Life Science
Medical Biology

In this brief review of achievements in "Life Science" obtained in SPring-8, I chose four research works among others because of their unique applications, i.e., (i) X-ray fluorescence microscopy for cellular mineral analysis, (ii) phase contrast X-ray imaging of fetal lungs, (iii) synchrotron radiation CT for the analysis of small-airway deformation and (iv) X-ray diffraction recording from a single sarcomere.

Ishizaka *et al.* utilized scanning X-ray fluorescence microscopy (SXFM) to detect minerals at the cellular level. They visualized platinum (Pt) with other elements in mammalian cells after treatment with an anticancer agent, *cis*-diamminedichloro platinum (II) (CDDP). They composed PC-9 cells (originally derived from a lung carcinoma) sensitive (PC/SEN) and resistive (PC/RES) to CDDP. Twelve hours after CDDP treatment, the level of Pt increased in PC/SEN cells, but it changed little in PC/RES cells, indicating that an enhanced accumulation of CDDP in the cells is responsible for the hypersensitivity of PC/SEN cells. They also found that the Zn level is high in untreated PC/RES cells with elevated intracellular glutathione level. They concluded that this method is useful for the better understanding of cancer biology.

Hooper *et al.* applied phase contrast X-ray imaging (PCXI) to evaluate the pattern of lung aeration of rabbit pups at birth. Lung images were analyzed before a breath or at fixed time intervals after birth. They found that PCXI was able to resolve terminal respiratory units, and air-filled structures gave them "speckle" appearances. The pattern of lung aeration was very dependent upon body position and was heavily influenced by respiratory activity. The increase in air volume can be calculated from the projected thickness of the lung image.

Sera *et al.* determined the localized morphometric deformation of small airways and alveoli using a synchrotron radiation CT system. Euthanized mice were mounted on the rotation stage of the CT system under quasi-static inflation to mimic respiration. They visualized the same airways of the same lung at functional residual capacity (FRC) and total lung capacity (TLC). The length (L) and diameter (D) of airway segments were measured, and the increases in L and D, i.e., ΔL and ΔD were normalized by FRC. Results showed that ΔD was larger than ΔL and both values were greater for a smaller-airway group. Thus, airways may deform differently depending on their size and tissue anisotropism.

Iwamoto *et al.* developed a technique of quick-freezing specimens of myofibrils isolated from an insect flight muscle. X-ray diffraction using microbeams was carried out to analyze the local structure. The strongest equatorial reflections (1.0 and 2.0) were observed. However, the 1.1 reflection was missing in the diffraction pattern of a myofibril, unlike in that of muscle. Because the beam diameter was ~2 μm, i.e., smaller than that of a single sarcomere, the diffraction should come from a single sarcomere within a single myofibril.

In summary, X-ray fluorescence microscopy, phase contact X-ray imaging, synchrotron radiation CT and X-ray diffraction method offer powerful tools for micro- or nano-order biological analysis.

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