Beyond Simple Dominant and Recessive Alleles

Concepts

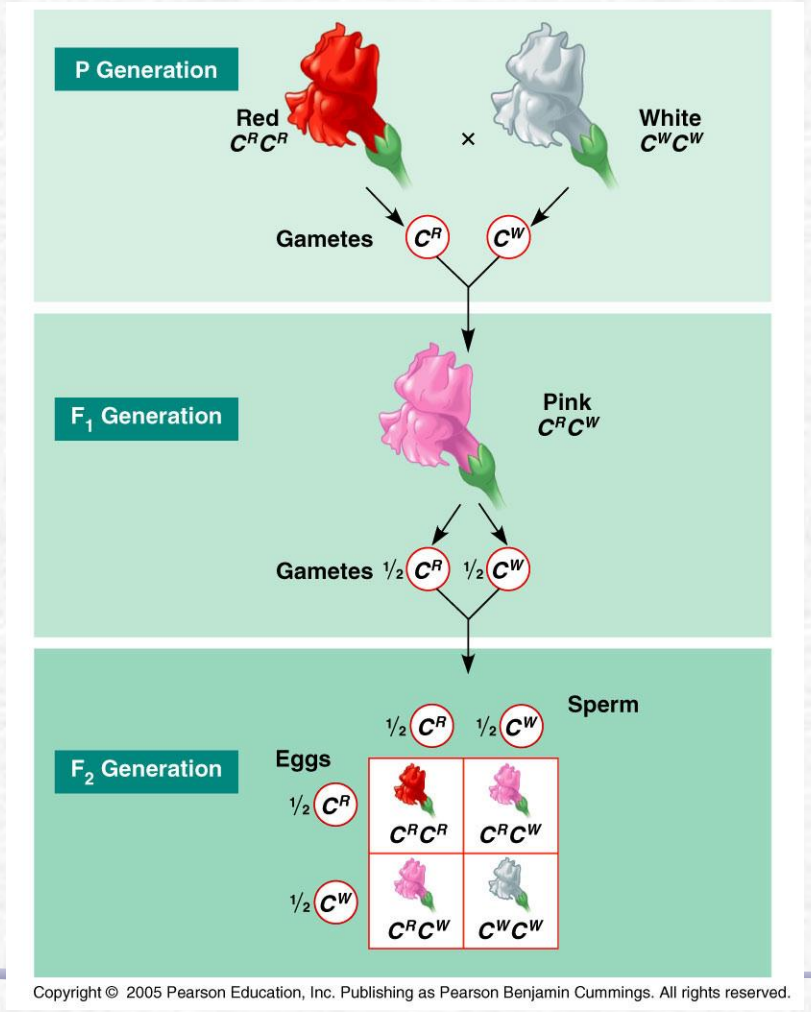
1. For some allele pairs, one allele is not dominant over other.
2. Many genes have more than two alleles.
3. Some genes are sex–linked (located on one of the two sex chromosomes).
4. Many characters are controlled by more than one gene.

Incomplete Dominant Alleles

- Pairs of alleles that **both** affect the phenotype when present in a heterozygote
- The heterozygous phenotype maybe a *blending* of the two homozygous phenotypes, OR…

Incomplete dominance – **Blending**

Ex: flower color in snapdragons



Two alleles:

- C^R - red
- C^W - white

$C^R C^R$ plants are red

C^WC^W plants are white

P - C^RC^R x C^WC^W

F1 - 100% C^RC^W pink

F2 - 1:2:1 red:pink:white

Codominant Alleles

- Pairs of alleles that **both** affect the phenotype when present in a heterozygote
- Instead of a blend, phenotype shows *distinct* features of both alleles

Codominant alleles - **phenotype shows distinct features of both alleles**

Example: Feather color in chickens

- Two alleles: F^B = Black

  F^W = White

$F^B F^B$ = black chicken; $F^W F^W$ = white chicken

- Cross a black chicken with a white chicken ($F^B F^B$ x $F^W F^W$)
  - Offspring is $F^B F^W$ = black and white speckled

Multiple Alleles

- Many genes have more than two alleles
- Does not mean an individual can have more than two alleles
- Only means there are more than two possible alleles in the population

Example of Multiple Alleles:

- Human blood type
- Gene codes a protein which can place a carbohydrate on the surface of red blood cells
- Three possible alleles
  - I^A - codominant
  - I^B - codominant
  - i - recessive

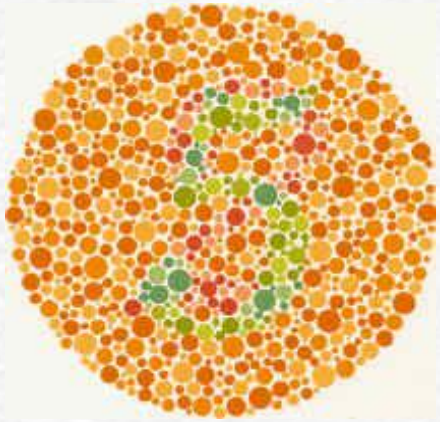
Possible genotypes and phenotypes

Genotype	Phenotype
• I^AI^A	Blood type A
• I^BI^B	Blood type B
• I^AI^B	Blood type AB
• I^Ai	Blood type A
• I^Bi	Blood type B
• ii	Blood type O

Sex-linked Traits

- If a sex-linked gene is located on the X chromosome, females will have two alleles, but males will only have one.
- If it's located on the Y chromosome, males will have one allele, and females will have no allele.
- Usually refers to traits coded for by genes on the X chromosome

Red-green color-blindness: an example of a sex-linked trait



Two possible alleles

- X^B - normal (dominant)
- X^b - color blind (recessive)

Color-blindness - Possible genotypes and phenotypes

Genotype	Phenotype
$X^B X^B$	normal female
$X^B X^b$	normal female
$X^b X^b$	color blind female
$X^B Y$	normal male
$X^b Y$	color blind male

Hemophilia – a second example of a sex-linked trait

- Recessive disorder defined by absence of one or more of the proteins required for blood clotting
- Two possible alleles:

  X^H – normal

  X^h - hemophilia

Hemophilia - Possible genotypes and phenotypes

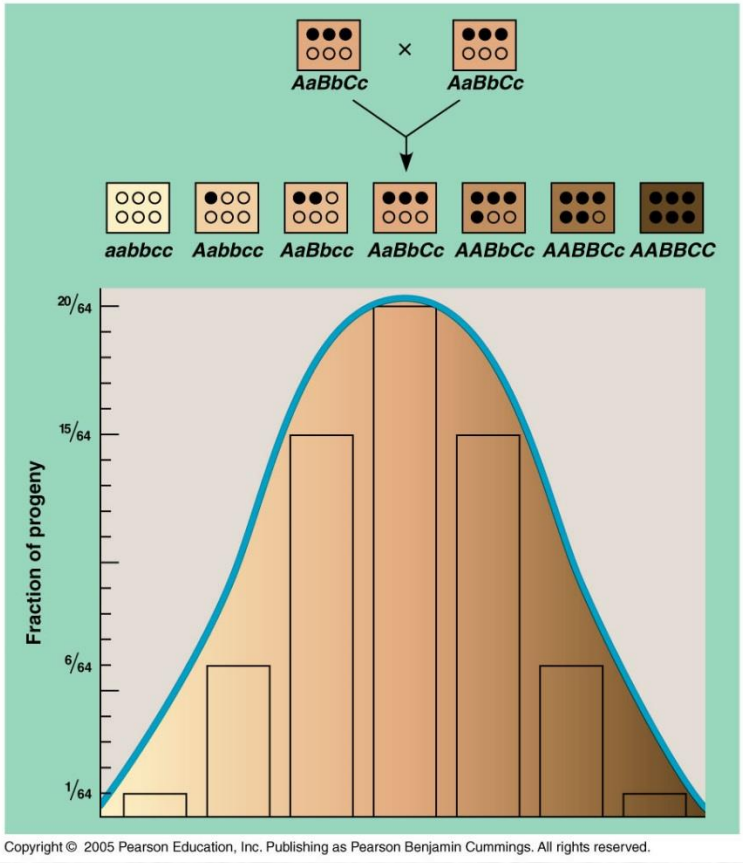
Genotype	Phenotype
X^HX^H	normal female
X^HX^h	normal female (carrier)
X^hX^h	female with hemophilia
X^HY	normal male
X^hY	male with hemophilia

Polygenic Characters

- Characters such as height, weight, and skin color result from the cumulative effects of many genes.
- These characters are not expressed as "either/or"" as was the case with Mendel's pea plant characters; instead they vary in the population along a continuum
- Such characters are called qualitative characters

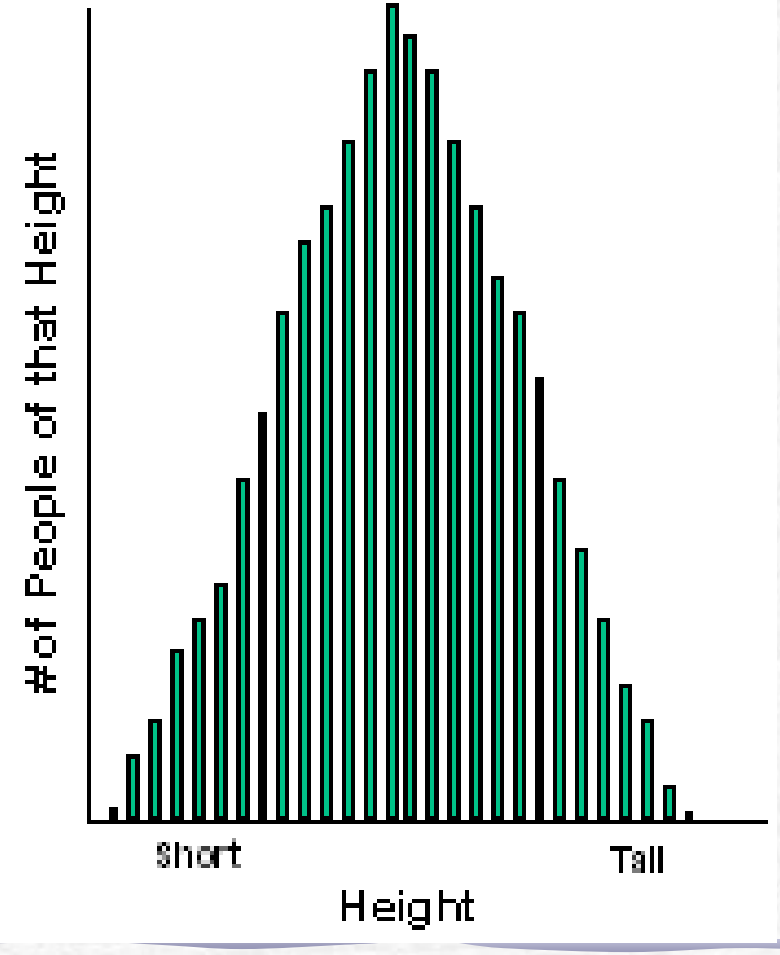
Skin Color as Example of a Polygenic Character

- Skin pigmentation (melanin production) is coded for by at least 3 separately inherited genes
- Each gene has a dark-skin allele (A,B, or C), which is codominant with other light-skin allele (a,b, or c).
- The more dominant alleles present, the darker the skin.



Polygenic inheritance – Human Height

- As few as 7 or as many as 20 genes might contribute to human height



Epistasis

- Black is dominant to chocolate B or b
  Yellow is recessive **epistatic** (when present, it blocks the expression of the black and chocolate alleles) E or e
- PhenotypePossible Genotypes
- BBEE
  BbEE
  BBEe
  BbEe
- bbEE
  bbEe
- BBee
  Bbee
  bbee
-
- Task: Determine the number of chocolate labs produced from a black female and a yellow male (BbEe x bbee)

Pleiotropy

- Some single alleles have more than one distinguishable phenotypic effect - This is called pleiotropy.
- An example is the coloration pattern and crossed eyes of Siamese cats, which are both caused by the same allele. These unrelated characters are caused by the same protein produced by the same allele.
- Another example is the gene that causes pigment color in rats. White rats also have very sensitive eyes and often become blind.