# Psychology 3102 (Carey)
# Problem Set: Mendel and Morgan

1) For the ABO blood system, what are the predicted genotypes and the phenotypes and their frequencies for the offspring of the following matings:  See the Applet "Offrping from the matings on the ABO blood group" for more examples.

- 1.a) AA x AB
  1.b) AO x OO
  1.c) BB x OO
  1.d) AO x BO

2) The MN blood group is another system due to a single gene with two codominant alleles, M and N. Codominant means that the phenotype for the heterozygote is MN. Give the expected frequency and genotypes from the following matings:

- 2.a) MM x NN
  2.b) MN x NN
  2.c) MN x MN

3) Suppose that you actually gathered data for the MN blood group and obtained the following results (expressed in terms of numbers of offspring)

| Number of offspring genotypes from three parental matings on the MN blood group. | | | | |
|---|---|---|---|---|
| | | Offspring Genotype | | |
| Father's Genotype | Mother's Genotype | MM | MN | NN |
| MM | MM | 108 | 2 | 0 |
| MM | MN | 58 | 62 | 1 |
| MM | NN | 0 | 134 | 2 |

- 3.a) Is there anything discrepant in these data with the system described in question 2? Point out each and every place you think there is a discrepancy.

- 3.b) What do you think might have caused these discrepancies? (This is tricky and has nothing to do with Punnett rectangles.)

4) Remember the hemoglobin molecule? It carries oxygen through the blood. Although the genetics are somewhat complex, we will simply consider two alleles for this molecule, S and s.  Genotype SS has normal hemoglobin but has little resistance to malaria, genotype Ss also has normal hemoglobin but has mild resistance to malaria, and genotype ss has abnormal hemoglobin and strong resistance to malaria. (Genotype ss would develop what is called sickle cell anemia.) Give the genotypes and the phenotypes for both hemoglobin and malarial resistance for the following matings:

- 4.a) SS x Ss
  4.b) Ss X Ss
  4.c) Assume that genotype ss is lethal (i.e., people die before they reach reproductive age). What is the only type of mating that can produce an ss offspring?

5) Monoamine oxidase A deficiency (MAOAD) is an X-linked recessive disorder. There are three alleles for this locus: the dominant allele A creates normal monoamine oxidase.  The two recessive alleles, a and a*, produce the deficiency. Genotype aa* will also have the deficiency. Give the expected outcomes for offspring as a whole and for the male and female offspring separately for the following matings:

- 5.a) Female with Aa and male with A
  5.b) Female with Aa* and male with a?
  5.c) Male with a* and female with AA?

6) The Rhesus blood group gene is actually complicated, but is usually simplified in textbooks as having two alleles, a `plus` (+) allele and a `minus` (-) allele. The + allele is dominant to the - allele. The typical blood grouping concantenates the phenotype at the ABO gene with the phenotype at the Rhesus locus (e.g., B+, O-, etc.).  Give the gametes and the associated probabilities for the following blood group genotypes or phenotypes

- 6.a) A person who is AA/+- (i.e., the person is genotype AA at the ABO locus and +- at the Rhesus locus).
  6.b) AO/+-
  6.c) BB/--
  6.d) You donate blood and find that your blood type is O- (O negative).  What are the gametes (and their probabilities) that you will give to your children.

7) Do the following problems on human blood types:
- 7.a) Calculate the genotypes, phenotypes, and expected frequencies for the offspring from a mating between a man with the genotype AA/+- and a woman with the genotype BO/+-.

- 7.b) Calculate the genotypes, phenotypes, and expected frequencies for the offspring from a mating between a man with the genotype AO/+- and a woman with the genotype BO/++.

- 7.c) Calculate the genotypes, phenotypes, and expected frequencies for the offspring from a man with genotype BO/++ and a woman with genotype OO/--.

- 7.d) ... a woman with genotype AO/+- and a man with genotype BB/++.

- 7.e) ... a man who has genotype AA/+- and a woman with genotype BO/+-.

- 7.f) Your professor's phenotype is O+. His father's phenotype is B- and his mother's phenotype is O+. Give the professor's genotype and his father's genotype. Can you figure out his mother's genotype? Why or why not?


8) Locus A and locus B are located on the same chromosome. The recombination fraction ( ) between the two loci is .07. Locus A has two alleles, *A* and *a*, while locus B has two alleles, *B* and *b*. Give the genotypes and their frequencies in the gametes of the following individuals: (Use the handout in class to help you set up these problems). See the Applet "Gametes under Linkage" for more examples.

- 8.a) A person with haplotypes *AB* and *ab*. (A haplotype consists of the genotypes along a single chromosome. Hence, haplotype *AB* means that this person has alleles *A* and *B* on one chromosome; haplotype *ab* means that the person has alleles *a* and *b* on the other chromosome).

- 8.b) A person with haplotypes *Ab* and *aB*.

- 8.c) A person with haplotypes *aB* and *AB*.

- 8.d) A person with haplotypes *ab* and *Ab*.


9) Achondroplasia is a rare form of dwarfism due to a dominant gene. Let *A* denote the dominant allele that causes the condition and let *a* denote the normal allele. Locus Z with alleles Z and z is linked to the achondroplasia locus with a recombination fraction of .12. Give the gametes for a person who is a heterozygote at the achondroplasia locus and also a heterozygote at the Z marker locus. The chromosome that contains the achondroplasia allele also has allele *z* at the marker.


10. Locus A (with alleles *A* and *a*) is linked to a rare dominant disorders with alleles *D* (which causes the disorder) and *d* (the normal allele). The recombination fraction ( ) between the marker and the disease gene is .05. Calculate the genotypes, phenotypes, and probabilities of the offspring from the following matings:

- 11.a) A man with haplotypes *AD* and *ad* and a women with *Ad* and *Ad*.

- 11.b) A woman with haptotypes *Ad* and *aD* and a man with *aD* and *aD*.

- 11.c) A woman with haplotypes *aD* and *Ad* and a man with *Ad* and *Ad*.

11) Below are six pedigrees for a rare dominant disorder.  All affected individuals in the pedigree are heterozygotes for the disorder.  The genotypes for a locus that may be linked to the disorder are given below each individual in the pedigree.  Assume that if the marker is linked, then there is no recombination between the marker and the disease gene.  For each of the pedigrees indicate the following:

- 12.a)  whether or not the pedigree is consistent for linkage.
- 12.b) the reason(s) why or why not the pedigree is consistent.
- 12.c) if the pedigree is consistent, then which marker allele is linked to the disease allele?

### Pedigree 1

Parents: affected male Aa × unaffected female aa

Offspring: Aa, aa, Aa, aa, Aa, aa, Aa

### Pedigree 2

Parents: unaffected male AA × affected female Aa

Offspring: AA, Aa, AA, AA, Aa, AA, Aa

### Pedigree 3

Parents: affected male Aa × unaffected female aa

Offspring: Aa, aa, Aa, aa, Aa, aa, Aa  AA, Aa, AA, AA, Aa, AA, Aa

### Pedigree 4

Parents: unaffected male AA × affected female Aa

Offspring: AA, Aa, AA, AA, Aa, AA, Aa

### Pedigree 5

Parents: unaffected male aa × affected female Aa

Offspring: Aa, aa, aa, Aa, Aa, Aa, aa  Aa, AA, AA, AA, Aa, Aa, Aa

### Pedigree 6

Parents: affected male Aa × unaffected female AA

Offspring: Aa, AA, AA, AA, Aa, Aa, Aa