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ТРЁХМЕРНАЯ ПЕЧАТЬ ОРГАНОВ И ТКАНЕЙ

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В данной статье изложена информация о трёхмерной печати, используемой в сфере медицины для создания протезов, искусственных органов и прочее; приведены данные о результатах последних проведённых операциях и экспериментах, включая достижения Башкирского государственного медицинского университета.

Ключевые слова: трёхмерная печать, биопечать, биочернила.

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3D-PRINTING OF ORGANS AND TISSUES

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This article provides information about three-dimensional printing used in the field of medicine to create prostheses, artificial organs, etc.; provides data on the results of recent operations and experiments, including the achievements of the Bashkir State Medical University.

Key words: three-dimensional printing, bioprinting, bioink.

Medicine became one of the first fields of technological know-how that decided to apply the capacity of three-D printers for realistic purposes. Moving from the clean to the hard, main scientists selected approaches to introduce additive printing into clinical practice.

The creators of three-D printers additionally didn’t stand, growing materials perfect for printing dental implants, prostheses, prototypes of human organs and even determined a manner to print with organic material.

Nowadays, 3-dimensional printing is used in almost all branches of medication: dentistry, prosthetics, surgical operation and microsurgery of the eye, gynecology and plenty of others. Currently, the progress of using 3-D printers keeps to grow, and within the future, three-D printing technology is probable to absolutely conquer the fields of diagnostics and prosthetics.

3-D printing, or three-D bioprinting, is a biotechnology for developing three-dimensional organic fashions of structures based totally on dwelling cells and auxiliary substances using a three-D bioprinter, wherein cells hold their capabilities and viability.

The history of 3-D printing started within the early 1980s with the invention by Charles Hull of this method of creating gadgets, which he known as «stereolithography». Later, a 3-D Systems business enterprise based with the aid of Hull evolved the first 3D printer - a tool with numerical manage, which uses the method of layer printing of an item, called «stereolithographic device». Hull’s work, in addition to the achievements of different researchers, revolutionized the production of gadgets through 3D printing in many fields, along with medicine and biology.

Three-D bioprinting has been used in medicine since the early 2000s, when it turned into first used for dental implants and prosthetics. Since then, the medical use of this technique has accelerated

significantly. In 2003, Thomas Boland creates the first 3-d bioprinter and gets the patent of this era. Organovo is the primary US company to commercialize 3D bioprinting era. (He tried to reconstruct the shape of DNA with the assist of a familiar 2D printer. The scientist did it! As a end result of studies he made a brilliant discovery that paved the manner for different, no much less wonderful innovations.Thomas Boland found that the scale of the human cellular is akin to the size of the ink droplet. This idea has end up the premise of the 3-d bioprinter principle).

The primary technique for bioprinting tissues involves collecting various cells from the patient and cultivating them in a mobile subculture device. These cells are then combined with a suitable biomaterial to create bioink, which is then fed into the bioprinting machine.

Inkjet-based bioprinting utilizes traditional inkjet technology to dispense droplets of diluted solutions using non-contact printers. The drop-on-demand inkjet technology is commonly used in bioprinting, employing thermal, piezoelectric, electrostatic, and electrohydrodynamic printing technologies.

Laser-assisted bioprinting involves using a laser as the energy source to position biomaterials onto a substrate, comprising a pulsed laser source, a metal film layer, and a receiving substrate. The resolution of this method ranges from percent- to micro-scale.

Extrusion-based bioprinting combines a fluid-dispensing piston with an automated robotic system controlled by a computer to deposit bioink material with advantages such as faster fabrication, improved structural integrity, and compatibility with CAD software.

The bioprinting process typically involves three main stages: pre-printing, bioprinting, and post-printing, aiming for the maturation of tissues and organs using 3D patterns created by CAD/CAM image processing.

Actually, 3-D bioprinting technique has numerous steps from starting to finalization. They may be categorized as pre-printing, bioprinting and publish-printing. In Table 1, this substeps are listed. Preprinting degree is extraordinarily critical that allows you to ensure that proper fine of the cells is acquired. Bioprinting level is blanketed bioink, bioprinter and bioprinting process which can be effected by physicochemical, organic and other system based totally parameters. As a result of the bioprinting manner, bioprinted substances are transferred to bioreactors in part of submit printing level. In this degree, tissue maturation have to be acquired by stimulation and developed tissue/organ can be monitored via biosensors with admire to functionality, tension and balance.

Using three-D printing, scientists have created artificial bones, knee meniscus, coronary heart valve, vertebral discs, different types of cartilage and bone, in addition to synthetic ears, blood vessels, tissues and organs.

- In 2010, a skin fragment become printed for the first time;
- In 2014 - coronary heart valve and liver tissue fragment;

- A prototype synthetic kidney was created in 2011 by means of 3D bioprinting;
- In 2016, a fraction of human nerve tissue with exactly positioned neurons is outlined on the bioprinter.

Scientists of the Institute of regenerative medicine from the University named after Sechenov in Moscow have revealed on 3-D-bioprinter synthetic eardrum, which in structure and features is certainly similar to the existing. The membrane is completely composed of tissue cells with vascular and capillary inclusion. By now, scientists have already done the primary experiments on chinchillas, transplanting debris of a brand new artificial membrane into their ears. Experiments confirmed awesome effects - the perforation of the membrane closed or even recovered the layers like the natural membrane. In the near destiny, surgeons plan to start operations the use of a 3D revealed membrane.

3D bioprinting is taken into consideration as a device that is capable of resolve the problems for most cancers sufferers by way of growing affected person particular treatment through mimicking of in vitro models more carefully actual most cancers conditions.

The main packages in three-D printing of organs and tissues consist of vascular, skeletal, hepatic, and cardiac based, within the order of importance.

At the interuniversity student campus of the Eurasian Scientific and Educational Center, a new laboratory has been established by Bashkir State Medical University. This laboratory is dedicated to the development of ceramic implants using advanced three-D printing methods. The team of researchers at the laboratory is working on producing implants from innovative materials that have the potential to be integrated with the body's own tissues. Over six thousand samples have already been printed, with preclinical tests conducted on cell cultures and animal trials initiated by the scientists.

After a year of dedicated research, a group of innovative BSMU college students successfully devised a groundbreaking technology to produce the essential component of bioink. This revolutionary product enables the synthetic generation of a variety of tissue cells and is perfectly suited for the 3D printing of implants. Utilizing dispersed collagen treated in a unique manner and combined with water at a specific concentration, they have created a gel for the 3D printing of synthetic organs. This development is poised to revolutionize the process of selecting implants for transplant patients in the future.

So, it's miles already possible to print flat organs and cartilages. In the destiny, college students plan to improve the technology to be able to create tubular organs within the coming many years.

Innovation improves the reliability of operations, saves time, reduces manufacturing charges and the value of cease merchandise, and, most importantly, improves and prolongs the lives of patients.

Progress in additive manufacturing and biomedical technologies will play a significant role in the advancement of bionic modeling and 3D printing of tissues and organs, ultimately potentially revolutionizing healthcare and saving numerous lives.

REFERENCES

1. 3D-печать в медицине: от открытий к практике [Электронный ресурс]. – Режим доступа: https://www.as3dm.ru/news/73#:~:text=В%201999%20г.%2Скопии%20органа%20пациента%20-%20мочевого%20пузыря (дата обращения: 03.03.2024)
2. 3Д-принтер – локомотив биоинженерии: перспективы развития в России [Электронный ресурс]. – Режим доступа: https://lit.sochisirius.ru/bioprinting (дата обращения: 05.03.2024)
3. Аддитивные технологии в медицине: как снизить риски для здоровья в медицине [Электронный ресурс]. – Режим доступа: https://blog.iqb.ru/3d-printing-medicine/ (дата обращения: 03.03.2024)
4. Путеводитель по 3D-печати в медицине [Электронный ресурс]. – Режим доступа: https://vektorus.ru/blog/3d-tehnologii-v-meditsine.html (дата обращения 04.03.2024)
5. Студенты БГМУ разработали гель для 3D-печати искусственных органов [Электронный ресурс]. – Режим доступа: https://bashgmu.ru/news/83680/ (дата обращения: 03.03.2024)