Published in final edited form as:

J Anim Sci. 2012 March ; 90(3): 922–923. doi:10.2527/jas.2011-4937.

Meat Science and Muscle Biology Symposium: Extracellular matrix in skeletal muscle development and meat quality¹

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For decades, research in muscle biology has been focused on enlarging skeletal muscle mass, which increases the quantity of meat production. It has been well established that myogenic cells are derived from multipotent mesenchymal stem cells (MSC). During the embryonic and fetal stages, muscle fibers are formed through the fusion of myogenic cells; enhancing the proliferation and myogenic differentiation of MSC increases the number of muscle fibers. After birth, muscle growth is characterized by enlargement of existing muscle fibers. Satellite cells, a pool of quiescent myogenic cells located underneath the basal lamina of muscle fibers, have an indispensable role in postnatal muscle growth. Recent studies have also identified MSC in adult muscle, such as pericytes, which are likely important to muscle growth. The MSC in muscle are most abundant during the early developmental stage and decrease as the maturity of muscle increases.

In addition to the quantity of meat production, the quality of meat is becoming more and more important to consumers. There are two major quality problems facing the meat industry, especially the beef industry; marbling and tenderness. Marbling, or intramuscular fat, imparts flavor and juiciness to the meat and is essential for the eating quality of meat. On the other hand, connective tissue and its crosslinking contribute to the background toughness of meat. Both marbling and connective tissue are located in the extracellular matrix of muscle fibers, with intramuscular adipocytes imbedded in the connective tissue. Multipotent stem cells and satellite cells also exist in the extracellular matrix; the local extracellular environment, the so-called niche, regulates the proliferation and differentiation of these MSC and satellite cells. Enhancing the adipogenic differentiation of MSC increases the number of intramuscular adipocytes, which form the basis for intramuscular fat deposition, whereas fibrogenic differentiation synthesizes collagens and elevates connective tissue content in muscle, and of course, myogenic differentiation increases muscle mass. Therefore, in order to enhance muscle growth and improve meat quality, it is very important to understand how the extracellular matrix affects the proliferation and differentiation of MSC and satellite cells, a field becoming increasingly important and inspiring.

¹A symposium held at the Joint Annual Meeting, July 10–14, 2011, New Orleans, LA.

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Traditionally, extracellular matrix is regarded as an inert tissue component, but now is appreciated as a critical regulator of muscle growth and development. Such a radical change in view owes to the efforts of countless biologists. In this “Extracellular matrix in muscle growth and meat quality symposium” at the Joint Annual Meeting in New Orleans, we invited 4 prominent researchers in this field who work from different perspectives. The objective of this symposium is to provide audience with both overview and in depth information about studies in extracellular matrix, muscle growth and meat quality.

In the first presentation, S. Kuang discussed the role of stem cell niche in satellite cell proliferation and differentiation and its contribution to postnatal muscle growth (Bi and Kuang, 2011). He discussed the properties of the stem cell niche, and how signals from extracellular cues, including intramuscular preadipocytes and connective tissue fibroblasts, interact with satellite cells and regulate the growth and regeneration of postnatal skeletal muscles.

In the second presentation, S.G. Velleman discussed signaling initiated from the extracellular matrix, and its roles in skeletal muscle growth (Velleman, 2011). Specifically, she discussed the role of proteoglycans, including syndecans and glypicans, as regulators of fibroblast growth factor-2 signaling and muscle growth and development. She presented that syndecan-4 mainly regulates muscle cell proliferation while glypican-1 alters differentiation.

The third presentation was made by G. J. Hausman, who discussed the properties and adipogenic differentiation of stromal-vascular cells (Hausman, 2011). Stromal-vascular cells are embedded in the extracellular matrix of muscle and adipose tissue, and contain a collection of MSC, and adipogenic and fibrogenic cells at different stages of differentiation. The adipogenic differentiation of stromal-vascular cells increases intramuscular adipocyte numbers and thus marbling of meat. The extracellular matrix and basement membrane provide a substratum for preadipocytes, which regulate preadipocyte development. Matrix metalloproteinases regulate preadipocyte proliferation and differentiation through regulating extracellular matrix protein turnover.

The last talk was presented by P. P. Purslow who discussed the turnover of connective tissue in skeletal muscle (Purslow et al., 2011). Connective tissue is the major component of the extracellular matrix, and the properties and turnover of connective tissue affect the background toughness of meat. In this talk, he discussed the role of metalloproteinases and oxidative stress in the turnover of connective tissue. He also discussed the impact of muscle fiber types on metalloproteinase expression and connective tissue remodeling.

These four symposium papers represent several important topics in this field and are not meant to be comprehensive. In fact, due to the limited time allocated to this symposium, we are unable to cover many other equally important topics, such as the embryonic differentiation of MSC to myogenic, adipogenic, and fibrogenic cells. Because this field is further expanding, additional interesting topics will certainly be generated. We hope this symposium and corresponding papers will entice newcomers to this exciting field and provide up-to-date information for experienced researchers.

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