As the leading causes of blindness globally, the most prevalent posterior segment ocular diseases are age-related macular degeneration, diabetic retinopathy, diabetic macular edema as well as eye injuries. With approximately 4.01% population suffering from age-related macular degeneration and 2.99% suffering from diabetic retinopathy followed by 1.56% people suffering from glaucoma. A range of ophthalmological diseases and eye traumas must be treated by surgery. Modern ophthalmological surgery includes vitrectomy - a kind of surgery that remove some or all of the vitreous humor from the eye. Its aim is to improve vision by removing hemorrhage in or behind the vitreous or proliferative membranes, reattaching detached retina and reducing the factors for angiogenesis. The remaining hole must be filled by intraocular tamponade in order to keep intraocular pressure and avoid sunken eye. Current clinical vitreous endo-tamponades include expansile gases (such as sulfur hexafluoride (SF_6) and perfluoropropane (C_3F_8)) and also silicone oil that, being pumped into vitreous humour, provide pressure and mechanical support for retina. Operated patients are advised to posture face down for at least 24 h to avoid dissemination of tamponade. Today, there is much demand to develop novel biomaterial for vitreous tissue replacement that will be similar to extracellular matrix of vitreous humour, biocompatible, will provide intraocular pressure and create favourable environment for healing process.

The goal of the project is to design vitreous hydrogel scaffold for filling an intraocular defect during vitrectomy (VitreGel). The VitreGel is conceptualized as artificial extracellular matrix of vitreous humor, will be injectable and contain compounds naturally originated in the vitreous tissue, such as hyaluronan, collagen II and/or collagen V/XI, protein opticin, fibrillins, metabolites (such as pipecolic acid, pantothenate), and copper-dependent enzyme lysyl oxidase (as a cross-linker). The injectable composite hydrogel VitreGel will have high water content, high clarity, suitable refractive indices, suitable density, tuneable rheological properties, injectability, biocompatibility, and antimicrobial properties to keep the intraocular postoperative area sterile.

The project will explore new scalable, high throughput, and rapid manufacturing techniques of biomaterials for ophthalmological applications. The results of the project will be a good basis for next stages of biomaterial design – in vivo experiments and clinical trials, implementation of the VitreGel into serial production and application in hospitals. The proposed antibiotics-free solution supports the directive to reduce reliance on non-renewable resources and replace substances of concern. The VitreGel, novel injectable composite scaffold for intraocular application, will significantly improve the quality of the patient’s life and reduce period of recovery after surgery.