I. In rabbits $B_-$ is black and $bb$ is white, while $L_-$ is long hair and $ll$ is short.

A black, long hair male is crossed to a white, short hair female.

a) Give the genotype of the black, long male if:

1) All the progeny are black with long hair ______ $BB, LL$

2) $\frac{1}{2}$ the progeny are black, long and $\frac{1}{2}$ are black short ______ $BB, Ll$

3) $\frac{1}{2}$ the progeny are black, long and $\frac{1}{2}$ are white, long ______ $Bb, LL$

b) give the genotypic and phenotypic ratios expected in the progeny if the male is $Bb, Ll$

- 1 $Bb, Ll$ 1 Black, Long
- 1 $Bb, ll$ 1 Black, short
- 1 $bb, Ll$ 1 white, Long

Genotypic ______ $Bb, Ll$ Phenotypic ______ $Bb, LL$

b) If two of the progeny from part a-1 are crossed, predict the phenotypic ratio in the progeny: ______ $9\text{ Black, long: 3 Black, Short: 3 white, long: 1 white, short}$

II. In an organism where $2N=6$, heterozygous for genes $A, B$ and $D$, with genes respectively on chromosomes 1-3, show the genes/alleles on chromosomes at metaphase of

a) Mitosis

![Diagram of Mitosis](image)

b) Meiosis I

![Diagram of Meiosis I](image)
III. In peony:

- **R'R' red**
- **E'E' no embryo (lethal)**
- **P_ 3 point leaf**
- **S_ single row petals**

- **R'R pink**
- **E'E small embryo**
- **pp single point leaf**
- **ss multi row petals**

- **RR white**
- **EE normal embryo**

A pink, single row, 3 point leaf plant (plant 1) that grew from a small embryo seed was selected from a cross involving a single point parent with multi row petals.

What is the genotype of plant 1? **R'R, E'E, Pf, Ss**

Plant 2 with the genotype **R'R', E'E, Pp, Ss** is used as a male to cross to plant 1.

What is the phenotype of plant 2? **Red, small embryo, 3 pt leaf, single row**

How many gamete genotypes can each plant produce? 1 **2X2X2X2** 2 **1X2X2X2**

What is the probability that plant 1 will produce a **R', E', P, S** gamete?

\[
\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}
\]

What fraction of the progeny from the cross will have the following genotype:

**R'R', E'E, Pp, ss**

\[
\frac{1}{2} \times 2/3 \times \frac{1}{2} \times \frac{1}{4}
\]

What fraction of the progeny from the cross with have the following phenotype:

Pink, normal embryo, single point leaves, single row petals?

\[
\frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} \times \frac{3}{4}
\]

Ignoring the other traits, if 10 progeny from the cross are selected at random, what is the probability that 7 will have 3 point leaves and 3 will have single point leaves?

\[
\frac{10!}{7!3!} \times (\frac{1}{4})^7 (\frac{3}{4})^3
\]

What is the probability that at least one will be multi rowed?

\[
1 - (\frac{3}{4})^{10}
\]

IV. What mode of inheritance most simply explains this pedigree? (check answer)

- **___Single gene dominant**
- **X ___Single gene recessive**
- **___Epistasis**
- **___Quantitative**
V. Eight different genes have been implicated in CLN disease in humans. Symptoms include odd fingerprints, progressive dementia and vision failure. Most cases are first detected in children, but for the latter traits, juvenile and adult onset has been verified. Very mild cases have been found in individuals following extreme exposure to reactive oxygen species. Check the terms that are clearly applicable to CLN based on this description:

- **Age of onset**
- **Phenocopy**
- **Pleiotrophy**
- **Teratogen**
- **Multiple alleles**
- **Lack of penetrance**
- **genetic heterogeneity**
- **Epistasis**
- **Variable expressivity**
- **quantitative trait**

VI. The 5 babies, including one set of twins, listed below came from 4 sets of parents, with the prospective **Mom’s Dad’s and Couples** listed in the first column. In each cell of the matrix, tell which blood-type(s), if any, could not occur. Note that ‘X’ is not an answer!

<table>
<thead>
<tr>
<th></th>
<th>Baby 1</th>
<th>Baby 2</th>
<th>Baby 3</th>
<th>Baby 4</th>
<th>Baby 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1:</td>
<td>A, M, Rh+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2:</td>
<td>O, MN, rh-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M3:</td>
<td>B, N, Rh+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M4:</td>
<td>A, MN, Rh+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1:</td>
<td>AB, N, rh-</td>
<td>ABO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2:</td>
<td>O, M, rh-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3:</td>
<td>A, MN, Rh+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4:</td>
<td>B, M, rh-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1:</td>
<td>A, M, Rh+/ AB, N, rh-</td>
<td>ABO</td>
<td>MN</td>
<td>MN</td>
<td>ABO MN</td>
</tr>
<tr>
<td>C2:</td>
<td>O, MN, rh- / O, M, rh-</td>
<td>Rh</td>
<td>ABO</td>
<td>ABO MN Rh</td>
<td>ABO, Rh</td>
</tr>
<tr>
<td>C3:</td>
<td>B, N, Rh+ / A, MN, Rh+</td>
<td>MN</td>
<td>MN</td>
<td>MN</td>
<td>MN</td>
</tr>
<tr>
<td>C4:</td>
<td>A, MN, Rh+ / B, M, rh-</td>
<td>MN</td>
<td>MN</td>
<td>MN</td>
<td>MN</td>
</tr>
</tbody>
</table>

Check the couples that could have the twins; 1 2 3 **X** 4 **X**

Are the twins Identical **NO** or Fraternal **YES** How do you know?

If identical, the two would have the exact same bloodtype; none of these do

Which, if any of the couples were at risk for Rh incompatibility **NONE**

(rh- mom is with rh- dad)
VII. When one truebreeding orange variety that averaged 16 seeds per fruit was crossed to another that averaged 28 seeds/fruit was found to follow an ideal model of quantitative inheritance. Selfing the F1 gave 9 distinct 'classes' of seeds/fruit ranging from 10 to 34.

a) Predict the average seeds/fruit for the F1 progeny: 22

b) How many genes for seeds/fruit are segregating (heterozygous) in the F1? 4

c) What is the average # of seeds/fruit expected in the F2? 22

d) How many seeds/fruit does each contributing allele add? 3

e) What fraction of the F2 progeny would have 10 seeds/fruit? 1/4

f) Does transgressive segregation occur for this trait? Yes. How do you know? F2 range surpasses the original parent values

g) Give potential genotypes for the 16 and 28 seeded parental lines.

16 A'A', BB, CC, DD 28 AA, B'B', C'C', D'D'

h) Give 2 seeds/fruit phenotypes that could not be true breeding. 13, 19, 25, 31

i) Variance in the F1 was 3 and it was 10 in the F2. Fill in the following blanks

\[ V_T = 10 \quad V_E = 3 \quad V_G = 7 \quad H^2 = \frac{7}{10} \]

VIII. Mom’s HLA genotype is A1 B6/A4 B3 and dad’s is A7 B2/A3 B14.

a) One twin has genotype A1 B6/A3 B14. What are the odds the other twin will have the same genotype if is:

Identical 1 Fraternal 1/4

b) Give three HLA genotypes that could serve as organ donors for the father without triggering a rejection response.