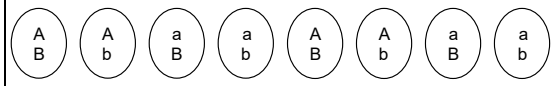
1(a)(i)	AABB AABb AaBB AaBb ; ;
1(a)(ii)	long chocolate ;
1(b)	 ; **AB** AABB AABb AaBB AaBb **Ab** AABb AAbb AaBb Aabb **aB** AaBB AaBb aaBB aaBb **Ab** AaBb Aabb aaBb aabb ; *F2 offspring phenotype number ratio:* **9** : **3** : **3** : **1** ; short black; short chocolate; long black; long chocolate ; *Mp 4 need phenotypes linked to genotypes by colour, symbol or initials*
1(c)	**1** structural gene codes for, (named) structural / functional, protein / polypeptide ; **2** regulatory gene codes for, transcription factor / repressor protein **or** regulatory gene, controls / helps / restricts, expression of (other) genes ;

4(a)	**1** diploid ; **2** allele ; **3** dominant (allele) ;
4(b)	*any **four** from:* **1** CDV acts as a selection pressure ; **2** DNA / allele, for black (coat) gives resistance to CDV **or** DNA / allele, for black (coat), gives (selective) advantage / is selected for, if / when, CDV is common / dogs are common ; *in the south (context must be established at least once):* **3** more CDV (infection) in wolves ; **4** black wolves, more likely to survive / have selective advantage / are selected for ; **ORA** greys **5** black wolves more likely to, breed / reproduce ; **ORA** greys **6** pass on / increase the frequency of, allele for black coat ; **ORA** grey
4(c)	**1** positive (linear) correlation / positive relationship / direct relationship / directly proportional **or** as % with (anti-CDV) antibodies increases the % of black wolvesincreases ; *plus any **three** from:* **2** wolves that survive CDV will, later / as a result, have antibodies ; **3** high % of antibodies show population with high level of CDV ; **4** in population with high % antibodies, grey wolves have died / more black wolves are left ; **5** gene / DNA / allele / protein, that gives black coat, helps survival / gives resistance to CDV / defends against CDV ; **6** AVP ;

5(a)	*any **four** from:* *mark as pairs* *Name* 1 dNTPs / DNA nucleotides ; *Explanation 1* to, anneal / bind, to **complementary** bases ; *Name 2* Taq polymerase ; *Explanation 2* to make, phosphodiester bonds / the sugar phosphate backbone / double-stranded DNA / a complementary strand of DNA **or** *ref. to* functioning at higher temperature / does not denature at the higher temperature / is thermostable ; *Name 3* buffer ; *Explanation 3* to provide, optimum / suitable / constant, pH for, polymerase / DNA **or** prevents, denaturation of polymerase / damage to DNA ;
5(b)(i)	*any **two** from:* 1 (DNA ladder) compared to (other fragments) ; 2 *ref. to* (estimate) length of (DNA) fragment / to identify the fragment number ; 3 *ref. to* show electrophoresis worked correctly ;
5(b)(ii)	*any **three** from:* 1 (PCR) amplifies / makes many copies of, DNA (fragments) ; 2 (PCR) *ref. to* selecting fragments, small enough / less than 1000 bp / not more than 916 bp (for sequencing) ; 3 (electrophoresis) separate the (DNA) fragments ; 4 (electrophoresis) confirms / identifies, fragment lengths / fragment number / PCR worked correctly ;
5(c)	(2^{35} =) 3.4×10^{10} ;
5(d)	*any **four** from:* 1 child may have disease when, neither parent has the disease / no family history ; 2 early, detection / treatment (for gene therapy to work) ; 3 improve, quality of life / life expectancy ; 4 *ref. to* informs family planning (for future pregnancies) ; 5 *idea that* it does not involve additional sampling ; 6 (screening is) expensive ; 7 treatment / gene therapy, expensive ; 8 test may not always be accurate ; 9 long-term effect of treatment, unknown / negative ;

2(a)

anaphase: **K** and **M** ;
cells containing pairs of homologous chromosomes: **J** and **K** ;
crossing over: **J** ;
haploid cells: **L** and **M** and **N** ;

2(b)

*any **two** from:*

1 to prevent self-pollination / to ensure cross-pollination ;
2 so, must cross with / other parent must be / pollen comes from, a, different / selected, plant / parent / individual / variety ;
3 to make plant a female parent ;

2(c)

*any **four** from:*

stage 1 – inbreeding to get two lines
1 inbreeding / line breeding ;
2 select for, disease resistance / rapid growth / high yield ;
3 select, best / desirable, offspring and cross with each other repeatedly ;
4 (results in) homozygous (loci) ;

stage 2 – outcross to get uniform vigorous offspring
5 hybridise / outcross / outbreed, with another, variety / type of maize ;
6 with a different desired trait ;
7 AVP ;

5(a)

*any **three** from:*

1 small so can keep, in small space / for low cost / with low maintenance ;
2 can select parents for, mating / cross-breeding / particular crosses ;
3 so get many, offspring / generations, in a short time ;
4 can be used to research, cancer / (named) neurodegenerative diseases ;
5 AVP ;

5(b)

1 *symbols*: **A** = grey body **a** = black body
B = long wing **b** = short wing ;

F1 phenotypes: grey long x grey long

2 *F1 genotypes*: **AaBb** x (**AaBb**) ;

	AB	**Ab**	**aB**	**ab** ;
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb ;

5 *F2 offspring phenotype number ratio:*
9 : **3** : **3** : **1** ;

6 grey long | grey short | black long | black short ;

5(c)

1 carry out a test cross / cross with a double homozygous recessive fruit fly / cross with fly with black body and short wings ;

*plus any **two** from:*

2 if **some** offspring have black body then F2 fly is, heterozygous for the body colour (gene) / **Aa** ;

3 if **all** offspring have grey body then F2 fly is, homozygous dominant for body colour (gene) / **AA** ;

4 if **some** offspring have short wings then F2 fly is, heterozygous for wing length (gene) / **Bb** ;

5 if **all** offspring have long wings then F2 fly is, homozygous dominant for wing length (gene) / **BB** ;