CURE FOR TYPE 1 DIABETES WITH BIOTECHNOLOGY – HOW FAR WE ARE FROM CLINICAL APPLICATION?

MICHAŁ WSZOŁA[1,2,3]*

[1] FOUNDATION OF RESEARCH AND SCIENCE DEVELOPMENT, POLAND
[2] POLBIONICA LTD
[3] MEDISPACE MEDICAL CENTRE
*E-MAIL: MICHAL.WSZOLA@FUNDACJABIRN.PL

[ENGINEERING OF BIOMATERIALS 163 (2021) 10]

Introduction
Type 1 diabetes (T1D) is an autoimmune disease, which affects the huge number of patients. Islet or pancreatic transplantation is a method of treating patients with diabetes mellitus. The limitation of these methods is the lack of organs for transplantation. The problem may be solved by 3D-bioprinting technology. 3D-bioprinting using living cells is the latest technique in the field of biomedical engineering. In this study, there are the results of bioprinted bionic pancreas tissue and the first studies on mouse and pig model.

Materials and Methods
Research was carried out on 60 mice (SCID) and 24 pigs. The mice were divided into 3 groups: control; IsletTx in which porcine pancreatic islets were transplanted under the renal capsule; 3D-bioprint in which bioink petals consisted of bioink A and porcine islets. The bioprinted petals were transplanted into the dorsal part of the muscles under the skin in mice. Daily glucose measurement was performed and the level of C-peptide was tested every 7-days.
The pigs were divided into 3 groups: control, diabetic group after pancreatectomy (T1D); induced diabetes group (after pancreatectomy), with transplanted in 7 days 3D-printed bionic petals (TX). The bionic petals were implanted under the peritoneum. The animals were measured daily with blood glucose levels (from 5-20 measurements per day). The pigs also showed a significantly lower insulin requirement after petals implantation.

Results and Discussion
The results obtained in mice initially showed no differences in the concentration of peptide-C and glucose between groups. However, as early as 7-days after transplantation, both parameters analyzed in the fasting state were significantly lower in the IsletsTx and 3Dbioprinted groups compared to the control group. On day 14, decreased values of C-peptide and glucose were observed only in the group with petals transplants.
The results of the observations in pigs showed a decrease in the mean blood glucose level 48 hours after the transplantation of the petals. Mean glucose levels were two times lower, compared to the period before petals transplantation. In addition, TX pigs required lower doses of insulin after petals implantation.

Conclusions
Transplantation of bionic petals in mice and pigs resulted in a decrease in mean glucose levels. The mice showed a reduced concentration of their own C-peptide, which can indicate relief in mice's owns islets function. None of the animals died due to postoperative complications or the lack of biocompatibility with the bionic structure. Positive effect of transplantation was maintained throughout the experiment, which proves the optimal selection of the composition of the bioink and bioprinting parameters.

Acknowledgments
Project „3D – BIOPRINTING OF SCAFFOLDS USING PANCREATIC ISLETS OR INSULIN PRODUCING CELLS IN ORDER TO CREATE BIONIC PANCREAS" funded by National Center for Research and Development in the framework of the programme „Prevention and Treatment of Civilization Diseases" STRATEGMED. Timeframe: 01.01.2017 – 30.06.2021.
Accomplished by the Bionic Consortium - Foundation of Research and Science Development, Medical University of Warsaw, Warsaw University of Technology, Nencki Institute, MediSpace sp. Z o.o.