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VIROLOGY

New Type Platforms for In Vitro Vaccine Assembly

J. G. Atabekov[a,b], N. A. Nikitin[b], and O. V. Karpova[b]

[a] *Faculty of Biology, Lomonosov Moscow State University, Moscow, Russia*
[b] *Bioengineering Center, Russian Academy of Sciences, Moscow, Russia*
e-mail: atabekov@genebee.msu.ru

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Abstract—Studying the structure of plant viruses and viral coat proteins along with the possibilities of their modification and structural remodeling is very important for the development of novel approaches to the design of biotechnological products, including those of medical use. Being nonpathogenic for mammals, in particular for humans, undoubtedly, make plant viruses advantageous for the development of new functional and biologically active materials, particularly, candidate vaccines. The present review focuses attention on characteristics and applying in biotechnology of spherical particles—the new type platforms generated by structural remodeling of plant viruses. Spherical particles do not have structural analogues among the icosahedral viruses and represent a new type of biogenic platforms. The assembly of the spherical particle–antigen immunogenic complexes in vitro bring in the possibilities of inexpensive and easy production of different vaccines.

Keywords: helical viruses, spherical particles, platforms, complexes with target antigens, immunogenicity, adjuvant properties, review.

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PLANT VIRUSES AS BIOTECHNOLOGY INSTRUMENTS

Plant viruses made up by the identical subunits of the coat protein and RNA may be used as building blocks or matrices for the production of various bioinorganic materials like nanotubes, nanoconductors, nanoelectrodes, and nanocontainers, for the incapsidation of inorganic compounds, and for the inorganic nanocrystalls production [1]. Due to the chemical and biological multifunctionality, virus particles can be modified both chemically and by genetic engineering without disturbing their structure. Plant viruses are absolutely safe to use in humans and livestock, since plants and animals do not have common pathogens [2].

Full genome plant virions may be used as platforms to which surface foreign antigenic determinants can be attached. According to Acosta-Ramirez et al. [3], the papaya mosaic virus in the mixture with the *Salmonella typhi* antigen is able to stimulate an immune response to the target antigen. Similar results can be obtained using the virus-like particles produced by the expression of the papaya mosaic virus coat protein in *E. coli* [4, 5]. The data available on the structure of the coat proteins of different viruses make it possible to attach target polypeptides to the terminal amino acid residues localized on the surface of the virus particle. In particular, the structure of the protein subunits of the tobacco mosaic virus was studied in detail, which allows the determination of the positions of individual amino acid residues on the surface of the virus particle [6, 7]. Attaching, chemically, or by the genetic engineering techniques, of an active foreign protein or peptide to the surface of the coat protein subunit of a self-replicating virus make it possible to use such constructs as the instruments for the direct implementation of the foreign protein/peptide activity as a part of the modified virus. In such a way, the tobacco mosaic virus particles in which a large fragment of protein A was fused with the C-end of the coat protein subunit without losing its ability to bind monoclonal antibodies in the process of their purification were constructed [8], as well as the potato virus X particle bearing the lipase molecules fused with the N-end of the coat protein subunits [9].

The development of the vectors on the basis of the full plant virus genomes containing the nucleotide sequences encoding foreign antigens, whose expression in the plant results in the assembly of virus particles bearing antigenic determinants of the human pathogens on their surface, opened new possibilities for the production of safe candidate vaccines [10–13].

The important practical implementation of these principles is the development of vaccines using self-replicating particles bearing on their surface an antigenic determinant (epitope) of the pathogen or any other functionally active polypeptide as the target peptide. For example, the chimeric forms of the tobamovirus and potexvirus genomes were obtained, which produced virus or virus-like particles bearing the