PLNT3140 INTRODUCTORY CYTOGENETICS

MID-TERM EXAMINATION

1 p.m. to 2:15 p.m. Thursday, October 20, 2016

Answer any combination of questions totalling to exactly 100 points. If you answer questions totalling more than 100 points, answers will be discarded at random until the total points equal 100. This exam is worth 20% of the course grade.

Hand in these question sheets along with your exam book.

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1. (20 points) Create a table, similar to the one below. For both prokaryotes and eukaryotes, cite at least two characteristics for each of the five categories given. (You can't just restate the same concept twice in different words.)

	Prokaryotes	Eukaryotes
Taxonomic groups		
Cell biology		
Genome structure		
Gene expression		
Cell cycle		

2. (15 points) Fill in the blanks. Just provide terms for a - e. You don't need to restate all of the text.

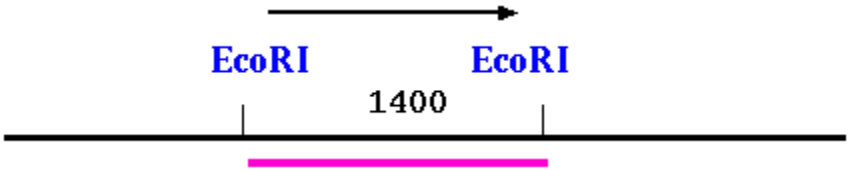
- Two conflicting goals in evolution:
  - accurately replicating the organism and its genome
  - generating genetic diversity to drive evolution
- Meiosis
  - ensures that all gametes receive _____a_____
  - generates genetic diversity through _____b_____ and _____c_____
- The nucleus is
  - the "hard drive" of the cell, essentially, a database of all genetic information
  - a mechanical and biochemical device optimized both for
    - _____d_____
    - accurate transmission of genetic information into the next cell generation
- Major changes in genome structure drive _____e_____ by creating reproductive barriers between subpopulations

3. (10 points) Telomeres in most eukaryotes are composed of single-stranded tandem repeats of short repeat units. Some examples include:

Oxytricha	5'$C_4A_4$3'
Saccharomyces	5'$C_{2-3}A(CA)_{1-3}$3'
Dictyostelium	5'$C_{1-8}T$3'

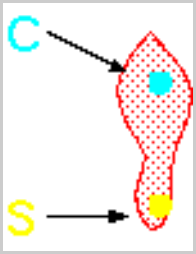
Why do telomeres consist of short repeats? In other words, how do these short repeats facilitate replication of the ends of the chromosome?

4. (10 points) A restriction map is shown, in which a gene is known to be flanked between two Eco RI sites. The 1400 bp Eco RI fragment was used to transform plants. In one transformed plant, a copy of this gene was incorporated at random into loci on 5 different chromosomes. Genomic DNA from that transformant plant was examined by Southern Blotting, using the same 1400 bp band as a hybridization probe. In one lane, genomic DNA was digested with Eco RI, and in the other lane, DNA was digested with HindIII. It is known that there are no HindIII sites present in this 1400 bp fragment. Draw what you would expect the Southern to look like, for each digest.



5. (10 points) Consider a cross between two parents CCSS x ccss. Of 96 progeny in the F2 generation, the counts for each of the four phenotypic classes are listed in the table. Probes for each of these loci were used in Fluorescent In-situ Hybridization, as indicated at right.

Phenotypic class	Number of progeny
CS	54
Cs	18
cS	18
cs	6



Both the genetic ratio and the FISH results point to the same conclusion. What is that conclusion?

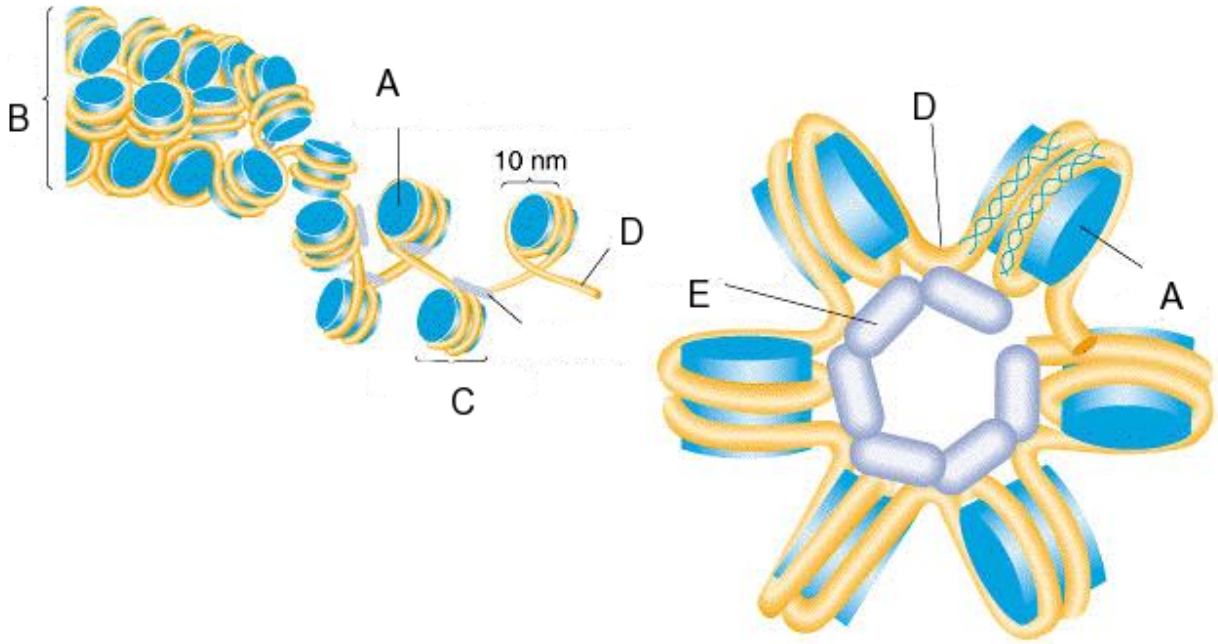
6. (10 points) Briefly describe the function of the substage condenser on a microscope. Draw a diagram to illustrate how it accomplishes this function.

7. (10 points) Each eukaryotic chromosome has numerous origins of replication. What is the advantage of having multiple origins of replication in eukaryotic chromosomes? Draw a diagram to illustrate your discussion.

8. (10 points) Briefly list the 5 stages of meiotic prophase I in chronological order, with special emphasis on chromosome pairing and recombination.

9. (5 points) Spindle fibers are microtubules, hollow rods formed from dimers of alpha- and beta-tubulins. A hollow rod is known by engineers to be a rigid structure, able to bear a lot of force for a small investment in mass. Considering the function of polar spindle fibers, why is it essential that the polar spindle be a rigid structure?

10. (10 points) Name the chromatin components labeled in the image below. Where a label is used twice, you can assume it is the same structure.



A.

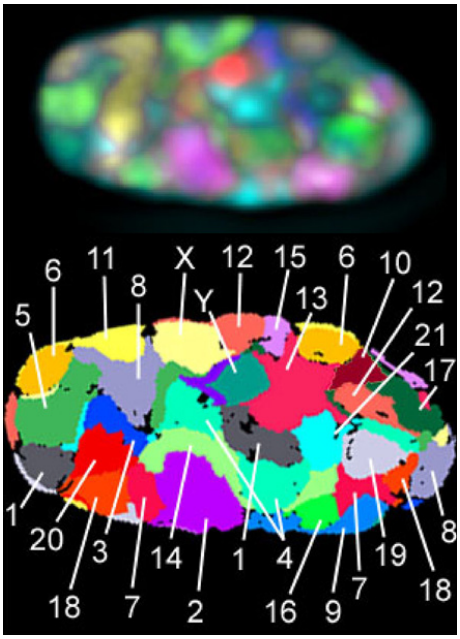
B.

C.

D.

E.

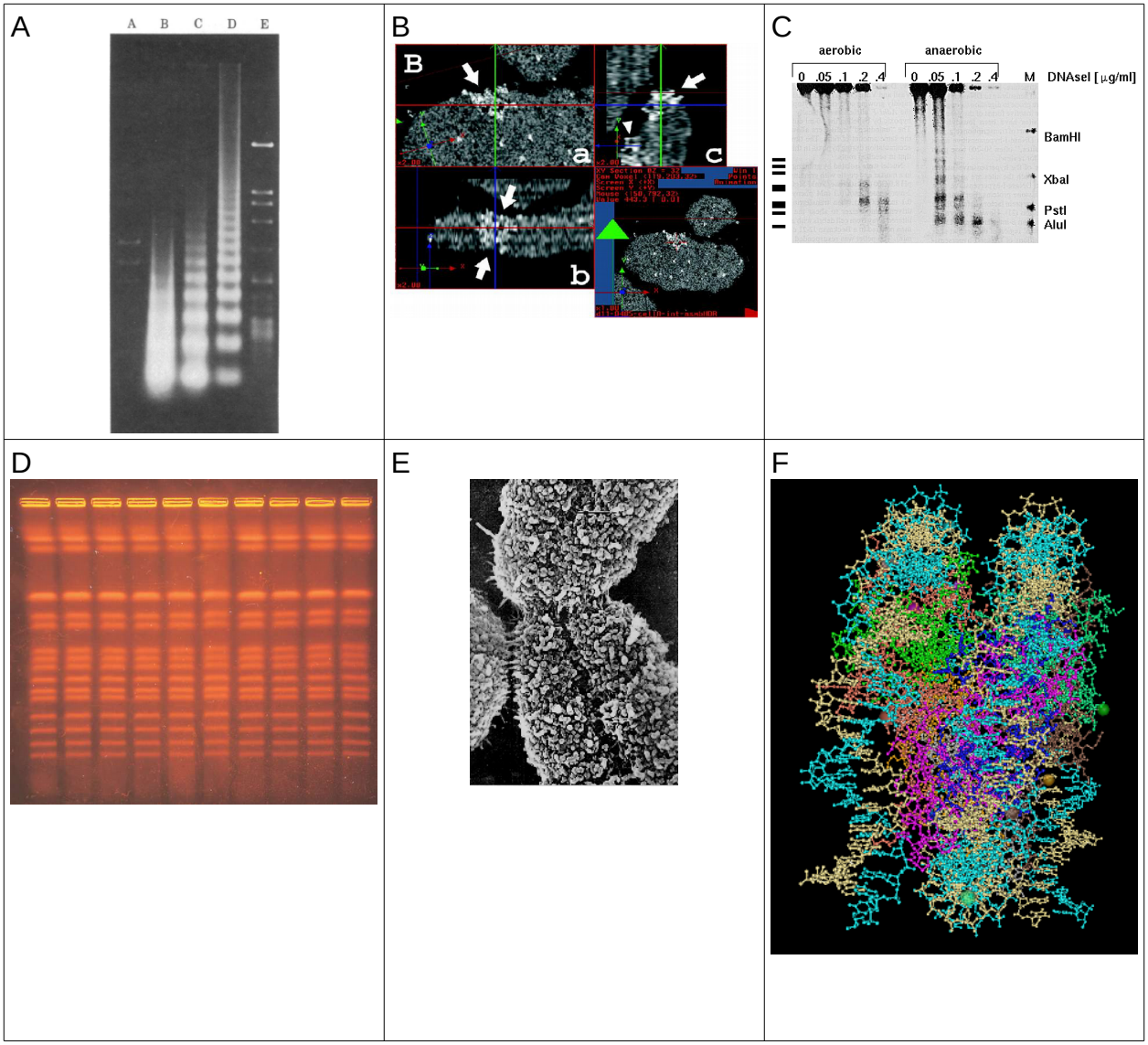
11. (10 points) In the figure at right, we see an interphase diploid nucleus in which each chromosome has been painted with a specific combination of fluorescent tags. A series of images was acquired, each at a different focal plane within the nucleus. We are seeing only one of those focal planes. At bottom is an interpretation of the image, showing the locations of different chromosomes.



a)For some chromosomes, we see both copies, while for others, we see only one copy of a chromosome. What is the reason we can't see both copies?

b) Is the area occupied by a chromosome in this 2-D image a good indicator of the actual volume of the chromosome, or of its length?

12. (10 points) Below are five statements and six figures. Match each statement with the figure that best describes it. One of the figures is not relevant to any statement, and has no match.



I. The eukaryotic chromosome is a single DNA molecule.

II. At least in some chromosomes, there are at least two higher-order levels of chromatin folding/coiling, between the domain level of organization, and the final mitotic chromosome.

III. DNA is associated with chromatin proteins in units with a periodicity of about 200 bp.

IV. The DNA double helix wraps twice around the nucleosome core particle.

V. Transcriptionally active genes have a more open chromatin conformation than inactive genes.