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Using optical tweezers to measure the forces exerted by molecular motors in onion cells

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Optical tweezers demonstrate how light can be applied to exert piconewton forces on a microscopic particle. This allows for the particle to be spatially manipulated in three dimensions. Optical tweezing is achieved by creating an optical trap. In this work, a single beam optical trap is created using a high numerical aperture microscope objective to focus a near infrared laser into a sample. The sample used for calibration of the setup is micron sized, dielectric particles suspended in a fluid. The particles have a higher refractive index than the fluid in which the particles are suspended. After the light refracts through a particle, a net force is applied to the particle that causes it to move into the focus of the beam due to conservation of momentum. When moving the trap position relative to the sample, the optical trap acts as optical tweezers moving the particle(s) currently in trap relative to the sample. Optical tweezers have been developed for various applications. However, here the optical tweezers is used to investigate the forces needed to stall the motion of molecular motors in onion (Allium cepa) cells. To do this, the optical tweezers were constructed and the forces applied to micron sized particles in the trap were calibrated. An integrated microscopy imaging setup was used to see and trap vesicles transported by molecular motors in the cells. The force calibration was then used to determine the intracellular forces of the molecular motors.

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