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Synthetic Biosystems for the Production of High Value Plant Metabolites

Status	Approved
Competition	Applied Genomics in Bioproducts or Crops
Sector	Environment
Genome Centre	Genome Alberta
Project Leaders	Peter Facchini, U. of Calgary / Vincent Martin, Concordia U.

Project Description

It has been said that plants are the world's best chemists. They can synthesize an immense diversity of molecules based on innumerable chemical- backbone structures and combinations of chemical-functional groups. The unparalleled biosynthetic capacity of plants has long been exploited through their use as traditional medicines and more recently the medical and commercial application of pure plant metabolites: pharmaceuticals (e.g. codeine, vinblastine, taxol); flavours (humulone, nootkatone, carvone); fragrances (jasmine, rose oil); pigments (carotenoids, anthocyanins, betalains); insecticides (pyrethrins), and other fine chemicals. The metabolic diversity of these compounds reflects the fundamental mechanisms that drive the evolution of plant natural products; plants interact with their environment mainly through chemical means and metabolites play diverse physiological roles from pathogen defence to pollinator attraction.

Plants produce these chemical products through metabolic biochemistry, relying on a staggering number of enzymes for biosynthesis. This catalytic diversity has remained largely untapped for the industrial production of high-value products.

We will use genomic tools coupled with analysis of metabolic products to identify genes from over 75 plants that can catalyze the synthesis of potentially important chemical compounds. Our principal tool will be ultra-high-throughput DNA sequencing to find interesting genes, followed by detection of chemical products synthesized under the direction of these genes. This will give us a "parts catalogue" of functional components. These components will be assembled into enzymatic pathways inside ordinary baker’s yeast cells, which can then be used for the production of new biological processes with specific industrial applications.

The main outcomes of this project are: (1) a public resource of genomic and metabolic information for 75 plants that produce a huge number of important natural products; (2) yeast strains that produce high-value natural plant products; (3) a catalogue of new enzymes for use as catalysts in synthetic biology applications; (4) the invention of functional-genomics methods for describing metabolic pathways and identifying unknown biosynthetic genes from plants; and (5) an analysis of regulatory, ethical, and economic subjects, which will help to ensure sound

and responsible plant-technology development.