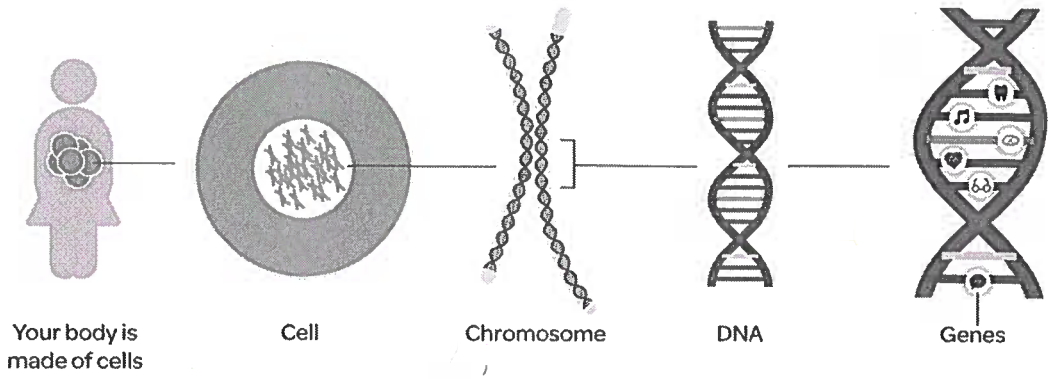
Key

Genetics

Work Package



This page is for quick reference notes

(Bb) **Heterozygous** - alleles in the organism that are different (Bb)

(BB) **Homozygous Dominant** - alleles in the organism that are the same and dominant (BB)

(bb) **Homozygous Recessive** - alleles in the organism that are the same and recessive (bb)

Dominant - an allele that masks the other alleles

Recessive - an allele that is masked by other alleles

Meiosis - the process of cell division that results in 4 haploid reproductive cells (gametes) → egg and sperm

Mitosis - the process of cell division that results in 2 diploid cells that are identicle to the parent

Monohybrid - ↳ the cross between two individuals with homozygous traits

1) For each of the genotypes (AA, Aa or aa) below determine what the phenotype would be. Purple flowers are dominant to white flowers.

PP purple Pp purple pp white

Hairy knuckles are dominant to non-hairy knuckles in humans.

HH hairy Hh hairy hh non-hairy

Bobtails in cats are recessive. Normal tails are dominant.

TT normal Tt normal tt bobtail

2) For each of the following write whether it is homozygous dominant, heterozygous or homozygous recessive.

AA homozygous-dominant

gg homozygous-recessive

Pp heterozygous

Ii heterozygous

tt homo- recessive

TT homo- dominant

Crosses with one homozygous dominant parent:

AA x AA

	A	A
A	AA	AA
A	AA	AA

Offspring Genotypes:
AA 4 Aa 0 aa 0

Offspring Phenotypes:
Dominant 4
Recessive 0

AA x Aa

	A	A
A	AA	AA
a	Aa	Aa

AA 2 Aa 2 aa 0

Dominant 4
Recessive 0

AA x aa

	A	A
a	Aa	Aa
a	Aa	Aa

AA 0 Aa 4 aa 0

Dominant 4
Recessive 0

Crosses with one heterozygous parent:

Aa x AA

	A	a
A	AA	Aa
A	AA	Aa

Offspring Genotypes:
AA 2 Aa 2 aa 0

Offspring Phenotypes:
Dominant 4
Recessive 0

Aa x Aa

	A	a
A	AA	Aa
a	Aa	aa

AA 1 Aa 2 aa 1

Dominant 3
Recessive 1

Aa x aa

	A	a
a	Aa	aa
a	Aa	aa

AA 0 Aa 2 aa 2

Dominant 2
Recessive 2

Crosses with one homozygous recessive parent:

aa x AA

	a	a
A	Aa	Aa
A	Aa	Aa

Offspring Genotypes:
AA 0 Aa 4 aa 0

Offspring Phenotypes:
Dominant 4
Recessive 0

aa x Aa

	a	a
A	Aa	Aa
a	aa	aa

AA 0 Aa 2 aa 2

Dominant 2
Recessive 2

aa x aa

	a	a
a	aa	aa
a	aa	aa

AA 0 Aa 0 aa 4

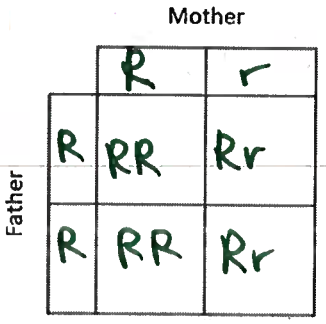
Dominant 0
Recessive 4

Mendelian Dominant Recessive Problems

1. Seed shape in pea plants can either be round or wrinkled. The allele for round shape is indicated by R. Is round seed shape dominant or recessive? dominant is shown by a capital letter

2. The allele for freckles is indicated by *F*. What is the genotype of a person who is heterozygous for freckles? Ff

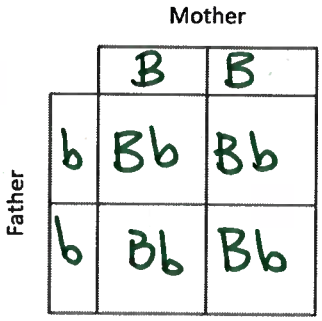
3. Draw a punnett square that represents a monohybrid cross between a female with the genotype Rr and a male with the genotype RR. What fraction of the offspring is predicted to have a phenotype of the dominant trait?



genotype
2RR : 2Rr

phenotype
4 dominant phenotype : 0 recessive phenotype

4. In mussels, brown colouring (B) is dominant, and blue colouring (b) is recessive. A homozygous brown mussel crosses with a blue mussel. What percentage of offspring are expected to be blue?



0 % will be blue

genotype
$\frac{4}{4}$ Bb

phenotype
$\frac{4}{4}$ brown

5. In sheep the allele for belly fur (A) is dominant to the allele for no belly fur (a). A mother with the genotype Aa and a father with the genotype Aa produce an offspring. What is the percent chance that the offspring will have no belly fur?

Mother

Father	A	a
A	AA	Aa
a	Aa	aa

25 % no belly fur

6. In pea plants, the allele for green pods is dominant (G) and the allele for yellow pods is recessive (g). A homozygous green-podded plant is crossed with a yellow podded pea plant. What are the possible genotypes of the parents (P generations)?

Parent generation genotypes: GG x gg

Use these genotypes to draw a punnett square and determine the possible genotypes and phenotypes of both the F1 and F2 generations.

F1:

Mother

Father	G	G
g	Gg	Gg
g	Gg	Gg

Offspring Genotypes:

$\frac{4}{4}$ Gg

Offspring Phenotypes:

$\frac{4}{4}$ green pods

F2:

Mother

Father	G	g
G	GG	Gg
g	Gg	gg

Offspring Genotypes:

$\frac{1}{4}$ GG, $\frac{2}{4}$ Gg, $\frac{1}{4}$ gg

Offspring Phenotypes:

$\frac{3}{4}$ green

$\frac{1}{4}$ yellow

7. In humans, the allele that codes for the ability to taste PTC is dominant (T) and the allele that codes for the inability is recessive (t). A male who is heterozygous for this trait marries a female who cannot taste PTC.

What are the genotypes of the male and female?

Tt male, tt female

Draw a punnett square to show the possible genotypes of the offspring.

	T	t
t	Tt	tt
t	Tt	tt

What % of their offspring will be able to taste PTC?

50%

8. Two black Guinea pigs were mated and over several years they produced 36 babies. 27 of the babies were black and 9 were white. Use a punnett square to give possible genotypes of the parents and the babies. Be sure to justify your answer.

$\frac{9}{36}$ = 25% white

$\frac{27}{36}$ = 75% Black.

Though both parents are black the only way for them to have white offsprings is if they both carry the white allele. In addition the ratio of 25% : 75% justifies the heterozygous x heterozygous cross.

9. In cats, the allele for short fur (H) is dominant to the allele for long hair (h). A heterozygous short haired cat is crossed with a long haired cat. What percentage of the offspring is expected to be heterozygous for hair length?

Hh x hh

	H	h
h	Hh	hh
h	Hh	hh

50% are Hh (heterozygous)

10. In watermelons, solid green rind colour (G) is dominant to stripes (g). A farmer crosses two watermelon plants that are heterozygous for rind colour. What are the odds that the offspring will have solid green rinds?

	G	g
G	GG	Gg
g	Gg	gg

75% are solid green (dominant)

11. In humans, brown eyes (B) are dominant over blue (b). A brown eyed man marries a blue eyed woman and they have three children, two of whom are brown eyed and one of whom is blue eyed. Draw the punnett square that illustrates this marriage. What is the man's genotype? What are the genotypes of the children?

Mother

Father	b	b
B	Bb	Bb
b	bb	bb

Child	Phenotypes	Possible Genotypes
Child #1	brown eyes	Bb
Child #2	brown eyes	Bb
Child #3	blue eyes	bb

for the children to have blue eyes, they must get b from mom & dad

12. The female dog is heterozygous. The male dog is heterozygous. Figure out the phenotypes and genotypes of their possible puppies by using a Punnett Square.

% of possible Genotypes:

AA ~~FF~~: 1 25%

Aa ~~Ff~~: 2 50%

aa ~~ff~~: 1 25%

% of possible Phenotypes:

Black fur: 75%

Grey fur: 25%

Mother

Father	A	a
A	AA	Aa
a	Aa	aa

13. In fruit flies, red eyes are dominant (E). White eyes are recessive (e). If the female fly has white eyes and the male fly has homozygous dominant red eyes, what are the possible phenotypes and genotypes of their offspring?

	E	E
e	Ee	Ee
e	Ee	Ee

genotype:

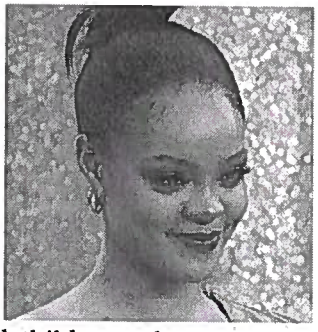
$\frac{4}{4}$ Ee

phenotype

$\frac{4}{4}$ red eyes.

14. Having a widow's peak like Wentworth Miller is Dominant. Not having a widow's peak like Rihanna is recessive.

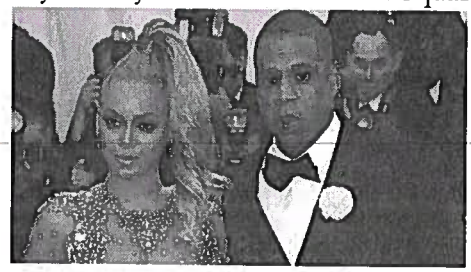
	A	a
a	Aa	aa
a	Aa	aa



If Wentworth Miller is Aa, and he and Rihanna had children, what are the possible phenotypes and genotypes of their children? 50% Aa, 50% aa

50% widow's peak, 50% no widow's peak.

15. Look at the phenotypes of Beyonce and Jay Z. If these two had children, could they have children with a widow's peak? Why or why not? Use a Punnett Square to explain your answer.



No.

	a	a
a	aa	aa
a	aa	aa

The only possible genotype is aa which is no widow's peak.

INCOMPLETE DOMINANCE

Bikini Bottom Genetics

Sponge Bob loves growing flowers for his pal Sandy! Her favourite flowers, Poofkins, are found in red, blue, and purple. Use the information provided and your knowledge of incomplete dominance to complete each section below.

1. Write the correct genotype for each colour if R represents a red gene and B represents a blue gene.

Red - RR (Rr) Blue - BB (rr) Purple - RB (Rr) OR

2. What would happen if Sponge Bob crossed a Poofkin with red flowers with a Poofkin with blue flowers? Complete the Punnett Square to determine the chances of each flower colour.

	R	R
B	RB	RB
B	RB	RB

(a) Give the genotypes and phenotypes for the offspring?

$\frac{4}{4}$ RB, $\frac{4}{4}$ purple

(b) How many of the plants would have red flowers? 0 %

(c) How many of the plants would have purple flowers 100%

(d) How many of the plants would have blue flowers 0 %

3. What would happen if Sponge Bob crossed two Poofkins with purple flowers? Complete the Punnet square to show the probability for each flower colour.

	R	B
R	RR	RB
B	RB	BB

(a) Give the genotypes and phenotypes for the offspring?

$\frac{1}{4}$ RR, $\frac{1}{4}$ BB, $\frac{2}{4}$ RB / 50% purple, $\frac{1}{4}$ Blue, $\frac{1}{4}$ red

(b) How many of the plants would have red flowers? 25 %

(c) How many of the plants would have purple flowers 50 %

(d) How many of the plants would have blue flowers 25 %

4. What would happen if Sponge Bob crossed a Poofkin with purple flowers with a Poofkin with Blue flowers? Complete the Punnett square to show the probability for plants with each flower colour.

	R	B
B	RB	BB
B	RB	BB

(a) Give the genotypes and phenotypes for the offspring?

$\frac{2}{4}$ RB, $\frac{2}{4}$ BB / $\frac{2}{4}$ purple, $\frac{2}{4}$ Blue

(b) How many of the plants would have red flowers? 0 %

(c) How many of the plants would have purple flowers 50 %

(d) How many of the plants would have blue flowers 50 %

5. The trait for coat colour in cats shows incomplete dominance. A) If you cross a white cat (WW) with a black cat (BB) what will be the possible genotypes and phenotypes of their kittens? B) If you cross two grey kittens (BW) what are the possible genotypes and phenotypes of their kittens?

Father \ Mother	W	W
B	BW	BW
B	BW	BW

genotype
$\frac{4}{4}$ BW

phenotype
$\frac{4}{4}$ grey

Father \ Mother	B	W
B	BB	BW
W	BW	WW

genotype
$\frac{1}{4}$ BB, $\frac{1}{4}$ WW, $\frac{2}{4}$ BW

phenotype
$\frac{1}{4}$ Black, $\frac{1}{4}$ white
$\frac{2}{4}$ grey

6. When a Snap Dragon homozygous for red flowers is crossed with one homozygous for white flowers, the offspring are pink. Predict the results of combining a pink flower with a homozygous white one. Show all possible genotypes and phenotypes of offspring.

original

Father \ Mother	R	R
W	RW	RW
W	RW	RW

the cross

Father \ Mother	R	W
W	RW	WW
W	RW	WW

genotype
$\frac{2}{4}$ RW, $\frac{2}{4}$ WW

phenotype
$\frac{2}{4}$ pink, $\frac{2}{4}$ white

7. For a particular plant, a cross between a purebred variety with blue flowers and a purebred variety with white flowers results in a plant with light-blue flowers. The cross is written as BB(blue) X WW(white) → BW (light blue).

a) What kind of dominance is suggested by this result? Explain why.

incomplete dominance as the heterozygous is a blend of the two alleles.

b) Draw a Punnett square for a cross between two plants with light-blue flowers. Show both the genotype and phenotype of the offspring in each box.

Father \ Mother	B	W
B	BB	BW
W	BW	WW

genotype
$\frac{1}{4}$ BB, $\frac{1}{4}$ WW, $\frac{2}{4}$ BW

phenotype
$\frac{1}{4}$ blue, $\frac{1}{4}$ white, $\frac{2}{4}$ light blue

c) If 120 flowers are produced in the F_2 generation from the cross above, predict how many flowers will have the genotypes and phenotypes:

$0.25 \times 120 \rightarrow$ BB - 30 Blue - 30

$0.50 \times 120 \rightarrow$ BW - 60 Light-blue - 60

$0.25 \times 120 \rightarrow$ WW - 30 White - 30

8. An imaginary flowering plant with orange petals is crossed with another plant with the same phenotype. The offspring consist of 10 plants with orange petal, 5 plants with red petals, and 5 plants with yellow petals. Suggest an explanation for this pattern of inheritance.

since two orange plants produce two new colours (red & yellow) then incomplete dominance is the factor

b) A plant with orange flowers is crossed with a plant with red flowers. If 60 offspring are produced, how many plants of each phenotype (red, orange, yellow) are likely to be produced?

R Y

R RR RY

R RR RY

Red - 30 Orange - 30 Yellow - 0

$0.5 \times 60 = 30$ RR

$0.5 \times 60 = 30$ RY

CO-DOMINANCE

Human blood types are determined by genes that follow the **CODOMINANCE** pattern of inheritance.

There are two dominant alleles (A & B) and one recessive allele (O).

Blood Type (Phenotype)	Genotype	Can donate blood to:	Can receive blood from:
O	ii (OO)	A,B,AB and O (universal donor)	O
AB	I^AI^B	AB	A,B,AB and O (universal receiver)
A	I^AI^A or I^Ai (I^AO)	AB, A	O,A
B	I^BI^B or I^Bi (I^BO)	AB,B	O,B

1. Write the genotype for each person based on the description:
   a. Homozygous for the "B" allele — I^BI^B
   b. Heterozygous for the "A" allele — I^Ai OR I^AO
   c. Type O — ii OR OO
   d. Type "A" and had a type "O" parent — I^Ai OR I^AO
   e. Type "AB" — I^AI^B
   f. Blood can be donated to anybody — ii OR OO
   g. Can only get blood from a type "O" donor — ii OR OO

2. Pretend that Brad Pitt is homozygous for the type B allele, and Angelina Jolie is type "O." **What are all the possible blood types of their baby?** *(Do the punnett square)*

only I^BO kids, blood type B.

Father \ Mother	O	O
I^B	I^BO	I^BO
I^B	I^BO	I^BO

3. Complete the punnett square showing all the possible blood types for the offspring produced by a type "O" mother and an a Type "AB" father. **What are percentages of each offspring?**

50% AO, 50% BO ∴ 50% type A
50% type B

Father \ Mother	O	O
A	AO	AO
B	BO	BO

4. Mrs. Brown is type "A" and Mr. Brown is type "O." They have three children named Matthew, Mark, and Luke. Mark is type "O," Matthew is type "A," and Luke is type "AB." Based on this information:
   a. Mr. Brown must have the genotype OO
   b. Mrs. Brown must have the genotype AO because Mark has blood type O
   c. Luke cannot be the child of these parents because neither parent has the allele B.

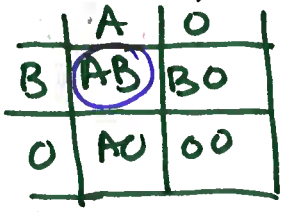
no B.

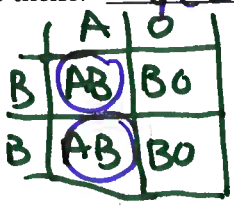
Father \ Mother	O	O
A	AO	AO
O	OO	OO

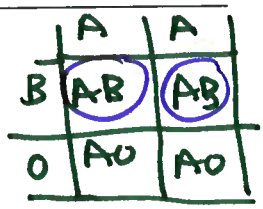
5. Two parents think their baby was switched at the hospital. Its 1968, so DNA fingerprinting technology does not exist yet. The mother has blood type "O," the father has blood type "AB," and the baby has blood type "B."
   a. Mother's genotype: OO
   b. Father's genotype: AB
   c. Baby's genotype: BB or BO
   d. Punnett square showing all possible genotypes for children produced by this couple.
   e. Was the baby switched? 50% chance that they were switched

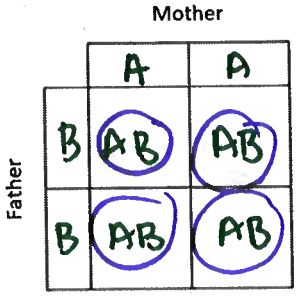
Father \ Mother	O	O
A	AO	AO
B	BO	BO

6. Two other parents think their baby was switched at the hospital. Amy the mother has blood type "A," Steven the father has blood type "B," and Priscilla the baby has blood type "AB."
   a. Mother's genotype: AA or AO
   b. Father's genotype: BB or BO
   c. Baby's genotype: AB
   d. Punnett square that shows the baby's genotype as a possibility
   e. Could the baby actually be theirs? yes









7. Based on the information in this table, which men **could not** be the father of the baby? **You can use the Punnett square if you need help figuring it out.**

Name	Blood Type
Mother	Type A
Baby	Type B
The mailman	Type O ✗
The butcher	TypeAB ✓
The waiter	Type A ✗
The cable guy	Type B ✓

mother is AO b/c baby is B. so baby is BO. Baby got O from mom. So must have gotten B from dad

8. The sister of the mom above also had issues with finding out who the father of her baby was. She had the state take a blood test of potential fathers. Based on the information in this table, why was the baby taken away by the state after the test?

Name	Blood Type
Mother	Type O
Baby	Type AB
Bartender	Type O
Guy at the club	Type AB
Cabdriver	Type A
Flight attendant	Type B

mother is OO, for baby to be AB, they must have A from parent 1, and B from parent 2. when it comes to this baby, you ARE NOT the mother.

AA OR AO BB or BO

9. A mother has type A blood and her daughter has type B blood. Is it possible that the father has type O blood? Explain your answer. No. the daughter could not have gotten B from mom, so must have gotten B from dad. so dad cannot be OO.

AA AO BB BO

10. A mother has type A blood, and the father has type B blood. Is it possible for their son to have type O blood? Explain your answer. Yes. If mom is AO and father is BO then there's 25% chance that their baby is going to have OO.

11. Three common alleles in human blood types are A, B, o. The o allele is recessive to both the A and the B alleles. Allele A makes a protein that produces molecule A, which attaches to the red blood cell's membrane. Allele B works the same way, resulting in molecule B attaching to the cell's membrane. The o allele does not code for a protein, and no molecules attach to the cell membrane. Match each genotype with the appropriate blood type.

a) oo O
b) AA A
c) Bo B
d) Ao A
e) BB B
f) AB AB

12. Draw a Punnett square showing a cross between a father with genotype Ao and a mother with genotype AB.

Mother

Father	A	B
A	AA	AB
O	AO	BO

a) What is the probability that the child will have blood type o?

0%.

b) What is the probability that the child will be homozygous type A?

25%.

13. Mr. and Mrs. Green had a baby the same day as two other couples, the Oranges and the Browns. The Greens began to believe that their baby had been switched at the hospital due to some of her traits. Using Punnett squares and the information provided, solve the problem of the switched babies. Where the babies switched at birth? Which baby belongs to which parents?

Parents	Blood Types	Possible Geno
Mr. Green	A	Ai or AA
Mrs. Green	A	Ao or AA
Mr. Orange	O	oo
Mrs. Orange	B	Bo or BB
Mr. Brown	AB	AB
Mrs. Brown	AB	AB

only A.
only B
A & B.

Baby	Blood Type	Possible Geno
Baby Green	AB	AB
Baby Orange	A	Ao, AA
Baby Brown	O	oo

↑ only way it can be AB is from A & B parents

Mother / Father

Mother / Father

Mother / Father

Mother / Father

Mother / Father

Mother / Father

Who are the real parents of:

Baby Green: Brown's Baby Orange: Green's Baby Brown: Orange's

SEX-LINKED TRAITS

1. What is the sex chromosome pairing for a male? What is the sex chromosome pairing for a female?

XY male
XX female

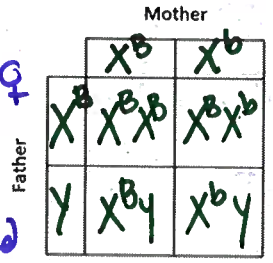
2. On which chromosome are the sex-linked genes located in?

X. Chromosome

3. A female is the carrier of the colour blind gene. She mates with a normal male. They have two boys (one is normal, one is colour blind) and they have 2 girls (one is normal, the other is a carrier).

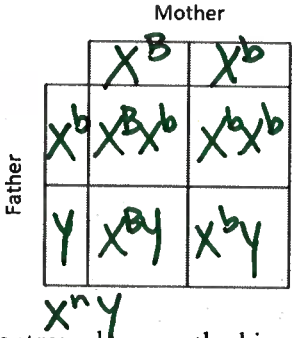
a) draw a Punnett square to show the above results

X^BX^B normal ♀
X^BX^b carrier ♀
X^BY normal
X^bY colour blind



b) If the carrier daughter marries a colour blind male, what are the chances that their sons will be colour blind? Daughters colour blind?

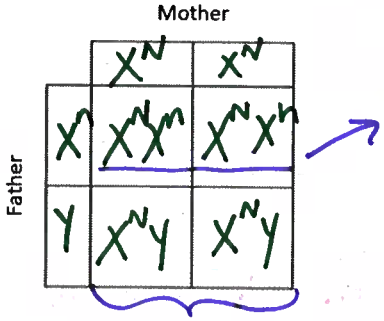
sons 50% chance
daughters 50% chance



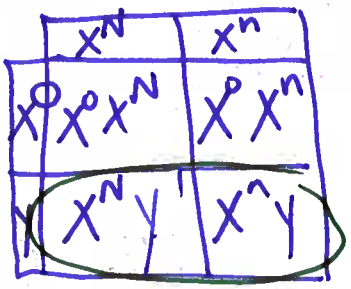
X^NX^N

X^nY

4. A lady with normal skin texture marries a man who has extremely smooth skin. All four of their children (two boys, two girls) have normal skin. Five out of eight grandsons end up with smooth skin. Explain how this is possible by making use of Punnett squares.



sons are dead ends because they don't pass on their X. to sons.



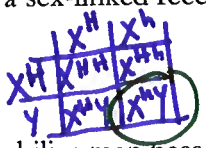
← grandsons

grandkids

~50% have smooth skin

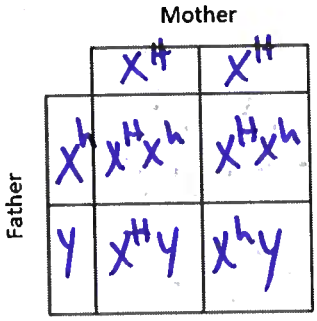
5. Haemophilia is a sex-linked recessive trait. Could a carrier woman have a haemophiliac son?

Yes.



6. Could a haemophiliac man pass the gene to his sons? Why? No males only pass Y, which does not have hemophiliac information

7. Give the offspring Phenotype and genotype ratios for a cross between a haemophiliac man and a homozygous normal woman.



genotype: X^HX^h 2/4, X^HY 1/4, X^hY 1/4

phenotype: 2/4 carrier daughters

1/4 normal male

1/4 hemophiliac male

8. The gene for colour blindness is located on the non-homologous portion of the X chromosome. It is recessive.

a) could a carrier woman have a colour blind son? Yes

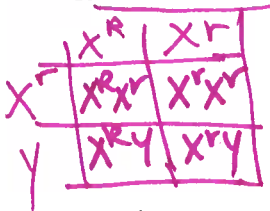
b) could she have colour blind daughters? depends on male, if male is colour blind, then she can.

9. The inheritance of eye colour in fruit flies is sex-linked.

X^R = Red eye (dominant)

X^r = White eye (recessive)

a) Use the symbols above to draw a Punnett square showing the outcome of a mating of a female with one allele for red eyes and one allele for white eyes with a white-eyed male



1/4 X^RX^r 1/4 X^RY

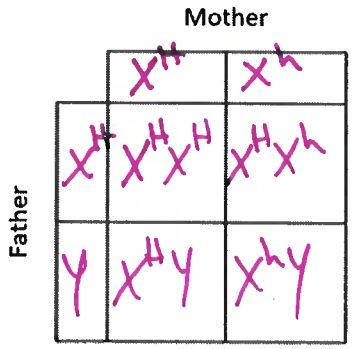
1/4 X^rX^r 1/4 X^rY

b) What percentage of the offspring will have white eyes: 50% red eyes: 50%

c) Are the red eyed male offspring able to pass the white eyed trait on to the next generation? Explain your answer. Also, therefore No because the males with red eyes ONLY have 1 X chromosome of red eye colour.

d) Are the red-eyed female offspring able to pass the white eyed trait on to the next generation? Explain your answer. yes because they can still be carriers.

10. Hemophilia is a sex-linked trait. What is the possibility that the children of a cross between a carrier female (X^HX^h) and a normal male (X^HY) will have hemophilia? Will be carriers? Will be normal? Show your work and possible genotypes and phenotypes of their children.



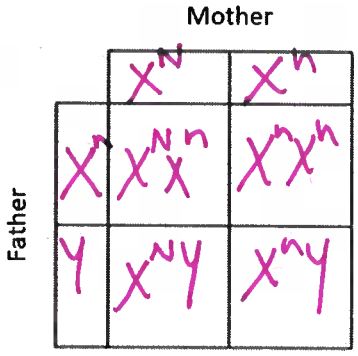
Phenotype(s)

normal ♀ carrier ♀ normal ♂ hemophiliac ♂

Genotype(s)

X^HX^H 1/4, X^HX^h 1/4, X^HY 1/4, X^hY 1/4

11. Colourblindness is a sex-linked, recessive trait in humans. That means it is found only on the X chromosome. Remember that a male is XY and a female is XX. A woman who is a carrier of the colour blindness gene X^NX^n marries a colour blind man X^nY. They plan on having children in a couple of years. What are the chances that their sons will be colour blind? What are the chances that their daughters will be colour blind? Use a Punnett square to solve this problem.



% of sons that will be CB

50%

% of daughter that will be CB

50%