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The role of biotechnology in the field of biomedical engineering

Meheta Datta [1], Farzana A Khan [2], Sangjukta Das [3], Shreyosee Saha [4], Ruhul A Khan [3, *]

[1] *Biotechnology and Genetic Engineering Discipline, Khulna University, Khulna, Bangladesh.*

[2] *National Institute of Preventive and Social Medicine, Mohakhali, Dhaka, Bangladesh.*

[3] *Institute of Radiation and Polymer Technology, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh.*

[4] *Department of Oncology, Faculty of Medicine, University of Chester, England, UK.*

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Abstract

The modern age is an arena of interdisciplinary research and knowledge domain which involves versatile field of sciences to work cooperatively for the improvement of the mankind. Biotechnology is providing for more personalized healthcare and continued analysis of the human body. As biotechnology advances day by day, we have to uphold the pace to discover future medical applications of it. Biotechnology is a huge and rapidly growing field. Biomedical technology involves the application of engineering and technology principles to the domain of living or biological systems. Generally biomedical denotes larger stress on issues related to human health and diseases. Different kinds of live expression systems like plant or insect cells, transgenic animals, mammals, yeast, *Escherichia* coli and more are particularly beneficial because biotechnology-derived medicines from them. This type of expressed gene or protein incorporates the identical nucleotide sequence as endogenous form of humans. Application of biotechnology in different domain of biomedical fields has already brought about a substantial difference which denotes the superiority over traditional ways of treatment. It is very easy to understand that how biotechnology can be played a crucial role in medical purposes. This paper will try to highlight the glimpse of multifaceted application of biotechnology in different field as well as from different angle of application.

Keywords: Biotechnology; Biomedicine; Micro-organisms; Plants; Prevention.

1. Introduction

Biotechnology is outlined as biology-based technology that uses organisms or their elements to form or modify commodities or improve plants, animals and microorganisms. Biotechnology is defined as “the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services”. Developing new tools, including recombinant, fermentation and genetic engineering technologies that address current tissue engineering issues, biotechnology has evolved over the years [1, 2]. Biotechnology uses science and engineering to manufacture materials with biological agents. Biological agents like enzymes, plant cells and microorganisms are availed to produce prescribed drugs, foods and organic chemistry used for warfare. In medication, trendy biotechnology finds promising applications in pharmacogenomics, genetic testing, gene therapy, and drug production. Pharmacogenomics is the study of how the genetic inheritance of a person affects his or her body’s response to the medicine. Life scientists used biotechnology to form vaccines within the late nineteenth century [3-5]. The conjugation of deoxyribonucleic acid to hydrophobic compounds, medicine or polymers is in a position to come up with a possible sort of bio-hybrid materials with varied distinctive properties that are helpful for a broad range of medical applications, like gene therapy, drug delivery, and biosensing. As an example,

* Corresponding author: Ruhul A Khan
Institute of Radiation and Polymer Technology, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh.

deoxyribonucleic acid particle structures are recently synthesized and used to deliver supermolecule probes, antisense deoxyribonucleic acid, and hydrophobic medicine for bioimaging, biosensing, and cancer medical aid [6-10].

Cellulose is a universal gift in cell walls of all tube-shaped structures plants, algae, plant life, and fungi. To lesser extent cellulose is additionally available in several marine animals, like tunicates and ocean squirts, and might even be synthesized by some microscopic organisms, like a bacterium [11-14]. Bacterial cellulose (BC) could be a refined sort of cellulose that is made by many forms of microorganism species that principally belong to the genus *Acetobacter* [15, 16]. Bacterial cellulose and its composites are applied in many medical applications like wound healing, skin and tissue regeneration, healing beneath infectious environments, development of artificial organs, blood vessels, and skin substitutes [11, 13, 15, 16]. Bacterial cellulose could be an extremely crystalline linear biopolymer of monosaccharide, that is made with a breadth of but a hundred nanometer primarily by the microorganism *Gluconacetobacter xylinus* (*G. xylinus*) (formerly named *Acetobacter xylinus*) in each artificial and non-synthetic mediums through oxidative fermentation [11,17,18]. Cellulose-producing bacterium performs within the pentose-phosphate cycle or the Krebs citric acid cycle, based on the physiological condition of the cell coupled with gluconeogenesis. Recently, nano-composites have received exceptional attention and are widely studied because of their glorious properties [19-22].

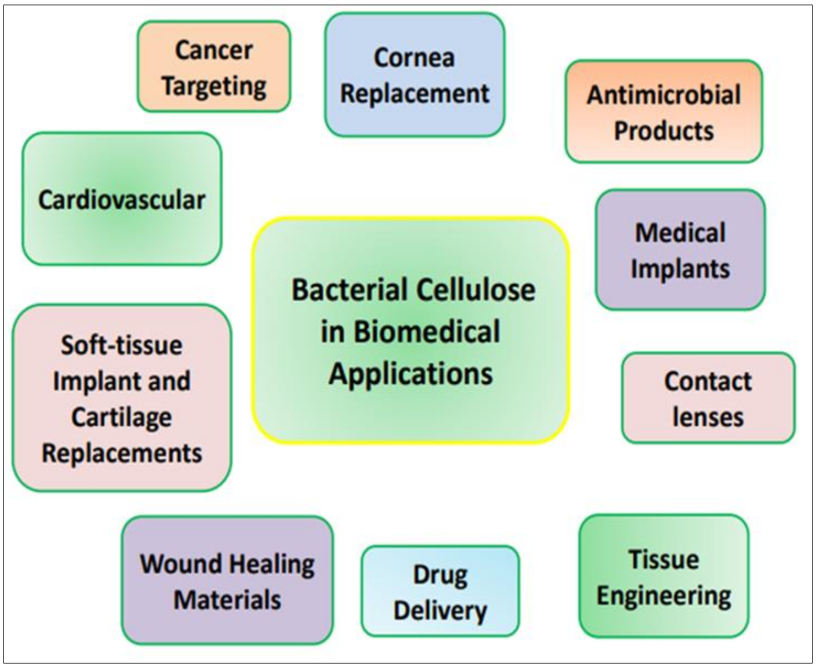

Figure 1 Biomedical application of Bacterial cellulose [11]

Bacterial cellulose is a lovely candidate for medical specialty applications because of its distinctive specific structure and properties, at the side of its biocompatibility. Bacterial cellulose and its composites have additionally been utilized in many alternative medical specialty applications, as well as cancer targeting, membrane substitute, biological diagnosing and biology–device interfaces [11, 13, 15, 16]. Currently, cellulose and its derivatives are found in medicines, cosmetics, optical films, textiles coatings, food items, packaging, and laminates [12, 23].

Recently, extremely crystalline nano-scale materials made from cellulose, specifically cellulose nanocrystals (CNCs) and drew important attention from several analysis communities, starting from Bio-resource Engineering to Materials Science and Engineering to Bionanotechnology [12,24]. Algae, that are either living thing or cellular eukaryotes, contain chlorophyll as their primary photosynthetic pigment. Many protoctist species, like *Valonia, Cladophora*, and *Boergesenia* ar legendary to synthesize cellulose microfibrils in their cytomembrane. Bacterial cellulose is extra-cellularly secreted by numerous species, principally to the subsequent genera: *Gluconacetobacter, Rhizobium, Agrobacterium, Aerobacter, Achromobacter, Azotobacter, Sarcina,* and *Salmonella*. Tunicates are the sole marine animals that are capable of manufacturing cellulose microfibrils; these microfibrils are embedded within the macromolecule matrix of the mantle [12, 25-28]. Chitin and its deacetylated spinoff chitosan are natural polymers composed of randomly distributed b-(1-4)-linked D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit). Biopolymers like Chitin and Chitosan exhibit numerous properties that open up a wide-ranging of applications in varied sectors particularly in life science. The most recent advances within the medicine analysis are vital rising trends that hold a good promise in wound-healing management products. Chitin and chitosan are thought of as helpful biocompatible materials to be utilized in a medical device to treat, augment or replace any tissue, organ, or performance of the body [29-34].

Chitin and chitosan are obtained from the shells of crustaceans like crabs, prawns, lobsters and shrimps, the exoskeletons of insects, and therefore the cell walls of fungi like *aspergillus* and *mucor.* It's primarily created commercially by deacetylation or removing acetyl group from the chitin chemical compound by treatment with alkali [35-37]. However, the biocompatibility, biodegradability, non-toxicity and antimicrobial activity of chitosan attract researchers in recent years and garnered interests within the field of medical engineering. The assembly of chitosan is related to fermentation processes, almost like those for the assembly of acid from fungus genus *niger*, *mould rouxii*, and *actinomycete,* that concerned alkali treatment yielding chitosan. Briefly, shells are ground to smaller sizes and minerals, primarily carbonate, are removed by extraction (demineralization, decalcification) with dilute acid followed by stirring at close temperature [29,38,39]. Presently receiving a good deal of interest from researchers throughout the world because of their fascinating properties like sturdy bactericide impact, biocompatibility, biodegradability, non-toxicity and high humidity absorption. Moreover, different biological properties like analgesic, antitumor, hemostatic, hypocholesterolemic, antimicrobial, and inhibitor properties have additionally been reported by researchers in some recent studies. Chitin and its derivatives have sturdy antimicrobial activities that offer varied protection against microorganisms and fungi. The blood serum of homoeothermic animals containing antibodies developed by chitin is beneficial for creating someone or animal proof against infection of the parasitic attack and therefore the associated diseases [29, 32, 40, 41].

2. Biotechnology

Biotechnology is that the exploitation and application of biological organisms and processes for industrial and different functions, particularly the genetic manipulation of microorganisms for the assembly of a specific goods. To place it in an exceedingly easy approach, biotechnology is that the use of living systems and organisms to develop or build merchandise, or "any technological application that uses biological systems, living organisms, or derivatives therefrom, to form or modify goods or processes for specific use". The last objective of biotechnology is to boost the standard of human life and health. Biotechnology finds applications in health & medication, agriculture, food process & preservation, bio-fuels and bio-energy, industry, environmental management, waste management, mining, forestry, cultivation, conservation, etc. Biotechnology is chiefly dealing with natural sciences. Bioscience is that the study of the build, its structure and performance in health and diseases. The first focus of bioscience is to grasp the disease mechanisms (using refined techniques) and dealing with the identification and treatment of these diseases. Bioscience is chiefly dealing with the facts, theories and models describing biological and clinical phenomena. Medical specialty engineering is an associate degree knowledge base and applied field of engineering and biology. Medical specialty engineering generally refers to the applying of bio-engineering to human medication, healthcare, surgery and rehabilitation. The sector of medical specialty engineering primarily involves biomaterials, bio-similar, bio-instrumentation, medical imaging and medical devices [42-44].

The field of biotechnology is huge and will be thought of tritely as merely the event of technology that's based on biology. The ideas of biotechnology will unfold many alternative fields [44]. Gene testing involves the interrogatory of the polymer molecule itself. The area of microorganisms unit needed for the assembly of antibiotics, (e.g, penicillin, antibiotic drug, Chloromycetin), vaccines, vitamins, enzymes, and lots of a necessary product. One in all the necessary applications of recombinant DNA technology is that the modification of microorganism cells to create substances helpful to humans. Bacterial cells produce human proteins; with the information for synthesizing the protein, a human DNA gene is inserted into the vector. As a tool to explore fundamental life processes, the use of microorganisms become attractive due to the following facts: they can be cultured in small and vast quantities conveniently and rapidly; they reproduce very rapidly; their growth can be controlled easily by chemicals and physical means; and their cells can be broken apart or the contents can be separated into fractions of many particle sizes. For these characteristics, microorganisms are used as research models to determine exactly how various life processes take place [45-47]. Among the microorganisms, bacterium area unit one in all the foremost abundant organisms and their ability to survive below extreme conditions, therefore it has attracted most of the scientists within the field of biogenesis of NPs [6, 48, 49].

The fact is that biotechnology, engineering and bio-nanotechnology are nearly novel ideas. To some extent, several new nanotechnological discoveries cross existing conceptual border of biotechnology and the other way around. Today, the event of biotechnology, however, has moved beyond the borders. The data has fully grown in several engineering fields similarly as in biomaterial and nano-biotechnology merchandise [6].

Bio-nanotechnology has created novel technologies for interfacing between nano-scale materials and biological systems supported the investigation of their interactions [6, 49]. The main products of bio-nanotechnology within the pharmaceutical field comprise nano-medicines and their parts, including.

- Carriers to boost each circulatory persistence and targeted medication to specific cells.
- Delivery vehicles to enhance governable drug release.
- Adjuvants for delivery of immunogen, genes and diagnostic.
- Additives to boost bioavailability, solubility, and stability of poorly soluble medication [6, 49].

Bio-nanotechnology in analysis results in varied medicine applications with varied benefits like labeling, medical specialty, bio-sensing, targeted imaging, yet as delivery, cellular delivery, medicine, bio-computing, bioelectronics, etc [50, 51]. Bio-nanotechnology has an impact on a medical specialty by facilitating early detection of inflammation, interference and early detection of cancer. Diagnostic detection techniques involve measure enzyme chain reactions, protein or antigen-based complexes, or enzyme-based reaction rates victimization MEMS. Whole-cell microorganism sensors and biosensors utilizing aptamers area unit used as different schemes of ascendable medical specialty. Inbound diagnostic strategies, NPs are a unit interfaced chemically or biological molecules like antibodies, antigens, and perform as nanoprobes. Bionanotechnology has been widely applied in pharmaceutical applications, that area unit well-known as drug delivery systems. The applications of bio-nanotechnology within the pharmaceutical field are delineating as utilization of bio-nanomaterials to the pharmacy and as campaigns like imaging, diagnostic, drug delivery and biosensors. It's been incontestable that the drug delivery systems influenced the absorption ability, excretion, and metabolism, distribution of the drug or different connected chemical parts within the body [6, 7]

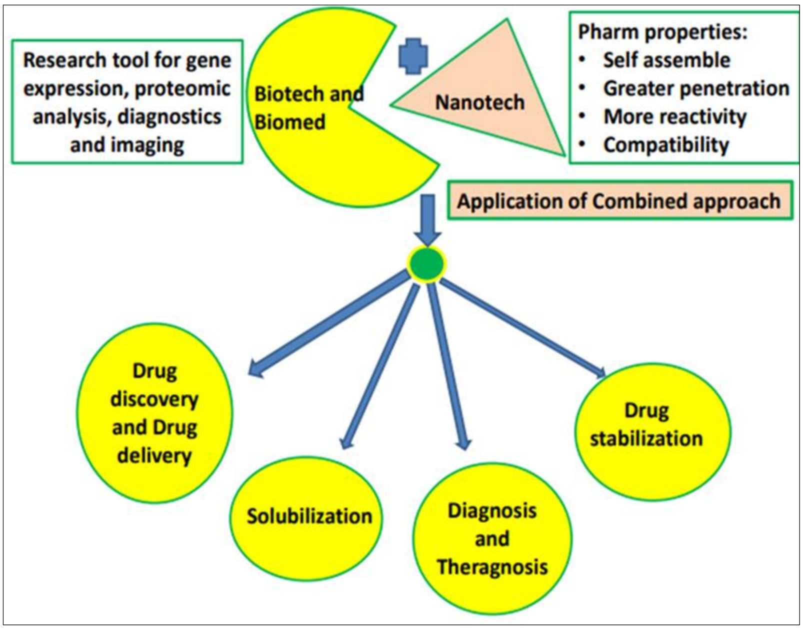

Figure 2 Application of Bio-nanotechnology [50,52]

3. Biomedical Engineering

Biomedical technology involves the application of engineering and technology principles to the domain of living or biological systems. Sometimes medicine denotes larger stress on issues associated with human health and sickness. Medicine engineering combined with biotechnology is usually referred to as medical technology or engineering science [45]. Biomedical engineering is that the application of engineering principles and style ideas to medical biological sciences for care functions. It seeks to introduce up-to-date advanced technologies that promote the event of care treatment, each diagnostic and therapeutic. Distinguished medicine engineering applications embody the event of bioassays for clinical identification, bio-fabrication of novel biomaterials, and tissue engineering for each pharmaceutical business and clinical medical care [53]. Biomedical engineering additionally involves the search for appropriate carriers of pharmaceutical agents and biomolecules that may be used as a treatment against diseases or as agents for cell stimulation [54-57].

3.1. Importance of Biotechnology in Biomedical Engineering

3.1.1. Tissue Engineering

Tissue engineering is a branch of science that unifies materials engineering and biomedicine–deals with the assembly of materials that will substitute and induce advanced regenerative processes in broken tissue. The expansion and manipulation of laboratory-grown cells, tissues or organs that may substitute or support the role of defective or injured elements of the body is the main operation of tissue engineering. The target of tissue engineering is to repair, replace, maintain, or enhance the task of a selected tissue or organ. Tissue engineering technology has developed to construct artificial tissues which will mimic the natural ones by combining modulated cells with completely different system materials, together with natural and artificial polymers. Among these materials polylactide (PLA), polyglycolide (PGA) and their polymer, polylactide-co-glycolide (PLGA) has received abundant attention as appropriate candidates for tissue engineering owing to their biodegradability and biocompatibility [29, 37, 58, 59]. Due to the distinctive characteristics of bacterial cellulose (BC), along with the 3D network structure, potential biocompatibility and considerably low toxicity, glorious mechanical properties yet as an extremely porous structure, BC is the best-suited material for tissue engineering applications [11,60,61]. The PVA–BC nano-composites presented tunable compressive mechanical feature with elastic modulus magnitudes which is closer to that of the initial articular cartilage. The PVA–BC nanocomposites exhibited tunable compressive mechanical characteristics with modulus magnitudes nearer there of the initial body part animal tissue. The PVA–BC nano-composites displayed enticing properties for replacement localized body part animal tissue injuries and plenty of alternative medical science issues, like broken bone discs. Supported the high mechanical properties, compatibility, foldability, and low value, the BC-based artificial membrane (AE) was ready and later on proprietary [11, 62]. BC is an attainable material to use for blood vessels for small- or large-sized vascular grafts because of its sensible mechanical strength (a burst pressure of up to 880 mmHg), porous structure, blood biocompatibility, mold ability and fold ability.

The grapheme oxide (GO) nano-sheets were embedded within the BC nano-fibers with atomic number hydrogen bonding. The BC–GO composite showed bigger biocompatibility compared to them on an individual basis applied substances additionally to induce cell proliferation. Completely different properties and biology assessments of BC tubes as a vessel substitute are probed, as well as BC biomaterial-induced clotting problems, cell adhesion, proliferation, viability and invasion, hemodynamic analysis, microcirculatory analysis, and so on. Bacterium polysaccharide has been examined in dental tissue regeneration. Microorganism polysaccharide ready by the *G. xylinus* strain could also be applied for regeneration of dental tissues in kith and kin [11, 63-68]. Significantly, bio-nanotechnology has revolutionized tissue engineering in the regeneration of the skin in terms of tissue repair or reconstruction of lost or broken tissue through the employment of growth factors, cell medical aid, injectable biopolymers, and biomaterials particularly in severe burns, bruises and chronic wounds, wherever the treatments on the market aren't decent for the bar of formation of scars [50, 69].

Langer & Vacanti introduced biomaterial-based TE. It had been outlined as a knowledge base field using engineering and life sciences principles to support biological substitutes that restore, maintain, or improve the operation of a tissue or a full organ [70-72]. An intersection between biotechnology and medicine engineering named TE, was established to support and promote denovo synthesis of scaffolds, therefore, conjointly to repair defective broken tissues as per patient's regeneration potential. Biomaterial scaffold is capable of providing additional to physical support, the chemical and biological clues required in forming practical tissue. Biomaterial technology is crucial within the creation of this native cell atmosphere, and numerous artificial and natural materials like polymers, ceramics, conjugated metals, or their composites, are studied and used in several manners. Macromolecule-derived biomaterials like albumin, vitronectin, fibronectin, laminin, collagen, elastin, casein, zein, conjointly provide an appropriate environment for the expansion of cells. Transplantation and biomaterial engineering were recently used for malady healing, with the aftermath of the previous, being cancer and graft rejection [70, 73-76].

Albumin scaffold has been with success verified and applied in bone tissue engineering. Albumen fiber scaffolds with mechanical properties associated with internal organ tissue have been with success fancied. These fiber scaffolds for engineering practical internal organ tissues [70, 77-80]. The area of Proteins is a major unit of cellular and extracellular players in native tissues thus; the following of tissue regeneration driven by protein-derived scaffolds or spatial and temporal management unharness of relevant communication molecules is being additional and additional relevant. Tissue-engineered constructs made from biotechnology-derived materials are given necessary insights into cellular organic phenomenon and behavior once within the presence of specific genetic sequences. Also reliable and correct 3D tissue-like structures area unit expected to be provided by tissue engineers to boost drug discovery. Through tissue engineering, superior 3D *in vitro* model area unit being developed, which permit higher and quicker drug screening [1, 81].

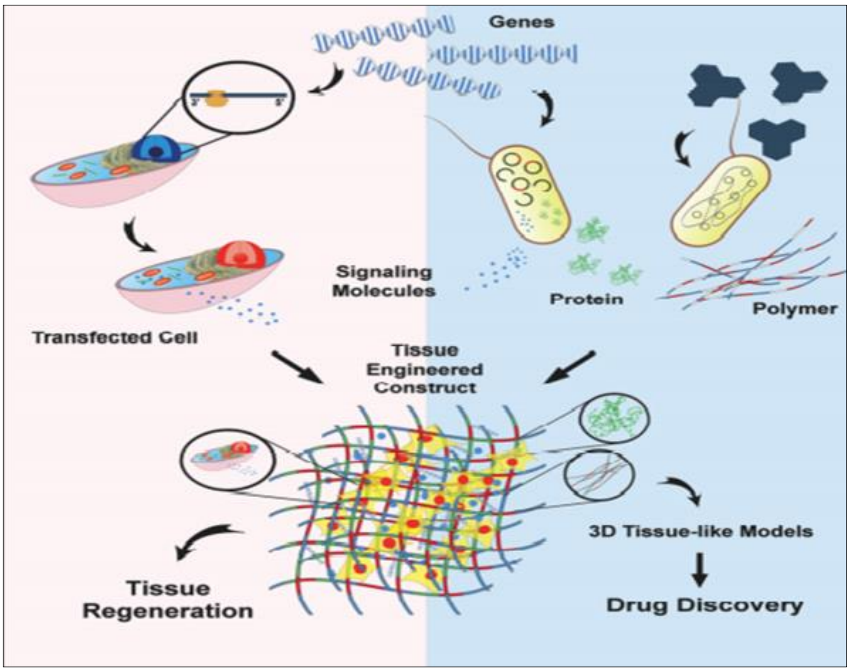

Figure 3 Tissue Engineering and Drug Discovery [1]

3.1.2. Wound Healing

The application of polysaccharides and chitosan as potential wound-healing accelerators has been investigated by several researchers for an extended time. Polysaccharides and their derivatives will be applied safely to animals as well as to humans. Varied kinds of chitin-based products are offered for medical applications, like finely divided powder, nonwoven materials, porous beads, preserved soft fleeces or gels, gauges, laminated sheets and clear films. The direct use of 'in situ' polysaccharide with plant mycelia from the fungus *Ganoderma tsugaue* to bring about wound healing sacchachitin membranes. A non-woven mat obtained by initial processing the mycelia to get rid of super molecule and pigment, followed by isolation of fibers within the 10–50 metric linear unit diameter vary and a final consolidation into a freeze-dried membrane beneath sterile conditions was utilized in a wound model study. The wound healing of this fungal-based non-woven mat as surmised from wound contraction measurements on 2 completely different animal model studies came out favorable. No adverse responses were discovered *in vivo* immunogenicity evaluations *in vitro* cell culture applying rat fibroblasts. Wound healing is accelerated by oligomers of degraded chitosan by tissue enzymes, and this material was found to be effective in regenerating the skin tissue of the wound space [29, 82-84].

According to the findings of many studies, BC has been introduced as a superb biomaterial in typical wound dressing. There square measure some BC-based dressing materials, like Bioprocess, XCell, and Biofill, that square measure on the market within the market commercially. It had been reported that the skin of patients wounds were treated with a BC membrane improved quicker than those patients who used typical wound dressings. Czaja et al. found that non-dried BCs exhibited notable compatibility for various body varieties, maintained an acceptable water balance, and significantly reduced wound pain. Additionally recently, animal studies by Fu et al. conjointly confirmed the results of BC-based wound dressing materials in fast tissue regeneration and healing additionally reducing the inflammatory response. Moreover, the outcomes of many studies show that the topical use of microbial cellulose (MC) membranes accelerates the method of wound healing [11, 85-87].

Another study conjointly reported that megacycle membranes showed higher potency compared to standard wound dressings in:

- Compatibility with the wound surface (excellent covering to any or all facial contours and a high level of cohesion even to the contoured regions, like mouth and nose, were seen);
- Protective damp surroundings within the wound;
- Important reduction in pain;
- Fast re-epithelialization and therefore the generation of granulation tissue;
- Reduction of scar formation [11, 87, 88].

Inspired by the high chemical process activity of natural metallo enzymes, M-N-C SACs with similar structures of natural metalloenzymes were exploited as single-atom nanozymes to mimic the chemical process activities of natural enzymes. Atomically distributed single metal atoms supported on carbon spheres (denoted as PMCS) were fictitious as single-atom nanozyme (SAzyme) with predominant peroxidase-mimicking activity for suppressing the microorganism proliferation and facilitating the wound regeneration [89, 90].

In the wound healing method, collagen plays a crucial role. It is demonstrated that raised concentration of hydroxyproline around the wound space is taken into account as associate indicator for the high quantity of collagen fiber that results in the elevation of the tensile strength that is a sign of wound healing. Lately, *Woodfordia fruticosa* was complexed with carbopol and then from it gold nanoparticles biosythesized to produce an ointment. Dhapte et al. (2014) investigated the wound healing potential of a gel formulation containing silver nanoparticles biosynthesized through *Bryonia laciniosa* and compared the results with already accessible marketed cream containing silver sulfa as a vigorous part [91-93].

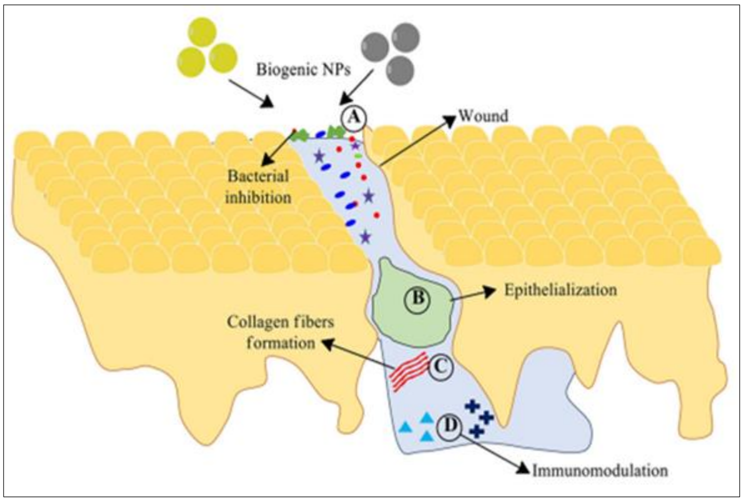

Figure 4 Mechanisms of wound healing shown by biogenic AuNPs and AgNPs. (A) Biogenic AgNPs and AuNPs inhibiting varied microorganism growths, ultimately enhancing wound healing method, (B) increased epithelization by nanoparticles, (C) increase within the production of albuminoid fibers, (D) Immunomodulation Appl Microbiol Biotechnol [91, 94].

3.1.3. Cancer Treatment

Cancer is one in all the leading diseases detected in developed countries with the looks of roughly one. About 6 million new cases were in 2017 within the USA alone. Presently obtainable medication for cancer treatment, together with taxol, antibiotic drug, cyclophosphamide, and 5-fluorouracil are invariably related to various adverse aspect effects like anemia, alopecia, fatigue, immunological disorder, neurologic problems, peripheral pathology, and fertility issues. Polysaccharides extracted from marine sources have arisen as doubtless effective chemical entities that have shown important metastatic tumor activities against a large vary of cancer cells. They're reported to destroy cancer cells and forestall metastasis by functioning on neoplasm cells via completely different mechanisms like cell cycle arrest, DNA damage, gas production, and depolarization of mitochondrial membrane [95,96].

Based on the high chemical process capability of SACs, it has a tendency to recently built single-Fe-atom catalysts (denoted as Fe–N–C SACs), that regenerate tumor-overexpressed H_2O_2 into •OH by Fenton reaction and at the same time caused ferroptosis via the promotion of lipoid peroxides for economical nano catalytic tumor-oxidative treatment. Within the acidic tumour condition, a chemical element nucleon cared-for approach OH*, resulting in the formation and the resulting liberation of liquid molecule from the active sites of the catalyst, that enabled the resurrection of the active sites of the catalyst (Figure). However, within the neutral condition, upon the decomposition of H2O2 into •OH, the natural action of OH* species was hardly complete, and therefore the residual species considerably deactivated the active sites of the catalyst, inflicting evident declination in chemical process activity. As a result, in keeping with the planned chemical process mechanism, Fe–N–C SACs may implement high method |chemical change chemical action activities via chemical element proton-mediated process underneath acidic tumour setting [89, 97-99].

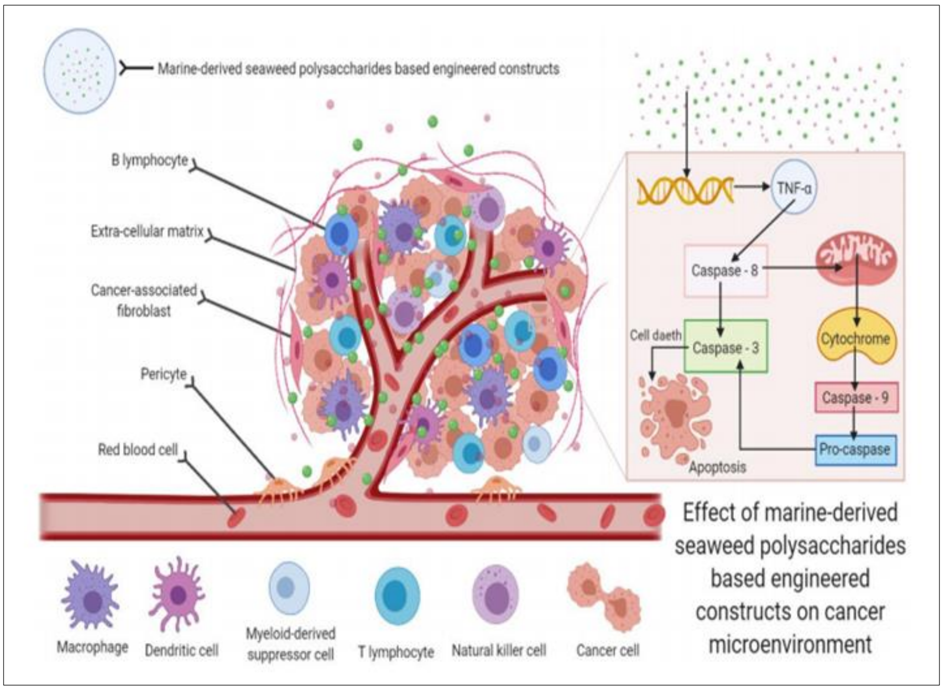

Figure 5 Anticancer potentialities of marine-derived alga polysaccharides primarily based built cues to destroy cancer cells and stop metastasis by performing on tumour cells microenvironment via totally different mechanisms like necrobiosis via programmed cell death [95].

Gene medical care treatment wherever genes square measure accustomed treat diseases show potentiality to treat cancer. Because of the physical size of therapeutic plasmids and since of their circulation half-life that usually in a minute a carrier is needed. Chitosan-coated polyisohexyl cyanoacrylate (PIHCA) nanoparticles are developed for blood vessel delivery of tiny busybodied polymer (siRNA) and are shown to possess effectualness against the Ras homolog sequence family, member A (RhoA) cancer target sequence [29,100-102]. By an array of advanced techniques such as colony formation, cell viability, cell cycle progression, cell migration, apoptosis and genetic damage accompanied by mitochondrial membrane and nuclear morphological potential, recently, Arumugam and coworkers, meticulously investigated the anti-cancer properties of brown alga extracted sulfated carbohydrate, fucoidan in a hepatoblastoma-derived (HepG2) cell line. The fucoidan conferred associate degree encouraging malignant tumor potentiality against HepG2 neoplastic cell lines by suppressing cell propagation, and cell detention that was reticulated with cell death and genetic harm [95,103].

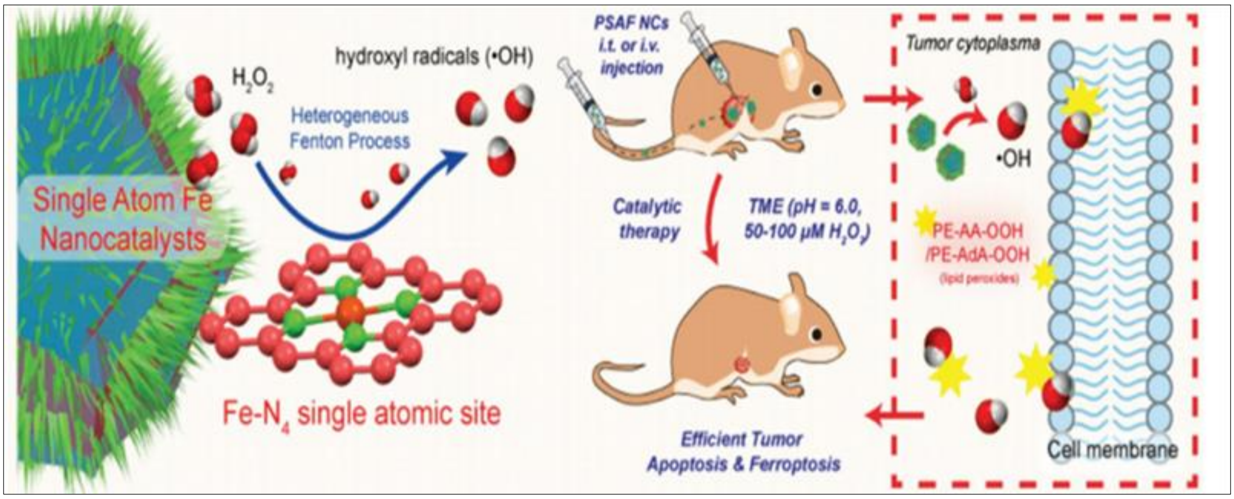

Figure 6 Schematic illustration of tumor therapy as catalyzed by Fe–N–C SAFs [89, 98, 99]

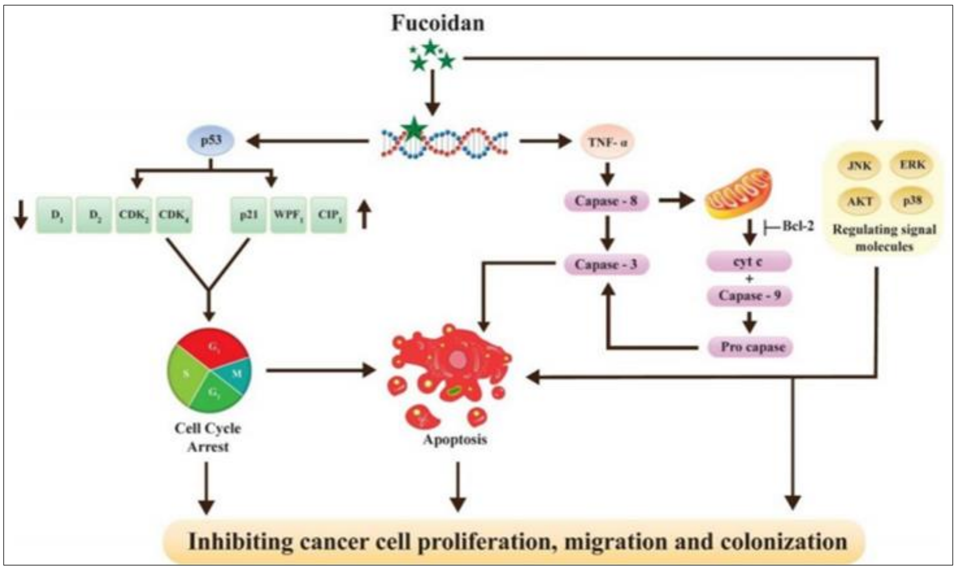

Figure 7 Anticancer activity of brown seaweed (*Turbinaria conoides*)-derived fucoidan in HepG2 cancer cells [95]

3.2. Artificial Kidney Membrane

An artificial kidney membrane has been developed recently that produces attainable repetitive dialysis and sustaining the lifetime of patients with chronic nephrosis. Chitosan holds promise for being employed as a synthetic excretory organ membrane because of its intrinsic high mechanical strength additionally to permeability to organic compounds and creatinine. Moreover, these membranes square measure impermeable to serum proteins. The film-forming properties of chitosan were extensively studied by many workers and a range of chitosan membranes are proposed for reverse diffusion, ion exchange action, and metal ion uptake, diffusion of dyes and separation of water-alcohol mixture systems [29,104-106]. Uragami et al. prepared a cross-linked chitosan/PVA mix with a hard and fast quantity of cross-linking agent and studied the transport of the salt ions through the chitosan/PVA membrane [107]. Hirano et al. produced a series of membranes from chitosan and its derivatives and therefore the membranes showed improved qualitative analysis properties. Chitosan membranes were changed with vinyl monomers victimization 60Co c-ray irradiation that showed an improved blood compatibility and permeability [29, 108-111].

3.2.1. Neural Engineering

Nerve injuries are one in every of the foremost sophisticated physical injuries. Once the nervous system is impaired, its recovery is tough and failure of different components of the body happens. The repair of nerve lesions has been tried in many alternative ways that which have in common the goal of guiding to create nerve fibers into the appropriate endoneurial tubes. A large kind of materials is urged for the assembly of artificial tubes for nerve repair, as well as biocompatible, nondegradable, and degradable materials [29, 112, 113]. Chitosan has been thought about as a possible material for nerve regeneration thanks to its distinctive properties like growth, medicinal drug activity, biodegradability, and biocompatibility. Haipeng et al. according to those neurons civilized on the chitosan membrane will grow well which chitosan tube will greatly promote the repair of the peripheral nervous system [29,114, 115]. Apart from that, bio-nanotechnology with nano-bioelectronics has several benefits in brain analysis and neurobiology. Carbon nanotubes electrically stimulate neural stem cells and generate signals for nanomaterial-neural interfaces, for the combination of technology devices with the human brain. [50, 116-119].

3.2.2. Pharmaceutical Engineering

The massive bulk of pharmaceutical medicines presently on sale are artificial chemicals derived either directly by chemical synthesis or by with chemicals changed molecules derived from biological sources. As an example, recombinant human insulin became the primary factory-made or industrial, recombinant pharmaceutical in 1982. Before the event of recombinant human insulin, animals (notably pigs and cattle) were the sole bloodless sources of hypoglycemic agent. The primary success of the recombinant DNA technology is that the insertion of the human insulin gene factor into *E. coli*, thereby sanctioning the microorganism colonies to supply insulin [3, 120, 121]. Human somatotropin is employed to counter growth failure in youngsters that's because of a scarcity of hGH production by the body. Before the introduction of recombinant hGH the secretion was derived from human cadavers. Cadaver-derived hGH was vulnerable to contamination with slow viruses that attack animal tissue. Such infective agents cause fatal diseases in some patients. Recombinant hGH has greatly improved the lengthy treatment of kids whose bodies don't turn out enough hGH [3,121].

Cells square measure then drawn from the cell banks and employed in biopharmaceutical production. Generally, the assembly method is split as Cultivation: the cells are transferred from the refrigerant cell bank to a liquid nutrient medium, wherever they're allowed to breed. The length of this step depends on the sort of cell used. Under favorable conditions microorganism cells such as *Escherichia coli* generally divide once every 20 minutes; thus, one cell provides multiple numbers of cells within twenty-four hour. On the other hand, mammalian cells divide only about once per twenty-four hour, and it takes likewise longer to get a sufficient number of cells. In the time of growth phase the cell culture is transferred successfully to huge culture vessels. [3, 46, 47,121].

Gene therapy is use of DNA as a pharmaceutical agent to treat the diseases. It derives its name from the thought that DNA can be acted as supplement or alters genes within individual's cells as a medical care to cure the diseases. The foremost common type of gene therapy in medical care involves victimization desoxyribonucleic acid that encodes a practical, therapeutic factor to interchange a mutated factor. In germ line gene therapy in medical care, germ cells (sperm or eggs) are changed by the introduction of particular genes with quince character that then integrated into their genomes. This may permit the therapy to be familial and passed on to later generations. In case of somatic gene therapy, the therapeutic genes are inserted into the somatic cells, or body, of a patient. Any modifications and effects are going to be restricted to the individual patient solely and cannot be transmissible by the patient's offspring or later generations [3,122, 123].

Gene therapy as a medical care treatment is a molecular biotechnology technique for correcting genetic disorders by exchange defective genes with practical or traditional genes. Gene therapy has some needs, which ought to be met. Firstly, all genes of interest should be cloned; treatment ought to deliver sufficient copies of traditional genes to focus on cell; transferred genes ought to have stable expression; changed cells should have a survival advantage over unqualified cells and at last organic phenomenon should correct or reverse the malady [47]. The goal of the Pharmaceutical business is to own a gene therapy medical product that will be delivered systemically. There primarily two ways that of implementing a gene therapy treatment: one is *in vitro*, which suggests outside the body, cells from the patient's blood or bone marrow are removed and grown within the laboratory. They're then exposed to a virus carrying the specified factor. The virus enters the cells, and also the desired factor becomes a part of the desoxyribonucleic acid of the cells. The cells are allowed to grow within the laboratory before coming back to the patient by injection into a vein. The second type of treatment called *in vivo*, this suggests within the body, no cells are far from the patient's body. Instead, vectors square measure won't to deliver the specified factor to cells within the patient's body [3, 47, 124].

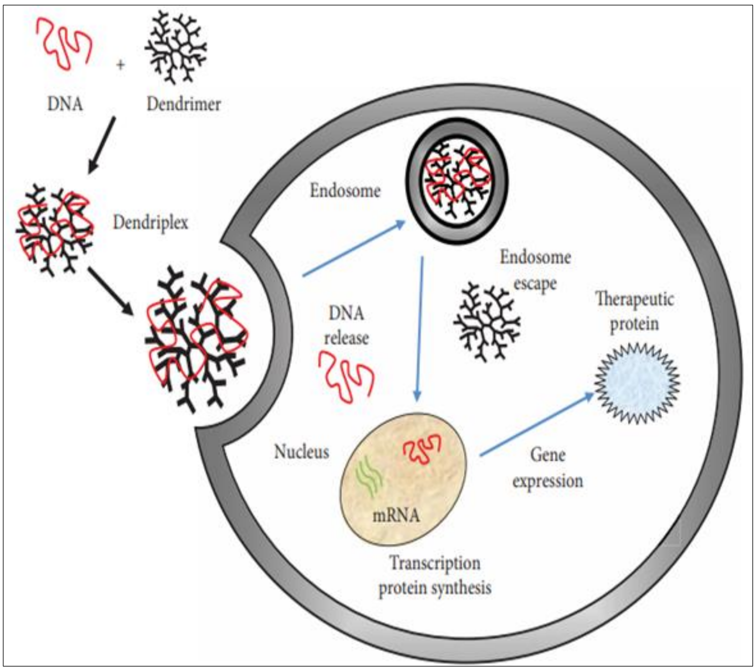

Figure 8 Schematic diagram for a possible route in the use of dendrimers as gene delivery vectors [128]

Due to their anti-photoaging, anti-inflammatory, antioxidant, and antitumor bioactivities seaweeds-derived bioactive polysaccharides have garnered exceptional interest. A bio-active compound, Sargachromanol E, which is extracted from the brown algae *Sargassum horneri* has redoubled scavenging ability against ROS (Reactive oxygen species) and prevented cell membranes from aerophilous modification in UV-exposed human dermal fibroblasts. Sargachromanol E has treatment on maintaining the skin scleroprotein fibers by inhibiting the expression of metalloproteinases (collagen-degrading matrix). Moreover to antioxidant potentiality, *S. horneri* derived polysaccharides exhibited potent moisture-absorption and maintenance capabilities. Li et al. evaluated the utility of *S. glaucescens* extracts in aid by carrying gouty arthritis in-vitro bioassays in stratum keratinocytes and dermal fibroblasts [95, 125-127].

As cellular plasmid DNA by itself is unable to penetrate the cell wall, the primary stage is then to make (*in vitro*) a push between dendrimer and deoxyribonucleic acid (called dendriplex). The dendriplex is then intercalary to cells *in vitro* (or is introduced into animals *in vivo* or ex vivo), wherever it'll be transported to the particular cell via the blood system. The dendriplex can bind to the cell wall and await the cellular uptake (endosome uptake), so permitting its incorporation within the living substance. Once the hydrogen ion concentration changes from 7.4 (extracellular value) to 5.5 (intracellular value), the deprotonation of dendrimer surface teams causes the dendriplex destruction and also release of macromolecule nucleic acid. This causes the endosome to escape; otherwise, the dendriplex is going to be degraded when the fusion of the endosome with lysosomes. At the same time, the endosomes go through lysis, and also the free macromolecule (DNA) is free into the living substance. Finally, the deoxyribonucleic acid travels through the living substance to enter the nucleus for sequential organic phenomenon [128-131].

3.2.3. Drug Delivery

Drug delivery has been the foremost promising field of liposome applications within the pharmaceutical trade. In clinical tests, liposomes have exhibited a high improvement of pharmacological medicine and bio-distribution of encapsulated drug or therapeutic agents and cut back the toxicity of those medicines by their accumulation at the target tissue. Currently, there are plenty of liposome-based medicines approved by the office for clinical applications with numerous stages of clinical trials [6, 132]. BC and alternative chemical compound materials are broadly studied for controlled drug delivery. Production of BC-based nano-composites to optimize the controlled drug delivery is that the most significant strategy to market the drug-delayed release effects of BC. In some studies, the mix of BC and polyacrylic acid (PAA) (BC–PAA) has been prepared by chemical change initiated through beam irradiation victimization varied doses of radiation. These BC–PAA composite hydrogels were examined as pH-responsive substances for controlled *in vitro* drug delivery utilizing varied contents of bovine albumin (BSA) as a model compound. The fictitious BC composites were used as a substitute carrier for percutaneous drug delivery. In recent studies, several drug delivery systems supported nano cellulose substances for diverse pharmaceutical applications are used. Microbial cellulose includes an appropriate structure to be used in drug delivery systems. A very important purpose of victimization microorganism cellulose is as an acceptable bourgeois of medicine is to manage the speed of drug unharnessed and optimize drug concentration. [11,133-142].

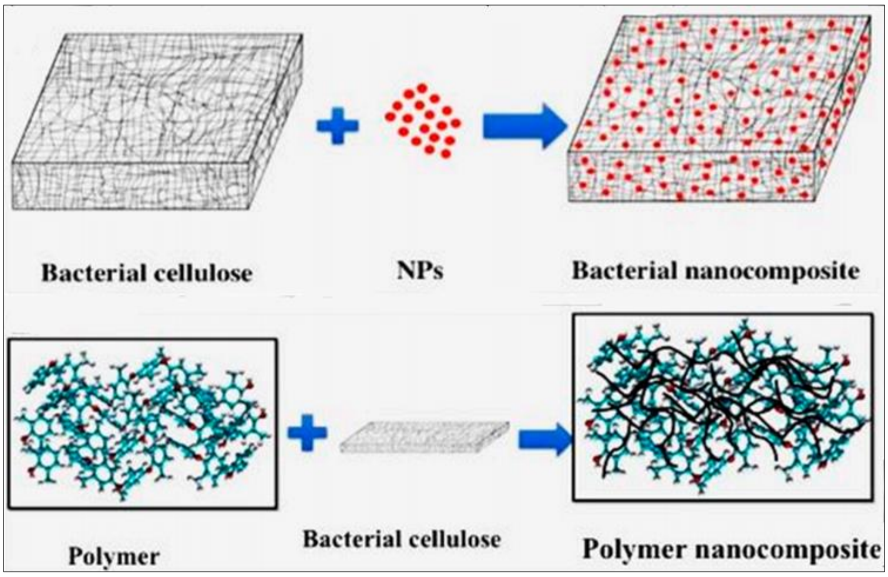

Figure 9 The use of BC as a matrix or reinforcement to prepare nano-composite [11]

The discovery and development of drugs within the clinical section is a very difficult and valuable method as a result of most of the medicine fail to attain favorable clinical effects because of their inability to achieve the target website of action. A substantial quantity of the administrated drug is disseminated over the traditional tissues or organs that don't seem to be concerned within the pathologic process, usually resulting in severe facet effects. The cationic sugar polysaccharide and chitosan, has drawn increasing attention in pharmaceutical and medical specialty sectors, as a result of its bumper convenience, inherent medicine properties, and alternative favorable biological properties like biocompatibility, biodegradability, non-toxic profile and low-immunogenicity that result in a potential application within the style of carriers for controlled unleash of drug delivery. A range of drug is also well incorporated into chitosan matrix is very kind of forms like beads, films, microcapsules, coated tablets etc. for controlled-release therapies. A less degree of polymerization like 60 % deacetylated chitin or hydroxypropyl chitosan is being considered as a vast development of per-oral sustained release tablets. The targeted malignant tumor drug delivery system is furthermore as following the trail of the drug carrier with a bio-friendly significant metal-free quantum dot could be a nice contribution to cancer therapy [29, 38,104,143].

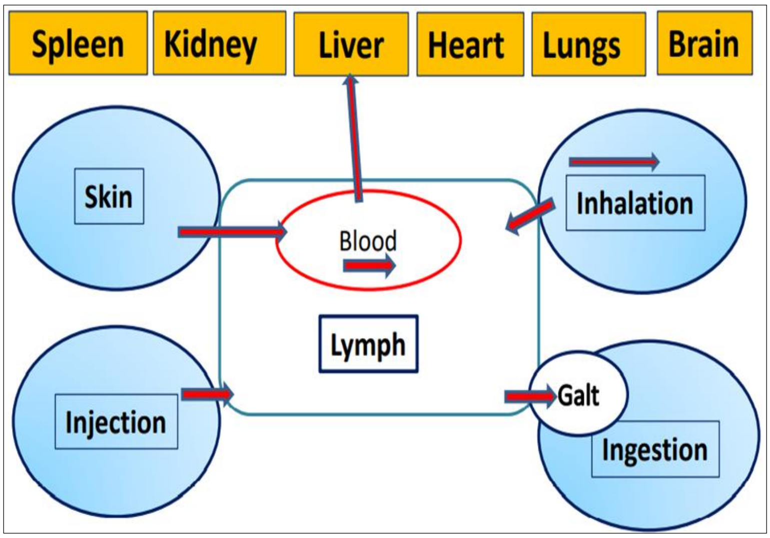

Figure 10 Translocation of nanosize biomaterials in the body after exposure to inhalation, ingestion, skin contact, and injection leading to systemic circulation and finally reaching all the organs [50]

3.2.4. Medical Devices

Bionanotechnology can be specialized in developing nanostructures of biomaterials for the designation and detection of diseases at earlier stages by conjugating nanoparticles with targeting *in vivo* imaging agents and neoplasm markers. Bionanotechnology has the potential for genomic diagnostics; electrospinning will generate nanofibers of varied morphologies like cores heath, porous surface, and side-by-side structures incorporated in composites, tissue scaffolds, wound healing, and drug delivery devices in medical specialty applications. It can also help come up with nonwovens for filtration, skinny coatings for defense, and membranes for aerosol purification and protection structures. Medicine like antibiotics, antitumor proteins, DNA, and the polymer is delivered through electrospun-built scaffolds.

Electrospinning generated fiber mats hold special applications in tissue engineering as they promote proliferation, healing, and mimic the extracellular matrix and can even be used as barriers for the elimination of autopsy, like wound dressings, and for tissue regeneration recombinant DNA technology primarily based on genetic engineering. Bionanotechnology merchandise can improve drug delivery through a targeted approach, thanks to the buildup of nano-products at high concentration due to the distinct pathophysiology of unhealthy tissue. Radio and magnetic signals are accustomed to guide the nanoparticles or nanorobots to the target within the body [50, 51,144]. In the gene therapy approach, the potency of the gene delivery into target cells plays a vital role in the success. Cationic liposome-DNA complexes, which are known as "lipoplexes", are presently thought to be a probably different to infectious agent tools or vectors for the gene delivery in pharmaceutical applications. Cationic liposomes are ionic liposomal particles composed of a cationic lipid and a neutrally charged lipid. For the formation of liposomal complexes containing condensed desoxyribonucleic acid, a cationic lipid includes amphiphilic groups that exhibit a positive charge, which simply creates interactions between the positively charged cyst and negative charged desoxyribonucleic acid. It was recommended that the discharge mechanism of desoxyribonucleic acid from the cationic lipid/DNA complexes in cells chiefly relates to the action of anionic lipids at first placed within the cytoplasmatic face of the endosome [6, 145-147].

Over the last decades, nanopores have incontestable potentials for sensing a diversity of analytes, contributory to the revolution of medical specialty and DNA/RNA sequencing. To date, many protein channels like a-hemolysin, aerolysin, MspA, FluA, Omp F/G, ClyA, CsgG, and PA63 and infectious agent connectors like phi29, T3, T4, and SPP1 are with success used as nano-pores for detection of polymers, polypeptides, tiny molecules, and DNA/RNA. Protein engineering, like insertion/deletion of amino acids and website directed cause, and introduction of purposeful modules are loosely wont to tune nano-pore properties. Different styles of analytes need distinctive nanopores with different sizes, shapes, and hydrophobic/ hydrophilic natures for sensitive and specific detection [6,148].

“Biosensors”, which are referred to as “biosensing”, “bio probes”, or “nano biosensors”, area unit outlined because the devices or systems that incorporate bioactive materials intimately coupled to appropriate transduction parts for detection the activity or concentration of chemical species in samples. Biosensors have the advantage of their speedy time interval in detection, together with the emergence of complementary technologies. The sophistication of fabrication technologies leads to the regularly reduced sizes of biosensing devices, which supplies rise to submicron sensing systems referred to as nano biosensors. It’s essential to quickly and sensitively notice pathogen DNA, giving effective diagnosing and acceptable antibiotic treatment time [6, 149].

Translocation of nanosized biomaterials within the body once exposed to inhalation, ingestion, skin contact, and injections resulting in circulation and eventually reaching all the organs. The performance of biosensors, as well as the sensitivity, linearity, specificity, reusability, reliability, and chemical stability is considerably influenced by the bio functionalization of the detector platform [6]. Some factors, like antibodies, receptors, and enzymes, are greatly used in bio analysis and biosensors as bio-sensing parts. These instruments will manage the time period of biological signals *in vivo*, together with the discharge of antibodies or proteins in response to broken tissue, inflammatory events, infections, genetic disorder, or internal organ pathology. One of the foremost common biosensors is that the blood sugar display. Moreover, Wang and Wang et al. ready B.C. nanofibers containing Au nanoparticles (BC-Au) nanocomposites as a supply for amperometric determination of aldohexose.

In another study, Eisele et al. applied B.C. as external lamella in aldohexose biosensors for the amperometric determination of merchandise of aldohexose enzyme reactions. Chronic stability (200 hours) was obtained with diluted blood (1:10), which was longer than that of the commercial Cuprophan® substrate (stability thirty hours) with an equivalent condition [11, 150-153]. Catheter is a skinny tube created as a medical device that can be inserted within the body to treat diseases or perform an operation. This versatile tube inserted through a slim gap into a body cavity, notably the bladder for removing fluid. The utilization of heparin coated chitosan in catheters draw abundant attention of the researchers within the field of medicine engineering because of its nice clinical performance and physical compatibility. Chitosan–heparin coated polymers additionally show glorious thrombo resistance properties. The period of time of the thrombo resistance can be extended by covalently binding the heparin to chitosan with the help of sodium cyanoborohydride. This surface treatment is helpful for medicine applications requiring blood compatibility for periods as long as four days [29, 154-156].

4. Conclusion

Biotechnology is one in the entire favored and most vital fields escort an inventory of helpful applications. The most effective factor concerning this huge field is employed within the medicines. The realm of genetic engineering and biotechnology introduces varied techniques. DNA molecules and genes to make an adequate diagnosis of diseases are used few techniques which are reported by the polymerase chain reaction similarly as gene therapy, recombinant DNA technology. Due to the rising analysis field, biotechnology comes with the upper potential for locating completely different kinds of biological issues. One in all the biotechnology applications that get a lot of fame is endocrine discovery. Excluding that, biotechnology together provides advanced medical devices and instrumentation for every preventive and diagnostic perform. In medical sector biotechnology has recombinant DNA technology that driven expectations for medication, therapeutic proteins, and varied biological organisms. It includes engineering yeasts, bacteria, animal cell and together modified human cells. The modified cells unit of measurement accustomed treats multiple genetic diseases. Each cell materials and living cells to supply each diagnostic and pharmaceutical merchandise area unit employed in biotechnology in drugs. It offers a lot of applications to drugs and it's the foremost exciting factor concerning biotechnology. Information of the genetic makeup of our species, the genetic basis of hereditary diseases, and the invention of technology to manage and fix mutant genes provides methods to treat the illness.

Recommendation

Biomedical engineering pinpoints a problem within a patient and fixes the problem through medical intervention and tries to improve patient’s heath. Other medicine rather than biomedicine only focus on curing diseases. From these studies, it'll be possible to apply biotechnological knowledge in the field of biomedicine for the betterment of human being and further identify new biotechnological principal for biomedical sector.

Compliance with ethical standards

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Disclosure of conflict of interest

No, we have no conflict.

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