 2300
Reception:	6:00 pm	EC 2300

FIU Biomedical Engineering
FLORIDA INTERNATIONAL UNIVERSITY

Wallace H. Coulter Biomedical Engineering Distinguished Lecture Series

Student Workshop

Inventions,
Patents and Confidentiality Agreements
Pedro "Peter" Hernandez, MBA, JD

Peter Hernandez is the Director of Technology Transfer and Commercialization and provides overall leadership and direction for patents and licensing. He plans, develops, directs, and assesses the University's Intellectual Property portfolio, including generation of licensing revenues. He is a member of the Texas, Florida and District of Columbia bar associations, and is registered with the United States Patent and Trademark Office. Mr. Hernández has over 20 years of experience in industry, engineering and intellectual property management, including transactional matters, business negotiations, patents, trademarks, trade secrets, and copyrights.

Annual Graduate Research Day

9:00 am	"Inventions, Patents and Confidentiality Agreements" Student Workshop (Pedro "Peter" Hernandez)
10:30 am	Poster Setup (Panther Pit)
11:00 am	Lunch for Student Presenters
11:30 pm	Poster session (Panther Pit)
4:00 pm	Distinguished Lecture (Ozcan Ozdamar)
5:30 pm	Best Poster Awards
6:00 pm	Reception (Panther Pit)

FRIDAY
SEPT. 28, 2012
9:00am-7:30pm

Location:
Panther Pit
& EC2300
10555 W Flagler St
Engineering Center
Miami, FL-33174

Ozcan Ozdamar, PhD

Professor and chairman of the Department of Biomedical Engineering at the University of Miami, Dr. Ozdamar is the founding director of the NeuroSensory Engineering Laboratory in the College of Engineering. He holds secondary appointments in the Departments of Otolaryngology and Pediatrics and the Neuroscience graduate program at the Miller School of Medicine at the University of Miami. He has published widely in engineering and biomedical journals on auditory electrophysiology, neurosciences, neural engineering and computer based neuro-instrumentation and co-founded two diagnostic electrophysiology companies.

TITLE: Advances in Neurosensory Engineering: Novel Applications in Auditory, Visual and Brain Monitoring and Neurotesting.

Recent advances in novel stimulus design and response acquisition and processing techniques are providing greater insight and understanding into how the cochlea, retina and the sensory brainstem pathways work and function. Over the last twenty-five years, the author and his group have developed many original techniques such as deconvolution averaging and swept tone acquisition for auditory/visual/neural screening and testing, anesthesia and intraoperative monitoring using electrocochleography, electroretinography, otoacoustic emissions, auditory and visual evoked potentials. These advanced techniques have been instrumental in producing new diagnostic applications in medicine and surgery as well as creating new business opportunities in neural engineering.

For more information visit: http//bme.fiu.edu www.bme.fiu.edu Contact: bmeinfo@fiu.edu; 305-348-6717

Poster #

1. MICROSPHERES FOR SIRT PET/CT PLANNING AND LUNG PERFUSION: Alenjandro Amor, Andrew. Milera, Seza. Gulec and Anthony. Mcgoron*
2. SIALIC ACID TREATMENT OF NUTRIENT DEPRIVED MALIGNANT CELLS DISPLAYS INCREASED CELL SURFACE SIALYLATED GLYCANS AND ALLOWS SELECTIVE DETECTION: Haitham Badr, Leila Djansugurova, Hafiz Ahmed, Chenzhong Li*
3. STUDY OF KNEE MOVEMENT PATTERNS DURING SIT TO STAND TASK AMONG YOUNG HEALTHY AND AGED MATCHED CONTROLS: Tatiana Bejarano, Dinesh Bhatia, Marcos Munoz, Mario Novo, Denis Brunt, Ranu Jung*
4. LABEL FREE SERS BASED BIOSENSOR FOR MONITORING ENVIRONMENTAL STRESS: Vinay Bhardwaj, Supriya Srinivasan, Joshy F. John, Anthony J. McGoron*
5. AN ALGORITHM AND GRAPHICAL USER INTERFACE (GUI) FOR COMBINED SEGMENTATION, FUNCTIONAL VOLUME (FV) ESTIMATION AND ACTIVITY CONCENTRATION (AC) CORRECTION OF TUMORS: A POSITRON EMISSION TOMOGRAPHY (PET) STUDY: Ruchir Bhatt and Anthony J McGoron*.
6. MOTOR RESPONSE INVESTIGATION IN INDIVIDUAL(S) WITH CEREBRAL PALSY USING NEAR INFRARED SPECTROSCOPY: Ujwal Chaudhary, Micheal Hall, Jean Gonzalez, Leonard Elbaum, Martha Bloyer and Anuradha Godavarty*
7. THE EFFECT OF RGDC MODIFIED POLYMERS ON NEURAL STEM CELL FATE: Xizi Dai and Yen-Chih Huang*
8. WEB BASED INTERACTIVE MEDICAL IMAGING TEACHING APPLICATIONS FOR NUCLEAR MEDICINE: Senait Debebe and Anthony Mcgoron*
9. A HYDROXYAPATITE NANOPARTICLE SYSTEM THAT AUGMENTS THE PHYSICAL AND BIOLOGICAL PROPERTIES AT THE INTERFACE OF BONE AND ENGINEERED CARTILAGE: Rupak Dua and Sharan Ramaswamy*
10. NITRIC OXIDE DEPENDENT SIGNALING IN VASORELAXATION: EFFECT OF TRANSIENT NITRIC OXIDE RELEASE: Tushar Gadkari and Nikolaos Tsoukias*
11. DEVELOPMENT OF CELL IMPEDANCE BASED SENSING SYSTEM FOR NANOTOXICITY ASSAY: Evangelia Hondroulis, Chang Liu and Chen-zhong Li*
12. THERMAL AND PH SENSITIVE MULTIFUNCTIONAL POLYMERIC NANOPARTICLES FOR CANCER THERAPY: Tingjun Lei, Romila Manchanda, Yen-Chih Huang, Anthony J. McGoron*
13. ENHANCED SURFACE PLASMON RESONANCE SENSING OF ARSENIC-PROTEIN INTERACTION: Chang Liu, Vittoria Balsamo, Chen-Zhong Li*
14. sGC IN SMC ACTS AS NITRITE REDUCTASE LEADING TO NO FORMATION: Kumpal Madrasi, Nikolaos Tsoukias* and Mahesh Joshi
15. OPTIMIZATION OF DRUG DELIVERY DURING THE COMBINATION OF HYPERTHERMIA AND CHEMOTHERAPY IN AN IN-VITRO 3-D TUMOR MODEL : A STUDY IN MULTICELLULAR SPHEROIDS: Abhignyan Nagesetti, Dr George S Dulikravich and Anthony J McGoron*
16. BIODEGRADABLE ELASTOMERS: S. Rath, S. Ramaswamy*
17. AN EXPERIMENTAL STUDY OF THE SMALL-SCALE VARIABILITY OF RAINFALL AT THE SOUTHERN DELMARVA PENINSULA: Rigoberto Roche, Ali Tokay, Paul G. Bashor.
18. FLEXIBLE GEN-2 HAND-HELD OPTICAL IMAGER: FLAT AND CURVED PHANTOM STUDIES: Manuela Roman, Sarah J. Erickson, Jean Gonzales, Pallavi Joshi, Anuradha Godavarty*
19. EFFECTS OF GEOMETRIC VARIATIONS AND PULSATILITY ON OSCILLATORY SHEAR

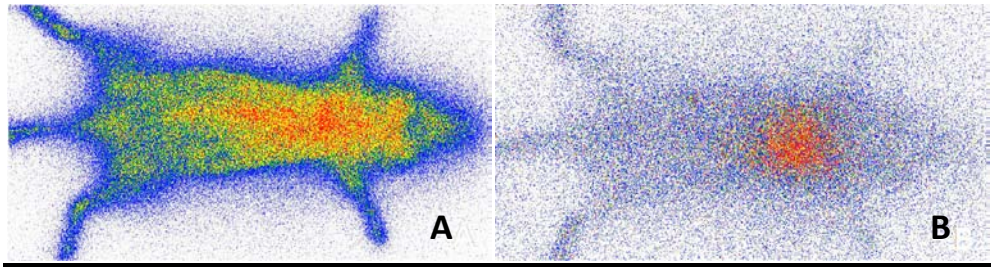
STRESS ENVIRONMENTS: Manuel Salinas, David E. Schmidt, Miguel Libera, Richard Lange, Sharan Ramaswamy*

20. BIO-CHIP FOR SINGLE CELL MANIPULATION AND MEASUREMENT: Pratikkumar Shah, Chenzhong Li*
21. DEVELOPMENT OF A HYBRID IMAGING/SPECTROSCOPY SYSTEM FOR INTRAOPERATIVE GUIDANCE OF PEDIATRIC CRANIOTOMY: Yinchen Song, Wei-Chiang Lin*
22. SILVER NANOPARTICLE BASED SERS BIOSENSOR FOR DETECTION AND ASSESSMENT OF NONSPECIFIC ENVIRONMENTAL TOXIN EXPOSURE: Supriya Srinivasan, Vinay Bhardwaj, Joshy John, Anthony J. McGoron*
23. PAPER BASED SENSOR FOR DNA OXIDATIVE DAMAGE BIOMARKER DETECTION: Xuena Zhu and Chenzhong Li*

Microspheres for SIRT PET/CT Planning and Lung Perfusion

Alejandro Amor, Andrew Milera, Seza Gulec, Anthony Mcgoron

Advisor: Anthony McGoron



Biodistribution for A: free Ga-68 and B:CHSg-NOTA-Ga-68 microparticles.

Abstract

Liver cancer (primary or metastatic) accounts for nearly 10% of all cancers in the US alone, the incidence being even greater in eastern countries. Treatment modalities involve surgery, chemotherapy, thermal ablation using radiofrequency or microwave probes and radiomicrosphere therapy (RMT) with Y-90 microspheres. For treatment planning Tc-99m-macro aggregated albumin (MAA) is infused into the proper hepatic artery and a perfusion scintigraphy is performed.

Significant difference in size, shape, and other properties of the MAA and the Y-90 microspheres complicates the treatment planning because the MAA particles cannot be expected to distribute the same as the Y-90 microspheres. There is a need for biodegradable microspheres with biological half life ≤48 hours. Microspheres must be labeled with a PET isotope with > 90% yield and ≥90 % in vivo stability after 4 h.

CHSg-NOTA microparticles were labeled with ^{68}Ga successfully with more than 90% yield at room temperature. Reaction kinetics placed the optimum reaction time at 15 minutes. Radiochemical stability was shown to be over 90 % after 4 hours of study at 37 ºC in both saline and PBS buffer. The particles conserved their shape and distribution during the labeling process. The in vitro half-life was determined to be approximately 48 hours. Biodistribution study shows that more than 90% of the CHSg-NOTA injected activity was allocated in the lungs.

Poster #1

Sialic Acid Treatment of Nutrient Deprived Malignant Cells Displays Increased Cell Surface Sialylated Glycans and Allows Selective Detection

Haitham Badr[1,2], Leila Djansugurova[1,2], Hafiz Ahmed[3], Chenzhong Li[4]

[1]*Department of Molecular Biology and Genetics, Faculty of Biology and Biotechnology, Al-Farabi Kazakh National University, Almaty, 050040, Kazakhstan*

[2]*Laboratory of Molecular Genetics, Institute of General Genetics and Cytology, Almaty, 050060, Kazakhstan*

[3]*Department of Biochemistry and Molecular Biology, School of Medicine, University of Maryland, Baltimore, MD 21202, USA*

[4]*Laboratory of Nanobioengineering and Bioelectronics, Department of Biomedical Engineering, Florida International University,*

Advisor: Chenzhong Li

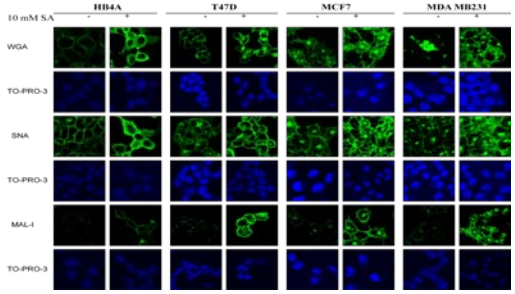


Figure 1: Lectin-mediated staining of normal and malignant cells.

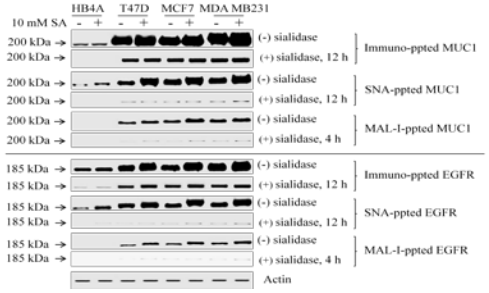


Figure 2: Examination of sialylation of Muc1 and EGFR.

Abstract

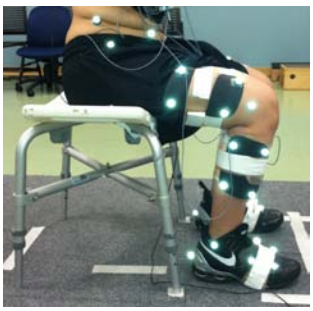
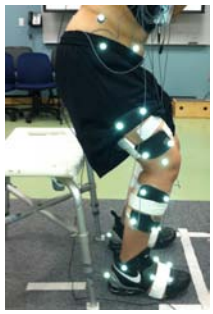
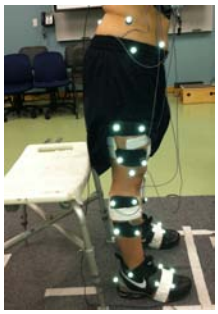
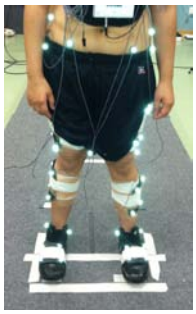
The development of metabolic engineering strategies for decorating cell surface with defined glycan epitopes would greatly facilitate our ability to harness the cells for the purpose of diagnosis and prognosis. Here, we demonstrate that a few breast cancer cells (T47D, MCF7 and MDA MB231), when treated with sialic acid under nutrient deprivation, display increased cell surface sialic acid as a result of increased expression of CMP-Neu5Ac, CMP-Neu5Ac synthetase, and Neu5Acα2→3/6 transferases. The presence of the increased cell surface sialic acid on the malignant cells is corroborated by stronger binding with lectins such as WGA (specific for Neu5Ac), SNA (specific for Neu5Acα2→6Gal), and MAL-I (specific for Neu5Acα2→3Gal). However, when compared with the normal cell (HB4A), all three malignant cells upon treatment with Neu5Ac were selectively detected by MAL-I suggesting preferential increase of Neu5Acα2→3Gal on the malignant cell surface. To corroborate over-sialylation in a molecular level, two cell surface receptors, epidermal growth factor receptor (EGFR) and Mucin 1 (Muc1) were either immuno-precipitated or precipitated with SNA and MAL-I from each cell extract. Muc1 and EGFR from only the malignant cells were precipitated by the MAL-I and were demonstrated to have more sialic acids compared to the normal cells. To our knowledge, this is a first report that nutrient deprived malignant cells upon treatment with Neu5Ac display increased cell surface sialylated glycans with defined structure and can be detected selectively. We propose that this metabolic engineering strategy can be applied to selectively capture circulating tumor cells, particularly from the breast cancer patients for better diagnosis and prognosis.

Poster #2

Study of knee movement patterns during Sit to Stand task among young healthy and aged matched controls

Tatiana Bejarano, Dinesh Bhatia, Marcos Munoz, Mario Novo, Denis Brunt, Ranu Jung

Advisor: Ranu Jung

Abstract

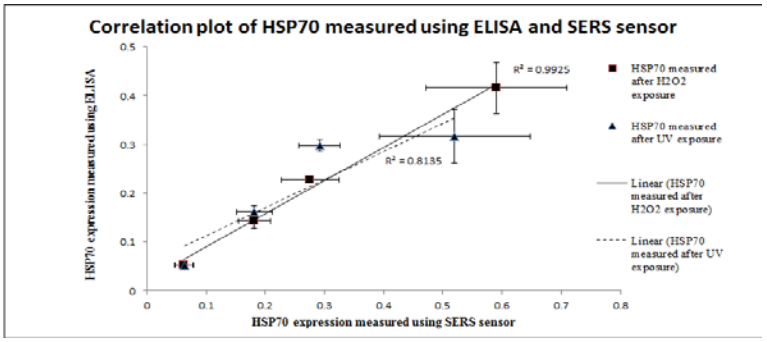
Investigation of muscle recruitment patterns and neuromuscular efficiency in healthy individuals compared to patients with knee OA in simple closed chain exercises might lead to a better understanding about the biomechanical changes in knee control during disease. The present study investigated lower extremity biomechanical parameters in 4 healthy adult young subjects (26 mean age) and 4 healthy aged subjects (59 mean age). Electromyogram (EMG) activity employing 8 channel recording system (Motion Lab Corp.) was recorded by placing surface electrodes on the bicep femoris (BF), gastrocnemius (GAS), tibialis anterior (TA), and vastus medialis (VM) muscles. Kinematic data (Qualysis motion analysis system) in the sagittal (frontal) plane and ground reaction forces (GRF) using dual ATMI force plates were obtained as the subjects performed Sit to Stand (STS) task from different degrees of knee flexion. Feet position was manipulated to create knee joint angles of either 70 or 90 degrees of knee flexion. GRF data identified different phases of movement (initiation of movement, peak propulsive force, peak breaking force, upright stance, and stabilization) and matched with the corresponding EMG data in Visual 3D analysis software. These results indicate that the STS task at 70° demonstrated a greater increase in slope of the ground reaction force as compared to 90° of knee flexion between initiation of movement to the standing phase. The BF and GAS illustrated activation from initiation to end of stabilization phase. TA was most active from the initiation to the end of the breaking force phase. VM peaked during the breaking force phase without showing significant modulation in 70° and 90° of knee flexion. Finally, aged subjects demonstrated a noticeable time delay and phase shift in activity patterns for 70° and 90° of knee flexion due to an increased need for momentum generation during STS task as compared to young controls.

Poster #3

Label free SERS based biosensor for monitoring environmental stress

Vinay Bhardwaj, Supriya Srinivasan, Joshy F. John, Anthony J. McGoron

Advisor: Anthony J. McGoron



Abstract

Increased threat of contamination of environment with bio warfare agents (BWAs) and other types of toxins/stress is a conceivable event as it might be deliberate (bioterrorism) or accidental like; anthrax attack in Japan and tragic factory accidents in Bhopal (India) and Chernobyl (formerly in soviet union). The major problem of such attacks/accidents is to detect and monitor the level of stress in the contaminated site when it is at ultra-low levels. Several “detect to protect” sensor devices have been developed and commercialized till date but none of these existing sensors is able to satisfy the most demanding requirement/s; label free portable/wearable biosensor chip. Almost all the current sensor technologies are label based detection trying to detect optical signal in extract released after killing/lysing the cell allowing only the end point study (ELISA, western blot) or in the genetically engineered whole/intact cells (bio reporters).

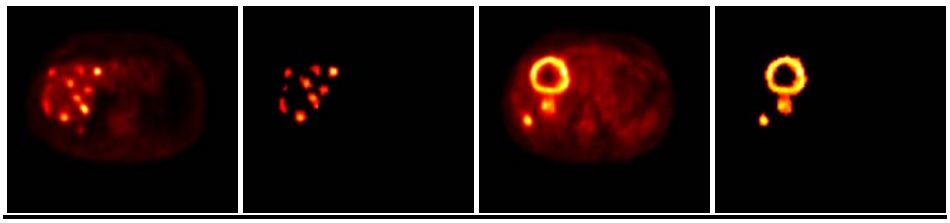
Our group has developed label-free silver based Surface Enhanced Raman Spectroscopy (SERS) sensor to detect environmental stress (hsp70 stress marker) extracellular in cell lysates of the yeast exposed to different stress. The results of SERS sensor were also compared to standard gold assay; ELISA. After successful detection invitro now we are putting efforts towards detection in intact cells. We have decorated the sensor with cell permeability peptide (TATHA2) to avoid endosomes entrapment of the sensor and get dispersed in cytosol and reach organelles where the hsp70 stress protein is ubiquitously distributed is a prerequisite for intracellular detection. Desired aggregation and interaction of SERS sensor at site of interest where the stress marker is present inside the cell is challenging but highly demanding in order to develop a label free portable/wearable SERS based biosensor chip for workers, civilians or military person working in contaminated sites.

Poster #4

An algorithm and graphical user interface (GUI) for combined segmentation, functional volume (FV) estimation and activity concentration (AC) correction of tumors: A positron emission tomography (PET) study

Ruchir Bhatt

Advisor: Anthony McGoron



Liver tumor segmentation demonstration

Abstract

Objective: PET images are low resolution images which also suffer from high noise and partial volume effect (PVE). The PVE causes overestimation of the FV and underestimation of AC, which in turn will effect dose estimation for radiation therapy and follow up after therapy. As FV and AC are correlated due to PVE, a combined tumor quantification algorithm (CTQA) was developed which would segment the tumors, estimate the FV and correct the AC. The application of CTQA was realized by use of GUI developed in MATLAB.

Method: CTQA has been previously tested on physical phantom where spherical tumors of size 0.5-16 ml were inserted and filled with 18F-FDG. The GUI helps user to initiate the algorithm and makes the application of CTQA comparatively easy. The CTQA was applied on ten patient data with hepatocellular metastatic carcinoma and the results were compared with manual segmentation and to fixed threshold at 50% of the maximum activity called T50. Manual segmentation was considered as gold standard.

Results: There is ten times reduction in time required to segment the tumors by automatic application when compared to manual segmentation. For clinical data the FV underestimation and AC overestimation was 60% +/-33% and 20 % +/-13% for T50 respectively as compared to manual segmentation. CTQA had a FV underestimation by 17% +/-9% and AC overestimation of 15% +/-11%.

Conclusion: CTQA is an effective way to segment and quantify tumors in PET image. CTQA would increase the effectiveness of dose estimation and follow up of a therapy. The efficiency of the GUI has to be further tested by a radiologist in a clinical setting.

Poster #5

Motor Response Investigation in Individual(s) with Cerebral Palsy Using Near Infrared Spectroscopy

Ujwal Chaudhary[1], Micheal Hall[1], Jean Gonzalez[1], Leonard Elbaum[2], Martha Bloyer[2] and Anuradha Godavarty[1]

[1]Optical Imaging Laboratory, Department of Biomedical Engineering, Florida International University,
[2] Department of Physical Therapy, Florida International University

Advisor: Anuradha Godavarty

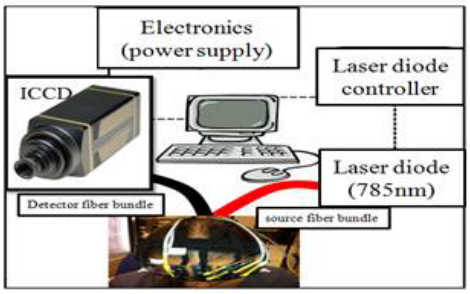


Figure 1: In-house developed CW-based NIRS system.

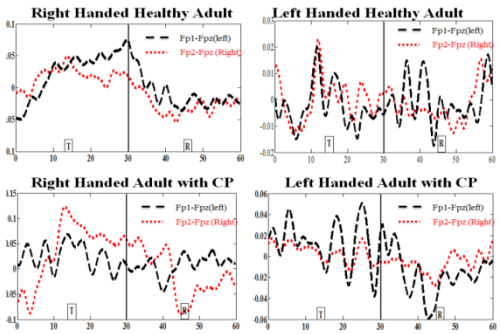


Figure 2: Change in optical response

Abstract

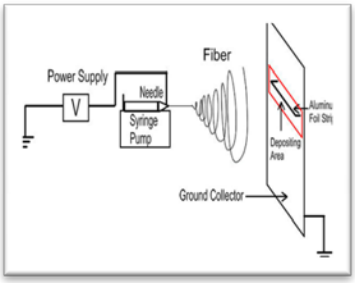
Cerebral palsy (CP) describes a group of motor impairment syndromes secondary to genetic and acquired disorders of the developing brain. Near infrared spectroscopy (NIRS) is an emerging neuro-imaging modality which is relatively robust to the movement artifacts and has been reliably used to monitor and investigate the cerebral oxygenation change in healthy and neurologically challenged adults and children. In the present study an in house developed NIRS system was used to investigate the change in the optical signals in the pre frontal region of the brain of individual(s) with cerebral palsy and controls in response to ball throw task. Two individuals with cerebral palsy (one left handed and one right handed) and seven controls (four right handed and three left handed healthy adults) were recruited for the study and the study was FIU-IRB approved. The participants were asked to perform the ball throw task during the study. The optical data obtained consists of change in intensity of light as it travels through the cortical region of the pre and anterior frontal region of the brain. The raw optical data were post processed using custom Matlab® code to obtain change in optical density (dOD). The dOD was also used to perform lateralization analysis to investigate the dominance feature of the brain. The preliminary result indicates difference in the cortical lateralization of the prefrontal region of the brain between adults with CP and healthy adults. Bilateral dominance was observed in the prefrontal cortical region of healthy adults in response to motor skill task, while an ipsilateral dominance was observed in adults with CP. In conjunction, similar contralateral dominance was observed during rest period both in healthy adults and adults with CP. The significance of this work is towards employing NIRS to design training and hence rehabilitation regime for individual with CP.

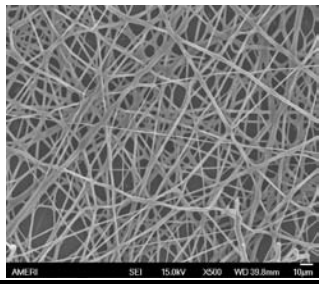
Poster #6

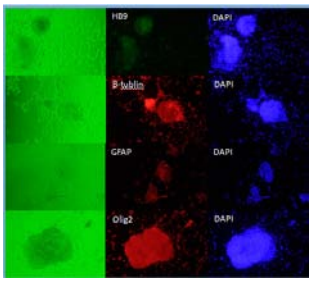
The effect of RGDC modified polymers on neural stem cell fate

Xizi Dai

Advisor: Yen-Chih Huang







Abstract

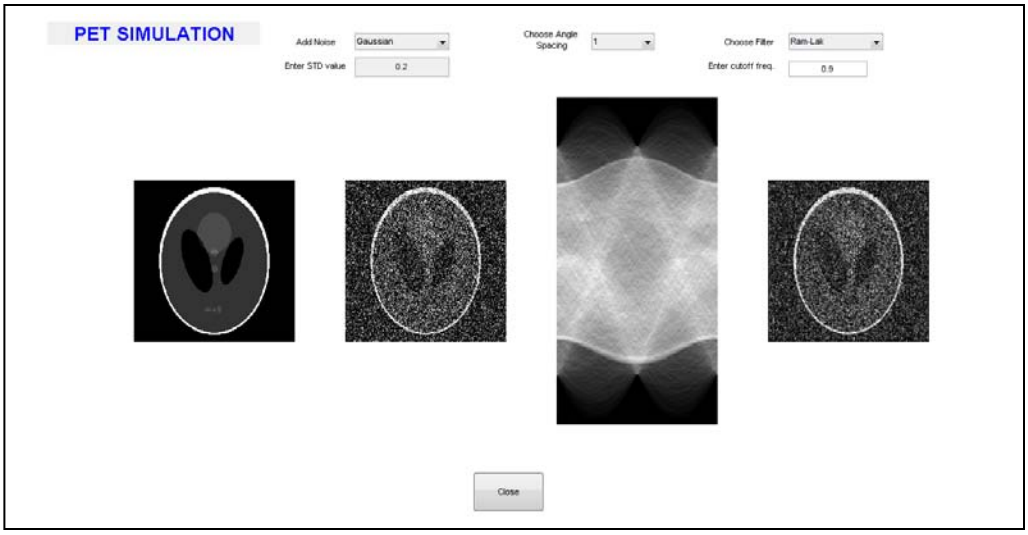
Peripheral nerve injury which cannot be directly repaired by end to end sutures is still a significant challenge in the clinical research. Nerve autograft transfers are the current gold standard for treating large nerve gap but limited by shortage of donor nerve, donor site morbidity and inadequate functional recovery. A potential regenerative strategy is stem cell transplantation; however, less than 1% cell survivability is far away from the minimal requirement. To improve cell viability, stem cells can be transported via an artificial scaffold which provides an environment conducive to survival after delivery. One major challenge in this approach is inadequate interaction between biomaterial and cells, leading in vitro to cell detachment and apoptosis and in vivo to foreign body reactions. To this end, we investigated peptide-modification of poly (glycerol dodecanoate co-Itaconic) (PGDI) and poly (glycerol dodecanoate co-Fumaric) (PGDF) electrospun fibers on neural stem cell (NSC) fate. In the previous study, we were able to directly differentiate embryonic stem (ES) cells into neural epithelial cells and then to functional motor neurons. To enhance neural cell adhesion on the scaffolds, the polymers were modified using Arg-Gly-Asp-Cys (RGDC). We hypothesize that the RGDC sequence immobilized on the polymer scaffolds through the reaction of thiol group in cysteine and double bond in PGDF/PGDI can effectively stimulate cell adhesion and hence improve the cell survivability, therefore these fiber scaffolds could be used as a potential cell carrier in nerve tissue engineering.

Poster #7

Web Based Interactive Medical Imaging Teaching Applications for Nuclear Medicine

Senait Debebe

Advisor: Anthony Mcgoron



Abstract

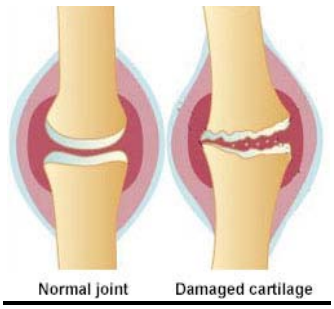
Medical Imaging is a multidisciplinary field which combines the knowledge of physics, mathematics, electrical and computer engineering. The necessity to know the techniques of Medical Imaging in clinical and research laboratories has made Medical Imaging a major training area in Biomedical Engineering. The tremendous amount of information and rapid change in the medical imaging field require teaching material to be more flexible to fit into the available class hours. Internet/Web-based education is one of the tools with which education is popularly delivered. Web-based interactive teaching models increase students learning gain in the field of medical imaging. We have developed interactive simulations of Nuclear medicine imaging. These learning applications provide an easy understanding of the physics, principles and methods behind nuclear medicine to successfully deliver information for students. In these applications the diverse mathematical derivations for image generation, recognition and reconstruction in a PET camera, the metabolism rate of glucose using [^{18}F] fluoro-deoxy-glucose (FDG) using 3 compartmental models are among the major simulation we have accomplished.

Poster #8

A HYDROXYAPATITE NANOPARTICLE SYSTEM THAT AUGMENTS THE PHYSICAL AND BIOLOGICAL PROPERTIES AT THE INTERFACE OF BONE AND ENGINEERED CARTILAGE

Rupak Dua

Advisor: Sharan Ramaswamy



Abstract

For the potential treatment of osteoarthritis in the knee, cartilage has been engineered using photopolymerizable, hydrogel-based scaffolding approaches; however there remains a need for enhanced anchorage of the engineered tissue to the underlying subchondral bone. Previous studies have taken approaches based on mechanical fixation, principles of protein biochemistry, blocking signaling pathways, and polymer science in order to form novel strategies of integration but have demonstrated limited success in terms of hydrogel retention within the defect space.

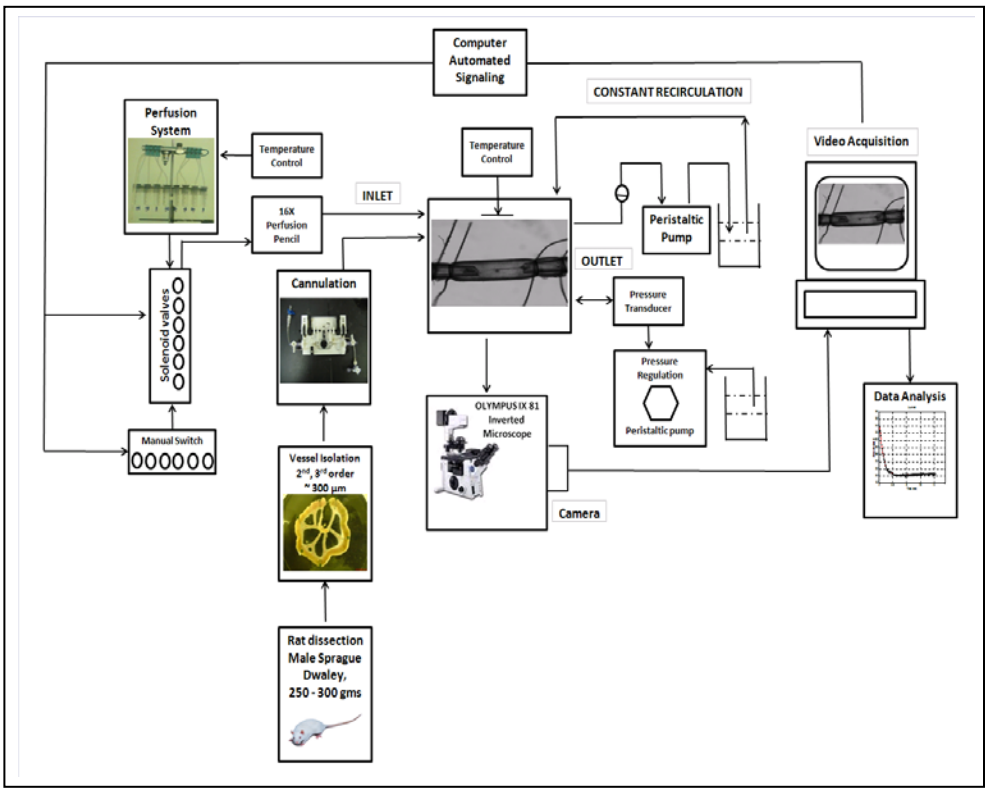
To overcome this issue of the scaffold retention, we have been trying by making an in-vitro model of Tissue engineered cartilage and bone in TEMIM lab, FIU. We are investigating if hydroxyapatite (HA) nanoparticles could be used to promote bone-in-growth into the basal region of photopoylmerizable hydrogels simulating a cartilage, thereby enhancing the retention of the tissue engineered constructs within the defective area for an appropriate healing period of around 4 weeks. We are looking into the mechanical stability of the constructs by performing the compression over a month for different point times. We are also analyzing the interfacial strength between the 2 layers over a period of 4 weeks by performing the shear testing. Preliminary results confirmed the viscoelastic behavior of the constructs that were used for making the tissue engineered constructs. We were also able to shown that there is an increase in the integration force between the engineered bone and tissue engineered cartilage over a period of time.

Poster #9

Nitric Oxide dependent signaling in vasorelaxation: Effect of transient Nitric Oxide release

Tushar Gadkari

Advisor: Nikolaos Tsoukias



Abstract

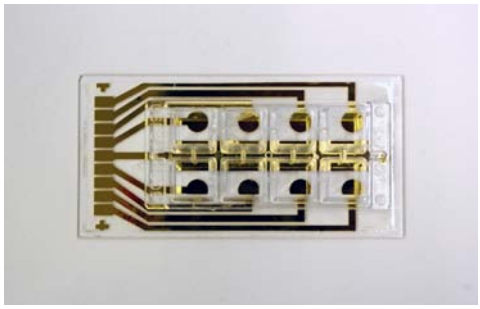
Nitric Oxide (NO) has been identified as the Endothelium Derived Relaxing Factor (EDRF) and a key regulator of vascular smooth muscle tone and blood flow. In response to hemodynamic or agonist stimuli endothelial cells produce NO which can diffuse to the smooth muscle where it activates soluble guanylate cyclase (sGC) leading to cGMP formation and to smooth muscle relaxation. Previous studies however, suggest that most of the NO produced will be scavenged by the blood. Thus, it is not clear how NO is able to play its important physiological role in the regulation of blood flow. We have previously suggested that transient burst-like NO release may limit scavenging by hemoglobin and that vascular tone may be regulated by the frequency of NO bursts. Experiments are designed to test if and under what conditions an interminent release of NO can play a role in regulating vascular diameter. Isolated rat mesenteric arterioles were pressurized and pre-constricted with NE (1-2mM). Transient exposure to NO was achieved by alternating perfusion with NO releasing mediator (Spermine NONOate; 10nM-100mM) or Acetylcholine (10nM-100mM) followed by a NO scavenger (oxyhemoglobin; 100mM). The time constants (+sd) for relaxation after NO exposure t_{on} (27+12 s) and constriction after NO removal t_{off} (117+51 s) were statistically different ($p<0.005$). This differences leads to a frequency dependent relaxation of the arteriole when bursts of saturating NO concentrations are applied. We thus propose that the of the NO-induced relaxation is determined by the frequency of endothelial Ca^{2+} oscillations that leads to concomitant NO bursts.

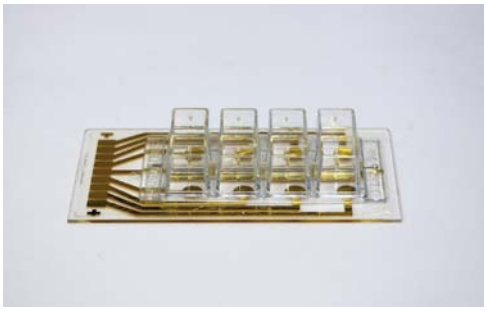
Poster #10

Development of Cell Impedance Based Sensing System for Nanotoxicity Assay

Evangelia Hondroulis, Chang Liu

Advisor: Chen-zhong Li





Abstract

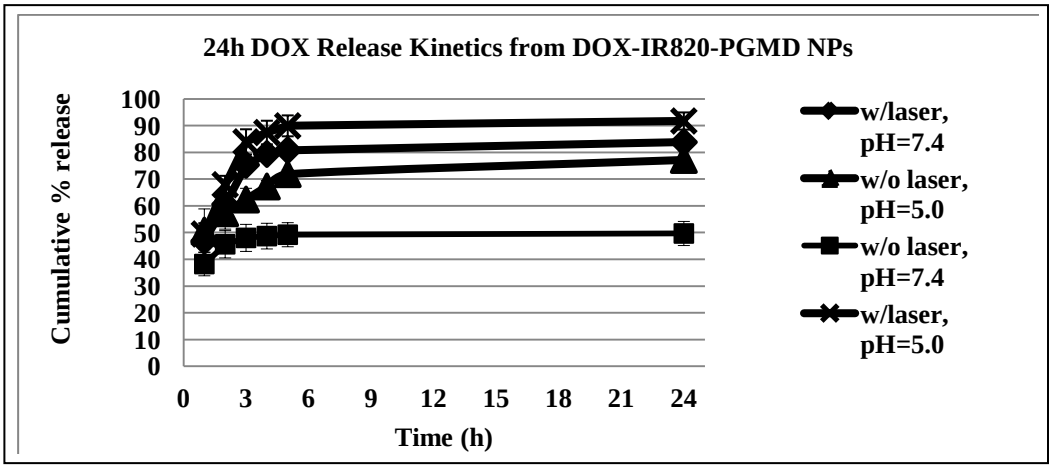
Nanotechnology involves the creation and manipulation of materials at nanoscale levels to create products that exhibit novel properties for many applications in various fields such as biotechnology and nanotechnology; however, despite the increased interest in the development of nanoparticles, few studies address their potential cytotoxicity. Nanotoxicology is an emerging field of study with time-limiting and complicated methods of testing. In this project, we aim to develop a system of monitoring cell behavior to various engineered nanoparticles using a novel approach. An electrical cell impedance system will be fabricated and utilized to kinetically analyze the cytotoxicity of nanoparticles of different materials. By measuring the impedance difference as the cells attach to an electrode, this system will be able to provide a more rapid, efficient and straightforward method of measurement compared to the current method of incorporating the nanoparticles into a cell culture directly. The integration of nanotechnology with biology, advanced Micro-Electro-Mechanical Systems (MEMS) technology and electrochemistry opens the possibility of developing novel biomedical devices. The novelty of this study will be the design and development of a cell impedance assay biosensing chip. This compact electrical biosensing chip will be easy-to-use and will have the capability to measure multiple samples simultaneously and in real-time which is critical for monitoring cytotoxicity.

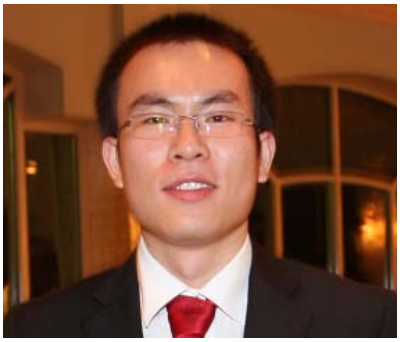
Poster #11

Thermal and pH Sensitive Multifunctional Polymeric Nanoparticles for Cancer Therapy

Tingjun Lei, Romila Manchanda, Yen-Chih Huang, Anthony J. McGoron

Advisor: Anthony J. McGoron





Abstract

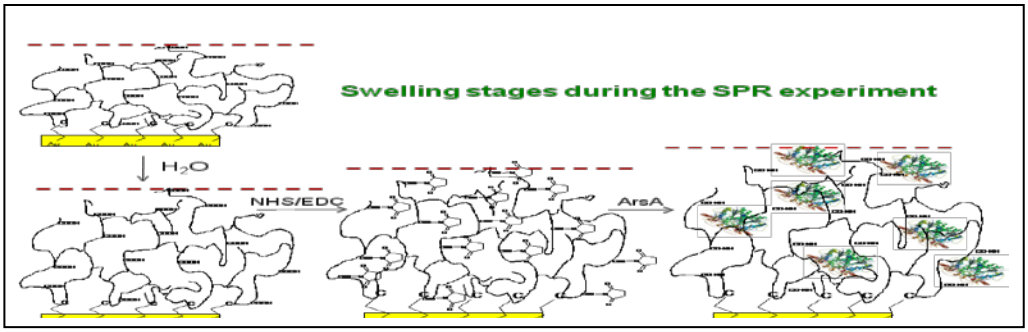
Intensive research has been conducted on developing more efficient and multifunctional drug delivery systems to deliver a therapeutic agent to the target site with amplified therapeutic value. Nanotherapeutic strategies in cancer have shown enhanced drug concentrations at tumor sites, increased treatment efficacy, and reduced side effects. This is due to the versatility of nanoparticles which allows for the design of carriers with tailored drug release profiles along with site-targeting (using biomarkers) and localized triggering (using pH, temperature, ultrasound, and light etc.) at tumor site. Our study aims to prepare novel poly-glycerol-malic acid-dodecanedioic (PGMD) nanoparticles (NPs) containing imaging/hyperthermia (HT) agent (IR820) and chemotherapeutic agent (doxorubicin) for cancer therapy. Hyperthermia and drug release is triggered by exposure of IR820 to Near-Infrared (NIR) laser light. PGMD polymer was prepared by the thermal condensation method. IR820 and DOX loaded PGMD NPs were prepared using the single oil emulsion technique. Drug release from NPs was initiated by exposure to a NIR laser and measured by a spectrofluorometer. Cell experiments were conducted in the drug-sensitive human uterine sarcoma cancer cell line (MES-SA) and its drug-resistant derivative MES-SA/Dx5 (Dx5). The subcellular localization of dual agent NPs and their free forms was studied using fluorescence microscopy. Cytotoxicity was measured using the Sulforhodamine B colorimetric assay. The size of the DOX-IR820-PGMDNPs was measured by dynamic light scattering (DLS) to be around 150 nm. The drug loading efficiency of DOX and IR820 was around 4% and 8%, respectively. DOX shows a cumulative release of ~45% at 24 hours in pH=7.4 PBS without laser exposure. DOX release from the NPs was enhanced ~85% after 24 hours by exposing NPs to laser for three minutes, which brings the temperature to 42 °C. When the NPs were placed in acidic buffer (pH=5.0), approx. 77% DOX release was induced in 24 hours. After exposure NPs to acid buffer and laser, the release was further enhanced to ~90% in 24h. Cytotoxicity of the drug loaded NPs was comparable in MES-SA but was higher in Dx5 compared to free drug ($p<0.05$). In conclusion, multifunctional NPs were synthesized and can be exploited by means of combination of different therapeutic techniques such as chemotherapy and HT, a tunable and predictable pharmacokinetic release profile using thermal or pH stimuli indicates that this novel and adjustable delivery system is a promising vector for treatment of various cancers. These dual agent NPs will be targeted in future work.

Poster #12

ENHANCED SURFACE PLASMON RESONANCE SENSING OF ARSENIC-PROTEIN INTERACTION

Chang Liu, Vittoria Balsamo, Chen-Zhong Li

Advisor: Chen-Zhong Li



Abstract

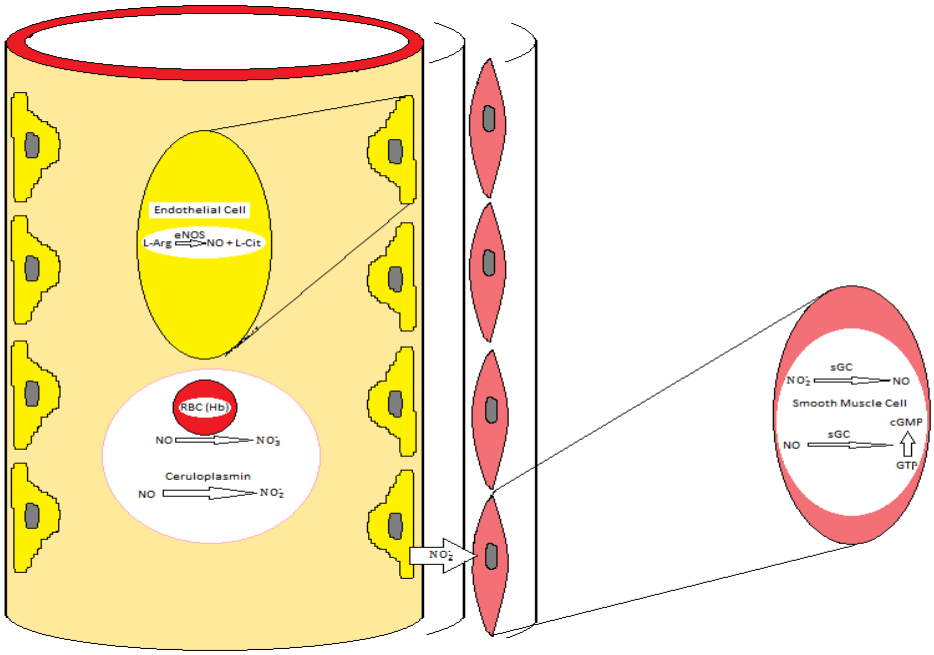
A novel polymer-nanoparticle composite coated gold substrate for Surface Plasmon Resonance (SPR) and Surface Enhanced Raman Scattering biosensing is reported in this work. The coated substrate was developed by means of a surface mediated radical co-polymerization process to obtain a highly sensitive hydrogel-based thin film with thermoresponsivity, pH sensitivity and specific binding sites for target analytes. Initially, N-isopropylacrylamide (NIPAAm) and acrylic acid (AAc) monomers were polymerized by the "grafting from" method in the presence of crosslinker and initiator. Following this, gold nanoparticles (AuNPs) were spin coated on the polymer thin layer and the aforementioned procedures were repeated twice to form a 3D multilayer structure, in order to enhance the sensitivity of the sensor by inducing localized surface plasmon resonance. The sensing platform was then utilized to study the conformational change of ArsA and ArsD ATPase upon the binding of arsenic derivatives. ArsA and ArsD are both plasmid-encoded arsenical resistance (ars) operon of plasmid R773 in cells of Escherichia coli, which produce resistance to trivalent and pentavalent salts metalloids arsenic. For comparison, a gold chip coated with only AuNPs was used as a control sensing platform. SPR measurements indicate that the polymer-nanoparticle coated sensors exhibited a twice higher sensitivity than that of the AuNPs decorated sensors while also provide information of temperature and pH change during the binding process.

Poster #13

sGC in SMC acts as Nitrite Reductase leading to NO formation

Kumpal Madrasi, Nikolaos Tsoukias and Mahesh Joshi

Advisor: Nikolaos Tsoukias



Abstract:

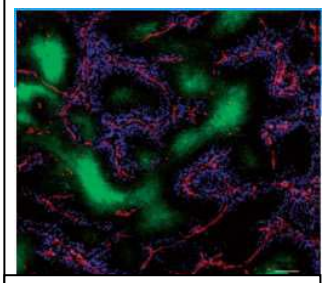
Several heme proteins including hemoglobin and nitric oxide synthase (NOS) have been documented to serve as nitrite (NO_2^-) reductase under anoxia. Since sGC is also a heme protein and an important signaling biomolecule, we hypothesized that it may function as NO_2^- reductase in cultured smooth muscle cells. Millimolar levels of NO_2^- were required to detect cellular NO as measured by NO specific fluorescent dye (Cu_2FL2E). However, in chemiluminescence analysis of cell lysates, addition of 400 - 600 µM NO_2^- was sufficient to detect measurable NO synthesis under anoxic conditions. This NO synthesis was inhibited with ODQ showing sGC in the cell lysate as the source of NO_2^- reduction. CO is a known activator of sGC and thus CO donor (50 µM CORM-2) significantly activated NO_2^- reduction to NO. The cellular uptake of NO_2^- was studied using the AE-1 inhibitor, DIDS and intracellular NO_2^- was measured by tri-iodide assay. DIDS (300 µM) significantly inhibited NO_2^- uptake and showing that NO_2^- uses AE-1 transport mechanism. These results demonstrate that sGC mediates NO_2^- reduction to form NO and that the AE-1 channel is one of the pathways for NO_2^- entry into SMC.

Poster #14

OPTIMIZATION OF DRUG DELIVERY DURING THE COMBINATION OF HYPERTHERMIA AND CHEMOTHERAPY IN AN *IN-VITRO* 3-D TUMOR MODEL: A STUDY IN MULTICELLULAR SPHEROIDS

Abhignyan Nagesetti, Dr George S Dulikravich.

Advisor: Anthony J McGoron



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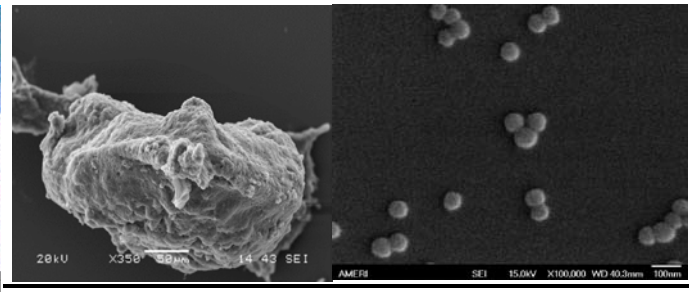

Student Photo

Abstract

The use of nanoparticle carriers for cancer therapy/diagnostics is limited by its penetration into the tumor tissue due to increased intratumoral pressure and tumor extracellular matrix (ECM). This causes heterogeneous distribution of drugs in the tumor tissue leading to multidrug resistance in tumors and loss of effectiveness of chemotherapy. The goal of this research is to optimize the efficacy of chemotherapy by using it in combination with hyperthermia to induce homogeneous distribution of nanoparticles in a 3-dimensional tumor model (spheroids). Tumor spheroids are representative models of avascular tumors *in-vivo*. They are clinically relevant as late stage cancer metastases (Ovarian cancer, Breast cancer etc.) as well as early stage tumors (before development of vasculature). Ovarian carcinoma (SKOV-3) and P-glycoprotein positive multidrug resistant uterine sarcoma (MES-SA/Dx-5) cell lines were used to create spheroid models using the liquid overlay technique. Fluorescent silica nanoparticles were prepared by reverse microemulsion technique to serve as model nanoparticles. . Furthermore, a mathematical model is developed by coupling the heat conduction equation and the thermoporoelastic equation (Duhammel-Neumann equation) to study the deformation of porous tumor tissue under thermal stress. Model predictions will be used to study the change in the effective diffusion coefficient of nanoparticles. Preliminary results show tumor spheroids with compact aggregation of cells, presence of ECM and stratified organization. Tumor spheroids were resistant to the combination of chemotherapy and hyperthermia. Silica nanoparticles were prepared with a diameter range of 60-70 nm. Their stability in aqueous solutions was increased by surface modification with Polyethylene Glycol. The 2-dimensional Electron Microscope images of the tumor spheroids were used to create the geometry of tumor tissue for the mathematical model. Finite element modeling to study thermal deformation, experiments on nanoparticle penetration and factors for thermal/chemo resistance such as HSP-70 and P-glycoprotein will be further investigated.

Poster #15

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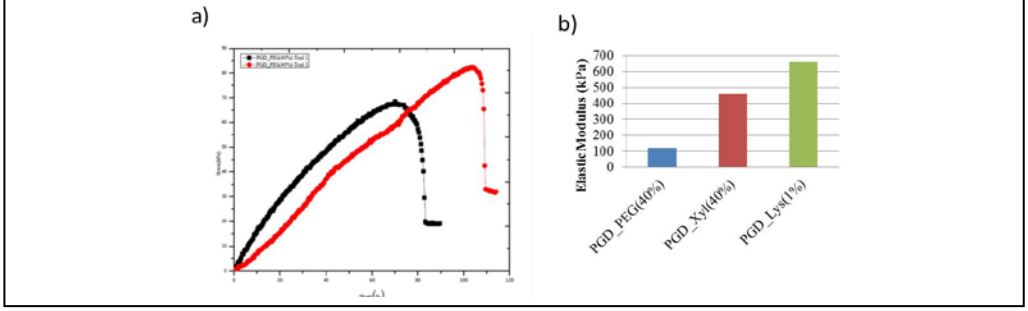
Biodegradable Elastomers

S.Rath,

Advisor: S. Ramaswamy



Abstract

Adult cardiac muscles have limited capability to regenerate after injury which inhibits natural repair processes of damaged cardiac cells. Challenges of heart transplant treatments call for an urgent need to explore new possibilities for replacing nonfunctional cardiac muscles with suitable and functional cardiac tissue. Efforts in cardiovascular regenerative medicine have been made to explore novel methods to mechanically induce stem cell differentiation and extra cellular matrix (ECM) protein production *in vitro*. However thus far, limited insights have been derived in scaffold optimization for ideal cell- matrix interactions and in the choice of progenitor cell source. Periodontal ligament cells (PLCs) are potential candidates for cardiomyocyte differentiation as they possess several embryonic cell markers. The focus of this study is to fabricate a polymer scaffold to mimic cardiac muscles *in vitro*.

Different co-polymers of Poly glycerol dodecanoate (PGD) with Xylitol (Xyl) 40%, poly ethylene glycol (PEG) 40% and Lysine (Lys) 1% were synthesized using poly-condensation polymerization reaction. Tensile testing was performed employing an environmental controlled chamber, precisely maintained at 37°C. Elastic modulus of each polymer sample was obtained from stress vs. strain measurements.

Myocardial tissue has complex muscle fiber structures along with cardiac ECM which provides unique cell to cell and cell to ECM interactions. It is critical to understand the mechanisms of these interactions in order to construct an optimal cardiac scaffold. Cardiac muscle has an elastic modulus of 100.3 ± 10.7 kPa which is comparable to PGD_PEG (40%) as shown in figure (a,b) above. This scaffold was chosen as the appropriate material to seed PLCs and culture cardiomyogenic tissue.

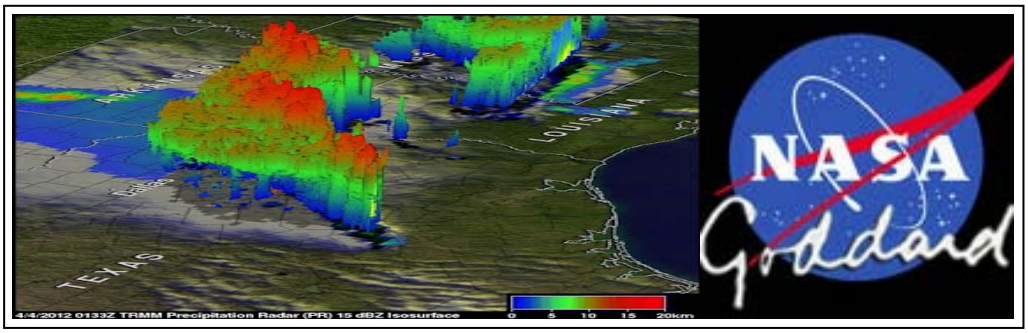
We have manufactured a mechanically suitable elastomeric scaffold to potentially guide engineered cardiomyogenic tissue formation. Currently, the effects of applied cyclic stretch on PLCs-seeded scaffolds are being investigated. We expect that these studies will advance our understanding of PLCs to PGD_PEG(40%),interactions that may lead to further cardiomyocyte differentiation.

Poster #16

An Experimental Study of the Small-Scale Variability of Rainfall At the Southern Delmarva Peninsula

Rigoberto Roche, Florida International University
NASA WaterSCAPES University Research Center,
Ali Tokay, JCET - University of Maryland Baltimore County,
NASA-Goddard Space Flight Center,
Paul G. Bashor, Computer Science Corporation,
NASA – Wallops Flight Facility,

Advisor: Anuradha Godavarty



Abstract

An experimental study was conducted at Mid-Atlantic region to investigate the rainfall variability within the instantaneous field of view of the microwave sensor based satellite rainfall estimate. The study was conducted through thirty rain gauges that were deployed at 11 sites where 8 sites had triple and remaining sites had dual gauges. The gauges were tipping bucket at 0.01 inches resolution. The time of the tip was recorded to a data logger which is powered by lithium battery. A continuous gauge record was obtained at every gauge site from May 2005 to September 2010. The gauges sites were distributed from Ocean City, Maryland to Kiptopeke, Virginia, at a maximum separation of 150 km and at a minimum separation of 1 km between the two sites at Wallops Island, Virginia. This study focuses on the variability of rainfall at different climatological periods. The observations were divided into 20 seasons, 10 cold/warm periods, and 5 years. A stretched exponential model was applied to the correlations of paired gauge rainfall at 30-minute integration period. Two tips (0.5 mm) were considered as the threshold for rain events. The correlations felt below 50% at 10 km distance most of the time in an observational period, while they were below 20% at 40 km distance. The variability was more noticeable between the seasons than between the warm/cold periods and between the years. This could, in part, be related to the sample size, partly differences in rainfall characteristics. Additionally, the remnants of tropical cyclones bring abundant rainfall to the Mid-Atlantic region but they may not be observed at a given year. The nugget parameter was mainly above 0.95 while the shape parameter was mainly between 0.4 and 1.0. The correlation distances remained mostly less than 50 km at a given observational period.

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Poster #17

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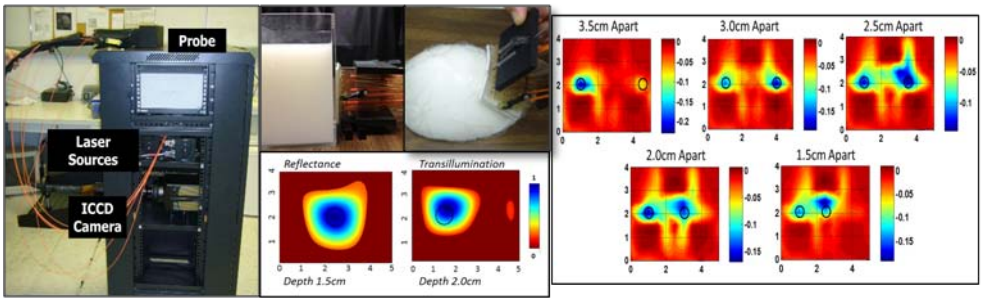
Flexible Gen-2 Hand-Held Optical Imager: Flat and Curved Phantom Studies

Manuela Roman, Sarah J. Erickson, Jean Gonzales, Pallavi Joshi, Anuradha Godavarty
Optical Imaging Laboratory, Department of Biomedical Engineering

Advisor: Anuradha Godavarty



Abstract

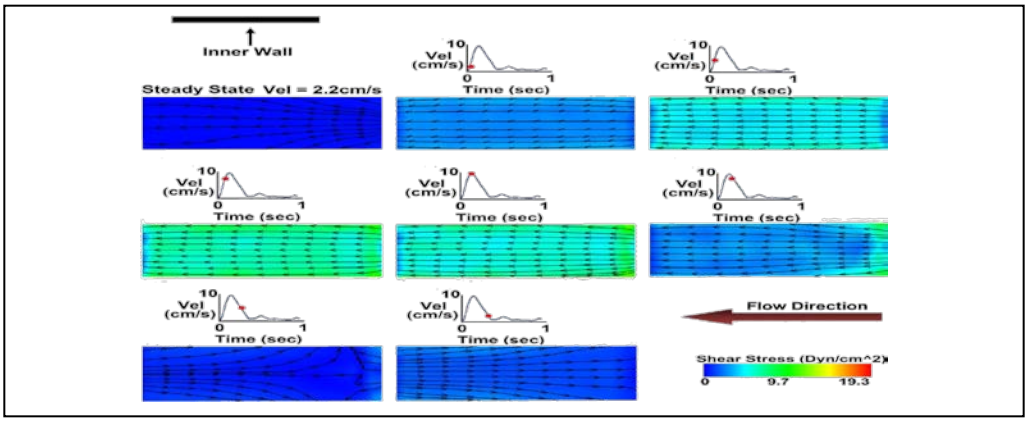
Diffuse optical imaging is a promising non-invasive and non-ionizing modality for breast cancer diagnosis. Hand-held optical imagers are developed toward rapid translation to the clinic due to their portability and patient-comfort. However, the imagers developed to date have flat probe faces which limit the ability to maintain full contact with the tissue and contour to the different curvatures of breast tissue. In our Optical Imaging Laboratory, we have developed a gen-2 hand-held optical imager capable of two-dimensional (2D) and three-dimensional (3D) imaging (via coregistration facilities), which has a flexible probe head designed to contour to different breast tissue curvatures. The optical imager is composed of an intensified charge-couple device (ICCD) based detector, six 785nm laser diodes which are connected to the probe heads via optical fibers, and a two-part forked probe design to enable both transillumination and reflectance based imaging. In the current work, studies are performed using flat and curved breast phantoms to compare the performance of the imager with the probe in both the flat and curved positions. Additionally, resolution studies are initiated in order to test the ability of the imager to resolve multiple targets (or tumors). Resolution studies have been carried out under various experimental conditions using slab phantoms (filled with 45% organic milk). Reflectance studies were performed in which targets were placed in ($10\times10\times10$ cm^3 phantoms at different depths (0.5 to 2.5cm) and different distances between targets (0.5 to 4cm). Different size targets (0.5cm to 1.0cm diameter) filled with India ink green have been used to represent real tumors under absorbance conditions. Preliminary 2D surface images of reflected measurements have demonstrated the ability of the system to resolve 0.95cm diameter targets placed 1.5cm apart at 1cm depth. Three dimensional tomography reconstructions are currently performed to assess the resolution capability under different experimental conditions.

Poster #18

Effects of Geometric Variations and Pulsatility on Oscillatory Shear Stress Environments

Manuel Salinas, David E. Schmidt, Miguel Libera, Richard Lange

Advisor: Sharan Ramaswamy



Abstract

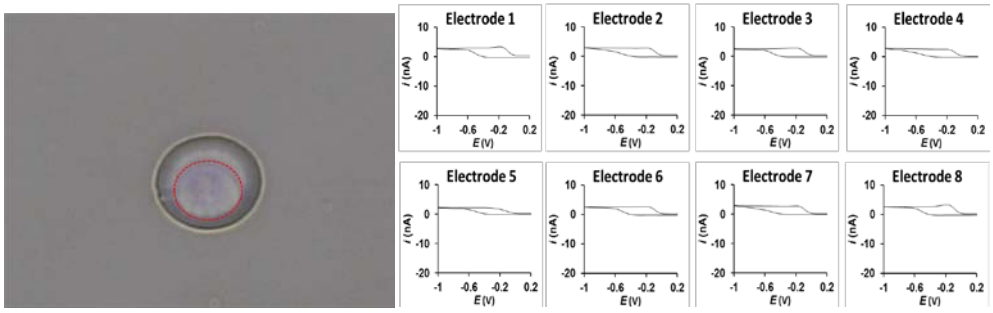
Mechanical conditioning has been shown to promote tissue formation in a wide variety of tissue engineering efforts. However the underlying mechanisms by which external mechanical stimuli regulate cells and tissues are not known. This is particularly relevant in the area of heart valve tissue engineering owing to the intense hemodynamic environments that surround native valves. Some studies suggest that oscillatory shear stress (OSS) caused by time-varying flow environments, play a critical role in engineered tissue formation derived from bone marrow derived stem cells (BMSCs). There is strong evidence to support this hypothesis in tissue engineering studies of bone. From observing native heart valve dynamics, OSS can be created by means of pulsatility or by cyclic specimen geometry changes. However, quantification of the individual or combined effects of these variables for the maximization of OSS environments *in vitro* is to date, not known. Accordingly, in this study we examined and quantified the role that i) physiologically relevant scales of pulsatility and ii) changes in geometry as a function of specimen flexure, have in creating OSS conditions for dynamic culture of tissue. A u-shaped custom made bioreactor capable of producing flow stretch and flexure was used. Computational Fluid Dynamic (CFD) simulations were performed through Ansys CFX (Ansys, Pittsburgh, PA) for both steady and pulsatile flow. We have shown that OSS can be maximized by inducing pulsatile flow over straight scaffolds. We believe that OSS promotes BMSCs tissue formation.

Poster #19

Bio-Chip for Single Cell Manipulation and Measurement

Pratikkumar Shah

Advisor: Chenzhong Li



Abstract

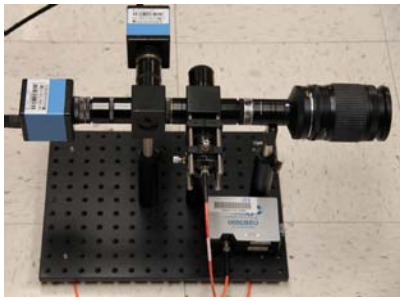
All aerobatic species on the earth uses O2 in its respiration. This metabolic process of respiration also produces reactive oxygen species such as super oxides (O^{-}_{2}·), hydroxyls (OH·), peroxyl (LO_2·), alcoxyl (LO·), hydroperoxyls (HO_2·). Toxic effects of these oxidative species can attack DNA, lipids, proteins and nucleic acids present in the body and may even lead to cell death. Mammalian cell has many antioxidants to balance the side effects of these free radicals. When the imbalance between antioxidants and reactive species becomes larger, indicates the pathological condition of body. Oxidative stress has been linked to many diseased conditions in human, such as inflammation, heart disease, cancer, neuronal diseases, etc. 8-hydroxy 2-deoxy guanine (8-OHDG) is the most frequently detected and studied oxidative DNA lesion. We propose to fabricate a lab on chip device to study single cell exocytosis of 8-OHDG under stress conditions. We are also integrating two approaches to trap a single cell by dielectrophoresis and surface modification. Dielectrophoresis allows us to capture a single cell in few seconds while surface modification helps us avoid nonspecific adsorption and longer cell viability during our studies.

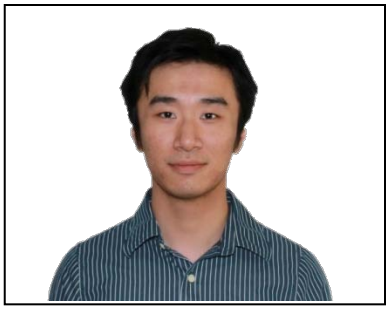
Poster #20

Development of a Hybrid Imaging/Spectroscopy System for Intraoperative Guidance of Pediatric Craniotomy

Yinchen Song

Advisor: Wei-Chiang Lin





Abstract

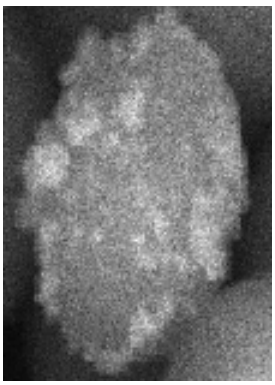
Pediatric brain tumors and intractable epilepsy are serious neurological disorders that affect more than 75,000 children worldwide each year. For the majority of children with these disorders, complete surgical removal of their neoplastic and epileptic lesions remains the ideal treatment option when applicable. These lesions often are similar in appearance to normal brain parenchyma, despite their distinctive pathophysiological characteristics, and hence are difficult to detect by visual inspection. Modern diagnostic technologies like magnetic resonance imaging often fail to reliably distinguish the lesions from the normal brain due to their limited sensitivity, and their availability in the operating room is limited due to their prohibitive costs. Since the success of this surgery type hinges upon the completeness of lesion removal, the goal of this research project, therefore, is to develop a new surgical guidance system that can intraoperatively detect the presence of neoplastic and epileptic brain lesions with high accuracy. The system itself is a hybrid optical imaging/spectroscopy system, and it detects unique *in vivo* hemodynamic and structural characteristics of pediatric neoplastic and epileptic brain lesions. Its scientific foundation is diffuse reflectance spectroscopy, which has been shown to detect tumorous and injured tissue *in vivo* with a high sensitivity and specificity. The system, once developed, will be used independently as well as in conjunction with a surgical microscope for seamless integration into the lesion removal procedure. The success of this project shall improve the prognoses of patients and reduce the emotional and financial burdens endured by pediatric brain tumor and epilepsy patients and their families.

Poster #21

Silver Nanoparticle based SERS Biosensor for detection and assessment of nonspecific environmental toxin exposure

Supriya Srinivasan, Vinay Bhardwaj, Joshy John, Anthony J. McGoron

Advisor: Anthony J. McGoron



Silver nanoparticles uptake study in yeast cells

Abstract

Non-specific toxicity determination in the presence of environmental toxicants is important for environmental monitoring. Evaluation of expression of stress proteins in response to environmental toxins is one such method. Yeast cells are robust eukaryotic cells which survive harsh environmental conditions and yet express these stress proteins. Thus, our aim is to develop a yeast whole-cell based biosensor that measures multiple toxicants promoted stress proteins simultaneously. We developed SERS substrate nanoparticles (NPS) of gold and silver to determine stress markers in yeast expressed against UV and H_2O_2 stressors. Specific immunosensors were created by conjugating monoclonal antibodies against these markers onto these NPs. The sensitivity of these immunosensors for detecting the proteins was compared with the traditional ELISA technique. Yeast cells were exposed to various levels of UV or H_2O_2 and the cells lysed to measure the expressed protein in the cell lysate. Toxicity and uptake of these nanoparticles in yeast cells was also measured to determine the best substrate for developing the whole-cell SERS sensor. Colloidal NPs were synthesized using different formulations Citrate reduced silver NPs were found to be the best substrate among all tested. Further, these NPs were used to measure heat shock protein 70 (HSP70; a stress marker) directly (without employing specific antibodies against the protein) in order to determine the protein's SERS spectral signature. The lowest concentration of the protein detected by direct measurement was 0.02 ng/ml (comparable to the conventional ELISA technique). HSP70 levels expressed in yeast cells before and after stress (0.05 ng/ml to 1 ng/ml) was successfully detected using the immunosensor (Silver NPs conjugated with anti- HSP70 antibody). These NPs killed 15% of yeast cells (10^5 cells/ml) with an uptake of 1500 NPs per cell after 12 hrs exposure. Thus, these NPs show promise for development of whole yeast cell SERS-based sensor for environmental toxicity measurement.

Poster #22

Paper based sensor for DNA oxidative damage biomarker detection

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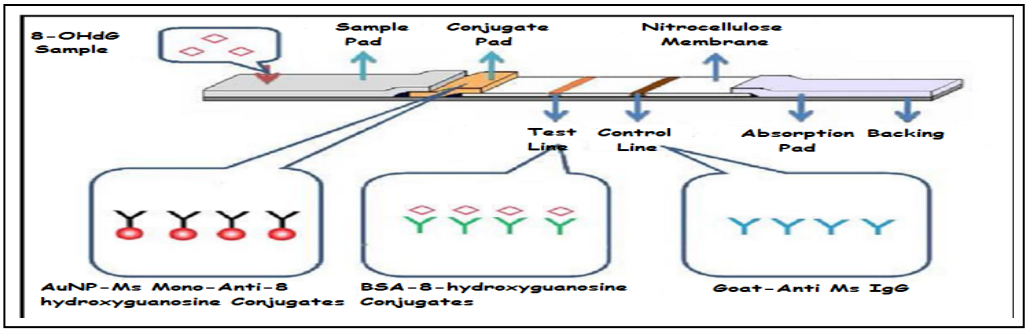

Abstract

In living cells reactive oxygen species (ROS) are formed continuously as a consequence of metabolic reactions. Under normal physiological conditions, there is a balance maintained between endogenous oxidants and antioxidants. However, when it gets exposed to adverse physicochemical, environmental or pathological agents such as atmospheric pollutants, cigarette smoking, ultraviolet rays, and toxic chemicals, the abnormal oxidant system then enters what is called oxidative stress. In the presence of oxidative stress, ROS generated in vivo can directly cause oxidative damage to lipids, proteins and DNA. This damage, if unrepaired, accumulates and leads to physiological attrition and an increased risk of several chronic diseases. In nuclear and mitochondrial DNA, 8-hydroxy-2'-deoxyguanosine (8-OHdG) is one of the predominant forms of free radical-induced oxidative lesions, and therefore has been widely used as a biomarker for oxidative stress and carcinogenesis. Studies showed that urinary 8-OHdG is a good biomarker for risk assessment of various cancers and degenerative diseases. Here we will develop a simple competitive colloidal gold-based immunoassay in lateral-flow format for the rapid detection of 8-OHdG. Nitrocellulose membrane strip is separately coated with goat anti-mouse IgG (control line) and 8-hydroxyguanosine-BSA conjugate (test line). Anti-8-Hydroxyguanosine (8-OHG) monoclonal will be labeled with gold nanoparticles firstly. Using 8-OHdG standard solutions, a positive reaction as a result of the remaining antibody-gold conjugate combining with antigen coated on the membrane will be obvious by visual detection. The test strip will provide a point of care testing method for quantitative, semi-quantitative, or qualitative detection of DNA oxidative stress with high sensitivity, specificity, speed of performance and the advantages of simplicity.

Poster #23