Glucotoxicity in Regeneration: Modeling Hyperglycemia-Induced Repair Failure in Planaria

Lee, Jaehyeon (School: George Walton Comprehensive High School)

Impaired wound healing is a widespread complication experienced by diabetic patients, with persistent hyperglycemic conditions being a central factor that disrupts cellular repair programs. Current research fails to clearly link hyperglycemia to regenerative defect because of confounded designs. Further, dose/concentration windows/thresholds where glucose shifts from repair-enhancing to inhibiting remains undefined. Last, most works stop at the proliferation aspect of regeneration, leaving differentiation effects (regenerative quality) largely unmapped. To this, I propose a novel model using amputated S. mediterranea in graded glucose media. Doses for experimentation were determined through a toxicity pilot. To ensure internal glucose uptake in cells, a 2-NBDG fluorescence assay was conducted, and fluorescence patterns consistent with dose-dependent uptake were observed. This validated causal interpretation of the regeneration outcomes obtained through three quantitative indicators: length growth, blastema area, and time to eyespot formation and pigmentation. In the regenerative indicators, lower glucose concentrations were correlated with enhanced regeneration, while higher concentrations were correlated with inhibited regeneration. In the differentiation indicator, all treatments decreased necessary time for formation and pigmentation, with the low glucose concentration being the most effective at doing so. Through this project, I successfully developed S. mediterranea as a low-confound in vivo platform to study hyperglycemia biology and better understand wound healing impairment in diabetic patients.

Awards Won:
Third Award of $1,200