Introduction

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Abstract These are the proceedings of an international meeting on “Structural Aspects of the Intercellular Matrices of Plants and Animals”, June 23–26, 2008 in St. Tropez, France. The meeting was sponsored by the Matrix Biology Institute (Edgewater, New Jersey, USA) and Phillips Hydrocolloids Research Ltd, London, UK, and organized by Janet Denlinger and Glyn Phillips (co-editors of this Special Issue), with Endre A. Balazs at Villas Nifnaha and Hylan, Parc de la Moutte, St. Tropez, France.

The comparison between the polysaccharide content and biological function of plant and animal intercellular matrices is the central theme of the following papers. They also focus on the role of these polysaccharides in the structure or matrix between plant and animal cells.

Endre Balazs in his introductory paper addresses the issue of the terminology used in the past and present to describe the structure between cells in plants and animals. He recalls that he had identified the “*intercellular matrix*” in 1969, previously called “*ground substance*”, to describe the structure of the “*highly organized extra-cellular environment of cells*”. He wished to distinguish between such matrices outside and between cells cultured in vitro and in vivo (in the living organism). To distinguish between these two types of matrices, he used the term “extracellular” or “pericellular” for an in vitro matrix, and “intercellular” for

an in vivo matrix. He now suggests that the in vivo matrix may properly be described as a biological matrix because it represents the matrix under biological conditions, in other words, a “biomatrix”.

The nomenclature for the structural material between cells in plants is usually described as “cell wall polysaccharides”. Nearly two decades ago Helen A. Stafford asked the question: “What is a Plant Cell?”¹ She was concerned that some confusion existed about the definition of the cell wall in plants. Some plant scientists considered the cell wall extracellular; others regarded its elements as subcellular components. She concluded in her remarks: “I have never seen a rationale supporting the concept that plant cell wall is extracellular rather than being an extracytoplasmic, intracellular component”. After nearly two decades we can respond to this question by pointing out the tremendous structural and functional difference between a cell with its nucleus and cytoplasm containing genetic material and nearly all the enzyme systems, and the substance outside this cell membrane. The cytoplasm and nucleus are placed within a semipermeable cell (plasma) membrane that separates ions, micro- and macromolecules from the external cell environment. Plasmolysis, experimental or biological, testifies to the uniqueness of the function of the cell membrane. Everything outside of this membrane is different in its composition and function. In plants, as in animals, the cells multiply, control growth and produce the biomatrix that surrounds them, which in plants may also serve to encapsulate them. The boundaries of the cell do not limit metabolism. Synthetic and destructive activities of molecules occur in the biomatrix and can strongly influence the life of the cells embedded in them. There is ample evidence that there is a structural and functional

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¹ See Ref. [1].

similarity in the matter surrounding the eukaryotic cells of plants and animals. Both are covered by the concept of “biomatrix”.

In summary

1. There is a structural similarity between the structure and function of the inter-cellular matrices of plants and animals. Both matrices may be described by the term “biomatrix”.
2. The functions of these biomatrices can also be regarded as comparable, as they protect the cells from mechanical or stress forces.
3. There is an increasing understanding of the “signaling” functions of the biomatrix, but the metabolic functions of the two systems cannot be directly correlated at this time. Examples to be investigated would be the biological functions of hyaluronan and other proteoglycans in animal biomatrices and the pectins and arabinogalactan proteins in biomatrices of the plant kingdom.
4. Some papers focus on the widespread use (therapeutic and industrial) of these polysaccharides. Hyaluronan, following Endre Balazs’ initiative and demonstration that hyaluronan could be produced in a non-inflammatory form to be used in a wide variety of clinical applications, is now a major pharmaceutical/commercial product. Plant matrices are now extensively used commercially. Pectin leads the way as a food ingredient and dietary fiber with great potential health benefits. Cellulose, hemicelluloses, and lignin, of course, have a long commercial history, and the xyloglucans are now finding increasing uses. The tree exudate, gum arabic, despite the lack of information about its biosynthetic and functional origin, remains the major natural emulsifier in beverages.
5. The interactions between the various biomatrix components in both animals and plants are discussed in the following papers. Notable are the different approaches used by the researchers studying plant and animal tissues to explain comparable phenomena. The concept of “excluded volume”, now referred to as “crowded molecules”, and “depletion flocculation”, or “phase separation”, refer to much the same thermodynamic processes but remain far apart in terms of communication between the two fields.
6. Aggregation or association of the polysaccharide molecules is a fundamental feature of polysaccharides in both types of biomatrices—animal and plant. It is not always clear if the term “polydispersity” adequately describes the material which can only be partly separated using current fractionation methods. GPC MALLS, gel electrophoresis and Field Flow Fractionation all have a part to play in untangling these polysaccharide units which are so happy to interact with one another.
7. There is need for further inter-disciplinary communication between researchers studying plant and animal tissues to enable both sides to understand both the nature of the matrices, the components themselves and their interactions. Further practical application can derive from such activity, with the eventual possibility of crossing the boundaries to yield hybrid products which contain elements of both plant and animal hydrocolloids.

The content of the following papers was the subject of an extensive discussion at a meeting held from June 23–26, 2008, in St. Tropez (France). Most of the authors of these papers were participants in this discussion. Two of them, Vincent Hascall (Department of Biomedical Engineering, Cleveland Clinic, Cleveland, Ohio, USA) and Mary Cowman (Polytechnic University, Brooklyn, New York, USA) participated in the discussions but did not submit papers. The meeting was organized by the undersigned at the Villas NIFNAHA and HYLAN in St. Tropez.

Reference

1. Stafford HA (1991) *The Plant Cell* 3:331