Meat Science and Muscle Biology: Extracellular Matrix in Skeletal Muscle Development and MeatQuality

838 Stem cell niche and postnatal muscle growth. S. Kuang*, *Purdue University, West Lafayette, IN.*

Stem cell niche plays critical roles in regulating the function of adult stem cells that underlie tissue growth, maintenance and regeneration. In the skeletal muscle, stem cells called satellite cells contribute to postnatal muscle growth and hypertrophy, thus meat production in animal agriculture. Satellite cells are located adjacent to mature muscle fibers underneath a basal lamina sheath. Microenvironmental signals from extracellular matrix mediated by the basal lamina and from the adjacent muscle fiber both impinging on satellite cells to regulate their activity. This talk focuses on how such signals acting together to affect stem cell fate in the niche, and use Dlk1 as an example to elucidate how extracellular cues dynamically regulate satellite cell function during muscle growth and regeneration. Ongoing research in my lab takes advantage of this knowledge to engineer bioactive scaffolds that mimic the key physical and chemical properties of satellite cell niche, and explore the potential of using engineered stem cell niche to enhance tissue regeneration in vivo.

Key words: stem cell niche, skeletal muscle, satellite cell

839 Extracellular matrix regulation of skeletal muscle formation and growth. S. Velleman*, *The Ohio State University/OARDC, Wooster.*

Skeletal muscle growth and development is a highly organized process regulated by interactions between muscle cells and their extracellular environment. Communication between the extracellular matrix (ECM) and cells plays a pivotal role in the regulation of muscle cell proliferation and differentiation. The ECM is a dynamic network of molecules secreted by the cells and includes collagens, proteoglycans, and noncollagenous glycoproteins. The ECM was viewed to be merely a component that the cells were embedded in and provided a structural framework for the cells. In skeletal muscle, the ECM is a major component of the intramuscular connective tissue. In recent years, the ECM has been shown to be an integral part of the cellular communication network regulating cell shape and gene expression. Proteoglycans are a diverse family containing a central core protein and at least one covalently attached glycosaminoglycan (GAG) chain. Proteoglycans are involved in tissue hydration, regulation of gene expression, cell proliferation and differentiation, migration, and adhesion which are all essential for the muscle development process. Two major groups of membrane-associated heparan sulfate proteoglycans, the syndecans and glypicans, are found in skeletal muscle. Both are capable of regulating fibroblast growth factor 2 (FGF2) signal transduction. Syndecan-4 and glypican-1 differentially affect muscle cell proliferation and differentiation and the cellular response to FGF2. Differential regulation of muscle growth by these proteoglycans results, in part, from different signal transduction pathways, such as mitogen activated protein kinase and protein kinase C α, being activated. Understanding the effect of these proteoglycans on these pathways is necessary to develop a comprehensive insight into the mechanisms of proteoglycan-mediated modulation of muscle development and growth. Recent research findings on syndecan-4 and glypican-1 regulation of muscle development will be discussed.

Key words: extracellular matrix, muscle, proteoglycans

840 The influence of extracellular matrix on intramuscular and extramuscular adipogenesis. G. J. Hausman*, *USDA ARS, Athens, GA.*

The extracellular matrix (ECM) and specific ECM components can have a major influence on cell growth, development and phenotype. The influence of the ECM and ECM components on adipogenesis in vivo and in vitro will be reviewed. Engelbreth-Holm-Swarm (EHS) substratum and laminin per se markedly increased attachment, spreading, and hypertrophy of preadipocytes in serum free primary cultures of adipose tissue stromal-vascular (SV) cells while antagonizing spreading of non-preadipocytes. In addition, adipocyte number increased on these substrata resulting in a greater proportion of preadipocytes. Furthermore, immunocytochemistry in primary cultures of adipose tissue S-V cells showed that preadipocytes express ECM components after preadipocyte recruitment and the ECM may be critical for morphological development of adipocytes. Preadipocytes on ECM substrata accumulated lipid but were "flat" and did not express ECM components, regardless of insulin or DEX treatment. The influence of ECM was examined in "marbling" adipocytes by developing a protocol to culture semitendinosus muscle stromal-vascular (SV) cells. The co-development of myotubes and preadipocytes was evident only on laminin substrata when compared with other ECM components following seeding and plating with fetal bovine serum (FBS) with or without DEX. In vivo studies of fetal adipose tissue staining for galactose binding lectins, type IV collagen and laminin will also be reviewed. Adipocyte reactivity for laminin was strong throughout development and was similar for developing adipocytes and vasculature. Staining for lectins and type IV collagen was greater for blood vessels than for adipocytes. The differentiation of the extracellular matrix of blood vessels and adipocytes is clearly distinct throughout development. Therefore, these studies indicated that the ECM and in particular laminin may play a critical role in morphological aspects of preadipocyte development.

Key words: adipogenesis, extracellular matrix, differentiation

841 Connective tissue turnover and meat quality. P. P. Purslow*, *Department of Food Science, University of Guelph, Guelph, ON, Canada.*

Intramuscular connective tissue (IM-ECM) is necessary for patterning muscle development and its turnover is also necessary during muscle growth. The amount and state of maturity of IM-ECM are strong contributors to cooked meat toughness. Amounts of IM-ECM in each muscle appear to be dictated by functional requirements, but its maturity may be reduced by increasing its turnover, as newly deposited IM-ECM has immature crosslinks. IM-ECM degradation is principally by the matrix metalloproteinases (MMPs), and synthesis is by intramuscular fibroblasts. Studies in our laboratory have shown: (1) Fibroblasts from 3 bovine muscles have different proliferation rates and different levels of MMP expression, with fibroblasts in the Semitendinosus being most active. (2) Reactive oxidative species depress new collagen synthesis and increase MMPs expression by intramuscular fibroblasts moderately. When vitamins E or C (or both) are added, both MMP expression and collagen synthesis are elevated. (3) IM-ECM degradative activity is located at the periphery of muscle fibers and fascicles in adult skeletal muscle, and is mostly MMP-related. The major-

ity of MMP expression is in fact from muscle cells, and the levels may vary with muscle fiber size or type. (4) The activity of collagenases expressed by myoblasts is comparable to fibroblasts in cell culture, and responds more to mechanical stimulation. Mechanical stimuli (exercise) are known factors for muscle adaptation and hypertrophy. (5) The stress hormone epinephrine increases the extracellular activity of MMP-2 from fibroblasts, but more so from myoblasts at physiological levels. The β-agonist ractopamine increases both MMP but especially the MMP inhibitor TIMP-1 expressed by myoblasts. These studies suggest that there is good capacity to manipulate IM-ECM turnover by several pathways, including dietary manipulations, by altering the rates of degradation by MMPs and synthesis of new collagen, with less heat-stable crosslinks. However, phenotypic differences between muscles may mean that different muscles may react quite differently to a given treatment applied to the whole animal.

Key words: extracellular matrix, meat quality, proteolysis