**From Gene to Phenotype**

**(Regulation; intra-and inter-locus relationships)**

**Study guide and reading assignments**

***Reading assignments:*** can be downloaded, as pdfs, from Canvas – in the “Files” folder.

* Required:
  + Bradbury et al. fragrance. Full paper
  + Schnabel and Springer\_heterosis. Page 72 – 79 (Transcriptomic variation) + Conclusions. The rest of the paper will be assigned once we have covered genome architecture.
* *Highly recommended, but not required:*
  + Morris and Mattick\_RNA reg

1. If diploid plants have, on average, 30,000 genes, why is it of interest/importance to understand gene regulation?
2. List and briefly define six ways that genes can be regulated.
3. Focusing on promoters, what is a promoter and how can it affect gene expression?
4. Do all transcription factors bind at promoters to influence gene expression?
5. In your opinion, is it correct to say that translational and post-translational modification of proteins is a type of gene regulation? Why or why not?.
6. Based on the Nature video on RNA and in-class slides,
   1. Describe how the video narration of mRNA synthesis relates to the presentation in class.
   2. What two types of small RNAs are the focus of the video, and how do these small RNAs regulate gene expression?
   3. How do siRNAs and miRNAs differ in terms of where/how they originate?
   4. What is Dicer, and what does it do to double stranded RNAs?
   5. On average, what size RNA remains after Dicer has done its job?
   6. What is the role of the argonaute proteins?
   7. What is the RISC?
   8. How does RISC affect mRNA?
   9. How do siRNAs and miRNAs differ in terms of specificity?
7. What other ways can RNAi achieve gene regulation besides cleavage of mRNA?
8. Explain the different dominance relationships that can exist at any genetic locus (complete dominance, incomplete dominance, co-dominance, over dominance).
9. Why are co-dominant alleles at a locus more useful for genetic analyses than dominant and recessive alleles?
10. Explain the different theories for heterosis and their relevance to breeding hybrid crops.
11. According to the dominance hypothesis for heterosis, should it be possible to develop an inbred with the same phenotype as an F1 hybrid? Why or why not?
12. Is heterosis as important in natural ecosystems as it is in agroecosystems?
13. Why is F1 hybrid seed more commonly grown than F2 hybrid seed?
14. Why is understanding epistasis important for breeders of pumpkins and squash? If you need more perspectives in order to answer this question, see <http://hortsci.ashspublications.org/content/40/6/1620.full.pdf>
15. What is epistasis and why might it be the rule rather than the exception?
16. Explain how the different relationships between alleles at interacting loci can lead to differences in the standard dihybrid ratio expectations for F2s and doubled haploids.
17. According to the required reading by Bradbury et al.:

* Is 2-acetyl-1-pyrroline associated with just aroma in rice?
* What was revealed by the comparing the sequence of the BAD2 gene between fragrant and non-fragrant varieties?
* What is the proposed type of mutation in BAD2 that leads to fragrant rice?
* Is fragrance dominant or recessive, and why?
* Is there more than one BAD gene in rice?
* Are some BAD genes reported to have pleiotropic effects, and if so, why would this be important to rice breeders?
* What additional experiment(s) would you like to perform to prove that that BAD2 is indeed responsible for fragrance in rice?

1. According to the required reading by Schnable and Springer on heterosis,

* What is the meaning of “heterosis” and why is it of importance to agriculture and horticulture?
* Compare and contrast the dominance and overdominance hypotheses for heterosis in terms of proposed mechanism and practical implications.
* Which are likely to be more important to plant breeders interested in heterosis - quantitative or qualitative traits, and why?
* Define and contrast IDPs, SV, CNV, and PAV.
* What is the transcriptome?
* Why can’t the authors provide a simple explanation of heterosis, given all the molecular tools available?