Chapter 12

# Metabolic Engineering of Flower Color Pathways Using Cytochromes P450

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Abstract A single plant species can contain more than 250 cytochromes P450. Cytochromes P450 catalyze various reactions in plant biosynthetic pathways and play critical and diversified roles in the biosynthesis of primary and specialized (secondary) compounds, including flavonoids. Flavonoids and their colored derivatives, anthocyanins, are major constituents of flower color. Functional combinations of the cytochromes P450, flavonoid 3‘-hydroxylase (F3‘H, CYP75B), flavonoid 3‘, 5’-hydroxylase (F3‘5oH, mostly CYP75A), and flavone synthase II (FNSII, CYP93B) determine flavonoid structure and flower color. The number of hydroxyl groups on the B-ring of anthocyanins catalyzed by F3‘H and F3’5’H have an impact on the color: the more the bluer. Wild-type or traditionally bred carnations, roses, and chrysanthemums lack blue/violet flower colors because of the deficiency of a F3’5’H and therefore lack the trihydroxylated (B-ring) anthocyanins based upon delphinidin. Metabolic engineering of the anthocyanin pathway and specifically manipulation of F3’5’H and F3’H genes has produced an array of flower color modifications in many species. By optimizing transgene expression and suppressing endogenous genes in a species-specific manner, transgenic carnations, roses, and chrysanthemums producing novel violet/blue-hued flowers were engineered. Downregulation of F3’5’H and F3’H genes, often with expression of a dihydroflavonol 4-reductase gene, yielded redder flowers in petunia, tobacco, and torenia. Modulation of FNSII gene expression also impacts flower color as flavones act as co-pigments to induce bluing of anthocyanins and flavones and anthocyanins also share the same precursors.