FACULTY OF SCIENCE
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VIRAL NANOTECHNOLOGY GROUP

OFFER

Our mission is to identify the crucial principles of the win-lose game between virus and cell and to use this knowledge for reprogramming virus particles into platforms that can be used to diagnose or treat disease.

- Experience in small scale antigen and vaccine production;
- Expertise in the design, modification, production and purification of polyomaviruses based VLPs;
- Protein production in baculovirus expression system;
- Expertise in molecular biology and virology of small DNA tumorogenic viruses;
- Education in virology and viral nanotechnology;
- Highly-qualified and enthusiastic human resources.

We explore **viruses** as sophisticated **nanoparticles** that have been engineered by evolution to optimize their interaction with host cells.

KNOW-HOW & TECHNOLOGIES

Using the polyomaviruses, papillomaviruses and related virus-like particles (VLPs, non-infectious viral capsids) as a research tool, we try to understand their natural interactions and further adjust viral capsid as biocompatible nanocarriers of therapeutic or diagnostic compounds for biomedical application or antigens for vaccines. Specifically we:

- use polyomavirus/papillomavirus VLPs to accommodate and deliver cargo molecules (e.g. drugs or DNA) into target cells – to study endocytosis or deliver compounds into the cell,
- modify VLPs to target specific (e.g. cancer) cells – VLPs can be used to diagnose or treat diseased tissue,
- modify VLPs to enhance the release of viral nanostructures from the cellular endolysosomal system – VLPs can deliver substances more efficiently or promote an immunological response,
- modify VLPs with selected epitopes and use them as adjuvants and antigen carriers – VLPs can be used as vaccines or antigens for antibody production,
- use VLPs derived from human polyomaviruses as a tool for the clinical diagnosis of infection.

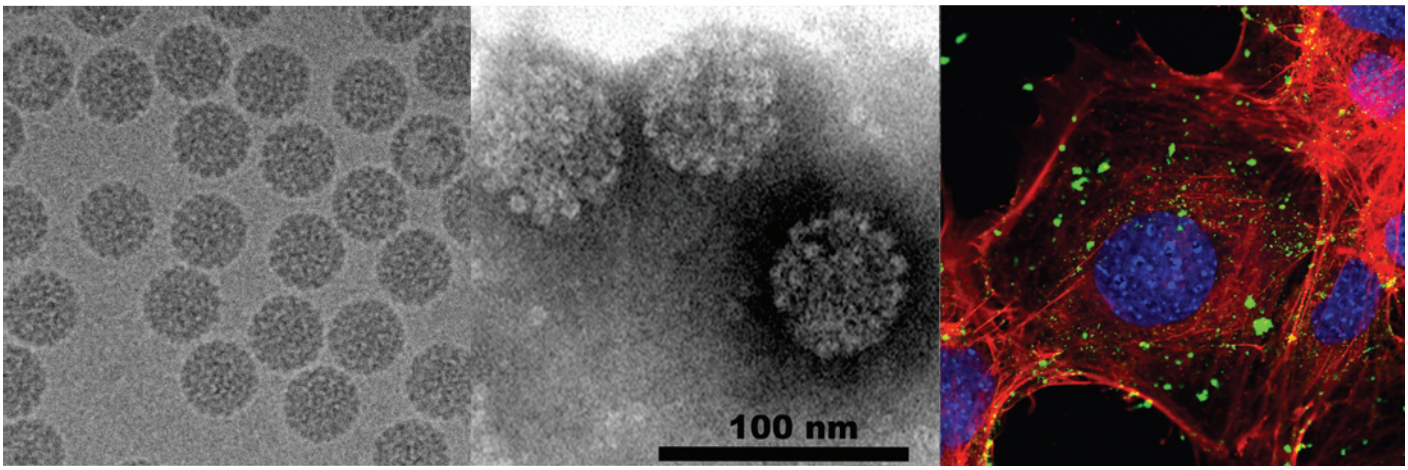

Figure: Mouse polyomavirus – cryo-electron micrographs of purified virions with diameter 45 nm. Virus-like particles derived from mouse polyomavirus – transmission electron micrographs (negative staining). Confocal micrographs showing mouse polyomavirus based virus-like particles conjugated with Alexa Fluor 488 (green) interacting with mouse fibroblast where nucleus is stained with DAPI (blue) and actin is stained with rhodamine phalloidin (red). Authors: Jakub Soukup, Jiřina Žáčková Suchanová, Alžběta Sekavová, respectively.

CONTENT OF RESEARCH

The group of viral nanotechnology is part of the laboratory of virology. In the area of basic research, the laboratory of virology is focused on the endocytosis of polyomaviruses, mechanism of delivery of their genomes into the cell nucleus and study of the innate immunity response to a viral infection. In application research, polyomavirus-based VLPs were successfully used for vaccine production or the production of diagnostics kits.

MAIN CAPABILITIES

- Production of selected polyomaviruses,
- production of pseudovirions derived from papillomaviruses and polyomaviruses,
- production of proteins/antigens/VLPs in mammalian and baculovirus expression system,
- *in vitro* disassembly and reassembly of viral capsids,
- genetic and chemical modification of viral capsids (successfully used for re-targeting of VLPs to unnatural, cancer-specific receptor or for vaccine production),
- virus/VLPs visualisation and study of cellular trafficking by microscopy and biochemical analysis.

KEY RESEARCH EQUIPMENT

- Fully-equipped laboratory for molecular genetics (including cyclers, real-time PCR instruments, in-house sequencing systems, etc.),
- ultracentrifuge,
- cell and tissue culture laboratory (BSL2),
- luminometry, photometry and fluorometry (Varioskan Flash Multimode Reader),
- flow cytometry facility,
- microscopic facility (including advanced confocal and electron microscopy),
- virus and cell culture biobank.

PARTNERSHIPS & COLLABORATIONS

ACADEMIC PARTNERS

Cooperation with academic research groups from Institute of Inherited Metabolic Disorders, First Faculty of Medicine, Charles University, Prague; Institute of Organic Chemistry and Biochemistry of the Czech Academy of Science (Prague, Czech Republic); School of Medicine, Cardiff University, UK.

PRIVATE AND PUBLIC SECTOR

VIDIA spol. s r.o., Czech Republic; Dyntec spol. s r. o., Czech Republic

MAIN PROJECTS

- Study of endocytosis via modification of viral nanoparticles. GACR P305/17-11397S.
- New materials and technologies for diagnostics of polyomaviruses in immunodeficient patients. TACR TH01010548.
- Investigation of viral particles as nanosystems for the transport of substances into tumour cells. Project sponsored by the League Against Cancer Prague.
- Development of diagnostic components and adaptable technology for preparing recombinant vaccines based on viral artificial nanostructures. TACR TA03010700.
- Participation in projects funded by the Charles University Grant Agency.

ACHIEVEMENTS

Publications in respected international journals, one patent and two utility models registered (co-inventor):

- UV No. 29249: Vakcína založená na proteinové virové nanočástici odvozené z bovinního papilomaviru 1.
- UV No. 29310: Vakcína založená na proteinové chimerické nanočástici proti prasečímu cirkoviru 2.
- Patent application No. E267152: Vakcína založená na proteinové chimerické nanočástici proti prasečímu cirkoviru 2.