ANSWER KEY

Cell Biology C

BirdSO Mini Invitational

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UC Berkeley '24

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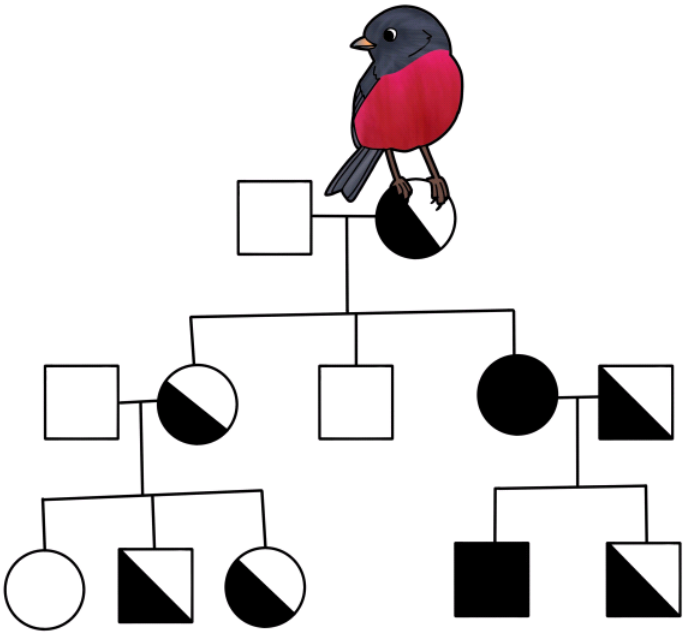


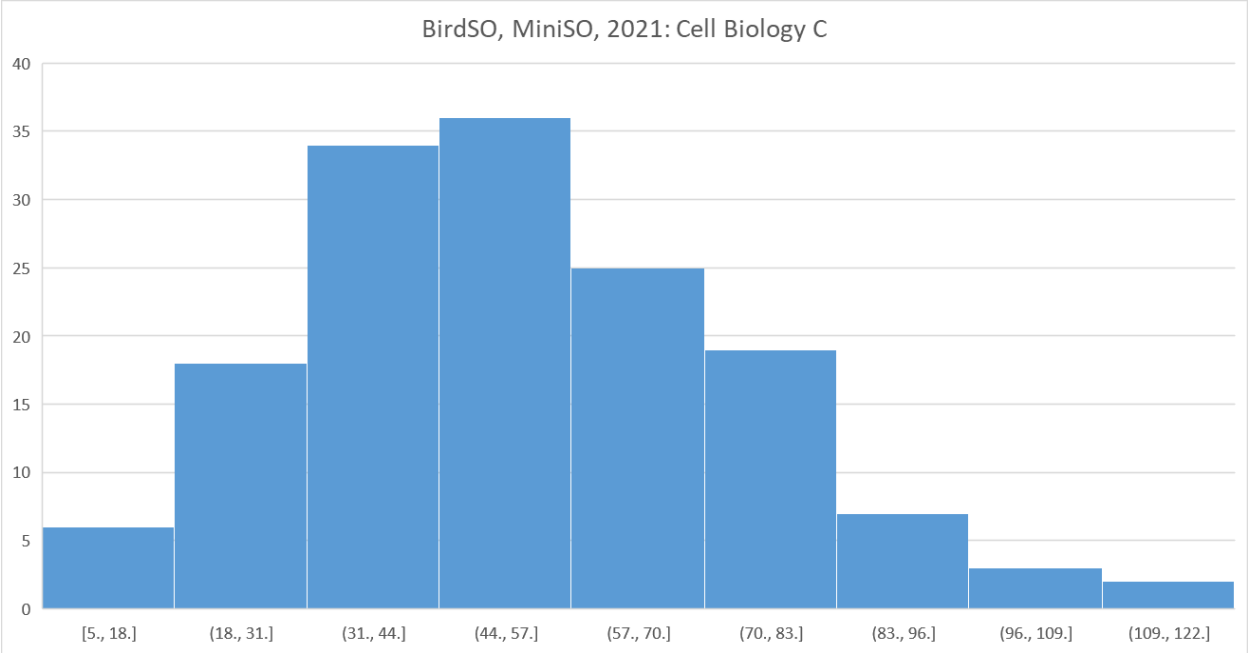
Instructions

Welcome to your Cell Biology Division C test for BirdSO! You will be allowed to use one 8.5" x 11" sheet of paper for notes and one stand-alone non-programmable, non-graphing calculators. You will have 50 minutes to complete this test. Please do not leave this page or it will flag you for out-of-browser time. This test will not be proctored, please take it at your own scheduled time.

Points: /168

If you would like to reach out with questions, etc…
email: megan.luo28@gmail.com, discord: @bluehouse08#9804

Score distribution for those interested:



For questions 1-10, please select true if the statement is true, otherwise please select false.

1. The most harmless amino acid mutation is nonsense. (1 point)

False

2. 16 carbon atoms are necessary for the citric acid cycle to produce 4 molecules of glucose. (1 point)

True

3. Pluripotent stem cells can give rise to all cells in the adult while totipotent can only give rise to any tissue in an organism. (1 point)

True

4. Glucose is a catabolic reaction. (1 point)

False

5. Crossing over and gene conversion occurs more in males than females. (1 point)

False

6. The human DNA is approx. 3 billion bp long. (1 point)

True

7. Chromosomes attach to microtubules via the ends of the chromatid. (1 point)

False

8. GFP is used for fluorescent visualization because it is small enough to enter the cell via pores. (1 point)

False

9. Glucose travels against the concentration gradient in the glucose-Na^+ symporter. (1 point)

True

10. During transcription, dsRNA will produce one complementary mRNA. (1 point)

False

11. Which of the following organelles has an internal low pH most similar to that of the stomach? (1 points)

    a. Peroxisomes
    b. Golgi apparatus
    c. Lysosome
    d. Mitochondria
    e. Chloroplasts

12. Membrane fluidity is an important characteristic for survival, how could a cell solidify their membrane to survive in cold temperature? (2 points)

    a. Add more transmembrane proteins so that there is a higher ratio of protein to lipids in the cell membranes.
    b. Increase the amount of lipids that have saturated fatty acid acyl groups in the membrane.
    c. Increase the amount of lipids that have unsaturated fatty acid acyl groups in the membrane.
    d. Synthesize more nonpolar tails per each phosphate head to increase the nonpolar attributes of the inside of the membrane.
    e. Synthesize more polar phosphate head groups to increase the polarity of the membrane to increase selectivity.

13. A scientist is testing a drug that reverses the membrane potential and inverts the proton gradient along the inner membrane of the mitochondrion. Which of the following might you observe? (2 points)

    a. ATP synthesis would slow down.
    b. ATP synthesis would speed up.
    c. ATP would be formed in the inter membrane space.
    d. ATP would be hydrolyzed in the inter membrane space.
    e. ATP would be hydrolyzed in the matrix.

14. Which of the following best describes how C4 plants adjust their cellular environment for carbon fixation by Rubsico? (2 points)

a. Increasing cyclic electron transport in the bundle sheath cells while limiting PSII activity.
b. Increasing cyclic electron transport in mesophyll cells while limiting PSII activity.
c. Increasing cyclic electron transport in mesophyll cells while limiting PSI activity.
d. Increasing cyclic electron transport in bundle sheath cells while increasing PSII activity.
e. Increasing cyclic electron transport in bundle sheath cells while limiting PSI activity.

15. In the regeneration phase of the Calvin-Benson cycle, 5 molecules of glyceraldehyde 3-phosphate are: (2 points)

a. Oxidized to make 6 molecules of 1,3-bisphosphoglycerate.
b. Rearranged to make 3 molecules of ribulose 1,5-bisphosphate.
c. Carboxylated by PEP carboxylase to make 4 molecules of xylulose 1,5-bisphosphate.
d. Reduced by NADPH to make 2 molecules of 3-phosphoglycerate.
e. Carboxylated and recovered as 4 molecules of 2-phosphoglycolate during photorespiration.

16. Which chemical reactions would be supported by increased cyclic electron flow rather than electron flow in the chloroplasts? (2 points)

a. Anabolic reactions that produce a higher ratio of ATP to NADPH.
b. Anabolic reactions that produce a higher ratio of NADPH to ATP.
c. Anabolic reactions that use a higher ratio of ATP to NADPH.
d. Anabolic reactions that use a higher ratio of NADPH to ATP.
e. Catabolic reactions that produce a higher ratio of ATP to NADPH.

17. Which process can occur at night (meaning without light)? (2 points)

a. Energy excitation and transfer from carotenoids to chlorophyll *a*.
b. Photorespiration in C4 plants.
c. Oxidation of plastocyanin by P700+.
d. Reduction of ferredoxin by PSI.
e. Carboxylation of PEP in CAM plants.

18. Cells remove the RNA primers that initiate DNA synthesis. Which of the following may explain this? (2 points)

a. RNA can be modified to become an exonuclease that can degrade regions of DNA.
b. RNA primers can be modified into tRNAs which would cause errors in protein synthesis.
c. RNA synthesis is more error prone than DNA synthesis so incorrect bases may persist in the genome.
d. RNA can lead to immediate signaling of lysosomes that will regrade both the primer *and* newly synthesized DNA.
e. Both C and D.

19. Cancer cells have more telomerase activity than normal differentiated cells. Which of the following may explain this? (2 points)

a. Cancer cells have a higher rate of respiration; thus, the mitochondrial genome must be preserved by growing telomeres.
b. Telomerase can be modified by cancer cells to prevent degradation of the cyclin subunit.
c. Cancer cells produce proteins specific to telomerase to increase activity to increase the respiration rate.
d. Cancer cells lose control of normal cell division; thus, additional telomeric DNA is needed to protect chromosomes.
e. None of the above.

20. Specific transcriptional activators in eukaryotes usually directly interact with what to bind to the enhancer sequences? (1 point)

a. SNPs
b. Primase
c. Promoter
d. TATA Box
e. Mediator proteins

21. In DNA replication, how do the leading and Okazaki fragments differ? (2 points)

a. The leading strand is synthesized by adding nucleotides to the 3’ end of the growing stand but the lagging strand is synthesized by adding nucleotides to the 5' end.
b. The leading strand is synthesized at twice the rate of the lagging strand.
c. The lagging strand is synthesized continuously, whereas the leading strand is synthesized in short fragments that are ultimately stitched together.

d. The leading strand is synthesized in the same direction as the movement of the replication fork, whereas the lagging strand is synthesized in the opposite direction.
e. None of the above.

22. DNA replication has a much higher fidelity than transcription. Select the reasons that contribute to this phenomenon. Select all that apply. (3 points)

a. 5' to 3' polymerization
b. 3' to 5' exonuclease activity of DNA Pol III
c. 5' to 3' exonuclease activity of DNA Pol I
d. Enzymes like MutS and MutL
e. None of the above.

23. Where in the cell would you expect to find glycoproteins? Select all that apply. (3 points)

a. The lysosome
b. Inside secretory granules
c. The nuclear envelope
d. The nucleolus
e. The peroxisome

24. Which of the following are true at the photosystems involved in photosynthesis? Select all that apply. (3 points)

a. Photosystems are comprised of a single pigment.
b. Photosystems are embedded in the inner chloroplast membrane.
c. Photosystems use light energy to pump hydrogen ions.
d. Photosystems are comprised of a light harvesting complex and a reaction center.
e. Photosystems use light energy to excited electrons.

25. In a mutated cell, the sequence encoding for pyruvate kinase has a nonsense mutation. Which of the following would occur as a result? Select all that apply. (3 points)

a. Pyruvate would form from PEP.
b. In high fructose-1,6-bisphosphate concentration, ATP will be synthesized.
c. In low fructose-1,6-bisphosphate concentration, PEP pyruvate would be synthesized.
d. Pyruvate kinase activity will increase.
e. None of the above.

26. Please select all the true statements regarding the domains of life. Select all that apply. (3 points)

    a. Bacteria utilizes several kinds of RNA polymerase.
    b. Arachea and eukarya both use methionine as the amino acid initiator while bacteria use formyl-methionine.
    c. Peptidoglycan can be present in plant cell walls.
    d. Eukarya are more closely related to archaea than bacteria is.
    e. Operons are found mostly in eukarya because it conserves space in the genome.

27. Please select all the true statements regarding eukaryotes. Select all that apply. (3 points)

    a. Nuclear pores are similar to cell membrane pores in that they are protein and particle selective; however, nuclear pores also will maintain RNA movement in and out of the nucleus.
    b. Membrane proteins are primarily excreted through pores or channels on the cell membrane and then by using a receptor mechanism, the protein will fuse with the outside of the cell surface.
    c. Lysosomes will degrade organelles or invading pathogens through a process called autophagy where they engulf and degrade the molecule using hydrolases.
    d. Both the mitochondria and the chloroplast typically have two membranes; however, the mitochondrion inner membrane has infoldings while the chloroplast membrane surrounds the stroma.
    e. Peroxisomes are similar to lysosomes in that they breakdown molecules; however, peroxisomes use enzymes that will oxidize molecules such as fatty acids and amino acids to produce hydrogen peroxide, which is later converted into water.

For questions 28-32, please explain why each statement is false. (2 points each)

28. During cellular respiration, pyruvate must be converted into acetyl-CoA before entering the mitochondria. (2 points)

Pyruvate is transported into the mitochondria and then it is then converted into acetyl-CoA.

29. During oxidative phosphorylation of cellular respiration, electrons are finally transferred to oxygen which then becomes oxidized to water with protons in the matrix. (2 points)

Oxygen is not oxidized, it is reduced by water.

30. C3, C4, and CAM plants all use phosphoenolpyruvate as their initial CO_2 acceptor. (2 points)

C3 uses Ribulose-1,5-bisphosphate (RuBP).

31. Mesophyll cells of C3 plants function during the night time to form organic acids. (2 points)

CAM plants not C3 plants.

32. During the reduction step of the Calvin-Benson Cycle, ATP reduces 1,3-bisphosphoglycerate, producing G3P. (2 points)

NADPH not ATP.

33. A scientist is attempting to express a gene outside of the eukaryotic cell by using the full length of a wild-type DNA sequence. The protein is non-functional after it is produced. Why might this happen? (2 points, +1 no spliceosome machinery, +1 introns are translated)

Since the full length of DNA is used but done outside of the cell, there is no machinery to splice the introns and exons. Usually, only the exons are used but introns will also be translated into the protein sequence, affecting protein folding and function.

34. How might a plant benefit from continuously keeping the stomata open? (2 points, +0.5 gas, 0.5 O_2 conc., +1 cbc)

Gases are able to continuously exchange gases allowing the Calvin-Benson cycle to run efficiently; oxygen concentration in the stroma decreases.

35. Which process are tumor cells more likely to use for cellular respiration? Briefly explain how this would change glucose uptake in tumor cells? (3 points, +1 for resp type, +2 for glucose)

Aerobic glycolysis or fermentation; glucose uptake would increase.

36. Plants can exist in both haploid and diploid form. In fact, most plants will alternate between the sporophyte and gametophyte. Getting rid of which process would prevent the plant from entering the gametophyte state? Explain. (2 points, +1 for meiosis, +1 reason)

Meiosis, this would prevent the diploid cells from becoming haploid spores.

37. Which enzyme in DNA synthesis will catalyze an energetically unfavorable nick-sealing reaction driven by being coupled to an energetically favorable process of ATP hydrolysis? (1 points)

DNA ligase

38. What were the two concepts of genetics that Mendel was able to prove in his pea plant experiments? (2 points)

Law of Segregation, Law of Independent Assortment

39. What element of DNA will most explain the variation in eukaryotic genomes despite their size? Give an example. (2 points, +1 for general idea, +1 for an example)

Amount of repetitive DNA (potential ex: transposable element)

40. During the light reactions of photosynthesis, water will directly give electrons to the electron transport chain to make up for lost electrons from PSII. Which other molecule(s) has a similar role to water during the light reaction and what electrons is it replacing? (2 points, +1 plastocyanin, +1 from PSI)

Plastocyanin, electrons lost from PSI

41. Epidermal growth factor (EGF) helps to determine an immature cell's fate. If high amounts of EGF bind to its receptor (EGFR), which fate is likely promoted in the cell? (1 point)

Primary fate

42. EGFR is a receptor tyrosine kinase (RTK). If an EGFR is found with a mutation that prevents the tyrosines from cross-phosphorylating but a dimer is still able to form, describe the likely **immediate and long term** effects in the pathway. (3 points, +1 not all tyrosines are phosphorylated, +1 no binding from other proteins, +1 signal ends)

An answer relating to how tyrosines would be not phosphorylated, preventing relay proteins from binding to the receptor to continue the signal downstream + some effect of the signal ending.

43. When the DNA helicase opens up the replicator fork for duplication. It requires helicase to unwind the DNA, what other molecule is required to structurally prepare the DNA before RNA primer binds? Briefly describe its purpose. (2 points, +1 for ss binding protein, +1 purpose)

Single-strand binding protein, it keeps the region of DNA straight.

44. DNA polymerase can edit its mistakes. A key part of the process is why replication proceeds from 5' to 3'. Explain why replication usually occurs in this direction. (3 points, +1 primer detection, +1 exonuclease, +1 chew until matched base pair)

When an unmatched nucleotide is placed, the 3'-OH end of the primer will block further elongation. Then a 3'-to-5' exonuclease attaches to the DNA polymerase to remove the incorrectly placed nucleotide until there is a matched base-paired 3'-OH end on the primer.

45. A scientist is mutating cells so that the synaptonemal complex does not form during meiosis. After growing many generations of the same cell line with the first mutated cell, it is discovered that there is much less genetic variation. Why might this be? (3 points, +2 complex promotes dsb and crossing over, +1 less genetic variation from no crossover)

The synaptonemal complex forms between homologous chromosomes during prophase I to promote double strand breaks that will lead to crossing over. Since this complex is no longer formed, crossing over will occur at a much lower frequency, preventing generation of more genetic variation.

46. A cell is transferred from a pH of 7 to a pH of 9. Assuming that this does not kill the cell, why might ubiquitin be better than miRNA in terms of helping to maintain the proteins necessary for the cell to survive in this new condition? (4 points, +2 ubiquitin portion, +2 miRNA portion)

Ubiquitin will degrade proteins that have been ubiquitylated which allows it to occur immediately in response to the environmental change. However, miRNA only regulates gene expression at the post-transcription and pre-translation level; it will degrade mRNA and block ribosome activity. This prevents it from immediately responding to the pH change.

47. There are regions, transposable elements, that can be moved from one place to another. This can occur through a "cut and paste" mechanism, "copy and paste" mechanism, or

using an RNA intermediate and reverse transcriptase. Describe the role that reverse transcriptase may play in this process. (2 points)

After transcribing and translating the element (retrotransposon) into ribonucleoprotein complex, reverse transcriptase can transcribe RNA to DNA.

48. A common chromatin modification is methylation of DNA usually to repress gene expression. In an experiment, a researcher performs de novo methylation on a plant cell with siRNAs. Which process will allow methylation to be seen in other cells? Briefly describe the process. (3 points, +1 name, +2 for description)

Maintenance methylation; DNA methyltransferase will recognize 5meC and add a methyl group to the cytosine of the CG on the complementary daughter strand. When one strand is methylated, methyltransferase will methylate the other strand.

49. A new drug is being tested that will push electrons into the lumen from the stroma. However, this experiment was contaminated and a drug that freezes plastoquinone, preventing it from transferring electrons, was also administered. How will this affect the role of photosynthesis? (4 points, +1 slow/stop, +3 reasoning)

It will slow or stop; While pushing electrons into the lumen should increase the rate of photosynthesis, the drug that destabilizes plastoquinone prevents the formation of the electrons used in the proton gradient. The transfer of e- from PSII to PSI.

50. Which part of photosynthesis in chloroplast is similar to cellular respiration in mitochondria? (2 points)

Formation of protein gradient to make ATP

51. Transcription and translation can occur simultaneously in prokaryotes. Please explain this phenomenon and list one advantage. (2 points, +1 for explanation, +1 for advantage)

Since prokaryotes do not have a membrane-bound nucleus, translation occurs in the cytoplasm. Potential advantage: rapid cellular response.

Protein synthesis is a complicated multi-step process that is fundamental to living cells. One particular step, translation, converts mRNA into amino acids prior to the protein folding process. Questions 52-56 will test your understanding of this process and the energy transfers needed.

52. Which of the following statements are true about translation? (2 points)

a. tRNA is not selective and the same subunit can bond to every amino acid.
b. A phosphoanhydride bond is broken causing the release of AMP and PPi.
c. The amino acid attaches to the 3' OH terminus of tRNA.
d. The amino acid attaches to the looped region of the tRNA cloverleaf structure.
e. B and C are true.
f. A, B, and C are true.

53. How many GTPs are used in one cycle of translation (one amino acid gets attached to a forming polypeptide chain)? (1 points)

5 GTP

54. What are the steps to polypeptide growth in chronological order and their respective sites on the tRNA? (2 points, +1 for steps, +1 for sites)

Initiation (A site), elongation (P site), chain termination (E site)

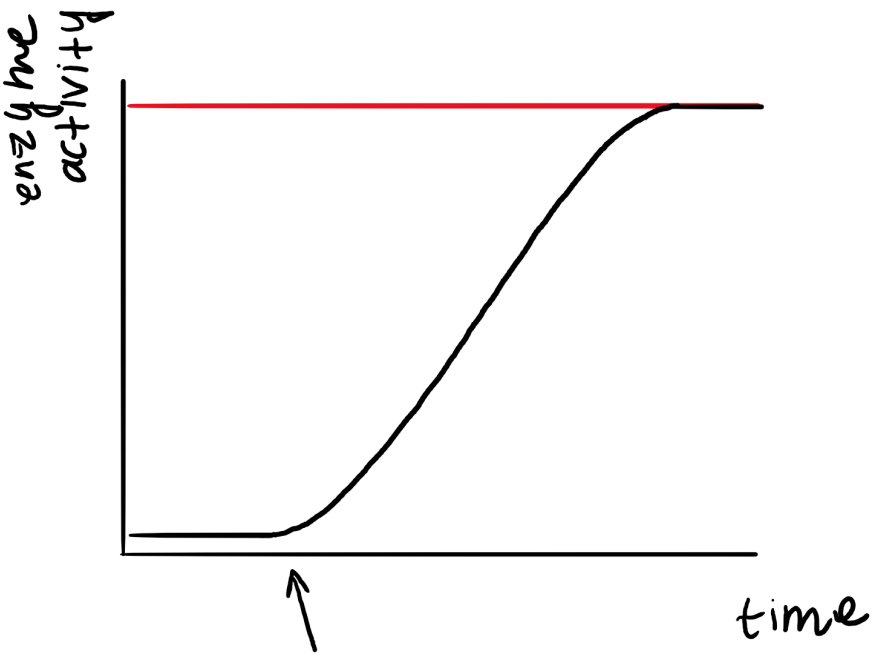
55. When tRNA attaches to an amino acid, it first forms a high energy phosphodiester bond and then forms an ester linkage. Explain why the phosphodiester bond forms first instead of a direct ester linkage. (3 points, +1 phosphodiester bond is higher energy, +2 breaking bond is favorable and exergonic)

The phosphodiester bond has higher energy than the ester bond formed between the amino acid and tRNA. The breaking of this bond makes the reaction to form the ester linkage favorable and exergonic. (deltaG is negative)

56. The start of a polypeptide chain is initiated with a methylamine amino acid. Describe the process of the initiation of translation with the mRNA, and a methylamine tRNA subunit. (2 points, +1 smaller tRNA and initiator tRNA, +1 GTP and large subunit)

The smaller ribosomal subunit binds to a initiator tRNA with Met and, using GTP, the large ribosomal subunit attaches so that the tRNA is now on the P site.

Below is a graph of enzyme activity over time, the arrow is the time point when the regulator for the enzyme is introduced. The black line represents the wild type of the enzyme. The red line represents a mutated version that does not react to the regulator. Please use the graph to answer questions 57-59.



57. Is this positive or negative regulation? Explain. (2 points, +1 negative, +1 reasoning)

Negative regulation because the graph with the mutated repressor is constitutively active instead of constitutively inactive.

58. The *lac* operon is regulated similarly to the enzyme in the diagram above. Which of the following species is least likely to have this operon encoded in their genome? (2 points)

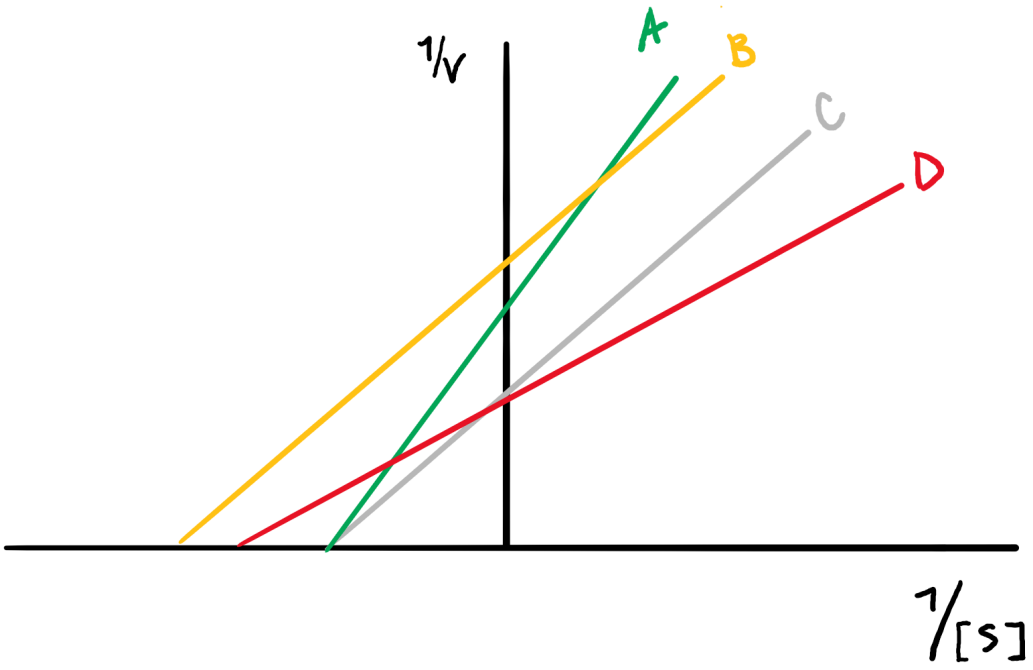
    a. *E. coli*
    b. *Homo sapiens*
    c. *Salmonella enterica*
    d. *Enterobacter cloacae*

59. Jacob and Monod had a famous experiment that identified mutations that affected the LacI repressor on the operon. They mutated the repressor to see how the regulator affected the transcription of genes required in lactose utilization. If you stumbled upon another operon in the *E. coli* genome, describe the roles needed for this experiment (e.g. reporter role (X-gal) was used in the original Jacob/Monod experiment). (4 points, +1 for inducer, +1 for two forms of repressor, +1 for reporter molecule that indicates expression, +1 for food source)

Something relating to having an operon, an inducer that would bind to the repressor, two forms of the repressor (one is wildtype, one is mutated), some reporter molecule that would

measure expression of lac genes, some food source/environment to sustain the cell in otherwise normal conditions.

Below is a Lineweaver-Burk plot that displays the effects of the different types of inhibition on an enzyme. If **LINE C** represents the enzyme without any inhibition, please identify which letters represent the following types of inhibition **and EXPLAIN** in questions 60-61.



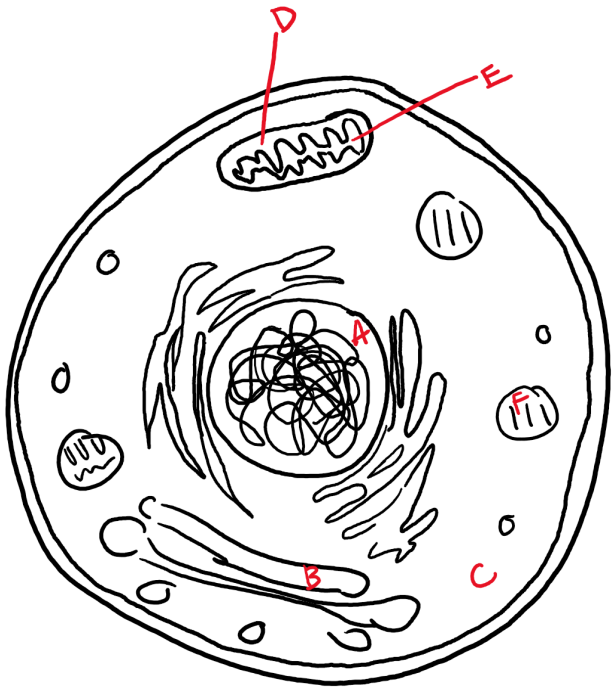
60. Uncompetitive Inhibition (2 points, +1 answer, +1 reasoning)

B, both the K_m and V_{max} decrease.

61. Noncompetitive (Mixed) Inhibition (2 points, +1 answer, +1 reasoning)

A, only V_{max} decreases, K_m remains the same.

For questions 62-65, match the following processes to where they would occur inside a cell based on the diagram below. You can use the same answer choice multiple times.



62. Electron transport chain (1 point)

D

63. Glycolysis (1 point)

C

64. Pyruvate Oxidation (1 point)

E

65. TCA Cycle (1 point)

E

For questions 66-67, match the types of signaling most commonly found in animals with their respective descriptions.

A. Endocrine
B. Paracrine
C. Synaptic
D. Contact/dependent

66. Short distance and sensory related (1 point)

B. Paracrine

67. Medium distance (1 point)

C. Synaptic

Muscle protein actin and motor protein myosin help promote movement in cells. In the plant cell *Nitella*, these two molecules work in conjunction to drive cytoplasmic streaming. Questions 30-33 will test your understanding of these processes and similar means to conduct cytoplasmic streaming.

68. Which direction on the cytoskeleton, actin, does the motor protein, myosin "walk" toward? (1 point)

positive

69. Calculate the rate of movement of the actin-myosin cytoplasmic streaming system such that the myosin is 75 nm/ATP and the rate of ATP hydrolysis is 10 ATP/sec. Please include units. (1 point)

750 nm/sec

70. Briefly describe the process that myosin and actin use during cytoplasmic streaming. (2 points, +1 ATPase, polymerize/depolymerize process)

Myosin is an ATPase thus it will ATP to depolymerize F-actin to G-actin and then to re-polymerize into F-actin, allowing myosin-directed movement.

71. In comparison to myosin and actin, microtubule and kinesin are also a similar pairing (cytoskeleton and motor protein). However, their mechanism slightly differs. Below, two drugs are given that are known to disrupt and slow cytoplasmic streaming. Which one would **only** disrupt myosin-actin based cytoplasmic streaming? Explain using the specific mechanism that the drugs would disrupt. (3 points, +1 cytochalasin, +1 for why cytochalasin works, +1 for why FCCP does not work)

    Cytochalasin: prevents the re-polymerization of filaments
    FCCP: disrupts ATP synthesis by transporting protons across membranes

Cytochalasin: Since cytochalasin prevents the re-polymerization of filaments, it would prevent G-actin from re-polymerizing into F-actin. However, kinesin and microtubules do not have a mechanism based on polymerization but, it still forms a proton gradient that drives ATP synthesis so FCCP would disrupt both myosin-actin and microtubule-kinesin based streaming.

The sodium-potassium pump is a key feature in the cell membrane as it helps to transfer signals along the nerve cells. Questions 72-76 will test your understanding of this kind of transport.

72. What is the ratio of the amount of Na^+ leaving the cell and K^+ entering the cell? Why is this ratio important? (2 points, +1 ratio, +1 importance)

3:2; This keeps the inside of the cell slightly more negative than the outside of the cell.

73. Is this a form of active or passive transport? (1 point)

active

74. The sodium-potassium pump has the ability to bind to both Na^+ and K^+. Generally explain what molecule controls the affinity for each ion and its general mechanism. (2 points, +1 for phosphate group, +1 for general description of mechanism)

A phosphate group controls the affinity between Na^+ and K^+. When the pump is not phosphorylated, it has a high affinity for Na^+. When it becomes phosphorylated by ATP the shape of the protein will change, causing a high affinity for K^+.

75. Once the K^+ binds to the protein, the pump has a mechanism to discriminate K^+ from Na^+ so that K^+ leaves the pump and enters the cell. The channel is voltage gated so that it attracts cations, but once cations enter the vestibule of the channel, how does it select for K^+? (3 points, +1 anhydrous state, +1 K^+ bigger, +1 better fit to carbonyl oxygens)

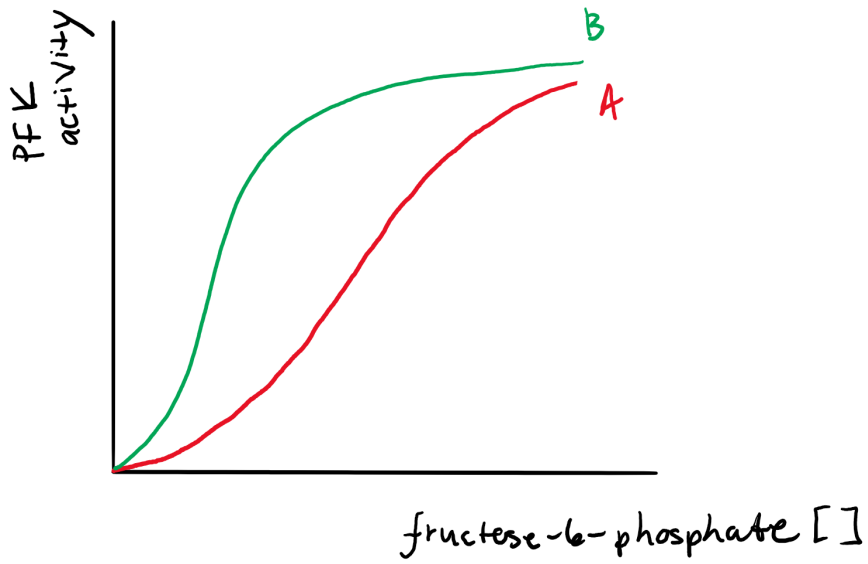
After the cations enter, water is stripped from the system so that both ions are in the anhydrous state. Now, the channel is able to detect that K^+ is slightly bigger as it forms more electrostatic forces with the slightly negative carbonyl oxygens allowing it to be selected to leave the channel.

76. Based on your understanding of the mechanism described in the previous question, which of the following would most likely be selected as the K^+ in the channel? (2 points)

    a. Ca^{+2}

b. Mg^{+2}
c. Br^{-1}
d. Mg^{+1}

77. During glycolysis, phosphofructokinase (PFK) is a kinase that phosphorylates fructose 6-phosphate to fructose 1,6-bisphosphate. ATP regulates PFK to prevent unnecessary energy to be harvested. In the figure below, which line would represent a system with **high ATP concentration**? Explain. (3 points, +1 for line a, +1 for ATP negatively regulates, +1 for why it slows PFK activity)

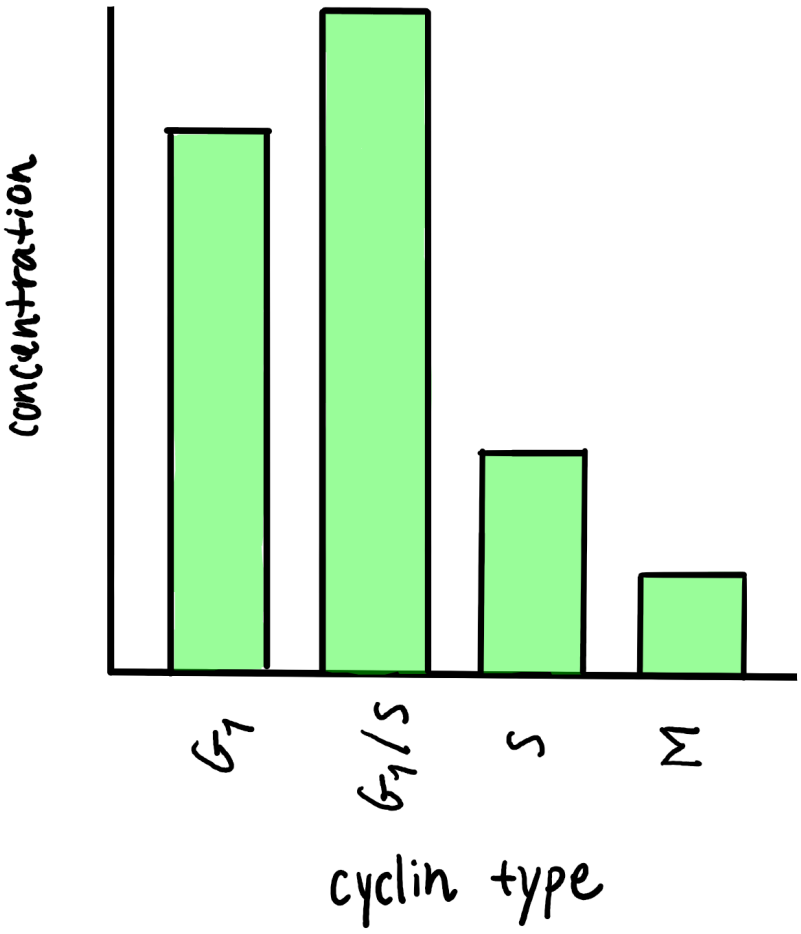


Line A (RED), since there is already high ATP concentration, ATP negatively regulates PFK by suppressing PFK activity so excess energy is not harvested from glucose.

78. In glycolysis which enzyme will generate NADH from NAD^{+}? (2 points)

a. Triose phosphate dehydrogenase
b. Isomerase
c. Aldolase
d. Phosphoglucose-isomerase
e. Hexokinase

Below is a graph of the concentrations of various types of cyclins at one point during the cell cycle. Use this information to answer questions 79-81.



79. Which cell cycle phase is represented in the graph? (2 points)

    a. G_1 phase
    b. Between G_1 and S phase
    c. S phase
    d. Between S and G_2 phase
    e. G_2 phase
    f. Between G_2 and M phase

80. In the wildtype of this cell, the M phase relies on Cdks and cyclins with MPF to initiate. In the mutated cell, MPF is able to be produced; however it is a different shape than prior, what can be a result of this change? (2 points)

Possible answers: phosphate groups are not able to be added to the correct proteins, phosphate groups will be added to wrong proteins initiating different parts of the cell cycle.

81. Cdk is to phosphate group as APC/C is to _____. (1 point)

Ubiquitin

82. During mitosis and meiosis, chromosomes are cleaved to allow separation into two daughter cells. Which of the following explain the differences between cleavage between meiosis I and II? (2 points)

    a. In Anaphase I, chiasmata are cleaved along the chromosome arms and during Anaphase II, chiasmata are cleaved at the centromeres.
    b. In Anaphase I, cohesins are cleaved at the centromeres and during Anaphase II, cohesins are cleaved along the centromeres.
    c. In Anaphase I, cohesins are cleaved along chromosome arms and during Anaphase II, cohesins are cleaved at the centromeres.
    d. In Anaphase I, chiasmata are cleaved at the centromeres and during Anaphase II, chiasmata are cleaved at the chromosome arms.
    e. None of the above are true.

83. Sometimes when chromosome separation does not occur properly, nondisjunction will occur. In meiosis, two types of nondisjunction may occur. Please describe a case when the chromosomes fail to separate so that it results in at least 1 haploid cell and list the number of chromosomes in each daughter cell. Assume the parent cell is 2n. (2 points, +1 Meiosis II, +1 for right number of chromosomes)

Nondisjunction occurs at Meiosis II where one of the cells fails to separate their chromosomes so that it forms daughter cells n-1 and n+1 chromosomes. The other two cells are both n.

84. A researcher is trying to collect trains of haploid yeast, numbered 1-6, that will produce Product Z and have single recessive mutations in the biosynthetic pathway. Pairwise crosses are done. A "-" means that there is no production; A "+" means there is no production. Please pick the statement that **best** describes the complementation test cross. (2 points)

	1	2	3	4	5	6
1	−	−	+	+	−	−
2		−	+	+	−	−
3			−	+	+	+
4				−	+	+
5					−	+
6						−

a. Mutants 3 and 5 most likely have mutations at different loci AND Mutants 1 and ^ most likely have mutations at different loci.
b. Mutants 6 and 3 most likely have mutations at different loci.
c. Mutants 3 and 5 most likely have mutants at different loci AND Mutants 2 and 3 most likely have mutations at different loci.
d. Mutations 1 and 4 are the same mutation.
e. Mutations 3 and 6 are the mutations at the same loci.

GCPRs are commonly used in signal transduction. It was famously linked to human taste receptors in the *Bufe et al.* paper, specifically the bitter taste. In a mutated bitter receptor cell, after the alpha subunit of the GPCR is activated, PIP_2 is not able to be properly converted into IP_3 and DAG. Use this information to answer questions 85-86.

85. What is the immediate step that is blocked in the signal transduction pathway? (2 points, +1 IP_3 cannot interact with receptor, +1 for no Ca^{+2} release)

Since IP_3 is not produced, it will fail to attach to the IP_3 receptor and release the stored Ca^{2+} into the cytoplasm.

86. Which of the following actions would allow the pathway to be continued so that the signal is continued? (2 points)

a. Using active transport to add DAG into the cytoplasm.
b. Releasing more ligands to attach onto the G-protein.
c. Activating the beta subunit of the G protein.
d. The artificial release of Ca^{+2} into the cytoplasm.
e. None of the above.