The extracellular matrix and cell wall

The extracellular matrix and cell wall. Collagen, integrins, fibronectin, cellulose, and pectin.

Introduction

We've spent a lot of time looking at what's inside a cell. What, then, is on the outside? It depends a lot on what kind of cell you're looking at.

Plants and fungi have a tough cell wall for protection and support, while animal cells can secrete materials into their surroundings to form a meshwork of macromolecules called the extracellular matrix. Here, we'll look in more detail at these external structures and the roles they play in different cell types.

Extracellular matrix of animal cells

Most animal cells release materials into the extracellular space, creating a complex meshwork of proteins and carbohydrates called the **extracellular matrix** (**ECM**). A major component of the extracellular matrix is the protein **collagen**. Collagen proteins are modified with carbohydrates, and once they're released from the cell, they assemble into long fibres called collagen fibrils[1]. Collagen plays a key role in giving tissues strength and structural integrity. Human genetic disorders that affect collagen, such as Ehlers-Danlos syndrome, result in fragile tissues that stretch and tear too easily.

In the extracellular matrix, collagen fibres are interwoven with a class of carbohydrate-bearing **proteoglycans**, which may be attached to a long polysaccharide backbone as shown in the picture below. The extracellular matrix also contains many other types of proteins and carbohydrates.

Proteoglycans are a special class of glycoproteins with certain distinguishing features. For one thing, they are heavily glycosylated, meaning that they have a lot of carbohydrate relative to their protein content. In addition, the carbohydrate chains of proteoglycans contain specific types of sugars with sulphate modifications, linked together to form linear chains[1].

You can consult the source referenced above (see references and attributions section at the end of the article) for more details about the biochemistry and structure of proteoglycans.

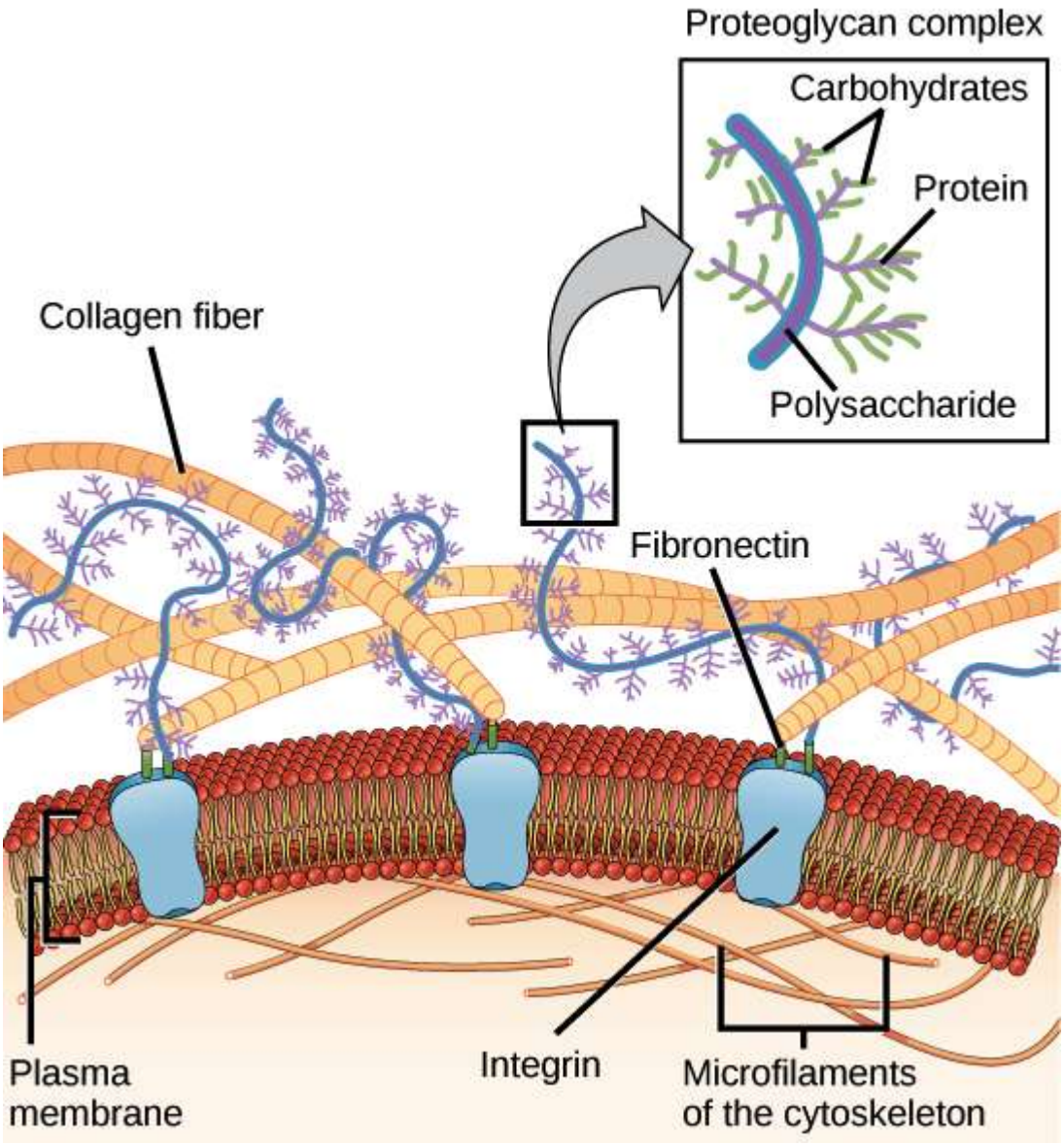

Diagram showing the extracellular matrix and its connections to the cell. A network of collagen fibres and proteoglycans is found outside of the cell. Collagen connects to integrin proteins in the plasma membrane via fibronectin. On the inside of the cell, the integrin's link up to the microfilaments of the cytoskeleton.

Image credit: OpenStax Biology.

The extracellular matrix is directly connected to the cells it surrounds. Some of the key connectors are proteins called **integrin's**, which are embedded in the plasma membrane. Proteins in the extracellular matrix, like the **fibronectin** molecules shown in green in the diagram above, can act as bridges between integrin's and other extracellular matrix proteins such as collagen. On the inner side of the membrane, the integrin's are linked to the cytoskeleton. Integrin's anchor the cell to the extracellular matrix. In addition, they help it sense its environment. They can detect both chemical and mechanical cues from the extracellular matrix and trigger signalling pathways in response[4,5].

Blood clotting provides another example of communication between cells and the extracellular matrix. When the cells lining a blood vessel are damaged, they display a protein receptor called tissue factor. When tissue factor binds to a molecule present in the extracellular matrix, it triggers

a range of responses that reduce blood loss. For instance, it causes platelets to stick to the wall of the damaged blood vessel and stimulates them to produce clotting factors.

The cell wall

Though plants don't make collagen, they have their own type of supportive extracellular structure: the cell wall. The **cell wall** is a rigid covering that surrounds the cell, protecting it and giving it support and shape. Have you ever noticed that when you bite into a raw vegetable, like celery, it crunches? A big part of that crunch is the rigidity of celery's cell walls.

Fungi also have cell walls, as do some protists (a group of mostly unicellular eukaryotes) and most prokaryotes—though I don't recommend biting into any of those to see if they crunch! Like the animal extracellular matrix, the plant cell wall is made up of molecules secreted by the cell. The major organic molecule of the plant cell wall is **cellulose**, a polysaccharide composed of glucose units. Cellulose assembles into fibres called micro fibrils, as shown in the diagram below.

Image of the plant cell wall, showing the network of cellulose micro fibrils and pectin's (with pectin's being particularly abundant in the middle lamella).

Most plant cell walls contain a variety of different polysaccharides and proteins. In addition to cellulose, other polysaccharides commonly found in the plant cell wall include hemicellulose and pectin, shown in the diagram above. The **middle lamella**, shown along the top of the diagram, is a sticky layer that helps hold the cell walls of adjacent plant cells together[6,7].