These booklets are a consolidation of your learning. They should be used in the following way - You should attempt the questions WITHOUT looking at the answers. Then mark your questions with red pen and add any missing marks you missed. You should then present the completed document to your teacher to show WITHIN TWO weeks of receiving the booklet.

THIS WILL IMPROVE YOUR GRADES...!!
Q1.

**Figure 1** shows an image of a small section of DNA.

**Figure 2** shows the structure of a small section of DNA.

(a) What is Part B?

(b) In **Figure 1** the structure of DNA shows four different bases.

There are four different bases and they always pair up in the same pairs.

Which bases pair up together?
(c) Syndrome H is an inherited condition.

People with syndrome H do **not** produce the enzyme IDUA.

**Figure 3** shows part of the gene coding for the enzyme IDUA.

![Figure 3](image)

Strand K shows a mutation in the DNA which has caused syndrome H.

The enzyme IDUA helps to break down a carbohydrate in the human body.

The enzyme IDUA produced from Strand K will not work.

Explain how the mutation could cause the enzyme **not** to work.

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(5)

(d) A recessive allele causes syndrome H.

A heterozygous woman and a homozygous recessive man want to have a child.

Draw a Punnett square diagram to determine the probability of the child having syndrome H.

Identify any children with syndrome H.

Use the following symbols:

A = dominant allele

a = recessive allele

Probability = ________________ %

(5)

(Total 12 marks)
Q2.

Polydactyly is an inherited condition caused by a dominant allele.

(a) The figure below shows the hand of a man with polydactyly. The man has an extra finger on each hand.

The man's mother also has polydactyly but his father does not.

(i) The man is heterozygous for polydactyly.

Explain how the information given above shows that the man is heterozygous for polydactyly.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

(ii) The man marries a woman who does not have polydactyly.

What is the probability that their first child will have polydactyly?

____________________________________________________________________

(3)

(1)
(b) The man has red hair. His sister has brown hair.

Both of their parents have brown hair.

Brown hair is caused by the dominant allele, **B**.

Red hair is caused by a recessive allele, **b**.

Complete the genetic diagram below to show how the man’s parents were able to have some children with red hair and some with brown hair.

<table>
<thead>
<tr>
<th>Father</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental phenotypes</td>
<td>____________</td>
</tr>
<tr>
<td>Parental Genotypes</td>
<td>____________</td>
</tr>
<tr>
<td>Gametes</td>
<td>______</td>
</tr>
</tbody>
</table>

Offspring genotypes: ____________________________

Offspring phenotypes: ____________________________

(5)
(Total 9 marks)

Q3.

In humans, hair colour is an inherited characteristic.

Red hair is caused by a recessive allele.

(a) When does a recessive allele control the development of a characteristic?

Tick (✔) one box.

- When the allele is present on only one of the chromosomes.
- When the dominant allele is not present.
- When the allele is inherited from the female parent.

(1)
(b) **Figure 1** shows the inheritance of hair colour in one family.

![Figure 1](image)

**Figure 1**

**Key**
- □ Male with brown hair
- ○ Female with brown hair
- ■ Male with red hair
- ● Female with red hair

(i) Brown hair is caused by a dominant allele, **B**.

Red hair is caused by the recessive allele, **b**.

What combination of alleles does person **1** have?

Tick (✔) one box.

- BB
- Bb
- bb

(ii) Person **3** married a woman with brown hair.

**Figure 2** shows how hair colour could be inherited by their children.

**Figure 2**

Complete **Figure 2** to show the combination of alleles that the children would inherit. One has been done for you.

![Figure 2](image)
Q4.

Our understanding of genetics and inheritance has improved due to the work of many scientists.

(a) Draw one line from each scientist to the description of their significant work.

<table>
<thead>
<tr>
<th>Scientist</th>
<th>Description of significant work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charles Darwin</td>
<td>Carried out breeding experiments on pea plants.</td>
</tr>
<tr>
<td>Alfred Russel Wallance</td>
<td>Wrote 'On the origin of species'.</td>
</tr>
<tr>
<td>Gregor Mendel</td>
<td>Worked on plant defence systems.</td>
</tr>
<tr>
<td></td>
<td>Worked on warning colouration in animals.</td>
</tr>
</tbody>
</table>

(b) In the mid-20th century the structure of DNA was discovered.

What is a section of DNA which codes for one specific protein called?

______________________________________________________________________________

(1)
(c) **Figure 1** shows one strand of DNA.

The strand has a sequence of bases (A, C, G and T).

![Figure 1](image)

How many amino acids does the strand of DNA in **Figure 1** code for?

Tick one box.

- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 6

(d) Mutations of DNA cause some inherited disorders.

One inherited disorder is cystic fibrosis (CF).

A recessive allele causes CF.

Complete the genetic diagram in **Figure 2**.

- Identify any children with CF.
- Give the probability of any children having CF.

Each parent does not have CF.

The following symbols have been used:

- **D** = dominant allele for not having CF
- **d** = recessive allele for having CF

![Figure 2](image)

Probability of a child with CF = ________________
(e) What is the genotype of the mother shown in Figure 2?

Tick one box.

Heterozygous  
Homozygous dominant  
Homozygous recessive

(Q5.

Humans reproduce sexually.

(a) Draw a ring around the correct answer to complete each sentence.

(i) At fertilisation genes join together.

(ii) At fertilisation a single cell forms. The cell has new pairs of nuclei.

(b) A child inherits cystic fibrosis. The child’s parents do not have cystic fibrosis.

(i) What does this information tell us about the cystic fibrosis allele?

Tick (✓) one box.

The allele is dominant.

The allele is recessive.

The allele is strong.

(Total 9 marks)
(ii) How many copies of the cystic fibrosis allele does the child have?

Draw a ring around your answer.

\[
\begin{array}{ccc}
\text{one} & \text{two} & \text{four} \\
\end{array}
\]

(1)

(c) The diagram shows a human body cell.

![Diagram of a human body cell]

Which part of the cell, A, B, C or D:

(i) contains the allele for cystic fibrosis

(1)

(ii) is affected by cystic fibrosis?

(1)

(Total 6 marks)

Q6.

Figure 1 shows a human body cell.

![Figure 1]

(a) Which part in Figure 1 contains chromosomes?

Tick one box.

A [ ] B [ ] C [ ]

(1)
(b) Humans have pairs of chromosomes in their body cells.

Draw one line from each type of cell to the number of chromosomes it contains.

<table>
<thead>
<tr>
<th>Type of cell</th>
<th>Number of Chromosomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human body cell</td>
<td>10</td>
</tr>
<tr>
<td>Sperm cell</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>92</td>
</tr>
</tbody>
</table>

(c) Humans have two different sex chromosomes, X and Y.

Figure 2 shows the inheritance of sex in humans.

Figure 2

Mother
X
X

Father
X
XX
XX

Y
XY
XY

Circle a part of Figure 2 that shows an egg cell.

(d) Give the genotype of male offspring.

(e) A man and a woman have two sons. The woman is pregnant with a third child.

What is the chance that this child will also be a boy?

Tick one box.

0%

25%

50%

100%
Q7.

(a) Mr and Mrs Smith both have a history of cystic fibrosis in their families. Neither of them has cystic fibrosis. Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.

Use a genetic diagram to show how they could have a child with cystic fibrosis.

Use the symbol A for the dominant allele and the symbol a for the recessive allele.

(b) Mr and Mrs Smith decided to visit a genetic counsellor who discussed embryo screening.

Read the information which they received from the genetic counsellor.

- Five eggs will be removed from Mrs Smith’s ovary while she is under an anaesthetic.
- The eggs will be fertilised in a dish using Mr Smith’s sperm cells.
- The embryos will be grown in the dish until each embryo has about thirty cells.
- One cell will be removed from each embryo and tested for cystic fibrosis.
- A suitable embryo will be placed into Mrs Smith’s uterus and she may become pregnant.
- Any unsuitable embryos will be destroyed.

(i) Suggest why it is helpful to take five eggs from the ovary and not just one egg.

(ii) Evaluate the use of embryo screening in this case.

Remember to give a conclusion to your evaluation.
(c) In someone who has cystic fibrosis the person’s mucus becomes thick.

The diagram shows how, in a healthy person, cells at the lung surface move chloride ions into the mucus surrounding the air passages.

The movement of chloride ions causes water to pass out of the cells into the mucus. Explain why.
Q8.

When humans reproduce, chromosomes and genes are passed on to the next generation.

In each of the following questions, draw a ring around the correct answer to complete the sentence.

(a) A gene is a small section of
   - cellulose.
   - DNA.
   - protein.

(b) The sex chromosomes in the human male are
   - X and X.
   - Y and Y.
   - X and Y.

(c) (i) Most human body cells contain
      - 23 chromosomes.
      - 46 chromosomes.
      - 92 chromosomes.

      (ii) The number of chromosomes in a human gamete (sex cell)
           - the same number as in body cells.
           - half the number in body cells.
           - twice the number in body cells.

(d) Gametes are produced by
    - meiosis.
    - mitosis.
    - fertilisation.

(Total 5 marks)
Q9.
DNA is the genetic material of human cells.

**Figure 1** shows the structure of part of a DNA molecule.

(a) (i) Describe where DNA is found in a human cell.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(2)

(ii) When a cell divides by mitosis the new cells are genetically identical.
What causes the cells to be genetically identical?

________________________________________________________________________
________________________________________________________________________

(1)

(b) Many genes have different forms called alleles.

(i) A person has polydactyly (extra fingers or toes). Polydactyly is caused by a dominant allele.
What is the smallest number of copies of the dominant allele for polydactyly that could be found in a body cell of this person?

______________  (1)

(ii) Another person has cystic fibrosis. Cystic fibrosis (CF) is caused by a recessive allele.
How many copies of the recessive CF allele are there in a body cell of this person?

______________  (1)
(c) A burglar broke into a house. The burglar cut his hand on some broken glass. Scientists extracted DNA from the blood on the broken glass.

The scientists analysed the DNA from the glass and DNA from three suspects, A, B and C. The scientists used a method called DNA fingerprinting.

**Figure 2** shows the scientists’ results.

![Figure 2](image)

Which suspect, A, B or C, is most likely to have been the burglar?

Tick (✓) one box.

A  
B  
C  

(Total 6 marks)
Q10.
The diagram shows part of a DNA molecule.

(a)  (i)  In which part of an animal cell is DNA found?

______________________________________________________________

(1)

(ii)  Complete the following sentence.

The letters A, C, G and T in the diagram represent four different compounds
called __________________________ .

(1)

(iii)  One strand of the DNA, in the section labelled X, contains the following sequence of
these compounds:

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

How many amino acids would this section of the DNA code for?  

(1)

(iv)  The section of DNA described in part (a) (iii) is a small part of a gene.
The sequence of compounds A, C, G and T in the gene is important.

Explain why.

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

(2)
Read the following information about genetic engineering.

The caterpillar of the European Corn Borer moth feeds on the fruits of maize (sweet corn). There is a chemical called Bt-toxin which is poisonous to the corn borer caterpillar but not to humans.

Scientists carried out the following steps.

1. The Scientists made a bacterial plasmid to which they added two genes:
   - Bt gene, which coded for production of the Bt-toxin
   - kan gene, which coded for resistance to an antibiotic called kanamycin.

2. They used this plasmid to produce genetically modified bacteria which could invade plant cells.

3. They mixed these genetically modified bacteria with pieces cut from maize leaves.

4. They placed the pieces of maize leaf on agar jelly in a Petri dish. The agar jelly contained the antibiotic, kanamycin. The kanamycin killed most of the pieces of maize leaf, but a few survived.

5. They took some cells from the surviving pieces of maize leaf and grew them in tissue culture.

The result was maize plants that now contained the Bt gene, as well as the kan gene, in all of their cells.

(i) What is a plasmid (Step 1)?

(ii) Why did the scientists add kanamycin to the agar jelly (Step 4)?

(iii) The scientists grew each Bt-maize plant from a single cell which contained the Bt gene.

   Explain why all the cells in the Bt-maize plant contained the Bt gene.
(iv) Kanamycin is an antibiotic.

Some scientists are concerned that the gene for kanamycin resistance has been put into maize.

Suggest why.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(2)
(Total 13 marks)

Q11.

In 1866, Gregor Mendel published the results of his investigations into inheritance in garden pea plants.

The diagram below shows the results Mendel obtained in one investigation with purple-flowered and white-flowered pea plants.

![Diagram of pea plant inheritance]

(a) (i) Calculate the ratio of purple-flowered plants to white-flowered plants in the F₂ generation.

\[
\text{Ratio of purple : white} = \frac{705}{224} = \frac{705}{224}
\]

(1)
(ii) There was a total of 929 plants in the F\textsubscript{2} generation.

Mendel thought that the production of a large number of offspring plants improved the investigation.

Explain why.

___________________________________________________________________________________________________________________________
___________________________________________________________________________________________________________________________
___________________________________________________________________________________________________________________________
___________________________________________________________________________________________________________________________

(2)

(b) (i) Some of the plants in the diagram are homozygous for flower colour and some are heterozygous.

Complete the table to show whether each of the plants is homozygous or heterozygous. For each plant, tick (✓) one box.

<table>
<thead>
<tr>
<th></th>
<th>Homozygous</th>
<th>Heterozygous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple-flowered plant in the P generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-flowered plant in the P generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purple-flowered plant in the F\textsubscript{1} generation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2)

(ii) Draw a genetic diagram to show how self-pollination of the F\textsubscript{1} purple-flowered plants produced mainly purple-flowered offspring in the F\textsubscript{2} generation together with some white-flowered offspring.

Use the following symbols:

\[ N = \text{allele for purple flower colour} \]
\[ n = \text{allele for white flower colour} \]

(3)

(c) When Mendel published his work on genetics, other scientists at the time did not realise how important it was.

Suggest two reasons why.

1. ____________________________________________________________________________________________________________________________________________________

2. ____________________________________________________________________________________________________________________________________________________

(2)

(Total 10 marks)
Mark schemes

Q1.
(a) phosphate
   
   allow \( \text{PO}_4^{3-} \)
   
   do not allow \( P \)

(b) A / adenine and T / thymine
   and
   C / cytosine and G / guanine
   
   do not allow U / uracil

(c) (mutation) changes from C to T DNA code
   or
   there is a change in the three bases / triplet from CAG to TAG
   
   (mutation) changes the amino acid
   
   (this could) change the protein
   
   (so it) forms a different shape / changed active site
   accept different tertiary structure
   
   (therefore) the enzyme no longer fits the substrate / carbohydrate

(d) mother / woman’s gametes correct: A  a
   
   father / man’s gametes correct: a  a
   
   correct derivation of offspring
   ecf
   
   identification of child with syndrome H or genotype aa
   
   0.5
   ecf
   allow 50% / 1 / 2 / 1 in 2 / 1:1
   
   do not accept 1:2

Q2.
(a) (i) man has (inherited) polydactyly (PD) allele (from mother)
man has (inherited) other / normal / recessive allele from father

because father does not have PD allele or if father had it father would have
had PD or father only has normal allele or father is homozygous recessive

allow gene for allele

(ii) 0.5 / ½ / 1 in 2 / 1:1 / 50%
do not allow 1:2 or 50/50
allow 50:50

(b) parental phenotypes: both brown

parental genotypes: both Bb

gametes: B b and B b

allow only on gametes answer line
allow ecf from genotypes

offspring genotypes: BB (2)Bb bb

allow ecf from gametes

offspring phenotypes correctly assigned to genotypes:
BB & Bb = brown  bb = red
do not penalise confusion of ‘phenotypes’ & ‘genotypes’ here

Q3.

(a) When the dominant allele is not present.

(b) (i) Bb

(ii) 3 correct = 2 marks
Q4.
(a) Charles Darwin
   Carried out breeding experiments on pea plants.
   Wrote 'On the origin of species'.

   Alfred Russel Wallace
   Worked on plant defence systems.

   Gregor Mendel
   Worked on warning colouration in animals.

(b) a gene
   allow allele

(c) 4

(d) correct derivation of children’s genotypes
   identification of children with cystic fibrosis (dd)

   0.25
   allow ecf
   allow ¼ / 25% / 1 in 4 / 1:3
   do not accept 1:4

(e) heterozygous

Q5.
(a) (i) gametes
apply list principle

(ii) chromosomes

apply list principle

(b) (i) The allele is recessive

no mark if more than one box is ticked

(ii) two

apply list principle

(c) (i) A

apply list principle

(ii) B

apply list principle

Q6.

(a) A

(b)

(c) one x circled under mother

accept if clearly indicated choice even if not circled

(d) XY

allow YX

(e) 50 (%)
Q7.

(a) both parents Aa

accept other upper and lower case letter without key or symbols with a key
allow as gametes shown in Punnett square

aa in offspring correctly derived from parents or
aa correctly derived from the parents given

ignore other offspring / gametes
for this mark parents do not have to be correct

offspring aa identified as having cystic fibrosis
may be the only offspring shown or circled / highlighted / described

(b) (i) any one from:

accept converse if clear, eg if you (only) took one it might have cystic fibrosis / might not be fertilised

• (more) sure / greater chance of healthy / non-cystic fibrosis egg / embryo / child
accept some may have the allele
reference to ‘suitable / good embryo’ is insufficient

• greater chance of fertilisation

(ii) advantages
to gain 3 marks both advantage(s) and disadvantage(s) must be given

any two from:

ignore references to abortion unless qualified by later screening

• greater / certain chance of having child / embryo without cystic fibrosis / healthy

• child with cystic fibrosis difficult / expensive to bring up

• cystic fibrosis (gene / allele) not passed on to future generations

disadvantages

any two from:

• operation dangers / named eg infection
ignore risk unqualified

• ethical or religious issues linked with killing embryos
accept wrong / cruel to embryos accept right to life
argument

ignore embryos are destroyed

• (high) cost of procedure

• possible damage to embryo (during testing for cystic fibrosis / operation)

plus

conclusion

a statement that implies a qualified value judgement
eg it is right because the child will (probably) not have cystic fibrosis even though it is expensive
or
eg it is wrong because embryos are killed despite a greater chance of having a healthy baby

note: the conclusion mark cannot be given unless a reasonable attempt to give both an advantage and a disadvantage is made

do not award the mark if the conclusion only states that advantages outweigh the disadvantages

1

(c) any three from:

• osmosis / diffusion
  do not accept movement of ions / solution by osmosis / diffusion

• more concentrated solution outside cell / in mucus
  assume concentration is concentration of solute unless answer indicates otherwise or accept correct description of 'water concentration'

• water moves from dilute to more concentrated solution
  allow correct references to movement of water in relation to concentration gradient

• partially permeable membrane (of cell)
  allow semi / selectively permeable

3

Q8.

(a) DNA

1

(b) X and Y

1

(c) (i) 46 chromosomes

1

(ii) half the number

1
(d) meiosis

Q9.
(a) (i) in the chromosome(s)
    ignore genes / alleles
    in the nucleus
    allow nuclei
    allow mitochondria
(ii) the DNA / chromosomes / genes are replicated / copied / multiplied / doubled / duplicated
    allow DNA is cloned
    ignore same DNA / chromosomes / genes if unqualified

(b) (i) 1 / one

(ii) 2 / two

(c) B

Q10.
(a) (i) nucleus
    correct spelling only
    accept mitochondrion
    ignore genes / genetic material / chromosomes
(ii) base(s)
    Accept all four correct names of bases
    ignore nucleotides and refs to organic / N-containing
(iii) 4
(iv) codes for sequence / order of amino acids
    ignore references to characteristics
    codes for a (specific) protein / enzyme
    or
    the sequence / order of three bases / compounds / letters
codes for a specific amino acid

or

the sequence / order of 3 bases / compounds / letters

codes for the order / sequence of amino acids

(b) (i) DNA

circular / a ring or a vector / described

(ii) kills any cells not having kan\(^r\) gene / so only cells with kan\(^r\) gene survive

hence surviving cells will also contain Bt gene / plasmid

(iii) cells divide by mitosis

ignore ref to asexual reproduction

correct spelling only

genetic information is copied / each cell receives a copy of (all) the gene(s) / all cells produced are genetically identical / form a clone

(iv) any two from:

• gene may be passed to pathogenic bacteria
• cannot then kill these pathogens with kanamycin or
• cannot treat disease with kanamycin
• may need to develop new antibiotics
• gene may get into other organisms
• outcome unpredictable

Q11.

(a) (i) 3.15 : 1

accept 3.147 : 1 or 3.1 : 1 or 3 : 1

do not accept 3.14 : 1

Ignore 705:224

(ii) any two from:

• fertilisation is random or ref. to chance combinations (of alleles / genes / chromosomes)
• more likely to get theoretical ratios or see (correct) pattern or get valid results if large number

allow ref. to more representative / reliable
do not allow more accurate or precise
ignore fair / repeatable
• anomalies have limited effect / anomalies can be identified
accept example of an anomaly

(b) (i) in sequence:

Homozygous
Homozygous
Heterozygous

All 3 correct = 2 marks
2 correct = 1 mark
1 or 0 correct = 0 marks

(ii) genetic diagram including:

Parental genotypes: Nn and Nn
allow other characters / symbols only if clearly defined

or

Gametes: N and n + N and n derivation of offspring genotypes:
NN Nn Nn nn
allow genotypes correctly derived from candidate’s P gametes

identification: NN and Nn as purple and nn as white
allow correct identification of candidate’s offspring genotypes but only if some F2 are purple and some are white

(c) any two from:

• did not know about chromosomes / genes / DNA
  or did not know chromosomes occurred in pairs
  ignore genetics
• had pre-conceived theories
  eg blending of inherited characters
  ignore religious ideas unless qualified
• Mendel’s (mathematical) approach was novel concept
  allow his work was not understood or no other scientist had similar ideas
• Mendel was not part of academic establishment
  allow he was not considered to be a scientist / not well known / he was only a monk
• work published in obscure journal / work lost for many years
• peas gave unusual results cf other species
  allow he only worked on pea plants
• Mendel’s results were not corroborated until later / 1900

[10]