Pattern recognition with markerless, stain-free, non-destructive imaging.

Ilya G. Goldberg
Image Informatics and Computational Biology Unit –
National Institute on Aging/NIH
Baltimore, MD
igg@nih.gov

***Abstract*—In the early stages of their characterization, biological systems have no known molecular biomarkers that can be used as probes. Imaging using stains and biomarkers typically alters the physiology of the samples, which may not be desirable when imaging is not the end-point and the samples have to continue to grow and function with as little perturbation as possible. Stem cell studies typify these two challenges. On the one hand, the earliest cell fate decisions are typically poorly understood, and molecular biomarkers of these events are either unknown or poorly characterized. On the other hand, these cells are poised to differentiate along multiple possible lineages, and small perturbations can have large effects on their developmental trajectories. The future of stem cell therapies requires overcoming these challenges to evaluate pluripotency and characterize early fate decisions, all while preserving viability and minimizing the impact of imaging on their physiology. Pattern recognition with brightfield images is not dependent on prior knowledge of or rational models for relating gross morphology to cell physiology. These relationships can be discovered automatically during classifier training as long as the collection of image descriptors is sufficiently large to distinguish the desired target physiologies. Rational models are not necessary even when quantifying relative phenotypic distance between multiple target morphologies. Two studies will be presented using brightfield imaging and pattern recognition using WND-CHARM for markerless stem-cell characterization. One of the applications will be focused on early cell fate decisions in mouse embryonic stem cells, and the other on evaluating the induction of human pluripotent stem cells.**

***Index Terms*—Pattern recognition, machine learning, brightfield microscopy, image analysis, stem cells.**

***Funding*— This research was supported entirely by the Intramural Research Program of the NIH, National Institute on Aging.**