Evolution of a Primitive Developmental Program in the Transition to Multicellularity. E. Wolinsky[1] and E. Libby[2], [1]Santa Fe Institute, 1399 Hyde Park Rd., Santa Fe, NM, 87501, USA, [2]Santa Fe Institute, 1399 Hyde Park Rd., Santa Fe, NM, 87501, USA (elibby@santafe.edu).

Introduction: Multicellular organisms rely on developmental programs to coordinate growth and differentiation from single cells, but the origins of such programs are unknown. A potential starting point is stochastic phenotypic variation produced by molecular noise. With appropriate environmental conditions, this noise-driven differentiation could possibly evolve to come under some form of regulatory control. We consider an experimental system used in the study of the origins of multicellularity, in which organisms produce stable fluctuations in the environment and oscillate between unicellular and multicellular forms. In this system there is a single optimal stochastic program for survival that is robust to perturbations and is unbeatable by other stochastic strategies. The only way for an organism to successfully invade is for it to developmentally regulate phenotype production and, thereby, a life cycle. Here, we investigate the performance of two primitive developmental programs. One program uses external environmental signals while the other relies on internal signals. We use mathematical models to compete these programs against the optimal stochastic strategy and find that both have areas of parameter space in which they are more successful. The use of external signals requires far less tuning of parameters than internal signals and is ultimately a better strategy. Both programs are robust to environmental perturbations and show that once regulatory control evolves in this system, it can easily invade. This provides a possible route from stochastic phenotypic variation to a developmentally regulated life cycle during a transition to multicellularity.