**Study Guide: Genomes of all sizes….**

**(Chromosomes and Linkage)**

**Study guide and reading assignments**

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

Cistue\_DH. Abstract, Introduction, Conclusions. Pay particular attention to Figure 2.

1. An average chromosome is ~ 5 centimeters long and an average cell is ~ 10 micrometers. What is the role of nucleosome structure in terms of accommodating multiple chromosomes into a single nucleus in a single cell?
2. Why is it that centromeres stay the same length but telomeres can get shorter?
3. What is the rationale behind numbering chromosomes?
4. If you had to speculate, would an X chromosome be most likely to appear larger or smaller in a suitable prepared specimen, under a light microscope?
5. Where would you most likely find examples of epigenetic silencing: constitutive or facultative heterochromatin?
6. Why does mitosis produce 2 genetically identical daughter cells whereas meiosis produce 4 daughter cells that will be genetically identical only if the Megaspore Mother Cell is 100% homozygous?
7. When would you expect to see the highest level of gene expression from the dominant allele at the Vrs1 locus: G1, S, G2, or mitosis?
8. What is so important about the S phase in both mitosis and meiosis?
9. What is the same and what is different between difference between chromatin, chromosome, and chromatid?
10. Describe two key functions of centromeres.
11. If a plant is 2n = 42, how many pairs of sister chromatids do you expect at Metaphase of mitosis?
12. What is a bivalent and why aren’t there bivalents in mitosis?
13. Diagram the 4 possible megaspores and microspores that would be produced by a plant heterozygous at 2 loci and homozygous at a third locus (e.g. VvNnRR). Assume the V, N, and R loci are on non-homologous chromosomes.
14. If you looked under a microscope at cells in a rapidly dividing root tip, would you expect to observe mitosis or meiosis?
15. What will happened when spindle fibers fail to pull apart replicated sister chromatids in a plant that is 2n -= 14? In a plant that is n = 7?
16. What does DNA replication have to do with telomere shortening?
17. When does recombination occur?
18. What is linkage and what does it represent in terms of genetic loci and their chromosomal locations?
19. Explain how, in the case of a species with complete linkage maps, the number of linkage groups will equal the n number of chromosomes.
20. What is intragenic recombination and what are the implications if the cross-over event is reciprocal vs. if the cross-over event is non-reciprocal?
21. Distinguish between coupling and repulsion linkages.
22. What is a bivalent and how might cross-overs be distributed across sister chromatids?
23. Can there be more than one cross-over per bivalent?
24. Summarize, in your own words, key points in non-sister chromatid exchange.
25. Why the emphasis on non-sister chromatid exchange vs. sister chromatid exchange?
26. Even when DNA compaction is not an issue, are crossovers occurring at equal frequency at all points in the chromosome?
27. Explain how independent assortment of loci on different chromosomes, and at loci on opposite ends of a chromosome, can lead to non-parental combinations of alleles.
28. Explain how recombination between linked loci can lead to lead to non-parental combinations of alleles.
29. How many phenotypic classes are there in a dihybrid ratio and what is their expectation for a random diploid population derived by doubled haploidy?
30. Demonstrate to your satisfaction that the maximum frequency of non-parental (non-recombinant) combinations of games at two loci is 50%.
31. Can linkage analysis be conducted with types of populations other than doubled haploids?
32. If there were a high frequency of repulsion linkages (using the term to describe linkage of favorable and unfavorable alleles) alleles, how could repeated cycles of selfing, or intermating, potentially be more useful than doubled haploids?
33. In the slides shown in class, why were chi square tests accepted for three of the tests and rejected for one of them?
34. To be sure you understand there where, when and how of meiosis, diagram two meiosis events per the VvNnLl examples shown in class.
35. “The recombination frequency between two linked loci is the sum of the recombinant phenotypic classes divided by the total population size.”
    1. True
    2. False
36. Why are double cross-overs less frequent at recombination frequencies of <10% and more frequent at recombination frequencies >10%?
37. Explain why the centiMorgan is useful, even though there is not a direct conversion to Mbp..
38. Three loci (A, B, and C) are linked in that order. Does the recombination frequency between A and C (*r*AC) equal the sum of the recombination frequencies between A and B (*r*AB) and B and C (*r*BC)?
39. What are 5 reasons for making linkage maps?
40. In the graphical genotype slides shown in class, does a continuous series of alleles from one parent mean that there were no crossovers in that region?
41. In the linkage maps shown in class slides, there are often gaps without markers. Give two possible explanations for these gaps.
42. Does chromosome 1A of bread wheat show homoeology with or synteny with chromosome 1H of barley?
43. *Do Fragaria* and Prunus show homoeology or syntney?
44. Based on assigned reading (Cistue et al\_DH),
    1. What is meant by sampling female gametes with the *Hordeum bulbosum* system vs. male gametes with anther culture?
    2. Were there major differences in recombination between megasporogenesis and microsporogenesis?
    3. Why was it “reassuring” that there were no difference in locus ordering between the two mapping populations?
    4. What is segregation distortion?
    5. Why was pleiotropy discussed in a paper on linkage?