WHAT SYMBIONTS, PATHOGENS AND CELL FUSIONS TEACH US ABOUT EVOLUTION

J.A. Shapiro

Department of Biochemistry and Molecular Biology, University of Chicago, Gordon Center for Integrative Science, 979 E. 57th Street, Chicago, IL 60637, USA

Over a half century of molecular genetics has transformed our view of how genomes operate in the cells of living organisms. Instead of the DNA-centric view in which the genome determines the properties of cells and organisms, we understand today that cells use their genomes as read-write (RW) data-storage systems. The ability of cells to restructure their genomes is critical to episodes of evolutionary change, where new genomic structures become necessary to survive and proliferate in a modified ecology. Contrary to conventional evolutionary views, the genome record teaches us that many of these changes involve intercellular and intracellular horizontal DNA transfer, cell fusions, novel symbiotic associations and unusual fertilization events. Illustrations of critical genome sequencing data come from all kingdoms of life (bacteria, archaea and eukarya) and from both microbes and larger organisms. Cell sensory and regulatory networks as well as the molecular toolkit for genome restructuring are central to a modern 21st Century view of the evolutionary process. The ability of cells to regulate genome restructuring at the epigenetic and other levels plays a key role in the timing of evolutionary events. It is likely that the complementary ability of cells to target change within the genome has played a significant part in the origination of evolutionary novelties, ranging from new protein domains to entire morphogenetic circuits. These ideas serve as the basis for a new way of thinking about the evolutionary process that both integrates ecological disruptions and suggests an innovative research agenda for the new century.