Genetics

Introduction

Human genetic traits can be used to illustrate a number of genetic examples. Such examples include complete dominance, incomplete dominance, codominance, and sex-linkage. Human heredity is complicated by the fact that many characteristics result from the action of two or more genes (polygenic) and/or are influenced by environmental factors. In this exercise you will study the inheritance pattern of some monogenetic human characteristics.

Some Monogenetic Human Characteristics

You will investigate several monogenetic (traits controlled by a single gene) human characteristics. You should determine your phenotype for each of these and your genotype so far is possible. When you have a dominant phenotype, you may have no way to know if you carry the recessive allele. In such cases you could use a dash (-) to represent the unknown second allele of your genotype. For instance, you probably do not have cystic fibrosis, a recessive characteristic. Hence, you know that you carry at least one of the dominant alleles “C”, but you do not know whether the second allele of the pair is “C” or “c”. You, therefore, represent your genotype as “C_”.

Monogenetic Characteristics:

1. **Attached ear lobes**: In most people the earlobes hang free, but when a person is homozygous for a certain recessive gene “e”, the earlobes are attached directly onto the side of the head so that there is no lobe hanging free.

2. **Pigmented iris of the eyes**: When a person is homozygous for a certain recessive gene “p”, there is no pigment in the front part of the eyes and a blue layer at the back of the iris shows through. This gives blue eyes. A dominant allele of this gene “P” causes pigment to be deposited in the front layer of the iris and masks the blue to a varying degree. Other genes determine the exact nature and density of this pigment and we have brown, hazel, violet, green, and other eye colors. We will concern ourselves here, however, only with the presence or absence of such pigment.

3. **Interlocking fingers**: When the fingers are interlocked, some people will almost invariably place the left thumb on top of the right and others will place the right over the left. Studies of family pedigrees suggest that the placing of the left over the right is due to a dominant gene “I”, while the right thumb on top is due to a recessive allele “i”; however, nongenetic factors may also be involved.

4. **PTC tasting**: Some persons detect a distinct bitter taste from a chemical, phenylthiocarbamide (PTC), while others do not taste it in weak concentrations. A dominant gene “T” seems to confer the ability to taste these chemicals, while those homozygous for the recessive allele (t) lack this ability. Allow paper to sit
on your tongue for about 10 seconds. If you have to wonder if you taste it or not, you are a nontaster.

(5) **Widow’s peak**: In some people the hairline drops downward and forms a distinct point in the center of the forehead. This is known as widow’s peak. It results from the action of a certain dominant gene (W). Determine your phenotype by examining your front hairline or by having one of your classmates examine your front hairline for a widow’s peak or a continuous (or in my case receding) hairline. You will have to skip this tabulation if a gene for baldness has had its effect at the front part of the head.

(6) **Bent little finger**: A dominant gene (B) causes the last joint of the little finger to bend inward toward the fourth finger. Lay both hands flat on the table, relax the muscles, and note whether you have a bent or a straight little finger.

(7) **Long palamar muscle**: When a person is homozygous for a certain recessive gene (l), he or she has a long palamar muscle, which can be detected by examination of the tendons that run over the inside of the wrists. Clench your fists and flex your hand. Now feel the tendons. If you have three, you have the long palamar muscle. If there are only two (the large middle one will be missing), you do not have this muscle. Check both arms as sometimes it can be present in one, but not the other.

(8) **Mid-digital hair**: Some people have hair on the second (middle) joint of one or more of the fingers, while others do not. The complete absence of hair from all fingers is due to a recessive gene (m), and its presence is due to a dominant allele (M).

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For each of the above traits determine your phenotype and genotype (as far as you can) and record them below. We will use this data in another lab.

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(1) What gametes can be formed by an individual organism of genotype Gg? Of genotype GgHh? (1 point)

(2) In *Drosophila*, a cross between a dark-bodied fly and a tan-bodied fly yields all tan-bodied flies. Which trait is dominant and which is recessive? Draw the cross. (1 point)

(3) When two black mice are mated, 16 of the progeny are black and five are brown. Using B=black and b=brown, draw the cross. (1/2 point)

(4) A mating between a black mouse and a brown mouse yields eight black and seven brown progeny. Using B=black and b=brown, Draw the cross. (1/2 point)

(5) In fruit flies, a gene for white eye color (Y) is dominant over its allele for yellow color (y). Give the genotypic and phenotypic ratios for the results of each of the following crosses: (3 points)

   a) YY x yy    b) Yy x yy    c) Yy x Yy

(6) True-breeding flies that have long wings and dark bodies are mated to true-breeding flies with short wings and tan bodies. All the F$_1$ have long wings and tan bodies. The F$_1$ are allowed to mate and produce:

88 tan, long; 32 dark, long; 28 tan, short; 12 short, dark

Draw the F$_1$ cross and indicate which phenotypes are dominant and which are recessive? (2 points)
Human Pedigrees

Human pedigree analysis is an important part of genetics. Human pedigrees allow geneticists to predict the probability of occurrence of certain genetic diseases and they allow geneticists to understand how particular diseases are inherited. Below are some common symbols used in the construction of human pedigrees.

Given the following pedigrees, indicate whether each type of inheritance is possible (indicate by placing a “Y” in the blank) or is not possible (indicate by placing an “N” in the blank).

\[\begin{array}{cccc}
\text{Autosomal Recessive} & \text{Y} & & \text{N}
\\
\text{Autosomal Dominant} & \text{Y} & & \text{Y}
\\
\text{X-Linked Recessive} & \text{N} & & \text{N}
\\
\text{X-Linked Dominant} & \text{N} & & \text{N}
\\
\text{Y-Linked} & \text{N} & & \text{N}
\end{array}\]
Some helpful hints:

1) The presence of only one phenotype in the progeny may suggest that only one gene is involved.
2) The presence of two phenotypes in the progeny suggests one gene and at least one heterozygous parent.
3) A 3:1 ratio in the progeny suggests one gene and both parents are heterozygous.
4) A 1:1 ratio among progeny suggests one gene and a heterozygote x homozygote.
5) Three phenotypes among the progeny in a 1:2:1 ratio suggests one gene with incomplete dominance (the heterozygote has a different phenotype than either homozygote).
6) A 2:1 ratio among progeny suggests one gene and a homozygous lethal.
7) If identical phenotypes yield different ratios in different crosses, consider the possibility of multiple alleles.
8) The chance of an offspring having a particular genotype is independent of previous offspring.
9) The presence of four phenotypes in the progeny suggests at least two genes.
10) The genotypes of the parents can be determined by examining single gene ratios in the progeny.
11) A 9:3:3:1 ratio in the progeny suggests two unlinked genes, a mating between two double heterozygotes, and a strict dominant-recessive relationship.
12) A 3:3:1:1 ratio in the progeny suggests two genes, one heterozygous in each parent and one heterozygous in one parent and homozygous recessive in the other.
13) The presence of four equally frequent classes (1:1:1:1) in the progeny suggests two genes, and a double heterozygote x double recessive.
14) With dominance, the presence of more than four phenotypes in the progeny suggests more than two genes.
15) The chance of getting a specific genotype or phenotype is the product of individual probabilities.
16) The product rule can be used to calculate ratios for any cross, even if lethals are involved.