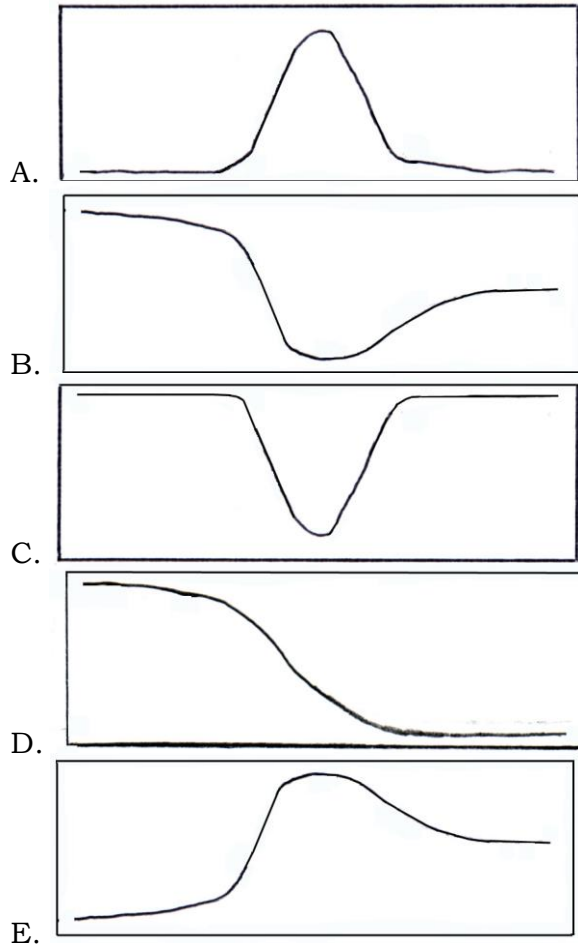


## 2008 SEMIFINAL EXAMINATION PART A

1. Which of the following graphs correctly displays the relationship of blood flow velocity in humans as blood flows from the aorta → arteries → arterioles → capillaries → venules → veins → venae cavae?



Questions 2 and 3 refer to the diagram shown below. The diagram illustrates feedback loops. Increased or decreased stimulation is indicated by + or —.

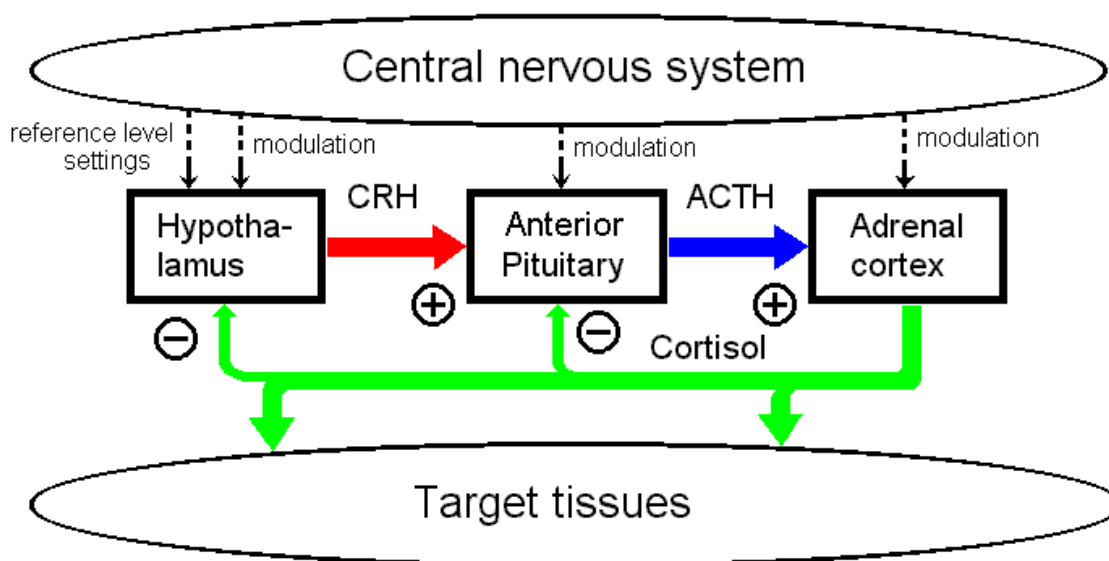


Fig 1. Structure diagram of the HPA axis

2. Which of the following would lead to a **DECREASE** in activity of the Anterior Pituitary gland?
  - A. A lack of receptors for Cortisol on the Hypothalamus.
  - B. A lack of receptors for Cortisol on the Anterior Pituitary.
  - C. Intravenous injection of a large amount of ACTH.
  - D. A tumor in the Hypothalamus causing it to secrete excess Corticotropin-Releasing Hormone.
  - E. Increased sensitivity of the Anterior Pituitary to Corticotropin-Releasing Hormone.
  
3. What would happen if the Adrenal Cortex was artificially stimulated to produce large amounts of Cortisol?
  - A. Less Corticotropin-Releasing Hormone would be released.
  - B. More ACTH would be released.
  - C. The activity of the Hypothalamus would increase.
  - D. The activity of the Anterior Pituitary would increase.
  - E. The Hypothalamus would become insensitive to Cortisol.

4. When a four-cell *Xenopus* embryo is divided into ventral and dorsal halves, the half containing the Nieuwkoop center will develop:
- A. ventralized features.
  - B. as a normal embryo.
  - C. without endoderm.
  - D. only to the 8-cell stage.
  - E. dorsalized features.
5. Insulin release results in all of the following physiological effects EXCEPT:
- A. up-regulation of glucose transporters in liver cells.
  - B. increased fat production from glycerol and fatty acids in adipose tissue.
  - C. inhibition of glycogen phosphorylase.
  - D. activation of glycogen synthase.
  - E. decreased glycogen stores in liver cells.
6. All of the following are stimulated by the sympathetic nervous system EXCEPT:
- A. increased heart rate.
  - B. increased secretion of the sweat glands.
  - C. dilation of the pupil.
  - D. constriction of blood vessels.
  - E. increased peristalsis in the gastrointestinal tract.
7. Concentration of urine is essential to the survival of many vertebrates. Which class of vertebrates would you expect does NOT use this mechanism for homeostasis?
- A. Aves
  - B. Lepidosauria
  - C. Mammalia
  - D. Osteichthyes
  - E. Testudines
8. In the genetic pathway containing genes A, B, and C, gene A negatively regulates gene B, which in turn negatively regulates gene C. If a loss-of-function mutation were introduced into gene B, what would be the resulting effect on the expression of gene C?
- A. Decreased expression of gene C.
  - B. No effect on expression of gene C.
  - C. Changes in expression levels of gene C would be the same as those for gene A.
  - D. Increased expression of gene C.
  - E. Changes in expression levels of gene C would be the same as those for gene B.

9. In terms of the MN blood group, assume there are 72 people with the genotype MM, 96 people with the genotype MN, and 32 people with the genotype NN. What is the frequency of the M allele?
- A. 0.12
  - B. 0.32
  - C. 0.60
  - D. 0.72
  - E. 0.80
10. Certain amino acids are considered essential in an animal's diet because they cannot be produced within the organism. Which of the following cellular processes would be most IMMEDIATELY affected by a dietary deficiency in essential amino acids?
- A. Cell division
  - B. Cellular respiration
  - C. Translation of mRNA
  - D. Replication of DNA
  - E. Oxygen transport
11. Both insects and vertebrates have hinged jaws. While the jaws serve the same general purpose, they evolved from different structures in the two groups. Such a situation is an example of:
- A. punctuated equilibrium.
  - B. hybrid vigor.
  - C. homology.
  - D. divergent evolution.
  - E. convergent evolution.
12. Infection with *Giardia* can cause degeneration of the intestinal villi. Which of the following is most likely to occur following a serious *Giardia* infection?
- A. An inability to produce insulin
  - B. An increase in the rate of carbohydrate digestion
  - C. A reduction in nutrient absorption from the small intestine
  - D. A reduction in bile production and storage
  - E. An increase in blood pressure
13. A person is infected by a bacterial pathogen. Which of the following would be the typical physiological response to that infection?
- A. B cell activation
  - B. Cytotoxic T cell activation
  - C. A decrease in body temperature
  - D. Rapid mitotic division in cells in contact with the bacterium
  - E. Release of interferon

**14. Which of the following cell types would you expect to be abundant in ER and Golgi Bodies?**

- I. Adipose cells**
- II. Islet of Langerhans cells**
- III. Plasma B cells**
- IV. Red blood cells**

- A. I only
  - B. III only
  - C. I and II only
  - D. II and III only
  - E. I, II, III, and IV
- 15. How do polypeptides find their way from the site of synthesis on the cytoplasmic ribosome to the place of their destination in the peroxisome?**

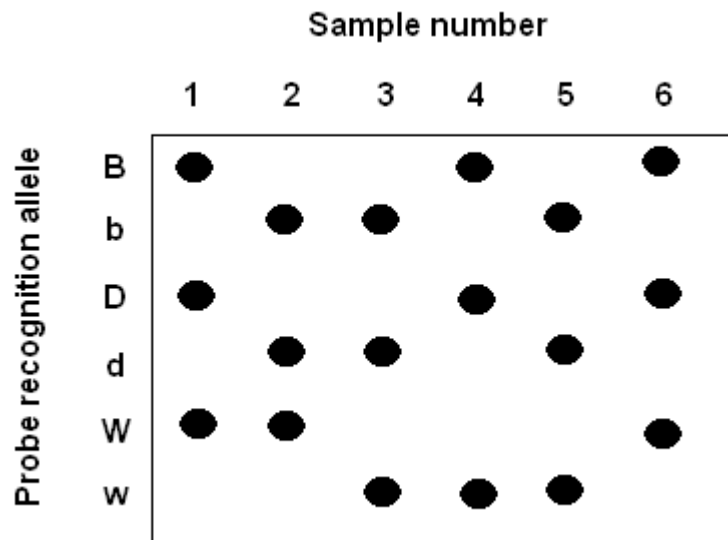
- A. Without signals
  - B. By specific transport along the cytoskeleton
  - C. By specific carboxy-terminal targeting signals
  - D. By specific vesicular transport
  - E. By transport within the ER
- 16. Which of the following combinations have only primary walls in a mature plant?**

A	Vessels members	Meristematic cells	Parenchyma cells
B	Collenchyma cells	Fibers	Sieve tube member
C	Sclereids	Collenchyma cells	Sieve cells
D	Meristematic cells	Tracheary elements	Collenchyma cells
E	Sieve elements	Meristematic cells	Collenchyma cells

**17. A day in the sun will expose your skin to UV light. Which is NOT true about the resulting DNA damage/repair pathway?**

- A. UV exposure will cause single bonded cross-linked thymine-thymine dimers which severely distort the phosphate backbone.
- B. UV exposure will cause double bonded perpendicular thymine-thymine dimers which kink the phosphate backbone.
- C. Photolyase will repair DNA damage by using energy from UV light to break open thymine dimers.
- D. During replication of damaged DNA, a single base pair deletion will be found on the newly synthesized DNA strand opposite to the thymine dimer site.
- E. UV exposure only causes heritable mutation after the action of nucleotide excision repair machinery.

18. Three different genes (B, D, and W) are found on a small region of chromosome 1. Each gene has two alleles. In order to determine the recombination frequency between these three genes, sperm were isolated from a male heterozygous for all three genes. The male had all dominant alleles on his maternal copy of chromosome 1, but only recessive alleles on his paternal copy of chromosome 1. Each sperm was isolated individually and PCR amplified in the BDW region. The amplified products were spotted on a nitrocellulose membrane and radioactive allele specific probes were hybridized with the samples. The resulting autoradiograph is shown below where a dark spot indicates successful hybridization of the probe with the membrane.



What is the recombination frequency between B and W?

- A. 1/4
  - B. 1/3
  - C. 1/2
  - D. 5/6
  - E. 1
19. Which of the following is not an activity of DNA polymerase?
- A. 5' to 3' endonuclease
  - B. 3' to 5' endonuclease
  - C. 5' to 3' exonuclease
  - D. 3' to 5' exonuclease
  - E. All are possible activities

- 20. You order a degenerate probe designed from the following hemoglobin protein sequence:**

Trp –	Gly –	Lys –	Val –	Asn
TGG	GGC	AAA	GTC	AAT
	T	G	T	C
	A		A	
	G		G	

**How many different probe sequences would be returned to you? How many would be specific to your gene of interest?**

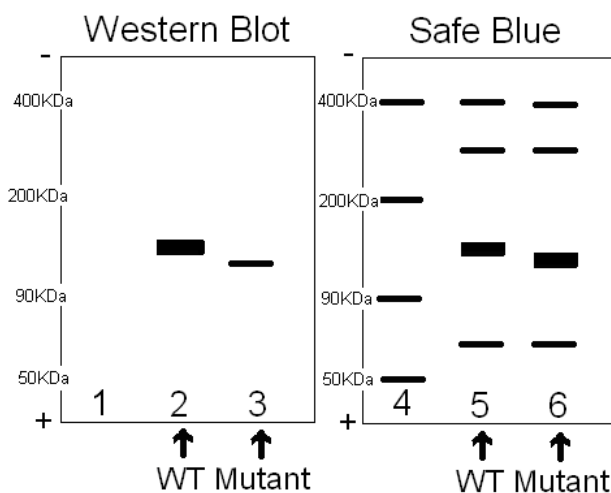
- A. 64 total, 5 specific to gene
  - B. 25 total, 5 specific to gene
  - C. 64 total, 1 specific to gene
  - D. 25 total, 1 specific to gene
  - E. 32 total, 1 specific to gene
- 21. In a laboratory, stems and roots of different plants were sectioned and slides were produced. When putting the slides into a box, they became mixed up. Which of the following cross sections corresponds to a primary root of Magnoliopsida?**

A	Epidermis	Cortex	Bicollateral bundles	Pith
B	Epidermis	Cortex	Pericycle	4 xylem strands alternate with 4 phloem strands
C	Periderm	Secondary Phloem	Cambium	Secondary Xylem
D	Epidermis	Cortex	Pericycle	20 xylem strands alternate with phloem
E	Epidermis	Sclerenchyma	Scattered vascular bundles	Hollow pith

- 22. In the Magnoliophyta, the nutritive function for growth of the pollen tube is performed by the:**

- A. body cell.
- B. endosperm
- C. megasporangium.
- D. megagametophyte.
- E. style.

Questions 23-24 refer to the following information and figure. You identify a mutant protein of transferrin. You purify both mutant and wild-type transferrin from two separate bacterial cell lines. You run two SDS-PAGE gels with identical samples and develop one with Coomassie Blue (Safe Blue). You follow a western blot and development procedure on the other gel using a primary antibody to transferrin that conjugated to a fluorescent molecule.



**23. What is the approximate molecular weight of mutant transferrin?**

- A. About 180 KDa
- B. About 130 KDa
- C. About 300 KDa
- D. About 90 KDa
- E. Impossible to determine from the information provided.

**24. Which of the following reasons most likely explains why the transferrin band in lane 2 is darker than the band in lane 3?**

- A. The mutant band in lane 3 is not transferrin.
- B. The fluorescent compound binds more efficiently to wild-type transferrin than to mutant transferrin.
- C. Mutant transferrin has a similar, but not identical epitope to the primary antibody.
- D. You added too much fluorescent antibody in lane 2.
- E. There is less mutant transferrin than wild-type transferrin.

**25. Which taxon has the largest number of species within its circumscription?**

- A. Liliopsida
- B. Magnolia
- C. Magnoliaceae
- D. Magnoliidae
- E. Magnoliopsida



- 26. A plant population that reproduces annually was found on a remote oceanic island. Two flower-color variants are present, red and blue. Flower color is known to be a monogenic trait. The frequencies of the two flower colors were observed annually over a ten year period. It was noted the proportion of plants with blue flowers steadily declined each year. From these data, it may reasonably be concluded that:**
- A. the increased frequency of red-flowered plants was a result of genetic drift.
  - B. migration of red-flowered plants into the population was the most likely cause of the observed change.
  - C. mutation occurred more frequently in red-flowered plants than in blue-flowered plants.
  - D. blue-flowered plants had a lower genetic fitness than the red-flowered plants.
  - E. red-flowered plants were capable of crossing with other red-flowered plants or with blue-flowered plants but blue-flowered plants could only cross with other blue-flowered plants.
- 27. Uniformitarianism is part of the intellectual foundation that Darwin used to develop his theory of evolution. What was this idea?**
- A. Natural processes today are the same as they have always been.
  - B. All species evolved from a uniform ancestor.
  - C. All creatures have a uniform genetic code.
  - D. All natural processes change at a uniform rate over time.
  - E. All creatures have uniform rates of mutation.
- 28. All known organisms transcribe genetic information into protein molecules via the same genetic code. This finding strongly supports the hypothesis that:**
- A. there is only one possible way to encode information in a macromolecule.
  - B. the earliest macromolecules probably arose when lightning struck an oxygen-free atmosphere.
  - C. all organisms are descended from a single common ancestor.
  - D. the genetic code will never be broken.
  - E. life arose at many different times in many different ways.
- 29. Sugars are converted to sucrose and transported out of leaf cells. Some of that sucrose is transported into the roots where it moves into root cells. In these cells it is converted to starch by which of the following organelles?**
- A. Peroxisomes
  - B. Lysosomes
  - C. Glyoxysomes
  - D. Mitochondria
  - E. Plastids

- 30. You find a small isolated group of flowering plants, all of which have red flowers. When you conduct literature research on the plant you find it can produce either red or white flowers, with red being completely dominant to white. You therefore conclude that the parents of the plants you found could have had which of the possible genotypes for flower color?**
- A. AA , AA
  - B. AA, Aa
  - C. Aa, Aa
  - D. AA, aa
  - E. All of the above are possible.
- 31. Of the following statements that compare and contrast the processes of mitosis and meiosis, which is (are) biologically appropriate?**
- A. Both mitosis and meiosis reduce ploidy by half.
  - B. Daughter cells in mitosis are generally genetically identical to parental cells, whereas daughter cells in meiosis are generally different from parent cells.
  - C. The primary significance of these two processes is that mitosis generally results in daughter cells having the same number of chromosomes as the parent cell, whereas meiosis generally reduces the chromosome number by half as compared to the parent cell.
  - D. Both B and C are appropriate.
  - E. All of the above are appropriate.
- 32. Some C<sub>4</sub> plants have decreased photorespiration and efficient photosynthesis and thus:**
- A. increase stomatal openings and thereby increase water loss.
  - B. decrease stomatal openings and thereby reduce water loss.
  - C. increase stomatal openings and thereby increase leaf temperature.
  - D. decrease stomatal openings the thereby reduce leaf temperature.
  - E. increase stomatal openings and thereby increase the rate of transpiration.
- 33. It is thought that in the phloem of certain plants, companion cells provide metabolic energy for the transport of substances into and out of the sieve tube cells. Which of the following statements would best support this assumption? There is (are):**
- A. an abundance of rRNA in the sieve-tube members.
  - B. no plasmodesmata between sieve-tube members and companion cells.
  - C. low rates of respiration in companion cells.
  - D. an abundance of mitochondria in companion cells.
  - E. low rates of translocation at low temperatures.

34. Which of the following accurately describes the sigmoid growth curve typical of controlled population growth restricted by density-dependent factors?
- A.  $dN/dt = rN$
  - B.  $dN/dt = rN (K-N)/K$
  - C.  $dN/dt = Ne^{rt}$
  - D.  $N_t = N_0e^{rt}$
  - E.  $N_t = rN (K-N)/K$
35. Emigration rate of lemmings was 5% when the population was 10/ha. After the population rises to 20 lemmings/ha, the emigration rate most likely will be:
- A. 0
  - B. < 1%
  - C. 5%
  - D. 10%
  - E. > 10%
36. For populations that exhibit \_\_\_\_\_ population growth, maximum harvesting yield is achieved when \_\_\_\_\_.
- 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 proportional to the population's size
  - E. exponential, the population reaches its carrying capacity
37. Various adaptations appeared in animals in their migration to land. In the ancestor common to modern reptiles, birds and mammals, which of the following traits appeared for the first time?
- A. Protostomic development
  - B. Tetrapod limbs
  - C. Amniotic eggs
  - D. Lungs
  - E. True jaws
38. Some populations are characterized by the presence of balanced polymorphism. This condition may be maintained by all of the following EXCEPT:
- A. Balancing selection
  - B. Natural selection
  - C. Disruptive selection
  - D. Directional selection
  - E. Frequency-dependent selection

**39. Alleles  $A$  and  $a$  in a population conform to Hardy-Weinberg equilibrium. Recessive individuals for this trait represent 16 of each 100 individuals. What is the most common genotype in this population?**

- A.  $AA$
- B.  $Aa$
- C.  $aa$
- D.  $A$
- E.  $a$

**40. Which of the following plant groups is now extinct?**

- A. Seed ferns
- B. Lycopods
- C. Horsetails
- D. Tree ferns
- E. Hornworts

## **2008 SEMIFINAL EXAMINATION PART B**

**FOR QUESTIONS 41-116, USING THE INFORMATION PROVIDED AND YOUR OWN KNOWLEDGE OF BIOLOGY, DETERMINE WHETHER THE STATEMENTS ARE ACCEPTABLE (A) OR UNACCEPTABLE (B). EACH QUESTION WILL HAVE A VALUE OF ONE-HALF POINT.**

**Of the following statements (41-44) concerning Sertoli cells, indicate if the statement is acceptable (A) or unacceptable (B).**

- 41. They are located in the testis.**
- 42. They react to endocrine signals.**
- 43. They react to autocrine signals.**
- 44. They contain tight junctions.**

**(Questions 45-48) The Aba family has a history of a recessive hereditary disease known to be caused by a large deletion on chromosome 17. Janet Aba is a carrier of the disease. She marries Joey Kea and they want to determine whether or not Joey is a carrier before starting a family. Which of the following are acceptable screening methods the diagnostic center could employ to determine Joey's genotype at this position (A) and which would not be an acceptable screening method (B)?**

- 45. UV light absorbance of DNA samples**
- 46. DNA sequencing of erythrocytes**
- 47. Gel electrophoresis on acrylamide of DNA fragments**
- 48. Direct sequencing of amplified chromosome 17 DNA**

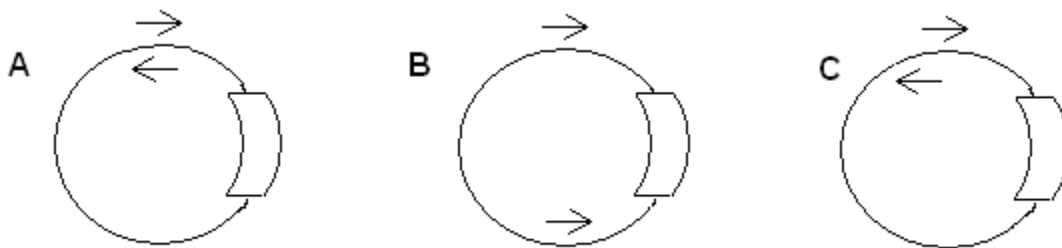
**(Questions 49-52) Determine whether or not each of the following is an acceptable statement concerning HIV. Acceptable (A) or Unacceptable (B)**

- 49. HIV binds to receptors on human leukocytes.**
- 50. The HIV genome encodes for its own reverse transcriptase.**
- 51. Death from HIV (and ultimately AIDS) is caused by progressive loss of B-cells.**
- 52. The best HIV drug targets are in the viral coat proteins, because they are the least susceptible to mutation.**

(Questions 53-56) Of the following statements, which would be acceptable (A) for why primase incorporates RNA primers onto the replicating DNA? Mark all unacceptable statements as B.

53. DNA polymerase can only start adding nucleotides to a molecule containing a 2' hydroxyl.
54. RNA primers allow the DNA polymerase to bind to begin replication.
55. The 2'hydroxyl of RNA functions as a signal indicating that this newly synthesized region has not been proofread.
56. RNA is synthesized in the 3' to 5' direction allowing DNA to be synthesized in the 5' to 3' direction.

(Questions 57-59) The following diagrams indicate a piece of DNA (the circular region), a gene (the boxed region), and a primer set (the arrows). Which of the following represents a PCR primer set that would completely amplify the gene? Acceptable (A) or Unacceptable (B)



57. Set A would completely amplify the gene
58. Set B would completely amplify the gene
59. Set C would completely amplify the gene

(Questions 60–62) Cloning by hybridization often involves finding a gene implicated in a human disease by complementing the human gene with a homologous yeast gene. With that in mind, which classes of genes may be cloned in the hybridization method? Acceptable (A) or Unacceptable (B)

60. The gene responsible for sickle cell anemia.
61. The gene responsible for congenital nystagmus.
62. The gene responsible for phenylketonuria.

**(Questions 63– 65) Which of the following sequences would be recognized by a restriction enzyme? Acceptable (A) or Unacceptable (B)**

**63. TATATA**

**64. TAAAAT**

**65. TTAAA**

**(Questions 66– 68) Which of the following is (are) part of RNA processing and synthesis? Acceptable (A) or Unacceptable (B)**

**66. Polyadenylation**

**67. Transport to the nucleolus**

**68. Catalytic function of small nuclear RNA**

**(Questions 69–71) Which of the following is (are) necessary component(s) of an effective cloning vector? Acceptable (A) or Unacceptable (B)**

**69. Multiple cloning site**

**70. Intrinsic ligase**

**71. An origin of replication**

**(Questions 72–76) You perform a dissection of a pig and a chicken and discover that both have four-chambered hearts. You logically and correctly assume that: Acceptable (A) or Unacceptable (B)**

**72. early mammals possessed feathers.**

**73. birds and mammals belong to the same class.**

**74. birds and mammals are closely related in an evolutionary sense.**

**75. birds and mammals had a common ancestor with a four-chambered heart.**

**76. all vertebrates have four-chambered hearts.**

**(Questions 77-81) Mycorrhizae: Acceptable (A) or Unacceptable (B)**

**77. may transfer nutrients from one plant to another.**

**78. growth depends on nutrients obtained from the plant.**

**79. permit plants to survive in phosphorus-poor soil.**

**80. increase the absorptive surface of plants.**

**81. form nitrogen-fixing nodules on the roots of plants.**

**(Questions 82-84) Certain Ecologists state that evidence supports the following generalizations: 1) producers are limited by competition for resources, 2) primary consumers (herbivores) are limited by predation, and 3) secondary consumers (carnivores) are limited by food. If these concepts of limiting factors are accepted, then you would expect to find evidence for competitive exclusion in which of the following trophic levels? Acceptable (A) or Unacceptable (B)**

**82. Producer**

**83. Herbivore**

**84. Carnivore**

**(Questions 85–88) Rapidly changing habitats generally are favorable to: Acceptable (A) or Unacceptable (B)**

**85. small organisms.**

**86. K-selected species.**

**87. species which reproduce numerous times in their lives.**

**88. organisms which practice exploitative competition.**



**(Questions 89–91) Important controls on the ultimate outcome of competition between species pairs that have recently come together include: Acceptable (A) or Unacceptable (B)**

**89. the initial number of competitors in each species.**

**90. timing of the arrival of the members of the pair.**

**91. physical environment.**

**(Questions 92–95) Which of the following provide(s) evidence for the “intentionality” of primate alarm calls? Acceptable (A) or Unacceptable (B)**

**92. Calls are made when a predator is spotted.**

**93. Individuals are more likely to call when their offspring are present.**

**94. Males are more likely to call when females are present.**

**95. Calls are made even when the individual is alone.**

**(Questions 96–99) Which one of the following is (are) a characteristic(s) typical of mollusks? Acceptable (A) or Unacceptable (B)**

**96. Mantle**

**97. Regulative development**

**98. Radula**

**99. Trochophore larva**

**(Questions 100–108) In plant systematics, three lines of evidence may be useful in determining relationships; xylotomical (wood anatomy), embryological and palynological. Match these three with the level for which they are most useful. Acceptable (A) or Unacceptable (B)**

**Xylotomical:**

**100. Order**

**101. Family**

**102. Genus**

**Embryological:**

**103. Order**

**104. Family**

105. Genus

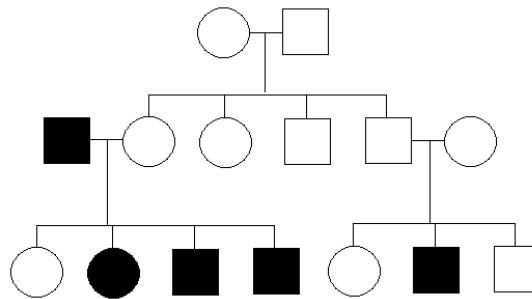
Palynological:

106. Order

107. Family

108. Genus

(Questions 109–113) The following pedigree is representative of a family with a history of Mickey Mouse syndrome, a disease causing the affected individual to speak with a high squeaky voice. Based on the pedigree shown, which of the following are possible modes of inheritance assuming complete penetrance and no spontaneous mutation? Acceptable (A) or Unacceptable (B)



109. Autosomal dominant

110. Autosomal recessive

111. X-linked dominant

112. X-linked recessive

113. Mitochondrial inheritance

(Questions 114-116) Ammonia is produced in freshwater fish during metabolic processes. Indicate for each of the following statements which is (are) acceptable (A) and which is (are) unacceptable (B) explanations for why elevated ammonia levels are dangerous to the organism.

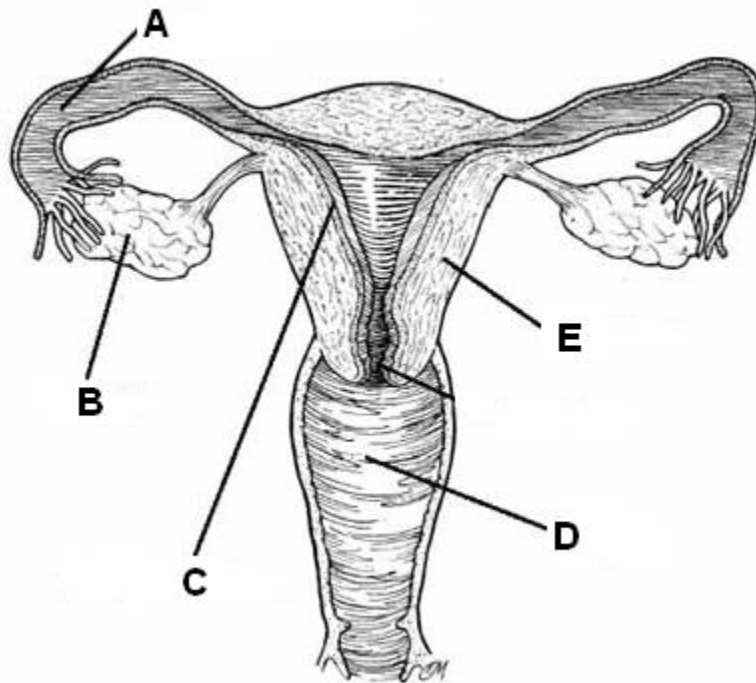
114. Ammonia can substitute for a potassium ion in ion-exchange mechanisms.

115. Ammonia can adversely affect amino acid transport.

116. Ammonia can cause a decrease in body pH which can adversely affect the tertiary structure of proteins.

**FOR QUESTIONS 117-121 MARK ALL CHOICES THAT APPLY. EACH QUESTION HAS A POINT VALUE OF 1, BUT ALL APPROPRIATE CHOICES MUST BE INDICATED TO RECEIVE CREDIT.**

**For Questions 117-119, match the structures indicated on the diagram below with their appropriate description amongst the statements that follow. Answers may be used once, more than once, or not at all. Please mark ALL answers that apply.**



- 117. Muscular contractions inside this (these) organ(s) assist in childbirth.**
- 118. Structures inside this (these) organ(s) produce estrogen in response to release of LH and FSH from the pituitary gland.**
- 119. Human embryonic development occurs in which organ(s).**

**120. Consider an autosomal recessive disease with an incidence of 1/10,000 in the general population of 100,000. Your best friend comes to you very upset because he has just taken a screening test for this disease and gotten a positive result. He is convinced he is a carrier, despite having no family history of the disease. You try to reassure him, but he says, "Don't bother. The Clinic said this test has 98% sensitivity and 90% specificity. With that level of sensitivity, it must be correct!" What is the chance your friend is NOT a carrier?**

- A. 2%**
- B. 10%**
- C. 20%**
- D. 49%**
- E. 83%**

**121. Which of the following structures or group of cells found in earthworms has similar functions to the liver of vertebrates?**

- A. Typhlosolis**
- B. Coelomocytes**
- C. Chloragog (chloragogue, chlorogogen)**
- D. Cells that line the inner surface of the small intestine**
- E. Calcium gland cells**

## 2008 SEMIFINAL EXAMINATION PART C

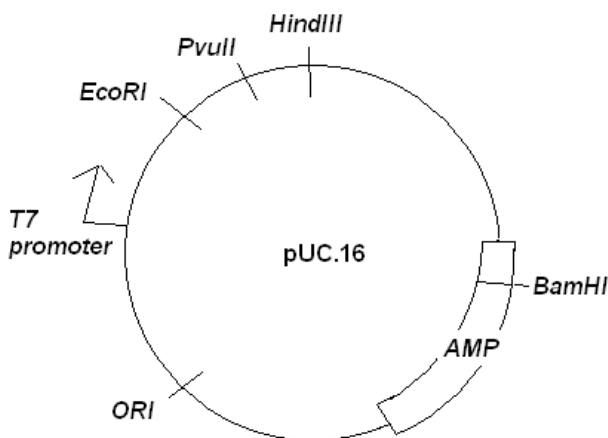
1. During the isolation of DNA, SDS may be used to dissolve the phospholipid membrane of the bacterial cells. List two other functions of SDS in molecular biology. (4 points)

a. \_\_\_\_\_

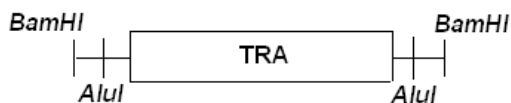
b. \_\_\_\_\_

2. You are studying the TRA gene in humans. The TRA gene is thought to be responsible for the migration behavior observed in chimps. After many weeks of cloning and isolating TRA to its coding sequence, you decide to put the coding sequence into a plasmid known as pUC.16. This pUC.16 plasmid is known to express high levels of recombinant protein and has an Amp<sup>R</sup> gene for ease of selection. The plasmid is shown below.

The version of TRA you now have is flanked on both ends by BamHI and AluI cut sites and a diagram of it is given below. Assume there are no other relevant cut sites in this gene. (7 points)



**PvuII: 5'- CAG\*CTG-3'**  
**HindIII: 5'- A\*ACGTT-3'**  
**BamHI: 5'-G\*GATCC-3'**  
**EcoRI: 5'-G\*AATTC-3'**  
**AluI: 5'-AG\*CT-3'**



- a. **Describe the procedure you would use to create a unique plasmid that has TRA under the control of the T7 promoter. NOTE: The plasmid must be functional in the capacity of a cloning vector and this procedure may require multiple steps.**

**You successfully clone TRA and place it under the control of an inducible promoter pUC.16. You transform the construct into bacterial cells. You add a compound that induces expression of cloned TRA and then decide to detect expression levels of induced TRA.**

- b. Of the following methods, circle those that you could use to quantify mRNA expression levels of TRA. (Circle all that apply.)**

1. RT-PCR
2. Microarray analysis
3. RNAi
4. Shot gun sequencing
5. Western blot analysis

- c. After you add your inducer, you realize that you want to restore basal level expression of TRA in your cells. Which of the following methods would reduce or eliminate TRA expression? (Circle all that apply.)**

- a. Adding TRA-specific antibodies to your cells.
- b. Adding TRA-specific siRNA to your cells.
- c. Adding TRA-specific repressor protein.
- d. Removing the TRA protein
- e. Removing the inducer

**3. Some mammals have the capability to digest cellulose. (5.5 points)**

- a. Compare and contrast the fore-gut and hind-gut approaches to cellulose digestion employed by these mammals. Include an example of which mammals use each approach.**

- b. Can humans digest cellulose? (Yes or No) Why or why not?**

- 4. There are a variety of glands in mammals. Provide a general system for classifying these glands and discuss the general characteristics of each group.**  
(3 points)



**5. With flowering plants in mind answer each of the following. (6.5 points)**

**a. Seeds in flowering plants are dispersed in four different ways. Name and briefly discuss each method of seed dispersal.**

**b. What is the evolutionary significance of seeds?**

**c. What is the evolutionary significance of the seed dispersal mechanisms?**

**d. Compare and contrast spores and seeds.**

**e. Compare the dispersal mechanisms of spores and seeds.**

**6. The British ecologist H. B. D. Kettlewell conducted famous experiments between 1952 and 1972 on the Peppered Moth. (6.5 points)**

**a. What was the original purpose of his research?**

**b. What was the experimental protocol that he followed?**

**c. What were the results that he found?**

**d. What were the interpretations and conclusions formed based on those results?**

**e. What is the modern-day interpretation of those results?**

7. A woman who is a heterozygous carrier of an X-linked recessive disease gene mates with a phenotypically normal male. The disease gene has a penetrance of 70%. On average, what proportion of this couple's sons will be affected with the disorder? (Show your work.) (1.5 points)
8. In humans, hereditary diseases are often present with no previous family history of the disorder. Briefly describe three genetic situations in which you would be most likely to observe a genetic disorder for which there is no previous family history of the disease phenotype. (2 points)

9. In a population an X-linked dominant disorder affects 1/100 males in the population. What proportion of females would be affected with the X-linked dominant disorder? (Show your work.) (2 points)
10. An investigator is studying the relationship between urine osmolarity in mice following consumption of 2% saline water in relation to normal tap water. She discovers that there is increased osmolarity of the urine and increased excretion of chloride after consumption of 2% saline water. This gives rise to a second question: how are the mice able to excrete the excess salt consumed while maintaining water balance? She assumes that there is ADH release during saline consumption. What evidence would be required to support the assumption of increased ADH release during periods of increased salt consumption? (2 points)