Molecular motor proteins: a legacy from Szent-Györgyi

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Movement is a fundamental attribute of life. The contraction of muscle, the beating of cilia and flagella, the segregation of genetic material during cell division, and intracellular transport of membranes, proteins and mRNAs are all examples of biological motility. Biological motion is driven by protein machines (10-50 nanometers in size) that convert a chemical energy source (adenosine triphosphate) into unidirectional motion along a biological polymer (microtubules or actin filaments). We have studied kinesin and dynein, the two different types of motors that move along microtubule tracks. To understand the mechanism of kinesin, we solved its structure by X-ray crystallography and electron microscopy, and have investigated kinesin's stepping behavior and force production by single molecule optical techniques. I also will discuss our more recent work using these same techniques to understand the mechanism of movement by cytoplasmic dynein and its regulation by dynactin. These studies reveal very distinct motility mechanisms of kinesin and dynein motors. Finally, I will discuss how molecular motors impact human health.