

Biology 2120
Spring 2009
Midterm Exam #1

Name (printed): _____

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

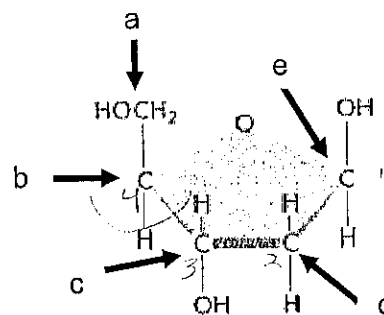
1. Write your name on both this exam *and* on the bubble sheet (fill in the bubbles for your name)
2. Write the *color* of your exam paper on the bubble sheet
3. Answer all questions, using only the space available for the drawings/short answer section (part II).
4. You have until 11:30 AM to finish 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): _____

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

1. In the diagram to the right, which arrow is pointing to the 4' carbon? Use the letter next to the arrow as your choice on your bubble sheet.

- A. a
- B. b
- C. c
- D. d
- E. e



2. Which single statement best describes a difference between alpha1,4 and beta1,4 bonds in sugars?

- a. The alpha1,4 bond is formed by a dehydration reaction, a beta1,4 is not.
- b. The beta1,4 bond exists only in DNA, the alpha1,4 exists in both DNA and RNA.
- c. The alpha1,4 bond is hydrolysed by an enzyme that does not break a beta1,4 bond.
- d. The alpha1,4 bond is found in glucose-containing disaccharides, the beta1,4 bond is not.
- e. The alpha1,4 bond is a glycosidic bond; the beta1,4 bond is not.

3. Why does carbon form four bonds but oxygen does not?

- a. Carbon is non-polar, oxygen is polar.
- b. Carbon does not form hydrogen bonds, oxygen does.
- c. Carbon can form double bonds, oxygen cannot.
- d. Carbon is more electronegative than oxygen.
- e. Carbon requires four electrons to fill its valence shell, oxygen requires two electrons to fill its valence shell.

4. Consider the following statements:

- i. DNA must be bound by something to be useful
- ii. DNA is only useful when it's converted to RNA
- iii. The information stored in DNA is converted into cellular action by proteins
- iv. Heterochromatin has more C-G basepairs than euchromatin

Which of these statements are true?

- a. i and ii
- ☒ b. ii and iii
- c. iii and iv
- d. i and iii
- e. ii and iv

5. What is a histone?

- ☒ a. A portion of DNA that forms a nucleosome
- ☒ b. A protein component of a nucleosome
- c. A protein that twists nucleosomes to form 30 nm fibers
- ~~d. A portion of DNA that does not contain genes~~
- ~~e. An enzyme that converts nucleosomes into heterochromatin~~

6. One difference between RNA and DNA is:

- ☒ a. Use of a hydrogen (DNA) vs. a hydroxyl group (RNA) on the 2' carbon of ribose
- ~~b. Use of a nitrogenous base (DNA) vs. phosphorous base (RNA)~~
- ~~c. Use of alpha 1,4-ribose (DNA) vs. use of beta 1,4 glucose (RNA)~~
- ~~d. Use of a phosphodiester bond (DNA) vs. a phosphoanhydride bond (RNA) in the backbone~~
- ~~e. Use of an aldose (DNA) vs. a ketose (RNA)~~

7. What is the difference between heterochromatin and euchromatin?

- a. Euchromatin contains nucleosomes, heterochromatin does not
- b. Euchromatin is found only in eukaryotic cells, heterochromatin is not
- c. Euchromatin is found in the nucleus, heterochromatin is not
- ☒ d. Euchromatin has a lower DNA packing ratio than heterochromatin
- e. Euchromatin contains more genes than heterochromatin

8. What function(s) does a proteoglycan play in maintaining a healthy extracellular environment?

- ☒ a. Attracts water, keeps tissues hydrated
- b. Provides elasticity
- ~~c. Forms the basal lamina~~ *glycoproteins*
- d. a and b
- e. a and c

9. Which statement best defines DNA packing ratio?

- a. The length of a DNA segment : the width of the same segment
- b. The number of twists in a DNA segment : the number of basepairs in the same segment
- ☒ c. The length of a packaged DNA segment : the length of the same segment when it is unpackaged
- ~~d. The number of histones in a DNA segment : the width of the same segment~~
- e. The width of a DNA segment : the number of basepairs in the same segment

1:10,000

Consider the following statements about tertiary protein structure:

- ☒ i. Tertiary structure is found primarily in multi-subunit proteins.
- ☒ ii. Tertiary structure is stabilized by disulfide bonds
- ☒ iii. Tertiary structure changes when a protein binds to its target,
- ☒ iv. Changes in tertiary structure do not result in changes in primary structure of the same protein
- ☒ v. All proteins must have at least two stable tertiary structures.

Which of these statements is false?

- ☒ a. i and ii
- ☒ b. iii and iv
- ☒ c. i and iv
- ☒ d. ii and v
- ☒ e. i only

11. A polypeptide backbone forms hydrogen bonds because:

- ☒ a. A phosphoanhydride bond is broken to create a phosphodiester bond between a carboxylic acid group and an amino group
- ☒ b. The side chains of amino acids contain carboxylic acid groups and amino groups
- ☒ c. The delta minus charge on the double bonded oxygen in the carboxylic acid group is attracted to the delta plus charge on the hydrogen portion of the amino group of a different amino acid
- ☒ d. The disulfide bonds created by cysteine amino acids contain a delta minus charge that is attracted to the delta plus charge on nearby water molecules
- ☒ e. The R groups in an alpha helix always point outward towards phospholipids

12. The word polarity is used in many different ways in biology. Which of the following structures does not contain electrical polarity?

- ☒ a. A water molecule
- ☒ b. A hydroxyl group
- ☒ c. A phosphoester
- ☒ d. The hydrophilic end of a detergent
- ☒ e. A hydrophobic amino acid side chain

13. Does hemoglobin exhibit tertiary structure?

- ☒ a. Yes, because it contains several alpha helices but no beta sheets
- ☒ b. No, because it is composed of several subunits
- ☒ c. Yes, because it contains disulfide bonds
- ☒ d. No, because it is not a transmembrane protein
- ☒ e. Yes, because it exhibits quaternary structure

14. What chemical properties enable amphiphiles to dissociate cells and proteins?

- ☒ a. They are both hydrophobic and hydrophilic
- ☒ b. They form both covalent and noncovalent bonds
- ☒ c. They break phosphoester bonds but not disulfide bonds
- ☒ d. They form both hydrogen bonds and peptide bonds
- ☒ e. They hydrolyze phosphoester and glycosidic bonds

10/32

15. Which answer best summarizes the steps necessary to perform indirect immunostaining of a specific human protein in the nucleus of a cell?

- a. Application of a mouse anti-human antibody coupled to a fluorescent tag.
- b. Application of a rabbit anti-human antibody followed by application of a goat anti-rabbit antibody conjugated to a fluorescent tag.
- c. Application a primary mouse anti-human antibody followed by a secondary mouse anti-human antibody conjugated to a fluorescent tag.
- d. Application of a goat anti-mouse antibody followed by a mouse anti-goat antibody conjugated to a fluorescent tag.
- e. Application of a human anti-mouse secondary antibody followed by a goat antihuman antibody conjugated to a fluorescent tag.

16. What three factors determine the resolution of a microscope?

- a. Wavelength of emitted light, source of contrast agent, aperture of refraction
- b. Wavelength of excitation filter, magnitude of angular contrast, refractive filter
- c. Wavelength of illuminating source, angular aperture, refractive index
- d. Wavelength of magnetic refraction, angular illumination, density of contrast agent
- e. Wavelength of specimen, refractive contrast agent, emission filter

$$r = 0.6 \lambda$$

$n \sin \alpha$ → aperture
index of ref.
 $\downarrow = \text{res}$

- 17. Fluorescent particles, once excited by light, emit light that has a ...
- a. Shorter phase
- b. Higher magnitude
- c. Brighter color
- d. Longer wavelength
- e. Deeper frequency

18. The Three Traits of Proteins predict that:

- a. There are more proteins in human cells than in bacteria.
- b. Transmembrane proteins typically contain alpha helical transmembrane domains.
- c. ARP2/3 nucleates actin filament formation after it binds to an existing actin filament.
- d. Collagen is a triple helical coiled-coil protein.
- e. Neurotransmitters trigger contraction of some muscles and relaxation of others.

19. What is the location of laminin and how is it degraded?

- a. It is secreted into the extracellular space and digested by a proteinase.
- b. It is stored in the nucleus and digested in a lysosome.
- c. It is attached to ARP2/3 and digested by a proteasome.
- d. It is found in hemidesmosomes and is digested by a proteasome.
- e. It is bound to the centrosome and digested by a proteinase.

20. What is the function of dynein?

- a. It binds to integrin receptors and actin filaments in a focal adhesion
- b. It transports membrane cargo to the minus end of microtubules
- c. It binds to both collagen and laminin, thereby forming a mesh-like matrix in the extracellular space
- d. It causes cancers to break through the basal lamina
- e. It keeps skin cells from ripping when the skin is scratched

21. Which one of the following statements about beta sheets is false?

- a. Beta sheets contain primary structure
- b. Beta sheets can form in multisubunit proteins
- c. Beta sheets are stabilized by hydrogen bonds
- d. Beta sheets are formed by alternating clusters of hydrophobic and hydrophilic amino acids
- e. Beta sheets do not form motifs by themselves, but they may be found in motifs

What is an integrin?

- a. ☒ A transmembrane, multisubunit receptor glycoprotein that binds to extracellular matrix glycoproteins
- b. ☐ An integral monotopic membrane protein that binds to adaptor proteins and actin filaments
- c. ☐ A lipid-anchored membrane protein that keeps the golgi complex attached to the centrosome
- d. ☐ A multispanning membrane protein that forms a channel in the middle of its bundled alpha helices
- e. ☐ A protein that binds to actin and promotes contraction of striated muscles

23. What is an advantage of using fluorescence-based staining methods over using phase contrast microscopy to study cells?

- a. ☒ Fluorescence-based methods generate more contrast than bright field microscopy, phase microscopes techniques don't.
- b. ☐ Fluorescence-based microscopes use longer wavelengths of illuminating light than phase contrast microscopes.
- c. ☐ Fluorescence-based methods can be used on live or dead cells; phase contrast techniques cannot.
- d. ☐ Fluorescence-based microscopes can illuminate thinner specimens than phase contrast microscopes.
- e. ☐ Fluorescence-based methods can detect the location of specific molecules in a cell, phase contrast techniques cannot.

24. Which statement about a lipid raft is true?

- a. ☒ A lipid raft is a dense cluster of integrin subunits coupled to cholesterol
- b. ☐ A lipid raft has far greater fluidity than individual phospholipids
- c. ☐ A lipid raft contains a high concentration of unsaturated fatty acids
- d. ☐ A lipid raft is a cluster of proteins, phospholipids, cholesterol, and other membrane lipids
- e. ☐ A lipid raft is the structural foundation of a hemidesmosome

25. Which property of multisubunit membrane proteins distinguishes them from all other types of membrane proteins?

- a. ☒ They contain alpha helical membrane spanning domains
- b. ☐ They contain more than one polypeptide
- c. ☐ They pass through the membrane several times
- d. ☐ They bind to phospholipid head groups rather than to phospholipid fatty acid tails
- e. ☐ They are expressed primarily in epithelial cells

26. The fluid mosaic model demonstrates that:

- a. ☒ Phospholipids are amphipathic
- b. ☐ Phospholipids form a double layered membrane that is fluid
- c. ☐ Lipid-anchored membrane proteins bind to adaptor proteins
- d. ☐ Membrane phospholipids are synthesized in the smooth ER
- e. ☐ Fatty acids are attached to glycerol in phospholipids

27. The "coke can" model of a channel protein we discussed in class is

- a. ☐ a multisubunit circular protein, with each subunit containing a single membrane spanning alpha helix, held together by hydrophobic amino acids facing the interior of the circle
- b. ☐ an integral monotopic protein that is circular in shape and composed of cluster of transport domains
- c. ☒ a multispanning protein with several alpha helices aligned in a circular pattern, with hydrophobic amino acids facing the outer edge of the circle
- d. ☐ a single-pass membrane protein that permits material to pass through the center of its membrane spanning alpha helix
- e. ☐ quite refreshing on a hot day

28. Which single statement illustrates a difference between fibronectin and collagen? → b, c, d

- a. ☐ Fibronectin and collagen have the same primary structure, but different secondary and tertiary structures
- b. ☐ Fibronectin binds to collagen, but collagen doesn't bind to fibronectin
- c. ☒ Fibronectin is a heterodimer, collagen is a heterotrimer
- d. ☐ Fibronectin lacks the central rod domain found in collagen
- e. ☐ Fibronectin is located in the sarcomere, collagen isn't

29. Consider the following statements about proteins:

- ☒ i. More than one motif may lie within one domain
- ☒ ii. More than one subunit may lie within one motif
- ☒ iii. Proteins with multiple domains must have quaternary structure
- ☒ iv. Two alpha helices linked by a beta sheet is a domain

Which of these statements is/are true?

- ~~a. i and iv~~
- ~~b. ii and iii~~
- ☒ c. i only
- ~~d. iv only~~
- ~~e. i, ii, and iv~~

30. What does the statement "Cells must remain in disequilibrium with the environment to stay alive" mean?

- ☒ a. The concentration of molecules in a cell must be different than the concentration of the same type of molecules outside the cell.
- ~~b. Molecules must not move across the plasma membrane.~~
- ~~c. No two cells can have the same concentration of the same molecules.~~
- ~~d. The amount of proteoglycans outside a cell must be higher than the amount of proteoglycans inside a cell.~~
- ~~e. One face of a membrane must have different phospholipids than the other face.~~

31. For microtubules to treadmill in a cell, which of the following conditions must be met?

- ~~i. The microtubules that treadmill must have "free" plus and minus ends~~
- ~~ii. All tubulin subunits in the cell must be bound to GTP~~
- ☒ iii. The microtubules that treadmill must not be connected to the centrosome in any way
- ☒ iv. Kinesin and dynein must move in opposite directions on the same treading microtubule
- ☒ v. The pool of tubulin subunits must be evenly distributed throughout the cytosol

- ~~a. i, iii, and v~~
- ~~b. ii and iv~~
- ~~c. i and iv~~
- ☒ d. i only
- ~~e. v only~~

32. What structural property of intermediate filaments contributes the most to their great mechanical strength?

- a. They are dimers
- ~~b. They contain covalently linked peptide bonds~~
- ~~c. They contain many binding sites for other proteins~~
- ~~d. They are rich in alpha helices~~
- ☒ e. They form coiled coils

33. Where would one expect to find functionally active ARP2/3 in a moving cell, and why?

- ☒ a. In a lamellopodium, because it helps form the actin "webbing" that links parallel bundles of actin filaments in filopodia
- ~~b. In a focal adhesion, because actin filaments bind to adaptor proteins~~
- ☒ c. In a filopodium, because ARP2/3 triggers new actin polymerization such as that needed to extend the plasma membrane
- ~~d. In hemidesmosomes, because it provides great mechanical strength to migrating cells~~
- ~~e. In the basal lamina, because it forms the branched network of ECM proteins that cell migrate on~~

34. What is a sarcomere?

~~a. A striated muscle cell~~

☒ b. The functional contractile unit of a striated muscle cell

~~c. A bundle of myosin motor proteins positioned very close to actin filaments in a striated muscle cell~~

~~d. A cluster of integrin receptors bound to actin in a striated muscle cell~~

~~e. The relative position of the endoplasmic and golgi complex in a striated muscle cell~~

✓ 35. Which statement best explains the "typical" distribution of the endoplasmic reticulum (ER) and golgi complex in an "average" eukaryotic cell?

☒ a. The ER is distributed throughout the cytosol by kinesin motor proteins, the golgi is condensed onto the centrosome by dynein motor proteins

b. The ER is aligned with actin filaments by myosin motor proteins, the golgi is concentrated near the plasma membrane by kinesin motor proteins

~~c. The golgi is located closer to the centrosome than the ER because it is bound to a higher percentage of kinesin motor proteins~~

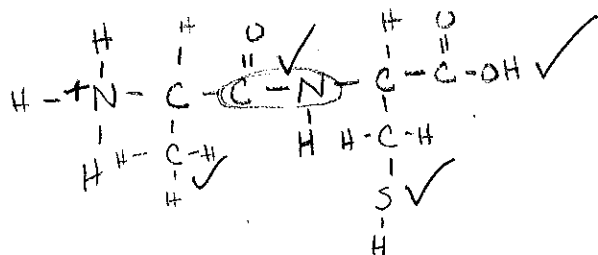
~~d. The ER and golgi switch between a distributed and condensed form depending on the direction of microtubule-bound vesicles that exit them~~

~~e. The golgi is connected to the centrosome by dynein motor proteins, the ER is connected to the plasma membrane by kinesin motor proteins~~

Part II. Drawings/short answer. Answer the questions in the space provided.

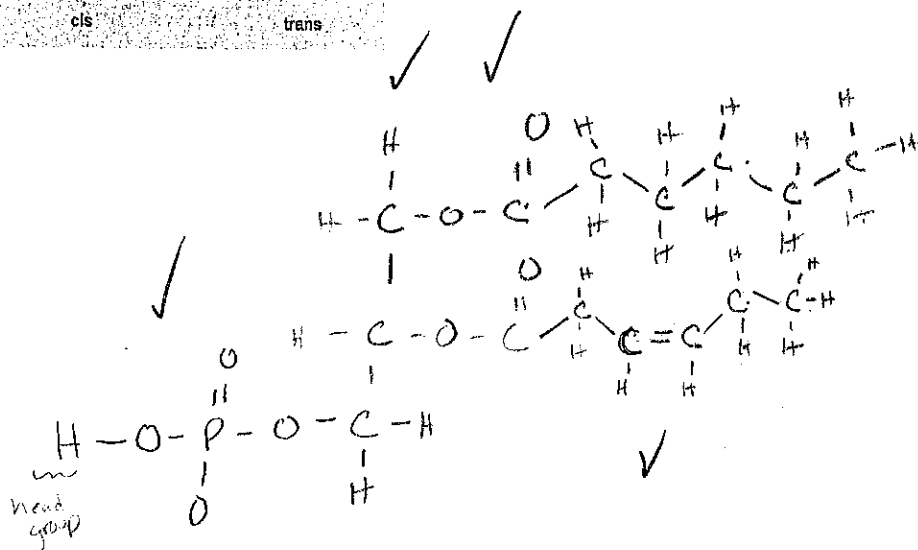
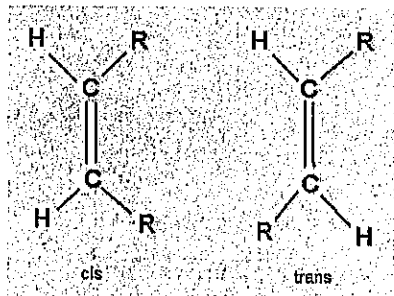
1. Using the table of amino acid side chains below, draw a dipeptide consisting of a non-polar amino acid at the amino terminus and a polar (*not ionic*) amino acid at the carboxy terminus. Circle the atoms that form the peptide bond.

Glycine	Serine	Alanine	Lysine	Cysteine	Aspartate
-H	-CH ₂ OH	-CH ₃	-CH ₂ -CH ₂ -CH ₂ - CH ₂ -NH ₃ ⁺	-CH ₂ -SH	-CH ₂ -COO ⁻



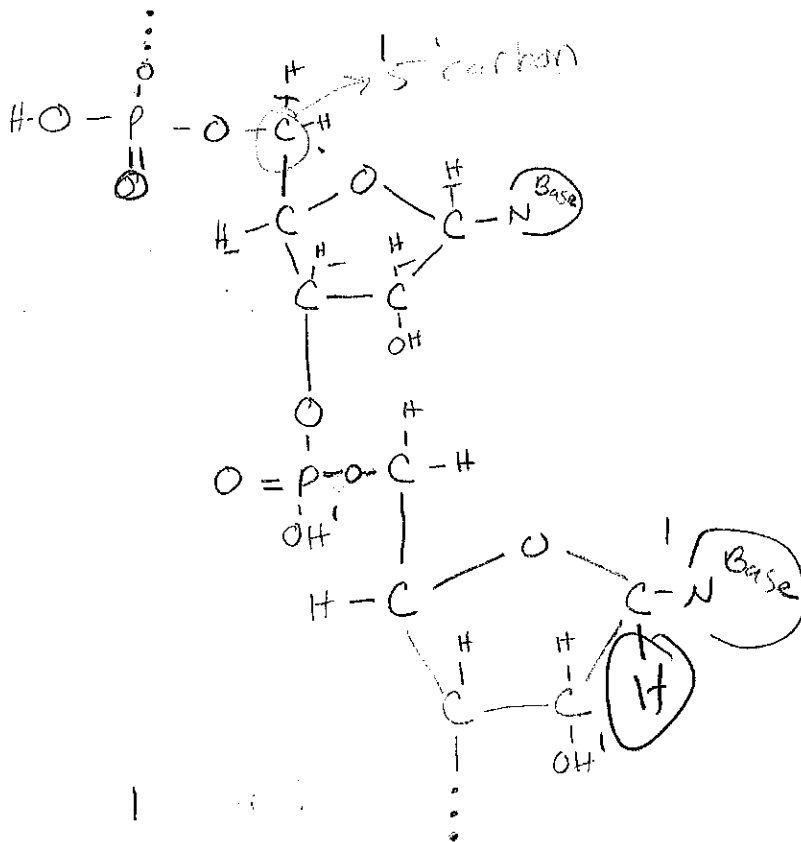
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2. Draw a "generic" phospholipid, containing the following: (1) one fully saturated fatty acid (2) one fatty acid that contains one *cis* double bond. (The structure of a *cis* double bond is shown below to help you.) Remember that single bonded carbon forms tetrahedral bonds, and use this information to show how a *cis* double bond introduces a "kink" in a fatty acid. You may use "H" as an abbreviation for the Head group. Show all other carbons, oxygens, hydrogens, etc. Assume that each fatty acid contains only six carbons.



7

3. Draw two nucleotides in the middle of an RNA molecule. You may use "..." to indicate additional nucleotides at either end of these two. Circle the 5' carbon at one end of the pair, and the 3' carbon at the other end.



6

A. Define the word *hypothesis*, as it applies to science:

A hypothesis is a statement which provides known facts, and gives a claim that can either be proven or disproven.

B. Define the term *logical argument*, and give one example (in any context):

A logical argument is a series of statements which are factual and related, and when put together they prove a conclusion.

Hamburgers contain high amounts of fat.

Fat contributes to heart disease.

Therefore, eating hamburgers may cause heart disease.

C. Translate the following title of a research article into everyday English:

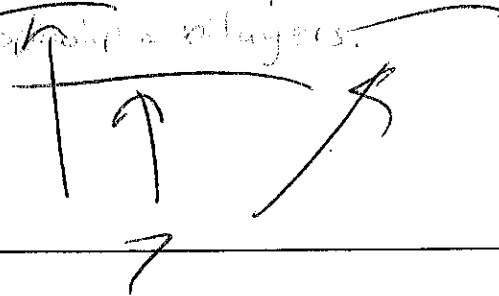
Langmuir 2006, 22, 9096–9099

Lipid Diffusion in Giant Unilamellar Vesicles Is More than 2 Times Faster than in Supported Phospholipid Bilayers under Identical Conditions

Magdalena Przybylo,[†] Jan Sýkora,[†] Jana Humpolíčková, Aleš Benda, Anna Zan, and Martin Hof*

In a controlled setting, diffusion in a specific vesicle is twice as fast than in diffusion in phospholipid bilayers.

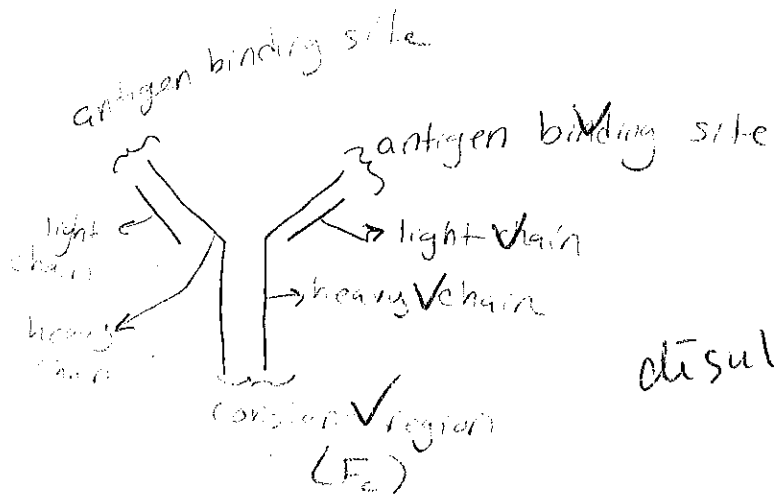
-2



5

5. Draw an antibody at the level of detail discussed in class. Label your diagram completely.

6



disulfide?
-1

SCORE: PART I 29 + PART II 30.5 = 60 out of 70 points total. *hp*