

**Dominant is NOT  
always seen in society!**



### “Hemingway Cats”



### HOW INHERITED TRAITS ARE TRANSMITTED



### *Purebreds and Mutts — A Difference of Heredity*

- Genetics is the science of heredity
- These black Labrador puppies are purebred—their parents and grandparents were black Labs with very similar genetic makeups
  - Purebreds often suffer from serious genetic defects



- The parents of these puppies were a mixture of different breeds
  - Their behavior and appearance is more varied as a result of their diverse genetic inheritance

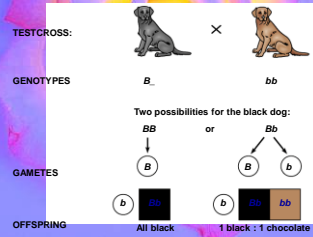


## We use a test cross to determine an unknown genotype.

Test cross = a cross between an individual of unknown genotype and an individual that is *homozygous recessive* for the trait in question.

## Geneticists use the testcross to determine unknown genotypes

- The offspring of a testcross often reveal the genotype of an individual when it is unknown



## Exceptions to Mendelism

Not everything is as simple as peas...

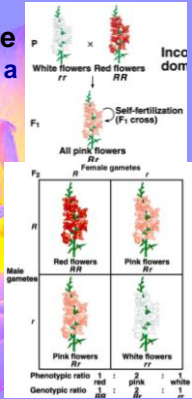
### 1. Incomplete Dominance - heterozygote expresses a phenotype intermediate between those of the two homozygotes.

Ex. snapdragon flower color

If cross Rr x Rr ...

Phenotypic ratio -> 1 red : 2 pink : 1 white

Genotypic ratio -> 1 RR : 2 Rr : 1 rr



### 2. Codominance - heterozygote expresses a phenotype that is distinct from and *not intermediate* between those of the two homozygotes.

Ex. Human AB blood type

Genotypes	Phenotypes	Type A	Type A
$I^A I^A$	A	$I^A I^A$	$I^A i$
$I^A i$	A	$I^A I^B$	$I^A B$
$I^B I^B$	B	$I^B I^B$	$I^B i$
$I^B i$	B	$I^B I^A$	$I^B B$
$I^A I^B$	AB	$I^A I^A$	$I^A i$
$ii$	None	$I^A I^B$	$I^A B$
		$I^B I^B$	$I^B B$
		$I^A i$	$ii$
		$I^B i$	$ii$

### The ABO Blood System

Blood Type (genotype)	Type A (AA, AO)	Type B (BB, BO)	Type AB (AB)	Type O (OO)
Red Blood Cell Surface Proteins (phenotype)	A agglutinogens only	B agglutinogens only	A and B agglutinogens	No agglutinogens
Plasma Antibodies (phenotype)	b agglutinin only	a agglutinin only	NONE	a and b agglutinin

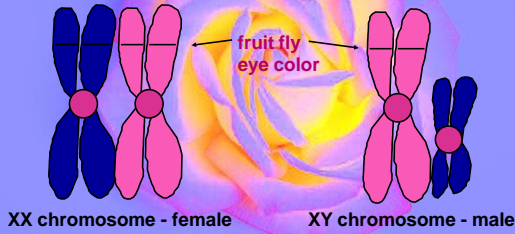
### Blood Transfusions

Blood Type	Receive Blood?	Give Blood?
OO	O only	Any type
AB	Any type	AB only
AA, AO	AA, AO, OO	AA, AO, AB
BB, BO	BB, BO, OO	BB, BO, AB

### 3. Sex-linked Traits

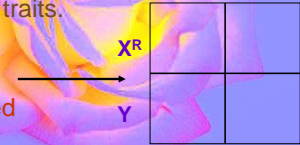
Example: Eye color in fruit flies

#### Sex Chromosomes

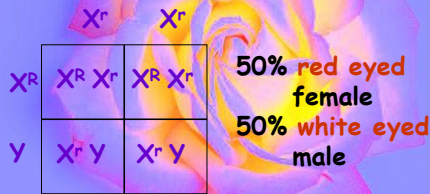


### Sex-linked Trait Problem

- Example: Eye color in fruit flies
- (red-eyed male) x (white-eyed female)  
 $X^R Y \times X^r X^r$
- Remember: the Y chromosome in males does not carry traits.
- RR = red eyed
- Rr = red eyed
- rr = white eyed
- XY = male
- XX = female

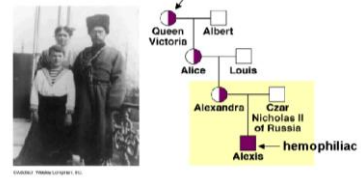


### Sex-linked Trait Solution:



### Female Carriers

In a sex-linked trait (like hemophilia), women are carriers, and men have the phenotype more often.



### 4. Lethal Alleles - certain allele combination causes death of an entire phenotypic class very early in development.

Ex. hairless trait in dogs [homozygous dominant (HH) individuals die as embryos]

Alleles	Genotypes	Phenotypes
$h$ = hair (wild type)	$HH$	lethal
$H$ = hairless (mutant)	$Hh$	Mexican hairless
	$hh$	hairy

**Cross 1**  
 Mexican hairless ( $Hh$ ) x Mexican hairless ( $Hh$ )

$H$	$h$
$H$	$Hh$
$h$	$Hh$
	$hh$

1/4 die as embryos ( $HH$ )  
 Of survivors:  
 2/3 = Mexican hairless ( $Hh$ )  
 1/3 = hairy ( $hh$ )

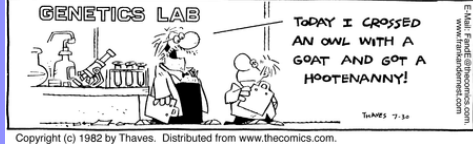
**Cross 2**  
 hairy ( $hh$ ) x Mexican hairless ( $Hh$ )

$H$	$h$
$h$	$Hh$
$h$	$hh$

All survive:  
 1/2 = Mexican hairless ( $Hh$ )  
 1/2 = hairy ( $hh$ )

Let's practice!

Frank and Ernest



Frank and Ernest



## 5. Dihybrid Cross

- Traits: Seed shape & Seed color
- Alleles: R round  
r wrinkled  
Y yellow  
y green

RrYy x RrYy

RY Ry rY ry      RY Ry rY ry

All possible gamete combinations

## Dihybrid cross



## Dihybrid cross

YyRr x YyRr

	YR	Yr	yR	yr
YR	YYRR	YYRr	YyRR	YyRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

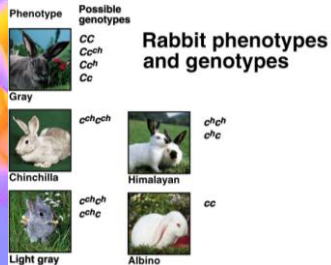
- 9/16 yellow round
- 3/16 green round
- 3/16 yellow wrinkled
- 1/16 green wrinkled

## Faster Method?

- Multiplication Rule!
- Overhead time!!!

### 5. Multiple Alleles gene exists as more than two alleles in the *population*.

- Rabbit coat color gene has 4 alleles:  
C, c, c<sup>ch</sup> & c<sup>h</sup>

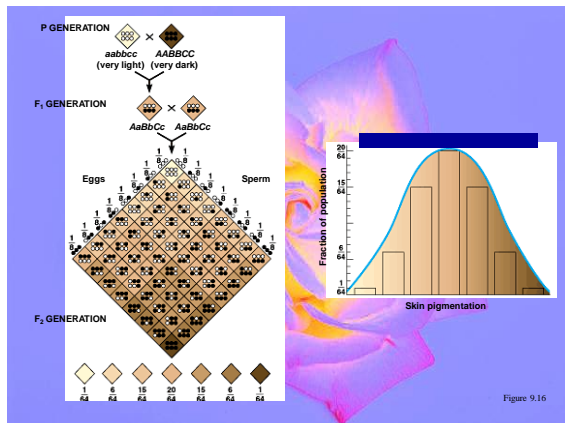


- 5 phenotypes
- 10 genotypes

### Complex Traits

Traits that do not follow Mendel's laws, but tend to "run in families".

- 6. Polygenic Traits - determined by the combined effect of more than one gene.  
Ex. height, eye color & skin color



### 7. Environmental factors – soil pH affects the color of hydrangea flowers

pH	Flower Color
4.5	deep, vivid blue
5.0	medium blue
5.5	lavender-purple
6.0	purplish-pink
6.5	mauve-pink
6.8	medium pink
7.0	deep, vivid pink



Acidic soil makes the flowers blue, basic or alkaline soil makes the flowers pink



Environmental factors—temperature and season affect the coat color of arctic foxes

