corrections in pen

82%

Biology 2120
Spring 2011
Midterm Exam #2

Name (printed):

This exam contains 11 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 top edge of 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 handed in 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. If you performed immunofluorescence microscopy to localize integrins in an epithelial cell, you would not expect to find them in:

A. Secretory vesicles
B. The Trans Golgi Network
C. The plasma membrane
D. The nucleus
E. The endoplasmic reticulum

lectins bind sugars hydrolases

I-cell lectins

2. Which logical argument is representative of the novel claims of the paper by Roussou et al. in module 2-2?

A. Premise 1: Lectins bind hydrolases.
Premise 2: Hydrolases secreted by fibroblasts from patients with mucolipidosis II bind lectins poorly.
Conclusion: Fibroblasts from patients with mucolipidosis II secrete fewer hydrolases than healthy patients.
B. Premise 1: Lectins bind sugar residues on glycoproteins.
Premise 2: Hydrolases secreted by fibroblasts from patients with mucolipidosis II bind lectins poorly.
Conclusion: Patients with mucolipidosis II have improperly glyosylated hydrolases.
C. Premise 1: Lectins bind sugar residues on glycoproteins.
Premise 2: Hydrolases are soluble glycoproteins.
Conclusion: The percentage of hydrolases removed from aqueous solution increases proportionally with the amount of lectins added.
D. Premise 1: Hydrolases are soluble glycoproteins.
Premise 2: Fibroblasts from patients with mucolipidosis II have improperly glyosylated hydrolases.
Conclusion: Hydrolases from mucolipidosis II are insoluble.
E. Premise 1: Lectins bind sugar residues on glycoproteins.
Premise 2: Hydrolases secreted by fibroblasts from patients with mucolipidosis II bind lectins poorly.
Conclusion: Hydrolases are glycoproteins.

3. Which protein most likely has a *stop transfer* sequence?

integral membrane

A. Lysosomal proton pump
B. TFIIH
C. Mitochondrial hsp70
D. aminoacyl tRNA synthetase
E. Elastin

4. How many times, minimum, must a ribosomal polypeptide subunit pass through the nuclear pore complex before it becomes functional?

A. Zero, because ribosomes function only in the cytosol.
B. One, because the mRNA that attaches to a ribosome must be exported from the nucleus.
C. Two, because the polypeptide is synthesized in the cytosol then assembled into a ribosomal subunit in the nucleus before returning to the cytosol.
D. Three, because exportin must be returned to the nucleus after Ran cleaves GTP in the cytosol, in addition to the two trips listed in answer C.
E. Four, because both small and large ribosomal subunits are assembled by the nucleolus following subunit synthesis in the cytosol.

5. Which one of the following does not result in the creation of a proton gradient in cells?

A. Oxidation of water by photosystem II, followed by oxidation of photosystem II in chloroplasts
B. Oxidation of NADH by Complex I in mitochondria
C. Oxidation of cytochrome c by Complex IV
D. Reduction of coenzyme Q by $FADH_2$
E. Reduction of $NAD^+ + H^+$ by glycolysis

6. Which statement best illustrates the principle that the nucleus functions to protect DNA?

A. TFIIH must phosphorylate RNA polymerase II before it can copy a DNA sequence.
B. DNA never leaves the boundaries of the nuclear membrane.
C. Nuclear lamins will dissociate when they are phosphorylated.
D. U1 and U2 snRNPs recognize specific sequences on pre-mRNA.
E. mRNA contains a polyadenylated tail but DNA does not.

7. Which of the following is not a similarity between mitochondria and chloroplasts?

A. Both are enclosed by a double membrane.
B. Both use proton gradients to generate ATP.
C. Both use a cycle of chemical reactions to generate CO_2
D. Both use transit sequences to target cytosolic proteins to their interior compartments.
E. Both contain a form of ATP synthase.

8. Nucleic acids are synthesized only in the 5' to 3' direction because:

A. The reaction generates pyrophosphate instead of monophosphate.
B. The reaction allows DNA polymerase to proofread.
C. The reaction permits double stranded DNA to be aligned as an antiparallel helix.
D. The reaction allows DNA polymerase to copy both strands of a double stranded DNA simultaneously.
E. The reaction

9. Which statement most accurately describes the function of telomerase?

A. It helps cells live forever
B. It helps cells prevent cancer
C. It helps cells divide more quickly
D. It helps multicellular organisms specialize
E. It helps prevent cells from dying

10. The function of the Calvin Cycle is:

A. To convert sunlight energy, CO_2, and H_2O into glyceraldehyde-3-phosphate (G3P).
B. To convert CO_2, NADPH, and ATP into glyceraldehyde-3-phosphate (G3P).
C. To convert a proton gradient, CO_2, and NADPH into ATP, glyceraldehyde-3-phosphate (G3P), and O_2.
D. To strip electrons from H_2O and generate a proton gradient and glyceraldehyde-3-phosphate (G3P).
E. To convert NADH and $FADH_2$ to a proton gradient and ATP

11. Depolymerization of microtubules is an important feature of:

A. Anaphase A
B. Anaphase B
C. Nuclear import
D. Nuclear export
E. None of the above

12. Which statement best describes the *core promoter*?

A. It encodes the TFIIE sequence that forms the core of the RNA polymerase II enzyme complex
B. It encodes the central (core) sequence of a gene
C. It encodes the sequences responsible for promoting DNA replication
D. It encodes the sequences immediately "upstream" of the mRNA transcription start site.
E. It encodes the sequences that promote expression of the core proteins in the nuclear pore complex.

13. If a eukaryotic cell could not form *astral* microtubules, what impact would this likely have on that cell?

A. It would be unable to secrete proteins.
B. It would not form lysosomes.
C. It would be unable to successfully complete cell division.
D. It would become smaller and rounder than unaffected normal cells.
E. It would die immediately.

14. What is the relationship between Signal Recognition Particle (SRP) and aminoacyl tRNA (aatRNA)?

A. SRP binds aatRNA in the snRNP during splicing, thereby forming the lariat.
B. SRP significantly slows translation of aminoacyl tRNA synthetase and thus inhibits aatRNA synthesis.
C. SRP binds to aminoacyl tRNA synthetase and significantly slows synthesis of aatRNA.
D. SRP binds tSNAREs that encode aatRNA, enhancing aatRNA synthesis.
E. SRP significantly slows the hydrolysis of aatRNA when it is bound to a ribosome.

15. How does redox potential help explain the function of the mitochondrial electron transport chain?

A. It explains why protons, rather than electrons, are passed through the ATP synthetase complex.
B. It explains why NADH generates more ATP equivalents than $FADH_2$.
C. It explains why water is the most abundant molecule in the mitochondrial matrix.
D. It explains why sugars must be converted to acetyl CoA before they can be metabolized in mitochondria.
E. It explains why electron transport occurs in the inner mitochondrial membrane instead of the outer mitochondrial membrane.

16. The difference between primary transcript (pre-mRNA) and mRNA is:

A. Pre-mRNA contains a polyadenylated tail, mRNA does not.
B. Pre-mRNA has not undergone splicing, mRNA has.
C. Pre-mRNA has not completed RNA synthesis, mRNA has.
D. Pre-mRNA is double stranded, mRNA is not.
E. Pre-mRNA occurs only in prokaryotes, mRNA occurs in prokaryotes and eukaryotes.

17. Which statement best describes the function of U1 and U2 snRNPs?

A. They bind to pre-mRNA at specific RNA sequences and are components of the spliceosome.
B. They form the A and P sites in ribosomes, respectively.
C. They form the 5' and 3' caps on mRNA, respectively.
D. They help link the small and large ribosomal subunits together during the initiation stage of translation.
E. They bind to the core promoter to initiate transcription.

18. If the protein named Ran was mutated so it could no longer bind GTP, what impact would this have on a cell?

A. All protein translation would cease.
B. Vesicle fusion with the Cis Golgi Network would cease.
C. Glucose would no longer be transported into the cytosol.
D. Proteins inside the nucleus would not function properly.
E. Ribosomes attached to the ER would not be able to translate proteins.

19. What statement best explains why glucose transport across the apical membrane in intestinal epithelial cells is classified as indirect active transport?

A. Glucose is stored in the liver, but is initially absorbed by a different organ, the small intestine.
B. Most sugars must be digested in the mouth to generate glucose prior to absorption in the small intestine.
C. Glucose digestion leads to the generation of ATP, and this ATP is then used to transport additional glucose.
D. Glucose is transported both into and out of intestinal epithelial cells without consuming ATP.
E. The formation of a glucose gradient requires a pre-existing sodium ion gradient.

20. What is the function of 7-methylguanosine during transcription?

A. It terminates transcription when the stop codon is reached by RNA polymerase II.
B. It initiates transcription by forming the 5' end of mRNA.
C. It permits the elongation phase of transcription by keeping the transcription bubble open.
D. It caps mRNA by forming an additional 5' end on mRNA.
E. It modifies the 5' end of mRNA.

21. Aminoacyl tRNA synthetase:

A. Forms a covalent bond between amino acids and tRNAs in the cytosol.
B. Forms a covalent bond between amino acids and a growing polypeptide in the P site of a mitochondrion.
C. Synthesizes tRNAs in the nucleus that later form peptide bonds in the P site of a mitochondrion.
D. Synthesizes tRNAs in the cytosol that later encode amino acids in the nucleus.
E. Forms the initiator tRNA that triggers transcription.

22. Does the gene encoding a collagen polypeptide include a signal sequence?

A. Yes, because it begins translation in the cytosol.
B. No, because the mRNA must undergo splicing to contain a signal sequence.
C. Yes, because it is secreted.
D. No, because collagens are located in the extracellular matrix.
E. Yes, because it binds integrins.

23. What causes I-cell disease?

A. Cells do not secrete mannose-6-phosphate.
B. Cells do not tag lysosomal proteins with mannose-6-phosphate.
C. Cells do not make mannose-6-phosphate receptors.
D. Cells do not synthesize lysosomal proton pumps.
E. Cells do not synthesize LDL receptors.

24. Which statement most accurately describes the *initiation phase* of translation?

A. Translation initiates in the nucleus immediately following transcription.
B. Translation initiates when SRP and SRP receptor both cleave GTP.
C. Translation initiates when hsp70 cleaves ATP.
D. Translation initiates when the two mitochondrial subunits bind to mRNA and initiator tRNA.
E. Translation occurs when the two mitochondrial subunits are assembled in the nucleous.

25. Which statement best describes the difference between kinetochore microtubules and polar microtubules?

A. Kinetochore microtubules form in Anaphase A, polar microtubules form in Anaphase B.
B. Kinetochore microtubules undergo dynamic instability, polar microtubules do not.
C. Kinetochore microtubules are capped at the plus ends, polar microtubules are not.
D. Kinetochore microtubules pull chromosomes apart, polar microtubules push centrosomes apart.
E. Kinetochore microtubules contain GTP caps, polar microtubules do not.

26. Which statement most accurately describes how translation is terminated?

A. The polyadenylated tail of mRNA binds to the A site of a ribosome, preventing addition of aminoacyl tRNAs.
B. The stop codon on mRNA occupies the P site of a ribosome, preventing the formation of peptide bonds.
C. Release factor cleaves GTP, thereby cleaving the 3' end of mRNA.
D. Release factor binds to the stop codon, so the P site cannot form any more peptide bonds.
E. Release factor cleaves the 7-methylguanosine cap, causing mRNA to dissociate from the ribosome.

27. Consider the following statements about the endomembrane system. Which of them are **false**?

i. The ER relies on a sodium gradient to drive proteins through the ER membrane; this is called indirect active transport
ii. The core oligosaccharide is transferred from dolichol phosphate to newly synthesized proteins in the ER
iii. t-SNARES bind to acidic hydrolases, thereby targeting them to the endosome/lysosome.
iv. The core oligosaccharide on proton pumps is modified to generate mannose-6-phophatre (M6P)
v. M6P receptors rely on a proton gradient to release their ligands

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

28. Which one of the following statements is **true**?

A. Translation of all mRNAs encoded by nuclear genes begins in the cytosol.
B. All proteins synthesized on the ER surface are attached to mannose-6-phosphate sugars.
C. All RNAs contain 7-methylguanosine.
D. Import of all proteins into the nucleus requires cytosolic hsp70.
E. Ribosomes translate all RNAs.

29. Based on our discussion in lecture, protein import into the peroxisome most closely resembles protein import in:

A. The lysosome
B. The nucleus
C. The chloroplast
D. The endoplasmic reticulum
E. The Trans Golgi Network

30. Which statement best describes glycolysis?

A. It converts glucose to NADH, $FADH_2$, and CO_2.
B. It converts CO_2 and H_2O to glucose and ATP.
C. It converts glucose to ethanol, acetyl CoA, and NADH.
D. It converts glucose to pyruvate, NADH, and ATP.
E. It converts glucose into a proton gradient that then makes ATP in mitochondria.

31. How did the research article by Rousson et al., discussed in recitation module 2-2, help clarify how the endomembrane system functions?

A. It illustrated that the Trans Golgi Network sorts proteins into vesicles that form endosomes.
B. It illustrated that acidity is required for activation of lysosomal hydrolases.
C. It illustrated that acidic hydrolases must be glycosylated to be properly sorted to lysosomes.
D. It illustrated that the core oligosaccharide is built on dolichol phosphate.
E. It illustrated that lysosomal proton pumps contain ER signal sequences.

32. Which statement best describes the function of Photosystem II?

A. It converts photon energy into high energy electrons
B. It makes NADPH
C. It dissipates a proton gradient to convert ADP + Pi into ATP
D. It transfers electrons between Photosystem I and Photosystem III to generate a proton gradient
E. It reduces CO_2 to generate glyceraldehyde-3-phosphate (G3P).

33. What does the study of sphingolipid activator proteins (SAPs), described in the paper in module 2-3, add to our understanding of how lysosomes function?

A. It illustrates that the core oligosaccharide is transferred to lysosomal proteins in the ER.
B. It illustrates that lysosomal enzymes can be activated by a mechanism independent of mannose-6-phosphate receptors.
C. It illustrates that acidic hydrolases must be secreted to be properly sorted to lysosomes.
D. It illustrates that lectins act as antibodies for glycoproteins.
E. It illustrates that I cell disease is caused by failure to form lysosomes.

34. Which of the following is found in the 70S initiation complex, but <u>not</u> in the 30S initiation complex, during translation in prokaryotes?

A. "Initiation factor" proteins
B. Initiator tRNA
C. Large ribosomal subunit
D. mRNA
E. Small ribosomal subunit

35. If a cell was transfected with a plasmid encoding Green Fluorescent Protein, and the result was accumulation of GFP in the nucleus, which statement best explains this result?

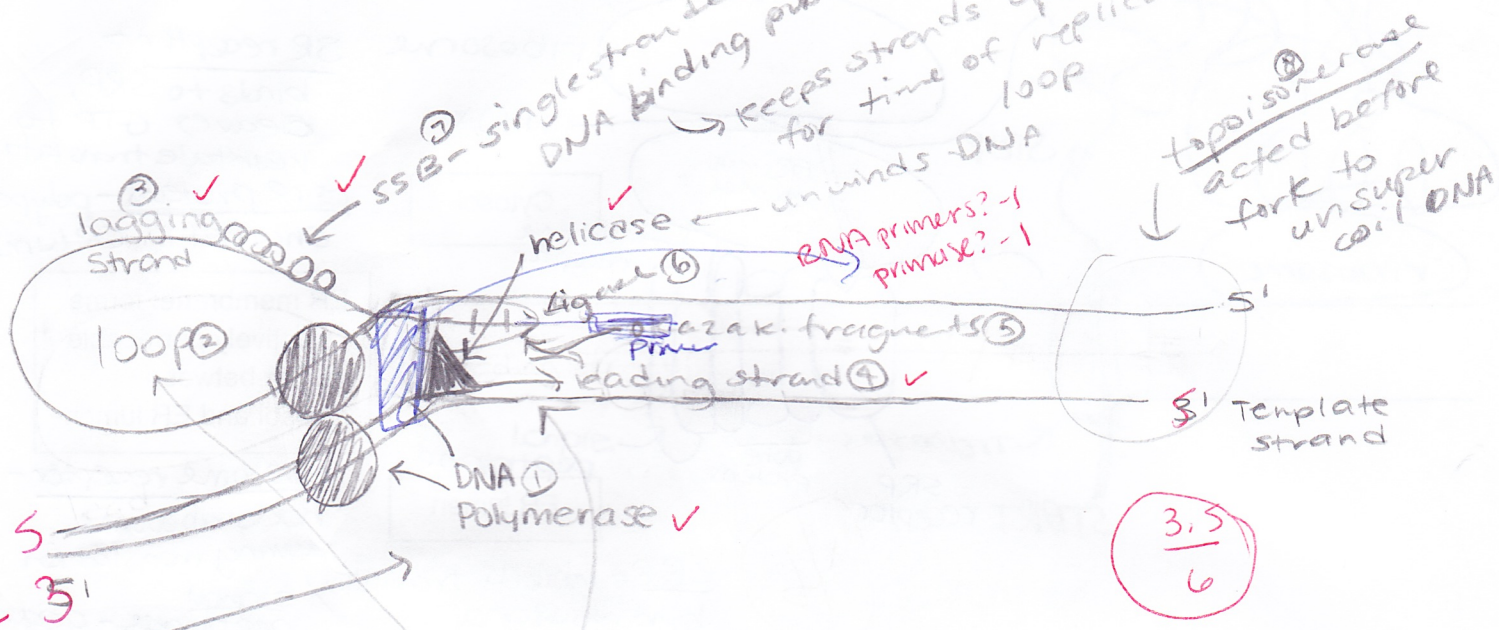
A. The GFP is cleaved by signal peptidase.
B. The GFP binds to Ran-GTP.
C. The GFP gene was engineered to include a Nuclear Localization Sequence.
D. The GFP gene was engineered to include a stop transfer sequence.
E. The GFP binds cytosolic hsp70.

5 wrong

* check this one

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

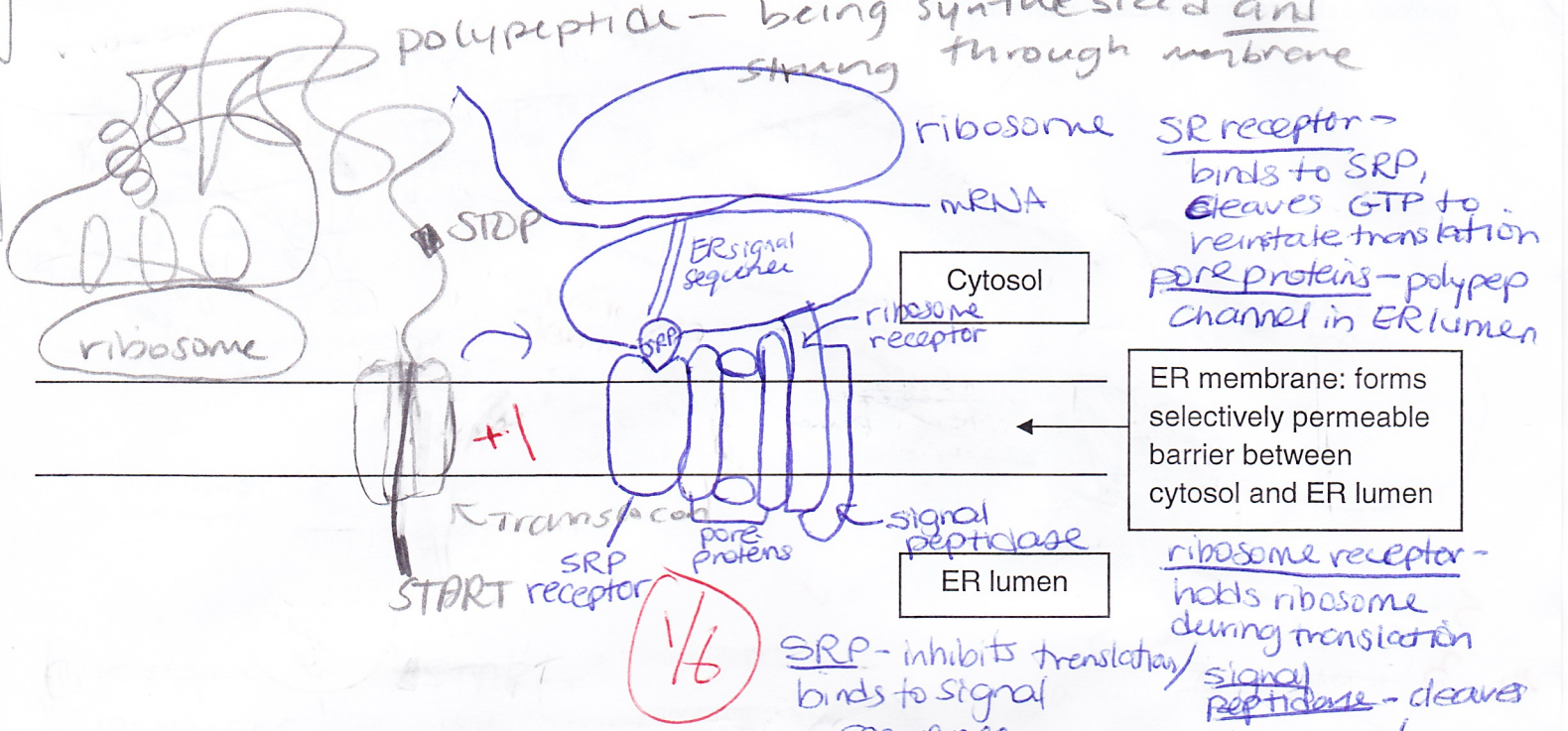
1. Draw the DNA replication fork at the level of detail discussed in class, illustrating how both strands of DNA are replicated simultaneously. Label your diagram completely.



Both DNA polymerases ① replicate DNA from the 5' end to 3' end. A loop ② is made on the strand facing 3' to 5' so the orientation of the DNA template is faced 5' to 3' for the period in which it is replicated. A leading strand ④ is created by the strand synthesized 5' to 3', and a lagging strand ③ is created from the looped strand.

- lagging strand ③ is synthesized in pieces called Okazaki ⑤ fragments, then joined by DNA Ligase ⑥

2. Draw a translocon in the ER membrane, label the structures you draw, and briefly describe the functions of each. The ER membrane has been drawn to get you started, and is described as an example of the format you should use.

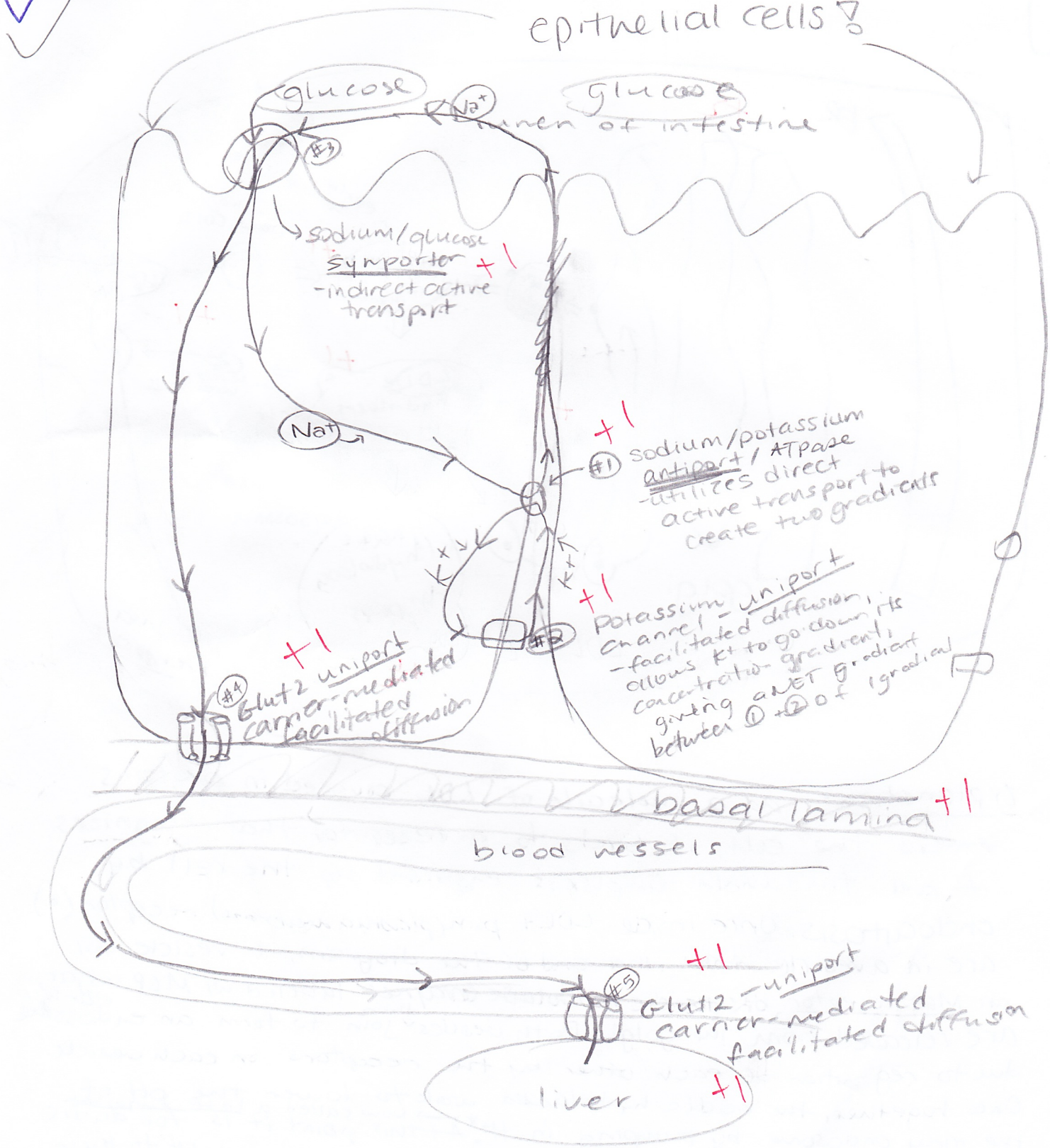


Translocon - the target on the ER membrane where a ribosome will dock + where a polypeptide will go through cotranslational modification as it passes through the membrane directly after + during synthesis.

START/STOP - These can be in different places, few examples,
- in my drawing, start lets polypeptide in and the stop will cause the protein to span the membrane once, becoming an integral membrane protein.
- The protein may also span membrane a few times, or lack a STOP sequence, causing it to end up in the ER lumen and not stuck in the membrane at all.

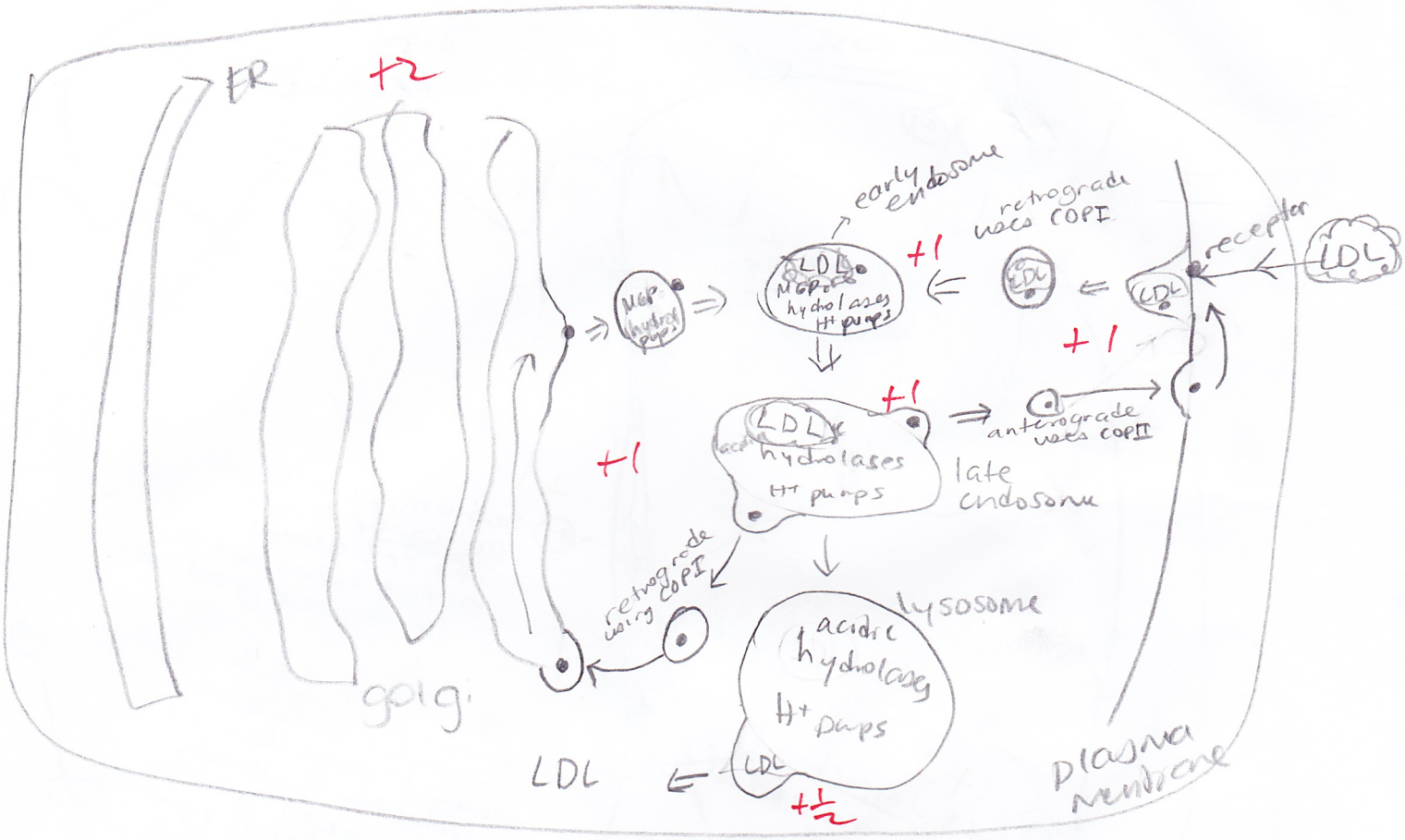
7

3. Illustrate how glucose is transported from the lumen of the small intestine to the liver, based on the drawing we generated in lecture. Label your diagram completely and indicate where **uniport**, **symport,** and **antiport** take place (these may occur in more than one location).



6.5/7

4. Diagram how cells build lysosomes, and include in your diagram an explanation for how recycling of receptors occurs.



Explanation: as a molecule of LDL covered in proteins enters the cell, it binds to a receptor that recognizes it and the whole complex is engulfed by the cell by endocytosis. Once inside, LDL + pom (plasma membrane) receptor (•) are in a vesicle. At the other end of the diagram, a vesicle w/ an M6P receptor and acidic hydrolase enzymes labeled w/ M6P sugar are released from the golgi. Both vesicles then join to form an early endosome due to recognition of each other by the receptors on each vesicle. Once together, the acidic hydrolases work to lower the pH of the early endosome by pumping in H+. → Now called a late endosome At this point, it is too acidic for the receptors, so they leave in vesicles and go back to their respective places. The protein around the LDL is then digested by the lysosome and LDL molecule is released from the lysosome so it can be used by the cell. (what late turns into)

5. Complete the Table below, using the appropriate numbers to indicate the correct cellular compartment(s) for each event. Assume metabolism is aerobic, not anaerobic. An example is provided for you.

1= Nucleus
2= ER membrane
3= ER lumen
4= Mitochondrial matrix
5= Inner mitochondrial membrane
6= Trans Golgi Network
7= Lysosome
8= Peroxisome
9= Inter membrane space in mitochondria
10= Early endosome
11= Late endsosome
12= Secretory vesicle
13= Cytosol
14= Chloroplast stroma
15= Inner chloroplast membrane
16= Thylakoid membrane

Event	Location(s)
Microtubule depolymerization	13 ✓ 13
Cleavage of signal peptide	~~2~~ 3
Reduction of O_2	4, ✓ 4
Generation of pyruvate	13 ✓ 13
Dissipation of H^+ gradient to create ATP	~~15~~, ~~9~~, 16, 5
Reduction of NAD^+	~~16~~ 13, 4
Oxidation of NADPH	~~9~~ 14
Digestion of Low Density Lipoprotein	7 ✓ 7
Binding to Ran-GTP	~~1~~, ~~13~~ 1
Oxidation of H_2O	~~16~~ 14

2/5

6. Complete the table below, indicating the reactants and products for the following metabolic reactions: 1.5/4

Metabolic Reactions	Reactants	Products
Glycolysis -.5	glucose NAD^+ $ADP + P_i$	pyruvate 1 ATP NADH
Calvin Cycle -.5	CO_2 ATP NADPH	G3P → (glucose) ADP+Pi
Mitocondrial Electron Transport Chain -1	O_2, ~~NADH~~, ~~Pyruvate~~ $FADH_2$, $ADP + P_i$ opt.	H_2O, NAD^+, FAD, ~~CO_2~~ ~~acetyl CoA~~ ATP ~~NADH~~
Krebs Cycle -.5	~~NADH~~ $ADP+P_i$ opt acetyl CoA NAD^+, FAD	ATP NADH ~~H+~~ $FADH_2$ CO_2

SCORE: PART I 28 + PART II 21.5 = 49.5 +5 out of 70 points total.

50 (55/70) 3.C