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## Multiscale X-Ray Analysis of Biological Cells and Tissues by Scanning Diffraction and Coherent Imaging

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Recent improvements in the quality of focusing optics for X-rays has greatly advanced structural imaging of soft biological materials. We have applied scanning X-ray diffraction, a method that involves raster-scanning of a microfocused X-ray beam and collecting a series of scattering patterns, on cardiac cells and tissue to image variations in the nanostructure of cardiac muscle. It is shown how the spacing of the myosin filaments in muscle varies throughout the tissue, but also within single cardiac muscle cells and how external factors influence the filament spacing. In many of these experiments, cumbersome scanning of large tissue areas can be spared if holographic imaging is used in conjunction with a diffraction experiment. By means of holographic imaging, the electron density, encoded in the phase shift of the sample, can be directly imaged. This low-dose imaging modality therefore offers a complementary contrast and can yield high-resolution images down to approximately 50 nm. It is shown how holographic imaging in 2D and 3D can be combined with a scanning X-ray diffraction experiment to image identical structures on multiple length scales. In the future, it can be expected that, with more brilliant radiation now offered by 4th generation synchrotrons and X-ray free electron lasers, structural imaging by means of holography and scanning diffraction will become a popular tool to image heterogeneous biological samples such as the aforementioned cardiac cells or tissue.

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