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A Review on Recent Advances in 3D Bioprinting

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ABSTRACT

Three-dimensional (3D) bioprinting technology has emerged as a powerful bio- fabrication platform for tissue engineering because of its ability to engineer living cells and bio-material based 3D objects Diverse bio-inks based on synthetic and natural biomaterials have also been created and successfully used for tissue regeneration at the same time. Over the past few decades, the fields of tissue engineering and regenerative medicine, which aim to develop functioning tissue-constructs replicating native tissue for the repair and/or replacementof damaged tissues or entire organs, have advanced quickly. Traditional tissue engineering methods, which include scaffolds, growth factors and cells, had less success fabricating complicated 3D structures and regenerating organs in vivo which made them logistically andfinancially unworkable for clinical applications. In this regard, 3D bioprinting, which is an extended application of additive manufacturing is now being explored for tissue engineering and regenerative medicine as it involves the top-down approach of building the Layer-by- layerconstruction of complicated tissue, thereby producing precise geometries due to controlled nature of matter deposition with the help of anatomically accurate 3D models of the tissue generated by computer graphics. In this article, we seek to present a thorough analysis of the 3D bioprinting techniques, including ink-jet printing, extrusion printing, stereolithography, andlaser aided bioprinting methods. With the exact control of structure, dynamics, and biologicalelements—such as cells and extracellular matrix (ECM)—3D bioprinting has a tremendous deal of promise to build very complex constructions.

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1. INTRODUCTION

3D printing called as -sterolithography was invented by Charles Hull in early 1980s. when he was working on making plastic objects from photopolymers at the company Ultra Violet Products in California. Actual and potential uses of 3D printer, can be organized into several broad categories, these include tissue and organ fabrication, creation of customized prosthetics, implants, and anatomical models, and pharmaceutical research regarding drug dosage forms, delivery, and discovery. Organ transplant surgery and follow-up is expensive, costing more than $300 billion in 2012. Additionally organ transplantation involves the often difficult task of finding a donor who is a tissue match. Everyday almost 79 people receive the organ they need, while 18 die on the waiting list. This problem could likely be eliminated by using cells taken from the organ transplant patient‘s own body to build a replacement organ. This would reduce the possibility of tissue rejection and eliminate the requirement for lifelong immunosuppressive medication. For use in tissue engineering and regenerative medicine, the field of three-dimensional (3D) bioprinting has experienced tremendous growth in recent years.By employing scaffolds and cell seeding, tissue engineering technology can be utilised to repairand regenerate tissue and organs, and it has been extensively researched in the regeneration of cartilage, bone, skin, vascular tissue, nerve, heart, and liver, among other tissues. In the recent years, tissue engineering has seen significant success. There are still restrictions, but. The purpose of tissue engineering, which relies on scaffold-based techniques, is the replacement orregeneration of damaged tissues or organs. The scaffold's biodegradability upon tissue restoration is a crucial requirement for these scaffold-based strategies. Furthermore,

proper cell-cell and cell-matrix interactions are crucial for successful tissue regeneration, which makesthe structural design of scaffolds crucial. Native tissues and organs' 3D structural characteristics and physical properties can influence their biological and physiological characteristics significantly. Generally, an incredible advantage of 3D printing is the possibilityof the fabrication of complex structures, unprofitable to manufacture using injection molding methods. Furthermore, 3D printers have been improved for extremely high resolution, which fosters their use in tissue engineering. There are documented attempts of the adaptation of industrial printers to make them usable for printing scaffolds for tissue engineering. Nowadays, 3D printing methods enable fabrication of TE construction of the regeneration of different typesof tissues, such as skin, cartilage, and vascular network, as well as whole organs.

This review summarizes limitations and general principles of the most extensively used additive manufacturing technologies, including extrusion-based as well as jetting systems. Thus, current methods of printing and printable materials will be discussed.

Additionally, the article highlights advanced scaffold fabrication methods for tissue engineering applications.

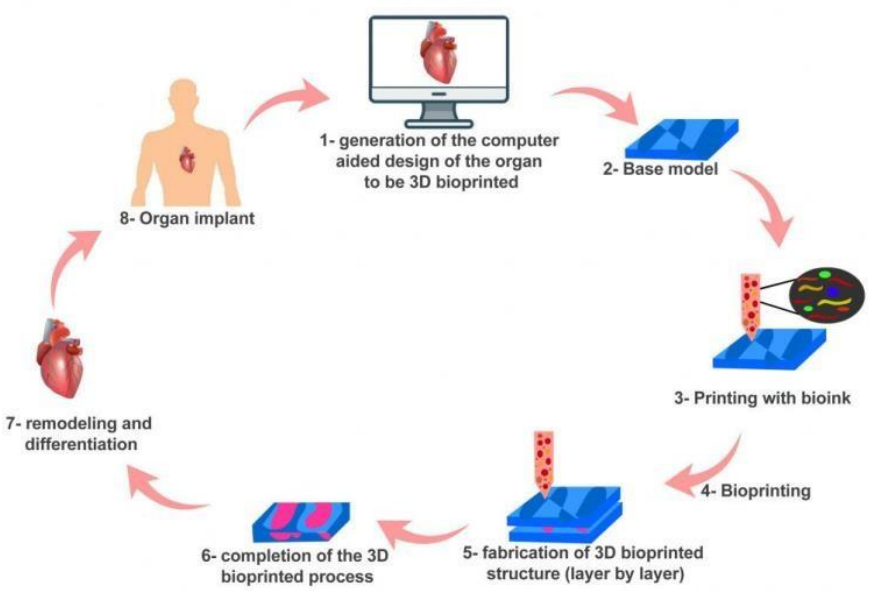

Figure 1. 3D Bioprinting

2. 3D PRINTING TECHNOLOGY AND 3D BIOPRINTING

3D printing is a rapid prototyping and additive manufacturing technique used to fabricate complex architecture with high precision through a layer-by-layer building process. This automated, additive process facilitates the manufacturing of 3D products with preciselycontrolled architecture, such as external shape, internal pore geometry, and interconnectivity, with high reproducibility and repeatability [1]. 3D printing includes many processes, such as light-mediated stereolithography (SLA), fused deposition modeling (FDM), selective laser sintering (SLS), inkjet printing, and extrusion printing [2]. 3D printing focuses on engineeringtechnology, mainly for structural design, material selection, and engineering manufacturing. 3D bioprinting introduces concepts of developmental biology, tissue engineering, and regenerative medicine into 3D printing [3]. 3D bioprinting enables precise control over multiple compositions, spatial distributions, and architectural accuracy and complexity, therefore achieving effective recapitulation of microstructure, architecture, mechanical properties, and biological functions of target tissues and organs. 3D bioprinting offers precise spatiotemporal control on the placement of cells, proteins, DNA, drugs, growth factors, and other bioactive substances to better guide tissue formation for patient-specific therapy.

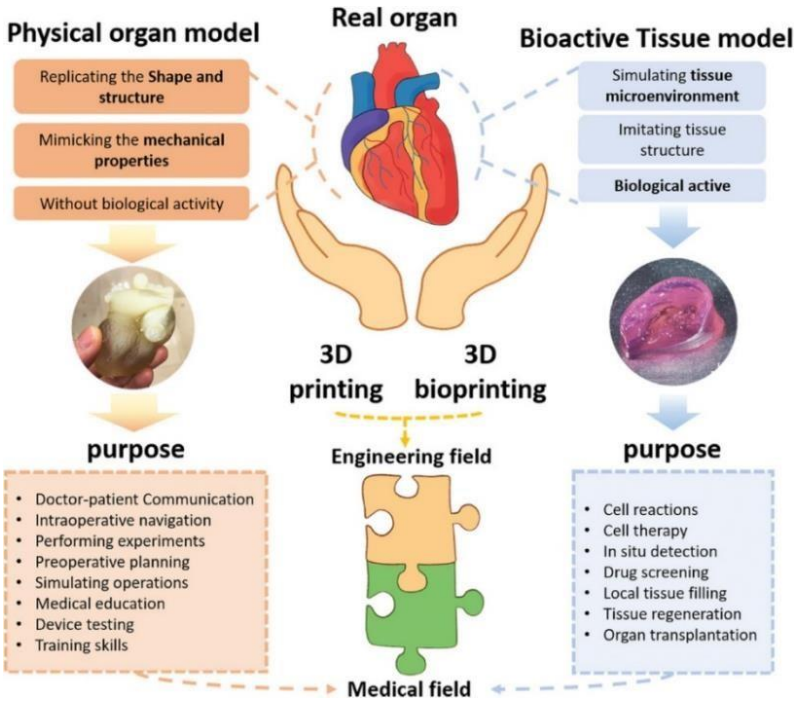

Figure 2. 3D Printing Technology and 3D Bioprinting

3. SCAFFOLDS FOR TISSUE ENGINEERING

An average of 13 people pass away each day as a result of the lengthy organ transplant waitinglist. Additionally, there is a troubling dilemma with regard to tissue compatibility. Tissue engineering might be able to provide many inventive scaffold building techniques in this case,making it simple to solve the tissue compatibility problem. Delivering a functional, suitable organ utilising the patient's own cells is the premise and the end goal. However, because there are so many variables pertaining to the physiology of the organism, such as the cultivation of various cell types, such a process may be quite difficult. Scaffolds are generally necessary for the development of graft structures. TE scaffolds serve as a foundation for cell migration, tissue differentiation and regeneration. Consequently, material characteristics particularly chemical and physical [17].. For cell growth and viability, as well as the architecture and morphology, are essential. Additionally, in order to successfully heal the flaws, it is sometimes necessary to recreate several coexisting tissues, including bones, glands, muscles, arteries, ligaments, nerves, and cartilage. At the macro, micro, and nano scales, the morphology, and architecture of the scaffolds are critical. At the macro level, the scaffold's size and form are influenced by the size and shape of the defect, which are crucial for the scaffold's contact and interactions with the native tissues, matrix-cell interactions, and the movement of nutrients. It is distinguished at the microscopic level by the scaffold porosity, pore shape, or pore spatial distribution, each of which determines the general permeability of the scaffold. The fibre surface features, which are thought to be in charge of cell differentiation and proliferation, areconnected to the morphology at the nanoscale. The type of manufacturing technique and the selection of a biomaterial are the two most important considerations in 3D printed scaffolds. Biomaterials can be categorized according to a number of factors, including biodegradability, physical and chemical composition, or the use of specific modifications. The nature of the injured tissue has an impact on the biomaterial selection. Biodegradable and piezoelectric biomaterials are typically preferred materials. The main groups of these materials consist of polymers (synthetic and natural), ceramics, and composites. Ceramic scaffolds are preferred in orthodontic applications; composite scaffolds have applications in dental tissue engineering, whereas polymers are used in soft tissue engineering [19].

DIFFERENT TE STRATEGIES

In TE, tissue scaffolds are typically employed in two different ways to address tissue abnormalities. In each, a scaffold is created, cells are seeded into it (sometimes the cells are embedded in the scaffold matrix), cell culture is performed in a bioreactor, and then the scaffold is filled with freshly generated tissue and implanted into the defect site. The selection of the implantation time is what makes the difference [4]. In the first technique, tissue that has fully developed and undergone remodeling is transplanted in the area of the defect. In this situation,the scaffold should have finished breaking down and metabolizing before being implanted. Thesecond method involves implanting a scaffold that is filled with immature tissue. The implanted scaffold should exhibit various rates of erosion (degradation) depending on the technique used.The manufacturing of TE scaffolds is typically followed by suitable surface alterations to obtain the desired structure/properties from the perspective of the cells. During cell culture, several hormones or growth agents are frequently administered.

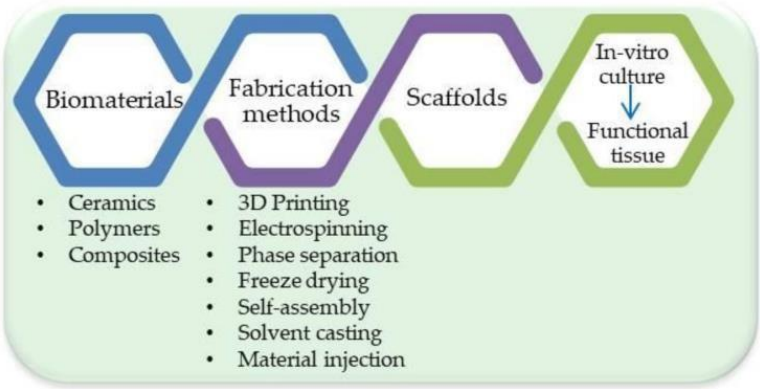

Figure 3.Tissue Engineering Process Conventional TE Scaffold Fabrication Techniques vs. 3D Printing Techniques

There are various methods of scaffold formation allowing them to meet the requirements in various specific applications. In addition, many biomaterials are constantly improved for more effective use in tissue engineering. A schematic illustration is shown in Figure

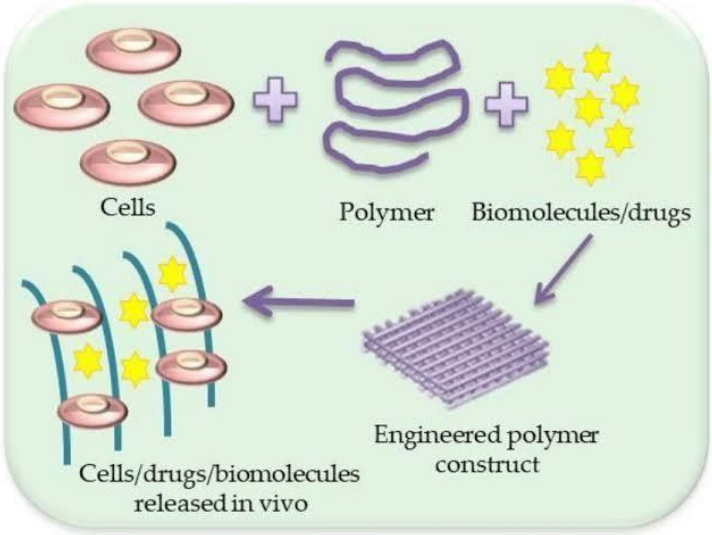

Figure 4. Schematic illustration of scaffold with cells/drugs or biomolecules' formation

Electrospinning, additive manufacturing, phase separation, solution casting, foaming, extrusion, and self-assembly are some of the most used technologies for fabricating scaffolds. The strategies are sometimes combined in attempt to reduce some of their drawbacks, which occasionally produces highly intriguing and encouraging results[13]. Figure illustrates numerous methods for creating three-dimensional scaffolds, and some of them are detailed in more detail

Figure 5. Scaffolds' fabrication techniques.

3D BIOPRINTERS FOR TISSUE ENGINEERING

In this section, we introduced seven types of bioprinters: (1) inkjet-based, (2) extrusion- based, (3) laser-assisted, (4)stereolithography, (5) acoustic, (6) microvalve, and (7)scaffold-free bioprinters.

We also provide a brief overview of the working principles ofeach printing module and its fundamental characteristics. The type of bioprinter should be carefully selected based Polymers on the structural properties of the targeted tissues/organs.

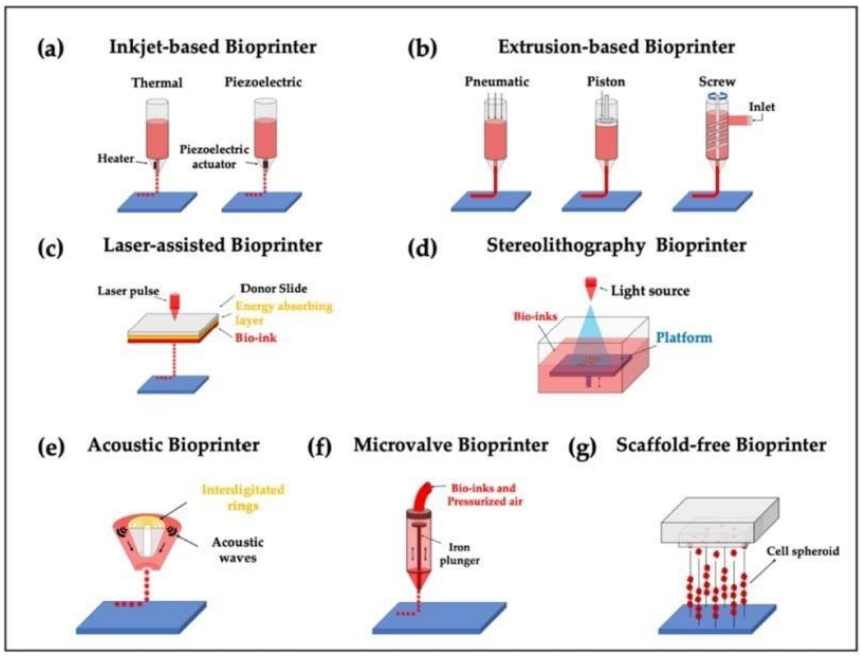

Figure 6. Different types of 3D bioprinters. (a) Inkjet- and (b) extrusion-based bioprinters (c)laser-assisted bioprinter (d) stereolithography-based bioprinter (e) acoustic and (f) microvalve bioprinters (g) scaffold-free bioprinter.

4.1 Inkjet-Based Bioprinter

The first inkjet-based bioprinter was described in 1988 by Klebe, who printed using a hydrogel solution using a commercially available Hewlett-Packard (HP) thermal drop-on-demand inkjetprinter. With the use of various dispensing forces based on heating reservoirs or piezoelectric actuators, inkjet-based printing modules have effectively been used to deposit cells or biomaterials as droplet units. The temperature is raised by the heating element next to the printing nozzle, which eventually leads to gasification and produces bubbles. The created bubbles are forcedly printed on a substrate as droplets. In contrast, bioprinters based on piezoelectric inkjets produce pressure pulses that print droplets containing cells via the nozzle.Although inkjet-based bioprinters have a number of benefits, including fast print times and lowcosts, their use is constrained by the small range of printed biomaterial viscosities. Due to the way that heat- and piezoelectric-based printing modules operate, cell lysis and damage may occur while printing. The cell viability of the printed cells can be maintained at 89% with onlya few cells being harmed when using a thermal inkjet printer, although the heating element only lasts a short time at high temperatures. Furthermore, irregular droplet size and nozzle blockage complicate the procedureprocedure[10].

Extrusion-Based Bioprinter

The first extrusion-based bioprinters appeared in 2002. These printers use mechanical or pneumatic equipment to deposit hydrogels with force (piston or screw). Extrusion-based bioprinters can handle high cell densities, viscosities, and dynamic crosslinking mechanisms better than inkjet-based bioprinters can. Additionally, because extrusion allows for the use of a broad variety of biomaterial viscosities, it offers a diverse selection of biomaterials, such as synthetic polymers, cell-laden hydrogels, cell aggregates, and microcarriers. Bioprint[12]. Additionally, by using their rapid printing velocity, they are able to create cell-filled bio-inks in the form of continuous extruded strands that can design a large-scale biomimetic structure. Despite these benefits, the comparatively poor cell viability and low resolution produced by the shear damage the printing nozzle induced through pressure or mechanical force need to beameliorated.

Laser-Assisted Bioprinter

David Odde originally introduced laser-assisted bioprinters in 1999 utilising optical cell entrapment. An energy-absorbing layer, a donor ribbon, and a layer of bio-ink make up this system. A high-pressure bubble is produced after a small area of the donor ribbon layer is illuminated by a laser. In order for the bio-ink to be placed on the substrate, the bubble pushesthe bio-ink layer while producing droplets. Because the dispenser and the bio-inks are not in contact while printing, the risk of contamination is minimal[11]. This system's primary benefitis its ability to deposit bio-inks

with comparatively high viscosity and resolution. Furthermore,as this technology uses a nozzle-free printing process, the problem of nozzle clogging is removed. Catros et al used a live/dead assay to examine the viability of Ea. Hy 926 cells in a prior study on laser-assisted bioprinters. According to their findings, the extracellular matrix (ECM) substrate thickness, bio-ink viscosity, and laser pulse energy all affect cell viability. According to the findings, cell damage tends to rise as laser energy increases. A thicker substrate and greater viscosity could shield the cells in the bio-ink from death. As a result, themain drawbacks of this approach are thought to be its complexity in use, high cost of printingmodules, and possibility for cell damage caused by laser intensity.

Stereolithography Bioprinters

Charles W. Hull first popularised stereolithography in 1986. This approach employs light to crosslink the bio-inks in the reservoir utilising a layer-by-layer process, as opposed to the inkjet-based, extrusion-based, and laser-assisted bioprinting techniques. This approach can only be used with light-responsive bio-inks, which commonly include gelatin methacrylamide(GelMa) and polyethylene glycol diacrylate, due to the way that it functions (PEGDA). A majordrawback of stereolithography is that the reservoir may be filled with photopolymers, which leads to material waste and a high cost of research in addition to the alternatives being limitedwith bio-inksbio-inks[14].

Acoustic Bioprinters

Acoustic bioprinting technology helps introduce nerve cells into spherical cage structure. Microscopically small cages can be produced at TU Wien (Vienna). Their grid openings are only a few micrometers in size, making them ideal for holding cells and allowing living tissueto grow in a very specific shape. Nerve cells have now been introduced into spherical cage structures using acoustic bioprinting technology, so that multicellular nerve tissue can developthere. It is even possible to create nerve connections between the different cagescages[15].

Microvalve Bioprinters

Overall, the microvalve-based bioprinting is a more reliable bioprinting system that facilitates precise control over the deposition of multiple types of cells and biomaterials with high cellularviabilities (>80%), high-throughput rates (up to 1 kHz) and with a moderate printing resolution(∼150 μm). A typical microvalve-based bioprinting system comprises a three-axis movable robotic platform and an array of multiple electromechanical microvalve print-heads. Each microvalve print-head is connected to an individual gas regulator that provides the pneumatic pressure (positive pressure) and the valve opening time (minimum 0.1 ms) which is controlledby the movement of both the plunger and the solenoid coil. The applied voltage pulse inducesa magnetic field in the solenoid coil that opens the nozzle orifice by pulling the plunger up in an ascending motion[16]. The bio-ink is deposited when the pneumatic pressure overcomes thefluid viscosity and surface tension at the opened orifice. The material deposition process is highly dependent on the nozzle diameter, the viscosity and surface tension of the bio-ink, the pneumatic pressure and the valve opening time[11].

Scaffold-free Bioprinter

Scaffold-free bio-inks are cell aggregations that provide high cell viability and resolution, mimic cell microenvironment closely to native tissue or organ for cell proliferation and differentiation, preserve cell phenotype and functionality for a long times and exhibit better cell-cell interactions[17].

5.BIO-INKS: BIOMATERIALS FOR 3D BIOPRINTING

Bio-inks, also known as rintable hydrogels, are a crucial component for creating functional tissue constructs in parallel with the developments in 3D bioprinting technology. Biocompatible, bio-printable, and degradable in the human body without producing harmful by products are the three requirements for biomaterials utilised in the production of bio-inks. Here, we introduce and outline the characteristics of traditional bio-inks made from natural andsynthetic polymers. Several examples of crosslinking mechanisms are given so that readers can better comprehend the chemical makeup of the aforementioned polymers. Finally, a brief discussion of various bio-inks that have recently been used for 3D bioprinting follows.

Natural Polymers

Natural polymers, especially in the form of hydrogels, have the advantage of providing encapsulated cells with a favourable microenvironment[18]. Here, we go through a variety of natural polymer types that are sources for bio-ink as well as some of their core characteristics.

Alginate

Brown seaweeds are used to create alginate, a natural polymer. Due to its negatively charged polymeric backbone, alginate can produce ionically crosslinked chains by adding a positively charged solution. Calcium chloride is the common solution that allows the alginate hydrogel to be ionically crosslinked (CaCl2). It is also possible to crosslink alginate using calcium sulphate (CaSO4) and calcium carbonate (CaCO3); however, because they are less water soluble than CaCl2, the time required to crosslink the alginate increases proportionately. Alginate-based hydrogels have been widely used for a range of biomedical applications due to their biocompatibility, low toxicity, and relative affordability. However, under physiological conditions, ionic crosslinked alginate hydrogels do not have the optimum long-term stability[19].

Gelatin

Collagen is partially hydrolyzed to create gelatin, a mixture of peptides and proteins with lowimmunogenicity, high water absorption, and good biocompatibility. Before producing an

activeliver tissue utilising 3D bioprinting and glutaraldehyde cross-linking, Yan et al. combined andsuspended liver cells in a gelatin and chitosan composite system. They demonstrated the hydrogel consisting of gelatin and chitosan's weak mechanical strength and simple collapse. Even though the hydrogel system's form is significantly improved and the scaffold's morphology and porosity are left unchanged, the introduction of glutaraldehyde reduces the system's biocompatibility. Because of this, pure gelatin is widely used in 3D bioprinting as a sacrificial material. Gelatin gradually dissolves in the fluid during the culture, forming a channel in the 3D scaffold that allows bacteria to pass through. Cells may survive, multiply, and even differentiate thanks to oxygen and nutrition. Researchers have tried a number of waysto change strength in addition to UV cross-linked gelatin in order to maintain gelatin's biocompatibility and improve the mechanical properties. Gelatin-methacrylamide (gelMA) hydrogels, according to study by Schuurman et al., encouraged chondrocyte formation and survival while providing a range of mechanical characteristics based on different cross-linkingvariables. By varying the polymer concentration, UV exposure time, and heat gelation before UV exposure, it is feasible to regulate the stiffness and swelling properties of hydrogels[16].

collagen

Since it is the main protein component of the ECM in actual tissues and organs, collagen has been obtained from sources like rat and porcine tendon. As a result, tissue engineering has extensively utilised it. Due to the widespread integrin-binding, collagen provides improved microenvironments for cell adhesion, proliferation, and function in its domains. Even if collagen is in a pre-gel state at low temperatures, it can still be thermally crosslinked. for therapy, 36 C. It can also be crosslinked using UV, glutaraldehyde, and carbodiimide and genipin, in addition to being quickly digested by collagenase. However, printing with pure ink is difficult. Collagen has a lower viscosity than elastin. Viscosity must be increased by a varietyof means. collagen; as an example, consider hybrid printing, which combines collagen with various hydrogels and uses synthetic polymers as a structural support to maintain the shape of printed reports of collagencollagen[18].

silk

Natural silk fibres made by silkworms and spiders are a desirable source for bio-ink production due to their nontoxicity, slow immunogenicity, and gradual disintegration. Silk naturally possesses a high viscosity and shear thinning, which are beneficial for fabricating the necessarystructure. The main drawback of silk is the ease with which nozzle clogging can take place dueto the shear stress brought on by -sheet crystallisation. Additionally, silk's weak ability to bindcells may hinder cell adhesion, growth, and functionality[19].

Agarose

Most often, specific kinds of red seaweed are used to create the polymer known as agarose. Like other bio-inks, agarose is a hydrating and non- immunogenic substance, although it is fragile when solid. However, because of its poor ability to adhere to cells, it is not suitable for use as a cell-laden biomaterial. Between 32 and 47 degrees Celsius, a sol-gel transition can be seen. Because of its thermo-reversible nature, it frequently serves as a sacrifice bio-ink for hollow channels as opposed to being used for cell encapsulation and cell culture[20].

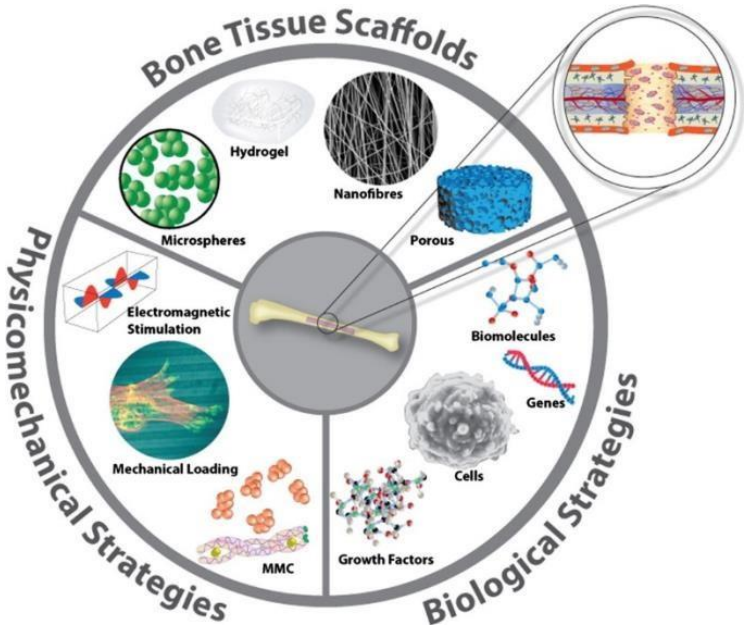

Figure 7. Bone tissue engineering

6. CURRENT APPLICATIONS OF TISSUE ENGINEERING BASED ON 3D BIOPRINTING

There is currently a growing demand for organ or tissue transplantation in tissue engineering due to a paucity of donors. A few of the tissues that have been successfully generated with 3D bioprinting include bone, cartilage, osteochondral tissue, blood arteries, livers, and organs-on-a-chip. It has been developed to combine complementary bio-inks with two or more bio-inks to improve the printability and viability of the bio-inks or to boost the mechanical integrity ofthe structure.

Bone Tissue

Bone is a type of hard tissue that supports the tissues and organs of the human body. Minor fractures can be self-healed by bone tissue, while severe wounds need external stimulation to stimulate regrowth. Up to now, bone tissue engineering has produced a large number of findings[21]. Lee et al. described a PCL and cell-filled alginate hybrid scaffold. They used PCL as a supporting structure in order to increase the construct's mechanical strength. After 25 daysof growth, the results showed that the cells had a cell viability of roughly 84 percent and wereequally distributed throughout the alginate hydrogel**.**

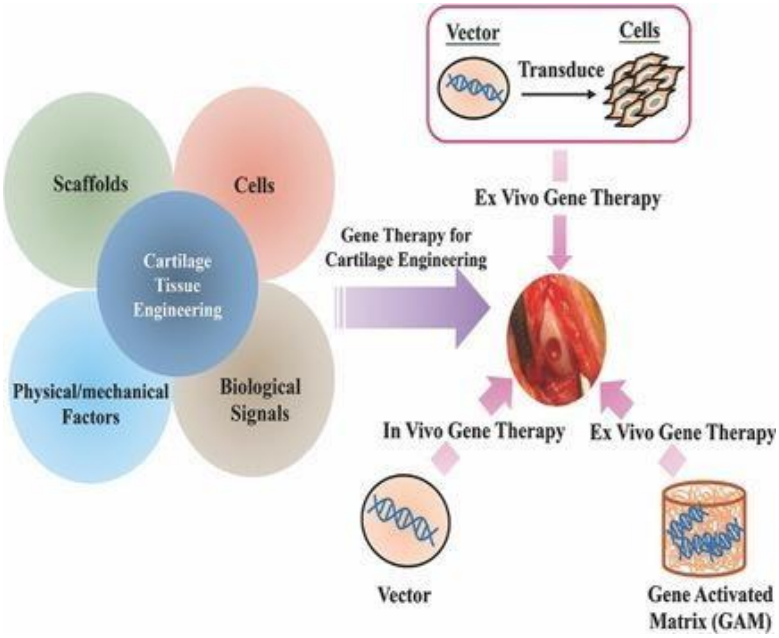

Figure 8: Cartilage tissue engineering

Cartilage

Cartilage is an avascular tissue with a minimal capacity for self-repair. By producing hybrid bio-inks based on alginate, numerous strategies for cartilage tissue engineering have been established. For cartilage tissue engineering, a nano fibrillated cellulose-alginate bio-ink was developed to boost the resolution of the bio-printed structure. The composite bio-ink demonstrated remarkable shape integrity and resolution as compared to pure alginate. Additionally, it provided good cell viability over a seven-day culture period. Kang et al. used a variety of bio-inks, such as PCL, PF127, gelatin, fibrinogen, HA, and glycerol, to produce ahuman-scale ear. The finished ear build was grown for more tissue development once the construction was produced, PF-127 was liquefied, and it was. Costantini et al employed eithera combination of GelMA and chondroitin sulphate aminoethyl Hyaluronic acid methacrylate (HAMA) or CS-EMA, GelMA, and CS-EME by using a method for coaxial dispensing to construct a 3D biomimetic structure. A robust framework was built using alginate as a temporary material. The most effective manufactured structure replacement for the creation of cartilage was found to be a mixture of GelMA and CS-EME. Recently, Ni et al. created hybrid bio-inks using hydroxypropyl methylcellulose and silk fibrin. A double network was created by adding hydroxypropyl methylcellulose to the silk fibrin, increasing its mechanical [18].

Trachea

The trachea, which has a cartilaginous tubular structure, carries air to the lungs. Many studies have attempted to fix or regenerate tracheal issues. For instance, Park et al. mixed PCL with alginate to produce a tubular structure. A 3% alginate gel encased each autologous chondrocyte and epithelial cell. Particularly, the trachea-like structures comprise five distinct layers. The PCL-based first, third, and fifth layers were followed by two bio-ink layers. Rabbits were then given artificial tracheas, and a respiratory epithelium effectively formed. Ke et al. bio-fabricated a tracheal device using PCL and bio-inks that contained cells. The mechanical properties of the synthetic tracheal structure were comparable to those of biological tissue. Recently, Kim et al. produced a two-layered object via electrospun 3D printing[23]

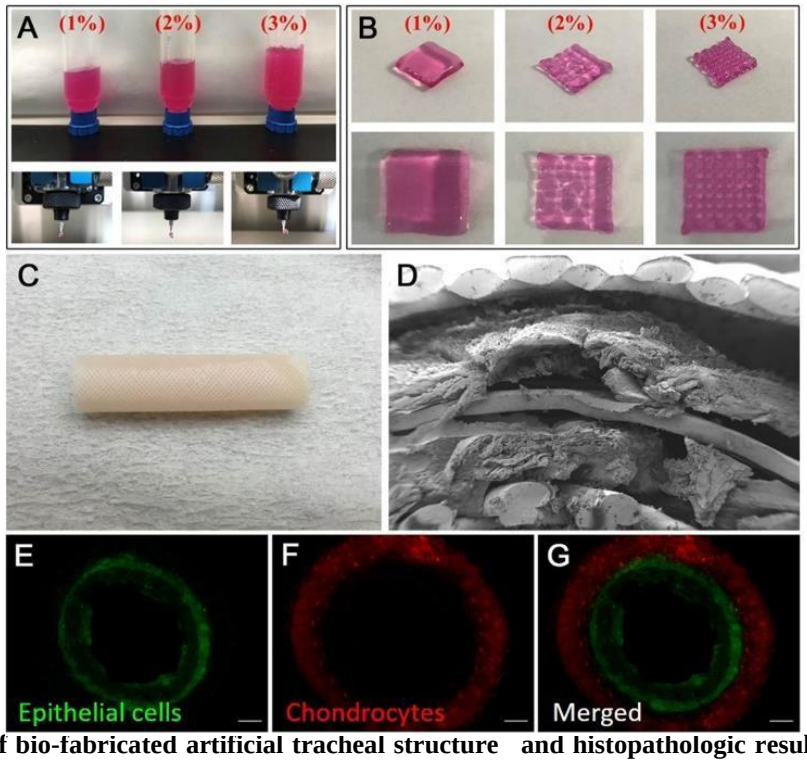

Figure9. Characteristics of bio-fabricated artificial tracheal structure and histopathologic results of epithelial formation [174]. (a) 1, 3 and 5% alginate hydrogel being extruded through the ceramicnozzle; (b) optical image of alginate cube type; (c) optical image of bio-fabricated artificial trachea structure; (d) cross-sectional SEM image of bio-printed trachea; (e–g).

SKIN

Internal organs and tissues are shielded physically by the epidermis, dermis, and hypodermis of the skin. Numerous studies in the field of skin tissue engineering suggest that damaged skin tissue can be replaced with artificial skin substitutes[24]. A fibrin-collagen bio-ink wasdeveloped by Skardal and others and used to treat wounds. Individual bio-inks were used to encase particular human amniotic fluid MSCs and fluid-derived stem (AFS) cells. The growthfactors secreted by AFS cells promoted angiogenesis and wound repair. The results demonstrated that the presence of cells in the bio-ink might significantly speed up wound closure compared to the non-cellular group. (Figure). Keratinocytes and fibroblasts were successfully combined with bioprinting to produce a 3D multicellular structure by Albanna etal. They also changed the crosslinking ratio of chitosan and genipin to adjust printability and make it comparable to that of commercial bio-ink. According to cell viability statistics, over 90% of cells kept working after 24 and 48 hours[25].

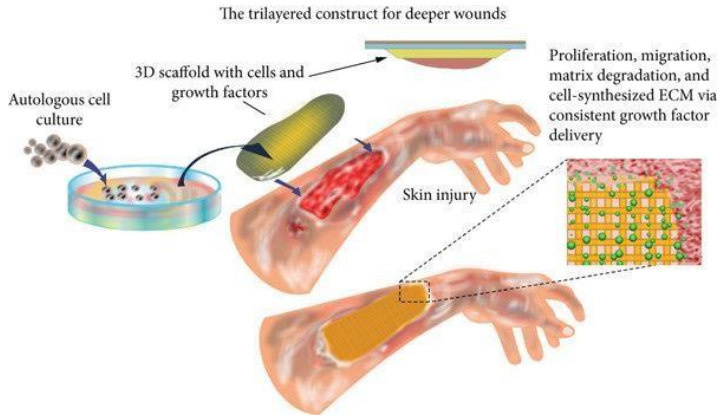

Figure 10. skin tissue engineering

SUMMARY AND CONCLUSION

This review article contains information about 3D printing technology and 3D bioprinters, 3D bioprinters for tissue engineering, scaffolds for tissue engineering, bio-inks, biomaterials for 3D bioprinting. To be better Various combinations of bio-inks were used for 3D bioprinting totest printability and cell viability applications. The possibility that tissues and organs would successfully regenerate and be transplanted is increased, according to our prediction, if the appropriate 3D bioprinters are used. Overall, we hope that this review will provide readers with crucial and valuable information. Advanced tissue engineering will rely on

bioprinting techniques and bio-inks in the future.

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