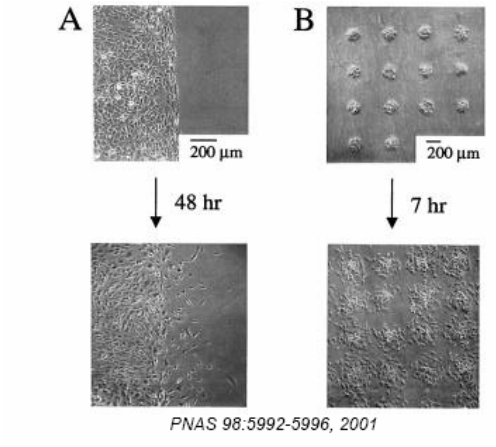
Mechanical Cues for Stem Cells

Over the past decade, embryonic and adult stem cells have gained enormous attention within the research community and the general public. The hope is that, depending on the stem cell type, one can produce specialized cell types and utilize them for the treatment of different diseases. Development of the enabling technologies for the production of specialized cell types from stem cells remains one of the major challenges for the research community.

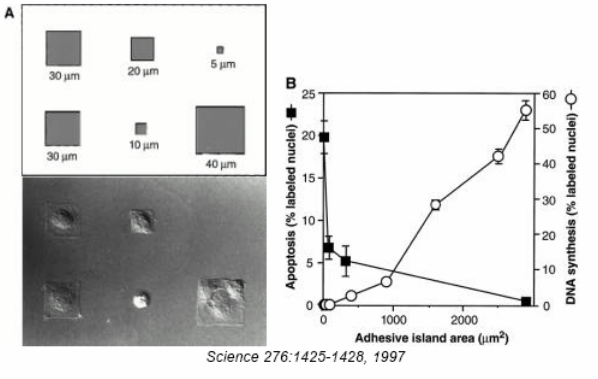
Stem Cells have three major choices: 1) Divide and proliferate or 2) Differentiate into specialized cell types or 3) Undergo apoptosis and die. The key challenge for researchers is to develop appropriate microenvironments to determine stem cell fate of choice. The fate of the stem cells can be appropriately decided by a synergistic combination of biochemical, physical and mechanical cues. It is useful to note that most of the differentiation and proliferation studies with stem cells focus on biochemical and physical cues. Modulation of signaling pathways and growth factor formulations constitute biochemical cues, while extracellular matrix modifications constitute the core of physical cues. Little or attention has been paid to mechanical cues as they might pertain to stem cells.

Several studies indicate that cells actively probe the mechanical properties of their environment and respond with significant changes in cell behavior including focal adhesion strengthening [1, 2], change in cell morphology [2-4], cytoskeleton stiffening [3, 5], and elasticity guided migration [2, 3, 5, 6]. These studies with different mammalian cells have demonstrated that cells do indeed respond to mechanical cues. The hypothesis that stem cells respond to their mechanical microenvironment thus warrants attention.

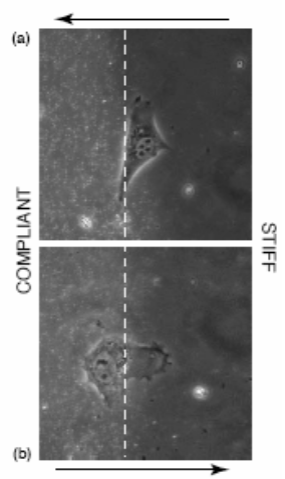
Geometry and cell shape can control cell fate and cell behavior



PNAS 98:5992-5996, 2001



Science 276:1425-1428, 1997



Biophysical Journal, 2000. 79: p. 144-152

Questions to ponder about….

- How sensitive are cells to changes in mechanical properties of their environment?
- How small of a change in elasticity can cells sense?
- Can the sensitivity of cells to mechanical cues be used in the development of bioassays?
- What kind of differentiation strategies need to be developed for specialized cells from stem cells?
- What kind of propagation strategies need to be developed for stem cells?

Key references….

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