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Assembly and dynamics of synthetic cilia[1]

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From motility of simple protists to determining the handedness of complex vertebrates, highly conserved eukaryotic cilia and flagella are essential for the reproduction and survival of many biological organisms. Despite extensive studies, the exact mechanism by which individual components coordinate to produce ciliary beating patterns remains unknown. We describe a novel approach towards studying ciliary beating. Instead of deconstructing a fully functional organelle from the top-down, we describe a process by which synthetic cilia-like structures are assembled from the bottom-up. We find that simple mixtures of microtubules, kinesin clusters, and a bundling agent produce spontaneous oscillations in MT bundles, suggesting that self-organized beating may be a generic feature of internally driven bundles. Furthermore, bundles in close proximity spontaneously coordinate their beating to generate metachronal traveling waves, reminiscent of the waves seen in ciliary fields. These findings and future refinements of the system can potentially provide insights into general design principles required for engineering synthetic cilia as well as understanding the biological analogues.

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