Answers DNA and Genes

Year 10 Science Chapter 2

p9

1 **DNA** is **d**eoxyribo**n**ucleic **a**cid.

2 DNA contains the genetic code considered to be the building blocks of all known living organisms.

3 **Physical traits** are noticeable characteristics controlled by segments of DNA called genes. Inherited traits can include hairline, earlobe, cleft chin, dimples, tongue rolling, eye colour, hair shape.

4 A double helix has the shape of a twisted ladder.

5 Of the following structural parts of DNA, which are the nucleotide bases?

a) guanine **d)** adenine **e)** thymine **f)** cytosine

p11

1 A is paired with T T is paired with A
G is paired with C C is paired with G

a) ACGCGTAGA
TGCGCATCT

b) TTGAGAGCCTGC
AACTCTCGGACG

c) CGATGTCTGAG
GCTACAGACTC

2 a)

A	T
G	C
G	C
C	C
T	A
A	T
T	A
T	~~C~~
C	G

b)

G	C
A	T
T	A
T	A
A	T
C	~~T~~
A	T
T	A
A	~~G~~

p13

1 A **gene** is a short section of DNA. A gene carries the code for making proteins from amino acids.

2 **Proteins** are large molecules built from sequences of amino acids. The DNA provides a code for the cells to produce proteins from amino acids. Proteins are used in our bodies for almost everything.

3 Each set of three bases that codes an amino acid is called a codon.

4 Decipher the following sections of genetic code (what is the sequence of amino acids)?

a) ATG- GAG - AAG- GGA - TAC
Start-glutamic acid-lysine-glycine-tyrosine

b) ATG- TTT - AAG - TGT
Start-phenylalanine-lysine-cysteine

c) TCA - AAC - CGT - GCC -TGA
Serine-asparagine-arginine-alanine-stop

5 A mutation changes the codon CTG to GTG.

a) CTG is coded to leucine and GTG is coded to valine

b) If CTG, part of the gene sequence for haemoglobin, changes to GTG then haemoglobin may not be properly sequenced and may not perform its function properly.

p15

1 **Chromosomes** are tightly coiled long strands of DNA. Chromosomes are found in the nucleus of plant and animal cells.

2 The chromatids are mostly identical halves of a chromosome.

3 The two **chromatids** of a chromosome are joined at the **centromere**.

4 Humans have 23 pairs of chromosomes, giving a total of 46 chromosomes.

5 A **gene** is a short section of DNA. A gene carries the code for making proteins from amino acids. A **chromosome** contains many genes along the length of the chromosome.

6 Females have two X chromosomes and males have an X and a Y chromosome.

7 23 chromosomes came from the mother and 23 chromosomes come from the father.

p17

1 Meiosis is a process of cell division that divides a parent cell into four daughter cells, each with half the number of chromosomes.

2 **Fertilisation** is the beginning of an organism's development. Human fertilisation has happened when the 23 female chromosomes has mixed with the 23 male chromosomes to form a single-celled **zygote** with 46 chromosomes.

3 The first division of the genetic material in the process of meiosis in humans reduces the number of chromosomes from 46 chromosomes (2 x 23 diploid) to 23 chromosomes (1 x 23 haploid).

The second division of the genetic material in the process of meiosis in humans separates the two chromatids from each chromosome.

4 Explain each of the following terms:

a) The **zygote** is the first cell of an organism. Zygote means 'yoked or joined together'.

b) The human female reproductive cell, the **ovum**, contains 23 choromosomes.

c) A diploid cell has paired chromosomes, one from each parent. In humans, a diploid cell has 23 pairs of chromosomes (46 chromosomes).

d) In humans, a haploid cell has a single set of chromosomes (23 chromosomes).

5 46 chromosomes (23 pairs).

p19

1 **a)** PP - purple flower **b)** Pp - purple flower **c)** pp - white flower

2 **a)** white - pp **b)** PP or Pp

3 What is the difference between each of the following terms:

a) Homozygous. Having identical pairs of genes for a pair of heriditary characteristics. *Example*: YY is homozygous and so is GG.
Heterozygous. Having different pairs of genes for a pair of heriditary characteristics. *Example*: YG is heterozygous (GY is the same gene pair as YG).

b) Dominant In a heterozygous gene pair, the seed takes on the characteristic of the dominant gene. *Example*: Given the gene pair YG, the seed will be yellow as yellow dominates green.
Recessive In a heterozygous gene pair, the seed takes on the characteristic of the dominant gene. *Example*: Given the gene pair YG, the seed will be yellow as the colour green is recessive and is overridden by the yellow colour.

c) Genotype The genotype is the genetic makeup of an organism and refers to the entire set of genes in the cell of an organism. Genotype is sometimes used to refer to the the genetic makeup of a gene pair. *Example*: The genotype for the yellow seed colour of a pea could be YY or YG. The genotype for the green seed colour of a pea is GG.
Phenotype The phenotype refers to the characteristic expression by a genotype. *Example*: The phenotype of the gene pair GG is green. The phenotype of the gene pair YG is yellow.

p19

4

Parent 1 \ Parent 2	P	p
p	Pp	pp
p	Pp	pp

50% are purple flowers (Pp) and 50% are white flowers (pp)

5

Parent 1 \ Parent 2	P	P
p	Pp	Pp
p	Pp	Pp

100% are purple flowers (Pp)

6

Parent 1 \ Parent 2	P	P
P	PP	PP
p	Pp	Pp

100% are purple flowers (Pp or PP)

7

Parent 1 \ Parent 2	P	p
P	PP	Pp
p	Pp	pp

75% are purple flowers (Pp or PP) and 25% are white flowers (pp)

8

Parent 1 \ Parent 2	p	p
p	pp	pp
p	pp	pp

100% are white flowers (pp)

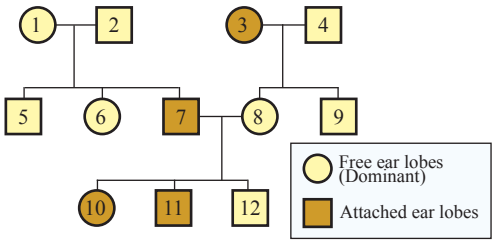
p21

1

Parent 1 \ Parent 2	P	P
p	Pp	Pp
p	Pp	Pp

Homozygous dominant (PP) crossed with homozygous recessive (pp) produces offspring that have a dominant phenotype (purple flower) and heterozygous genotype (Pp).

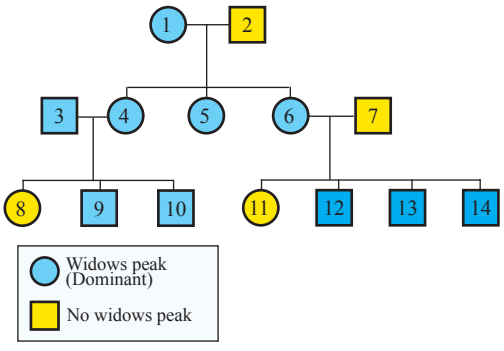
2



Using key: E = free ear lobe
e = attached ear lobe

3 = ee 4 = EE 8 = Ee 9 = Ee
7 = ee 10 = ee 11 = ee 12 = Ee
1 = Ee 2 = Ee 5 could be Ee or EE
6 could be Ee or EE

3



Using key: W = widows peak
w = no widows peak

2 = ww 1 is probably WW because no offspring is ww
4 = Ww 5 = Ww 6 = Ww 3 = Ww
7 = ww 8 = ww 9 could be WW or Ww
10 = could be WW or Ww 11 = ww
12 = Ww 13 = Ww 14 = Ww

p23

1 The Punnet square below shows a cross between:

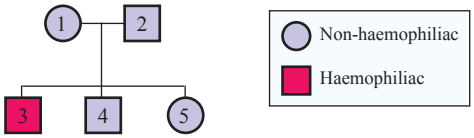
- A female parent (XX) who is not a haemophiliac but carries the haemophilia gene (X).
- A male parent (XY) without haemophilia.

		Parent 2	
		X	Y
Parent 1	X	XX	XY
	X	XX	XY

The offspring
XX no haemophilia
XY no haemophilia
XX no haemophilia but carries the gene
XY haemophiliac (The Y doesn't mask the X)

50% of the males of a cross between an XX and an XY will have haemophilia.

2



3 = XY 4 = XY 5 = XX or XX
2 = XY 1 = XX

3

		Parent 2	
		X	Y
Parent 1	X	XX	XY
	X	XX	XY

50% of the children expected to have haemophilia (XX and XY)

4 The above punnet square shows that it is possible for a female to have haemophilia (XX)

p25

1 A **mutation** is a change in the DNA sequence of a gene or chromosome.

2 A change in a single gene is called a genetic mutation. A change in a chromosome is called a chromosomal mutation.

3 A **codon** is a sequence of three nucleotide bases that code for a specific amino acid.

4 **a)** CTG (leucine) to GTG (valine)
b) If CTG, part of the gene sequence for haemoglobin, changes to GTG then haemoglobin may not be properly sequenced and may not perform its function properly.

p26

1

		Parent 2	
		A	A
Parent 1	o	Ao	Ao
	o	Ao	Ao

All offspring will be Ao - type A because A is dominant over o.

2

		Parent 2	
		A	B
Parent 1	A	AA	AB
	o	Ao	Bo

50% of offspring type A (AA or Ao), 25% type AB, and 25% type B (Bo).

3 Type AB+ is the universal recipient.

4 Type O- is the universal donor.

p27

1 The **human genome** is the complete set of genetic information contained by the 23 pairs of human chromosomes.

2 The Human Genome Project involved the mapping of DNA sequences within the 23 pairs of human chromosomes.

3 here are an estimated 20,000 to 25,000 human protein-coding genes.

4 The noncoding DNA on the genome appears to be associated with a wide variety of biochemical activities.

p30

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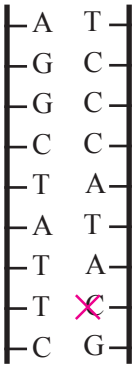
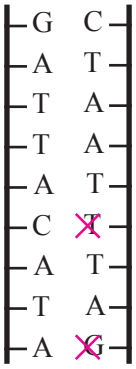


b)



p31

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7

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8

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p33

1 A cubic metre has 1000 x 1000 x 1000 cubic millimetres. The column would be 1 000 000 000 millimetres high = 1 000 000 metres high = 1000 kilometres high.

2 A massive horizontal force is unlikely to make the rope perfectly horizontal.

3 Red = 6, blue=4, yellow=5

4 Blue = 5, Red = 3, Yellow = 7

p34

1

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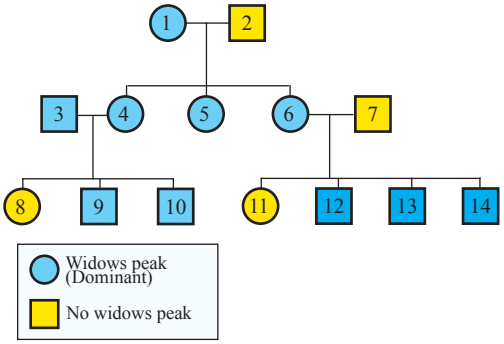

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50% of the males of a cross between an XX and an XY will have haemophilia.

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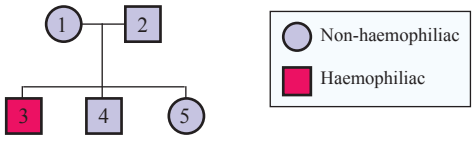

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p35

1 **a)** 50% of offspring are expected to be type A.

2 **c)** Type B can't receive Type AB blood.

3 **d)** hereozygous.

p36

1

Parent 1 \ Parent 2	R	r
r	Rr	rr
r	Rr	rr

50% of offspring will be round (Rr) and 50% will be wrinkled (rr).

2 The ratios suggest a cross between two heterozygous round (Rr) seeds. No other combination of round seeds will produce some wrinkled seeds (rr).

3 The 23rd chromosome appears to have a long chromosome and a short chromosome suggesting XY thus male.

4 It might be expected that anything that may disrupt the process of coding proteins might lead to mutations. Examples may be lack of nutrients, electromagnetic radiation, radioactivity, smoking, toxic products in the cell.

5 An answer with reasonable logic would be acceptable, for example: The anti-discrimination laws suggest that discrimination by insurance companies against genetic mutations is probably unlawful if it can be argued that a genetic mutation may result in a disability.

6 **a)** 8 pairs = 16 chromosomes **b)** 8 chromosomes in an ova

7 Females have two X chromosomes (XX)and males have an X chromosome and a Y chromosome (XY). The Y chromosome is short and carries few genes.

The X chromosome is much longer and carries many more genes. Because the X chromosome carries many more genes, the X chromosome largely influences the phenotype of the male (XY).

Recessive genes on a X chromosome is more likely to be displayed in a male and are described as being sex-linked or X-linked. There are more than 50 sex-linked conditions on the X chromosome.

The following shows a recessive X-linked haemophilia gene X

Female XX no haemophilia
XX no haemophilia
XX haemophilia

Male XY no haemophilia
XY haemophilia

A female needs two X genes to have haemophilia
A male needs just one X gene to have haemophilia