MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, November 30 2022 at 13:30, D. Dan and Betty Kahn Building, Auditorium 1.

A study of brush biopsy for malignant cell detection

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Gastric brush cytology is a medical diagnostic procedure used to sample mucosal surfaces. The brush's bristles are rubbed back and forth along the lesion or stricture, detaching and entrapping cells. For cancer diagnosis, brush cytology can yield a high specificity of nearly 100%, but the sensitivity of diagnosis remains disappointingly low, with only 45% of malignant strictures being diagnosed. The brushing parameters, such as number of passes, rate, and applied force, which ensure efficient sampling of suspicious lesions and a high yield of trapped cells, are still unresolved. This research aims to increase brush cytology's diagnostic yield by understanding the governing phenomena in brushing.

During sampling, the brush bristles are submerged in a mucus gel, which covers the stomach epithelium, and shear the lesion as the brush rubs over it. As a result, cells or their debris are expelled into the surrounding mucus. In order to estimate the shear forces developed during brushing, we developed a model system using alginate, a hyper-elastic polysaccharide with tunable mechanical properties. Alginate beads were rubbed by nylon-based bristles while monitoring the developed forces. An analysis of the mucus rheology revealed a range of shear rates that enabled rubbing with only minor effects on the bulk structure of the mucus-gel. During brushing the bristles are wetted by the mucus, causing a capillary rise among bristles, moving the mucus upwards. Long- and short-range interactions in the mucus's mucin chains allow the rose gelled mucous to remain bound among the bristles while entrapping the expelled cells. The rising height was studied numerically and found to depend on the bristle's spatial arrangement, the mucus' pH, which varies in the depth of the mucus, and the mucus' affinity with the bristles. Experimental study of the capillary rise using reconstructed porcine mucin showed good agreement with numerical simulations. Capillary rise was observed to be accompanied by the entrapment of fluorescent microbeads introduced into the mucus as a cell simulant. An *ex-vivo* model developed for brushing porcine stomach walls showed good agreement with simulated capillary rise and rubbing forces.

Note: The seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Matthew Suss.