Generation of Terminal Airway Skeletons Using Synchrotron Radiation X-ray Tomographic Microscopy

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Even subtle differences in the branching pattern of the acinar airways are crucial for airflow and particle deposition in the pulmonary gas-exchange area. Until now, the resolution of three-dimensional imaging methods has been too low for the generation of acinar airway skeletons. To overcome this limitation we used synchrotron radiation based X-ray tomographic microscopy (SRXTM) with increased field of view at an isometric voxel length of 0.74 µm. Heavy metal stained and paraffin embedded rat lungs obtained at postnatal days 4–60 were studied.

Using a region growing algorithm, we segmented individual acini inside a larger dataset. The acinar skeleton was extracted using a successive erosion technique based on the distance transformation of the extracted segments. The three dimensional topology of the resulting skeleton corresponds to the acini extracted in the first step as shown in figure 1.

The skeletons have been exported as an XML-File containing a full description on the branching pattern including the amount and positions of the nodal points of the branches. This permits us to analyze the complexity of the skeletons, e.g. by calculating the nodal point or segment density (nodal points/volume or segments/volume) and the total amount of them per lung.

Future work will focus on the inclusion of small alveoli in the skeleton to enable an accurate estimation of alveolar numbers in the segments. We

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conclude that SRXTM images are suitable for the generation of acinar skeletons and we would like to use this method for the analysis of the 3D-structure of the gas-exchanging airways throughout lung development.

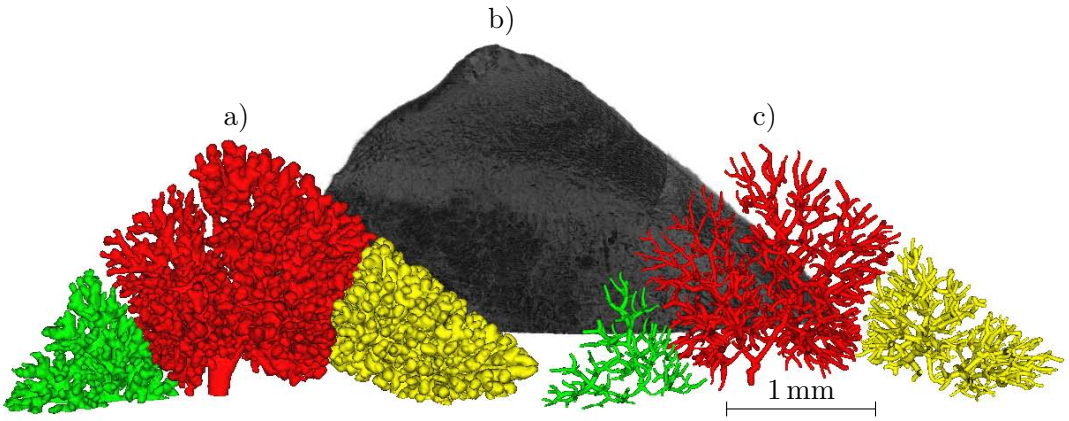

Figure 1: Overview of a three-dimensional dataset of a Sprague Dawley rat lung obtained at postnatal day 4. a) Three independent airway segments extracted using a region growing algorithm. The green segment contains one partially cut acinus, the red segment contains two entire acini and the yellow segment contains one complete and one partially cut acinus. b) Three-dimensional view of the full sample. c) Skeletons of segmented acini.