Osteoarthritis is one of the most common diseases to afflict humanity. Elder parts of populations, which are still growing in developed countries, are especially vulnerable. The nature of this tissue limits the self-repair of cartilage. All currently used treatment methods require a lot of time and money, while often not bringing the expected results. Scientists are trying to obtain better treatment methods by applying discoveries in the field of biocompatible materials, 3D printing, and laboratory tissue culture. These new tools can allow for obtaining synthetic cartilage that could replace the damaged piece of the joint. Such an implant should immediately act like natural tissue and allow the patient to move freely without pain. Greatest implants should be biodegradable and absorbed by the patient's body and stimulating the patient's tissues to rebuild and take the place of the implant at the same time. Several months after the implementation, the patient's joint should be healed and be in the same condition as before the disease. The main purpose of research in this grant proposal is to use adenosine for obtaining a better bone and cartilage implant. Adenosine is one of four basic elements of RNA, and also a substrate of the main energy carrier in every living cell – ATP. It has been known for many years that adenosine present in the intercellular space has anti-inflammatory properties, and the latest research indicates that it can also affect the differentiation and development of bone and cartilage cells. Accurate application of adenosine can significantly accelerate tissue regeneration. However, it is necessary to study different combinations of adenosine, ceramics, polymer, and hydrogel in the production of implant, and then compare them to indicate which combination would be best suited for medical applications.

In this project, implants made of two parts will be produced by using 3D printers. The first part will involve biocompatible and biodegradable polymers mixed with ceramic materials, based on calcium phosphate compounds (which is the main mineral component of our bones), and with adenosine. This material will form the "bone" part of the implant. The second part is an attached layer of adenosine connected with flexible hydrogel - a polymer that can absorb and hold large amounts of water. This hydrogel, thanks to its mechanical properties, can effectively mimic articular cartilage. All obtained implants will be tested to determine whether there can be toxic. The rate of adenosine release from such implants will also be examined. The shape and surface of the implants will be carefully examined by using an electron microscope - which allows the sample to be viewed at 30,000 magnification. In the final experiment, bone cells - osteoblasts, as well as cartilage cells - chondrocytes will be placed on the obtained implants. Their growth and behavior will be monitored sequentially after 1, 3, 7, 14, and 21 days of culture. After each time, the samples will be fixed and stained, and then observed by using a laser confocal scanning microscope. This device allows for observation of every cell, and thanks to staining even such small elements as the cell nucleus or cell walls. Additional staining will also determine whether the cells growing on the implant begin to rebuild bone and cartilage tissue. Obtained images will allow assessing how the composition of the implant affects the speed of reconstruction processes. The information obtained from the above research will be used to develop better implants, as well as the approximate moment of introducing new treatment methods for patients suffering from osteoarthritis.