

The sound of proteins

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Biologists have converted protein sequences into classical music in an attempt to help vision-impaired scientists and boost the popularity of genomic biology. New research published today in the open access journal *Genome Biology* describes how researchers have found a way to present human proteins as musical notes.

Rie Takahashi and Jeffrey H. Miller from the University of California, Los Angeles, USA, have so far transcribed segments of two human proteins into music. But to make their melodies more pleasing on the ear, they had first to overcome a few problems – how to incorporate rhythm, and how to cram the 20 standard amino acids (the building blocks of proteins) into just 13 notes.

The duo focus on codons – sets of three adjacent bases that code for particular amino acids. They decided to include four different note durations with codons that appear more frequently transcribed into longer notes than those which appear less often. Individual amino acids are expressed as chords, in which similar amino acids are paired. For example, the amino acids tyrosine and phenylalanine are both assigned a G major chord, but they can be distinguished because the notes in the chord are arranged differently. This means the resulting music has a 20 note range spanning over 2 octaves, but with just 13 base notes.

The team find their music more melodic and less ‘jumpy’ than previous attempts, which have focussed on DNA sequences and protein folding, and hence closer to the musical depth of popular compositions. They are currently piloting a computer program, written by a collaborator Frank

Pettit, which uses their translation rules to convert amino acids into music and hope it will speed up the translation of large segments of genomes. Further examples of converted proteins and the computer program are accessible for online use [www.mimg.ucla.edu/faculty/miller_jh/gene2music/home.html]. The browser allows anyone to send in a sequence coding for a protein that is then converted into music and returned to the inquirer as a midi file.

Citation: Conversion of amino-acid sequence in proteins to classical music: search for auditory patterns, Rie Takahashi and Jeffrey H Miller, *Genome Biology* (In press)

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