

OHP Picture 1

Recap:

- Decomposition of a phenotypic observation P into 2 components:

$$P = \boxed{G} + E \Rightarrow \text{genetic model}$$

understand G! ← (pointing to G)
↓ genetic (pointing to G)
environment (pointing to E)
→ simplest model: 1 Locus (pointing to G)

- Parents pass a random sample of their alleles to offspring
- Goal: Selection of animals as parents of future generation.

Assume: 1 Locus 1 Locus G



OHP Picture 2

Population : 1 Locus : G , 2 Alleles G_1, G_2

The diagram shows a population of 10 animals (N=10) at a single locus G with two alleles, G_1 and G_2 . The animals are represented by ovals:

- Animal 1: G_1 / G_1 (homozygous)
- Animal 2: G_1 / G_2 (heterozygous)
- Animal 3: G_2 / G_2 (homozygous)
- Animal 10: G_2 / G_2 (homozygous)

□ Locus G shows 2 different variants (G_1 and G_2) in the population

□ Di-plotid : 2 alleles mean 3 genotypes

- $G_1 G_1$
- $G_1 G_2 \Rightarrow$ heterozygous
- $G_2 G_2$

□ Genotypes $G_1 G_2 = G_2 G_1$
(not the case with haplotypes)

OHP Picture 3

Locus G is characterized within our population by the following quantities:

□ Genotype frequency: Rate of occurrence of each genotype in the population:

$$f(G_1G_1) = \frac{\#G_1G_1\text{-genotypes}}{N} = \frac{4}{10} = 0.4$$

$$f(G_1G_2) = \frac{3}{10} = 0.3$$

$$f(G_2G_2) = \frac{3}{10} = 0.3$$

□ Allele frequency:

$$f(G_1) = \frac{\#G_1\text{-alleles}}{2 \cdot N} = \frac{2 \cdot 4 + 3}{20} = \frac{11}{20} = 0.55$$

$$f(G_2) = \frac{3 + 2 \cdot 3}{20} = \frac{9}{20} = 0.45$$

OHP Picture 4

□ Genotype - and Allele - frequencies give a description of the current status of a population with respect to a given locus.

□ What happens from parents to offspring?

Assume : $f(G_1) = p$; $f(G_2) = q = 1-p$

Random mating : (Idealized population of infinite size)

Alleles	G_1	G_2
$\rightarrow G_1$	$f(G_1 G_1) = p \cdot p = p^2$	$f(G_1 G_2) = p \cdot q$
$\rightarrow G_2$	$f(G_2 G_1) = q \cdot p$	$f(G_2 G_2) = q \cdot q = q^2$

Summary : $f(G_1 G_1) = p^2$; $f(G_1 G_2) = 2 \cdot p \cdot q$
 $f(G_2 G_2) = q^2$

□ Mating: Parents have genotype frequencies according to Hardy-Weinberg Equilibrium

$$\left. \begin{aligned} f(G_1G_1) &= p^2 \\ f(G_1G_2) &= 2pq \\ f(G_2G_2) &= q^2 \end{aligned} \right\} \begin{aligned} f(G_1) &= f(G_1G_1) + \frac{1}{2}f(G_1G_2) \\ &= p^2 + \frac{1}{2} \cdot 2pq \\ &= p^2 + pq = p(p+q) \\ &= p \end{aligned}$$

allele freq. in sperm

	$f(G_1) = p$	$f(G_2) = q$
	\uparrow	\uparrow
	G_1	G_2

$$\begin{aligned} f(G_2) &= q^2 + pq \\ &= q(q+p) \\ &= q \end{aligned}$$

$f(G_1) = p$	$f(G_1G_1) = p \cdot p = p^2$	$f(G_1G_2) = pq$
$f(G_2) = q$	$f(G_2G_1) = q \cdot p$	$f(G_2G_2) = q^2$

allele freq. in egg

genotype frequencies in offspring

□ Summary: Hardy Weinberg Law

1. Relationship between allele frequencies and genotype frequencies is given by

$$f(G_1) = p ; f(G_2) = q$$

$$f(G_1G_1) = p^2 ; f(G_1G_2) = 2 \cdot pq ; f(G_2G_2) = q^2$$

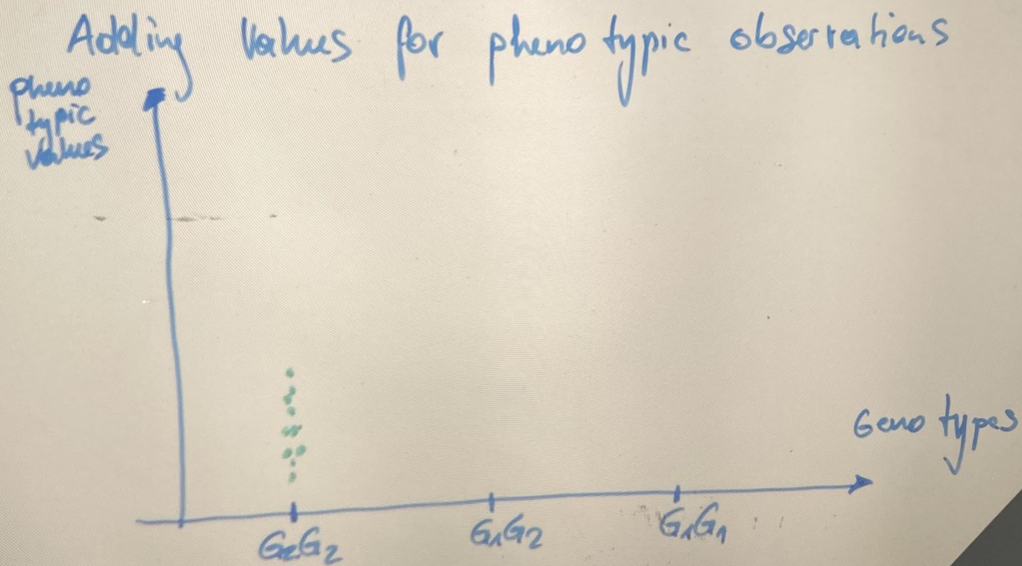
2. Under random mating, genotype frequencies and allele frequencies stay constant from generation to the next one.

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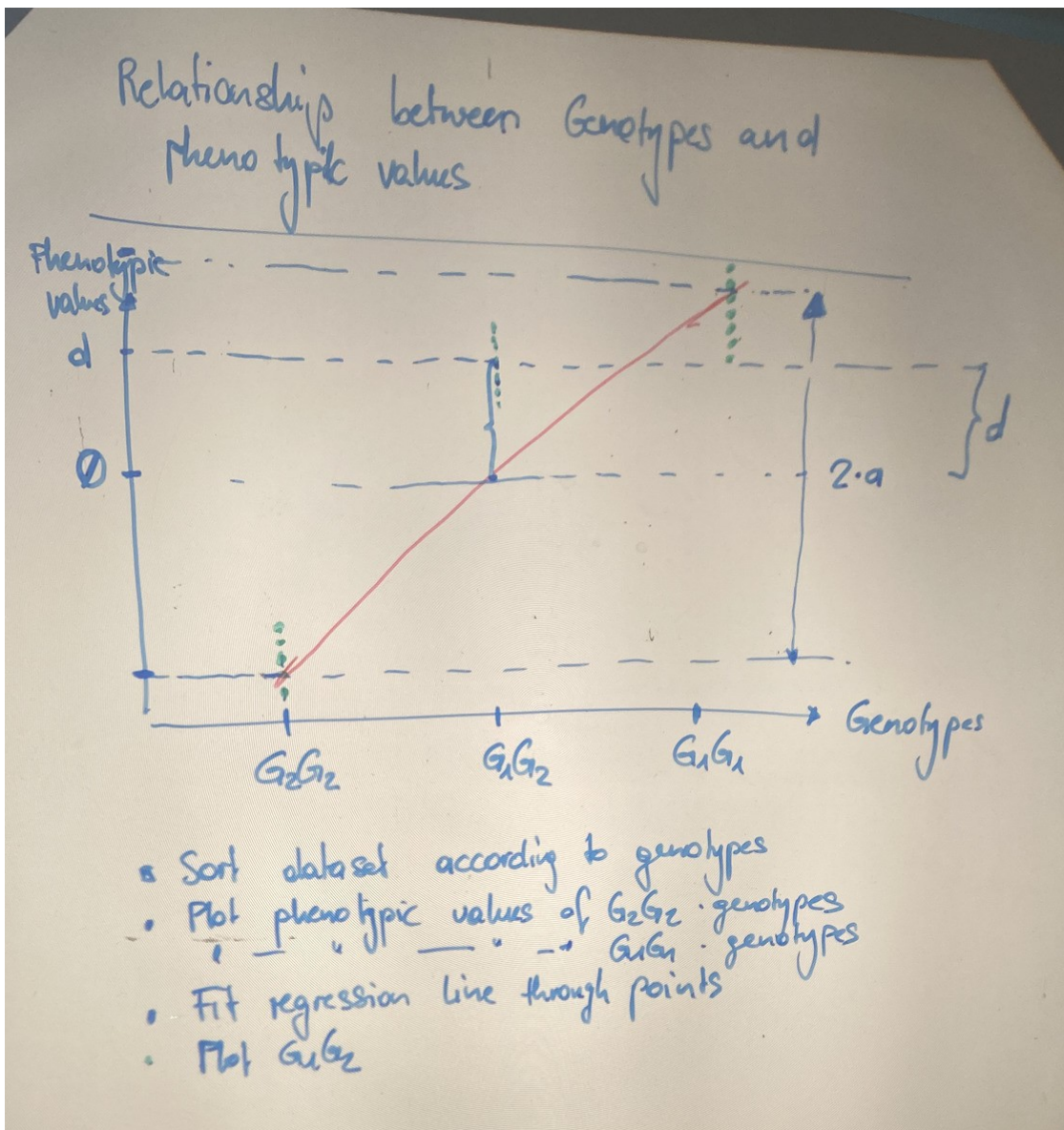
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OHP Picture 8



Genotypic Values

Genotype	Genotypic Value (V)
G_1G_1	$+a = V_{11}$
G_1G_2	$+d = V_{12}$
G_2G_2	$-a = V_{22}$

Population

- V is a discrete random variable
- Expected value of V:

$$E(V) = \begin{matrix} V_{11} \cdot f(G_1G_1) \\ + V_{12} \cdot f(G_1G_2) \\ + V_{22} \cdot f(G_2G_2) \end{matrix} \rightarrow \text{Hardy-Weinberg}$$

$$\begin{aligned}
 &= a \cdot p^2 + d \cdot 2pq + (-a) \cdot q^2 \\
 &= (p^2 - q^2) \cdot a + 2pqd \\
 &= (p - q)a + 2pqd \\
 &= \mu \quad (\text{mu})
 \end{aligned}
 \left. \begin{array}{l} (p^2 - q^2) \\ = (p+q)(p-q) \\ = (p-q) \end{array} \right\}$$

Population Mean

OHP Picture 10

