39.314 INTRODUCTORY CYTOGENETICS

MID-TERM EXAMINATION

1 p.m. to 2:20 p.m.   Tuesday, October 27, 2005

This examination is worth 15% of the course grade.

Hand in these question sheets along with your exam book.

1. (15 points) The diagram below presents data from a cell-culture experiment. The DNA content of cells was measured, and the number of cells with a given amount of DNA were plotted on the graph. Note that B refers to the entire region between A and C,D.

DNA HISTOGRAM
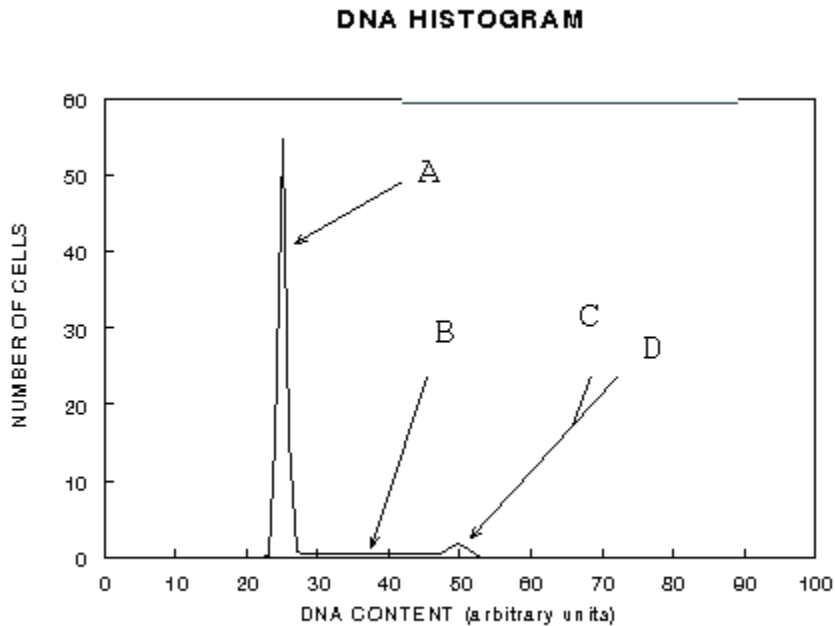
       a) Why are most cells in fraction A? What stage of the cell cycle does A represent?
       b) What stage of the cell cycle is B? Why does it cover a wide range of DNA amount per cell?
       c) What stages of the cell cycle are represented by C and D?

2. (20 points) List the 5 phases of meiotic propase I, and describe the key events that occur in each. Answer in point form for clarity.

3. (5 points) Aside from the need from crossing over, why is chromosome pairing an essential part of meiosis?

4. (10 points) Each chromosome is a very long DNA molecule, containing thousands of genes. An alternative way that the eukaryotic chromosome might have evolved is to have each gene as a separate dsDNA molecule. In this model, the chromosome would be a protein matrix holding many short dsDNAs. List 2 disadvantages of this alternative kind of chromosome.

5. (5 points) Here is an example of a single step in PCR. Re-draw, labeling 5' and 3' ends.
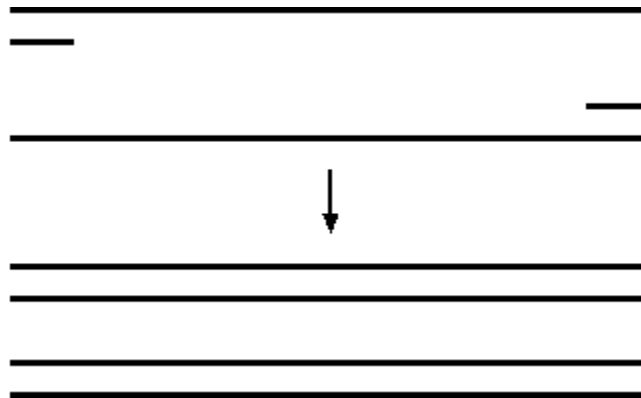
6. (10 points) Maize cells were grown in synchronous culture. That is, all cells in the culture were at the same point in the cell cycle, at any given time. To study the expression of the alcohol dehydrogenaseI gene (AdhI), Argon gas was bubbled into the culture, creating an anerobic condition that induces AdhI expression. One batch of cells was harvested during G1 and nuclei were isolated. Another batch was harvested just at the beginning of prophase of mitosis (ie. condensed chromosomes are beginning to be visible, but the nuclear envelope is still intact). Nuclei were isolated from these cells as well. DNAse sensitivity experiments were conducted using each nuclei prep. In nuclei from G1, the AdhI gene was degraded. Using the nuclei from early prophase, the AdhI gene remained intact. In 1 or 2 sentences, explain the reason for this difference.

7. (20 points) Traditionally, transformation of novel genes into plants and animals has employed various methods for delivering DNA into cells (eg. transfection, microinjection, *Agrobacterium* infection), but these methods all ultimately depend upon the DNA repair mechanisms of the target cell to insert the DNA into chromosomes at a random location, anywhere in the genome.

Recently, artificial chromosomes have been developed for plants, although they are not yet available or mamalian cells.

a) What are the three critical features needed to create an artificial chromosome?

b) List two advantages of transformation with artificial chromosomes, compared to random insertion of genes.

8. (15 points)

A	B
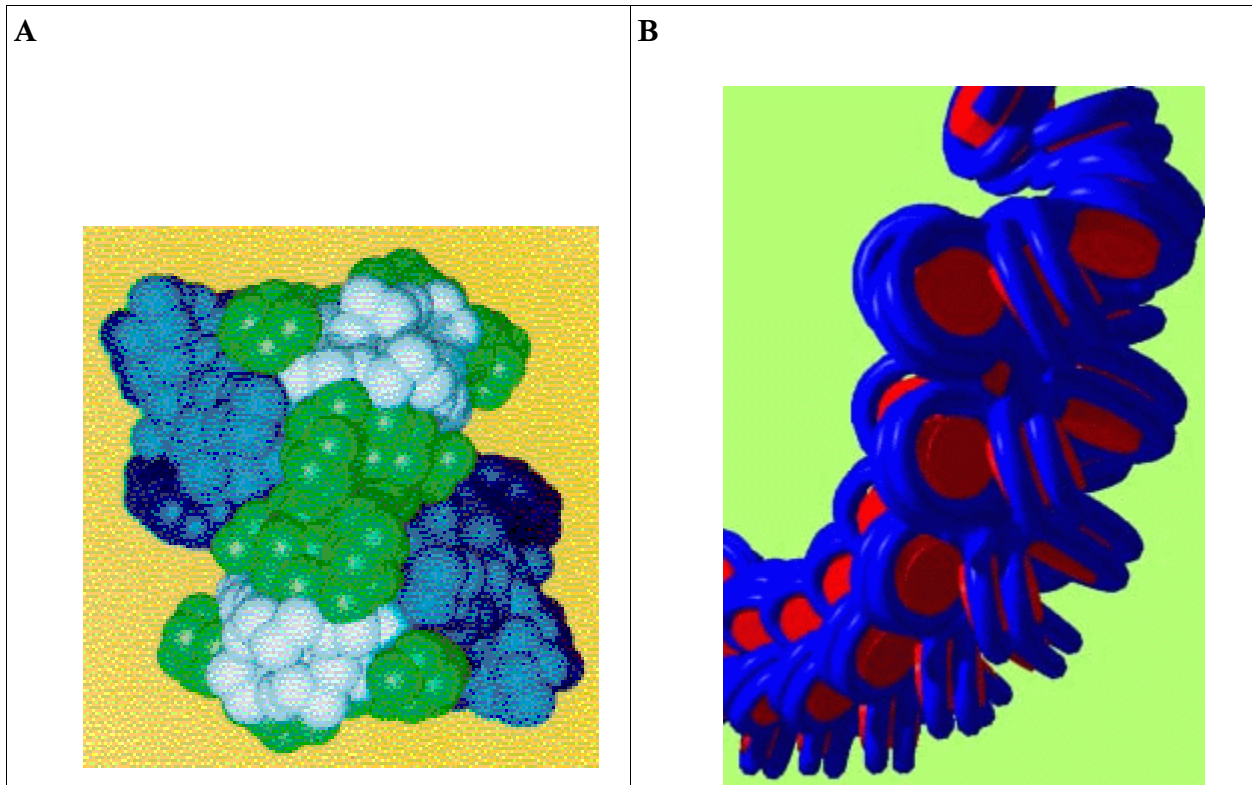
a) Briefly describe the molecular complexes shown in A and B

b) Which histone is present in B, but not in A?