

Biology 1002 Final Exam

By: The Education Team at WebStraw



Introduction

Hi! Thanks for checking out this Biology 1002 at Western University resource!

The Western biology team at WebStraw has combed through the Biology 1002B course and has come together to present you this practice final exam. **You should save this exam until the end of your studying**, so that you can identify gaps in your knowledge and concepts you need to go back and reinforce. The questions are designed to challenge your fundamental understanding of lecture/reading ideas and facilitate your thinking as you apply these concepts.

We would also be delighted to hear your feedback on our content and if you found it useful. Please do not hesitate to reach out to us by clicking [**here**](#)

Best of luck on this practice exam, and your real one too! WebStraw's rooting for you.

WebStraw Western's Bio 1002B Practice Final Exam begins on the next page.

1. Which of the following proteins can only be found in *chlamydomonas* and arabidopsis, but not humans?

- a) Opsin
- b) RDH12, an enzyme responsible for the the biosynthesis of retinal
- c) Rubisco
- d) Hexokinase

2. The figure to the right shows the change in gene expression of *hsp1* over a 12-hour period as temperature decreases in comparison to a housekeeping gene using Northern Blot Analysis. The blot on top shows the analysis of the house-keeping gene while the blot on the bottom shows the analysis of *hsp1*. Which of the following explanations is consistent with the idea of the control of gene expression?



- a) The housekeeping gene is not expressed constitutively
- b) The decrease in transcript abundance of *hsp1* may be due to the decrease in the rate of transcription
- c) The decrease in protein abundance of *hsp1* may be due to the decrease in the rate of degradation of *hsp1* transcript
- d) The decrease in transcript abundance of *hsp1* may be due to a decrease in the degradation of the *hsp1* transcript

3. Two proteins that perform very similar functions have their sequences compared using BLAST. The result is a very high E-value. What conclusions can be drawn from the observation?

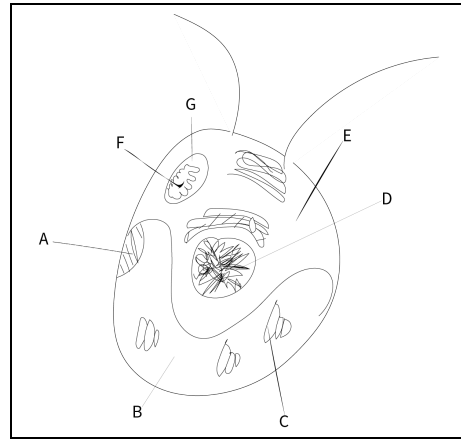
- 1. This is evidence for molecular convergence.
- 2. Proteins with very different primary sequences can fold into almost identical shapes.
- 3. The proteins are similar purely by chance.
- 4. The 2 sequences likely originated by common ancestry.

- a) 1, 2, and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) 1, 2, 3, and 4 are all correct

4. How many of the following statements correctly match a cellular component with its labelled feature?

1. Hexokinase can be found in E
2. PolyA polymerase can be found in D
3. snRNP can be found in D
4. Rubisco can be found in B
5. DNA can be found in B
6. D1 protein can be found in C

- a) 2
- b) 3
- c) 4
- d) 5
- e) 6



5. In the year 2130, NASA discovered a new enzyme with unknown **chemical and thermodynamic properties**. Some of these foreign enzyme-like structures are extracted, and denominated as “alienosomes”. A sample of active alienosomes and their designated substrates are placed in an isolated container and carefully studied. It is found that, in the process of catalyzing its respective reaction, the measured temperature of the container decreases.

What can be concluded about these newly discovered alienosomes?

1. Assuming the alienosomes are not using an external energy source, the reaction being carried out by the alienosomes must be endergonic.
2. Assuming the alienosomes are using an external energy source, the Gibbs free energy of the system must be decreasing, so the alienosome reaction must be exergonic.
3. Assuming the entropy of the system is unchanged, the Gibbs free energy should be decreasing from the initial to the final state of the enzymatic reaction, meaning the reaction will be spontaneous.
4. Assuming the alienosomes are not using any external energy source, the entropy of the products should be higher than the entropy of the initial substrates.

- a) 1, 2, and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) 1, 2, 3, and 4 are all correct

6. We learned in class that a $\Delta F508$ mutation results in the loss of CFTR function in cystic fibrosis patients. This is because the CFTR transporters, which are necessary to regulate cellular osmosis and maintain an external mucus layer, are flagged by HSP90 chaperone proteins and are degraded by proteasomes.

We also learned that, if HSP90 protein expression is reduced, this allows some mutated CFTR transporters to leave the ER and reach the membrane.

Which of the following scenarios could theoretically allow the **decrease of the HSP90 protein expression in a cell to lead to no defective CFTR reaching the outer cell membrane?**

1. There is a malfunction in the biosynthetic pathways that codes for the HSP90 protein that prevents them from being able to identify protein misfolding.
 2. There is a flaw in the signal peptide of the polypeptide chain produced from a particular CFTR mRNA. As a result, the transporter is produced in an area of the cytosol near the cell membrane.
 3. The expression of CFTR proteins is increased alongside the decrease in HSP90 proteins.
 4. There is a non-synonymous mutation in the CFTR mRNA.
- a) 1, 2, and 3
 - b) 1 and 3
 - c) 2 and 4
 - d) 4 only
 - e) 1, 2, 3, and 4 are all correct.

7. Which of the following statements about protein folding is correct?

1. The native conformation of protein is its highest energy state
 2. Protein folding is an exergonic process
 3. High concentration of urea affects protein folding by interaction with non-polar bonds
 4. Difference in the primary sequence of amino acids accounts for the difference in the tertiary structure of proteins
- A. 1, 2, and 3
 - B. 1 and 3
 - C. 2 and 4
 - D. 4 only
 - E. 1, 2, 3, and 4 are all correct.

8. When *Arabidopsis* cells are exposed to non-ideal temperatures, the cells will activate mechanisms to maintain a homeostatic state. Which of the following mechanisms would these cells ideally employ to preserve homeostasis when exposed to **high temperatures**?

1. Deacetylation of nucleosomes containing genes coding for proteins involved with the production of desaturase enzymes.
2. Decrease membrane fluidity beyond its homeostatic state.
3. Increase the coupling of the H⁺ gradient to ATP synthase in oxidative phosphorylation.
4. Methylation of the promoter region of a gene coding for proteins involved with decreasing membrane fluidity

- a) 1, 2, and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) 1, 2, 3, and 4 are all correct

9. How many of the following elements contribute to the spontaneous movement of electrons during photosynthesis?

1. Light
2. Increasing redox potentials
3. ATP
4. Oxidation of water

- a) 1
- b) 2
- c) 3
- d) 4

10. Cellular respiration and photosynthesis are two similar processes, both being present in plants, algae, and certain bacteria amongst others.

Which of the following statements are true regarding photosynthesis and cellular respiration?

1. Both cellular respiration and photosynthesis make use of ATP synthase
2. Adding an uncoupler would increase both the the rate of the citric acid cycle in respiration, and the rate of the calvin cycle in photosynthesis
3. Cellular respiration is a catabolic process while photosynthesis is an anabolic process.
4. Only cellular respiration utilizes a proton gradient to generate ATP

- a) 1, 2 and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) 1, 2, 3, and 4 are all correct

11. Suppose we are studying the genes *psbA* (which codes for D1), *DICER1* (which nonspecifically splices mRNA transcripts), and *CYCLASE1* (which codes for a protein involved in apoptosis) in plant X. Which of the following would need to occur **in the cytoplasm** of plant X's leaf cell to decrease the rate of photosynthesis?

1. Inactivation of the *psbA* gene.
2. Degradation of *DICER1* mRNA transcripts in the cytoplasm.
3. Increase the amount of $P680^+$
4. Increase expression of *CYCLASE1*.

- a) 1, 2 and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) All of 1, 2, 3, and 4 are correct

12. Which of the following would you expect to occur if a tyrosine kinase receptor that regulates cell proliferation was abnormally upregulated?

- a) The concentration of hexokinase proteins will increase.
- b) The "Warburg Effect" would take place, where metabolism continues through glycolysis and the citric acid cycle in the presence of oxygen.
- c) NADH will be regenerated in sufficient amounts for glycolysis.
- d) Pyruvate kinase will be inhibited.

13. Tom is discussing the causes of cystic fibrosis (CF) at Dr Sharan's office hours. He states that the CF phenotype arises from the $\Delta F508$ mutation in the cystic fibrosis transmembrane regulator, leading to a non-functional protein.

Later on in the conversation, Tom mentions that insufficient diffusion of oxygen in cell respiration will lead to a decrease in the amount of ATP produced as the rate of chemiosmosis is influenced by the presence of oxygen.

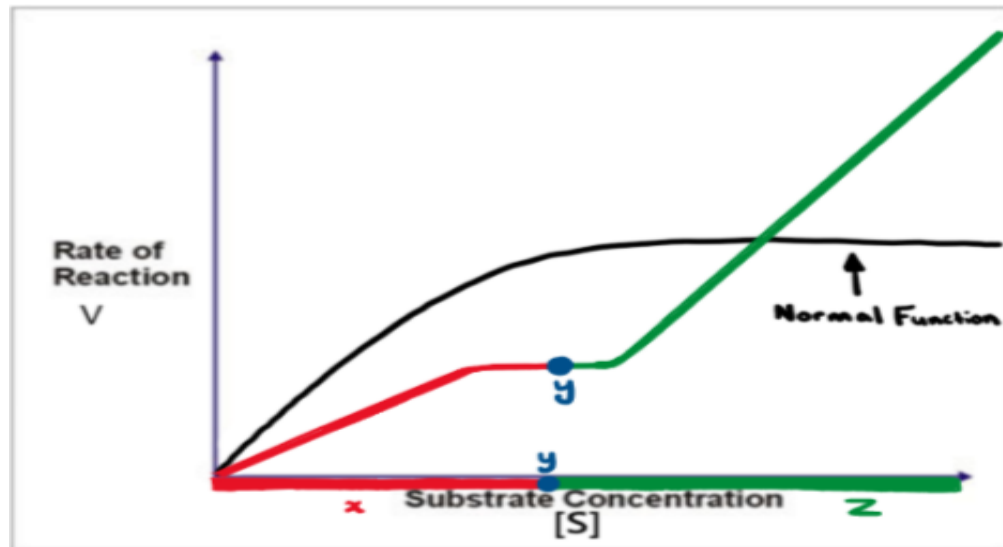
How should Dr Sharan respond to Tom to correct their answer and/or make it more precise?

- a) Yes, it is true that the $\Delta F508$ CFTR loses its function. However, this will have no impact on electron transport.
- b) Yes, it is true that the $\Delta F508$ CFTR loses its function. However, the decreased amount of ATP is due to the decrease in the rate of electron transport, not a direct decrease in chemiosmosis.
- c) No, the $\Delta F508$ CFTR is still functional, but it does not make it to the plasma membrane as it is tagged for degradation due to improper folding. However, it is true that the decreased amount of ATP is due to lower rates of chemiosmosis as a result of less oxygen.
- d) No, the $\Delta F508$ CFTR is still functional, but it does not make it to the plasma membrane as it is tagged for degradation due to improper folding. In addition, the decreased amount of ATP is due to the decrease in the rate of electron transport, not a direct decrease in the rate of chemiosmosis.

14. Which of the following changes to the environment in mitochondria will result in the lowest rate of electron transport over time? Assume that the mitochondria are in the presence of only NADH and excess oxygen.

- A. Adding NADH
- B. Adding an uncoupler
- C. Adding ADP + Pi
- D. Adding oxygen

Use the diagram below to answer the following two questions:



15. The graph above represents the activity of the **hexokinase enzyme** involved in glycolysis functioning at 38°C. Which one of the following statements is correct:

- V_{max} (the maximum rate of reaction) would be independent of the temperature of the environment in which the enzymes operate
- The difference between the graphs in the region of the curve marked “x” (BEFORE point y) can be explained by the addition of a competitive inhibitor
- The plateau represented in the normal function would have been due to enzymes being degraded following each catalysis
- The K_m of a given curve defines a certain concentration of substrate

16. In region Z (after point Y), there is a noticeable increase in velocity (rate of product formation). Assuming that the concentration of the inhibitor stays the same, which of the following would result in this increase in enzyme activity?

- Increase the concentration of ATP
 - Filtering out glucose-6-phosphate (the product of the catalyzed reaction) as it is being produced.
 - Continuing to add glucose, with no other changes made
 - Increase in hexokinase concentration
- 1, 2, and 3
 - 1 and 3
 - 2 and 4
 - 4 only
 - 1, 2, 3, and 4 are all correct

17. The *BRAD.Y* gene is found in streptococcus bacteria and codes for enzymes that induce immune responses against a deadly virus named P-REP 101 that infects primates. The gene is named after Dr. Haffie who discovered the gene.

The first patient that Dr. Haffie meets is a chimpanzee named Jason, who is diagnosed with a fatal case of P-REP 101 infection, which is impossible to be cured since chimpanzees do not produce the necessary immune responses against P-REP 101.

Dr. Haffie attempts to modify the *BRAD.Y* gene so that he can put it into Jason. Which of the following components would he have to change for the gene to function in Jason?

1. 3' UTR
 2. Promoter
 3. 5' UTR
 4. Stop codon
-
- a) 1, 2 & 3
 - b) 1 & 3
 - c) 2 & 4
 - d) 4 only
 - e) 1, 2, 3, and 4 are all correct

18. Cellular molecules interact with each other using a variety of intermolecular and intramolecular forces. Which of the following interactions likely has a different type of attractive force than the others?

- a) A tRNA binding to mRNA during translation
- b) The ribosome binding to the SD box
- c) The cloverleaf structure of a tRNA
- d) The binding of the release factor to the A site
- e) A hairpin loop formed at the terminator sequence

19. Which of the following cells express telomerase?

1. A cell in the inner cell mass of a blastocyst
2. A cardiac cell converted to an iPS cell
3. A cancerous liver cell
4. A cell in the crypt of intestinal villi

- a) 1, 2, and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) 1, 2, 3, and 4 are all correct

20. Tom is trying to create new cardiomyocytes to transplant into a heart attack patient. He obtains a sample of skin fibroblasts from the patient and reprograms them into induced pluripotent stem cells (iPS) using the mouse Yamanaka factors Oct3/4, Sox2, Klf2, and c-Myc. He then uses cardiomyocyte specific transcription factors to make the iPS cells differentiate into cardiomyocytes and implants them into the patient. What should we expect?

- a) The patient's body rejects them since the implanted cells are recognized as foreign.
- b) The implantation is successful and the patient's cardiomyocytes are replenished.
- c) The patient eventually develops a tumour in their heart.
- d) The implantation is not successful as Tom did not generate iPS cells correctly.

21. Consider a mutation that occurs in the lac operon such that the lac repressor protein cannot repress the expression of the lac operon. Which of the following mutations could result in this situation?

1. Mutations occur in lacP (promoter) such that the lac repressor cannot bind.
2. Mutations occur in lacI, leading to constitutive activation of the lac repressor protein.
3. Mutations occur in lacZ, interfering with lac repressor synthesis.
4. Mutations occur in lacO (operator) such that the lac repressor cannot bind.

- a) 1, 2, and 3
- b) 1 and 3
- c) 2 and 4
- d) 4 only
- e) 1, 2, 3, and 4

22. Alzheimer's results from the activity of beta-secretase on the APP protein instead of alpha-secretase. Which scenario describes a likely cause of this outcome?

- a) A mutation to the beta-secretase gene leads to the overexpression of beta-secretase, leading to cleavage of APP such that it is soluble.
- b) A mutation to the alpha-secretase gene renders the protein non-functional. As a result, APP is cleaved by beta-secretase such that it is insoluble.
- c) A mutation in presenilin 1 that increases the activity of beta-secretase to cleave APP such that it is soluble.
- d) None of the above scenarios are accurate descriptions.

23. Which of the following are mechanisms that can increase heteroplasmic load in your mitochondrial genome?

- a) Mutations in your mother's mitochondrial genome in her egg cells
- b) Mutations in your father's mitochondrial genome in his sperm cells
- c) Mutations in your mitochondrial genome
- d) 2 of the above are true

24. John is a cancer patient who had previously gone into remission but his cancer came back. Based on your knowledge from Dr Sharan's lecture **only**, which of the following would be the best way(s) to proceed with treatment and why?

- a) Use the original treatment since it is proven to be effective in causing remission. The tumour reappeared because the treatment was not used for long enough.
- b) Use a different treatment because the new tumour developed from the cells that were previously unaffected by the original treatment.
- c) Use a different treatment because this tumour developed independently from the previous tumour and will have a different genetic composition.
- d) 2 of the responses above are possible ways to treat the new tumour.

25. Which of the following is correct regarding cancer stem cells:

- a) They are rapidly dividing cells that are resistant to chemotherapy.
- b) Chemotherapy resistance in cancer stem cells contributes to tumor relapse following treatment.
- c) Non-specific cancer therapies, such as chemotherapy, are effective against eradicating cancer stem cells if administered at high and frequent doses.
- d) A large portion of the tumor consists of cancer stem cells.
- e) All of the above

26. Which of the following is a probable outcome of a mutation to p53?

1. Apoptosis
 2. Increased Cell Proliferation
 3. Decreased Gene Expression
 4. Increased Rate of Mutations
-
- a) 1, 2, and 3
 - b) 1 and 3
 - c) 2 and 4
 - d) 4 only
 - e) 1, 2, 3, and 4 are all correct

27. Which of the following is true?

- a) Passenger mutations in a cancer cell do not directly contribute to the cell's progression to malignancy.
- b) Abnormal expression of tumour suppressor genes will always be driver mutations for cancer.
- c) Cancer stem cell (CSC) specific therapies that lead to self-renewal of CSCs are the most effective treatment for achieving tumour regression.
- d) A cancer cell that has undergone more subsequent clonal expansions should be targeted when treating cancer, instead of targeting tumour cells that have undergone less clonal expansion.
- e) Mutations in cancer cells confer a selective advantage to nearby healthy cells, causing excessive proliferation.

28. A first year student in a molecular biology laboratory at Western University is carrying out their very first PCR reaction in an attempt to amplify some eukaryotic gDNA. To the student's dismay, their supervisor is nowhere to be found as he/she is about to start and the student has forgotten which reactants are required to carry out this type of reaction.

Which reactants would you suggest are necessary for their PCR reaction, in addition to their gDNA sample?

1. Reverse transcriptase enzyme
 2. PCR primers
 3. DNase
 4. Taq polymerase
-
- a) 1,2 and 3
 - b) 1 and 3
 - c) 2 and 4
 - d) 4 only
 - e) 1, 2, 3, and 4 are all correct

29. Which of the following is NOT an advantage of PCR?

- a) PCR can be used to screen for genetically inherited diseases.
- b) Isolating a human cell and using RT-PCR to generate cDNAs can provide us with a way of analyzing all gene transcripts produced by our body.
- c) PCR can be used to amplify a specific mutated sequence introduced into the DNA.
- d) Conducting PCR on a strand of template DNA only requires knowledge of a small region of its sequence.
- e) Isolating some chromosomal DNA and conducting PCR allows us to amplify the alleles at the STR loci for further analysis.

30. With the advancement of cloning technology in recent years, there has been a popular trend of pet-owners cloning their cats or dogs when they reach old age, so that this new clone will be a “carbon copy” of their previous pet (this is an extremely expensive process, so we do not recommend you try this with your pets).

However, pet owners are often shocked when these cloned cats/dogs behave differently, and may even have entirely different physical appearances (i.e: fur patterns).

Assuming their pets were actually cloned, what is the most likely biological explanation for this?

- a) The clone has DNA binding proteins bound to different regulatory regions, different regions of DNA methylation, and different histone modifications.
- b) These observable behavioural and physical differences are due to the accumulation of natural mutations over time as the clone matures.
- c) These observable differences are due to different levels of heterochromatin gene expression between the original and the cloned pet.
- d) The clone has many genes that may have been deactivated by histone acetylation, leading to behavioural and physical differences.
- e) The clone expresses novel gene products that cannot be found in the original pet, leading to behavioural and physical differences.

31. Which of the following components are NOT required for RT-PCR:

- i) Ribosomes
 - ii) RNA template
 - iii) RNA probes
 - iv) Q5 polymerase
 - v) Taq polymerase
-
- a) ii, iv
 - b) i, ii, iii
 - c) i, ii, iii, iv
 - d) i, ii, iii, v
 - e) None of the above

32. Recall that histone acetylation/deacetylation (catalyzed by histone acetyltransferases and histone deacetylases respectively) are important mechanisms for regulating gene expression in our DNA.

How is this regulation achieved?

1. Acetylation of lysine residues leads to higher affinity between RNA polymerase and our DNA.
 2. Deacetylation, like methylation, modifies our DNA and changes its affinity for histones.
 3. Acetylation involves the catalytic addition of acetyl groups to certain nucleotides, which ultimately affects gene expression.
 4. Deacetylation, like demethylation, involves a catalytic reaction which affects the ability of promoter regions to be effectively bound by RNA polymerase.
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- a) 1, 2, and 3
 - b) 1 and 3
 - c) 2 and 4
 - d) 4 only
 - e) 1, 2, 3, and 4 are all correct

33. Which of the following on mRNA splicing is correct:

- a) Beta-thalassemia is the result of a mutation that created a new 3' splice site and the expression of an early stop codon that terminates translation prematurely in the hemoglobin beta gene.
- b) Spliceosomes are only made up of snRNPs, which are ribonuclear proteins.
- c) The introns are sometimes retained in the mRNA after splicing.
- d) Under normal circumstances, introns also contain coding regions.
- e) None of the above

34. Recall that Richard Lenski's long-term evolution experiment was a famous scientific exploration that helped support evolution on the genotypic level.

Which of the following is an intended purpose of the Long Term Evolution Experiment?

1. To determine whether or not aerobic citrate metabolism was possible within E.coli
 2. To show that freezing E.coli was an effective method to compare evolved and ancestral strains
 3. To prove that phenotypic actualization and refinement is always a result of similar mutations due to historical contingency
 4. To determine whether or not adaption was possible due to random mutation alone
-
- a) 1, 2, and 3
 - b) 1 and 3
 - c) 2 and 4
 - d) 4 only
 - e) 1, 2, 3, and 4 are all correct

35. Which of the following statements are false?

- a) When " w " > 1 , it means that the growth rate in the evolved strain is faster than the growth rate in the ancestral strain.
- b) A strain of E. coli that is adapted to grow faster at 45°C (as opposed to ancestral E. coli that grows best at 37°C) will grow much slower at lower temperatures than ancestral E. coli would since the evolved strain is used to growing in higher temperatures.
- c) The mutations that caused strains to become Cit⁺ in Lenski's replay experiments were extremely similar to the first mutation he observed.
- d) The actualization mutation in Lenski's experiment depended on a previous potentiation mutation.
- e) All of the above are true.

36. In the Long-term Evolution Experiment, what was the value of purposefully limiting the amount of glucose to support growth for only 8 hours instead of unlimited glucose?

- a) To create an environment where a specific type of mutation in E.coli populations would be evolutionarily advantageous.
- b) To create an environment where mutations that helped the E.coli populations grow without glucose would occur.
- c) To maintain E.coli samples at a manageable size for sequencing analysis.
- d) 2 of the above are reasons.

--- END OF EXAM ---

To see the solution key, [click here](#)