**Extra Inheritance Question Pack Mark schemes**

**Q1.**

(a)     1.      (Expression / appearance / characteristic due to) genetic constitution / genotype / allele(s);

2.      (Expression / appearance / characteristic due to) environment;

*1.      Accept: named characteristic.*

*1.      Accept: homozygous / heterozygous / genes / DNA.*

*1.      Ignore: chromosomes.*

**2**

(b)     Epistasis

**OR**

Epistatic (interaction / control);

*Accept: phonetic spellings.*

*Ignore: preceding word e.g. (recessive / dominant) epistasis.*

**1**

(c)     **AAbb** – white

**aaBB** – yellow;

*Both correct for one mark.*

**1**

(d)     1.      AaBb, Aabb, aaBb, aabb;

2.      White, (white), yellow, green;

3.      2 : 1 : 1;

*Note: If genotypes are incorrect = zero marks.*

*1.      Accept: equivalent genotypes e.g. ABab for AaBb.*

*Accept: sequence of phenotypes does not need to mirror genotypes but must be correct.*

*3.      Accept: ratios of 2:1:1 or 1:2:1 or 1:1:2 even if sequence of phenotypes do not match if mark points 1* ***and*** *2 have been awarded.*

*3.      Accept: alternative ratios in correct proportions e.g. 4:2:2*

*3.      Ignore: percentages / fractions.*

**3**

**[7]**

**Q2.**

(a)     (i)      black;

**1**

(ii)     chocolate;

**1**

(b)     **BE**, **Be**, **bE**, **be** and **be**;

**BbEe, Bbee, bbee, bbEe;**

1 black: 2 yellow: 1 chocolate;

**3**

(c)     (i)      no enzyme coded for when no dominant / **E** allele;



phaeomelanin not converted – (remains yellow);

**2**

(ii)     **E** allele results in enzyme producing eumelanin;

**B** allele - more eumelanin deposited in hairs;

**2**

**[9]**

**Q3.**

(a)     2.84:1;

*Accept ‘2.84 to 1’ or (just) 2.84*

*Do not accept 1:2.84 or 142:50*

**1**

(b)     1.      Some embarrassed / some not willing to show tongue / cannot tell;

2.      Could not decide whether thumb was straight or not / thumb bending is judgemental / subjective;

**2**

(c)     1.      (No) - should be 92.9% / should be calculated from 182 out of 196 / should not be calculated from 182 out of 200;

*Allow either no or yes approach but no mark awarded for no or yes on its own*

2.      (Yes) – assumes 4 out of 200 use either hand;

*Accept ambidextrous*

3.      (But) sample may not be representative;

*This could be expressed in other ways e.g. only based on one part of the country / might not be the same in different parts of the UK / might not be representative of UK*

4.      Small sample size / only sampled 200;

**2 max**

**[5]**

**Q4.**

(a)     1.      Homologous chromosomes pair up / bivalents form;

2.      Crossing over / chiasmata form;

3.      Produces new combination of **alleles;**

4.      Chromosomes separate;

5.      At random;

6.      Produces varying combinations of chromosomes / genes / alleles (*not twice*) ;

7.      Chromatids separated at meiosis II / later;

*Independent assortment / random segregation = marking points 4 and 5*

**6 max**

(b)     (i)

|  |  |  |  |
| --- | --- | --- | --- |
| Parental phenotypes | Agouti | White |  |
| Parental genotypes | BbAa | bbaa | ; |
| Gamete genotypes | BA     Ba     bA     ba | ba | ; |
| Offspring genotypes | BbAa     Bbaa | bbAa     bbaa | ; |
| Offspring phenotype | Agouti     Black | White     White | ; |

*Phenotypes must match genotypes*

*Allow marking points 2 and 3 if correctly derived from wrong parental genotypes*

**4**

(ii)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Colour of offspring*** | ***Observed (O)*** | ***Expected (E)*** | ***(O-E)*** | ***(O-E)2*** |  |
| Agouti | 34 | 30 | 4 | 16 | 0.53 |
| Black | 35 | 30 | 5 | 25 | 0.83 |
| White | 51 | 60 | 9 | 81 | 1.35 |
|  |  |  | ***Σ*= 2.71 or 2.72** | | |
|  |  |  | ;;       2 | | |

*(χ2 correct = 2 marks)*

*((O-E)2 all correct = 1 mark)*

p = 0.05;

2 degrees of freedom;

Differences due to chance / no significant difference as χ2 less than / to left of critical value OR Not due to chance / difference is significant as χ2 greater than to right of critical value;

*(as appropriate for candidates χ2)*

**3**

**[15]**

**Q5.**

(a)     Parents genotypes                        Aabb                           aaBb            ;

Gametes formed                      Ab         ab                   aB       ab ;

*if parental genotypes wrong allow correctly derived gametes only*

Offspring genotypes        AaBb        Aabb        aaBb         aabb

***and***

Offspring phenotypes 1  Walnut ;     1 Pea :    1 Rose :    1 single ;

*Just* ***one*** *mark for offspring genotypes* ***and*** *phenotypes  
If parents not diploid, no marks gained*

**3**

**[3]**

**Q6.**

(a)     epistasis;  
one gene influences the expression of another / description  
using example in question;

**2**

(b)     aaDD, aa Dd (or DDaa, Ddaa);

**1**

(c)     (i)      AaDd (or DdAa);

**1**

(ii)     aadd, Aadd (or ddaa, ddAa);

**1**

(iii)     cross with black individual / genotype aaDd or aaDD;  
genotype is Aadd if agouti offspring / genotype is aadd if no  
agouti offspring;  
*Accept*;  
repeat cross using original parents many times;  
ratio is 4 albino : 3 agouti : 1 black if Aa, or 2 albino : 1 agouti :  
1 black if aa;

**2**

**[7]**

**Q7.**

(a)     (i)      BBXAY,   BbXAY;

**1**

(ii)     BbXAXa,   bbXAXa;

**1**

(b)     *parental genotypes* −         BbXAY         x         BbXA Xa;

**1**

*Gametes* −            (BXA, bXA,) BY, bY,             BXA, B Xa, bXA, b Xa ;

**1**

Genotypes of sons-                                          ;

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Male gametes | |
|  | | BY | bY |
| Female gametes | BXA | BBXAY | BbXAY |
| B Xa | BB Xa Y | Bb Xa Y |
| bXA | BbXAY | bbXAY |
| b Xa | Bb Xa Y | bb Xa Y |

**1**

0.125 / 12.5% / 1/8 ;

**1**

**[6]**

**Q8.**

(a)     is always expressed(in the phenotype) / produces (functional) proteins;

**1**

(b)     codominance;

**1**

(c)     *Parental geneotypes* -    hhCRCw,                       HhCwCw;

Gametes-                      

*Offspring geneotypes -* HhCRCw,   hhCRCw,  HhCwCw,   hhCwCw;

*Offspring pheneotypes -* hornless   horned   hornless   horned

roan         roan      white       white  
*Ratio of offspring* -          1               1            1               1;

**4**

(d)     (i)      sperm(with more DNA) have X chromosome;  
X is larger / has more genes than Y;

**2**

(ii)     female for milk / males for meat / male or female for breeding;

**1**

**[9]**

**Q9.**

(a)     hhDD,     hhDd;

*(both correct 1 mark)*

**1**

(b)     Epistasis;

One gene controlling / inhibiting the expression of another;

**2**

(c)     Gametes correct    HD, Hd, hD, hd,                     hd

(*correct for both parents)*;

Genotypes             HhDd,  Hhdd,  hhDd,  hhdd  ;

Phenotypes            wiry     wiry     non-wiry, short         non-wiry, long

Ratio                              2                         1                               1         ;

**3**

**[6]**

**Q10.**

(a)     aabb;

**1**

(b)     AaBb and aabb;

**1**

(c)     Pea comb offspring will produce blue eggs;

Alleles **A** and **B** are inherited together / are on the same chromosome;

**2**

(d)     Reference to crossing over;

Reduce chance of genes being separated (by crossing over);

If crossing over occurred some gametes will contain alleles **A** and **b**;

**2 max**

(e)     Two suitable environmental factors;

e.g.

Diet / named component of diet;

Temperature;

Light intensity / duration;

Disease;

**2 max**

(f)     Cross C / Xf Xf and XFY;

**1**

(Only) cross where all males are one phenotype and all females are a different phenotype;

Cross showing all males are slow feather production, all females fast feather production;

**2**

(g)     Two alleles for each gene present in male / chromosomes are homologous in male;

Female has one allele for each gene;

Recessive alleles always expressed in female;

Males need two recessive alleles for allele to be expressed / in males recessive alleles can be masked by dominant allele

**3 max**

**[14]**

**Q11.**

(a)     Both alleles are expressed / shown (in the phenotype).

*Accept: both alleles contribute (to the phenotype)*

*Neutral: both alleles are dominant*

**1**

(b)     Only possess one allele / Y chromosome does not carry allele / gene / can’t be heterozygous.

*Accept: only possess one gene (for condition)*

*Neutral: only 1 X chromosome (unqualified)*

**1**

(c)     1.      XGXB,   XBXB,   XGY,   XBY;

*Accept: equivalent genotypes where the Y chromosome is shown as a dash e.g. XG-, or is omitted e.g. XG*

*Reject: GB, BB, GY, BY as this contravenes the rubric*

2.      Tortoiseshell female, black female, ginger male, black male;

3.      (Ratio) 1:1:1:1

*2 and 3. Award one mark for following phenotypes tortoiseshell, black, (black) ginger in any order with ratio of 1:2:1 in any order.*

*Allow one mark for answers in which mark points 1, 2 and 3 are not awarded but show parents with correct genotypes i.e. XGXB and XBY* ***or gametes as*** *XG, XB and XB, Y*

*3. Neutral: percentages and fractions*

*3. Accept: equivalent ratios e.g. for 1:1:1:1 allow 0.25 : 0.25 : 0.25 : 0.25*

**3**

(d)     (i)      Correct answer of 0.9 = 2 marks;

Incorrect answer but shows q2 = 0.81 = one mark.

*Note: 0.9% = one mark*

**2**

(ii)     Homozygous dominant increases and homozygous recessive decreases.

**1**

**[8]**

**Q12.**

(a)     Table completed as below:

|  |  |  |
| --- | --- | --- |
| Kingdom | Animalia / Animals |  |
| Phylum | Chordata |  |
| Class | Mammalia |  |
| Order | Rodentia |  |
| Family | Caviidae |  |
| Genus | *Cavia* | Column 1 correct; |
| Species | *porcellus* | Column 2 correct; |

**2**

(b)     Mutation occurs;

Correct e.g. of isolating mechanism

e.g.  
temporal − different breeding seasons / feeding times /   
ecological / behavioural − different courtship displays / different niches / habitats / feeding areas /

mechanical − mismatch of reproductive parts /

gamete incompatibility − sperm killed in female’s reproductive tract /   
hybrid inviability / hybrid infertility;

*Ignore references to “genetic isolation” or “reproductive isolation”*

Different selection pressures operate / changes in allele frequency / divergence of gene pools;

**3**

(c)     Using candidate’s symbols for alleles −

e.g. B = black, b = brown, S = short, s = long:

Parental genotypes correct:        Male **A**          Female **B**

                                           SSBb            SsBB;

Gametes correctly derived from

candidate’s parental genotypes: SB     Sb     SB     sB;

offspring genotypes correctly

derived from candidate’s

suggested gametes         − accept Punnett square or line diagram;

offspring genotypes correct:       SSBB     SsBB     SSBb     SsBb;

*If monohybrid:cross  0 marks*

**4**

(d)     There is no (significant) difference between observed and expected results / any difference is due to chance;

**1**

**[10]**

**Q13.**

(a)     (i)      Two, as white blood cells are diploid cells / alleles are present on each chromosome of an homologous pair / one maternal and one paternal;

**1**

(ii)     A **and** B

*(reject IA and IB)*

**1**

(b)     1 in 8 / 1 / 8 / 12.5% / 1:7 / 0.125;  
(*Reject 1:8*)  parents IAIO and IBIO ;  
give 1:3 / ¼ / 1 in 4 / 25% probability of blood group A and half will be male;

*(accept 2nd and 3rd points from a suitable genetic diagram)*

**3**

**[5]**

**Q14.**

(a)     Gg / suitable equivalent;

Grey : black about 3: 1;

*[Note: Can be in table / diagram]*

**2**

(b)     To determine the probability;

*[Accept: Likelihood]*

Of the results being due to chance;

*[Accept: Coincidence]*

**2**

(c)     (i)      both alleles will be expressed (in the phenotype);

**1**

(ii)     0.25 / 25%; = 2 marks  
CN = 250 / 1000; = 1 mark

**2**

(iii)    *P2* = (0.25)2 / 0.0625 / square of calculated figure for CN; = 2 marks

*p2 +2pq + q2* = 1.0; = 1 mark

= 31.25 / 31;

*[Accept: Derived from either p2 or q2]*

**3**

**[10]**

**Q15.**

(a)     males are XY and females XX / males have one X chromosome and females two X chromosomes;  
males only have one allele (of the gene) present / recessive allele always expressed;  
colour blindness is masked in heterozygote / female needs 2 recessive alleles to be colour blind;

**2 max**

(b)     (i)      5 - hh Xb Y;  
6 - Hh XB Xb ;

**2**

(ii)     h Xb , h Y, and H XB, h XB, H Xb , hXb;

**1**

(iii)     1 / 8 or 12.5% or 0.125;;

*either*

genetic diagram to show genotypes Hh Xb Xb , Hh XBY, hh XB Xb,  
hh XBY, HHXbXb, Hh XbY, hh Xb Xb; hh XbY;  
1 / 8;  
*or*P (boy) = 0.5, P (colour blind) = 0.5, P (white streak) = 0.5;  
(0.5 × 0.5 × 0.5 =) 0.125;

**2**

**[7]**

**Q16.**

(i)      female XX, male XY;  
Y shorter / smaller than X;

**2**

(ii)      haemophilia is a recessive allele;  
defective allele (gene) present on X, missing from Y;  
male 0.5(50% / ½) probability of haemophilia;  
female 0 / no chance;  
(0.25(25% / ¼) first baby having haemophilia);  
  
*or*XHXhXHY;  
XHXH + XHXh + XHY + Xh Y;  
XhY is a sufferer

**3 max**