

PLNT3140 INTRODUCTORY CYTOGENETICS

MID-TERM EXAMINATION

1 p.m. to 2:15 p.m. Thursday, October 16, 2014

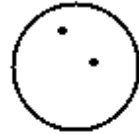
Answer any combination of questions totalling to exactly 100 points. If you answer questions totalling more than 100 points, answers will be discarded at random until the total points equal 100. This exam is worth 20% of the course grade.

Hand in these question sheets along with your exam book.

1. (10 points) Draw two chromosomes (four chromatids total) along with their kinetochores and spindle fibers for mitotic metaphase and for meiotic metaphase I. What are the differences that you would see under the microscope, between the two?

2. (5 points) If you look under the microscope at a typical differentiated tissue (eg. plant roots), only a small percentage of the cells you look at will be undergoing mitosis. Why is that?

3. (10 points) The image at right shows what you might see under the microscope if doing FISH with a probe that detects a single locus in diploid cells at Interphase. Draw similar images showing what you would expect to see under the microscope with the same FISH probe during the different phases of mitosis.



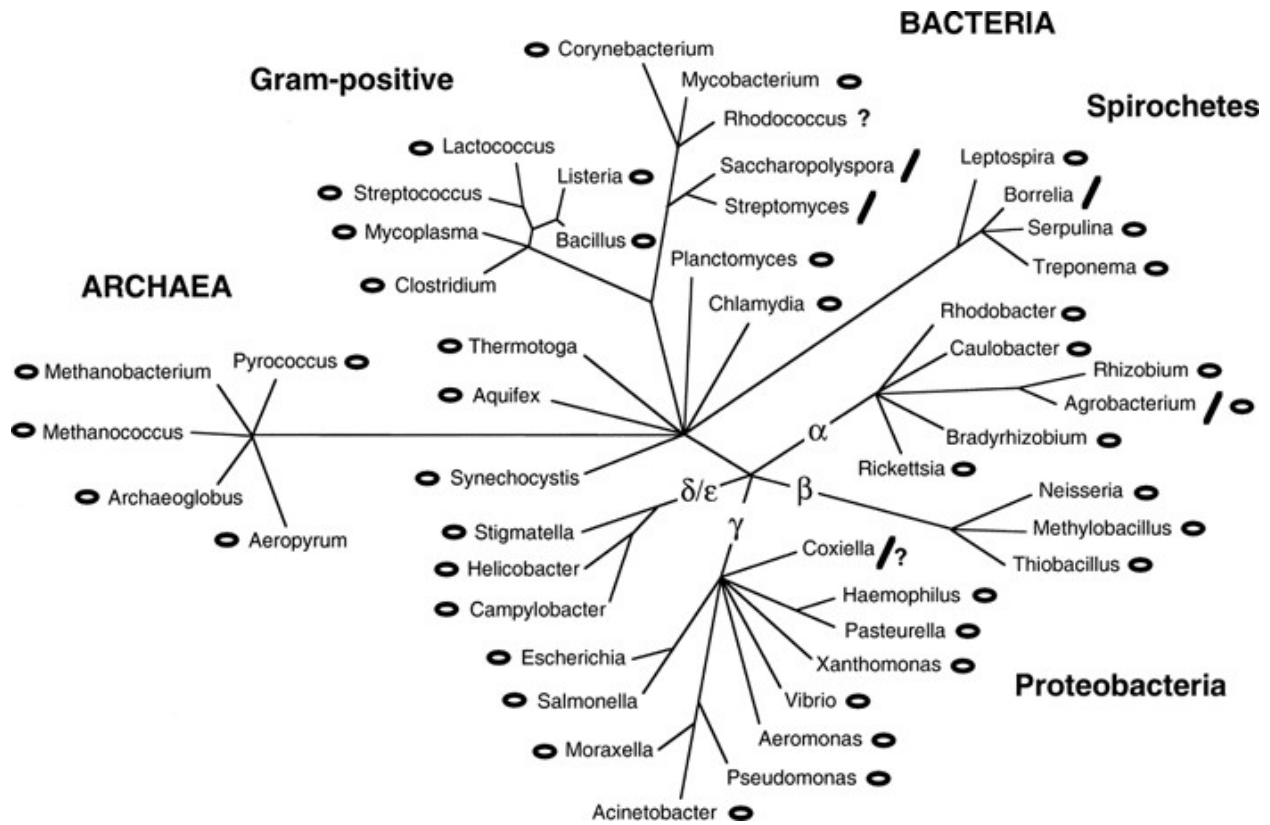
4. (10 points) Define convex and concave lenses. What is different about these two types of lenses, with respect to how they focus light?

5. (20 points) Fill in the blanks in your exam book. You don't have to rewrite the paragraph.

Like all organelles, the nucleus is designed for carrying out specific functions. The purpose of the nucleus is to support the critical processes of ____a____ and ____b____. These two processes conflict with the processes occurring at ____c____ during the cell cycle. At this stage, chromosomes must be ____d____, whereas during G1, chromosomes are ____e____.

The nuclear envelope has two surfaces, the outer and inner membranes. Spanning this membrane are protein complexes known as ____f____. These regulate ____g____. At prophase of mitosis, the nuclear membrane ____h____. At this time, chromosomes begin to become visible because they are coiling. At telophase, the nuclear envelope ____i____ and the chromosomes ____j____.

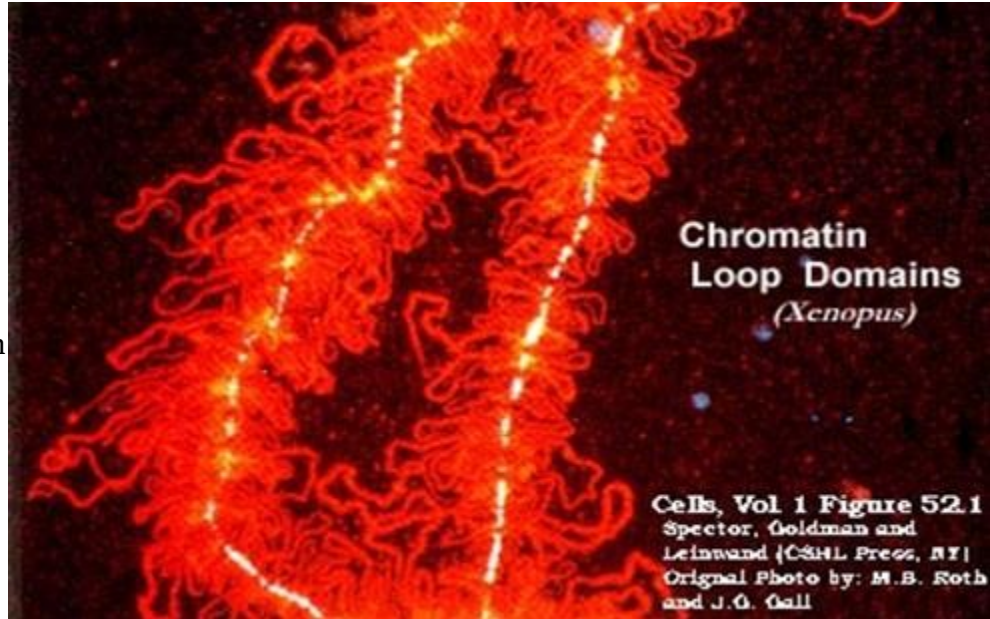
6. (10 points) In the figure below, an oval indicates the presence of a circular genome in various genera of prokaryotes, while a rod indicates a linear genome. What does this figure tell you about the evolution of linear genomes in prokaryotes.



7. (5 points) To make it possible for sperm to swim rapidly through a viscous environment, it is necessary for each sperm cell to have as narrow a cross-section as possible. What evolutionary adaptation has occurred in the nuclei of mammalian cells that helps to minimize the size of the sperm head?

8. (15 points) Suppose you wanted to genetically engineer plants to express a disease resistance gene constitutively, using the 35S promoter. In doing so, you want to eliminate the problem that when genes insert at random chromosomal sites, some sites are favorable to expression of the foreign gene, and others tend to express the gene weakly, or not at all. What is a common mechanism for these site-specific differences in expression? Draw a simple map of a recombinant construct designed to overcome this problem. Explain how the construct solves the problem.

9. (10 points) In the figure at right a "lampbrush" chromosome from *Xenopus* oocytes during meiotic metaphase I. These lampbrush chromosomes show a strong signal when probed with fluorescent antibodies to Topoisomerase II.



What does this observation tell us about the chromosome scaffold, and the mechanism by which chromatin structure controls gene expression? Why are lampbrush chromosomes so unusual for cells at meiotic metaphase I?

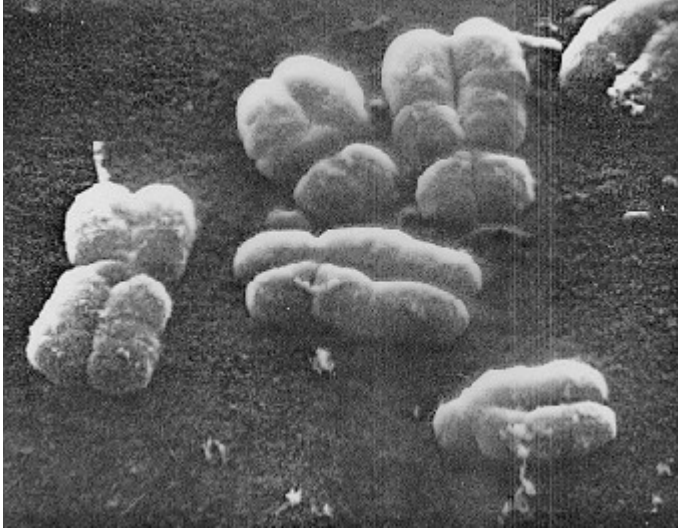
10. (10 points) (Note: the term b is used twice in this paragraph.)

At _____ a _____ of mitosis, the chromosomes are tightly clustered together in bundles resulting from migration of the chromosomes to opposite poles of the mitotic call during anaphase. Thus, the _____ b _____ of the chromosomes in the newly-forming nucleus reflects the _____ b _____ of the chromosomes in telophase. At this stage, the _____ c _____ re-forms around the individual chromosomes, and the resultant vesicles fuse to form a _____ d _____. The 3-dimensional locations of the chromosomes during interphase are referred to as _____ e _____.

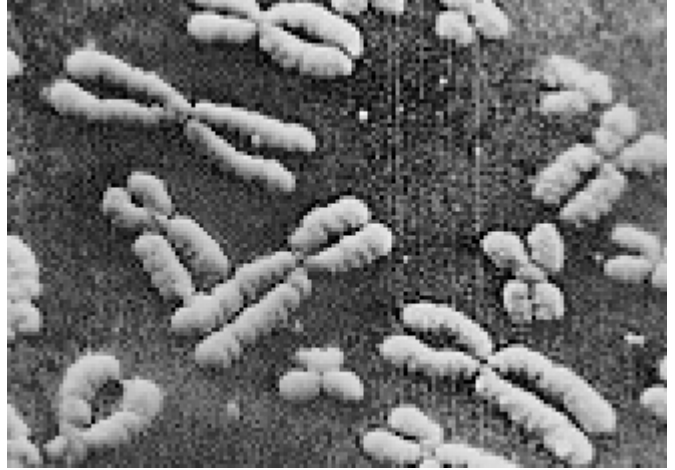
11. (5 points)

Which of these electron micrographs shows G-banded chromosomes, and which shows untreated chromosomes? Explain your answer.

A



B



12. (10 points) The diagram below shows both original strands at one end of a linear chromosome. Redraw the diagram below, indicating the newly-synthesized strands after DNA replication, if DNA polymerase was to replicate a linear chromosome, without telomerase activity. Show leading and lagging strands, and label 5' and 3' ends.

