USA BIOOlympiad 2006

2006 Semi-Final Exam

1. If a strand of DNA has the following nucleotide sequence —ATTCGCTAGACC — what will be the nucleotide sequence of micro RNA (miRNA) be? **Cell Biology – Structure/Function of Cells – Chemical Components. (A.B.)**

A. UAAGCGAUCUGG
B. AUUCGCUAGACC
C. TAAGCGATCAGG
D. ATTCGCTAGACC
E. None of the above

2. To convert carbon dioxide to two molecules of glucose, how many high energy compounds and electron carriers are required to complete the task? **Cell Biology – Structure/Function of Cell - Metabolism. (A.B.)**

A. 9 ATP and 6 NADPH
B. 18 ATP and 12 NADPH
C. 36 ATP and 24 NADPH
D. 18 ATP and 24 NADPH
E. 9 ATP and 12 NADPH

3. Suppose you see an electron micrograph of a cell that has a super abundance of mitochondria, Golgi apparatus and rough endoplasmic reticulum. This cell probably: **Cell Biology – Structure/Function of Cells - Organelles. (A.B.)**

A. manufactures lysosomes.
B. manufactures glycolipids.
C. manufactures enzymes.
D. stores calcium.
E. manufactures steroid hormones.

4. Which of the following types of proteins may be expressed from prophage? **Cell Bioloby – Microbiology. (W.P.)**

A. toxins
B. outer membrane proteins
C. lysis proteins
D. both A and B
E. A, B, and C

5. A yeast extract contains all the enzymes required for alcohol production. The extract is incubated under anaerobic conditions in 1 liter of media containing: 200 mM glucose, 20 mM ADP, 40 mM ATP, 2 mM NADH, 2 mM NAD+ and 20 mM Pi (inorganic phosphates). What is the maximum amount of ethanol that can be produced in these conditions? **Cell Biology – Structure/Function of Cells - Metabolism (Methods). Contributor Unknown.**

A: 2 mM
B. **20 mM**
C. 40 mM
D. 200 mM
E. 400 mM

6. The concentration of ions inside an amoeba is expressed below as ion-units per milliliter. The composition of the extra-cellular environment (ECE) is given for comparison. Assume the amoeba has been in the environment for some time.

	Na^+	K^+	Cl^-	HCO_3^-
Amoeba	1	42	3	119
ECE	21	16	41	119

Simple diffusion alone could account for which ionic concentration inside the amoeba: [Assume the membrane is permeable in some degree to all of the above ions.] **Cell Biology – Structure/Function of Cells - Transport. (T.H.)**

A. Na^+
B. HCO_3^-
C. Na^+, K^+, Cl^- and HCO_3^-
D. Na^+, Cl^- and HCO_3^-
E. K^+

7. The protein Fluorollin is made of 3 domains which are conjugated, each of which absorbs and emits light at the following wavelengths:
Domain A Absorbs: 230-270 nm Emits: 280-310 nm
Domain B Absorbs: 290-310 nm Emits: 330-360 nm
Domain C Absorbs: 340-360 nm Emits: 390-420 nm

If you wanted to determine the subcellular location of Fluorollin protein by fluorescence microscopy, which of the following emission wavelengths would you monitor if you excite at 240 nm? **Cell Biology – Structure/Function of Cells – Components(Methods). (M.K-C)**

A. 290 nm
B. 310 nm
C. 320 nm
D. 350 nm
E. **400 nm**

8. If you wanted to genetically engineer a plant to be more resistant to drought, increasing amounts of which of the following hormones might be a good first attempt: **Plant Anatomy/Physiology. (TH)**

A. abscisic acid
B. brassinosteroid
C. gibberellin
D. cytokinin
E. auxin

9. Which of the following is a homosporous genus? **Plant Anatomy/Physiology. (TH)**

A. Pinus
B. Hibiscus
C. **Lycopodium**
D. Selaginella
E. Lillium

10. Which group of plants can be used to detoxify soil by removing **arsenic**, which at one time was used in pressure-treated lumber? **Plant Anatomy/Physiology. (T.H)**

A. conifers
B**. mosses**
C. ferns
D. horsetails
E. lycopods

11. Sapwood is ____ than heartwood and is found closer to the _____. **Plant Anatomy/Physiology. (T.H.)**

A. **younger ; cambium**
B. older ; center of the stem
C. older ; cambium
D. younger ; center of the stem
E. younger; closer to the phloem.

12. A UNIQUE feature of fertilization in angiosperms is that: **Plant Anatomy/Physiology. (T.H.)**

A. it is a double fusion event; one sperm fertilizes the egg, the other sperm combines with the polar or fusion nucleus.
B. the sperm may be carried by the wind to the female gametophyte.
C. a pollen tube carries two sperm nuclei into the female gametophyte.
D. a chemical attractant guides the sperm toward the egg.
E. the sperm cells have flagella for locomotion.

13. Why do adults usually die when their body temperature exceeds 105°F, but young children may survive that temperature, at least for a longer period of time? **Animal Anatomy/Physiology – Regulation. (A.B.)**

A. children's proteins are denatured at higher temperatures than adults
B. children have a larger relative surface area than adults
C. children sweat more than adults
D. at a higher temperature children's hemoglobin carries more oxygen than adult hemoglobin
E. adults lose their ability to sense warmth as they age

14. Which of the following best illustrates physiological homeostasis?. **Animal Anatomy/Physiology – MDKA**

A. When blood CO_2 increases, you breathe faster and eliminate CO_2.
B. Cells in the body have the same chemical composition.
C. Organs are composed of the same four types of tissues.
D. The lungs have a large surface area for exchange of gases.
E. The parietal-temporal-occipital association area.

15. Training exercises such as jogging, swimming and aerobics will result in skeletal muscle tissue producing an increased: **Animal Anatomy/Physiology – Regulation. (Author not known)**

A. number of sarcomeres per unit
B. membrane potential at the motor end plate
C. number of motor units
D. number of intercalated disks
E. number of mitochondria per muscle fiber

16. The primary excitatory neurotransmitter in the central nervous system is: **Animal Anatomy/Physiology – Regulation. (MDKA)**

A. dopamine.
B. serotonin.
C. glutamate.
D. gamma-aminobutyrate (GABA).
E. norepinephrine

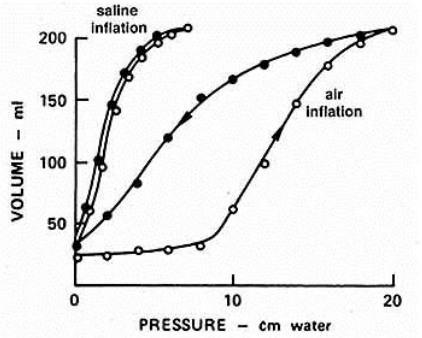
17. Tetanus toxin causes convulsive paralysis by: **Animal Anatomy/Physiology – Regulation. (Author not known)**

A. binding to acetylcholine receptor and blocking acetylcholine.
B. inhibiting acetylcholine esterase.
C. causing massive acetylcholine release from motor neurons.
D. blocking nearly all acetylcholine release from motor neurons.
E. inhibiting sarcomere contraction.

18. During ventricular systole, the ejection phase is associated by which of the following relative pressures in the atrium (a), ventricle (V) and aorta (A)? **Animal Anatomy/Physiology – Circulation (Author unknown)**

A.\a<V<A
B. a>V<A
C. a<V>A
D. a>V>A
E. a=V<A

19. The following graph shows the pressure-volume curve of a mammalian lung when it is removed from the body and filled under two conditions. One condition is when the lung is inflated with air and the second is when it is inflated with saline solution (the entire lung is filled with saline). In both instances the excised lungs retained the thin film of liquid that lines the respiratory alveoli.

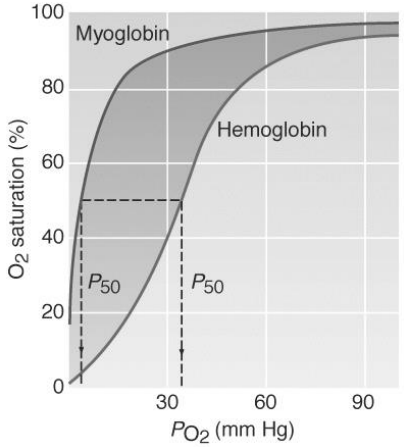


Based on the data presented in the graph, which of the following statements is true? **Animal Anatomy/Physiology – Respiration. (Author unknown)**

A. The lung cannot increase its volume if it is filled with saline instead of air.
B. Surface tension created by the air-liquid interface on the alveolar surface increases the work needed to inflate the lung.

C. Resistance to flow of fluids through the respiratory passageways is greater than is the resistance to flow of air, so more work is needed to inflate the lung with saline than with air.
D. Lung compliance is independent of infusion media.
E. The work required to inflate the lungs with air at small volumes is less than the work required to inflate the lung at large volumes.

20. The following graph shows the dissociation curves for hemoglobin and myoglobin. **Animal Anatomy/Physiology – (Author unknown)**



Based on the data presented in the graph, which of the following statements is true?
A. The high affinity of myoglobin for O_2 at low partial pressures of O_2 prevents hemoglobin from unloading O_2 in to muscle.
B. Myoglobin binds single molecules of O_2 that unloads to the active muscle prior to hemoglobin unloading.
C. Myoglobin helps hemoglobin bind as much O_2 as possible in the lungs.
D. Hemoglobin binds O_2 tightly thus preventing O_2 from being made available to skeletal muscle.
E. The high affinity of hemoglobin for O_2 at low partial pressures of O_2 prevents myoglobin from unloading O_2 in to muscle.

21. Sampling blood from the splanchnic vein (from abdominal viscera) can help determine the dietary levels of all of the following constituents except:
A. proteins
B. sucrose (glucose-fructose disaccharide)
C. alcohol
D. fat
E. Can determine all of the above constituents

22. What is the proximate cause of the cuteness response? **Ethology. (W.T.S.)**
A. Infants who did not look cute were more likely to be killed.
B. Infants have relatively large eyes located in the middle of the face.
C. Individuals who didn't find babies cute were more likely to destroy their own genes.
D. A and B are both proximate causes.
E. B and C are both proximate causes.

23. Which of the following statements is an entirely UNACCEPTABLE statement about "circadian rhythm:" **Ethology. (TH)**

A. it may have the same signal-transduction pathway in all organisms
B. it may need to be reset on a daily basis
C. it may help to cause photoperiodic responses
D. it is completely independent of day and night length
E. no one knows with certainty the exact mechanisms of biological clocks

24. Joan and Claude come to you seeking genetic counseling. Claude was married before, and he and his first wife had a child with cystic fibrosis, a homozygous recessive condition. A brother of Joan's died of cystic fibrosis and Joan has never been tested for the gene. If they marry, what is the probability that Joan and Claude will have a son that WILL NOT be a carrier for or have cystic fibrosis? **Genetics/Evolution – Genetics. (A.B.)**

A. ½
B. ¼
C. 1/12
D. 1/6
E. 1/8

25. In foxes, there are 9 coat colors: red, standard silver, Alaskan silver, double-black, smoky red, cross-red, blended-cross, substandard silver, and sub-Alaskan silver. A red fox was crossed with a double-black fox and their offspring were then crossed with each other. The F_2 phenotypes were; 10 red : 18 smoky red : 20 cross-red : 39 blended-cross : 9 standard silver : 19 substandard silver : 12 Alaskan silver : 22 sub-Alaskan silver : 8 double-black. How many genes are involved in this cross? **Genetics/Evolution – Genetics. (A.B.)**

A. 18 genes
B. 4 pairs of genes
C. 9 genes
D. 9 pairs of genes
E. 4 genes

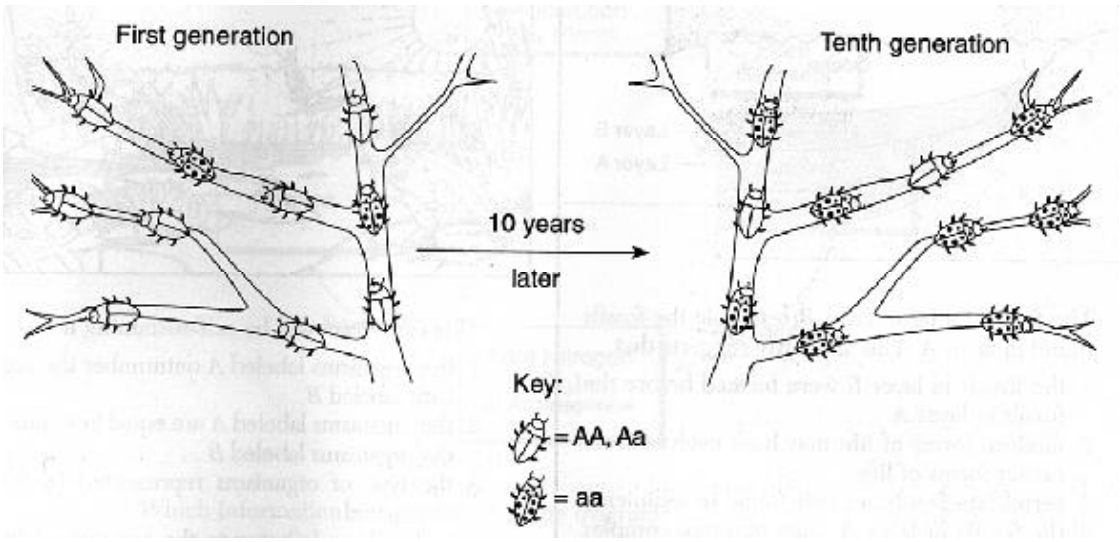
26. Variation in the *Biston betularia* (peppered moth) is a characterized by which of the following evolutionary processes? **Genetics/Evolution. – Evolution. (W.T.S.**)

A. epistasis
B. transient polymorphism
C. balance polymorphism
D. aneuploidy
E. autopolyploidy

27. If a child is blood type O, which of the following blood type is impossible for either parent: **Genetics/Evolution – Genetics. (T.H.)**

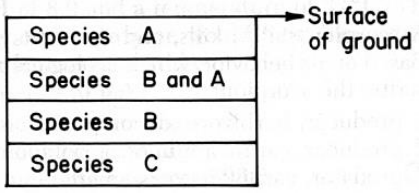
A. A
B. B
C. O
D. AB
E. none are impossible

28. Population genetics shows us that certain traits of a species will become more abundant if they benefit the species. The diagram below illustrates the change that occurred in the frequency of phenotypes in an insect population over 10 generations. A probable explanation for this change would be that over time there was: **Genetics/Evolution – Evolution (W.T.S.)**



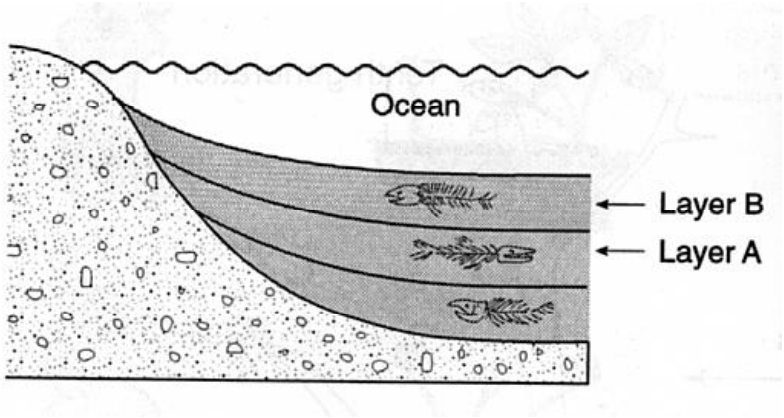
A. a decrease in the population of this insect
B. an increase in the population of this insect
C. a decrease in the adaptive value of gene a
D. **an increase in the adaptive value of gene a**
E. a decrease in the mutation rate of gene A

29. The diagram below represents a section of undisturbed layers of sedimentary rock in New York State and shows the location of fossils of several closely related species. According to currently accepted evolutionary theory, which is the most probable assumption about species A, B and C? **Genetics/Evolution – Evolution/Methods. (W.T.S.)**



A. Species B is more abundant than species C.
B. Species A and B are genetically identical.
C. Both species A and C are descended from species B.
D. Species B descended from species A.
E. **Species C existed before species B.**

30. Consider the figure, below.



Fossils demonstrate gradualism, the theory on the time frame of evolution that states that species gradually change over time. The diagram below shows undisturbed sedimentary strata at the bottom of an ocean. The fossils found in layer B resemble the fossils found in layer A. Such similarity suggests that: **Genetics/Evolution – Evolution. (W.T.S.)**

A. the fossils in layer B were formed before the fossils in layer A
B. **modern forms of life may have evolved from earlier forms of life**
C. vertebrate fossils are only found in sediments
D. the fossils in layer A must be more complex than those in layer B
E. ancient forms teleologically anticipate later evolution.

31. The best description of the relationships between fundamental niches (FN) and realized niches (RN) of two competing species that **coexist** is: **Ecology – Biotic Communities. (Author unknown)**

A. $FN_A = RN_A$; $FN_B = RN_B$
B. $FN_A > RN_A$; $FN_B = RN_B$
C. $FN_A < RN_A$; $FN_B < RN_B$
D. $FN_A > RN_A$; $FN_B > RN_B$
E. $FN_A = RN_A$; $FN_S > RN_S$

32. Which combination of the following statements represent general principles of island colonization? **Ecology – Ecosystem (Evolution). (W.T.S.)**

1) more species are likely to be established on larger islands, and fewer on smaller islands 2) there is a greater probability of colonization if the island is closer to another land mass. 3) Over time, colonial populations become genetically divergent from their parent population due to natural selection, mutation, and/or genetic drift. 4) The older the island, the more likely it will be colonized. 5) Geographic isolation reduces gene flow between populations.

A. only 3 and 4
B. only 1, 2, 4, and 5
C. **1, 2, 3, 4, and 5**
D. only 1, 2, and 3
E. only 2 and 3

33. For populations that exhibit _____ population growth, maximum harvesting yield is achieved when _____. **Ecology – Populations. (Author unknown)**

A. exponential, population growth rate is highest
B. logistic, the population reaches its carrying capacity
C. logistic, population growth rate is highest
D. logistic, population growth rate is not changing with population size
E. exponential, the population reaches its carrying capacity

34. Of the following characteristics, select the most distinctive key character for the Magnoliophyta: **Biosystematics. (T.L.H.)**

A. leaf type
B. pollen structure
C. presence of seeds
D. fruit
E. roots

35. Use the information given in Figures 1 and 2 in answering the following question: **Biosystematics. (Arnold Kluge – Univ of Michigan)**

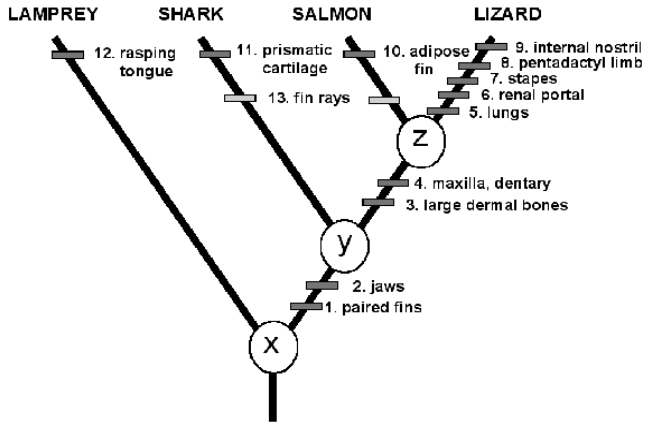


Figure 1. An example of a phylogeny showing characters by which taxa are recognised. Characters 1 – 4 are synapomorphies, 5 – 12 are autapomorphies and 13 is an attribute seen in the salmon and the shark.

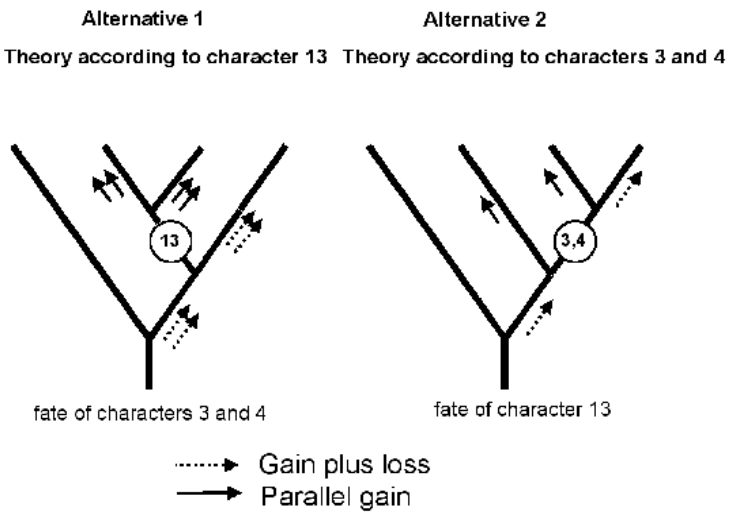


Figure 2. Two possible ways to organize the data from Figure 1.

35. continued. Which of the following statements is MOST APPROPRIATE in regard to figures 1 and 2 above?

A. Alternative 2 shows more parsimony than does Alternative 1.

B. The Lamprey and the Lizard are the oldest because they have the longest line.

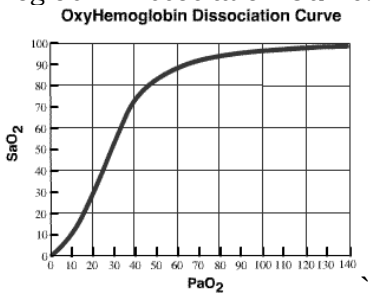
C. The four groups shown in Figure 1 are equally related as they are all at the same horizontal level.

D. X, Y and Z are characteristics common to all groups.

E. the Lamprey is more closely related to the Shark than to the Salmon or Lizard.

2006 Semi-Final Exam
Part B: Section 1
Cell Biology

Consider a standard Oxyhemoglobin Dissociation Curve.



36. Given the following possibilities, which of these are appropriate in describing why the curve has its particular shape? (Choose A, B, C, or D) (3 points)

i. binding of one ligand to a hemoglobin subunit increases the probability of binding of the remaining subunits
ii. binding of one ligand to a hemoglobin subunit inhibits the probability of binding of the remaining subunits
iii. there is increasing oxygen loading affinity at progressively higher PO2
iv. there is decreased oxygen loading affinity at progressively higher PO2
v. suggests that hemoglobin has multiple binding sites

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

37. Chloroplasts and mitochondria are similar in certain respects. Given the following characteristics, which are common to both chloroplasts and mitochondria? (Choose A, B, C, D, or E) (4 points)

i. both are single-membrane bounded structures
ii. both are double-membrane bounded structures
iii. both undergo reactions that are primarily oxidative in nature
iv. both have similar, although not identical, electron transfer systems
v. both contain ribosomes
vi. both undergo reactions that are primarily reductive in nature
vii. both contain DNA and RNA
viii. both undergo chemiosmosis

A. i, iii, v, vii, and viii only
B. i iv, vi, vii and viii only
C. ii iv, v, vii and viii only
D. ii, iii, vi , vii, and viii only
E. ii, iv, vi, vi, and viii only

38. Consider the following data:

The maximum rate of photosynthesis of green plant is about 20 mg glu/dm^{-2}/hr^{-1}
The heat of combustion of glucose is approximately 686 Kc/mole
The gram molecular weight of glucose is 180gm.

How much energy (Kcal/m) could be made over a 12 hr lighted period, by a green plant having a total leaf surface area of 2000 dm^{-2}? (3 points)

A. 183.2 Kc
B. 1832 Kc
C. 1524.4 Kc
D. 916 Kc
E. 9.16 Kc

If 1 dm^{-2} make 20 mg of glucose in 1 hour then 2,000 dm^{-2} (20mg x 2,000 dm^{-2}) would make 40,000 mg or 40 gm of glucose. In 12 hours this amount of leaf tissue would make (40gm x 12hr) 480 gm of glucose. 480 gm of glucose is (480gm/ 180gm) approximately 2.67 moles of glucose. Thus if 1 mole of glucose releases 686 Kc/mole then 2.67 mole (2.67 x 686 Kc/mole) would release 1,832 Kc of energy.

39. There is a large difference in pH across the thylakoid membrane between the thylakoid compartment and the stroma. From the list given below, choose those that are appropriate in explaining the difference. (Choose A, B, C, or D) 3 points

i. the transport of protons into the thylakoid compartment by the electron transfer system
ii. the transport of protons out of the thylakoid compartment into the stroma by the electron transfer system
iii. protons splitting from water remaining in the thylakoid compartment
iv. protons splitting from water exiting the thylakoid compartment
v. the removal of hydrogen from the stroma during the reduction of NADP to NADPH
vi. the retention of hydrogen in the stroma during the reduction of NADP to NADPH

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

Questions 40 to 49 refer to the information given below:

The appropriate functioning of the electron transport system in mitochondria is essential to the life of aerobic organisms. However, a variety of compounds can in one way or another inhibit this system. Given below are a list of such inhibitors and their mode of action. (10 points)

Rotenone – blocks NADH dehydrogenase in Complex 1
Oligomycin – blocks ATP synthase
Dinitrophenol – an uncoupling agent- loss of coupling between H^+ and ETC
Atractyloside – block transport of ADP in and ATP out of the mitochondrial matrix
Valinomycin – carries potassium or rubidium ions across the membrane

These actions can have an effect on oxygen consumption either by causing a higher or a lower consumption. For each of the following inhibitors choose the appropriate effect.

40. Rotenone
- **A. higher oxygen consumption**
- B. lower oxygen consumption

41. Oligomycin
- A. higher oxygen consumption
- **B. lower oxygen consumption**

42. Dinitrophenol
- **A. higher oxygen consumption**
- B. lower oxygen consumption

43. Atractyloside
- A. higher oxygen consumption
- **B. lower oxygen consumption**

44. Valinomycin
- A. higher oxygen consumption
- **B. lower oxygen consumption**

These actions can also effect hydrogen ion transport or the nature of the H^+ gradient. For each of the following inhibitors choose the appropriate effect.

45. Rotenone
- **A. increased hydrogen gradient**
- B. decreased hydrogen gradient

46. Oligomycin
- **A. increased hydrogen gradient**
- B. decreased hydrogen gradient

47. Dinitrophenol
- **A. increased hydrogen gradient**
- B. decreased hydrogen gradient

48. Atractyloside
- A. increased hydrogen gradient
- **B. decreased hydrogen gradient**

49. Valinomycin
- **A. increased hydrogen gradient**
- B. decreased hydrogen gradient

50. In angiosperms a spore differs from a seed in a variety of ways. Given below is a list of possible ways this occurs. TLH – PLANT ANATOMY/PHYSIOLOGY – 5 POINTS

i. A spore is haploid, a seed has both haploid and diploid tissue

ii. A spore is diploid, a seed is haploid.
iii. A spore is the consequence of meiosis, a seed the consequence of fertilization
iv. A spore develops into a gametophyte, a seed develops into a new sporophyte
v. A spore develops into a sporophyte, a seed develops into a gametophyte
vi. A spore is unicellular, a seed is multicellular (more complex: embryo, endosperm, seed coat)
vii. A spore contains little or no stored food, a seed contains stored food (endosperm)

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

ANIMAL ANATOMY/PHYSIOLOGY – 29 POINTS

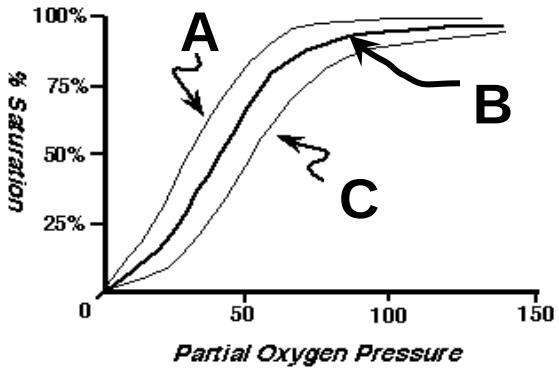
Question 51 to 55 refer to the information below.
A 22 year old man weighing 70 kg has an episode of gastroenteritis with acute vomiting and diarrhea. Over 24 hours he loses 2 kg of body weight. A blood sample shows that his plasma concentrations of sodium and potassium are normal (145 mEq/L and 4 mEq/L respectively). Indicate whether the following parameters are currently increased, decreased or unchanged as a result of this illness. Choose one answer for each condition**. Animal Physiology/ MDKA 5 points**

A. unchanged
B. increased
C. decreased

51. Plasma osmolality: **(A - unchanged)**
52. Plasma ADH (anti-diuretic hormone **(B - increased)**
53. Urine osmolality: **(B - increased)**
54. Sensation of thirst: **(B - increased)**
55. Extracellular fluid volume: **(C - decreased).**

Questions 56 to 60 refer to the chart below.

OXYGEN-HEMOGLOBIN DISSOCIATION CURVES



Given the above three oxygen-hemoglobin dissociation curves – A , B, or C – indicate for each of the following which of the three (A, B or C on answer key) best fits the condition stated. Animal physiology/ MDKA 5 points

56. Expected curve for a decrease in H+ ions **(basic pH – A)**

57. Expected curve with a body temperature of 38.5° C **(increase body temperature – C)**

58. Expected curve with carbon monoxide exposure - a competitive inhibitor for DPG. **(DPG shifts curve to the right, therefore with an inhibitor it will go left or A)**

59. Expected curve for pH 7.4 **(normal pH and conditions therefore – B)**

60. Expected curve for carbon dioxide exposure **(respiratory acidosis as the bicarbonate/Hb buffering system is forced to the left therefore – C)**

A Virtual Experiment: Questions 61 to 65

A confluent layer of macrophage cells are grown in two (2), 25 cm^2 tissue culture flasks with appropriate medium containing 10% plasma serum. For the experiment all medium is removed from the flask and the cells are washed with appropriate buffers to remove all traces of serum and media. *E. coli* bacteria, suspended in serum free media, are then added or "fed" to the macrophages. The process of *E. coli* death from phagocytosis was then studied.

61. It is necessary in a phagocytosis study to remove the serum because: (3 pts MDKA)

A. The complement proteins would have independently killed the bacteria.

B. The B cells would have independently killed the bacteria.

C. The natural killer cells would have independently phagocitized the bacteria.

D. Serum proteins would have inhibited the membrane attack complex (MAC).

E. Serum proteins would have inhibited the MHC complex.

After 30 minutes the cells in flasks in tissue culture flask one (1) and two (2) are washed with appropriate buffers to remove all *E. coli*. Serum free media is added and the flasks incubated.

62. The macrophage cell notifies other cells of an immunological invader by: 4 pts MDKA

i. up-regulating expression of MHC I molecules upon activation.
ii. up-regulating expression of MHC II molecules upon activation.
iii. interacting with the complement system.
iv. acting as an antigen presenting cell.
v. inactivating viruses once they enter the macrophage.
vi. decreasing enzymatic production
vii. increasing enzymatic production

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

63. During incubation the macrophage and microbe are at war. Which statement is true. 3 pts MDKA

A. The macrophage digests the E. coli through the oxidative burst.
B. The E. coli protects itself through the oxidative burst.
C. The oxidative burst is characterized by an increased production of hydrogen peroxide.
D. The oxidative burst results in the formation of a Membrane Attack Complex.
E. A and C

The macrophages are then lysed by adding ice cold water. The lysed macrophages and water are then centrifuged and the bacteria isolated from the macrophage debris. The bacteria were suspended, diluted and plated on agar. After 90 minutes the same procedure was followed for tissue culture flask 2 and the bacteria were again plated. Bacterial plates 1 and 2 were incubated for 24 hours.

64. Why were the macrophages lysed with a brief exposure to ice cold water and not the *E. coli*? 2 pts MDKA

A. Rapid cold-shock results in osmotic lysis.
B. Gram positive bacteria are impervious to osmotic insult.
C. The membrane lipid bilayer is impermeable to water.
D. Lysis occurs only with eukaryotic cells.
E. Cell walls limit osmotic lysis.

65. When you compare bacteria plate 1, (45 minutes) and bacteria plate 2 (90 minutes) you would predict: 3 pts MDKA

A. equal colonies on plate 1 and 2
B. no colonies on plate 1
C. no colonies on plate 2
D. more colonies on plate 1 then plate 2
E. more colonies on plate 2 than plate 1

66. During an adult thyroidectomy the parathyroids are often removed and transplanted under the skin under the clavicle. Assume the patient takes and is responsive to all thyroid replacement medications. However, if the <u>parathyroid</u> transplant fails, possible physiological consequences are: 4 points

i. erratic heart rate at rest
ii decreased vitamin D metabolism
iii increased rate of carbohydrate absorption

iv. muscle weakness
v. goiter
vi. osteoporosis
vii. iodine deficiency

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

ETHOLOGY – 6 Points

Questions 67 to 72 refer to the following information:

An ecological community is defined as a group of actually or potentially interacting species living in the same place. A community is bound together by the network of influences that species have on one another. For each of the following types of interspecific and/or intraspecific interactions (left column) match with the letter for the appropriate the sign and effect, noted in the box, below. (W.T.S. 6 points)

LETTER	SIGN	EFFECT
A	+/+	both species benefit from interaction
B	+/0	one species benefits, one unaffected
C	-/-	each species affected negatively
D	+/-	one species benefits, one is disadvantaged

type of interaction

67. herbivory ___**D**___
68. mutualism ___**A**___
69. parasitism ___**D**___
70. competition ___**C**___
71. predation ___**D**___
72. commensalism ___**B**___

GENETICS/EVOLUTION – 23 POINTS

Questions 73 to 75

Twenty spontaneous white-eyed (w) mutants of Drosophila are examined individually to determine their reversion frequencies. Of these 12 revert spontaneously at a frequency of 10^{-3} to 10^{-5} (Class A). Another 6 do not revert spontaneously at a detectable frequency but can be induced to revert at frequencies ranging from 10^{-5} to 10^{-6} by treatment with alkylating agents (Class B). The remaining 2 cannot be made to revert under any conditions (Class C). Indicate the most appropriate choice for each of the following:

73. Which class of mutants are probably missense mutations? (A.B. – 3 points)
A. Class A
B. Class B
C. Class C

74. Which class of mutants are probably deletions?

A. Class A
B. Class B
C. Class C

75. Which class of mutants would you suspect to result from the insertion of transposable elements?

A. Class A
B. Class B
C. Class C

Question 76 to 81 refer to the following information.

In *Drosophila*, a cross (Cross 1) is made between two mutant flies, one homozygous for the recessive mutation bent wind (*b*) and the other homozygous for the recessive mutation eyeless (*e*). The mutations *e* and *b* are alleles of two different genes that are known to be very closely linked on the tiny autosomal chromosome 4. All the progeny of this cross exhibited the wild-type phenotype for both traits. One of the female progeny was crossed to a male of genotype *b e/b e* (Cross 2). The progeny of Cross 2 were mostly of the expected types, but there was a single rare female that was wild-type for both traits. **(A.B. – 6 points/ 1 for each question)**

76. What is the genotype of the progeny from cross 2?

A. $b^+ e^+/b$ e and b $e^+/$ b e
B. b e^+/b^+ e and b^+ e/ b e^+
C. **b e^+/b e and b^+ e/b e**
D. b e^+/b e^+ and b^+ e/ b e

77. Could the rare wild-type female from cross 2 have arisen by: crossing-over?

A. Yes
B. No

78. Explanation of answer to question --- above

A. would result in a gamete that was b^+ e^+
B. would result in a gamete that was b e
C. would result in a gamete that was b^+ e
D. would result in a gamete that was b e^+

79. Could the rare wild-type female from cross 2 have arisen by: Non-disjunction?

A. Yes
B. No

80. Explanation of answer to question ---

A. would result in a gamete that was b^+ e^+/b e
B. would result in a gamete that was b^+ e/b e^+
C. would result in a gamete that was b e^+/ b^+ e
D. would result in a gamete that was b e/b^+ e^+

81. The rare wild-type female from cross 2 (above) was test crossed to a male of genotype *b e/b e* (Cross 3). The progeny were as follows:

1/6 wild type
1/6 bent, eyeless
1/3 bent
1/3 eyeless

Which of the explanations given in questions 76-80 above are compatible with this result?

A. The female must have been a product of nondisjunction
B. The female must have been a product of crossing-over

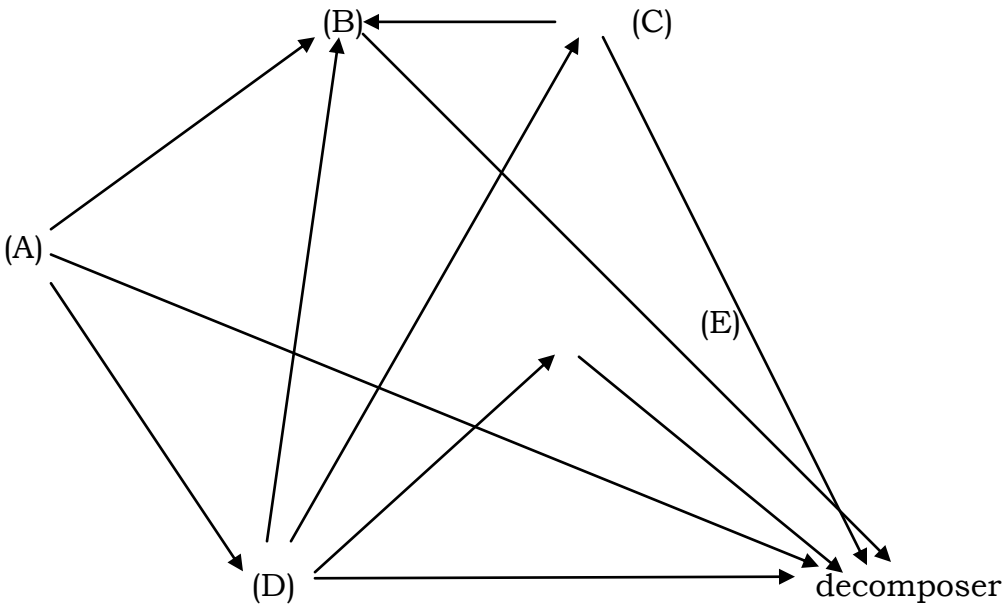
82. The frequency of an allele *A* in a population is 30%. Assuming a two-allele system, a) what is the frequency of the *a* allele and b) what are the frequencies of all possible genotypes in this population? (2 points)

A. 0.7 – AA = 0.09; Aa = 0.42; aa = 0.49
B. 0.3 – AA = 0.49 ; Aa = .42; aa = 0.09
C. 0.6 – AA = 0.16; AA = 0.58; aa = 0.36

ECOLOGY – 11 POINTS

Questions 83 to 87 refer to the figure below.

The figure below represents a food web in a particular ecosystem. Each letter represents a species. The arrows indicate the direction of energy flow. Place the proper letter or letters to the left of statements 1 – 5. TLH – ECOLOGY – 5 POINTS



83. Which species would most likely represent a primary producer?

84. Which species would most likely represent humans if they were part of this ecosystem?

85. Which species is (are) most likely to be an herbivore?

86. Which species is (are) most likely to be a carnivore?

87. Which species is (are) most likely to be an omnivore?

ANS. 1-A; 2-B; 3-D; 4-C & E; 5-B

Questions 88 to 89 refer to the following paragraph.

In Argentina at 32˚ S latitude there are deserts east of the Andes Mountains. In Chile at 18˚ S latitude there are deserts west of the mountains in. Select from the following list of explanations those that best explain these two situations. **(6 POINTS / 3 each)**

i. easterly winds
ii. westerly winds
iii. descending dry air masses
iv. ascending dry air masses
v. rain shadow on east side of mountain
vi. rain shadow on west side of mountain

88. Argentina deserts mentioned above are most likely the result of:
A. i, iv and v only
B. i, iii, and vi only
C. ii. iii, and v only
D. ii, iv and vi only

89. Chile deserts mentioned above are most likely the result of:
A. i and v only
B. i and iv only
C. ii and v only
D. ii and iv only

BIOSYSTEMATICS – 6 POINTS

Questions 90 to 93 refer to following

Given below is a list of features select the letter or letters associated with each of the category boxes given in the table.

FERTILIZATION	ORGANS OF RESPIRATION
i. Internal ii. External	iii. Gills iv. Air sacs v. Skin vi. Lungs

Consider the following groups of organisms and indicate the most appropriate feature or features to describe fertilization and the organ(s) of respiration. (4 Points)

90. Mammals

A. i, v and vi only
B. i, and vi only
C. i and v only
D. ii and vi only
E. i., ii and v only

91. Birds

A. i and vi only
B. i, and vi only
C. i and v only
D. ii and v only
E. i, v and vi only

92. Amphibians

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

93. Fishes

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

PART C

1. Match the following evolutionary terms with their definitions, placing the letter of the appropriate match in the blank provided to the left of each term. Each choice will be used and will be used only once.

_____. Adaptive radiation	A. A body structure switching from one function to another
_____. Allopatric speciation	B. A juvenile trait being retained into adulthood
_____. Convergent evolution	C . A single population of a species diverging into two species
_____. Divergent evolution	D. A species giving rise to morphologically distinct species
_____. Evolutionary trend	E. Development of an entirely new body form or structure
_____. Extinction	F. Distantly related species coming to look superficially alike
_____. Iterative evolution	G. Isolated populations of a species becoming

different species

_____. Macroevolution — H. Long-term evolutionary change in the same direction

_____. Microevolution — I. One lineage "quickly", in an evolutionary sense, giving rise to many descendant species

_____. Neoteny — J. One lineage repeatedly giving rise to similar descendants

_____. Preadaptation — K. Small-scale evolutionary changes in a lineage

_____. Sympatric speciation — L. The death of all members of a species

ANSWERS:

I
G
F
D
H
L
J
E
K
B
A
C

2. Beginning with CO_2 and H_2O, write a)one or more formula that would adequately represent the pH buffering system in the blood and b) a formula that will illustrate the way in which hemoglobin binds with oxygen in the blood. c) Draw a saturation curve relating oxygen saturation of Hb to the partial pressure in the blood. Be certain to label correctly your x and y axes and describe why you drew the curve as you did.

a) $CO_2 + H_2O \leftrightarrow H_2CO_3$
$H_2CO_3 \leftrightarrow H^+ + HCO_3^-$ **3 points**
$HCO_3^- \leftrightarrow H^+ + CO_3^{2-}$

b) $HbH + 4O_2 \leftrightarrow Hb(O_2)_4 + H^+$ **1 point**

Additional biosystematics question.

3. Some zoologists have placed the sponges into the subkingdom Parazoa. Provide below two valid reasons they might have for doing so. **2 points**

ANS:

No true tissues
Do not produce germ layers ***these three get at the same point –***
Cellular level of organization ***accept only one***

Unique feeding system (no "mouth")

4. This is fill in the blank. Each answer if 0.5 points. Write in the test book.

Character	**Magnoliopsida**	**Liliopsida**
Cotyledons (number)		
Leaf Venation (type)		
Vascular Cambium (present or absent		
Primary Vascular Bundles (arrangement)		
Pollen (type)		
Floral Parts (number in each set)		
Root System (type or types)		
Pith in Roots (yes or no)		

Number of Xylem Points in Root		
Pericycle (number of layers)		
Mesophyll (nature of)		

OPTIONAL: List 5 ways that chloroplasts and mitochondria are similar. **5 points**

a) **both double-membrane structures**

b) **both have similar, but not identical electron transfer systems**

c) **similar RNA and DNA**

d) **similar ribosomes**

e) **both undergo chemiosmosis**

Congratulations on being a semi-finalist!