
# Advanced Bioimaging Group

## Forskningsleder Jonathan R. Brewer

## Gruppens kerneforskningsområder

The group is focused on the use of **advanced Bioimaging techniques** to answer **fundamental questions** in biological systems and is internationally recognized for performing advanced studies in bio-imaging of tissue and biomaterials. The group has worked extensively with characterization of skin and **artificially grown skin models** and is now working on development of skin cancer models, **tissue bioprinting** and developing an **organ on a chip**-based system for artificial skin. Recently the group expanded its research to include imaging and **production of artificial spider silk**. Together with some of the leading scientist in the field JBs group has developed novel imaging tools to understand spider silk at a nanoscopic level. We also work with **development of novel bioimaging techniques** and are presently developing an image-based method to quantify expression, localization, **and spatial organization of RNA in single cells and tissue**, based on multiplexed error-robust fluorescence in situ hybridization (MERFISH). JB is the Director of the Danish Molecular Biomedical Imaging Center (www.DaMBIC.dk). DaMBIC is a bioimaging facility at the forefront of bioimaging in Denmark.

Er du interesseret i at skrive projekt i gruppen, så kontakt:

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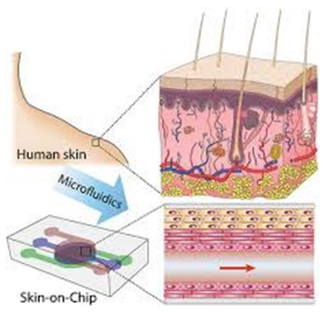
## Beskæftigelse af tidligere studerende

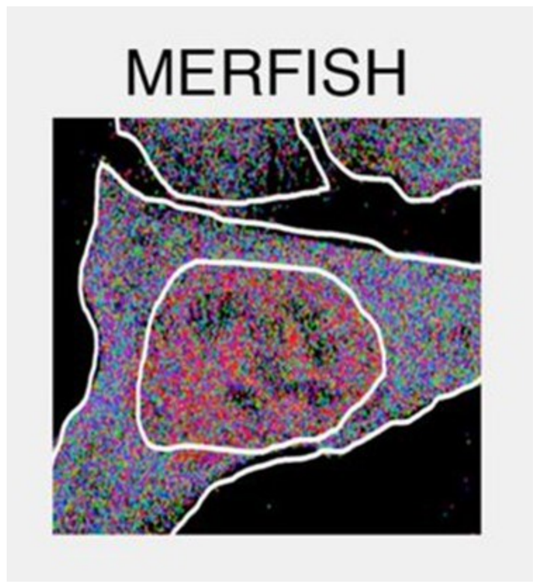
Many of the students from my group have gone on to do Phds at SDU or other universities. Some are now employed as postdocs or in the pharma industry and at hospitals.

## Projekt Beskrivelse

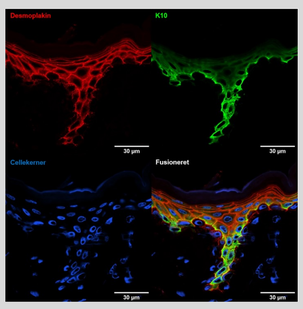
**Characterization of skin on a chip using spatial transcriptomics**



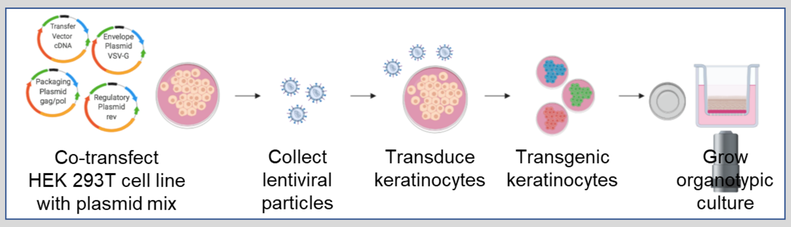

In this project, bioimaging is to be combined with spatially resolved transcriptomics, in order to study the mechanical regulation of cell renewal in skin tissue and artificial skin. A skin-on-a-chip model, which combines cell biology with microsystem biology to create a more realistic artificial skin model, is currently under development. In a project, different time points of skin-on-a-chip models and traditionally grown skin models can be compared using immunohistochemistry, smFISH and MERFISH. Single-molecule Fluorescent In Situ Hybridization (smFISH) is a technique allowing the detection of RNA species at a single molecule level. Multiplexed Error-Robust Fluorescent In Situ Hybridization (MERFISH) is a new technique, allowing the simultaneous imaging of several hundred RNA species in just a few hours. These techniques enable us to draw comparisons between artificially grown skin and real human tissue and improve the culturing process of organotypically grown cultures. In another project, the regulation of mRNA species during wound healing will be investigated using the previously mentioned techniques.

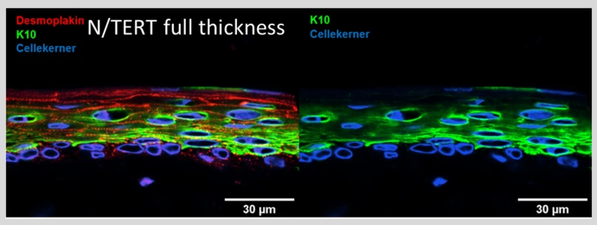


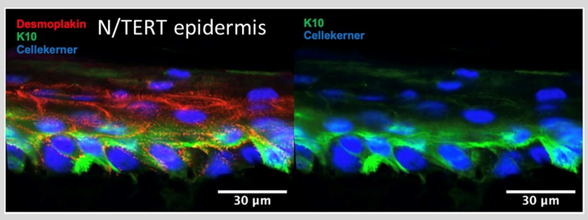

**Artificial skin cancer model as screening tool for anti-cancer drugs**




Artificial skin can be developed in vitro from cultured human skin cells and models like these are used in various areas within skin research. One area is skin cancer which can be mimicked by incorporation of skin cancer cells into these skin models. In this project, we develop melanoma skin cancer models and study their applications as screening tools for discovery, development, and testing of anti-melanoma drugs. The melanoma skin models are treated with the drug, and tumor regression is investigated using techniques such as HE staining and antibody labelling of important proteins combined with microscopy. We The outcome of this project will contribute to an understanding of the applications and limitations that these models can have in skin cancer research.

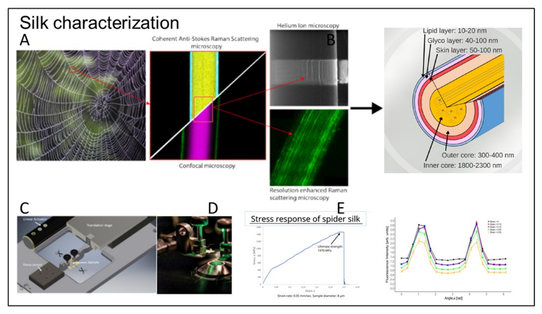



**Spider silk as a model for the synthesis of superior biomaterials**

An interesting set of materials which nature offers are the extremely strong and tough biomaterials such as spider silk. Spider dragline silk is exceptionally strong and elastic, being up to three times tougher than Kevlar, despite being exceptionally light and biodegradable. Due to low yield and the cannibalistic and territorial nature of spiders, mass production of silk from spiders is not possible. Thus, for mass production, synthesis of artificial spider silk is necessary. However, fabrication of artificial silk with the same properties as spider silk has not yet been achieved. In this project we propose to create new methods to fabricate artificial spider silk which will provide an environment friendly and strong substitute material. This will be done by developing a biomimetic silk spinning method and by using bacteria strains which can produce eco-friendly artificial silk.




A) The Brewer group has devolved multiple unique characterization techniques for spider silk. Which can visualize the different structures in the silk. We have as the only lab in the word succeeded in imaging the nano fibrils in the fiber core. B) Schematic showing the hierarchical structure of spider silk. C) Shows a custom-made microscope mountable force pully for characterizing spider silk. D) shows a typical stress strain curve for spider silk. E) The panel shows the change in the order of the proteins in the silk as a function of strain. The order is measured using a multiphoton polarization-based method developed by the brewer group. F) Diagram showing the automated flow control for the silk production. G) An example of a design for a prototype chip for 3D focusing of the silk dope. H) Microfluidic chip mounted on a microscope for online characterization of silk production.