Genetics Primer

Return to Mr. Lazaroff's Biology
Last Updated: 03/09/2009

Probability: *The likelihood that an even will occur (i.e., If you flip a coin, w/ one heads and one tails, the likelihood of getting heads is 1 in 2, or 50%).*

Genetics: *The probability that a trait will be inherited.*

Chromosome: *A long molecule of DNA, sections of which are called genes.*

- **Homologous Pair:** *A pair of chromosomes in an individual (one of which came from the individual's mother, the other one from the individual's father). Humans have 23 such pairs, since we have 23 types of chromosomes (n = 23).*
- **Diploid:** *Having a double set of chromosomes (2n), which is characteristic of parents and zygotes.*
- **Haploid:** *Having a single set of chromosomes (n), which is characteristic of gametes.*

Gene: *A section of the DNA molecule (chromosome) that codes for a specific trait (i.e., carries the genetic instructions for expressing, or making, that trait). One example of a trait that is controlled by a gene is a person's hairline.*

Allele: *A variation, or type, of a gene. There are 2 alleles for hairline: straight and widow's peak.*

NOTE: Think of the *Gene* being *General*, and the *Allele* being *Specific*
NOTE: For ONE gene, each person will have TWO alleles.

Genotype: *(Think GENES) The combination of alleles in an organism.*

- **For examples of Genotypes, see below.**

Phenotype: *The physical traits of an organism. These traits may be visible, such as eye color, or not visible, such as blood type.*

Dominant: *A trait that is expressed with one or two copies of the allele.*

- **Allele** - *A single allele can be referred to as dominant, but for a trait to be expressed it is necessary to think about genotypes.*
- **Phenotype** - *A trait expressed if the genotype is either homozygous dominant or heterozygous.*

Recessive: *A trait that is* ***ONLY*** *expressed with two copies of the allele.*

- **Allele** - *A single allele can be referred to as recessive, but for a trait to be expressed it is necessary to think about genotypes.*
- **Phenotype** - *A trait expressed only if the genotype is homozygous recessive.*

NOTE: *There is nothing about a specific trait that lets you know whether it is dominant or recessive. That can only be determined through a test cross, or a pedigree, which allows you to observe whether a trait will be masked when the genotype is heterozygous (such a trait is recessive).*

Genotypes:

NOTE: *Homo-* = same *Hetero-* = other *-zygous* = zygote

- **Homozygous Dominant** - *Having two dominant alleles (i.e., **BB**).*
  (same zygote)
- **Heterozygous** - *Having one dominant and one recessive allele (i.e., **Bb**).*
  (other zygote)
- **Homozygous Recessive** - *Having two recessive alleles (i.e., **bb**).*
  (same zygote)

Parent: *An individual, with a diploid set of chromosomes, who produces gametes.*

Gametes: *A haploid cell, produced by a parent, for the purposes of sexual reproduction.*

- **Ovum (pl. ova)** - *A haploid female gamete, produced in the ovary.*
- **Spermatazoan (pl. spermatozoa)** - *A haploid male gamete, produced in the testes.*

Zygote: *A diploid cell formed from the fusion of haploid male and female gametes. These will develop into offspring, and then adults.*

Gene Expression:

- **Transcription:** *The copying of a portion (one gene) on one side of the DNA molecule, producing an mRNA molecule.*
  (1) RNA Polymerase unzips one region (a gene) of the DNA molecule
  (2) RNA Polymerase adds RNA nucleotides to one side of the DNA molecule
  (3) These RNA nucleotides form an mRNA copy of the gene
  (4) The mRNA copy leaves through the pores in the nuclear membrane
- **Translation:** *The formation of a protein (a.k.a. protein synthesis) molecule using the mRNA template*
  (1) The mRNA attaches to a ribosome
  (a) free ribosomes make proteins for use in the cell
  (b) attached ribosomes (on the rough E.R.) make proteins for export
  (2) A tRNA molecule brings an amino acid (the monomers for protein) to the ribosome

(3) The tRNA anticodon attaches to the mRNA codon at the ribosome
(4) The amino acid forms a peptide bond with a neighboring amino acid, brought by another tRNA
(5) This repeated process forms the primary structure (the amino acid sequence) of the protein.
(6) Hydrogen bonds, and the occasional covalent bond, lead to the formation of the secondary, tertiary, and quaternary structure of the protein.

- **Operon:** *This is the mechanism that turns a gene on and off by either allowing or blocking transciption.*

Development:

Punnett Squares: *A graphical representation of the probability that a trait will be inherited by an organism's offspring.* (The square was devised by Reginald Punnett, in case you were curious . . .)

- **For examples of punnett Squares, Click *HERE*.**

Common Monogenic Traits:

- Widow's Peak (Dominant) - Straight Hairline (Recessive)
- Melanin Production (Dominant) - Albinism (Recessive)
- Free Earlobes (Dominant) - Attached Earlobes (Recessive)
- PTC Taster (Dominant) - No Taste (Recessive)
  NOTE: PTC = phenylthiocarbimide
- Mid-digit Hair (Dominant) - NO Mid-digit Hair (Recessive)
- Left Thumb over Right (Dominant) - Right Thumb over Left (Recessive)
  NOTE: When folding one's hands together, with alternating fingers
- Little finger bends toward index finger (Dominant) - Little finger DOESN'T bend towards index finger (Recessive)
  NOTE: Lay your hands flat on the table and relax.
- Thumb Straight (Dominant) - Thumb naturally bends back at an angle greater than 60 degrees (Recessive)
- Dimpled Chin (Dominant) - No Dimple in Chin (Recessive)
  NOTE: You need to squeeze your chin (with a partner, or in front of a mirror) to tell.

Name: ______________________ Date: ________ Period: ___

What traits do you have?

Trait	Dominant Trait	Recessive Trait	# of students (Dominant)	# of students (Recessive)	Dominant:Recessive ratio
Chin	Cleft Chin	No cleft			
Dimples	Dimples	No dimples			
Finger Hair	Mid-Digit Hair	Hairless fingers			
Freckles	Freckles	No freckles			
Pinky	Bent Pinky	Straight Pinky			
Thumbs	Straight thumb	Hitchhiker's (curved) thumb			
Forelock	White forelock	No white forelock			
Earlobes	Free earlobes	Attached earlobes			
Hairline	Widow's Peak	Straight hairline			
Interlocking Hands	Thumb: left over right	Thumb: right over left			
Tongue	Tongue roller	Non tongue roller			
Eye Color	Other color eyes	Blue eyes			
PTC Tasting	PTC taster	Non PTC taster			
Eyelids	Drooping eyelids	Open eyelids			
Hallux Length	Second toe longer than big toe	Second toe shorter than big toe			
Skin Color	Brown/dark skin	Tan/light skin			
Color Vision	Normal vision	Color blind			

Do You Have It?

Genetic Traits

Chin

Cleft chin (dominant trait) vs no cleft (recessive trait). Do you have an indentation in your chin?

Dimples

Dimples (dominant trait) vs. No dimples (recessive trait). Dimples are a slight natural depression or indentation in the face to the right or left of the mouth. If a person has only one dimple, they should be counted as having dimples. If you don't have dimples, you have the less frequent trait

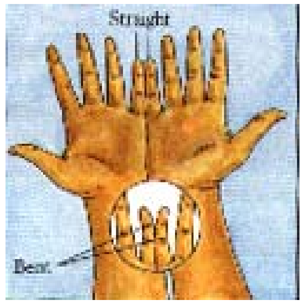
Has dimples

Finger Hair

Mid-digit hair (dominant trait) vs. No mid-digit hair (recessive trait) Look for hair only on the finger shown by the white arrow below.

Pinky

Straight pinky (recessive trait) vs. Bent pinky (dominant trait) Hold your hands together as if you are covering your face. If the tips of the pinkies (or baby fingers) point away from one another, the pinkies are ***bent***.



Thumbs

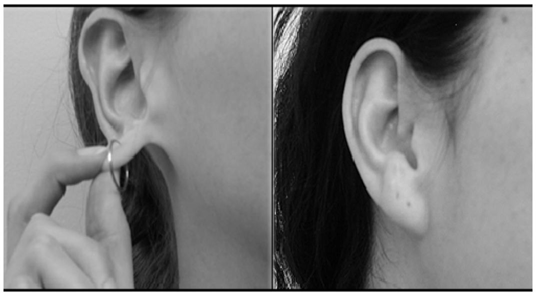
Straight thumb (dominant trait) vs. Curved thumb (recessive trait) Try to bend your thumb backwards at the joint. Some people can form at least a 45 degree angle at the point. This is called hitchhiker's thumb. If you can make a hitchhiker's thumb you
have the less frequent trait. If your thumb does not bend backward, you have the most frequent trait. When viewed from the side as in the illustrations below, curved thumbs can be seen as part of a circle

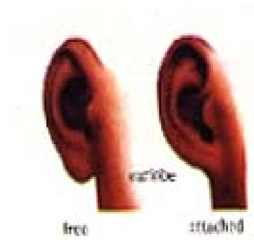
Forelock

White forelock (dominant trait) vs. No white forelock (recessive trait)
A white forelock is a patch of white hair, usually located at the hairline just above the forehead. Below is a photo of Sammo Hung. It clearly shows his white forelock.

Earlobes: Free ear lobes (dominant trait) vs. Attached ear lobes (recessive trait) Have a partner examine your earlobes. If your earlobes hang free at the bottom, you have the dominant trait. If they are attached, you have the recessive trait. In most people, earlobes hang free and detached but in some people the earlobes are attached directly to the side of the head. The size and appearance of the lobes are also inherited traits.



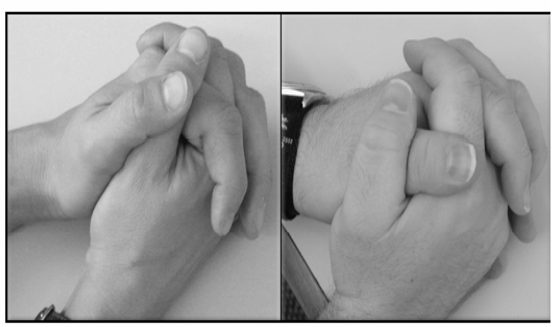
Detached earlobes Attached earlobes



Hairline
If you have the most frequent widow’s peak trait you display a V-shaped point formed by the hair near the top of your forehead. If you have the less frequent trait, your hairline is straight.

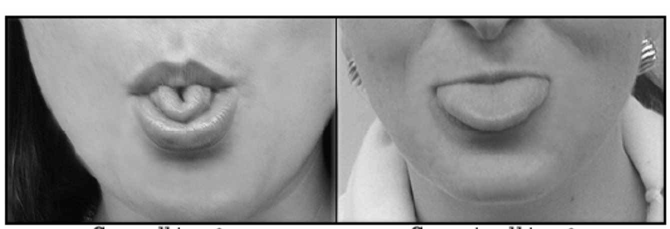
Has straight hairline Has widow’s peak

Interlocking hands
Without thinking about it, fold your hands together by interlocking your fingers. Which thumb is on top? If the left thumb is on top, you have the most frequent trait. If the right thumb is on top, you have the less frequent trait. Try folding your hands together with the other thumb on top. How does this feel?



Crosses left thumb over right Crosses right thumb over left

Tongue
Can you roll your tongue into a U-shape? If you can then you are dominant. If you cannot, then you are recessive.



Can roll tongue Cannot roll tongue

Eye color

The allele for brown eyes is considered dominant over the allele for blue eyes. The exact color of the human eye is determined by the amount of a single pigment called melanin that is present in the iris of the eye. Melanin is a dark brown pigment that is deposited on the front surface of the iris. If a lot of melanin is present, the eye will appear brown or even black. If very little melanin is present the iris appears blue. Intermediate amounts of melanin produces gray, green, hazel or varying shades of brown. Genes work by directing the production of enzymes, chemicals that control all of the processes that occur in our body. Eye color genes, through the enzymes they produce, direct the amount and placement of melanin in the iris. Newborn babies all have blue eyes because at the time of birth they haven't begun to produce melanin in their irises. A baby's eyes may change to green, brown or other colors as melanin production begins. Albinos have no pigment in their irises so the blood vessels in the back of the eye reflect light making the eyes look pink. Albinos also lack melanin in their skin and hair. Since albinism is caused by a recessive allele, two normal parents may produce an albino. An albino can have normal offspring if the other parent is normal for melanin production.
http://www.seps.org/cvoracle/faq/eyecolor.html

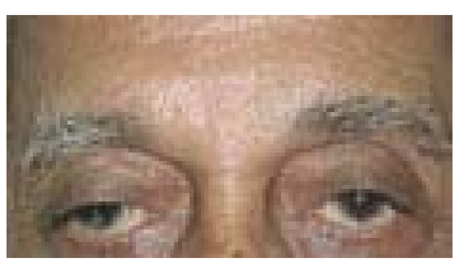
PTC Tasting

For some people (and some chimpanzees also), the chemical PTC tastes very bitter. For others, it is tasteless. PTC is a harmless compound that tastes bitter to those who have the dominant (and in this case the most frequent) trait. Those with the recessive trait do not taste the bitterness. PTC-like chemicals are found in the Brassica-family of vegetables, such as cabbages, broccoli, brussel sprouts, and kale. Some scientists think that tasters have fewer cavities, suggesting that there might be a substance in the saliva of tasters that inhibits the bacteria that cause cavities to form.

1931. PTC Paper Taster

Eyelids

Drooping eyelids (dominant trait) vs open eyelids (recessive trait). Look at your partner with relaxed eyes. Do your eyelids droop?



Hallux Length

Which of your toes is longer? Is your second toe longer than your first toe (dominant trait) or is your first toe (hallux) longer than your second (recessive trait)?

Long Second Toe	**Short Second Toe**
	

Skin color
Dark skin (dominant) vs light skin (recessive)

Color vision
Normal vision Dominant) vs color blind (recessive)
Do you see anything in the circle?? In class test.
Defects in color vision occur when one of the three cone cell color coding structures fails to function properly. One of the visual pigments may be present and functioning abnormally, or it may be absent altogether.
For practical purposes, all color-deficient individuals have varieties of red or green deficiency. Blue deficiencies are very rare. Color deficient patients are not completely red or green blind. Compared to persons with normal color vision, they have some trouble differentiating between certain colors, but the severity of the color deficiency is variable. Color blindness is a malfunction of the retina, which converts light energy into electircal energy that is then transmitted to the brain. This conversion is accomplished by two types of photoreceptor cells in the retina: rods and cones.
The cones are responsible for encoding color. Each cone contains structures or visual pigments sensitive to one of three wavelengths of light: red, green, and blue. Normal persons are able to match all colors of the spectrum by mixtures of only three fundamental color sensitivities. Hence, the huge variety of colors we perceive stems from the cone cells' response to different compositions of wavelengths of light.
http://k12science.ati.stevens-tech.edu/curriculum/genproj/traits.html
http://www.toledo-bend.com/colorblind/Ishihara.html
http://members.aol.com/protanope/colorblindtest.html
http://biosci.usc.edu/courses/2001-spring/documents/bisc102-humantraitslab.pdf

PUNNET SQUARE COIN TOSSING LAB

An exercise in probability...

DETERMINING THE *GENOTYPIC* AND *PHENOTYPIC* RATIOS
OF *POTENTIAL OFFSPRING* . . . THROUGH THE FLIP OF A COIN!

So what about Mendel . . .
By the way, how random is a coin toss, anyway?

Mr. Lazaroff's Biology

I. PURPOSE: To demonstrate the laws of probability, and the ratios of potential offspring, given specific sets of parents.

II. HYPOTHESIS: If I keep accurate records, then I will collect data that closely reflects the ratios predicted through the laws of probability.

III. EXPERIMENTAL DESIGN:

A. MATERIALS:

1. Two coins (preferably not of the same type, so as to avoid confusion)

B. PROCEDURE:

1. Assign letters, as instructed, to heads and tails of each coin.

- **Trial 1** - BB x BB Coin 1: Heads = B, Tails = B
(Parents) Coin 2: Heads = B, Tails = B
- **Trial 2** - bb x bb Coin 1: Heads = b, Tails = b
(Parents) Coin 2: Heads = b, Tails = b
- **Trial 3** - BB x bb Coin 1: Heads = B, Tails = B
(Parents) Coin 2: Heads = b, Tails = b
- **Trial 4** - BB x Bb Coin 1: Heads = B, Tails = B
(Parents) Coin 2: Heads = B, Tails = b
- **Trial 5** - Bb x bb Coin 1: Heads = B, Tails = b
(Parents) Coin 2: Heads = b, Tails = b
- **Trial 6** - Bb x Bb Coin 1: Heads = B, Tails = b
(Parents) Coin 2: Heads = B, Tails = b

BB x BB Trial 1

BB	Bb	bb	
BB			BOTH Coin 1 & Coin 2 get HEADS
BB			Coin 1 gets HEADS & Coin 2 gets TAILS
BB			Coin 1 gets TAILS & Coin 2 gets HEADS
BB			BOTH Coin 1 & Coin 2 get TAILS

bb x bb Trial 2

BB	Bb	bb	
		bb	BOTH Coin 1 & Coin 2 get HEADS
		bb	Coin 1 gets HEADS & Coin 2 gets TA
		bb	Coin 1 gets TAILS & Coin 2 gets HEA
		bb	BOTH Coin 1 & Coin 2 get TAILS

BB x bb Trial 3

BB	Bb	bb	
	Bb		BOTH Coin 1 & Coin 2 get HEADS
	Bb		Coin 1 gets HEADS & Coin 2 gets TAILS
	Bb		Coin 1 gets TAILS & Coin 2 gets HEADS
	Bb		BOTH Coin 1 & Coin 2 get TAILS

BB x Bb Trial 4

BB	Bb	bb	
BB			BOTH Coin 1 & Coin 2 get HEADS
	Bb		Coin 1 gets HEADS & Coin 2 gets TA
BB			Coin 1 gets TAILS & Coin 2 gets HEA
	Bb		BOTH Coin 1 & Coin 2 get TAILS

Bb x bb Trial 5

BB	Bb	bb	
	Bb		BOTH Coin 1 & Coin 2 get HEADS
	Bb		Coin 1 gets HEADS & Coin 2 gets TAILS
		bb	Coin 1 gets TAILS & Coin 2 gets HEADS
		bb	BOTH Coin 1 & Coin 2 get TAILS

Bb x Bb Trial 6

BB	Bb	bb	
BB			BOTH Coin 1 & Coin 2 get HEADS
	Bb		Coin 1 gets HEADS & Coin 2 gets TA
	Bb		Coin 1 gets TAILS & Coin 2 gets HEA
		bb	BOTH Coin 1 & Coin 2 get TAILS

2. Flip each coin simultaneously and record the appropriate letters for the pair of coin tosses (in Chart # 1; click HERE to print a copy); **be sure to note whether or not the letter is underlined**. (e.g. Toss 1 = BB) This will be useful in demonstrating that more than one combination of chromosomes can produce individuals with the same genotype

- Note: Each coin = one parent (the alleles of that parent)
- Heads & Tails = each possible gamete for that parent
- Heads = one allele for that gene
- Tails = the other allele for that gene
- Heads & Tails = on homologous chromosomes
- Heads = one chromosome in a homologous pair
- Tails = the other chromosome in a homologous pair
- The pair of letters you record = the genotype of a potential child of the

two parents in that trial

3. Repeat step # 2 19 more times, for a total of 20 tosses in each of the six trials = 120 tosses in all
4. Add up the totals for each of your group's trials and calculate the genotypic and phenotypic ratios for each trial (Group Ratios in Chart # 1click HERE to print a copy).

Genotypic Ratio - # BB : # Bb : # bb
Hint: BB and BB and BB and BB = BB
Phenotypic Ratio - # Dominant : # Recessive
Hint: Dominant = BB or Bb, Recessive = only bb

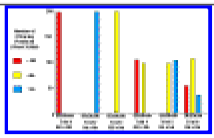
NOTE: To calculate the ratios, **divide each number by the lowest number** ***other than zero.***

Original Ratio	How to Calculate	Reduced Ratio
11 : 9 : 0	**11 : 9 : 0** **9 : 9 : 0**	**1.22 : 1 : 0**
Genotypic Ratio (BB : Bb : bb)		
105 : 95	**105 : 95** **95 : 95**	**1.11 : 1**
Phenotypic Ratio (Dominant : Recessive)		

5. Write the total results for each of the 6 trials on the chalkboard, and record the results for all of the groups in a class chart (Click HERE to print a copy.). (I will give your group a number.)
6. Add the totals for each trial in the class chart (Click HERE to print a copy.), then calculate the genotypic and phenotypic ratios for each of the class trial totals (Class Ratios in Chart # 2; click HERE to print a copy).
7. Construct a punnett Square for each of the six trials and write the genotypic and phenotypic ratios for each square (True Ratios).

Hint: Use the parents indicated for each trial in step # 1.

8. Graph the Class totals (Not the ratios!!) for each of the six trials; this is easier to see if it is done as ***six separate graphs, side by side, on one page.*** ALL GRAPHS MUST BE HAND DRAWN! This is to ensure that I know that you know how to make a graph, rather than having the computer make it for you!

Hint: The **X axis** should contain ***each of the 3 possible genotypes*** in order = BB : Bb : bb	 Make all six of the graphs BAR GRAPHS.	The **Y axis** should contain ***the numbers from each of the trials*** (i.e. how many per genotype).

IV. DATA: You will need to follow these links to print both *Chart # 1* and *Chart # 2*.

NOTE: If you miss the lab, you can get a copy of the Lab Data on the eChalk.

1. Your group chart (Chart # 1; click HERE to print a copy) to show the results (genotypes) of all 20 tosses (children) for each of the six trials in your group.
2. The genotypic and phenotypic ratios for each of the trials in Chart # 1 (Click HERE to print a copy).
3. A class chart (Chart # 2; click HERE to print a copy) to show the results of each of the six trials for all of the groups in the class.
4. The genotypic and phenotypic ratios for each of the trials in Chart # 2 (Click HERE to print a copy).
5. The six possible punnett squares as indicated in step # 1 for each trial.
6. The genotypic and phenotypic ratios for each of the punnettt squares.
7. A graph showing the class totals for each of the six trials, all on one bar graph (i.e., 220 : 0 : 0, 0 : 0 : 220, etc.).

ALL GRAPHS MUST BE HAND DRAWN!

	BB x BB	**bb x bb**	**BB x bb**
Genotypic Ratio	BB : Bb : bb ____ : ____ : ____	BB : Bb : bb ____ : ____ : ____	BB : Bb : bb ____ : ____ : ____
Phenotypic Ratio	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____

	BB x Bb	**Bb x bb**	**Bb x Bb**
Genotypic Ratio	BB : Bb : bb ____ : ____ : ____	BB : Bb : bb ____ : ____ : ____	BB : Bb : bb ____ : ____ : ____
Phenotypic Ratio	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____

V. QUESTIONS:

1. How close were your group's ratios for each trial to the ratios of the class as a whole? Be *specific*.
2. How close were the class ratios for each trial to the ratios predicted by each of the punnett squares? Be *specific*.
3. Were any of the individual group's results extremely different from the ratios predicted by the punnett squares? Give a *specific* example and compare the ratios.
4. What does the data say about sample size and the accuracy of calculating ratios? Explain.

Compare *your* Sample Size with that of *Gregor Mendel* . . .

5. Can you, with confidence, predict the actual *genotypic* outcome for any one given toss of the coin in trial 6? Trial 4? Trial 3? Explain.
6. Can you, with confidence, predict the actual *phenotypic* outcome for any one given toss of the coin in trial 6? Trial 4? Trial 3? Explain.
7. If BB = BB = BB = BB, why did I have you indicate whether or not the B came from the heads or the tails (i.e., what does the underlining indicate in terms of chromosomes?)?
8. Define the following: P generation, F_1 generation, F_2 generation. Indicate which ones are used in the lab above. Use *specific* examples.

VI. CONCLUSION: *You should know what to do! If you DON'T, click here!*

This must be 1/2 page minimum. Discuss everything you learned in today's lab. Be sure to discuss possible errors in accuracy, and any ways to improve this lab. Be sure to include any additional questions triggered by this lab, and propose ways to test those questions in an additional experiment. Note: I don't want you to waste any of the 1/2 page discussing whether or not you enjoyed the lab; your discussion here should be purely of a scientific nature.

Mr. Lazaroff's **Biology** Classes
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ANSWERS TO COIN TOSS LAB QUESTIONS:

1. How close were your group's ratios for each trial to the ratios of the class as a whole? Be *specific*.

STUDENT ANSWERS WILL VARY.

2. How close were the class ratios for each trial to the ratios predicted by each of the punnett squares? Be *specific*.

ANSWERS WILL VARY, BUT LOOK FOR EXACT MATCHES FOR TRIALS 1,2, & 3.

3. Were any of the individual group's results extremely different from the ratios predicted by the punnett squares? Give a *specific* example and compare the ratios.

STUDENT ANSWERS WILL VARY.

4. What does the data say about sample size and the accuracy of calculating ratios? Explain.

THE INDIVIDUAL GROUP TRIALS, WITH ONLY 20 KIDS, WILL BE LESS ACCURATE, OVERALL, THAN THE LARGER SAMPLE SIZE PROVIDED BY THE CLASS AS A WHOLE.
STUDENTS WHO, BY CHANCE, GOT PERFECT RATIOS IN THEIR SMALL TRIALS SHOULD STILL MENTION THE VALUE OF LARGE SAMPLE SIZE, BUT SOME WILL IGNORE THE IMPORTANCE, AND BE OVERLY SWAYED BY CHANCE.

5. Can you, with confidence, predict the actual *genotypic* outcome for any one given toss of the coin in trial 6? Trial 4? Trial 3? Explain.

FOR TRIAL 6, THERE ARE THREE POSSIBLE GENOTYPES (BB, Bb, BB), SO ONE **CAN'T** ACCURATELY PREDICT THE GENOTYPE FOR ONE TOSS.
FOR TRIAL 4, THERE ARE TWO POSSIBLE GENOTYPES (BB, Bb), SO ONE **CAN'T** ACCURATELY PREDICT THE GENOTYPE FOR ONE TOSS.
FOR TRIAL 3, THERE IS ONLY **ONE** POSSIBLE GENOTYPES (Bb), SO ONE **CAN** ACCURATELY PREDICT THE GENOTYPE FOR ONE TOSS.

6. Can you, with confidence, predict the actual *phenotypic* outcome for any one given toss of the coin in trial 6? Trial 4? Trial 3? Explain.

FOR TRIAL 6, THERE ARE TWO POSSIBLE PHENOTYPES (DOMINANT & RECESSIVE), SO ONE **CAN'T** ACCURATELY PREDICT THE PHENOTYPE FOR ONE TOSS.
FOR TRIAL 4, DESPITE THE TWO GENOTYPES, THERE IS **ONE** POSSIBLE PHENOTYPE (DOMINANT), SO ONE **CAN** ACCURATELY PREDICT THE PHENOTYPE FOR ONE TOSS.
FOR TRIAL 3, THERE IS ONLY **ONE** POSSIBLE PHENOTYPE (DOMINANT), SO ONE **CAN** ACCURATELY PREDICT THE PHENOTYPE FOR ONE TOSS.

7. If $BB = B\underline{B} = \underline{B}B = \underline{BB}$, why did I have you indicate whether or not the B came from

the heads or the tails (i.e., what does the underlining indicate in terms of chromosomes?)?

EACH COIN HAD TWO SIDES, REPRESENTING A HOMOLOGOUS PAIR.
EACH SIDE WAS **ONE** OF THE HOMOLOGOUS CHROMOSOMES.
THE LETTERS INDICATED **ONE** *ALLELE* FOR **ONE** *GENE* ON **ONE** OF THE *HOMOLOGOUS CHROMOSOMES*.
GIVEN THAT EACH CHROMOSOME HAS THOUSANDS OF GENES (33,000 ON 23 CHROMOSOMES), THE IDENTICAL LETTER B DOESN'T MEAN THAT *ALL* THE ALLELES WILL BE THE SAME ON THAT CHROMOSOME.
UNDERLINING CALLS ATTENTION TO THAT FACT.

8. Define the following: P generation, F_1 generation, F_2 generation. Indicate which ones are used in the lab above. Use *specific* examples.

P GENERATION = BOTH COINS
F_1 GENERATION = THE RESULTS OF EACH COIN TOSS
F_2 GENERATION = NOT PRESENT IN THIS LAB

The Not So Random Coin Toss

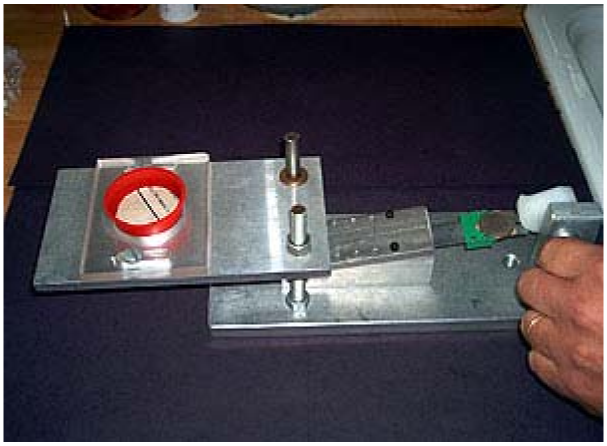
Mathematicians Say Slight but Real Bias Toward Heads

From **All Things Considered** on **National Public Radio**
February 24, 2004

Feb. 24, 2004 -- Flipping a coin may not be the fairest way to settle disputes. About a decade ago, statistician Persi Diaconis started to wonder if the outcome of a coin flip really is just a matter of chance. He had Harvard University engineers build him a mechanical coin flipper. Diaconis, now at Stanford University, found that if a coin is launched exactly the same way, it lands exactly the same way.

Statistician Persi Diaconis' mechanical coin flipper.
Credit: Susan Holmes

The randomness in a coin toss, it appears, is introduced by sloppy humans. Each human-generated flip has a different height and speed, and is caught at a different angle, giving different outcomes.



Persi Diaconis' mechanical coin flipper, designed by Harvard University engineers.
Diaconis says that if a coin is flipped exactly the same way, the coin lands the same way.
Credit: Susan Holmes

But using high speed cameras and equations, Diaconis and colleagues have now found that even though humans are largely unpredictable coin flippers, there's still a bias built in: If a coin starts out heads, it ends up heads when caught more often than it does tails. NPR's David Kestenbaum reports.

*Note: In football's inaugural kickoff coin toss, the coin is not caught but allowed to bounce on the ground. That introduces an extra complication, one mathematicians have yet to sort out.

"Ideal Mate" Assignment

Mr. Lazaroff's Biology

part I

See part II

Sorry for being heterocentric, but since offspring are biologically derived from opposite sex parents, your "Ideal Mate" (or perhaps we should call this person your "ideal breeding partner") needs to be of the opposite sex.
They may, however, be *raised* by same sex parents.

Photograph:

Bring in a photograph of your "ideal mate." *In terms of sexuality, feel free to consider the "ideal mate" as merely a person *with whom to have children*, rather than as a life partner. The photo may be from an internet site, or an actual photograph. ***NO MAGAZINE PHOTOS***, as too many people in the past have removed them from magazines in the library!

Limitations:

1. The photo must pass the *prude family member test* (i.e., it cannot offend the most prudish member of your family!). ***AS SUCH, no nude photos, or photos depicting violent acts will be accepted!***

2. The photos cannot be taken from materials in either the school library or the public library! ***Get them from home, or from the internet, PLEASE!***

Story:

Write a one page story of how the two of you met. Let your imagination go. HAVE FUN!

Limitations:

1. No descriptions of sexual encounters!

2. No descriptions of illegal activites (including drug use)!

3. No descriptions of sexist, racist, agist, homophobic, heterophobic, or other separatist thinking or actions!

THE TRAITS: IF YOU DON'T KNOW, MAKE THE TRAIT THE OPPOSITE OF YOU!

1. Tongue Rolling: ***Can*** **OR** ***Can't***
2. Eye Color: ***Brown*** **OR** ***Not Brown ****
3. Hair Color: ***Brown*** **OR** ***Not Brown ****
4. Hair Type: ***Curly*** **OR** ***Straight***
5. Widows Peak: ***Peak*** **OR** ***No Ppeak***
6. Height (3 choices!): ***Tall (above 5' 8'')*** **OR** ***Medium (5' 2 1/2" to 5' 7 1/2")*** **OR** ***Short***

(below 5' 2") *

7. Earlobe: ***Free*** **OR** ***Attached***

8. Mid-digit (i.e., between the two knuckles) Finger Hair: ***Hair*** **OR** ***No hair***

9. Freckles: ***Freckles*** **OR** ***No freckles***

10. Gender: ***Female*** **OR** ***Male***

11. Colorblindness: ***Normal*** **OR** ***Colorblind*** **NOTE: For this assignment, your ideal mate WILL BE COLORBLIND!**

12. Vision: ***Normal & Farsighted*** **(Hyperopia) OR** ***Nearsighted (Myopia)***

13. Cheek Dimples: ***Dimples*** **OR** ***No Dimples***

14. Lip Thickness: ***Broad Lips*** **OR** ***Thin Lips***

15. Chin: ***Cleft Chin*** **OR** ***No Cleft***

16. Pinky shape: ***Bent*** **OR** ***Straight*** *(Place your hands palms up, with the pinkies touching; if the pinkies point away from each other, they're bent.)*

17. Hallux (a.k.a. Big Toe) Length: ***2nd Toe is the Longest*** **OR** ***Big Toe is the Longest***

18. Pollux (a.k.a. Thumb) Shape: ***Straight*** **OR** ***"Hitchhiker's Thumb"*** *(The thumb naturally bends backwards toward the wrist.)* *******

19. Skin Color: ***Dark Skin*** **OR** ***Light Skin ****

20. Eyelids: ***Drooping*** **OR** ***Open***

21. Crossing your hands (i.e., interlaced fingers and thumbs): ***Left Thumb over Right*** **OR** ***Right Thumb over Left ****

22. PTC Taster: ***Drooping*** **OR** ***Open*** *(Tasters will find PTC bitter; the presence of PTC in cabbage, broccoli, brussel sprouts and kale, may help to explain why some people dislike them so much!)*

**** The traits marked with an asterisk are actually polygenic (controlled by many genes), so the results of your pedigrees may contradict what you would expect in a simple monogenic trait (controlled by one gene).***

"Ideal Mate" Assignment

Mr. Lazaroff's Biology

part II
The *PRELUDE*

DON'T MISS THESE: HELPFUL FILES

The *FINISHED Product*

See part I

Sorry for being heterocentric, but since offspring are biologically derived from opposite sex parents, your "Ideal Mate" (or perhaps we should call this person your "ideal breeding partner") needs to be of the opposite sex.
They may, however, be *raised* by same sex parents.

The PRELUDE: *(Check the homework page for the due date!)*

You must make a list of the PHENOTYPE (Physical Trait!) ONLY of all the traits below, for as many of the following individuals as you can -- If you are *ADPOPTED*, please CLICK HERE! ***EITHER E-MAIL YOUR FAMILY MEMBERS, OR TAKE ADVANTAGE OF THE WEEKEND'S LOWER LONG DISTANCE RATES, OR USE A CELL PHONE'S LONG DISTANCE PLAN!***

<table>
<tr><td colspan="2">Maternal Grandparents</td><td colspan="2">Paternal Grandparents</td></tr>
<tr><td>Aunts & Uncles
(Mom's Siblings)</td><td>Mom</td><td>Dad</td><td>Aunts & Uncles
(Dad's Siblings)</td></tr>
<tr><td>1st Cousins
(if any) and their Spouses (if any)</td><td colspan="2">You (of course!) and
Your Siblings (if any)
and their Spouses (if any)</td><td>1st Cousins
(if any) and their Spouses (if any)</td></tr>
<tr><td>2nd Cousins
(if any)</td><td colspan="2">Nieces & Nephews
(if any)</td><td>2nd Cousins
(if any)</td></tr>
<tr><td colspan="4">NOTE: If you have any half-brothers or half-sisters,
then you will need to include: step-parents, step-grandparents,
step-aunts, step-uncles, step-nieces, step-nephews, and step-cousins!</td></tr>
<tr><td colspan="4">Once again, the more data the better (THINK SAMPLE SIZE!)</td></tr>
<tr><td colspan="4">THE TRAITS

1. Tongue Rolling: Can OR Can't</td></tr>
</table>

2. **Eye Color:** ***Brown*** **OR** ***Not Brown****
3. **Hair Color:** ***Brown*** **OR** ***Not Brown****
4. **Hair Type:** ***Curly*** **OR** ***Straight***
5. **Widows Peak:** ***Peak*** **OR** ***No Ppeak***
6. **Height (3 choices!):** ***Tall (above 5' 8'')*** **OR** ***Medium (5' 2 1/2" to 5' 7 1/2")*** **OR** ***Short (below 5' 2") ****
7. **Earlobe:** ***Free*** **OR** ***Attached***
8. **Mid-digit (i.e., between the two knuckles) Finger Hair:** ***Hair*** **OR** ***No hair***
9. **Freckles:** ***Freckles*** **OR** ***No freckles***
10. **Gender:** ***Female*** **OR** ***Male***
11. **Colorblindness:** ***Normal*** **OR** ***Colorblind***
12. **Vision:** ***Normal & Farsighted* (Hyperopia)** **OR** ***Nearsighted (Myopia)***
13. **Cheek Dimples:** ***Dimples*** **OR** ***No Dimples***
14. **Lip Thickness:** ***Broad Lips*** **OR** ***Thin Lips***
15. **Chin:** ***Cleft Chin*** **OR** ***No Cleft***
16. **Pinky shape:** ***Bent*** **OR** ***Straight*** *(Place your hands palms up, with the pinkies touching; if the pinkies point away from each other, they're bent.)*
17. **Hallux (a.k.a. Big Toe) Length:** ***2nd Toe is the Longest*** **OR** ***Big Toe is the Longest***
18. **Pollux (a.k.a. Thumb) Shape:** ***Straight*** **OR** ***"Hitchhiker's Thumb"*** *(The thumb naturally bends backwards toward the wrist.)* *****
19. **Skin Color:** ***Dark Skin*** **OR** ***Light Skin ****
20. **Eyelids:** ***Drooping*** **OR** ***Open***
21. **Crossing your hands (i.e., interlaced fingers and thumbs):** ***Left Thumb over Right*** **OR** ***Right Thumb over Left ****
22. **PTC Taster:** ***Drooping*** **OR** ***Open*** *(Tasters will find PTC bitter; the presence of PTC in cabbage, broccoli, brussel sprouts and kale, may help to explain why some people dislike them so much!)*

**** The traits marked with an asterisk are actually polygenic (controlled by many genes), so the results of your pedigrees may contradict what you would expect in a simple monogenic trait (controlled by one gene).***

HELPFUL FILES

Pedigree Details: This TEXT file has the info above, so you can copy and paste it into e-mail to your family members! (pedigree_details.txt)

Family Pedigree Traits: There is an EXCEL version (family_pedigree_traits.xls)
and a TEXT version (family_pedigree_traits.txt) . You can import the TEXT version into any spreadsheet to which you have access. These files will make it a great deal easier to collect the data!

I realize that some people may be adopted, or from complex families with half-siblings, etc. If you are adopted, and you have no contact with your birth parents, be sure to gather the information for yourself and for your adopted family. I will help you to see which of your traits integrate well with those of your adopted family when you complete the pedigrees, but even if we have to speculate on your genotype, the rest of the pedigree will still allow you to problem-solve using real data.

In the case of deceased individuals, such as grandparents, ask other relatives what they know. NOTE: You don't need to know *ALL* the information for *EVERY* individual, but, as in the coin toss lab and sample size, *THE MORE DATA THE BETTER!* (As you work through the pedigrees, you will see that some of the blanks can be filled in, just by using a little logic!) You will need to use this information to

construct *Pedigrees* for each of the *10 Traits* below.

THE FINISHED PRODUCT: *DUE ONE WEEK AFTER THE PRELUDE! Check the homework page for the due date!)*

ASSIGNMENT:

READ THE PEDIGREE TUTORIAL

1. You must make a ***LIST*** of the ***phenotype*** (for each of the ***10 Traits***) for all of the following *six* individuals: yourself, your mother, your father, your "ideal mate", your female child, your male child. **NOTE:** See the ***HINTS*** section for help with your "Ideal Mate," who, incidentally, ***must be colorblind!***

You need to construct a ***Pedigree*** for each of the ***10 Traits*** below.

(a) Construct a blank ***Pedigree*** and make multiple copies.
(b) Each ***Pedigree*** needs to have numbers labeling each generation (e.g., I, II, III, etc.) and numbers labeling each individual (e.g., 1, 2, 3, etc.).
(c) The first ***Pedigree*** needs to have the names of each individual. Specify, in addition to the names, the following three people: your mom ("Mom"), your dad ("Dad"), and you ("Me").
(d) Each of the other ***Pedigrees*** will be for one of the ***Traits*** below.
(e) ***BE SURE TO READ THE PEDIGREE TUTORIAL!!***

2. Fill in the phenotypes for the first four people, and then fill in the genotypes for all the ***recessive*** individuals **-** ***How do we know that genotype for sure?***

3. Construct a punnett Square to determine your own genotype for each of the traits below - a minimum of 22 punnett squares (one for each of the ***Traits*** below) . In each of these squares your mom and dad will be on the outside of the square, and you and any siblings will be the children inside the square. Include the *genotypic ratio* and *phenotypic ratio* for each square. Indicate which one you are in the punnett square: females with a *circle* and males with a *square*.

4. *Whenever possible*, consider *other* members of the family when constructing the squares (e.g. If your parents each have a *dominant phenotype* for a specific trait, but you have a sibling with a ***recessive*** *phenotype* for that same trait, then your parents **cannot be homozygous dominant for that trait!** WHY?). You may have to go back to your grandparent's generation to be sure!

5. At a certain point you may need to make a choice as to *homozygous dominant or heterozygous*, but **only** if **both** are possible in the punnett square (or ***Pedigree***) above.

6. Construct 22 punnett squares, 1 for each of the ***Traits*** below (In each of these squares you and your "ideal mate" will be on the outside of the square, and your children will be the inside the square.), to determine the *genotype* and *phenotype* for **two** potential children: one female, one male **(LABEL!)**, *be **consistent** for all **22** of the punnett squares.* Include the *genotypic ratio* and *phenotypic ratio* for each square. Indicate which one's in the punnett square are your children: females with a *circle* and males with a *square*.

7. Name your children, and draw their pictures (reflecting the *phenotypes* for each trait).

NOTE: Ultimately you need to have completed a minimum of: *44 punnett squares*, *2 drawings*, *and* the 22 *Pedigrees*!

HINTS:

1. If there is any trait you are **unsure** of in your "ideal mate," make it the **opposite** of yourself.

2. For your "ideal mate," any **dominant** trait in the phenotype should be the **heterozygous genotype** *(that will make the punnett squares more interesting!).* The same holds true if you are uncertain as to **your** genotype, **but only if the punnett square says you can be either.**

TRAITS (See Above): Note: these dominant and recessive traits have single alleles, but the genotypes will have two! (e.g., Tongue rolling genotypes are RR : Rr : rr)

NOTE: Colorblindness is carried on the X chromosome - females needs 2 alleles for it to show up, but males (XY) needs only 1 allele to be colorblind!

LISTS: *Don't Even **ATTEMPT** the punnett squares, or the **Pedigrees** until you finish the lists of traits for each individual! **NOTE: The Sample list below is incomplete, but it gives you an idea of what you should be completing. The Phenotype is easy, but the genotype you will need to determine through the pedigrees that will follow.***

		Mom			Dad	
		Phenotype	Genotype		Phenotype	Genotype
Trait #	Trait Name					
1	Roll tongue					
2	Eye color					
3	Hair color					
4	W.'s Peak					
5	Height					
6	Earlobe					
7	Finger hair					
8	Freckles					
9	Sex					
10	Colorblind					
		You			Ideal Mate	
		Phenotype	Genotype		Phenotype	Genotype
Trait #	Trait Name					
1	Roll tongue					
2	Eye color					
3	Hair color					
4	W.'s Peak					
5	Height					
6	Earlobe					
7	Finger hair					
8	Freckles					
9	Sex					
10	Colorblind					
		Female Child			Male Child	
		Phenotype	Genotype		Phenotype	Genotype
Trait #	Trait Name					
1	Roll tongue					
2	Eye color					
3	Hair color					
4	W.'s Peak					
5	Height					
6	Earlobe					
7	Finger hair					
8	Freckles					
9	Sex					
10	Colorblind					

punnett Squares: NOTE: Copy and paste these as needed to show all of the actual punnett squares you will need

Trait: ___________ Trait: ___________ Trait: ___________

Mom --->

Dad --->			
Genotypic Ratio	BB : Bb : bb _____ : _____ : _____	BB : Bb : bb _____ : _____ : _____	BB : Bb : bb _____ : _____ : _____
Phenotypic Ratio	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____
	Trait: __________	Trait: __________	Trait: __________
Mom --->			
Dad --->			
Genotypic Ratio	BB : Bb : bb _____ : _____ : _____	BB : Bb : bb _____ : _____ : _____	BB : Bb : bb _____ : _____ : _____
Phenotypic Ratio	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____	Dominant : Recessive _____ : _____

Drawings:

Female Child's Name: ____________________

(Draw picture below)

Male Child's Name: ____________________

(Draw picture below)

Conclusion: (Minimum of 1 page)

You didn't honestly think I was going to let you off the hook so easily, did you? You know what to do. Be sure to also reflect not only on what you learned, but on the accuracy of your data (think about sample size, the number of offspring, etc,).

Mr. Lazaroff's Biology

Pedigree Tutorial

Mr. Lazaroff's Biology

A Pedigree is a Graphic Representation of Inheritance!

In your Ideal Mate Assignment, part II, you are required to figure out the phenotype of your potential offspring. In order to do that, you need to know their genotypes. To do that, you must know the genotypes (and phenotypes) of you and your ideal mate. To do that, however, you need to know the genotypes (and phenotypes) of your parents and your ideal mates parents, and so on . . .

In the hints section of the Ideal Mate Assignment, part II, you were given hints to help you figure out the genotype and phenotype of your ideal mate (i.e., if you don't know the phenotype, make it the opposite of yourself; if the phenotype is dominant, make it heterozygous). The reason for this is rather obvious, for such information is not easily available. I cannot, however, be as easy on you!

In order for you to complete the Ideal Mate Assignment, part II, you need to do the following, in the order below:

1. The Prelude -- collect phenotypic information for as many relatives as you can. Remember the idea of sample size -- the more, the better!
2. Using this information, fill out the phenotype side of the table for your parents, and yourself.
3. The only part of the genotype side you can now fill in is for those individuals who are recessive, for they must be what genotype?
4. Using the hints section, fill out the phenotype and genotype for your ideal mate.

Now comes the hard part . . .

5. Construct and fill out a family pedigree as per the given instructions.
6. As you fill out the pedigree, it becomes necessary to compare the phenotypes of the parents and the children to the six possible punnett squares. You will need one pedigree for each of the ten traits listed, so it is a good idea to make a **master** pedigree (with the names of all the family members), and then **ten copies**, which you will fill out.
7. Although it may, under very specific conditions, become necessary to decide on a either the homozygous dominant or heterozygous genotype, it is usually possible to determine the exact genotype of most people in a pedigree (see the pedigree instructions).

8. Using the genotypes you have determined for your parents from the pedigree (for which you had to refer to the punnett squares, as stated above), simply copy them in the genotype side of the table.
9. Given that you needed to refer to the punnett squares in the construction of the pedigree for each trait, simply copy the appropriate punnett square (using the letters described, such as R's for tongue rolling, F's for ear lobes) for your parents, with you and your siblings being within the square. You will need one square for each of the ten traits listed.
10. Having determined your genotype, and your ideal mate's (from the hints section), fill out the appropriate punnett squares for each of the ten traits listed, with your potential children being within the square.
11. Using the genotypes and phenotypes that are possible within each of the punnett squares in the step above, fill in the phenotypes and genotypes for your potential children in the table.
12. Lastly, using the phenotypes for your potential children, create a drawing that incorporates all of the ten traits.

As you will see, this assignment requires not only an understanding of the relationship between genotypes and phenotypes, but, in addition, the use of that information to build punnett squares, and interpret your ***unique*** family pedigree. ***Even adopted members of the class can construct a pedigree using the information from their adopted family; although this will not help the adopted student to discover her/his own specific inheritance, it will help them to learn a great deal about genetics in general, and their adopted family in particular.***

Given the importance of punnett squares in this whole process, we need to start off with a bit of review:

Remember, there are only SIX punnett Squares:

BB x BB

	B	B
B		
B		

Trial 1

bb x bb

	b	b
b		
b		

Trial 2

BB x bb

	B	B
b		
b		

Trial 3

BB x Bb

	B	b
B		
B		

Trial 4

Bb x bb

	B	b
b		
b		

Trial 5

Bb x Bb

	B	b
B		
b		

Trial 6

From our punnett Square/Coin Toss Lab, they were given the following Trial Numbers:

Once the squares have been filled out . . .

	B	B
B	BB	BB
B	BB	BB

	b	b
b	bb	bb
b	bb	bb

	B	B
b	Bb	Bb
b	Bb	Bb

	B	b
B	BB	Bb
B	BB	Bb

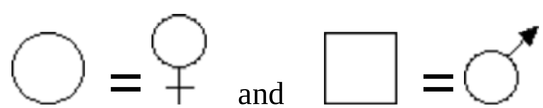
	B	b
b	Bb	bb
b	Bb	bb

	B	b
B	BB	Bb
b	Bb	bb

Fill out the Genotypic & Phenotypic Ratios:					
BB : Bb : bb ___ : ___ : ___	BB : Bb : bb ___ : ___ : ___	BB : Bb : bb ___ : ___ : ___	BB : Bb : bb ___ : ___ : ___	BB : Bb : bb ___ : ___ : ___	BB : Bb : bb ___ : ___ : ___
Dom. : Rec. ___ : ___	Dom. : Rec. ___ : ___	Dom. : Rec. ___ : ___	Dom. : Rec. ___ : ___	Dom. : Rec. ___ : ___	Dom. : Rec. ___ : ___
Which should give you the following UNREDUCED Ratios:					
4 : 0 : 0 **4 : 0**	**0 : 0 : 4** **0 : 4**	**0 : 4 : 0** **4 : 0**	**2 : 2 : 0** **4 : 0**	**0 : 2 : 2** **2 : 2**	BB : Bb : bb 1 : 2 : 1 Dom. : Rec. 3 : 1
Which should be REDUCED to the following Ratios:					
BB : Bb : bb 1 : 0 : 0 Dom. : Rec. 1 : 0	BB : Bb : bb 0 : 0 : 1 Dom. : Rec. 0 : 1	BB : Bb : bb 0 : 1 : 0 Dom. : Rec. 1 : 0	BB : Bb : bb 1 : 1 : 0 Dom. : Rec. 1 : 0	BB : Bb : bb 0 : 1 : 1 Dom. : Rec. 1 : 1	BB : Bb : bb 1 : 2 : 1 Dom. : Rec. 3 : 1

How to Build a Pedigree

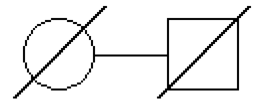
1. Females are indicated with a circle, and males are indicated with a square.



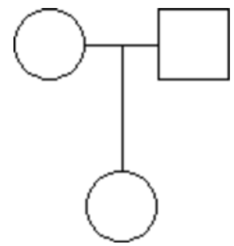
An individuals who is deceased should have a diagonal line passing through her/his symbol.

2. A straight, horizontal line connecting a female and a male indicates that the two are married, and/or produced children.

NOTE: When individuals are deceased, we indicate them in a pedigree as follows . . .



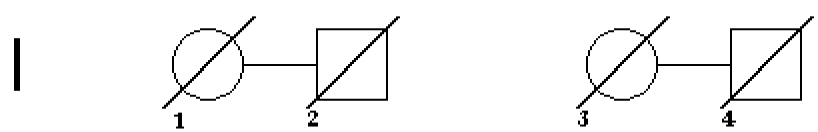
3. A straight, vertical line connected to the vertical line above indicates the children produced by that union.



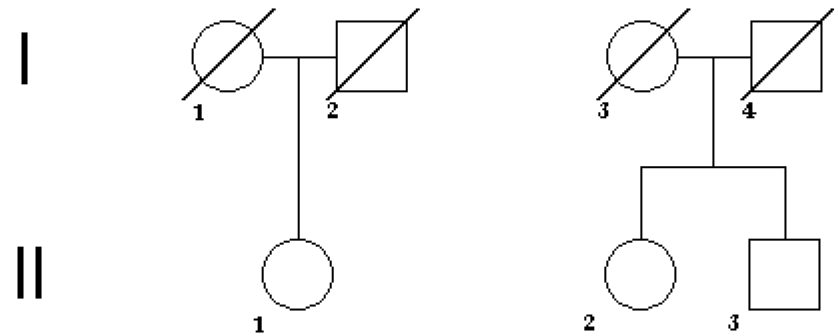
4. If more than one child is produced by that union, a straight, horizontal line is drawn from the vertical line above, and all the children hang down from that horizontal line.
5. All of the children from a specific union should be placed in birth order.
6. Despite placing the children from a specific union in birth order, the order of children from multiple families need not be in order from left to right.
7. Each generation should be given a roman numeral, with the oldest in the pedigree (traditionally at the top) being labeled "I."
8. Each individual within a given generation should be numbered using Arabic numerals, from left to right.
9. Using such a numbering system, each individual gets a unique identification (e.g., I-3, II-1, III-5, etc.).
10. Start off with your grandparent's generation, although a pedigree can start out with the oldest generation for whom you have information.

Building Mr. Lazaroff's Pedigree

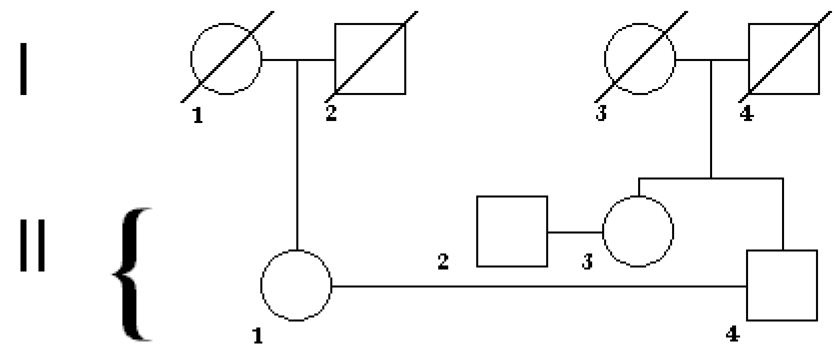
I = Granparents



I = Granparents, II = Parents, Aunts & Uncles

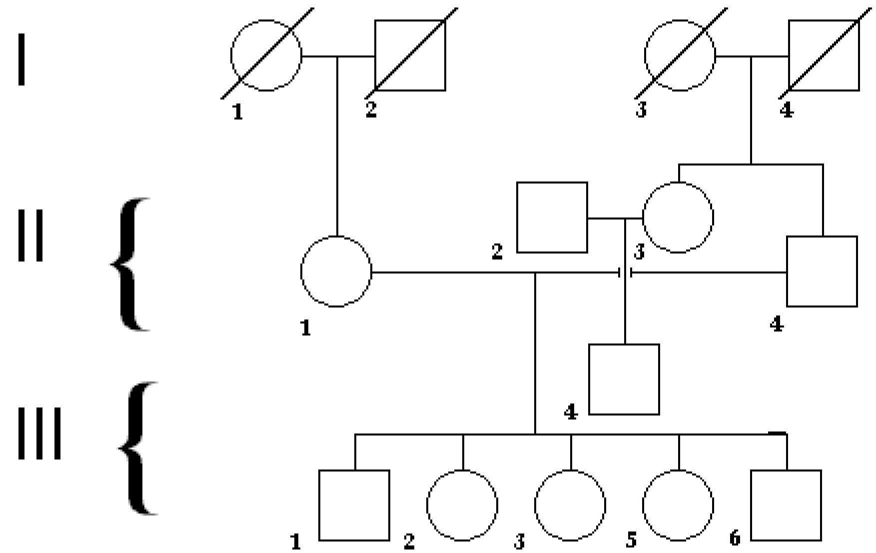


I = Granparents, II = Parents, Aunts & Uncles (*including by marriage*)

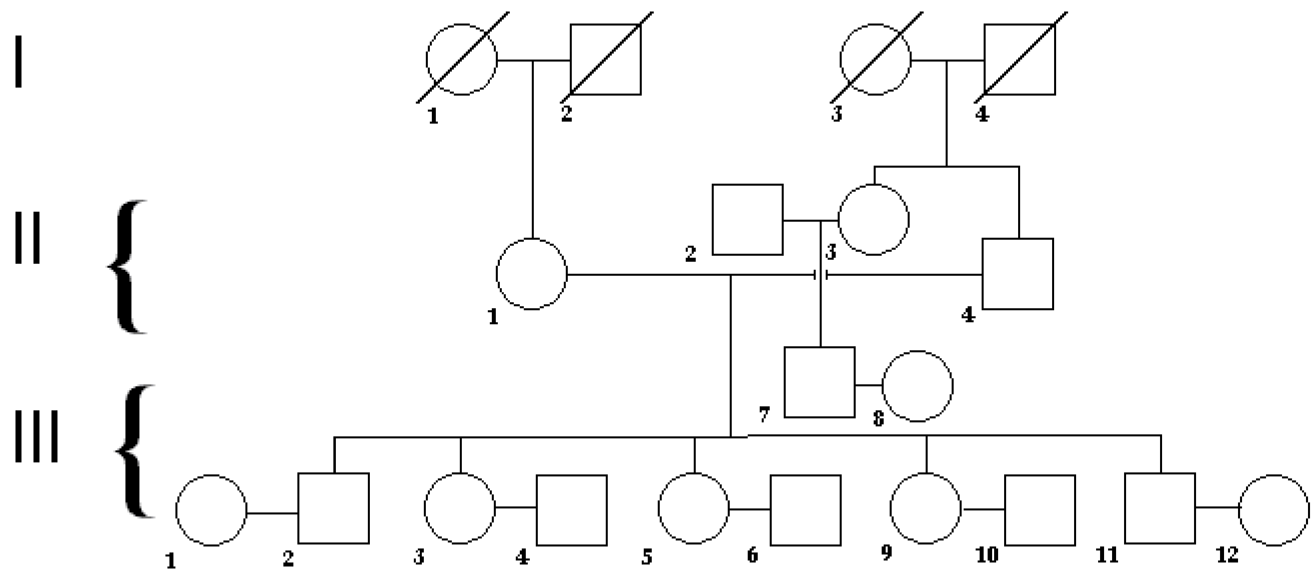


NOTE I: If a male and female who are not immediately next to each other on the pedigree, such as II-1 and II-4, have children, then it is necessary to place them on the same horizontal level. Place the other individuals in the generation, II-2 and II-3, on a different horizontal level. It will then be necessary to indicate the two horizontal levels of generation II with a bracket. Remember, the different horizontal levels are merely a device to make it easier to indicate different marriages within one generation.

I = Granparents, II = Parents, Aunts & Uncles (*including by marriage*)
III = Yourself, Siblings, 1st Cousins

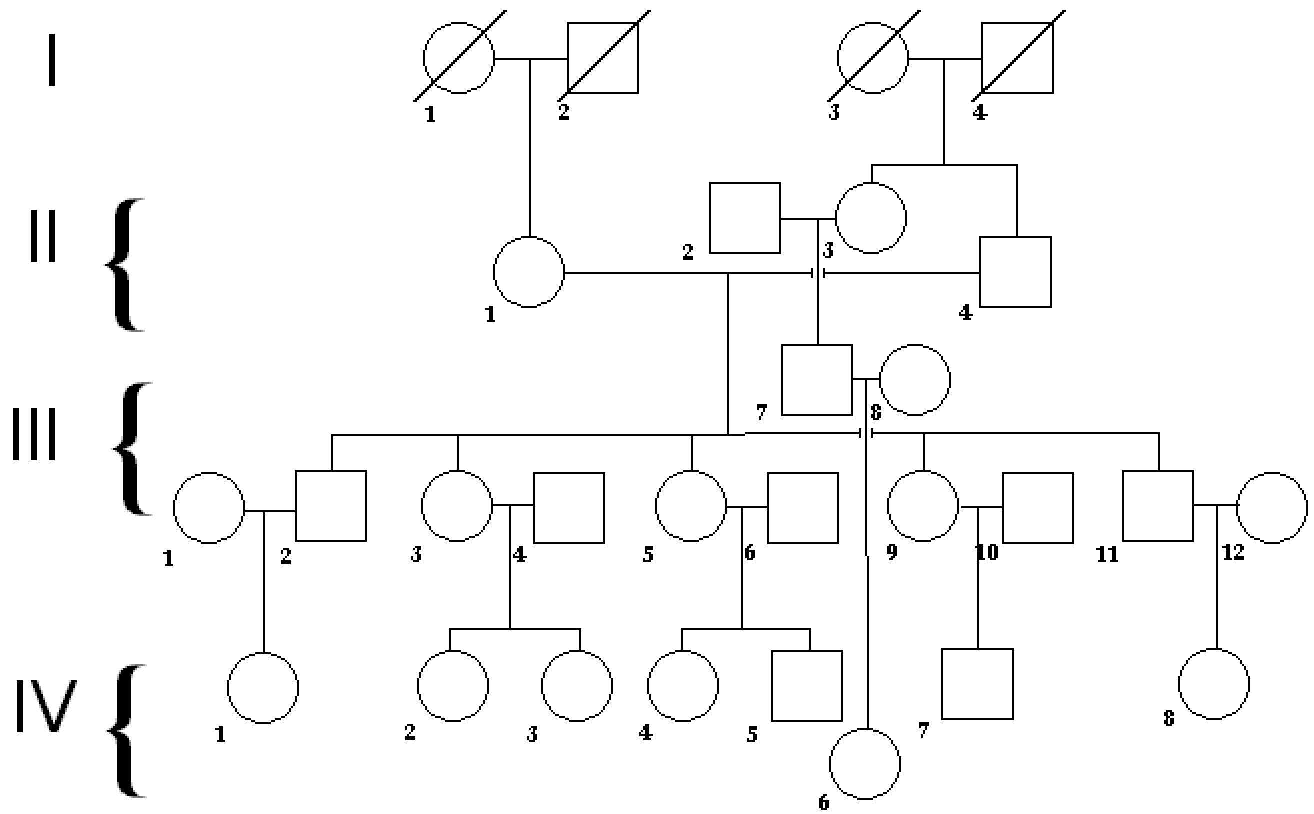


I = Granparents, II = Parents, Aunts & Uncles (*including by marriage*)
III = Yourself, Siblings, 1st Cousins (*including by marriage*)



I = Granparents, II = Parents, Aunts & Uncles (*including by marriage*)
III = Yourself, Siblings, 1st Cousins (*including by marriage*)

IV = Your Generation's *Children* (including Neices & Nephews)

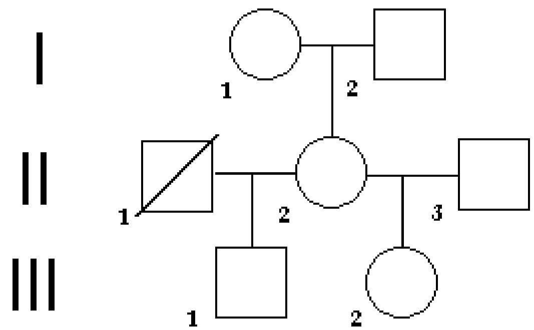


NOTE II: Given the complexity indicated in the note above, it may become necessary to have lines cross to indicate the different children of multiple marriages. Note that individual IV-6 in Mr. Lazaroff's Pedigree is clearly the child of individuals III-7 and III-8, despite the crossing of lines.

Notes I and II illustrate an interesting point. Given that life is more complex than a simple pedigree can illustrate, it becomes necessary to extend part of a pedigree not only up and down, but also left and right. Most pedigrees are thus drawn with the paper in landscape view. Also, don't forget that these pedigrees only touch upon other families. The top generation is not truly the oldest, for thousands of years worth of ancestry has been ignored! In addition, when we include our cousins, we need to include the spouse of our blood-aunt or blood-uncle. Those individuals, however, have their own pedigrees that intersect our own. With many aunts and uncles, the true situation becomes even more complex. From our grandparents alone, we are talking about the intersection of four other pedigrees. From Mr. Lazaroff's pedigree, a fifth pedigree intersects in generation II (for II-2), and six more in generation III (for III-1, III-4, III-6, III-8, III-10, and III-12)!

NOTE III: When a person remarries, due to either death or divorce, indicate the other marriage on the opposite side; this will make it easier to indicate the children of each union. It is not necessary to indicate which marriage happened first, or that a divorce took place. In the sample pedigree below, individual II-2 was married twice; individual III-1 is the child of II-2 and II-1, and individual III-2 is the child of II-2 and II-3. Individuals III-1 and III-2 are half-siblings because they share a biological parent (II-2).

Sample Pedigree

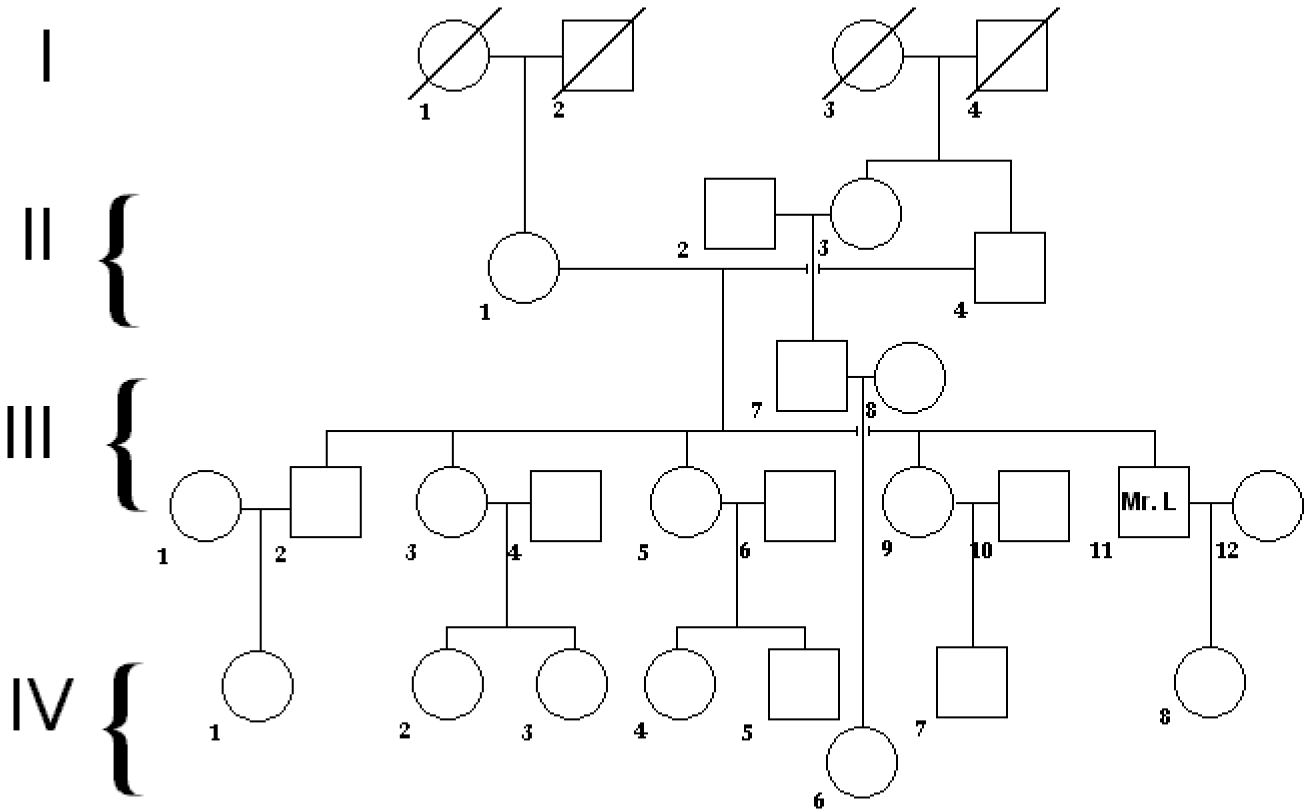


NOTE IV: When a person remarries, the children of the new spouse from a previous marriage should **not** be included in your pedigree. In an official pedigree, the children **would** be included if the second marriage **produced children** (i.e., if half-siblings were produced), but **not** if the only siblings are step-siblings (i.e., step-brother, step-sister).

NOTE V: Individuals who are adopted should **only** be included if they had children with a blood relative. This is not to diminish their importance in the emotional make-up of the family, but rather to indicate that they cannot be included in terms of the inheritance of physical traits.

The Pedigrees above are a graphic representation of Mr. L's Family.
Look at the Pedigree below to see where Mr. L is, and, using the proper designation
(i.e., II-2? IV-5?) answer the following questions:
(1) Who is Mr. L?

(2) Who is Mr. L's Daughter?
(3) Who is Mr. L's Mother?
(4) Who is Mr. L's Paternal Grandfather?
(5) Who is Mr. L's oldest sibling? Is that person a brother or a sister?



How to Fill in a Pedigree’s Phenotypes and Genotypes

As a graphic representation of inheritance, it is important to have a different pedigree for each of the ten traits being studied.

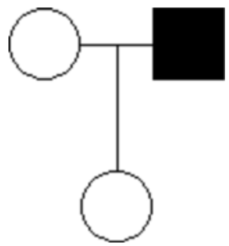
BACKGROUND

1. There are *three* genotypes, or combinations of alleles for *one* gene (e.g., BB : Bb : bb), and only *two* phenotypes, or

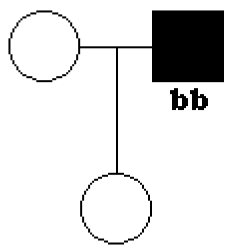
traits that can expressed from that gene (e.g., dominant or recessive).
2. A phenotype is the *physical expression* of a genotype.
3. It follows that *two of the genotypes must correspond to one phenotype*. The homozygous dominant (BB) and heterozygous (Bb) genotypes are *both dominant*.
4. The recessive phenotype can therefore only have the homozygous recessive genotype. As such, *any individual who is recessive for a trait must be homozygous recessive*.

Filling in a Pedigree

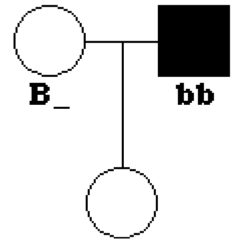
1. First of all, shade in the symbols for all the individuals who have the recessive trait.



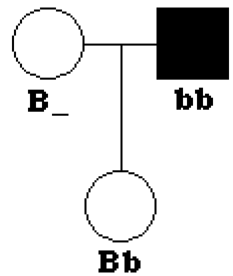
2. These individuals, as explained above, ***must be homozygous recessive***, so write their genotype (e.g., bb, rr, tt, etc.) underneath these individual's shaded symbols.



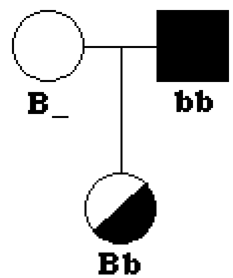
3. Given that The homozygous dominant (BB) and heterozygous (Bb) genotypes are both dominant, at this point it becomes necessary to look at more than one generation in order to figure out the genotypes of all the dominant individuals.
4. The given that we don't know the genotype of the mother above, we indicate it as B_.



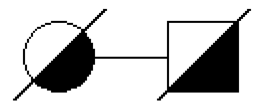
5. Given that the daughter above had to have inherited a recessive allele from her father, but she is nonetheless dominant, we have to label her as heterozygous (Bb).



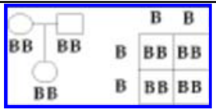
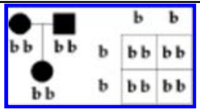
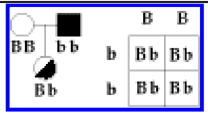
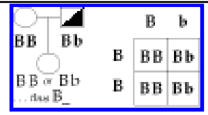
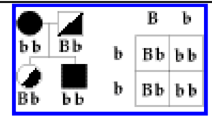
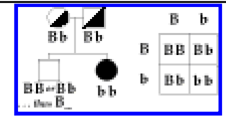
6. Being heterozygous, the daughter is called a carrier, as she carries the recessive allele (b), but she does not express the recessive trait. Carriers are indicated by diagonally shading the lower half of the symbol.



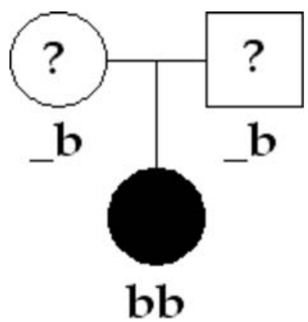
NOTE: When deceased individuals are carriers, we indicate them in a pedigree as follows . . .



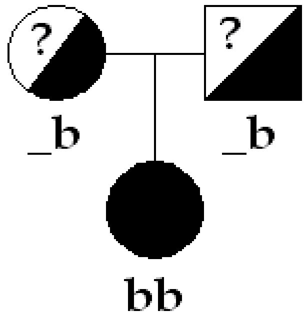
7. Don’t forget that working out a pedigree basically involves using the information we learned in the punnett squares, so you will need to compare the pedigree to the punnett squares in order to predict whether an individual is homozygous dominant or heterozygous.

Click on the links below to see a comparison of the punnett squares and specific pedigree examples!					
BB x BB	**bb x bb**	**BB x bb**	**BB x Bb**	**Bb x bb**	**Bb x Bb**
					
Don't assume this is the case if everyone is dominant! Be on the safe side and say B_	**You can, however, assume that everyone here is homozygous recessive (bb)**	**NOTE: Even if the mother above is Heterozygous, any dominant child will be Bb**	**Once again, you cannot be SURE of the genotype for a dominant person, so you have to put B_**	**NOTE: Based on the recessive child, you CAN figure out the genotype of the Father above**	**Once again, based on the recessive child, you KNOW the genotypes of BOTH Parents**

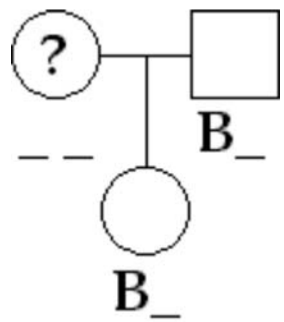
8. In general, you will find that the more information you have, the better (think about the importance of sample size from the punnett square/coin toss lab), but occasionally we do not have enough information to be completely sure.
9. Despite this, we can usually narrow it down to one of two possibilities. For example, an individual who is dominant has to be either BB or Bb. We know, at the very least, that they have to have at least one dominant allele to be dominant. We can therefore indicate what we know by indicating that the individual is B_.
10. Another example of narrowing a genotype down to one of two possibilities is slightly more unusual. In this example, we know that a child is recessive, but we do not know the phenotype of either parent. In such a case, the only way for a child to be recessive is for both parents to have contributed one recessive allele. As such the parents can be either Bb or bb, so we can therefore indicate what we know by indicating that the individual is _b.



11. Since we know that the parents have to at least be a carrier, another way to represent such an individual is to shade them in as a carrier, but still indicate the uncertainty with a question mark.



12. It is very rare that we cannot determine anything about the genotype of an indivdual. Such an example would involve a person whose phenotype we don't know, and whose parents' phenotypes are also unknown. If they have had a child, we can often figure out at least if they are B_ or _b, but in the case where they have had a dominant child with a dominant adult, we still cannot be sure. We must, therefore, indicate the lack of knowledge about a genotype using _ _. (This determination, however, is not approprite when we know the phenotype!)



NOTE: A pedigree can also illustrate the principle of a test cross.

When Mendel took two purebred (They were known to be purebred given the extremely large sample size; our pedigrees are way too small of a sample size to conclude that all of the dominant individuals are homozygous dominant.) populations of peas (e.g., tall and short) and bred them, he discovered which trait was dominant because one trait disappeared in the next generation.

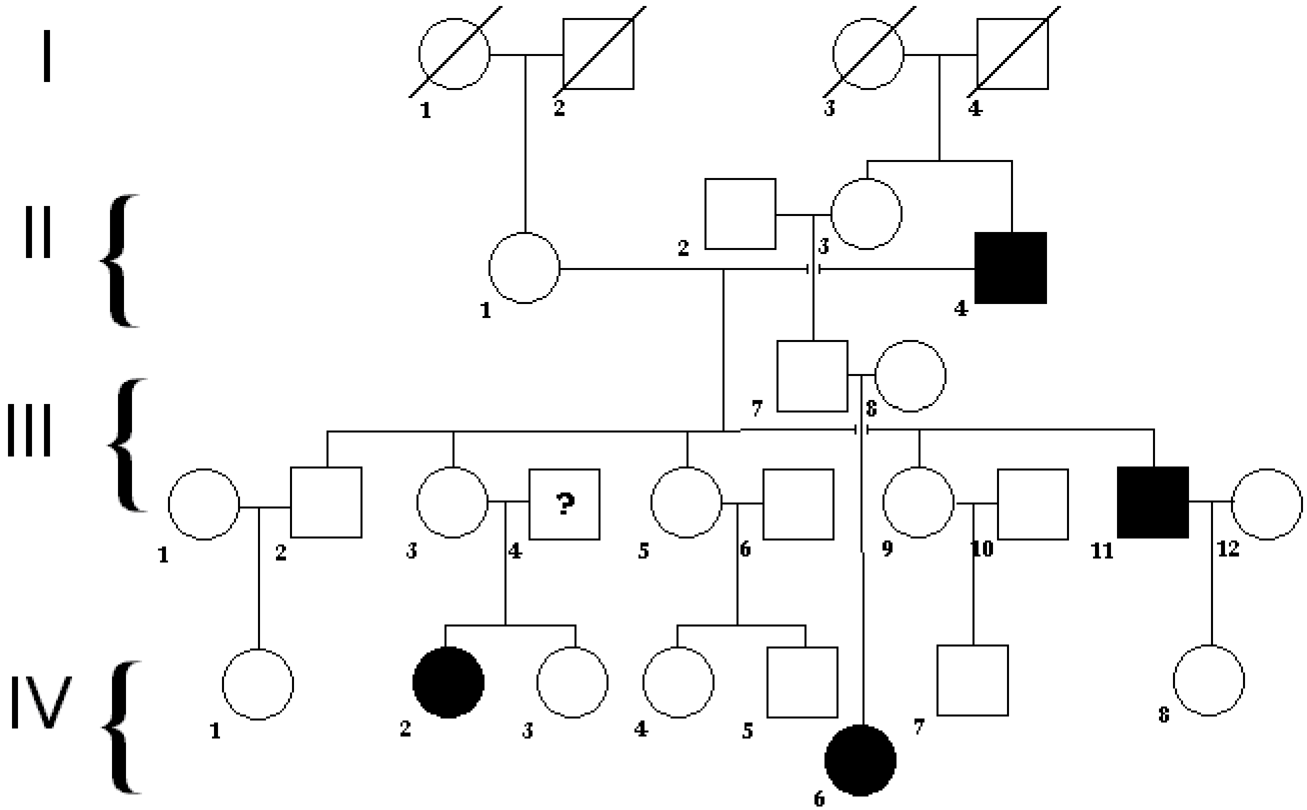
This type of cross became known as a test cross. The trait that disappeared (short) was recessive (tt), the trait that showed up in the next generation (tall) was dominant (TT), and all the dominant children were Tt.

In the case of a homozygous recessive parent (bb), or a heterozygous parent (Bb), and a parent for whom all we know is that they are dominant (B_), we can sometimes determine the exact genotype of the dominant parent by looking at the children.

If there is a recessive child, who must, of course, be homozygous recessive (bb), then the parent we had indicated as B_ must have contributed a recessive allele to her/his child, and must, therefore, be heterozygous (Bb).

TRY OUT YOUR KNOWLEDGE!

Here is a sample of a Mr. Lazaroff's pedigree, using a fictitious trait.



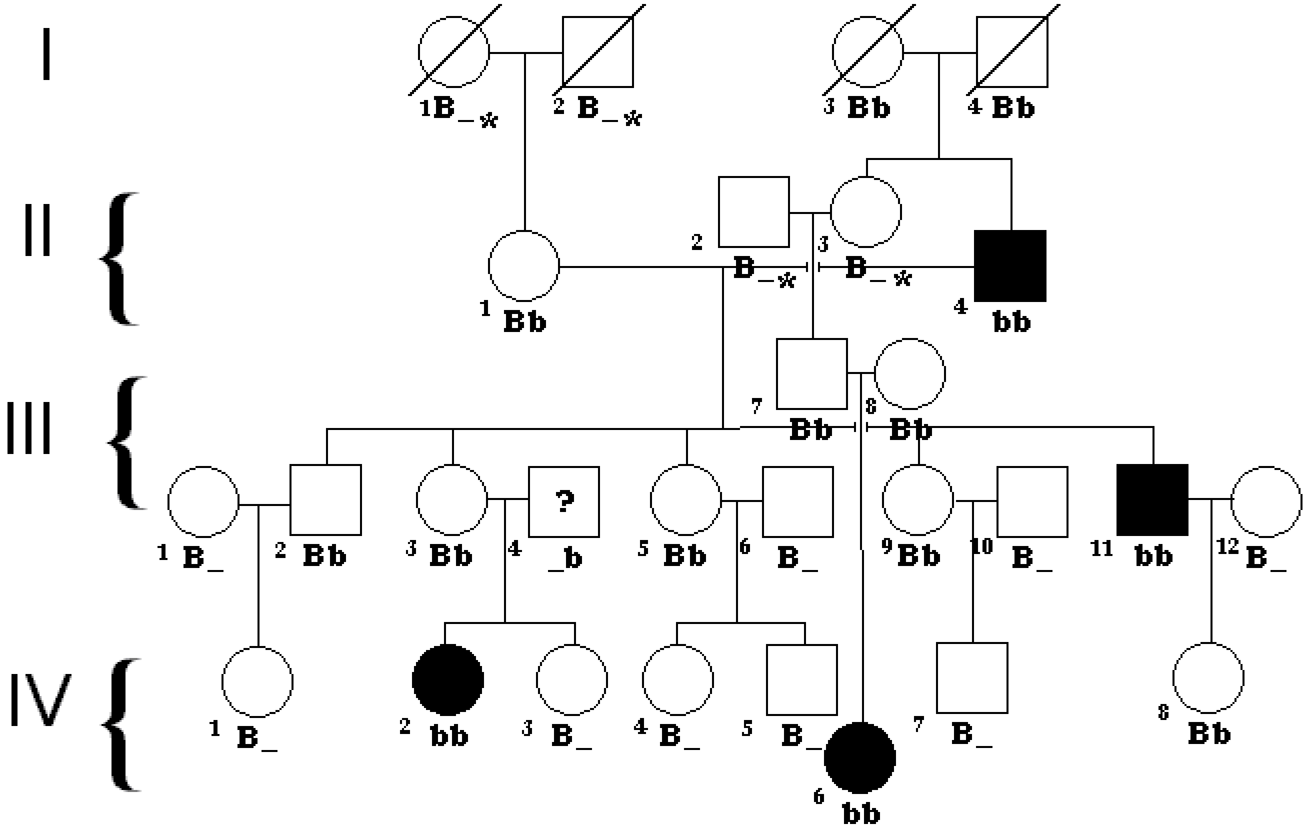
(1) Try to figure out the genotypes of every individual.
(2) When you have written in the Genotypes,
and before you have done any more shading,|
click on the link below to check your work.

Click here to see the answers without any further shading.

Mr. Lazaroff's Biology

Solution to Mr. Lazaroff's Sample Pedigree Problem

(without any further shading)



NOTE: Occasionally we can say a little more than just B_. In the pedigree above, in individuals I-1 and I-2, at least one of them MUST BE heterozygous (Bb). The same can be said for individuals II-2 and II-3!

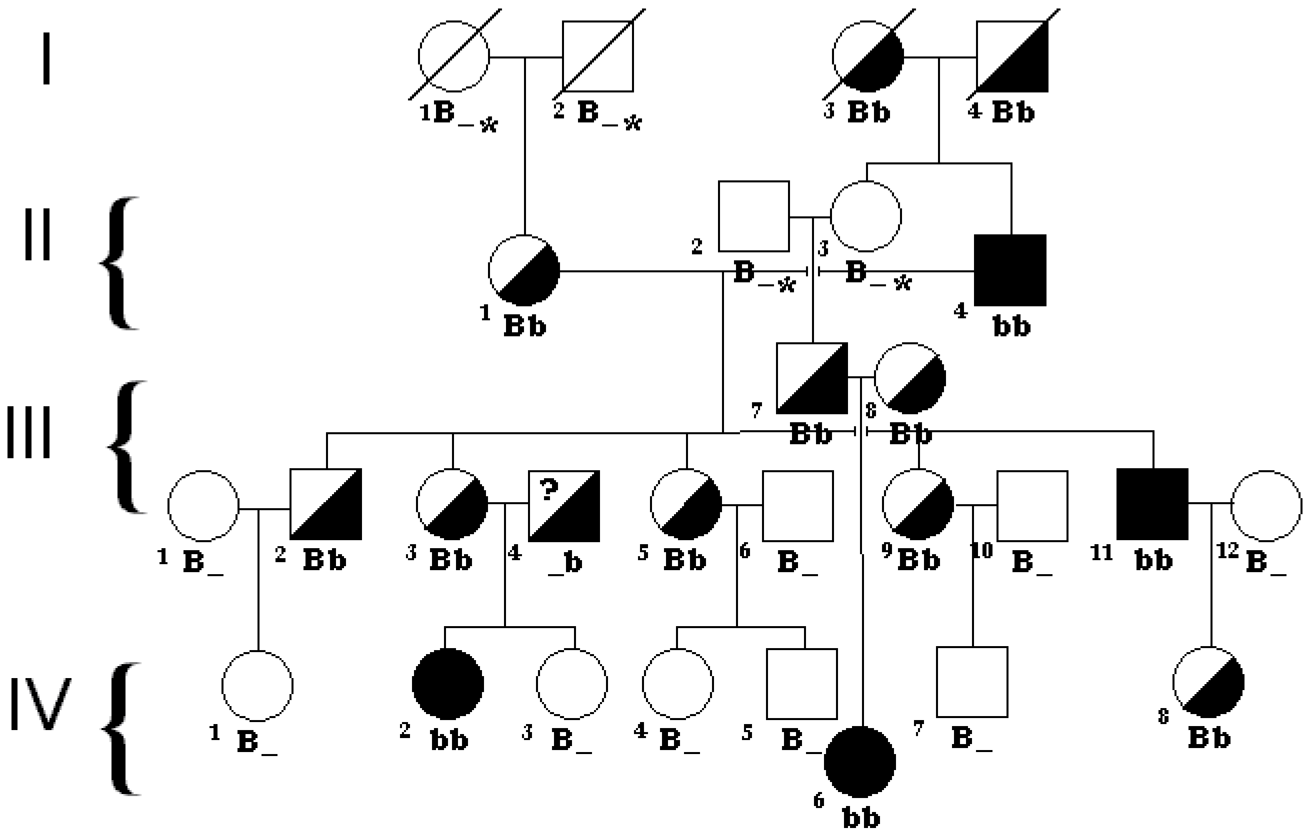
After you have finished shading in the carriers, click on the link below to check your work.

Click here to see the answers with shading added.

Return to Pedigree Tutorial

Solution to Mr. Lazaroff's Sample Pedigree Problem

(with shading added)



NOTE: Occasionally we can say a little more than just B_. In the pedigree above, in individuals I-1 and I-2, at least one of them MUST BE heterozygous (Bb). The same can be said for individuals II-2 and II-3!

Return to the answers without the shading.

Return to Pedigree Tutorial