

# Phylogenomic reconstruction of ancestral terpenoid biosynthesis

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Terpenoids occupy a special place in organic geochemistry owing to their high preservation potential in the geological record. Terpenoids are among essential building blocks of life and are deeply intertwined with fundamental cellular processes, including membrane organization, cell wall formation, respiration and phototrophy. Despite the enormous functional and structural diversity of terpenoids, the basal part of terpenoid biosynthesis is shared by all terpenoids and are catalyzed by homologous enzymes. In particular, biosynthesis of terpenoids that serve as precursors for biomarkers in the geological record is catalyzed by mostly only two enzyme families: *trans*-prenyltransferase (*trans*-PT) and terpene cyclase (class II TC). The *trans*-PT family has a long evolutionary history since the onset of terpenoid biosynthesis most likely before the divergence of Bacteria and Archaea, while the class II TC family likely evolved in Bacteria. These two enzyme families are evolutionarily distinct from each other and their functions were also initially different. However, both families experienced substantial functional divergence in the course of evolution. For instance, some *trans*-PT enzymes were transformed into TC (known as class I TC). In some eukaryotes, class I TC was even fused with class II TC, generating novel large enzymes (class I+II TCs). Some fused enzymes were again split into smaller enzymes, but the resulting enzymes were distinct from ancestral class I and II TCs. Hence, the diversity of biomarkers is a result of the functional diversification and interplays of these two enzyme families. However, the evolutionary history of *trans*-PT and class II TC families and their complex relationship with each other is yet to be fully understood. This talk describes an attempt of reconstructing the detailed evolutionary trajectory of *trans*-PT and class II TC families, utilizing currently-available large genomic datasets. Mono-, sesqui-, di- and triterpenoids are being integrated into a coherent story of terpenoid evolution.

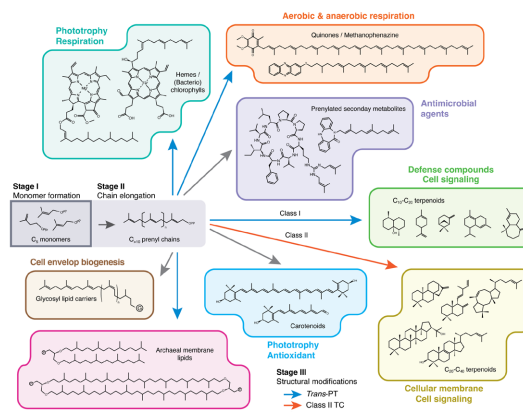


Figure 1. Schematic diagram of terpenoid biosynthesis and the distribution of *trans*-prenyltransferase (PT) and terpene cyclase (TC) families