



# The 63<sup>rd</sup> Annual Merck State Science Day Competition May 23, 2013

## BIOLOGY

### Directions:

#### To register as a student:

You will need to ask your teacher for the school phone number used as an identifier for your school.

Fill out the form using your normal email address but please use a password that is NOT associated with any other secure accounts (Your MSSD password).

You must also select the test you will be taking at this time.

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#### On the day of the MSSD competition:

You will be asked to login using your email address and your MSSD Password.

You are encouraged to register early and to log into your test page. Try the Demo Test if you have not already done so. In this demo test, answers are not saved. In a regular test, each answer is stored when **Submit** is used.

When finished, select **FINISHED TEST** in lower left.

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#### Using the Answer Panel

The Demo Test "answer panel" at the bottom of the window is pre-set to show 3 answer boxes per page. (A normal test may show 10 or more answers per page.)

1. The current question has a black border.
2. Questions that have been answered will be tinted **Green**
3. Click **Submit** to record your answer and scroll to the next test question (even if it is on the next page).
4. Any answer can be edited. Delete your original choice, enter your new letter choice, then **Submit** the correction.
5. > moves to the next set of questions ( < moves back)
6. Click on any number to answer that question.

Hint: The size of the lettering in the bottom answer panel can be adjusted using CTRL + to magnify the browser view. The TEST view can be adjusted using the size control in the PDF viewer (eg Adobe Reader).

The test has **120 items** that will be scored. You have **90** minutes in which to answer all the questions.

There is only one correct answer per question. Do not spend too much time on any one question. Do the items you find easier first, and then go back to those you find more difficult or time consuming during the time you have remaining. Your individual score will be computed on the basis of the number of correctly answered items.

**Multiple Choice**

Identify the choice that best completes the statement or answers the question and enter it in the answer window on the computer screen, then **SUBMIT**.

1. Mendel discovered the law of independent assortment by statistically analyzing the results of his pea crosses. The cellular basis for this law is (are) the
  - A) random fertilization of gametes.
  - B) two divisions of meiosis.
  - C) random arrangement of chromosomes in Metaphase I.
  - D) unequal cytokinesis in mammalian females.
  - E) crossing over seen in Prophase I.
2. A child with AB blood type could NOT have a
  - A) parent with type O blood.
  - B) parent with type A blood.
  - C) parent with type B blood.
  - D) parent with type AB blood.
  - E) all of the above are possible.
3. A man with red-green color blindness marries a woman who has normal vision. The woman's family has no history of color blindness. They may eventually have
  - A) a color blind son.
  - B) a color blind daughter.
  - C) a color blind grandson.
  - D) a color blind granddaughter.
  - E) none of the above.
4. In fruit flies, grey body (wild type) is dominant to black body. Red eyes (wild type) are dominant to cinnabar eyes. A fly which is heterozygous for both traits is crossed with a cinnabar-eyed, black-bodied fly. The results are:
  - 100 wild type flies
  - 100 cinnabar-eyed, black bodied flies
  - 9 red-eyed, grey bodied flies
  - 9 cinnabar-eyed, black-bodied flies

These results indicate that

- A) the genes are independently assorting.
- B) the genes are on the same chromosome.
- C) one of the genes has mutated.
- D) the genes are exhibiting epistasis.
- E) multiple alleles are involved.

Box A

A simplified model of the inheritance of human skin color suggests that 3 separately inherited genes cause skin darkness. Each gene has 2 alleles which are incompletely dominant to each other; one causing light color and one causing dark.

5. This model (Box A) of skin color is an example of
  - A) multiple allele inheritance.
  - B) polygenic inheritance.
  - C) pleiotrophy.
  - D) hybridization.
  - E) incomplete penetrence
6. According to this model (Box A) of skin color, the children of two individuals who are both heterozygous for all three genes would have a \_\_\_\_ chance of having the palest skin tone.
  - A) 1/2
  - B) 1/4
  - C) 1/8
  - D) 1/64
  - E) 0

7. Achondroplasia dwarfism is caused by a dominant allele. The homozygous dominant condition is fatal. Two achondroplasia dwarves would expect
- A) about 2/3 of their children would also be dwarves.
  - B) about 1/2 of their children would also be dwarves.
  - C) about 1/4 of their children would be dwarves.
  - D) about 3/4 of their children would be dwarves.
  - E) all of their children would be dwarves.

8. In mice, white fur color is recessive to black fur color. A separate locus has a dominant allele which causes each hair to have a striped appearance known as agouti. The recessive form of this allele causes the hairs to have solid coloration. Crossing two black, agouti mice for several years yielded the following offspring phenotype ratios:

32 black, agouti  
13 black, solid  
15 white, agouti  
2 white, solid

The parents were most likely

- A) both heterozygous for both genes.
  - B) one heterozygous for both genes, one homozygous recessive for both genes.
  - C) one heterozygous black, homozygous agouti and the other heterozygous for both.
  - D) one homozygous dominant for both genes and the other heterozygous for both genes.
  - E) both homozygous recessive for both genes.
9. An X-linked dominant trait would NOT be
- A) passed from mother to son.
  - B) passed from father to daughter.
  - C) passed from mother to daughter.
  - D) passed from father to son.
  - E) present in every generation.
10. Prader-Willi syndrome causes low muscle tone, constant hunger feelings and problem behaviors. Angelman syndrome causes seizures, severe intellectual limitations and frequent laughter. These two syndromes have dramatically different symptoms, but the same chromosomal defect. This is an example of
- A) epistasis.
  - B) nondisjunction.
  - C) imprinting.
  - D) penetrance.
  - E) pleiotropy.
11. A sample of pond water was enriched with a phosphate solution. The primary productivity of the pond water sample doubled after enrichment. What would be the effect of enriching a fresh sample of the original pond water with a nitrate solution?
- A) The primary productivity will decrease by 1/2.
  - B) The primary productivity will remain the same.
  - C) The primary productivity will double.
  - D) The primary productivity will triple.
  - E) The primary productivity will quadruple.
12. The effects of a fat-soluble environmental toxin will be seen most dramatically in the
- A) producers.
  - B) primary consumers.
  - C) omnivores.
  - D) tertiary consumers.
  - E) decomposers.
13. Humans have disrupted the nitrogen cycle by all of the following EXCEPT
- A) fertilizing crops.
  - B) using CFCs.
  - C) deforesting large areas.
  - D) burning coal.
  - E) burning gasoline.

14. Increased amounts of nitrogen compounds in the soil are one cause of
- the spread of invasive species.
  - the increase in extreme weather events.
  - acid deposition.
  - ground level ozone formation.
  - loss of keystone species.
15. Which of the following is NOT a similarity between meiosis and mitosis?
- Both can create gametes.
  - Both begin with replicated chromosomes.
  - Both utilize kinetochores to attach chromosomes to spindle fibers.
  - Both maintain chromosome count after the first division.
  - Both occur in protists.
16. Which of the following is NOT a greenhouse gas?
- CH<sub>4</sub>
  - H<sub>2</sub>O
  - SO<sub>2</sub>
  - CFCs
  - N<sub>2</sub>O
17. According to the MacArthur-Wilson equilibrium model of biogeography an island with low species richness would be
- small and close to the mainland.
  - small and distant from the mainland.
  - large and close to the mainland.
  - large and distant from the mainland.
  - connected to the mainland.
18. After tropical rainforests, the ecosystem which provides the greatest contribution to world net primary productivity is the
- boreal forest.
  - wetlands.
  - tropical seasonal forest.
  - open ocean.
  - coral reef.
19. Which of the following would be a density-dependent factor?
- predation.
  - climate change.
  - r-strategist life cycle.
  - logistic growth rate.
  - all of the above are density-dependent.

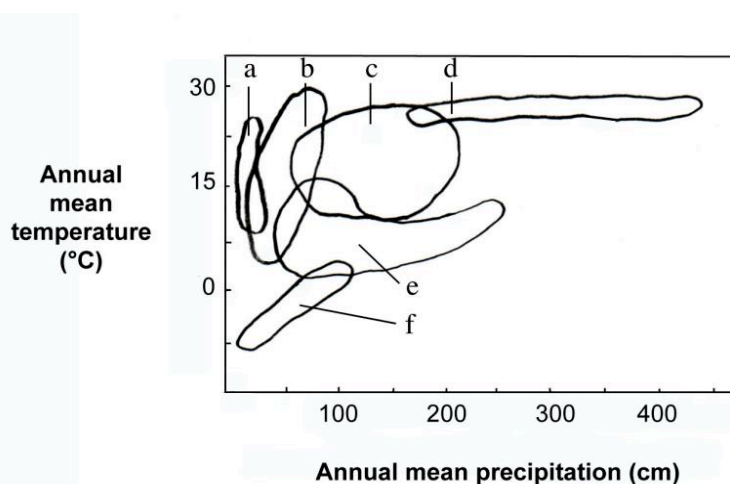


Fig. B

20. The biome represented by letter e in Fig. B is the
- tropical rainforest.
  - boreal forest.
  - prairie.
  - mid latitude deciduous forest.
  - desert.

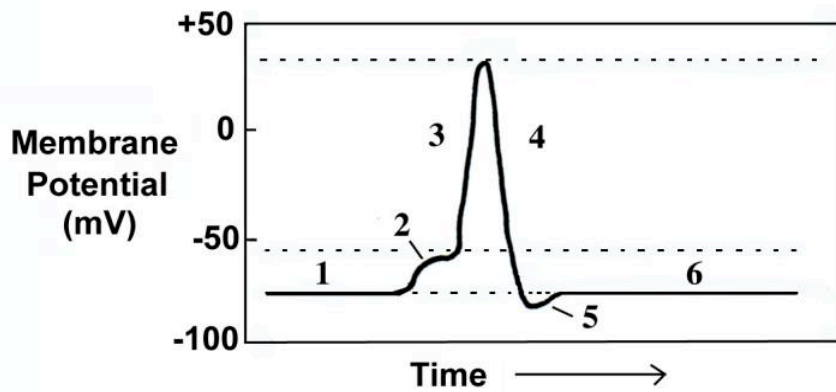


Fig. C

21. During this phase in Fig. C, sodium channels are closed and potassium channels are open.
- A) 2
  - B) 3
  - C) 4
  - D) 5
  - E) 6
22. This phase in Fig. C determines the rate at which action potentials can be generated.
- A) 2
  - B) 3
  - C) 4
  - D) 5
  - E) 6

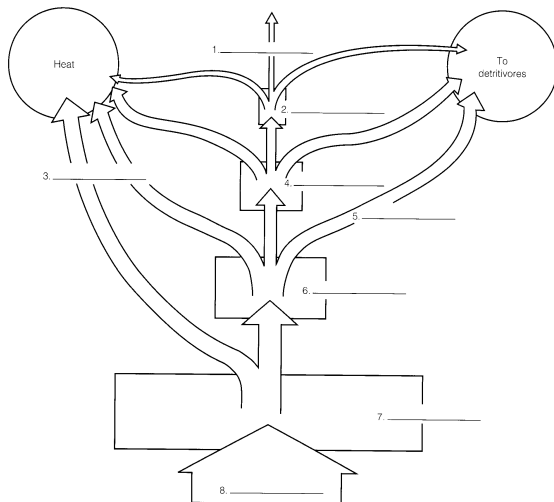
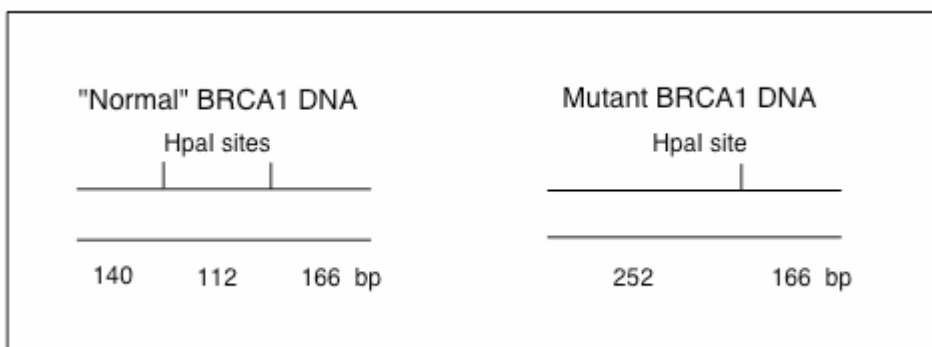


Fig.D

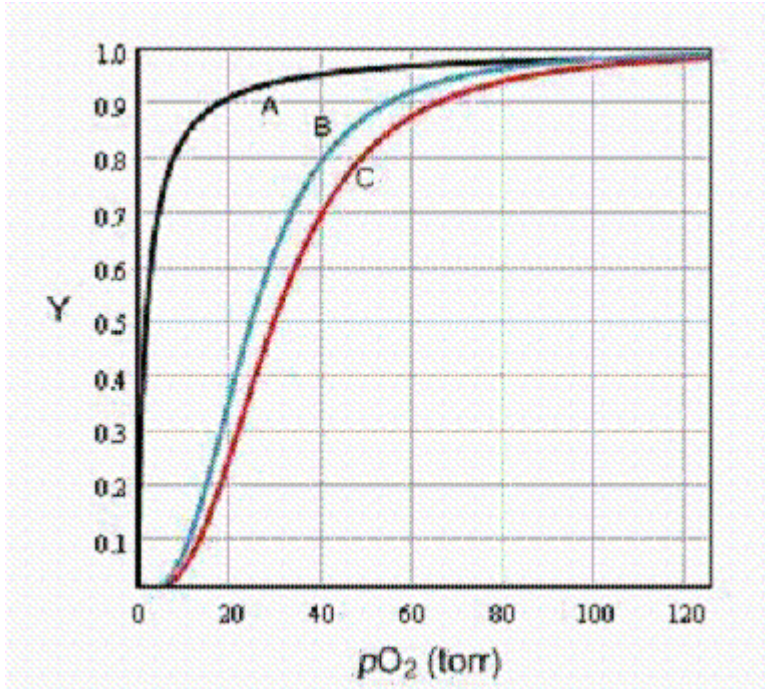
23. How many trophic levels are depicted in the diagram in Fig. D?
- A) 4
  - B) 5
  - C) 6
  - D) 7
  - E) it can not be determined.

Fig. E. The diagram below shows how Hpa1 cuts a 418 bp fragment of human DNA into different sized pieces. Hpa1 has 2 recognition sites on the normal fragment of DNA, but only 1 on the mutant fragment.

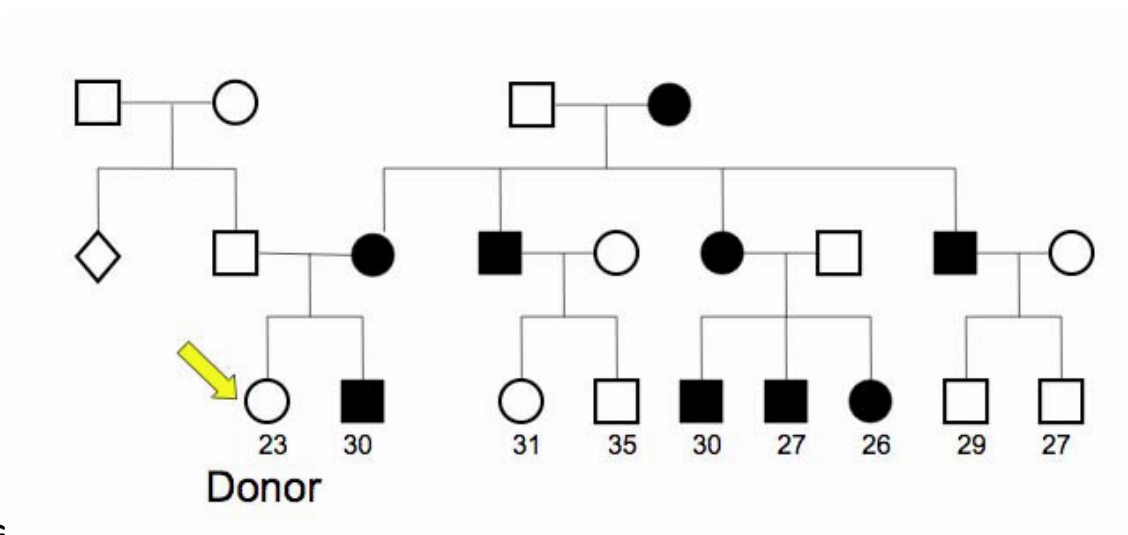


24. A sample from an individual is tested for the BRCA1 mutant allele. Which of the following restriction fragment lengths (in bp) would indicate a positive result for this allele?
- A) 112
  - B) 140
  - C) 166
  - D) 252
  - E) 418
25. Based on Fig E., the mutation involved in the BRCA1 gene is most likely
- A) a single nucleotide substitution.
  - B) a frame-shift mutation.
  - C) a chromosomal translocation.
  - D) a silent mutation.
  - E) a trinucleotide deletion.

**Fig. F.** This curve represents the dissociation of hemoglobin and oxygen. The y-axis is % O<sub>2</sub> saturation of hemoglobin.



26. Which of the above curves in Fig. F would be associated with muscle tissues during exercise?
- A) A
  - B) B
  - C) C
  - D) all of the above curves.
  - E) none of the above curves.
27. Which of the curves in Fig. F is most similar to fetal hemoglobin's dissociation curve?
- A) A
  - B) B
  - C) C
  - D) all of the above curves.
  - E) none of the above curves.



**Fig.G**

28. Assuming that this condition in Fig. G is observable shortly after birth, the most probable inheritance pattern for this condition is
- autosomal dominant.
  - autosomal recessive.
  - X-linked dominant.
  - X-linked recessive.
  - Y-linked.
29. Assume that this condition in Fig. G manifests itself in teenagers. If person 23 is currently an infant, what are the odds that she will eventually display the condition?
- 0
  - 25%
  - 50%
  - 75%
  - 100%
30. Sprays made of a mixture of oil and water are used to kill mosquitoes. This spray would
- coat their lungs.
  - block tracheal openings.
  - interfere with capillary gas exchange.
  - interfere with nutrient absorption.
- only one of the above
  - only two of the above
  - only three of the above
  - all of the above
  - none of the above
31. Cardiac muscle cells
- are branched.
  - are striated.
  - have many nuclei.
  - are spindle shaped.
- only one of the above
  - only two of the above
  - only three of the above
  - all of the above
  - none of the above

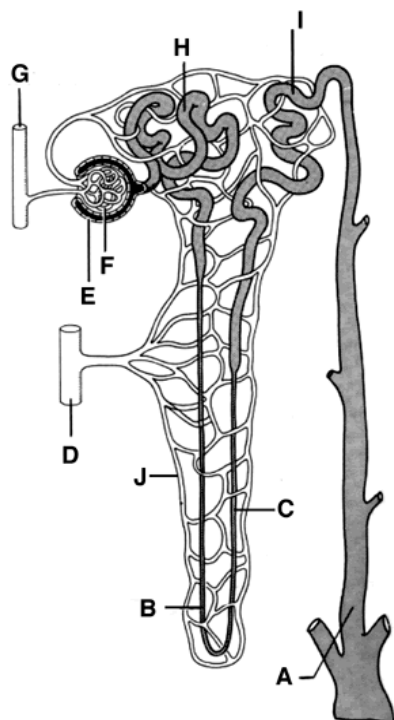


Fig. H

32. Which region in Fig. H is directly involved in regulating blood pH?
- A
  - B
  - C
  - F
  - I

33. This portion of Fig. H is permeable to urea
- A
  - B
  - C
  - H
  - none of the above.
34. The shortening of telomeres over the lifetime of a person is primarily due to
- decreased efficiency of DNA pol III over time.
  - build up of anti-DNA antibodies over time.
  - inability of DNA polymerase to add nucleotides to a 5' end.
  - removal of RNA primers after DNA replication is complete.
  - random loss of Okazaki fragments.
35. Ultraviolet radiation causes potentially carcinogenic mutations primarily by
- creating DNA thymine dimers.
  - creating missense mutations.
  - creating frame shift mutations.
  - shortening telomeres.
  - disabling repair enzymes.

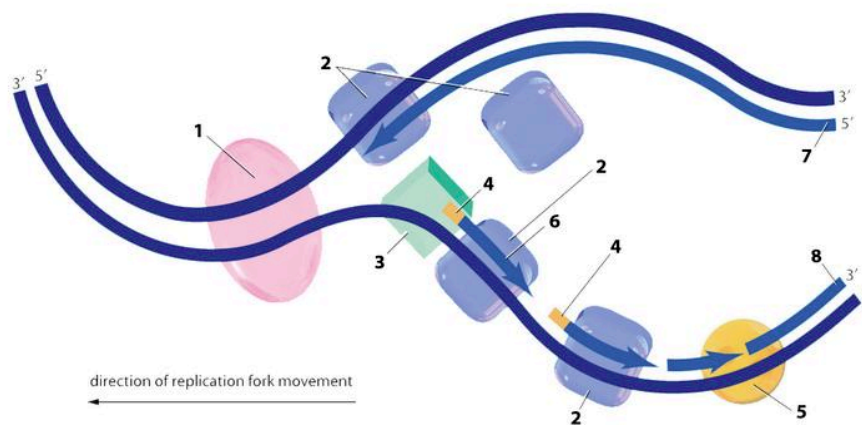


Fig J

36. The circle labeled number 5 in Fig. J represents
- DNA ligase.
  - DNA pol I.
  - DNA pol III.
  - primase.
  - helicase.
37. The above diagram (Fig. J) is incomplete, as it shows only one side of the replication bubble. If the complete replication bubble were depicted, then the strand labeled number 8 would be
- an Okazaki fragment.
  - a leading strand.
  - an RNA primer.
  - a single-strand binding protein.
  - a lagging strand.
38. A patient with abnormally high adrenal corticosteroid levels in his blood would display which of the following symptoms?
- increased blood glucose, decreased inflammatory response, loss of muscle tissue
  - low blood pH, increased urine
  - tiredness, weight gain, sensitivity to cold
  - decreased urine volume, high urine osmolarity
  - loss of bone density, fatigue
39. Which of the following is NOT true of IgA's?
- IgA's function as a dimer composed of Y shaped elements.
  - IgA's are the most abundant type of circulating antibody.
  - IgA's are produced by cells in mucus membranes.
  - IgA's are found in many body secretions such as saliva and tears.
  - IgA's prevent attachment of viruses and bacteria.



40. Hyperventilation results in which of the following?
- An increase of the CO<sub>2</sub> concentration in the blood.
  - A relaxation of the blood vessel walls.
  - An increase in blood pH.
  - A reduced Ca<sup>++</sup> affinity for serum proteins.
  - A return to positive pressure breathing.
41. My mother used to say "one bad apple spoils the whole bunch". Her saying was
- true, because apple spoilage is caused by bacteria which can be transmitted from one apple to another.
  - true, because apple spoilage is caused by a hormone which is released by one ripe apple.
  - false, because apple spoilage is caused by age of the apple and is not contagious.
  - false, because apple spoilage is caused by improper handling and storage only.
  - false, because apple spoilage is caused by environmental temperature only.
42. The humoral response involves all of the following EXCEPT
- class II MHC proteins.
  - helper T cells.
  - cytotoxic T cells.
  - cloned plasma cells.
  - IL-2.
43. A student listed the following sequence for the neuromuscular junction:
- The presynaptic membrane depolarizes and Ca<sup>++</sup> rush in.
  - Synaptic vesicles release acetylcholine, via exocytosis, into the synaptic cleft.
  - The postsynaptic membrane is depolarized.
  - The depolarization spreads to the sarcoplasmic reticulum, causing Ca<sup>++</sup> to be released.
  - Ca<sup>++</sup> binds to tropomyosin, exposing the actin heads.
  - ATP is hydrolyzed, allowing cross bridges between actin and myosin.

The teacher returned the list with the following comments:

- All items are correct and in the proper order.
  - One item is incorrect but all the items are in proper order.
  - All items are correct but one is out of order.
  - One item is incorrect and one other item is out of order.
  - Two items are incorrect but the items are in proper order.
- ~~44. You left some bean seedlings growing next to a window during spring break. When you returned, the seedlings were strongly bent towards the window. You take small samples of the cells on the stem side near the window and the stem side far from the window. After testing the pH of the cells walls of both samples, you find that~~
- ~~both samples have a pH near 7.~~
  - ~~the sample near the window has a lower pH than the sample far from the window.~~
  - ~~the sample far from the window has a higher pH than the sample near the window.~~
  - ~~both samples have a pH near 5.~~
  - ~~both samples have a pH near 9.~~
45. Your school ecology club is raising poinsettias in the greenhouse as a winter fundraiser. You needed to check on the greenhouse temperature during the night. Hoping that you would not disrupt the flowering signals, you used a \_\_\_\_\_ light to enter the greenhouse. Alas! You chose the wrong light and the fundraiser is a disaster. Which light did you use?
- ultraviolet
  - dim
  - blue
  - red
  - yellow

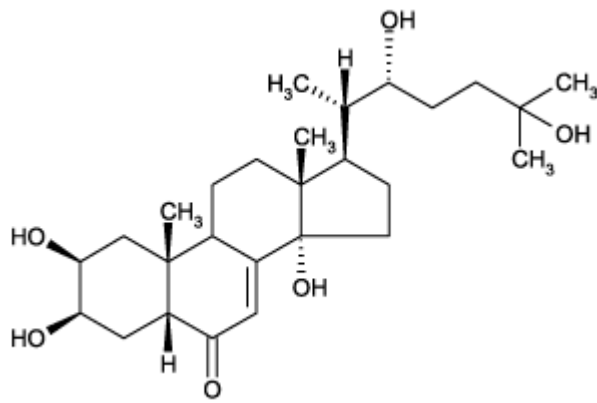


Fig K.

46. The diagram above (Fig. K) is of ecdysone, the hormone involved in the molting process of arthropods. Based upon its chemical structure you predict that
- this hormone binds with a cytoplasmic receptor and the complex alters the expression of specific genes.
  - this hormone binds with a G protein coupled receptor and triggers the release of a second messenger.
  - this hormone binds with tyrosine kinase receptors and triggers a cascade sequence.
  - this hormone enters the cell and acts directly as a second messenger, triggering phosphorylation of specific enzymes.
  - this hormone inserts into the plasma membrane and alters membrane fluidity.
47. Before and after treating a cell culture with a putative growth factor, you perform careful analyses of the DNA and protein content. You discover that after treatment:
- the DNA content has doubled.
  - MPF factor has remained low.
  - cyclin levels have increased.

You conclude that the growth factor has caused your cell culture to enter the \_\_\_\_\_ phase.

- G1
- S
- G2
- M
- G0

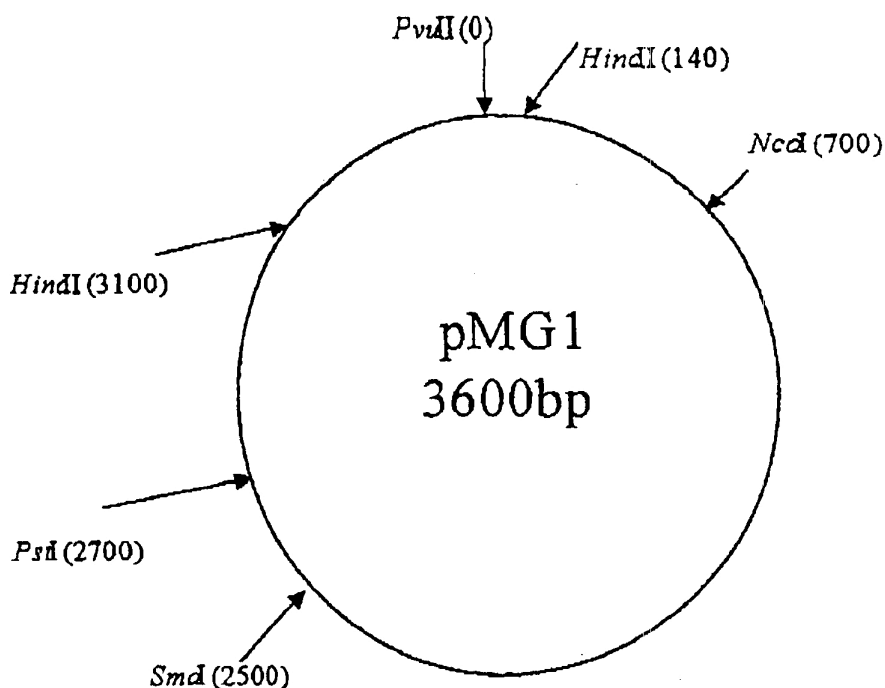


Fig. L

48. Given the restriction map of pMG1 above (Fig. L), predict the band sizes (in bp) found after cutting the plasmid with HindI and SmaI
- 600, 640, 2360.
  - 600, 2360, 3240.
  - 600, 2060, 2360.
  - 140, 500, 600, 2360.
  - 140, 600, 2060, 2360.

49. After cutting pMG1(Fig. L) with all of the indicated restriction enzymes plus a new, previously untested enzyme, and running the DNA gel, a new thick band of 100 bp appears. One previous band is missing. The new enzyme must have cut between the sites of
- PvuII and HindI.
  - SmaI and PstI.
  - HindI and NcoI.
  - HindI and HindI.
  - NcoI and SmaI.

Fig. M

	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

50. What amino acid sequence would be coded for by the complement of the following DNA sequence?

5' ACGCCTGACTTTAACGTA 3'

- thr - pro--asp - phe - asp -val
  - cys - gly - leu - asn - leu - his
  - met - gln - phe - gln - ser - ala
  - met - pro- asp - asn - asn - ala
  - thr - pro - leu - asn - asp - val
51. Eukaryotic gene transcripts frequently undergo modification before translation occurs. The structures which begin the process of splicing mRNA are the
- introns.
  - snRNPs.
  - siRNAs.
  - aminoacyl-tRNA synthetases.
  - ribosomes.
52. A difference between transcription in bacteria and transcription in eukaryotes is that
- bacteria have a single type of RNA polymerase but eukaryotes have specialized types of RNA polymerase.
  - bacteria promotor regions do not contain the TATA region while eukaryotic promotor regions do have a TATA box.
  - bacterial transcription proceeds in a 5' to 3' direction while eukaryotic transcription proceeds in a 3' to 5' direction.
  - bacterial transcription and translation are spatially separate while the two processes are temporally separate in eukaryotes.
  - bacteria use a different ribosome structure from eukaryotic ribosomes.
53. When placed in a medium containing both glucose and lactose, *E. coli* will
- utilize the glucose first because CRP is activated.
  - utilize the glucose first because cAMP levels will remain high.
  - utilize the lactose first because the CAP operon is repressed by lactose.
  - utilize the lactose first because the *lac* operon is induced by the presence of lactose.
  - utilize both the glucose and the lactose at approximately equal rates.

54. The *ras* gene is involved in 20 - 30% of human cancers. When mutated at a single point, *ras*, a proto-oncogene, becomes hyperactive. The explanation for its role in carcinogenesis is that
- A) mutated *ras* no longer makes a growth inhibition protein, thus stimulating the cell cycle.
  - B) mutated *ras* codes for a local growth signal which stimulates the cell cycle.
  - C) mutated *ras* protein continually binds to a tyrosine kinase receptor, which stimulates the cell cycle.
  - D) mutated *ras* protein increases production of ATP which provides the energy to stimulate the cell cycle.
  - E) mutated *ras* creates antibodies against apoptosis enzymes.
55. Cells contain free ribosomes and bound ribosomes. What is a difference between these ribosomes?
- A) The proteins produced by bound ribosomes are used primarily in the cytosol while the proteins produced by free ribosomes are used primarily in membranes
  - B) Pancreatic cells tend to have higher amounts of free ribosomes
  - C) The proteins produced by free ribosomes are used primarily in the cytosol while the proteins produced by bound ribosomes are used primarily in membranes
  - D) Free ribosomes and bound ribosomes have completely different structures
  - E) Both A and B are correct
56. The cells found in the testes and ovaries tend to have high numbers of which organelle:
- A) Golgi Apparatus
  - B) Smooth Endoplasmic Reticulum
  - C) Rough Endoplasmic Reticulum
  - D) Lysosomes
  - E) Mitochondria
57. The *cis* face of the Golgi Apparatus is usually located near which organelle:
- A) Lysosome
  - B) Nucleus
  - C) Chloroplast
  - D) Ribosome
  - E) Endoplasmic Reticulum
58. What would happen to a cell with a genetic defect that produced no lysosomes?
- A) Nothing since the cytosol has a neutral pH
  - B) The cell would be destroyed due to autodigestion
  - C) The cell would be destroyed due to autophagy
  - D) The cell would adapt by peroxisomes functioning as lysosomes
  - E) The cell would adapt by vacuoles fusing together to form lysosomes
59. A cell was unable to form a cleavage furrow during mitosis; thus, it was unable to go through cytokinesis. What part of the cytoskeleton is impacted?
- A) Microtubules
  - B) Microfilaments
  - C) Intermediate Filaments
  - D) Both A and B are correct
  - E) Both A and C are correct
60. The method of *freeze-fracture* is involved with:
- A) Determining the amount of red blood cells in a human
  - B) Isolating chromosomes from the nucleus
  - C) Separating the phospholipid bilayer
  - D) Tracking the movement of proteins throughout the body
  - E) Tracking the movement of hormones throughout the body

61. How does the saturation levels of membrane fatty acids differ in plants adapted to cold environments as compared to plants adapted to warmer environments?
- A) The percentage of unsaturated phospholipids will decrease in the autumn to prevent the membrane from solidifying in the winter
  - B) The percentage of saturated phospholipids will increase in the autumn to prevent the membrane from liquifying in the winter
  - C) The percentage of unsaturated phospholipids will decrease in the summer to prevent the membrane from solidifying in the autumn
  - D) The percentage of unsaturated phospholipids will increase in the autumn to prevent the membrane from solidifying during the winter
  - E) The percentage of unsaturated and saturated phospholipids does not adjust
62. Why can substances, such as hydrocarbons, cross a lipid bilayer without help from membrane proteins?
- A) They are polar which allows them to move through the bilayer easily
  - B) They move with the concentration gradient so they do not need a membrane protein to do so
  - C) They move against the concentration gradient so they do not need a membrane protein to do so
  - D) They are hydrophobic so they can easily dissolve in the lipid bilayer
  - E) They are hydrophilic so they can easily dissolve in the lipid bilayer
63. Tuna normally live in saltwater; however, a biology student thought it would be a good idea to place one in the pond in his backyard. Why is this not a good idea?
- A) The student will be placing the tuna into a hypertonic environment causing the fish's cells to shrivel.
  - B) The student will be placing the tuna into a hypotonic environment causing the fish's cells to shrivel
  - C) The student will be placing the tuna into a hypertonic environment causing the fish's cells to lyse
  - D) The student will be placing the tuna into a hypotonic environment causing the fish's cells to lyse
  - E) The student will be placing the tuna into a hypertonic environment creating turgor pressure in the fish's cells.
64. Which of the following is *NOT* an example of passive transport?
- A) Osmosis
  - B) Diffusion
  - C) Facilitated Diffusion
  - D) Phagocytosis
  - E) All of the above are examples of passive transport
65. If phosphorylation never occurred in the sodium-potassium pump, what would happen?
- A) The sodium ions would not be able to bind to the pump
  - B) The sodium ions would not be able to be released from the pump
  - C) Only two sodium ions would be able to bind to the pump
  - D) Both sodium and potassium would move via a concentration gradient
  - E) All of the above would occur
66. Which of the following is *correct* about exocytosis?
- A) Nerve cells use exocytosis to release neurotransmitters
  - B) Skin cells use exocytosis to release sweat and other waste products
  - C) Plant cells use exocytosis in the production of ribosomes
  - D) Kidney cells use exocytosis in the production of urine
  - E) Bladder cells use exocytosis to absorb excess water

67. A scientist labeled the plasma membrane proteins of a mouse cell and a human cell with two different markers and fused the cells. Using a microscope, they observed the markers of the hybrid cells which were spread evenly throughout. What could the scientists have concluded?
- A) Proteins from the human cell and mouse cell mutated to form entirely different proteins
  - B) Proteins from the human cell were transformed into proteins from the mouse cells.
  - C) The proteins from the mouse cell engulfed the proteins from the human cell indicating that the proteins could perform endocytosis
  - D) The proteins from the human cell engulfed the proteins from the mouse cell indicating that the proteins could perform phagocytosis
  - E) The proteins from the human and mouse mixed indicating that some proteins can move sideways
68. How did LaMarck come up with his theories of evolution?
- A) He observed organisms in their natural environment
  - B) He measured the beak sizes of different birds
  - C) He compared current species with fossil forms
  - D) He collected specimens of leaves and viewed them under his microscope
  - E) He collected different samples of blood and ran tests on the samples
69. Which phenomenon (s) shaped Darwin's theory of evolution?
- A) Use and disuse
  - B) Catastrophism
  - C) Gradualism
  - D) Uniformitarianism
  - E) Both C and D are correct
70. Which of the following points does *NOT* go along with Darwin's theory of natural selection?
- A) A population is the smallest unit that can evolve
  - B) A species is the smallest unit that can evolve
  - C) Natural selection can amplify or diminish *only* heritable traits
  - D) Traits that are favored are dependent upon the environment in which the organism lives
  - E) Both B and C are not part of Darwin's theory
71. Darwin thought that the animals of the Galápagos Islands were similar to those of the nearby coast of South America because:
- A) the animals' ancestors had migrated from South America to the Galápagos Islands
  - B) the animals had all been brought to the islands by humans
  - C) the islands had slowly drifted away from the mainland
  - D) the animals in both places had evolved in nearly identical environments
  - E) the islands were constantly drifting
72. Artificial selection may have been used by humans to:
- A) Slow down the process of convergent evolution
  - B) Speed up the process of divergent evolution
  - C) Stop evolution in domestic organisms
  - D) Study the process of coevolution
  - E) Eliminate the presence of homologous structures
73. Which of the following terms are paired correctly?
- A) Wing of a butterfly and wing of a bird are examples of vestigial structures
  - B) Wing of a bat and fin of a whale are examples of homologous structures
  - C) Flower color and stem length are examples of analogous structures
  - D) Beak of a bird and beak of a giant squid are examples of homologous structures
  - E) Both A and B are correct
74. Population genetics is a combination of the ideas of which two scientists:
- A) Darwin & Lyell
  - B) Darwin & Mendel
  - C) Lyell & Mendel
  - D) Mendel & Hardy
  - E) Darwin & Wallace

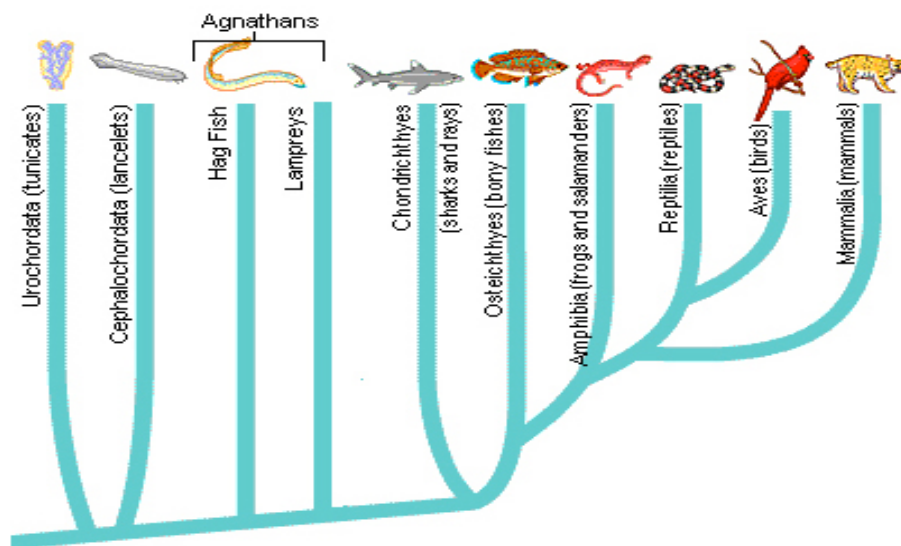
75. A population of walrus were found to lack genetic variability for all their traits. This could be explained by which evolutionary phenomenon:
- A) Founder effect
  - B) Artificial selection
  - C) Coevolution
  - D) Genetic drift
  - E) Convergent evolution
76. Suppose a population of birds with 500 gene loci is fixed at half of these loci and has two alleles at each of the other loci. How many alleles are found in the gene pool of this population?
- A) 250
  - B) 500
  - C) 750
  - D) 1000
  - E) 1500
77. Which of the following conditions is *NOT* required for Hardy-Weinberg equilibrium?
- A) The population is infinitely large
  - B) There is no net immigration or emigration in a population
  - C) Individuals may mate randomly
  - D) Selection only occurs minimally
  - E) No net mutations
78. Nonrandom mating : increases the proportion of homozygotes::
- A) Migration of individuals: gene flow
  - B) Mutation: major change in allele frequencies
  - C) Hardy-Weinberg equation: natural selection
  - D) Inbreeding: frequency of alleles
  - E) Convergent evolution: vestigial structures
79. Which of the following statement(s) is *NOT* correct about variation in a given population?
- A) The environment impacts the variation of a population
  - B) Variation could be a result of meiosis
  - C) Not all phenotypic variation is heritable
  - D) Discrete and quantitative characters do not contribute to variation
  - E) All of the statements above are true
80. Which of the following words best completes the analogy below:  
vestigial: functional:: vacated:
- A) Used
  - B) Visceral
  - C) Broken
  - D) Homologous
  - E) Occupied
81. What would you expect the *relative fitness* of a mule to be?
- A) .1
  - B) .5
  - C) .8
  - D) 0
  - E) .02
82. The weight of most human babies is approximately 3-4 kilograms. Babies who are much smaller or larger suffer higher rates of mortality. This is an example of what evolutionary phenomenon:
- A) Coevolution
  - B) Stabilizing selection
  - C) Divergent evolution
  - D) Directional selection
  - E) Convergent evolution
83. Which of the following traits would *NOT* be useful to the study of genetic variation in a population of fish?
- A) Length of the fish
  - B) Color of the fish
  - C) Fin size of the fish
  - D) Diet of the fish
  - E) All of these would be useful

84. A patient presents to her doctor with an abnormal sized thyroid gland. The doctor immediately asked the patient about her diet. What trace element did the doctor conclude the patient was lacking?
- A) Carbon
  - B) Hydrogen
  - C) Iodine
  - D) Calcium
  - E) Phosphorous
85. What type of bonds are responsible for allowing a gecko lizard to walk up a wall?
- A) Nonpolar covalent bonds
  - B) Polar covalent bonds
  - C) Nonpolar ionic bonds
  - D) Nonpolar hydrogen bonds
  - E) Polar hydrogen bonds
86. Oxidation-reduction reactions are important in organisms because they:
- A) Prevent nuclear reactions from occurring
  - B) Allow the creation and destruction of energy
  - C) Prevent molecules from becoming unstable
  - D) Allow the passage of energy from molecule to molecule
  - E) None of the above are correct- oxidation-reduction reactions do not occur in living organisms
87. Cotton consists of giant molecules of cellulose, a compound with numerous regions of partial positive and partial negative regions associated with polar bonds. Even though cotton is polar, why doesn't it dissolve in water?
- A) Cotton also contains maltose which prevents it from dissolving
  - B) The cellulose in cotton is too large to dissolve in water
  - C) The cellulose in cotton is arranged in long twisted chains of glucose preventing it from dissolving
  - D) Cotton also contains sucrose which prevents it from dissolving
  - E) None of the above are correct
88. Which substance (s) acts as a buffer to prevent the pH of blood from becoming too acidic or too basic?
- A) Hydrogen peroxide
  - B) Hydrochloric acid
  - C) Water vapor
  - D) Carbonic acid
  - E) Sulfur dioxide
89. What role does the functional group, *carboxyl*, serve in organic compounds?
- A) Acts as a base
  - B) Stabilizes the protein structure
  - C) Makes the molecule it is part of an anion
  - D) Attracts nitrogen molecules
  - E) None of the choices above are correct
90. After you eat a slice of apple, which reaction(s) must occur for the amino acid monomers in the protein of the apple to be converted into proteins in your body?
- A) Dehydration
  - B) Hydrolysis
  - C) Neutralization
  - D) Isomerization
  - E) Both A and B are correct
91. What is the relationship between glycogen and amylopectin, a form of starch found in plants?
- A) They are both examples of lipids
  - B) They are both branched molecules
  - C) They are both enantiomers
  - D) They both contain sulfur functional groups
  - E) They both contain amino groups



92. Why are human sex hormones considered to be lipids?
- A) They contain phosphate functional groups
  - B) They are synthesized from cholesterol
  - C) They have phospholipid tails
  - D) They form double layered aggregates
  - E) Both C and D are correct
93. Which of the following is *NOT* a function of proteins?
- A) Transport
  - B) Storage
  - C) Defense
  - D) Structure
  - E) Ketone Production
94. *Sickle Cell Anemia* is an inherited blood disorder. It is due to a change in the structure of the protein, hemoglobin. What structure of the hemoglobin is abnormal?
- A) Primary structure
  - B) Secondary structure
  - C) Tertiary structure
  - D) Heptanary structure
  - E) A,B,C are correct
95. What is the difference between the pentose sugars, *deoxyribose* and *ribose*?
- A) There is no difference- they are simply isomers of one another
  - B) Deoxyribose lacks an oxygen atom on the second carbon
  - C) Dexoyribose lacks an oxygen on the third carbon
  - D) Ribose lacks an oxygen atom on the second carbon
  - E) Ribose lacks an oxygen atom on the third carbon
96. Why is studying *free energy* important to biologists?
- A) Allows biologists to determine how much energy is required for photosynthesis to occur
  - B) Allow biologists to determine how much energy is required for cellular respiration to occur
  - C) Allows biologists to predict what kinds of changes can happen without help
  - D) Allows biologists to predict the rate at which mutations will occur
  - E) Allows biologists to predict the rate at which crossing over will occur
97. What is responsible for energy coupling in cells?
- A) NADPH
  - B) Oxygen gas
  - C) ATP
  - D) FAD
  - E) NAD<sup>+</sup>
98. Which of the following statement(s) are *NOT* true about enzymes?
- A) Very small amount of enzymes are needed to catalyze a reaction
  - B) An enzyme can catalyze both the forward and reverse reaction
  - C) The active site of an enzyme is only slightly altered after the reaction
  - D) An enzyme always catalyzes the reaction in the direction of equilibrium
  - E) An active site may provide a microenvironment that is more conducive to a particular type of reaction
99. Which enzyme in glycolysis is allosterically regulated by ATP and its products?
- A) Aldolase
  - B) Phosphofructokinase
  - C) Hexokinase
  - D) Phosphoglucoisomerase
  - E) Enolase
100. How many carbon dioxide molecules are lost during the Citric Acid Cycle?
- A) Two
  - B) Three
  - C) Four
  - D) Five
  - E) Six

- 101.** Which of the following is *True* about the electron transport chain?
- I. Electron transport chain makes no ATP directly
  - II. A source of the electrons in the electron transport chain comes from FADH<sub>2</sub>
  - III. Ubiquinone is the only member of the electron transport chain that is not a protein
- A) Choice I above is true  
B) Choice II above is true  
C) Choice III above is true  
D) Choices I and II are true  
E) Choices I, II, and III are true
- 102.** Why does lactic acid build up in our muscle cells when we have used up the supply of oxygen?
- A) ATP is still being made so our body has to compensate  
B) ATP will accumulate stimulating phosphofructokinase which increases the rate of glycolysis  
C) AMP will accumulate stimulating phosphofructokinase which increases the rate of glycolysis  
D) Pyruvate is not being produced  
E) It is an unknown phenomenon that biologists are still searching for an answer
- 103.** Which color of light is *least* effective in driving photosynthesis?
- A) Red  
B) Blue  
C) Orange  
D) Green  
E) Yellow
- 104.** The oxygen we inhale is produced from the breakdown of which molecule:
- A) Carbon dioxide  
B) Carbonic acid  
C) Water  
D) Rubisco  
E) Glucose
- 105.** Which of the following differentiates C<sub>4</sub> plants from CAM plants?
- A) Presence of an extra layer of cells in the leaves of CAM plants  
B) Carbon fixation and the Calvin cycle occur in the same cells at different times in C<sub>4</sub> plants  
C) C<sub>4</sub> plant's cells lack stomata  
D) CAM plant's cells lack stomata  
E) Carbon fixation and the Calvin cycle occur in the same cells at different times in CAM plants
- 106.** How does photorespiration differ from cellular respiration and photosynthesis?
- A) Unlike photosynthesis, photorespiration does not produce sugars  
B) Unlike cellular respiration, photorespiration does not generate ATP  
C) Unlike photosynthesis, photorespiration does not use carbon dioxide  
D) Unlike cellular respiration, photorespiration does not consume oxygen  
E) All of the above are differences



107. The phylogenetic tree indicates the most common ancestor of birds, reptiles, and mammals are:
- Sharks
  - Lampreys
  - Hagfish
  - Amphibians
  - Lancelets
108. What is the difference between ultrametric trees and phylograms?
- Nothing- they are both the same
  - Phylogram looks at the evolutionary relationship of more species
  - Ultrametric trees tend to have more branching
  - Phylograms tend to have more branching
  - None of the above are correct
109. Why could numerous base changes that occur in DNA have no effect on an organism's fitness?
- Fitness is measured by the parents of the organism and not the actual organism
  - The base changes could occur in regions of the genome that do not code for genes
  - The base changes could occur only in gamete cells thus not affecting the fitness
  - The base changes could balance out other base changes that were beneficial
  - Fitness is measured by the environment of the organism
110. Which of the following statement(s) are *TRUE* about the universal tree of life?
- There are two common ancestors of all living things
  - The Archaea domain is more closely related to the Eukarya domain than the Bacteria domain
  - The Archaea domain is more closely related to the Bacteria domain than the Eukarya domain
  - There is only one domain that consists of prokaryotes
  - There are two domains that consist of eukaryotes

**END OF TEST**



MULTIPLE CHOICE

- |       |                             |        |
|-------|-----------------------------|--------|
| 1. C  | 38. A                       | 75. D  |
| 2. A  | 39. B                       | 76. C  |
| 3. C  | 40. C                       | 77. D  |
| 4. B  | 41. B                       | 78. A  |
| 5. B  | 42. C                       | 79. D  |
| 6. D  | 43. B                       | 80. E  |
| 7. A  | 44. <del>B</del> eliminated | 81. D  |
| 8. A  | 45. D                       | 82. B  |
| 9. D  | 46. A                       | 83. E  |
| 10. C | 47. C                       | 84. C  |
| 11. B | 48. A                       | 85. A  |
| 12. D | 49. B                       | 86. D  |
| 13. B | 50. A                       | 87. B  |
| 14. A | 51. B                       | 88. D  |
| 15. D | 52. A                       | 89. E  |
| 16. C | 53. B                       | 90. E  |
| 17. B | 54. A                       | 91. B  |
| 18. D | 55. C                       | 92. B  |
| 19. A | 56. B                       | 93. E  |
| 20. B | 57. E                       | 94. E  |
| 21. C | 58. B                       | 95. B  |
| 22. D | 59. B                       | 96. C  |
| 23. A | 60. C                       | 97. C  |
| 24. D | 61. D                       | 98. C  |
| 25. A | 62. D                       | 99. B  |
| 26. A | 63. D                       | 100. A |
| 27. A | 64. D                       | 101. E |
| 28. A | 65. B                       | 102. C |
| 29. C | 66. A                       | 103. D |
| 30. B | 67. E                       | 104. C |
| 31. B | 68. C                       | 105. E |
| 32. E | 69. E                       | 106. B |
| 33. A | 70. B                       | 107. D |
| 34. C | 71. A                       | 108. E |
| 35. A | 72. B                       | 109. B |
| 36. A | 73. B                       | 110. B |
| 37. B | 74. B                       |        |