5 Reproduction and inheritance

Using and interpreting data

Question	Mark scheme	Marks
1 a)	• alleles are alternative forms of a gene / eq • found at the same position / locus on the chromosome / eq • control the same character but in different ways / eq • an example, e.g. there are two versions of the gene for eye colour, brown and blue / B and b / recessive or dominant / eq	2
b)	*Give credit for the following, shown on a genetic diagram:* • parent genotypes • possible gametes • genotypes of offspring and • phenotypes linked to genotypes The examples show acceptable ways of answering for 4 marks. **Example 1** parent genotypes: Ff × Ff possible gametes: F, f, F, f offspring genotypes: FF, Ff, Ff, ff phenotypes (linked to genotypes): orange fur, orange fur, orange fur, white fur **Example 2** (Punnett square) parent 1 (Ff) gametes: F, f parent 2 (Ff) gametes: F, f F / F: FF; F / f: Ff; f / F: Ff; f / f: ff phenotypes (linked to genotypes): FF orange fur; Ff orange fur; ff white fur *Guidance on marking:* *1. If parent genotypes wrong, allow transfer error to max of 3 for gametes, offspring and phenotypes.* *2. Only give phenotype mark if it is clear that student knows the fur colour for each genotype.*	4
c)	• 25% / $\frac{1}{4}$ / 0.25 / 1 in 4 / eq *[no transfer error from incorrect cross in b)]*	1
d)	• allele for white fur may be present, but recessive / eq • will not show in the phenotype if dominant allele present / eq • prey see white tigers more easily (than orange tigers) / eq • prey escapes / food scarce / eq • white tigers seen more easily (than orange tigers) by hunters / poachers / villagers / eq • killed / shot / eq more easily • white tigers captured / eq • for zoos / eq	2
Total		**9**

<table>
<tr><th>Question</th><th>Mark scheme</th><th>Marks</th></tr>
<tr><td>2 a)</td><td>
Give credit for the following, shown on a genetic diagram:
• parent genotypes
• possible gametes
• genotypes of children and
• phenotypes linked to genotypes
The examples show acceptable ways of answering for 4 marks.

Example 1
parent genotypes Hh × hh
possible gametes H h h
genotypes of children Hh hh
phenotypes (linked to genotypes) Huntington's disease normal

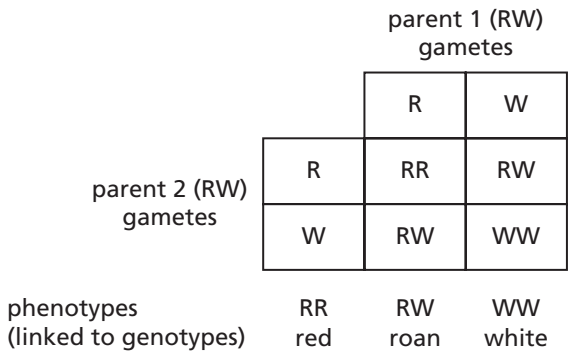
Example 2
parent genotypes Hh × hh
possible gametes H h h h
genotypes of children Hh Hh hh hh
phenotypes (linked to genotypes) Huntington's disease normal

Example 3
(Punnett square)
parent 1 (hh) gametes
<table>
<tr><td></td><td>H</td><td>h</td></tr>
<tr><td>H</td><td>Hh</td><td>Hh</td></tr>
<tr><td>h</td><td>hh</td><td>hh</td></tr>
</table>
parent 2 (Hh) gametes
phenotypes (linked to genotypes)
Hh Huntington's disease
hh normal

Guidance on marking:
1. If parent genotypes wrong, allow transfer error to max of 3 for gametes, offspring and phenotypes.
2. Only give phenotype mark if student has shown Huntington's and normal phenotypes for possible children linked to the correct genotypes.
</td><td>4</td></tr>
<tr><td>b)</td><td>• 50% / $\frac{1}{2}$ / 0.5 / 1 in 2 / eq
[no transfer error from incorrect cross in a)]</td><td>1</td></tr>
<tr><td>Total</td><td></td><td>5</td></tr>
</table>

<table>
<tr><th>Question</th><th>Mark scheme</th><th>Marks</th></tr>
<tr><td>3 a)</td><td>• both / two alleles equal / eq (no mark if 'genes' used instead of 'alleles')
• (both) expressed / shown in heterozygote / phenotype / eq
• example described, phenotype of heterozygote described / eq</td><td>2</td></tr>
<tr><td>b)</td><td>Give credit for the following, shown on a genetic diagram:
• parent genotypes
• possible gametes
• genotypes of offspring and
• phenotypes linked to genotypes
The examples show acceptable ways of answering for 4 marks.

Example 1
parent genotypes RW × RW
possible gametes R W R W
offspring genotypes RR RW RW WW
phenotypes (linked to genotypes) red roan roan white

Example 2
(Punnett square)
 

phenotypes (linked to genotypes) RR red RW roan WW white

Guidance on marking:
1. Ignore gender of individual parents.
2. If parent genotypes wrong, allow transfer error to max of 3 for gametes, offspring and phenotypes.
3. Only give phenotype mark if it is clear that student knows the hair colour for each genotype.</td><td>4</td></tr>
<tr><td>c)</td><td>• 0.5 / $\frac{1}{2}$ / 50% / 1 in 2 / eq
(no transfer error from incorrect cross in b))</td><td>1</td></tr>
<tr><td>d) i)</td><td>• having two different alleles
• governing the same characteristic / at the same gene locus / eq</td><td>2</td></tr>
<tr><td>ii)</td><td>• one circle, around an individual with genotype RW</td><td>1</td></tr>
<tr><td>Total</td><td></td><td>10</td></tr>
</table>

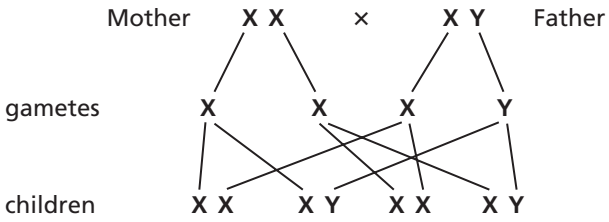
Question	Mark scheme	Marks
4 a)	• always shown in phenotype / always expressed / expressed in heterozygote / expressed in heterozygote and homozygote / eq	1
b)v	*Give credit for the following, shown on a genetic diagram:* • parent genotypes • possible gametes and • genotypes of offspring The examples show acceptable ways of answering for 3 marks. **Example 1** parent genotype RR rr possible gametes R r offspring genotype Rr **Example 2** parent genotypes RR × rr possible gametes R R r r offspring genotypes Rr Rr Rr Rr **Example 3** (Punnett square) parent 1 (rr) gametes: r, r parent 2 (RR) gametes: R, R R: Rr, Rr R: Rr, Rr *Guidance on marking:* *1. Accept symbols other than R and r. Accept any letter used for the symbol, such as A, a and N, n. (Students should be encouraged to choose symbols with care so that upper and lowercase are easily distinguished.)* *2. Only award mark for parent genotypes if dominant and recessive letters are the same, e.g. RR and rr. RR and ww = 0.* *3. If parent genotypes wrong, allow transfer error for gametes and offspring.*	3
c) i)	• the larger the number of results studied / eq • the closer to the expected theoretical values / eq *OR* • randomness / chance / eq • during fertilisation / pollination / seed germination / plant growth / eq *OR* • other valid reason *(up to 2 marks)*	2
ii)	• RR, Rr, (Rr), rr *(the offspring of the cross Rr × Rr)* *Guidance on marking:* *1. Accept symbols other than R and r, e.g. A and a (see Note 1 above).* *2. Reject combinations of different letters e.g. R and W or R and w.*	1
Total		**7**

Question	Mark scheme	Marks
5 a) i)	• the genetic makeup of an individual (with respect to the alleles it carries for a particular characteristic) *(no mark if 'genes' used instead of 'alleles)*	1
ii)	• RR and Rr	1
b)	*Give credit for the following, shown on a genetic diagram:* • parent genotypes • possible gametes • genotypes of offspring and • phenotypes linked to genotypes The examples show acceptable ways of answering for 4 marks. **Example 1** parent genotypes Rr × rr possible gametes R r r offspring genotypes Rr rr phenotypes (linked to genotypes) red eye white eye **Example 2** parent genotypes Rr × rr possible gametes R r r r offspring genotypes Rr Rr rr rr phenotypes (linked to genotypes) red eye, red eye, white eye, white eye **Example 3** (Punnett square) parent 1 (rr) gametes: r, r parent 2 (Rr) gametes: R → Rr, Rr; r → rr, rr phenotypes (linked to genotypes) Rr red eye, rr white eye *Guidance on marking:* *1. If parent genotypes wrong, allow transfer error to max of 3 for gametes, offspring and phenotypes.* *2. Only give phenotype mark if it is clear that student knows the eye colour for Rr and rr.*	4
c)	• genotype: Rr • phenotype: red eye *(the offspring of the cross RR × rr)*	2
d)	• Rr / heterozygous / eq *(for white-eyed flies [rr] to appear in the offspring, the red-eyed parent must have been heterozygous [Rr])*	1
Total		**9**

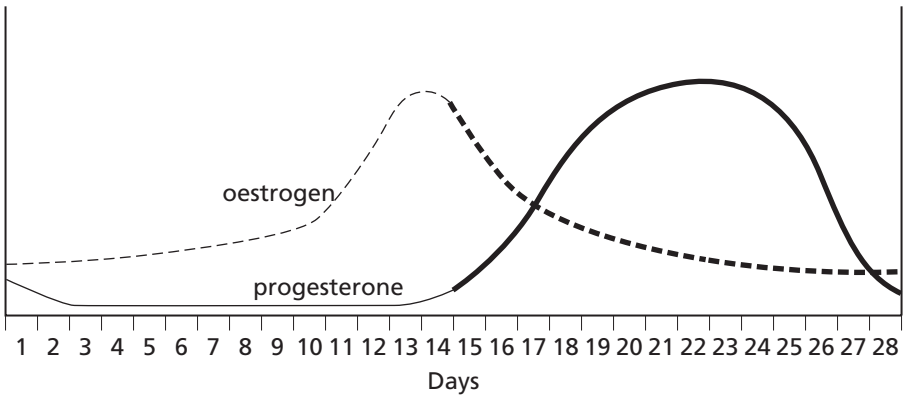
Understanding structure, function and processes

Question	Mark scheme	Marks
1 a)	• nucleus	1
b) i)	• B / C • cell has 2 sets of chromosomes *OR* homologous pairs of chromosomes	2
ii)	• B	1
iii)	• Two daughter cells • 8 chromosomes	2
c)	• DNA molecule is very large / very long / polymer / eq • DNA has two strands • (strands) coiled to form a double helix / eq • each strand a sequence of four different bases / nucleotides • A, T, G, C / adenine, thymine, guanine, cytosine • (the two strands) linked by paired bases • A pairs with T / G pairs with C	4
Total		**10**

Question	Mark scheme	Marks
2 a)	• B = stigma • C = petal	2
b)	• D • B • F • A	4
c)	• D • F	2
d) i)	• transfer of pollen • from anther to stigma / from male part of flower to female part of flower / eq	2
ii)	*insect-pollinated flower:* • has large petals / eq • has coloured petals / eq • produces nectar / eq • produces scent / eq • pollen rough / sticky / eq	3
e) i)	*asexual reproduction:* • gametes not involved / eq • cell division *only* by mitosis / no meiosis involved / eq • only one parent cell needed / does not need two parent cells / eq • offspring genetically identical to each other / to parent / no variation amongst offspring / between offspring and parent / eq	2
ii)	• results in genetic variation / offspring differ from one another and from parent / eq • (so) may be able to survive change in environmental conditions / eq • seeds can survive unfavourable conditions / cold / heat / dry conditions / desiccation / eq • seeds / offspring dispersed over a wide area / may reach new habitats / eq	2
Total		**17**

Question	Mark scheme	Marks
3 a)	• A = sperm duct / sperm tube / eq • B = testis / testes	2
b)	• urethra *(no mark for incorrect spelling that could be confused with 'ureter')*	1
c)	• line drawn to touch part of the testis and no other structure, labelled **M**.	1
d) i)	• testis / testes	1
ii)	• increased muscle development / increased body mass / voice becomes deeper / eq	1
e) i)	• male and female gametes, OR ovum / egg cell and sperm cell, fuse / join / eq • to form a zygote	2
ii)	• all egg cells / female gametes carry an **X** chromosome • sperm cells / male gametes carry either an **X** or a **Y** chromosome • (after fertilisation) the fertilised egg cells may be (genotype) **XX**, a girl, or **XY**, a boy *Marks may be awarded for showing the same information on a genetic diagram. The examples show two of the several ways this could be done.* **Example 1**  **Example 2** egg cells / female gametes sperm cells / male gametes X: X, X X: XX girl, XX girl Y: XY boy, XY boy	3
iii)	• 50% / $\frac{1}{2}$ / 0.5 / 1 in 2 / eq	1
Total		**12**

Question	Mark scheme	Marks
4 a) i)	*water needed for:* • enzyme action / metabolism / eq • starch / eq breakdown to glucose / eq • mobilising food stores / transport of glucose / eq from stored carbohydrate / eq	2
ii)	*oxygen in air needed:* • for respiration / eq • (respiration) releases energy • from stored food / carbohydrate / glucose • (energy) needed for growth / metabolism / cell division / eq	2
b)	• enzyme action involved in germination / metabolism / eq • rate of enzyme action increases as temperature increases / eq • one example such as breakdown of (stored) food / eq • rate of diffusion / transport increases (from food storage areas to growth points / root tip / shoot tip / eq)	2
c)	• mitosis *(no mark for incorrect spelling that could be confused with 'meiosis')*	1
Total		**7**

Question	Mark scheme	Marks
5 a)	A = oviduct / fallopian tube, E = vagina	2
b)	B, A, B, C	4
c)	*Two from the following list:* breasts develop, hips widen, hair growth (under arms and in pubic area), menstruation begins / eq	2
d) i)	• ovary / follicle / corpus luteum / placenta (in pregnant woman) / eq	1
ii)	• maintains the uterus lining / further development of the uterus lining / prevents ovulation / eq	1
e) i)	• oestrogen: any line shown falling to low level by day 28 (ideally, final level same as on day 1) *(credit graphs showing more detail than expected at this level, such as small rise and fall days 20–24)* • progesterone: any line shown rising to a similar level to the peak for oestrogen, then falling to a low level by day 28 *(diagram for reference, students are expected to know only the general trends)* 	2
ii)	• fertilised egg cell / ovum must implant / eq in lining of uterus / eq • to form placenta / eq • to obtain nutrients / eq • to produce hormones / progesterone / eq	2
Total		**14**

Applying principles

Question	Mark scheme	Marks
1 a)	• none	1
b) i)	• an allele / characteristic *(no mark if 'gene' used instead of allele)* • not shown in the phenotype / eq • unless homozygous / eq *OR* if the other allele is different / dominant / eq	2
ii)	• (child / person) 3 has cystic fibrosis / eq • but not shown in parents / parents normal / eq *(give credit for other valid reasoning)*	2
c) i)	• person 3 *(if more than one answer, no mark)*	1
ii)	• person 1 / person 2 *(if any other individuals listed, in addition to 1 and 2, no mark)*	1
d) i)	• parent 1, Ff • parent 2, Ff *(both Ff = 2 marks)*	2
ii)	• 25% / $\frac{1}{4}$ / 0.25 / 1 in 4 / eq *[no transfer error from incorrect parent genotypes in d)i)]*	1
Total		**10**

Question	Mark scheme	Marks
2 a)	• short hair	1
b)	• cat 4 and / or cat 7 has long hair / eq • parents of cat 4 / 7 have short hair / long hair not shown in parents / long hair not shown in cats 1 and 2 / eq *(give credit for other valid reasoning)*	2
c)	• *cat 2*: Hh • *cat 7*: hh	2
d) i)	• *three from cats:* 4, 7, 8 and 12 *(three listed, 2 marks; one or two listed, 1 mark)* *(no mark if any incorrect individuals included)*	2
ii)	• *three from cats:* 1, 2, 9, 10, 11 *(three listed, 2 marks; one or two listed, 1 mark)* *(no mark if any incorrect individuals included)*	2
Total		**9**

Question	Mark scheme	Marks
3 a)	• X-rays cause damage / kill cells / eq • cause mutation / are mutagens / eq • (affect) the genetic material / nucleus / gene / allele / DNA	2
b)	• A, B and D: have the same genes / alleles / eq as before exposure OR may have been damaged / killed / eq by the X-rays • C: mutated by the X-rays so that now resistant to weedkiller OR new / changed allele / gene in C makes it resistant / eq	2
c)	• (cuttings) new plants / offspring will all have resistance / eq OR (seeds) not all will have resistance / eq • (cuttings) are genetically identical to C / have same genes / alleles / genotype / eq as C OR (seeds) offspring show genetic variation / have different genes / alleles / genotypes / eq to parent(s) • (cuttings) growth only by mitosis / eq OR (seeds) meiosis / fertilisation involved in seed production • (cuttings) asexual reproduction OR (seeds) sexual reproduction	2
Total		**6**

Question	Mark scheme	Marks
4 a)	• (dry mass) reduced / eq from day 0 to day 11 *(allow ± 1 day)* • (dry mass) reduced / eq from 0.5 g at day 0 • (dry mass) reduced / eq to 0.25 g *(allow ± 0.05 g)* • (dry mass) at minimum / lowest on day 11 *(allow ± 1 day)* • (dry mass) increases / rises from day 11 to day 30 *(allow ± 1 day)* • (dry mass) increases from 0.25 g *(allow ± 0.05 g)* / to 2.0 g *(allow ± 0.1g)* / eq	3
b)	• respiration / combination with oxygen / eq • of stored food / starch / eq • releases energy for growth / eq • (loss of mass due to) loss of carbon dioxide gas / eq	2
c) i)	• day 11 *(allow ± 1 day)*	1
ii)	• dry mass starts to increase due to photosynthesis • carbon dioxide from air combines with water from soil • (to form) carbohydrate / glucose / eq	2
Total		**8**

Question	Mark scheme	Marks
5 a)	• a change in the structure of a gene / allele / DNA / eq • (change) can be passed on / inherited / eq • (mutations are normally) rare / random / eq • can be spontaneous / rate (of mutation) increased by radiation / chemicals / mutagens / eq	2
b)	• (bacterium carrying the mutation) survives and reproduces / eq • (when bacterium reproduces) it passes on the mutation / allele / gene / resistance / eq to offspring • (after infecting another person) resistant bacteria survive the presence of antibiotic OR non-resistant bacteria die / do not reproduce / eq • resistant bacteria multiply to give offspring / next generation / OR non-resistant bacteria do not reproduce / eq • offspring / next generation more likely to be resistant / eq • increasing numbers of resistant bacteria in population / eq • reference to natural selection / selection pressure / eq	4
c)	• (if course of antibiotics completed) all bacteria killed except for a very few resistant bacteria / eq • (if only a few resistant bacteria) they are destroyed by the white blood cells / antibodies / immune system / eq • (so) resistant bacteria are unable to multiply / eq • (so) resistant bacteria are unable to pass on the gene / allele for resistance / eq	2
Total		**8**

Extended writing

Question	Mark scheme	Marks
1	• (pollen) tube grows / pollen grain germinates • (grows down) style • digestion / enzymes (involved) • ovary (appropriate ref linked to pollen tube growth / ovules) • (pollen tube / male gamete) enters ovule / eq • through micropyle • (male) nucleus / (pollen grain) nucleus / male gamete • fertilisation / fuse / join + female gamete / nucleus / ovum / egg or ref to zygote formation • ovule becomes seed • ovule wall becomes seed coat / testa • ovary becomes fruit / correct reference to other parts of the flower forming part of the fruit	6
Total		**6**

Question	Mark scheme	Marks
2	• pollen carried from the anther / stamen of one flower to the stigma of another (by wind) ***up to two examples*** *of adaptation for wind pollination from the list:* – no petals, so no obstruction / brightly coloured petals absent / eq – stamens or anthers outside flower, so exposed to wind / eq – filaments / stamens long so exposed to wind / eq – style long or stigma outside flower, so exposed to wind / eq – stigma large / feathery, so pollen trapped / eq – large quantities pollen produced / pollen light, so can be carried far by wind / eq • (pollen) tube grows / pollen grain germinates • (grows) down style / towards ovary • (pollen tube / eq) enters ovule / eq • (male) nucleus / (pollen grain) nucleus / male gamete • fertilise / fuse / join + female gamete / nucleus / ovum / egg • to form zygote	6
Total		**6**

Question	Mark scheme	Marks
3	• runners / any other named type of asexual reproduction, artificial or natural • roots form where runners touch ground / eq / description of other named type of asexual reproduction • cuttings / any other named type of asexual reproduction, artificial or natural • person cuts sections of leafy stem, inserts into soil / eq / description of other named type of asexual reproduction • in short time period, many new plants grow / rapid increase in numbers / eq • new plants grow close to parent where conditions for growth proved favourable / eq • cell division by mitosis • so offspring same genes / eq as parent / no variation / eq • so adapted to grow well in existing environment / eq	6
Total		**6**

Question	Mark scheme	Marks
4	• from day 1, lining breaks down and is shed / leaves uterus / eq • (from day 1) ovum / egg cell develops in ovary • ovary / follicle produces oestrogen • oestrogen causes thickening / eq of uterus lining • ovulation / ovum released • (ovulation near to) day 14 • oestrogen level begins to fall after ovulation / day 14 / eq • ovary / follicle / eq produces progesterone • progesterone causes further development of lining / maintains the uterus lining / prepares lining for implantation / eq • if ovum / egg cell not fertilised, level of progesterone falls / eq • carried (from ovary) to uterus in the blood (once for either oestrogen or progesterone) / eq	6
Total		**6**

Question	Mark scheme	Marks
5	• living organisms have many offspring / overproduction of offspring / eq • but numbers remain relatively constant • the offspring face a struggle for survival / some selection occurs / eq • there is variation in the characteristics of the offspring / eq • so some may be better suited to survival than others / eq • these offspring are *more likely* to reproduce / eq • and pass on genes for favourable characteristics to their offspring / eq • idea that (after many generations) descendants significantly different from the original / eq • named example of natural selection (e.g. antibiotic resistance in bacteria, peppered moth / eq) • description of natural selection in the example named (e.g. bacteria that are resistant to an antibiotic survive exposure and pass on the gene for resistance to their offspring)	6
Total		**6**