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Self-Assembly of Collagen Molecules into Fibrils in Solution

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Introduction

Type I collagen is a major constituent of many biological tissues, including skin, bone, tendon and cartilages. Its main functions are to shape extracellular matrices, promote cell attachment and provide tissues with strength, flexibility and elasticity. At the core these functions is its remarkable ability of collagen to form highly organized fibrils through the self-assembly of the molecules²,³. The fibrillogenesis involves the lateral association of collagen triple helices into staggered parallel arrays that give rise to the characteristic D-band periodicity of 67 nm. Currently, the mechanisms of collagen self-assembly are poorly understood. Here, we combine the nanometer-scale resolution of cryo-transmission electron microscopy (cryoTEM)⁵ with molecular dynamics⁶ to investigate the self-assembly of collagen molecules into fibrils in solution.

Self-assembly

Collagen self-assembly occurs by:

- Formation of molecular aggregates;
- Assembly of the strands into disordered, loosely packed structures;
- Further organization into compact, ordered fibrils with the development of the D-banding;
- As the fibril matures, the spacing of the D-banding decreases from 70 nm to 66 nm.

Conclusions

Collagen self-assembly occurs by:

- Formation of molecular aggregates;
- Assembly of the strands into disordered, loosely packed structures;
- Further organization into compact, ordered fibrils with the development of the D-banding;
- As the fibril matures, the spacing of the D-banding decreases from 70 nm to 66 nm. This indicates the self-organization of the molecules within the fibrils during the self-assembly.

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References