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Communication

Liquid crystalline ordering of procollagen as a determinant of three-dimensional extracellular matrix architecture [1]

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Abstract

The precise molecular mechanisms that determine the three-dimensional architectures of tissues remain largely unknown. Within tissues rich in extracellular matrix, collagen fibrils are frequently arranged in a tissue-specific manner, as in certain liquid crystals. For example, the continuous twist between fibrils in compact bone osteons resembles a cholesteric mesophase, while in tendon, the regular, planar undulation, or â€œcrimpâ€, is akin to a precholesteric mesophase. Such analogies suggest that liquid crystalline organisation plays a role in the determination of tissue form, but it is hard to see how insoluble fibrils could spontaneously and specifically rearrange in this way. Collagen molecules, in dilute acid solution, are known to form nematic, precholesteric and cholesteric phases, but the relevance to physiological assembly mechanisms is unclear.

In vivo, fibrillar collagens are synthesised in soluble precursor form, procollagens, with terminal propeptide extensions. Here, we show, by polarized light microscopy of highly concentrated (5â€“30 mg/ml) viscous drops, that procollagen molecules in physiological buffer conditions can also develop long-range nematic and precholesteric liquid crystalline ordering extending over 100 Î¼m^2 domains, while remaining in true solution. These observations suggest the novel concept that supra-fibrillar tissue architecture is determined by the ability of soluble precursor molecules to form liquid crystalline arrays, prior to fibril assembly.

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Keywords

extracellular matrix; liquid crystals; procollagen

Abbreviations

ECM, extracellular matrix

[1] ***Edited by M. F. Moody***

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