A 2015 Portrait of Adipocyte : Role of Adipocytes

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Adipocytes are found in distinct depots throughout the body, however they can also be found mixed with different cell types in other locations, especially in loose connective tissue. There are two types of adipocytes, brown and white, that differ in several important properties. Even among white adipocytes, cells from different sites can have distinct molecular and physiological properties. The conceptual transformation of adipose tissue from a passive organ of energy storage to an active participant in hormonal regulation of homeostatic systems occurred relatively recently. In 1994, adipose tissue was characterized as the source of the hormone leptin, opening the vistas of research focused on adipocyte endocrinology. In the past two decades, the endocrine role of leptin has expanded to include regulation of reproduction and immune function, and numerous other adipose tissue-derived molecules that have an effect on glucose homeostasis, vascular biology, lipoprotein metabolism, and inflammation have been identified.

Further, adipocyte size has been linked to an increased risk of metabolic complications such as Type 2 diabetes or cardiovascular disorders. Most of our current knowledge about adipogenesis comes from in vitro studies of fibroblasts or preadipocyte cell cultures and slight is known about depot-specific aspects of differentiation. Study suggests that more differentiation would lead to the increased number of fat cells this would not necessarily preclude more fat tissue in total, since adipocytes are highly variable in size. Moreover, increased differentiation can offer the organism with means to escape lipid deposition in extra-adipose tissue which is associated with secondary complications such as insulin resistance.

White adipose tissue is vital for maintaining energy metabolism of the organism by storing excess energy as lipid. Its function can be grouped into three main categories with potentially overlapping mechanisms: lipid metabolism, glucose metabolism and endocrine functions. Adipose tissue is composed of a variety of different cells. The most noticeable fraction are mature adipocytes which store and release lipids in response to circulating hormones. For several decades, it was thought that adipose tissue and constituent adipocyte function was limited to the storage and release of fat. However, in the past years it has become clear that adipocytes not only serve to store energy but directly influence whole-body energy homeostasis through exocrine signaling proteins that regulate various processes such as blood pressure, immune function, angiogenesis and energy balance. Further, the recurrent use of pre-adipocyte cell lines to study adipocyte biology in vitro has added to this controversy because the functional characteristics and transcriptional patterns of these multipotent cells are similar to immune cells. In fact, immature fat cells can Trans differentiate into macrophages both in vitro and in vivo. Recent studies using large-scale genetic analyses to characterize gene expression patterns in adipose

tissue from a variety of obese and lean mice have begun to explain the role of the adipocyte as a hormone and cytokine secreting cell. Both adipocyte size and total body weight are strong predictors of the number of mature macrophages found within adipose tissue, the correlation being even stronger for visceral than for subcutaneous fat. These bone marrow-derived macrophages seem to occupy fat in response to as-yet-unknown signals and in obese animals tend to aggregate and form giant cells characteristic of chronic inflammatory disorders, suggesting that adipose tissue is a site of active inflammation.

Gene expression studies on sorted cells from adipose tissue revealed that macrophages produce almost all TNF-α, whereas mature adipocytes secrete the majority of leptin and roughly equal IL-6 gene expression was found within macrophages, adipocytes, and nonmacrophage stromal-vascular cells. Notably, these studies suggest that macrophage invasion of fat and inflammation-related gene expression in adipose tissue may be a sentinel event, preceding the development of insulin resistance in these animals. Therefore, weight gain is associated with infiltration of fat by macrophages and elaboration of pro-inflammatory signals from adipose tissue. Notably, these inflammatory changes are most marked within visceral fat, the fat depot associated with greatest metabolic risk, and seems to precede other features of the metabolic syndrome, including impaired glucose homeostasis. The existing paradigm of adipose tissue endocrinology has been changed significantly by introducing immune cells as a source of inflammatory mediators released from adipose tissue, as well as a paracrine regulator of adipocyte function and hormone secretion, thereby potentially controlling the metabolism that result from excess adiposity.