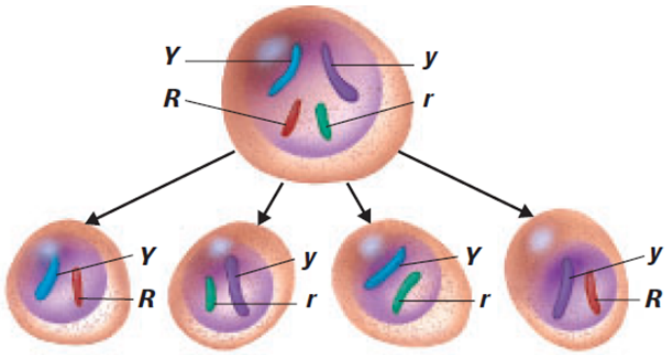
Topic 6 – Dihybrid crosses and Polygenic traits

- Dihybrid cross – cross of two individuals that differ in two traits whose genes are found on different chromosomes



■ Ex. Cross between **two** pea plants with yellow, round seeds (**heterozygous** for both traits)

Tall, round plant genotype = YyRr

YyRr x YyRr

Possible gametes YR Yr yR yr

Punnet Square:

Eg. A homozygous round (R) seed, homozygous short (t) pea plant is crossed with a homozygous wrinkled (r) seed, heterozygous tall pea plant. Determine the phenotypic ratio of the offspring.

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Eg. In humans, free earlobes are controlled by the dominant allele E, and attached earlobes by the recessive allele e. The widows peak hairline is regulated by the dominant allele W, and the straight hairline by the allele w.

Consider the mating of EeWw x EeWw

What is the probability of getting free earlobes?
What is the probability of getting attached earlobes?
What is the probability of getting widows peak?
What is the probability of getting straight hair line?
What is the probability of getting
(a)free earlobes and widows peak?
(b) a straight hairline and free ear lobes?
(c) a widow's peak and attached ear lobes?

In guinea pigs, black coat colour (*B*) is dominant to white (*b*), and short hair length (*S*) is dominant to long (*s*).
Indicate the genotypes and phenotypes from the following crosses:

(a) A guinea pig that is homozygous for black and heterozygous for short hair crossed with a white, long-haired guinea pig.

(b) A guinea pig that is heterozygous for black and for short hair crossed with a white, long-haired guinea pig.

(c) A guinea pig that is homozygous for black and for long hair crossed with a guinea pig that is heterozygous for black and for short hair.

Gene Interaction

- Polygenic traits - traits are regulated by more than one gene

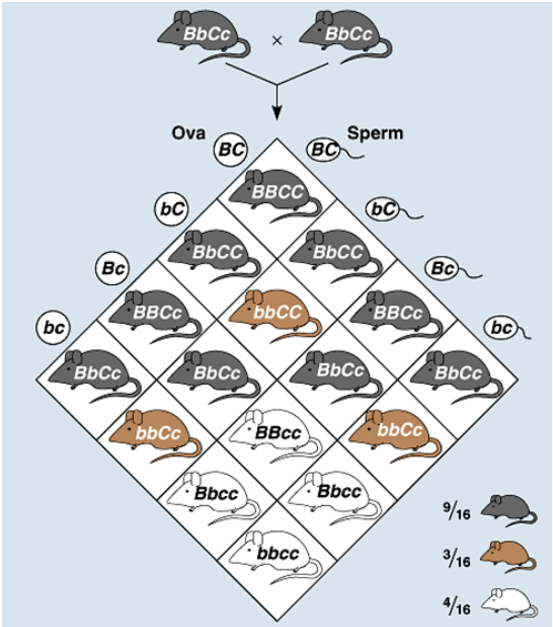
- In humans, skin color, eye color and height

- Ex. Coat color in dogs. B allele produces a black coat color. b allele produces brown coat color. However a second gene located on a separate chromosome affects coat color. A W allele prevents the formation of color pigements, resulting a white coat. A w allele does not prevent pigment formation and the coat is colored

WwBb = _____ wwbb = _____ WWBB = _____

- Epistatic interaction – when one gene interferes with the expression of another gene

- Ex. Coat color in dogs above

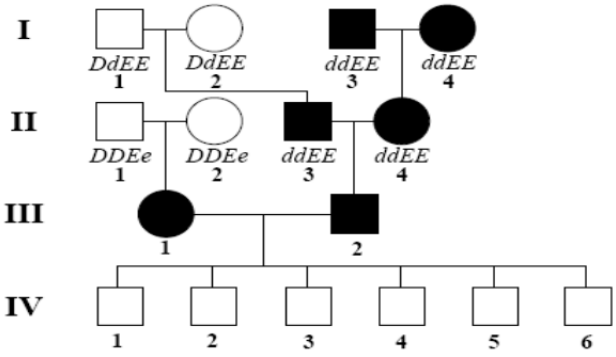


- Complementary interaction – when two different genotypes interact to produce a phenotype that neither is capable of producing itself

- Ex. Combs of chickens
  - R allele produces a rose comb
  - P allele produces a pea comb
  - R and P alleles together produce a walnut comb

Deaf-mutism is an autosomal recessive trait that is caused by two genes. Individuals who are homozygous recessive for either gene will have deaf-mutism. The two genes are designated as *D* and *E* in the diagram below.

Partial Pedigree for Deaf-Mutism



—from *Huskey, 1998*

A possible genotype of individual **IV-3** is

A. *ddEE*
B. *ddEe*
C. *DDee*
D. *DdEe*

Individuals **III-1** and **III-2** are expecting their seventh child. What is the probability of this child having deaf-mutism?

A. 0.00
B. 0.25
C. 0.50
D. 0.75

For human blood, the alleles for types A and B are codominant, but both are dominant over the type O allele.
The Rh factor is separate from the ABO blood group and is located on a separate chromosome. The Rh+ allele is dominant to Rh-.
Indicate the possible phenotypes of a child of a woman with type O, Rh- and a man with type A, Rh+

Cat coat colour results from the interaction of three different genes. A gene for black-based colours is located on an autosomal chromosome. A gene for red-based colours is located on the X chromosome. A different gene located on a separate autosomal chromosome determines pigment density in cat hair.

The black-based gene has three possible alleles: *B*–black, *b*–chocolate, and b^l–cinnamon. If pigmentation in cat hair is dense, the phenotypes listed below are possible.

Genotype	Phenotype
BB, Bb, Bb^l	black
bb, bb^l	chocolate
b^lb^l	cinnamon

There are two alleles for the pigment-density gene: dense pigment (*D*) and dilute pigment (*d*). The chart below shows the interaction of two autosomal genes affecting coat colour—the black-based gene and the density gene.

Black-based pigment gene	Density gene	
	D_	***dd***
*B_*	*B_D_* black colour	*B_dd* blue colour
bb; bb^l	*bbD_;* bb^lD_ chocolate colour	*bbdd;* bb^ldd lilac colour
b^lb^l	b^lb^lD_ cinnamon colour	b^lb^ldd fawn colour

According to the data above, the relationship among these alleles is such that the

A. black allele is codominant with the chocolate and cinnamon alleles

B. black allele is codominant with the chocolate allele, and the chocolate allele is codominant with the cinnamon allele

C. black allele is dominant over the chocolate and cinnamon alleles, and the chocolate allele is dominant over the cinnamon allele

D. black allele is dominant over the chocolate and cinnamon alleles, and the chocolate and cinnamon alleles are codominant

A blue-coloured female cat is bred with a cinnamon-coloured male cat. The offspring produced are black-coloured, blue-coloured, chocolate-coloured, and lilac-coloured. The genotypes of the parental cats are indicated in row

Row	Female Cat	Male Cat
A.	Bb^ldd	b^lb^lDd
B.	Bb^ldd	b^lb^lDD
C.	*Bbdd*	b^lb^lDd
D.	*Bbdd*	b^lb^lDD

A black-coloured female cat with the genotype *BbDd* is bred with a fawn-coloured male cat. The percentage of their offspring predicted to be chocolate-coloured is

A. 13%
B. 19%
C. 25%
D. 50%

Use the following information to answer the next four questions.

Two different genes control the expression of kernel colour in Mexican black corn: black pigment gene *B* and dotted pigment gene *D*. Gene *B* influences the expression of gene *D*. The dotted phenotype appears only when gene *B* is in the homozygous recessive state. A colourless variation occurs when both genes are homozygous recessive.

After pure-breeding black-pigmented plants were crossed with colourless plants, all of the offspring were black-pigmented.

—from *Griffiths et al., 1993*

The genotypes of the parents of these F_1 offspring could be

A. *BBDD* × *bbdd*
B. *BbDD* × *bbdd*
C. *Bbdd* × *bbDD*
D. *bbDD* × *BBdd*

Plants of the F_1 generation are suspected of being heterozygous for both genes. A test cross of colourless plants with the heterozygote plants should produce a phenotypic ratio in the offspring of

A. 1 : 0
B. 3 : 1
C. 2 : 1 : 1
D. 1 : 1 : 1 : 1

What is the probability of dotted offspring being produced from the test cross described above?

Answer: _____

(Record your **answer as a value from 0 to 1, rounded to two decimal places**, in the numerical-response section on the answer sheet.)

If the total number of offspring produced in the test crosses was 1 024 plants, how many plants would you expect to be black-pigmented?

Answer: _____

(Record your **answer as a whole number** in the numerical-response section on the answer sheet.)

Use the following information to answer the next two questions.

In tomato plants, purple stems (*P*) are dominant to green stems (*p*), and red tomatoes (*T*) are dominant to yellow tomatoes (*t*). The two genes are located on separate chromosomes.

A purple-stemmed, red-tomato plant is crossed with a purple-stemmed, yellow-tomato plant. They produce:

28 purple-stemmed, red-tomato plants
31 purple-stemmed, yellow-tomato plants
11 green-stemmed, red-tomato plants
9 green-stemmed, yellow-tomato plants

The genetic composition of the parents is

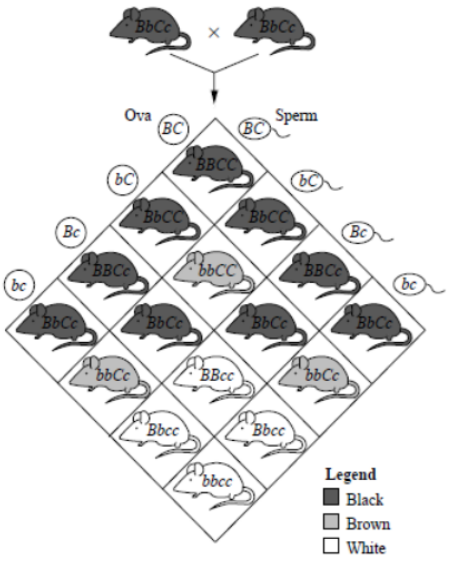
A. *PpTt* and *PPTT*
B. *PPTt* and *PpTT*
C. *PpTt* and *PpTt*
D. *PpTt* and *Pptt*

One of the green-stemmed, red-tomato plants was crossed with another tomato plant. One of the offspring was a purple-stemmed, yellow-tomato plant. If this offspring were crossed with a green-stemmed, yellow-tomato plant, then the possible phenotype or phenotypes of the offspring would be

A. green-stemmed, yellow-tomato plants
B. green-stemmed, yellow-tomato plants and purple-stemmed, yellow-tomato plants
C. green-stemmed, yellow-tomato plants; purple-stemmed, yellow-tomato plants; and purple-stemmed, red-tomato plants
D. green-stemmed, yellow-tomato plants; purple-stemmed, yellow-tomato plants; purple-stemmed, red-tomato plants; and green-stemmed, red-tomato plants

Use the following information to answer the next three questions.

Punnett Square for a Dihybrid Cross to Investigate Coat Colour in Mice



Coat colour in mice is controlled by the interaction of two genes. Three phenotypes result: black coat, brown coat, and white coat.

—from *Campbell, 1993*

In the dihybrid cross between the two black mice, the *C* allele codes for

A. black colour
B. brown colour
C. colour absent
D. colour present

What is the expected phenotypic ratio that results from a cross between two black mice heterozygous for both genes?

Phenotypic Ratio: _____ : _____ : _____
Coat Colour: **Black** **Brown** **White**

What is the expected phenotypic ratio resulting from a cross between a *bbCc* female mouse and *BbCc* male mouse?

Phenotypic Ratio: _____ : _____ : _____
Coat Colour: **Black** **Brown** **White**