Prof. Pal Maliga, Ph.D.

Waksman Institute
Rutgers University
190 Frelinghuysen Road
Piscataway, NJ 08854-8020
United States

Pal Maliga received his Ph.D. degree in 1972 from the University of Szeged, Hungary. His early research at the Biological Research Center in Szeged focused on cell biology approaches to manipulate the plastid and mitochondrial genomes of higher plants.

In 1988, he was appointed Professor of Genetics at Rutgers, The State University of New Jersey. Since then his research group at the Waksman Institute has developed the technology for plastid transformation in higher plants using tobacco as a model system. They currently use plastid transformation to characterize the plastid transcription machinery and to understand the rules of mRNA translation, RNA editing and production of recombinant proteins in plastids. In addition, they are directing their efforts to extend the technology of plastid transformation to *Arabidopsis* and rice.

Transplastomic Technology for Safer and Better Transgenic Crops

Plastids are plant cellular organelles with their own genome ~150 kb in size, and have a prokaryotic-type transcription and translation machinery. The plastid type that differentiates for photosynthesis, the chloroplast, is the best characterized. A leaf cell typically carries about 100 chloroplasts, each having about 100 identical genome copies. It is a challenge to obtain genetically stable transplastomic lines by gradually changing all the genome copies.

A unique genetic feature of plastids in most crops is that plastids are transmitted to the seed progeny by the maternal parent only. As a consequence, plastid transgenes, including genes encoding herbicide resistance, are not transmitted by pollen. In contrast, the spread of herbicide resistance genes via pollen is a concern in crops with weedy relatives such as oilseed rape and rice where the genes are incorporated in the nucleus. Better control of transgene flow by incorporating herbicide resistance in the plastid genome will extend the life of the environment-friendly herbicides. Resistance to glyphosate and Basta are examples of successfully providing protection against commercial herbicides by plastid transgenes.

Production of recombinant proteins in chloroplasts is a promising and an unexplored area. Recombinant proteins from plastid transgenes may accumulate in leaves up to a level of 20% to 25% of total soluble cellular protein. The high level accumulation of recombinant protein is due to a high transgene copy number and in addition, the availability of expression signals that will predictably yield proteins in the range of 0.1% to >20%. The expression of recombinant proteins in chloroplasts holds a great potential for low-cost production of vaccines, antibodies, and industrial enzymes. The recombinant protein levels are sufficiently high so as to allow the direct use of leaf protein extracts in some applications without further purification. Engineering of agricultural input traits such as insecticidal properties can also benefit from high expression levels, exemplified by production of the insecticidal *Bacillus thuringiensis* endotoxin in chloroplasts.

Plastid transformation is a difficult technology. Currently, it is routinely done only in tobacco. The present challenge is to extend the technology to all major crops. Plastid transformation has been reduced to practice in potato, and it appears that rice and relatives of oilseed rape also yield to persistent efforts.