MENDELIAN GENETICS

LEVEL 1

1. "In humans, brown eyes are dominant over blue eyes." Explain the meaning of this statement.

If the allele for brown eyes is present, it will show in the phenotype.

a) What is the genotype of a person:

- homozygous for brown eyes BB
- homozygous for blue eyes bb
- heterozygous for brown eyes Bb

2. If a smooth coat guinea pig is mated to a rough coat guinea pig and all of the 12 offspring have smooth coats, what is the genotype of the smooth coat guinea pig?

A - smooth coat a - rough coat ∴ AA

a) Give the reason you think smooth coat to be a *dominant* or *recessive* characteristic.

Smooth coat is dominant b/c the rough coat dissapeared in the F1 generation.

b) What would be the *genotype* of a heterozygous smooth coat guinea pig? Aa

c) What is the *phenotype* of a homozygous rough coat guinea pig? aa

d) If the genotype of a smooth coat guinea pig is **Ss**, draw the gametes that could possibly form if the animal were:

male Ss → S, s

female Ss → S, s

3. In humans, curly hair (C) is dominant to straight hair (c). A man with curly hair whose mother has straight hair marries a woman with straight hair. What are the possible genotypes of :

a) the man Cc

b) his mother cc

c) his wife cc

d) their four children 50% Cc
50% cc

e) What are the chances of their first child having curly hair? 50%

f) What are the chances of their second child having curly hair? 50%

4. Give one similarity and one difference between the following pairs:

	similarity	difference
a) dominant and recessive traits	- both represented by alleles.	- recessive only shows in a homozygous genotype.
b) heterozygous and homozygous	- both involve 2 alleles	- homozygous = both alleles the same. heterozygous = both alleles different.

MENDELIAN GENETICS
LEVEL 2

1. In humans, night blindness (N) is dominant over normal vision (n).

a) Give the possible genotypes for an individual who has

- night blindness NN or Nn
- normal vision nn

b) What are the possible genotypes for the following people:

- a person with night blindness whose mother was normal Nn
- the mother of a child with night blindness N_ or nn
- a normal visioned woman whose mother was night blind nn
- the night blind mother of a normal visioned daughter Nn

c) A normal visioned man marries a normal visioned woman. What are the chances that their first child will have normal vision? nn × nn

100% nn → all will have normal vision.

d) A man with night blindness whose mother was normal and whose father was night blind marries a woman who is normal but whose brother is night blind. What kind of children can they have and in what proportion? P_1: Nn × nn

children = 50% Nn (nightblind); 50% nn (norm

Give the genotypes of :

- the man Nn his mother nn his father N_
- the woman nn her brother Nn

2. Broccoli normally has dull green (G) foilage (leaves). A recessive mutation results in glossy (g) leaves which are highly susceptible to insect attack.

a) What are the possible genotypes of broccoli having:

dull green leaves? GG or Gg glossy leaves? gg

b) Market gardners never use seeds from glossy leaf plants, yet these plants still appear from time to time. Why do you think this happens? b/c the plants producing seeds are heterozygous.

c) If you uproot glossy leaf plants when they appear, explain how this practise may or may not be successful to eliminate the gene for glossy leaves. It will reduce the frequency of "g" allele, but there is no way to eliminate it b/c there is now easy way to identify heterozygotes.

MENDELIAN GENETICS
LEVEL 3

1. In humans freckles (**F**) are dominant to normal skin (**f**). A woman with normal skin tone marries a man with freckles. They have seven children, five of which are normal and two of which have freckles. List the genotypes of the parents and children.

First: Write down the allele designations

F - Freckles f - normal

Second: Write down the actual cross

P_1: Ff × ff

Third: Organize your Punnett square

F_1:

	F	f
f	Ff	ff

50% Ff
50% ff

∴ dad = Ff
mom = ff
$\frac{5}{7}$ children = ff
$\frac{2}{7}$ children = Ff

Fourth: Count out the phenotype ratios

50% freckles
50% normal

2. In humans free ear lobes (**E**) are dominant to attached ear lobes (**e**). A man with free ear lobes, whose mother had attached ear lobes, marries a woman with attached ear lobes, both of whose parents had free ear lobes. They have 5 children with free ear lobes and 1 with attached ear lobes. List the genotypes of all the people mentioned.

First: Write down the allele designations

E - free ear lobes e - attached ear lobes

Second: Write down the actual cross

P_1: Ee × ee

Third: Organize your Punnett square

F_1:

	E	e
e	Ee	ee

50% Ee
50% ee

∴ man = Ee
woman = ee
$\frac{5}{6}$ kids = Ee
$\frac{1}{6}$ kids =

Fourth: Count out the phenotype ratios

50% free ear lobes
50% attached ear lobes

MENDELIAN GENETICS
LEVEL 3

3. In watermellons the genes for green colour (**G**) and short shape (**S**) are dominant over their alleles for striped colour and long shape. Suppose a plant heterozygous for both these traits is crossed with a plant with long striped fruit. What phenotypes would this cross produce and in what ratio?

First: Write down the allele designations

G - green g - striped A - short a - long

Second: Write down the actual cross

P_1: GgAa × ggaa

Third: Organize your Punnett square

	GA	Ga	gA	ga
ga	GgAa	Ggaa	ggAa	ggaa

phenotypes:

genotype: 25% GgAa – Green + Short – 25%
25% Ggaa – Green + long – 25%
25% ggAa – striped + short – 25%
25% ggaa – striped + long – 25%

Fourth: Count out the phenotype ratios

4. (a) In the fruit fly vestigial wings and hairy body are produced by two recessive genes located on different chromosomes. The normal alleles, long wings and hairless body, are dominant. Suppose a vestigial winged hairy male is crossed with a female homozygous for long wings and hairless body. What would be the genotypes and phenotypes of the offspring?

First: Write down the allele designations

A - long wings a - vestigial wings B - hairless b - hairless

Second: Write down the actual cross

P_1: aabb × AABB

Third: Organize your Punnett square

	AB
ab	AaBb

– 100% AaBb

Fourth: Count out the phenotype ratios

100% Long wings, hairless body

MENDELIAN GENETICS
LEVEL 3

4 (b) If the F_1 generation were interbred, give the phenotype ratio of the F_2 generation.

First: Write down the allele designations

see above.

Second: Write down the actual cross

P_1 AaBb × AaBb

Third: Organize your Punnett square

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Fourth: Count out the phenotype ratios

Long Wings, Hairless : Long Wings, Hairy : Vestigial + Hairless : Vestigial + Hairy

9 : 3 : 3 : 1

4 (c) Suppose a hairy female heterozygous for long wings were crossed with a vestigial winged male heterozygous for the hairless characteristic. What would be the phenotype of the F_1 generation?

First: Write down the allele designations

see above

Second: Write down the actual cross

P_1 : Aabb × aaBb

Third: Organize your Punnett square

	Ab	ab
aB	AaBb	aaBb
ab	Aabb	aabb

25% AaBb
25% Aabb
25% aaBb
25% aabb

Fourth: Count out the phenotype ratios

25% Long wings, hairless
25% Long wings, hairy
25% vestigial wings, hairless
25% vestigial wings, hairy

MENDELIAN GENETICS

LEVEL 4

1. In humans broad lips (**B**) are dominant to thin lips (**b**) and long eyelashes (**L**) are dominant to short eyelashes (**l**). If a woman with thin lips who is heterozygous for long eyelashes marries a man who is heterozygous for broad lips and long eyelashes, what percentage of their children will have:

a) broad lips and long eyelashes 3/8
b) broad lips and short eyelashes 1/8
c) thin lips and long eyelashes 3/8
d) thin lips and short eyelashes 1/8

First: Write down the allele designations

B-broad lips b-thin lips L long eyelashes l-short eyelashes

Second: Write down the actual cross

bbLl × BbLl

Third: Organize your Punnett square

	BL	Bl	bL	bl
bL	BbLL	BbLl	bbLL	bbLl
bl	BbLl	Bbll	bbLl	bbll

$\frac{1}{8}$ BbLL $\frac{1}{8}$ bbLL
$\frac{2}{8}$ BbLl $\frac{2}{8}$ bbLl
$\frac{1}{8}$ Bbll $\frac{1}{8}$ bbll

Fourth: Count out the phenotype ratios

broad lips long lashes : broad lips short lashes : thin lips long lashes : thin lips short lashes

3 : 1 : 3 : 1

2. In humans nearsightedness (**N**) is dominant to normal vision (**n**) and large eyes (**E**) are dominant to small eyes (**e**). If a man heterozygous for both traits marries a woman heterozygous for both traits, what percentage of their children will be:

a) nearsighted and have large eyes 9/16
b) nearsighted and have small eyes 3/16
c) normal visioned and have large eyes 3/16
d) normal visioned and have small eyes 1/16

First: Write down the allele designations

N-nearsighted, n-normal, E-large eyes e-small eyes,

Second: Write down the actual cross

P1: NnEe × NnEe

Third: Organize your Punnett square

	NE	Ne	nE	ne
NE				
Ne				
nE				
ne				

Fourth: Count out the phenotype ratios

9 : 3 : 3 : 1

nearsighted large eyes : nearsighted small eyes : normal large eyes : normal small eyes

MENDELIAN GENETICS
LEVEL 4

3. In pea plants tallness (**T**) is dominant to shortness (**t**) and round seed (**R**) is dominant to wrinkled seed (**r**). If we cross a heterozygous tall plant that produces wrinkled seeds with a short plant that produces wrinkled seeds, what percentage of the offspring will be:

a) tall and have round seeds 0
b) tall and have wrinkled seeds 50%
c) short and have round seeds 0
d) short and have wrinkled seeds 50%

First: Write down the allele designations

T-tall t-short R-round r-wrinkled

Second: Write down the actual cross

P: Ttrr × ttrr

Third: Organize your Punnett square

	Tr	tr
tr	Ttrr	ttrr

Fourth: Count out the phenotype ratios

50% - tall & wrinkled seeds
50% - short & wrinkled seeds

4. Yellow guinea pigs (YY) crossed with white ones (WW) always produce cream-coloured offspring. Two cream-coloured guinea pigs when crossed produce yellow, cream and white offspring.

a) What are the genotypes of these offspring? 25% YY ; 50% YY' ; 25% Y'Y'
b) What percentage of each colour will appear in the offspring? 25% Yellow, 50% Cream, 25% White
c) What kind of cross does this illustrate? incomplete dominance.

First: Write down the allele designations

Y - yellow Y' - white.

Second: Write down the actual cross

P: YY' × YY'

Third: Organize your Punnett square

F_1

	Y	Y'
Y	YY	YY'
Y'	YY'	Y'Y'

25% YY
50% YY'
25% Y'Y'

Fourth: Count out the phenotype ratios

25% - Yellow
50% - Cream
25% white

MENDELIAN GENETICS

LEVEL 5

1. In radishes the shape may be long or round or oval. Crosses between long and oval gave 159 long and 156 oval. Crosses between round and oval gave 199 round and 203 oval. Crosses between long and round gave 576 oval. Crosses between oval and oval gave 121 long, 243 oval and 119 round.

a) What type of inheritance is involved? Incomplete dominance

IMPORTANT
At this point it is important to determine how the blend is happening (i.e. which alleles are dominant and which trait indicates a blend. You can tell this from the data.
HINT: a dominant trait crossed with the same dominant trait will produce only that trait. Use this logic to determine which trait is the blend.

b) Do the cross between: (although not necessarily in this order)

- the long and oval

First: Write down the allele designations

L - long L' round

Second: Write down the actual cross

P1 LL × LL'

Third: Organize your Punnett square

	L	L'
L	LL	LL'

50% LL
50% LL'

Fourth: Count out the phenotype ratios - 50% Long, 50% oval.

- the round and oval

First: Write down the allele designations

Second: Write down the actual cross

P1: L'L' × LL'

Third: Organize your Punnett square

	L	L'
L'	LL'	L'L'

50% LL'
50% L'L'

Fourth: Count out the phenotype ratios

50% ~~Long~~ Round
50% Oval

MENDELIAN GENETICS
LEVEL 5

- the long and round

First: Write down the allele designations

L - long L' round.

Second: Write down the actual cross

P_1: LL × L'L'

Third: Organize your Punnett square

	L'
L	LL'

100% LL'

Fourth: Count out the phenotype ratios - 100% Oval.

- the oval and oval

First: Write down the allele designations

L - long L' - round

Second: Write down the actual cross

LL' × LL'

Third: Organize your Punnett square

	L	L'
L	LL	LL'
L'	LL'	L'L'

25% LL
50% LL'
25% L'L'

Fourth: Count out the phenotype ratios - 25% Long; 50% Oval, 25% Round.

c) Try a cross between:

- the long and long

LL × LL

↓

F_1: 100% LL - Long.

- the round and round

L'L' × L'L'

↓

F_1: 100% L'L' - Round

MENDELIAN GENETICS

LEVEL 5

2. In Shorthorn cattle, the heterozygous condition of the alleles for red coat and white coat is roan coat. What would be the phenotype possibilities of progeny (offspring) of:

(a) a roan Shorthorn to a red Shorthorn

First: Write down the allele designations

R - red R' white

Second: Write down the actual cross

P1: RR × RR'

Third: Organize your Punnett square

	R	R'
R	RR	RR'

50% RR
50% RR'

Fourth: Count out the phenotype ratios - 50% Red Cattle 50% Roan Cattle

(b) a roan Shorthorn to a roan Shorthorn

First: Write down the allele designations

see above

Second: Write down the actual cross

P1: RR' × RR'

Third: Organize your Punnett square

	R	R'
R	RR	RR'
R'	RR'	R'R'

25% RR
50% RR'
25% R'R'

Fourth: Count out the phenotype ratios

25% Red
50% Roan
25% White

MENDELIAN GENETICS

LEVEL 5

3. When platinum foxes are crossed together the offspring usually appear in the ratio of 2 platinum foxes to 1 silver fox. When a pure white fox appears from such matings it always dies shortly after being born. P - silver P' - white.

a) What type of cross do you think this might be? Incomplete Dominance.

b) What evidence do you have for one of the alleles being lethal? White Fox dies

c) Do the punnett square cross for a platinum fox and a silver fox.

First: Write down the allele designations

P - silver P' white

Second: Write down the actual cross

P_1: $PP' \times PP$

Third: Organize your Punnett square

	P	P'
P	PP	PP'

50% PP - Silver
50% PP' - Platinum

Fourth: Count out the phenotype ratios - 50% Silver 50% Platinum

d) What evidence is there for the white allele being dominant or recessive?

Incompletely dominant b/c of 3rd phenotype (platinum).

3. A man with type O blood marries a woman with type AB blood.

First: Write down the allele designations

i - O I^A - A I^B - B

Second: Write down the actual cross

$ii \times I^AI^B$

Third: Organize your Punnett square

	I^A	I^B
i	I^Ai	I^Bi

Fourth: Count out the phenotype ratios

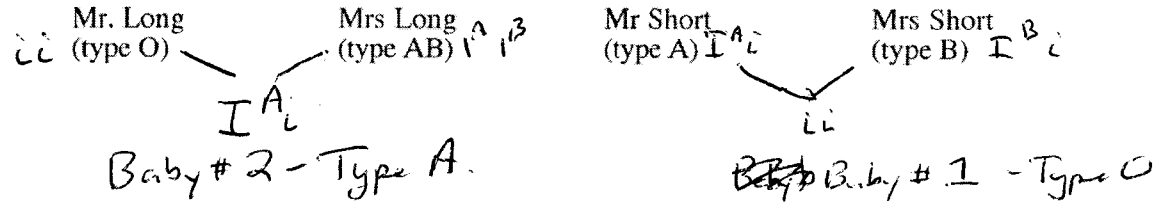
What percentage of their offspring will have:

a) type O blood 0%
b) type AB blood 0%
c) type A blood 50%
d) type B blood 50%

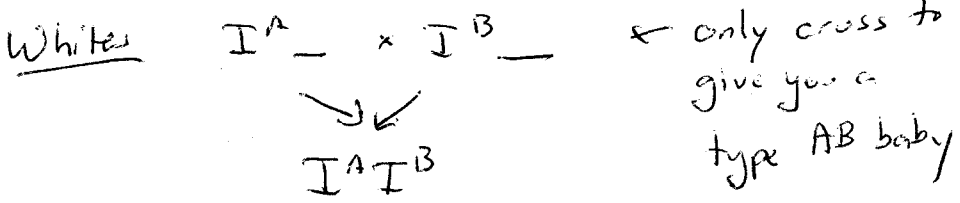
MENDELIAN GENETICS

LEVEL 6

1. Blood typing is used to determine the parents of two infants in a hospital nursery. Baby #1 is type O and Baby #2 is type A. Given the information below on parental blood types, determine the parents of each baby.



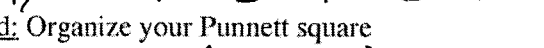
2. Four babies were born in a hospital on the same night and their blood types were found to be types O, A, B and AB. The four pairs of parent were the Smiths (types O & O), the Browns (types AB & O), the Whites (types A & B) and the Greens (types B &B). Prove your choice for the parents of the baby with type AB.



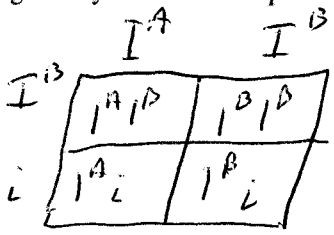
3. If a man with blood type B, one of whose parents had blood type O, marries a woman with blood type AB, what would be the theoretical percentage of their children with blood type B?

First: Write down the allele designations

Second: Write down the actual cross



Third: Organize your Punnett square



50%

Fourth: Count out the phenotype ratios

50% Type B

25% Type A

25% Type AB

MENDELIAN GENETICS

LEVEL 6

4. Red-green colourblindness is inherited as a sex linked recessive trait. If a colourblind woman A marries a man who has normal vision:

a) Do the punnett square for the possible genotypes of the offspring.

First: Write down the allele designations

A - normal a - colour blind

Second: Write down the actual cross

P_1: $X^aX^a \times X^AY$

Third: Organize your Punnett square

	X^A	Y
X^a	X^AX^a	X^aY

Fourth: Count out the phenotype ratios - 50% Normal ♀
- 50% Colourblind ♂

b) What percentage of the children would have colourblindness? 50% - all ♂ children

c) What percentage of the boys would be colourblind? carriers of colourblindness? all

d) What percentage of the girls would be colourblind? carriers of colourblindness? none colour blind, all carriers.

MENDELIAN GENETICS

LEVEL 7

1. Suppose gene **b** is sex linked, recessive and lethal. A man marries a woman who is heterozygous for this gene. If the couple had many normal children, what would be the predicted ratio of boys to girls?

First: Write down the allele designations

B - normal b - lethal

Second: Write down the actual cross

P_1: $X^BX^b \times X^BY$

Third: Organize your Punnett square

	X^B	Y
X^B	X^BX^B	X^BY
X^b	X^BX^b	X^bY

Fourth: Count out the phenotype ratios

50% - normal ♀

25% - normal ♂

25% - lethal ♂

2:1 ratio - girls : boys

2. A woman's father a hemophiliac (a sex linked recessive trait). Two of her three brothers as well as an uncle on her mother's side are hemophiliacs. The woman marries a non hemophiliac man.

H - normal h - hemophiliac

a) What are the possible genotypes of:

the woman X^HX^h her husband X^HY her father X^hY

her brothers X^hY & X^HY her uncle X^hY her mother X^HX^h

b) If the woman has a hemophiliac son, what must be her genotype? – heterozygous – X^HX^h

c) If the woman has a daughter, what is the probability the daughter is a carrier? 50% chance.

3. A family of four children has one hemophiliac daughter and one hemophiliac son. Determine the genotypes of the parents and all four children.

P_1: $X^HX^h \times X^hY$

F_1

	X^h	Y
X^H	X^HX^h	X^HY
X^h	X^hX^h	X^hY

hemophiliac daughter = X^hX^h

" son = X^hY

normal daughter = X^HX^h

" son = X^HY

phenotypes: 25% normal ♀ 25% hemophiliac ♀

25% normal ♂ 25% hemophiliac ♂

MENDELIAN GENETICS
LEVEL 7

4. A man and his wife both have normal colour vision but a daughter has red-green colourblindness. The man sues his wife for divorce on the grounds of infidelity. You are the judge. Prove whether the man has a case or is mistaken.

First: Write down the allele designations

A - normal a - colour blind

Second: Write down the actual cross

P_1: X^AX^a - X^AY

Third: Organize your Punnett square

	X^A	Y
X^A	X^AX^A	X^AY
X^a	X^AX^a	X^aY

* There is no possible way to get a colourblind female based on this cross ∴ the man has a case.

Fourth: Count out the phenotype ratios

50% Normal ♀

25% Normal ♂

25% Colourblind ♂

5. A woman heterozygous for Duchenne muscular dystrophy (a sex linked recessive trait) marries a man without the gene for this genetic disease.

First: Write down the allele designations

D - normal d - muscular dystrophy

Second: Write down the actual cross

P_1: X^DX^d × X^DY

Third: Organize your Punnett square

	X^D	Y
X^D	X^DX^D	X^DY
X^d	X^DX^d	X^dY

Fourth: Count out the phenotype ratios

a) What percentage of their children will have the disease? 25%

b) What percentage of their sons will have the disease? 50% of sons

c) What percentage of their daughters will have the disease? none

d) What percentage of their daughters will be carriers of the disease? 50% of daughters

50% normal ♀

25% normal ♂

25% dystrophy ♂

MENDELIAN GENETICS

LEVEL 8

1. The fruit fly has a dominant gene for grey body colour (**G**) and a recessive gene for black body colour (**g**). There is another dominant gene for normal wings (**N**) with its recessive allele producing vestigial wings (**n**). Flies heterozygous for grey bodies and normal wings were crossed.

a) Do the punnett square to determine the expected phenotype ratio. P_1: GgNn × GgNn

	GN	Gn	gN	gn
GN				
Gn				
gN				
gn				

9: G_N_ → grey + normal
3: gg N_ → black + normal
3: G_ nn → grey + vestigial
1: gg nn → ~~grey~~ black + vestigial

b) The observed results were:

grey body, normal wings	246
black body, vestigial wings	80

What type of crossing might account for the discrepancy between observed and expected results? body colour & wing shape are linked. (on the same chromosome).

c) If these genes were to be located on chromosome #3, draw the chromosomes with the genes attached.

d) If the observed results were:

grey body, normal wings	220
black body, vestigial wings	70
grey body, vestigial wings	19
black body, normal wings	18

What type of cross would this most likely be? dihybrid cross still (GgNn × GgNn)

How would you defend your choice?

G + N are still linked as are g + n. However, they are slightly farther apart than in 1b above and are slightly more susceptible to crossing over.

MENDELIAN GENETICS

LEVEL 9

1. The fruit fly has a dominant gene for grey body colour (**G**) and a recessive gene for black body colour (**g**). There is another dominant gene for normal wings (**N**) with its recessive allele producing vestigial wings (**n**). Flies homozygous for grey bodies and normal wings were crossed with flies that had black bodies and vestigial wings.

a) Do the punnett square to determine the expected phenotype ratio.

First: Write down the allele designations

G - grey g - black N - normal wings n - vestigial wings.

Second: Write down the actual cross

GGNN × ggnn

Third: Organize your Punnett square

	gn
GN	GgNn

Fourth: Count out the phenotype ratios

100% Grey body, Normal Wings.

b) The observed results were:

grey body, normal wings	236
black body, vestigial wings	253
grey body, vestigial wings	50
black body, normal wings	61

Given this information, what type event has occurred for this ratio to appear?

G + N alleles are fairly close together on the same chromosome. Same for g + n alleles.

∴ linked traits do not independantly assort.

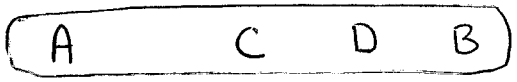
MENDELIAN GENETICS

LEVEL 9

1. The crossing over frequency between linked genes

A and B	40%
B and C	20%
C and D	10%
C and A	20%
D and B	10%

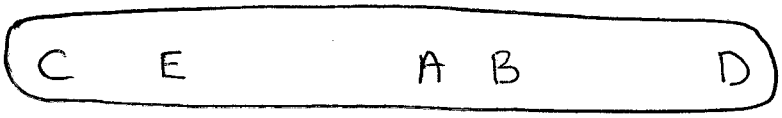
What is the sequence of genes on the chromosome? (Draw the cromosome)



2. The crossover frequency between linked genes

A and B	10%
B and C	40%
C and D	70%
D and E	60%
D and B	30%

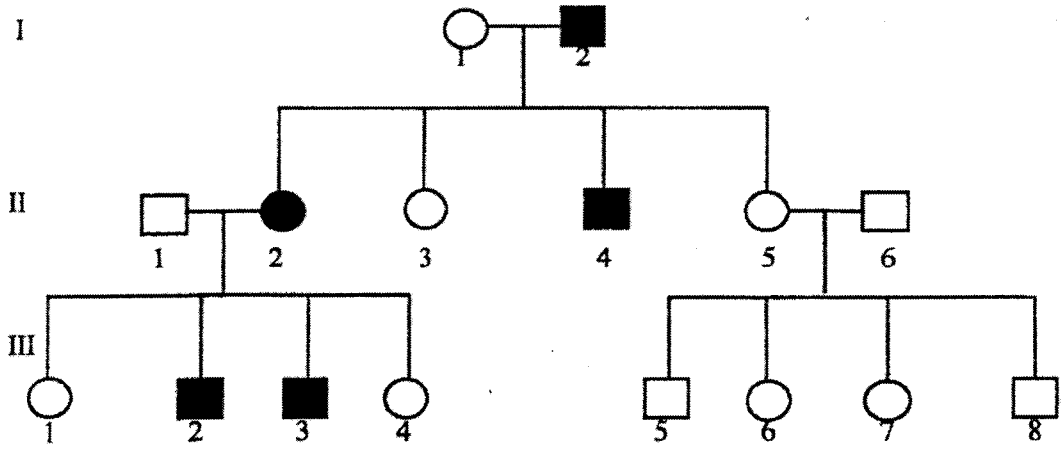
What is the sequence of genes on the chromosome? (Draw the cromosome)



A - normal
a - affected.

PEDIGREE
LEVEL 1

1. Examine the following pedigree and fill in the list that follows:



List all possible genotypes for individuals:

I 1 X^AX^a 2 X^aY

II 1 X^AX 2 X^aX^a 3 X^AX^a 4 X^aY 5 X^AX^a
6 X^AX-

III 1 X^AX^a 2 X^aY 3 X^aY 4 X^AX^a 5 X^aY
6 X^AX 7 X^AX- 8 X^AY

2. The above pedigree is tracing a **sex linked trait**. What evidence is there to support this premise?

mostly ♂ are affected.

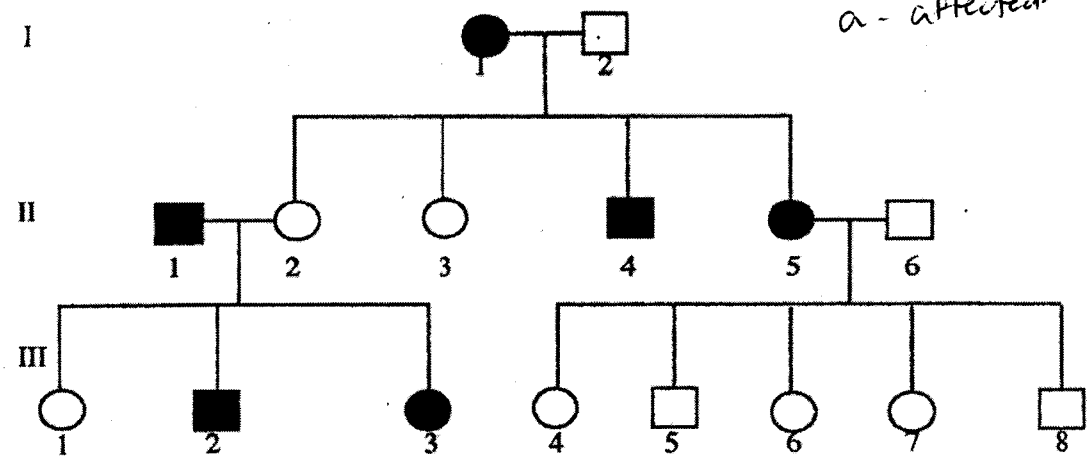
3. How might the pedigree have appeared if the trait was **autosomally inherited** rather than sex linked?

more even distribution of ♂ & ♀ affected

PEDIGREE
LEVEL 2

A - normal
a - affected

1. Examine the following pedigree and fill in the list that follows:



List all possible genotypes for individuals:

I 1 aa 2 Aa

II 1 aa 2 Aa 3 Aa 4 aa 5 aa
6 AA most likely

III 1 Aa 2 aa 3 aa 4 Aa 5 Aa
6 Aa 7 Aa 8 Aa

2. What is the importance of a pedigree in predicting whether an individual will have a genetic disease?

You can trace conditions back several generations to determine mode of inheritance.

3. What value might a pedigree have in determining whether certain individuals without a genetic disease may have children with a higher chance of having the disease?

It can determine likelihood of being a carrier for a disease & how what outcomes may be possible given a particular cross.