

# Overhead Pictures

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9/18/2020

# Genetic Model

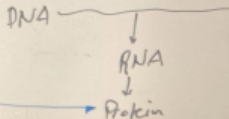
## Simple Genetic Model

$$P = G + E \rightarrow \text{environment}$$

phenotype  
(traits: growth, health, milk yield)

genotype

taken to be valid for all practical purposes, because of the "Central Dogma of Molecular Biology"



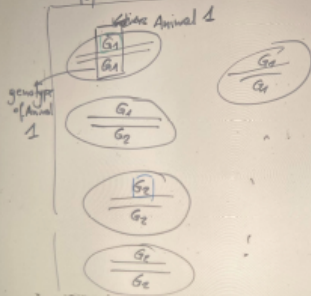
How can we describe or model the component G?

# Single Locus

The Simple Model of one Genetic Locus

is used to model  $G$

Population: Assume locus  $G$ , two Alleles  $G_1, G_2$



Two alleles at locus  $G$  lead to 3 possible  
genotypes:  $G_1G_1, G_1G_2, G_2G_1, G_2G_2$

# Frequencies

Frequencies:

Genotype

$$f(G_1G_1) = \frac{4}{10} = 0.4$$

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

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

} add up to 1

Alleles:

$$\begin{aligned} f(G_1) &= f(G_1G_1) + \frac{1}{2} f(G_1G_2) \\ &= 0.4 + 0.15 = 0.55 \end{aligned}$$

$$f(G_2) = f(G_2G_2) + \frac{1}{2} f(G_1G_2) = 0.45$$

# Hardy-Weinberg

In an ideal population (very large,  $\Rightarrow$  random mating, ...)

- Hardy-Weinberg Assumption in parent generation

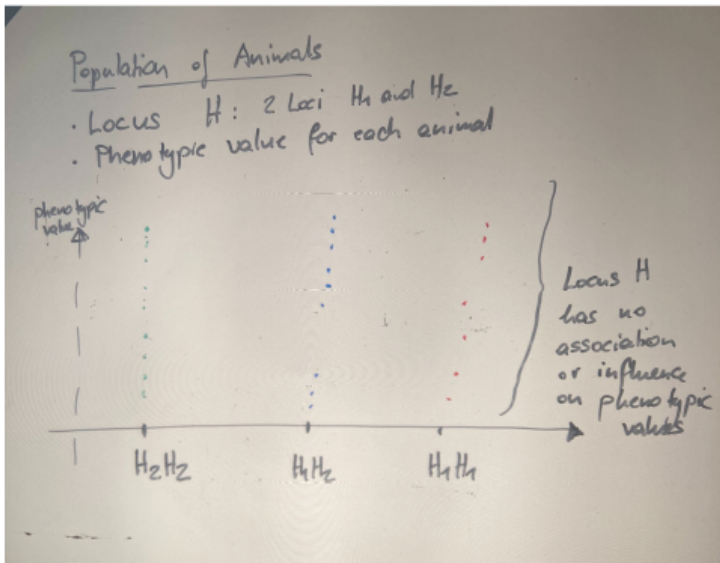
Allele:  $f(G_1) = p$ ,  $f(G_2) = q \Rightarrow q = 1 - p$

Genotype Frequencies:

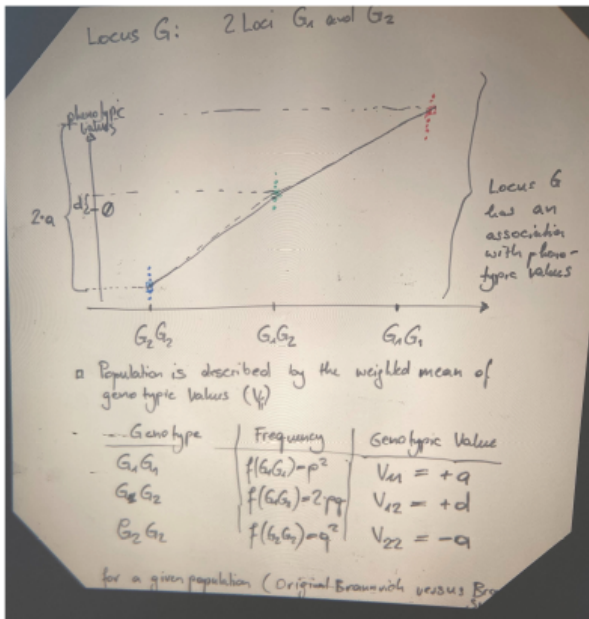
Alleles	$\downarrow$ $G_1$   $G_2 \Rightarrow$ Alleles in gametes	
	$\Rightarrow G_1$	$G_2$
$G_1$	$f(G_1G_1) = p \cdot p = p^2$	$f(G_1G_2) = p \cdot q$
$G_2$	$f(G_2G_1) = q \cdot p$	$f(G_2G_2) = q^2$

$G_1G_2$  and  $G_2G_1$  are the same  
 $\Rightarrow f(G_1G_2) = 2pq$

# No Association



# Locus With Association



# Population Mean

for a given population (Original Braunnöh versus Bra  
Swiss)

Population mean: (Genetics)

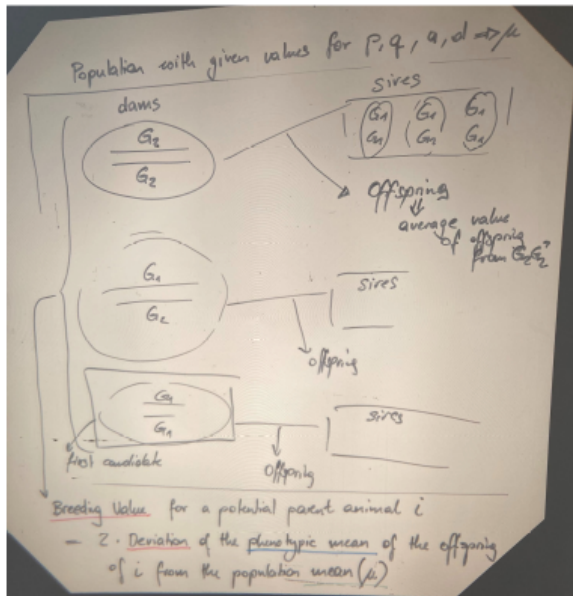
$$\begin{aligned}\mu &= V_{11} \cdot f(G_1G_1) + V_{12} \cdot f(G_1G_2) + V_{22} \cdot f(G_2G_2) \\&= \underline{a \cdot p^2} + d \cdot 2pq + \underline{(-a) \cdot q^2} \\&= \underline{(p^2 - q^2)a} + 2pq \cdot d \\&= \underbrace{(p-q) \cdot \underbrace{p+q}_{=1} a}_{=1} + 2pq \cdot d = (p-q) \cdot a + 2pq \cdot d\end{aligned}$$

Statistics:

- Random variable  $V$  for genotypic values
- Population mean corresponds to the expected value  $E[V] = \mu$

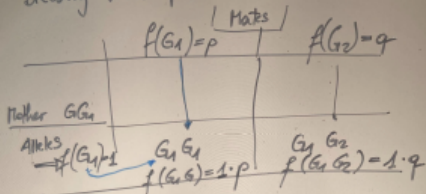


# Breeding Value I



## Breeding Value II

Breeding value for a  $G_1G_1$  mother:



⇒ Genotype frequencies of offspring of mother  $G_1G_1$ :

$$\begin{aligned} f(G_1G_1) &= p \\ f(G_1G_2) &= q \\ f(G_2G_2) &= 0 \end{aligned}$$

BV<sub>m</sub> for mother  $G_1G_1$ :

$$BV_m = 2 \cdot (\mu_m - \bar{m})$$

deviation (Abweichung)

$\mu_m$  is the mean genotypic value of all offspring of mother  $G_1G_1$ :

$$\mu_m = p \cdot a + q \cdot d + 0 \cdot (-a)$$

## Breeding Value III

BV<sub>m</sub> for mother G<sub>1</sub>G<sub>1</sub>: deviation (Abweichung)

$$BV_m = 2 \cdot (\mu_m - \mu)$$

$\mu_m$  is the mean genotypic value of all offspring of mother G<sub>1</sub>G<sub>1</sub>:

$$\mu_m = p \cdot a + q \cdot d + 0 \cdot (-a)$$

$$\rightarrow BV_m = 2 [ (p \cdot a + q \cdot d) - [(p-q)a + 2pqd] ]$$

$$= 2 [ \cancel{p}a + q \cdot d - \cancel{p}a + qa - 2pqd ]$$

$$= 2 [ \cancel{q}d + qa - \cancel{2pqd} ]$$

$$= 2 [ qa + qd(1 - 2p) ]$$

$$= 2q[a + (q-p)d] \quad p+q-2p = q-p$$