**Analysis of Genes Affecting Plant Regeneration and Transformation in Poplar**

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**Progress to Date**

1) Optimization studies related to RT for macro- and micronutrients, hormone conditions, *Agrobacterium* strains, surfactants, and many other factors are nearly completed. Results are being used to guide GWAS treatments.

2) We have nearly completed phenotyping three GWAS populations (*in vivo* stem regeneration and rooting, *in vitro* regeneration). Machine vision phenotype processing of all images is nearly compete.   
3) We have produced a GUI tool to speed annotation of images for GWAS. It enables users to specify both positive and negative types of objects, then draws boundaries around objects precisely (Figure).

3) A preliminary GWAS using GEMMA and SKAT algorithms have identified SNPs near to genes that are strong candidates for controlling rate of *in vivo* regeneration.

4) A Jupyter-based phenomic analysis work flow is nearly completed for image processing and analysis of regeneration and transformation rates on Petri dishes.

4) Surveys and concept maps from samples of rural middle and high-school students have been been analyzed, and a manuscript is in preparation.

5) Curricula related to helping teachers improve middle and high school student literacy around crop genetics and credibility of internet sources, have been used in teaching students and made available to the public.

*Example of false color output from graphical user interface developed to facilitate annotation of in vitro regeneration phenotypes. False colors show customized configurations of class and object hierarcy possible for display.*



**Project Objectives**

Regeneration of differentiated organisms from single cells is a critical need for functional genomics and for the production of genetically engineered organisms. The project will conduct a genome-wide investigation of the genes that control regenerability and transformation (RT) in *Populus*, which is one of the best studied crop species with respect to these traits. The project will identify genetic elements that control RT, develop novel phenomic methods based on image analysis, and develop new social science and education methods for teaching about genetic engineering to high school students and teachers.

Specific objectives are to (1) explore a variety of RT methods to maximize variation in RT responses; (2) develop new phenomic tools, including an image capture and generalizable machine-vision system, to precisely determine *in vivo* and *vitro* phenotypes; (3) using GWAS, map sets of alleles that are associated with variation in RT frequency; and (4) study cognitive processes with respect to GE crops, develop case studies and new teaching materials, deliver them to rural and underserved communities in the Pacific Northwest, and through publications, social media, and conferences share the project’s insights and teaching modules internationally.

**Highlights**

[**Recognition and quantitative analysis of transformation in tissue cultures using hyperspectral imaging and machine learning**](http://people.forestry.oregonstate.edu/steve-strauss/sites/people.forestry.oregonstate.edu.steve-strauss/files/Nagle_Strauss_SIVB2020.pdf)  
Society for In Vitro Biology National Meeting (online), June 2020, invited lecture.

[**Transformation Improvement in Poplar (Populus trichocarpa): Effects of antioxidant and auxin treatments**](http://people.forestry.oregonstate.edu/steve-strauss/sites/people.forestry.oregonstate.edu.steve-strauss/files/SIVB_2020_poster.pdf)  
Society for In Vitro Biology National Meeting (online), June 2020, volunteered poster.

[**Transformation phenomics: Detection of transgenic tissues in plant tissue cultures by cross-referencing of RGB and hyperspectral image datasets analyzed by deep learning and regression**](http://people.forestry.oregonstate.edu/steve-strauss/sites/people.forestry.oregonstate.edu.steve-strauss/files/NaglePhenomeFINAL_lowres.pdf)  
Phenome 2020, Tucson, AZ, February 2020, invited lecture.

**Keywords:** *Populus*, *in vitro*, machine vision, differentiation, GWAS, phenomics, transformation

**Project** [**Website**](http://people.forestry.oregonstate.edu/steve-strauss/genes-affecting-plant-regeneration-and-transformation-poplar)

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