1 **(a)**	the allele that is expressed (if it is present) / AW; always seen in the phenotype; masks (effect of) recessive allele;	**max 1**	**I** 'powerful' defines the phenotype defines characteristic(s)
(b) (i)	*Parent genotype*: Ff , Ff; *Parent phenotype*: (with) flecks × (with) flecks; *Gametes*: F , f, F , f; Working shown to derive genotype; *Offspring genotype*: FF , Ff , ff; linked to correct phenotype	**5**	**ECF** on incorrect key usage **ECF** from each line **A** Punnett square / criss-cross lines
(ii)	ff × ff; parents may be implied as first part of the question asks for parental genotype both parents must have a recessive <u>allele</u> / (if ff × ff) no dominant or F <u>allele</u>, in either parent / (if ff × ff) both parents must be homozygous, recessive / without flecks no parent must be homozygous dominant / presence of (even) one dominant allele in parents could result in flecks;	**2**	**A** Ff × Ff and Ff × ff **ECF** on incorrect key usage from **(i)** **A** gene for allele
		[Total: 8]	

<table>
<tr>
<td>2 (a (i)</td>
<td>
<table>
<tr><td>genetic term</td><td>example used in the passage</td></tr>
<tr><td>an allele</td><td>Hb^N / Hb^S;</td></tr>
<tr><td>a heterozygous genotype</td><td>Hb^NHb^S;</td></tr>
<tr><td>a homozygous genotype</td><td>Hb^S Hb^S;</td></tr>
<tr><td>phenotype</td><td>/ extreme pain / sickle cell anaemia / mild symptoms;</td></tr>
</table>
</td>
<td>4</td>
<td>A N / S, R NS and N × S

A NS

A SS

A the disease</td>
</tr>
<tr>
<td>(ii)</td>
<td>malaria, is severe disease / may be fatal;

idea that it is the selective agent / ref to (natural) selection;

people with sickle cell anaemia / Hb^S are resistant to malaria;

Hb^NHb^N / homozygous dominant, susceptible to malaria;

Hb^NHb^N more likely to die (of malaria) before have children (to pass on genes);

Hb^N Hb^S / sickle cell carriers, do not die from sickle cell anaemia;

Hb^N Hb^S / sickle cell carriers, have children (and pass on genes);

and pass on the (Hb^s) <u>allele</u>;

description of sickle cells are less prone to infection;

idea that no advantage of Hb^S in areas where no malaria;
AVP;</td>
<td>max 5</td>
<td>A reference to selective advantage for MP2
R immune for resistance (but ECF after first time)

A carrier for sickle cell trait

AVPs:
2 in 4 / ½ , have advantage of resistance to malaria;
(if Hb^N Hb^S × Hb^N Hb^S) 1 in 4 chance of, Hb^S Hb^S / homozygous recessive;</td>
</tr>
</table>

2	**(b)**	(chromosome) mutation; an extra chromosome; non-disjunction / failure during meiosis / translocation;	**max 1**	**A** trisomy 21 **R** more than one chromosome **I** older mothers, inherited
	(c)	discontinuous variation – influenced by genes alone; **ORA** discontinuous variation – no effect of the environment / does not change over (life)time; **ORA** discontinuous variation, is discrete / has no intermediates / is qualitative / AW; **ORA** limited number of <u>phenotypes</u>;	**max 3**	assume answer is about discontinuous unless stated otherwise continuous variation influenced by gene and environment = 2 marks (**MP1** and **MP2**) **A** continuous is measurable
			[Total: 13]	

	Answers		Marks	Guidance for Examiners
3 **(a)**	**1**	(red blood cells) get stuck in capillaries / do not flow smoothly / capillaries blocked**;**		**ignore** less haemoglobin
	2	reduce , supply of, oxygen / nutrients (to tissues / cells / muscles) **;**		**A** carries <u>less</u> oxygen / nutrients…
	3	reduce , removal of, carbon dioxide / wastes, (from tissues / cells / muscles) **;**		**A** carries <u>less</u> carbon dioxide…
	4	ref to respiration (in tissues) **;**		
	5	cause sickle cell crises **;**		
	6	pain **;**		
	7	increased chance of, thrombosis / blood clotting **;**		
	8	death of tissues / cells **;**		
	9	AVP **;**	**[max 4]**	**I** reduced life expectancy
(b) (i)	allele(s) **;**		**[1**	
(ii)	H^A , H^S + H^A , H^S **;**			Could be in Punnett square **A** just A and S
	(H^AH^A , H^AH^S , H^AH^S) <u>H^SH^S</u> **;**		**[2]**	**A** just S and S
(iii)	0.25 / 25 % / ¼ / 1 in 4 **;**		**[1**	**I** ratios

	Answers		Marks	Guidance for Examiners
3 (c) (i)	**1** **2** **3** **4** **5** **6** **7** **8** **9** **10**	malaria, is severe disease / may be fatal **;** *idea that it is the* selective agent / ref to natural selection **;** H^AH^A / homozygous dominant, susceptible to malaria **;** H^AH^S / heterozygous, resistant **; A** H^SH^S resistant ; H^AH^S survive / H^AH^A more likely to die before have children **;** H^AH^S have children and pass on, the allele / H^S **;** (if H^AH^S x H^AH^S) 1 in 4 chance of, H^SH^S / homozygous recessive **;** 2 in 4 / ½ , have advantage of resistance to malaria **;** AVP **;** e.g. ref to malarial parasite / AVP **;** e.g. ref to transmission of malaria	**[max 4]**	**A** sickle cell trait / carrier for H^SH^A throughout the answer **R** immune
(ii)	**1** **2** **3** **4** **5** **6** **7** **8** **9**	malaria not very serious / not a severe strain of malaria **;** people have other genetic protection from malaria **;** malaria has only recently spread to these areas / no malaria before**;** mutation not occurred in populations of these areas **;** people with mutation / have sickle cell allele , have not migrated here **;** (majority of) population in Australia has not lived there for long **;** came from areas where no malaria, is / was, present **;** AVP **;** AVP **;**	**[max 2]**	E.g. Thalassemia **A** mutation described **I** gene, for allele
			[Total:14]	

Question	E answers	Mark	Additional Guidance
4 (a	halves the number of chromosomes / diploid to haploid ; **ignore** halves the genetic material produces variation / AW ;	 [2]	**accept** produces haploid, nuclei / cells / gametes **ignore** prevents doubling of chromosome number
(b) (i)	question is discounted	[2]	
(ii) 1	(only) one fertilisation / one zygote / one fertilised egg ;		**R** 'from a single cell' but allow ecf for other MPs
2	zygote / fertilised egg / (cells in) embryo, divides / splits in two ;		**R** egg divides
3	by <u>mitosis</u> ;		
4	into two (groups of) genetically identical cells ;	[2]	**A** same , genetic material / genetic make-up / genome **R** similar
(c)	increase in, complexity / AW ; ref to specialisation / differentiation ; ref to different types of cells ; ref to, tissues / organs ;	[max 2]	**ignore** (rapid) growth / change in shape **A** 'legs / arms / AW, start to grow'
(d)	1. ^{h}Y ; 2. $^{H}X^{h}$; 3. $^{H}X^{H}$;	[3]	***do not accept*** male genotypes for **MP2** and **MP3**

Question	E answers	Mark	Additional Guidance
4 (e) 1 2	mutation / change in DNA **;** in the gene, for blood clotting protein **/** on X chromosome **;**		**MP2** can only be awarded if **MP1** is awarded
3	in the mother / mother is a carrier / mother is heterozygous **;** **R** parent(s) is / are heterozygous		**MP3 A** in context of allele passing down the female line for several / many generations (without being expressed in a male)
4	haemophilia is <u>sex linked</u> / shows <u>sex linkage</u> **;**		**ignore** carried on the X chromosome as this is in the question
5	*idea that* the mother's egg with the mutant allele fuses with a Y bearing sperm **;**		
6	e.g. cause of mutation **;** ionising radiation / chemical(s)	[max 2]	