at the single-molecule level. Our results suggest that G6pDH stochastically fluctuates between active—inactive states, favoring the active state upon closure of the tweezers. Our discovery may represent a general approach for refining nanodevices for advanced applications.

939-Plat
Regulation of Lipid Membrane Trafficking and Transmembrane Signaling by Graphene
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Cholesterol, a lipid molecule found ubiquitously in eukaryotic cells, plays a vital role in the integrity, dynamics, and trafficking of the lipid membrane, in addition to influencing many transmembrane proteins. However, the functionality of membrane cholesterol is far from clear, largely due to its inability to manipulate membrane cholesterol with high spatiotemporal precision. Popular tools like statins or methyl-β-cyclodextrin (MβCD) only lead to chronic and indiscriminative cholesterol reduction. Moreover, there is no selective approach to increase membrane cholesterol. Our recent work involving carbon nanomaterials provided an unexpected answer. Graphene, a one-atom thick carbon crystal, has been explored for biomedical applications because of its remarkable chemical and physical properties. Using in vitro and in vivo measurements, we have found that graphene selectively interacts with cholesterol. This enhances cholesterol at the plasma membrane, and thus enhances membrane lipid phase order, likely promoting the formation of cholesterol-rich lipid nanodomains. Neurons grown on graphene exhibited presynaptic potentiation, specifically caused by a larger pool of releasable vesicles and an increase of fast recycling. By addition or depletion of membrane cholesterol, we found that the graphene-induced presynaptic enrichment of membrane cholesterol is necessary and sufficient to promote potentiation. In non-neuronal cells, graphene significantly elevates ATP-induced intracellular Ca2+—signaling by promoting the activation of P2Y receptors, a group of GPCRs which are selectively responsive to extracellular ATP. Furthermore, we found that graphene enhances P2Y receptor signaling on the timescale of seconds, as rapidly as its effect on membrane packing. This then reveals an intriguing interaction between graphene and cholesterol, and its impact on plasma membrane structure, trafficking, and transmembrane proteins. Given the current challenges in manipulating membrane cholesterol, this graphene-cholesterol interaction will accelerate studies of membrane cholesterol function and broaden the biological application of carbon nanomaterials.

940-Plat
Development of a Fluorescence-Based Assay for Functional Studies of Transporter Proteins on the Single Molecule Level
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Here we present the development of the assay including characterization and broadening the biological application of carbon nanomaterials.

941-Symp
Cost and Precision in Small Gene Regulatory Networks
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Genes in early fly development are expressed with astonishing precision, despite the molecular noise intrinsic to all biochemical reactions. An attempt to understand the regulatory mechanisms in this system, I will discuss the nature of hunchback mRNA expression based on analysis of live imaging experiments. Inspired by fly development, I will then discuss trade-offs that gene regulatory circuits have to face in order to precisely respond to signals in the presence of molecular noise.

942-Symp
Metaphase Chromatin Plates Explain the Structure and Physical Properties of Condensed Chromosomes
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Previous studies showed that during mitosis chromatin filaments are folded into multilayer plates (1). These structures can be self-assembled from chromatin fragments obtained by micrococcal nuclease digestion of metaphase chromosomes (2). Chromosomes of different animal and plant species show great differences in size (which are dependent on the amount of DNA that they contain), but in all cases chromosomes are elongated cylinders that have relatively similar shape proportions (the length to diameter ratio is approximately 13). It is possible to explain this morphology by considering that chromosomes are self-organizing supramolecular structures formed by stacked layers of planar chromatin having different nucleosome-nucleosome interaction energies in different regions (3). The nucleosomes in the periphery of the chromosome are less stabilized by the attractive interactions with other nucleosomes and this generates a surface potential that destabilizes the structure. Chromosomes are smooth cylinders because this morphology has a lower surface energy than structures having irregular surfaces. The symmetry breaking produced by the different values of the surface energies in the telomeres and in the lateral surface explains the elongated structure of the chromosomes. The results obtained by other authors in nanomechanical studies of chromatin and chromosome stretching have been used to test the proposed supramolecular structure. It is demonstrated quantitatively that internucleosome interactions between chromatin layers can justify the work required for elastic chromosome stretching. Chromosomes can be considered as hydrogels with a lamellar liquid crystal organization. The good mechanical properties of this structure may be useful for the maintenance of chromosome integrity during mitosis. Furthermore this chromatin organization avoids random entanglement of the extremely long genomic DNA molecules in chromosomes.

References:

Symposium: Epigenetics