

## Math 151- Sample Exam 3 - Fall 2015 Lou Gross

This sample exam is designed to be of similar length to the one that will be given in class (60 minutes) and can be done without using a calculator though, as for the in-class exam, you can use a standard calculator if you'd like.

1. Data on wing coloration in the scarlet tiger moth (*Panaxia dominula*) indicates that coloration in this species behaves as a single-locus, two-allele system in which individual moths either have white spotted wings (AA), have few spots (aa) or are intermediate (Aa) having an intermediate level of spotting. Observations of a wild population of this species find that 60% of the population have white spotted wings, 10% have few spots and the remainder have an intermediate level of spotting. Consider a mating between two individuals chosen from this population in which the individuals are chosen based on the observed fractions of each genotype. For this mating, what is the probability that an offspring will have few spots? Note that this is equivalent to finding the fraction of all offspring in the next generation which are of type aa.
2. You wish to evaluate the effects on patients of interactions of two drugs at a time, in a disease for which there are 5 drugs available. How many different treatments do you need to evaluate (e.g. how many different pairings of two drugs are there)?
3. What are the sample spaces for the following experiments:
  - (a) Blood tests on individuals indicate they have lower than normal (L), normal (N) or above normal (A) levels of lipid and these individuals also have their BMI (Body Mass Index) determined as being either at level 1, 2 or 3.
  - (b) An island contains 4 species of lizards (species are labeled A, B, C and D) with many individuals of each species present on the island. A researcher sets two traps which each capture a single lizard. The researcher doesn't care which trap captured which lizard.
4. Tumor markers are a group of proteins, hormones, enzymes, and other cellular products that are produced in higher than normal amounts by malignant cancer cells. Blood tests have been developed to estimate whether a cancerous tumor is present based upon the blood level of these markers. Suppose that a particular tumor marker test has a false positive rate (e.g. the test is positive for a tumor, given that the patient does not have a tumor) of 6% and a false negative rate (e.g. the test is negative for a tumor, given that the patient does indeed have a tumor, also called the sensitivity of the blood test) of 14%. For this type of cancer, 20% of patients being tested have a cancerous tumor.
  - (a) What fraction of patients being tested both have a cancerous tumor and have a positive tumor marker test?
  - (b) What fraction of patients being tested have a positive tumor marker test?
  - (c) Given that the tumor marker test for a patient is positive, what is the probability that the patient does indeed have a cancerous tumor?

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5. Only 20% of the students in a school have been successful in a skill evaluation test. In a small class of 5 students from this school, what is the probability that at least 3 of the students have been successful in this skill evaluation?

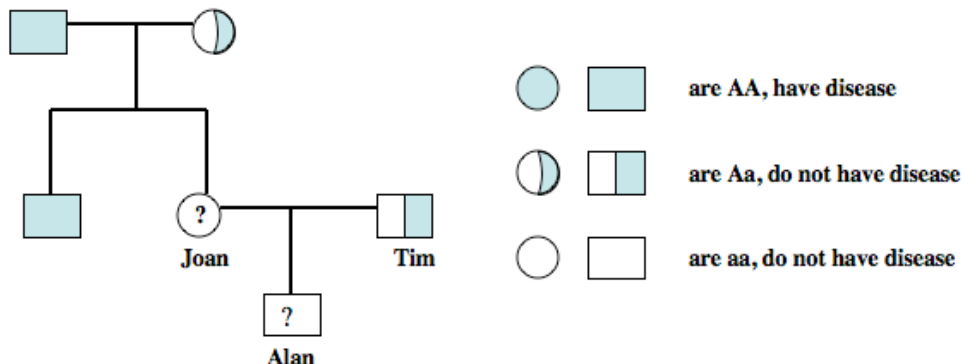
6. Of 250 children going to a doctor, 60 are males with a bacterial ear infection, 40 are females with a bacterial ear infection, 110 of the children are male and 140 are female.

- (a) What is the probability that a child has a bacterial ear infection?
- (b) Given that a child is female, what is the probability the child has a bacterial ear infection?
- (c) Given that a child is male, what is the probability the child does NOT have an ear infection?

7. In a dietary survey, 20% of those surveyed eat a low fat diet, 35% of those surveyed are obese and 3% are both obese and eat a low fat diet.

- (a) What fraction of those surveyed are obese and do not eat a low fat diet?
- (b) Given that a person in this survey is not obese, what is the probability that person eats a low fat diet?

8. Consider a family having the following pedigree for a single-locus disease. AA individuals all have the disease, Aa individuals do not have the disease, and aa individuals do not have the disease. It is not known whether Joan has the disease, and Tim is known to be of type Aa.



- (a) What is the probability that Joan is Aa?
- (b) What is the probability that Joan and Tim's child is AA?