A team of scientists working at beamline 9.0.1 of the Advanced Light Source (ALS) at the U.S. Department of Energy's Lawrence Berkeley National Laboratory has used x-ray diffraction microscopy to make images of whole yeast cells, achieving the highest resolution—11 to 13 nanometers (billionths of a meter)—ever obtained with this method for biological specimens. Their success indicates that full 3-D tomography of whole cells at equivalent resolution should soon be possible. Three-dimensional imaging of whole cells under conditions close to those in nature, namely a hydrated (watery) environment, is already done. The ability to increase resolution to the 10-nanometer range would significantly advance research in both biology and materials sciences.

X-rays have the ability to look deep into thick specimens, or right through them. Even the best x-ray microscope lenses, can't focus x-rays with high efficiency. The intense radiation would quickly damage biological specimens. At the same time, the geometry of the highest-resolution zone plates makes for an extremely narrow depth of focus. To get around these barriers, the research team used lensless x-ray diffraction microscopy. To produce a high-resolution diffraction pattern from noncrystalline structures like the membranes and organelles of a cell, the light has to be coherent, that is, laser-like, having all the same frequency and phase. Beamline 9.0.1 was built to supply this kind of light. As they proceed through the cell, the coherent x-rays are scattered and differentially absorbed by the cell's internal structures. There's no lens either in front or behind the sample as the light passes through the cell and reaches the detector, so there's nothing to limit resolution or efficiency. In the current experiment, additional images of the same freeze-dried cells were made first by scanning transmission x-ray microscopy (using a lens), which was of lower resolution but helped confirm features at different planes, and then by scanning electron microscopy, which was of higher resolution but could only show surface details such as sugar molecules in the cell walls, which the researchers had labeled with gold particles to serve as position markers.

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