

Name _____

Student ID # _____

**BIO SCI 97 FALL 2005
FINAL EXAMINATION**

**DO NOT OPEN EXAM UNTIL TOLD TO DO SO
BEFORE BEGINNING:**

1. Write your **name** and **ID** number in the upper right corner of **this page**
2. Write your **name** and **ID** number on your **Scantron** card, and full in the code box for your ID
3. Write your exam version number (see top of this page) on the Scantron right after your name
4. **SIGN THE BACK** of your Scantron card in the large white space
5. Write your **name** and **ID** number on the answer sheet for Part II
6. Fill in your section and exam versions on the scantron as directed by the Professor

DURING THE EXAM:

1. For Part I, Choose the SINGLE best answer to each question. If none of the answers seem correct, or if more than one seems correct, choose the one that seems **most correct**. Mark your Scantron card with a dark PENCIL.
2. For Part II, answers that are not clearly and carefully written will be marked wrong.

VERY IMPORTANT:

1. You must sit in your assigned seat unless given permission to do otherwise. If you are not sitting in your assigned seat you may be given a zero on the exam.
2. This is a closed book test - no notes of any type are allowed.
3. Do not talk to another student. Do not look at another student's answers.
4. On desk - ID, Scantron, exam, answer sheet, pencil, calculator (calculator is optional).
5. If you are seen with a cell phone or pager you may be given a zero on the exam.

NOTES for all questions:

- Affected = has the disease
- Unaffected = does not have the disease (but may be a carrier if the disease is recessive)
- Normal = does not have the disease and is not a carrier.
- For all questions, assume any trait or disease mentioned has 100% penetrance, unless it is stated otherwise
- For inheritance questions, assume no new mutations, unless it is stated otherwise.
- All diseases mentioned are genetic diseases, unless it is stated otherwise.
- Pedigrees will only show you if someone is affected (black symbol) or unaffected (white symbol). If someone is a heterozygous carrier of a recessive disease, they will be depicted as unaffected.

PART 1 – MULTIPLE CHOICE – ANSWER ON YOUR SCANTRON CARD

Each question is worth one point unless otherwise noted.

1. Which one of the following statements regarding cloning of human beings or other vertebrate animals is the most correct?
 - A. Some human clones have lived to adulthood.
 - B. Some attempts at human reproductive cloning have been made, but these individuals have died shortly after birth.
 - C. Human embryos have been cloned for use in stem cell research.
 - D. No human embryos or human beings have ever been cloned.
 - E. No vertebrate animal has ever been cloned.

2. Which one of the following statements (A-D) are TRUE?. If you think more than one is true, pick E.
 - A. Scientific studies of food products containing genetically modified (GM) ingredients have consistently indicated that they are less nutritious than similar organic products, and also contain a greater amounts of cancer causing carcinogens.
 - B. The standard American diet does not include food containing genetically engineered crops.
 - C. There is a world-wide ban on the cloning of pets and the sale of genetically-modified pets.
 - D. It is possible to have a fetus tested for certain genetic traits or disorders and to choose selective abortion on the basis of that information. Furthermore, it is legal to do this in at least some states in the U.S.
 - E. More than one of the above statements (A-D) is true.

3. Which of the following (A-D) is TRUE of eugenics? If you think none are true, pick E.
 - A. It is a pseudo-science that has been practiced in Nazi Germany, but not in the United States.
 - B. Although it may have been practiced in some U.S. states, it was never practiced in California.
 - C. It is currently in clinical trials at several major medical centers.
 - D. It has the potential to rapidly eliminate low-fitness recessive alleles from the gene pool.
 - E. None of the above statements (A-D) are true.

4. Which of the following statements (A-D) about recessive alleles is TRUE? If you think more than one is true, pick E.
 - A. They usually encode a protein that has gained a new function
 - B. They usually encode a non-functional protein or a protein with diminished function
 - C. They rapidly eliminated from the gene pool if disadvantageous
 - D. People carrying deleterious (that is, "bad") recessive alleles should probably not have children.
 - E. More than one of the above statements (A-D) is true.

5. Lissencephaly results from haploinsufficiency of the LIS1 gene. The disease has 100% penetrance and 100% lethality. Affected individuals die before or shortly after birth. What is the best explanation for the existence of disease-causing LIS1 alleles in the gene pool?
 - A. Delayed age of onset
 - B. New mutations
 - C. Inefficient natural selection
 - D. Heterozygote superiority
 - E. None of the above choices provides a reasonable explanation

6. An autosomal recessive disease has an incidence of 1/10,000. What is the approximate frequency of heterozygote carriers for this disease? Assume Hardy-Weinberg conditions apply.
 - A. 1/50, or 2%
 - B. 1/100, or 1%
 - C. 1/1000, or 0.1%
 - D. 1/10, or 10%
 - E. 1/4, or 25%

7. The complement of the DNA sequence 5'-ACGT-3' is? (NOTE: only the top strand is shown – the question asks for the bottom strand in the 5'→3' direction)

- A. 5'-ACGT-3'
- B. 5'-TGCA-3'
- C. 5'-ACTG-3'
- D. 5'-TCAG'-3'
- E. 5'-GCAT-3'

8. The following statements refer to Duchenne Muscular Dystrophy (DMD), a single-gene, x-linked recessive disorder. Which of the following statements (A-D) is FALSE (pick E if you think A-D are all true).

- A. If a female carrier of DMD mates with a normal man, half of her sons will be affected, on average.
- B. If a female carrier of DMD mates with a normal man, half of her daughters will be carriers, on average.
- C. If a female carrier of DMD mates with a male affected with DMD, all of their sons will be affected.
- D. If a male affected with DMD mates with a normal woman, all of his daughters will be carriers.
- E. None of the statements are false.

9. Why aren't many antibiotics effective against viruses? (which of the following statements is most correct regarding this question?)

- A. In fact, most antibiotics are somewhat effective against viruses.
- B. Many antibiotics target the bacterial peptidoglycan cell wall, and viruses do not have such a structure.
- C. Many antibiotics bind to the bacterial ribosome and inhibit bacterial protein synthesis, but don't bind to human ribosomes or to the ribosomes of the virus.
- D. Viruses have acquired multiple antibiotic resistance genes.
- E. More than one of the above statements (A-D) is correct.

Note: C implies that viruses have ribosomes. But they don't. So C is false.

10. The process in which recipient bacterial cells acquire genes from cell-to-cell contact with other cells is called

- A. transduction
- B. ligation
- C. transformation
- D. conjugation
- E. transposition

11. Based on your knowledge of the following processes, which of the following are major contributors to the rapid spread of antibiotic resistance among bacteria?

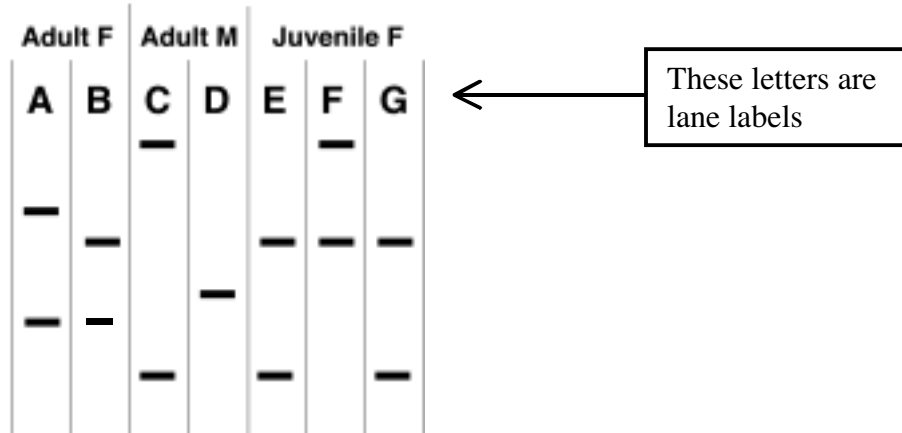
- A. conjugation
- B. transposition
- C. transduction
- D. A and B
- E. A, B and C

12. If a population is at Hardy-Weinberg equilibrium...
- (i) can you calculate the genotype frequencies if you know the allele frequencies?
- (ii) can you calculate the allele frequencies if you know the genotype frequencies?
- (i) = yes; (ii) = NO
 - (i) = yes; (ii) = yes
 - (i) = NO; (ii) = yes
 - (i) = NO; (ii) = NO
 - only for x-linked genes
13. If a population is NOT at Hardy-Weinberg (and you don't know why it is not at HW equil.)...
- (i) can you calculate the genotype frequencies if you know the allele frequencies?
- (ii) can you calculate the allele frequencies if you know the genotype frequencies?
- (i) = yes; (ii) = NO
 - (i) = yes; (ii) = yes
 - (i) = NO; (ii) = yes
 - (i) = NO; (ii) = NO
 - (i) = yes; (ii) = only if there's no inbreeding
14. The fraction of your alleles that you share with your first cousin is?
- 1/16
 - 1/8
 - 1/4
 - 1/3
 - 1/2
15. Blood pressure is a multifactorial trait with a heritability of 0.6. A study is conducted on identical (monozygotic, or MZ) twins that were separated at birth and reared apart. They are compared to fraternal (dizygotic, or DZ) twins reared apart (NOTE: This often happens with twins given up for adoption). The most likely outcome of this study is that...
- MZ twins will have almost identical blood pressures, much more so than DZ twins
 - MZ twins will have more similar blood pressures than DZ twins, but there will still be significant variation between MZ twins due to environmental factors
 - Both MZ and DZ twins will have very similar blood pressures
 - DZ twins will have more similar blood pressures than MZ twins
 - Environmental factors more important than genetic factors with regard to blood pressure
16. The first widely successful genetically modified crop was a strain of soybeans that...
- contained the human factor VIII gene.
 - contained a gene that made the elongated beanstalks round up for easier harvesting.
 - contained a gene from another plant that made them grow faster.
 - contained a gene from a bacterium that made them resistant to a powerful herbicide.
 - Actually, it was not a strain of soybeans, but a strain of pigs that yielded low-fat bacon.

17&18.

THIS PROBLEM IS WORTH 2 POINTS – FILL IN BOTH NUMBERS ON YOUR SCANTRON

On July 17, 1918, the last Russian Tsar, Nicholas II, was machine gunned to death on the orders of the new communist government. Executed with him were his wife, the Tsarina Alexandra, their four young daughters, and their hemophiliac son. Also executed were the family's personal physician (a male) and three adult female servants. In 1979, the remains of eight people were found in a shallow grave near the area where the bodies were rumored to have been disposed of. The degree of bone development and the presence of Y-specific DNA indicated the presence of two adult females (A-B), two adult males (C-D), and three juvenile females (E-G) in the grave. DNA typing with a probe for a polymorphic region revealed the pattern shown below.



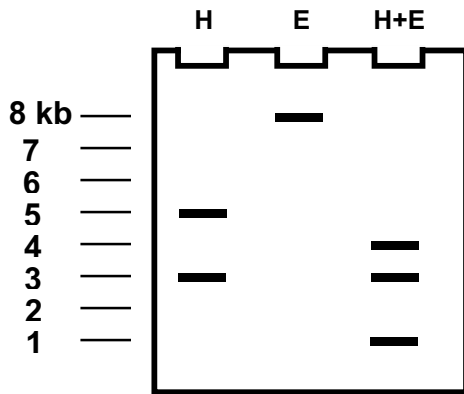
Based on the DNA typing results, identify the DNA that most likely comes from the Tsarina and the Tsar.

- None of the juveniles could be related to any of the adults
- Tsarina = lane A, Tsar = lane C
- Tsarina = A, Tsar = D
- Tsarina = B, Tsar = C
- Tsarina = B, Tsar = D
- OJ did it

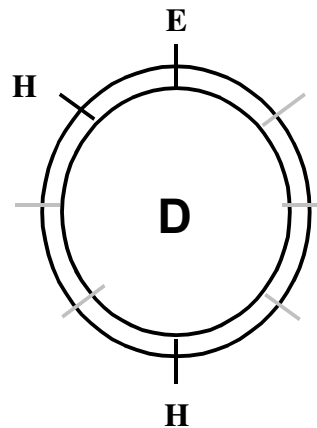
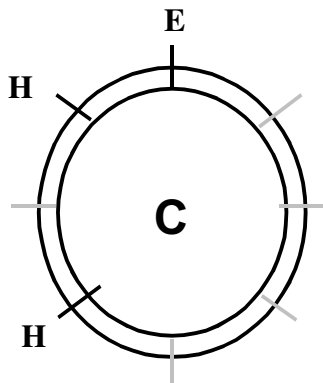
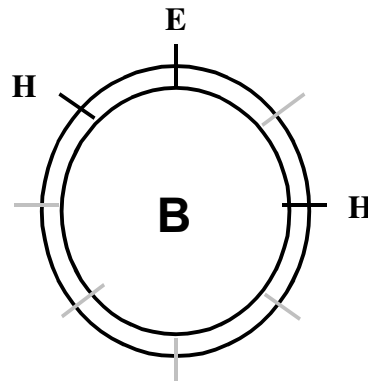
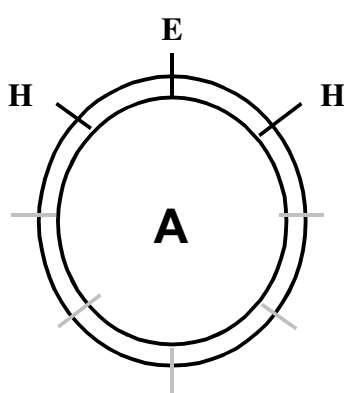
19 & 20.

THIS PROBLEM IS WORTH 2 POINTS – FILL IN BOTH NUMBERS ON YOUR SCANTRON

An 8 kb plasmid is digested with EcoRI (E) and/or HindIII (H), and the digests are run on an agarose gel and stained. The results are shown below; molecular size standards are shown on the left.



Based on the results of the gel, which single plasmid map looks the most correct? Fill in answer E if you think none of them are correct. Note: the light grey lines are just size indicators.



PART II - Short Answer Questions – Not Scantron – Write on Part II Answer Sheet
10 points total. Questions are worth 1 point each.

21-25. In a certain small population of nine students at Hardy-Weinberg equilibrium, one of the students is affected by an autosomal recessive condition called 'sleepyheadness', which causes him to fall asleep during class, despite the stimulating lectures of his charismatic professors.

Note that your answers need not necessarily divide evenly among the 9 students. For example, you may calculate the heterozygote frequency to be 0.5, which would imply that there's 4.5 heterozygotes – that's okay.

21. What is the allele frequency, p , of the dominant SH allele? What is the allele frequency, q , of the recessive sh allele? Your answer should take the form " $p = _$, $q = _$ ".

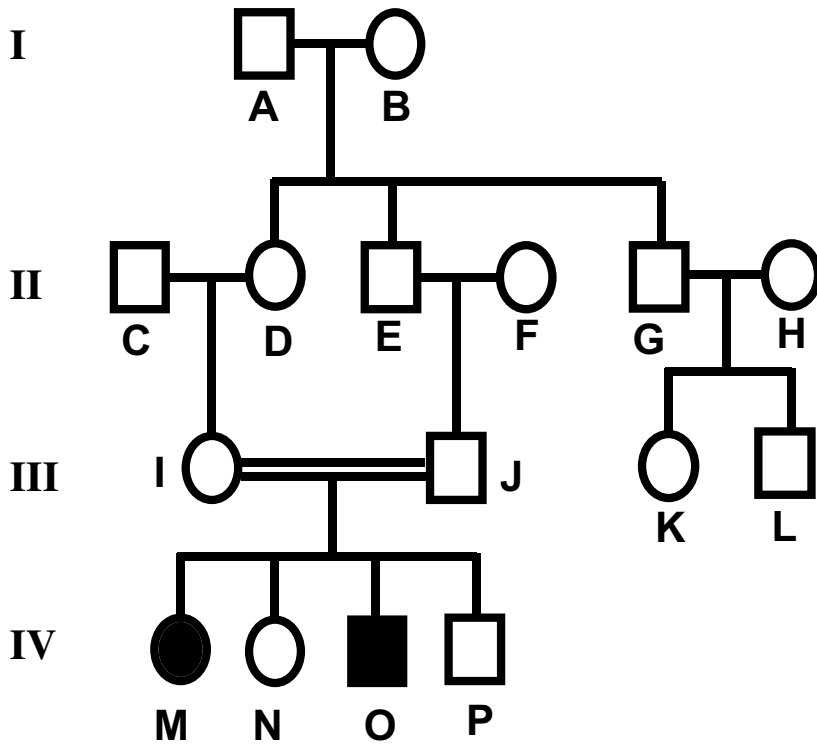
22. What is the frequency of heterozygous carriers of sleepyheadness?

23. What if sleepyheadness was an x-linked recessive condition? In that case, what would the allele frequencies be? And what would the genotype frequency of heterozygous female carriers be? Your answer should take the form " $p = _$, $q = _$, het = $_$ ".

For questions 24 and 25, let's go back to assuming that sleepyheadness is autosomal recessive.

24. One day, the professor's laser pointer accidentally overloads and randomly kills one of the students in class. It just so happens that this was the sleephead. This type of evolution is..
(A) migration (B) new mutation (C) genetic drift (D) natural selection (E) inbreeding (F) random mating (G) none of the above.

25. The tragic laser pointer accident also kills the professor and welds the doors of the room permanently shut. The eight students left, not wishing to consign themselves to genetic oblivion, have no choice but to randomly mate with each other. Soon there are 16 kids in the new generation. What are the expected allele frequencies in this new generation? And what is the expected (genotype) frequency of sleepyheads in this new generation? Your answer should take the form " $p = _$, $q = _$, sleepy = $_$ ".



26-30. The above pedigree shows the inheritance of a rare birth defect syndrome in a family.

26. Given the pedigree, which mechanism(s) of inheritance is/are reasonably likely? (You may choose more than one – write down the appropriate letter(s) to indicate your answer.)

- A. Autosomal recessive
- B. Autosomal dominant
- C. X-linked recessive
- D. X-linked dominant
- E. Cannot be determined from the information given

27. In alphabetical order, list all the individuals in generations II, III and IV who are HIGHLY LIKELY* to be heterozygous for the disease-causing allele (*likelihood almost 100%, based on the information given).

28. The chance that individual K is a carrier of the disease causing allele is _____. (You may answer as a fraction or a percentage).

29. The chance that individual P is a carrier of the disease causing allele is _____. (You may answer as a fraction or a percentage).

30. Assume what is shown in the above pedigree is not a rare birth defect syndrome, but a relatively common single-gene trait. In that case, which mechanism(s) of inheritance is/are reasonably likely? (You may choose more than one – write down the appropriate letter(s) to indicate your answer.)

- A. Autosomal recessive
- B. Autosomal dominant
- C. X-linked recessive
- D. X-linked dominant