Cell Tissue Res (1981) 218:117–121

Cell and Tissue Research


# B-Cells of the Synovial Membrane

## III. Relationship with the Specific Collagenous Structure of the Intimal Interstitium in the Mouse

Gabrielle Linck and Aimé Porte
Institut de Physiologie, ULP, Section Sciences*, Strasbourg, France

**Summary.** An ultrastructural study of the synovial membrane in mice revealed that, in addition to specific polypeptide-producing secretory cells (B-cells), the intima is characterized by a specific differentiation of the interstitium adjacent to the synovial cavity. Scattered collagen fibrils are embedded in a fine fibrillar material, which often appears as cross-striated strands resembling long-spacing-collagen (periodicity from 90 to 120 nm). Similar material was found along the synovial cavity in the rat, guinea pig, rabbit and man. The close relationship between this material and B-cells observed in the mouse suggests that the maintenance of the specialized intimal interstitium may depend on the secretory function of B-cells.

**Key words:** Synovial membrane – B-cells – Intimal interstitium – Long-spacing-collagen – Mouse

The intimal layer of the synovial membrane comprises two cell types (Barland et al. 1962): the A- or M-(macrophage-like) cells, and B- or F-(fibroblast-like) cells. The A-cells are obviously histiocytes, while the B-cells, by far the most numerous, display the features of elements secreting polypeptides. These features are particularly obvious in the mouse, clearly distinguishing the B-cells from fibroblasts (Linck and Porte 1978a, 1981). The B-cells, specific to the synovial membrane, may produce proteins of the synovial fluid such as lubricating factors (Swann and Mintz 1979), but may also have a more complex function in controlling the intimal interstitium which, as reported presently, displays a specific structure along the entire synovial cavity indicating a specialized role in blood/synovial fluid exchange.

## Materials and Methods

Young and adult male and female mice were perfused with a solution of 5% glutaraldehyde in phosphate buffer, 0.1 M, pH 7.4. Metatarso- and metacarpo-phalangeal joints, sagittally divided into hemi-joints,

*Send offprint requests to:* G. Linck, Institut de Physiologie, 21 Rue René Descartes, 67084 Strasbourg Cedex, France

* LA 309 CNRS Neuroendocrinologie Comparée

0302-766X/81/0218/0117/$01.00

were fixed in the same solution for 4–6 h, decalcified for 6–8 days in glutaraldehyde fixative containing 0.1 M EDTA, postfixed in 1.5% osmium tetroxide and embedded in an Araldite-Epon mixture. The thin sections, stained with uranyl acetate and lead citrate, were examined with a Siemens Elmiskop 1 A. A few observations were also made on rat and guinea-pig metatarso- and metacarpo-phalangeal joints, rabbit knees and on one sample of the synovial membrane from the knee of an adult man not suffering from any joint disease.

## Results and Discussion

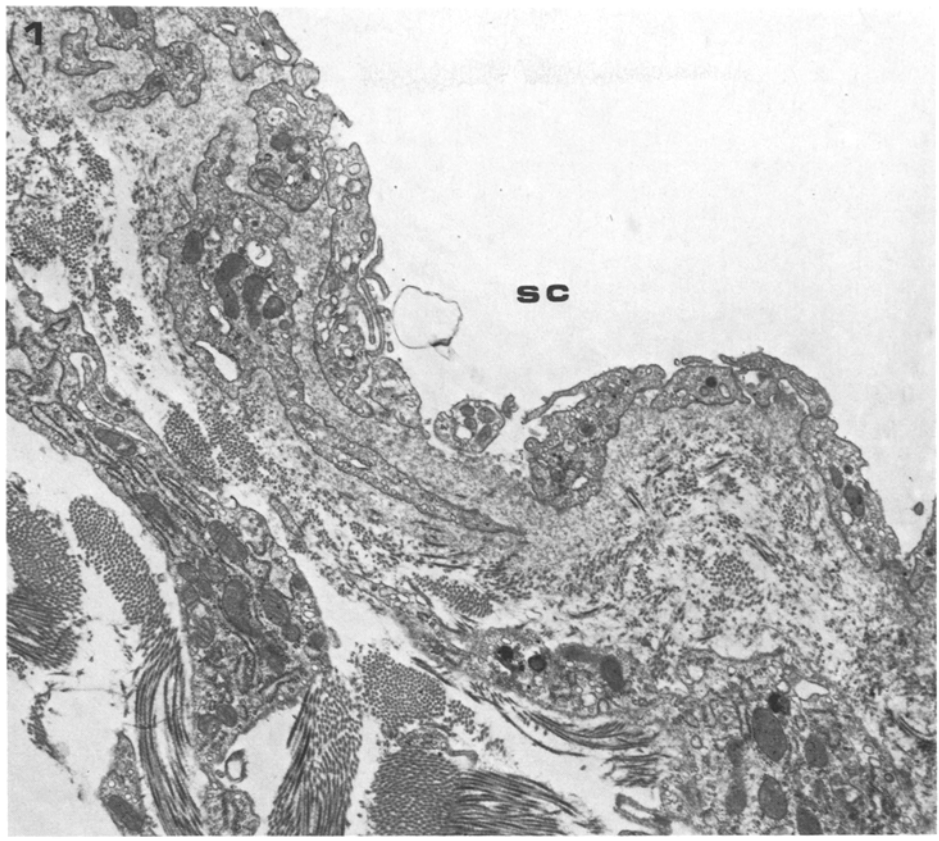
Collagen fibrils, grouped in bundles in the sub-intima, tend to fan out forming a fibrillar sheet at the level of the intimal cells. Near the synovial cavity, these fibrils are sparser, occurring either singly or loosely grouped in parallel and embedded in fine fibrillar material, which forms a continuous layer along the entire synovial cavity (Fig. 1, 2). This material frequently displays cross-striations with a periodicity of 90 to 120 nm (90 nm being more frequent) usually referred to as long-spacing-collagen (Figs. 2–4). The periodic spacing of the common collagen fibrils in our samples ranged from 54 to 62 nm. Cross-striated strands were often closely related to and parallel to the dispersed collagen fibrils.

Fibrillar material, concentrated around the apical poles of B-cells, continues as a narrow layer along and between their intermingled extensions, which line the synovial cavity. This material, found only occasionally in deeper intimal areas, was always in close contact with B-cells, which were then surrounded by a narrow striated layer (Fig. 5).

Similar observations were made on the synovial membrane of the rat, guinea pig, rabbit and man. Such fibrillar material was sometimes poorly preserved but did form a continuous layer along the synovial cavity in the more optimally fixed samples.

Striated fibrillar material of the long-spacing-collagen type has been reported in various, albeit mainly pathological tissues (see Edwards 1975; Daroczy and Haust 1979). Its regular occurrence along the synovial cavity probably reflects a functional specialization of the intimal interstitium in contact with the synovial fluid. This material forms a continuous layer under the B-cell extensions lining the synovial cavity and is reminiscent of specific collagenous structures such as the Descemet membrane under the corneal endothelium. Differentiation of the interstitium of the synovial membrane may be of major functional significance, since it became apparent from physiological observations (Simkin and Pizzorno 1979) that interstitial tissue may play a major role in controlling the trans-synovial transport of substances of various molecular weights.

The close relationship of the B-cells with this fibrillar material which, during the development of the synovial cavity of the mouse, first appears at the same time as the secretory activity of the B-cells (Linck and Porte 1978b), strongly suggests that the B-cells are involved in the differentiation of the intimal interstitium. B-cells may secrete collagen as can be concluded from their uptake of $^{3}$H-proline (unpublished observations). The secretory features of these cells indicate that they synthesize specific protein(s) or glycoprotein(s), which are diffusely released into the intima (Linck and Porte 1978a, b). Long-spacing-collagen formation is known to be favored by glycosaminoglycans and glycoproteins (Gross 1956). Interactions



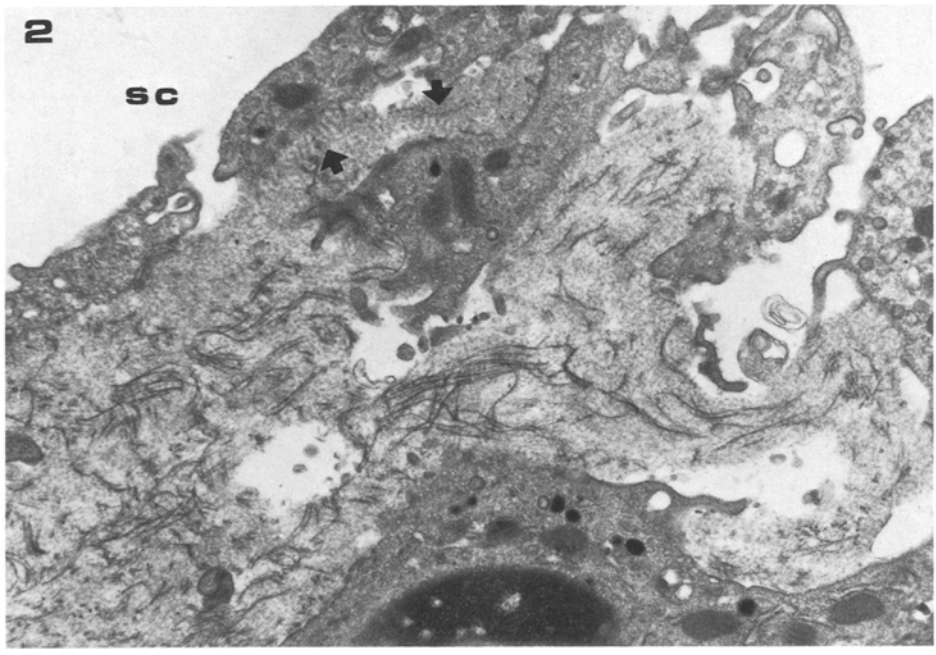
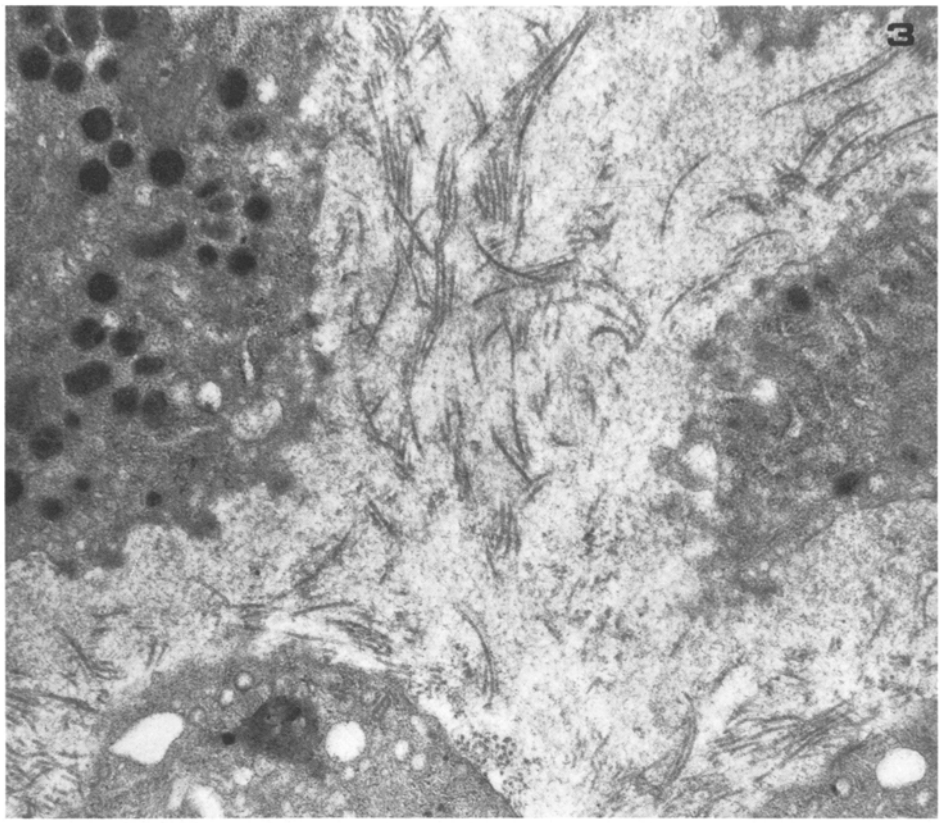
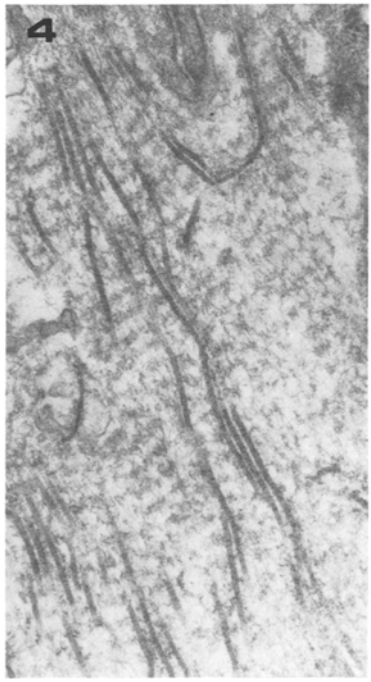




**Fig. 1.** Area of the synovial membrane where the intima is reduced to a narrow but continuous layer of fine fibrillar material lining the B-cell extensions along the synovial cavity (*sc*). Note the different organization of collagen fibrils: in bundles in the sub-intima, diffuse in the intima. ×12,000

**Fig. 2.** General aspect of intimal interstitium. Collagen fibrils embedded in fine fibrillar material with an obvious striated organization in contact with extensions of B-cells (*arrows*) along the synovial cavity (*sc*). B-cell (bottom). ×13,000



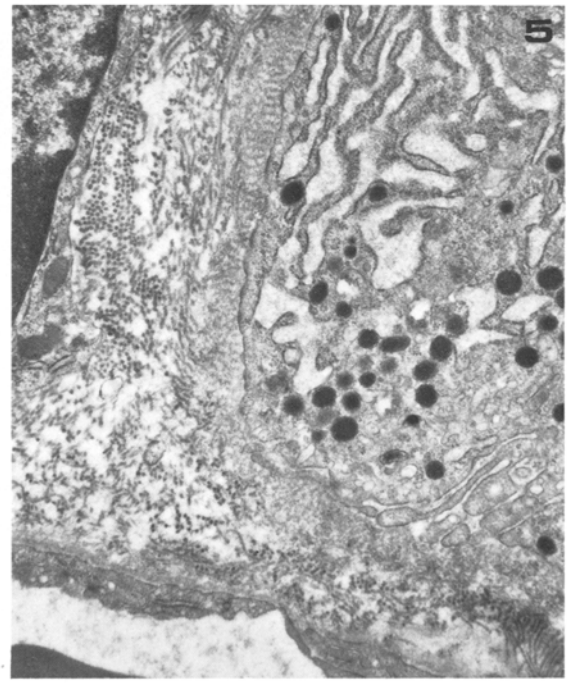




**Fig. 3.** Fine fibrillar material with obvious striations (top right) surrounding B-cells and enclosing collagen fibrils. × 20,400

**Fig. 4.** Cross-striations of the fine interstitial material in contact with parallel-oriented collagen fibrils. × 31,000

**Fig. 5.** Deep intima displaying dispersed collagen fibrils and a capillary (bottom). A narrow layer of cross-striated material in close contact with a B-cell rich in rER and dense secretory vesicles. × 13,600

between native collagen and an as yet unidentified factor(s) synthesized by B-cells may be involved in the specialization of the intimal interstitium.

*Acknowledgements:* This study was carried out under INSERM CRL Grant n° 79.1.218.4 The authors are grateful to Georgette Haller and Marie-Jeanne Klein for their valuable assistance.

## References

Barland P, Novikoff AB, Hamerman D (1962) Electron microscopy of the human synovial membrane. J Cell Biol 14:207–220

Daroczy J, Haust MD (1979) Long-spacing-collagen in dermal disorders. Acta Morphol. Acad Sci Hung 27:265–271

Edwards RP (1975) Long-spacing-collagen in skin biopsies from patients with lepromatous leprosy. British J Dermatol 93:175–182

Linck G, Porte A (1978a) B-cells of the synovial membrane. I. A comparative ultrastructural study in some mammals. Cell Tissue Res 187:251–261

Linck G, Porte A (1978 b) B-cells of the synovial membrane. II. Differentiation during development of the synovial cavity in the mouse. Cell Tissue Res 195:251–265

Linck G, Porte A (1981) B-cells of the synovial membrane. IV. Ultrastructural evidence of secretory variations in hypophysectomized or propylthiouracyl-treated mice. Cell Tissue Res 218:123–128

Simkin PA, Pizzorno JE (1979) Synovial permeability in rheumatoid arthritis. Arthritis Rheumatism 22:689–696

Swann DA, Mintz G (1979) The isolation and properties of a second glycoprotein (LGP-II) from the articular lubricating fraction from bovine synovial fluid. Biochem J 179:465–471

Accepted March 13, 1981