

## New Carotenoid Has Implications for Evolution, Bioengineering

Nature makes hundreds, and possibly thousands, of different carotenoids, using two main routes. One starts with a 30-carbon backbone, the other with a 40-carbon backbone. Daisuke Umeno and Frances H. Arnold of the California Institute of Technology, Pasadena, show that a synthase for the  $C_{30}$  pathway can also assemble a 35-carbon backbone when fed certain  $C_{15}$  and  $C_{20}$  precursors. "Thus a whole new pathway, never reported in nature, became possible in the laboratory," says Umeno. "I believe our work shows how easily secondary metabolic pathways can evolve," says Umeno. "With a combination of metabolic engineering and directed evolution, we can make use of this potential to generate large numbers of new compounds, some of which may have interesting and useful biological activities. Thus, this is a kind of combinatorial chemistry as performed over evolutionary time scales in nature, now collapsed to laboratory time scales."



Arnold and Umeno

(D. Umeno, and F. H. Arnold. 2003. A  $C_{35}$  carotenoid biosynthetic pathway. *Appl. Environ. Microbiol.* 69: 3573–3579.)