Genetics – Lecture 5; Probability and strategies for analysis of Mendelian genetic data

Q1. Albinism is recessive. Given a family of 4 having heterozygous parents, what are the chances that:

a) 1st child is albino
   Need (aa), **¼** chance.
b) 3rd child is normally pigmented
   Need (A_), **¾** chance.
c) All 4 children normally pigmented.
   $(3/4)^4$
d) Only 1st child is albino
   P(aa,A_,A_,A_) = $\mathbf{(1/4) * (3/4)^3}$
e) Only one child will be albino
   P(aa,A_,A_,A_) or
   P(A_,aa,A_A_) or
   P(A_,A_,aa,A_) or
   P(A_,A_,A_aa)
   $\mathbf{[(1/4)(3/4)^3] \quad * 4}$
f) 4th child is a normally pigmented female
   p(A) x p(female) = (3/4)(1/2) = **3/8**

Q2. Assume there are four genes on separate chromosomes, and that lower case letters indicate recessive alleles. Given the following cross:

AaBBCcdd × aaBbCcDd

a) What is the probability of an offspring that is dominant for all four traits?
   Dominant for all four traits: A_B_C_D_

p(Aa x aa)	A_	½
p(BB x Bb)	B_	1
p(Cc x Cc)	C_	¾
p(dd x Dd)	D_	½

   ½ * 1 * ¾ * ½ = **3/16**

b) If 64 offspring are produced, how many of the above offspring would you expect to be dominant for all four traits?
   3/16 * 64 = **12**

Q3: In lemurs, two autosomal loci determine type of tail. One locus controls shape of tail; the allele for straight tail (A) is dominant over kinked tail (a). Another locus controls colour (black, white, or striped); there are two alleles at this locus and heterozygotes (Bb) have the striped phenotype. Assume you have a male and female that are heterozygous at both loci.

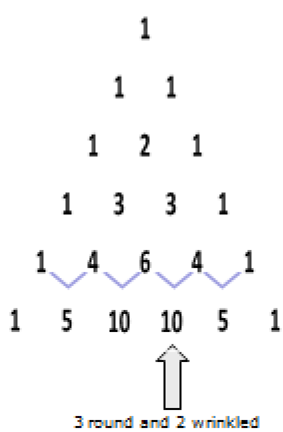
a) What is the phenotype of the male and female?
   Straight and striped for both.
   AaBb * AaBb

b) Predict the phenotypic ratios of their offspring.

Locus 1			Locus 2	Offspring
BB	¼	x	A_ (3/4)	BBA_ (3/16)
		x	Aa (1/4)	BBaa
Bb	2/4	x	A_ (3/4)	BbA_
		x	Aa (1/4)	
bb	¼	x	A_ (3/4)	
			Aa (1/4)	

3. Combination of events
- Possible distribution of boys and girls in a family of 2 children.
- Coefficient of 2 reflects that there are 2 possible orders for 1 boy and 1 girl.
- Easy way:
- If n is the total number (e.g. family size), there are n+1 terms in the list.

Pascal's triangle



e.g. How many combinations of 3 round and 2 wrinkled peas in a pod with 5 peas?
Construct Pascal's triangle for n+1 = 6 terms (left)

10 combinations.

Another way:
- Number of combinations = n! / x!y!
- E.g. same question as above: 5!/ 3!2!

Q4: Assume that three genes (loci) in wheat (a diploid species) contribute a dose of pigment to the kernel. Alleles at any locus that deliver a dose of pigment are denoted **+**, and alleles that don't are **–**

a) What is the max and min number of + alleles an individual can have?

Minimum 0, maximum 6.

b) How many combinations of alleles are possible that give us 3 + and 3 –

6! / 3!3! = 20

4. Binomial probability
Use coefficient if asked for in any order.
If in a specific sequence, just use probability multiplication with no coefficient

What is the probability of 3 round and 2 wrinkled peas in a pod with 5 peas?
r = (prob of round) (R_) = ¾
w = (prob of wrinkled) (rr) = ¼
(5! / 3!2!) * r^3 * w^2 = 0.26

Q5: You plan to cross heterozygous peas for recessive waxy and wrinkled. Given a pod of 16 peas, what is the probability that you will observe 10 normal-normal, 3 normal-wrinkled, 2 waxy-normal, and 1 waxy-wrinkled.

9/16 A_B_	Normal normal
3/16 aaB_	Waxy normal
3/16 A_bb	Normal wrinkled
1/16 aabb	Waxy wrinkled

(16! / 10!3!2!1!) * $(9/16)^{10}(3/16)^{3}(3/16)^{2}(1/16)^{1}$