

Fall 2002 Biology 111 Exam #2 – Classical Genetics
Answer Key

There is no time limit on this test, though I have tried to design one that you should be able to complete within 3 hours, except for typing. There are four pages for this test, including this cover sheet. You are not allowed to use your notes, old tests, the internet, or any books, nor are you allowed to discuss the test with anyone until all exams are turned in at 8:30 am on Friday October 11. **EXAMS ARE DUE AT CLASS TIME ON MONDAY OCTOBER 11.** You may use a calculator and/or ruler. The **answers to the questions must be typed on a separate sheet of paper** unless the question specifically says to write the answer in the space provided. If you do not write your answers in the appropriate location, I may not find them.

-3 pts if you do not follow this direction.

Please do not write or type your name on any page other than this cover page.

Staple all your pages (INCLUDING THE TEST PAGES) together when finished with the exam.

Name (please print):

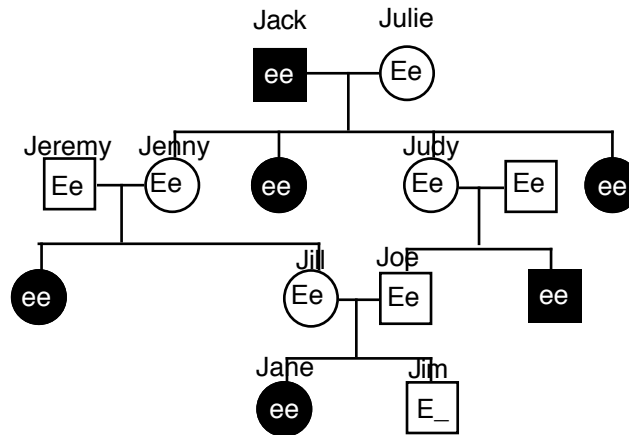
Write out the full pledge and sign:

On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete (excluding typing)?

12 pts.

1) Draw a pedigree in the space provided that describes the following family:
 A man (Joe) and a woman (Jill) marry and have two children. The first child (Jane) has a disease but the second child (Jim) does not. Joe and Jill each have a sibling of the same gender as themselves and also have the same disease as Jane. Joe's mother, Judy, was the third born of four daughters. Jack and Julie were Judy's parents and Jack too has the same disease as Jane. In the F1 generation, the second and fourth children also had the same disease as Jane. Judy's oldest sister (Jenny) married Jeremy who had two daughters, Janice and Jill, Jane's mother. Jane's maternal aunt had the same disease as Jane.



12 pts.

- 2) a) Fill in the genotypes of every person in Jane's extended family tree. Use the letters E and e as your alleles. Make sure you write clearly these two letters.
 b) Did Jane suffer from a recessive, dominant or codominant disease? To get full credit, you must justify your conclusion by citing data from your pedigree.

You can tell it is recessive because it skips a generation (e.g. Jane but not her parents) and there are no partial phenotypes (the way we show codominance).

9 pts.

- 3) a) What were the odds of Jill and Joe having a homozygous dominant child?

1/4

- b) What would the odds be of Jill and Joe having a third child that is heterozygous and male.

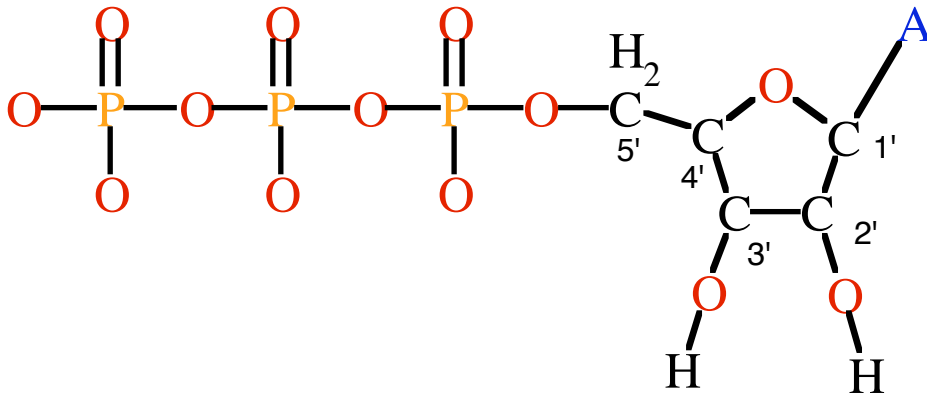
1/4

- c) Calculate the odds of Joe and Jill having Jane, Jim and this third child. When calculating the odds, consider gender and each child's genotype for the disease.

$$3/256 = 1/2 * 1/4 \text{ (Jane)} * 1/2 * 3/4 \text{ (Jim)} * 1/4 \text{ (third child is male heterozygote)}$$

10 pts.

4) In the space provided, draw a picture of one RNA nucleoside triphosphate. You may simply use one of the four letters to represent the base. Be sure to number the carbons in the sugar and do not simply list a phosphate as a P with a circle around it.



10 pts.

5) We discussed five types of point mutations. Rank these five in order from most disruptive to least disruptive for the primary structure of the encoded protein. When you make your list, put the most disruptive as number 1 and the least disruptive as number 5. Ties are permitted in your ranking. Finally, for each mutation, explain why you placed it where you did in the order of five. These explanations should be no longer than two sentences each. The five types of point mutations are: missense mutation, single base pair deletion, nonsense mutation, silent mutation, single base pair insertion.

- 1) Nonsense because a stop codon is inserted which will truncate the protein.
- 2) and 3) 1 bp insertion/deletion because these will cause a frame shift which will alter all amino acids downstream of the point mutation. A stop codon is possible as well.
- 4) Missense mutation because the wrong amino acid will be incorporated into the protein. This could be bad or benign, depending on the new amino acid.
- 5) Silent mutations do not affect the protein at all.

10 pts.

6) What kind of molecule is SRY and in what cellular process is it involved? Imagine yourself with a wild-type SRY, describe your phenotype.

SRY is a transcription factor that directs transcription. When present early in development, the fetus will transcribe genes needed to become a male. A wt SRY person would have a male phenotype.

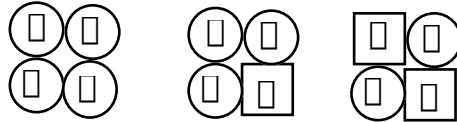
7 pts.

7) Explain how a mutation in a gene's signal sequence could produce a genetic disease.

If a signal sequence were normally present but the mutant gene did not code for one, then the translated protein would not be produced in the rER and thus would not be located in the appropriate place. Conversely, if a protein normally lacked a signal sequence but the mutant gene contained one, then the protein would inappropriately be made on the rough ER and again be located in the wrong place in all cells.

10 pts.

8) Given the molecular cause of sickle cell disease, explain why it is a codominant disease. Be sure to include a diagram (not a pedigree) in your answer that illustrates why sickle cell disease cannot be a dominant or recessive disease. Again, write clearly for any labels included in your figure.



In a heterozygous individual, both wild-type and mutant \square hemoglobin proteins are made. Recessive alleles exhibit no phenotype in presence of a dominant allele. However, mutant \square hemoglobin does exert an effect. This can be seen in the diagram above where three forms of hemoglobin tetramers are made in each RBC. With this mixture, it is possible for heterozygotes to exhibit intermediate phenotypes due to the blend of hemoglobin tetramers in each RBC.

10 pts.

9) Using the figure below, draw:

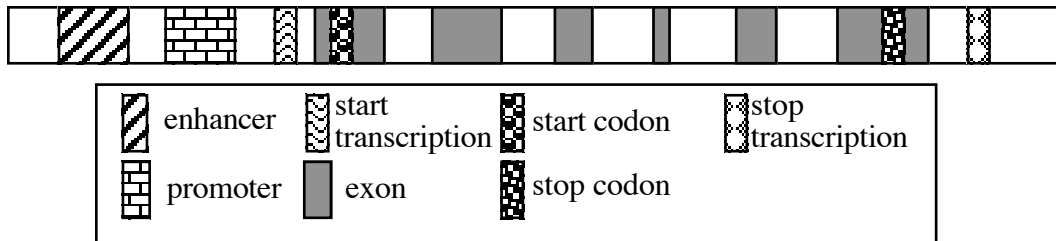
a) the pre-mRNA



b) the mRNA



For your diagrams, you may use colors or other shading/patterns as long as each part is clearly indicated and easily understood.



10 pts.

10) Using the data below, draw a picture that indicates:

a) which loci are linked and which ones are not.

b) the distance between any linked loci

c) which alleles were on each parental chromosome.

Your drawing must include paternal and maternal chromosomes for this diploid species.

There are three little heard of, rare and recessive traits in a particular mammalian species: no fingernails, hairy eyelids, and green hair. A particular couple produced 3000 offspring. The mother was wild-type but the father had no nails, hairy eyelids, and green hair. They produced the following offspring:

728 with nails, hairy eyelids, non-green hair

727 with nails, hairy eyelids, green hair

726 with no nails, non-hairy eyelids, non-green hair

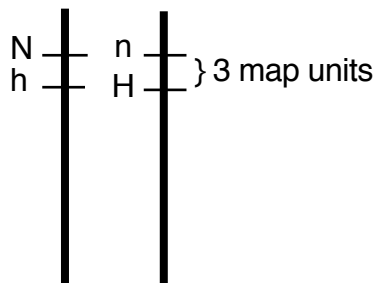
729 with no nails, non-hairy eyelids, green hair

23 with nails, no hairy eyelids, non-green hair

22 with nails, no hairy eyelids, green hair

21 with no nails, hairy eyelids, non-green hair

24 with no nails, hairy eyelids, green hair



Picture of maternal chromosomes.

Green hair locus is unlinked to the other two loci.