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# Advancing Innovation through Biomimicry and AI: Inspiration to Implementation

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The integration of biomimicry principles with artificial intelligence (AI) presents a compelling approach to addressing complex challenges across various domains. This article explores the synergy between biomimicry and AI, elucidating how the emulation of natural processes and structures can inspire innovative solutions. Beginning with an overview of biomimicry's historical roots and notable achievements, the narrative progresses to highlight AI's role in accelerating biomimetic research and innovation. Various applications of biomimicry, ranging from material development to biotech and climate change mitigation, are discussed, showcasing the breadth of possibilities offered by this interdisciplinary approach. Challenges and ethical considerations inherent in combining biomimicry and AI were also examined, emphasizing the need for

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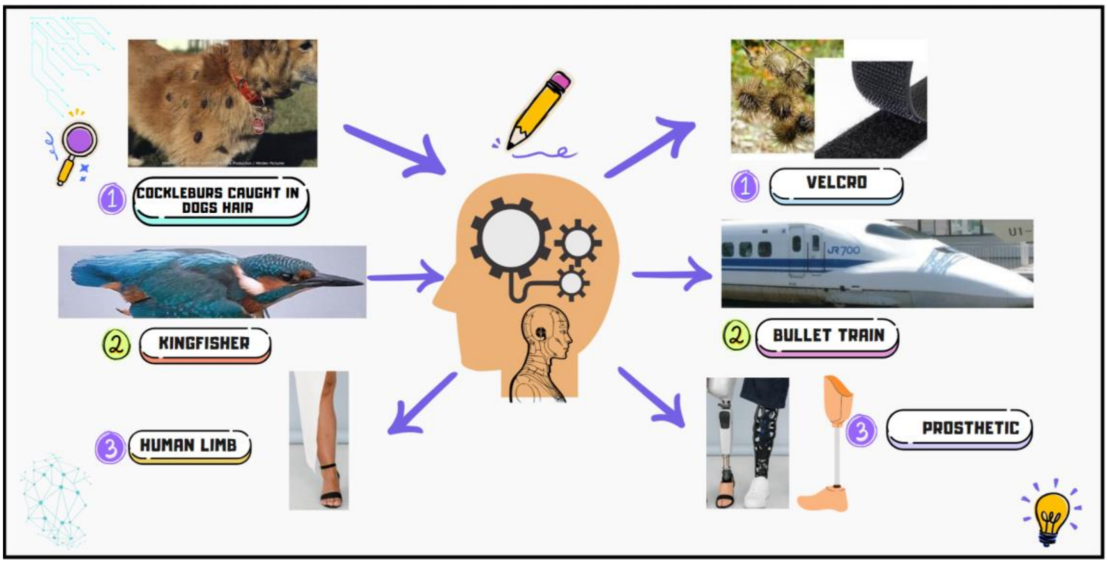
multidisciplinary collaboration and ethical awareness. Looking ahead, future directions in research are outlined, including the development of AI algorithms that integrate knowledge from diverse biological sources and the incorporation of moral considerations into biomimetic design processes. Ultimately, the article concludes by suggesting that the convergence of biomimicry and AI holds promise for fostering sustainable, efficient, and ethically informed technological advancements, facilitating a harmonious relationship between humanity and the natural world.

**GRAPHICAL ABSTRACT:**




*Keywords: Biomimicry; AI; nature-inspired design; biotech.*

## 1. INTRODUCTION

Biomimicry, bionics, biomimetics, biomorphism, and "organic design" all allude to imitating nature in some way. A promising new branch of study called "biomimicry" is characterized by its ability to solve design issues by drawing inspiration from natural elements, systems, and models. Perhaps the earliest examples of a biomimetic device is the scarecrow, which was created by humans who observed their own body forms and attempted to mimic them in order to frighten birds away from their fields [1,2,3]. Examining the anatomy of birds in order to design an aerial vehicle is another instance of early biomimetics. Well-known scientists, like Leonardo da Vinci, examined the composition of bird wings and attempted to replicate such characteristics. The graphic below displays a sample of a piece of Leonardo da Vinci's drawings. The similarity of the device to a bird's wing is clearly seen [4,5,6,7].

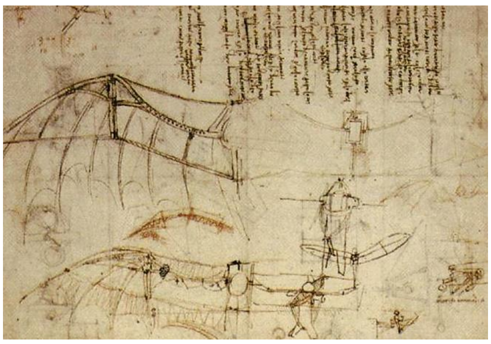


**Fig. 1. Leonardo Da Vinci's design for a glider [9]**

Biological mimicry offers a compassionate, interconnected comprehension of life's workings and, eventually, our role within it. It's a strategy that mimics and takes inspiration from strategies used by living animals. After billions of years of research and development, failures are fossils; what's left is the key to our survival. In order to solve our most important design challenges in a sustainable fashion that takes into account the needs of all living creatures on Earth, new ways of living—products, systems, and processes—are being developed [8].

The Greek words "bios," which means "life," and "mimesis," which means imitation, were combined to create the term, which was first used by Janine M. Benyus in 1997. Biologically influenced design is sometimes referred to by names like "biomimetics," "bio-inspired," and "biologically inspired"[10].

With sustainable and effective methods, nature has developed technologies that are better than those developed y mankind in 3.8 billion years [4].

Some of Notable achievements inspired by Nature:

**1) Velcro (Inspired by Burrs and Dog Hair):** The wonderful discovery of velcro was inspired by the natural world, especially by dog hair's tendency to attach to different surfaces and burrs. George de Mestral, a Swiss engineer, created it in the 1940s. He was inspired by this natural occurrence to construct two fabric strips that could be pushed together to establish a tight bond: one with small hooks and the other with loops. Combining the French terms "velours" (velvet) and "crochet" (hook), he called his creation "Velcro." [11,12]

**2) Bullet Train design (Inspired by Kingfishers):** The aerodynamic characteristics of the kingfisher bird served as inspiration for the bullet train's design, especially for the form of its snout. Eiji Nakatsu, a Japanese engineer, created this creative design idea in the 1990s.The bird glided silently into the water because to its bullet-shaped, streamlined beak. Nakatsu designed the bullet train's nose to resemble the form of a kingfisher, taking inspiration from its beak. The end product was a long, pointed nose with a smooth curve, which greatly enhanced the aerodynamics of the train. In addition to lessening noise and air pressure disruptions when the train emerged from tunnels, the revised nose shape increased energy efficiency by lowering drag [13,14]. As a result, the bullet train improved overall passenger experience and became one of the world's most sophisticated high-speed rail systems. It also became quieter, quicker, and more fuel-efficient. This biomimicry example shows how design concepts inspired by nature may result in creative solutions that solve practical problems and benefit society and the environment [15,16].

**3) Prosthetic (Inspired by Human Limbs):** Prosthetic technology has advanced dramatically, frequently taking cues from the complex structure and operation of human limbs. Through a thorough analysis of the biomechanics of naturally occurring joints, muscles, and bones, engineers and designers have developed prosthetic limbs that nearly resemble the functions and range of motion of their biological counterparts. Because of their strength, flexibility, and low weight, materials like silicone and carbon fiber are used to make prosthetic limbs that fit comfortably and allow for more natural movement. Furthermore, "smart" prostheses that can adjust to the user's motions and send input to the nervous system to improve control and functioning have been made possible by developments in robotics and sensor technology [17,18].

**4) Artificial Neural Networks in Deep Learning (In spired by Neurons):** The architecture and operation of biological neurons in the human brain serve as a major source of inspiration for Artificial Neural Networks (ANNs) used in deep learning. Artificial neurons, also known as perceptrons, function similarly to neurons in that they take in input signals, process them using a weighted network of connections, and then output a signal. Within the neural network, these artificial neurons are arranged into layers. Each layer does a particular computation before sending the results to the one above it. The idea of deep learning is based on the idea that the intricate interconnectivity of neurons in the neural networks of the brain is mirrored by numerous layers of linked neurons. Similar to how the brain uses synaptic plasticity to adapt and learn from experience, artificial neural networks (ANNs) may learn from data by training and modifying the weights of their connections. All things considered, ANNs' functionality and design are directly influenced by the biological makeup and physiology of neurons, which enables them to efficiently simulate and resolve a variety of challenging problems in artificial intelligence and machine learning [19,20].

**5) Echolocation/SONAR (Inspired by Bats):** The advanced echolocation skills of bats serve as a major source of inspiration for echolocation, commonly referred to as SONAR (Sound Navigation and Ranging). In order to travel and hunt prey in the dark, bats use high-frequency sound waves and listen for the echoes that bounce back from things in their environment. Similar to this, SONAR devices map subterranean or underwater environments, identify objects, and measure distances by sending out sound pulses into the air or water and then analyzing the echoes that return. SONAR technology mimics the biological process of echolocation and is used for a variety of purposes, such as fish discovery, underwater exploration, navigation, and monitoring. The effectiveness and precision of echolocation-based devices demonstrate how extraordinary nature's processes have evolved to solve complicated puzzles, offering priceless lessons for technology advancement.

**6) Shock Absorbers (Inspired by Woodpeckers):** The incredible tenacity of woodpeckers has served as an inspiration for shock absorbers, which are essential parts of equipment and automobiles. Woodpeckers do not suffer from pain or brain damage despite the immense stresses created by their fast pecking activity. Specialized anatomy, like as a distinct beak structure and a highly shock-absorbing cranium, enable this. These ideas have been applied by engineers researching woodpeckers to create shock absorbers that efficiently reduce and disperse impact forces. Shock absorbers can enhance safety, stability, and durability in a variety of applications by mitigating shocks through the use of materials and structures that are inspired by the anatomy of woodpeckers. These materials and structures include layered fibrous tissues and flexible cartilage-like structures. Engineering advancements are continually spurred by the study of nature's designs, which shows how bioinspired ideas may be applied to solve practical problems.

**7) Aeroplane design (Inspired by birds and insects):** The flying mechanics of insects and birds have long served as inspiration for aviation design. The curved form of bird wings and its capacity to change shape and angle mid-flight have impacted aviation wing design to maximize lift and efficiency. Similarly, aircraft designers have been influenced to construct streamlined and aerodynamic fuselages and wings by the lightweight bodies and effective wing structures of insects. Furthermore, research on the flying patterns of insects and birds has aided in the creation of flight control systems, which allow aircraft to navigate and stable in a variety of air currents. The design of airplanes keeps changing, pushing the frontiers of aviation technology with ever-more-efficient, safer, and quicker models that mimic nature's aerodynamic principles.

**8) Genetic Algorithms (Based on 'Survival of the Fittest'):** The idea of "survival of the fittest" in biological evolution serves as the inspiration for genetic algorithms, which are computer procedures. The process of natural selection, in which individuals with advantageous qualities have a higher chance of surviving and procreating and transferring those traits to subsequent generations, is modelled by these algorithms. In genetic algorithms, a population of potential solutions to an issue is subjected to selection, crossover, and mutation, among other repeated improvement methods. Solutions improve throughout time to more closely resemble optimum or nearly ideal solutions to the given situation. By utilizing the concepts of natural selection and adaptation, genetic algorithms provide a strong and flexible method for resolving complicated issues. They are extensively employed in optimization, search, and machine learning applications.

Other noteworthy inventions involving biomimicry include (but not limited to) swarm optimization algorithms, SONAR, Snake Robots, Gecko feet adhesives, etc [21].

**History of Biomimicry word:** The term "biomimetics" was initially coined in 1957 by bioengineer and physicist Otto Schmitt to describe his novel gadget that mimicked the electrical function of a neuron. Bionics, according to Jack Steele, is the study of natural systems. Under the strong influence of cybernetics, a branch of science that focuses on regulating systems like the human body, it was strengthened in the 1960s. Simultaneously, the German words "biologie" and "technik" were combined to create the new word "bionik," which refers to the transfer of biological concepts to technology. The word was used less frequently over the following thirty years. But with the help of Janine Benyus' book Biomimicry: Innovation Inspired by Nature, it had a major comeback in the late 1990s. In order to better comprehend the systems and processes of nature in action,

**Table 1. Ways AI supporting biomimicry and their supplementary data**

| SR. No. | Ways AI is supporting Biomimicry | Supplementary Data | References |
|---|---|---|---|
| 1. | **Design Inspiration:** AI systems are able to analyze enormous volumes of biological data as well as photos to find structures and patterns in the natural world that might serve as inspiration for creative creations. AI-driven simulations, for instance, may be used to build stronger and more robust materials by simulating the structural characteristics of natural materials like lotus leaves and spider silk. | An example of the approach is Daimler Chrysler's prototype of a bionic car. To create a large volume and small wheelbase car, the design for the car is based on a boxfish (ostracon Meleagris), an aerodynamic fish with a box-like body. The chassis and structure of the car are also biomimetic, which are designed using a computer modelling method based on how trees can grow in a way that minimizes stress concentrations. | [26,27] |
| 2. | **Sustainability:** AI-guided biomimicry is helping to develop sustainable solutions for a range of sectors. AI-driven biomimetic technology can help decrease waste, cut down on resource consumption, and lessen environmental impact by mimicking some of nature's most efficient processes, such photosynthesis and water filtering. | Maibritt Pedersen Zari presented how biomimicry approaches to architectural design can lead to greater sustainability and the development of a regenerative built environment. A framework is used as a design methodology for exploring various advantages and disadvantages through different forms of biomimicry. She also suggested various approaches as the design process and method based on the literature review and analysis of current biomimetic technologies. | [28,29] |
| 3. | **Optimization:** Through the simulation of natural processes and evolutionary algorithms, AI systems may optimize designs. This enables scientists to optimize biomimetic designs for optimal efficacy and efficiency. Among other things, optimization algorithms can be used to enhance prosthetic limb functioning, energy system efficiency, and vehicle aerodynamics. | A popular evolutionary algorithm is the genetic algorithm [13] that uses the principle of natural selection to evolve a set of solutions towards an optimum solution. Genetic algorithms (GA) are population-based algorithms and they can efficiently handle non-linear problems with discontinuities and many local minima. These are widely used in the field of building optimization. Wright and Farmani used GA for simultaneous optimization of the fabric construction, HVAC system size and the control strategy | [30,31] |
| 4. | **Material Science:** AI's contribution to the discovery and creation of biomimetic materials is transforming the field of materials science. Through the analysis of natural materials' molecular structure and characteristics, artificial intelligence algorithms can propose novel compositions and fabrication techniques for the production of synthetic materials with comparable qualities. This covers materials that can repair themselves, lightweight composites, and surfaces that can adapt. | Composite materials design, Design of self-assembling amphiphilic materials, Design of nanoplasmonic materials, Design of ion channels ,Design of disks prepared from fiber-reinforced, Polymer design, Phosphor optimization, Modeling of a granular plastomer conglomerate | [29,32,33,34] |
| 5. | **Robotics:** Robots with artificial intelligence (AI) are being developed to imitate the movement and behavior of insects, animals, and other living things. Through examining how animals move and engage with their surroundings, scientists can create more nimble and versatile robots for a range of uses, such as agriculture, exploration, and search and rescue. | Mechatronic and soft robotics are taking inspiration from the animal kingdom to create new high-performance robots. Here, they focused on marine biomimetic research and used innovative bibliographic statistics tools, to highlight established and emerging knowledge domains. | [35,15] |
| 6. | **Drug Discovery and Healthcare:** AI is assisting in the search for novel medications and therapeutic agents by analysing vast databases of genetic and molecular data and modelling biological processes. Artificial Intelligence (AI) algorithms have the ability to find possible medication candidates more rapidly and precisely than traditional approaches by imitating the behaviour of natural molecules and biological systems. | The field of regenerative medicine is constantly advancing and aims to repair, regenerate, or substitute impaired or unhealthy tissues and organs using cutting-edge approaches such as stem cell-based therapies, gene therapy, and tissue engineering. Nevertheless, incorporating artificial intelligence (AI) technologies has opened new doors for research in this field.<br>By using AI, researchers can gain insights into the drug target's function and potential effectiveness, saving time and resources. Additionally, it can predict the toxicity of | [36,37]<br>[38,39] |

| SR. No. | Ways AI is supporting Biomimicry | Supplementary Data | References |
|---|---|---|---|
| | | potential drug candidates by analyzing their chemical structures and properties. This can help to identify potential safety concerns early in the drug discovery process, reducing the risk of adverse events.<br>Deep learning is a subset of machine learning that uses artificial neural networks to learn from data. These neural networks are designed to mimic the structure and function of the human brain, allowing them to identify more complex patterns and make decisions based on the data they have been trained with. | |

Benyus is also one of the co-founders of the Biomimicry Institute, a platform and organization that brings together the many biomimicry profiles of engineers, biologists, and designers. The most popular description of biomimicry is provided by Janine Benyus in her book, which also explains the word's Greek roots, bios, which means "life," and mimesis, which means "to mimic." According to Bajaj, biomimicry nowadays include researching and simulating biological systems that have undergone environmental testing and have undergone modifications due to evolution [22,23].

**Biomimicry:** Philosophy & interdisciplinary design approaches taking nature as a model to meet the challenges of sustainable development.

**Biomimetics:** Interdisciplinary cooperation of biology & technology or other fields of innovation with the goal of solving practical problems through the function analysis of biological systems, their abstraction into models and the transfer into & application of these models to the solution.

**Bio-inspiration:** Creative approach based on the observation of biological system

**Bionics:** Technical discipline that seeks to replicate, increase, or replace biological functions by their electronic or mechanical equivalents.

**Bio-inspired design:** Discovery of fundamental biological principles and analogies that can be transferred to human engineering to make designs, possibly better than nature.

**Three basic principles of Biomimicry:** Janine Benyus has talked about the three fundamental ideas of biomimicry. The fundamental premise of biomimicry is "nature as model," since it explains the process of how things should arise (poiēsis). The ethical tenet of biomimicry is "nature as measure," which indicates that there are moral boundaries or expectations placed by Nature on our capabilities.

The epistemological tenet of biomimicry is "Nature as mentor," which maintains that Nature is the ultimate fount of knowledge, insight, and error-free living [24].

**Artificial Intelligence:** A subfield of computer science known as artificial intelligence studies how robots may imitate biological intelligence in humans, animals, or any other living thing. To a certain extent, biomimetic AI is necessary. For instance, people who have long-term medical conditions like kidney or breast cancer do not want to live their whole waking lives feeling hopeless. Theoretically, these systems might let patients to live according to their own terms by providing them with an interface that continually learns new demands. They could also anticipate and address emergencies that are detected by real-time (or "stream-processing") analysis of patient data [25].

The field of "biomimicry," which aims to address human problems by mimicking the structures and functions of nature, is being greatly advanced by artificial intelligence. Here are some ways AI is supporting:
All things considered, AI is quickening the speed of biomimetic research and innovation by offering strong instruments for analysing biological data, modelling natural processes, and creating solutions based on the principles of nature [40].

**Applications of biomimicry:**

Many researchers are taking inspirations from biomimicry in emerging fields. Currently, biomimicry is being used in the following fields.

1. **Materials:** One of the main uses of biomimicry is in material development. The creation of bioinspired materials involves creating intelligent materials, changing

their surfaces, creating new structural forms, and improving already-existing characteristics [41,42].

2. **Robotics:** The applications in robotics are inspired by animal's locomotion. Improvement in movement kinetics will be helpful in man-made moving vehicles operating in the air (micro-airplanes with wings), water (swimming robots), and on the ground (small hexapodal robots) [43].

**(a) Snake bot are unique reptiles:** They can bend and twist their bodies to fit into small spaces and cracks, wrap around branches, slither across rough terrain, and other situations since they don't have a stiff skeleton. Researchers developed the "snake bot" by studying the anatomy of snakes and analyzing contemporary issues in space exploration, medicine, and search and rescue. This bio-inspired robot moves its ventral scales to push itself in a straight line, mimicking the rectilinear propagation of snakes. Serpentine robots are able to burrow beneath the surface, scale trees, investigate areas that are inaccessible to people or dangerous for them, and even help with space research.

**(b) Bat-based echo locative Devices:** The terms "echo" and "location" refer to the process of locating physical objects in relation to the source of sound by utilizing the echo's velocity, timing, intensity, and distance. Many creatures, both aquatic and aerial, employ this capacity to sight and hear in order to find, locate, and catch prey in total darkness. When it comes to echolocation, bats are a shining example because of their very precise echoic cognitive-dynamic system, which enables them to flourish in nocturnality. Sugar Bats that feed themselves can even distinguish between flowers that are rich in nectar and those that are not.

**(c) Elephant's trunk-based robotic arm**: Elephants' long, extended trunks serve several different functions. About 40,000 muscles make up its trunk, which consists of the top lip and nose (M. Maxillo-labialis). It is incredibly powerful and nimble, and it can also carry out a variety of jobs including picking up tiny twigs and pushing large trees. Additionally, it has around 8 liters of water storage. The trunk is a very adaptable organ because of its tremendous flexibility. Many of the robots on the market today lack the flexibility that invertebrate creatures do. Even though research has been done on mimicking snakes to create robots, snakes are still classified as vertebrates. With more joints, its functioning can be nearly identical to that of invertebrates. The term "hyper-redundant" refers to these kinds of robots. These hyper-redundant manipulators, resembling elephants, have a segmented "backbone" structure with over 20 degrees of freedom. Actuation is facilitated by a network of tendons running through the structure, enabling the robot to change shape to adapt to its surroundings [44].

3. **Energy:** Several uses include energy management software that lowers energy usage during peak hours, turbine location motivated by a school of swimming fish, and drag-reducing patterns from sharks.
4. **Architecture:** The self-cooling termite mounds in Africa served as the model for several self-cooling structures, including Eastgate Center in Harare. Additionally, seasonal flooding is controllable.
5. **Transportation:** The most efficient pathways may be found by using bee-inspired algorithms trained using Kingfisher. Transportation research also includes studying traffic management and crash avoidance technologies.
6. **Agriculture:** The deployment of polyculture, or a mixture of plants, on agricultural land in an effort to increase soil health and integrity, using inspiration from prairie fields. The Namibian beetle served as an inspiration for gathering dew to use as water in dry areas.
7. **Sensors and communication:** Bioinspired sensors can be used for distributed sensing, embedded sensing, and distant sensing. Chemical signal communication can be employed underwater, in pipelines, and in tunnels. A technique for communicating underwater has also been modelled after dolphin communication [45].

8. **Biomimicry in computation:**

**i)** The human body's neural network serves as the inspiration for **ANNs,** or artificial neural networks. Interconnected neurons make up a neural network, which is based on the fundamental unit of a neuron. The linked neurons in the human body do parallel processing, making it one of the greatest instances of parallel processing [46].

**ii) DNA computing:** Math, biochemistry, and computer engineering are all combined in DNA computing. Encoding information as DNA strands is the aim of DNA computing. Another name for it is molecular computing. Bio-operations are essentially the simulation of different logical and arithmetic processes. To get the desired effects, it modifies DNA strands. An estimated 8,000 DNA strands may operate at a pace greater than the current state-of-the-art supercomputer by a factor of 104.

Four bases make up DNA: Guanine (G), Cytosine (C), Thymine (T), and Adenine (A)

9. **Biomimicry and AI for climate change mitigation:**

The current state of climate change is having a significant effect on environmental systems worldwide. Therefore, in order to reduce the effects of climate change and the suffering that results, mitigation, adaptation, and resilience are all essential. Together with the field of biomimetics, artificial intelligence has great potential to mitigate climate change. By using data input (such as weather, temperature, humidity, etc.) in comparison to its natural counterparts (plants, animals, insects, etc.), correlations can be created, solutions can be suggested based on the ability to receive large amounts of data continuously, biomimicry-based strategies and proposals can be generated that are accurate, appropriate, and suitable, and data-driven techniques can be used to enable decision making and translate relevant strategies and proposals to design principles [47].

We have a fantastic potential to make use of this capacity and modify our conventional procedure, especially during the project's early idea stages, in order to offer prompt and attractive options. While AI will replace jobs now performed by architects through iterative processes including quick engineering and other tweaking, it will not replace architects per se. AI has the ability to help with climate-focused AI solutions from a variety of industries and domains, as well as monitor and mitigate climate change. This would entail finding the opportunities and potentials associated with taking lessons and best practices from nature [48].

10. **Biomimicry in biotech:**

Within the biotech sector, biomimicry is examining natural biological processes and applying this understanding to create novel remedies for health issues affecting humans. A noteworthy instance of biomimicry in biotechnology is the creation of artificial spider silk. After decades of research, scientists have now been able to properly recreate the natural silk generated by spiders in the lab. Numerous possible uses for this synthetic spider silk exist, such as tissue engineering, medication delivery, and wound healing.

The creation of nanoscale drug delivery systems, which were influenced by the way viruses infect cells, is another instance of biomimicry in the biotech industry. Researchers have created artificial nanoparticles that can replicate the methods viruses employ to infiltrate and infect cells in order to deliver medications straight to sick cells.

The study of plant and animal immune systems is one way that biomimicry is being used in biotech. Immune systems are crucial for defending organisms against infections, and the strategies they employ to stave off illness might serve as models for novel therapeutic approaches for human ailments. For instance, the immune system of llamas, which generate a distinct kind of antibody that is smaller and more stable than human antibodies, has been the subject of investigation. The creation of nanobodies-tiny proteins that may be used to target cancer cells, stop viral infections, and cure autoimmune diseases-has been facilitated by this finding [49].

**Bio-inspired AI: When generative AI and biomimicry OVERLAP:** It's important to remember that biomimicry and generative AI are somewhat similar: Both disciplines use nature as an inspiration to create original solutions. They both rely on the collective genius of the lives that before them. Both are synthesizing fresh outputs and distilling insights. Three aspects of nature provide as inspiration for generative AI: unsupervised learning, neural networks, and evolution. When they combine, they create a potent force that can drive innovations inspired by nature in a variety of sectors by combining the computational prowess of AI with the creative brilliance of nature.

This is not to argue that every generative AI is biomimicry; in fact, there are few particular examples and genres that are biomimicry, even though many applications lack the Ethos and Reconnect of biomimicry [50].

**Challenges and ethical considerations:** Although it has great promise, combining biomimicry and AI has a number of drawbacks. These include the necessity for multidisciplinary cooperation between biologists, engineers, computer scientists, and ethicists; ethical implications of bio-inspired technology; and worries about intellectual property rights and biodiversity protection. It is imperative to tackle these obstacles in order to guarantee conscientious and fair innovation in this domain.

**Multidisciplinary cooperation:** Collaboration across disciplines: Integrating biomimicry with AI necessitates the cooperation of specialists in a number of disciplines, including biology, engineering, computer science, and ethics. Since every field has its own viewpoints, approaches, and goals, cooperation and efficient communication are crucial. The technological solutions for biomimetic designs are developed by engineers and computer scientists, while biologists offer insights into natural systems and biological principles. Ethicists add to the conversation by analyzing the moral and societal ramifications of bioinspired technology. It might be difficult to achieve effective multidisciplinary cooperation because of disparities in terminology, research approaches, and language. In order to overcome these obstacles, it is necessary to promote a collaborative culture, set common objectives, and provide forums for multidisciplinary discussion and exchange.

**Ethical implications:** Using bio-inspired technology brings up a number of ethical questions, such as those pertaining to equity, privacy, and autonomy. For instance, concerns concerning surveillance ethics and individual privacy rights may arise from AI-driven monitoring systems that draw inspiration from animal behavior. The creation of biologically inspired autonomous weapons raises moral questions about the use of technology to combat and the possibility that such weapons may be used in a way that goes against humanitarian norms. In order to address these ethical consequences, one must pay close attention to the possible effects on society as well as ethical rules and values including responsibility, transparency, and respect for human rights.

**Rights to intellectual property:** Navigating intellectual property issues related to bio-inspired ideas becomes increasingly important as biomimetic designs and AI algorithms grow more common. Ascertaining the rightful owner and credit for bio-inspired technology can be difficult, particularly when several parties are involved in the development process. To encourage innovation and provide just recompense for inventors and contributors, explicit policies and procedures for intellectual property protection are required. For the area of bio-inspired AI to be innovative and creative, it is imperative to strike a balance between the requirement for intellectual property protection and the encouragement of open innovation and information sharing.

**Preservation of biodiversity:** Concerns regarding biomimicry's possible effects on ecosystems and biodiversity are raised by the technology industry's growing adoption of it. The commercial extraction of biological components from nature may unintentionally exacerbate ecological imbalance, species extinction, and habitat damage. Promoting sustainable practices and reducing ecological impact is crucial to striking a balance between innovation and conservation. This might entail putting protective measures in place for delicate ecosystems, carrying out in-depth analyses of the effects on the environment, and embracing ecological stewardship and responsibility ideals. Furthermore, encouraging sustainable methods and ethical sourcing in biomimetic design and AI development might aid in reducing adverse environmental effects and advancing biodiversity preservation.

**Future directions:** In the future, the combination of AI with biomimicry has the potential to propel revolutionary developments in a wide range of fields. Future research paths may concentrate on creating AI algorithms that can combine knowledge from various biological sources, encouraging interdisciplinary cooperation via open-access platforms, and encouraging the incorporation of moral issues into biomimetic design procedures. A new paradigm is being brought about by generative AI, particularly in terms of how we will create, work in the future, and generate new jobs. The professional bar to produce material (picture, design, or video) has been lowered to the lowest possible level, making the world maybe fairer. You cannot be replaced by AI, but someone who uses AI could [46].

## 2. CONCLUSION

The combination of biomimicry with artificial intelligence (AI) offers fresh perspectives on difficult problems and encourages harmony between technology used by humans and the natural world. Through the use of artificial intelligence and the wisdom found in nature, scientists may build a future for mankind that is more robust, sustainable, and morally sound. In the discipline of "bio-inspired AI," computer science and biology are combined to create cutting-edge algorithms and computing strategies that are modelled after natural systems. In an effort to develop more intelligent and efficient systems, scientists are looking more and more to the natural world for inspiration as they continue to push the frontiers of artificial intelligence (AI). Scientists want to develop more effective artificial intelligence (AI) systems that can handle a variety of tasks, from improving logistics to redesigning aeroplanes, by researching how complicated issues are solved in live beings. The combination of biomimicry with AI presents a number of problems and ethical issues that need for coordinated efforts by ethicists, industrial stakeholders, legislators, and researchers. Stakeholders can guarantee that bio-inspired technologies benefit society while minimizing potential risks and negative effects on the environment and society by encouraging multidisciplinary collaboration, upholding ethical standards, safeguarding intellectual property rights, and placing a high priority on biodiversity conservation.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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