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Review Article

Bionics and the Total Artificial Heart and Other Organs and Structures

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Abstract

From prehistoric people's subconscious bionic actions to significant bionic designs in modern engineering, bionic consciousness, ideas, and practice have paved the way for the advancement of humanity, the growth of society, and the invention of science and technology. The term "bionics" describes the fusion of technological innovations created by humans with natural structures and functioning systems. Following the trauma or disease, bionics devices stimulate the nerves or muscles to give therapeutic intervention, sensory feedback, or motor function; they may also record the electrical activity from the nerves or muscles to identify disease states; they can enable the voluntary control of devices like prosthetic limbs; or they can provide closed-loop feedback to modify neural prostheses. The kind of prosthetic limb a person can use depends on various factors, including the person, the reason for the amputation or loss of the limb, and the location of the missing limb. Novel bio-inspired therapies have emerged recently that work by rearranging the bodily parts already present in a person to improve physiology. Instead of substituting biological tissue in this case, engineering concepts are used to reorganize and manipulate the natural tissue and organs to replace or enhance physiological activities (auto-bionics). This research aims to investigate the history, summarize, and simplify the understanding of the application of bionics in medical treatment.

Keywords: *Auto-Bionics; Bionic Consciousness; Closed-Loop Feedback; Prosthetic Limbs; Sensory Feedback; Targeted Muscle Reinnervation*

Abbreviations

AMD: Age-Related Macular Degeneration; BIE: Biologically Inspired Engineering; CAAHEP: Commission on Accreditation of Allied Health Education Programs; CNT: Carbon Nanotubes; CoA: Committee on Accreditation; EMG: Electromyogram; FES: Functional Electrical Stimulation; IMI: Intelligent Medical Implants; NCOPE: National Commission on Orthotic and Prosthetic Education; TAH: Total Artificial Heart; TMR: Targeted Muscle Reinnervation

Introduction

One of humankind's oldest contributions has been the creation of instruments for treating illness and injuries [1]. Humans have extensively imitated nature in several cases as they slowly advanced toward a technologically advanced culture. A mechanical device that was not present in nature in its purest form was created by humans about 6,000 years ago. Hertel attributed the development of the wheel to an abrupt turn in human technological progress, which took a very different path from that point forward than that of nature. Since then, non-wheel-based natural processes have been overlooked as models for constructing mechanical devices. This historical development explains why innovators who base their products on biological organisms have been so rare. Descartes described the mechanical sculptures he saw in the caverns in "Jardins de nos Rois," John Yolton presented a highly vivid rendition of his depiction. These hydraulic automata could speak, move, and even play musical instruments [2].

Throughout his evolutionary history, man has successfully claimed the land and the oceans. Nonetheless, he had to admit for a long time that he could not conquer the air. Millions of hardworking, landlocked, and tired humans must have wished to fly like birds. As a result, it is not surprising that the first deep scientific attempts to copy nature were studies involving the creation of flying machines [2].

The utilization of artificial limbs dates back to 600 BC. Wooden legs, metal arms, and hooks for hands-while these rudimentary substitutes restored some semblance of mobility or function to the user. They could have been more comfortable, easier to use, inadequately functional, and unsightly [3].

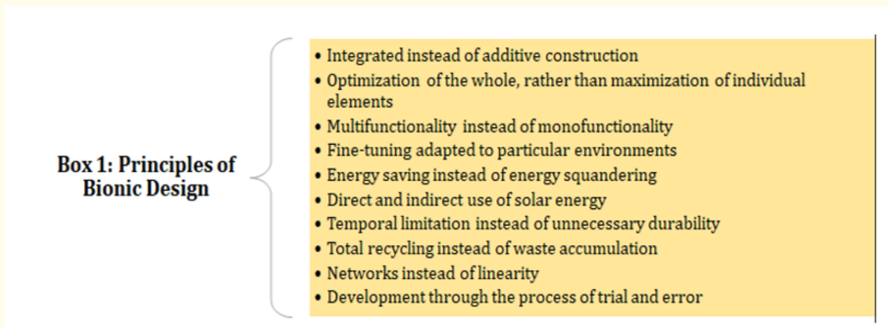
According to Galileo Galilee, people should focus on nature's quantifiable, measurable aspects and ignore the qualitative aspects. According to Francis Bacon, humanity is the "master of nature”. René Descartes introduced the dualistic, mutually incompatible categories that conceptually separate humankind from nature, subject from object, and mind from body. He also developed the mechanical clockwork metaphor. Together, they laid the groundwork for a detached, objectivist, reductionistic science [4].

As the decades passed, basic sciences and particular engineering sciences advanced to a high degree. On the other hand, the combination of biology and engineering has a very recent history. Bionics, also known as biologically inspired engineering (BIE), originally arose over 100 years ago (1907) when the first organic substance, bakelite, was made (consisting of wood, phenol, and formaldehyde). BIE grew tremendously in the twentieth century. For instance, it is in the name of the Harvard University Wyss Institute for Biologically Inspired Engineering (Cambridge, Massachusetts, USA) [5].

Otto Schmitt invented the term "biomimetics" in 1957 while developing a physical device that mimicked the electrical impulses of a neuron [6]. Whereas the term "bionics," used today, was coined by Maj. (later Col.) Jack E. Steele of the United States Air Force's Aerospace Division. Steele claims to have created the phrase in August 1958 to advance bionics as a brand-new science. The Wright-Patterson Center of the United States Air Force hosted the official launch of the research initiative, which would take the term "bionics", in the spring of 1959. At the Twelfth Annual Aeronautical Electronics Conference, which took place in May 1960, bionics were the focus of one of the meeting's sessions, which was presided over by Dr. John E. Keto of the US Air Force.

Major Steele's report was one of four on bionics that was read. They were released in Waveguide, the Dayton Section of the Institute of Radio Engineers, in August 1960. However, a convention in Dayton, Ohio, attended by 700 engineers, physicists, mathematicians, psychologists, psychiatrists, biologists, and biophysicists, served as the formal introduction of the new discipline. About 30 speakers discussed bionics; a 500-page book records the event [2].

Bionics has grown in importance as a support subject for engineers and technologists since the 1970s, thanks mainly to the pioneering work of German zoologist Werner Nachtigall. Nachtigall defines bionics as "using natural inspiration as a source of autonomous technological design". Nachtigall developed a set of bionic design principles presented in box 1 [4].



Box 1: *Principles of bionic design*

In a study titled "Microelectronic devices for surgical implantation" that was published in 1973, Donaldson and Davis described several neuroprostheses that were currently in use and being researched, including dorsal column stimulators, electromyogram (EMG) telemeters, visual prostheses, and pacemakers for the heart (fixed-rate, atrial-triggered, and demand). The discipline of bionics was still in its infancy at the time, the concept of medically implanting an electronic device was novel, and only some people had worked on the technical challenges involved. Only pacemakers were commercial items then, and there were no restrictions. After 40 years, there are many more different sorts of devices, both in clinical usage and being developed [7]. Figure 1 depicts a historical timeline of bionics [8-12].

Discussion

Biomimicry

Innovation that is influenced by nature is known as "biomimicry". It is defined as understanding the underlying principles of biological processes and then applying these insights to producing bio-inspired devices [4]. Numerous fields, including mathematics, engineering, material science, health, architecture, and even the arts, have substantially used biomimicry, including swarm intelligence models and genetic algorithms [6].

Bionics

Bionics, defined by its originator in its present form, is "the science of systems whose foundation is based on using systems, or which have characteristics of living systems, or which resemble these". Other definitions include "the study of living and life-like systems, to discover novel principles, techniques, and processes to be applied to man-made technology" and "the art of applying the knowledge of the functions of living systems to addressing technological issues," making it a biological-engineering science.

Bionics, by definition, is a multidisciplinary field that combines biological sciences and engineering sciences. Biophysics, biomechanics, cybernetics and biocybernetics, biotechnics or bionics, bioengineering, biomedical engineering, and information theory are transdis-

1945	•Willen J. Koff creates the first renal dialysis machine.
1950	•Alan Turing invented the Turing Test. The exam is a procedure in which a "judge" participates in "dialogue" with a computer and a real human. If the judge cannot distinguish which party is the computer, the computer passes the test.
1958	•The word "bionics" was coined by Jack Steele, and the first artificial pacemaker was fully installed into a human patient at Karolinska University Hospital in Sweden.
1961	•MIT is developing a computer-controlled mechanical hand.
1962	•John Charnley invents high-density polythene, which is later utilized in prosthetic hip joints.
1971	•Bausch & Lomb creates the first soft contact lens in the world.
1978	•The first multi-channel cochlear implant is utilised, which allows the recipient to hear by emulating the function of the cochlea.
1987	•A deep-brain electrical stimulation device is implanted in a patient with advanced Parkinson's disease.
1996	•Scottish researchers announced the creation of the world's first cloned animal, a sheep dubbed Dolly.
1997	•World chess champion Garry Kasparov is beaten by a computerized chess machine called Deep Blue.
1997	•Alvaro Rios Poveda, a Colombian researcher, created an upper limb and hand prosthetic with sensory input.
1999	•Sony introduces AIBO, the first artificially intelligent pet. The pet can walk, see, comprehend, and respond to verbal commands.
2000	•A human eye is implanted with an artificial silicon retina. The artificial retina is constructed from silicon microchips containing hundreds of microscopic light-converting components.
2001	•Amputee Jesse Sullivan receives a fully robotic arm developed by the Rehabilitation Institute of Chicago. The arm features a nerve muscle graft that allows him to move the mechanical limb with his mind.
2002	•Bionic Eye Argus I was clinically tested on six individuals.
2002	•Kevin Warwick's CNS was implanted with an array of 100 electrodes as part of Project Cyborg. The signal was sent, and it prompted a prosthetic arm to replicate Warwick's hand movements. Warwick's nervous system was later linked to the internet.
2004	•Hugh Herr's Rheo Knee and Hugh Herr's Bionic Knee for walking and jogging.
2004	•Artificial hearts that are fully functioning have been produced.
2011 & 2013	•Argus ll, Bionic Eye, received the CE mark in Europe in 2011 and FDA approval was granted in early 2013 for humanitarian use in the USA.
2015	•Surgeons in Manchester have performed the first bionic eye implant in a patient with the most common cause of sight loss in the developed world
2020	•Darren Fuller, a war veteran, was the first to obtain a bionic arm through the public healthcare system.

Figure 1: *The timeline of bionics history [8-12]*

ciplinary topics [2]. Mechanical limb prostheses, artificial muscles and hearts, and retinal and cochlear implants are all examples of bionic therapy [13,14]. If a person can express cognitive control over essential motor functions and a device can pick up a sense that feeling, bionics may help them regain lost mobility [14]. Bionics includes both auto-bionics and exo-bionics (Figure 2) [1]**.**

Application of bionics

Traditional bionic uses in healthcare include artificial organs that may replace, duplicate, and even improve biological function compared to native organic equivalents, which are quite old. A new generation of bio-inspired therapies has recently emerged that will enhance physiology by rearranging, swapping out, and redesigning a person's existing biological parts (Figure 3). In this case, the technology uses engineering concepts to rearrange and manipulate natural tissue and organs to replace or enhance physiological functions rather than replace biological tissue [1].

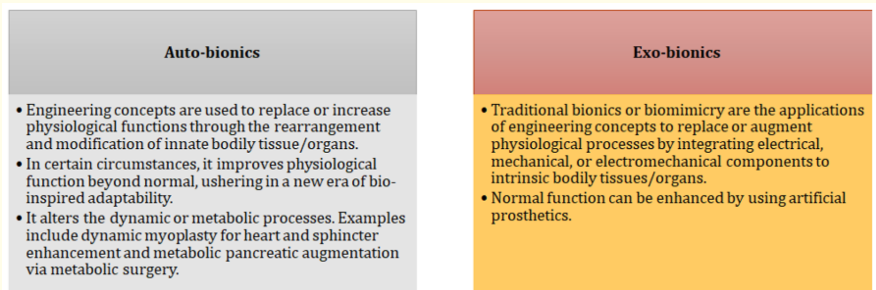


Figure 2: *Auto-bionics and exo-bionics [1]*

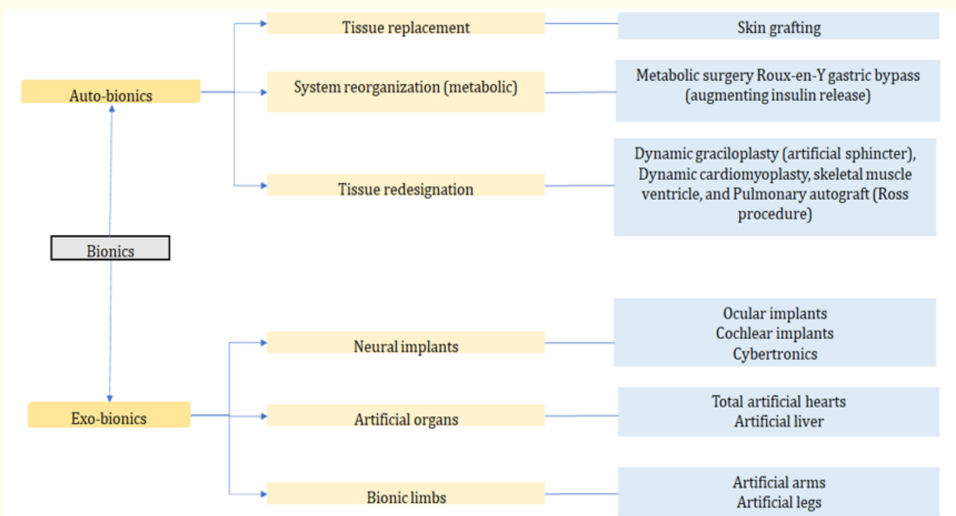


Figure 3: *Traditional applications of bionics in healthcare [1]*

Auto-bionics

The use of auto-bionic therapies is still in its early stages, and medical science has only recently recognized the benefits of such a notion. Static applications include skin grafting, artery and vein grafts for coronary surgeries, and using muscle flaps in reconstructive surgery. However, specific auto-bionic treatments are active and cause dynamic or metabolic alterations. Examples include enhancing the heart and sphincters through dynamic myoplasty and the metabolic pancreas through metabolic surgery. Some auto-bionic therapies can result in an organ operating supra-physiologically, similar to exo-bionics, where a prosthesis can hyper-amplify normal function.

Examples include the Ross surgery, dynamic cranioplasty, Roux-en-Y gastric bypass, metabolic gastric bypass, and skeletal muscle ventricle (Figure 4). In some circumstances, auto-bionics, a new age in bio-inspired flexibility, can improve physiological performance beyond normal [1]. Further reconstructive input can take advantage of nerve and tendon grafting/transfers, free tissue transfer, and complex bone reconstruction [15].

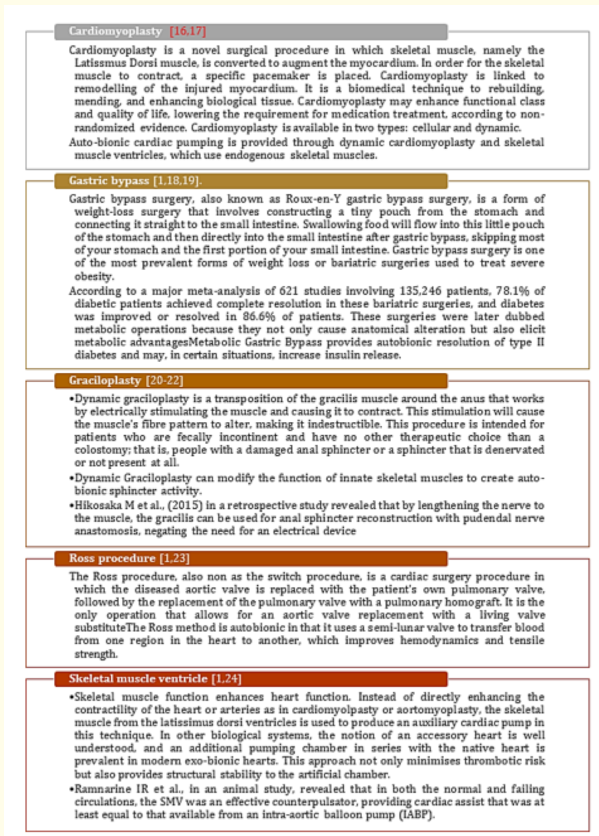


Figure 4: *Application of auto-bionic treatments [1,16-24]*

Bionic limb prosthesis

In recent decades, there have been encouraging improvements in creating bionic limb solutions that might potentially address some residual health and fitting difficulties, individually or totally. Some technological advancements provide improved prosthetic attachment using osseointegrated implants that can either expand the residual limb and improve socket fit or protrude the skin to enable the fitting of bone-anchored prostheses. Other advancements, such as targeted muscle reinnervation (TMR), regenerative peripheral nerve interfaces, agonist-antagonist myoneural interfaces, and sensory feedback, aim to minimize discomfort and increase control of prosthetic limbs [25].

Electronic impulses from muscles or nerves above the level of amputation often control a bionic limb. The prosthetic device sensors are connected to the residual nerves or muscles above the amputation site to complete bidirectional control via feeling restoration. As a result, these gadgets provide intuitive control and a natural flow of experience from the artificial device to the user. Bionic hands were the first practical proof of concept [26-32].

Depending on the implant utilized, the kind of tissue interfaced, and the bionic limb, three primary categories may be made: direct muscle, direct nerve, and nerve-transferred muscle interfacing (TMR) (Figure 5) [25,32-38].

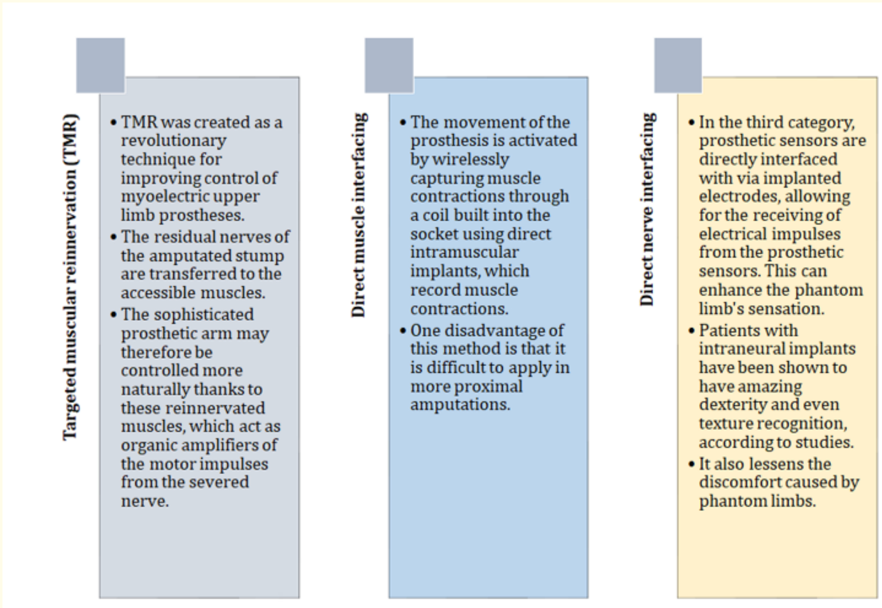


Figure 5: *Implants, nerve, and muscles transferring [25,32-38]*

Artificial muscle

Devices with artificial muscles driven by soft robotics can simulate the contraction and twisting of complicated biological systems like the heart. These artificial muscles may endure complex deformations, assisting heart function while remaining light in weight and small in size [39]. Artificial muscles are comprised of actuators and other parts that imitate the operation of a genuine muscle to move like an actual muscle. Replicating its expansion, contraction, and rotation, as well as, when employed in conjunction with one another, bending, are examples of such actions [40-43].

The most current research on artificial muscle components demonstrates that these muscles can range from actuators that control the muscles themselves being repeated to wires and carbon nanotubes (CNTs) becoming more easily produced, allowing for additional contributions to the field of artificial muscles. When a voltage is applied between a muscle fiber and a counter-electrode, ions travel to and from the surrounding electrolyte and the muscle, which causes the electrochemically powered CNT muscles to contract [44].

Artificial hearts

An artificial heart is a device that substitutes both ventricles and all four heart valves, thereby replacing the original heart. It is inserted into the body to replace the natural heart and wired to an outside power source through a driveline. It restores regular blood flow to the body's organs. Patients with advanced cardiac disease who cannot receive a heart transplant may be candidates for a total artificial heart (TAH). Drs. T. Akutsu and W. J. Kolff were the first to create a TAH in 1958.

They spoke about a pneumatically propelled polyvinyl chloride heart with two collapsible sacs inside a single air chamber made of plastic. Pneumatic ventricles have been the most effective in animal longevity due to their straightforward design and capability to regulate the heart from an outside-situated energy and control module [45]. Over 1,700 patients have successfully transitioned to heart transplantation using a TAH as a temporary life-saving therapy [46].

Retinal implants

The retina gradually deteriorates in individuals with age-related macular degeneration (AMD) or genetic retinal degeneration, such as retinitis pigmentosa, sometimes resulting in complete blindness in adults; nevertheless, the visual pathway beyond the retina is frequently intact and mostly functioning. A retinal implant would be adequate to reinstate functional levels of vision in these circumstances.

Argus II, Boston Retinal Implant Project, Epi-Ret 3, Intelligent Medical Implants (IMI), and Alpha-IMS are a few examples of retinal implants [47]. The ability of retinal implants to adapt to visual experience by using the remaining cells of the visual pathway is a significant benefit. However, as the success of this operation depends heavily on the survival of the inner retinal neural networks, damaged or missing inner retinal systems (such as glaucoma and optic neuropathy) would limit its efficacy and require alternative procedures [48].

Professor Kwabena Boahen of Ghana worked at the University of Pennsylvania's Department of Bioengineering. During his eight years at Penn, he created a silicon retina that could analyze pictures similarly to a live retina. He corroborated the findings by comparing the electrical signals produced by his silicon retina to those produced by a salamander eye while both retinas saw the same image [49].

Cochlear implants

A profoundly deaf or extremely hard-of-hearing individual may benefit from a cochlear implant. The implant comprises two parts: one behind the ear and one surgically inserted beneath the skin. Bypassing damaged ear tissue, cochlear implants stimulate the auditory nerve directly. The auditory nerve carries impulses the implant produces to the brain, interpreting them as sound [50]. The number of people who have gotten a cochlear implant far outnumbers those who have received other neural prostheses, making it the most successful prosthesis in restoring function. [51].

Challenges with bionic use

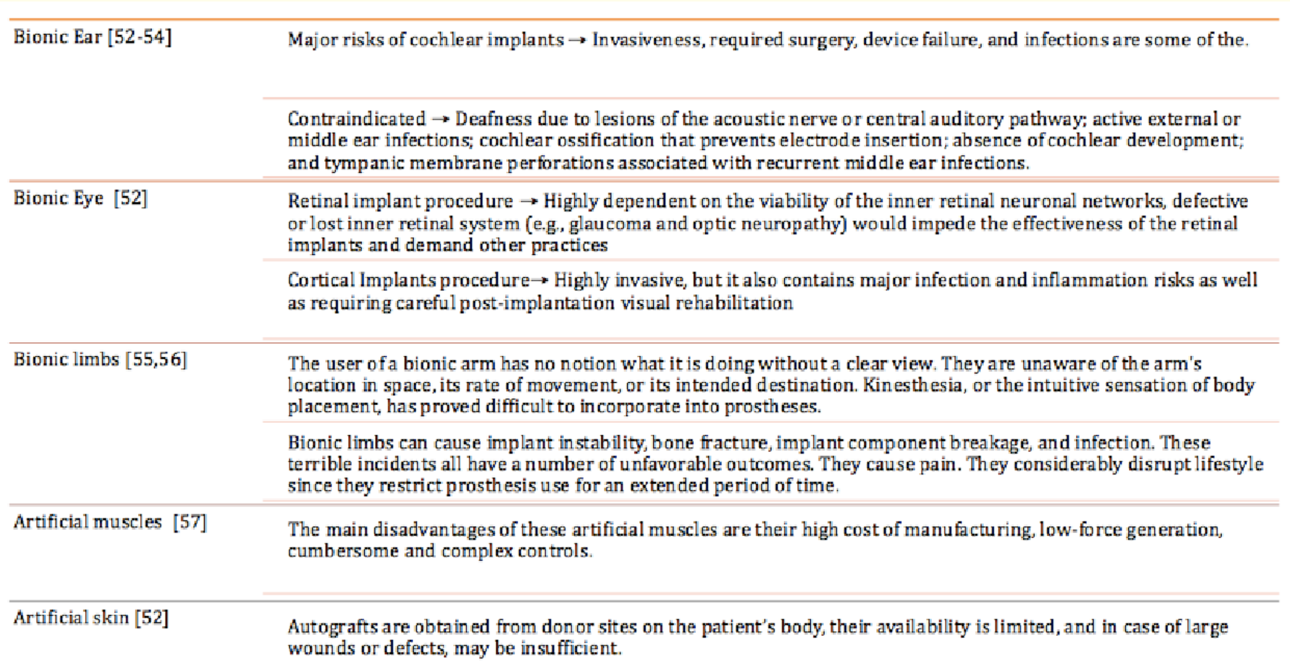
The limitations and contraindications for bionic use are shown in Figure 6.

Physician training in bionics application

Orthotists and prosthetists design and fabricate supportive medical devices and measure and fit patients for them. All orthotists and prosthetists must complete a master’s degree in orthotics and prosthetics. These programs include courses in upper and lower extremity orthotics and prosthetics, spinal orthotics, pediatric orthotics, functional electrical stimulation (FES) technology, and plastics and other materials used for fabrication. Also, orthotics and prosthetics programs have a clinical component in which the student works under the direction of an orthotist or prosthetist.

The rigorous training enables the orthotist or prosthetist to care for patients of all ages with orthopedic, neurologic, and integument conditions affecting the limbs, head, and trunk [58].

The American Board for Certification in Orthotics, Prosthetics and Pedorthics offers certification for orthotists and prosthetists. To earn certification, a candidate must complete a Commission on Accreditation of Allied Health Education Programs (CAAHEP)-an accredited master’s program, and the National Commission on Orthotic and Prosthetic Education (NCOPE)-an accredited residency program, and pass a series of three exams.



Bionic Ear [52-54]	Major risks of cochlear implants → Invasiveness, required surgery, device failure, and infections are some of the.
	Contraindicated → Deafness due to lesions of the acoustic nerve or central auditory pathway; active external or middle ear infections; cochlear ossification that prevents electrode insertion; absence of cochlear development; and tympanic membrane perforations associated with recurrent middle ear infections.
Bionic Eye [52]	Retinal implant procedure → Highly dependent on the viability of the inner retinal neuronal networks, defective or lost inner retinal system (e.g., glaucoma and optic neuropathy) would impede the effectiveness of the retinal implants and demand other practices
	Cortical Implants procedure→ Highly invasive, but it also contains major infection and inflammation risks as well as requiring careful post-implantation visual rehabilitation
Bionic limbs [55,56]	The user of a bionic arm has no notion what it is doing without a clear view. They are unaware of the arm's location in space, its rate of movement, or its intended destination. Kinesthesia, or the intuitive sensation of body placement, has proved difficult to incorporate into prostheses.
	Bionic limbs can cause implant instability, bone fracture, implant component breakage, and infection. These terrible incidents all have a number of unfavorable outcomes. They cause pain. They considerably disrupt lifestyle since they restrict prosthesis use for an extended period of time.
Artificial muscles [57]	The main disadvantages of these artificial muscles are their high cost of manufacturing, low-force generation, cumbersome and complex controls.
Artificial skin [52]	Autografts are obtained from donor sites on the patient's body, their availability is limited, and in case of large wounds or defects, may be insufficient.

Figure 6: *Limitations and contraindications for bionic use [52-57]*

NCOPE is a sponsor Committee on Accreditation (CoA) in the CAAHEP system. A CAAHEP-accredited O&P education is required to pursue national-level certification and obtain a state practice license [59,60].

Factors influencing research in and development of bionics

Finding prosthetic fittings that allow for prolonged, high levels of everyday activity is challenging. Additionally, prosthetic limbs are unsightly visually, inconvenient to wear, challenging to operate, and need a person's physical force to move. Indeed, acute and chronic skin conditions, edema, neuromas, muscular contractures, and fractures may affect the residuum's skin, nerves, muscles, and bones. This effect makes it challenging to handle everyday prosthesis loading. It is also difficult to fit sockets around odd-shaped stumps. Patients in hotter climates are particularly vulnerable because sweating from humidity and heat makes wearing sockets difficult. In 25 - 57% of instances, problems with prosthetic fit result in recurrent and, all too frequently, irreversible prosthesis abandonment [55].

Moreover, the ability of prostheses to provide patients with feelings is still a concern that has to be resolved. Hand-related sensations, including touch, pain, pressure, and temperature sensing, are crucial because they allow people to learn about their surroundings [32]. Bionic limbs can connect the organic residuum to an electrical device, enabling motor control and sensory feedback.

Due to the rise in the prevalence of critical organ failure, growing success rates, and quick improvements in post-transplant outcomes, organ transplantation has seen a sharp increase in demand worldwide over the past ten years. But there are severe organ scarcity problems since there aren't enough organs for transplant to match the current demand. Due to this, there has been a significant rise in the number of people on transplant waiting lists and the number of people passing away while on the waiting list [61].

These increasing incidences of organ failure, along with a scarcity of organs and tissues for transplant [62], the ongoing problems of immunosuppression, and the ongoing improvements required for traditional exo-bionic operations, will result in further requirements, adoption, and development of bionic concepts, necessitating the expanded story of bionic therapies [63,64].

Bionics comparison to the original structure

Although bionic prosthetics (nonbiological systems) can help replace a missing body part that may have been lost due to trauma, disease, or a congenital defect, in some cases, they function better than the original limb [3]. Still, they are different from the original biological systems. Various disparities and structural gaps exist between the biological and nonbiological systems (Figure 7). Reaching seamless integration is still a significant challenge in designing bionic systems and devices [52].

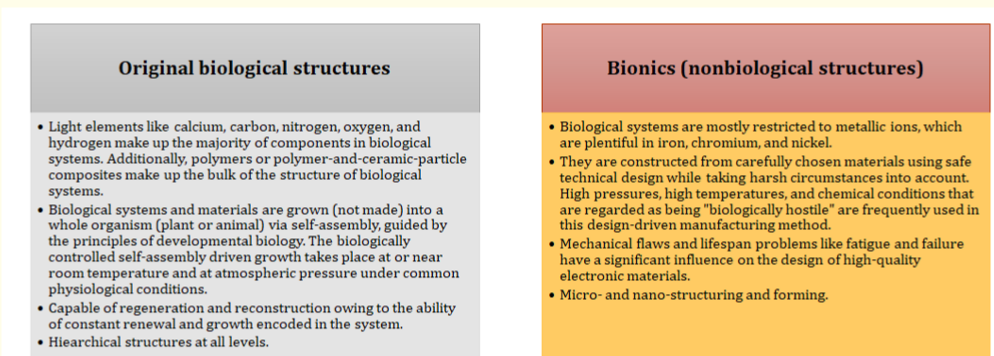


Figure 7: *Comparison between original biological structures and bionics (nonbiological structures) [52]*

Market scenario and bionic procedures information

According to research, the market for bionic prosthetics was valued at USD 790.8 million in 2016 and is projected to increase at a CAGR of 9.2% from 2016 to 2027. According to a survey released by the International Osteoporosis Foundation in 2017, one in three women and one in five men over 50 are expected to experience fragility fractures for the remainder of their lives. One of the main reasons projected to drive the market over the coming years is the increased frequency of accidents, diabetes, vascular diseases, malignancies, and congenital abnormalities, which has increased amputees [65].

The most significant limitation of bionic prostheses is their high cost. The expense of bionic prostheses is a deterrent from the patient's point of view, especially for maintenance, repair, and replacement, and restrictions increase component complexity to carry out more varied duties. Care for bionic prosthetic devices is expensive over the long term [65]. Even if some people can afford bionic technology, they may not need it as severely as others, considering the cost of the bionic prosthesis, the procedures necessary for the amputee to correctly fit the prosthesis, and the placement of the brain chip.

The amputee's brain is connected to a brain chip, enabling interaction between the amputee and the prosthetic limb. The placement of the brain chip can potentially cause tissue damage and scarring, prompting the brain to reject the chip to protect the amputee [66]. Each bionic operation costs between $5,000 to $300,000, including taxes, travel expenses to treatment facilities, and other expenses.

A functional bionic prosthetic arm typically costs between $20,000 and $100,000 [67]. An entry-level electronic bionic limb can cost between $8,000 and $10,000, while a more advanced one can cost between $50,000 and $70,000 or more [68].

Cochlear implants typically cost between $30,000 and $50,000, excluding insurance [69]. Additionally expensive, a bionic eye is projected to cost about $150,000 before surgery and aftercare training [70]-costs for an artificial heart range from $100,000 to $300,000 per unit [71].

Future perspectives and research regarding bionics

The field of bionics has the potential to revolutionize the healthcare industry [72]. Using bionics to restore the lost functionality of whole organs has sparked significant research interest and excitement. This enthusiasm is not surprising, given the potential benefits to society that such achievements may bring [73]. Sensory prosthetics, cochlear implants, and artificial vision have all been significant milestones for linking any mechanical body component to the brain. Using auto-bionics in reconstructive procedures and managing diabetes, cancer, heart disease, and obesity will also become more prevalent, including artificial spines or bones, as technology develops [1].

The way operations are carried out might change significantly because of all the technological breakthroughs it offers. While significant obstacles are being overcome as newer models are created and the learning curve flattens, it is still a pipe dream to expect bionics to replace conventional medicine or surgery. The surgical profession is trained to work with "natural" tissues, so switching to artificial ones won't be simple. However, software and hardware continue to advance and enter the biomechanical realm. In that case, it will dramatically influence the idea of natural *vs.* artificial and might reshape how researchers and physicians now approach disease and operations [72].

The upcoming 10 years might be interesting for the bionics industry. Engineers are starting to create a manufacturing toolkit that is sophisticated enough to capture the conspicuous aspects of plants and animals, just as biologists are learning about the structural and physiological principles that underpin the functional qualities of living things. Engineers may feel inspired to seek out and use natural design ideas when the performance gap between biological structures and their mechanical analogs closes. Despite the first alien appearance of the machines they create, a strange resemblance may be found in their biological roots [72].

There could be a paradigm shift toward brain prosthetics and neurobionics, in which existing bionic capabilities will be merged with and controlled by the neurological system. Advances in intracortical microelectrode arrays, which allow unprecedented and selective access to the neurons of the central nervous system, the use of engineered materials such as conductive polymers and composites in neural interfaces, and better models to process and decode brain signals all promise significant improvements in the next generation of bionic devices [74-76]. Before that, various issues must be addressed, including (i) long-term electrode dependability, (ii) severe brain tissue injury after electrode implantation, (iii) meningeal reactions, and (iv) electrode and insulation material degradation [77].

Despite the hurdles, it is plausible to imagine future bionics capable of repairing lost and injured organs by bioprinting a replacement organ in minutes using the patient's cells obtained from induced pluripotent stem cells or by direct differentiation in a couple of weeks. Additionally, there are countless possibilities for augmentation. A bionic eye with super-resolution, visible and infrared capabilities and the capacity to link to the cloud to collect and remember endless quantities of data would be an example. Via advances in neural prosthetics, that eye would be seamlessly merged with the neurological system to the point where it could be regarded as an extension of the body. It would be controlled not through the mediation of our bodies, as our present gadgets and equipment are, but in the same way, human limbs, legs, and eyes are controlled by the brain and thoughts. These gadgets are becoming more commonplace in reality every day, moving away from fantasy [52].

The popularity of robotic exoskeletons, used in industrial settings to improve physical capabilities, shows that a human-machine hybrid future is on the way [78].

Conclusion

The field of bionics, which seeks to improve the human body by utilizing biological design principles in tissue redesignation (using one tissue instead of another), tissue reconstruction, and system reorganization (rearranging intrinsic organ/tissue structure), is growing. Only a few examples are dynamic graciloplasty, the Ross method, dynamic cardiomyoplasty, skeletal muscle ventricles, and Roux-en-Y gastric bypass. In addition to reducing the need for organ donation, these techniques may also result in innovative treatments and physiological improvements that can successfully compete with current exo-bionic therapies (such as prostheses). Innovative bionic solutions have several positive qualities to offer, but certain drawbacks still need to be resolved before such devices are widely used. The main limitation is a need for more extensive study into how electrodes behave in muscles and nerves, which must be done while considering their functioning and safety.

Conflict of Interest Statement

The authors declare that this paper was written without any commercial or financial relationship that could be construed as a potential conflict of interest.

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