## Additional file 15. Log-likelihood values and parameter estimates for 13 vertebrate *UGT* groups

| Human | UGT1 | | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | **$\ell$[2]** | **$\kappa$[3]** | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -4579.946207 | 1.8171 | $\omega$ = | -4469.765726 | N/A | None |
| M1a | -4469.765726 | 2.21556 | $p_0$ = | 0.4914 | N/A | Not allowed |
| | | | $p_1$ = | 0.5086 | | |
| M2a | -4467.204119 | 2.26076 | $p_0$ = | 0.48402 | 5.123214 | 73 N |
| | | | $p_1$ = | 0.48961 | p>0.05 | 85 R |
| | | | $p_2$ = | 0.02636 | | 173 P |
| | | | $\omega_2$ = | 4.34434 | | |
| M3 | -4461.842346 | 2.14917 | $p_0$ = | 0.40984 | 236.207722 | 66 S 67 F 69 S 73 N 74 V 79 S |
| | | | $p_1$ = | 0.50296 | p<0.001 | 85 R 89 T 90 Y 96 D 103 G |
| | | | $p_2$ = | 0.0872 | | 121 S 173 P 202 V |
| | | | $\omega_0$ = | 0.05505 | | |
| | | | $\omega_1$ = | 0.58631 | | |
| | | | $\omega_2$ = | 2.5443 | | |
| M7 | -4466.625334 | 2.09458 | p = | 0.41737 | N/A | Not allowed |
| | | | q = | 0.55151 | | |
| M8 | -4462.183057 | 2.16067 | $p_0$ = | 0.93622 | 8.884554 | 66 S 73 N 74 V 79 S 85 R |
| | | | $p_1$ = | 0.06378 | p<0.05 | 89 T 90 Y 96 D 103 G |
| | | | p = | 0.46916 | | 173 P 202 V |
| | | | q = | 0.74336 | | |
| | | | $\omega$ = | 2.80545 | | |

| chimpanzee | UGT1 | | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | **$\ell$[2]** | **$\kappa$[3]** | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -4587.579615 | 1.85035 | $\omega$ = | 0.32954 | N/A | None |
| M1a | -4483.262354 | 2.25802 | $p_0$ = | 0.50276 | N/A | Not allowed |
| | | | $p_1$ = | 0.49724 | | |
| M2a | -4474.178767 | 2.25802 | $p_0$ = | 0.49047 | 18.167174 | 69 S 82 F 85 R |
| | | | $p_1$ = | 0.49063 | p<0.001 | 90 Y 96 D 173 P |
| | | | $p_2$ = | 0.0189 | | |
| | | | $\omega_2$ = | 8.44283 | | |
| M3 | -4468.881555 | 2.17922 | $p_0$ = | 0.42923 | 237.39612 | 69 S 74 V 82 F |
| | | | $p_1$ = | 0.5333 | p<0.001 | 85 R 90 Y 96 D 173 P |
| | | | $p_2$ = | 0.03746 | | |
| | | | $\omega_0$ = | 0.06145 | | |
| | | | $\omega_1$ = | 0.62704 | | |
| | | | $\omega_2$ = | 4.72817 | | |
| M7 | -4479.23935 | 2.13036 | p = | 0.46155 | N/A | Not allowed |
| | | | q = | 0.66339 | | |
| M8 | -4469.127367 | 2.19031 | $p_0$ = | 0.97269 | 20.223966 | 69 S 74 V 82 F |
| | | | $p_1$ = | 0.02731 | p<0.001 | 85 R 90 Y 96 D 173 P |
| | | | p = | 0.49495 | | |
| | | | q = | 0.76549 | | |
| | | | $\omega$ = | 5.60754 | | |

| Rhesus monkey | | UGT1 | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | $\ell^2$ | $\kappa^3$ | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -4699.455941 | 1.85048 | $\omega$ = | 0.33039 | N/A | None |
| M1a | -4590.841918 | 2.29792 | $p_0$ = | 0.48876 | N/A | Not allowed |
| | | | $p_1$ = | 0.51124 | | |
| M2a | -4582.255511 | 2.35105 | $p_0$ = | 0.47426 | 17.172814 | 85 R |
| | | | $p_1$ = | 0.51101 | p<0.001 | 173 P |
| | | | $p_2$ = | 0.01473 | | 235 S |
| | | | $\omega_2$ = | 8.56278 | | |
| M3 | -4575.518425 | 2.20155 | $p_0$ = | 0.38463 | 247.875032 | 73 N 79 S 85 R 89 T |
| | | | $p_1$ = | 0.57285 | p<0.001 | 90 Y 173 P 202 V 235 S |
| | | | $p_2$ = | 0.04253 | | |
| | | | $\omega_0$ = | 0.04472 | | |
| | | | $\omega_1$ = | 0.58094 | | |
| | | | $\omega_2$ = | 3.74773 | | |
| M7 | -4582.050067 | 2.18168 | p = | 0.41253 | N/A | Not allowed |
| | | | q = | 0.56903 | | |
| M8 | -4573.367194 | 2.22686 | $p_0$ = | 0.98229 | 17.365746 | 73 N 79 S 85 R |
| | | | $p_1$ = | 0.01771 | p<0.001 | 89 T 173 P 202 V 235 S |
| | | | p = | 0.4268 | | |
| | | | q = | 0.6004 | | |
| | | | $\omega$ = | 6.30747 | | |

| Baboon | | UGT1 | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | $\ell^2$ | $\kappa^3$ | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -4688.688005 | 1.84708 | $\omega$ = | 0.31979 | N/A | None |
| M1a | -4581.695245 | 2.33063 | $p_0$ = | 0.48991 | N/A | Not allowed |
| | | | $p_1$ = | 0.51009 | | |
| M2a | -4574.153041 | 2.36294 | $p_0$ = | 0.47904 | 15.084408 | 85 R |
| | | | $p_1$ = | 0.50889 | p<0.001 | 173 P |
| | | | $p_2$ = | 0.01207 | | 202 V |
| | | | $\omega_2$ = | 9.42254 | | |
| M3 | -4567.186338 | 2.20894 | $p_0$ = | 0.39301 | 243.003334 | 44 G 73 N 79 S 82 F 85 R |
| | | | $p_1$ = | 0.5637 | p<0.001 | 90 Y 132 P 173 P 192 I |
| | | | $p_2$ = | 0.04329 | | 201 D 202 V 235 S |
| | | | $\omega_0$ = | 0.04509 | | |
| | | | $\omega_1$ = | 0.57327 | | |
| | | | $\omega_2$ = | 3.82652 | | |
| M7 | -4573.069873 | 2.19115 | p = | 0.41723 | N/A | Not allowed |
| | | | q = | 0.59358 | | |
| M8 | -4565.370368 | 2.22247 | $p_0$ = | 0.98331 | 15.39901 | 73 N 79 S 82 F 85 R |
| | | | $p_1$ = | 0.01669 | p<0.001 | 132 P 173 P 201 D 202 V |
| | | | p = | 0.43098 | | |
| | | | q = | 0.63279 | | |
| | | | $\omega$ = | 6.54355 | | |

| Dog | | UGT1 | | | | |
|---|---|---|---|---|---|---|
| **Model**[1] | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters**[4] | | **LRT($2\Delta\ell$)**[5] | **Positively Selected Sites**[6] |
| M0 | -4524.519175 | 1.4809 | $\omega$ = | 0.34333 | N/A | None |
| M1a | -4403.464553 | 1.76763 | $p_0$ = | 0.50426 | N/A | Not allowed |
| | | | $p_1$ = | 0.49574 | | |
| M2a | -4399.948839 | 1.81705 | $p_0$ = | 0.49389 | 7.031428 | 85 R 87 I 92 K |
| | | | $p_1$ = | 0.47215 | p<0.05 | 160 G 176 L |
| | | | $p_2$ = | 0.03396 | | |
| | | | $\omega_2$ = | 5.03228 | | |
| M3 | -4395.550168 | 1.7596 | $p_0$ = | 0.19346 | 257.938014 | 8 V 17 L 18 G 24 H 25 Q 34 A 44 A 47 A 51 L 56 V 59 R 60 R 65 A |
| | | | $p_1$ = | 0.44128 | p<0.001 | 66 T 68 T 69 S 71 G 72 R 73 G 74 V 76 E 77 N 78 V 79 P 84 R 85 R |
| | | | $p_2$ = | 0.36527 | | 86 V 87 I 89 T 90 Y 91 K 92 K 93 V 94 K 95 E 96 D 97 S 98 A 99 L |
| | | | $\omega_0$ = | 0 | | 100 L 102 S 103 A 105 S 106 H 109 H 111 K 112 E 115 A 116 S 118 A |
| | | | $\omega_1$ = | 0.23533 | | 121 S 131 L 135 P 139 L 147 F 151 A 153 P 155 S 156 L 157 D 158 F |
| | | | $\omega_2$ = | 1.21422 | | 159 Q 160 G 167 P 173 A 175 S 176 L 177 N 180 H 184 L 188 K 190 M |
| | | | | | | 192 I 193 F 195 S 197 S 199 L 202 V 206 P 207 Y 208 E 209 P 217 K |
| | | | | | | 220 T 222 Q 225 M 227 S 228 A 235 G 239 K 258 A 259 S 262 P |
| M7 | -4399.436303 | 1.66142 | p = | 0.38922 | N/A | Not allowed |
| | | | q = | 0.49974 | | |
| M8 | -4393.857663 | 1.72149 | $p_0$ = | 0.93491 | 11.15728 | 65 A 66 T 78 V 85 R 87 I |
| | | | $p_1$ = | 0.06509 | p<0.01 | 90 Y 92 K 96 D 106 H 160 G 173 A 176 L |
| | | p = 0.43441, q = 0.66237, $\omega$ =3.41597 | | | | |

| Mouse | | UGT1 | | | | |
|---|---|---|---|---|---|---|
| **Model**[1] | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters**[4] | | **LRT($2\Delta\ell$)**[5] | **Positively Selected Sites**[6] |
| M0 | -5362.461457 | 1.74243 | $\omega$ = | 0.37507 | N/A | None |
| M1a | -5251.296323 | 2.06104 | $p_0$ = | 0.5134 | N/A | Not allowed |
| | | | $p_1$ = | 0.4866 | | |
| M2a | -5250.0753 | 2.11421 | $p_0$ = | 0.4977 | 2.442046 | 65 A |
| | | | $p_1$ = | 0.45687 | p>0.05 | 69 E |
| | | | $p_2$ = | 0.04544 | | 71 G |
| | | | $\omega_2$ = | 2.77215 | | 72 R 91 M |
| M3 | -5233.547367 | 2.04632 | $p_0$ = | 0.22884 | 257.82818 | 24 Q 25 Q 40 H 44 G 47 S 60 K 64 T 65 A 66 T 68 V 69 E |
| | | | $p_1$ = | 0.53115 | p<0.001 | 71 G 72 R 73 T 74 A 76 N 77 Q 78 D 79 S 82 F 83 L 84 L |
| | | | $p_2$ = | 0.24001 | | 85 R 86 V 88 K 89 I 90 Y 91 M 92 K 93 V 95 R 96 D 98 S |
| | | | $\omega_0$ = | 0.02385 | | 100 L 105 S 106 H 111 A 112 E 115 A 121 H 142 T 149 L |
| | | | $\omega_1$ = | 0.35809 | | 151 K 152 L 155 S 158 S 167 L 173 S 188 K 190 V 191 L |
| | | | $\omega_2$ = | 1.45111 | | 192 L 195 S 201 R 202 V 209 S 227 P 258 L |
| M7 | -5240.642609 | 1.94832 | p = | 0.51704 | N/A | Not allowed |
| | | | q = | 0.63706 | | |
| M8 | -5235.409624 | 2.04022 | $p_0$ = | 0.86729 | 10.46597 | 65 A 66 T 69 E 71 G 72 R 73 T |
| | | | $p_1$ = | 0.13271 | p<0.01 | 74 A 76 N 78 D 79 S 83 L 85 R |
| | | | p = | 0.65805 | | 86 V 90 Y 91 M 92 K 93 V 96 D |
| | | | q = | 1.15583 | | 98 S 100 L 112 E 121 H 142 T |
| | | | $\omega$ = | 1.80595 | | 151 K 152 L 192 L 195 S 201 R |

| Rat | | UGT1 | | | | |
|---|---|---|---|---|---|---|
| **Model**[1] | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters**[4] | | **LRT($2\Delta\ell$)**[5] | **Positively Selected Sites**[6] |
| M0 | -5472.965706 | 1.5423 | $\omega$ = | 0.3483 | N/A | None |
| M1a | -5350.67835 | 1.72435 | $p_0$ = | 0.57007 | N/A | Not allowed |
| | | | $p_1$ = | 0.42993 | | |
| M2a | -5348.251714 | 1.79042 | $p_0$ = | 0.54558 | 4.853272 | 65 A 66 A 71 G |
| | | | $p_1$ = | 0.40942 | p>0.05 | 90 Y 91 N 92 K 100 L |
| | | | $p_2$ = | 0.045 | | |
| | | | $\omega_2$ = | 3.45562 | | |
| M3 | -5326.752004 | 1.74248 | $p_0$ = | 0.24616 | 292.427404 | 24 Q 25 Q 44 G 47 S 60 N 63 V 64 T 65 A 66 A 69 E |
| | | | $p_1$ = | 0.54161 | p<0.001 | 71 G 72 R 73 S 74 V 78 D 79 P 82 F 83 L 85 R 86 V |
| | | | $p_2$ = | 0.21224 | | 89 T 90 Y 91 N 92 K 93 V 95 R 98 S 99 M 100 L 102 S |
| | | | $\omega_0$ = | 0.02401 | | 105 S 106 H 111 A 116 S 131 L 142 S 149 L 150 N 151 A |
| | | | $\omega_1$ = | 0.34448 | | 155 S 156 L 158 L 173 S 177 N 192 I 195 T 202 V 203 V |
| | | | $\omega_2$ = | 1.54386 | | 205 S 206 P 208 G 209 S 222 K 235 N 258 L |
| M7 | -5336.803533 | 1.65271 | p = | 0.52163 | N/A | Not allowed |
| | | | q = | 0.73587 | | |
| M8 | -5329.276411 | 1.73862 | $p_0$ = | 0.87595 | 15.054244 | 60 N 65 A 66 A 69 E 71 G 73 S |
| | | | $p_1$ = | 0.12405 | p<0.001 | 78 D 79 P 83 L 85 R 89 T 90 Y |
| | | | p = | 0.67894 | | 91 N 92 K 93 V 98 S 100 L 102 S |
| | | | q = | 1.353 | | 105 S 142 S 158 L 173 S 177 N |
| | | | $\omega$ = | 1.95515 | | 195 T 202 V 203 V 209 S 258 L |

| Chicken | | UGT1 | | | | |
|---|---|---|---|---|---|---|
| **Model**[1] | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters**[4] | | **LRT($2\Delta\ell$)**[5] | **Positively Selected Sites**[6] |
| M0 | -6742.092626 | 2.07232 | $\omega$ = | 0.38713 | N/A | None |
| M1a | -6580.492931 | 2.31284 | $p_0$ = | 0.57999 | N/A | Not allowed |
| | | | $p_1$ = | 0.42001 | | |
| M2a | -6567.258855 | 2.46347 | $p_0$ = | 0.54945 | 26.468152 | 69 A 71 L 84 E 87 H 92 K |
| | | | $p_1$ = | 0.40166 | p<0.001 | 93 V 95 R 98 D 106 W |
| | | | $p_2$ = | 0.0489 | | 130 V 173 A 203 I 222 I |
| | | | $\omega_2$ = | 4.74842 | | |
| M3 | -6555.365391 | 2.31977 | $p_0$ = | 0.34388 | 373.45447 | 37 A 40 N 47 E 65 D 66 N 69 A 71 L 72 K |
| | | | $p_1$ = | 0.49129 | p<0.001 | 74 A 76 E 78 G 84 E 85 Q 87 H 88 R 89 L |
| | | | $p_2$ = | 0.16483 | | 90 Q 92 K 93 V 94 K 95 R 96 L 98 D 99 V |
| | | | $\omega_0$ = | 0.06109 | | 102 I 103 S 106 W 109 K 121 N |
| | | | $\omega_1$ = | 0.46493 | | 130 V 158 F 173 A 193 D 195 S 197 L |
| | | | $\omega_2$ = | 1.7753 | | 199 L 201 D 202 F 203 I 205 K 222 I |
| M7 | -6569.82083 | 2.20258 | p = | 0.50568 | N/A | Not allowed |
| | | | q = | 0.68377 | | |
| M8 | -6552.635115 | 2.33776 | $p_0$ = | 0.9276 | 34.37143 | 40 N 69 A 71 L 84 E 87 H 90 Q |
| | | | $p_1$ = | 0.0724 | p<0.001 | 92 K 93 V 95 R 98 D 106 W |
| | | | p = | 0.59799 | | 130 V 173 A 202 F 203 I 222 I |
| | | | q = | 0.94708 | | |
| | | | $\omega$ = | 2.97901 | | |

| Zebrafish | | UGT1A | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | $\ell^2$ | $\kappa^3$ | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -4318.270545 | 1.42374 | $\omega$ = | 0.28891 | N/A | None |
| M1a | -4246.095061 | 1.53385 | $p_0$ = | 0.72087 | N/A | Not allowed |
| | | | $p_1$ = | 0.27913 | | |
| M2a | -4244.528178 | 1.56154 | $p_0$ = | 0.71681 | 3.133766 | 66 N 70 E |
| | | | $p_1$ = | 0.26392 | p>0.05 | 101 S |
| | | | $p_2$ = | 0.01928 | | 173 Y |
| | | | $\omega_2$ = | 4.0526 | | 202 S |
| M3 | -4238.240721 | 1.51694 | $p_0$ = | 0.44515 | 160.059648 | 57 S 64 A 65 E 66 N 67 L 69 K |
| | | | $p_1$ = | 0.45953 | p<0.001 | 70 E 72 Q 73 N 84 T 88 V 91 R |
| | | | $p_2$ = | 0.09532 | | 94 L 95 Q 97 L 101 S 173 Y |
| | | | $\omega_0$ = | 0.07075 | | 197 G 202 S 206 S 258 V |
| | | | $\omega_1$ = | 0.39859 | | |
| | | | $\omega_2$ = | 1.79333 | | |
| M7 | -4246.880684 | 1.48292 | p = | 0.60474 | N/A | Not allowed |
| | | | q = | 1.23665 | | |
| M8 | -4238.036997 | 1.51677 | $p_0$ = | 0.92152 | 17.687374 | 57 S 65 E 66 N 67 L 70 E 73 N |
| | | | $p_1$ = | 0.07848 | p<0.001 | 84 T 88 V 91 R 94 L 97 L |
| | | | p = | 0.90846 | | 101 S 173 Y 202 S 206 S 258 V |
| | | | q = | 2.62772 | | |
| | | | $\omega$ = | 1.9508 | | |

| Zebrafish | | UGT1B | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | $\ell^2$ | $\kappa^3$ | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -3821.397591 | 1.60209 | $\omega$ = | 0.25823 | N/A | None |
| M1a | -3754.061545 | 1.92987 | $p_0$ = | 0.6209 | N/A | Not allowed |
| | | | $p_1$ = | 0.3791 | | |
| M2a | -3754.061545 | 1.92987 | $p_0$ = | 0.6209 | 0 | |
| | | | $p_1$ = | 0.23285 | p>0.05 | |
| | | | $p_2$ = | 0.14626 | | |
| | | | $\omega_2$ = | 1 | | |
| M3 | -3746.892296 | 1.88372 | $p_0$ = | 0.38952 | 149.01059 | 40 L 59 S 61 E 62 Q 63 L 66 S 67 L 69 K 70 G 73 Q |
| | | | $p_1$ = | 0.40644 | p<0.001 | 75 V 76 F 77 T 79 S 81 A 84 M 85 D 87 F 88 V 89 Q |
| | | | $p_2$ = | 0.20404 | | 90 L 91 E 94 L 96 F 97 T 99 S 100 Q 101 V 102 E |
| | | | $\omega_0$ = | 0.03238 | | 104 C 153 P 159 L 176 G 182 N 190 F 194 G 198 V |
| | | | $\omega_1$ = | 0.30138 | | 199 L 202 V 205 A 206 S 213 R 221 Y 250 V 251 F |
| | | | $\omega_2$ = | 1.15784 | | 258 Q 260 S |
| M7 | -3748.453462 | 1.83922 | p = | 0.44133 | N/A | Not allowed |
| | | | q = | 0.89796 | | |
| M8 | -3747.027755 | 1.87853 | $p_0$ = | 0.84435 | 2.851414 | 40 L 59 S 62 Q 63 L 66 S 67 L 70 G 73 Q |
| | | | $p_1$ = | 0.15565 | p>0.05 | 75 V 76 F 77 T 79 S 81 A 85 D 88 V 89 Q |
| | | | p = | 0.59311 | | 90 L 91 E 94 L 99 S 100 Q 101 V 102 E |
| | | | q = | 2.16612 | | 153 P 159 L 176 G 190 F 198 V 199 L |
| | | | $\omega$ = | 1.22287 | | 202 V 205 A 206 S 213 R 221 Y 250 V 251 F |

| **Human** | **UGT2** | | | | | |
|---|---|---|---|---|---|---|
| **Model**[1] | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters**[4] | | **LRT($2\Delta\ell$)**[5] | **Positively Selected Sites**[6] |
| M0 | -6378.440841 | 2.03159 | $\omega$ = | 0.3792 | N/A | None |
| M1a | -6223.085308 | 2.15207 | $p_0$ = | 0.5887 | N/A | Not allowed |
| | | | $p_1$ = | 0.4113 | | |
| M2a | -6216.57934 | 2.27307 | $p_0$ = | 0.57797 | 13.011936 | 8 M 45 S 47 N 71 F |
| | | | $p_1$ = | 0.38053 | p<0.01 | 78 N 79 R 97 K 98 D |
| | | | $p_2$ = | 0.0415 | | 100 H103 S 133 V 329 N |
| | | | $\omega_2$ = | 3.58045 | | 417 S |
| M3 | -6214.925999 | 2.24208 | $p_0$ = | 0.47633 | 327.029684 | 8 M 10 G 43 P 45 S 47 N 64 I 67 V 71 F 73 L 75 W 76 L 78 N 79 R |
| | | | $p_1$ = | 0.40777 | p<0.001 | 81 S 87 R 88 F 90 Q 96 I 97 K 98 D 99 F 100 H 102 V 103 S 104 Q |
| | | | $p_2$ = | 0.1159 | | 112 K 118 A 128 L 133 V 145 G 153 R 156 P 158 S 160 V 197 Y 206 T |
| | | $\omega_0$ = 0.03973, $\omega_1$ = 0.63079, $\omega_2$ = 2.25067 | | | | 207 L 209 W 329 N 377 A 398 N 417 S 422 A |
| M7 | -6225.012005 | 2.10748 | p = | 0.21195 | N/A | Not allowed |
| | | | q = | q= 0.29526 | | |
| M8 | -6214.456244 | 2.24394 | $p_0$ = | 0.91863 | 21.111522 | 8 M 10 G 21 D 25 K 35 A 37 G 39 L 40 F 41 I 43 P 44 T 45 S 47 N |
| | | | $p_1$ = | 0.08137 | p<0.001 | 52 F 56 R 57 V 62 E 63 R 64 I 66 G 67 V 69 K 70 D 71 F 73 L 75 W |
| | | | p = | 0.27687 | | 76 L 77 E 78 N 79 R 80 P 81 S 82 P 87 R 88 F 90 Q 92 M 93 A 95 V |
| | | | q = | 0.49562 | | 96 I 97 K 98 D 99 F 100 H 101 M 102 V 103 S 104 Q 106 I 110 V |
| | | | $\omega$ = | 2.57616 | | 112 K 118 A 128 L 130 S 133 V 134 F 142 L 143 K 145 G 153 R 156 P |
| | | | | | | 158 S 159 T 160 V 163 H 167 V 169 Y 196 S 197 Y 206 T 207 L 209 W |
| | | | | | | 211 S 214 S 248 R 250 Y 293 V 296 L 303 L 325 A 329 N 377 A 394 E |
| | | | | | | 395 V 398 N 403 V 417 S 422 A |

| **Mouse** | **UGT2** | | | | | |
|---|---|---|---|---|---|---|
| **Model**[1] | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters**[4] | | **LRT($2\Delta\ell$)**[5] | **Positively Selected Sites**[6] |
| M0 | -7758.999805 | 1.66263 | $\omega$ = | 0.27134 | N/A | None |
| M1a | -7593.014406 | 1.80026 | $p_0$ = | 0.6882 | N/A | Not allowed |
| | | | $p_1$ = | 0.3118 | | |
| M2a | -7592.975076 | 1.80659 | $p_0$ = | 0.68775 | 0.07866 | 159 T |
| | | | $p_1$ = | 0.31115 | p>0.5 | |
| | | | $p_2$ = | 0.0011 | | |
| | | | $\omega_2$ = | 4.46072 | | |
| M3 | -7584.144422 | 1.73597 | $p_0$ = | 0.54903 | 349.710766 | 8 M 10 G 24 L 25 R 39 L 43 P 44 S 45 S 47 S 51 T 60 G 63 K 64 I |
| | | | $p_1$ = | 0.31668 | p<0.001 | 66 S 67 V 69 K 71 F 73 L 74 T 75 W 79 R 87 T 90 K 91 E 95 V 97 E |
| | | | $p_2$ = | 0.13429 | | 99 F 101 L 102 V 112 K 115 K 118 S 130 S 133 V 145 G 155 S 159 T |
| | | | $\omega_0$ = | 0.06086 | | 160 V 184 Q 196 S 197 Y 199 M 209 W 211 Q 214 S 219 A 227 C |
| | | | $\omega_1$ = | 0.4633 | | 250 Y 394 E 398 N 458 V |
| | | | $\omega_2$ = | 1.14667 | | |
| M7 | -7588.299719 | 1.69517 | p = | 0.40064 | N/A | Not allowed |
| | | | q = | 0.8832 | | |
| M8 | -7584.514194 | 1.73022 | $p_0$ = | 0.81062 | 7.57105 | 47 S 69 K 71 F 73 L |
| | | | $p_1$ = | 0.18938 | p<0.5 | 74 T 97 E 99 F |
| | | p = 0.68851, q = 3.18426, $\omega$ = 1.00774 | | | | 159 T 160 V 211 Q |

| Rat | UGT2 | | | | | |
|---|---|---|---|---|---|---|
| **Model[1]** | $\ell$[2] | $\kappa$[3] | **Estimate of Parameters[4]** | | **LRT($2\Delta\ell$)[5]** | **Positively Selected Sites[6]** |
| M0 | -8858.273247 | 1.68898 | $\omega$ = | 0.29892 | N/A | None |
| M1a | -8593.840049 | 1.8352 | $p_0$ = | 0.63102 | N/A | Not allowed |
| | | | $p_1$ = | 0.36898 | | |
| M2a | -8593.670226 | 1.84778 | $p_0$ = | 0.6298 | 0.339646 | 211 Q |
| | | | $p_1$ = | 0.36229 | p>0.5 | |
| | | | $p_2$ = | 0.0079 | | |
| | | | $\omega_2$ = | 2.32473 | | |
| M3 | -8582.004433 | 1.78155 | $p_0$ = | 0.43316 | 552.537628 | 8 M 10 G 16 V 21 D 24 L 25 R 34 V 35 A 38 A 39 L 42 T 43 P 45 S |
| | | | $p_1$ = | 0.30836 | p<0.001 | 46 V 47 S 49 S 51 T 54 I 57 V 58 P 59 F 60 G 61 K 62 E 63 K 64 I |
| | | | $p_2$ = | 0.25848 | | 66 S 67 V 69 K 70 D 71 F 73 L 74 T 75 W 76 L 77 E 79 R 81 S 82 P |
| | | | $\omega_0$ = | 0.03241 | | 83 S 85 I 87 T 88 F 89 Y 90 K 91 E 92 M 93 A 94 K 95 V 96 I 97 E |
| | | | $\omega_1$ = | 0.31256 | | 98 E 99 F 102 V 103 S 104 R 105 G 106 I 108 D 109 G 110 V 111 L |
| | | | $\omega_2$ = | 1.03414 | | 112 K 115 K 118 T 122 R 123 G 124 K 128 L 129 L 130 S 134 F 143 K |
| | | | | | | 145 G 155 S 156 P 158 S 159 T 160 V 166 K 167 V 169 F 176 A 182 T |
| | | | | | | 184 Q 188 A 196 S 197 Y 199 M 205 E 206 T 209 W 211 Q 214 S 219 A |
| | | | | | | 226 L 227 C 231 G 250 Y 294 K 303 L 320 K 325 A 333 L 334 F 380 P |
| | | | | | | 387 K 394 E 395 V 398 N 403 A 410 R 411 A 458 V 460 A |
| M7 | -8585.621695 | 1.73674 | p = | 0.31242 | N/A | Not allowed |
| | | | q = | 0.5888 | | |
| M8 | -8581.130328 | 1.78311 | $p_0$ = | 0.85585 | 8.982734 | 47 S 69 K 71 F 74 T 90 K |
| | | | $p_1$ = | 0.14415 | p<0.5 | 91 E 97 E 102 V 105 G 197 Y |
| | | | p = | 0.41843 | | 206 T 209 W 211 Q 394 E |
| | | | q = | 1.32916 | | |
| | | | $\omega$ = | 1.22911 | | |

**Model[1]** Maximum likelihood models implemented in the codeml program of the PAML package.

M0, one-ratio; M1a, neutral; M2a, selection; M3, discrete; M7, $\beta$; M8, $\beta+\omega$.

**$\ell$[2]** Estimated log-likelihood values by the codeml program.

**$\kappa$[3]** Estimated transition/transversion rate ratio by the codeml program.

**Estimation of Parameters[4]** $\omega=K_A/K_S$ nonsynonymous/synonymous rate ratio; p=proportion of sites for each site class. M0: one estimated $\omega$ for all sites; M1a: estimate $p_0$=proportion of sites with $\omega_0=0$, $p_1=1 - p_0$, proportion of sites with $\omega_1=1$; M2a: estimate $p_0$ ($\omega_0=0$), $p_1$ ($\omega_0=1$), and $\omega_2$, $p_2=1 - p_0 - p_1$. M3: estimate $p_0$, $p_1$, $\omega_0$, $\omega_1$, and $\omega_2$; $p_2=1 - p_0 - p_1$. M7: estimate p and q (parameters of $\beta$ distribution of $\omega$ between 0 and 1). M8: same as M7 except additional site class where an estimated $\omega$ is allowed.

**LRT($2\Delta\ell$)[5]** Statistical likelihood ratio test; comparing the test statistic ($2\Delta\ell$) calculated from paired codeml models (M1a vs M2a; M0 vs M3; and M7 vs M8) with the critical value of chi-square asymptotic distribution with appropriate degrees of freedom (i.e. 2 d.f., 4 d.f., and 2 d.f., respectively). $2\Delta\ell$ and level of significance are shown for M2a, M3, and M8 models.

**Positively Selected Sites[6]** Codon positions predicted to be under positive selection with a posterior probability >0.90 by one codeml model (M2a, M3, or M8), and >0.50 by at least one other model.