PLNT3140 INTRODUCTORY CYTOGENETICS
FINAL EXAMINATION

December 14, 2012
Time: 18:00 - 20:00
Location: Engineering2 E2-130, Seats 1 - 26

Answer any combination of questions totaling to exactly 100 points. If you answer questions totaling more than 100 points, answers will be discarded at random until the total points equal 100. There are 10 questions to choose from, totaling 120 points. This exam is worth 35% of the final grade.

Ways to write a readable and concise answer:
i. Just answer the question. Save time by specifically addressing what is asked. Don't give irrelevant background if it doesn't contribute to the question that was asked.
ii. Avoid stream of consciousness. Plan your answer by organizing your key points, and then write a concise, coherent answer. Make your point once, clearly, rather than repeating the same thing several times with no new information.
iii. Point form, diagrams, tables, bar graphs, figures are welcome. Often they get the point across more clearly than a long paragraph.
iv. Your writing must be legible. If I can't read it, I can't give you any credit.

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1. (5 points) What is the distinction between the terms 'evolution' and 'speciation'.

2. (5 points) When cells are transformed with an artificial chromosome, there is always a concern that the artificial chromosome might have incorporated into one of the host chromosomes, rather than segregating on its own as an independent chromosome. How you distinguish between these two possibilities?

3. (15 points) Describe the three kinetic classes of DNA in a eukaryotic genome, as defined in a C_0t experiment. Roughly how many copies of sequences are found in each class? What types of sequences are found in each class?

4. (10 points) We learned that the three basic components of eukaryotic chromosomes are centromeres, telomeres and origins of replication. Yet, it has been possible to transform cells in a number of species with artificial chromosomes whose main chromosomal component is nothing more than a section of centromeric satellite sequences. These constructs function as independent chromosomes. What cellular mechanisms are thought to account for these observations?

5. (10 points) What does the data in this table tell us about the relationship between life history and genome evolution?

Table 9.6. Duration of mitosis and meiosis in a number of plant species, together with their DNA values in picograms and their annual or perennial habit; where the DNA values are different, both are given.

Species	**Picograms per Haploid Genome**	**Mitosis in Hours**	**Meiosis in Hours**	**Plant Habit**
Crepis capillaris	1.20	10.8	--	Annual
Haplopappus gracillis	1.85	10.5	36.0	Annual
Pisum sativum	3.9, 4.8	10.8	--	Annual
Ornithogalum virens	6.43	--	96.0	Perennial
Secale cereale	8.8, 9.6	12.8	51.2	Annual
Vicia faba	13.0, 14.8	13.0	72.0	Annual
Allium cepa	14.8, 16.25	17.4	72.0	Perennial
Tradescantia paludosa	18.0	18.0	126.0	Perennial
Endymion nonscriptus	21.8	--	48.0	Perennial
Tulipa kaufmanniana	31.2	23.0	--	Perennial
Lillium longiflorum	35.3	24.0	192.0	Perennial
Trillium erectum	40.0	29.0	274.0	Perennial

Source: Van't Hof, 1965, and Bennett, 1972.

6. (10 points) How are doubled haploid plants produced in the lab? What advantages to doubled haploid plants offer to geneticists and plant breeders?

7. (10 points)

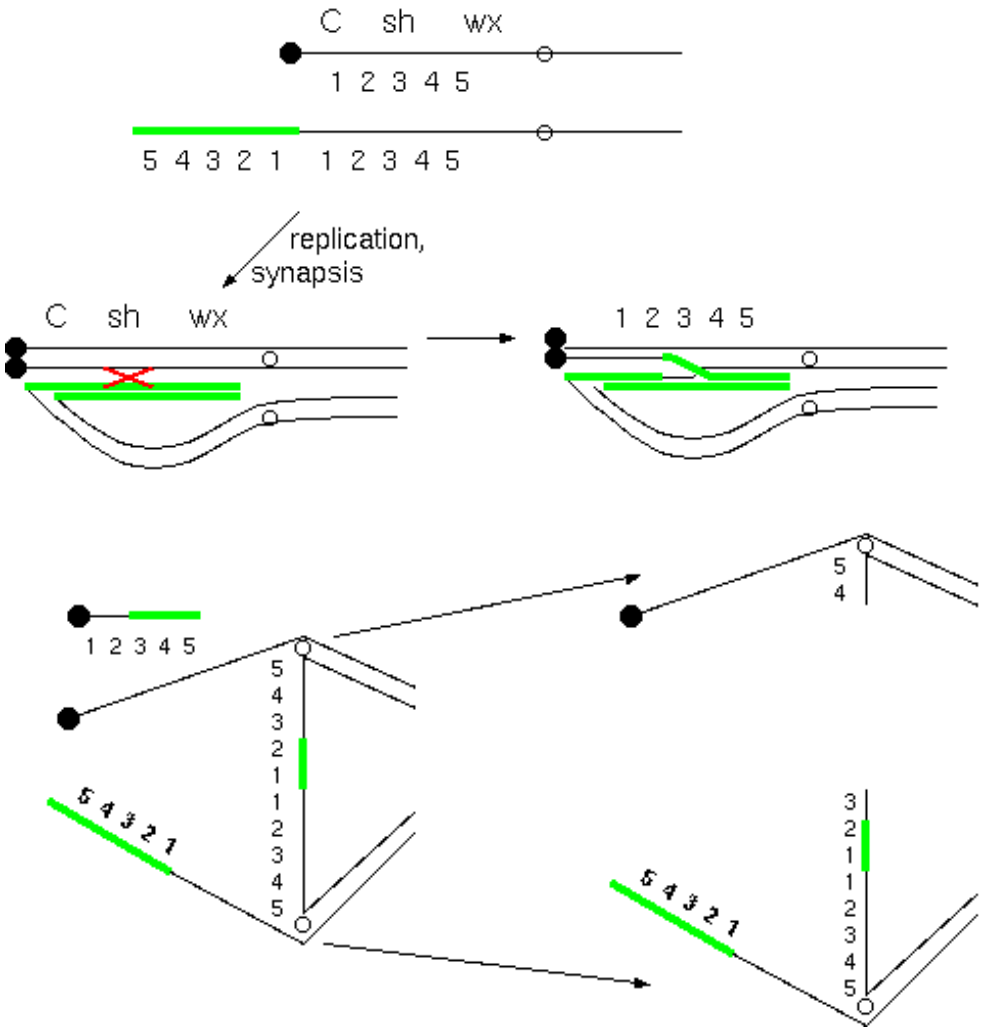
a) Suppose you are working with a species for which chromosomes have never before been studied. Using simple staining techniques, how can you determine the number and identity of chromosomes in the genome? That is, what information can you use to distinguish chromosome 3 from 8, or 7 from 2 etc? (Assume that banding techniques have not yet been worked out, for this species.)

b) Some genomes have large numbers of small chromosomes. For example, there are salamanders with > 200 chromosomes. What unique problems do such genomes pose for identifying chromosomes?

8. (10 points)

a) What is illustrated in the diagram below?

b) Draw a diagram showing the final chromosomal products.



9. (10 points)

Otto SP, Whitton J (2000) Polyploid incidence and evolution. Ann. Rev. Genet. 34:401-437.

"*One of the biggest stumbling blocks to the successful establishment of polyploidy in sexual species is the requirement for a genetically compatible mate.*" (Otto SP, Whitton J (2000))

a) Explain what the authors mean.

b) Plants lend themselves to polyploidy more readily than do animals. One of the reasons appears to be that plants seem to have mechanisms that compensate for variations in gene dosage. Aside from that, what is it about the reproductive biology of plants that makes it easier for polyploid species to arise?

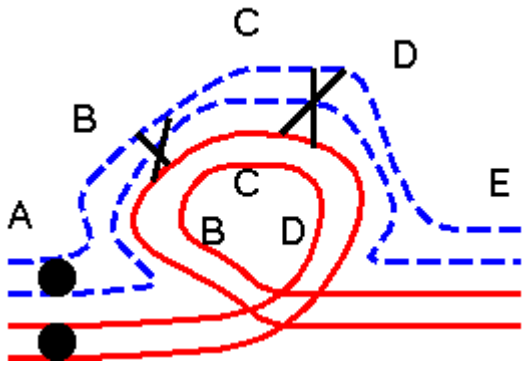
10. (15 points) For each blank, provide the appropriate term of phrase.

The process of constructing a linkage map using molecular markers begins by making an educated guess about the _____a_____ of the markers. For any marker, the neighboring markers most closely-linked to it also are most alike in the phenotypic scores, for most segregating progeny. The farther you go in either direction from a given marker, the more different will be the scores. Neighboring loci in any region will always have the most similar segregation patterns. By definition, the more closely-linked two loci are, the more often they will _____b_____.

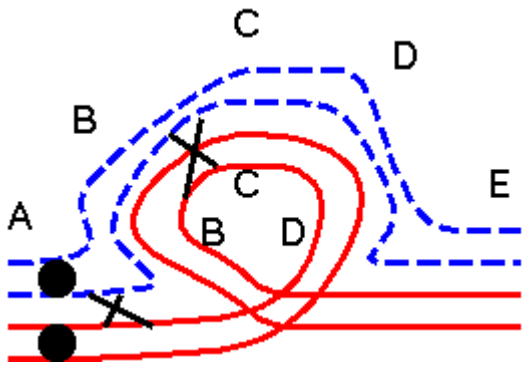
The next step is to calculate distances between adjacent loci using the method of _____c_____. This method begins by assigning an arbitrary distance between adjacent all loci eg. 5 cM, representing 5% recombination. The EM algorithm calculates the likelihood that this map would generate exactly the observed pattern of phenotypes in the dataset. Next, the program would try another guess for map distances between markers, and again calculates the liklihood of seeing the data, given the new guess. If the new guess has _____d_____, it is chosen it as the current working map. As the iterations progress, the changes to the map get smaller and smaller. The process is repeated until the difference in log liklihood between the current map and the previous map is _____e_____ (eg. 0.1).

11. (10 points) For each of the following diagrams, indicate the outcome of double crossovers in meiosis by listing the number of normal, inverted, dicentric, or acentric chromosomes.

a



b



12. (10 points) Why are circular chromosomes possible in prokaryotes, but problematic in eukaryotes? Draw a diagram to illustrate your explanation.