

Supplementary materials

Table S1: Full details of the genetic code organization (amino acid numbers 1–1274) in the S-protein gene of Table 2. The genome codes (1274 codes) were divided into seven classes (classes 1–6 had 200 codes each; class 7 had 74 codes).

Class 1: Amino acids 1–200

| Amino acid No. 1-100 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 | Amino acid No. 101-200 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 |
|----------------------|--------|------------------------|-----------------------|------------------------|--------|------------------------|-----------------------|
| 1 | ATG | 45M | 3rd | 101 | ATA | 29I | 2nd |
| 2 | TTT | 63F | 4th | 102 | AGA | 25R | 2nd |
| 3 | GTT | 62V | 4th | 103 | GGC | 10G | 1st |
| 4 | TTT | 63F | 4th | 104 | TGG | 43W | 3rd |
| 5 | CTT | 60L | 4th | 105 | ATT | 61I | 4th |
| 6 | GTT | 62V | 4th | 106 | TTT | 63F | 4th |
| 7 | TTA | 31L | 2nd | 107 | GGT | 58G | 4th |
| 8 | TTG | 47L | 3rd | 108 | ACT | 49T | 4th |
| 9 | CCA | 16P | 2nd | 109 | ACT | 49T | 4th |
| 10 | CTA | 28L | 2nd | 110 | TTA | 31L | 2nd |
| 11 | GTC | 14V | 1st | 111 | GAT | 54D | 4th |
| 12 | TCT | 51S | 4th | 112 | TCG | 35S | 3rd |
| 13 | AGT | 57S | 4th | 113 | AAG | 37K | 3rd |
| 14 | CAG | 36Q | 3rd | 114 | ACC | 1T | 1st |
| 15 | TGT | 59C | 4th | 115 | CAG | 36Q | 3rd |
| 16 | GTT | 62V | 4th | 116 | TCC | 3S | 1st |
| 17 | AAT | 53N | 4th | 117 | CTA | 28L | 2nd |
| 18 | CTT | 60L | 4th | 118 | CTT | 60L | 4th |
| 19 | ACA | 17T | 2nd | 119 | ATT | 61I | 4th |
| 20 | ACC | 1T | 1st | 120 | GTT | 62V | 4th |
| 21 | AGA | 25R | 2nd | 121 | AAT | 53N | 4th |
| 22 | ACT | 49T | 4th | 122 | AAC | 5N | 1st |
| 23 | CAA | 20Q | 2nd | 123 | GCT | 50A | 4th |
| 24 | TTA | 31L | 2nd | 124 | ACT | 49T | 4th |
| 25 | CCC | 0P | 1st | 125 | AAT | 53N | 4th |
| 26 | CCT | 48P | 4th | 126 | GTT | 62V | 4th |
| 27 | GCA | 18A | 2nd | 127 | GTT | 62V | 4th |
| 28 | TAC | 7Y | 1st | 128 | ATT | 61I | 4th |
| 29 | ACT | 49T | 4th | 129 | AAA | 21K | 2nd |
| 30 | AAT | 53N | 4th | 130 | GTC | 14V | 1st |
| 31 | TCT | 51S | 4th | 131 | TGT | 59C | 4th |

| | | | | | | | |
|----|-----|------|-----|-----|-----|-----|-----|
| 32 | TTC | 15F | 1st | 132 | GAA | 22E | 2nd |
| 33 | ACA | 17T | 2nd | 133 | TTT | 63F | 4th |
| 34 | CGT | 56R | 4th | 134 | CAA | 20Q | 2nd |
| 35 | GGT | 58G | 4th | 135 | TTT | 63F | 4th |
| 36 | GTT | 62V | 4th | 136 | TGT | 59C | 4th |
| 37 | TAT | 55Y | 4th | 137 | AAT | 53N | 4th |
| 38 | TAC | 7Y | 1st | 138 | GAT | 54D | 4th |
| 39 | CCT | 48P | 4th | 139 | CCA | 16P | 2nd |
| 40 | GAC | 6D | 1st | 140 | TTT | 63F | 4th |
| 41 | AAA | 21K | 2nd | 141 | TTG | 47L | 3rd |
| 42 | GTT | 62V | 4th | 142 | GGT | 58G | 4th |
| 43 | TTC | 15F | 1st | 143 | GTT | 62V | 4th |
| 44 | AGA | 25R | 2nd | 144 | TAT | 55Y | 4th |
| 45 | TCC | 3S | 1st | 145 | TAC | 7Y | 1st |
| 46 | TCA | 19S | 2nd | 146 | CAC | 4H | 1st |
| 47 | GTT | 62V | 4th | 147 | AAA | 21K | 2nd |
| 48 | TTA | 31L | 2nd | 148 | AAC | 5N | 1st |
| 49 | CAT | 52H | 4th | 149 | AAC | 5N | 1st |
| 50 | TCA | 19S | 2nd | 150 | AAA | 21K | 2nd |
| 51 | ACT | 49T | 4th | 151 | AGT | 57S | 4th |
| 52 | CAG | 36Q | 3rd | 152 | TGG | 43W | 3rd |
| 53 | GAC | 6D | 1st | 153 | ATG | 45M | 3rd |
| 54 | TTG | 47L | 3rd | 154 | GAA | 22E | 2nd |
| 55 | TTC | 15F | 1st | 155 | AGT | 57S | 4th |
| 56 | TTA | 31L | 2nd | 156 | GAG | 38E | 3rd |
| 57 | CCT | 48P | 4th | 157 | TTC | 15F | 1st |
| 58 | TTC | 15F | 1st | 158 | AGA | 25R | 2nd |
| 59 | TTT | 63F | 4th | 159 | GTT | 62V | 4th |
| 60 | TCC | 3S | 1st | 160 | TAT | 55Y | 4th |
| 61 | AAT | 53N | 4th | 161 | TCT | 51S | 4th |
| 62 | GTT | 62V | 4th | 162 | AGT | 57S | 4th |
| 63 | ACT | 49T | 4th | 163 | GCG | 34A | 3rd |
| 64 | TGG | 43W | 3rd | 164 | AAT | 53N | 4th |
| 65 | TTC | 15F | 1st | 165 | AAT | 53N | 4th |
| 66 | CAT | 52H | 4th | 166 | TGC | 11C | 1st |
| 67 | GCT | 50A | 4th | 167 | ACT | 49T | 4th |
| 68 | ATA | 29 I | 2nd | 168 | TTT | 63F | 4th |
| 69 | CAT | 52H | 4th | 169 | GAA | 22E | 2nd |
| 70 | GTC | 14V | 1st | 170 | TAT | 55Y | 4th |
| 71 | TCT | 51S | 4th | 171 | GTC | 14V | 1st |
| 72 | GGG | 42G | 3rd | 172 | TCT | 51S | 4th |
| 73 | ACC | 1T | 1st | 173 | CAG | 36Q | 3rd |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 74 | AAT | 53N | 4th | 174 | CCT | 48P | 4th |
| 75 | GGT | 58G | 4th | 175 | TTT | 63F | 4th |
| 76 | ACT | 49T | 4th | 176 | CTT | 60L | 4th |
| 77 | AAG | 37K | 3rd | 177 | ATG | 45M | 3rd |
| 78 | AGG | 41R | 3rd | 178 | GAC | 6D | 1st |
| 79 | TTT | 63F | 4th | 179 | CTT | 60L | 4th |
| 80 | GAT | 54D | 4th | 180 | GAA | 22E | 2nd |
| 81 | AAC | 5N | 1st | 181 | GGA | 26G | 2nd |
| 82 | CCT | 48P | 4th | 182 | AAA | 21K | 2nd |
| 83 | GTC | 14V | 1st | 183 | CAG | 36Q | 3rd |
| 84 | CTA | 28L | 2nd | 184 | GGT | 58G | 4th |
| 85 | CCA | 16P | 2nd | 185 | AAT | 53N | 4th |
| 86 | TTT | 63F | 4th | 186 | TTC | 15F | 1st |
| 87 | AAT | 53N | 4th | 187 | AAA | 21K | 2nd |
| 88 | GAT | 54D | 4th | 188 | AAT | 53N | 4th |
| 89 | GGT | 58G | 4th | 189 | CTT | 60L | 4th |
| 90 | GTT | 62V | 4th | 190 | AGG | 41R | 3rd |
| 91 | TAT | 55Y | 4th | 191 | GAA | 22E | 2nd |
| 92 | TTT | 63F | 4th | 192 | TTT | 63F | 4th |
| 93 | GCT | 50A | 4th | 193 | GTG | 46V | 3rd |
| 94 | TCC | 3S | 1st | 194 | TTT | 63F | 4th |
| 95 | ACT | 49T | 4th | 195 | AAG | 37K | 3rd |
| 96 | GAG | 38E | 3rd | 196 | AAT | 53N | 4th |
| 97 | AAG | 37K | 3rd | 197 | ATT | 61I | 4th |
| 98 | TCT | 51S | 4th | 198 | GAT | 54D | 4th |
| 99 | AAC | 5N | 1st | 199 | GGT | 58G | 4th |
| 100 | ATA | 29I | 2nd | 200 | TAT | 55Y | 4th |

Class 2: Amino acids 201–400

| Amino acid No. 201-300 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 | Amino acid No. 301-400 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 |
|------------------------|--------|------------------------|-----------------------|------------------------|--------|------------------------|-----------------------|
| 201 | TTT | 63F | 4th | 301 | TGT | 59C | 4th |
| 202 | AAA | 21K | 2nd | 302 | ACG | 33T | 3rd |
| 203 | ATA | 29I | 2nd | 303 | TTG | 47L | 3rd |
| 204 | TAT | 55Y | 4th | 304 | AAA | 21K | 2nd |
| 205 | TCT | 51S | 4th | 305 | TCC | 3S | 1st |
| 206 | AAG | 37K | 3rd | 306 | TTC | 15F | 1st |
| 207 | CAC | 4H | 1st | 307 | ACT | 49T | 4th |
| 208 | ACG | 33T | 3rd | 308 | GTA | 30V | 2nd |

| | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 209 | CCT | 48P | 4th | 309 | GAA | 22E | 2nd |
| 210 | ATT | 61I | 4th | 310 | AAA | 21K | 2nd |
| 211 | AAT | 53N | 4th | 311 | GGA | 26G | 2nd |
| 212 | TTA | 31L | 2nd | 312 | ATC | 13I | 1st |
| 213 | GTG | 46V | 4th | 313 | TAT | 55Y | 4th |
| 214 | CGT | 56R | 4th | 314 | CAA | 20Q | 2nd |
| 215 | GAT | 54D | 4th | 315 | ACT | 49T | 4th |
| 216 | CTC | 12L | 1st | 316 | TCT | 51S | 4th |
| 217 | CCT | 48P | 4th | 317 | AAC | 5N | 1st |
| 218 | CAG | 36Q | 3rd | 318 | TTT | 63F | 4th |
| 219 | GGT | 58G | 4th | 319 | AGA | 25R | 2nd |
| 220 | TTT | 63F | 4th | 320 | GTC | 14V | 1st |
| 221 | TCG | 35S | 3rd | 321 | CAA | 20Q | 2nd |
| 222 | GCT | 50A | 4th | 322 | CCA | 16P | 2nd |
| 223 | TTA | 31L | 2nd | 323 | ACA | 17T | 2nd |
| 224 | GAA | 22E | 2nd | 324 | GAA | 22E | 2nd |
| 225 | CCA | 16P | 2nd | 325 | TCT | 51S | 4th |
| 226 | TTG | 47L | 3rd | 326 | ATT | 61I | 4th |
| 227 | GTA | 30V | 2nd | 327 | GTT | 62V | 4th |
| 228 | GAT | 54D | 4th | 328 | AGA | 25R | 2nd |
| 229 | TTG | 47L | 3rd | 329 | TTT | 63F | 4th |
| 230 | CCA | 16P | 2nd | 330 | CCT | 48P | 4th |
| 231 | ATA | 29I | 2nd | 331 | AAT | 53N | 4th |
| 232 | GGT | 58G | 4th | 332 | ATT | 61I | 4th |
| 233 | ATT | 61I | 4th | 333 | ACA | 17T | 2nd |
| 234 | AAC | 5N | 1st | 334 | AAC | 5N | 1st |
| 235 | ATC | 13I | 1st | 335 | TTG | 47L | 4th |
| 236 | ACT | 49T | 4th | 336 | TGC | 11C | 1st |
| 237 | AGG | 41R | 3rd | 337 | CCT | 48P | 4th |
| 238 | TTT | 63F | 4th | 338 | TTT | 63F | 4th |
| 239 | CAA | 20Q | 2nd | 339 | GGT | 58G | 4th |
| 240 | ACT | 49T | 4th | 340 | GAA | 22E | 2nd |
| 241 | TTA | 31L | 2nd | 341 | GTT | 62V | 4th |
| 242 | CTT | 60L | 4th | 342 | TTT | 63F | 4th |
| 243 | GCT | 50A | 4th | 343 | AAC | 5N | 1st |
| 244 | TTA | 31L | 2nd | 344 | GCC | 2A | 1st |
| 245 | CAT | 52H | 4th | 345 | ACC | 1T | 1st |
| 246 | AGA | 25R | 2nd | 346 | AGA | 25R | 2nd |
| 247 | AGT | 57S | 4th | 347 | TTT | 63F | 4th |
| 248 | TAT | 55Y | 4th | 348 | GCA | 18A | 2nd |
| 249 | TTG | 47L | 3rd | 349 | TCT | 51S | 4th |
| 250 | ACT | 49T | 4th | 350 | GTT | 62V | 4th |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 251 | CCT | 48P | 4th | 351 | TAT | 55Y | 4th |
| 252 | GGT | 58G | 4th | 352 | GCT | 50A | 4th |
| 253 | GAT | 54D | 4th | 353 | TGG | 43W | 3rd |
| 254 | TCT | 51S | 4th | 354 | AAC | 5N | 1st |
| 255 | TCT | 51S | 4th | 355 | AGG | 41R | 3rd |
| 256 | TCA | 19S | 2nd | 356 | AAG | 37K | 3rd |
| 257 | GGT | 58G | 4th | 357 | AGA | 25R | 2nd |
| 258 | TGG | 43W | 3rd | 358 | ATC | 13I | 1st |
| 259 | ACA | 17T | 2nd | 359 | AGC | 9S | 1st |
| 260 | GCT | 50A | 4th | 360 | AAC | 5N | 1st |
| 261 | GGT | 58G | 4th | 361 | TGT | 59C | 4th |
| 262 | GCT | 50A | 4th | 362 | GTT | 62V | 4th |
| 263 | GCA | 18A | 2nd | 363 | GCT | 50A | 4th |
| 264 | GCT | 50A | 4th | 364 | GAT | 54D | 4th |
| 265 | TAT | 55Y | 4th | 365 | TAT | 55Y | 4th |
| 266 | TAT | 55Y | 4th | 366 | TCT | 51S | 4th |
| 267 | GTG | 46V | 3rd | 367 | GTC | 14V | 1st |
| 268 | GGT | 58G | 4th | 368 | CTA | 28L | 2nd |
| 269 | TAT | 55Y | 4th | 369 | TAT | 55Y | 4th |
| 270 | CTT | 60L | 4th | 370 | AAT | 53N | 4th |
| 271 | CAA | 20Q | 2nd | 371 | TCC | 3S | 1st |
| 272 | CTT | 48P | 4th | 372 | GCA | 18A | 2nd |
| 273 | AGG | 41R | 3rd | 373 | TCA | 19S | 2nd |
| 274 | ACT | 49T | 4th | 374 | TTT | 63F | 4th |
| 275 | TTT | 63F | 4th | 375 | TCC | 3S | 1st |
| 276 | CTA | 28L | 2nd | 376 | ACT | 49T | 4th |
| 277 | TTA | 31L | 2nd | 377 | TTT | 63F | 4th |
| 278 | AAA | 21K | 2nd | 378 | AAG | 37K | 3rd |
| 279 | TAT | 55Y | 4th | 379 | TGT | 59C | 4th |
| 280 | AAT | 53N | 4th | 380 | TAT | 55Y | 4th |
| 281 | GAA | 22E | 2nd | 381 | GGA | 26G | 2nd |
| 282 | AAT | 53N | 4th | 382 | GTG | 46V | 3rd |
| 283 | GGA | 26G | 2nd | 383 | TCT | 51S | 4th |
| 284 | ACC | 1T | 1st | 384 | CCT | 48P | 4th |
| 285 | ATT | 61I | 4th | 385 | ACT | 49T | 4th |
| 286 | ACA | 17T | 2nd | 386 | AAA | 21K | 2nd |
| 287 | GAT | 54D | 4th | 387 | TTA | 31L | 2nd |
| 288 | GCT | 50A | 4th | 388 | AAT | 53N | 4th |
| 289 | GTA | 30V | 2nd | 389 | GAT | 54D | 4th |
| 290 | GAC | 6D | 1st | 390 | CTC | 12L | 1st |
| 291 | TGT | 59C | 4th | 391 | TGC | 11C | 1st |
| 292 | GCA | 18A | 2nd | 392 | TTT | 63F | 4th |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 293 | CTT | 60L | 4th | 393 | ACT | 49T | 4th |
| 294 | GAC | 6D | 1st | 394 | AAT | 53N | 4th |
| 295 | CCT | 48P | 4th | 395 | GTC | 14V | 1st |
| 296 | CTC | 12L | 1st | 396 | TAT | 55Y | 4th |
| 297 | TCA | 19S | 2nd | 397 | GCA | 18A | 2nd |
| 298 | GAA | 22E | 2nd | 398 | GAT | 54D | 4th |
| 299 | ACA | 17T | 2nd | 399 | TCA | 19S | 2nd |
| 300 | AAG | 37K | 3rd | 400 | TTT | 63F | 4th |

Class 3: Amino acids 401–600

| Amino acid No. 401-500 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 | Amino acid No. 501-600 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 |
|------------------------|--------|------------------------|-----------------------|------------------------|--------|------------------------|-----------------------|
| 401 | GTA | 30V | 3rd | 501 | AAT | 53N | 4th |
| 402 | ATT | 61I | 4th | 502 | GGT | 58G | 4th |
| 403 | AGA | 25R | 2nd | 503 | GTT | 62V | 4th |
| 404 | GGT | 58G | 4th | 504 | GGT | 58G | 4th |
| 405 | GAT | 54D | 4th | 505 | TAC | 7Y | 1st |
| 406 | GAA | 22E | 2nd | 506 | CAA | 20Q | 2nd |
| 407 | GTC | 14V | 1st | 507 | CCA | 16P | 2nd |
| 408 | AGA | 25R | 2nd | 508 | TAC | 7Y | 1st |
| 409 | CAA | 20Q | 2nd | 509 | AGA | 25R | 2nd |
| 410 | ATC | 13I | 1st | 510 | GTA | 30V | 2nd |
| 411 | GCT | 50A | 4th | 511 | GTA | 30V | 2nd |
| 412 | CCA | 16P | 2nd | 512 | GTA | 30V | 2nd |
| 413 | GGG | 42G | 3rd | 513 | CTT | 60L | 4th |
| 414 | CAA | 20Q | 2nd | 514 | TCT | 51S | 4th |
| 415 | ACT | 49T | 4th | 515 | TTT | 63F | 4th |
| 416 | GGA | 26G | 2nd | 516 | GAA | 22E | 2nd |
| 417 | AAG | 37K | 3rd | 517 | CTT | 60L | 4th |
| 418 | ATT | 61I | 4th | 518 | CTA | 28L | 2nd |
| 419 | GCT | 50A | 4th | 519 | CAT | 52H | 4th |
| 420 | GAT | 54D | 4th | 520 | GCA | 18A | 2nd |
| 421 | TAT | 55Y | 4th | 521 | CCA | 16P | 2nd |
| 422 | AAT | 53N | 4th | 522 | GCA | 18A | 2nd |
| 423 | TAT | 55Y | 4th | 523 | ACT | 49T | 4th |
| 424 | AAA | 21K | 2nd | 524 | GTT | 62V | 4th |
| 425 | TTA | 31L | 2nd | 525 | TGT | 59C | 4th |
| 426 | CCA | 16P | 2nd | 526 | GGA | 26G | 2nd |
| 427 | GAT | 54D | 4th | 527 | CCT | 48P | 4th |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 428 | GAT | 54D | 4th | 528 | AAA | 21K | 2nd |
| 429 | TTT | 63F | 4th | 529 | AAG | 37K | 3rd |
| 430 | ACA | 17T | 2nd | 530 | TCT | 51S | 4th |
| 431 | GGC | 10G | 1st | 531 | ACT | 49T | 4th |
| 432 | TGC | 11C | 1st | 532 | AAT | 53N | 4th |
| 433 | GTT | 62V | 4th | 533 | TTG | 47L | 3rd |
| 434 | ATA | 29I | 2nd | 534 | GTT | 62V | 4th |
| 435 | GCT | 50A | 4th | 535 | AAA | 21K | 2nd |
| 436 | TGG | 43W | 3rd | 536 | AAC | 5N | 1st |
| 437 | AAT | 53N | 4th | 537 | AAA | 21K | 2nd |
| 438 | TCT | 51S | 4th | 538 | TGT | 59C | 4th |
| 439 | AAC | 5N | 1st | 539 | GTC | 14V | 1st |
| 440 | AAT | 53N | 4th | 540 | AAT | 53N | 4th |
| 441 | CTT | 60L | 4th | 541 | TTC | 15F | 1st |
| 442 | GAT | 54D | 4th | 542 | AAC | 5N | 1st |
| 443 | TCT | 51S | 4th | 543 | TTC | 15F | 1st |
| 444 | AAG | 37K | 3rd | 544 | AAT | 53N | 4th |
| 445 | GTT | 62V | 4th | 545 | GGT | 58G | 4th |
| 446 | GGT | 58G | 4th | 546 | TTA | 31L | 2nd |
| 447 | GGT | 58G | 4th | 547 | ACA | 17T | 2nd |
| 448 | AAT | 53N | 4th | 548 | GGC | 10G | 1st |
| 449 | TAT | 55Y | 4th | 549 | ACA | 17T | 2nd |
| 450 | AAT | 53N | 4th | 550 | GGT | 58G | 4th |
| 451 | TAC | 7Y | 1st | 551 | GTT | 62V | 4th |
| 452 | CTG | 44L | 3rd | 552 | CTT | 60L | 4th |
| 453 | TAT | 55Y | 4th | 553 | ACT | 49T | 4th |
| 454 | AGA | 25R | 2nd | 554 | GAG | 38E | 3rd |
| 455 | TTG | 47L | 3rd | 555 | TCT | 51S | 4th |
| 456 | TTT | 63F | 4th | 556 | AAC | 5N | 1st |
| 457 | AGG | 41R | 3rd | 557 | AAA | 21K | 2nd |
| 458 | AAG | 37K | 3rd | 558 | AAG | 37K | 3rd |
| 459 | TCT | 51S | 4th | 559 | TTT | 63F | 4th |
| 460 | AAT | 53N | 4th | 560 | CTG | 44L | 3rd |
| 461 | CTC | 12L | 1st | 561 | CCT | 48P | 4th |
| 462 | AAA | 21K | 2nd | 562 | TTC | 15F | 1st |
| 463 | CCT | 48P | 4th | 563 | CAA | 20Q | 2nd |
| 464 | TTT | 63F | 4th | 564 | CAA | 20Q | 2nd |
| 465 | GAG | 38E | 3rd | 565 | TTT | 63F | 4th |
| 466 | AGA | 25R | 2nd | 566 | GGC | 10G | 1st |
| 467 | GAT | 54D | 4th | 567 | AGA | 25R | 2nd |
| 468 | ATT | 61I | 4th | 568 | GAC | 6D | 1st |
| 469 | TCA | 19S | 2nd | 569 | ATT | 61I | 4th |

| | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 470 | ACT | 49T | 4th | 570 | GCT | 50A | 4th |
| 471 | GAA | 22E | 2nd | 571 | GAC | 6D | 1st |
| 472 | ATC | 13I | 1st | 572 | ACT | 49T | 4th |
| 473 | TAT | 55Y | 4th | 573 | ACT | 49T | 4th |
| 474 | CAG | 36Q | 3rd | 574 | GAT | 54D | 4th |
| 475 | GCC | 2A | 1st | 575 | GCT | 50A | 4th |
| 476 | GGT | 58G | 4th | 576 | GTC | 14V | 1st |
| 477 | AGC | 9S | 1st | 577 | CGT | 56R | 4th |
| 478 | ACA | 17T | 2nd | 578 | GAT | 54D | 4th |
| 479 | CCT | 48P | 4th | 579 | CCA | 16P | 2nd |
| 480 | TGT | 59C | 4th | 580 | CAG | 36Q | 3rd |
| 481 | AAT | 53N | 4th | 581 | ACA | 17T | 2nd |
| 482 | GGT | 58G | 4th | 582 | CTT | 60L | 4th |
| 483 | GTT | 62V | 4th | 583 | GAG | 38E | 3rd |
| 484 | GAA | 22E | 2nd | 584 | ATT | 61I | 4th |
| 485 | GGT | 58G | 4th | 585 | CTT | 60L | 4th |
| 486 | TTT | 63F | 4th | 586 | GAC | 6D | 1st |
| 487 | AAT | 53N | 4th | 587 | ATT | 61I | 4th |
| 488 | TGT | 59C | 4th | 588 | ACA | 17T | 2nd |
| 489 | TAC | 7Y | 1st | 589 | CCA | 16P | 2nd |
| 490 | TTT | 63F | 4th | 590 | TGT | 59C | 4th |
| 491 | CCT | 48P | 4th | 591 | TCT | 51S | 4th |
| 492 | TTA | 31L | 2nd | 592 | TTT | 63F | 4th |
| 493 | CAA | 20Q | 2nd | 593 | GGT | 58G | 4th |
| 494 | TCA | 19S | 2nd | 594 | GGT | 58G | 4th |
| 495 | TAT | 55Y | 4th | 595 | GTC | 14V | 1st |
| 496 | GGT | 58G | 4th | 596 | AGT | 57S | 4th |
| 497 | TTC | 15F | 1st | 597 | GTT | 62V | 4th |
| 498 | CAA | 20Q | 2nd | 598 | ATA | 29I | 2nd |
| 499 | CCC | 0P | 1st | 599 | ACA | 17T | 2nd |
| 500 | ACT | 49T | 4th | 600 | CCA | 16P | 2nd |

Class 4: Amino acids 601–800

| Amino acid No. 601-700 | Codons | Codon No. Amino acid | Plane No. in Figure 1 | Amino acid No. 701-800 | Codons | Codon No. Amino acid | Plane No. in Figure 1 |
|------------------------|--------|----------------------|-----------------------|------------------------|--------|----------------------|-----------------------|
| 601 | GGA | 26G | 2nd | 701 | GCA | 18A | 2nd |
| 602 | ACA | 17T | 2nd | 702 | GAA | 22E | 2nd |
| 603 | AAT | 53N | 4th | 703 | AAT | 53N | 4th |
| 604 | ACT | 49T | 4th | 704 | TCA | 19S | 2nd |

| | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 605 | TCT | 51S | 4th | 705 | GTT | 62V | 4th |
| 606 | AAC | 5N | 1st | 706 | GCT | 50A | 4th |
| 607 | CAG | 36Q | 3rd | 707 | TAC | 7Y | 1st |
| 608 | GTT | 62V | 4th | 708 | TCT | 51S | 4th |
| 609 | GCT | 50A | 4th | 709 | AAT | 53N | 4th |
| 610 | GTT | 62V | 4th | 710 | AAC | 5N | 1st |
| 611 | CTT | 60L | 4th | 711 | TCT | 51S | 4th |
| 612 | TAT | 55Y | 4th | 712 | ATT | 61I | 4th |
| 613 | CAG | 36Q | 3rd | 713 | GCC | 2A | 1st |
| 614 | GAT | 54D | 4th | 714 | ATA | 29I | 2nd |
| 615 | GTT | 62V | 4th | 715 | CCC | 0P | 1st |
| 616 | AAC | 5N | 1st | 716 | ACA | 17T | 2nd |
| 617 | TGC | 11C | 1st | 717 | AAT | 53N | 4th |
| 618 | ACA | 17T | 2nd | 718 | TTT | 63F | 4th |
| 619 | GAA | 22E | 2nd | 719 | ACT | 49T | 4th |
| 620 | GTC | 14V | 1st | 720 | ATT | 61I | 4th |
| 621 | CCT | 48P | 4th | 721 | AGT | 57S | 4th |
| 622 | GTT | 62V | 4th | 722 | GTT | 62V | 4th |
| 623 | GCT | 50A | 4th | 723 | ACC | 1T | 1st |
| 624 | ATT | 61I | 4th | 724 | ACA | 17T | 2nd |
| 625 | CAT | 52H | 4th | 725 | GAA | 22E | 2nd |
| 626 | GCA | 18A | 2nd | 726 | ATT | 61I | 4th |
| 627 | GAT | 54D | 4th | 727 | CTA | 28L | 2nd |
| 628 | CAA | 20Q | 2nd | 728 | CCA | 16P | 2nd |
| 629 | CTT | 60L | 4th | 729 | GTG | 46V | 3rd |
| 630 | ACT | 49T | 4th | 730 | TCT | 51S | 4th |
| 631 | CCT | 48P | 4th | 731 | ATG | 45M | 3rd |
| 632 | ACT | 49T | 4th | 732 | ACC | 1T | 1st |
| 633 | TGG | 43W | 3rd | 733 | AAG | 37K | 3rd |
| 634 | CGT | 56R | 4th | 734 | ACA | 17T | 2nd |
| 635 | GTT | 62V | 4th | 735 | TCA | 19S | 2nd |
| 636 | TAT | 55Y | 4th | 736 | GTA | 30V | 2nd |
| 637 | TCT | 51S | 4th | 737 | GAT | 54D | 4th |
| 638 | ACA | 17T | 2nd | 738 | TGT | 59C | 4th |
| 639 | GGT | 58G | 4th | 739 | ACA | 17T | 2nd |
| 640 | TCT | 51S | 4th | 740 | ATG | 45M | 3rd |
| 641 | AAT | 53N | 4th | 741 | TAC | 7Y | 1st |
| 642 | GTT | 62V | 4th | 742 | ATT | 61I | 4th |
| 643 | TTT | 63F | 4th | 743 | TGT | 59C | 4th |
| 644 | CAA | 20Q | 2nd | 744 | GGT | 58G | 4th |
| 645 | ACA | 17T | 2nd | 745 | GAT | 54D | 4th |
| 646 | CGT | 56R | 4th | 746 | TCA | 19S | 2nd |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 647 | GCA | 18A | 2nd | 747 | ACT | 49T | 4th |
| 648 | GGC | 10G | 1st | 748 | GAA | 22E | 2nd |
| 649 | TGT | 59C | 4th | 749 | TGC | 11C | 1st |
| 650 | TTA | 31L | 2nd | 750 | AGC | 9S | 1st |
| 651 | ATA | 29I | 2nd | 751 | AAT | 53N | 4th |
| 652 | GGG | 42G | 3rd | 752 | CTT | 60L | 4th |
| 653 | GCT | 50A | 4th | 753 | TTG | 47L | 3rd |
| 654 | GAA | 22E | 2nd | 754 | TTG | 47L | 3rd |
| 655 | CAT | 52H | 4th | 755 | CAA | 20Q | 2nd |
| 656 | GTC | 14V | 1st | 756 | TAT | 55Y | 4th |
| 657 | AAC | 5N | 1st | 757 | GGC | 10G | 1st |
| 658 | AAC | 5N | 1st | 758 | AGT | 57S | 4th |
| 659 | TCA | 19S | 2nd | 759 | TTT | 63F | 4th |
| 660 | TAT | 55Y | 4th | 760 | TGT | 59C | 4th |
| 661 | GAG | 38E | 3rd | 761 | ACA | 17T | 2nd |
| 662 | TGT | 59C | 4th | 762 | CAA | 20Q | 2nd |
| 663 | GAC | 6D | 1st | 763 | TTA | 31L | 2nd |
| 664 | ATA | 29I | 2nd | 764 | AAC | 5N | 1st |
| 665 | CCC | 0P | 1st | 765 | CGT | 56R | 4th |
| 666 | ATT | 61I | 4th | 766 | GCT | 50A | 4th |
| 667 | GGT | 58G | 4th | 767 | TTA | 31L | 2nd |
| 668 | GCA | 18A | 2nd | 768 | ACT | 49T | 4th |
| 669 | GGT | 58G | 4th | 769 | GGA | 26G | 2nd |
| 670 | ATA | 29I | 2nd | 770 | ATA | 29I | 2nd |
| 671 | TGC | 11C | 1st | 771 | GCT | 50A | 4th |
| 672 | GCT | 50A | 4th | 772 | GTT | 62V | 4th |
| 673 | AGT | 57S | 4th | 773 | GAA | 22E | 2nd |
| 674 | TAT | 55Y | 4th | 774 | CAA | 20Q | 2nd |
| 675 | CAG | 36Q | 3rd | 775 | GAC | 6D | 1st |
| 676 | ACT | 49T | 4th | 776 | AAA | 21K | 2nd |
| 677 | CAG | 36Q | 3rd | 777 | AAC | 5N | 1st |
| 678 | ACT | 49T | 4th | 778 | ACC | 1T | 1st |
| 679 | AAT | 53N | 4th | 779 | CAA | 20Q | 2nd |
| 680 | TCT | 51S | 4th | 780 | GAA | 22E | 2nd |
| 681 | CCT | 48P | 4th | 781 | GTT | 62V | 4th |
| 682 | CGG | 40R | 3rd | 782 | TTT | 63F | 4th |
| 683 | CGG | 40R | 3rd | 783 | GCA | 18A | 2nd |
| 684 | GCA | 18A | 2nd | 784 | CAA | 20Q | 2nd |
| 685 | CGT | 56R | 4th | 785 | GTC | 14V | 1st |
| 686 | AGT | 57S | 4th | 786 | AAA | 21K | 2nd |
| 687 | GTA | 30V | 2nd | 787 | CAA | 20Q | 2nd |
| 688 | GCT | 50A | 4th | 788 | ATT | 61I | 4th |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 689 | AGT | 57S | 4th | 789 | TAC | 7Y | 1st |
| 690 | CAA | 20Q | 2nd | 790 | AAA | 21K | 2nd |
| 691 | TCC | 3S | 1st | 791 | ACA | 17T | 2nd |
| 692 | ATC | 13I | 1st | 792 | CCA | 16P | 2nd |
| 693 | ATT | 61I | 4th | 793 | CCA | 16P | 2nd |
| 694 | GCC | 2A | 1st | 794 | ATT | 61I | 4th |
| 695 | TAC | 7Y | 1st | 795 | AAA | 21K | 2nd |
| 696 | ACT | 49T | 4th | 796 | GAT | 54D | 4th |
| 697 | ATG | 45M | 3rd | 797 | TTT | 63F | 4th |
| 698 | TCA | 19S | 2nd | 798 | GGT | 58G | 4th |
| 699 | CTT | 60L | 4th | 799 | GGT | 58G | 4th |
| 700 | GGT | 58G | 4th | 800 | TTT | 63F | 4th |

Class 5: Amino acids 801–1000

| Amino acid No. 801-900 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 | Amino acid No. 901-1000 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 |
|------------------------|--------|------------------------|-----------------------|-------------------------|--------|------------------------|-----------------------|
| 801 | AAT | 53N | 4th | 901 | CAA | 20Q | 2nd |
| 802 | TTT | 63F | 4th | 902 | ATG | 45M | 3rd |
| 803 | TCA | 19S | 2nd | 903 | GCT | 50A | 4th |
| 804 | CAA | 20Q | 2nd | 904 | TAT | 55Y | 4th |
| 805 | ATA | 29I | 2nd | 905 | AGG | 41R | 3rd |
| 806 | TTA | 31L | 2nd | 906 | TTT | 63F | 4th |
| 807 | CCA | 16P | 2nd | 907 | AAT | 53N | 4th |
| 808 | GAT | 54D | 4th | 908 | GGT | 58G | 4th |
| 809 | CCA | 16P | 2nd | 909 | ATT | 61I | 4th |
| 810 | TCA | 19S | 2nd | 910 | GGA | 26G | 2nd |
| 811 | AAA | 21K | 2nd | 911 | GTT | 62V | 4th |
| 812 | CCA | 16P | 2nd | 912 | ACA | 17T | 2nd |
| 813 | AGC | 9S | 1st | 913 | CAG | 36Q | 3rd |
| 814 | AAG | 37K | 3rd | 914 | AAT | 53N | 4th |
| 815 | AGG | 41R | 3rd | 915 | GTT | 62V | 4th |
| 816 | TCA | 19S | 2nd | 916 | CTC | 12L | 1st |
| 817 | TTT | 63F | 4th | 917 | TAT | 55Y | 4th |
| 818 | ATT | 61I | 4th | 918 | GAG | 38E | 3rd |
| 819 | GAA | 22E | 2nd | 919 | AAC | 5N | 1st |
| 820 | GAT | 54D | 4th | 920 | CAA | 20Q | 2nd |
| 821 | CTA | 28L | 2nd | 921 | AAA | 21K | 2nd |
| 822 | CTT | 60L | 4th | 922 | TTG | 47L | 3rd |
| 823 | TTC | 15F | 1st | 923 | ATT | 61I | 4th |

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|-----|-----|-----|-----|-----|-----|-----|-----|
| 824 | AAC | 5N | 1st | 924 | GCC | 2A | 1st |
| 825 | AAA | 21K | 2nd | 925 | AAC | 5N | 1st |
| 826 | GTG | 46V | 3rd | 926 | CAA | 20Q | 2nd |
| 827 | ACA | 17T | 2nd | 927 | TTT | 63F | 4th |
| 828 | CTT | 60L | 4th | 928 | AAT | 53N | 4th |
| 829 | GCA | 18A | 2nd | 929 | AGT | 57S | 4th |
| 830 | GAT | 54D | 4th | 930 | GCT | 50A | 4th |
| 831 | GCT | 50A | 4th | 931 | ATT | 61I | 4th |
| 832 | GGC | 10G | 1st | 932 | GGC | 10G | 1st |
| 833 | TTC | 15F | 1st | 933 | AAA | 21K | 2nd |
| 834 | ATC | 13I | 1st | 934 | ATT | 61I | 4th |
| 835 | AAA | 21K | 2nd | 935 | CAA | 20Q | 2nd |
| 836 | CAA | 20Q | 2nd | 936 | GAC | 6D | 1st |
| 837 | TAT | 55Y | 4th | 937 | TCA | 19S | 2nd |
| 838 | GGT | 58G | 4th | 938 | CTT | 60L | 4th |
| 839 | GAT | 54D | 4th | 939 | TCT | 51S | 4th |
| 840 | TGC | 11C | 1st | 940 | TCC | 3S | 1st |
| 841 | CTT | 60L | 4th | 941 | ACA | 17T | 2nd |
| 842 | GGT | 58G | 4th | 942 | GCA | 18A | 2nd |
| 843 | GAT | 54D | 4th | 943 | AGT | 57S | 4th |
| 844 | ATT | 61I | 4th | 944 | GCA | 18A | 2nd |
| 845 | GCT | 50A | 4th | 945 | CTT | 60L | 4th |
| 846 | GCT | 50A | 4th | 946 | GGA | 26G | 2nd |
| 847 | AGA | 25R | 2nd | 947 | AAA | 21K | 2nd |
| 848 | GAC | 6D | 1st | 948 | CTT | 60L | 4th |
| 849 | CTC | 12L | 1st | 949 | CAA | 20Q | 2nd |
| 850 | ATT | 61I | 4th | 950 | GAT | 54D | 4th |
| 851 | TGT | 59C | 4th | 951 | GTG | 46V | 3rd |
| 852 | GCA | 18A | 2nd | 952 | GTC | 14V | 1st |
| 853 | CAA | 20Q | 2nd | 953 | AAC | 5N | 1st |
| 854 | AAG | 37K | 3rd | 954 | CAA | 20Q | 2nd |
| 855 | TTT | 63F | 4th | 955 | AAT | 53N | 4th |
| 856 | AAC | 5N | 1st | 956 | GCA | 18A | 2nd |
| 857 | GGC | 10G | 1st | 957 | CAA | 20Q | 2nd |
| 858 | CTT | 60L | 4th | 958 | GCT | 50A | 4th |
| 859 | ACT | 49T | 4th | 959 | TTA | 31L | 2nd |
| 860 | GTT | 62V | 4th | 960 | AAC | 5N | 1st |
| 861 | TTG | 47L | 3rd | 961 | ACG | 33T | 3rd |
| 862 | CCA | 16P | 2nd | 962 | CTT | 60L | 4th |
| 863 | CCT | 48P | 4th | 963 | GTT | 62V | 4th |
| 864 | TTG | 47L | 3rd | 964 | AAA | 21K | 2nd |
| 865 | CTC | 12L | 1st | 965 | CAA | 20Q | 2nd |

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|-----|-----|-----|-----|------|-----|-----|-----|
| 866 | ACA | 17T | 2nd | 966 | CTT | 60L | 4th |
| 867 | GAT | 54D | 4th | 967 | AGC | 9S | 1st |
| 868 | GAA | 22E | 2nd | 968 | TCC | 3S | 1st |
| 869 | ATG | 45M | 3rd | 969 | AAT | 53N | 4th |
| 870 | ATT | 61I | 4th | 970 | TTT | 63F | 4th |
| 871 | GCT | 50A | 4th | 971 | GGT | 58G | 4th |
| 872 | CAA | 20Q | 2nd | 972 | GCA | 18A | 2nd |
| 873 | TAC | 7Y | 1st | 973 | ATT | 61I | 4th |
| 874 | ACT | 49T | 4th | 974 | TCA | 19S | 2nd |
| 875 | TCT | 51S | 4th | 975 | AGT | 57S | 4th |
| 876 | GCA | 18A | 2nd | 976 | GTT | 62V | 4th |
| 877 | CTG | 44L | 3rd | 977 | TTA | 31L | 2nd |
| 878 | TTA | 31L | 2nd | 978 | AAT | 53N | 4th |
| 879 | GCG | 34A | 3rd | 979 | GAT | 54D | 4th |
| 880 | GGT | 58G | 4th | 980 | ATC | 13I | 1st |
| 881 | ACA | 17T | 2nd | 981 | CTT | 60L | 4th |
| 882 | ATC | 13I | 1st | 982 | TCA | 19S | 2nd |
| 883 | ACT | 49T | 4th | 983 | CGT | 56R | 4th |
| 884 | TCT | 51S | 4th | 984 | CTT | 60L | 4th |
| 885 | GGT | 58G | 4th | 985 | GAC | 6D | 1st |
| 886 | TGG | 43W | 3rd | 986 | AAA | 21K | 2nd |
| 887 | ACC | 1T | 1st | 987 | GTT | 62V | 4th |
| 888 | TTT | 63F | 4th | 988 | GAG | 38E | 3rd |
| 889 | GGT | 58G | 4th | 989 | GCT | 50A | 4th |
| 890 | GCA | 18A | 2nd | 990 | GAA | 22E | 2nd |
| 891 | GGT | 58G | 4th | 991 | GTG | 46V | 3rd |
| 892 | GCT | 50A | 4th | 992 | CAA | 20Q | 2nd |
| 893 | GCA | 18A | 2nd | 993 | ATT | 61I | 4th |
| 894 | TTA | 31L | 2nd | 994 | GAT | 54D | 4th |
| 895 | CAA | 20Q | 2nd | 995 | AGG | 41R | 3rd |
| 896 | ATA | 29I | 2nd | 996 | TTG | 47L | 3rd |
| 897 | CCA | 16P | 2nd | 997 | ATC | 13I | 1st |
| 898 | TTT | 63F | 4th | 998 | ACA | 17T | 2nd |
| 899 | GCT | 50A | 4th | 999 | GGC | 10G | 1st |
| 900 | ATG | 45M | 3rd | 1000 | AGA | 25R | 2nd |

Class 6: Amino acids 1001–1200

| Amino acid No. 1001-1100 | Codons | Codon No. Amino acid | Plane No. in Figure 1 | Amino acid No. 1101-1200 | Codons | Codon No. Amino acid | Plane No. in Figure 1 |
|-----------------------------|--------|-------------------------|--------------------------|-----------------------------|--------|-------------------------|--------------------------|
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|------|-----|-----|-----|------|-----|-----|-----|
| 1001 | CTT | 60L | 4th | 1101 | CAC | 4H | 1st |
| 1002 | CAA | 20Q | 2nd | 1102 | TGG | 43W | 3rd |
| 1003 | AGT | 57S | 4th | 1103 | TTT | 63F | 4th |
| 1004 | TTG | 47L | 3rd | 1104 | GTA | 30V | 2nd |
| 1005 | CAG | 36Q | 3rd | 1105 | ACA | 17T | 2nd |
| 1006 | ACA | 17T | 2nd | 1106 | CAA | 20Q | 2nd |
| 1007 | TAT | 55Y | 4th | 1107 | AGG | 41R | 3rd |
| 1008 | GTG | 46V | 3rd | 1108 | AAT | 53N | 4th |
| 1009 | ACT | 49T | 4th | 1109 | TTT | 63F | 4th |
| 1010 | CAA | 20Q | 2nd | 1110 | TAT | 55Y | 4th |
| 1011 | CAA | 20Q | 2nd | 1111 | GAA | 22E | 2nd |
| 1012 | TTA | 31L | 2nd | 1112 | CCA | 16P | 2nd |
| 1013 | ATT | 61I | 4th | 1113 | CAA | 20Q | 2nd |
| 1014 | AGA | 25R | 2nd | 1114 | ATC | 13I | 1st |
| 1015 | GCT | 50A | 4th | 1115 | ATT | 61I | 4th |
| 1016 | GCA | 18A | 2nd | 1116 | ACT | 49T | 4th |
| 1017 | GAA | 22E | 2nd | 1117 | ACA | 17T | 2nd |
| 1018 | ATC | 13I | 1st | 1118 | GAC | 6D | 1st |
| 1019 | AGA | 25R | 2nd | 1119 | AAC | 5N | 1st |
| 1020 | GCT | 50A | 4th | 1120 | ACA | 17T | 2nd |
| 1021 | TCT | 51S | 4th | 1121 | TTT | 63F | 4th |
| 1022 | GCT | 50A | 4th | 1122 | GTG | 46V | 3rd |
| 1023 | AAT | 53N | 4th | 1123 | TCT | 51S | 4th |
| 1024 | CTT | 60L | 4th | 1124 | GGT | 58G | 4th |
| 1025 | GCT | 50A | 4th | 1125 | AAC | 5N | 1st |
| 1026 | GCT | 50A | 4th | 1126 | TGT | 59C | 4th |
| 1027 | ACT | 49T | 4th | 1127 | GAT | 54D | 4th |
| 1028 | AAA | 21K | 2nd | 1128 | GTT | 62V | 4th |
| 1029 | ATG | 45M | 3rd | 1129 | GTA | 30V | 2nd |
| 1030 | TCA | 19S | 2nd | 1130 | ATA | 29I | 2nd |
| 1031 | GAG | 38E | 3rd | 1131 | GGA | 26G | 2nd |
| 1032 | TGT | 59C | 4th | 1132 | ATT | 61I | 4th |
| 1033 | GTA | 30V | 2nd | 1133 | GTC | 14V | 1st |
| 1034 | CTT | 60L | 4th | 1134 | AAC | 5N | 1st |
| 1035 | GGA | 26G | 2nd | 1135 | AAC | 5N | 1st |
| 1036 | CAA | 20Q | 2nd | 1136 | ACA | 17T | 2nd |
| 1037 | TCA | 19S | 2nd | 1137 | GTT | 62V | 4th |
| 1038 | AAA | 21K | 2nd | 1138 | TAT | 55Y | 4th |
| 1039 | AGA | 25R | 2nd | 1139 | GAT | 54D | 4th |
| 1040 | GTT | 62V | 4th | 1140 | CCT | 48P | 4th |
| 1041 | GAT | 54D | 4th | 1141 | TTG | 47L | 3rd |
| 1042 | TTT | 63F | 4th | 1142 | CAA | 20Q | 2nd |

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|------|-----|-----|-----|------|-----|-----|-----|
| 1043 | TGT | 59C | 4th | 1143 | CCT | 48P | 4th |
| 1044 | GGA | 26G | 2nd | 1144 | GAA | 22E | 2nd |
| 1045 | AAG | 37K | 3rd | 1145 | TTA | 31L | 2nd |
| 1046 | GGC | 10G | 1st | 1146 | GAC | 6D | 1st |
| 1047 | TAT | 55Y | 4th | 1147 | TCA | 19S | 2nd |
| 1048 | CAT | 52H | 4th | 1148 | TTC | 15F | 1st |
| 1049 | CTT | 60L | 4th | 1149 | AAG | 37K | 3rd |
| 1050 | ATG | 45M | 3rd | 1150 | GAG | 38E | 3rd |
| 1051 | TCC | 3S | 1st | 1151 | GAG | 38E | 3rd |
| 1052 | TTC | 15F | 1st | 1152 | TTA | 31L | 2nd |
| 1053 | CCT | 48P | 4th | 1153 | GAT | 54D | 4th |
| 1054 | CAG | 36Q | 3rd | 1154 | AAA | 21K | 2nd |
| 1055 | TCA | 19S | 2nd | 1155 | TAT | 55Y | 4th |
| 1056 | GCA | 18A | 2nd | 1156 | TTT | 63F | 4th |
| 1057 | CCT | 48P | 4th | 1157 | AAG | 37K | 3rd |
| 1058 | CAT | 52H | 4th | 1158 | AAT | 53N | 4th |
| 1059 | GGT | 58G | 4th | 1159 | CAT | 52H | 4th |
| 1060 | GTA | 30V | 2nd | 1160 | ACA | 17T | 2nd |
| 1061 | GTC | 14V | 1st | 1161 | TCA | 19S | 2nd |
| 1062 | TTC | 15F | 1st | 1162 | CCA | 16P | 2nd |
| 1063 | TTG | 47L | 3rd | 1163 | GAT | 54D | 4th |
| 1064 | CAT | 52H | 4th | 1164 | GTT | 62V | 4th |
| 1065 | GTG | 46V | 3rd | 1165 | GAT | 54D | 4th |
| 1066 | ACT | 49T | 4th | 1166 | TTA | 31L | 2nd |
| 1067 | TAT | 55Y | 4th | 1167 | GGT | 58G | 4th |
| 1068 | GTC | 14V | 1st | 1168 | GAC | 6D | 1st |
| 1069 | CCT | 48P | 4th | 1169 | ATC | 13I | 1st |
| 1070 | GCA | 18A | 2nd | 1170 | TCT | 51S | 4th |
| 1071 | CAA | 20Q | 2nd | 1171 | GGC | 10G | 1st |
| 1072 | GAA | 22E | 2nd | 1172 | ATT | 61I | 4th |
| 1073 | AAG | 37K | 3rd | 1173 | AAT | 53N | 4th |
| 1074 | AAC | 5N | 1st | 1174 | GCT | 50A | 4th |
| 1075 | TTC | 15F | 1st | 1175 | TCA | 19S | 2nd |
| 1076 | ACA | 17T | 2nd | 1176 | GTT | 62V | 4th |
| 1077 | ACT | 49T | 4th | 1177 | GTA | 30V | 2nd |
| 1078 | GCT | 50A | 4th | 1178 | AAC | 5N | 1st |
| 1079 | CCT | 48P | 4th | 1179 | ATT | 61I | 4th |
| 1080 | GCC | 2A | 1st | 1180 | CAA | 20Q | 2nd |
| 1081 | ATT | 61I | 4th | 1181 | AAA | 21K | 2nd |
| 1082 | TGT | 59C | 4th | 1182 | GAA | 22E | 2nd |
| 1083 | CAT | 52H | 4th | 1183 | ATT | 61I | 4th |
| 1084 | GAT | 54D | 4th | 1184 | GAC | 6D | 1st |

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|------|-----|-----|-----|------|-----|-----|-----|
| 1085 | GGA | 26G | 2nd | 1185 | CGC | 8R | 1st |
| 1086 | AAA | 21K | 2nd | 1186 | CTC | 12L | 1st |
| 1087 | GCA | 18A | 2nd | 1187 | AAT | 53N | 4th |
| 1088 | CAC | 4H | 1st | 1188 | GAG | 38E | 3rd |
| 1089 | TTT | 63F | 4th | 1189 | GTT | 62V | 4th |
| 1090 | CCT | 48P | 4th | 1190 | GCC | 2A | 1st |
| 1091 | CGT | 56R | 4th | 1191 | AAG | 37K | 3rd |
| 1092 | GAA | 22E | 2nd | 1192 | AAT | 53N | 4th |
| 1093 | GGT | 58G | 4th | 1193 | TTA | 31L | 2nd |
| 1094 | GTC | 14V | 1st | 1194 | AAT | 53N | 4th |
| 1095 | TTT | 63F | 4th | 1195 | GAA | 22E | 2nd |
| 1096 | GTT | 62V | 4th | 1196 | TCT | 51S | 4th |
| 1097 | TCA | 19S | 2nd | 1197 | CTC | 12L | 1st |
| 1098 | AAT | 53N | 4th | 1198 | ATC | 13I | 1st |
| 1099 | GGC | 10G | 1st | 1199 | GAT | 54D | 4th |
| 1100 | ACA | 17T | 2nd | 1200 | CTC | 12L | 1st |

Class 7: Amino acids 1201--1274

| Amino acid No. 1201-1274 | Codons | Codon No. • Amino acid | Plane No. in Figure 1 |
|--------------------------|--------|------------------------|-----------------------|
| 1201 | CAA | 20Q | 2nd |
| 1202 | GAA | 22E | 2nd |
| 1203 | CTT | 60L | 4th |
| 1204 | GGA | 26G | 2nd |
| 1205 | AAG | 37K | 3rd |
| 1206 | TAT | 55Y | 4th |
| 1207 | GAG | 38E | 3rd |
| 1208 | CAG | 36Q | 3rd |
| 1209 | TAT | 55Y | 4th |
| 1210 | ATA | 29I | 2nd |
| 1211 | AAA | 21K | 2nd |
| 1212 | TGG | 43W | 3rd |
| 1213 | CCA | 16P | 2nd |
| 1214 | TGG | 43W | 3rd |
| 1215 | TAC | 7Y | 1st |
| 1216 | ATT | 61I | 4th |
| 1217 | TGG | 43W | 3rd |
| 1218 | CTA | 28L | 2nd |
| 1219 | GGT | 58G | 4th |

| | | | |
|------|-----|-----|-----|
| 1220 | TTT | 63F | 4th |
| 1221 | ATA | 29I | 2nd |
| 1222 | GCT | 50A | 4th |
| 1223 | GGC | 10G | 1st |
| 1224 | TTG | 47L | 3rd |
| 1225 | ATT | 61I | 4th |
| 1226 | GCC | 2A | 1st |
| 1227 | ATA | 29I | 2nd |
| 1228 | GTA | 30V | 2nd |
| 1229 | ATG | 45M | 3rd |
| 1230 | GTG | 46V | 3rd |
| 1231 | ACA | 17T | 2nd |
| 1232 | ATT | 61I | 4th |
| 1233 | ATG | 45M | 3rd |
| 1234 | CTT | 60L | 4th |
| 1235 | TGC | 11C | 1st |
| 1236 | TGT | 59C | 4th |
| 1237 | ATG | 45M | 3rd |
| 1238 | ACC | 1T | 1st |
| 1239 | AGT | 57S | 4th |
| 1240 | TGC | 11C | 1st |
| 1241 | TGT | 59C | 4th |
| 1242 | AGT | 57S | 4th |
| 1243 | TGT | 59C | 4th |
| 1244 | CTC | 12L | 1st |
| 1245 | AAG | 37K | 3rd |
| 1246 | GGC | 10G | 1st |
| 1247 | TGT | 59C | 4th |
| 1248 | TGT | 59C | 4th |
| 1249 | TCT | 51S | 4th |
| 1250 | TGT | 59C | 4th |
| 1251 | GGA | 26G | 2nd |
| 1252 | TCC | 3S | 1st |
| 1253 | TGC | 11C | 1st |
| 1254 | TGC | 11C | 1st |
| 1255 | AAA | 21K | 2nd |
| 1256 | TTT | 63F | 4th |
| 1257 | GAT | 54D | 4th |
| 1258 | GAA | 22E | 2nd |
| 1259 | GAC | 6D | 1st |
| 1260 | GAC | 6D | 1st |
| 1261 | TCT | 51S | 4th |

| | | | |
|------|-----|--------|-----|
| 1262 | GAG | 38E | 3rd |
| 1263 | CCA | 16P | 2nd |
| 1264 | GTG | 46V | 3rd |
| 1265 | CTC | 12L | 1st |
| 1266 | AAA | 21K | 2nd |
| 1267 | GGA | 26G | 2nd |
| 1268 | GTC | 14V | 1st |
| 1269 | AAA | 21K | 2nd |
| 1270 | TTA | 31L | 2nd |
| 1271 | CAT | 52H | 4th |
| 1272 | TAC | 7Y | 1st |
| 1273 | ACA | 17T | 2nd |
| 1274 | TAA | 23stop | 2nd |

Table S2: Full table of constituent-codon members of the same planes-linkage value in the 1st–4th planes of Figure 1.

| Plane No. in Figure 1 | Linkage number | Codon No. | | | | | | Total number |
|-----------------------|----------------|--------------------------------|--------------------------------|------------------------|----------------------------|------------------------|------------------------|--------------|
| The 1st plane | 3 | 5, 2, 1 | 13, 9, 5 | 15, 5, 15 | 14, 5, 5 | 10, 15, 13 | 14, 5, 5 | 8 |
| | | 6, 8, 12 | 3, 11, 11 | | | | | |
| The 2nd plane | 5 | 29, 17, 16, 26, 17 | 19, 20, 29, 31, 16 | 18, 31, 20, 29, 16 | 26, 20 19, 21, 25 | | | 4 |
| | 4 | 30, 22, 21, 26 | 20, 16, 17, 22 | 25, 30, 30, 30 | 21, 17, 16, 16 | 16, 19, 21, 16 | | 5 |
| | 3 | 29, 29, 25 | 22, 26, 21 | 31, 22, 16 | 28, 31, 21 | 19, 22, 17 | 21, 31, 16 | 18 |
| | | 31, 20, 19 | 18, 16, 18 | 17, 19, 30 | 17, 20, 31 | 20, 20, 31 | 18, 20, 22 | |
| | | 26, 21, 18 | 30, 17, 20 | 22, 16, 20 | 30, 29, 26 | 17, 19, 16 | 20, 21, 22 | |
| The 3rd plane | 3 | 37, 38, 38 | | | | | | 1 |
| The 4th plane | 8 | 63, 53, 54, 58, 62, 55, 63, 50 | 50, 51, 50, 53, 60, 50, 50, 49 | | | | | 2 |
| | 7 | 54, 63, 58, 58, 63, 53, 63 | | | | | | 1 |
| | 6 | 50, 49, 53, 62, 62, 61 | 53, 61, 54, 58, 55, 63 | 49, 48, 58, 54, 51, 51 | 59, 62, 50, 54, 55, 53, 55 | 61, 50, 54, 55, 53, 55 | 62, 58, 58, 53, 55, 53 | 8 |
| | | 53, 63, 49, 61, 57, 62 | 60, 58, 54, 61, 50, 50 | | | | | |
| | 5 | 63, 62, 63, | 61, 63, 58, | 48, 59, 53, | 49, 53, 58, | 59, 51, 63, | 62, 50, 62, | 9 |

| | | | | | | | | |
|---|-------------------|-----------------------|-----------------------|-----------------------|-------------------|-------------------|--------|----|
| | | 60, 62 | 49, 49 | 58, 62 | 62, 58 | 58, 58 | 60, 55 | |
| | | 48, 62, 50, 51, 52 | 58, 51, 53, 62, 63 | 63, 53, 57, 50, 61 | | | | |
| 4 | 59, 62, 53, 60 | 56, 58, 62, 55 | 60, 61, 62, 53 | 63, 59, 53, 54 | 62, 55, 51, 57 | 63, 48, 53, 61 | | 20 |
| | 51, 62, 55, 50 | 53, 60, 54, 51 | 58, 63, 53, 59 | 58, 62, 60, 49 | 49, 49, 54, 50 | 60, 49, 48, 49 | | |
| | 56, 62, 55, 51 | 49, 53, 51, 48 | 61, 59, 58, 54 | 63, 53, 58, 61 | 62, 54, 63, 59 | 61, 59, 52, 54 | | |
| | 62, 55, 54, 48 | 59, 59, 51, 59 | | | | | | |
| 3 | 49, 53, 51 | 53, 62, 49 | 53, 58, 49 | 58, 62, 55 | 48, 63, 60 | 48, 61, 53 | | 33 |
| | 50, 58, 50 | 50, 55, 55 | 58, 55, 60 | 51, 61, 62 | 48, 63, 58 | 51, 48, 49 | | |
| | 63, 49, 53 | 54, 54, 63 | 60, 51, 63 | 49, 62, 59 | 51, 49, 53 | 53, 49, 51 | | |
| | 50, 57, 55 | 57, 63, 59 | 55, 58, 54 | 60, 49, 62 | 49, 51, 58 | 53, 63, 58 | | |
| | 55, 52, 60 | 48, 52, 58 | 49, 50, 48 | 63, 48, 56 | 53, 63, 55 | 59, 54, 62 | | |
| | 54, 62, 54 | 61, 53, 50 | 59, 57, 59 | | | | | |

Table S3: Full details of the aggregative population of the genetic code organization in the S-protein gene.

| S-protein code 1–1274 | | | | | | | | | | |
|-------------------------|--------|---|---|---|---|---|---|---|------------|---|
| Codon No. Amino acid | Codons | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | Sum ①–⑦ | Amino acid replacements ^a |
| 0P | CCC | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 4 | P25S |
| 1T | ACC | 3 | 2 | 0 | 3 | 1 | 0 | 1 | 10 | T723I, T732S, T732I, T778I |
| 2A | GCC | 0 | 1 | 1 | 2 | 1 | 2 | 1 | 8 | |
| 3S | TCC | 4 | 3 | 0 | 1 | 2 | 1 | 1 | 12 | S94F, S940F |
| 4H | CAC | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 4 | H146Q, H1101Y |
| 5N | AAC | 5 | 6 | 4 | 7 | 6 | 6 | 0 | 34 | |
| 6D | GAC | 3 | 2 | 3 | 2 | 3 | 4 | 2 | 19 | D178N, D936N, D936H, D1118Y, D1168G, D1259H, D1260Y |
| 7Y | TAC | 3 | 0 | 4 | 4 | 1 | 0 | 2 | 14 | |
| 8R | CGC | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| 9S | AGC | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 5 | S477R, S477I, S813I |
| 10G | GGC | 1 | 0 | 3 | 2 | 4 | 3 | 2 | 15 | G932S |
| 11C | TGC | 1 | 2 | 1 | 3 | 1 | 0 | 4 | 12 | C1235F |
| 12L | CTC | 0 | 3 | 1 | 0 | 3 | 3 | 2 | 12 | L216F |
| 13I | ATC | 0 | 3 | 2 | 1 | 4 | 4 | 0 | 14 | |
| 14V | GTC | 5 | 3 | 4 | 3 | 1 | 4 | 1 | 21 | V70I, V367F , V1068F |

| | | | | | | | | | | |
|------------------------------|-----|---|---|---|----|----|---|---|----|---|
| 15F | TTC | 7 | 1 | 4 | 0 | 2 | 4 | 0 | 18 | |
| The 1st plane subtotal | | | | | | | | | | 203 (16%: 203/1274) |
| 16P | CCA | 3 | 3 | 7 | 3 | 5 | 2 | 2 | 25 | P9L, P1162S, P1162R |
| 17T | ACA | 2 | 5 | 7 | 10 | 6 | 8 | 2 | 40 | T19I, T33I, T299I, T323I , T547I, T716I, T791I, T1006I, T1117I |
| 18A | GCA | 1 | 5 | 2 | 6 | 9 | 4 | 0 | 27 | A27S, A27V, A522V, A647S, A684V, A1070S |
| 19S | TCA | 2 | 4 | 2 | 5 | 6 | 7 | 0 | 26 | S698L, S704L, S982A |
| 20Q | CAA | 2 | 4 | 7 | 9 | 14 | 9 | 1 | 46 | Q23H, Q957R |
| 21K | AAA | 6 | 5 | 6 | 4 | 8 | 5 | 4 | 38 | |
| 22E | GAA | 5 | 6 | 4 | 7 | 3 | 7 | 2 | 34 | E180V, E309Q, E484K , E654Q, E1202Q |
| 23Stop | TAA | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |
| 24R | CGA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25R | AGA | 4 | 5 | 6 | 0 | 2 | 3 | 0 | 20 | R102I, R102S, R346K , R357K |
| 26G | GGA | 1 | 3 | 2 | 2 | 1 | 4 | 3 | 16 | |
| 27Stop | TGA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28L | CTA | 3 | 2 | 1 | 1 | 2 | 0 | 1 | 10 | |
| 29I | ATA | 3 | 2 | 2 | 5 | 2 | 1 | 3 | 18 | |
| 30V | GTA | 0 | 3 | 4 | 2 | 0 | 5 | 1 | 15 | V687L, V1104L, V1177I |
| 31L | TTA | 5 | 6 | 3 | 3 | 5 | 5 | 1 | 28 | |
| The 2nd plane subtotal | | | | | | | | | | 344 (27%: 344/1274) |
| 32P | CCG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33T | ACG | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 3 | |
| 34A | GCG | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | A879V |
| 35S | TCG | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | S221L |
| 36Q | CAG | 5 | 1 | 2 | 4 | 1 | 2 | 1 | 16 | Q14H, Q52R, Q173K, Q218H, Q1208H |
| 37K | AAG | 4 | 4 | 5 | 1 | 2 | 5 | 2 | 23 | K558N, K1073T |
| 38E | GAG | 2 | 0 | 3 | 1 | 2 | 4 | 2 | 14 | E96D |
| 39Stop | TAG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 40R | CGG | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | |
| 41R | AGG | 2 | 3 | 1 | 0 | 3 | 1 | 0 | 10 | R190M |
| 42G | GGG | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 3 | |
| 43W | TGG | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 12 | W152R |
| 44L | CTG | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 3 | L452R |

| | | | | | | | | | | |
|------------------------------|-----|----|----|----|----|----|---|---|---------------------------|---|
| 45M | ATG | 3 | 0 | 0 | 3 | 3 | 2 | 3 | 14 | M731I, M740V, M1237T |
| 46V | GTG | 1 | 3 | 0 | 1 | 3 | 3 | 2 | 13 | V213L, V382L , V1122L |
| 47L | TTG | 3 | 5 | 2 | 2 | 4 | 3 | 1 | 20 | L141F, L1063F, L1224F |
| The 3rd plane subtotal | | | | | | | | | 137 (11%: 137/1274) | |
| 48P | CCT | 5 | 8 | 5 | 3 | 1 | 7 | 0 | 29 | P251S, P330S, P384L, P384S, P479S , P631S, P681H, P681L |
| 49T | ACT | 10 | 9 | 8 | 9 | 3 | 5 | 0 | 44 | T51I, T76I, T76N, T95I, T240I, T676I, T678I, T719I, T747I, T1027I |
| 50A | GCT | 3 | 8 | 5 | 8 | 10 | 7 | 1 | 42 | A67S, A243S, A575S, A672V, A706V, A771S, A846V, A892V, A899S, A1020V |
| 51S | TCT | 6 | 8 | 7 | 7 | 3 | 4 | 2 | 37 | S71F, S884F |
| 52H | CAT | 3 | 1 | 1 | 2 | 0 | 5 | 1 | 13 | H69Y, H245Y |
| 53N | AAT | 13 | 7 | 12 | 7 | 7 | 8 | 0 | 54 | N440K, N501Y |
| 54D | GAT | 5 | 7 | 8 | 5 | 9 | 8 | 1 | 43 | D80G, D111N, D198G, D253G, D574Y, D614G, D796Y, D796H, D839Y, D1084Y, D1153Y |
| 55Y | TAT | 6 | 12 | 6 | 5 | 3 | 6 | 2 | 40 | Y453F |
| 56R | CGT | 1 | 1 | 1 | 4 | 1 | 1 | 0 | 9 | R214L |
| 57S | AGT | 4 | 1 | 1 | 5 | 3 | 1 | 2 | 17 | S689I, S929T |
| 58G | GGT | 7 | 7 | 13 | 7 | 8 | 4 | 1 | 47 | G142V, G184S, G252V, G257D, G261V, G446V , G639S, G1124V, G1167A, G1219V |
| 59C | TGT | 3 | 4 | 5 | 5 | 1 | 4 | 6 | 28 | C1243F |
| 60L | CTT | 6 | 3 | 6 | 4 | 11 | 4 | 2 | 36 | L5F, L822F, L938F |
| 61I | ATT | 4 | 5 | 6 | 9 | 10 | 7 | 3 | 44 | I233V, I720V, I818V |
| 62V | GTT | 13 | 4 | 8 | 10 | 6 | 7 | 0 | 48 | V3G, V6A, V6F, V90F, V1040F |
| 63F | TTT | 14 | 13 | 9 | 6 | 8 | 7 | 2 | 59 | F490S, F565L, F888L |
| The 4th plane subtotal | | | | | | | | | 590 (46%: 590/1274) | |

^aFull details of 154 amino acid replacements in the S-protein of the first 2000 of 46,251 variants extracted from the CoV-GLUE, Amino acid variation database. Variants listed in boldface indicate amino acid replacements in the receptor-binding domain of the S-protein.

Table S4: Full details of the 154 amino acid replacements in the S-protein in the first 2000 of 46,251 variants in Table 4.

| Codon No•Amino acid | Amino acid replacements ^a | | Replacement-related plane No. in Figure 1 | |
|---------------------|--------------------------------------|---------------------------|---|--|
| 0P | P25S | CCC 0 → 3 TCC | 1st→1st | |
| 1T | T732S | ACC 1 → 3 TCC | | |
| | T723I | | | |
| | T732I | ACC 1 → 13 ATC | | |
| | T778I | | | |
| 2A | non | | | |
| 3S | S94F | TCC 3 → 15 TTC | 1st→1st | |
| | S940F | | | |
| 4H | H146Q | CAC 4 → 20 CAA, 36 CAG | 1st → 2nd, 3rd | |
| | H1101Y | CAC 4 → 7 TAC | 1st→1st | |
| 5N | non | | | |
| 6D | D936H | GAC 6 → 4 CAC | 1st→1st | |
| | D1259H | | | |
| | D178N | GAC 6 → 5 AAC | | |
| | D936N | | | |
| | D1118Y | GAC 6 → 7 TAC | | |
| | D1260Y | | | |
| | D1168G | GAC 6 → 10 GGC | | |
| 7Y | non | | | |
| 8R | non | | | |
| 9S | S477R | AGC 9 → 8 CGC | 1st→1st | |
| | S477I | AGC 9 → 13 ATC | | |
| | S813I | | | |
| 10G | G932S | GGC 10 → 9 AGC | | |
| 11C | C1235F | TGC 11 → 15 TTC | | |
| | C1253F | | | |
| 12L | L216F | CTC 12 → 15 TTC | | |
| 13I | non | | | |
| 14V | V70I | GTC 14 → 13 ATC | 1st→1st | |
| | V367F | GTC 14 → 15 TTC | | |
| | V1068F | | | |
| 15F | non | | | |
| 16P | P1162S | CCA 16 → 19 TCA | 2nd→2nd | |
| | P1162R | CCA 16 → 24 CGA | | |
| | P9L | CCA 16 → 28 CTA | | |

| | | | |
|--------|--------------|--------------------------|--------------|
| | T33I | | |
| | T19I | | |
| | T299I | | |
| | T323I | | |
| 17T | T547I | ACA 17 →29 ATA | |
| | T716I | | |
| | T791I | | |
| | T1006I | | |
| | T1117I | | |
| | A27S | | |
| | A647S | GCA 18 →19 TCA | |
| | A1070S | | |
| 18A | A27V | | |
| | A522V | GCA 18 →30 GTA | |
| | A684V | | |
| | S982A | TCA 19 →18 GCA | |
| 19S | S698L | | |
| | S704L | TCA 19 →31 TTA | |
| | Q23H | CAA 20 →4 CAC, 52CAT | 2nd→1st, 4th |
| 20Q | Q957R | CAA 20 →24 CGA | 2nd→2nd |
| 21K | non | | |
| | E309Q | | |
| 22E | E654Q | GAA 22→20 CAA | |
| | E1202Q | | |
| | E180V | GAA 22 →30 GTA | |
| 23stop | | | |
| 24R | non | | |
| | R102S | AGA 25 →9 AGC, 57 AGT | 2nd→1st, 4th |
| 25R | R346K | AGA 25→21 AAA | |
| | R357K | | |
| | R102I | AGA 25 →29 ATA | |
| 26G | G1251V | GGA 26 →30 GTA | |
| 27stop | | | |
| 28L | non | | |
| 29I | non | | |
| | V687L | GTA 30→28 CTA, 31 TTA | 2nd→2nd, 2nd |
| 30V | V1177I | GTA 30 →29 ATA | |
| | V1104L | GTA 30 →31 TTA | |
| 31L | non | | |

| | | | |
|--------|--------------|----------------------------------|----------------------|
| 32P | non | | |
| 33T | non | | |
| 34A | A879V | GCG 34 →46 GTG | 3rd→3rd |
| 35S | S221L | TCG 35 →47 TTG | |
| 36Q | Q14H | CAG 36 →4 CAC, 52 CAT | 3rd→1st, 4th |
| | Q218H | | |
| | Q1208H | | |
| | Q173K | CAG 36→ 37AAG | 3rd→3rd |
| | Q52R | CAG 36 →40 CGG | |
| 37K | K558N | AAG 37 →5 AAC, 53 AAT | 3rd→1st, 4th |
| | K1073T | AAG 37→33 ACG | 3rd→3rd |
| 38E | E96D | GAG 38 →6 GAC, 54 GAT | 3rd→1st, 4th |
| 39stop | | | |
| 40R | non | | |
| 41R | R190M | AGG 41 →45 ATG | 3rd→3rd |
| 42G | non | | |
| 43W | W152R | TGG 43→40 CGG, 41 AGG | 3rd→3rd, 3rd |
| 44L | non | | |
| 45M | M731I | ATG 45→13 ATC, 29 ATA, 61 ATT | 3rd→1st, 2nd, 4th |
| | M740V | ATG 45 →46 GTG | 3rd→3rd |
| | M1237T | ATG 45 →33 ACG | 3rd→3rd |
| 46V | V213L | GTG 46→44 CTG, 47 TTG | 3rd→3rd, 3rd |
| | V382L | | |
| | V1122L | | |
| 47L | L141F | TTG 47 →15 TTC, 63 TTT | 3rd→1st, 4th |
| | L1063F | | |
| | L1224F | | |
| 48P | P251S | CCT 48 →51 TCT | 4th→4th |
| | P330S | | |
| | P384S | | |
| | P479S | | |
| | P631S | | |
| | P384L | CCT 48 →60 CTT | |
| | P681L | | |
| 49T | P681H | CCT 48 →52 CAT | |
| | T76N | ACT 49 →53 AAT | |
| | T51I | ACT 49 →61 ATT | |
| | T76I | | |

| | | | |
|-----|--------------|----------------------------|----------------|
| | T240I | | |
| | T676I | | |
| | T678I | | |
| | T719I | | |
| | T747I | | |
| | A67S | | |
| | A243S | | |
| | A575S | GCT 50 → 51 TCT | |
| | A771S | | |
| | A899S | | |
| 50A | A672V | | |
| | A706V | | |
| | A846V | GCT 50 → 62 GTT | |
| | A892V | | |
| | A1020V | | |
| 51S | S71F | | |
| | S884F | TCT 51 → 63 TTT | |
| 52H | H69Y | | |
| | H245Y | CAT 52 → 55 TAT | |
| 53N | N440K | AAT 53 → 21 AAA, 37 AAG | 4th → 2nd, 3rd |
| | N501Y | AAT 53 → 55 TAT | 4th → 4th |
| 54D | D796H | GAT 54 → 52 CAT | |
| | D111N | GAT 54 → 53 AAT | |
| | D796Y | | |
| | D574Y | | |
| | D839Y | GAT 54 → 55 TAT | |
| | D1084Y | | |
| | D1153Y | | |
| | D80G | | |
| | D198G | GAT 54 → 58 GGT | |
| | D614G | | |
| 55Y | Y453F | TAT 55 → 63 TTT | 4th → 4th |
| 56R | R214L | CGT 56 → 60 CTT | |
| 57S | S689I | AGT 57 → 61 ATT | |
| | S929T | AGT 57 → 49 ACT | |
| 58G | G1167A | GGT 58 → 50 GCT | |
| | G257D | GGT 58 → 54 GAT | |
| | G184S | | |
| | G639S | GGT 58 → 57 AGT | |
| | G142V | | |
| | G252V | GGT 58 → 62 GTT | |

| | | | |
|-----|--------------|-----------------|--|
| | G261V | | |
| | G446V | | |
| | G1124V | | |
| | G1219V | | |
| 59C | C1243F | | |
| | C1247F | TGT 59 → 63 TTT | |
| | C1250F | | |
| 60L | L822F | | |
| | L938F | CTT 60 → 63 TTT | |
| 61I | I233V | | |
| | I720V | ATT 61 → 62 GTT | |
| | I818V | | |
| 62V | V6A | GTT 62 → 50 GCT | |
| | V3G | GTT 62 → 58 GGT | |
| | V6F | | |
| | V90F | GTT 62 → 63 TTT | |
| | V1040F | | |
| 63F | F490S | TTT 63 → 51 TCT | |
| | F565L | | |
| | F888L | TTT 63 → 60 CTT | |

^aSome amino acid replacements (e.g., H146Q, Q23H, and V213L) have more than one mutant, probably a single point mutation. Only one of them is an actual mutant. Variants listed in boldface indicate amino acid replacements within the receptor-binding domain.

Table S5: Full details for the real Alpha to Omicron lineages of SARS-CoV-2.

| Lineage | Amino acid replacement ^a | Replacement-related plane No. in Figure 1 |
|----------------|---|--|
| B.1.1.7 (α) | GAC 6 → 4 CAC (D1118H) | 1st → 1st |
| | ACA 17 → 29 ATA (T716I) | |
| | TCA 19 → 18 GCA (S982A) | 2nd → 2nd |
| | CCT 48 → 52 CAT (P681H) | |
| | GCT 50 → 54 GAT (A570D) | |
| | AAT 53 → 55 TAT (N501Y) | 4th → 4th |
| | GAT 54 → 58 GGT (D614G) | |
| B.1.351 (β) | GCA 18 → 30 GTA (A701V) | 2nd → 2nd |
| | GAA 22 → 21 AAA (E484K) | |
| | AAG 37 → 5 AAC, 53 AAT (K417N) | 3rd → 1st, 4th |
| | AAT 53 → 55 TAT (N501Y) | |
| | GAT 54 → 50 GCT (D80A) | 4th → 4th |
| | GAT 54 → 58 GGT (D215G, D614G) | |

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|------------------|---|---------------|
| | ACC 1 → 5 AAC (T20N) | 1st → 1st |
| | GAA 22 → 21 AAA (E484K) | 2nd → 2nd |
| | AAG 37 → 33 ACG (K417T) | 3rd → 3rd |
| | AGG 41 → 9 AGC, 57 AGT (R190S) | 3rd→1st, 4th |
| | CCT 48 → 51TCT (P26S) | |
| P.1 (γ) | ACT 49 → 61ATT (T1027I) | |
| | CAT 52 → 55TAT (H655Y) | |
| | AAT 53 → 55 TAT (N501Y) | 4th → 4th |
| | GAT 54 → 55 TAT (D138Y) | |
| | GAT 54 → 58 GGT (D614G) | |
| | CTT 60 → 63 TTT (L18F) | |
| | GTT 62 → 63 TTT (V1176F) | |
| | ACA 17 → 21 AAA (T478K) | 2nd → 2nd |
| | ACA 17 → 25 AGA (T19R) | |
| | GAG 38 → 42 GGG (E156G) | 3rd → 3rd |
| B.1.617.2 (δ) | CTG 44 → 40 CGG (L452R) | |
| | CCT 48 → 56 CGT (P681R) | |
| | GAT 54 → 58 GGT (D614G) | 4th → 4th |
| | GAT 54 → 53 AAT (D950N) | |
| | GGT 58 → 54 GAT (G142D) | |
| | CTG 44 → 36 CAG(L452Q) | 3rd → 3rd |
| | ACT 49 → 53 AAT(T859N) | |
| C.37 (λ) | ACT 49 → 61 ATT(T76I) | |
| | GAT 54 → 58 GGT (D614G) | 4th → 4th |
| | GGT 58 → 62 GTT(G75V) | |
| | TTT 63 → 51 TCT(F490S) | |
| | TCC 3 → 15 TTC (S375F) | 1st → 1st |
| | AAC 5 → 21 AAA, 37 AAG (N764K) | 1st→2nd, 3rd |
| | TAC 7 → 4 CAC (Y505H) | 1st → 1st |
| | AGC 9 → 5 AAC (S477N) | |
| | ACA 17 → 21 AAA (T478K) | 2nd → 2nd |
| | TCA 19 → 16 CCA (S373P) | |
| | CAA 20 → 4 CAC, 52CAT (Q954H) | 2nd →1st, 4th |
| B.1.1.529 (o) | CAA 20 → 24 CGA (Q498R) | 2nd → 2nd |
| | GAA 22 → 18 GCA (E484A) | |
| | AAG 37 → 5 AAC, 53AAU(K417N) | 3rd→1st, 4th |
| | CCT 48 → 52 CAT (P681H) | 4th →4th |
| | CAT 52 → 55 TAT (H655Y) | 4th →4th |
| | AAT 53→21 AAA, 37 AAG (N440K,N679K,N969K) | 4th→2nd, 3rd |
| | AAT 53 → 55 TAT (N501Y) | 4th → 4th |
| | GAT 54→ 55 TAT (D796Y) | 4th → 4th |

GAT 54→ 58 GGT (D614G)
GGT 58→ 54 GAT (G142D, **G339D**)

^aSome amino acid replacements (e.g., H146Q, Q23H, V213L) had more than one mutant, probably a single point mutation. Only one of them is an actual mutant. Variants listed in boldface indicate amino acid replacements within the receptor-binding domain of the S-protein.