Projects available for MTNANO and BIOPHYSICS students

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More information: http://home.phys.ntnu.no/brukdef/prosjekter/biopolymerphysics/index.html

Topic 1: Bacterial microarrays for bacterial gene expression studies

Control of bacterial adhesion in predesigned patterns supports determination of molecular parameters of individual cells in populations of bacteria in an efficient manner, while strictly controlling the environment of the bacteria. In the present project we explore application of soft lithography for preparation of patterned supports designed for monitoring of bacterial populations at the individual bacterial level.

We use micro contact printing to pattern surfaces with arrays of "islands" of bacterial adhering chemicals surrounded by chemicals that resist bacterial adhesion in order to produce single bacterial arrays with live bacteria. These surfaces are intended to be used as a tool to study the heterogeneity of gene expression in the attached bacteria. The bacteria are genetically altered to express the fluorescent protein GFP when certain genes are expressed and the onset of gene expression can therefore be monitored using a confocal microscope.

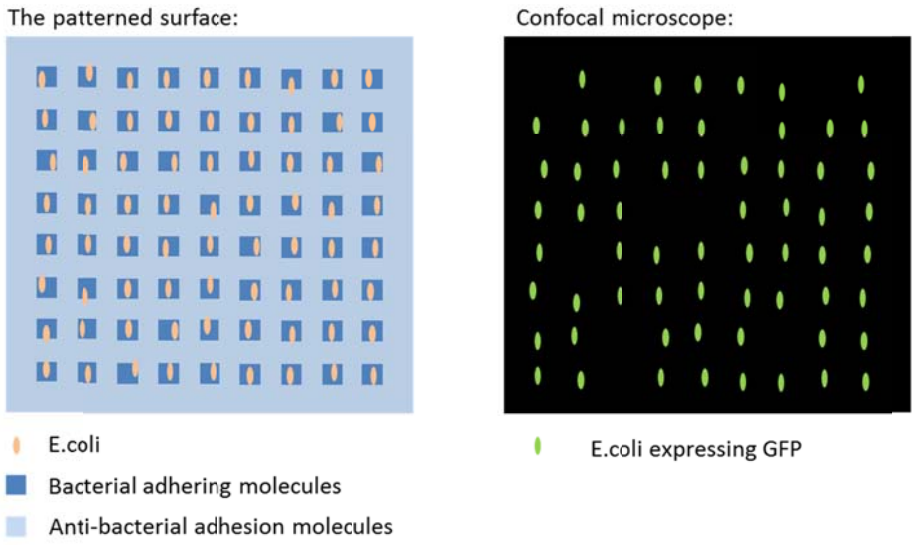

Figure 1: Schematic illustration of bacterial microarrays for bacterial gene expression studies

This project will include preparing patterned arrays for bacterial adhesion, incubation of bacteria on these surfaces and monitoring of the fluorescent signal from the attached bacteria using a confocal microscope. The images from the confocal microscope will be used for statistical analysis of the gene expression of the bacteria.

Supervisors topic 1: Associate Professor Marit Sletmoen, PhD student Nina Bjørk Arnfinnsdottir

Topic 2: Studies of intermolecular binding events relevant for glycobiology using optical tweezers

Eukaryotic cell surfaces are covered by glycoconjugates. These molecules are responsible for a number of cell surface recognition events, including bacterial and viral binding to host cells and leukocyte adhesion during an inflammatory response. They also regulate many intracellular processes, including transcription, translation and protein trafficking. Despite their biological importance, much is still unknown related to the molecular basis of their function.

A major focus of our research is to quantify binding between glycoconjugates and relevant biological binding partners. The purpose of this research is to shed light on the functions of such molecules in cell-based systems. Motivated students are welcome to participate in this research. Possible research tasks for a project are detailed below.

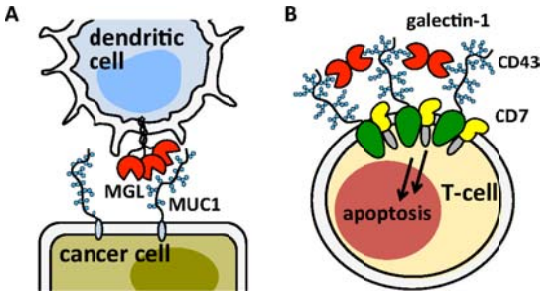

Figure2. Schematic representation of two major binding modes between the glycoproteins mucins and lectin receptors. (A) The lectins MGL of dendritic cells form discrete adhesion complexes with the mucin MUC1 overexpressed on cancer cells. (B) Galectin-1 cross-linking of the mucin-type glycoprotein CD43 and CD7 triggers apoptosis in T-cells. Image from Godula et al, J. Am. Chem. Soc. 2012, 134, 15732−15742

Task 1: As illustrated in figure 2A mucin molecules can serve as ligands for lectin receptors. In collaboration with Joy Burchell and coworkers at the Breast Cancer Biology Group, Kings College, London, we are currently using AFM to characterize the binding of mucins to MGL receptors. This study could benefit from complementary optical tweezers studies, and motivated students are welcome to contribute to this research.

Task 2: We have previously studied the physical interactions of SBA with a mucin polymer that possesses a cancer antigen. (Sletmoen et al, Biopolymers Vol 91, Nr 9, 2009). Force profiles of the interactions showed signatures consistent with a model that involves ‘‘binding and jumping’’ of SBA along the mucin chain.

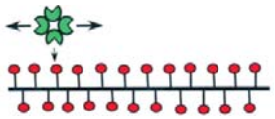

Figure 3: SBA protein (green) sliding on mucin polymer.

However, several questions still remain related to the binding of this mucin to SBA proteins. The increased spatial- and force - resolution provided by the optical tweezers compared to AFM is likely to give access to additional insight, and motivated students are invited to contribute to this work.

Task 3: The Tn cancer antigen N-acetylgalactosamine (GalNAc) is expected to be responsible for the binding properties demonstrated by some mucins. Demonstrating that polystyrene beads functionalized with GalNAc do bind to polystyrene beads functionalized with SBA would be an important step towards developing the OT technique into a powerful tool to study biologically important carbohydrate – protein and carbohydrate – carbohydrate binding events.

Supervisors topic 2: Associate Professor Marit Sletmoen, PhD student Kristin Elisabeth Haugstad