Sample Questions for the March Term Test

Biology 022

1. Given a preparation of isolated chloroplasts, which one of the following treatments would result in the thylakoid lumen having the lowest pH?

A. Incubation in complete darkness.
B. Low light and a high stromal ADP concentration.
C. High light and inhibition of ATP synthase.
D. High light and incubation with a proton-leaking ionophore.
E. Low light and incubation with DCMU, a compound which prevents electron transfer from P680 to PQ.

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2. Which of the following statements is correct?

A. $P680^+$ is reduced to P680 by donation of an electron from O_2.
B. Absorption of one photon is required to move one electron from P680 to $NADP^+$.
C. PSII is not required for the synthesis of ATP using cyclic electron transport.
D. P680 is more easily oxidized than P680*.
E. The results of the 'Jagendorf experiment' proved that, in an intact plant cell, light is not required for the photosynthetic production of ATP

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3. Prokaryotes that undergo anoxygenic photosynthesis are limited in where they can grow because they

A. cannot make NADPH.
B. cannot produce O_2.
C. require very high light levels.
D. cannot use H_2O as an electron donor.
E. contain only two photosystems.

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4. What is the minimum number of photons that the photosynthetic apparatus must absorb to synthesize 2 molecules of NADPH?

A. 2
B. 4
C. 8
D. 16
E. 24

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5. C4 plants are more common in hot dry climates than C3 plants because

A. C4 plants have a lower transpiration ratio.
B. C plants require less ATP for photosynthetic carbon reduction.
C. at warmer temperatures (>30°C) photorespiration limits the growth of C3 plants.
D. at warmer temperatures, C4 plants use PEP carboxylase instead of Rubisco to fix CO_2.
E. Both A and C are correct.

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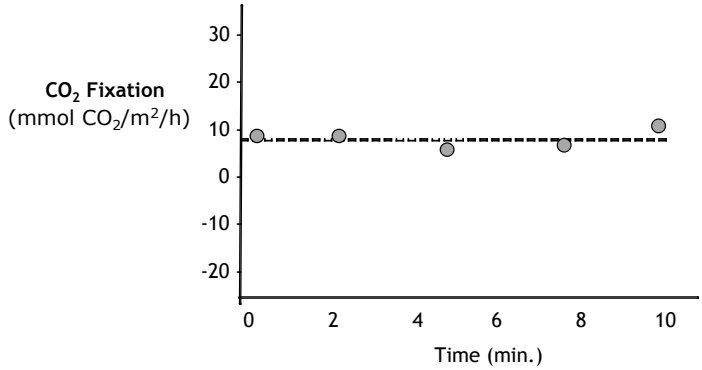
6. Which of the following statements about the Calvin Cycle is NOT correct?

A. The carboxylation reaction is catalyzed by the enzyme Rubisco.
B. It requires the regeneration of ribulose 1,5 bisphosphate (RuBP).
C. Requires 3 ATP for each CO_2 fixed.
D. It takes place in the lumen of the thylakoid.
E. One molecule of glyceraldehyde-3-phosphate (G3P) is synthesized for every three CO_2 molecules fixed.

7. A plant is placed into a CO_2 analysis chamber. Which answer is the best explanation for the 10 minutes of data presented here?



A. The rate of photosynthesis is equal to the rate of respiration.
B. The plant is below the light compensation point.
C. The plant is in the light - but no respiration is occurring.
D. The Calvin Cycle is not operating.
E. The plant is growing.

8. Nitrogen fixation does not occur in anaerobic bacteria because

A. nitrogenase requires oxygen (O_2) as an electron donor.
B. anaerobes cannot generate the high amounts of reducing power and ATP required.
C. nitrogenase is inhibited by oxygen (O_2).
D. anaerobes cannot live in N_2 -containing environments.
E. anaerobes are unable to form heterocysts which are required for nitrogenase to function.

9. Heterocysts

A. contain PSI.
B. form only in the presence of NH_4^+/NH_3.
C. are found in the roots of leguminous plants.
D. contain mitochondria.
E. contain high concentrations of O_2.

10. Which of the following statements is NOT correct?

A. The cytochrome oxidase found in bacteroids can operate at very low O_2 concentrations.
B. NH_4^+/NH_3 are toxic because they consume respiratory O_2.
C. Only prokaryotes can fix nitrogen.
D. Nitrogen fixation demands a lot of energy because N_2 contains a triple bond.
E. Temporal separation allows for photosynthesis and nitrogen fixation to occur in single-celled cyanobacteria.

11. According to Fick's law, the rate of diffusion

A. increases as the diffusion distance decreases.
B. increases as the respiratory surface area decreases.
C. decreases as the viscosity of the respiratory medium decreases.
D. increases as the concentration gradient decreases.
E. Both A and D are correct.

12. Which of the following statements about gas exchange is NOT correct?

A. The reason some fish need to keep moving is because the rate of diffusion of O_2 in water is low compared to air.
B. Organisms with a circulatory system can have a low surface area / volume ratio.
C. Regardless of organism, respiratory surfaces must be kept dry.
D. Hemoglobin increases the O_2 carrying capacity of a circulatory system.
E. The counter current exchange system ensures that diffusion is always from water into the bloodstream.

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13. Which of the following statements about hemoglobin and O_2 binding is correct?

A. The PO_2 is higher inside exercising muscle cells than in the surrounding blood.
B. About 80% of the oxygen carrying-capacity of hemoglobin is used to deliver O_2 to resting tissues.
C. The binding of oxygen to hemoglobin requires the formation of a covalent bond.
D. The release of more O_2 by hemoglobin during the Bohr Shift is a result of a drop in pH.
E. All the above statements are correct.

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14. An evolutionary advantage gained by endosymbiosis was

A. increased energy production.
B. decreased formation of reactive oxygen formation
C. ability to maintain cells with a lower surface area/volume ratio.
D. protect chromosomes by localizing them within the nucleus.
E. Both A and C are correct.

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15. Lateral gene transfer

A. was completed about 3 billion years ago.
B. enabled the mitochondrion to take overall control of cell function.
C. is the movement of genes from the nucleus to the chloroplast
D. is the movement of genes from one chromosome to another.
E. has made it necessary for many mitochondrial proteins to be imported from the cytosol.

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16. The finding that *Giardia* (a Diplomonad) contains the gene cpn60 suggests that

A. it must have had mitochondria - but then lost them.
B. endosymbiosis occurred after the diplomonads lineage split from other eukaryotes.
C. it once contained a chloroplast.
D. the gene was transferred from the nucleus to the mitochondrion.
E. chloroplasts are derived from cyanobacteria.

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17. The major source of reactive oxygen species (ROS) production within cells is

A. carbon fixation.
B. ATP synthesis
C. electron transport.
D. glycolysis.
E. nitrogen fixation.

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18. Caloric restriction

A. decreases the extent of damage to nuclear DNA.
B. decreases the rate of formation of mitochondrial ROS.
C. decreases life span by inhibiting ATP synthesis.
D. elevates the intracellular anthocyanin levels.
E. increases the rate of mitochondrial respiration.

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19. Worms (*C. elegans*) with a mutation to the cytochrome complex

A. can tolerate high O_2 concentrations.
B. cannot synthesize ATP.
C. have lower ROS levels than control (wild-type) cells.
D. have increased lifespan.
E. behave like control (wild-type) worms, if they are treated with a SOD mimic.

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20. To protect against the damaging effects of ROS, which of the following enzymes must have evolved soon after the development of aerobic metabolism.

A. Rubisco
B. Nitrogenase
C. Catalase
D. ATP synthase
E. phosphofructokinase

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21. Although genes have tended to move out of organelles into the nucleus, several genes remain in organelles today. The likely reason that a given gene is still found in organelles today is that it is

A. coding for a product (protein or RNA) needed inside the organelle.
B. coded on the opposite DNA strand relative to nuclear genes.
C. tightly regulated by redox potential (electron transport).
D. trapped by the organelle membrane.
E. circular.

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22. The majority of cellular carbon on Earth found in the bodies of

A. prokaryotes.
B. insects.
C. green plants.
D. diatoms.
E. mammals.

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23. During transfer of chromosomal DNA from a bacterial donor to a recipient cell by conjugation, the donor cell would

A. have its DNA partially degraded.
B. be called "Hfr" (High Frequency Recombination).
C. be killed.
D. replicate DNA discontinuously.
E. transfer all genes with equal frequency.

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24. In the classic Griffiths experiment involving "rough" and "smooth" cells

A. dead bacterial cells "came back to life" after receiving genes from the environment.
B. rough cells were engulfed by smooth cells to form endosymbionts.
C. mice died when a virus moved DNA from donor to recipient cells.
D. dead donor cells provided genes to live recipients.
E. dead donor mice provided genes to live recipients.

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25. With respect to the lambda phage infection cycle,

A. all infected hosts undergo the lysogenic cycle before the lytic cycle.
B. all host genes can be transferred by specialized transduction with equal frequency.
C. insertion of the phage into the host chromosome is reversible.
D. phage genes are expressed to produce proteins for the phage envelope.
E. the inserted phage would be replicated by "rolling circle" replication.

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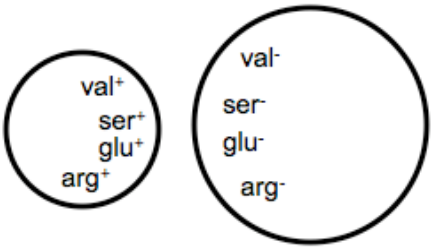
26. With respect to diagram at right, how many cross-overs would be needed to create a circular arg^- glu^+, ser^+, val^- chromosome?



A. 0; It can't be done.
B. 1
C. 2
D. 3
E. 4

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27. Of the several different types of information that are coded in DNA, which type is actually understood by the cell in the form of double-stranded DNA?

A. enhancer
B. protein targeting signal sequence
C. start codon
D. terminator hairpin
E. splice signal

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28. "Epigenetic" changes do NOT

A. show inheritance from one generation to another.
B. change DNA sequence.
C. affect the chemical structure of nucleotides in promoters.
D. affect the expression of genes.
E. result from the effects of environment.

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29. Mutations are always

A. changes in double-stranded DNA sequence.
B. recessive.
C. responsible for the loss of some function.
D. affecting coding regions of genes.
E. caused by DNA polymerase failing to proof-read.

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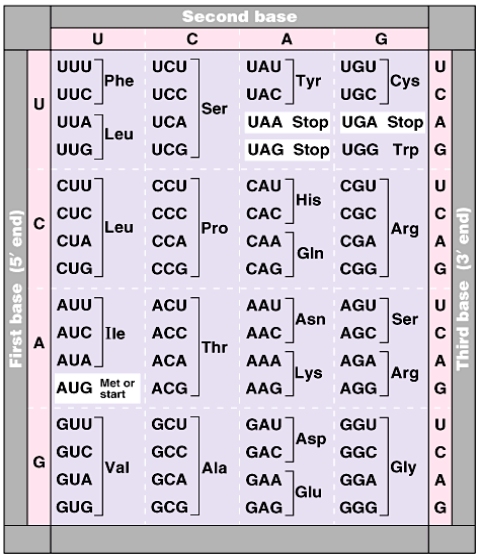
30. The image of several genes coding for various tRNAs on the mitochondrial genome was displayed several times in class. Assume that you have the partial sequence for one of these tRNA genes (shown below as double stranded DNA), but you don't know which tRNA gene it is.

$^{3'}$GGCCTTAAGACGCA**GTA**AATGCCGGCCGATT$^{5'}$
$^{5'}$ CCGGAATTCTGCGT**CAT**TTACGGCCGGCTAA$^{3'}$

Assume that the bolded base pairs indicate the section of this sequence that codes for the anticodon region of the tRNA and that the top strand is transcribed.



Which tRNA gene is this?

(Advice: Sketch out the role of DNA, mRNA and tRNA with attention to complementary base pairing and polarity. Consult the Table of Genetic Codes for codon assignments for various amino acids.)

A. methionine (Met; start)
B. histidine (His)
C. valine (Val)
D. tyrosine (Tyr)
E. glutamine (Gln)

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31. Huntington disease shows genetic anticipation. The mechanism underlying anticipation is that

A. triplet repeat elements code for multiple glutamines.
B. ubiquitinylated huntingtin protein accumulates in neurons.
C. the number of triplet repeats tends to increase during DNA replication.
D. triplet repeats move into coding regions from non-coding regions.
E. hairpin loops stop transcription prematurely.

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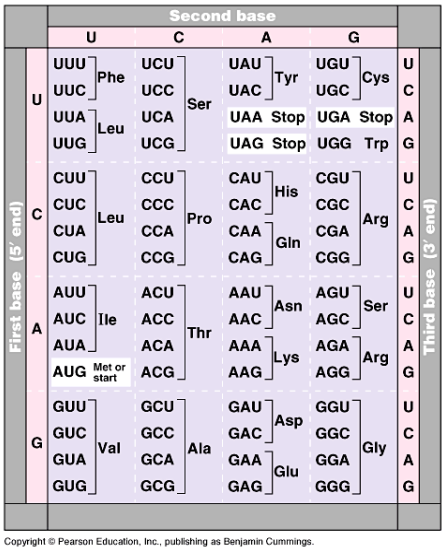
32. Note the indicated mutation in a DNA sequence taken from the middle of a gene.

G ATC GGT TAC TGA TCG$^{3'}$
C TAG CCA ATG ACT AGC **Original**

G ATC GGT *G*AC TGA TCG$^{3'}$
C TAG CCA *C*TG ACT AGC **Mutant**
^

Consult the Table of Genetic Codes at right to deduce the type of mutation that would result from this change. (Note that spacing indicates the reading frame and that the top strand is transcribed.)



A. frameshift
B. missense
C. nonsense
D. silent (no change in amino acid)

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33. A stop codon

1. is the last three bases transcribed into mRNA.
2. base pairs with tRNA.
3. signals the end of transcription.
4. is the same in prokaryotes and eukaryotes.

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. All

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34. During gene expression, which of the following types of RNA can engage in complementary base pairing with mRNA in eukaryotes?

1. tRNA
2. miRNA
3. snRNA
4. rRNA

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. All

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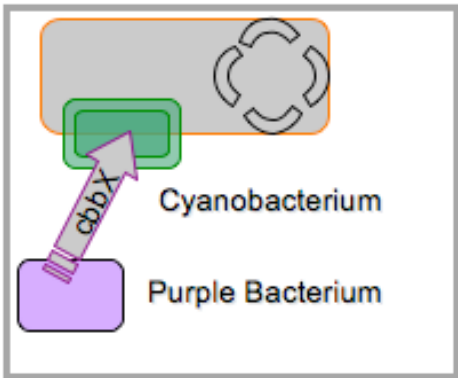
35. This figure represents the proposed transfer of the cbbX gene from purple bacterium to a cyanobacterium (that ultimately gave rise to modern algal chloroplasts).



Such a transfer may have occurred as a result of

1. transduction
2. transformation
3. conjugation
4. reverse transcription

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. All

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36. Which of the following sequences are transcribed <u>but not translated</u>?

1. promoter
2. polyadenylation signal
3. protein targeting signal
4. arginine tRNA gene

A. 1, 2 and 3
B. 1 and 3
C. 2 and 4
D. 4 only
E. All
