## SUPPLEMENTARY DATA

### *Audio files*

We created four musical pieces included as MP3 files:

1. 01 Spinning Melody 1_ Vivo.mp3: $HAB_3$ Melody 1: forms fibers
2. 02 Spinning Melody 2_ Andantino.mp3: $HA_3B$ Melody 1: doesn't form fibers
3. 03 Spinning Melody 3_ Vivo.mp3: $HAB_3$ Melody 2: forms fibers (longer than Melody 1)
4. 04 Spinning Melody 4 Andantino; Bright.mp3: $HA_3B$ Melody 2: doesn't form fibers (longer than Melody 2)

### *Translation from silk to music*

We describe the process used here to translate the silk sequences to music using a set of rules. These rules facilitated a dialog using category theory to develop ologs between music and materials. Future developments are needed to improve the rigor of the translation, and the use of the formal approach outlined here, using category theory as a tool to ask the right questions, is critical in achieving this goal. The "spinning melodies" can be performed as a group of four or individually, showing possible "sound surrogates" representing musical interpretations of peptide sequences spun into silk fibers. The final draft score and sketches can represent another visual system that shows the behavior of the protein system.

1. **Key To Pitches** (total array of all melodies): The letters expressing the protein sequences are simply assigned pitches (notes), and the combinations that represent the A (hydrophobic) and B (hydrophilic) sequences can thus be heard as "themes" or "shapes" in the flute melodies (this leads to a 12-note A-sequence and the 20-note B-sequence).

M=E; H=B; S=Bflat; G=G; L=Aflat; V=Dflat; P=Eflat; R=D; K=Fsharp; E=E(octave higher than M); F=F; Q=Eflat (octave lower than P); D=D (octave lower than R); Y=Fsharp (octave higher than K)

2. **Range**: Variation from one spinning melody to another involves playing themes or shapes (sequences) higher or lower, within the limits of the flute's capabilities. These variations were chosen for variety, aesthetic flow/pacing and dynamism to create a satisfying listening experience.

Lowest Flute D (M2 above Middle C) to Highest Flute C

3. **Constants**:

- Pitches are defined at the outset and remain consistent (*i.e*. so-called "TS linkers", a short sequence of two amino acids that connect longer phrases, are always C—Bflat)
- TS linkers are always long notes (six-beat duration for each pitch)
- Certain notes tend to retain a distinctive duration throughout all the pieces
- All four pieces begin with the same 48-note phrase (representing the His-tag sequence (H) that is present before the $A_xB_y$ part)

- The pitch integrity of the 12-note A-sequence and the 20-note B-sequence remains essentially intact throughout the pieces despite changes in order of phrase appearances
- The pieces all end "identically," with the TS linker (except the last piece includes a little four-note coda that threatens to start the whole process over again at the first melody)

4. **Variables**:

- Register: some registers are strictly determined, but loosens toward the end of #4
- Meter (time signature): Nos. 1 and 3 are 6/8; Nos. 2 and 4 are 3/4
- Tempo: Nos. 1 and 3 "Vivo" [quarter=112-116]; Nos. 2 and 4 "Andantino" [quarter=108])
- Dynamics: for expressive range—quite detailed and changeable
- Duration: in both meters, eighth-note motion is the most common; some quarters and longer notes help shape phrases the way composer hears them
- Breath and phrase-length (flutists have to breathe)
- Order of A and B-sequence phrase appearances

McDonald (the composer) was informed only after writing the music which of the sequences formed a fiber and which did not. Music was performed by Elizabeth Erenberg, flute soloist.

***Category theory: background***

Three questions, listed here, guide the creation of a category:

| | | |
|---|---|---|
| A. | Name: | What is the name for the subject to discuss? |
| B. | Objects: | What is there? What shall be considered permanent? |
| C. | Morphisms: | What transformations can occur? How are objects related to each other? |

There are also three rules, written formally in earlier work [20]. Informally, the rules can be stated as follows:

| | | |
|---|---|---|
| 1. | Identity: | Any object can just "be there". Identity itself counts as a morphism. |
| 2. | Composition: | One morphism followed by another results in a third "composite" morphism. |
| 3. | Associativity: | The composition of three or more consecutive morphisms is uniquely determined by pairwise compositions. |

By answering questions A, B, and C, and following rules 1, 2, and 3, a mathematical object called a category is created. Once a category **X** has been created, it can be compared rigorously with any other category **Y** by means of a functor F: **X**→**Y**. A functor translates the essential features of category **X** into the context of category **Y** and it thus essential to develop the mapping between one system (e.g. silk) to another (e.g. music).