68% class average.

1507

Biology 2120
Spring 2007
Midterm Exam #1

Name (printed): [redacted]

This exam contains 12 pages, *including the multiple choice bubble sheet.* Please verify that you have all pages.

1. Write your name on both this exam *and* on the bubble sheet (fill in the bubbles for your name)
2. Write the *color* of your exam paper on the bubble sheet
3. Answer all questions, using only the space available for the drawings/short answer section (part II).
4. You have until 11:30 AM to finish the exam- to receive credit for taking the exam, your exam *must* be in the box at the front of class when the proctor announces that the examination period has ended.
5. As indicated in the course syllabus, cheating in this course is strictly forbidden. Anyone who cheats on this exam will receive an F in the course and be referred for disciplinary action. By signing your name below, you indicate that you understand, and agree to comply with, this policy.

Name (signed) [redacted]

Part I. Multiple Choice. Choose the single best answer to each question.

✓ 1. The primary advantage of phase contrast microscopy relative to other types of microscopy is:

A. Phase contrast provides much better contrast than transmission electron microcopy
B. Phase contrast provides better resolution than bright field microscopy
C. Phase contrast allows one to visualize living cells, while scanning electron microscopy does not
D. Phase contrast allows one to tag a specific protein in a cell, while bright field microscopy does not
E. Phase contrast provides better magnification than fluorescence microscopy

(B)

2. Proteins are typically about 50 nm or less in diameter, but we routinely say we can visualize proteins in a light microscope with a resolution of nothing smaller than 200 nm. How is this possible?

A. The condenser lenses on the microscope condense the light down a single point which increases the resolving power of this light
B. Fluorescent tags can be added to proteins, and these emit light in the visible range when excited by the appropriate wavelength of light
C. The light excites electrons in the proteins which can be detected by an electron-sensitive screen like the one found in electron microscopes
D. Digital cameras have a higher resolving power than the human eye, so when we use a digital camera to capture the light from a light microscope, we can exceed the resolution limit of conventional light microscopes with image analysis software
E. If metal ions are used to generate contrast, these ions are so small that the proteins they attach to can be visualized in a light microscope

✓ 3. Why does the wavelength of an excitation beam matter when using either a light microscope or an electron microscope?

A. The shorter the wavelength, the more likely that a small particle will disrupt the wave, and this generates contrast at higher resolutions
B. The longer the wavelength, the stronger the signal:noise ratio, thereby improving resolution without impairing contrast
C. The shorter the wavelength, the more of the excitation beam can be bent by a condenser lens, thus illuminating the specimen with a more intense beam
D. The longer the wavelength, the more likely it will be absorbed by contrast agents, thus improving resolution
E. The shorter the wavelength, the higher the energy in the excitation beam, and thus the more likely this can pass through the specimen to be detected

4. Choose the one condition where hydrogen bonding is not needed:

A. Proper alignment of paired DNA strands in an antiparallel orientation
B. Stabilization of beta sheets in DNA binding proteins
C. Joining two fibronectin molecules together to form a dimer
D. Stabilization of transmembrane alpha helices in a channel protein
E. Addition of telomeric DNA to the ends of chromosomes by telomerase

5. Which statement *best* illustrates what hydrogen bonds do in proteins?

working with full charges

A. Adding a *fluorescent tag* to a protein allows one to observe it with a light microscope
B. Increasing the *ionic strength* of the solution in which a protein is found will change the shape of that protein
C. Adding *detergent* to cells will make membrane proteins soluble
D. Adding a *reducing agent* to the solution in which a protein is found will stop a chemical reaction performed by that protein
E. Antibodies bind very tightly to their targets (e.g, protein antigens)

6. The Central Dogma of Molecular Biology predicts that:

A. Errors in an *amino acid* sequence will cause errors in the *nucleotide* sequence that encodes it
B. Stopping protein translation will cause mutations in cells
C. Two copies of every gene must be carried by cells, in case one copy is mutated
D. Telomeres should be only expressed in germ cells
E. Mutations in messenger RNA most likely results from mutations in DNA

7. If all stages of DNA packaging contain nucleosomes, what is the function of a nucleosome?

A. To increase the packing ratio of DNA in a cell by approximately seven-fold
B. To make unwinding of heterochromatin easier
C. To make replicons, thereby making DNA easier to replicate
D. To supercoil DNA during mitosis
E. To make it easier to find specific genes in the DNA sequence

8. If you were to compare a liver cell and a skin cell from the same organism, which statement about them would be true?

A. Both cells have almost identical heterochromatin and euchromatin
B. Neither cell expresses integrin receptors
C. Both cells express more telomerase than a brain cell
D. Both cells have almost identical DNA sequences — telomere shortening or point mutations
E. Neither cell would have DNA sequences encoding histone genes in their euchromatin

9. Which of the following statements about *epiderolysis bullosa simplex* (EBS) is **false**?

A. In EBS patients, all epithelial tissues are fragile, such that they can rupture in response to even minor trauma
B. In EBS patients, intermediate filaments don't attach to hemidesmosomes or desmosomes
C. EBS patients develop blisters on their skin because their skin grows faster than normal individuals
D. EBS cannot be cured with anti-cancer drugs — not cancer related.
E. EBS is a genetic disease, and is not caused by infection

The following 3 questions refer to the research article by Margadant et al. that was discussed in recitation:

10. Which statement best summarizes the findings of this article?

A. Cyclins make cells grow
B. Actin polymerization isn't required for cells to grow
C. FAK phosphorylates cyclins
D. Actin is dispensible for formation of filopodia
E. Cyclin D makes cells cancerous

11. What was phalloidin and fluorescence microscopy used for in this article?

A. To observe the structural organization of the F-actin cytoskeleton in cells at different times
B. To observe the stage of the cell cycle that cells were in at different times
C. To dissolve actin stress fibers immediately after cell division had been completed
D. To correlate actin stress fiber formation with cyclin D expression
E. To show that actin stress fibers are necessary for FAK activation

12. Western blots were used in this manuscript to show that:

A. FAK binds to MAPK
B. MAPK activates cyclin D
C. FAK stimulates actin polymerization
D. Actin depolymerization in activates FAK and MAPK
E. FAK binds to cyclin D

13. A DNA packaging ratio of 15,000 is indicative of:

A. A mutated gene in that DNA
B. DNA that is going through mitosis
C. A cell in G_0 phase
D. A cell lacking chromatin
E. A cell that is expressing a large amount of cyclin D

14. If all proteins are made up of the same 20 amino acids, and nine of these amino acids are hydrophobic, isn't *every* protein hydrophobic?

A. Well, yeah. Duh. That's why we use detergent to clean things
B. No, not necessarily- some of those hydrophobic amino acids get buried in the lipid core of membranes, effectively neutralizing them
C. Not at all! Proteins also have polar and charged amino acids, and that cancels out any hydrophobicity, so proteins are never hydrophobic
D. Neither yes or no- some regions of a protein may be hydrophobic, but these regions do not necessarily dominate the overall solubility properties of the entire protein
E. Yes, but not all of the time- a protein can switch between being hydrophobic and hydrophilic when it needs to; this explains why different proteins are different shapes

15. Which statement is true?

A. All peptide bonds in proteins are the same
B. All domains in all proteins are the same
C. All proteins in two cells of the same type (e.g., skin) are the same
D. All peptide bonds always form alpha helices and beta sheets
E. Peptide bonds blink on and off, with lots of pretty colors

16. Which statement about Van der Waals interactions is true?

A. They form the theoretical basis for hydrophobic interactions amongst amino acid side chains
B. They are stronger than hydrogen bonds, but not as strong as covalent bonds
C. Although they are quite weak, they contribute to protein structure because they are nearly ubiquitous
D. They participate in the formation of peptide bonds, but are not strong enough to stabilize any other part of a protein
E. They are especially important in skin cells, where they provide the strength necessary to resist shear forces

17. Consider the following statements:

i. Because all proteins bind something, all proteins contain at least one motif
ii. A domain is defined by its primary sequence
iii. Although a protein binds something, it doesn't have to bind to that thing all of the time
iv. When a protein binds something, the protein changes shape

Which of these statements are true?

A. i, iii, and iv
B. ii and iv
C. i and iv
D. ii and iii
E. iii and iv

A/E good choices
b (i) true?
motifs - organized 2nd° structure

18. Cancer cells usually make proteins that do not function properly. Based on this fact, what else can you predict about these proteins?

A. These proteins likely control a cell's progression through the cell cycle
B. These proteins likely have altered tertiary structure, compared to their counterparts in normal cells
C. These proteins likely have altered quaternary structure, compared to their counterparts in normal cells
D. These proteins likely have different domains than their counterparts in normal cells
E. These proteins likely cause other cells to become cancerous

19. A healthy diet needs to contain, among other things, a minimum level of fiber. Which of these items would contain a relatively high amount of dietary fiber, and why?

A. Steak; because it is actually muscle tissue, and muscle is rich in microfilaments (i.e., fibers)
B. French fries; because potatoes are plants, and plants store their sugars in the form of cellulose
C. Apples; because fruits have a high concentration of β sugars, which our bodies can then polymerize via β(1,4) bonds to form cellulose
D. Grass; because grass has very high concentrations of cellulose and starch, so we get all the sugars we need to build a tough cytoskeleton including intermediate filaments (fibers)
E. Pizza with whole wheat crust; because whole wheat flour has more cellulose than the processed white flour in "regular" (white flour) pizza crust

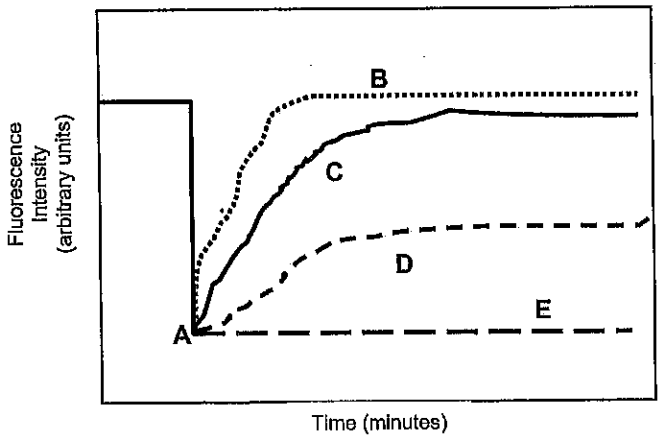
20. Where are α(1,6) glycosidic bonds found in cells?

A. In carbohydrates such as glycerol
B. In branched sugars such as glycogen
C. In cis bonds of fatty acids
D. In the sugar-phosphate backbone of DNA
E. In charged amino acid side chains

The following two questions refer to the diagram at right.

21. This graph represents the results of which technique we discussed in class?

A. Fluorescence recovery after photobleaching
B. Indirect immunofluorescence microscopy of actin
C. Fluorescence permeability through a gap junction
D. Fluorescence permeability through a tight junction
E. Fluorescence detection of proteins via Western blot



Assuming that lines B, C, D, and E overlap entirely until point A, where they diverge as indicated, what can you say about lines C and E? (Note: the correct answer here may not match the technique in the correct answer for the previous question)

A. If this is a gap junction permeability experiment, line C shows cells that have been injected with calcium, while line E shows cells that have not been injected with calcium
B. If this is a Western blot, line C has a higher mobility in the gel than does line E
C. If this a FRAP experiment, line C represents a saturated phospholipid, while line E represents an integrin
D. If this is a tight junction permeability experiment, then calcium was added in condition C, but not in condition E
E. If this is an indirect immufluorescence microcopy experiment, line C represents a brighter signal than line E

23. Despite their different chemical structures, the head groups of all phopholipids have one thing in common. What is it?

A. They are hydrophobic
B. They are attached directly to glycerol
C. They are polar
D. They define the relative fluidity of the phospholipid to which they are attached
E. They bind to at least one protein in the plasma membrane

24. *All* biological membranes share one essential property. What is it?

Some membranes don't have to do everything

A. They are made entirely of phospholipids
B. They serve as semipermeable barriers between two different environments
C. They exclude water
D. They are connected directly to the cytoskeleton by integrins
E. They become permeable when excited by a laser beam of light

25. The fluid mosaic model of membrane structure predicts that:

A. Raising the concentration of cis-unsaturated fatty acids will make a membrane less fluid
B. Integrins bind to the cytoskeleton via adaptor proteins like vinculin
C. Phospholipids may be diffuse freely in a membrane, while the proteins embedded in that membrane may not
D. There are at least seven different classes of membrane proteins, some of which attach via phospholipids
E. A transmembrane protein usually adopts an alpha-helix structure in the membrane-spanning region

26. During lecture, we saw two different applications of the protein spectrin in different cells. What is the one common property between these two applications?

A. Spectrin acts as a stabilizing bridge between two transmembrane proteins
B. Spectrin increases the fluidity of membranes
C. Spectrin mediates the attachment of two neighboring cells to each other
D. Spectrin is a transmembrane protein
E. Spectrin can be labeled with a fluorescent tag

27. A proteoglycan is_____ while a glycoprotein is_____.

A. Found on the outside of cells; found on the inside of cells
B. Attached to the structural proteins in the ECM; attached to the cytoskeleton
C. Always hydrophilic; always hydrophobic
D. A structure composed of a large number of sugars, usually attached to a single polypeptide; a protein composed of one or more polypeptides, with a small number of sugars attached to them
E. A complex network of sugars linked together by core proteins that are woven into a helical shape; a membrane protein found in the stomach

28. Which statement about microtubules is ***false***?

A. They are approximately 25 nm in diameter but can range in length from a few nm to several μm.
B. They bind to both the endoplasmic retiuculum and to the Golgi, but via different motor proteins
C. They undergo "dynamic instability" in cells
D. They bind to both GTP and GDP
E. They form the mitotic spindle and microvilli

29. A "GTP cap" is: – no coating provided.

A. A collection of microtubule binding proteins that stabilize the "+" end of a microtubule when they are bound to GTP
B. A binding pocket on the tubulin dimer that attaches to GTP
C. A coating of GTP found at the end of a microtubule- the GTP forms a network that prevents individual tubulin subunits from detaching from the "+" end
D. A high concentration of GTP-bound tubulin subunits in a cell
E. A collection of tubulin subunits that are bound to GTP and have joined the microtubule by adding to the "+" end

30. Which property of intermediate filaments best illustrates their ability to confer structural stability to cells?

A. They are not structurally polarized
B. They bind to membrane proteins
C. They are organized into six different classes, each class being expressed in a subset of tissues
D. They are assembled as coiled coils
E. They are trimeric proteins

31. Which statement about kinesin and dynein is ***false***? very obvious

A. Kinesin binds ATP, while dynein binds GTP
B. Kinesin moves towards the plus end of a microtubule, while dynein moves towards the minus end of a microtubule
C. Kinesin and dynein are both multisubunit proteins
D. Kinesin and dynein are both found in the cytosol of cells
E. Neither kinesin nor dynein are found in desmosomes

32. Arp2/3 is:

A. An actin-binding protein that caps the plus ends of actin, preventing further elongation
B. A motor protein that slides actin filaments past each other in muscle
C. A protein that nucleates the formation of a new actin filament off the side of an already-existing filament
D. A protein that causes branching of the cytoskeleton during mitosis
E. A protein that is necessary for cells to complete the cell cycle

33. What does "actin treadmilling" result in?

A. A progressive lengthening of an actin filament as new actin monomers are added
B. A back-and-forth movement of actin filaments during muscle contraction
C. A switch from "catastrophe" to "rescue" of actin filaments in cells
D. Decreased consumption of ATP by actin-binding motor proteins
E. A progressive turnover of actin subunits in an actin filament without any change in the filament's length

34. Cyclins:

A. Phosphorylate cyclin dependent kinases (cdks) to drive cells through cell cycle checkpoints
B. Bind to cyclin dependent kinases as part of cdk activation, and are degraded after a checkpoint is passed
C. Remove phosphates from cdks, thereby activating them
D. Phosphorylate nuclear lamins, thereby dissolving the nuclear membrane
E. Make cells cancerous

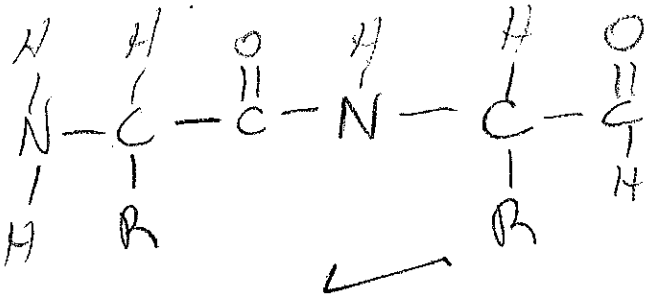
A/C good choices

. The role of retrograde kinesins is:

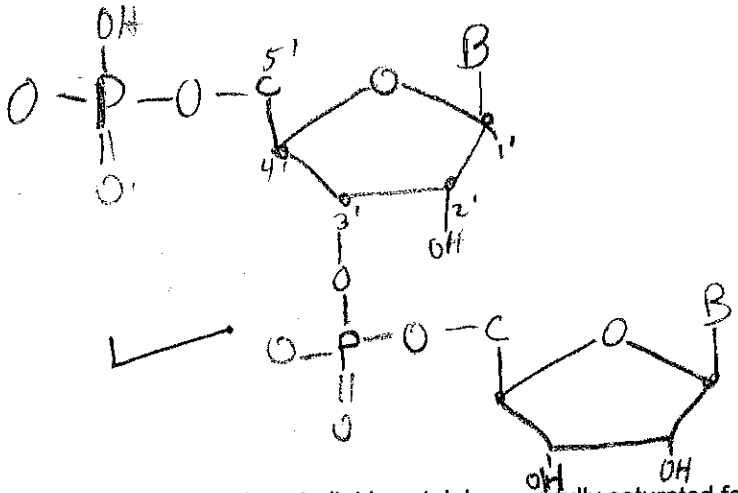
A. To elongate kinetochore microtubules during anaphase B
B. To pull astral microtubules towards the plasma membrane
C. To shorten kinetochore microtubules during anaphase A
D. To pull kinetochores apart during metaphase
E. To crosslink polar miroctubules

Part II. Answer the question in the space provided.

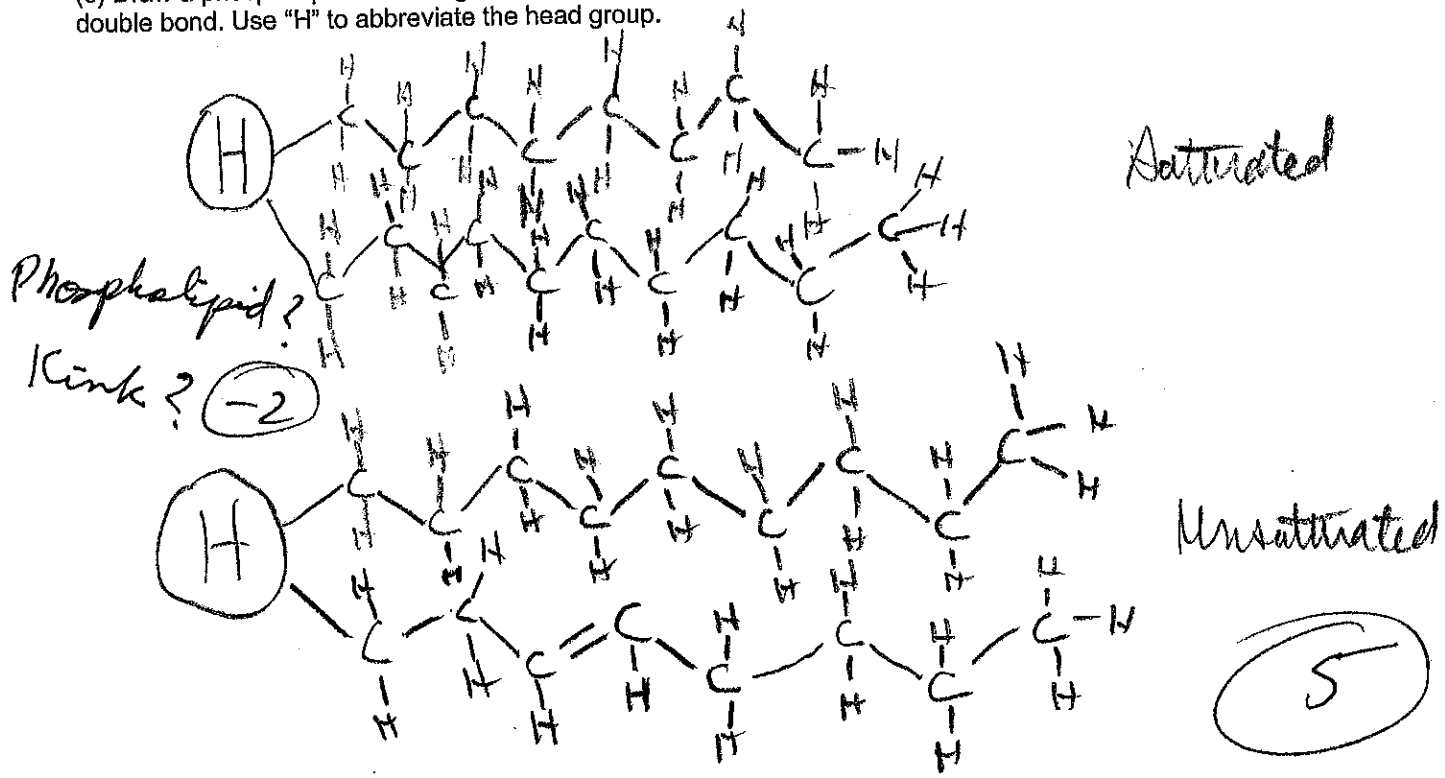
1. (a) Draw a dipeptide (two amino acids joined together via a peptide bond), using R" as the abbreviation for the side chain.



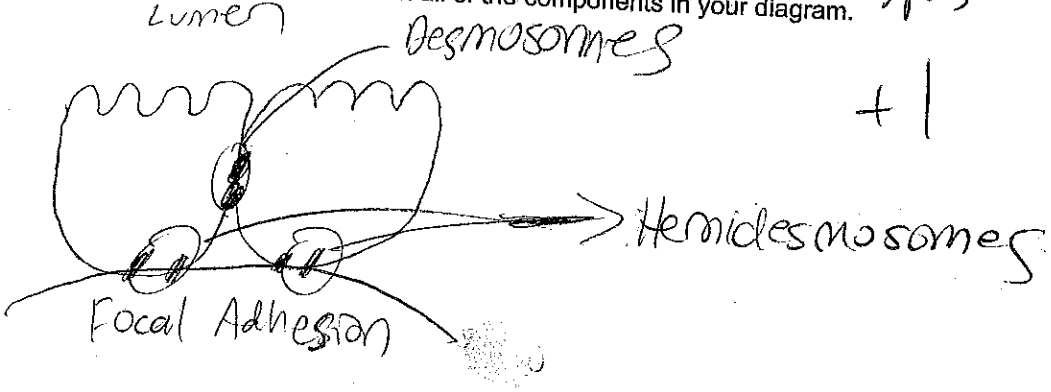
(b) Draw a dinucleotide of RNA, using "B" as the abbreviation for the bases.



(c) Draw a phospholipid containing one fully saturated fatty acid, and one unsaturated fatty acid with a single cis double bond. Use "H" to abbreviate the head group.



(a) Draw a focal adhesion, and label all of the components in your diagram. 3 pts



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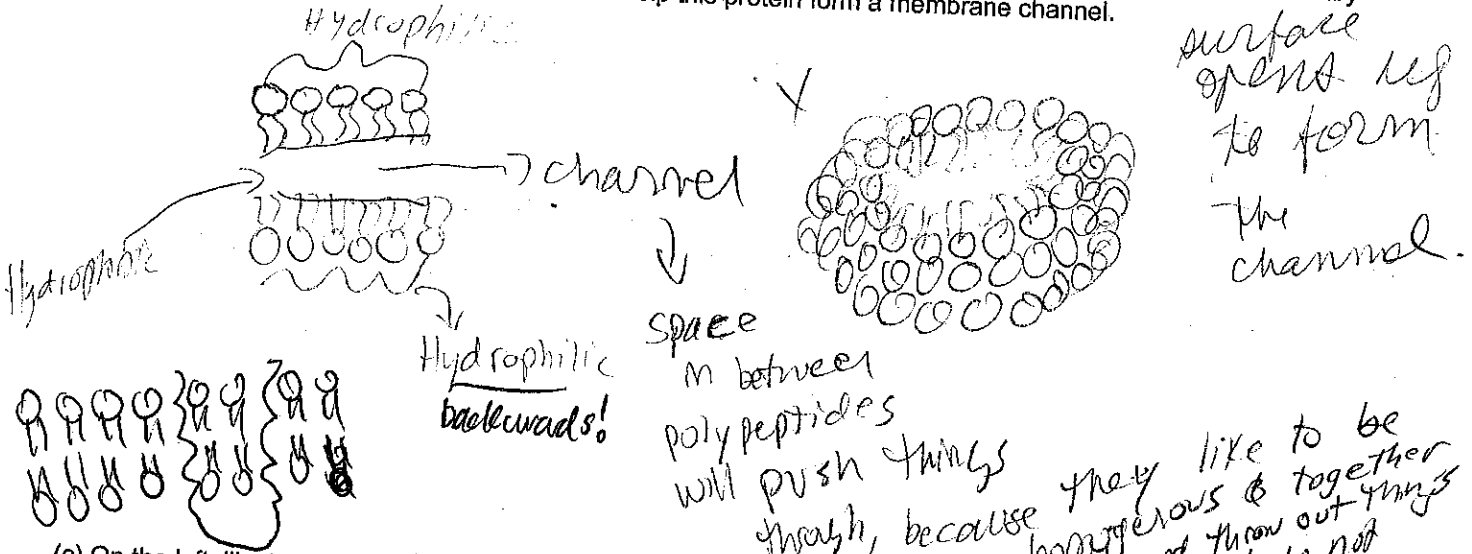
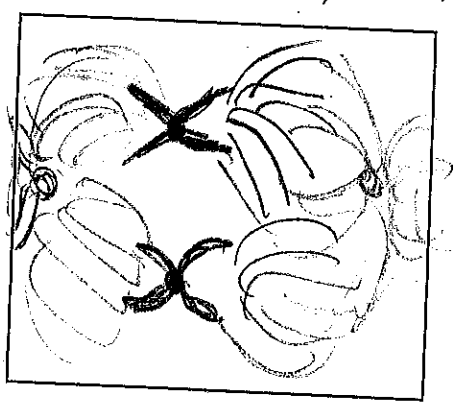
2.5

(b) Draw the structure of a membrane channel composed of a single polypeptide. Indicate the relevant secondary structures and any other structural features that help this protein form a membrane channel. 2 pts

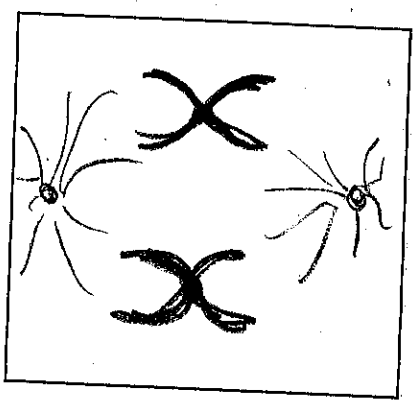


(c) On the left, illustrate the structural organization of microtubules in a cell in G1 phase of the cell cycle, and on the right illustrate the same cell if it were treated with nocodazole. Assume that you are visualizing tubulin by fluorescence microscopy. You can assume the borders of the boxes are the plasma membrane of the cells. 2 pts.

Normal (untreated)



Nocadazole-treated



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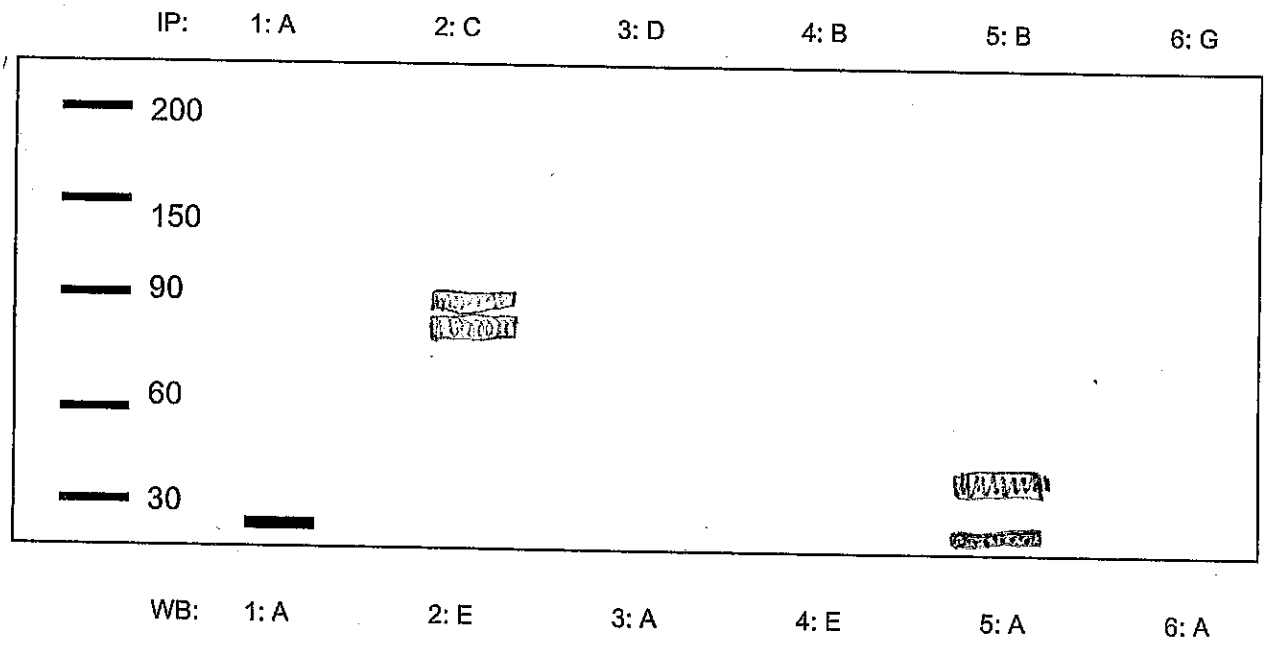
3. Assume that seven cellular proteins bind to each other in the following way (a line indicates that the proteins bind each other, keep in mind that some proteins do bind to more than one other protein): A—D—G , B—E, C—F. Now assume that you do the following immunoprecipitation/western blots to discover these binding partnerships. In each lane, the immunoprecipitating antibody is shown above the gel, and the western blotting antibody is shown below the gel. Using the table of molecular weights for each protein below, show the resulting western blot pattern you would observe for each combination of IP and WB. Molecular weight markers are given at left. Lane 1 is given as an example.

Protein	Mol. Wt. (kD)
A	25
B	40
C	75
D	125
E	80
F	45
G	120



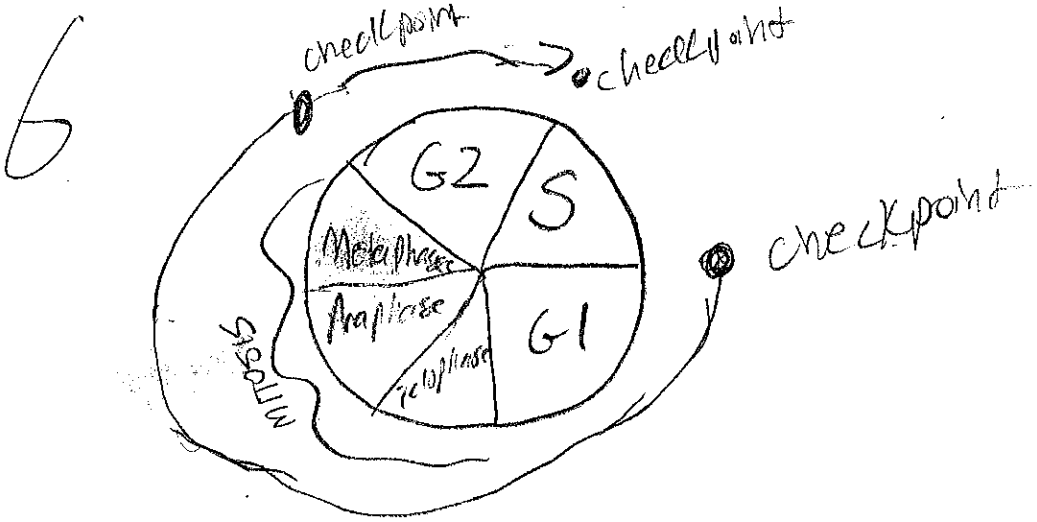
G + A + D = 25 + 125 + 120 = 150 = 270

B + E = 40 + 80 = 120

C + F = 75 + 45 = 120

4. Draw a diagram of the cell cycle, and label each phase. Illustrate how cyclins and cdks regulate progression through the cycle. Also show in this diagram why cells in the Margadant paper were able to divide *continuously*.

19.37 in book



5. Draw a mitotic spindle, and label it completely, including the location of the three types of microtubules and their polarity. Indicate how microtubule motors change the shape of this spindle during anaphase.

Fig 19.40 in book