Lab: Genetics
A study in human variation.

Purpose:

A) Recognize the basic mechanism by which chromosomes independently assort in gamete formation.
B) Appreciate the wide range of variations possible even from identically genotypic parents.

This lab is ideal for both introductory and upper level Biology students because it generates a high interest level while introducing or reinforcing basic genetics principles. During this activity, students are gathering, organizing, interpreting, and analyzing data. In addition, students are using concrete models for probability, independent assortment, and other important central concepts.

Introductory Narrative for Students:

Have you ever wondered why so much variation in appearance is present even when people are closely related? This phenomenon is present not only because a large variety of traits exist in a human population, but also because humans continue to create variation as they reproduce. Even relatives as close as brother and sister can vary widely in their appearance. Why siblings are very different both in genotype and phenotype is the question we want to address. This activity should help you answer that question and stimulate other questions. You are going to be a parent! Congratulations!

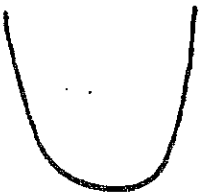
What would your baby look like if both you and your classmate (who will simulate your spouse) have one dominant gene and one recessive gene for each of the facial features illustrated in the following pages. In other words, each of you will be heterozygous for each trait. To determine the facial appearance of your child, you and your spouse will each flip a coin to determine what bit of information or gene you will contribute to the child.). HEADS will represent DOMINANT (shown with a large letter) and TAILS will represent RECESSIVE (shown with a small letter). Flip the coins to determine which gene of each pair you contribute. Each child will have two genes for each trait; one from each parent. You will supply one gene and your spouse will supply one gene. Record the genetic contributions of each parent on the chart provided. When you have determined all of the features for a particular structure (eyes for example), draw and color the way the baby will look after he/she has reached high school age. You and your spouse will produce one child.

The traits indicated by an asterisk are believed to be inherited in the explained manner. Most of the traits, however, in this activity were created to illustrate how human heredity works in a simplified model and to reinforce basic genetic principles. In actuality, inherited characteristics of the face are much more complicated than this activity illustrates. Most of these facial characteristics are determined by many genes working together in a way geneticists do not yet understand. We hope you will be successful in this very important role as parents. Your first task is to record your names, as parents, on the attached data sheet.

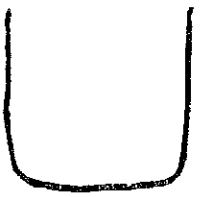
First, we should determine the sex of the child. Which parent should flip a coin to determine the sex of the child? _____. Heads will be a boy (Y-bearing sperm) and tails will be a girl (X-bearing sperm). Give your child a name and record the name on your data sheet or you can wait to name your child until it is drawn. Continue with Trait 1.

1. **FACE SHAPE:**

ROUND (RR, Rr)



SQUARE (rr)



2. CHIN SHAPE: Next three flips

VERY PROMINENT (VV, Vv)

LESS PROMINENT (vv)

3. CHIN SHAPE: ONLY flip coins for this trait if chin shape genotype is VV or Vv. (The genotype vv prevents the expression of the next two pairs of genes.) EPISTASIS

ROUND (RR, Rr)

SQUARE (rr)

4. CLEFT CHIN: 11900*

PRESENT (AA, Aa)

ABSENT (aa)

5. SKIN COLOR:

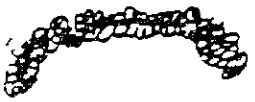
To determine the color of skin, assume there are three gene pairs involved. Flip your coins first to determine the genotype of the first pair of genes (AA,Aa, aa). Then flip your coins again to determine the genoptype of the second pair of genes (BB, Bb, bb). Flip for the last time to determine the third pair of genes (CC, Cc, cc). If your gene pairs are --1-- then the skin color is --2--.

Each capital letter represents an active allele for pigmentation.

--1--	--2--	--1--	--2--
6 capitals	very dark black	3 capitals	medium brown
5 capitals	very dark brown	2 capitals	light brown
4 capitals	dark brown	1 capital	light tan
NO capital	white		

6. HAIR TYPE: 13945

CURLY (CC)



WAVY (Cc)

STRAIGHT (cc)

7. WIDOW'S PEAK: The hair-line comes to a point in the center of the forehead. 19400

PRESENT (WW, Ww)

ABSENT (ww)

8. COLOR OF EYEBROWS: Consider all eyebrow traits (next three) before drawing.

VERY DARK (HH)

MEDIUM DARK (Hh)

LIGHT (hh)

9. EYEBROW THICKNESS:

BUSHY (BB, Bb)

FINE (bb)

10. EYEBROW PLACEMENT:

NOT CONNECTED (NN, Nn)

CONNECTED (nn)

11. EYE COLOR: Darker eyes are produced in the presence of more active alleles. In this situation, the large letters (A or B) represent alleles which are active in depositing dark pigment. Small letters (a and b) represent alleles which deposit little pigment.

To determine the color of the eyes, assume there are two gene pairs involved, one which codes for depositing pigment in the front of the iris and one which codes for depositing pigment in the back of the iris. Determine the genotype of the first pair (AA, Aa, aa) and then the second pair (BB, Bb, bb). If your genotype is --1-- the eye color is --2--. In reality, the determination of eye color is much more complicated.

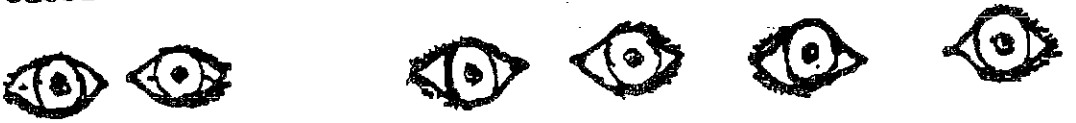
--1--	--2--
AABB	Dark brown
AABb	Brown
AaBB	Brown
AaBb	Brown

--1--	--2--
AAbb	Dark blue
aaBB	Dark blue
Aabb	Light blue
aabb	Pale blue
aaBb	MEDIUM BLUE

EYE TRAITS -- NEXT FOUR FLIPS Determine the phenotype with respect to all four flips before drawing the eyes.

12. EYES -- DISTANCE APART:

CLOSE TOGETHER (EE) AVERAGE DISTANCE (Ee) FAR APART (ee)



13. EYES -- SIZE:

LARGE (EE)

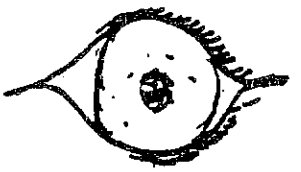
MEDIUM (Ee)

SMALL (ee)

14. EYES -- SHAPE:

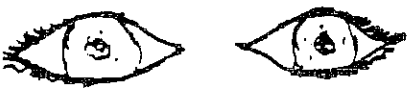
ALMOND (AA, Aa)

ROUND (aa)

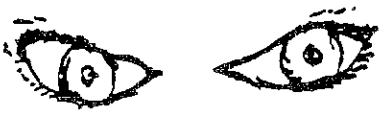


15. EYES -- SLANTEDNESS:

HORIZONTAL (HH, Hh)



UPWARD SLANT (hh)



16. EYELASHES: 19033 ("movie type")

LONG (LL, Ll)

SHORT (ll)

Mouth and lips traits will be determined in the next four flips.

17. MOUTH -- SIZE

LONG (MM)

AVERAGE (Mm)

SHORT (mm)

18. LIPS:

THICK (LL, Ll)

THIN (ll)

19. PROTRUDING LIP:

VERY PROTRUDING (HH) SLIGHTLY PROTRUDING (Hh) ABSENT (hh)

20. DIMPLES: 12610

PRESENT (DD, Dd) ABSENT (dd)

Nose and ear traits are determined in the next 7 flips. Record your genotypes on your data sheet but do not draw these features until all the traits are established.

21. NOSE SIZE:

BIG (NN) MEDIUM (Nn) SMALL (nn)

22. NOSE SHAPE:

ROUNDED (RR,Rr) POINTED (rr)

23. NOSTRIL SHAPE:

ROUNDED (RR,Rr) POINTED (rr)

Next four flips along with the preceding flip control ear traits.

24. EARLOBE ATTACHMENT:

FREE (FF, Ff)

ATTACHED (ff)

25. DARWIN'S EARPOINT: 12430

PRESENT (DD, Dd)

ABSENT (dd)

26. EAR PITS: 12870*

PRESENT (PP, Pp)

ABSENT (pp)

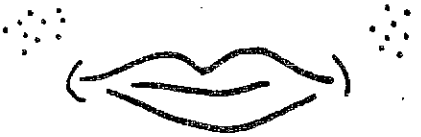
27. HAIRY EARS: 13950 (Hairy ears is sex-limited to males)

ABSENT (HH, Hh)

PRESENT (hh)

28. FRECKLES ON CHEEKS:

PRESENT (FF, Ff)



ABSENT (ff)

29. FRECKLES ON FOREHEAD:

PRESENT (FF, Ff)

ABSENT (ff)

30. Hair Color:

To determine the color of hair, assume there are three gene pairs involved. Flip your coins first to determine the genotype of the first pair of genes (AA, Aa, aa). Then flip your coins again to determine the genotype of the second pair of genes (BB, Bb, bb). Flip for the last time to determine the third pair of genes (CC, Cc, cc). If your gene pairs are (1) then the hair color is (2).

Each capital letter represents an active allele for hair color.

6 capitals = Black Hair
5 capitals = Dark Brown
4 capitals = Medium Brown
3 capitals = Light Brown
2 capitals = Red
1 capital = Blonde
0 capitals = White

Questions:

1. Find another couple and compare your child with their child. List 5 traits which both of your children have.
2. Using the same child for comparison, list 5 traits which are different in your children.
3. How did you determine which chromosome (with its associated gene) each parent would contribute to the child?
4. If each coin represents a homologous pair of chromosomes, how does the flip represent the behavior of chromosomes in meiosis?
5. What is the probability that both recessive genes will be contributed to the child for a specific trait? (Remember, both parents are heterozygous).
6. Recall your observations of several other children produced by your classmates. In terms of independent assortment, explain why each child is different.
7. Examine the genotypes and phenotypes of skin color. Summarize the relationship between the number of active genes and the color of the skin.
8. Define dominant.
9. Define recessive.
10. Define incomplete dominance.
11. Define genotype.
12. Define phenotype.
13. Define allele.
14. Define locus.

DATA SHEET

Parents' Name _____ and _____

Child's Name _____ sex _____

Trait No.	Trait	Gene from Mother	Gene from Father	Genotype	Phenotype
1	Face Shape				
2	Chin Shape				
3	Chin Shape				
4	Cleft Chin				
5	Skin Color				
6	Hair Type				
7	Widow's Peak				
8	Eyebrows/Color				
9	Eyebrows/Thickness				
10	Eyebrows/Placement				
11	Eye Color				
12	Eyes/Distance Apart				
13	Eyes/Size				

3 FLIPS

2 FLIPS

14	Eyes/Shape				
15	Eyes/Slantedness				
16	Eyelashes				
17	Mouth Size				
18	Lips				
19	Lips/Protruding				
20	Dimples				
21	Nose/Size				
22	Nose/Shape				
23	Nostril/Shape				
24	Earlobe Attachment				
25	Earpoint				
26	Ear Pits				
27	Ears/Hairy				
28	Freckles/Cheeks				
29	Freckles/Forehead				
30	Hair Color				