

## Opening and editing sequence alignments

**Required functionality and modules:** Discovery Studio Client.

**Required data files:** kinases.fasta.

**Time:** 10 minutes.

### Introduction

Sequence alignments are usually created by alignment programs, such as ClustalW or Muscle. Visualization of the sequence alignment provides useful insights into the relationships between sets of homologous sequences. In addition, inspection of the automatically generated sequence alignment and manual edits of the alignment are often desirable. Discovery Studio Client provides an interactive environment for viewing, analyzing, and editing sequence alignment.

In this tutorial you will learn how to manually edit sequence alignment of three highly homologous protein sequences.

- [Opening and viewing the sequences](#)
- [Manually adjusting the sequence alignment](#)

### Opening and viewing the sequences

From the Files Explorer, open **Samples | Tutorials | Quick Start Tutorials | kinases.fasta**.

This opens the kinases.fasta file in the Sequence Window with three sequences, 1e2k, 1ki4, and 1ki3.

The background of the residues are colored according to sequence similarity. The first 25 residues are identical in three sequences and are colored blue to indicate this. The remaining sequence block is poorly aligned, with most positions not similar and the residue backgrounds colored white. The sequence identity and similarity of the three unaligned sequences are very low and are indicated on the status bar at the bottom of the application window.

The screenshot displays the Discovery Studio Client 2.5 interface. The main window shows a sequence alignment of three protein sequences: 1e2k, 1ki4, and 1ki3. The alignment is visualized with colored backgrounds for residues, indicating sequence similarity. The first 25 residues are identical in all three sequences and are colored blue. The remaining residues are colored white, indicating low similarity. A red arrow points to a specific residue in the 1e2k sequence at position 30, labeled "Cursor location". Another red arrow points to the "Status Bar" at the bottom of the window, which displays "Sequence Identity: 9.4; Sequence Similarity: 15.5". The status bar also shows the server address "Server: localhost:9943".

| Residue | 1e2k | 1ki4 | 1ki3 |
|---------|------|------|------|
| 1       | M    | M    | M    |
| 2       | P    | P    | P    |
| 3       | T    | T    | T    |
| 4       | L    | L    | L    |
| 5       | R    | R    | R    |
| 6       | V    | V    | V    |
| 7       | I    | I    | I    |
| 8       | D    | D    | D    |
| 9       | G    | G    | G    |
| 10      | P    | P    | P    |
| 11      | H    | H    | H    |
| 12      | G    | G    | G    |
| 13      | M    | M    | M    |
| 14      | G    | G    | G    |
| 15      | K    | K    | K    |
| 16      | T    | T    | T    |
| 17      | T    | T    | T    |
| 18      | T    | T    | T    |
| 19      | Q    | Q    | Q    |
| 20      | L    | L    | L    |
| 21      | L    | L    | L    |
| 22      | V    | V    | V    |
| 23      | A    | A    | A    |
| 24      | D    | D    | D    |
| 25      | D    | D    | D    |
| 26      | I    | I    | I    |
| 27      | V    | V    | V    |
| 28      | V    | V    | V    |
| 29      | Y    | Y    | Y    |
| 30      | V    | V    | V    |
| 31      | E    | E    | E    |
| 32      | P    | P    | P    |
| 33      | M    | M    | M    |
| 34      | T    | T    | T    |
| 35      | Y    | Y    | Y    |
| 36      | W    | W    | W    |
| 37      | R    | R    | R    |
| 38      | V    | V    | V    |
| 39      | L    | L    | L    |
| 40      | G    | G    | G    |
| 41      | A    | A    | A    |
| 42      | S    | S    | S    |
| 43      | E    | E    | E    |
| 44      | T    | T    | T    |
| 45      | I    | I    | I    |
| 46      | A    | A    | A    |
| 47      | N    | N    | N    |
| 48      | I    | I    | I    |
| 49      | Y    | Y    | Y    |
| 50      | T    | T    | T    |
| 51      | T    | T    | T    |
| 52      | Q    | Q    | Q    |
| 53      | H    | H    | H    |
| 54      | R    | R    | R    |
| 55      | L    | L    | L    |
| 56      | D    | D    | D    |
| 57      | G    | G    | G    |
| 58      | H    | H    | H    |
| 59      | R    | R    | R    |
| 60      | L    | L    | L    |
| 61      | I    | I    | I    |
| 62      | F    | F    | F    |
| 63      | D    | D    | D    |
| 64      | R    | R    | R    |
| 65      | H    | H    | H    |
| 66      | P    | P    | P    |
| 67      | P    | P    | P    |
| 68      | A    | A    | A    |
| 69      | L    | L    | L    |
| 70      | T    | T    | T    |
| 71      | L    | L    | L    |
| 72      | I    | I    | I    |
| 73      | F    | F    | F    |
| 74      | D    | D    | D    |
| 75      | R    | R    | R    |
| 76      | H    | H    | H    |
| 77      | P    | P    | P    |
| 78      | I    | I    | I    |
| 79      | A    | A    | A    |
| 80      | A    | A    | A    |
| 81      | L    | L    | L    |
| 82      | L    | L    | L    |
| 83      | C    | C    | C    |
| 84      | Y    | Y    | Y    |
| 85      | P    | P    | P    |
| 86      | A    | A    | A    |
| 87      | A    | A    | A    |
| 88      | R    | R    | R    |
| 89      | R    | R    | R    |
| 90      | V    | V    | V    |
| 91      | Y    | Y    | Y    |
| 92      | G    | G    | G    |
| 93      | L    | L    | L    |
| 94      | L    | L    | L    |
| 95      | A    | A    | A    |
| 96      | N    | N    | N    |
| 97      | T    | T    | T    |
| 98      | V    | V    | V    |
| 99      | R    | R    | R    |
| 100     | Y    | Y    | Y    |
| 101     | L    | L    | L    |
| 102     | Q    | Q    | Q    |
| 103     | C    | C    | C    |
| 104     | G    | G    | G    |
| 105     | G    | G    | G    |
| 106     | S    | S    | S    |
| 107     | W    | W    | W    |
| 108     | R    | R    | R    |
| 109     | E    | E    | E    |
| 110     | D    | D    | D    |
| 111     | W    | W    | W    |
| 112     | Q    | Q    | Q    |
| 113     | L    | L    | L    |
| 114     | S    | S    | S    |
| 115     | G    | G    | G    |
| 116     | W    | W    | W    |
| 117     | R    | R    | R    |
| 118     | D    | D    | D    |
| 119     | W    | W    | W    |
| 120     | Q    | Q    | Q    |
| 121     | L    | L    | L    |
| 122     | S    | S    | S    |
| 123     | G    | G    | G    |
| 124     | P    | P    | P    |
| 125     | R    | R    | R    |
| 126     | P    | P    | P    |
| 127     | H    | H    | H    |
| 128     | I    | I    | I    |
| 129     | G    | G    | G    |
| 130     | D    | D    | D    |
| 131     | T    | T    | T    |
| 132     | L    | L    | L    |
| 133     | F    | F    | F    |
| 134     | R    | R    | R    |
| 135     | A    | A    | A    |
| 136     | P    | P    | P    |
| 137     | E    | E    | E    |
| 138     | L    | L    | L    |
| 139     | L    | L    | L    |
| 140     | A    | A    | A    |
| 141     | P    | P    | P    |
| 142     | N    | N    | N    |
| 143     | I    | I    | I    |
| 144     | V    | V    | V    |
| 145     | L    | L    | L    |
| 146     | P    | P    | P    |
| 147     | P    | P    | P    |
| 148     | T    | T    | T    |
| 149     | L    | L    | L    |
| 150     | P    | P    | P    |
| 151     | G    | G    | G    |
| 152     | L    | L    | L    |
| 153     | P    | P    | P    |
| 154     | I    | I    | I    |
| 155     | P    | P    | P    |
| 156     | P    | P    | P    |
| 157     | T    | T    | T    |
| 158     | P    | P    | P    |
| 159     | L    | L    | L    |
| 160     | P    | P    | P    |
| 161     | L    | L    | L    |
| 162     | A    | A    | A    |
| 163     | L    | L    | L    |
| 164     | A    | A    | A    |
| 165     | A    | A    | A    |
| 166     | M    | M    | M    |
| 167     | L    | L    | L    |
| 168     | A    | A    | A    |
| 169     | A    | A    | A    |
| 170     | L    | L    | L    |
| 171     | A    | A    | A    |
| 172     | A    | A    | A    |
| 173     | R    | R    | R    |
| 174     | R    | R    | R    |
| 175     | V    | V    | V    |
| 176     | Y    | Y    | Y    |
| 177     | G    | G    | G    |
| 178     | L    | L    | L    |
| 179     | L    | L    | L    |
| 180     | A    | A    | A    |
| 181     | N    | N    | N    |
| 182     | T    | T    | T    |
| 183     | V    | V    | V    |
| 184     | R    | R    | R    |
| 185     | Y    | Y    | Y    |
| 186     | L    | L    | L    |
| 187     | Q    | Q    | Q    |
| 188     | C    | C    | C    |
| 189     | G    | G    | G    |
| 190     | G    | G    | G    |
| 191     | S    | S    | S    |
| 192     | W    | W    | W    |
| 193     | R    | R    | R    |
| 194     | E    | E    | E    |
| 195     | D    | D    | D    |
| 196     | W    | W    | W    |
| 197     | Q    | Q    | Q    |
| 198     | L    | L    | L    |
| 199     | S    | S    | S    |
| 200     | G    | G    | G    |
| 201     | P    | P    | P    |
| 202     | R    | R    | R    |
| 203     | H    | H    | H    |
| 204     | I    | I    | I    |
| 205     | G    | G    | G    |
| 206     | T    | T    | T    |
| 207     | S    | S    | S    |
| 208     | G    | G    | G    |
| 209     | P    | P    | P    |
| 210     | R    | R    | R    |
| 211     | P    | P    | P    |
| 212     | H    | H    | H    |
| 213     | I    | I    | I    |
| 214     | G    | G    | G    |
| 215     | D    | D    | D    |
| 216     | T    | T    | T    |
| 217     | L    | L    | L    |
| 218     | F    | F    | F    |
| 219     | R    | R    | R    |
| 220     | A    | A    | A    |
| 221     | P    | P    | P    |
| 222     | E    | E    | E    |
| 223     | L    | L    | L    |
| 224     | L    | L    | L    |
| 225     | A    | A    | A    |
| 226     | P    | P    | P    |
| 227     | N    | N    | N    |
| 228     | G    | G    | G    |
| 229     | P    | P    | P    |
| 230     | L    | L    | L    |
| 231     | A    | A    | A    |
| 232     | P    | P    | P    |
| 233     | N    | N    | N    |
| 234     | G    | G    | G    |
| 235     | D    | D    | D    |
| 236     | L    | L    | L    |
| 237     | N    | N    | N    |
| 238     | V    | V    | V    |
| 239     | Y    | Y    | Y    |
| 240     | L    | L    | L    |
| 241     | N    | N    | N    |
| 242     | V    | V    | V    |
| 243     | A    | A    | A    |
| 244     | L    | L    | L    |
| 245     | D    | D    | D    |
| 246     | V    | V    | V    |
| 247     | L    | L    | L    |
| 248     | A    | A    | A    |
| 249     | K    | K    | K    |
| 250     | R    | R    | R    |
| 251     | L    | L    | L    |
| 252     | R    | R    | R    |
| 253     | S    | S    | S    |
| 254     | M    | M    | M    |
| 255     | H    | H    | H    |
| 256     | V    | V    | V    |
| 257     | F    | F    | F    |
| 258     | I    | I    | I    |
| 259     | L    | L    | L    |
| 260     | D    | D    | D    |
| 261     | D    | D    | D    |
| 262     | Y    | Y    | Y    |
| 263     | D    | D    | D    |
| 264     | Q    | Q    | Q    |
| 265     | S    | S    | S    |
| 266     | P    | P    | P    |
| 267     | A    | A    | A    |
| 268     | G    | G    | G    |
| 269     | C    | C    | C    |
| 270     | R    | R    | R    |
| 271     | D    | D    | D    |
| 272     | A    | A    | A    |
| 273     | L    | L    | L    |
| 274     | L    | L    | L    |
| 275     | Q    | Q    | Q    |
| 276     | L    | L    | L    |
| 277     | L    | L    | L    |
| 278     | T    | T    | T    |
| 279     | S    | S    | S    |
| 280     | G    | G    | G    |
| 281     | M    | M    | M    |
| 282     | V    | V    | V    |
| 283     | Q    | Q    | Q    |
| 284     | T    | T    | T    |
| 285     | H    | H    | H    |
| 286     | V    | V    | V    |
| 287     | T    | T    | T    |
| 288     | P    | P    | P    |
| 289     | G    | G    | G    |
| 290     | S    | S    | S    |
| 291     | I    | I    | I    |
| 292     | P    | P    | P    |
| 293     | T    | T    | T    |
| 294     | P    | P    | P    |
| 295     | G    | G    | G    |
| 296     | S    | S    | S    |
| 297     | I    | I    | I    |
| 298     | P    | P    | P    |
| 299     | T    | T    | T    |
| 300     | P    | P    | P    |
| 301     | I    | I    | I    |
| 302     | C    | C    | C    |
| 303     | D    | D    | D    |
| 304     | L    | L    | L    |
| 305     | A    | A    | A    |
| 306     | R    | R    | R    |
| 307     | T    | T    | T    |
| 308     | F    | F    | F    |
| 309     | A    | A    | A    |
| 310     | R    | R    | R    |
| 311     | E    | E    | E    |
| 312     | M    | M    | M    |
| 313     | G    | G    | G    |
| 314     | E    | E    | E    |
| 315     | -    | -    | -    |
| 316     | -    | -    | -    |
| 317     | -    | -    | -    |
| 318     | -    | -    | -    |
| 319     | -    | -    | -    |
| 320     | I    | I    | I    |
| 321     | C    | C    | C    |
| 322     | D    | D    | D    |
| 323     | L    | L    | L    |
| 324     | A    | A    | A    |
| 325     | R    | R    | R    |
| 326     | E    | E    | E    |
| 327     | M    | M    | M    |
| 328     | G    | G    | G    |
| 329     | E    | E    | E    |
| 330     | -    | -    | -    |
| 331     | -    | -    | -    |
| 332     | -    | -    | -    |
| 333     | -    | -    | -    |
| 334     | -    | -    | -    |
| 335     | -    | -    | -    |
| 336     | -    | -    | -    |
| 337     | -    | -    | -    |
| 338     | -    | -    | -    |
| 339     | -    | -    | -    |
| 340     | -    | -    | -    |
| 341     | -    | -    | -    |
| 342     | -    | -    | -    |
| 343     | -    | -    | -    |
| 344     | -    | -    | -    |
| 345     | -    | -    | -    |
| 346     | -    | -    | -    |
| 347     | -    | -    | -    |
| 348     | -    | -    | -    |
| 349     | -    | -    | -    |
| 350     | -    | -    | -    |



|      |  |     |     |     |     |     |  |
|------|--|-----|-----|-----|-----|-----|--|
|      | 1  | 10  | 20  | 30  | 40  | 50  |  |
| 1e2k | MPTLLRYYIDGPHGMGKTTTTQLLVADIVVYVPEPMTYWRVVGASETIANIYTTQHRL     |     |     |     |     |     |  |
| 1ki4 | MPTLLRYYIDGPHGMGKTTTTQLLV--DIVVYVPEPMTYWRVVGASETIANIYTTQHRL    |     |     |     |     |     |  |
| 1ki3 | MPTLLRYYIDGPHGMGKTTTTQLLVLDIVVYVPEPMTYWRVVGASETIANIYTTQHRL     |     |     |     |     |     |  |
|      | 60   | 70  | 80  | 90  | 100 | 110 |  |
| 1e2k | DQGEISAGDAAVVMTSAQITMGMPYAVTDAVLAPHIGGEAG---PPPALTLLIFDRHP I   |     |     |     |     |     |  |
| 1ki4 | DQGEISAGDAAVVMTSAQITMGMPYAVTDAVLAPHIGGEAG---PPPALTLLIFDRHP I A |     |     |     |     |     |  |
| 1ki3 | DQGEISAGDAAVVMTSAQITMGMPYAVTDAVLAPHIGGEAGSAPPALTLLIFDRHP I     |     |     |     |     |     |  |
|      | 120  | 130 | 140 | 150 | 160 | 170 |  |
| 1e2k | AALLCYPAAARYLMGSMTPQAVLAFVALIPPTLPGTNIVL GALPEDRHIDRLAKRQRPG   |     |     |     |     |     |  |
| 1ki4 | AALLCYPAAARYLMGSMTPQAVLAFVALIPPTLPGTNIVL GALPEDRHIDRLAKRQRPG E |     |     |     |     |     |  |
| 1ki3 | AALLCYPAAARYLMGSMTPQAVLAFVALIPPTLPGTNIVL GALPEDRHIDRLAKRQRPG   |     |     |     |     |     |  |
|      | 180  | 190 | 200 | 210 | 220 | 230 |  |
| 1e2k | ERLDLAMLAAIRRVYGLLANTVRYLQCGGSWREDWGQLSGTGRPHIGDTLFTLFRAP      |     |     |     |     |     |  |
| 1ki4 | ERLDLAMLAAIRRVYGLLANTVRYLQCGGSWREDWGQLSGRPHIGDTLFTLFRAP ELL    |     |     |     |     |     |  |
| 1ki3 | ERLDLAMLAAIRRVYGLLANTVRYLQCGGSWREDWGQLSGRPHIGDTLFTLFRAP ELL    |     |     |     |     |     |  |
|      | 240  | 250 | 260 | 270 | 280 | 290 |  |
| 1e2k | ELLAPNGDLYNVFAWALDVLAKRLRSMHVFILDYDQSPAGCRDALLQLTSGMVQTHVT     |     |     |     |     |     |  |
| 1ki4 | APNGDLYNVFAWALDVLAKRLRSMHVFILDYDQSPAGCRDALLQLTSGMVQTHVTPG      |     |     |     |     |     |  |
| 1ki3 | LAPNGDLYNVFAWALDVLAKRLRSMHVFILDYDQSPAGCRDALLQLTSGMVQTHVTP      |     |     |     |     |     |  |
|      | 300  | 310 | 320 | 330 | 340 |     |  |
| 1e2k | TPGSIPTICDLARTFAREMGE  |     |     |     |     |     |  |
| 1ki4 | SIPITICDLARTFAREMGE---   |     |     |     |     |     |  |
| 1ki3 | GSIPTICDLARTFAREMGE---   |     |     |     |     |     |  |

Cursor location

Place the cursor in front of the PRO residue in the 1ki4 sequence as shown above, then press the **space bar** once to insert a gap.

Select the PRO residue from 1e2k and the aligned gap from 1ki4 as shown in the following image by clicking on the left mouse button and dragging over the two positions.

Press the **space bar** three times to insert gaps in the 1e2k and 1ki4 sequences before the selected residue.

|      |  |     |     |     |     |     |  |
|------|--|-----|-----|-----|-----|-----|--|
|      | 1  | 10  | 20  | 30  | 40  | 50  |  |
| 1e2k | MPTLLRYYIDGPHGMGKTTTTQLLVADIVVYVPEPMTYWRVVGASETIANIYTTQHRL     |     |     |     |     |     |  |
| 1ki4 | MPTLLRYYIDGPHGMGKTTTTQLLV--DIVVYVPEPMTYWRVVGASETIANIYTTQHRL    |     |     |     |     |     |  |
| 1ki3 | MPTLLRYYIDGPHGMGKTTTTQLLVLDIVVYVPEPMTYWRVVGASETIANIYTTQHRL     |     |     |     |     |     |  |
|      | 60   | 70  | 80  | 90  | 100 | 110 |  |
| 1e2k | DQGEISAGDAAVVMTSAQITMGMPYAVTDAVLAPHIGGEAG---PPPALTLLIFDRHP I   |     |     |     |     |     |  |
| 1ki4 | DQGEISAGDAAVVMTSAQITMGMPYAVTDAVLAPHIGGEAG---PPPALTLLIFDRHP I A |     |     |     |     |     |  |
| 1ki3 | DQGEISAGDAAVVMTSAQITMGMPYAVTDAVLAPHIGGEAGSAPPALTLLIFDRHP I     |     |     |     |     |     |  |
|      | 120  | 130 | 140 | 150 | 160 | 170 |  |
| 1e2k | AALLCYPAAARYLMGSMTPQAVLAFVALIPPTLPGTNIVL GALPEDRHIDRLAKRQRPG   |     |     |     |     |     |  |
| 1ki4 | AALLCYPAAARYLMGSMTPQAVLAFVALIPPTLPGTNIVL GALPEDRHIDRLAKRQRPG E |     |     |     |     |     |  |
| 1ki3 | AALLCYPAAARYLMGSMTPQAVLAFVALIPPTLPGTNIVL GALPEDRHIDRLAKRQRPG   |     |     |     |     |     |  |
|      | 180  | 190 | 200 | 210 | 220 | 230 |  |
| 1e2k | ERLDLAMLAAIRRVYGLLANTVRYLQCGGSWREDWGQLSGTGRPHIGDTLFTLFRAP      |     |     |     |     |     |  |
| 1ki4 | ERLDLAMLAAIRRVYGLLANTVRYLQCGGSWREDWGQLSGRPHIGDTLFTLFRAP ELL    |     |     |     |     |     |  |
| 1ki3 | ERLDLAMLAAIRRVYGLLANTVRYLQCGGSWREDWGQLSGRPHIGDTLFTLFRAP ELL    |     |     |     |     |     |  |
|      | 240  | 250 | 260 | 270 | 280 | 290 |  |
| 1e2k | ELLAPNGDLYNVFAWALDVLAKRLRSMHVFILDYDQSPAGCRDALLQLTSGMVQTHVT     |     |     |     |     |     |  |
| 1ki4 | LAPNGDLYNVFAWALDVLAKRLRSMHVFILDYDQSPAGCRDALLQLTSGMVQTHVTPG     |     |     |     |     |     |  |
| 1ki3 | LAPNGDLYNVFAWALDVLAKRLRSMHVFILDYDQSPAGCRDALLQLTSGMVQTHVTP      |     |     |     |     |     |  |
|      | 300  | 310 | 320 | 330 | 340 |     |  |
| 1e2k | TPGSIPTICDLARTFAREMGE  |     |     |     |     |     |  |
| 1ki4 | SIPITICDLARTFAREMGE---   |     |     |     |     |     |  |
| 1ki3 | GSIPTICDLARTFAREMGE---   |     |     |     |     |     |  |

Selected residues

Select the two aligned PRO residues from 1ki4 and 1ki3 as shown above and press the **space bar** twice to insert two gaps.

Now the three sequences are aligned and most of the residues are identical. The percentage sequence identity and similarity are well over 90% as shown in the status bar.

|      | 1   | 10  | 20  | 30  | 40  | 50  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------|-----|-----|-----|-----|-----|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1e2k | M   | P   | T   | L   | R   | V   | Y | I | D | G | P | H | M | G | K | T | T | T | Q | L | L | V | A | D | I | V | Y | V | P | E | P | M | T | Y | W | R | V | L | G | A | S | E | T | I | A | N | I | Y | T | T | Q | H | R | L |   |   |   |   |
| 1k4  | M   | P   | T   | L   | R   | V   | Y | I | D | G | P | H | M | G | K | T | T | T | Q | L | L | V | A | - | - | D | I | V | Y | V | P | E | P | M | T | Y | W | R | V | L | G | A | S | E | T | I | A | N | I | Y | T | T | Q | H | R | L |   |   |
| 1k3  | M   | P   | T   | L   | R   | V   | Y | I | D | G | P | H | M | G | K | T | T | T | Q | L | L | V | A | L | D | I | V | Y | V | P | E | P | M | T | Y | W | R | V | L | G | A | S | E | T | I | A | N | I | Y | T | T | Q | H | R | L |   |   |   |
|      | 60  | 70  | 80  | 90  | 100 | 110 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1e2k | D   | Q   | G   | E   | I   | S   | A | G | D | A | A | V | M | T | S | A | Q | I | T | M | G | M | P | Y | A | V | T | D | A | V | L | A | P | H | I | G | G | E | A | G | - | - | - | P | P | A | L | T | L | I | F | D | R | H | P | I |   |   |
| 1k4  | D   | Q   | G   | E   | I   | S   | A | G | D | A | A | V | M | T | S | A | Q | I | T | M | G | M | P | Y | A | V | T | D | A | V | L | A | P | H | I | G | G | E | A | G | - | - | - | P | P | A | L | T | L | I | F | D | R | H | P | I |   |   |
| 1k3  | D   | Q   | G   | E   | I   | S   | A | G | D | A | A | V | M | T | S | A | Q | I | T | M | G | M | P | Y | A | V | T | D | A | V | L | A | P | H | I | G | G | E | A | G | S | S | A | P | P | A | L | T | L | I | F | D | R | H | P | I |   |   |
|      | 120 | 130 | 140 | 150 | 160 | 170 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1e2k | A   | A   | L   | C   | Y   | P   | A | A | R | Y | L | M | G | S | M | T | P | Q | A | V | L | A | F | V | A | L | I | P | P | T | L | P | G | T | N | I | V | L | G | A | L | P | E | D | R | H | I | D | R | L | A | K | R | Q | R | P | G |   |
| 1k4  | A   | A   | L   | C   | Y   | P   | A | A | R | Y | L | M | G | S | M | T | P | Q | A | V | L | A | F | V | A | L | I | P | P | T | L | P | G | T | N | I | V | L | G | A | L | P | E | D | R | H | I | D | R | L | A | K | R | Q | R | P | G |   |
| 1k3  | A   | A   | L   | C   | Y   | P   | A | A | R | Y | L | M | G | S | M | T | P | Q | A | V | L | A | F | V | A | L | I | P | P | T | L | P | G | T | N | I | V | L | G | A | L | P | E | D | R | H | I | D | R | L | A | K | R | Q | R | P | G |   |
|      | 180 | 190 | 200 | 210 | 220 | 230 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1e2k | E   | R   | L   | D   | L   | A   | M | L | A | A | I | R | R | V | Y | G | L | L | A | N | T | V | R | Y | L | Q | C | G | G | S | W | R | E | D | W | G | Q | L | S | G | T | G | P | R | P | H | I | G | D | T | L | F | T | L | F | R | A | P |
| 1k4  | E   | R   | L   | D   | L   | A   | M | L | A | A | I | R | R | V | Y | G | L | L | A | N | T | V | R | Y | L | Q | C | G | G | S | W | R | E | D | W | G | Q | L | S | G | - | - | P | R | P | H | I | G | D | T | L | F | T | L | F | R | A | P |
| 1k3  | E   | R   | L   | D   | L   | A   | M | L | A | A | I | R | R | V | Y | G | L | L | A | N | T | V | R | Y | L | Q | C | G | G | S | W | R | E | D | W | G | Q | L | S | G | - | - | P | R | P | H | I | G | D | T | L | F | T | L | F | R | A | P |
|      | 240 | 250 | 260 | 270 | 280 | 290 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1e2k | E   | L   | L   | A   | P   | N   | G | D | L | Y | N | V | F | A | W | A | L | D | V | L | A | K | R | L | R | S | M | H | V | F | I | L | D | Y | D | Q | S | P | A | G | C | R | D | A | L | L | Q | L | T | S | G | M | V | Q | T | H | Y | T |
| 1k4  | E   | L   | L   | A   | P   | N   | G | D | L | Y | N | V | F | A | W | A | L | D | V | L | A | K | R | L | R | S | M | H | V | F | I | L | D | Y | D | Q | S | P | A | G | C | R | D | A | L | L | Q | L | T | S | G | M | V | Q | T | H | Y | T |
| 1k3  | E   | L   | L   | A   | P   | N   | G | D | L | Y | N | V | F | A | W | A | L | D | V | L | A | K | R | L | R | S | M | H | V | F | I | L | D | Y | D | Q | S | P | A | G | C | R | D | A | L | L | Q | L | T | S | G | M | V | Q | T | H | Y | T |
|      | 300 | 310 | 320 | 330 | 340 |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1e2k | T   | P   | G   | S   | I   | P   | T | I | C | D | L | A | R | T | F | A | R | E | M | G | E |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1k4  | T   | P   | G   | S   | I   | P   | T | I | C | D | L | A | R | T | F | A | R | E | M | G | E |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1k3  | T   | P   | G   | S   | I   | P   | T | I | C | D | L | A | R | T | F | A | R | E | M | G | E |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |