Chapter 2

EXTRACELLULAR MATRIX IN OVARIAN FOLLICULAR DEVELOPMENT

Ayşegül Burçin YILDIRIM[1]
Derya KARABULUT[2]

INTRODUCTION

Ovarian follicular epithelium is an example of a unique epithelium which has ovarian follicle development, maturation or epithelial-mesenchymal transformation (EMT). (1)

Primordial follicles contain a monolayer granulosa cell surrounded by the follicular basal lamina which is containing the inactive oocyte. Granulosa cells proliferate and form a multi-layered epithelium by development of the primordial follicle.(2) On the apical side of the membrane granulosa, an antral cavity develops. After follicle burst, follicular fluid and egg have release. In the following days, granulosa cells, which synthesize steroidogenic enzymes, turn into steroidogenic cells. (1)

Meanwhile, the follicular basal lamina structure degrades and cells migrate from the surrounding stromal theca cell layer to the membrane granulosa layer. When the corpus luteum is formed, the granulosa cells turn into granulosa lutein cells.(3) Thus, the granulosa loses its epithelial character and undergoes epithelial-mesenchymal transformation. (4)

1 Asst. Prof.Dr., Gaziantep Islam, Science and Tecnology University, Department of Histology and Embryology, aysegulburcin@gmail.com

2 Asst. Prof.Dr., Erciyes University, Faculty of Medicine, Department of Histology and Embryolog, deryakkus@hotmail.com, karabulutdry@gmail.com

ovaries clearly differ in their ECM composition. The localization of proteins and proteoglycans found in structures such as follicular basal lamina, focimatrix, thecal matrix, also varies according to both species and follicle development stage.

Follicular fluid proteins or BFB have potential to be diagnostic markers for follicle and oocyte maturation and a marker to evaluate oocyte quality. In addition, it is important to clarify the structure of FBL according to the follicle development stages, in order to understand the function of BFB and FBL in its structure.

REFERENCES

1. Berkholtz CB, Lai BE, Woodruff TK, Shea LD. Distribution of extracellular matrix proteins type I collagen, type IV collagen, fibronectin, and laminin in mouse folliculogenesis. Histochem Cell Biol. 2006;126:583-592.
2. Rodgers RJ, Irving-Rodgers HF, van Wezel IL, Krupa M, Lavranos TC. Dynamics of the membrana granulosa during expansion of the ovarian follicular antrum. Mol Cell Endocrinol. 2001;171:41–48
3. O'Shea, JD. 1987. Heterogeneous cell types in the corpus luteum of sheep, goats and cattle. J. Reprod. Fertil. Suppl. 34, 71-85.
4. Rodgers RJ, Irvıng Rodgers HF. Extracellular matrix of the bovine ovarian membrana granulosa. Mol. Cell. Endocrinol. 2002;191:57-64.
5. Cenan RS, Ergin E, Ekici Y, Ataç FB. Structural and Functional Properties of the Extracellular Matrix. J Lit Pharm Sci. 2018;7(3):251-60.
6. Lin CQ, Bissell MJ. Multi-faceted regulation of cell differentiation by extracellular matrix. FASEB J. 1993;7:737– 43.
7. Madri JA, Basson MD. Extracellular matrix-cell interactions: dynamic modulators of cell, tissue and organism structure and function. Lab Invest. 1992;66:519 –21.
8. Iwahashi M, Muragaki Y, Ooshima A, Nakano R. Type VI collagen expression during growth of human ovarian follicles. Fertil Steril. 2000;74:343–347.
9. Rodgers RJ, van Wezel IL, Irving-Rodgers HF, Lavranos TC, Irvine CM, Krupa M. Roles of extracellular matrix in follicular development. J Reprod Fertil Suppl. 1999;54:343–352.

10. Keene DR, Engvall E, Glanville RW. Ultrastructure of type VI collagen in human skin and cartilage suggests an anchoring function for this filamentous network. J Cell Biol. 1988;107:1995–2006.
11. Trueb B, Schreier T, Bruckner P, Winterhalter KH. Type VI collagen represents a major fraction of connective tissue collagens. Eur J Biochem. 1987;166:699 –703.
12. Huet C, Pisselet C, Mandon-Pepin B, Monget P, Monniaux D. Extracellular matrix regulates ovine granulosa cell survival, proliferation and steroidogenesis: relationships between cell shape and function. J Endocrinol. 2001;169:347-360.
13. Woodruff TK, Shea LD. The role of the extracellular matrix in ovarian follicle development. Reprod Sci. 2007;14:6–10.
14. Irving-Rodgers HF, Harland ML, Rodgers RJ. A novel basal lamina matrix of the stratified epithelium of the ovarian follicle. Matrix Biol. 2004;23:207–217
15. Irving-Rodgers HF, Rodgers RJ. Extracellular matrix of the developing ovarian follicle. Semin Reprod Med. 2006;24:195–203.
16. Timpl R, Brown JC. Supramolecular assembly of basementmembranes. Bioessays. 1996;8:123–132.
17. Paulsson M. Basement membrane proteins: structure, assembly and cellular interactions. Crit Rev Biochem Mol Biol. 1992;27:93–127.
18. Irving-Rodgers HF, Hummitzsch K, Murdiyarso LS, Bonner WM, Sado Y, Ninomiya Y, Couchman JR, Sorokin LM, Rodgers RJ. Dynamics of extracellular matrix in ovarian follicles and corpora lutea of mice. Cell Tissue Res. 2010; 339:613–624.
19. Erickson, AC and Couchman, JR. Still more complexity in mammalian basement membranes. J. Histochem. Cytochem. 2000;48:1291-1306.
20. Bagavandoss P, Midgley Jr AR, Wicha M. Developmental changes in the ovarian follicular basal lamina detected by immuchanges in the ovarian follicular basal lamina detected by immunofluorescence and electron microscopy. J Histochem Cytochem. 1983;31:633-640
21. MacArthur ME, Irving-Rodgers HF, Byers S, Rodgers RJ. Identification and immunolocalization of decorin, versican, perlecan, nidogen, and chondroitin sulfate proteoglycans in bovine small-antral ovarian follicles. Biol Reprod. 2000;63:913–924
22. van Wezel IL, Rodgers RJ. Morphological characterization of bovine primordial follicles and their environment in vivo. Biol. Reprod. 1996;55:1003-1011.
23. Yurchenco PD, Patton BL. Developmental and pathogenic mechanisms of basement membrane assembly. Curr Pharm Des. 2009;15:1277–1294.

24. Christensen AP, Patel SH, Grasa P, Christian HC, Williams SA. Oocyte glycoproteins regulate the form and function of the follicle basal lamina and theca cells. Developmental Biology. 2015;401:287–298.
25. Richardson MC, Davies DW, Watson RH, Dunsford ML, Inman CB, Masson GM. Cultured human granulosa cells as a model for corpus luteum function: relative roles of gonadotrophin and low density lipoprotein studied under defined culture conditions. Human Reprod. 1992;7: 12-18.
26. Luck MR. The gonadal extracellular matrix. Oxford Rev. Reprod. Biol. 1994;16:33-85.
27. Andersen MM, Krøll, J, Byskov AG, Faber M. Protein composition in the fluid of individual bovine follicles. J. Reprod Fertil. 1976;48:109-118.
28. Perloff WH, Schultz J, Farris EJ, Balin H. Some aspects of the chemical nature of human ovarian follicular fluid. Fertil.Steril. 1954;6:11–17.
29. Shalgi R, Kraicer P, Rimon A, Pinto M, Soferman N..Proteinsofhuman follicular fluid: theblood–follicle barrier.Fertil.Steril. 1973;24:429–434.
30. Hess KA,Chen L,Larsen WJ. The ovarian blood follicle barrier is both charge-and size-selective in mice. Biol.Reprod. 1998;58:705–711.
31. Zhou D, Ohno N, Terada N, Li Z, Morita H, Inui K, Yoshimura A and Ohno S. Immunohistochemical analyses on serum proteins in nephrons of protein-overload mice by ‘in vivo cryotechnique’. Histology and Histopathology. 2007;22:137–145.
32. Cran DG, Moor RM and Hay MF. Permeability of ovarian follicles to electron-dense macromolecules. Acta Endocrinologica. 1976;82 631–636.
33. Zhuo L and Kimata K. Cumulus oophorus extracellular matrix: its construction and regulation. Cell Structure and Function. 2001;26:189–196.
34. Zhou H, Ohno N, Terada N, Saitoh S, Fujii Y, Ohno S. Involvement of follicular basement membrane and vascular endothelium in blood follicle barrier formation of mice revealed by ‘in vivo cryotechnique’.. Reproduction. 2007;134:307–317.
35. Siu MK, Cheng CY. The blood-follicle barrier (BFB) in disease and in ovarian function. Adv Exp Med Biol. 2012;763:186-192.