Project Overview
Analysis of genes affecting plant regeneration and transformation in poplar

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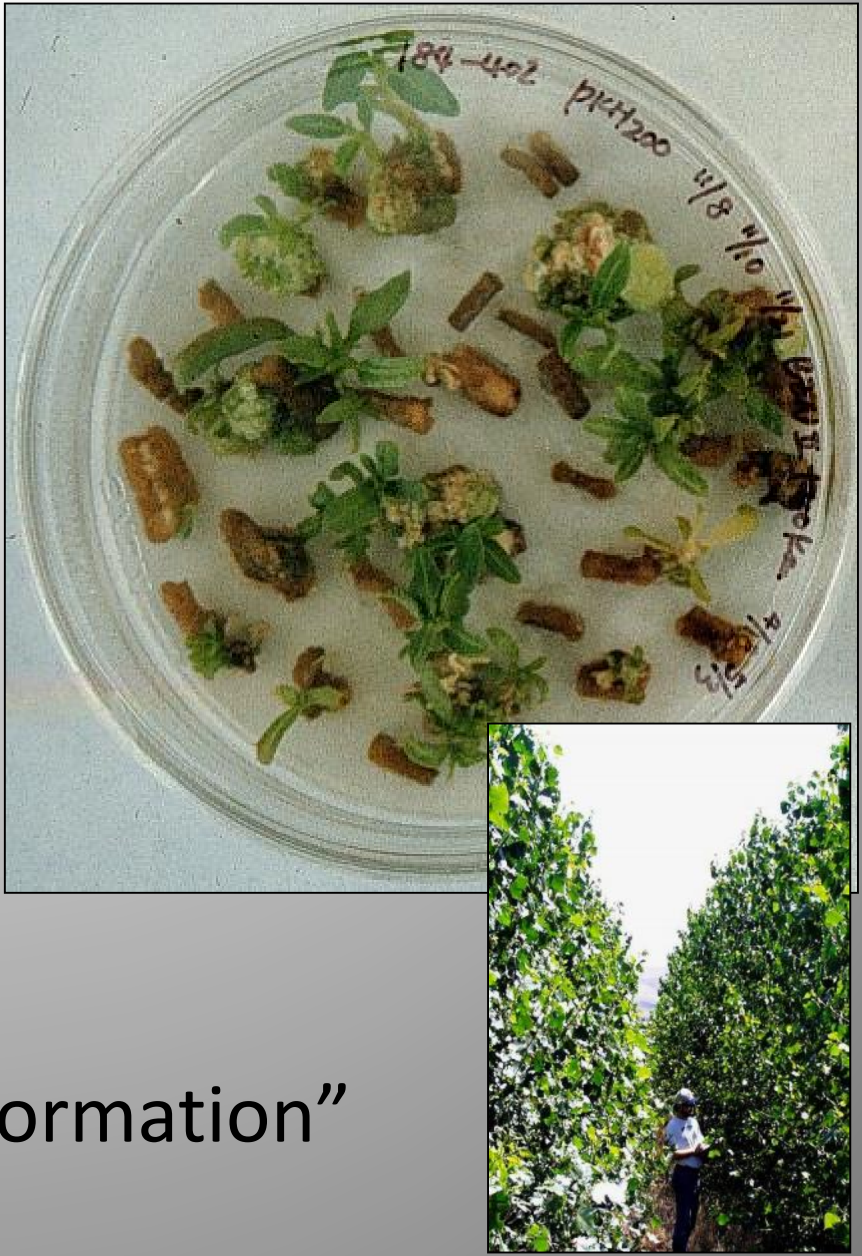
A National Science Foundation funded project

- NSF Plant Genome Research Program (IOS # 1546900)
- All NSF projects require both scientific research and outreach/education efforts
- Leverage the expertise and research discoveries to benefit education and society
- An interdisciplinary, 5 year project
  - Botany, genetics, computer science, statistics, bioinformatics, social science, education

What is genetic engineering?

- Direct modification of DNA
  - Vs. indirect modification in breeding and marker selection
- Asexually modified, usually in somatic cells
  - Then regenerated into whole organisms, most often starting in Petri dishes
- Gene transfer called "transformation"



The same process required for "gene editing"

nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

Dawn of the gene-editing age

PAGE 155

CRISPR EVERYWHERE

CONSERVATION

A WORLD OF TWO HALVES

E. O. Wilson's vision for an Earth shared with nature

PAGE 170

PLANT BIOLOGY

FLOWER ARRANGEMENT

An attractant/receptor pair driving pollen-tube growth

PAGES 178, 241 & 245

GROUP DYNAMICS

THE RIGHT SIZE FOR A LAB

The skills mix and head count needed for success

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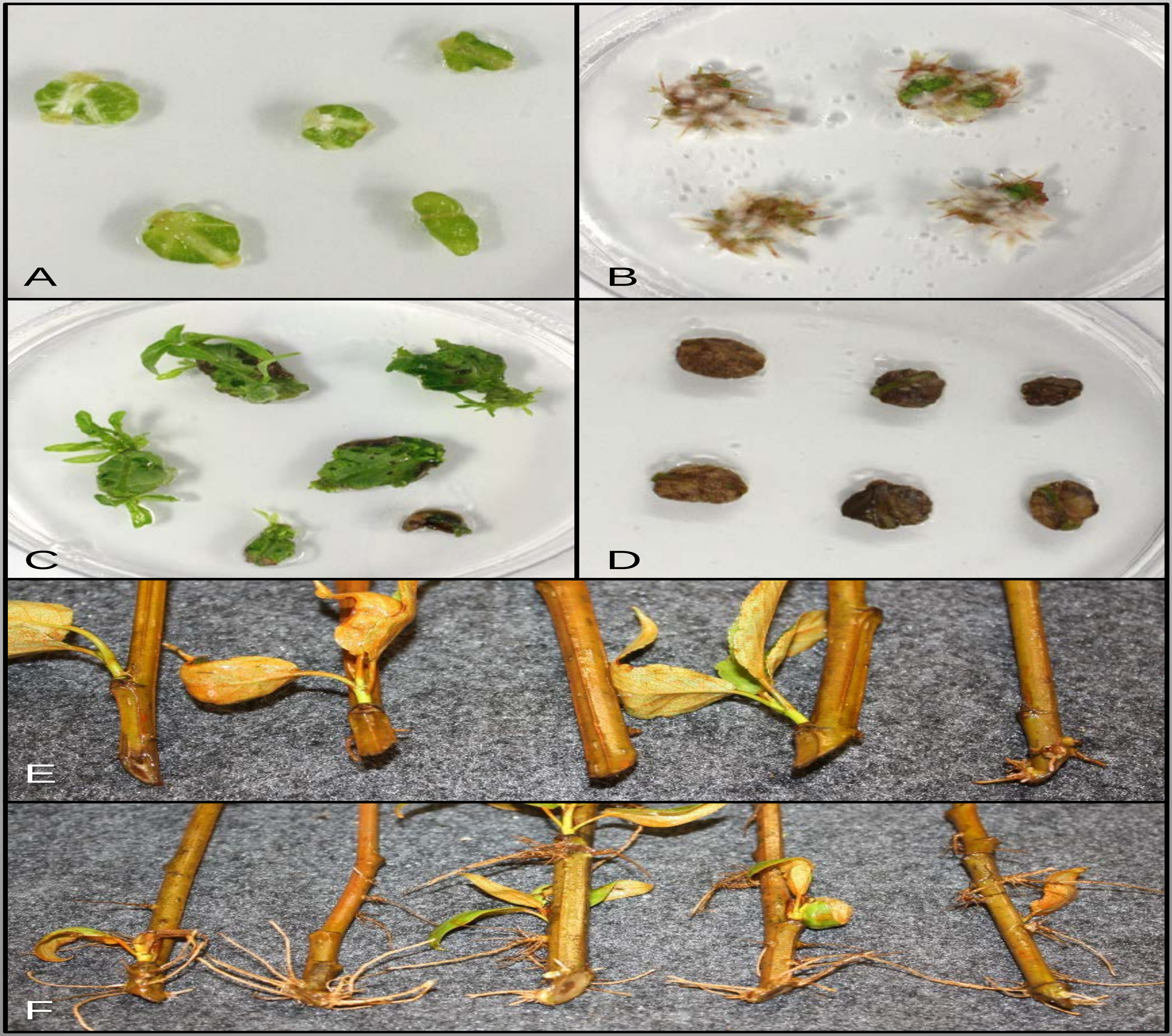
Regeneration and transformation varies widely among wild cottonwoods



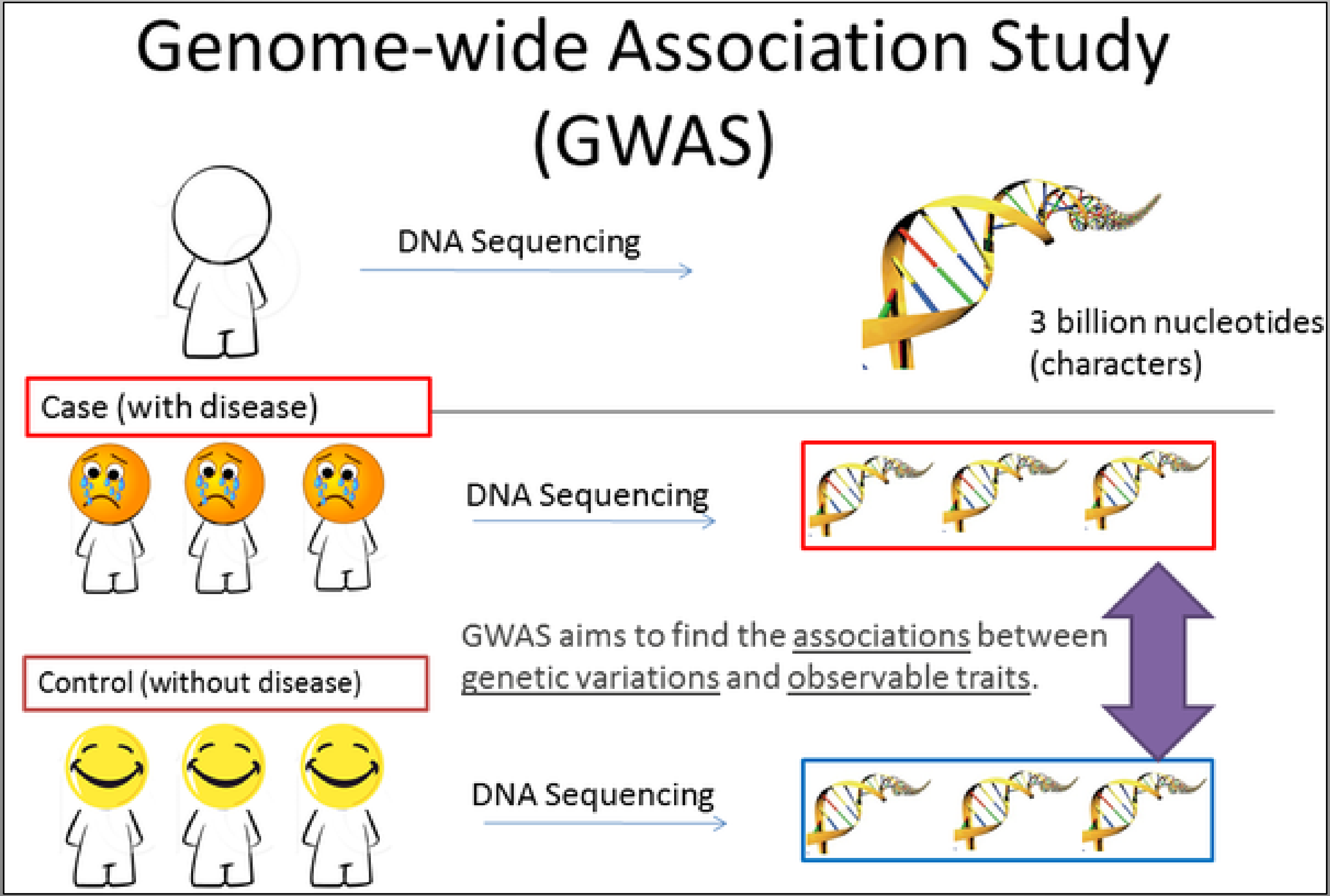
Project rationale and goals - 1

- Regeneration and transformation (RT) is critical to producing genetically engineered plants for science or application
- The biological controls on RT, and the causes of the great genetic variability in it, are unknown
- If we ID the genes that control RT, we can gain insight into how it works
- If we understand RT better, we can develop better methods for genetic engineering

Project rationale and goals - 2

- The project will conduct a genome-wide association study (GWAS) of RT in *Populus* (= cottonwoods, aspens)
  - Use of DOE re-sequenced cottonwood collection (~1,000 wild genotypes)
  - We add on the RT traits and map the genes
- The project has three main activities
  1. Develop novel phenomic (= in depth trait analysis) methods based on image analysis
  2. Identify genetic elements that control RT by GWAS
  3. Develop new social science and education methods for teaching about genetic engineering to high school students and teachers

GWAS is widely used in human genetics to understand diseases, etc



Genome-wide Association Study (GWAS)

DNA Sequencing

3 billion nucleotides (characters)

Case (with disease)

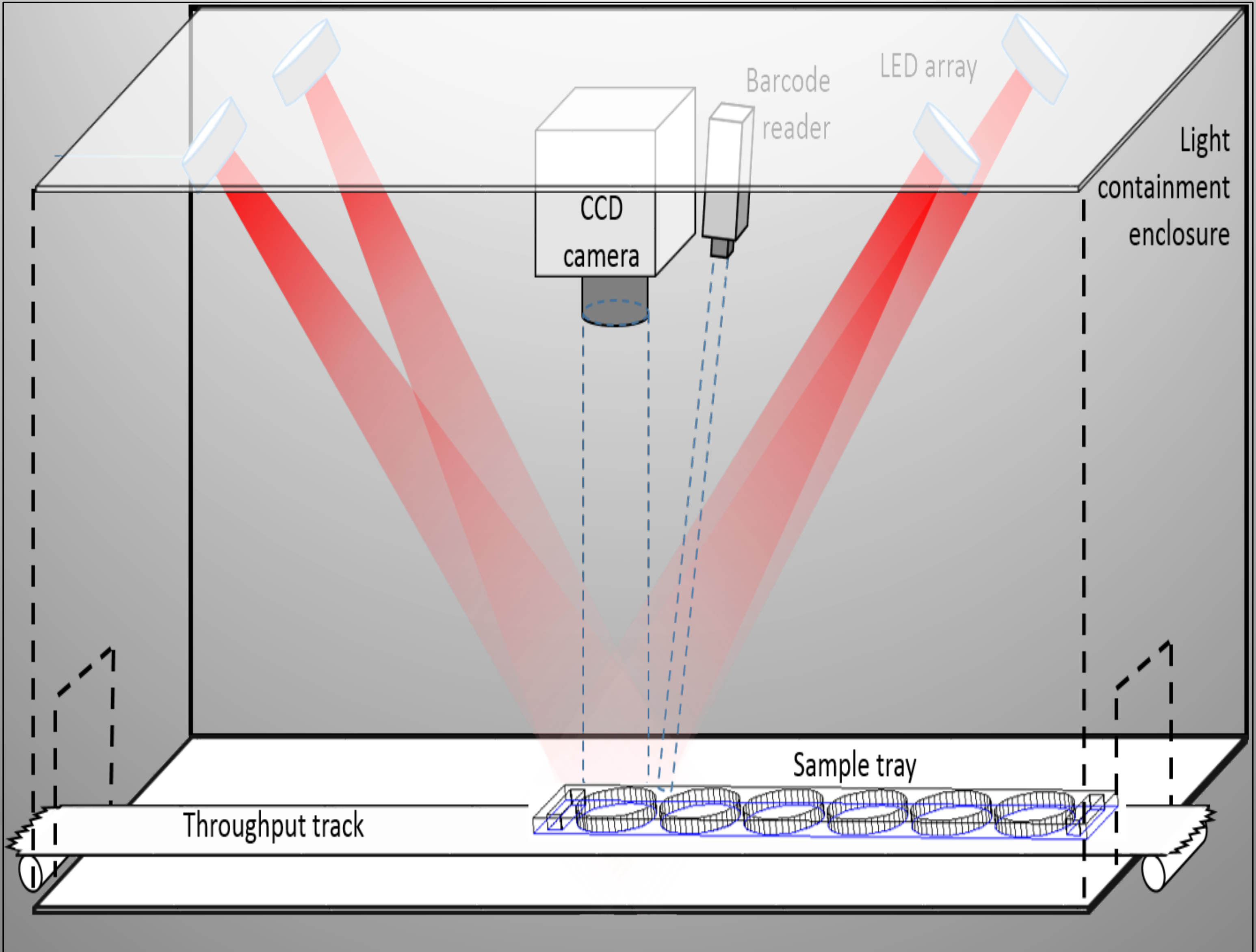
DNA Sequencing

GWAS aims to find the associations between genetic variations and observable traits.

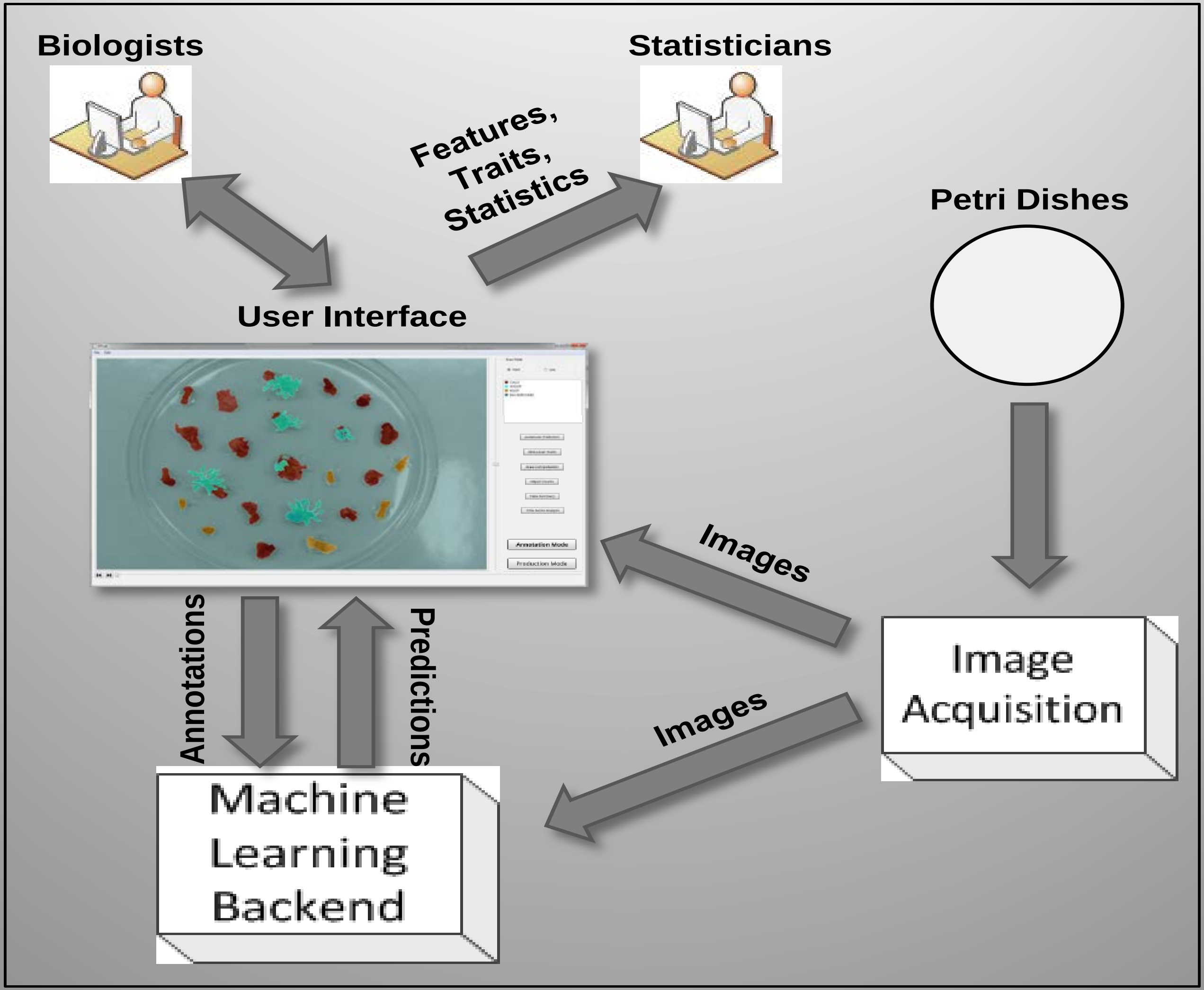
Control (without disease)

DNA Sequencing

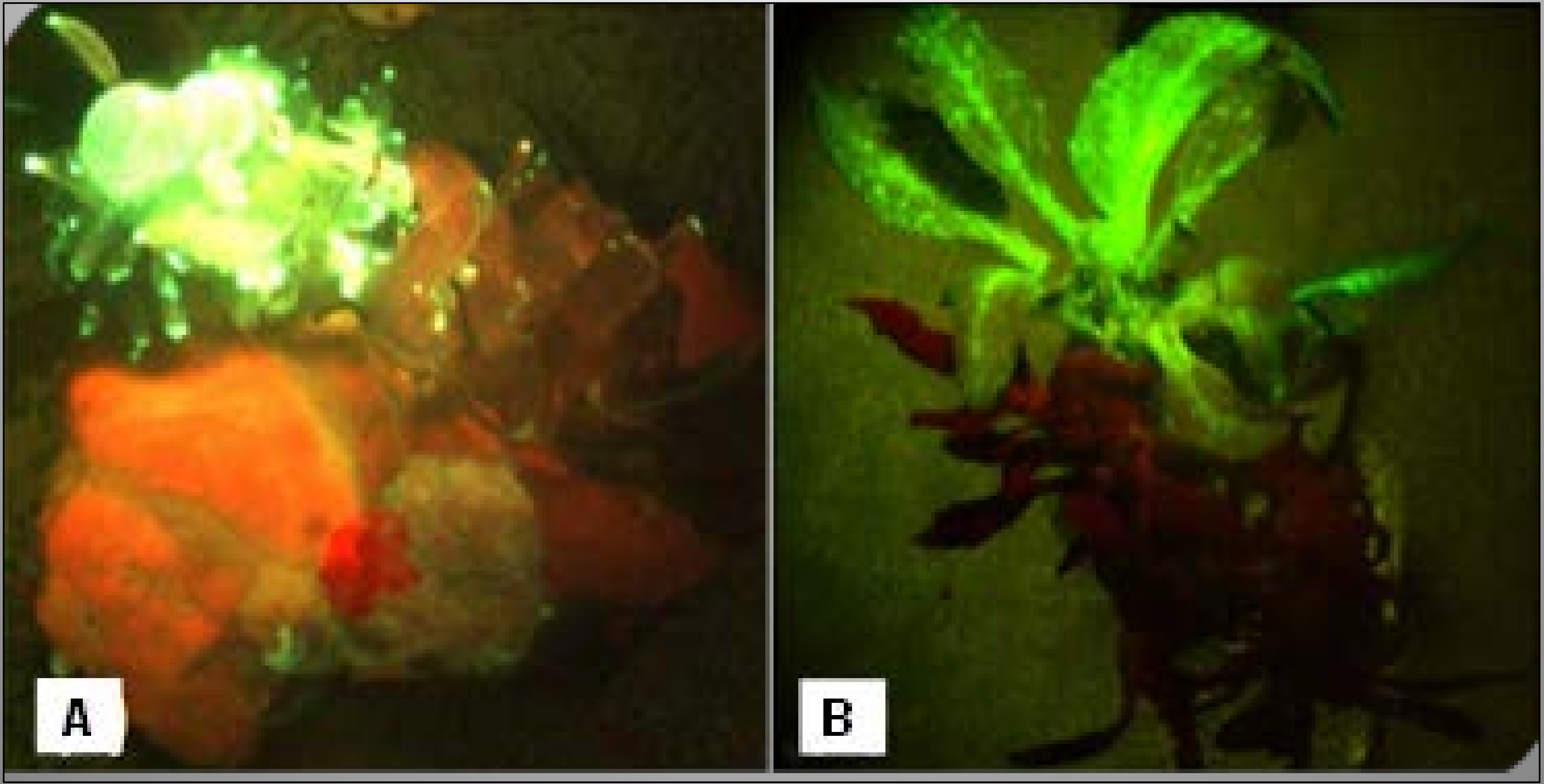
Phenomics: Image acquisition system concept



Phenomics: Machine vision analysis concept



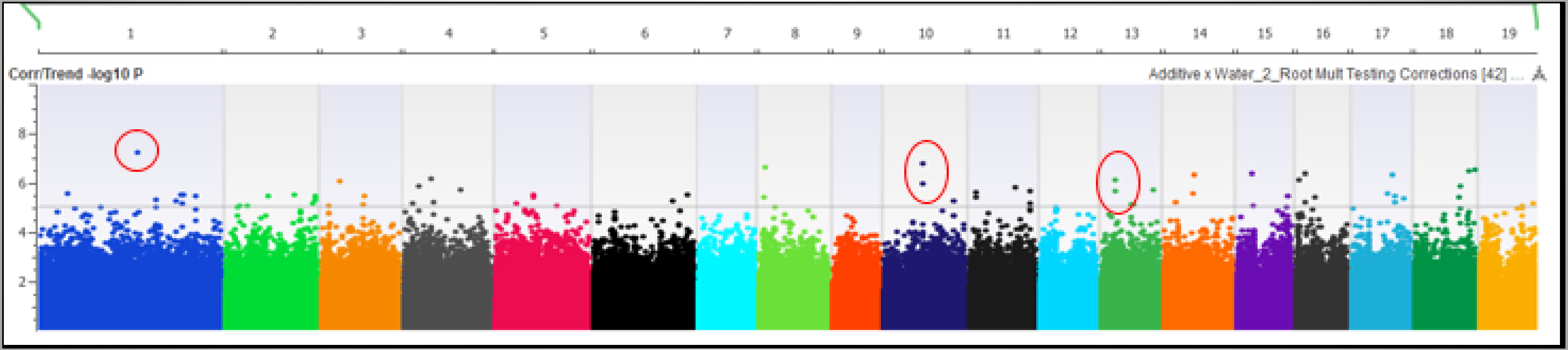
Phenomics: Hyperspectral analysis of transformation with fluorescent marker genes



Pilot study of rootability

Machine vision analysis

Some preliminary gene identifications

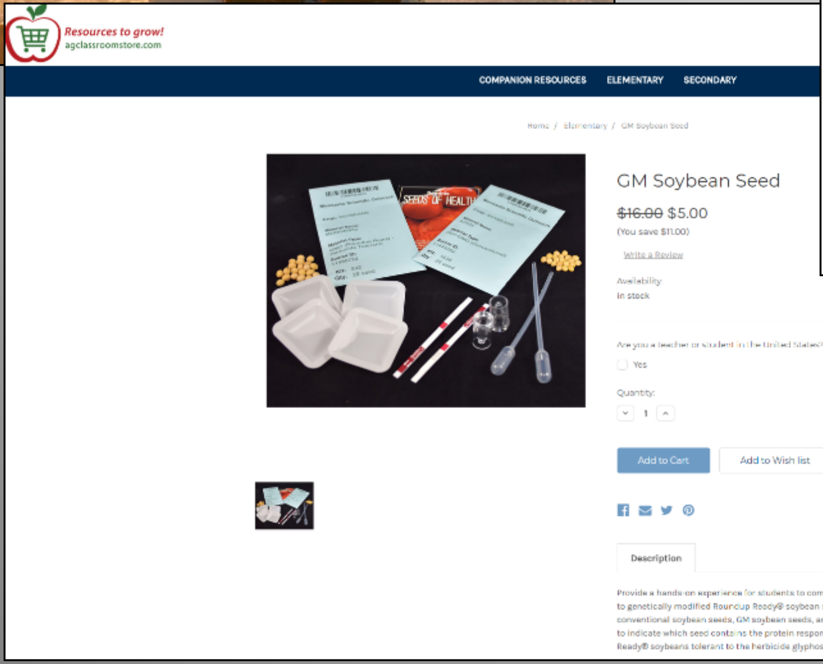


Chromosome	Position	-log10 P-value	Gene	Notes/Description
1	27299510	7.20	Potri.001G264500.1	SNP in gene, UBX domain, Arabidopsis homolog PUX1 gene, loss of which is known for accelerated growth of roots
10	10735457	5.94	Potri.010G081300.1	Protein Argonaute 10, known for small RNA-directed gene slicing, expressed in roots
10	10808758	6.71	Potri.010G081900.1	Expression in roots, Arabidopsis homolog dyggve-melchior-clausen syndrome protein
13	3730879	6.09	Potri.013G051100.2	SNPs very close, both hit in gene. Zinc finger FYVE domain containing protein, high expression in root tips
13	3730867	5.61		

Outreach: Genetic aspects of case studies

- Two GMOs under consideration at present
- Herbicide resistant soybean
  - Most widely used GMO, great economic and ecological benefits, and also significant agronomic and ecological problems
  - Great materials and teaching modules available, including diagnostic "GMO dipstick"
- Bruising reduced "Innate Potatoes"
  - Only potato genes modified or introduced
  - Example of response to consumer demand, GMO controversy
  - Clearly visible consumer-friendly trait, no need for dipstick

Soy system well developed, materials available for free or low cost



GM Soybean Seed

~~$16.00~~ $5.00

(You save $11.00)

Write a Review

Availability:
In stock

Are you a teacher or student in the United States? Required

☐ Yes

Quantity:
1

Description

Provide a hands-on experience for students to compare conventional soybean seeds to genetically modified Roundup Ready® soybean seeds. This kit includes conventional soybean seeds, GM soybean seeds, and the testing materials to indicate which seed contains the protein responsible for making Roundup Ready® soybeans tolerant to the herbicide glyphosate.

National Agricultural Literacy Curriculum Matrix

The Science of a GMO

Grade Level(s)
9 - 12

Estimated Time
3 hours, plus observation of seed/plant growth

Purpose
Students will compare and contrast methods of selective plant breeding, describe the scientific process of creating a genetically modified plant, compare genetically modified soybean seeds to conventional soybean seeds, describe the impact weeds have on plant growth, and understand how a genetically modified seed can help farmers manage weeds. This lesson is listed on NSTA's website as a Classroom Resource.

Materials
Interest Approach:

- *What is the Difference?* survey (administered with *Kahoot!*) and student devices for participation

Innate vs. parent lines after cutting

<1 minute
after cutting

1 hour after
cutting

2 days
after cutting