**Genetics and Heredity Lab**

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ / 65

**Genetics** is the study of the way in which different characteristics of an organism (e.g. finger shape, eye color, height, the ability to make a certain digestive enzyme) are determined and passed on from parent to offspring.

The basic unit of heredity is the **gene**. A gene is a **locus** on a **chromosome** containing a portion of **DNA** that codes for a specific **protein**. Each gene is able to govern a particular feature of an organism by determining the type of protein produced. This protein can function as a structural protein, enzyme, or hormone (e.g. insulin) affecting that particular feature. Typically, each gene has several different forms (called **alleles**) that result in the variation of a feature one sees in different individuals. For example, one form (allele) of the gene for finger shape (B) may code for bent little fingers, whereas another form of that same gene (b) may code for straight fingers. The difference between the alleles is in the type of protein produced by each, which is due to a difference in the base sequence of DNA making up each allele.

The genetic make-up of an individual for a particular trait is referred to as the **genotype**. Since organisms are typically **diploid** (i.e. with chromosomes occurring in **homologous pairs**), there are a pair of genes governing each trait. For example, the genotype for finger shape may be Bb which actually represents the pair of alleles on a homologous pair of chromosomes.

The actual expression of these alleles is called the **phenotype**. The phenotype of a trait is always the product of the interaction between the individual's genetic make-up for that trait and the individual's environment. The purpose of today's lab is to consider some basic terminology and concepts of genetics and to determine the genotype of members of the class by looking at your phenotypes for 20 different traits.

**Formation of Gametes**

In preparation for the genetics problems below, write the possible **gametes** (sex cells) that can be formed from the following genotypes. Place a circle around each gamete. Remember that gametes are haploid and that each gamete must contain one of each kind of gene found in the genotype of the diploid parent forming the gamete. (5)

|  |  |
| --- | --- |
| **Genotype** | **Possible Types of Gametes** |
| AA |  |
| Aa |  |
| AABb |  |
| AaBb |  |
| AaBbCc |  |

**Using the information presented, try to solve the following problems:**

1. In peas, the allele (T) for tallness is dominant over the allele for short stems (t). If a plant which is homozygous for tallness is crossed with one homozygous for short stems: (4)
   1. What are the genotypes of the parents?
   2. What are the possible types of gametes they can produce? (Draw a circle around each gamete.)
   3. What is/are the possible genotype(s) of the offspring? What is/are the possible phenotype(s)?

Genotypes

Phenotypes \_\_\_\_\_\_\_\_

2. In the following matings, write the gametes that can be produced by each parent, and draw a circle around each gamete. Then write the possible genotype(s) of their offspring. Use a Punnett Square to organize the information in part b. (6)

* 1. TT • Tt **parent 1 parent 2**

gametes offspring genotypes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**b.** Tt • Tt

gametes offspring genotypes

3. In cattle, the allele (**A**) that produces the polled (hornless) condition is dominant over the allele (**a**) for the horned condition. A certain polled bull is bred to three cows. With Cow A, which is horned, a polled calf is produced; with Cow B, also horned, a horned calf is produced; and with Cow C, which is polled, a horned calf is produced. Give the Genotypes of each of the parents and the calves produced by each cow. (7)

**Bull**

**Cow A**   **calf**

**Cow B**   **calf**

**Cow C**   **calf**

**Human Genetics**

In this part of the lab you will look at 23 different traits in each of yourselves. By observing the phenotype of each trait, you will then try to determine your genotype for each feature. We have selected traits which are easy to determine. Many of them, such as eye color, are governed by more than one pair of alleles. Others are also affected by different exposure in the environment, as in the case of freckles. For the sake of simplicity, we will ignore these shades of difference in the expression of these traits and simply lump dark colored eyes into one category and light colored eyes into another. Record your results in the chart which follows below. Also record these data on the summary chart for the entire section up at the front of the lab. There are photographs and illustrations at the front of the room and on your lab table to assist you.

**Traits**

PTC Tasting- The allele (T) for tasting PTC is dominant over the non-tasting allele (t).

Sodium Benzoate Tasting- The taster allele (S) for sodium benzoate is dominant over the non-taster allele (s).

Shape of Little Finger- Hold your hands before your face with the palms toward you. Place the little fingers side by side and press them together. Do they run parallel their entire lengths or do the terminal digits flare out away from each other? Each bone in a finger is termed a phalanx. The allele for bent phalanx (B) is dominant over straight phalanx (b).

Mid-Digital Hair- Hair on the back of the middle digits of the fingers (H) is dominant over hairless middle digits (h).

Hitchhiker's Thumb- Hold your hand in the hitchhiker's position and look at the angle that is formed. If the thumb forms an angle with the fist of greater than 50 degrees it is due to the recessive allele (ht). If the thumb cannot hyperextend, it is due to the presence of the dominant allele (HT).

Palmar Muscle- The long palmar muscle lies along the inner aspect of the forearm with a tendon extending through the wrist to the palm of the hand. Count the tendons in the wrist on the palmar side. If you have three tendons the muscle is present; if you can find only two tendons, the muscle is absent. The allele for the absence of the palmar muscle (P) is incompletely dominant over the allele for its presence (P'). If it is found in one arm and not the other, the person is heterozygous (PP') for the trait.

Tongue Rolling- The ability to roll the tongue into a longitudinal U-shaped trough (R) is dominant over the lack of this ability (r).

Tongue folding- Tongue folding (F) is dominant over the lack of the ability (f). A tongue folder must be able to hold the tongue out and without bracing it against the teeth, fold the tip back sharply.

Dimples- The allele for dimples (D) is dominant over the allele for no dimples (d).

Freckles- The allele for some to many freckles (FR) is dominant over the one for the absence of freckles (fr).

Ear Lobe Attachment- Free ear lobe (E) is dominant over attached ear lobe (e).

Darwin's Ear Point- Darwin's ear point (EP) is dominant over no ear point (ep). Check both ears. The size of the ear point may vary.

Eye Color- Assume an allele for various shades of brown eyes (BR) is dominant over the allele for blue or blue-gray eyes (br). (Note: this is an over simplification. There are over 40 shades of eye color, and undoubtedly several pairs of alleles are involved.)

Hair Color, Dark/Light- Assume the allele for dark hair (HC) is dominant over light hair (hc), and that a person heterozygous, HChc, will have dark hair. As in the case with eye color, this is an oversimplification, for there are many shades of hair color. In addition, sunlight and chemicals can alter the expression of the genes for hair color.

Hair Color, Red/Non-red- The color of red is inherited independently of dark/light hair coloration. Assume that the gene for red (rd) is recessive to the gene for non-red (RD), and that a person who is heterozygous (RDrd) will have non-red hair.

Hair Form- Assume the allele for curly hair (U) is not completely dominant over the allele for straight hair (U'). The heterozygous condition (UU') produces wavy hair.

Hair Whorl Pattern **-** When viewed from above, the whorl pattern of the hair which is clockwise is due to the dominant allele (W). The counterclockwise pattern is due to the allele (w) in the homozygous condition.

Hairline- Examine the hairline on your forehead. The allele for a widow's peak (V) is dominant over the allele for a straight or curved hairline (v).

Cephalic Index- This trait is governed by several pairs of alleles and may be influenced by environmental conditions during development. (See the chart on your desk.) The adaptive value of a particular head shape is not known. Measure the width of the head at its broadest point above the ear with a caliper. Hold the caliper carefully when transferring it from the head to the meter stick so that the measurement will be accurate. Measure the length, placing one point of the caliper midway between the eyebrows and the other point at the point on the back of the head that will give the greatest length. Then divide the width by the length. The cephalic indices are classified:

.75 or less → narrow head

.76 - .79 → median head

.80 or more → broad head

**In the chart below, record your phenotype for each trait (taster or non-taster, straight or bent little finger, etc.), and circle your genotype.** (38)

**Trait Your** **Phenotype Circle Your** **Genotype**

PTC Tasting T- tt

Sodium Benzoate Tasting S- ss

Bent Little Finger B- bb

Mid-Digital Hair H- hh

Hitchhiker's Thumb HT- htht

Palmar Muscle PP PP' P'P'

Tongue Rolling R- rr

Tongue Folding F- ff

Dimples D- dd

Freckles FR- frfr

Ear Lobe Attachment E- ee

Darwin's Ear Point EP- epep

Eye Color BR- brbr

Hair Color, Dark/Light HC- hchc

Hair Color, Red/Non-red RD- rdrd

Hair Form UU UU' U'U'

Hair Whorl Pattern W- ww

Hairline V- vv

Cephalic Index narrow medium broad

1. Because an allele is dominant, does this necessarily mean that it will occur at a high frequency in a group? (3)

What does the term "dominant" mean?

1. By knowing the phenotype for a feature (e.g. eye color), can we always determine the genotype exactly? (2)

Explain.