Day 2
Quantitative Genetics: Autopolyploids

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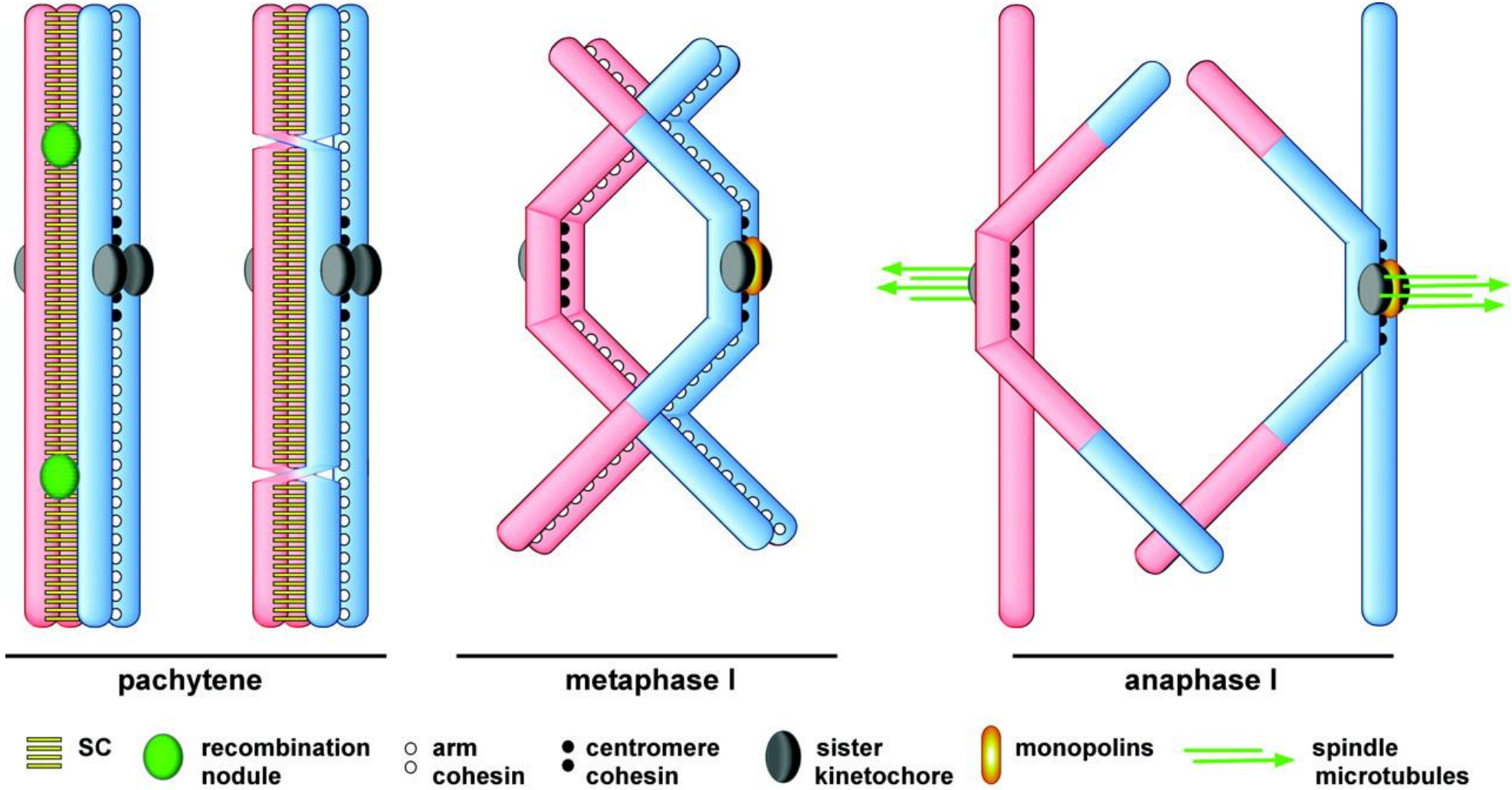
Types of Polyploids

- Paleopolyploids (e.g. maize)
  - Genome is a fusion of ancestorial genomes
  - Diploids with large chromosomes and gene duplications
- Allopolyploids (e.g. wheat)
  - Genome contains subgenomes from related species
  - Diploid like inheritance as subgenomes don’t recombine
- Autopolyploids (e.g. potato)
  - More than two copies of each chromosome
  - Complex meiosis

Meiosis Review



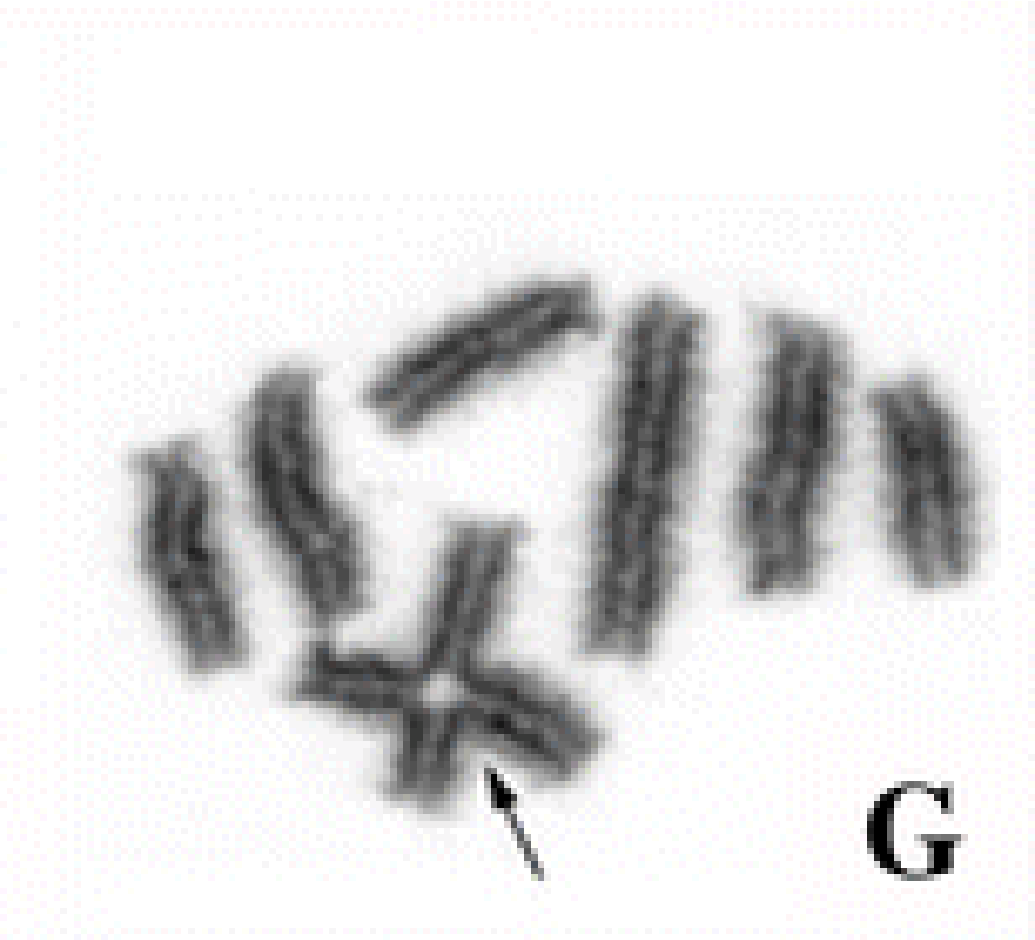
Source: Page and Hawley (2003)

Tetraploid Chromosome Paring

Figure 1 Three metaphase configurations of one set of homologous chromosomes in tetraploid meiosis. A. two bivalents; **B**. "cross-type" quadrivalent; **C**. "parallel" quadrivalent. In a cross-type quadrivalent two branches contain the tops of two chromosomes, and two branches the bottoms of two chromosomes; the location of the chromosome exchange point (the position where the branches meet) may vary between meioses.

Source: Voorips and Maliepaard (2012)

Example Images



Important Considerations

- Chromosome pairing is species specific
  - Ratio of bivalent to quadrivalent pairing
  - AlphaSimR model cross-type quadrivalents or bivalents

- Location of centromere matters in quadrivalent pairing
  - AlphaSimR defaults to middle of chromosome (metacentric)
  - Determines probability of a double reduction

- Random mating does not achieve HWE

Double Reduction

- It’s possible to get two copies from a single chromosome
  - Only occurs in quadrivalent pairing
  - Resulting in higher rates of inbreeding

- Assume a tetraploid with four alleles (ABCD)
  - Potential gametes with bivalent pairing:
    - AB, AC, AD, BC, BD, CD
  - Additional gametes possible with quadrivalent pairing:
    - AA, BB, CC, DD

Genotype Coding

- Universal in diploids, but no consensus in polyploids
- Higher orders of dominance (polynomial series)
  - Digenic, trigenic, tetragenic

Diploid		Tetraploid (Easton, 1976)	
Dosage	Value	Dosage	Value
2	a	4	2a
		3	a+3d+t+w
1	d	2	4d
		1	-a+3d-t+w
0	-a	0	-2a

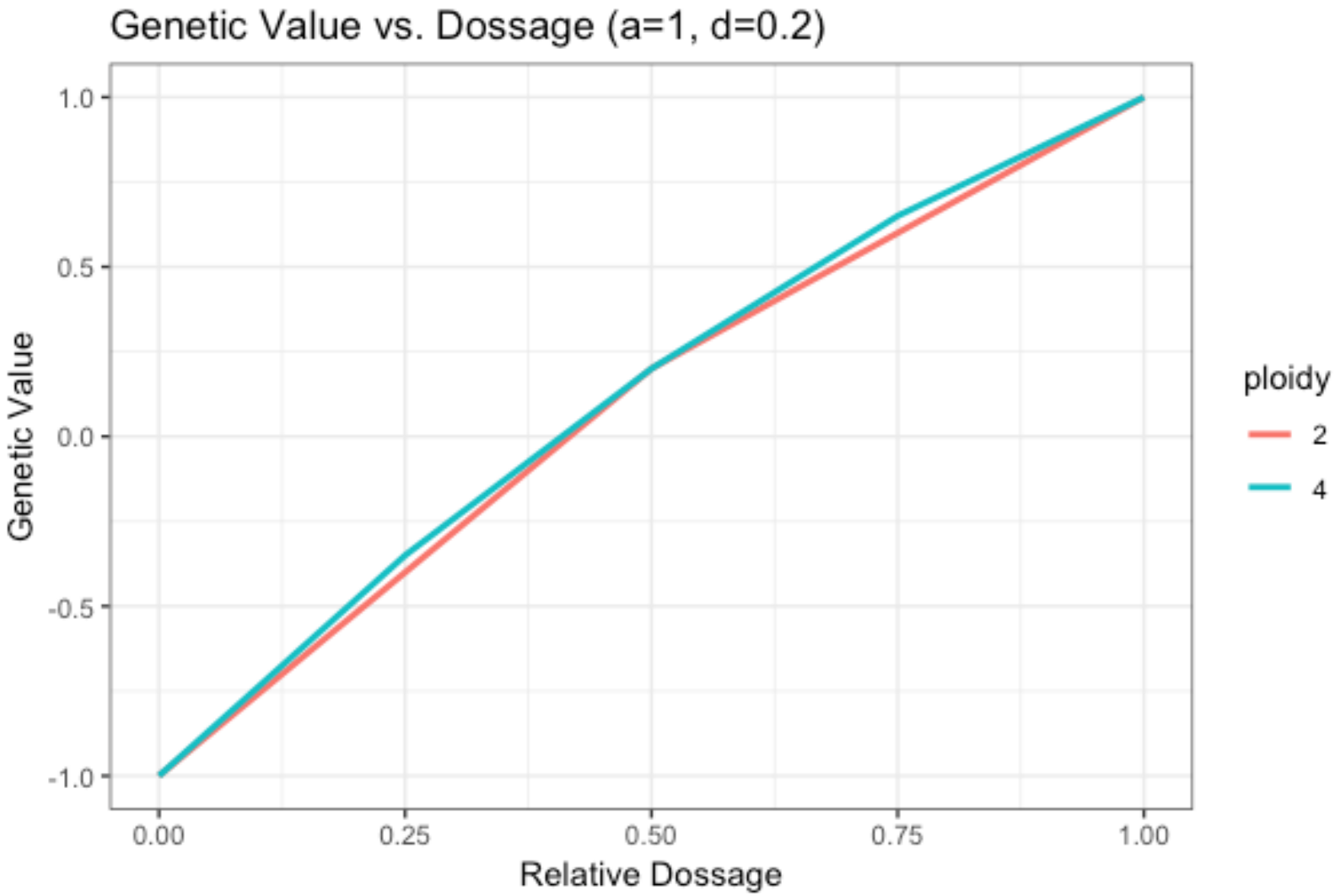
AlphaSimR Coding (Digenic Only, Dosage Scaling)

Relative dosage	Diploid	Tetraploid	Value
1	2	4	a
0.75		3	0.5a+0.75d
0.5	1	2	d
0.25		1	-0.5a+0.75d
0	0	0	-a

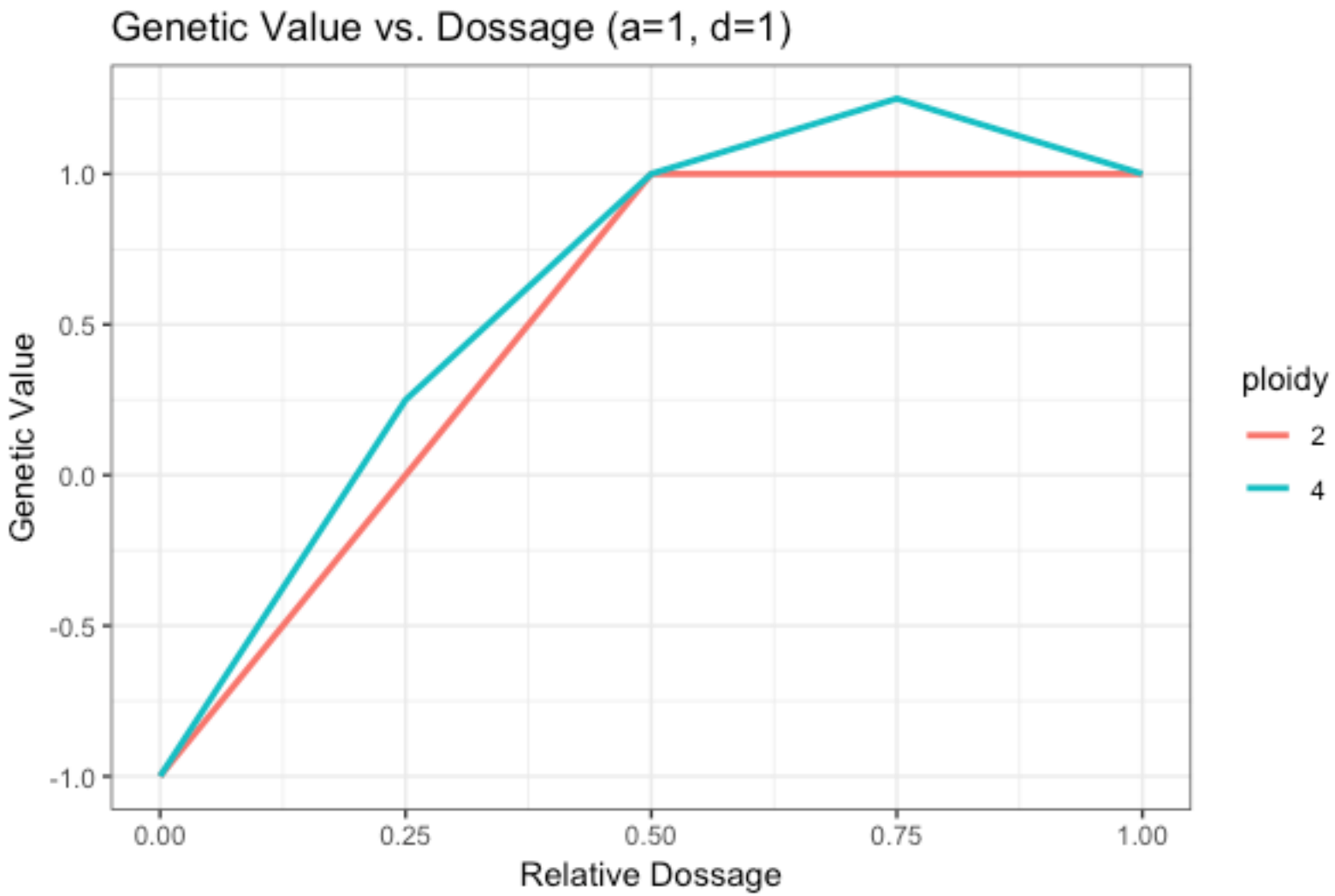
$$a = \left(x - \frac{ploidy}{2}\right)\left(\frac{2}{ploidy}\right)$$

$$d = x(ploidy - x)\left(\frac{2}{ploidy}\right)^2$$

Partial Dominance



“Complete” Dominance



Unique Polyploid Properties

- Griffing like effect on dominance variation
  - Digenic dominance contributes to selection response in tetraploids
    - Progeny inherit two chromosome copies from their parents
  - Should extend to higher order dominance at higher ploidy

- Progressive heterosis
  - Heterosis is maximized with a single cross in diploids (AxB)
  - Double cross needed in tetraploids (AxB)x(CxD)

AlphaSimR Demonstration