Complications of diabetes include nerve end damage, reduced peripheral blood flow, which can also lead to slow wound healing, ulcers and amputations. This work proposes the use of a dielectric probe to track the wound healing process of a diabetic subject. It is based on the principle that the microwave dielectric properties of tissues such as skin or muscle, provide information on their structure, composition and physiological state. We used an automatic network analyzer, together with a dielectric probe, to measure dielectric constant and dielectric loss factor of the skin of our subject over a one-month period. Data was collected between 100 MHz and 8.5 GHz frequency range. Results showed a proportional increase in dielectric constant and loss factor with increase in the wound-induced edema. This work enhances the development of an electromagnetic wound-monitoring technique and provides data for tissue engineering applications.

3129-Pos Board B821

Array Microscope for High Throughput Stiffness Characterization of Cancer Biology

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The reciprocity of mechanical information between cells and their microenvironment has increased appreciation for the role of physics in cancer progression. Although much interest is given to studying the signaling pathways that govern how normal cell function and structure become abnormal during cancer progression, these changes convolute already difficult and highly variable mechanical measurements of single cells. To address the need of minimizing single measurement variability as well as the desire to explore the large signaling-protein parameter spaces of cancer biology, we have developed an automated high throughput microscope system that utilizes passive microbead diffusion to characterize cell mechanics. Here, we describe the instrumentation advances of our system, including 12 independently controllable optical paths - each of which is capable of video rate image acquisition in brightfield and two-channel fluorescence, and is equipped with electronically tunable autofocus. In all, video data collection across a 96-well plate takes as little as 10 minutes. A data analysis pipeline then identifies and tracks microbeads, filters and applies statistical analysis to mechanical measurements, and occurs completely unsupervised. We show that the thermal diffusion of micron-sized beads connected to integrin surface receptors via fibronectin can distinguish ovarian, melanoma and bladder cancers with varying metastatic potentials. With sampling sizes in the thousands, we report stiffness differences between cancer cell types as well as the effect of loss and gain of function constructs aimed to alter actin cytoskeletal structures. Our results support previously published work describing the inverse relationship between mechanical stiffness and invasion behavior, and ultimately, demonstrate the value of our high throughput instrument and passive rheology assay as a screening tool for studying relevant signaling pathways involved in cancer cell mechanics.

3130-Pos Board B822

Power, Direction, and Synchrony - Mechanical Problems and Solutions from Jumping Leafhopper Insects

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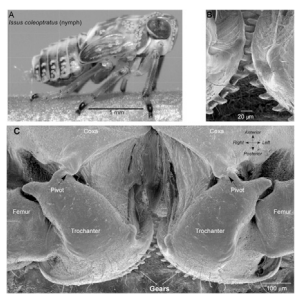
Jumping insects solve a very difficult mechanical problem. The huge power requirements (as high as 30,000 W/kg of muscle) require mechanical systems to amplify the limited power generation capability of muscle. Moreover, the energy release must be precisely controlled to control direction and speed. Lastly, the legs must be coordinated to within microseconds, lest the jump spin out of control. I will show how jumping insects in the Auchenorryncha (planthoppers, treehoppers, leafhoppers, and froghoppers) solve these problems. To generate the power, they use a composite bow like 'spring' which is slowly loaded prior to a jump. Fast recoil of this spring then powers the jump itself. To control the direction, the legs of the insect are used as a linkage system to direct the spring's recoil. By adjusting the femur/tibia joint on each of the hindmost legs, the insect controls the jump's azimuth. By using the forelegs to tilt the body, the insect likewise controls the jump's elevation. To ensure that the legs propel the insect at exactly the same time, the nymphs of these insects use a pair of 'gears'.



3131-Pos Board B823

Computational Model of Passive Diffusion Across the Retinal Pigment Epithelium

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Retinal pigment epithelium (RPE) is an important part of the normal visual function. Located behind the retina, one of its main functions as a part of the blood-retinal barrier is to regulate the transport between the retina and systemic blood circulation. The barrier properties, and changes in them, have a role in certain retinal diseases, such as age-related macular degeneration. Previously, mostly pharmacokinetic compartmental models have been proposed. In this study, for the first time we introduce an accurate physical structure-based model of passive diffusion across the RPE.

Our model relates the permeability coefficients of RPE structures to the physicochemical properties of materials forming the RPE. Model is based on a similar corneal diffusion model proposed by Edwards & Prausnitz (2001). Transcellular and paracellular diffusion components are described by separate permeability equations based on the material properties of each pathway and the basic interactions between each pathway and the characteristics of the diffusing molecule. The structure of our tight junction (TJ) model has not been utilized in other structure-based epithelial models of this type, and it takes into account both the pore pathway for small molecules and the leak pathway for large molecules. Our RPE model was able to predict correct magnitude for the permeabilities and its behavior corresponds to experimental results. Further, the permeability magnitude and behavior of the TJ model appear similar to the experimental data from intestine epithelial cell TJs. However, due to the inconsistent experimental data of RPE permeability, rigorous validation cannot be made.

RPE barrier models would facilitate novel drug development against retinal diseases. Our model forms a good platform for the future development and refinements as it combines our knowledge of the RPE structure and diffusion.

3132-Pos Board B824

Guidance of Molecular Shuttle Movements Driven by Kinesin Motor: A Simulation Study

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Much effort has been devoted to integrating motor proteins, such as kinesin and myosin, into Lab-on-a-Chip, aiming at development of stand-alone self-powered Lab-on-a-Chip devices. One of such attempts is molecular shuttles powered by kinesin motors. In order to take advantage of this transport system, proper guidance of movements of the molecular shuttles is needed. The guidance is commonly achieved with use of microfabricated guiding tracks. Various types of microfabricated guiding tracks have been developed. However, our understandings about details on how molecular shuttles are guided are limited. Hence, developments of guiding methods are largely depending on experimental trial-and-errors. Here, in order to elucidate how the guidance occurred, we performed computer simulations on guiding behaviors of molecular shuttles driven by kinesin motors. Three-dimensional movements of molecular shuttles propelled by kinesin motors on microfabricated tracks were reproduced. We discuss how the guidance of molecular shuttles occurred for each guiding method.

Micro- and Nanotechnology II

3133-Pos Board B825

Studies on Intracellular Delivery of Thiol-Capped Cdte Nanocrystals Mediated by Liposomes in Mesenchymal Stem Cells

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Mesenchymal stem cells (MSCs) are adult stem cells which have the ability to differentiate into cells of the mesenchymal lineage, such as osteocyte, and other types of cells, such as hepatocyte-like cells when appropriated condition is applied. This makes them promising cell sources for bone and liver repair, and tracking the fate and function of transplanted MSCs in vivo become paramount in order to develop a novel therapeutic strategy in tissue repair.

Quantum dots (QDs) are colloidal semiconductor nanocrystals which show a broad absorption band with a large and flexible cross-section allowing multiphoton microscopy. They also have a size tunable emission and high resistance to photobleaching. In addition, quantum dots provide an active surface for chemical conjugation with proteins, antibodies and short peptides.