Science

KS3

Genetics

Biology Topic Pack IX for KS3 Science

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POD 12357

Contents

Teacher's Introduction

Welcome to the Key Stage 3 Genetics Topic Pack, which should be used in Year 9, or possibly Year 8, depending on your school's chosen learning route for Science (as it includes some difficult and sophisticated concepts). This is one of 31 packs designed to support learning across the National Curriculum for Key Stage 3 Science. The pack can act as an accompaniment to the teacher's classwork, and should engage students of all abilities. It can be given to students before lessons or may be used as cover lesson work or homework, and the end-of-topic questions work well as a formative assessment.

It is assumed that your learners will have **already covered** the following content, much of which will be covered in our KS3 Biology Pack IV (Reproduction in Humans) and KS3 Biology Pack V (Reproduction in Plants):

- reproduction in humans, including gametes
- reproduction in plants, including flower structure and insect pollination, fertilisation

Pre-teaching activities could include creating family trees and recognising distinct character traits that run in the learners' families.

The National Curriculum points covered by this topic pack are:

- heredity as the process by which genetic information is transmitted from one generation to the next
- a simple model of chromosomes, genes and DNA in heredity, including the part played by Watson, Crick, Wilkins and Franklin in the development of the DNA model

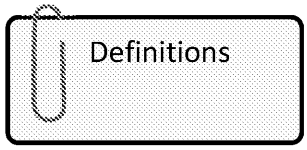
It should be noted that the structural and functional understanding of the simple model of the chromosomes will stretch the KS3 knowledge of both the Chemistry and the Physics curriculum, requiring, as it does, a rudimentary understanding of large biochemical structural molecules. Other examples of such molecules could be chlorophyll, haemoglobin, enzymes and starch. Securing learners' prior knowledge and concepts of such large biochemical structural molecules through models, diagrams and publicly available videos, and demonstrating the link between structure and function, would support this unit.

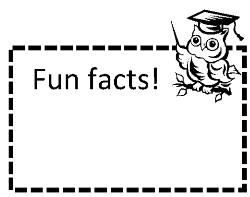
Important:
It is advised that the introduction to Punnett squares on page 11 is taught as a worked example before the learners attempt the material. Similarly, a familiarity with probability and sample size will facilitate success.

It is assumed that the differences between species, continuous and discontinuous variation, natural selection and the importance of diversity will be taught afterwards. These will be covered in our KS3 Biology Pack X (Evolution).

The topic pack includes the following components:

- Explanations and examples of the key concepts
- Key scientific terms and definitions
- Comprehension questions (to be answered in a student's workbook)
- Fun facts
- Working scientifically – focus: probability
- Crossword
- End-of-topic questions (to be answered in a student's workbook)*
- Answers





This topic pack covers the material seen in the following three textbooks:

- *Activate 2* (Gardom Hulme et al.): Chapter 3.5 (pp. 50–51)
- *Activate 3* (Gardom Hulme at al.): Chapter 4.1–4.2 (pp. 4–7), Chapter 2.5 (pp. 30–31)
- *Exploring Science 9* (Levesley et al.): Chapter 9Aa–b (pp. 8–12)

October 2023

* A write-on version of the end-of-topic questions is provided on the ZigZag Education Support Files system, which can be accessed via **zzed.uk/productsupport**

Our natural understanding of genetics and the work of Gr

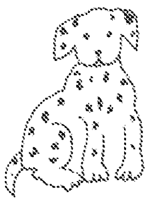
Do you look a bit like your mum? Do all the children in your family have dark hair maybe? **Characteristics** like hair colour and the shape of our eyes and nose are inherited. We have a natural understanding of **inheritance**. For instance, we can all guess which puppy belongs to the adult dog below.

Characte

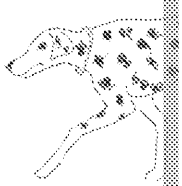
Inheritan characteri our paren

Q1. Choose the correct puppy: A, B or C.


A


B


C



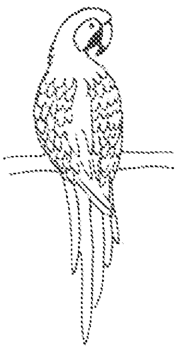
We also understand that different **species** have inherited characteristics in common and that these characteristics will be handed down to their **offspring**.

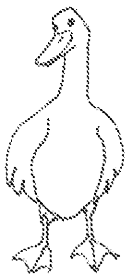
We can guess what the developing chicks inside the eggs below will grow to look like.

Sp sha and

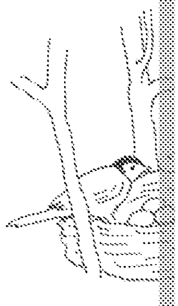
Off or a

Q2. Choose the correct chick: A, B or C.


A


B


C

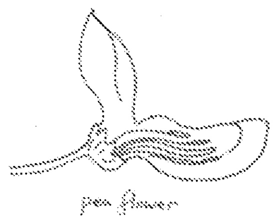


The **gametes** or sex cells **preserve** information about inherited characteristics.

One of the first people to start thinking beyond our natural understanding of inheritance into the science behind it was Gregor Mendel. He lived in Austria in the nineteenth century in a monastery, which is a religious community where monks live and worship.

Q3. a) In what century did Gregor Mendel live and work?

b) Where did he live?



Mendel undertook very careful experiments looking into how flower colour is inherited in pea plants. He took pea plants with purple flowers and pea plants with white flowers. He was very careful to ensure that they were **true breeding** plants, which means that the purple flowered plants would always give purple flowering offspring and that the white flowered plants would always give white flowering offspring. He then **pollinated** white flowered plants using pollen from purple flowered plants and pollinated purple flowered plants with pollen from white flowered plants.

Fu
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tran
to t

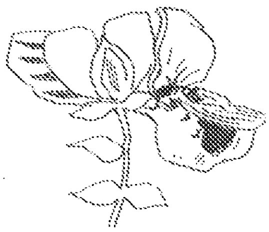
True breeding – a situation where a particular characteristic i

Pollination – the process of fertilising the ovum of a plant wit

Q4. a) What plant did Mendel use in his studies?

b) What characteristic did Mendel investigate?

c) What coloured flowering offspring will a true breeding white flowered p



The first cross offspring (F1) all had purple flowers. How flowered plants with each other, white flowering plants a cross offspring (F2) had purple and white flowers in a ra plants to one white flowered plant. This means that in a quarter of them will be white and the rest purple. Inter purple/white flowering plants ever occurred.

Q5. If an experiment yielded 12 F2 plants, how many might you expect to be:

a) white?

b) purple?

c) purplish?

Mendel knew nothing about DNA or genes, but he worked out that flower colour is inherited as a distinct characteristic (purple or white) and that purple appeared to dominate over the white flowered characteristic if present. He also showed that some characteristics (or **traits**) can be hidden within the inheritable information (or **genotype**) of the individual, and not shown on the observable characteristics (**phenotype**).

Trait – ano

Genotype – individual, w expressed o

Phenotype characterist the outward

Q6. a) Which colour did Mendel consider to dominate over other colours?

b) What flower colour trait (or characteristic) seemed to be hidden in the F

How scientists have added to our understanding

Mendel's pioneering work led to the idea of a '**gene**' holding the genetic code for a characteristic, e.g. flower colour.

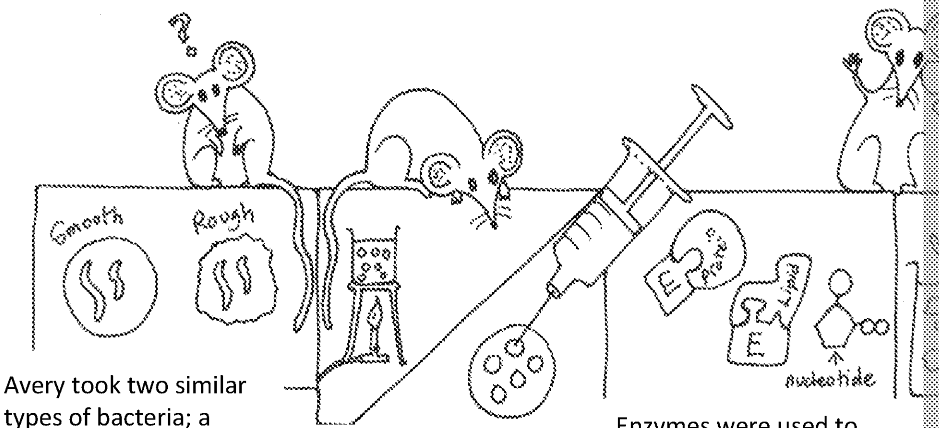
Scientists realised that some substance within an organism was preserving information about these individual characteristics, but what? And how did it work?

Gene
inheri

Deox
molec
preser
the nu

Friedrich Miescher, a medical researcher from Switzerland, found an acidic substance in the nucleus of cells which he called nuclein. We know it as **deoxyribonucleic acid** (DNA).

Oswald Avery showed that it was Miescher's nuclein (DNA) that coded the genet
transferring DNA from one bacterial cell to another and showing that the recipie
characteristics of the donor bacteria.



Avery took two similar types of bacteria; a smooth type that causes a lethal disease in mice, and a harmless 'rough' bacteria.

Some smooth bacteria cells were killed by heating, and their cell contents were extracted.

Enzymes were used to remove the protein and lipids from the extract, leaving only nucleotides (DNA).

Avery concluded that smooth bacteria nucleotides (DNA) had transformed the ro
DNA was the material of inheritance.

Erwin Chargaff showed that DNA contained four particular **nucleobases** called ad
guanine (G) and cytosine (C). Chargaff demonstrated that the number of molecu
number of molecules of T in any strand of DNA and that the number of G molecu
of C molecules.

Q7. What did Friedrich Miescher call the acid substance he derived from the nu

Q8. How did Avery show that DNA coded the genetic information of the cell?

Q9. What important piece of information did Chargaff determine?

The next important piece of evidence for the structure of DNA actually came through Linus Pauling's work on proteins. He realised that proteins could come in two forms. One of these forms was a **helix**, or spiral. A helix gives a characteristic diffraction pattern through **X-ray diffraction** images of crystals and this became a major clue in the determination of the structure of DNA.

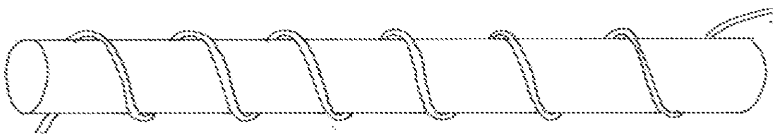
Nucleobase – a
(A, T, C and G) t
DNA together to

Helix – a spiral

X-ray diffractio
determining the
substance by pa

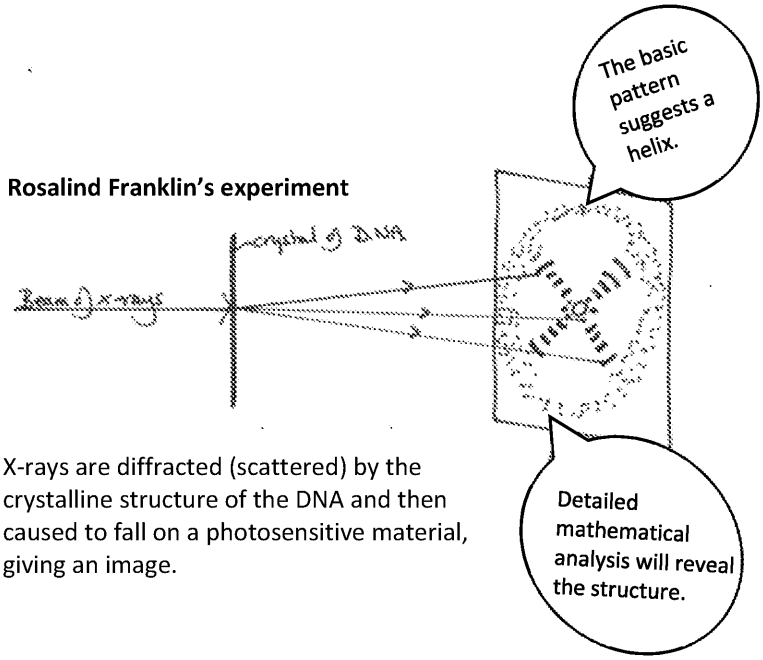
A helix is a spiral, like you might get if you wound a wire round a broom pole or similar object (see diagram below).

Fun fact
Raymond
the famo
was Rosa



At Kings College, University of London, Rosalind Franklin and her student, Raymo
diffraction image of DNA which showed it to be helical in form.

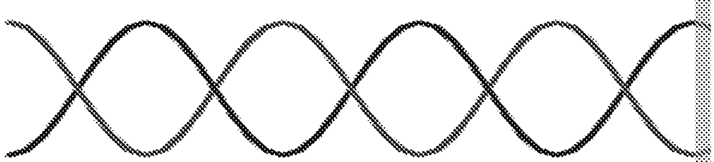
Rosalind Franklin's experiment



X-rays are diffracted (scattered) by the crystalline structure of the DNA and then caused to fall on a photosensitive material, giving an image.

James Wat
Cambridge
possible m
everything
They made
the perfect
paired base
the **double**

Fun fact!
Rosalind Franklin determined the structure of DNA mathematically at
much the same time as Watson and Crick 'guessed' correctly with thei



Q10. What did Linus Pauling learn about the structure of large proteins?

Q11. What was the investigative method that Rosalind Franklin (and Linus Pau determine the structure of large organic molecules?

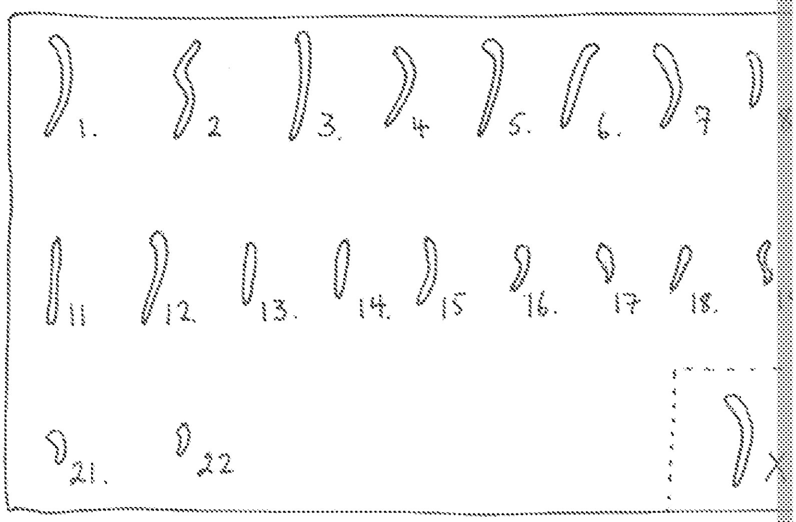
Q12. Did Watson and Crick finally determine the shape of the DNA model by m three-dimensional model making?

After 1953, Francis Crick continued to expand our understanding of how the DNA characteristics first explored by Gregor Mendel. Francis Crick and others realised
- The sequence of the bases could make up a code.
- The unique pairing between the bases (A with T, and G with C) would allow the code.
- Lengths of code would represent the different characteristics or genes.

During the second half of the twentieth century, scientists began to understand more and more about genes; what characteristics they control and where they occur on the 23 pairs of **chromosomes** in the human **genome**. Inherited disorders of health began to be better understood and the first experiments in genetic engineering, cloning and embryo transfer took place.

Chromoso found in the cells which in the form

Genome – material tha



The number and visual appearance of human chromo

Since 2000, there has been a collaborative effort between scientists worldwide t Gene editing techniques have become increasingly accurate and medical applica

Golden Rice is an example of gene editing. A form of blindness resulting from vitamin A deficiency happens in populations that rely on rice as a food source and have very few vegetables in their diet. Unmodified rice cannot provide vitamin A, but Golden Rice can. Genes are taken from another organism's genome and inserted into the genes of rice to make an orange/yellow pigment called carotene. Our bodies can use carotene to make vitamin A. Scientists hope that, if people grow and eat this Golden Rice, it will prevent blindness.

Fun fact!
The karyotyp the number a chromosome human karyo

Q13. Reorder the following sentences to explain how rice was genetically mod containing carotene.

A Allow the modified rice cells to grow and divide and become a new pl

B Insert the gene into a section of rice chromosome

C Identify the gene for carotene in another suitable organism (donor pl

D Grow more Golden Rice plants to get seeds so that vulnerable populat carotene-rich rice

E Use a special tool to cut this gene from the correct chromosome in a d

How inheritance works

A gene is a section of a DNA molecule. It consists of a code which is made from t
A single strand of DNA is a chromosome. The human genome has 23 chromosom
contain all the information needed to make a human.

However, in each of your cells you have two sets of chromosomes, one set from each of your biological parents. This means that you have two copies of each gene. These copies may not contain the same information. For instance, a classmate could have a dark-haired gene from their mother and a light-haired gene from their father. These different copies of the same gene are called **alleles**.

Q14. If the human genome has 23 chromosomes, but most cells have two of ea how many chromosomes will the nuclei of most human cells have in total

Looking back on what we learned about Mendel's experiment, we can now unde

- There is a gene in pea plants determining the characteristic flower colour.
- This gene has two alleles – a white flowered allele and a purple flowered allele.
- We can also conclude that the purple flowered allele is **dominant** because the offspring of white and purple flowered plants always have the phenotype purple flowers.
- The white flowered allele is **recessive**; it can be 'hidden' and not expressed in the phenotype of the pea plant.

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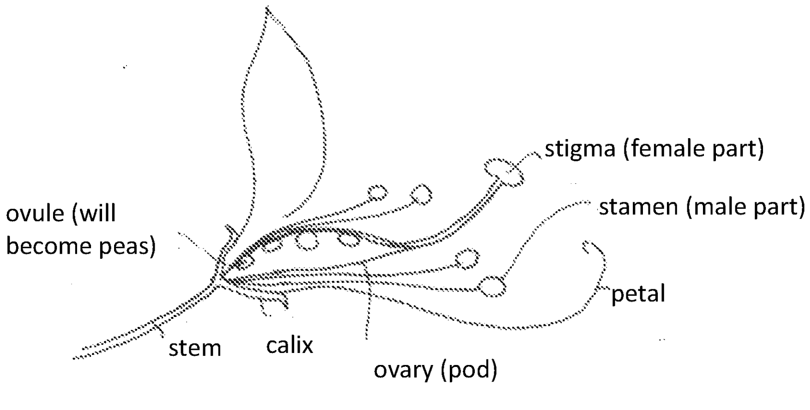


Longitudinal section of a pea flower

(Not sc
A domi
express
if it cau

Let's think a bit more about the child with a dark-haired mother and a light-haire
dark hair is dominant, you might think that the child will definitely have dark hai
but remember, some alleles can be hidden!

How then does an offspring get one set of chromosomes from each of their biological parents? This happens by the production of special cells called sex cells or gametes. In animals the gametes are the **ovum** (egg cell) and **sperm**, and in plants they are the **ovule** and **pollen**. Ova and the ovule are produced in the ovaries. These are two organs in the abdomen of animals and a single organ at the base of the pistil (female part) of a plant. Sperm is produced in the testes of animals and pollen is produced in the stamens of plant

Ovum – the
Ovule – the
Sperm – th
Pollen – the

Gametes are special because they contain only one set of chromosomes. In hum
of the human genome. A new life begins when the sex cells fuse. This embryoni
chromosomes – one from each of its biological parents – and it has two alleles o
called its genotype. The genotype may consist of dominant alleles, which expres
alleles, which remain hidden.

What we look like, and what's in our genes

Remember – phenotype is what we look like and genotype is what's in our genes

Fun fact!
Lack of me
skin (white
by a mutat
very comp
intensity o

In Mendel's F1 generation, the pea plants' phenotype is purple and their genotype has one (dominant) purple flowering allele and one (recessive) white flowering allele.

So that we can understand the inheritance of single allele traits such as flower colour (and make predictions), scientists use a form of shorthand. The allele is given a letter code, often a single letter such as P
is given a capital letter and the recessive allele is given a small letter.

A purple flowering allele's shorthand is P and a white flowering allele's shorthan

Fun fact!
The pigment
skin or hair is
genes have b
production.
such a range

Some information can be worked out from an organism's phenotype. Take the child with the dark-haired mother and a light-haired father.

If we give dark hair the shorthand D (because it's dominant) and light hair the shorthand d, we can say:

- The mother's genotype (both alleles, one from each parent) can be DD or Dd – as both would give a dark-haired person.
- The father's genotype has to be dd because he doesn't have dark hair.

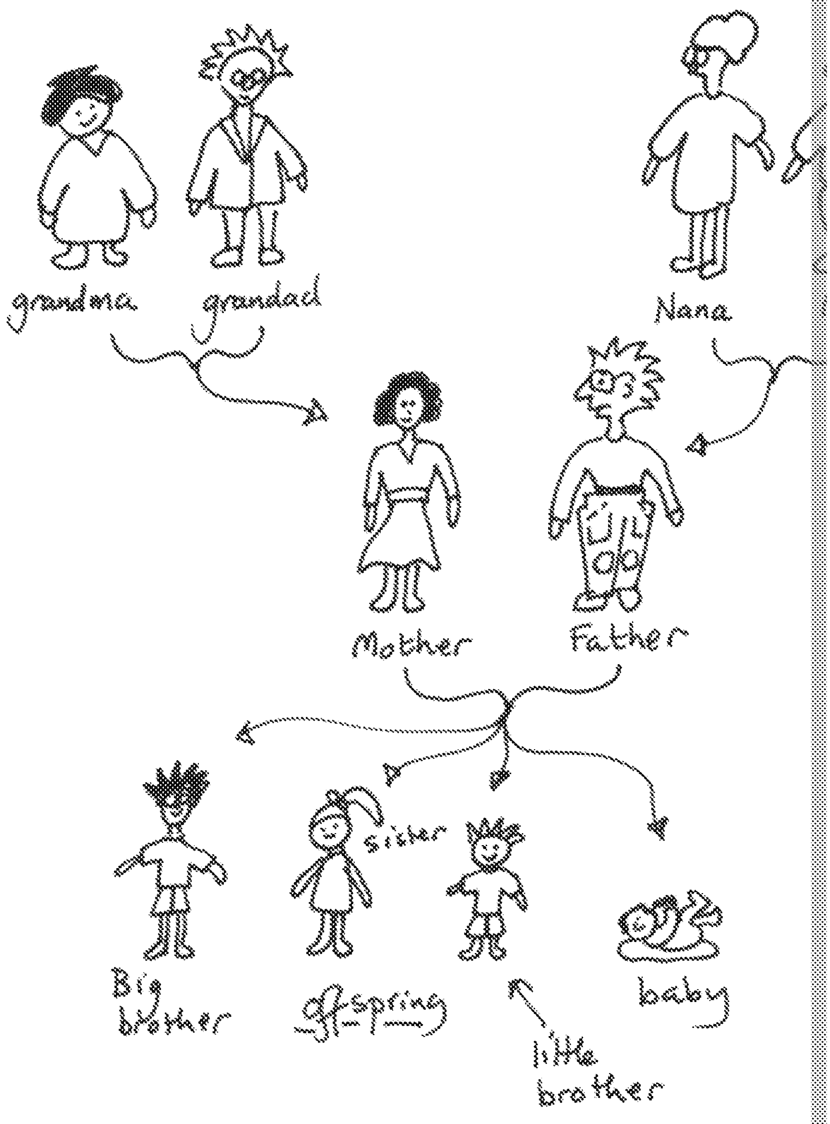
**Q15. Mendel started his investigations with true breeding purple flowered pea
breeding white flowered pea plants. True breeding tells us that their gen
identical alleles.**
**If the shorthand for flower colour is P; the dominant allele (purple) is repr
allele (white) is represented by p.**

a) Suggest the genotype for the flowing pea plants. (The first one has be

Non-true breeding purple flowered plants	
True breeding white flowered plants	
True breeding purple flowered plants	

b) (i) Which genotype can be described as double recessive?
(ii) Which genotype can be described as double dominant?

Q16. Here is a family tree.



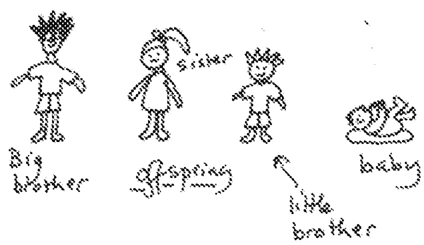
If the shorthand for hair colour is D; the dominant allele (dark) is represent
(light) is represented by d.

a) Draw a chart like the one below and complete all possible genotypes fo

	Phenotype – what they look like	Po
Grandma	Dark hair	
Grandad	Light hair	
Mother	Dark hair	
Nana	Light hair	
Papa	Light hair	
Father	Light hair	

Q16 continued.

Now consider the offspring.



b) Draw a chart like the one below and complete the phenotype for all pos brothers and the sister.

	Phenotype – what they look like	Po
Big brother		
Sister		
Little brother		

c) The big brother has dark hair, but the little brother and the sister have li born, he was quite bald. Was there any way of knowing whether the ba Give your reasoning.

Fun fact!
Some children's hair darkens as they mature as more melanin is produced by the hair follicles as the individual grows. Producti around aged 35, after which people's hair often goes grey.

Punnett squares, problems and probability

Punnett squares are tables used to predict the possible genotypes of offspring. They also tell you the probability of different phenotypes being seen. They work like this…

> **Punnett s**
> used to pre
> particular g
> one or two

Draw a square 2 × 2 table…

Mark the parents' genotype on the left and top edges of the square like this…
(dark-haired parent DD, light-haired parent dd)

	D	D
d		
d		

Now, fill in the squares with one allele from each parent…

	D	D
d	Dd	Dd
d	Dd	Dd

In this case, 100 % off the offspring will have the genotype Dd and the phenotyp

This is very like Mendel's F1 cross. He crossed double dominant purple flowered
white flowered plants to get 100 % F1 (hybrid) plants with phenotype purple flo

The Punnett square for this cross looks like this…

	P	P
Little p	Pp	Pp
Little p	Pp	Pp

All offspring are genotype Pp and have purple flowers (because they have at leas
allele for purple flowers).

Q17. a) Copy and complete the Punnett square below to consider Mendel's F2
Pp (hybrid) purple flowered plants.

b) Complete the table below using the results from part a).

Genotype	Phenotype	
PP		
Pp		
pp		

c) What percentage of the offspring will have phenotype 'purple flowerin

Example – cystic fibrosis
Cystic fibrosis is a serious medical condition caused by a single recessive gene. It is one of a class of diseases that are termed inborn errors of metabolism. This means that they are inherited and exist at birth and they prevent the body from functioning properly.

Fun fact!
Polydactyly is an in
where the individu
toes. The extra dig
it can be a function
is caused by a singl

Cystic fibrosis causes too much mucus to be made by the body's cells. Mucus is excreted by the cells of the respiratory and digestive tract mucus results in difficulty breathing and digesting, and repeated infections. Peo copies of the recessive gene for the condition.

If we call the shorthand for cystic fibrosis C, then the genotype of a person with t treatment, children with cystic fibrosis are living to adulthood. If they have child dominant for the condition (CC), crossing CC and cc using a Punnett square gives having the disease as zero as they will always have a dominant C gene from their

This Punnett square shows how a parent with cystic fibrosis can have healthy ch dominant for the condition:

	little c	little c
C	Cc	Cc
C	Cc	Cc

Working scientifically – probability

Probability is an expression of the likelihood that something will happen. Probability can be expressed as a percentage, as we have done in the table in Q16b, or as a fraction or a decimal, or even in words, e.g. likely, very likely, etc.

	P	P
Little p	Pp	Pp
Little p	Pp	Pp

In the cross described by the Punnett square (above) between a true breeding p
true breeding white flowered pea plant, the probability of getting purple flowere
probability of getting white flowered offspring is zero.

Let's explore other ways of describing these two extremes…

Outcome PP × pp cross	**Percentage**	**Word description**	**On a 0–1 s a frac**
Purple flowered	100 %	Certain	1
White flowered	0 %	Impossible	0

The shorthand for the probability of an event happening is P(event). Note that t
purple flowers. Sometimes this happens in science; there are only so many lette

---

Q18. Draw and complete a table like the one below to show the probability of t and white in the F2 cross you completed in Q17 a.

P(purple) is the shorthand for the probability of a purple flowering offspri
P(white) is the shorthand for the probability of a white flowering offspring

Outcome Pp × Pp cross	Percentage	Word description	On a 0 – 1 or as a fra
P(purple flowering)			
P(white flowering)			

The **sample space** is a list of all possible outcomes and is written S = (list of outco

	P	P
Little p	Pp	Pp
Little p	Pp	Pp

Considering the genotypes of the offspring in the F1 cross above, the sample spa
For the phenotypes, the sample space (S) = (purple, white)

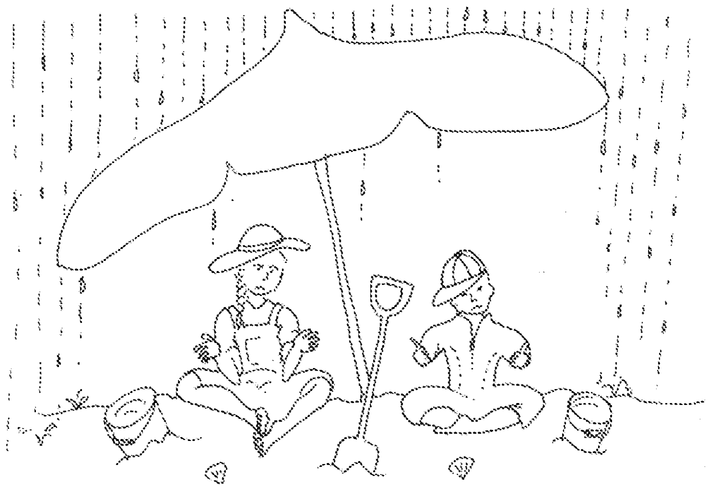
Q19. The Punnett square below considers a parent with cystic fibrosis and one w carries the gene for cystic fibrosis.

	little c	little c
C	Cc	Cc
little c	cc	cc

a) Identify the sample space for the genotype outcomes.

b) What is the probability of any offspring having cystic fibrosis?

Trends in probabilities tend to show when the sample number of chance events is chance events can distort our impression of the likelihood of an outcome. If you and it rained every day you might conclude that the holiday brochure was wrong weather data for the region for the whole summer, you would see that you were

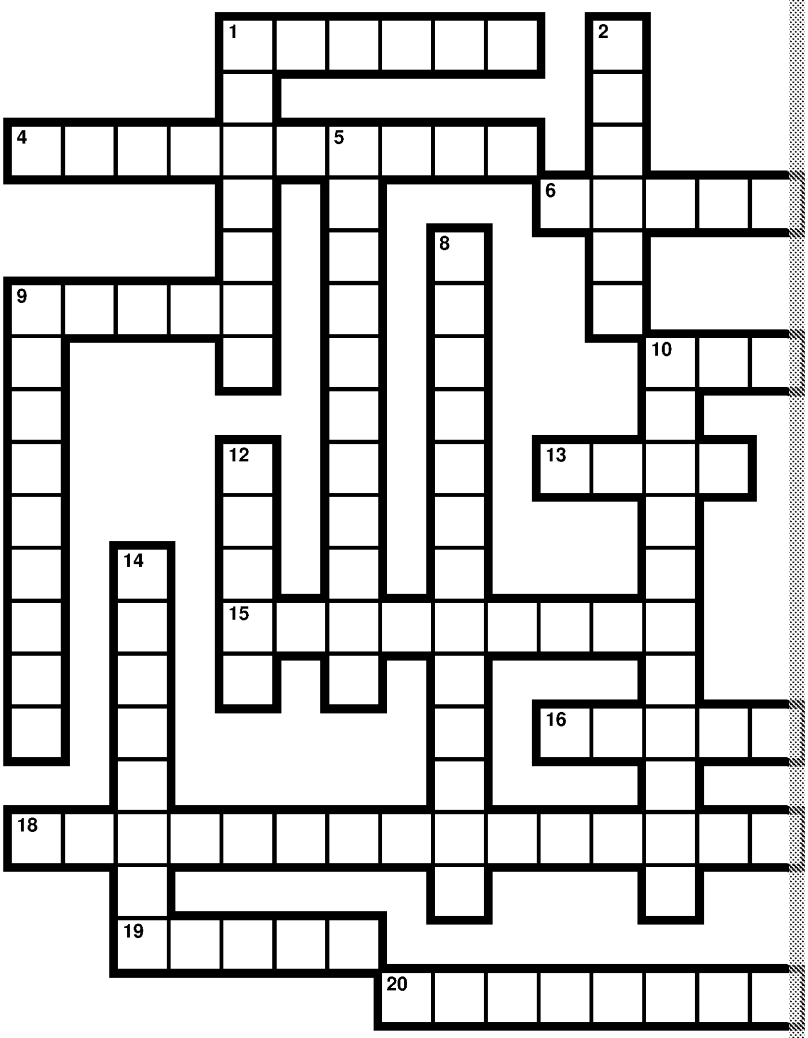


Fun fact!
Even though po dominant gene population. A confers no adv perhaps a disa people with tw polydactyly be developing off

Mathematically, a small sample size can give an inaccurate answer too. The prob coin toss is 1/2 (or 50 %). This probability is the same for every coin toss because head is the same each go; it is not changed or influenced by the outcome of the p the coin twice – it is quite likely that you could throw two heads in a row. It is fa 10 heads in a row, and close to impossible that you might throw 100 heads in a r

The true likelihood, or probability, of any outcome will become apparent if the s

Crossword



Across

1 The complete set of genetic material that describes an organism (6)
4 A strand of DNA in the nucleus which carries genetic information in the form of genes (10)
6 The genetic information in the nucleus (8)
9 The female sex cell in plants (otherwise known as an egg) (5)
10 Shorthand for deoxyribonucleic acid (3)
13 The female sex cell in animals (otherwise known as an egg) (4)
15 An allele that can be in an organism's genotype but is only expressed in the phenotype when present as a pair (9)
16 The outward appearance of an individual (9)
18 A method of determining the structure of a crystalline substance by passing X-rays through it (1-3,11)
19 Another word for characteristic (5)
20 A characteristic that is always expressed in successive crosses (4,8)

Down

1 The scientific
2 Form of a gen trait (6)
3 A distinct ser a single inher
5 All the possib
7 The likelihood happening (1
8 A diagram us genetic cross
9 A general wo person's child
10 Two linked he
11 To keep some
12 The male sex
14 An allele that present (8)
17 The male sex

End-of-topic Questions

1. Mendel noticed that pea plants were either tall or short and never medium that height was inherited as a distinct trait or characteristic.

   Mendel took true breeding tall pea plants and crossed them with true breed hybrid pea plants were tall.

   a) Which characteristic is dominant – tallness or shortness?

   Suppose the dominant allele is labelled T and the recessive allele is labelled

   b) Copy and complete these Punnett squares:

   (i) True breeding tall × true breeding short

	T	**T**
t		
t		

   (ii) F1 hybrid × F

	T	**t**
T		
t		

   (iii) Of the outcomes in part (ii) above, list all the possible genotypes

   (iv) What is the ratio of phenotypes tall : short in the F1 hybrid cross

   c) Of the three genotypes TT, Tt and tt:

   (i) Which is homozygous recessive?

   (ii) Which is homozygous dominant?

   (iii) Which is heterozygous?

2. a) In the cross shown to the right where a heterozygous purple flowered crossed with a white flowered plant, what is the probability of an offsp having white flowers?

   b) If the ratio of tall : short offspring of a large number of experimental cr pollinations was 1 : 1 (or 50 : 50), suggest the phenotypes of the paren Use the terms homozygous and heterozygous in your answer. Draw Punnet squares if it helps your reasoning.

3. Below is a list of the famous scientists who made the discoveries that led to Match the scientists with the bit of the DNA puzzle that they discovered.

(i) Gregor Mendel
(ii) Friedrich Miescher
(iii) Oswald Avery
(iv) Linus Pauling
(v) Erwin Chargaff
(vi) Rosalind Franklyn and others
(vi) Watson and Crick

A	Made a model of DNA that 'worke
B	Took an X-ray image that indicated helical structure
C	Showed that large biological molec
D	Showed that it was the DNA in a ce genetic information
E	Identified the relationship betwee and C
F	Isolated a substance from the nucle called nuclein
G	Showed that characteristics are pa offspring and that some traits can

4. Two people are having a baby. Unbeknown to either of them, they are both they both have the genotype Cc.

   a) Draw a Punnett square to explore the possible outcomes.

   b) Identify the sample space for the genotype outcomes.

   c) What is the probability of any offspring having cystic fibrosis?

   d) The couple have four healthy children. How can this be? (Think about

Answers

Comprehension questions

1. B
2. C
3. a) Nineteenth century
   b) In a monastery, in Austria (accept either or both)
4. a) Pea plants
   b) Flower colour
   c) White (flowering offspring)
5. a) Three
   b) Nine
   c) None
6. a) Purple
   b) White
7. Nuclein
8. By transferring DNA from one bacterial cell to another and showing that the recipie characteristics of the donor bacteria
9. Chargaff discovered the nucleobases and showed that A and T, and C and G, were a
10. That they could be helices
11. X-ray diffraction (imaging) (accept X-ray crystallography)
12. Making 3D models
13. C – Identify the gene for carotene in another suitable organism (donor plant)
    E – Use a special tool to cut this gene from the correct chromosome in a donor plan
    B – Insert the gene into a section of rice chromosome
    A – Allow the modified rice cells to grow and divide and become a new plant
    D – Grow more Golden Rice plants to get seeds so that vulnerable populations can
    Accept – C, E, B, A, D
14. 46
15. a)

Non-true breeding purple flowered plants	Pp
True breeding white flowered plants	(i) pp
True breeding purple flowered plants	(ii) PP

    b) (i) pp is double recessive
       (ii) PP is double dominant
16. a)

	Phenotype – what they look like	Possible genoty
Grandma	Dark hair	DD or Dd
Grandad	Light hair	dd
Mother	Dark hair	(i) Dd
Nana	Light hair	(ii) dd
Papa	Light hair	(iii) dd
Father	Light hair	(iv) dd

    b)

	Phenotype – what they look like	Possible genoty
Big brother	Dark hair	Dd
Sister	Light hair	dd
Little brother	Light hair	dd

    c) The baby's hair could be either dark or light. There is no way of knowing until
    The baby could have received either a D allele or a d allele from their mother,
    father. Accept this information written, or via a Punnett square.
    The baby's genotype could be Dd (dark hair) or dd (light hair)
    Extra credit should be given if the learner understands that both outcomes hav however this is expressed

17. a)

	P	little p
P	PP	Pp
little p	Pp	pp

b)

Genotype	Phenotype	% Offspring
PP	Purple flowering	25 %
Pp	Purple flowering	50 %
pp	White flowering	25 %

c) 75 %

18.

Outcome Pp × Pp cross	Percentage	Word description	On a 0–1 scal as a fractio
P(purple flowering)	75 %	Likely	$\frac{3}{4}$
P(white flowering)	25 %	Less likely	$\frac{1}{4}$

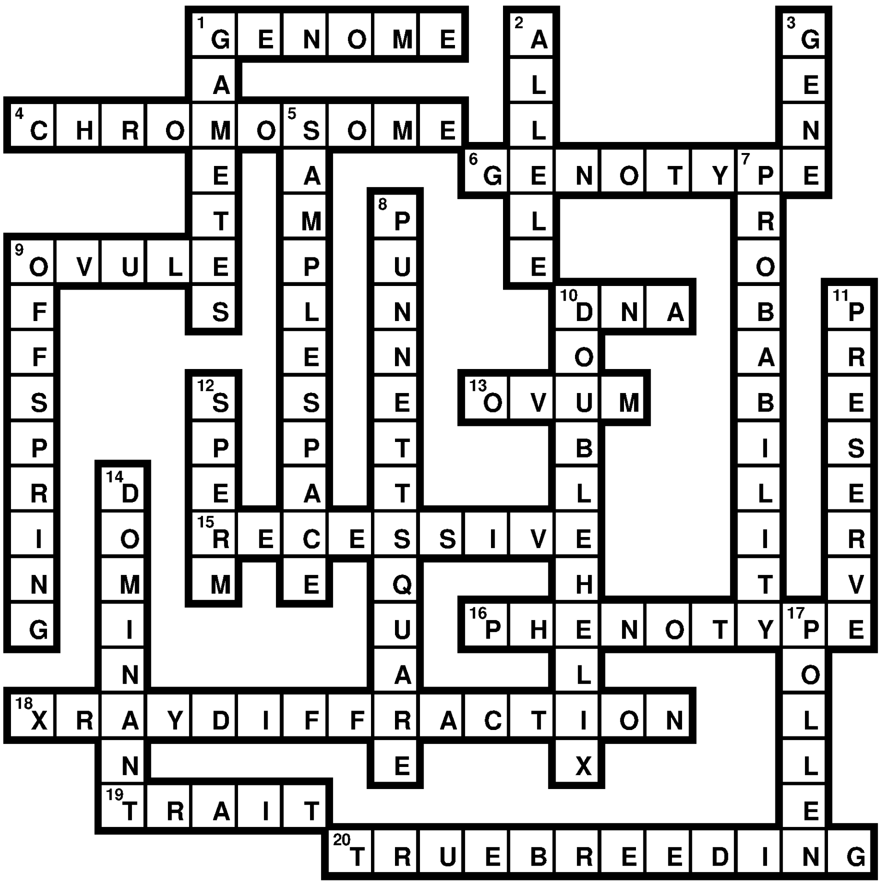
Allow any word description that confers the right meaning, e.g. three quarters of th

19. a) S = (Cc, cc)

b) 50 %

Accept half the time or any other correct expression

Crossword



End-of-topic questions

1. a) Tallness
   b) (i)

	T	T
t	Tt	Tt
t	Tt	Tt

(ii)

	T	t
T	TT	Tt
t	Tt	tt

(iii) S = (TT, Tt, tt) (accept just TT, Tt and tt)
(iv) 3 : 1

c) (i) tt
(ii) TT
(iii) Tt

2. a) The probability is 50 % (accept other ways of saying the same thing: 1 in 2, a h
   b) If the ratio of tall : short offspring of a large number of experimental cross pol one parent will have the genotype homozygous recessive and will have the ph will have a heterozygous genotype and will have the phenotype tall.

	T	t
t	Tt	tt
t	Tt	tt

3. (i) Gregor Mendel – G
   (ii) Friedrich Miescher – F
   (iii) Oswald Avery – D
   (iv) Linus Pauling – C
   (v) Erwin Chargaff – E
   (vi) Rosalind Franklyn and others – B
   (vii) Watson and Crick – A
4. a)

	C	c
C	CC	Cc
c	Cc	cc

b) s = (CC, Cc, cc) – correct form required
c) 25 % (accept other ways of saying the same thing: 1 in 4, a quarter, etc.)
d) There is a 75 % of having a healthy child each time two gametes fuse to make
The probability is not altered by previous births
Over a large number of births, the ratio of healthy babies compared to babies
However, with a small sample size, seeming anomalies can occur as in this cas