Theme: Embryonic development and regeneration

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Summary. Regeneration and development are intricately linked processes. Following injury and disease, many developmental pathways are reactivated in order to regenerate damaged tissues. Understanding these developmental mechanisms and how they are recycled in response to tissue damage can inform efforts to achieve regeneration in cases where it does not naturally occur (as with human limbs) and efforts to utilize embryonic stem cells to engineer cell types and tissues in vitro with an eye towards therapies. With a strong core of faculty in Developmental Biology, connections between these faculty and tissue engineers at Rice, and translational collaborations within the Texas Medical Center, Rice is poised to capitalize on these strengths to become a leader in development and regeneration.

Current strengths. There are currently several faculty in Biosciences working in areas of Developmental Biology relevant to regeneration and utilizing different, complementary model systems including Chicken, Mouse, and Zebrafish embryos and human embryonic stem cells. This range of systems is ideal for techniques from genetics, imaging, and embryonic manipulation and offers excellent potential for advancing fundamental understanding of development and using this knowledge to inform biomedical and engineering applications. Examples of emerging synergistic projects are (1) understanding the role of cellular communication in stem cells and model organisms with the goal of controlling signaling to give rise to particular cells types and tissues and (2) using barcoding technologies to track the fate of stem cells and their derivatives introduced in vivo to better understanding how engineered tissue integrates into a host. This work also benefits from collaborations with Bioengineers at Rice who specializes in three-dimensional tissue engineering and manipulation of the cell environment to achieve particular outcomes and from translational collaborations within the Texas Medical Center.

Investment needed. (1) Personnel such as postdocs working on collaborative projects would allow for generation of preliminary data for competitive multi-investigator proposals. (2) Faculty hiring in the fields of development, stem cell biology and tissue engineering with an eye towards complementing existing strengths and model systems. (3) Core facilities with common equipment. Of particular need are two-photon and light-sheet microscopy capabilities for live imaging on developmental length and time scales and flow cytometry for sorting particular populations of live cells for use in tissue engineering.

Potential impact. It is anticipated that success in this area would lead recognition of Rice as a leading institution in this field and to a collaborative center grant. This would in turn help attract top faculty and students in the area of developmental biology and would make the success funded by this initiative self-sustaining.