but had minimal effect on spontaneous uptake of SPIOs by HeLa cells. Our study suggests that applied magnetic force enhances cellular uptake of SPIOs by both increasing the accumulation of SPIOs near cell surface and activating caveolae-mediated endocytosis. These results have significant implications to the medical application of SPIOs as nanocarriers in disease treatment.

gang.bao@bme.gatech.edu

11:00–Ballroom B

Substrate stiffness dependent cell migration behaviors

Yuan Zhong, Baohua Ji†

Biomechanics and biomaterials laboratory, Department of Applied Mechanics, Beijing Institute of Technology, Beijing, China

Cell migration behaviors play key roles in both physiological and pathological processes. Experimental observations showed that cell migration behaviors are very sensitive to the substrate rigidity. However, the underlying mechanisms about how substrate stiffness influences the cell migration behaviors have not yet been understood. In this study, a FEM-based simulation method was developed by modeling the dynamics of cell adhesion at cell front, de-adhesion at cell rear and movement of cell body under the cell contractile force. Our simulations showed that cell migration speed biphasically depends on the matrix stiffness and this dependence can be tuned by the stiffness gradient. The underlying mechanism is that the matrix stiffness can influence the balance of competition of stability of cell adhesion between the cell front and cell rear, which consequently control the driving force of cell migration. The rigidity gradient will bias this competition which allows cell to exhibit a durotaxis behavior.

bhji@bit.edu.cn

11:20–Ballroom B

Cell entry of one-dimensional nanomaterials

*Xinghua Shi**,++,†, *Annette von dem Bussche***, *Robert H. Hurt*+,++, *Agnes B. Kane***,+, *Huajian Gao*+,++

**State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing, China*

***Department of Pathology and Laboratory Medicine, Brown University, Providence, USA*

+*Institute for Molecular and Nanoscale Innovation, Brown University, Providence, USA*

++*School of Engineering, Brown University, Providence, USA*

Materials with high aspect ratio, such as carbon nanotubes, have been shown to cause length-dependent toxicity in certain cells because their long length prevents complete ingestion, which frustrates the cell. Biophysical models have been proposed to explain how spheres and elliptical nanostructures enter cells but one-dimensional nanomaterials have not been examined. Here we show experimentally and theoretically that cylindrical one-dimensional nanomaterials such as carbon nanotubes enter cells through the tip first. For nanotubes with end caps or carbon shells at their tips, uptake involves tip recognition through receptor binding, rotation driven by asymmetric elastic strain at the tube-bilayer interface, and then near-vertical entry. The precise angle of entry is governed by the relative time scales for tube rotation and receptor diffusion. Nanotubes without caps or shells on their tips show a different mode of membrane interaction, posing an interesting question whether modifying the tube tips may help avoid frustrated uptake.

shixh@imech.ac.cn

11:40–Ballroom B

Probing mechanical principles of cell-matrix focal adhesion: A coupled stochastic-elastic framework

*Jin Qian**, *Jizeng Wang**, *Yuan Lin***, *Bin Chen*+, *Huajian Gao**,†

**School of Engineering, Brown University, Providence, USA*

***Department of Mechanical Engineering, The University of Hong Kong, Hong Kong, China*

+*Institute of High Performance Computing, A*STAR, Singapore*

Unlike adhesion of conventional hard materials in engineering commonly described by JKR and DMT type models, the exact nature and mechanism of adhesion between soft cells and extracellular matrices (ECM) are far from understood. Cells are known to probe and feel the mechanical property of their surrounding microenvironment, and respond to the presence of cytoskeletal and/or external stresses via localized focal adhesions. We will present some recent theoretical and numerical studies aimed at probing the basic mechanical principles of focal contacts in cell-matrix adhesion via stochastic-elasticity models. The field distributions of interfacial traction and deformation are assumed to obey classical elasticity descriptions whereas the rupture and rebinding of individual molecular bonds are governed by stochastic equations. Results and discussions will be organized to address the key experimental observations on focal adhesion, which present strong size effect, stiffness dependence and force regulation.

huajian_gao@brown.edu

12:00–Ballroom B

Modeling the influence of mechanical factors on longitudinal bone growth

*Leah L. Sharipova**,†, *Alexander B. Freidin**, *Gérard A. Maugin***

**Institute of Problems of Mechanical Engineering RAS, St. Petersburg, Russia*

***Institut Jean Le Rond d'Alembert, Université Pierre et Marie Curie (Paris 6), Paris, France*

Longitudinal bone growth is carried out mainly by the processes of growth and ossification in the growth plate that are directed, besides genetic, hormonal, metabolic, vascular, also by mechanical factors. The growth plate is modeled by a layer of cartilage of the thickness h located in an infinite medium that is bone. We consider the period of time when the thickness h remains constant, that is two competitive processes take place: biological growth (due to proliferation and hypertrophy of cartilage cells) and ossification. We model the former as a volumetric growth of cartilage, the latter as a stationary movement of the ossification interface.