Homework 4 for Cell Biology--- 2017

1. Match the definition below with its term from the list above:

Cytoskeleton; minus end; protofilament; dynamic instability; Neurofilament; tubulin; intermediate filament; plus end; treadmilling; keratin

A. A linear chain of protein subunits joined end to end, which associates laterally with other such chains to form cytoskeletal components.
B. The property of sudden conversion from growth to shrinkage, and vice versa, in a protein filament such as a microtubule or an actin filament.
C. The end of a microtubule or an actin filament at which addition of monomers occurs most readily; the fast-growing end.
D. General term for the fibrous protein filaments (about 10nm in diameter) that form ropelike networks in animal cells.
E. The process by which a polymeric protein filament is maintained at constant length by addition of protein subunits at one end and loss of subunits at the other.
F. System of protein filaments in the cytoplasm of a eukaryotic cell that gives the cell its shape and the capacity for directed movement.

2. A typical time course of polymerization of actin filaments from actin subunits is shown in Figure 16-1.

A. Explain the properties of actin polymerization that accounts for each of the three phases of the polymerization curve.

B. How would the curve change if you doubled the concentration of actin? Would the concentration of free actin at equilibrium be higher or lower than in the original experiment, or would it be the same in both?

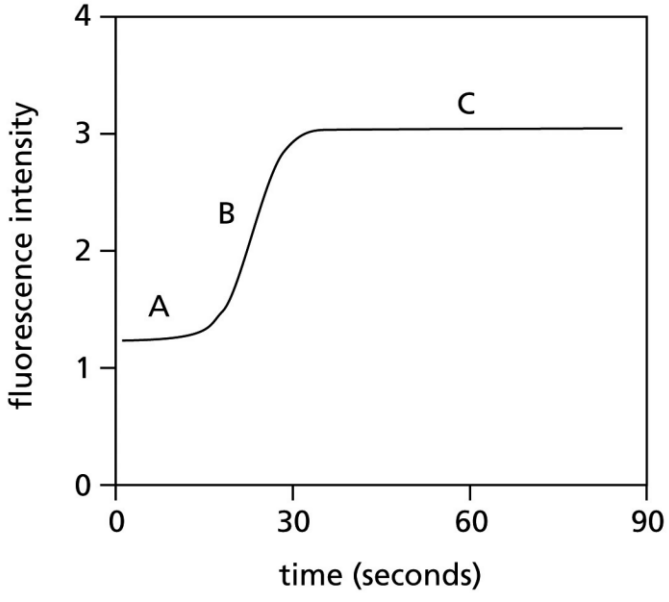

Figure 16-1 MBoC5: The Problems Book (© Garland Science 2008)

3. Order the following events in animal cell division.
   A. Alignment of chromosomes at the spindle equator.
   B. Attachment of microtubules to chromosomes.
   C. Breakdown of nuclear envelope.
   D. Condensation of chromosome.
   E. Decondensation of chromosome.
   F. Duplication of centrosome
   G. Elongation of the spindle.
   H. Pinching of cell in two.
   I. Re-formation of nuclear envelope.
   J. Separation of centrosomes.
   K. Separation of sister chromatids.

4. The β-tubulin subunit of a αβ-tubulin dimer retains its bound GTP for a short time after it has been added to a microtubule, yielding a GTP cap whose size depends on the relative rats of polymerization and GTP hydrolysis. A simple notion about microtubule growth dynamics is that the ends with GTP caps grow, whereas ends without GTP caps shrink. To test this idea, you allow microtubules to form under conditions where you can watch individual microtubules. You then sever one microtubule in the middle using a laser beam. Would you expect the newly exposed plus and minus ends to grow or to shrink? Explain your answer.

5. When phalloidin is mixed with actin in a molar ration of at 1:1, the growth rate of microfilament increases at both ends, as shown for minus ends in Figure 16-15A,
   A. Decide how phalloidin increases the growth rate of actin filaments? Explain your reasoning.
   B. In Figure 16-15B actin filaments growth in the presence or absence of phalloidin were diluted in the absence of actin monomers and their disassembly was arrayed. Do these results confirm or contradict your conclusions for part A? Explain your answer.
   C. What is the critical concentration for actin assembly at the minus end in the absence of phalloidin? What is the critical concentration for actin assembly at the minus end in the presence of phalloidin?
   D. Propose a molecular mechanism for the effects of phalloidin on actin assembly.

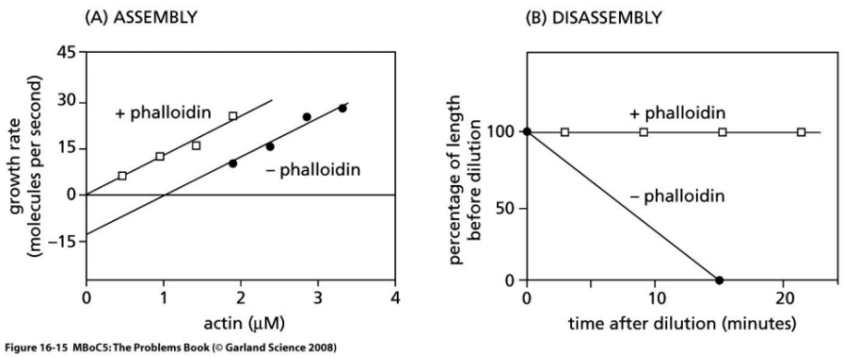

Figure 16-15 MBoC5: The Problems Book (© Garland Science 2008)

6. When cells in G_0 are exposed to mitogenic growth factors, they enter S phase about 20 hours after stimulation, as can be detected by incorporation of the nucleoside analog BrdU. If antibodies to cyclin D are microinjected into cells up to 12 hours after adding mitogenic growth factors, very few of the injected cells incorporate BrdU. By contrast, cyclin D-specific antibodies have little effect on BrdU incorporation, when injected more than 14 hours after exposure to factors (figure 17-41). What critical event in G_1 do antibodies against cyclin D block? Why do antibodies against cyclin D have no effect after 14 hours?

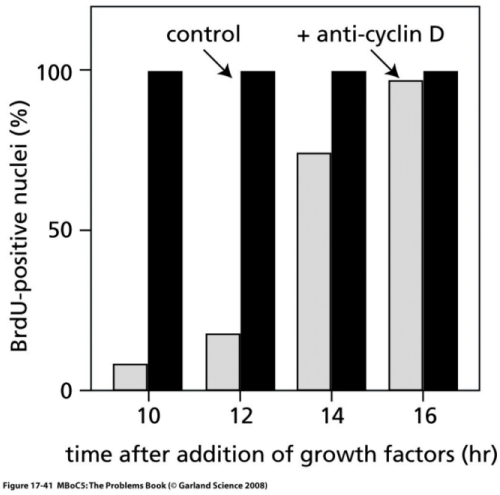

Figure 17-41 MBoC5: The Problems Book (© Garland Science 2008)

Figure 17–41 Percentage of control cells and cells injected with cyclin D antibodies that had entered S phase as detected by incorporation of BrdU (Problem 17–140). After addition of mitogenic growth factors, cells were injected with cyclin D antibodies (or not) at the times indicated, and then were assayed for BrdU incorporation 26 hours after addition of the mitogen, a time when uninhibited cells should have been well into S phase. *Black bars* indicate results with control cells that were not injected with cyclin D antibodies. *Gray bars* indicate results with cells that were injected with cyclin D antibodies.

7. One important biological effect of a large dose of ionizing radiation is to halt cell division.

A. How does a large dose of ionizing radiation stop cell division?

B. What happens if a cell has a mutation that prevents it from halting cell division after being irradiated?

C. What might be the effects of such a mutation if the cell was not irradiated?

D. An adult human who has reached maturity will die within a few days of receiving a radiation dose large enough to stop cell division. What does this tell you (other than that one should avoid large dose of radiation)?

8. Match the definition below with its terms from the list below:

Anaphase A; analphase B; astral microtubule; bi-orientation; catastrophe factor; centrosome; condensing; interpolar microtubule; kinetochore microtubule; metaphase plate; microtubule-associated protein (MAP); microtubule flux; mitotic spindle; securing; separase; spindle assembly checkpoint; telophase

A. Movement of tubulin subunits toward the spindle poles as a result of addition of new subunits at the plus ends of microtubules and their disassembly at minus ends.

B. Stage of mitosis in which the spindle poles move apart.

C. Mechanisms ensuring that cells do not enter anaphase until all chromosomes are correctly bi-oriented on the mitotic spindle.

D. Centrally located organelle of animal cells that after duplication organizes each spindle poles.

E. Stage of mitosis in which the chromosomes begin to move toward the two spindle poles.

F. Imaginary plane midway between the spindle poles in which chromosomes are positioned at

metaphase.

G. Microtubules that overlap in the spindle midzone and interact via their plus ends, generating an antiparallel array.

H. Final stage of mitosis in which the two sets of separated chromosomes decondense and become enclosed by nuclear envelope.

I. Complex of proteins that used the energy of ATP hydrolysis to promote the compaction and resolution of sister chromatids.

J. Protease whose activation at the end of metaphase results in the cleavage of cohesin and the separation of sister chromatids.

K. Microtubule that radiates outward from the spindle pole and contacts the cell cortex, helping to position the spindle in the cell.

9. You add the protein synthesis inhibitor emetine just before cells enter mitosis. In the absence of colchicine, emetine-treated cells entered and exited mitosis normally, and divided into two daughter cells, which then remained indefinitely in interphase. In the presence of colchicine, the emetine-treated cells stayed in mitosis for about 2 hours and then decondensed their chromosomes and re-formed nuclei without dividing. In the presence and absence of colchicine, the exit from mitosis coincided with the disappearance of cyclin B.

   A. what effect, if any, does colchicine have on cyclin B synthesis and destruction? Can these effects explain how colchicine causes metaphase arrest?

   B. how do you suppose that inhibition of protein synthesis eventually reversed the metaphase arrest produced by colchicine?

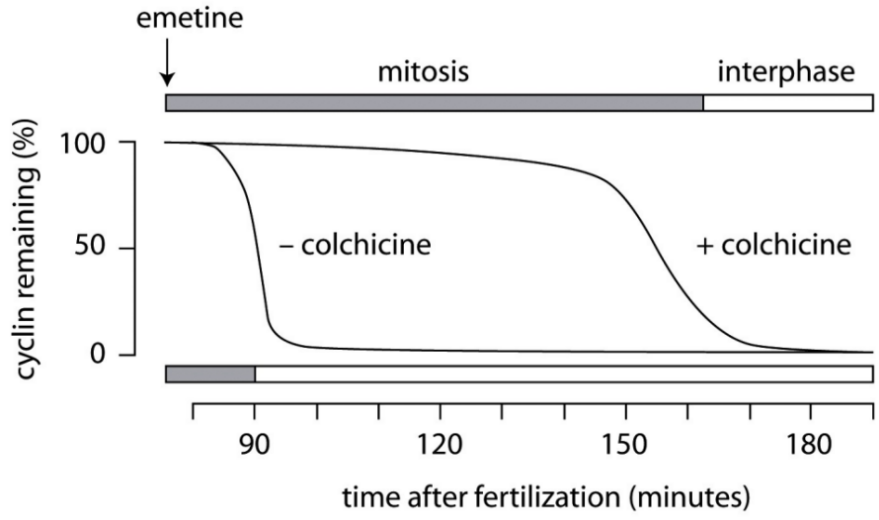

Figure 17-8 MBoC5: The Problems Book (© Garland Science 2008)