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Healthcare Technology and Innovations in 3D Bioprinting

Shweta Sharma[1]

Department of Computer Science, R.K. Patni Girls' College, Kishangarh, Rajasthan, India[1]

ABSTRACT: Bioprinting is a multidisciplinary study field of additive manufacturing that blends, material sciences, and biology, and produces bio constructs with structures of 3-Dimensional that resemble genuine living tissues. Bioprinting has established that in the biomedical research field,biomedical research from attracting and wide companies, research institutes, and universities similar. In this situation, this study presents acritical evaluation and scientometric analysis of the existing literature as well as the bioprinting industry to offer alandscape comprehensive picture of the field's rapidly changing and complicated situation. Due to the capacity of their specified patterns to print with great precision of dimensional, different three-dimensional processes are printing rapidly to make employed medical devices. 3D printing techniques the ability to prepare patient-matched devices and the restrictions owing to the process of traditional manufacturing such as several stages and inefficiency of processing for complicated geometries are responsible for largely application medical sectors. It has advanced quickly with Three-dimensional (3D) printing, with important uses in medicine.The creation ofcells, and supporting components biomaterials, enabling the manufacture of functional living tissues was one of the most significant3D bioprinting advancements leading. This study discusses several distinct 3D bioprinting technologies and procedures.

KEYWORDS: - Healthcare Technology, Trends, and Digital Innovations, BIOPRINTING, Current developments, 3D Bioprinting Strategies.

I. INTRODUCTION

In 2022, healthcare technology trends and digital innovations will be discussed.

In COVID-19 the planet across is still felt and imprinted. 2020 is the year even though has passed. The industries of all that have been transformed through the pandemic's effectsworldwide, probably have changed the most. In unique ways to continue the healthcare business has changed in the healthcare business to give the service of great level, substantial to thanks in developments of process and technology to meet required for increased demand and healthcare for the protected health information of expanding digitalization[1].

Even in the year 2022, COVID-19's presence is still felt across the planet. That said, it's vital to stay on top of the technological advances that are driving digital transformation[2][3]. The most critical healthcare technology developments that will influence the market in 2022, according to MobiDev specialists[4][5].

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Figure 1: Healthcare Technologies

Healthcare Technology Trends

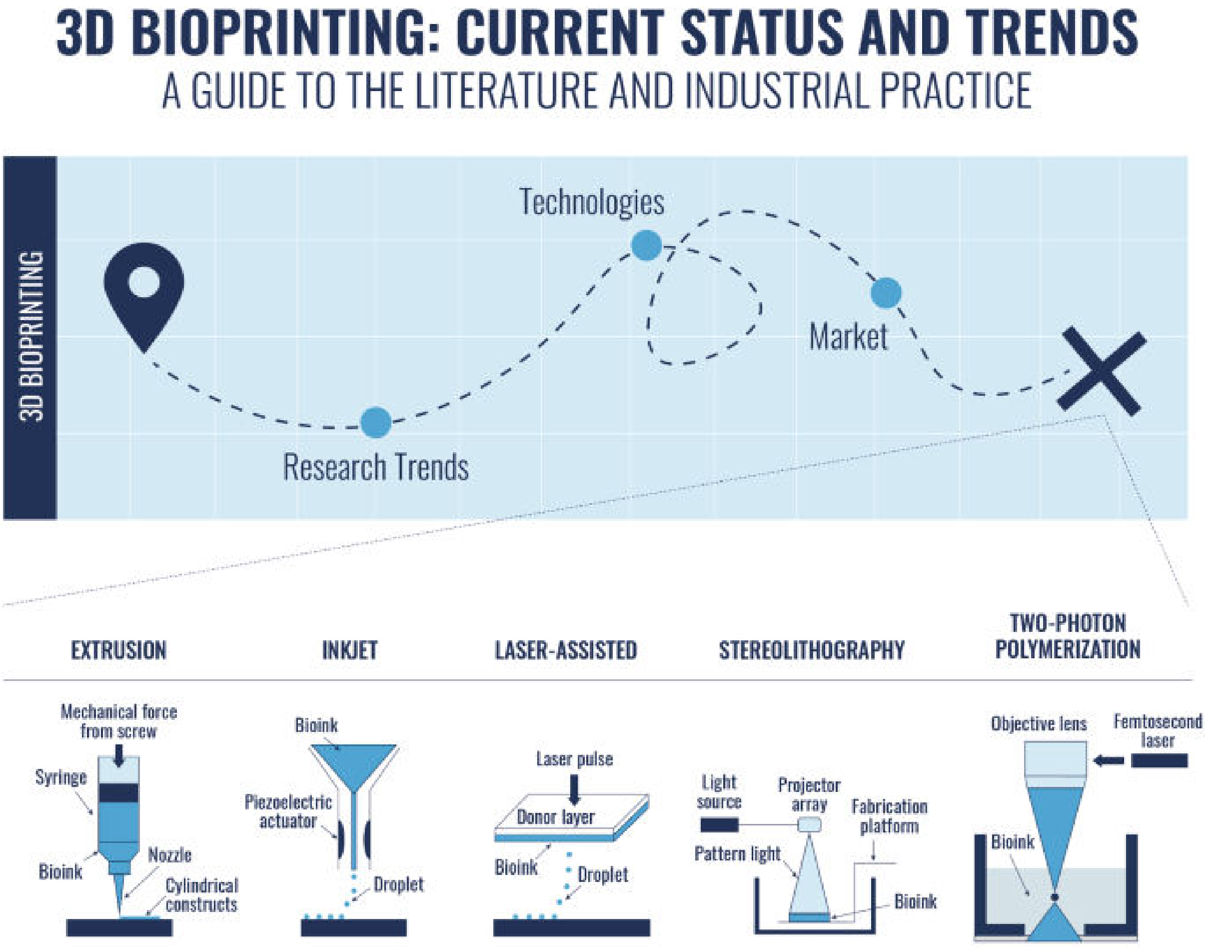

Figure 2:- Current status and trends in 3D Bioprinting

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Trend 1: Healthcare and Artificial Intelligence (AI)

A lot of noise hasmade artificial intelligence in 2022 a valuable technology, especially in the healthcare industry[6][7].

DIAGNOSIS AND DRUG DEVELOPMENT WITH ARTIFICIAL INTELLIGENCE

Responding to and treating outside the disease, artificial intelligence offers a wide range of uses[8][9]. AI is extremely useful for increasing the speed with which information is processed and decisions are made. Machine learning is particularly useful in the healthcare business for the creation of novel drugs and the efficiency of diagnosis processes[10][11].

AI is assisting in the analysis of CT images to detect pneumonia in people present with COVID-19 treated for the effects. InnerEye is a radiotherapy AI tool created by Microsoft[12]. This drastically reduces the time it takes to complete the 3D contouring of the patient, reducing the duration to minutes rather than hours[13]. On GitHub, the project is open source. Another Microsoft AI system, Project Hanover, is a biomedical research publication designed to catalog after PubMed. This shortens the time it takes to diagnose cancer and aids in determining which medications should be used for each patient[14][15].

NATURAL LANGUAGE PROCESSING

Chatbots can boost telehealth's efficiency. UCLA researchers created a Virtual Interventional Radiologist by combining chatbot technology with AI algorithms (VIR). This was created to assist individuals in self-diagnosing as well as clinicians in diagnosing those patients. Natural language processing-powered chatbots are not yet giving ready a primary diagnosis, but with the process, they can help. They're also well-equipped to assist patients in gathering information before effective therapy can create[16].

HEALTHCARE in Artificial Intelligence: DATA

Data is the most crucial factor in artificial intelligence's success in healthcare. Training data, to be precise. It will never surpass the Machine Learning softwarequality of itsdatasettraining. The model will perform better if we provide it with more data of greater quality and breadth[17]. Your AI team must be made up of professional software engineers and data experts who be able to collaborate to get the best outcomes.

Trend 2: The Remote Care and Telemedicine Evolution

Like 2020 the beginning of the pandemic, it has a long way in telehealth. It will experts in healthcare hold frequent video conference discussions with patients over the offer suggestions and issues their internet to address[18]. That allows this to happen the infrastructure has improved substantially. By 2026, the market is to reach an estimated in telehealth $185.6 billion.With that in mind, what does the future hold for us?

COMPLYING WITH REGULATIONS

USE WEBRTCFOR VIDEO CONFERENCING

In various cases, a solution is necessary is more devotedthat can conform to allowedsecrecy standards more explicitly. WebRTC, API-based an open-source system that connects mobile applications and web browsers and enables the transmission of audio, video, and data [19], is one of the most significant technologies that will be required if you need specialized telemedicine app. This is very useful for services like teleconferencing[20].

DATA STORAGE AND CLOUD HOSTING

While most cloud storage systems are generally safe, they are not always complying with regulatory rules regarding protected health information[21]. Cloud hosting solutions that are HIPAA compliant are essential for any healthcare organization that uses electronic health records to preserve performance and efficiency (EVR).

Data storage and teleconferencingare not the only capabilities that might be beneficial to your company. That the other elements that might be beneficial includelocation services,safety, appointment management, safe messaging, providing healthcare evaluations, visit history, and wearable connectivity[22].

Some apps, such as Google Fit and Apple HealthKit, may require retaining fitness data from consumer devices. Maintaining these linkages securely and effectively may be extremely beneficial to both the patient and the caregiver [23].

Trend 3: In Healthcare Settings, Extended Reality

In the healthcare business, extended reality augmented realitywhich includes, mixed reality, andvirtual reality has a lot of promiseoffers. The technology of VR and AR the potential have to improve the healthcare businesssignificantly, from surgery to assistingfrom helping telemedicine presentations [24].

Artificial intelligence and specialized sensors are widely used in the creation of augmented reality. Appropriate data and software knowledge will be necessary whether you aretypes of hardwareand creating mobile devices or other [25]. To make these solutions effective, AR developers place a strong emphasis on combining AI with the software frameworks of the target technology [26].

FUTURE OR HYPE IN METAVERSE?

To rebrand the argument over Facebook and on social concentration experiences of virtual reality is warranted is ranging. It's up to you to decide ultimately whether you are or not to invest in this. Even is a massively exaggerated metaverse, it has some virtual reality in the possibilities of healthcare settings [27[28].

Also offers a virtual reality living in Connecticut senior Maplewood for treatment of the elderly, which may support them relive prior experiences and enhance their mental well-being[29].

Meta's transition to cartoon-style meetings might be beneficial for VR treatment, but its usefulness as a replacement for standard teleconferencing is unknown. However, certain emerging technologies, like spatial audio, have the potential to increase healthcare system efficacy by offering a digital experience of more immersive [30].

Trend 4: In the field of healthcare, the Internet of Things (IoT) and wearables are becoming increasingly popular. Technologies of the Internet of Things (IoT) and Wearables in possibleof the healthcare business have expanded dramatically they have as become normal. The term "Internet of Medical Things" have used to describe the trends of microprocessing applicability in the technology of telehealth and telemedicine[31].

SOLUTIONS FOR IOMT CREATED

Getting all of these computers to interact with each other can be difficult, especially with the industry trend toward employing many microcontrollers in conjunction. Another stumbling block that is practically every producer has a protocoltheirproprietary for getting their gadgets to communicate with one another. Integration may be difficult as a result of this[32].

Many environmental conditions can impair communications, which can make connectivity a problem. On local Buffering methods, microcontrollers must grow new robust to combat this. Safety is also a major problem[33].

Trend 5: Privacy and Security in Healthcare in 2022

Security and Privacy, inefficiency the addition of quality of service, in the top priorities of the healthcare sector. Kroger pharmaceutical data was compromised in a data breach in February 2021, thanks to Accellion's file-transfer service FTA secure. Theonly ones do notthat think this way. Last year, over 550 businesses had data breaches that affected over 40 million individuals, according to HealthITSecurity.com.

Every healthcare practitioner can connect with patients using technologies such as Facetime and Skype, which may not be entirely compatible with regulatory rules. Although the US Health and Human ServicesDepartment of(OCR) Office for Civil Rights has formally established reduced enforcement standardsfor public health emergency organizations, it isnot to relyon crucial that preference. As the outbreak subsides, enforcement will return to normal. Getting ahead of the game now might save you a lot of money in the long run[34].

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Although compliance video conferencing software is available, there are situations when a more tailored solution is required. This is especially true ifdoes not work well the present data infrastructure with the solutions accessible. More significantly, it wants to use an existing system of a healthcare practitioner to share ePHI with patients via the software of a third party, they must first seek a business partner except for the vendor, which may be time-consuming or complex.

There is still no guaranteed third-partyprogramthat will keep persistent information safe. Furthermore, it is challenging to keep information safe during remote medical calls. The transmission of structured ePHI data is required, and these calls might complicate the procedure[35].

Trend 6: Bioprinting and Organ Care Technology

Organ transplants are an essential element of the healthcare sector, with the global transplantation market expected to reach $26.5 billion by 2028. Every year, around 2,000 heart transplants are performed in the United States, according to Matthew J Everly. However, over 50,000 people are predicted to require a heart transplant. What can be done to assist all of these heart disease patients?

EXTENDING TIME FOR ORGAN EVALUATION AND TRANSPORT TO IMPROVE ORGAN CARE TECHNOLOGY

This is the future technology that will likely on Artificial Intelligence take action to without the need for a doctor to assist the organ alive and keep the organ for extended periods.

Extra crucially, being able to improvemay be a machine learning evaluate whether or not an organ that is being kept is acceptable for transplantation. The sooner this can be discovered, the more lives can be saved.

NEW ORGANS CREATED THROUGH BIOPRINTING

Other approaches should be considered in adding organs to the keeping of the body alive outside. Even though it may seem like science fiction, Organs are 3D printed and are very real, if quite evolving, that has been technology already put through clinical trials. Organs like the corneas, ears, bones, and skin are all clinical trials undergoing 3D printing.

The procedure is similar to that of regular 3D printing. To begin, make a computer model of the tissue. Because the materials utilized in the printing process are essentially live cells termed bioink, careful attention to resolution and matrix structure is required. They must next use stimulation to assess the organ's functioning.

Using the cells of the patient requesting transplantation is one technique to prevent organ rejection. These cells may be cultured and subsequently developed into the bio-ink required for printing.

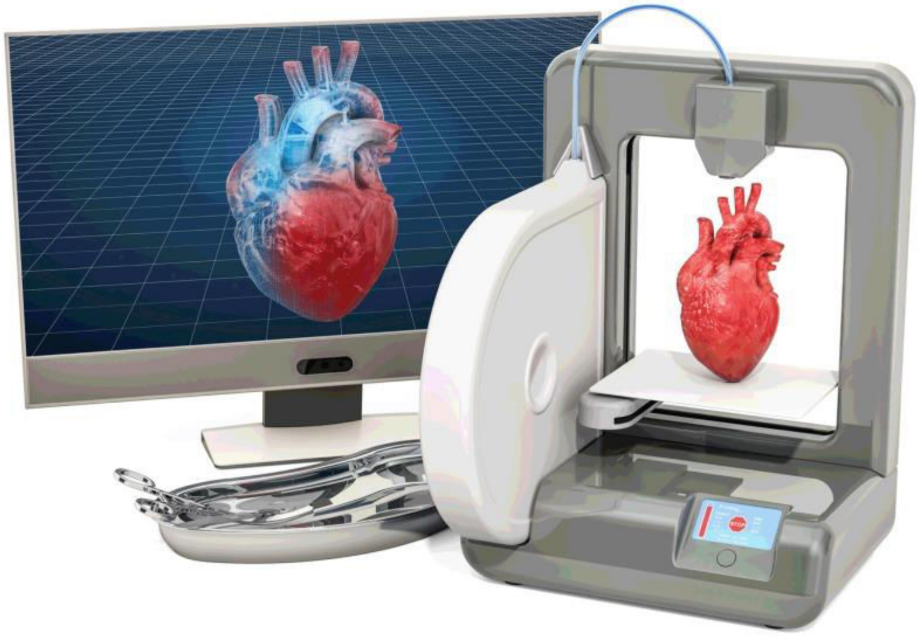

Figure 3:- 3D Bio-printing

III. CURRENT DEVELOPMENTS IN 3D BIOPRINTING

3.1 3DBioprinting Techniques

It is based on the process of 3D bioprinting on the exact loading of biomaterials. This procedure stage is divided into three parts:- printing, post-processing, and preparation. The process of preparation creating entails anatomically using correct 3D models tolls of computer graphics like CAM.CAD. and converting into a 2D layers of a stack through user-defined thickness will that be fed into the printing for bioprinter. Also involved stages selecting the bio-ink or substance. The printing of using the tissues additive techniques of the processing of manufacturing stage. The maturation of the manufactured construct in a bioreaction, as well as its structural and functional characterization, is referred to as post-processing. Figure 4 depicts a flow diagram of the bioprinting process and the procedures required[36].

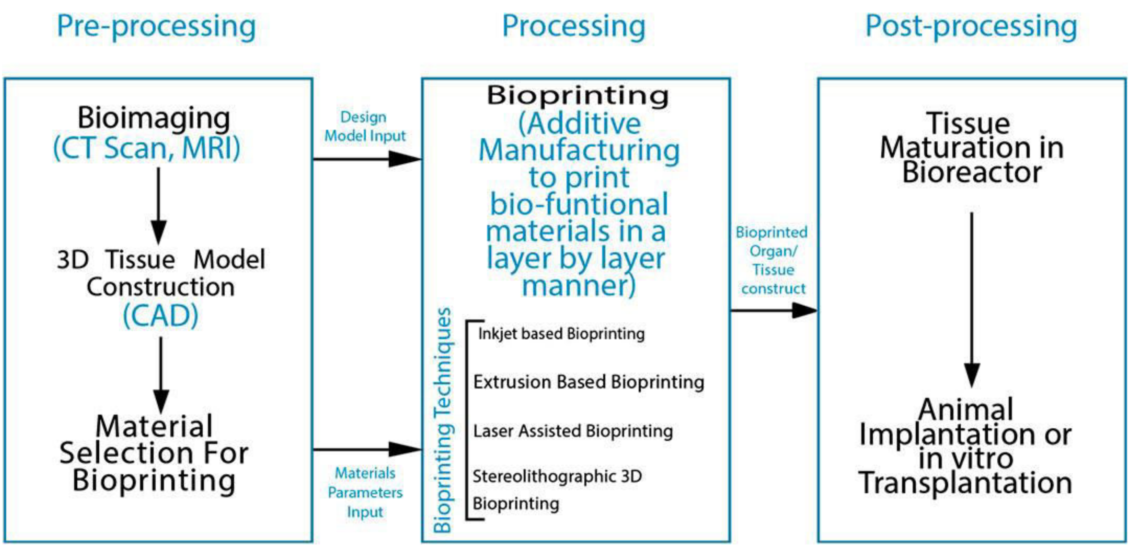

Figure 4:- Flow diagram for the process of 3D Bioprinting.

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It was done can be the use of Bioprinting with or without a scaffold. The forms of the biomaterial matrix for the stratum cellular in the base of scaffold technique. It can be the matrix made of nanofibers, hydrogel, films, or any other that can be 3D structure printed through bio-ink.It's crucial to remember 3D construct should that closely resemble the ECM locationoriginal for cells to multiply and grow. The entire procedure entails putting tissue spheroids and pipettes and depositing thenthem onto printing molds using an extrusion mechanism. The cells secrete their own ECM and establish a network, which leads to tissue development and the removal of the mold. The mold is only employed as a support structure and isn't used at all. This approach permits cells to be liberated from biomaterial that inhibits cell contact and slows cell proliferation. Cell self-organization boosts ECM synthesis while preserving tissue functioning.

3.2 3D Bioprinting Using Inkjet

Inkjet printing is especially advantageous since it is inexpensive and non-contact, reducing the risk of contamination.Ink-jet printing's capacity to create constructions and complex multicellular patterns through printing numerous cell types, biomaterials, and other materials simultaneously in a single manufacturing process utilizing separate printheads is a key feature. Ink-jet bioprinting was the first step in the evolution of 3D printing of tissues and organs.

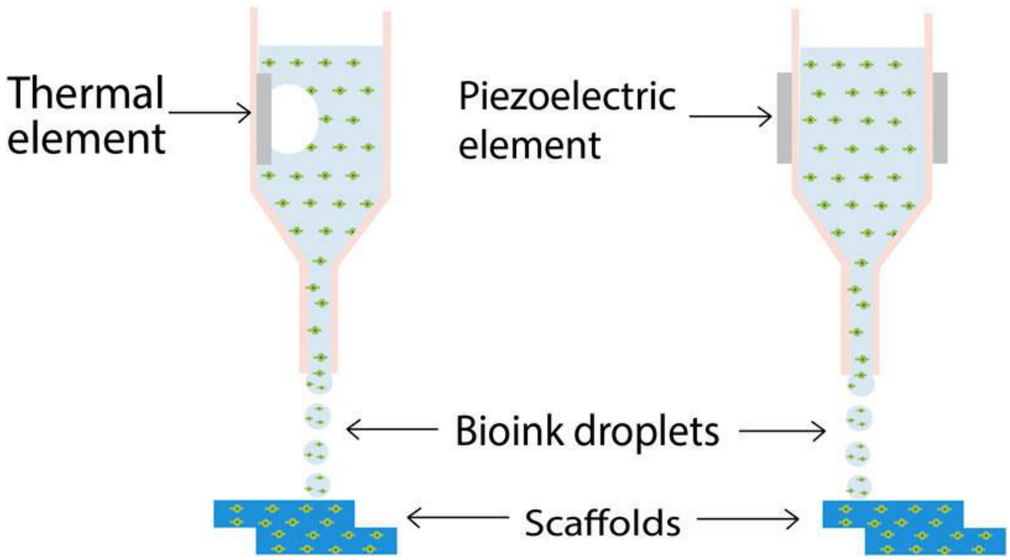

Figure 5:- Inkjet 3D bioprinting schematic design. A heating element produces droplet formation in thermal inkjet printing.

3.3 3D Bioprinting Using Extrusion

Pressure-assisted bioprinting technologies orDirect ink writing (DIW) can be used for extrusion-based bioprinting, as demonstrated in Fig 6. in which the device continually extrudes material from the nozzle, layer through layer, to produce 3D constructions. Materials used for DIW should have appropriate rheological qualities that allow for simple printing. To allow the printing nozzle out of the extrusion, the material needs to be shear thinned. A shear yield stress should also be present.A shear force greater than the resin's yield stress is used to create flow. When the resin is put on a substrate, the shear tension is removed, and the resin regains its stiffness. To obtain desirable rheological qualities, polymer resins are frequently combined through fillers like silica particles or nano-clay. The fillers cause shear-thinning flow behavior, resulting in a material with a shear yield stress at ideal resin/filler ratios. These rheological qualities allow the printed item to retain its form, resulting in self-standing structures. This notion was recently explained in full, along with an explanation of the support material's essential rheological qualities.

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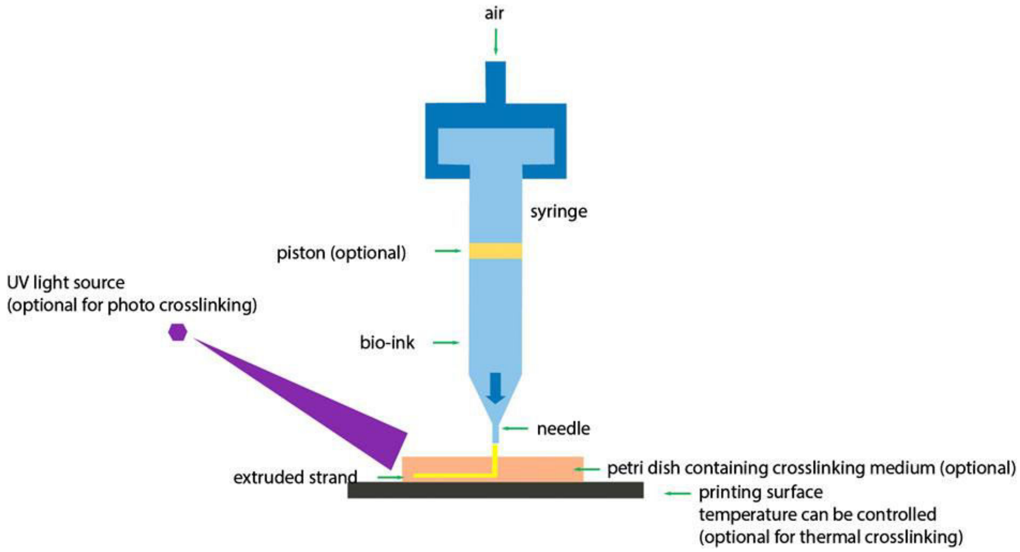

Figure 6:- Extrusion-based 3D bioprinting schematic design. The use of pressure on bioink in extrusion-based 3D bioprinting is a possibility.

Traditional scaffolding methods like solvent casting, electrospinning, and salt leaching, for example, do not provide the regulated pore architecture that CAD/CAM-controlled additive manufacturing procedures do. The pressure-assisted deposition has usually been utilized to address this issue. Polymers like(PCL) Polycaprolactone, Polylactide (PLA), and theircomposites or blendsthrough ceramics like(TCP) tricalcium phosphate and Hydroxyapatite (HAP)have been the focus of procedures for designing and optimizing scaffolds. The attention has switched to cell-encapsulated hydrogels created through direct printing after the introduction of organ bioprinting. Chemical cross-linking is then used to reinforce the build. According to liver tissue indicators, the design had a lot of cell viability and activity. Because of enzymatic breakdown, the gelatin-chitosan constructions were difficult to maintain, but the approach still allowed for simultaneous cell and biomaterial deposition. Other researchers have employed gelatin-based hydrogels to create 3D biomimetic constructions for hepatocytes and adipose-derived stem cells. According to research, different cells, such as bone grafts, chondrocytes for osteochondral grafts, and others, can be incorporated into Matrigel® to build a multicellular, biomimetic construct.

3.4 3D Bioprinting with Laser Assist

Herein procedure, a pulsed is used a laser beam to deposit bio-ink and cells onto the substrate. The use of a laser for material allows for adeposition non-contact direct writing approach for 3D printing. A pulsed laser source, with a ribbon coated bio-ink, andon a receiving substrate on which the bio-ink is to be deposited are the three fundamental parts of Laser-Assisted 3D Bioprinting (LAB), as shown in. The laser is used to cause the heat-sensitive bio-ink in the "ribbon" to volatilize. The bio-ink is applied on a target plate composed of quartz or another material that permits laser light to pass through it. Depending on the optical parameters of the laser and the ink, a laser-absorbing, bio-ink, and ribbonbetween thesacrificial interlayer aid viable cell transfer. To aid in the deposition process and maintain cell development, the substrate on the ink is to be depositedwhich is covered with either a normal polymer, nutritional media, or biopolymer. Because the bio-ink is volatile, a high-speed jet of cell-laden bioink is driven onto the substrate when a laser pulse is applied. "

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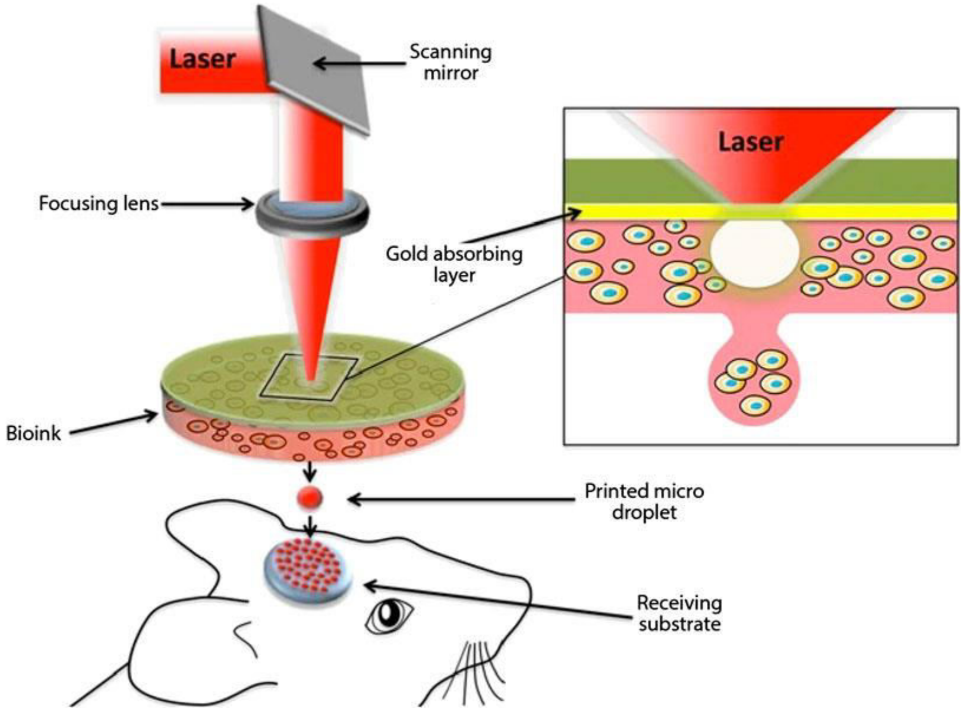

Figure 7:- 3D bioprinting with laser assistance is depicted in this diagram.

The (LIFT) laser-induced forward transfer technology, on the other hand, was first suggested by employing For a high-energy laser pulse of direct writing features of an optically through direct deposition optically transparent substrate.In the guise of AFA-LIFT and BioLP, this method was expanded to print biomolecules. To shield the cells from laser exposure, of any metal or its oxide a laser-absorbing layer (e.g., TiO2, Ag, Ti, etc.) is inserted at the ribbon-bioink interface as a sacrificial layer[37][38]. The use of pulsed laser induces fast thermal development of the sacrificial layer, allowing modest volumes of bio-ink to be propelled onto the substrate with minimum cell damage. The BioLP procedure differs in that slightly it uses a low-powered pulsed laser and a hydrogel such as Matrigel® as the sacrificial layer[39][40][41]. The computer-controlled is the entire procedure and is used to enablea CCD camera-specific cell patterning. Cells can be imprinted directly onto/in the depths of an as encapsulatedin anECM layer or as particlesin an ECM biomaterial. The thickness of the ECM onto the cells which are placed, the laser-pulse energy, the viscosity of the bioink, and other factors all affect cell survival during the printing process. Increased sacrificial layer thickness and bio-ink viscosity resulted in increased cell survival, whereas increased laser intensity increased cell mortality. The impact of printing speed on printing resolution was also investigated. It shows their research that printing cell mixes onto the ECM using LAB may be used to create soft free form tissuethat can hosta high cell density in vivo [42][43][44].

3.5 3D Bioprinting Using Stereolithography

The stereolithographic technique of bioprinting, as shown in Figure 8, is based on the design's height rather than its intricacy, since it layers the pattern by adding ingredients and Projecting the light of a photo-sensitive in a heat-curable bio-ink through-plane by the plane way[45][46][47].

Because the printing technology uses light as a cross-linking agent, the ink must include photocurable moieties. For photopolymerization of tissue engineering scaffolds, are commonly used[48][49]. Light-initiated polymerization is used to create three-dimensional tissue constructions. The single-photon approach and the multiphoton method are the two basic types of stereolithographic printing[50][51].

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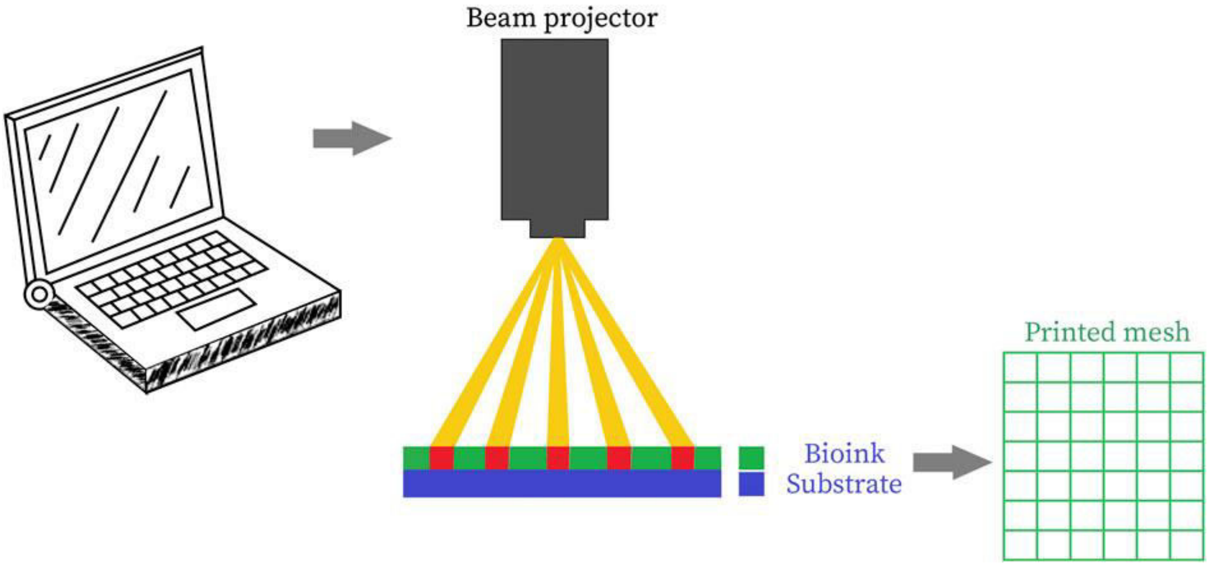

Figure 8:- Stereolithographic 3D bioprinting is depicted in this diagram.

IV. CONCLUSION

The requires the effective translation of the collaboration of doctors, engineers, scientists regulatory bodies: it is coordinated to require is an effort to translate into a real-world healthcare environment this transformative technology and perhaps future the revolutionize future of surgery[52][53].

In 2022 approaches, will continue healthcare technology to all areas in advance. While improving the security will across the board, it will continue threats to change and address must be via prevention rather than response. Machine Learning, Artificial Intelligence, and extended reality, among other emerging knowledge and innovation, will improve the quality and continue the efficiency of care.

3D bioprinting is possibility offers a unique that it creates tissues from the ground up, the danger of eliminating immunological rejection transplant Although as well donor addressing shortage concern. 3D bioprinting the use of lead to might a more therapy for individualized the patient, which could lead to better effects of clinical and a more appealing presence.

Although all advancements in the industry, biocompatibility and the integration of the printed construct of the body remains a significant problem. The quality to preserve the printed construct, printing procedures of standardization, and required are strict the quality control to retain cell viability in the formulation of bio-ink and print than in exact geometries[54].

The demands to meet the tissue engineering profession, 3D bioprinting include has expanded to a variety of technologies for the creation of tissue, laser aided bioprinting, stereolithography, including inkjet printing, extrusion bioprinting, and others. When cultural methods are compared to manual tissue, techniques of 3D bioprinting provide viable and high-throughput tissue printing with accurate cell patterning and superior spatial control[55].

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