A NEW GIANT LENS FOR CONFOCAL MESOSCOPY
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Optical lenses reached the limit of resolution set by the wavelength of light more than a century ago. However, no attempt was made to achieve the maximum resolution in the case of low-magnification lenses, probably because the visual image would then have contained detail too fine to be perceived by the human eye. Currently available lenses of less than 10x magnification are of simple construction and their numerical apertures are 0.2 or less, as compared with 1.3 or more in high-power lenses. They are adequate for the eye or a standard camera, but thin confocal optical sections are not possible because of the low numerical aperture.

We have developed a novel lens system called the Mesolens, which, with a magnification of 4x and an N.A. of 0.5, combines high spatial resolution with a wide field of view. When compared with a standard 4x objective, its lateral resolution is 2.5 to 5 times better and its depth resolution is 10 times better. This lens provides, for the first time, good optical sectioning of specimens as large as entire 10 day mouse embryos (5mm long) with subcellular detail in every developing organ. The lens is difficult to make because of the need for a higher degree of aberration control than in any standard camera lens and it is too large (optical train 50cm x 7 cm) to fit on any standard microscope [1].

Figure 1: A single confocal optical section of 11-day mouse embryo taken using the Mesolens. This specimen was stained for Golgi bodies and clearly shows in a single image (with no stitching and tiling) the whole organism, which is 5mm in diameter, with sub-micron spatial resolution. The full size image shows the microanatomy of the whole embryo, while in the enlarged portion at the bottom left, bright dots corresponding to the Golgi bodies of individual cells can be seen in the developing heart.

We will show recent data and discuss the Mesolens and its applications, including unexpected ones such as the detection of bioluminescent labels in individual cells at near-video rates, which is made possible by the high capture efficiency of the lens.