Connecting Genotype to Phenotype in 7-12 Classrooms with iTAG Barley

**iTAG (Inheritance of Traits and Genes)**

- **Science in action**
- Segregation [1 gene (RET) / 1000's (RNA-Seq)]
- Mutation
- Epistasis
- Domestication & Agriculture
- => Scientifically literate citizens

**Oregon Wolfe Parents**

OWB Dom Hooded
(Kap / Kap, Lks2 / Lks2)

OWB Rec Short-Awned
(kap / kap, lks2 / lks2)

**Also:** Vrs1 gene (2 row vs. 6 row) - a domestication trait

**Genes that Affect Awn Development**

- **Kap** (from German "kapuze" meaning hood)
  - Creates a morphological hood by developing an extra palea on the distal end of the lemma followed by rudimentary florets with inverse polarities.
  - Example of a homeotic mutation (Maize knotted homolog).

**Genes that Affect Awn Development (cont.)**

- **Lks2**
  - Affects the length of awns.
  - **NOTE:** lks2 is epistatic to Kap.

**Immortal doubled haploids easily genotyped and phenotyped**
**Genes that Affect Agronomic Performance**

- **Vrs1**
  - 2 row (Vrs1) vs 6 row (vrs1)
    - Encodes a transcription factor that includes a homeodomain with a closely linked leucine zipper motif
  - 6-rowed phenotype originated multiple times and in different regions, through independent mutations of Vrs1.
  - Improved yield established barley as a founder crop for the Near Eastern Neolithic civilization.

**Kap Amplification in OWB Parents and 18 Doubled Haploid Progeny**

- OWB Dom
- OWB Rec
- Line 1
- Line 2
- Line 3
- Line 4
- Line 5
- Line 6
- Line 7
- Line 8
- Line 9
- Line 10
- Line 11
- Line 12
- Line 13
- Line 14
- Line 15
- Line 16
- Line 17
- Line 18
- 1 kb Ladder
- 1 kb Ladder

Note: Size difference caused by a 305 bp intron insertion

**Sequence of “iTAG” Module**

Scaffolding for a 10th grade classroom; 40’ increments

1. Plant OWB following the planting protocol
2. Pipette practice
3. Leaf tissue DNA extraction
4. PCR of Kap gene
5. Kap amplicon electrophoresis
6. Gel staining protocol
7. Work the puzzle
8. PCR of Vrs1 gene
9. Restriction digest of Vrs1 amplicon

**NSF-Funded Classroom Equipment**

- 1. Microcentrifuge
- 2. Thermocycler
- 3. Power supply and four gel boxes
- 4. Four sets of pipetteman
- 5. Blue light Transilluminator
- 6. Consumables
- Total ~ $20,000

**Lab Manual**

- Teacher Version
- Student Version
- Available as an iBook or online [http://www.public.ias.state.edu/~imagefp/subpages/outreach.html](http://www.public.ias.state.edu/~imagefp/subpages/outreach.html)
Extensions to the Module

- Strawberry DNA Extraction
- Tip Top Electrophoresis

Teacher - Scientist Engagement

2009: An Idea

2010: NSF Award # 0922746
iTAG implemented in 35 high school classrooms from 2010 - 2014 and has impacted more than 1,000 students from rural to urban communities

2014: NSF Award # 1339348
iTAG Teacher Workshop: projected to be implemented in 53 high school classes and impact over 1,400 students in 2015-16

iTAG Workshop

iTAG Scholars in Action

iTAG Teachers in Action