



Genetic mutations

1. Fill in the gaps in this passage.

Genetic mutations are (a) _____ in the sequence of genetic code in our (b) _____.
Some are lethal; some don't matter at all. Common genetic disorders that humans have include:
(c) _____, _____ and _____.

If the mutation happens in the (d) _____ (the sex cells), then the mutation can be passed onto offspring. If the mutation happens in the body cells then new body cells will have that change but the mutation (e) **will/will not** (*cross one out*) be passed on to offspring.

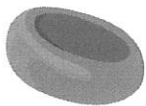
2. Cystic fibrosis is a genetic disorder in which the lungs produce thick mucus that blocks the airways and causes breathing difficulty. This disorder is caused by a recessive gene.

(a) Describe why a person who has cystic fibrosis disorder is lucky to live to their mid-thirties, given what the disorder does to their body.

(b) Explain how the above information on cystic fibrosis means that two healthy parents can produce a child with cystic fibrosis. The following genotypes may help you with your answer:

cc = Cystic fibrosis; CC = Normal; Cc = Carrier of cystic fibrosis

3. Sickle cell anaemia causes the usual round red blood cells to be shaped like a sickle. As a result, the person is less able to carry oxygen around the body as the shape of the cells can block veins and arteries. This disease is not common in Australasia. However, it is common in countries where you find malaria because, if you are a carrier of sickle cell anaemia, you are protected against malaria.



Normal red blood cell



Sickle cell

Explain what a person's genotype would be if this person was immune to malaria and a carrier of sickle cell anaemia.



Genetic mutations

1. Cystic fibrosis is a genetic disorder in which the lungs produce thick mucus that blocks the airways and causes breathing difficulty. This disorder is caused by a recessive gene.

Explain how the above information means two healthy parents can produce a child with cystic fibrosis. The following genotypes may help you with your answer:

cc = Cystic fibrosis; CC = Normal; Cc = Carrier of cystic fibrosis

2. Sickle cell anaemia causes the usual round red blood cells to be shaped like a sickle. As a result, you are less able to carry oxygen around the body as the shape of the cells can block veins and arteries. This disease is not common in Australasia but is common in countries where you find malaria because, if you are a carrier of sickle cell anaemia, you are protected against malaria.



Normal red blood cell



Sickle cell

(a) Describe why a person who has sickle cell anaemia has a reduced life expectancy compared with a person who has normal red blood cells.

(b) Explain what a person's genotype would be if this person was immune to malaria and a carrier of sickle cell anaemia.

3. As genetic testing is becoming more prevalent, an ethical debate about genetic disorders has arisen. Should an insurance company have all the information from any genetic testing you undertake before deciding to take you on as a client? Write your answer in your book.

In your answer you should include:

- why insurance companies have the right to know the amount of risk they are facing when taking you



Genetic mutations

Find other people in your class working at this level and work in a small group on this worksheet.

Every child in Australasia has a blood sample taken to test for multiple disorders that can cause serious disability if not identified early. The samples are retained on cards called Guthrie cards.

1. Imagine a group of scientists wishes to analyse the DNA contained on Guthrie cards so that it can identify other genetic conditions and develop a cure for them.

If Guthrie cards were used in this manner, what would be the pros, cons and interesting questions for the different groups of people involved? Answer this question by completing the table below. If you need more room, make a larger table in your book and fill it in.

Group affected	Pros (positives)	Cons (negatives)	Questions that this group might have
(a) Children and their parents			
(b) Scientists and doctors			
(c) Insurance companies			
(d) Employers			
(e) Police			

2. Now suppose the police see that a lot of people's DNA could be identified through the Guthrie cards database. They apply to the High Court to have those records released and the DNA mapped so that DNA evidence left behind in crimes can be compared and crimes solved faster with less cost to the taxpayer.

You are a government lawyer acting for the hospitals who have the Guthrie cards, as they are opposing this court action. In your group discuss your reasons for opposing the police and then use this discussion to write your own argument in your book, opposing the police use of Guthrie cards.

3. An insurance company decides to see if it can use the information contained on the Guthrie cards before taking on new clients. It gets around the government's opposition by getting prospective clients to sign a waiver giving the insurance company the right to use and analyse the DNA found on the client's Guthrie card. Using the "pros, cons and questions" format above, develop your own opinion either for or against this practice. Write your answer in your book.



Genetics punnet squares

1. Sunflowers can be tall or short. The allele for tall sunflowers is dominant over the allele for short sunflowers.

(a) Complete this punnet square to show the outcome when two heterozygous sunflowers are crossed.

Note: *T* = Tall and *t* = short.

(b) Complete the following information.

Height of offspring: _____ % tall and _____ % short

Genotypes: _____ % TT; _____ % Tt; _____ % tt

	T	t
T		
t		

2. In mice, white fur (*W*) is dominant over grey fur (*w*). If a white mouse is crossed with a grey mouse, what percentage of their children will be white mice and what percentage will be grey? Express the answer in percentages and use the punnet square to show your reasoning.

Percentages: _____

	W	w
w		
w		

3. Short hair (*H*) in guinea pigs is dominant over long hair (*h*). Two heterozygous guinea pigs produce a long-haired offspring. What is the chance of doing this? Express the answer as a percentage and use the punnet square to show your reasoning.

Percentage: _____

	H	h
H		
h		

4. Lactose is a sugar found in milk. Most people can digest lactose; however, people who cannot are described as lactose intolerant and have the genotype of *ee*. If a heterozygous person for tolerating lactose mates with a lactose intolerant person, what is the chance of their offspring having lactose intolerance? Express your answer as a percentage and use the punnet square to show your reasoning.

Percentage: _____

	E	e
e		
e		



Genetics punnet squares

1. In mice, white fur (W) is dominant over grey fur (w). If a white mouse is crossed with a grey mouse, what percentage of their children will be white mice and what percentage will be grey?

Percentages: _____

	W	w
w		
w		

2. In poodles, coat colour is controlled by a single gene. Black coat colour (B) is dominant over brown coat colour (b). Complete the punnet square to show the cross between two heterozygous poodles. Give proportions of expected genotypes and phenotypes.

Genotypes: _____

Phenotypes: _____

3. A long-haired guinea pig has a recessive genotype for hair (hh). It is mated with a guinea pig with short hair (HH). What proportion of the offspring will be short-haired? Use a punnet square to show your reasoning.

Percentage: _____

4. Lactose is a sugar found in milk that most people can digest. Some people cannot digest lactose and are said to be lactose intolerant, which is a recessive trait. If a man who is said to be heterozygous for lactose intolerance has children with a woman who has lactose intolerance, what proportion of their offspring will be lactose intolerant? Use a punnet square to show your reasoning.

Percentage: _____



Genetics punnet squares

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Genotypes: _____

Phenotypes: _____

2. A long-haired guinea pig has a recessive genotype for hair (hh). It is mated with a guinea pig with short hair (HH). What proportion of the offspring will be short-haired? Use a punnet square to show your reasoning.

Percentage: _____

3. When two short-haired guinea pigs were mated together, they only produced offspring with short hair. Explain why it is not certain that the genotype of the guinea pigs is heterozygous or homozygous dominant. Use a punnet square to show your reasoning.

Explanation: _____

4. Cystic fibrosis is a genetic disease caused by two recessive genes. Among people of Caucasian ancestry, 1 in 25 is a genetic carrier for cystic fibrosis, usually without knowing it. What is the probability that one of your future children has cystic fibrosis? (Assume that both you and your future partner have that 1 in 25 chance of being a carrier.) Use a punnet square to show your reasoning.

Probability: _____

5. In some cultures, male offspring are prized and female offspring are not. Use the punnet square to explain why the sperm from the father determines the sex of the offspring rather than the egg from the mother.

Explanation: _____

- (b) True; the text identifies other types of non-ionising radiation such as UV light and visible light.
 - (c) True; non-ionising radiation does not have enough energy to turn particles into ions but it does have enough energy to heat particles.
 - (d) True; to cause a tumour a mobile phone would have to alter DNA.
 - (e) True; teenagers are more likely to miss out on sleep because they stay up too late using their phones or are interrupted in their rest due to answering messages in the middle of the night.
2. It means that the radiation can heat up objects/cells but cannot turn cells into ions (charged particles).
 3. The energy is not strong enough to turn cells into ions.

Proficient

1. (a) True; radiation from the Sun is also electromagnetic radiation.
- (b) True; this is what ionising radiation does.
- (c) True; it is non-ionising radiation so can only heat cells – it cannot alter DNA of cells.
2. (a) True; the text implies that teenagers stay up too late and don't sleep right through the night due to interruptions from their mobile phone.
- (b) False; the radiation from the mobile phone doesn't have enough energy to alter the DNA in your ear cells – it can only heat the cells up.

Advanced

1. (a) True; radiation from the Sun is also electromagnetic radiation.
- (b) True; this is what ionising radiation does.
- (c) True; it is non-ionising radiation so can only heat cells – it cannot alter DNA of cells.
2. (a) No, it doesn't mean you are getting cancer. It means your mobile phone is emitting ER radiation that has enough energy to heat up your ear cells but it doesn't have enough energy to alter your ear cell's DNA.
- (b) Your level of risk depends on how long you spend in the Sun but generally you are more at risk of getting cancer from tanning in the Sun than you are of getting cancer from using a mobile phone.

Genetic mutations (pp 14–16)

Basic

1. (a) changes
- (b) DNA
- (c) *A range of answers is possible, including any three of the following:* Huntington's disease, cystic fibrosis, sickle cell anaemia, Down syndrome.
- (d) gametes
- (e) will not
2. (a) This person would be lucky to live into their thirties as the thick mucus that the lungs produce blocks the airways and fills up the lungs which stop working so the person cannot breathe effectively.
- (b) Two healthy parents could be carriers of the disorder with genotypes (Cc). When they mate, they have a 1/4 chance of producing a cystic fibrosis sufferer with a cc genotype.

3. This person would be a carrier of the disorder and be heterozygous, eg, Ss.

Proficient

1. Two healthy parents could be carriers of the disorder with genotypes (Cc). When they mate, they have a 1/4 chance of producing a cystic fibrosis sufferer with a cc genotype.
2. (a) The person with sickle cell anaemia has sickle-shaped red blood cells that cannot carry oxygen effectively and so the person has a reduced life expectancy.
- (b) This person would be a carrier of the disorder and be heterozygous, eg, Ss.
3. *Answer could include the following points:* The insurance company should know if you are going to develop a genetic disorder that is expensive to treat because you will be a higher-risk client. However, people's genes are their business and they don't know the future whereas a genetic screen could predict a future that is filled with hospitals and a genetic disorder.

Advanced

Answers could include the following points:

1. (a) Pros: The genetic disorder may have a cure if the gene is still dormant; Cons: They will know their fate; Questions: How did I get this disorder?
- (b) Pros: Can know the prevalence of a disorder in the population, can put health money where it is most needed; Cons: Knowing prevalence may not lead to a change in funding and a cure; Questions: Does this affect how we plan our health spending as a nation?
- (c) Pros: Can identify high-risk people who are likely to develop a genetic disorder that will be expensive to treat; Cons: May be an unpopular policy among consumers if insurance company raises premiums for some people or refuses to insure them; Questions: Is it ethical for an insurance company to find out about people's genes?
- (d) Pros: Can see who is likely to need time off work; Cons: May not employ good people because further down the track they are likely to develop a genetic disorder; Questions: Is it an employer's business to know about their employees' genes?
- (e) Pros: Know everyone's DNA so if they commit a crime they can be identified without lots of money spent on solving the case; Cons: Too much information could mean that the police don't do any detective work any more; Questions: How would the data be secured?
2. Some reasons for opposing the police are: the database contains data collected from people for a purpose they did not authorise; the Guthrie card was not collected for this purpose; who would look after these data?
3. Pros: Insurance company is looking to reduce costs and risks with insuring clients; Cons: Many people would not understand what they are signing; many people won't know that they have a genetic disorder while the insurance company would hold information about how their life is going to turn out; Questions: Does the presence of a gene that may lead to a disorder actually mean the insurance company will refuse to insure the client?

Genetics punnet squares (pp 17-19)

Basic

1. (a)

	T	t
T	TT	Tt
t	Tt	tt

(b) Height of offspring: 75% tall and 25% short;
Genotypes: 25% TT; 50% Tt and 25% tt

2.

	W	w
w	Ww	ww
w	Ww	ww

50% are white and 50% are grey.

3.

	H	h
H	HH	Hh
h	Hh	hh

The chance of two short-haired guinea pigs producing a long-haired guinea pig is 25%.

4.

	E	e
e	Ee	ee
e	Ee	ee

50% chance

Proficient

1.

	W	w
w	Ww	ww
w	Ww	ww

50% are white and 50% are grey.

2.

	B	b
B	BB	Bb
b	Bb	bb

Genotypes: 25% BB; 50% Bb and 25% bb;
Phenotype: 75% are black and 25% are brown.

3.

	H	H
h	Hh	Hh
h	Hh	Hh

All (100%) of the offspring are short-haired because the dominant allele (H) is present in all the genotypes of the offspring.

4.

	E	e
e	Ee	ee
e	Ee	ee

There is a 50% chance of the offspring being ee and so being lactose intolerant.

Advanced

1.

	B	b
B	BB	Bb
b	Bb	bb

Genotypes: 25% BB; 50% Bb and 25% bb;
Phenotype: 75% are black and 25% are brown.

2.

	H	H
h	Hh	Hh
h	Hh	Hh

All (100%) of the offspring are short-haired because the dominant allele (H) is present in all the genotypes of the offspring.

3.

	H	H
h	Hh	Hh
h	Hh	Hh

Even if both parents are heterozygous, the offspring could still be 100% short-haired as there is only a 50% chance of a long-haired guinea pig.

4.

	C	c
C	CC	Cc
c	Cc	cc

Both parents would need to be heterozygous for cystic fibrosis which means a 1/25 chance. So, $1/25 \times 1/25 = 1/625$ chance of matching up. Then it is another 1/4 chance of producing the needed cc genotype so $1/625 \times 1/4 = 1$ in 2 500 chance of producing a child with cystic fibrosis.

5.

	X	X
X	XX	XY
Y	XY	YY

The male has the Y chromosome and so the presence of the Y chromosome from the male determines whether the offspring is male (XY) rather than female (XX).

Life processes (pp 20-22)

Basic

- Movement, Reproduction, Sensitivity, Growth, Respiration, Excretion, Nutrition
- (a) A rock has none of the seven life processes so it is non-living.
(b) A clock can only move and it has none of the other six life processes so it is non-living.
(c) A blade of grass has all seven of the life processes (including movement as it can grow towards the sun) so it is living.
- A tree can move – it can grow towards the light and move in the breeze – so it is living.
- A car cannot grow, cannot reproduce and is not sensitive.