ANTHR 1 – Introduction to Biological Anthropology
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EVOLUTIONARY GENETICS - "CHEAT SHEET"

Mendelian Inheritance (Simple Inheritance)

1. For every trait a person has, she/he has **TWO ALLELES** (alleles are different forms of a gene, sort of like Accords and Civics are different forms of Hondas). One allele came from the person's mom and the other allele came from the person's dad.

2. Some alleles are **DOMINANT** others are **RECESSIVE**, and still others are **CO-DOMINANT**. Dominant does not mean "better" or "stronger," it simply means that if a person gets one dominant allele and one recessive allele, in most cases, only the dominant allele is expressed in the phenotype (the observable trait).

    - A dominant allele is expressed whenever it is present in at least one copy.
    - A recessive allele is only expressed when it is present as both alleles in the individual (such as bb for blue eyes)
    - CAPITAL LETTERS are used to indicate dominant alleles and lower case letters are used to indicate recessive alleles

3. Each individual has a **phenotype** (what it looks like---the physical, observable trait), and a **genotype** (what alleles it possesses---it's genetic make up). The genotype "codes for," or controls what the phenotype will be.

EXAMPLE:

There is a gene that codes for the ability to roll one's tongue. This trait is **monogenic** – a person can either roll his/her tongue or not. There are two alleles for this trait: **R,** which codes for the ability to tongue-roll, and **r**, which codes for the inability to tongue-roll.

- Because we each possess two alleles for the tongue-rolling trait (one from our mother and one from our father), we have one of three possible combinations.
- We may have two of the same allele: RR or rr, a condition known as **homozygous** (homo = same). Or we may have a pair of *non-matching alleles*: Rr, a condition known as **heterozygous** (hetero – different).
- These combinations are called **genotypes**. These genotypes (RR, Rr, rr) produce either a tongue-roller or a non-tongue-roller. The observable trait---the result of the genetic code---is the **phenotype**.

RR = homozygous dominant = tongue roller
Rr = heterozygous dominant = tongue roller
rr = homozygous recessive = cannot roll tongue

- **Monogenic** traits are those traits that are controlled by or "coded for" by one gene and that appear in simple either/or variation. For example, the flowers on Mendel's pea plants were either white or red, but never pink or somewhat red.
- **Polygenic** traits are traits that are controlled by more than one gene and produce a range of variation in the phenotypes such as in hair color, skin color, or height.
- In some cases, heterozygous genotypes result in phenotypes that exhibit some action of both alleles. Such alleles are said to be **CO-DOMINANT**, and they result in a greater number of possible phenotypes, as in the ABO blood type gene.

EXAMPLE (of Co-dominance):

The ABO blood type gene has *three* alleles:

A – a dominant allele
B – also a dominant allele
O – a recessive allele

- In this system, **A** and **B** are both dominant alleles, and when paired together, exhibit the action of both alleles, producing Blood Type **AB**. Thus, A and B are **co-dominant**, and both are dominant over O.

The following table illustrates the genotypical and phenotypical combinations possible in the ABO system:

Genotype	**Phenotype**
AA or AO	Type A Blood
BB or BO	Type B Blood
AB	Type AB Blood
OO	Type O Blood

- Whenever one parent is ***homozygous dominant*** and the other is ***homozygous recessive***, the offspring will all be ***heterozygous***. That is, they will each inherit two different alleles, one from each parent's genotype.

EXAMPLE:

Mother = homozygous dominant for Type A Blood
Mother's genotype = AA
Mother's gametes = A, A

Father = homozygous recessive for Type O Blood
Father's genotype = OO
Father's gametes = O, O

	O	**O**
A	AO	AO
A	AO	AO

- The **Punnett square** (a device used to determine the outcome of potential mating) indicates that there is only *one phenotype* (Type A blood) and *one genotype* (heterozygous dominant-AO) possible.

- Whenever both individuals in the parental generation are **heterozygous** for a trait, three different genotypes will result:

EXAMPLE:

Mother = heterozygous dominant for tongue-rolling
Mother's genotype = Rr
Mother's gametes = R, r

Father = heterozygous dominant for tongue-rolling
Father's genotype = Rr
Father's gametes = R, r

	R	**r**
R	RR	Rr
r	Rr	rr

- There is a 75% chance that the offspring from this mating will be able to roll their tongues, and a 25% chance that this mating will produce a non-roller.

- There are *two phenotypes* (roller or non-roller) and *three genotypes* (homozygous dominant – RR; heterozygous dominant – Rr; and homozygous recessive).

Mendel's laws:

1. **The Principle of Segregation** – According to the principle of segregation (separation), for any particular trait, the pair of alleles of each parent separate and only one allele passes from each parent on to an offspring. Which allele in a person's pair of alleles is inherited is a matter of chance.

    - The segregation of alleles occurs during **meiosis**

2. **The Principle of Independent Assortment** – The way in which the paired alleles for one trait are segregated is TOTALLY INDEPENDENT from the way in which the paired alleles for a *different trait* are segregated. For example, eye color has no connection with the ability to roll one's tongue.

HOW GENES WORK

- The genetic code is a set of instructions for the production (or synthesis—that is, the putting together) of **proteins** from **amino acids**.
- Proteins are the basic building blocks of an organism's cells
- The genetic code is found in the nucleus of cells on long strands called **chromosomes**
- A chromosome is made up of a protein core and strands of nucleic acid called, **DNA**
- DNA carries all of our genetic information, and is the "blueprint" for constructing a living thing

MITOSIS

- When cells replicate (divide), each chromosome (and the DNA it contains) copies itself
    - There are now two pairs of each chromosome. When the cell replicates/divides, each new cell receives a full set of chromosome pairs.

MEIOSIS

- The process of producing gametes (sex cells, which are called ova in females and sperm in males)
    - Each gamete has only one member of each chromosome pair and so only one member of each pair of alleles so that when sex cells combine during reproduction, they will have the normal number of chromosomes (46 or 23 pairs)

PRINCIPLES OF GENETIC INHERITANCE

(Adapted from Mayr 2001:91-93)

1. Genes consist of DNA
2. DNA itself does not change, however, the expression and function of genes can be influenced by the environment (exposure to toxins, radiation, diet, stress, etc.)
3. DNA contains info that controls the production of proteins
4. DNA is located in the nucleus of every cell and is organized along strands of chromosomes
5. Sexually reproducing organisms are **diploid**; they have two sets of chromosomes—one from male parent, one from female parent
6. Reproductive cells (gametes) of male and female have only one chromosome set (**haploid**)
    a. when egg is fertilized (zygote) has full amount of chromosomes
7. Genes can mutate and alter the expression and function of genes that will affect the phenotype
    a. Mutations are the result of errors in the process of DNA copying/replicating itself
    b. Some mutations can be passed down to offspring
8. Different types of genes do different things in the cell. Some genes belong to a special group called "control genes" which activate and deactivate other genes. If these genes become altered, they can dramatically affect the phenotype
9. The totality of the genes of an individual constitute its genome