frontiers in Bioengineering and Biotechnology

REVIEW
published: 18 September 2020
doi: 10.3389/fbioe.2020.580937

Genetic Material Manipulation and Modification by Optical Trapping and Nanosurgery-A Perspective

Alfonso Blázquez-Castro[1,2*], *José Fernández-Piqueras*[1,2,3,4] *and Javier Santos*[1,2,3,4]

[1] *Department of Biology, Faculty of Sciences, Autonomous University of Madrid, Madrid, Spain,* [2] *Genome Dynamics and Function Program, Genome Decoding Unit, Severo Ochoa Molecular Biology Center (CBMSO), CSIC-Autonomous University of Madrid, Madrid, Spain,* [3] *Institute of Health Research Jiménez Diaz Foundation, Madrid, Spain,* [4] *Consortium for Biomedical Research in Rare Diseases (CIBERER), Carlos III Institute of Health, Madrid, Spain*

Light can be employed as a tool to alter and manipulate matter in many ways. An example has been the implementation of optical trapping, the so called optical tweezers, in which light can hold and move small objects with 3D control. Of interest for the Life Sciences and Biotechnology is the fact that biological objects in the size range from tens of nanometers to hundreds of microns can be precisely manipulated through this technology. In particular, it has been shown possible to optically trap and move genetic material (DNA and chromatin) using optical tweezers. Also, these biological entities can be severed, rearranged and reconstructed by the combined use of laser scissors and optical tweezers. In this review, the background, current state and future possibilities of optical tweezers and laser scissors to manipulate, rearrange and alter genetic material (DNA, chromatin and chromosomes) will be presented. Sources of undesirable effects by the optical procedure and measures to avoid them will be discussed. In addition, first tentative approaches at cellular-level genetic and organelle surgery, in which genetic material or DNA-carrying organelles are extracted out or introduced into cells, will be presented.

Keywords: optical trapping, optical tweezers, laser scissors, genetic manipulation, cell surgery, genomic instability, cytogenetics, DNA damage response