



James Umen

Assistant Professor
Plant Biology Laboratory

“My laboratory is interested in fundamental questions in cell biology—how do cells control growth and division, how do they determine their size, and how do the genetic pathways that control size and division evolve to generate life’s incredible diversity?”

Sex chromosomes and sexual selection strongly influence every aspect of biology, including development, behavior, and even ecological interactions between species. Umen’s research team has taken advantage of a unique group of green algae to begin answering a longstanding question in developmental and evolutionary biology: How do different sexes evolve?

While the single-celled alga *Chlamydomonas* has two sexes whose reproductive cells look identical, its close relative *Volvox* is multicellular and has evolved females and males that produce eggs and sperm, respectively. When Umen and his collaborators sequenced the sex-determining chromosomal region from both species, they found intriguing differences. Not only was the size of the sex-determining region from multicellular *Volvox* much larger than that of its unicellular relative *Chlamydomonas*, but the genes within this sex-determining region were found to evolve in a very different manner from those of the single-celled species. Unlike *Chlamydomonas*, the male and female versions of genes in the *Volvox* sex-determining region were so distinct that they looked as if they came from different species.

Using revolutionary “deep-sequencing” technology, which allows researchers to quickly identify genes and their expression patterns, Umen’s laboratory found a large number of newly evolved genes in the *Volvox* mating locus that do not have counterparts in *Chlamydomonas*. Moreover, they found sex-linked patterns of molecular evolution and expression for many of the genes in the locus, indicating that sex chromosomes are a rich source of new genetic material and can play a major role in driving changes in sexual development. A recent study in humans has indicated that—similar to the *Volvox* sex-determining region—the human Y chromosome, long considered a place of slow evolutionary decay, instead is a hotspot of evolution that is changing more quickly than any other part of humanity’s genetic code.

These findings suggest that driven by common processes, sex chromosomes in species as diverse as algae and primates are evolving rapidly and dynamically.

For more information, please visit salk.edu/faculty/umen.html

Left to right:

Seated: Yubing Li, Jim Umen, Shigeki Stoner, Cristina Lopez

Standing: Sa Geng, Matt Zones, Peter De Hoff, Brad Olson

