### Vraag 1

#### Question 1

1.1a

<table>
<thead>
<tr>
<th>Pattern of Inheritance</th>
<th>Possible?</th>
<th>Moontlik?</th>
<th>Ja / Nee</th>
<th>Yes / No</th>
<th>Indien nee, gee 'n rede vir u antwoord.</th>
<th>If no, give a reason for your answer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autosomal recessive</td>
<td>NO (1/2)</td>
<td>...........</td>
<td></td>
<td></td>
<td>Does not skip a generation OR</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Need a recessive allele from both parents OR</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(II-1 &amp; II-5 do not carry – defined) OR</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>At least one affected parent for each affected child. OR</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AR traits are transmitted by unaffected parents ANY 1</td>
<td>..........................................................</td>
</tr>
<tr>
<td>Autosomal dominant</td>
<td>YES (1/2)</td>
<td>...........</td>
<td></td>
<td></td>
<td>..........................................................</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>..........................................................</td>
<td>..........................................................</td>
</tr>
<tr>
<td>X-linked dominant</td>
<td>YES (1/2)</td>
<td>...........</td>
<td></td>
<td></td>
<td>..........................................................</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>..........................................................</td>
<td>..........................................................</td>
</tr>
<tr>
<td>Y-linked</td>
<td>NO (1/2)</td>
<td>...........</td>
<td></td>
<td></td>
<td>No father to son transmission (1) OR</td>
<td>..........................................................</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Females are affected by this trait (1)</td>
<td>..........................................................</td>
</tr>
</tbody>
</table>

b. X-linked dominant     (1)

c. Dizygotic (1/2) different sexes (1/2)

d. deceased / dead (1) only female (1/2)

e. adopted (1)

1.2 a. 1 black : 2 black & white : 1 white (for a – d: 1 pt, 1 ratio - ½ per mistake)

b. 1 black : 2 gray : 1 white

c. 2 gray : 1 white

d. Any epistatic modification of the 9:3:3:1 ratio that = 16

  e.g. 9:3:4; 12:3:1; 9:6:1 (1)

  associated with black, white and gray (1)
Vraag 2  |  Question 2

2.1a

**Incomplete penetrance:** Not everyone with the genotype will express the phenotype.  (1)

**Variable expressivity:** Everyone with the genotype will express the phenotype to some degree OR

Different degrees of expression of the phenotype.  (1)

b.  **Epistasis:** two or more genes that code for a single phenotype (1).

**Multiple alleles:** One gene with more than two alleles (1).

2.2a  2 genes (1) 2 alleles per gene / 4 alleles (1)

b.  12: 3 : 1  (1)

c.  

\[
\begin{array}{cccc}
\text{Wit} & \text{White} & \text{geel} & \text{yellow} & \text{rood} & \text{red} \\
\text{aa} & \text{Bbl} & \text{bb} \\
\end{array}
\]

white $\rightarrow$ yellow $\rightarrow$ red (1)

aa converts white $\rightarrow$ yellow (1/2) OR

A_ inhibits pigment (1/2)

B_ converts yellow $\rightarrow$ red (1/2)

2.3a  1 gene (1) 4 alleles (only get this mark if stated 1 gene) (1)

\[
\begin{array}{cccc}
\text{C}^1\text{C}^3 & \text{Pers} | \text{Purple} & \times & \text{C}^2\text{C}^3 & \text{Blou} | \text{Blue} \\
\end{array}
\]

\[
\begin{array}{cccc}
1\text{C}^1\text{C}^2 & : & 1\text{C}^1\text{C}^3 & : & 1\text{C}^2\text{C}^3 & : & 1\text{C}^3\text{C}^3 \\
2\hspace{1em}2 & : & 1 & : & 1 & : & 1 \\
\end{array}
\]

2 pers : 1 blou : 1 turkoois

2 purple : 1 blue : 1 turquoise

½ per genotype, only mark blue $1x = 4 x \frac{1}{2} = 2$
**Question 3**

3.1a Down syndrome / chromosomal abnormality (1)

b. amniocentesis / chorionic villus sampling (1)

c. Heterozygote screening (1)

d. In vitro fertilization (1) followed by pre-implantation genetic screening (1)

3.2a

<table>
<thead>
<tr>
<th>Monozygote twins</th>
<th>Diszygote twins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Konkordansie:</strong></td>
<td><strong>Concordance:</strong></td>
</tr>
<tr>
<td>69% (1/2).........</td>
<td>21% (1/2)........</td>
</tr>
<tr>
<td>0.69 (1/2)</td>
<td>0.21 (1/2)</td>
</tr>
</tbody>
</table>

b. Strong genetic influence (69% in MZ twins) (1)

Some environmental influence (concordance not 100% in MZ twins, must be some environmental influence)

**Question 4**

a. (1) -1/2 per mistake

<table>
<thead>
<tr>
<th>Agglutinasie met type O+ bloed? Ja of Nee.</th>
<th>Anti-A teenliggame Anti-A antibodies</th>
<th>Anti-B teenliggame Anti-B antibodies</th>
<th>Anti-Rhesus faktor teenliggame Anti-Rhesus factor antibodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agglutination with type O+ blood? Yes or No</td>
<td>No................................</td>
<td>No................................</td>
<td>Yes................................</td>
</tr>
</tbody>
</table>

b. (1/2)

Rr (1/2) indication that gt is heterozygous acceptable

c. Marie should be blood type A or B OR
to be O she must have received the i allele from both parents (1)

d. Marie has Bombay phenotype (1)

She is homozygous recessive at another locus (hh) (1)

She does not produce the H-substance / 5th sugar in the glycolipid (1)

Cannot express the $I^a$ or $I^b$ allele / no attachment for the 6th sugar (1)

This is as a result of epistasis (1) OR where another gene prevents expression of her ABO genotype (1)

She is nonpenetrant for her ABO genotype (1) any 3

d. Marie is Rh+ (1)

Erythroblastosis only arises when the mother is Rh- (1/2) and the baby is Rh+ (1/2) OR

She will never produce anti-D/Rhesus factor antibodies OR

Rh+ baby will not cause problems (i.e. Rhesus factor incompatibility)
Vraag 5 | Question 5

5.1 (1 mark each =5)

<table>
<thead>
<tr>
<th>Sex-influenced:</th>
<th>Expressed preferentially in one sex OR present ( \checkmark )</th>
<th>Allele is dominant in one sex and recessive in the other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex-limited:</td>
<td>Only expressed in one sex OR present ( \checkmark )</td>
<td>Zero penetrance in one sex</td>
</tr>
<tr>
<td>Sex-linked:</td>
<td>Gene carried on sex chromosome (X, Y, Z or W)</td>
<td></td>
</tr>
<tr>
<td>Cytoplasmic inheritance:</td>
<td>Genes / DNA in the cytoplasm transmitted from one parent OR</td>
<td>Genes in mitochondria or chloroplast transmitted from one parent</td>
</tr>
<tr>
<td>Maternal effect:</td>
<td>Nuclear genotype of maternal parent determines phenotype of offspring OR</td>
<td>Protein or factor present in cytoplasm of egg determines phenotype of offspring.</td>
</tr>
</tbody>
</table>

5.2

a. Sitoplasmiese oorerwing  
   *Cytoplasmic inheritance*

   ![Family Tree 1](image1)

   1 mark for all affected males in generation II (1)

   1 mark for all female carriers in II (1) OR

   (1) for affected male in III if female carriers not indicated

b. X-gekoppelde resessiewe oorerwing  
   *X-linked recessive inheritance*

   ![Family Tree 2](image2)

5.3a sex-limited (1)

b. Yellow male: .....*Heterozygous (Aa)*...(1)...... Yellow female: *homozygous recessive (aa)*...(1)......

5.4a All dextral / right coiling (1)

b. s” codes for a protein / substance that is found in the cytoplasm of the egg. (1)

This protein / substance influences early development of the offspring (1/2) OR

This causes the spindle fibres to orientate to the right. (1) OR

The zygote divides in a right handed direction. (1) max 2