Biophysical aspects of extracellular matrix function

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Biophysical aspects of extracellular matrix function

Introduction

The extracellular matrix (ECM) can be defined as a collection of macromolecules that mainly provide structural and biochemical support to cells inside a tissue. Cells in the tissue secrete these macromolecules, such as fibrous proteins and proteoglycans. Through the variability of content that make up the ECM in different tissues its functions can be different, however, common functions include cell-to-cell communication, cell development and differentiation.

Common structures found in the ECM:

Fibroblasts:

The fibroblast is a cell that synthesizes collagen inside a tissue. These cells are commonly found in connective tissue.

Fibrous proteins:

These proteins include collagen, elastin and laminin. Their main function is to provide structural support for the extracellular matrix and surrounding cells.

Proteoglycans:

Common proteoglycans found in the ECM include Glycoaminoglycans (GAGs) that provide resistance to compressive forces acting on the ECM.

Water:

Molecules of H2O are also found in extracellular matrix to keep surrounding cells inside the tissue hydrated.

Biophysical aspect of Collagen fibers:

Inside the collagen fibers, we can find that collagen is made up of procollagen subunits. These subunits self-assemble to form an arrangement of overlapping regions. This property allows collagen fibers to be rigid and hence not break when a force is applied. The overlapping of the procollagen subunits forms collagen fibrils with an approximate diameter of 75nm. Collagen fibrils then organize to form collagen fibers in order to provide a stronger structural support to the ECM. Inside the body there are multiple regions where the properties of collagen are important, for example in tendons. These tendons need to be able to resist a large force, hence the rigid properties of collagen.

Biophysical aspect of Elastin fibers:

Elastin is composed of the protein fibrillin and acts together with collagen to give the ECM and the tissues viscoelastic properties. The properties of elastin is a result from the cross-links holding 60 kDa elastin subunits together. These form networks with the collagen fiber bundles and give elastic support to the tissues. As we can see in the body, the elastic properties are important for certain tissues, such as tendons, as well as in arteries. In arteries this property is helpful to assist with the wave propagation of the blood supply to enhance the blood flow.

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