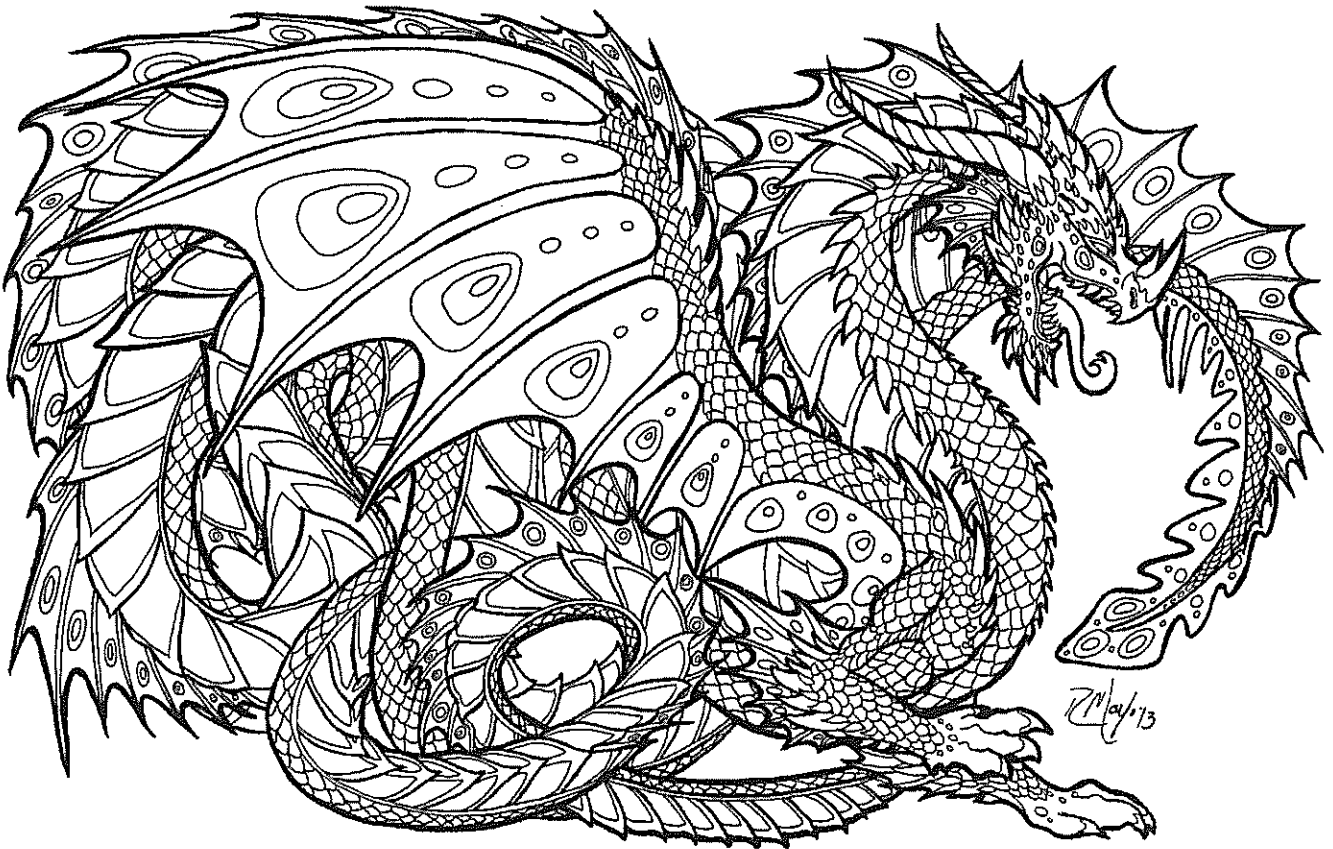


# Genetics and Inheritance

---



By the end of this unit you will have an understanding of:

- Genetic terms
- Patterns of inheritance
- Genetic disorders

This book has been created to help you remember all of the important information about genetics and inheritance. Once the exercises are completed it can be used as a revision tool!

Complete the following questions and if you're having trouble come and ask for help!

### In a Nutshell!

- What is genetics?
  - "Genetics is the study of **heredity**, the process in which a parent passes certain **genes** onto their children."
- What does that mean?
  - Children **inherit** their biological parents' genes, these express specific **traits**, such as some physical characteristics (eye color), natural talents, and genetic disorders.

### Exercise One

1. Define the following terms

**Genes:**.....

.....

.....

**Traits:**.....

.....

.....

**Allele:**.....

.....

.....

**Genotype:**.....

.....

.....

**Phenotype:**.....  
.....  
.....

**Dominant genes:-**  
.....  
.....  
.....

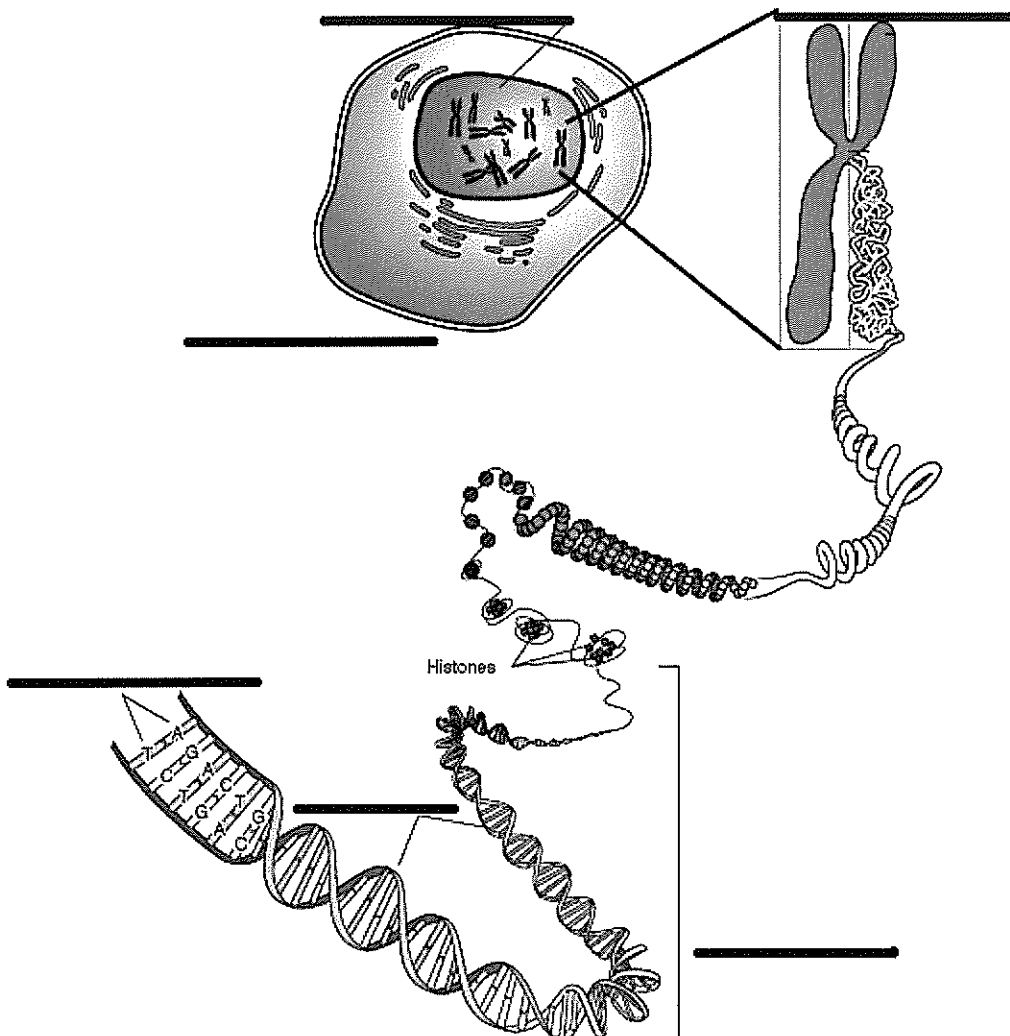
**Recessive genes:-**  
.....  
.....  
.....

**Homozygous:**  
.....  
.....  
.....

**Heterozygous:**  
.....  
.....  
.....

2. The allele for blue eyes is recessive to the allele for brown eyes. What are the chances that two blue-eyed parents will have a brown-eyed child? What are the chances of two brown-eyed parents having a blue-eyed child? Use a diagram to help explain your answer.

3. Label the diagram below with the following words that correspond with the location indicated: **base pair**, **cell**, **chromosome**, **DNA (Deoxyribonucleic Acid)**, **double helix\***, **genes**, **nucleus**



4. *What is the difference between an allele and a gene?*
  
  
  
  
  
  
  
  
  
  
5. *What is the difference between a chromosome and a gene? Use a diagram to assist with your explanation.*
  
  
  
  
  
  
  
  
  
  
6. *Wavy hair in humans is dominant to straight hair. A wavy-haired man married a straight-haired woman and they had two children. The first child had wavy hair and the second child had straight hair. State the genotype of all four individuals and use suitable symbols to show your working.*
  
  
  
  
  
  
  
  
  
  
7. *If a woman with brown hair (BB) and a man with blond hair (bb) had children,*
  - a. *What are the possible genotypes?*
  
  
  
  
  
  - b. *What are the possible phenotypes?*
  
  
  
  
  
  - c. *What is the probability that they will have a child with blond hair?*
  
  
  
  
  
  - d. *What is the probability that they will have a child with brown hair*

8. If 'T' is the gene for tall and 't' is the gene for short and a heterozygous tall plant was crossed with a homozygous short plant,
- e. What would be the possible genotypes?
  - f. What are the resulting phenotypes?
  - g. What is the probability that the plant will be tall?
  - h. What is the probability that the plant will be short?
9. Dimples (D) is dominant to no dimples. Write the genotypes for individuals who are:
- a. homozygous for dimples
  - b. heterozygous for dimples
  - c. have no dimples
10. If a right-handed man marries a left-handed woman and all their children are left-handed, does this mean that right handedness is dominant? Discuss.
11. A girl wants to check if her grey cat is heterozygous or homozygous. Assuming breeding was ethical and time efficient, what cross should she carry out?

12. In reference to question 11, what results would she obtain if the cat is:

a. homozygous?

b. heterozygous?

13. When a cell undergoes meiosis, how many daughter cells are produced?

14. A brown animal is crossed with a white one. All the offspring are brown. What does this suggest about the gene for brown colour in this organism?

15. In the eye colour of vinegar flies, the trait for red eye colour ( $R$ ) is dominant over the trait for white eye colour ( $r$ ).

a. What colour are the eyes of a fly with the genotype  $Rr$ ?

b. What are one or more possible combinations of alleles for eye colour in the zygote of a white-eyed vinegar fly?

16. In terms of chromosomes, explain why a sperm or an ovum (egg) cannot possibly produce a new human on its own:

17. The table below states alleles for a variety of common human characteristics. Use the table to list the genotypes of five individuals that are homozygous for a particular dominant trait, five that are homozygous for a recessive trait and five that are heterozygous for a trait. For each individual, state their genotype and phenotype in your list.

Dominant trait		Recessive trait	
Description	Allele symbol	Description	Allele symbol
Brown eyes	<i>B</i>	Blue eyes	<i>b</i>
Right-handedness	<i>R</i>	Left-handedness	<i>r</i>
Ability to roll tongue	<i>T</i>	Cannot roll tongue	<i>t</i>
Rhesus positive (Rh <sup>+</sup> ) blood	<i>D</i>	Rhesus negative (Rh <sup>-</sup> ) blood	<i>d</i>
Free ear lobes	<i>F</i>	Attached ear lobes	<i>f</i>
Peaked hairline (widow's peak)	<i>W</i>	Straight hairline	<i>w</i>
Not red hair	<i>R</i>	Red hair	<i>r</i>
Mid-digital hair present	<i>G</i>	Mid-digital hair absent	<i>g</i>
Normal skin pigmentation	<i>A</i>	Pigmentation lacking (albinism)	<i>a</i>

18. Two individuals who are heterozygous for the dominant trait, right handedness, marry.

a. Write out the genotypes of the parents.

b. Draw a Punnet square to calculate the possible offspring these parents may produce.

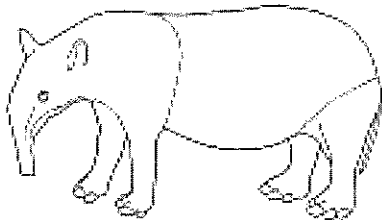
19. Draw a Punnet square to show the outcome of a cross between a homozygous dominant parent and a homozygous recessive parent for the coat colour ( $B$ =black and  $b$ =white). Give the ratio for the genotype and phenotype of the offspring.

20. Draw a Punnet square showing a cross between a homozygous dominant parent and a homozygous recessive parent for the coat colour ( $B$ =black and  $b$ =white). Give both the genotypic and phenotypic ratios.

21. How does genetic and environmental sex determination differ?

22. Draw a Punnet square to show the outcome of a cross between a homozygous dominant parent and a homozygous recessive parent for the feather colour  $G$ =green and  $g$ =yellow.

23. The brown tapir can either have a Striped coat ( $S$ ) or a Plain coat ( $s$ )



- Which coat type is dominant?
- A homozygous striped tapir is crossed with a homozygous plain tapir. Construct a punnet square for this mating event.
- What will be the genotype of the  $F_1$  offspring?
- What will be the phenotype of the  $F_1$  offspring?

24. One of the F1 offspring was crossed with another spotted tapir from a different area of the rain forest. Four babies are produced, three have striped coats and one has a plain coat.

- a. What genotype was the "foreign" tapir?
- b. What genotype would the plain tapir have?
- c. Draw the punnet square for this mating.

25. Two of the F1 tapirs were crossed with each other.

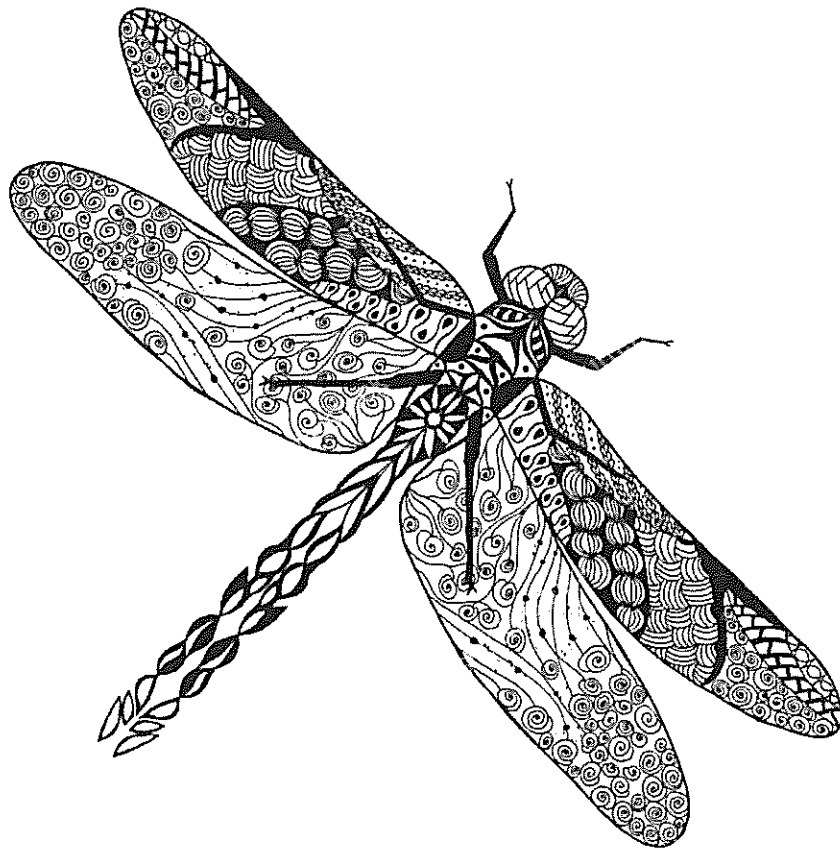
- a. Draw the punnet square for this mating.
- b. c. What will be the genotypes of the F2 offspring
- c. What will be the phenotypes of the F2 offspring?

Relax and color me in!





Relax and color these in!



## Genetics Word Search

N	E	X	S	D	N	A	G	P	A	L	F	C	H	A
M	U	V	I	E	S	Q	Y	X	L	S	H	Q	O	L
V	R	C	I	L	Q	G	Z	E	J	R	N	G	M	L
U	P	F	L	S	E	U	C	R	O	J	E	F	O	E
K	S	I	F	E	S	H	E	M	N	N	Z	M	Z	L
T	I	A	R	T	U	E	O	N	O	A	P	Z	Y	E
F	I	S	U	K	D	S	C	M	C	J	R	D	G	F
K	E	C	T	G	O	W	E	E	E	I	R	Q	O	Z
A	N	I	O	M	C	P	G	P	R	V	N	V	U	Y
H	E	T	E	R	O	Z	Y	G	O	U	S	G	S	T
B	G	E	G	S	Y	T	H	E	R	E	D	I	T	Y
G	K	N	G	G	O	Q	P	T	V	Z	S	H	X	V
D	M	E	H	N	E	P	Y	T	O	N	E	H	P	E
V	E	G	E	X	L	T	N	Y	N	G	E	W	F	Z
X	B	G	U	B	H	I	B	H	S	A	J	T	S	C

ALLELE

CELL

CHROMOSOME

DNA

GENE

GENETICS

GENOME

GENOTYPE

HELIX

HEREDITY

HETEROZYGOUS

HOMOZYGOUS

NUCLEUS

PHENOTYPE

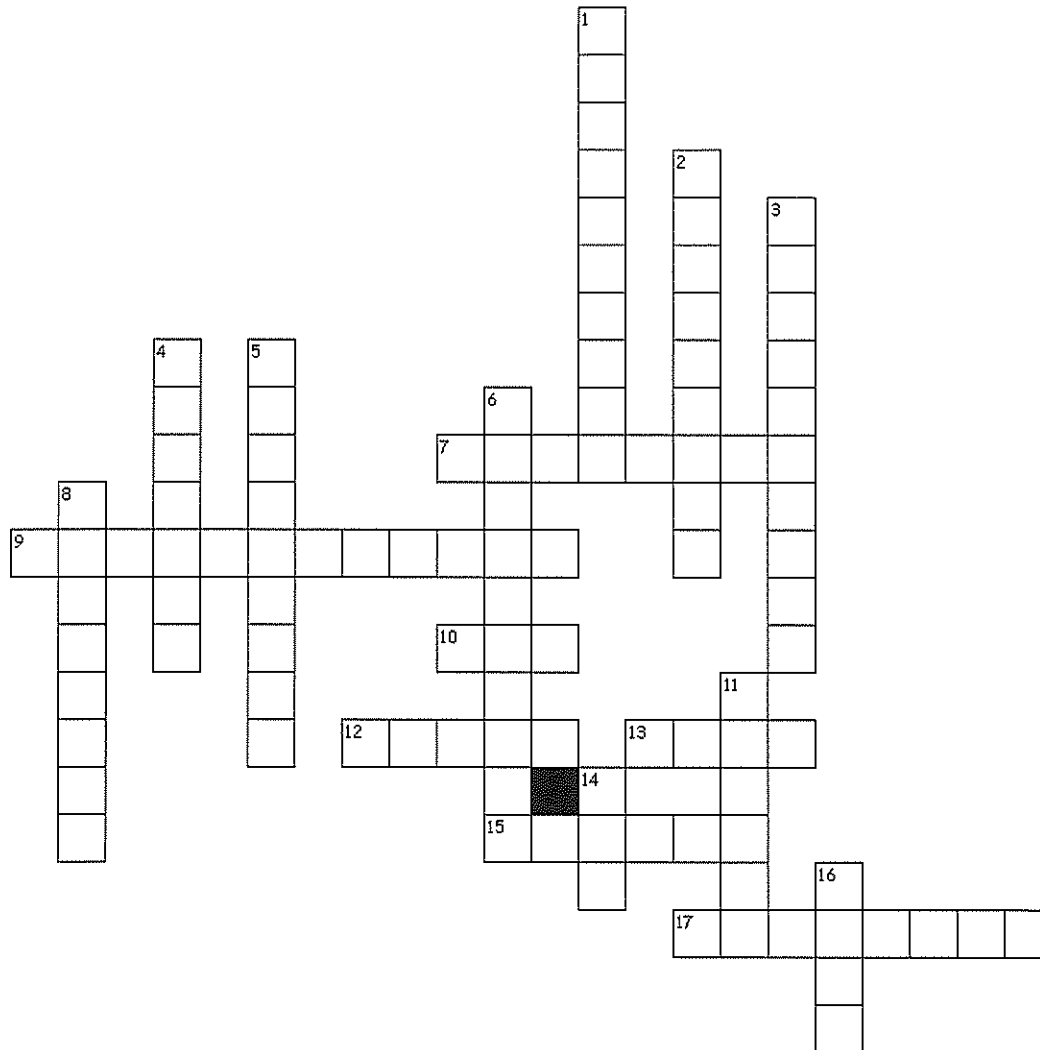
RECESSIVE

RNA

SEQUENCING

TRAIT

## Genetics Crossword



### Across

7. The passing on of characteristics from parents to offspring
9. When there are two different alleles for a trait
10. Genetic code of a living thing
12. A characteristic that is inherited; can be dominant or recessive
13. There are over a 50 trillion of these in your body
15. A full set of chromosomes; all the inheritable material within an organism
17. Branch of biology that studies heredity

### Down

1. A structure made up of DNA and protein wound up into a tight "package"
2. An allele that is masked when a dominant allele is present
3. When there are two identical alleles for a trait
4. The part of the cell where DNA is kept
5. Outward appearance of an organism
6. The process of decoding the bases (letters) of the genome
8. The combination of genes in an organism
11. Alternative forms of a gene
14. Abbreviation for ribonucleic acid, encoded by DNA
16. Set of information that controls a trait.

### ***Quick review of genetic terms used so far!***

Match the following terms with their definitions by writing the corresponding term in the third column. The first one has been done for you

<b>Terms</b>	<b>Definitions</b>	<b>Matching term</b>
Allele for the dominant trait	1. A specific sequence of DNA that codes for a particular trait (e.g. eye colour)	gene
Allele for the recessive trait	2. Having two copies of the same allele (e.g. AA or aa)	
Gregor Mendel	3. Different forms of the same gene (e.g. you may have one for blue eyes and one for brown eyes)	
Chromosome	4. The allele that masks the effect of the recessive trait. An individual only needs one copy of this allele for it to be expressed (see in the phenotype)	
Gene	5. The 'father' of genetics. His experiments on pea plants are responsible for much of our knowledge of genetics.	
Allele	6. Having two different alleles (e.g. Aa)	
Homozygous or pure-breeding	7. Structures within the nucleus of cells that are made up of DNA	
Heterozygous or hybrid	8. When a trait is carried on an X or Y chromosome	
Genotype	9. The combination of genes an individual has (e.g. Bb)	
Phenotype	10. A 'map' of all the genetic material in humans	
Pedigree	11. A chemical that makes up chromosomes and determines the particular traits we have (i.e. what we look like)	
Sex-linked inheritance	12. A diagram used to trace the inheritance of traits through a family.	
DNA	13. The allele that is masked by the dominant trait. An individual needs two copies of this allele for it to be expressed (seen in the phenotype)	
Gene expression	14. The physical characteristics of an individual (e.g. brown hair)	
Human genome	15. The appearance of characteristics in an organism that are coded for by genes	

26. A red homozygous bull mates with a white homozygous cow and produces several red and white splotchy calves. Draw the punnet square for this crossing.

27. Draw the punnet square for the crossing of a F1 heterozygous bull with a F1 heterozygous cow.

28. In the case above, what are the percentages of:

a. Heterozygous roan offspring.

b. Homozygous red offspring.

c. Homozygous white offspring

29. Draw the punnet square for the crossing of a homozygous white cow with a roan bull.

30. What should the genotypes & phenotypes for parent cattle be if a farmer wanted only cattle with red fur?

31. A cross between a black cat & a tan cat produces a tabby pattern (black & tan fur together).

- a. What pattern of inheritance does this illustrate?
- b. What percentage of kittens would have tan fur if a tabby cat is crossed with a black cat?

32. A cross between a blue blahblah bird & a white blahblah bird produces offspring that are silver. The colour of blahblah birds is determined by just two alleles.

- a. What are the genotypes of the parent blahblah birds in the original cross?
- b. What is/are the genotype(s) of the silver offspring?
- c. What would be the phenotypic ratios of offspring produced by two silver blahblah birds?

33. The color of fruit for plant "X" is determined by two alleles. When two plants with orange fruits are crossed the following phenotypic ratios are present in the offspring:

- 25% red fruit
- 50% orange fruit
- 25% yellow fruit.

What are the genotypes of the parent orange-fruited plants?

34. In snapdragons, red flower colour allele ( $R$ ) and white flower colour allele ( $R'$ ) combine to produce pink flowers ( $RR'$ ).

a. What kind of inheritance is this? How do you know?

b. Why do you have to use the kinds of letters shown?

c. List all possible genotypes and their corresponding phenotypes for the characteristic flower colour.

d. Determine the phenotype of the offspring from the following crosses:

i. Red and pink

ii. Both pink

35. Write the genotype of a male and a female

36. Explain why the human population is approximately 50 per cent male and 50 percent female.

37. Explain why a carrier of a genetic disease is not affected by it.

38. Explain why males are more likely to be affected by genetic diseases and disorders than females.

39. Complete a punnett square for the cross between a human female (XX) and a human male (XY). What is the chance that the parents will have a girl?

40. If the same parents have four boys, what is the probability their fifth child will be a girl? Explain.

*41. Hemophilia is a recessive sex-linked disease carried on the X chromosome in humans.*

*a. Write the genotype of a woman who does not have hemophilia.*

*b. Write the genotype of a woman with hemophilia.*

*c. Write the genotype of a woman who is a carrier (heterozygous) for hemophilia.*

*d. Write the genotype of a man who has hemophilia.*

*e. Write the genotype of a man who does not have hemophilia.*

*42. A woman who is heterozygous for hemophilia marries a normal male. What are the possible phenotypes of their children?*

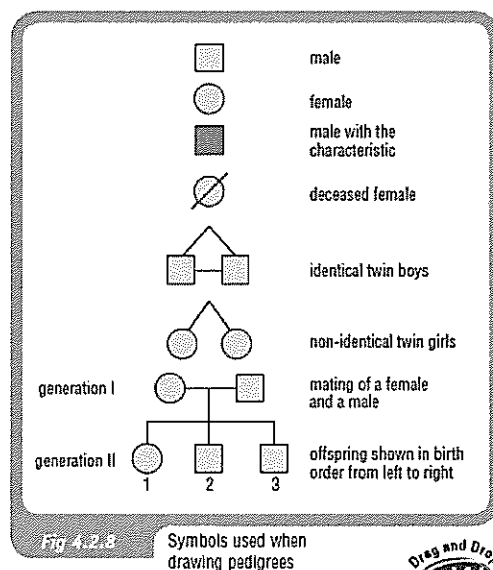
*43. A woman who is a carrier for hemophilia marries a man with hemophilia. Could any of their children have hemophilia? If so, would the child be male or female?*

44. Colour-blindness is a sex-linked recessive trait in humans. A colour-blind man marries a female who is a carrier for colour-blindness. What is the probability that they will have a child who is colour-blind?

45. A colour-blind male marries a female who is not colour-blind (homozygous). What are the possible phenotypes of their children?

### Pedigrees

A pedigree is a pictorial family tree where individual who show a particular disease or and are often analysed to determine whether a particular characteristic is dominant or recessive.



46. The gene for human blood groups has three alleles, A, B and O.

Alleles A and B are co-dominant; Allele O is recessive to both A and B.

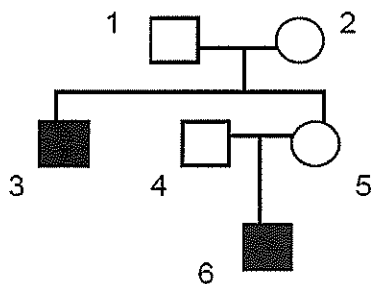
Two parents, one blood group A and the other blood group B, had one child who was blood group O and another child who was blood group AB.

Using a Punnet square or pedigree, explain the genotype of the parents in this cross and the genotypes of the O and AB children.

47. The condition shown in the pedigree below is haemophilia, in which the gene, h, is recessive and on the X-chromosome.

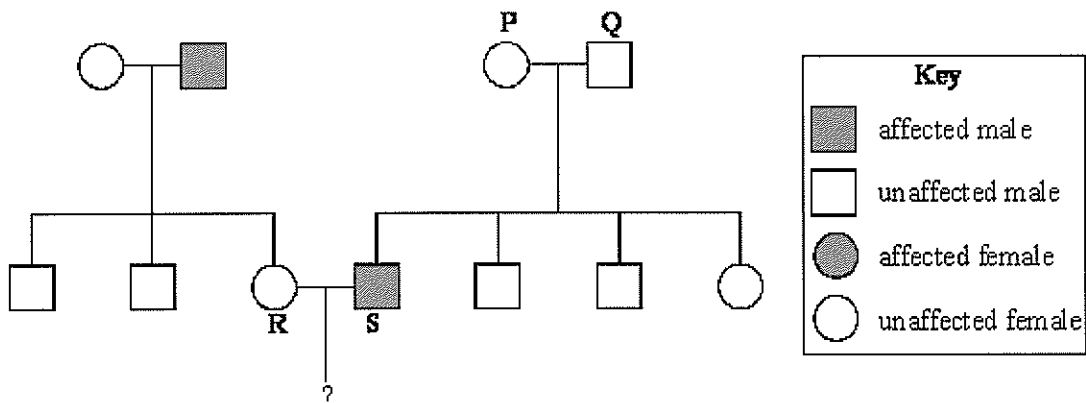
a. What type of inheritance is this?

b. Work out the possible phenotypes and genotypes for the people in the pedigree.



48. The black pigment in human skin and eyes is called melanin. A single gene controls the production of melanin. A person who is homozygous for the recessive allele of the gene has no melanin and is said to be albino.

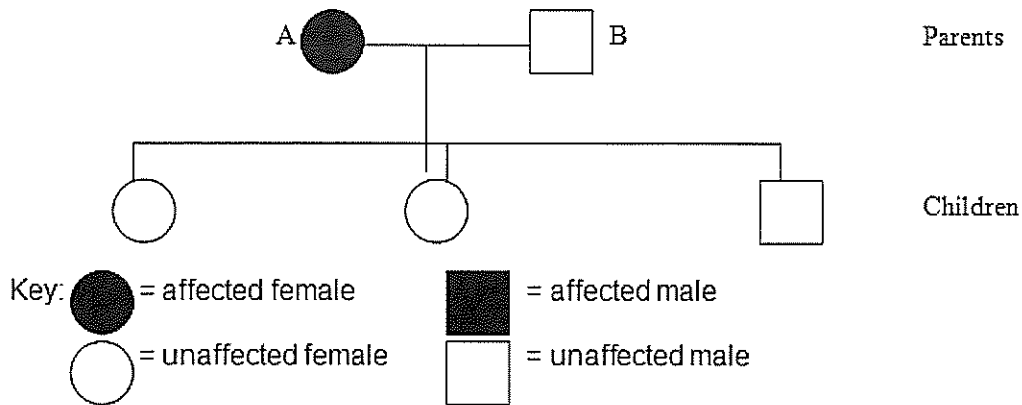
The diagram below shows the inheritance of albinism in a family.



a. Use a genetic diagram (Punnet square or pedigree) to explain the inheritance of the albino allele by children of parents P and Q.

b. R and S decide to have a child. What is the chance that this child will be an albino? Use a genetic diagram to explain your answer

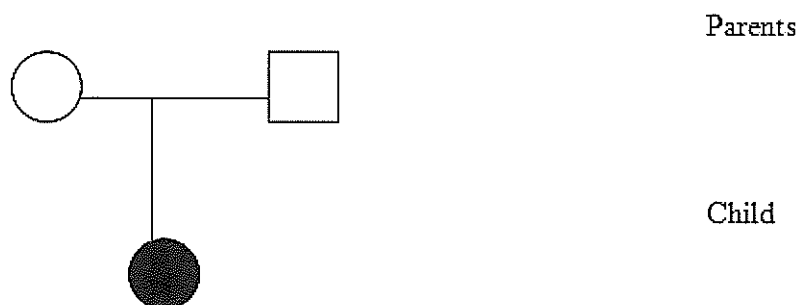
49. This is a family tree for a family suffering from a rare recessive blood disorder. This medical condition is caused by a recessive gene ( $r$ ). The father in this family does not carry a copy of the recessive disease gene.



a. What is the genotype of the female A?

b. What are the genotypes of the children?

50. This is the tree of another family afflicted with the disease described in Q49.



a. *What are the genotypes of the parents?*

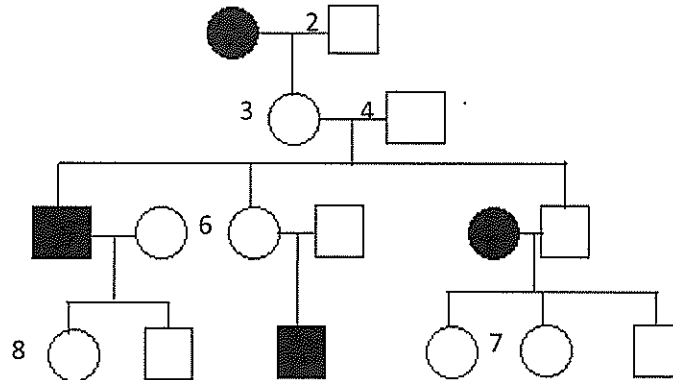
b. *If this family have another child, what are the chances that the new baby would be affected by this blood disorder? (Hint: You have to draw out the full cross to answer this question)*

51. *The ability to taste a bitter chemical called PTC is due to a dominant gene (P). Predict the ability to taste PTC among children of parents who are:*

a. *homozygous tasters (PP) and non-tasters.*

b. *both heterozygous tasters .*

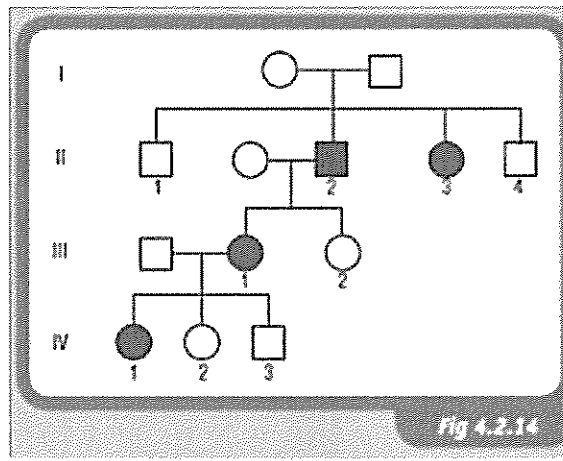
52. The below pedigree shows the occurrence of a recessive sex linked disease called hopooooola (fictional!) found on the X sex chromosome.  $XH$  is a disease free chromosome while  $Xh$  carries the disease.



What is the genotype of the following individuals?

Individual	Genotype
1 (easy)	
2 (easy)	
3 (harder)	
4 (easy)	
5 (easy)	
6 (hardest)	
7 (hardest)	
8 (harder)	

53. Tongue rolling is a dominant trait controlled by a dominant gene ( $R$ ) and a recessive gene ( $r$ ). A pedigree for tongue rolling is shown in the figure below. Suggest the genotypes of each of these individuals.



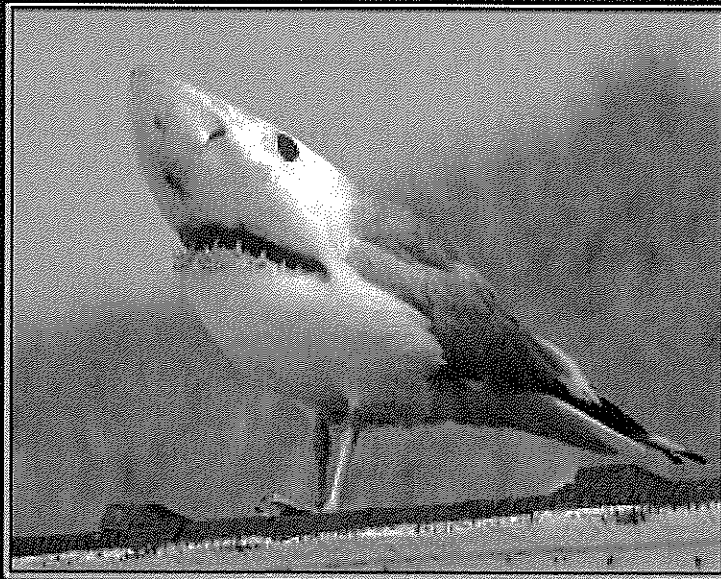
a. Generation I male

b. Generation II #1

c. Generation III #1

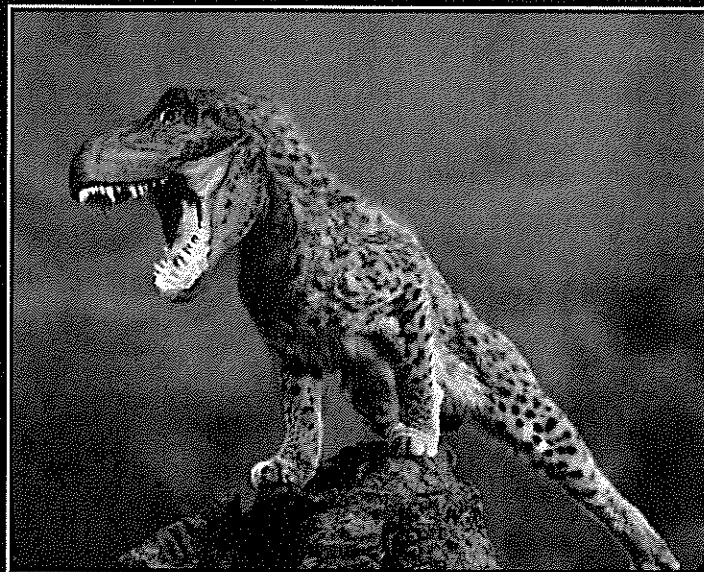
54. *Select a genetic disease and create a pamphlet for display in the reception area of a doctor's surgery. The pamphlet should outline information about the cause of the disease (gene or chromosomal abnormality), pattern/s of inheritance, the frequency of the disease in the population, diagnosis, symptoms and treatment. (the next page has been left blank for you to create this!)*





# GENETIC ENGINEERING

Some things just shouldn't be done



# GENETIC ENGINEERING

Just another reason why mad scientists shouldn't work in zoos.

