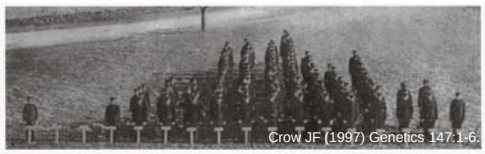
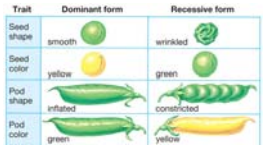
Quantitative Genetics Chapter 24

1. Quantitative Traits
2. Descriptive Statistics
3. Polygenic Hypothesis
4. Estimating gene number
5. Heritability



Crow JF (1997) Genetics 147:1-6.

Qualitative vs Quantitative Traits



Qualitative Traits

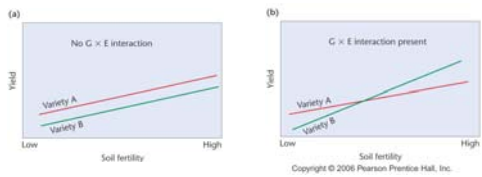
Quantitative Traits

Types of Quantitative Traits

- Continous
  - Height in humans
  - Fat content of cows milk
- Meristic
  - Leaf hairs in *Brassica napa*
  - Egg production in chickens
- Threshold
  - Breast Cancer

Multifactorial Traits

- Genetic
- Environment
- Genetic/Environment Interactions



Descriptive Statistics

- Mean

$$\bar{X} = \frac{\Sigma X_i}{n}$$

- Variance

$$s^2 = \frac{\Sigma X_i^2 - n\bar{X}^2}{n - 1}$$

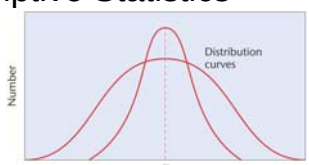
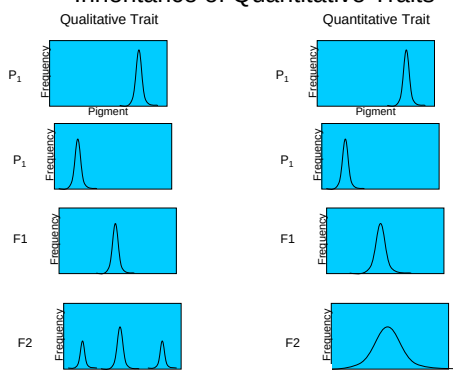


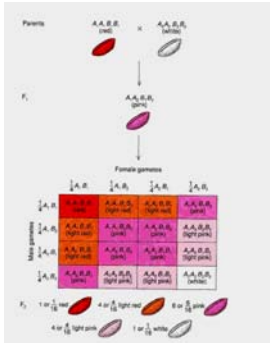
TABLE 24.2 SAMPLE INCLUSION FOR VARIOUS s VALUES

Multiples of s	Sample Included (%)
$\bar{X} \pm 1s$	68.3
$\bar{X} \pm 1.96s$	95.0
$\bar{X} \pm 2s$	95.5
$\bar{X} \pm 3s$	99.7

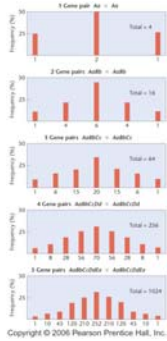
Inheritance of Quantitative Traits



Polygenic Hypothesis

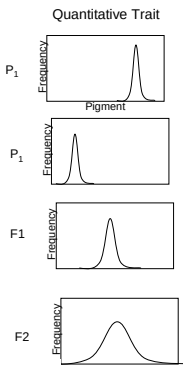


Multiple Genes



Where N is the number of genes with additive Alleles affecting a trait, the

# of phenotypic classes = 2n +1



Estimating Gene Number

$$N = \frac{D^2}{8(s^2_{F2} - s^2_{F1})}$$

where N is the number of genes that affect the trait in these population and D represents the difference between the means of the two parental populations.

Nature versus Nuture Heritability

Heritability – the proportion of variance in a population that is due to genetic differences

$Vp = Vg + Ve + Vi$

Ignoring genetic/environment interaction

$Vp = Vg + Ve$

Broad Sense Heritability (H^2)

$H^2 = Vg/Vp$

Narrow Sense Heritability – The proportion of variance in a population due to additive alleles

$Vp = Vg + Ve$

$Vg = Va + Vd + Vi$

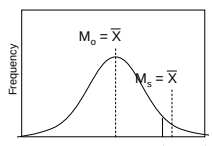
$Vp = (Va + Vd + Vi) + Ve$

Narrow Sense Heritability (h^2)

$h^2 = Va/Vp$

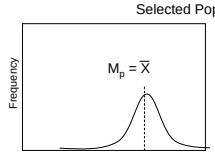
Estimating Narrow Sense Selection Experiment

Original Population



$$h^2 = \frac{M_p - M_o}{M_s - M_o}$$

Selected Population



Estimating Narrow Sense-2

The slope of the regression is equal to the narrow sense heritability[4]

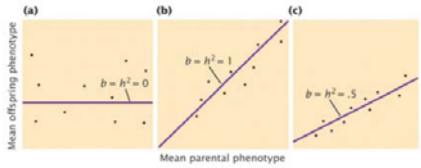


Figure 22.17

Post Turkey Review

If only one parent is used $h^2=2b$

Estimating Narrow Sense Heritability – 3 Twin Studies

Analysis of Monozygotic Twin and Dizygotic Twins

Correlation of Traits among twins

Trait	r_m	r_d	h2
Fingerprint Ridge Count	0.96	0.47	0.98
Height	0.90	0.57	0.66
IQ	0.83	0.66	0.34
Social Maturity	0.97	0.89	0.16

$h^2 = 2(r_m - r_d)$

Cautions about heritability

- Heritability depends on environmental conditions.
- Heritability describes the source of variation within a population not between populations
- Heritability does not explain the source of variation between particular individuals in a population
- Heritability does not describe the source of a trait within an individual

TABLE 24.4 ESTIMATES OF HERITABILITY FOR TRAITS IN DIFFERENT ORGANISMS

Trait	Heritability (h^2)
Mice	
Tail length	60%
Body weight	37
Litter size	15
Chickens	
Body weight	50
Egg production	20
Egg hatchability	15
Cattle	
Birth weight	45
Milk yield	44
Conception rate	3

Heritability of traits in humans

Trait	h^2
Longevity	29%
Height	85%
Weight	63%
Verbal Ability	63%
Memory	47%
Sociability	66%
Masculinity	12%
Humor	20%
Happiness	80%