by leak currents through nanopores and respective shifts in the transmembrane ion balance. We employed whole-cell patch-clamp to explore the effect of 300-ns USEP on voltage-gated sodium channels in neuroblastoma cells (NG108). We found that a single USEP could inhibit VG INa , with the threshold at about 1.8 kV/cm. Voltage-dependent activation and inactivation curves shifted to more negative membrane potentials: V0.5 of activation moved from -22.8 ± 0.2mV before USEP to -26.4 ± 0.6mV after it (mean $\pm$ s.e.), and V0.5 of inactivation changed from -65.9 ± 0.2mV to -72.2 ± 0.2, respectively; the slope factor did not change. Concurrently, USEP exposures induced a non-inactivating, voltage-sensitive inward current due to nanopore formation. The presence of 100μM Gd3+ in the bath buffer significantly reduced the nanopore current and also eliminated the inhibitory effect of USEP on VG INa. This finding suggests that USEP-induced inhibition of VG INa. and changes in its kinetic characteristics may be mediated by opening of nanopores and consequent alterations of the ion equilibrium.

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3123-Pos
Rectification of a Modified Nanofluidic Diode Dependent on the pH

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We study the affect of varying pH on the rectification of a nanofluidic diode. The diode is a conically shaped nanopore in PET or Kapton that has a distribution of charge along the surface. The distribution is such that there is a boundary where one side is positively charged and the other side is negatively charged. We also measure nanopores that have neutral and negative charges on either side of the boundary. The charges are modified by a 2 step chemical reaction using EDC/PFP for the 1st step and ethylenediamine or propylamine for the second step. Characterization of the nanopore was done by taking I-V curves from -5V to 5V with buffered solutions of KCl.

3124-Pos
Light-Induced Permeability Changes in Liposomes Containing Photo-Polymerizable Phospholipids

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We have designed a novel class of light-triggerable liposomes prepared from a photo-polymerizable phospholipid $DC_{8,9}PC$ (1,2- bis (tricosa-10,12-diynoyl)-*sn*-glycero-3-phosphocholine) and DPPC (1,2-Dipalmitoyl-*sn*-Glycero-3-Phosphocholine). Exposure to UV radiation (254 nm) for 0-45 minutes (25 ^{0}C) resulted in photo-polymerization of $DC_{8,9}PC$ in these liposomes and the release of an encapsulated fluorescent dye (calcein). Photopolymerization and permeability changes did not occur from UV-triggered Egg PC/$DC_{8,9}PC$ liposomes. We propose that phase separation and packing of polymerizable lipids in the liposome bilayer are major determinants of photo-polymerization resulting in the formation of local defects and/or lipidic pores in the liposome membrane. Differential Scanning Calorimetry show phase transition peaks at 36.8 ^{0}C and 41.6 ^{0}C, respectively, in liposomes composed of DPPC:$DC_{8,9}PC$ (9:1 mole ratio) indicating that the reactions occurred while these lipids are in the gel phase (25 ^{0}C). Our results indicate that $DC_{8,9}PC$ and DPPC molecules undergo de-mixing in the gel phase. This hypothesis is supported by Molecular Dynamics simulations that indicate separation of $DC_{8,9}PC$ and DPPC in the solid phase lipid bilayer. Cryo-electron microscopic images of the liposomes show major changes in liposome morphology after UV irradiation. When an appropriate tunable photo-sensitizer dye is included in the aqueous compartment of these liposomes, release of contents is triggered by excitation with a laser at the wavelength of the encapsulated dye. Inhibition of release in the presence of oxygen radical scavengers indicate that the mechanism of release involves chemical changes in $DC_{8,9}PC$ unrelated to photo-polymerization. The laser-mediated chemical modifications in $DC_{8,9}PC$ are being analyzed by MS, LC, GC and NMR. We are further developing these liposomes for undergo triggered release of chemotherapeutic agents (e.g. doxorubicin) and are testing their efficacy *in vitro* and *in vivo*.

3125-Pos
Label-Free Immunoassay Based on Functionalized Nanopipette Probes

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Nanopipette technology is capable of detecting and functional analyzing biomolecules based on difference on their size, shape and electrical charge. This unique label-free biosensor is inexpensive, easy to fabricate and versatile. It gives a fast and real time output even in small reaction volume (attoliters). At this point, the nanopipette size and geometry, together with the surface chemistry preparation for attachment of a biomarker, antibody or protein probe was optimized by both experiments and modeling to result in detectable signals by the nanopipette. In this phase, the goal of the surface chemistry procedure was to prepare nanopipette tip in a way that only controlled amount of the surface is functionalized and used for probe attachment. Preliminary experiments are demonstrating the sensitivity and selectivity of the technique with specific proteins targeting HPV as well as environmental toxins. These results prove that nanopipettes functionalized with appropriate molecular recognition elements can be used as HPV/toxin sensors. A highly sensitive nanopipette probe can be precisely positioned, unlike other nanosensing technologies, at any subcellular region of a single living cell with submicron accuracy using a micromanipulator. This approach uses a movable sensor on an attached cell, in contrast to a fixed sensor detecting responses from floating cells. The functionalized nanopipette paves the way for in vivo immunoassay down to the single cell level.

Reference:

S. Umehara, M. Karhanek, R. W. Davis and N. Pourmand, PNAS, 2009, 106, 4611.

3126-Pos
The Nano-Scale Secret of Biological Secretion for Adhesion

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We discovered, by employing the atomic force microscope and transition electron microscopy, that 1) ivy and marine mussels secrete nanoparticles for surface permanent adhesion, whose force is significant larger than the force generated by gecko for reversible surface adhesion; and 2) Sundew secretes nanoparticles, which are cross-linked with muco-polysaccharide for high elastic adhesive for prey trapping. The nanoparticle-based adhesion mechanism has important implications for engineering surface adhesive materials and devices for biomedical applications.

Adhesion in nature has been the focus of intense study over the past few years. Nevertheless, research in this field has primarily concentrated on understanding the chemical aspects of adhesion. While scientists have been able to determine some of the molecular structures present in the adhesives secreted by surface affixing biological systems, such as mussels and barnacles, the fundamental adhesion mechanisms used by these systems are still unknown. This research focuses on the nano-scale morphological similarities of adhesive materials secreted from marine mussels, barnacles and ivy. We have discovered that marine mussels secrete large amounts of adhesive materials in the form of nanoparticles for surface adhesion. This is in keeping with our previous work, which indicated a similar phenomenon for ivy. Both studies concur with earlier research on marine barnacles, polychaetes and sea stars. Taken together, these results indicate that nanoparticles are used by natural, biological systems to increase surface adhesion.

We recently extended the study to Sundew and observed that nanoparticles secreted from the Sundew tentacles form scaffolds by cross-linking with muno-polysaccharide. The secreted material is highly elastic and has been effectively used by the sundew for trapping prey.

The ivy nanoparticles have been isolated from the secretion using SEC-HPLC. Physical properties have been further characterized and will be discussed in details through this talk.

Biotechnology & Bioengineering II

3127-Pos
A Novel Approach for Efficient Photosynthetic Hydrogen Production

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Despite its enormous complexity, the plant PSI is arguably the most efficient nano-photochemical machine in Nature. It emerged as a homodimeric structure containing several chlorophyll molecules over 3.5 billion years ago, and has perfected its photoelectric properties ever since. Based on the structure of cyanobacterial and plant PSI together with the information gained from recently discovered PSI encoded by marine viruses we suggested a holistic solution for reasonable and efficient photosynthetic hydrogen production. Essentially what separates photosynthesis and respiration is the unique soluble cytochrome recognition by cytochrome oxidize and PSI. We think that the virus eliminated it by the introduction of PsaJ-F fusion protein. This generates a novel photorespiration that can be operated under anaerobic conditions providing there is an electron acceptor available. Thus practically we can utilize it for hydrogen production from organic material where the electron is donating by PSI > -0.6 V instead of NADH -0.34 V where PSII is inactivated and that way to separate for the first time in photosynthetic organism oxygen and hydrogen production in the light. Thus our system utilizes cyanobacteria engineered to have a novel