Diffraction Quality of Protein Crystals Grown in Microgravity Environment and Molecular Mechanism of Crystal Growth

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Molecular mechanism of protein crystal growth is not essentially affected by the gravity because the crystal growth in a microgravity field in space proceeds by the same way on earth. However, the unit cell volume of the space-grown crystals is slightly smaller than that of the earth-grown ones. Transfer of protein molecules under the microgravity field is controlled by the diffusion transport instead of the convection transport on earth. These facts may be responsible for the improvement of the quality for the space-grown crystals.

An analysis of the molecular packing of the orthorhombic crystals ($P2_12_12_1$) of hen egg-white lysozyme (HEWL) indicated that the molecular arrangement of the crystals grown at 20°C and 37°C (named form I and form II, respectively) was quite different from each other, but both of them had a common molecular unit consisting of two molecules in the asymmetric unit. The space-grown orthorhombic crystal was similar in the molecular packing to the earth-grown form I crystal. Evaluating Van der Waals energy for the intermolecular interaction, we proposed a molecular-growth mechanism of HEWL orthorhombic crystal: one protein molecule but not a mass more than a dimmer is a growth unit. Further, we emphasize that protein molecules are incorporated into the nuclei preferentially to complete the molecular unit which is consisted of two molecules. These two molecules alternately piles up with forming a layer along c axis in form I crystal. In form II crystal, on the other hand, crystal grows with forming an alternate line of each molecules on the layer perpendicular to c axis. However, it cannot still exclude a possibility that a dimer (the molecular unit) may be the growth unit.