Differential Metabolic Profiling of Preadipocytes and Adipocytes

Summary

The Biolog Phenotype MicroArray™ system and MicroPlates PM-M1 through M4 were applied to a cellular model system for nutrient-metabolism profiling, comparing white and brown adipocytes, which have very different physiological roles. This comparative analysis also examined the metabolic changes that occur when preadipocytes transition to a differentiated state. Four major comparisons were observed: brown preadipocytes with brown adipocytes, white preadipocytes with white adipocytes, brown with white preadipoctyes, and brown with white adipoctyes. Simple assay protocols recommended for PM-M1-M4 plates were used as described elsewhere (1).

Results

The greatest difference between brown and white preadipocytes was in the increased metabolism of glycogen and the three sugar phosphates (fructose-6-phosphate, glucose-1-phosphate, and glucose-6-phosphate) by brown preadpipocytes (Figure 1). Interestingly, metabolism of these four nutrients decreased subsequent to brown adipocyte differentiation. During white adipocyte differentiation, there was a strong increase in the metabolism of acetoacetic acid, succinamic acid, leucine and leu-leu. A strong decrease in metabolism of dextrin and butyric acid was seen coincident with differentiation of both white and brown preadipocytes.

Conclusions

Using the simple colorimetric multiplexing Phenotype MicroArray assay method for simultaneously measuring multiple energy-producing pathways in cells, we observed several significant differences in energy metabolism profiles between white and brown adipocytes before and after differentiation. The metabolism of glycogen was high in brown versus white preadipocytes, but decreased during cellular differentiation. This observation is consistent with a report that murine brown preadipocytes show a myogenic transcriptional profile, suggesting that brown and white fat arise from separate cell lineages. Further discussion can be found in reference below (1). Another consistent difference between brown and white preadipocytes was the elevated metabolism of various sugar phosphates. These results support previous literature reports, in which brown adipose tissue was shown to have a 15-fold increase in glucose-6-phosphate dehydrogenase activity. The results provide additional evidence for the relationship between brown preadipocytes and muscle, and demonstrate that cost effective Phenotype MicroArray technology can be used to fingerprint similarities and differences between distinct cell types, at various stages of differentiation, and to expose metabolic differences between cell types thought to be similar.

[1]From: From Bochner, BR, Siri M, Huang, RH, Noble S, Lei X-H, Clemons, P.A., Wagner, B.K., (2011) Assay of the Multiple Energy-Producing Pathways of Mammalian Cells. PLoS ONE 6(3):e18147.doi:10.137/journal.pone.0018147

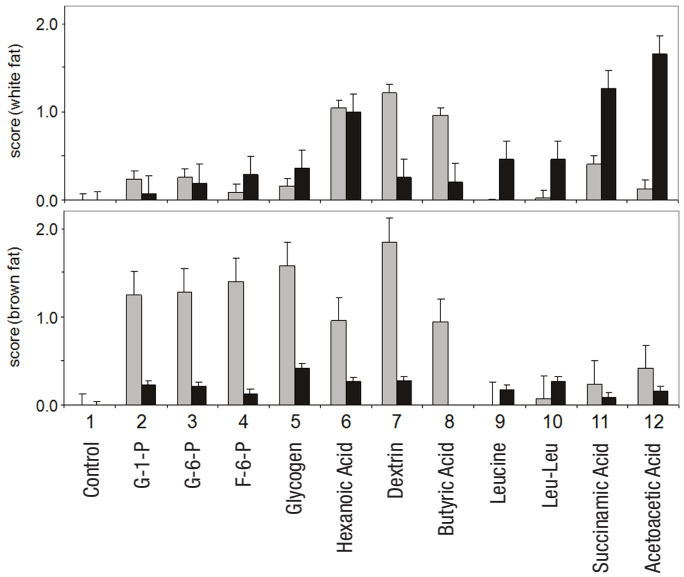

Figure 1: Comparison of Brown and White Preadipocytes (gray) and Adipocytes (black). *All peptides containing leucine resulted in at least some increase in metabolism after white adipogenesis, although at a low absolute rate of (redox) dye reduction. These results indicated that, while these adipogenic processes may superficially appear to be similar, each produces a different metabolic response (fingerprint).*

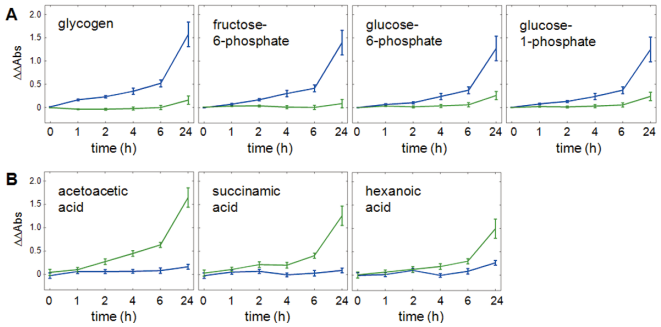

Figure 2: Comparison of Substrate Metabolism in Brown and White Preadipocytes and Adipocytes. *A) Brown preadipocytes (blue lines) and white preadipoctyes (green lines). B) Brown adipocytes (blue lines) vs. white adipocytes (green lines).*

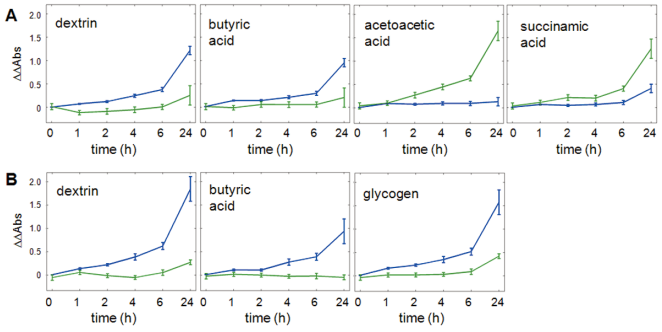

Figure 3: Analysis of Effects of Adipocyte Differentiation on Substrate Metabolism. *A) Undifferentiated preadipocytes (blue) and white fully differentiated adipocytes (green). B) Undifferentiated brown preadipoctyes (blue) and brown fully differentiated adipocytes (green).*

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