Introduction to Patterns of **Inheritance/Genetics**

INTRODUCTION

The pioneer of modern day genetics was an Austrian monk named Gregor Mendel, who established the basic laws of heredity from his studies with pea plants in the mid 1800s. Mendel's fundamental genetic principles may be applied to a variety of traits from many different organisms.

Each genetic trait, such as flower color, is regulated by a pair of genes called **alleles**. These alleles are found at particular places on the chromosomes called loci. During meiosis, each pair of alleles splits up or segregates so that only one allele from each pair is contained within a gamete (egg or sperm). This is Mendel's **Law of Segregation**. In sexual reproduction, egg and sperm from parents unite to form a new individual or **zygote**. Thus, each parent contributes one allele for each genetic locus. Mendel's **Law of Independent Assortment** states that during meiosis, each pair of alleles is *assorted randomly* and *inherited independently* of the others. Note that this principle holds true only for genes that are located on different chromosomes.

If the two alleles for a trait are different (*heterozygous*) rather than alike (*homozygous*), the **dominant** allele will be expressed over the other (**recessive**) one. Geneticists use an upper case letter to symbolize a dominant allele and the lower case of the same letter to symbolize the recessive allele. For example, in garden peas a purple flower is dominant over a white flower. Thus, P = purple allele, and p = white allele. In some cases neither allele is dominant and a blending of the trait results. Other traits are sex-limited and are only expressed in one sex. Observable characteristics of an organism, *e.g.*, blue eyes or freckles, are referred to as the **phenotype** while the genes actually regulating a particular phenotype are known as the **genotype** of the organism.

Although many human traits are regulated by complex genetic principles, Mendel's Laws can be used to illustrate the inheritance of several visible traits. In today's class you will perform two activities. First, you will survey genetic traits in your laboratory class. Secondly, with a partner you will flip coins to simulate the segregation and independent assortment of chromosomes during gamete formation. Specifically, you will look at inheritance of human facial characteristics.

Genetics of Human Facial Characteristics

In this activity you will pair up with a classmate, who will simulate your spouse. You will flip coins to simulate the role of probability in the independent assortment of chromosomes during meiosis. Assume that each "parent" is heterozygous for the trait, that is, carrying one dominant and one recessive allele for each trait. "Heads" represents a dominant allele and "tails" represents a recessive allele. Thus, if you flip heads and your partner flips tails, the child will be heterozygous (Aa) for the trait. If both flip heads, the genotype is AA and if both flip tails the genotype is aa.

While we treat the inheritance of facial traits simply today, realize that the inheritance is much more complex, involving many genes working in unknown ways.

1. First, **determine the sex of your child**. In humans, males (XY) determine the sex of a child. The "father" parent will flip a coin. If heads is flipped, the baby is a boy (Y-bearing sperm); if tails is flipped, the result is a girl (X-bearing sperm). Remember, because females have two X chromosomes, all their eggs contain only X chromosomes. Thus only the father needs to flip a coin.

2. Record your child's name and sex on the data sheet. **Continue simultaneously flipping coins for *each* facial trait**. Record the genetic contribution of each parent and the offspring's phenotype on the chart.

3. Finally, make a drawing of your offspring to share with the class.

Data Sheet

Parent's names _____ and _____

Child's name _____ Child's sex ____

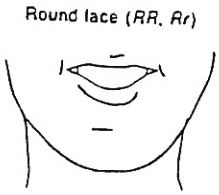
☞ Use the drawings on the following pages (8-13) to help you complete this table

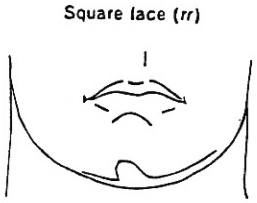
Trait	Gene from mother	Gene from father	*Genotype* of child	*Phenotype* of child
1. face shape				
2. chin size				
3. chin shape				
4. cleft chin				
5. skin color				
6. hair type				
7. widow's peak				
8. eyebrow color				
9. eyebrow thickness				
10. eyebrow placement				
11. eye color				
12. eye distance				
13. eye size				
14. eye shape				
15. eye slantedness				
16. eyelashes				
17. mouth size				
18. lips				
19. protruding lip				
20. dimples				
21. nose size				
22. nose shape				
23. nostril shape				
24. earlobe attachment				
25. Darwin's earpoint				
26. ear pits				
27. hairy ears				
28. freckles on cheek				
29. freckles on forehead				

Appendix, A Gallery of Drawings:
Genotypes and Phenotypes of Facial features

Facial Traits

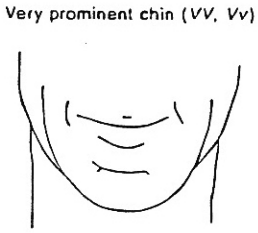
1. Face shape

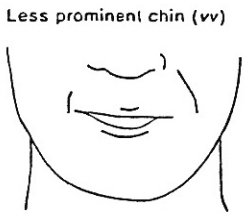




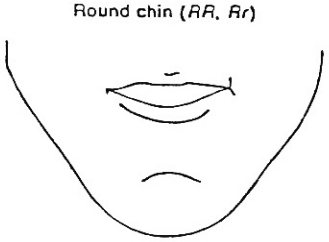
Chin Traits—next three flips.

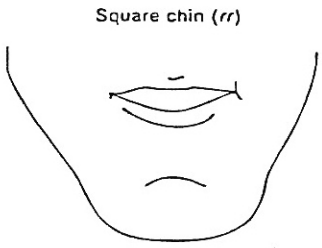
2. Chin size



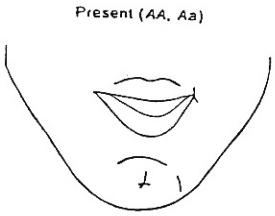


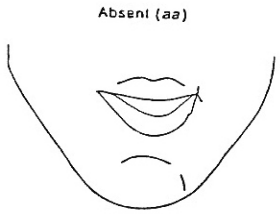
3. Chin
shape: Only flip coins for this trait and cleft chin if chin size genotype was VV or Vv. The genotype vv prevents the expression of the next two pairs of genes.





4. Cleft chin





Skin Color

5. Skin color: to determine skin color, assume there are three genes, located at three different loci, that contribute the amount of pigment produced. Both you and your partner should flip coins to determine the genotype of the first pair of alleles (AA, Aa, aa). Then flip again to determine the genotype of the second pair of alleles (BB, Bb, bb).

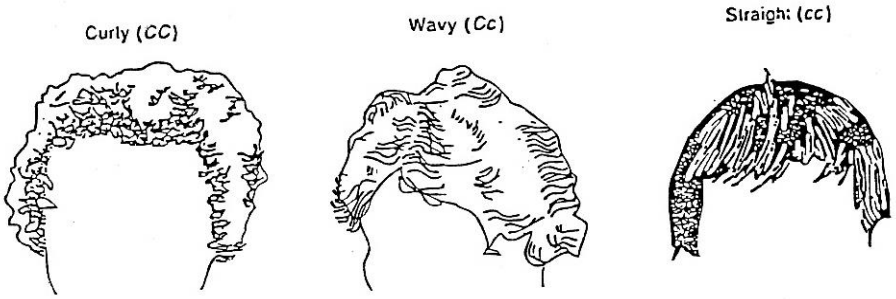
Flip for the last time to determine the third pair of alleles (CC, Cc, cc). Determine the phenotype of your offspring based on the following polygenic model:

Six dominant alleles—very dark black
Five dominant alleles—very dark brown
Four dominant alleles—dark brown
Three dominant alleles—medium brown
Two dominant alleles—light brown
One dominant alleles—light tan
Zero dominant alleles—fair skin

Example: If you flipped heads for the first two genes and tails for the third gene, and your partner flipped tails for the first gene and heads for the second and third gene, your offspring's genotype would be AaBBCc and your offspring's phenotype would be dark brown.

Hair Traits—next two flips.

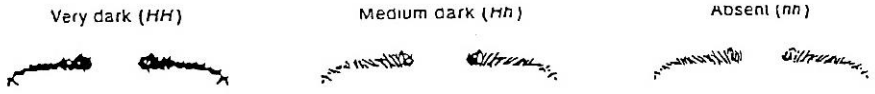
6. Hair type



7. Widow's peak: The hairline comes to a point in the center of the forehead.

Eyebrow Traits—next three flips.

8. Eyebrow color



9. Eyebrow thickness

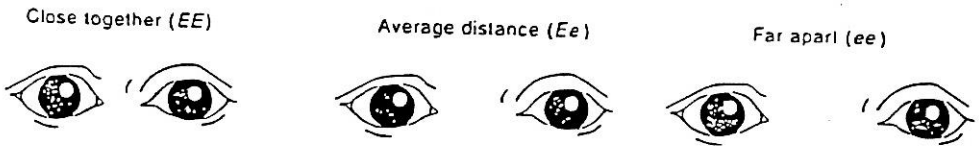
10. Eyebrow placement

Eye Traits—next six flips.

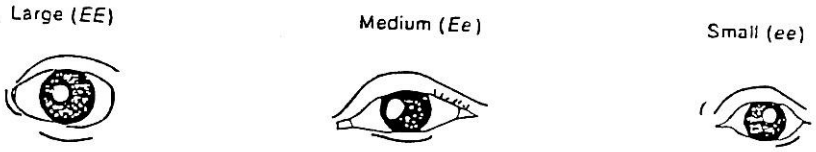
11. Eye color: Darker eyes are produced in the presence of more active alleles. In this situation, the large letters (A or B) represent alleles that are active in depositing dark pigment. Small letters (a or b) represent alleles that deposit little pigment. To determine eye color, assume there are two genes involved, one that codes for depositing pigment in the front of the iris and one that codes for depositing pigment in the back of the iris. Therefore, both you and your partner will need to flip twice. Determine the genotype of the first pair of alleles (AA, Aa, aa) and the second pair of alleles (BB, Bb, bb). Determine the phenotype of your offspring according to the following guidelines:

AABB	dark brown
AABb, AaBB, or AaBb	brown
AAbb or aaBB	dark blue
Aabb or aaBb	light blue
aabb	pale blue

12. Eye distance



13. Eye size



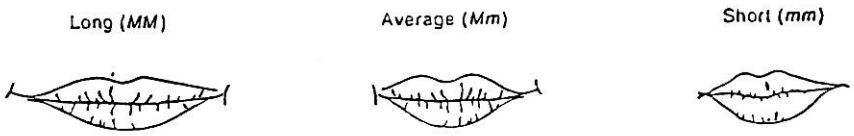
14. Eye shape

15. Eye slantedness

16. Eyelashes

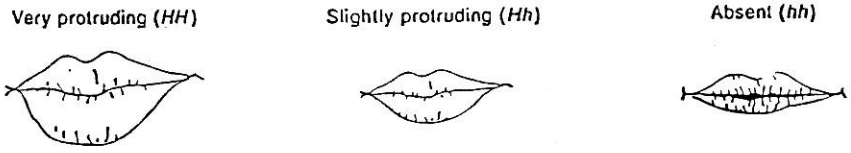
Mouth and Lip Traits—next four flips.

17. Mouth size



18. Lips

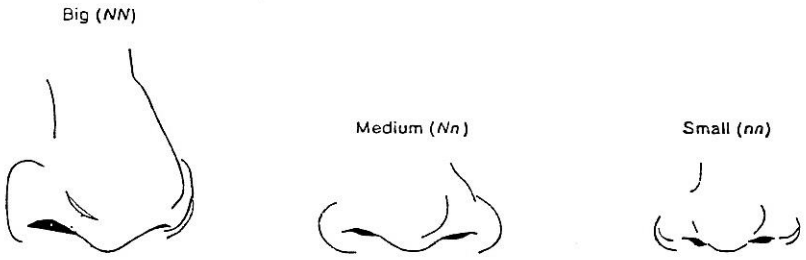
19. Protruding lip



20. Dimples

Nose Traits—next three flips.

21. Nose size



22. Nose shape

23. Nostril shape

Rounded (*RR, Rr*)

Pointed (*rr*)

Ear Traits—next four flips.

24. Earlobe attachment

Free (*FF, Ff*)

Attached (*ff*)

25. Darwin's earpoint

Present (*PP, Pp*)

Absent (*pp*)

26. Ear pits

Present (*DD, Dd*)

Absent (*dd*)

27. Hairy ears. Hairy ears is sex-limited to males.

Absent (*HH, Hh*)

Present (*hh*)

Freckles—next two flips.

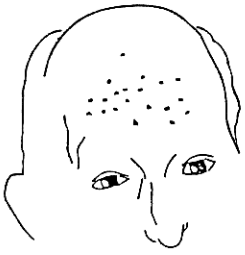
28. Freckles on cheeks

Present (*FF, Ff*)

Absent (*ff*)

29. Freckles on forehead

Present (*FF, Ff*)



Absent (*ff*)