Lab 9, Biol-1, C. Briggs, revised Spring 2018

Name: _____
Lab day of week: _____

Sample Size

Adapted from Schmidt, et al. 2006. Life All Around Us.

Objectives

Observe the benefits of large sample sizes.

Instructions

1. Form pairs.
2. Within your pair, toss a coin 40 times. Record the number of "heads" and the number of "tails." Tally marks may be helpful.
3. Learn to calculate "percent deviation" for events with two outcomes.
4. Calculate the percent deviation of your results.
   % deviation = ((|expected #A - actual #A| + |expected #B - actual #B|) / total number of tosses) x 100
5. Share your results with the class, and record average class data.

More practice

1. What are the chances of a family having five boys in a row?

2. A couple has 10 children: three girls, and seven boys. What is the percent deviation from what you expected, according to probability?

3. What did you learn about sample size, with respect to percent deviation?

Karyotypes

Adapted from Schmidt, et al. 2006. Life All Around Us.
Image by courtesy: National Human Genome Research Institute - Human Genome Project, Public Domain, https://commons.wikimedia.org/w/index.php?curid=889304

Objectives

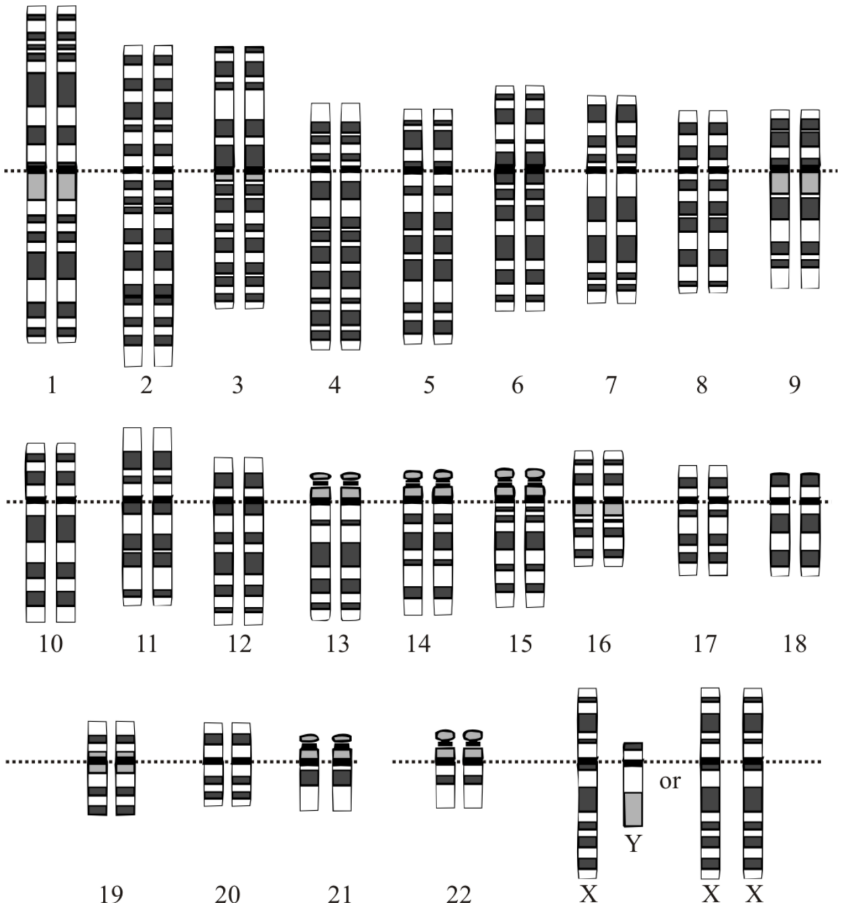
Learn to assemble and interpret a karyotype.

Instructions

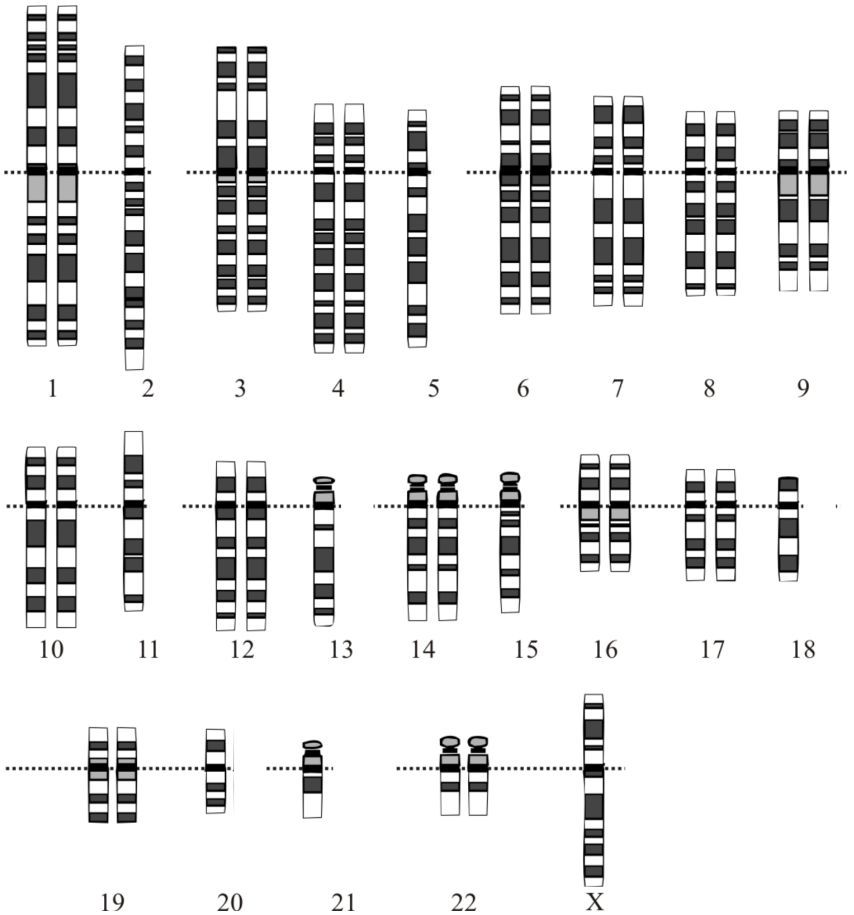
1. Examine the complete karyotype.
2. Pick up a sheet of chromosomes, and use them to complete the partially-completed karyotype.
3. You will have an extra or missing chromosome. Determine what genetic condition is caused.
4. What genetic condition did your karyotype cause? How often does the condition occur, and what are the symptoms?

   Extra chromosome 13: "Patau syndrome"
   Extra chromosome 18: "Edwards syndrome"
   Extra chromosome 21: "Down syndrome"
   Sex chromosomes: X: "Turner syndrome"
   Sex chromosomes: XYY: "Jacobs syndrome"
   Sex chromosomes: XXY: "Kleinefelter syndrome"
   Sex chromosomes: XXX: "Metafemale syndrome"

Complete karyotype



Incomplete karyotype



Types of Inheritance Patterns

Adapted from Schmidt, et al. 2006. Life All Around Us.

Objectives

Practice Punnett squares for a variety of situations. Look up any unfamiliar medical conditions.

Tip: For letters that look similar in upper- and lower-case (such as C, P, and S), try drawing a line above the lower-case letters.

Dominant / recessive: Corn plants in pots

Some plants can be albino. Normal, green pigmentation comes from a dominant version of a gene (N allele). Albinism causes plants to appear white, and arises from two recessive alleles (n).

1. Draw a Punnett square for a cross between plants with genotypes Nn and Nn. (This can also be written Nn x Nn.)

2. Are the parent plants in #1 homozygous or heterozygous?

3. What is the phenotypic ratio of the offspring?

4. Examine the potted corn (*Zea mays*) plants. (Each pot holds multiple plants.) These plants are the result of a cross between two corn plants that were both heterozygous for albinism. Choose one pot. What is its phenotypic ratio?

5. Calculate the phenotypic ratio for all of the plants, collectively.

6. In general, thinking about sample size, when can you expect to get a ratio closer to what is expected -- when you examine one pot, or all the pots collectively?

7. Draw a Punnett square for a cross between an albino plant and a plant heterozygous for the trait.

(a) What is the phenotypic ratio of the offspring?

(b) Assuming you grow some green offspring from the above cross, can you finally be sure of their specific genotype?

Human traits / dominant

1. Some kinds of polydactyly (extra fingers or toes) are caused by a dominant allele (P). Two people heterozygous for polydactyly marry and start a family. What are the chances that they have a child with a normal number of fingers and toes? Use a Punnett square to show your work.

2. Ichthyosis (scaly skin) can be caused by a dominant allele (F). Someone with ichthyosis has children with someone who has normal skin. What are the chances that they have a child with normal skin? Use Punnett squares to show your work.

Human traits / recessive

1. Cystic fibrosis is caused by recessive mutations of a gene that controls production of sweat, digestive fluids, and mucus. A man and a woman wish to start a family, and both have family histories of cystic fibrosis. Genetic tests indicate that they are both carriers. What are their odds of having a child with cystic fibrosis?

Test cross

1. Observe the dried corn cobs. Two true-breeding corn plants were crossed: one with all red kernels, one all white.
2. Which color seems to be dominant?

3. Can you visually tell the difference between a heterozygous kernel and a homozygous dominant kernel?

4. Now let's imagine a "test cross," which crosses (1) a dominant individual (with an unknown genotype) with (2) a homozygous recessive individual.
   (a) Draw a Punnett square to show the phenotypic ratio of a cross between a homozygous dominant plant and a homozygous recessive plant.

(b) Now draw a Punnett square to show the phenotypic ratio of a cross between a heterozygous plant and a homozygous recessive plant.

(c) So, if you do a test cross, and find that half of the kernels are white, was the second parent homozygous dominant, or heterozygous?

Multiple alleles

Blood types A and B are codominant over type O, which is recessive. It is helpful to think of blood types as the following:

Type O = "OO" Type A = "AO" Type B = "BO" Type AB = "AB"

Mrs. Garcia and Mrs. Lopez both give birth at the same time. In the hubbub, the babies get mixed up. Since the mothers want to take home their actual baby, blood tests are run.

Mr. Garcia = type O	Mr. Lopez = type A	Baby X = type AB
Mrs. Garcia = type AB	Mrs. Lopez = type B	Baby Y = type B

Whose baby is whose? Use Punnett squares to defend your answer.

Dihybrid cross

For your reference, this figure shows an example dihybrid cross of RrFf x RrFf.

	RF	**Rf**	**rF**	**rf**
RF	RRFF	RRFf	RrFF	RrFf
Rf	RRFf	RRff	RrFf	Rrff
rF	RrFF	RrFf	rrFF	rrFf
rf	RrFf	Rrff	rrFf	rrff

In guinea pigs (*Cavia porcellus*), black fur (B) is dominant to white fur (b). Short hair (S) is dominant to long hair (s). Use a Punnett square to determine the phenotypic ratio of a cross between two parents heterozygous for both traits.

Incomplete dominance

Snapdragon flowers (*Antirrhinum* sp.) exhibit incomplete dominance. Homozygous individuals have either red (RR) or white (rr) flowers, and heterozygous individuals (Rr) produce pink flowers. What is the phenotypic ratio of a cross between two heterozygous plants? Use a Punnett square to show your work.

Polygenic, or multifactorial inheritance

Human skin color is controlled by multiple genes. Let's assume that two sets of genes are involved: Aa and Bb. The dominant alleles cause more melanin production than the recessive alleles. In a marriage between two people with mixed heritage (AaBb x AaBb), a variety of skin tones could result. Draw a Punnett square for this couple and determine what fraction of the offspring will have each skin color. (Count the number of dominant alleles for each combination.)

			# seen
Interpretation:	4 dominant alleles, ex: AABB	= deep brown skin	_____
	3 dominant alleles, ex: AaBB	= dark brown skin	_____
	2 dominant alleles	= tan / light brown skin	_____
	1 dominant alleles	= olive / fair skin	_____
	0 dominant alleles	= very fair skin	_____

X-linked, or sex-linked traits

1. Color-blindness is carried on the X-chromosome, and is recessive. Use X^N for normal vision, and X^n for the colorblind allele. A man with normal vision marries a woman with normal vision. The woman has a color-blind father. What are the genotypes of the man and the woman?

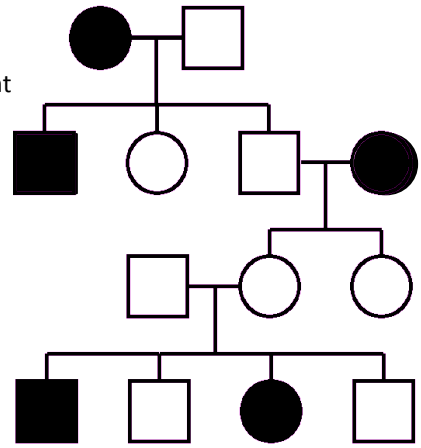
2. Draw a Punnett square to show their progeny (offspring).
   a. What is the chance that a child is color-blind?

   b. What is the chance that a male child is color-blind?

   c. What is the chance that a female child is color-blind?

Pedigree

Sickle-cell disease can result from recessive alleles. Hemoglobin can be distorted and cause red blood cells to become rigid and sickle-shaped. This can cause pain, anemia, bacterial infections, and stroke. Consider the following pedigree, where circles represent females and squares represent males, and filled-in shapes show the disease. "D" can stand for the normal allele, and "d" for the sickle-cell allele. Write in the genotype for each individual. (Sickle-cell is not a sex-linked disease.)



Cat Genetics

Adapted from John McDonald, Myths of Human Genetics, http://udel.edu/~mcdonald/mythintro.html

(Since earwax type is the only single-gene trait easily observed in human beings, we will examine cats instead.)

Objectives

Learn to describe various aspects of a complex phenotype, and predict potential offspring from a cross.

Instructions

1. Examine some cats. Start with Petfinder.com, or if you have no access to that site, you may work from memory.
2. Use the options from the table below to describe some cats with their genotype. Do this for at least one female and one male.

Locus	Genotypes	Phenotypes
L (hair length)	LL	short hair
	Ll	short hair
	ll	long hair
W (white)	WW	completely white hair
	Ww	completely white hair
	ww	some colored hair
S (piebald spotting)	SS	some white hair
	Ss	some white hair
	ss	no white hair
D (dense pigment)	DD	black, brown, or orange
	Dd	black, brown, or orange
	dd	gray, light brown, or cream
O (orange) (sex-linked)	OO (♀) or O- (♂)	orange or cream
	Oō (♀)	orange and black, or cream and gray
	ōō (♀) or ō- (♂)	black or gray

3. Write observed cat characteristics in this table.

	Example	Cat 1	Cat 2	Cat 3...
Name	*Gus*			
Sex	*male*			
L	*L?*			
W	*ww*			
S	*Ss*			
D	*D?*			
O	*O-*			

4. Choose one male and one female cat. Predict potential phenotypes of offspring resulting from a cross between two cats you examined. Show your work and results below. (Consider using a table to summarize the possible outcomes.)

Lab 9 Assignment

Submit your completed lab exercise. That is all.