

## Names for RHAG (ISBT 030) Blood Group Alleles

### Intro

General description: The RHAG blood group system consists of three antigens carried on a multipass membrane glycoprotein called RhAG (Rh-associated glycoprotein; aka CD241). It consists of 409 amino acids and both amino and carboxyl termini are predicted to be intracellular. It is predicted to sit in the membrane in a tri-molecular complex with either RhD or RhCE in a 2:1 ratio. (1; PMID 16281947)

Gene name: *RHAG*

Number of exons: 10

Initiation codon: Within exon 1

Stop codon: Within exon 10

Entrez Gene ID: 6005

LRG: LRG\_822

LRG sequence: NG\_011704.1 (genomic)

NM\_000324.2 (transcript)

Reference allele: *RHAG\*01* (shaded)

Reference allele RHAG1, RHAG3

*RHAG\*01* encodes:

Antithetical antigens: n.a.

Additional information RHAG3 assigned provisionally. Assignment of null (N) and mod (M) alleles has been made according to the phenotypic expression of RhD and RhCE antigens.

† The breakpoints for the deleted *RHAG* allele(s), *RHAG\*01N.15* (PMID: 25069376 (25); PMID: 28470789 (26)) have not been determined and are assumed to be the same until proven different. At that time, a new allele number will be assigned to distinguish the alleles from each other.

| Phenotype   | Allele name  | Nucleotide change | Exon<br>Intron | Predicted amino<br>acid change | (Reference No.) PMID             | Accession<br>number | rs number    |
|---|--|-------------------|----------------|--------------------------------|----------------------------------|---------------------|--------------|
| RHAG:1 or Duclos+   | <b><i>RHAG*01</i></b>                              |                   |                |                                |                                  |                     |              |
| RHAG:-1 or Duclos-  | <b><i>RHAG*01.-01</i></b>                          | c.316C>G          | 2              | p.Gln106Glu                    | PMID: 19744193                   | n.a.                | rs1180686517 |
| RHAG:2 or OI(a+)<br>Variant also weakens<br>RhAG expression (3) | <b><i>RHAG*01.02</i></b>                           | c.680C>T          | 5              | p.Ser227Leu                    | PMID: 19744193<br>(1), Abstract  | n.a.                | rs902283342  |
| RHAG:-3,5 or DSLK-,<br>Kg+                                      | <b><i>RHAG*01.-03</i></b>                          | c.490A>C          | 3              | p.Lys164Gln                    | PMID: 19744193<br>PMID: 32705675 | n.a.                | rs144305805  |
| RHAG:4  | <b>obsolete as of<br/>2018, PMID:<br/>30421425</b> |                   |                |                                |                                  |                     |              |
| <b>Weak phenotypes</b>  |  |                   |                |                                |                                  |                     |              |
| Rhmod   | <b><i>RHAG*01M.01</i></b>                          | c.1183delA        | 9              | p.Asn395Thrfs*68               | PMID: 11961248                   | n.a.                | n.a.         |
| Rhmod   | <b><i>RHAG*01M.02</i></b>                          | c.3G>T            | 1              | p.Arg2_Met8del                 | PMID: 9915949                    | n.a.                | rs121918588  |
| Rhmod   | <b><i>RHAG*01M.03</i></b>                          | c.236G>A          | 2              | p.Ser79Asn                     | PMID: 8563755                    | n.a.                | rs121918586  |
| Rhmod   | <b><i>RHAG*01M.04</i></b>                          | c.269G>T          | 2              | p.Gly90Val                     | (2), Abstract                    | n.a.                | n.a.         |
| Rhmod   | <b><i>RHAG*01M.05</i></b>                          | c.398T>C          | 3              | p.Leu133Pro                    | (1), Abstract                    | n.a.                | n.a.         |
| Rhmod   | <b><i>RHAG*01M.06</i></b>                          | c.560G>A          | 4              | p.Gly187Asp                    | (2), Abstract                    | n.a.                | n.a.         |
| Rhmod   | <b><i>RHAG*01M.07</i></b>                          | c.1195G>T         | 9              | p.Asp399Tyr                    | PMID: 10895258                   | n.a.                | n.a.         |
| Rhmod   | <b><i>RHAG*01M.08</i></b>                          | c.182T>G          | 2              | p.Ile61Arg                     | PMID: 18931342                   | n.a.                | rs863225469  |
| Rhmod   | <b><i>RHAG*01M.09</i></b>                          | c.194T>C          | 2              | p.Phe65Ser                     | PMID: 18931342                   | n.a.                | rs863225468  |
| Rhmod   | <b><i>RHAG*01M.10</i></b>                          | c.572G>A          | 4              | p.Arg191Gln                    | (3), Abstract                    | n.a.                | rs550840907  |
| Rhmod   | <b><i>RHAG*01M.11</i></b>                          | c.241G>C          | 2              | p.Gly81Arg                     | PMID: 27079312                   | HF934040            | n.a.         |
| Rhmod   | <b><i>RHAG*01M.12</i></b>                          | c.920C>T          | 6              | p.Ser307 Phe                   | PMID: 32378229                   | n.a.                | n.a.         |

| Phenotype              | Allele name        | Nucleotide change    | Exon<br>Intron | Predicted amino<br>acid change   | (Reference No.) PMID            | Accession<br>number | rs number                  |
|------------------------|--------------------|----------------------|----------------|----------------------------------|---------------------------------|---------------------|----------------------------|
| Rhmod                  | <b>RHAG*01M.13</b> | c.514A>G             | 4              | p.Met172Val                      | (8), Abstract                   | n.a.                | rs759281201                |
| Rhmod                  | <b>RHAG*01M.14</b> | c.572G>A<br>c.707A>C | 4<br>5         | p.Arg191Gln<br>p.Gln236Arg       | PMID: 31032541                  | MH397221            | rs550840907<br>rs777825752 |
| <b>Null phenotypes</b> |                    |                      |                |                                  |                                 |                     |                            |
| Rhnull                 | <b>RHAG*01N.01</b> | c.154_157delinsGA    | 2              | p.Pro52Aspfs*57                  | PMID: 8563755                   | n.a.                | rs387906519                |
| Rhnull                 | <b>RHAG*01N.02</b> | c.1086delA           | 8              | p.Ala363Leufs*15                 | PMID: 8563755                   | n.a.                | rs1562011389               |
| Rhnull                 | <b>RHAG*01N.03</b> | c.157+1G>A           | i1             | Aberrant splicing                | PMID: 9746795<br>PMID: 10394146 | n.a.                | rs1166675172               |
| Rhnull                 | <b>RHAG*01N.04</b> | c.945+1G>A           | i6             | Aberrant splicing                | (4), Abstract<br>PMID: 30990901 | n.a.                | n.a.                       |
| Rhnull                 | <b>RHAG*01N.05</b> | c.946-1G>A           | i6             | Aberrant splicing                | PMID: 9746795                   | n.a.                | rs1562012697               |
| Rhnull                 | <b>RHAG*01N.06</b> | c.946-1G>T           | i6             | Aberrant splicing                | PMID: 9759472                   | n.a.                | n.a.                       |
| Rhnull                 | <b>RHAG*01N.07</b> | c.1067+1G>A          | i7             | Aberrant splicing                | PMID: 9442063                   | n.a.                | rs1562012617               |
| Rhnull                 | <b>RHAG*01N.08</b> | c.808G>A<br>c.838G>A | 6              | p.Val270Ile<br>p.Gly280Arg       | PMID: 10467273                  | n.a.                | rs16879498<br>rs104893987  |
| Rhnull                 | <b>RHAG*01N.09</b> | c.836G>A             | 6              | p.Gly279Glu                      | PMID: 9454778<br>PMID: 9716608  | n.a.                | rs121918587                |
| Rhnull                 | <b>RHAG*01N.10</b> | c.1094T>G            | 8              | p.Leu365Arg                      | (4), Abstract                   | n.a.                | n.a.                       |
| Rhnull                 | <b>RHAG*01N.11</b> | c.1139G>T            | 9              | p.Gly380Val<br>Aberrant splicing | PMID: 10467273                  | n.a.                | rs121918589                |
| Rhnull                 | <b>RHAG*01N.12</b> | c.353C>T             | 3              | p.Ala118Glu                      | (5), Abstract                   | n.a.                | n.a.                       |
| Rhnull                 | <b>RHAG*01N.13</b> | c.1003G>A            | 7              | p.Gly335Ser                      | PMID: 25296744                  | n.a.                | rs976240588                |
| Rhnull                 | <b>RHAG*01N.14</b> | c.946-2A>G           | i6             | Aberrant splicing                | (6), Abstract                   | n.a.                | rs754264275                |

| Phenotype | Allele name                | Nucleotide change                      | Exon<br>Intron | Predicted amino<br>acid change | (Reference No.) PMID              | Accession<br>number | rs number    |
|-----------|----------------------------|--|----------------|--------------------------------|-----------------------------------|---------------------|--------------|
| Rhnull    | <b><i>RHAG*01N.15†</i></b> | c.(?-62)_(*638_?)del;<br>Gene deletion | 43840          | p.0                            | PMID: 25069376<br>PMID: 28470789† | n.a.                | n.a.         |
| Rhnull    | <b><i>RHAG*01N.16</i></b>  | c.310C>T                               | 2              | p.Gln104Ter                    | PMID: 26175207                    | n.a.                | rs1240511011 |
| Rhnull    | <b><i>RHAG*01N.17</i></b>  | c.640+3del14                           | i4             | Aberrant splicing              | PMID: 27079312                    | HG971762            | n.a.         |
| Rhnull    | <b><i>RHAG*01N.18</i></b>  | c.790C>T                               | 5              | p.Arg264X                      | (1), no PMID                      | AB938314.1          | rs1397420527 |
| Rhnull    | <b><i>RHAG*01N.19</i></b>  | c.543delT                              | 4              | p.Phe181Leufs*5                | (7), Abstract                     | n.a.                | n.a.         |
| Rhnull    | <b><i>RHAG*01N.20</i></b>  | c.672C>A                               | 5              | p.Ser224Arg                    | PMID: 21682734                    | n.a.                | n.a.         |
| Rhnull    | <b><i>RHAG*01N.21</i></b>  | c.571C>T                               | 4              | p.Arg191Ter                    | (9), Abstract                     | n.a.                | rs758540029  |
| Rhnull    | <b><i>RHAG*01N.22</i></b>  | c.540C>A                               | 4              | p.Tyr180Ter                    | PMID: 28063760                    | n.a.                | n.a.         |
| Rhnull    | <b><i>RHAG*01N.23</i></b>  | c.532delG                              | 4              | p.178Glyfs185                  | PMID: 29266289                    | KY094063            | n.a.         |
| Rhnull    | <b><i>RHAG*01N.24</i></b>  | c.12delA                               | 1              | p.Phe5fs                       | (10), Abstract                    | n.a.                | n.a.         |
| Rhnull    | <b><i>RHAG*01N.25</i></b>  | c.236G > A                             | 2              | pSer79Asn                      | PMID: 29508504                    | GQ477180            | rs121918586  |
| Rhnull    | <b><i>RHAG*01N.26</i></b>  | c.544G>A                               | 4              | p.Gly182Ser                    | PMID: 34309026                    | MW570764            |              |

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| <b>Track of changes</b> |                    | <b>from</b>              | <b>to</b>                                       |
|-------------------------|--------------------|--------------------------|---|
| <b>1</b>                | <b>Version</b>     | <b>v6.1 30-MAR-2021</b>  | <b>v6.2 30-NOV-2021</b>                         |
| 2                       | Author             | created Jill Storry      | Jill Storry, September 2021                     |
| 3                       | Reviewer           | reviewed n.a.            | n.a.  |
| 4                       |                    |                          |   |
| 5                       | General            | All                      | update to newest project-2-format               |
| 6                       | Allele Table       | Antigen/<br>allele added | <i>RHAG*01N.26</i>                              |
| 7                       | Allele Table       | renumbered               | renumbered '(3), Abstract' to '(1), Abstract'   |
| 8                       | Allele Table       | renumbered               | renumbered '(8), Abstract' to '(2), Abstract'   |
| 9                       | Allele Table       | renumbered               | renumbered '(11), Abstract' to '(3), Abstract'  |
| 10                      | Allele Table       | renumbered               | renumbered '(16), Abstract' to '(4), Abstract'  |
| 11                      | Allele Table       | renumbered               | renumbered '(22), Abstract' to '(5), Abstract'  |
| 12                      | Allele Table       | renumbered               | renumbered '(24), Abstract' to '(6), Abstract'  |
| 13                      | Allele Table       | renumbered               | renumbered '(29), Abstract' to '(7), Abstract'  |
| 14                      | Allele Table       | renumbered               | renumbered '(31), Abstract' to '(8), Abstract'  |
| 15                      | Allele Table       | renumbered               | renumbered '(32), Abstract' to '(9), Abstract'  |
| 16                      | Allele Table       | renumbered               | renumbered '(36), Abstract' to '(10), Abstract' |
| 17                      | Allele Table       | renumbered               | renumbered '(28), No PMID' to '(1), No PMID'    |
| 18                      | Allele Table       | renumbered               | renumbered '(41), In press' to 'PMID: 34309026' |
| <b>20</b>               | <b>End Version</b> | <b>v6.1 30-MAR-2021</b>  | <b>v6.2 30-NOV-2021</b>                         |

| <b>Track of changes</b> |                             | <b>from</b>                                   | <b>to</b>                                |
|-------------------------|-----------------------------|---|--|
| <b>1</b>                | <b>Version</b>              | <b>v6.0 30-OCT-2020</b>                       | <b>v6.1 30-MAR-2021</b>                  |
| <b>2</b>                |                             |   |  |
| <b>3</b>                | Author created              | Jill Storry                                   | Jill Storry                              |
| <b>4</b>                | Reviewer reviewed           | n.a.  | n.a.                                     |
| <b>5</b>                | Allele Table Antigen/allele | <i>RHAG*01.-03</i>                            | RHAG:-3 renamed RHAG:-3, 5 or DSLK-, Kg+ |
| <b>6</b>                | References                  | References found for all alleles and collated | Reference for the change above added     |
| <b>7</b>                | <b>End Version</b>          | <b>v6.0 30-OCT-2020</b>                       | <b>v6.1 30-MAR-2021</b>                  |

| Track of changes |                    |                                      | from                   | to  |
|------------------|--------------------|--------------------------------------|------------------------|---|
| <b>1</b>         | <b>Version</b>     |                                      | <b>v5.0 170514</b>     | <b>v6.0 30-OCT-2020</b>   |
| <b>2</b>         | Author             | created                              | Geoff Daniels          | Jill Storry   |
| <b>3</b>         | Reviewer           | reviewed                             | n.a.                   | n.a.  |
| <b>5</b>         | General            |                                      |                        |   |
| <b>6</b>         | Intro              | Text changed                         |                        | It is predicted to sit in the membrane in a tri-molecular complex with either RhD or RhCE in a 2:1 ratio. (1; PMID 16281947)                            |
| <b>7</b>         | Intro              | LRG ID line added:                   |                        | LRG_822   |
| <b>8</b>         | Allele Table       |                                      |                        |   |
| <b>9</b>         | Allele Table       | Text change:<br>Line moved to Intro: |                        | RHAG3 assigned provisionally. Assignment of null (N) and mod (M) alleles has been made according to the phenotypic expression of RhD and RhCE antigens. |
| <b>10</b>        | Allele Table       | Text change:                         |                        |   |
| <b>11</b>        | Allele Table       | Antigen/allele                       | <i>RHAG*-01</i>        | <i>RHAG*01.-01</i>  |
| <b>12</b>        | Allele Table       | Antigen/allele                       | <i>RHAG*02</i>         | <i>RHAG*01.02</i>   |
| <b>13</b>        | Allele Table       | Antigen/allele                       | <i>RHAG*-03</i>        | <i>RHAG*01.-03</i>  |
| <b>14</b>        | Allele Table       | Antigen/allele added:                | RHAG:4                 | Deleted. RHAG:4 was made obsolete 2018 (39)   |
| <b>15</b>        | Allele Table       | Antigen/allele                       | p.Arg263X              | Corrected to p.Arg264X after review of the original paper and the Ensembl database  |
| <b>16</b>        | Allele Table       | Antigen/allele added:                |                        | <i>RHAG*01M.13, RHAG*01M.14</i>   |
| <b>17</b>        | Allele Table       | Antigen/allele added:                |                        | <i>RHAG*01N.19 to RHAG*01N.25</i>   |
| <b>19</b>        | References         |                                      | References 1-8 updated | References found for all alleles and collated   |
| <b>20</b>        | <b>End Version</b> |                                      | <b>v5.0 170514</b>     | <b>v6.0 30-OCT-2020</b>   |