

Joanna Jadwiga Białkiewicz*

Defining biomimetic residential architecture: indicators and selected projects

Abstract

This article examines contemporary biomimetic strategies in collective housing, showing how the implementation of criteria that define biomimetic architecture affects the form, functioning, and underlying concepts of such projects. The selected case studies are characterized by the dominance of megastructures and vertical constructions, mixed-use programs, spatial flexibility, and a drive towards energy self-sufficiency. Biomimetics manifests itself in advanced technological systems, biologically inspired processes and materials, and architectural forms referencing natural structures. The analysis highlights the potential of biomimetic solutions to improve residents' quality of life, foster social relations, increase climate resilience, and reduce environmental impact. At the same time, it underscores that biomimetic collective housing remains largely conceptual, reflecting both growing interest in the idea and significant challenges to its realization.

Key words: biomimicry, biomimetics, bioinspiration, biophilia, residential architecture

Introduction

The term *biomimetics* emerged in the midtwentieth century and initially referred to medical engineering solutions inspired by the structure and functioning of living organisms. In the 1970s, Werner Nachtigall and Göran Pohl, in *Bau-Bionik: Natur – Analogien – Technik*, formulated the concept of biomimetic design as a scientific discipline and extended it to other fields of human activity, including architectural design (2013). From that point on, biomimetics began to be referenced in relation to architecture, alongside the term *biomimicry* introduced in 1997. In her book *Biomimicry: Innovation Inspired by Nature* (1997), Janine Benyus defined biomimicry as the imitation (*mimesis*) of life (*bio*) in order to seek solutions in nature to problems arising in different fields of human activity. Drawing from nature can occur at different levels – from the micro scale, where sources of inspiration are individual elements or functionalities of living organisms, to the most synthetic

macro scale, that is, modeling based on the overall functioning of ecosystems¹.

In the human–nature relationship, architecture is a field with a profound impact – both on the natural environment and on human beings themselves – by shaping the space of human functioning. The dichotomy between the built and natural environments is deeply rooted in human consciousness. The concept of biomimicry challenges this by advocating for abandoning an anthropocentric perspective and returning to nature as a model, measure, and mentor. Benyus wrote about achieving true *sustainability* by making cities more like forests, i.e., grounding the functioning of civilization in strategies that are the only legitimate ones because they have been developed over millions of years by nature. The idea of applying biomimicry in architecture has gained significant popularity over the past decade and a half, fitting squarely within both contemporary needs

* ORCID: 0000-0002-8827-9397. Faculty of Architecture, Cracow University of Technology, Poland, e-mail: joanna.bialkiewicz@pk.edu.pl

¹ The literature most often distinguishes three levels of mimicry in biomimetics: emulation of the form and/or function of an organism or its elements (*Organism Level*); emulation of organism behaviour and its interaction with the environment (*Behaviour Level*); and emulation of natural ecosystems (*Ecosystem Level*).

(ecology and sustainable development) and technological capabilities (scientific and technological progress). However, despite the interest among architects, built works are primarily individual buildings, most often public-use structures or experimental pavilions and installations that demonstrate biomimetic structures or building materials. If biomimetic architecture is to have a real impact on the environment of human life, it must create the places closest to people and their dwellings. The aim of this paper is to present examples of biomimetic residential architecture and to identify the dominant tendencies and defining characteristics of this type of project.

State of research

Among the available publications on biomimetics, there is a lack of studies devoted specifically to residential architecture; however, reference should be made to literature addressing the general issues of biomimetics in architecture. Michael Pawlyn (2011) indicated both the features of architectural objects and the principles of the design process itself, in accordance with the idea of biomimicry. The fundamental concept is a shift away from linear systems typical of the industrial economy (*from cradle to grave*) towards circular systems, in which every waste product simultaneously serves as a resource (*from cradle to cradle*). Guidance for architects includes reliance on renewable energy sources, use of local resources, and form optimization. As with living organisms, buildings should have their own metabolism and adapt to change. Siobhan Barry and Greg Keefe (2010) described the concept of Bio-City – a biomimetic highrise operating in a closed metabolic cycle, using green algae that produce biomass subsequently burned in bioreactors. Maibritt Pedersen Zari has addressed biomimicry in urban design in several works. According to Pedersen Zari, the human-built environment must function as a living system composed of cooperating organisms, rather than a set of buildings lacking interconnections (Pedersen Zari 2018). At the core of Pedersen Zari's theory, further developed with Katharina Hecht (Pedersen Zari, Hecht 2020), is the definition of *ecosystem services* – what the ecosystem provides and produces – and how this can be mimicked in technology and design strategies for urbanism. At the same time, Pedersen Zari noted that there is no clear definition of biomimetics specifically for architects, and that only an analysis of different interpretations of the concept can help determine which approaches yield the most effective results. In Poland, Jakub Onyszkiewicz, in his doctoral dissertation *Elementy biomimetyki w projektowaniu architektury w środowisku zrównoważonym* [Elements of biomimetics in designing architecture in sustainable environment] (2019), defined features of a biomimetic architectural object – largely consistent with Pawlyn's criteria – and evaluated around 200 projects accordingly. In numerous publications after 2020, biomimicry is positioned as a tool for sustainable design (Ilieva et al. 2022; Borham, Croxford and Wilson 2024; Ali Hussein, Abbas Abbood 2024). An attempt to relate biomimetics directly to residential architecture was made by Mohamed Reza Akbarian and Mahdis Kolivand Salooki (2025, 50, 51),

who listed *key indexes of biomimetic architecture grouped into categories: mimicking form and structure, mimicking processes, mimicking ecological systems, sustainability and energy efficiency, harmony with the environment*. Independently of biomimetic concepts, studies of contemporary residential architecture address the affordable housing crisis (Fishman 2018), sustainable building (Mazur 2021), and issues such as the individualization of multi-family housing (Stoiljković, Petković-Grozdanović and Jovanović 2015), resilience (Paulichen, Leite and Pina 2019), modular, non-predetermined solutions (Djukanovic, Alegre and Bastos 2025), architectural recycling of existing structures (Hernández Falagán 2021), and other proposals to adapt housing to the needs of a postindustrial and postpandemic society (Seruga 2014; Klochko 2022). It should be noted that many of these proposals can fall within the criteria of biomimetic architecture.

For the purposes of this paper, information on particular projects and built works was drawn mainly from websites: architectural studios, competitions (e.g., *eVolo Skyscraper*), and individual portfolios.

Methods

The adopted research method is a comparative multiple case study. The set comprises projects with the same function – collective housing – albeit in most cases it is not their only function. Due to the relatively small number of completed buildings, the principal object of analysis is the design itself, as the material manifestation of an architectural concept. The selected projects, apart from the functional criterion, share the realization of certain criteria that define their biomimetic character. The criteria described below were identified based on an analysis of selected literature that addresses, in theoretical terms, the application of biomimetics and biomimicry in architecture. The way each project meets the adopted criteria is presented descriptively in a table. Based on this comparison, conclusions are drawn as an attempt to synthesize the issue in the form of answers to the following questions:

1. What objectives of residential architecture are served by the application of biomimetic elements?
2. Which characteristics of contemporary collective housing projects result from the implementation of criteria defining their biomimetic nature?

Criteria defining the biomimetic character of residential architecture

A fundamental issue in establishing criteria that define a biomimetic character is the need to clarify the terms “biomimetics” and “biomimicry” in relation to architecture. Pohl and Nachtigall (2015) refer to the “classical” definition of biomimetics, according to which it is a scientific discipline concerned with the adaptation and implementation of biological structures, processes, and principles of development in technology. This corresponds to the definition formulated in the international standard ISO 18458:2015 (Verbrugge, Rubinacci and Khan 2023), which states that biomimetics focuses on functional analysis of biological

systems, their abstraction into models, and their transfer and application in technology. In the light of these definitions, biomimetic products are primarily technological innovations reproducing biological systems at the structural level (e.g., biomimetic materials) or process level (e.g., a ventilation system modeled on termite mounds). Effective classification of bio-inspired technological solutions requires a system that reflects their developmental history and the transfer of knowledge from biology to technology (Speck et al. 2017). The fundamental indicator of whether we are dealing with a biomimetic product/object is thus the transfer of a selected biological principle. Some authors treat “biomimetics” and “biomimicry” as synonyms; others distinguish between biomimetics—oriented towards technological innovation, imitating natural forms and structures in a de-contextualized way (Mitxelena, Genua 2017) – and biomimicry, which sees in nature primarily normative principles of ecological sustainability. In this view, nature is not only a source of biological models for technical fields, but a source of standards that define the ecological “correctness” of human technological outputs. The aim of biomimicry is therefore to emulate natural systems and strategies in order to create solutions that meet human needs while simultaneously minimising the environmental impact of civilisation. In architecture, this means creating a built environment that is sustainable and potentially regenerative towards natural ecosystems. As Henry Dicks (2016) emphasized, biomimicry cannot be reduced to copying nature’s systems without integrating the resulting technologies into the circular systems characteristic of the biological world. Table 1 presents selected definitions of the terms biomimetics, biomimicry, bioinspiration, and biophilia that have appeared in the literature over the last five years. For the purposes of this study, a synthetic definition is adopted: biomimetics is an interdisciplinary design process based on understanding and abstracting biological principles and transferring them to technology. The concept of biomimicry, according to which nature is not only a model but also a measure and a mentor (Dicks 2016), adds to biomimetics goals aligned with sustainability and focuses on linking technological solutions to environmental challenges. The ideological premise of biomimicry is to renew the human–nature bond by addressing civilisational problems in ways that emulate the functioning of ecosystems.

From these definitions of biomimetics and biomimicry, the following determinants of biomimetic architecture can be identified (Fig. 1):

1. Transfer of solutions from nature to technology through an interdisciplinary design process (collaboration among architects, biologists, engineers, chemists, etc.); technological innovation creating synthetic counterparts of biological structures and functionalities.

2. Inspiration derived from a specific biological model. Structural and functional biomimetics. This includes the imitation of the form, structure, or functionality of a living organism (animal or plant).

3. Biomimetic materials (synthetic materials that mimic the structure and functions of natural ones); biomaterials.

4. The purpose of technological innovation – ecological functioning of buildings and their complexes:

- minimizing environmental impact;
- designing material cycles and building life cycles within circular systems, recycling;
- harvesting energy from renewable sources, energy efficiency;
- reducing CO₂ emissions;
- retention and recovery of rainwater;
- natural ventilation.

5. Structures exhibiting biological qualities such as optimality, resilience, and adaptability. Autopoietic and kinetic systems enabling buildings to respond and adapt autonomously to changing environmental conditions.

In the context of concepts related to architecture, it is also worth noting the term biophilia, defined primarily as the creation of built environments that foster and deepen the human–nature relationship. This is crucial because, unlike biomimetics and biomimicry, it directly concerns the user of architecture, aiming at their psycho-physical well-being. Including biophilic aspects thus seems necessary, especially in residential architecture, which constitutes the built environment closest to every person. Accordingly, the set of indicators is supplemented by biophilic elements (Uchiyama, Blanco and Kohnsaka 2020), such as:

- enabling direct contact with nature;
- introducing plant elements;
- using natural materials;
- the presence of water;
- biomorphic shapes and patterns;
- ensuring optimal temperature and air quality, access to daylight or its simulation.

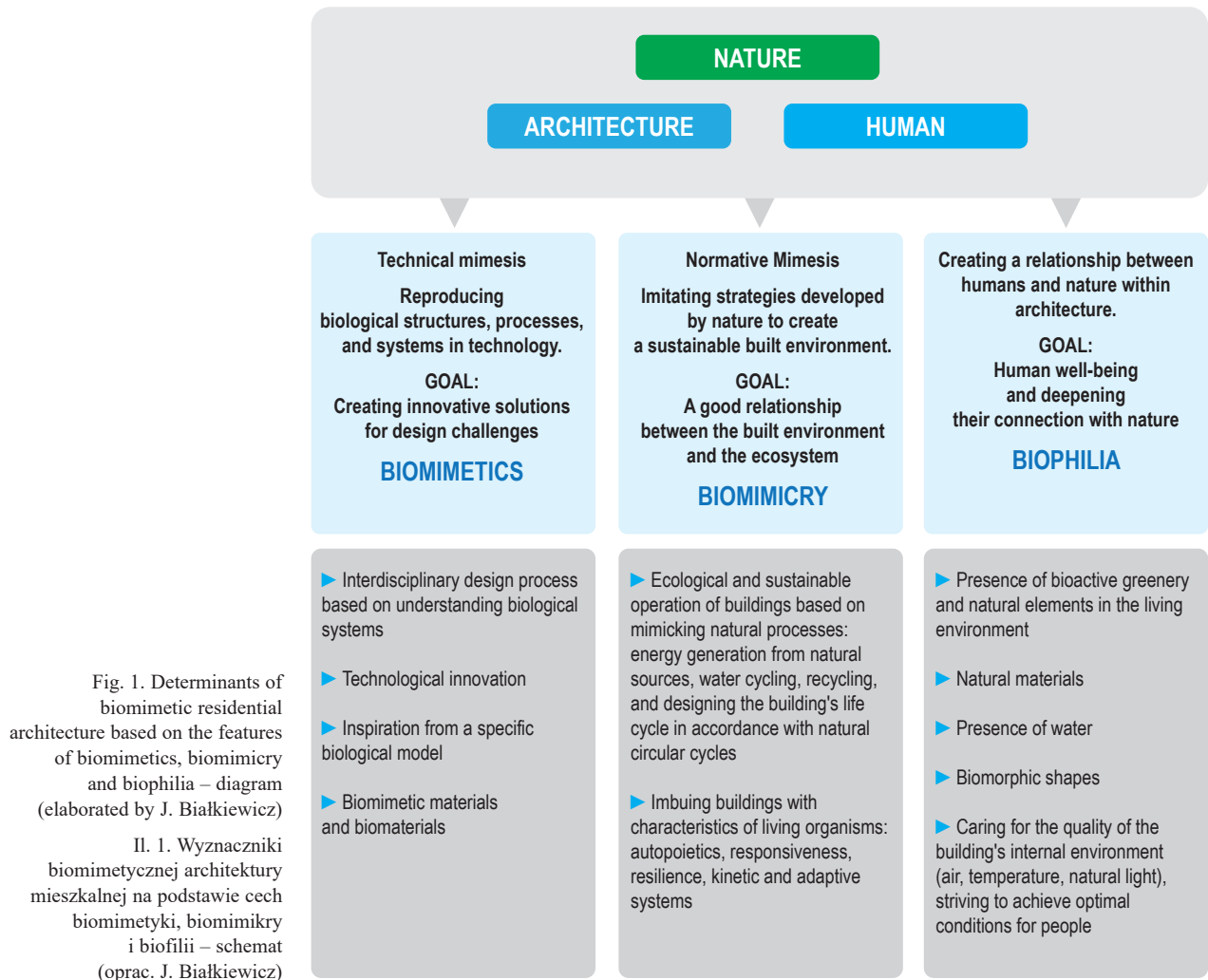
Contemporary residential projects can be broadly divided into those that respond to current needs and those anticipating future needs. Housing – especially collective housing – struggles with numerous problems arising from urban phenomena such as *urban sprawl*, dispersion of development, and deepening social and spatial segregation. Historic centres are emptying, while gated luxury estates form enclaves accessible only to the wealthiest. Biomimetic architecture – through its innovative, interdisciplinary, and technologically advanced dimension – requires high financial outlays for research, materials, and experimental implementations etc. Consequently, the few realized residential buildings that aspire to be biomimetic are typically high-end and located in the wealthiest urban centres of the world. Dominant, instead, are futuristic conceptual projects. The underlying idea is to emulate biological systems that evolve, adapt, and survive by developing qualities such as resilience and regeneration. Hence, biomimetic design features numerous visions of habitats for extreme environments or able to ensure human survival in the face of various catastrophes.

Selected biomimetic residential projects

The examples of biomimetic residential projects cited in this paper are divided into two typological groups: urban high-rises and specialpurpose residential habitats. For selected architectural objects, the implementation of individual indicators is described in Table 2.

Table 1. Definitions of biomimetics, biomimicry and related terms (biophilia, bio-inspiration) in the literature after 2020 (elaborated by J. Białkiewicz)
 Tabela 1. Definicje biomimetyki, biomimikry i pojęć pokrewnych (biofilia, bioinspiracja) w literaturze po 2020 (oprac. J. Białkiewicz)

	Ilieva et al. 2022	Gerola, Robaey and Blok 2023	Sangler Contreras et al. 2023	Chayaamor-Heil 2023	Sedira et al. 2024	Bijani, Aflaki and Esfandiari 2025	Akbarian, Kolivand Salooki 2025
Biomimicry	An interdisciplinary method for studying and transferring principles and mechanisms from nature to solve design challenges. Biomimicry serves both innovation and sustainability; its guiding ideas are biosynergy (renewing the human–nature bond) and ecosystem regeneration.	Focuses on the ecological sustainability effect. Nature is a source not only of biological models for technology but also of normative principles. Three typologies are listed, with medium, strong or very strong sustainability effects: normative inspiration, normative imitation, normative integration.	Imitating natural forms, processes, and functions to solve human (technical) problems. In architecture, the goal is to design buildings and structures with the qualities of biological organisms, such as efficiency, resilience, and adaptability.	Biomimicry and biomimetics are based on the same methodology of an interdisciplinary approach to design through understanding and relying on biological models. Biomimicry adds to biomimetics the goals of sustainable development and focuses on linking design and technological solutions to environmental challenges.	Learning and emulating nature's strategies to solve human problems; reliance on "life's principles" to achieve resilience and adaptability characteristic of living organisms.	The pursuit of innovative and sustainable solutions to human problems by imitating biological patterns and strategies developed by nature.	An innovative design approach that emulates solutions to human problems and challenges; by studying and emulating nature's strategies, effective and sustainable solutions for humanity can be developed.
Biomimetics	Biomimetic design identified with the practice of biomimicry.	Focuses on the reproduction of innovative biological functions. Three typologies are listed with very weak, weak, and medium sustainability effects: technical inspiration, technical imitation, technical integration.	Identified with biomimicry	An interdisciplinary design process based on understanding and abstracting biological functions and principles and transferring them to technology.	Biology-based technology. The study of the formation, structure, and function of substances and materials of biological origin, as well as biological processes and mechanisms, with the aim of synthesizing similar products using technology.	Nature inspired forms adapted/applied in architecture in two ways: as replicas of natural forms or by reproducing a biological process.	Biomimetic architecture – an innovative and sustainable design approach that imitates structures, processes, and systems from the natural world.
Bio-inspiration			Creating buildings and environments that foster deep human–nature relationships.	A creative design approach based on observing biological principles (unlike biomimicry, the goal may be purely aesthetic or symbolic).	Identified with biomimetics – biologically inspired design.	Using nature as inspiration in design without direct copying; nature provides ideas and patterns for creative solutions, often relying on advanced technology.	
Biophilia				Architecture focused on creating a close bond between building users and nature.			



Bioscrapers – Citytrees – biomimetic residential high-rises

Population growth and its concentration in urban centres necessitate the intensification of urban fabric, which can essentially be pursued in two ways: by erecting mixed-use high-rises or mixed-use horizontal structures. While garden-city concepts of low-rise development still attract supporters and promoters today, high-rises are likely to dominate in the future². As early as 1964, Warren Chalk presented the concept of *Capsule Homes*, i.e., a multi-residential tower grouping modular housing units (capsules) around a circulation core. Most biomimetic residential high-rise projects remain conceptual today; however, a few completed examples can be identified. These include “Vertical Forests” (*Bosco Verticale*, Fig. 2) designed by Stefano Boeri, which the architect himself describes as “home for trees and birds, that also houses humans”. *The concept behind the Bosco Verticale defines not only the urban and technological features of the project but also its architec-*

tural design and expressive qualities (www.stefano-boeri-architetti.net). The first pair of such towers was completed in Milan in 2014 (Liu 2023). Subsequent towers were designed for Chinese cities Huanggang (2017–2021) and Nanjing (2016), Dubai (2022), Lausanne in Switzerland (*The Tower of Cedars*, 2015), and Tirana in Albania (2017). The concept of a residential high-rise with trees and other vegetation integrated into the façade – undeniably striking visually – has become popular among designers. Examples include *Tree Tower Toronto* (Penda Design, 2017), *Tour Végétale in Nantes* (Edouard François, 2011), and *Riviera Tower in Athens* (Foster + Partners, 2021–2025). Urban “tower – forests”, although they meet some biophilic criteria, beyond the general idea of imitating trees, lack a concrete, identifiable biological model.

More biomimetic are the projects of Vincent Callebaut, who describes himself as an *Archibiotect*, pointing to the characteristic fusion of architecture, biology, and technology in his work. Alongside botanical inspirations (e.g., *The Rainbow Tree* in Cebu, the Philippines), Callebaut has designed structures that mimic a variety of biological structures – for example, a DNA-chain-inspired construction (*Agora Garden* in Taipei, Taiwan, 2010–2018; *Citytrees*, 2014) and honeycomb structures (*Honeycomb Towers in Paris Smart City 2050*, 2014–2015). Notably, *Agora Gar-*

² The expansion of linear structures (low-rise development amid greenery) leads to longer circulation routes, and consequently, higher operating costs.

Table 2. Examples of biomimetic residential architecture projects according to selected criteria (elaborated by J. Białkiewicz)
 Tabela 2. Przykłady biomimetycznych projektów z zakresu architektury mieszkaniowej, według wybranych kryteriów (oprac. J. Białkiewicz)

	Innovation/Technology	Biological inspiration	Biomimetic materials and biomaterials	Ecological functioning (designed)	Autopoiesis, adaptation, resilience	Biophilia
<p>The Bionic Tower (project, Shanghai) 1997–2001</p> <p>Eloy Celaya, Maria Rosa Cervera, Javier Gómez</p>	<p>An innovative structural system enabling the construction of a 1228 m high residential tower – a technological imitation of a tree.</p>	<p>The form and structure of the building are inspired by the cypress tree – its green part consists of scale-like membranes through which wind of any strength can pass without moving the tree. The method of anchoring the building is modeled on the cypress root system – shallow but highly branched.</p>	<p>Synthetic materials modeled on the structure of bone and spider webs, with a thin plastic exterior imitating the properties of skin.</p>	<p>A biologically inspired structure enabling natural ventilation; energy generated from wind and sunlight through a turbine at the top of the tower and solar panels. Rainwater and seawater retention.</p>	<p>Tall structure resistant to wind, vibration, fire, flood and earthquakes; ventilation and air-conditioning systems self regulate temperature in response to external conditions.</p>	<p>The design includes 12 floors covered with vegetation, the presence of water, and internal gardens.</p>
<p>Condo Tower (New Sky Condos) (project, Lima) 2013</p> <p>B+U Architects</p>	<p>Technologically advanced material solutions. Replacing load-bearing walls with a modified concrete shell that effectively transfers weight.</p>	<p>The building's façade is inspired by the structure of skin, with pores and hair that open and close automatically depending on external conditions. The form and color scheme of the building evoke associations with a biological organism.</p>	<p>A silicone composite capable of movement (lengthening, shortening and rotation) under the influence of external conditions.</p>	<p>Openings in the building structure surrounded by composite "hairs" regulate temperature and sunlight and absorb air pollutants.</p>	<p>The building adapts automatically to external conditions, its form is dynamic.</p>	<p>Plant elements and gardens on balconies; biomorphic shapes; opening glass walls blurring the line between interior and exterior; control over temperature and sunlight inside.</p>
<p>Paris – Smart City 2050 (project, Paris) 2014–2015</p> <p>Vincent Callebaut</p>	<p>Innovative technologies for the construction, acquisition, storage and processing of energy by buildings.</p>	<p>The tower structure is modeled after a honeycomb (Honeycomb Towers) and mangrove trees (Mangrove Towers). The solar shield structure is modeled after dragonfly wings.</p>	<p>Biomaterial: algae.</p>	<p>The buildings are designed to generate more energy than they consume, including through solar panels and wind turbines. Rainwater retention and greywater recycling. Green algae on the façades produce biofuel that is processed in bioreactors. Mechanical ventilation systems, CO₂ and pollutant absorption.</p>	<p>Buildings adapt their metabolism to changing external conditions.</p>	<p>Trees and vegetation on building façades; interaction with nature – cultivated gardens for residents; biomorphic shapes.</p>
<p>A Living Resilience (project) 2017</p> <p>Jack Francis, Rebecca Beer, Elina Savvas, Andrew Waller</p>	<p>Façade "scales"; geometry based on the Fibonacci sequence; chitin scales 3D printed.</p>	<p>Inspired by the structure and function of a pine cone (morphological inspiration).</p>	<p>Chitin façade scales – fully recyclable biopolymer.</p>	<p>A façade system of "scales" that open and close in response to the time of day, protecting against the cold while maximizing solar energy gain.</p>	<p>A responsive façade enhances the building's resilience to extreme temperature fluctuations; an adaptive, dynamic structure.</p>	<p>Plant elements integrated within the "scales"; designed to ensure thermal comfort and access to sunlight; a space dedicated to agriculture.</p>

	Innovation/Technology	Biological inspiration	Biomimetic materials and biomaterials	Ecological functioning (designed)	Autopoiesis, adaptation, resilience	Biophilia
<p>Wertykalna Oaza (project) 2019–2021 FAAB</p>	<p>The ECO-DNA system and the “green skin” system are managed by residents via a mobile app. The “green skin” is an AI-assisted system – a designed combination of selected plants and microorganisms. Developed in collaboration with specialists in dendrology, climatology, zoology, and microbiology.</p>	<p>Mimicking metabolic functions, the façade is designed to resemble living skin.</p>	<p>Composition of plants and microorganisms on VOS WCC panels.</p>	<p>The ECO-DNA system enables the conversion of solar energy into electricity. The “green skin” regulates temperature, absorbs CO₂ and pollutants, produces oxygen, and also supports rainwater retention. Natural transpiration processes help cool and humidify the air.</p>	<p>Depending on the selection of “green skin” system components, the building can withstand both extremely low and high temperatures. The building’s appearance evolves with changes to its biological components.</p>	<p>A vertical garden system within the façades, designed to maintain air quality, regulate temperature, and reduce indoor noise levels.</p>
<p>Mitosis (project) 2020 GG-loop</p>	<p>The project utilizes parametric modeling software. The building volume and residential cluster layouts are derived from simulations of parameters related to specific site conditions and user needs.</p>	<p>Inspired by the biological process of mitosis (cell division) – the entire concept is based on modules that can be combined in various configurations.</p>	<p>Biomaterials; prefabricated timber panels.</p>	<p>The selected materials and plants absorb CO₂. The ecosystem is capable of generating more energy than it consumes.</p>	<p>The system’s modularity allows for extensive adaptability. The entire complex is designed to evolve with its surroundings.</p>	<p>The concept envisions an ecosystem where residents live surrounded by plants and animals. Vertical gardens and entire forested sections are integral to the design. Natural materials (wood), large glazing, and the feeling of being immersed in nature from every perspective.</p>
<p>Lilypad (project) 2008–2017 Vincent Callebaut</p>	<p>Prototype technologies for an amphibious city; innovative materials.</p>	<p>Inspired by the giant water lily Victoria Regia amazonica.</p>	<p>Polyester fiber skin coated with titanium dioxide–absorbs pollutants like a plant; use of biomass.</p>	<p>The building is designed to be completely self-sufficient – achieving a positive energy balance with zero CO₂ emissions. It produces oxygen, utilizes waste, and purifies water.</p>	<p>The structure enables human habitation in the middle of the ocean and can move in accordance with ocean currents.</p>	<p>The entire structure is covered with hanging gardens; the presence of water (a central lagoon); biomorphic shapes; spaces designated for agriculture.</p>
<p>Coral Reef (project, Haiti) 2011 Vincent Callebaut</p>	<p>A composition of prefabricated residential modules placed on an artificial pier constructed on seismic piles, incorporating technology for harvesting energy from water movement.</p>	<p>Inspired by coral reef structure.</p>	<p>Local timber</p>	<p>The complex is energy self-sufficient, composed of passive residential units. Hydroelectric turbines beneath the pier convert the kinetic energy of the tides into electricity.</p>	<p>The structure is earthquake-resistant. The complex can expand and develop without limit.</p>	<p>The roof of each residential module is also a garden; natural material – wood; glazing, access to sunlight.</p>
<p>Puffer Village (project, Benin) 2021 Sajjad Navidi</p>	<p>An innovative system for inflating or filling the substructure and superstructure of residential units with water, triggered by water level data from specialized sensors.</p>	<p>The biological model is the pufferfish – a fish characterized by its ability to inflate its body with water or air.</p>	<p>No information available.</p>	<p>Each residential unit independently generates energy from tidal kinetic energy as well as through photovoltaic panels.</p>	<p>The structure responds to changes in water levels during tides and heavy rainfall.</p>	<p>Each residential unit is surrounded by a wooden fence covered with plants cultivated through aquaponics.</p>

Table 2 cont. Examples of biomimetic residential architecture projects according to selected criteria (elaborated by J. Białkiewicz)
 Tabela 2 cd. Przykłady biomimetycznych projektów z zakresu architektury mieszkaniowej, według wybranych kryteriów (oprac. J. Białkiewicz)

Innovation/Technology	Biological inspiration	Biomimetic materials and biomaterials	Ecological functioning (designed)	Autopoiesis, adaptation, resilience	Biophilia
Innovative energy generator technologies and "cells" that convert ocean waste into 3D printing material.	The designers focused on the process of creating an independent ecosystem that grows organically, starting with energy production. A biomorphic element can be noted – the energy generators are called Energy Elephants.	The material for printing residential units is sourced from recycled ocean waste.	Energy is generated in power units from the kinetic energy of waves and wind. The units, called "cells" (Nexus), collect plastic waste and print additional capsule modules. Each residential capsule is equipped with a wind turbine, photovoltaic façade, and a full waste recycling system.	The essence of the project is the organic growth of the development, which produces its own energy from renewable sources.	The project envisions the presence of trees and green spaces between the residential capsules.
EML (Engineered Living Materials) technology. Plants and microorganisms grow on parametrically designed polymeric matrices to form the structure. The system is complemented by 3D-printed clay inserts. Developed in collaboration with biologists and microbiologists.	There is no specific biological model; the project does not so much mimic biological functions as it harnesses them through technology. The concept is based on "synthetic biology".	Biomaterials – plants and animal microorganisms, engineering materials composed of living cells.	Regenerative bioactive materials are designed to provide all "ecosystem services", actively filtering air, water, and soil.	A residential structure built from self-replicating, self-regulating, and self-healing materials, responsive to changing environmental conditions.	Biomaterials – vegetation serves as the building material; biomorphic forms; blurring the boundary between the residential unit and nature.
Advanced technological materials and structural solutions enable the capsules to move under any conditions.	The shape and structure are modeled on plant cell anatomy; the capsule shells feature nodules inspired by the armor of desert beetles of the genus <i>Onymacris</i> .	Biomaterial – algae; a construction material modeled on spiderwebs.	The algae harvest solar energy and produce pulp that serves as biofuel. The bionic coating allows for water absorption and regulates light access.	Thanks to its variable structure and color, the capsule adapts to environmental conditions (desert, forest, mountain). The capsule also moves on water. Thanks to its shell, it can obtain water in desert conditions. Single-person capsules can be combined into teams.	The mobile residential capsule allows humans to experience direct contact with nature in any chosen biome.
Material innovation – the tower's exterior cladding consists of ETFE and a nanotechnology-based material with anti-corrosion properties and energy-loss prevention.	Inspired by corals (morphological and functional).	Synthetic materials with biological properties.	A skyscraper powered entirely by a closed-loop system converting ocean waste into energy. Seawater is filtered and desalinated.	Adaptive structure – each building module can be detached. The purpose of the structure is to provide shelter and sustain the ecosystem. It features an extendable external "shell" designed to withstand hurricane-force winds.	Vertical gardens integrated into the building structure; biomorphic, rounded forms; interior gardens; access to sunlight.
The Corallite (project) 2023 Chris Soria, Sharon Mathew, Steffany Brady, Stefania Ingarano, Aimee Platt, Chun-Tien Kuo, Brandon Geiger					



Fig. 2. Bosco Verticale, Milan, Boeri Studio, 2014 (source: courtesy of Stefano Boeri Architetti, photo by Dimitar Harizanov)

Il. 2. Bosco Verticale, Mediolan, Boeri Studio, 2014 (źródło: dzięki uprzejmości Stefano Boeri Architetti, fot. Dimitar Harizanov)

den is among the few such projects realized³. Callebaut has proposed entire ensembles of biomimetic towers as solutions for future cities, including the world's largest metropolises such as Paris (*Paris Smart City 2050*, 2014–2015) and New York (*Treescrapers*, 2023). While New York's *Treescrapers* are primarily based on the concept of high-rises with vegetation-covered façades, the Paris project shifts away from the primacy of the biophilic factor towards a more technological biomimicry approach, drawing inspiration from the structure and functionality of natural forms. Among the eight proposed tower prototypes are, for example, *Photosynthesis Towers* with biofaçades covered with algae. A similar idea of high-rises using algae to produce energy appears in the *Bioscrapers* project for Chicago (project by Walter R. Hughes, 2020). Close in character to *Treescrapers* is *Mitosis*, designed for Amsterdam by GG-loop. The Cross-Laminated Timber (CLT) panels used by the architects appear to be among the most popular materials (alongside synthetic polymers and nanomaterials) for shaping biomimetic residential buildings.

The vast majority of biomimetic projects are futuristic visions. Conversely, one may note that a significant proportion of visions of future cities are based precisely on biomimetic architecture. An example is "AI × Future Cities" – a series of images created by architect and designer

³ The building's environmental qualities are confirmed by LEED Gold and Low Carbon Building Alliance certification at the diamond level.

Manas Bhatia using the AI tool Midjourney. These visions are dominated by towers with façades covered in algae or trees. Fascinated by how insects and animals build their habitats, Bhatia also creates visions of "symbiotic architecture", according to which in the future humans might inhabit growing, metabolizing structures that look and function like trees. In 2013, the U.S. studio B+U Architects presented a biomimetic residential tower for Lima (Peru). In this project, a reduced presence of biophilic elements can be observed alongside a strong biomimetic component, namely the concept of replicating natural functionalities in a synthetic manner. Among the futuristic visions of biomimetic residential architecture, there are also works by Polish architects, such as the *Vertical Oasis* project by FAAB Studio (Fig. 3). It is a design of an advanced, technologically driven biomimetic building combining residential, office, and commercial functions, whose metabolic functionality is defined by a "green skin" – a designed composition of plants and microorganisms. Interesting examples of futuristic residential architecture concepts are provided by projects showcased in thematic competitions, such as *24H* – organized by the portal *if – ideas forward*. From the 2017 edition devoted to biomimetic housing comes, for example, the commended project *A Living Resilience* (project by J. Francis, R. Beer, E. Savvas, A. Waller) – a tower that mimics the structure and function of a pine cone. In futuristic visions, residential towers sometimes reach enormous sizes; an early, pioneering example is *Bionic Tower* (project by M.R. Cervera, J. Pioz, E. Celaya, 1997–2001),



Fig. 3. Vertical Oasis, project: FAAB (source: courtesy of ©FAAB)

Il. 3. Wertykalna Oaza, projekt FAAB (źródło: dzięki uprzejmości ©FAAB)

which could accommodate up to 100,000 residents across 300 floors (project by Cervera, Carreras-Solanas). A common feature of biomimetic high-rises is the integration of multiple functions, offering residents proximity and easy access to offices, shops, and service points. Architects also tend to incorporate publicly accessible communal spaces that promote social interaction.

Biomimetic special-purpose habitats

In addition to residential architecture whose main goal is to provide comfortable and healthy living environments

and social functioning, another thread relevant to biomimetic solutions is special-purpose housing. These are residential projects that also respond to challenges and threats such as natural or climate-related disasters or global armed conflict. The guiding idea is resilient and regenerative architecture capable of ensuring human survival. Another desirable natural quality in the built environment is adaptability—the ability to adjust to any, even extreme, living conditions. Hence numerous projects of habitats in “hostile” ecosystems, e.g., in hot arid climates.

Among futuristic visions of future human settlements, a recurring concept is floating or on-water housing units. This responds to threats from climate warming and the risk of significant sea-level rise. These visions may take the form of vertical ecosystems, such as *The Corallite* (project by CannonDesign, 2023), whose structure is modeled on coral. More frequently, however, we see onwater settlements composed of modular housing units. Examples include *Lilypad* by Vincent Callebaut (2008–2017) and *In Absentia* by DADA – Deo Alrashid Alam Design Architecture (Fig. 4). A prototype on-water settlement already intended for implementation is the *Oceanix* for the South Korean port city of Busan (2022, BIG – Bjarke Ingels Group, SAMOO) (Fig. 5).

The eVolo Skyscrapers competition entries demonstrate a striking variety of specialpurpose habitats. They include residential buildings for war refugees, e.g., *Honeycomb Refugee Skyscraper* (project by N. Badr, N. Maestro, H. Elahmar, 2017); desert-region habitats, e.g., *Skyscrapers Forest for Desert Regions* (project by Daffonchio & Associates Architects, 2019); and earthquakeresistant buildings in seismic zones – *Mega-Bio-Cell* (project by M. Fazel, S. Adnan Almousa, M. Safari, 2018) and *Coral Reef* (project by V. Callebaut, 2011). As nature adapts to any conditions through evolution, resilient residential buildings of the future are conceived as evolving—responsive to change, easy to reconfigure (which modular construction enables) or relocate – for example, *Xerophyte Tower* (project by A. Lillystone, S. Mills, 2015). Also relevant are the con-



Fig. 4. In Absentia, concept rendering, DADA (2021) (source: courtesy of DADA – Deo Alrashid Alam Design Architecture)

Il. 4. In Absentia, wizualizacja koncepcji, DADA (2021) (źródło: dzięki uprzejmości DADA – Deo Alrashid Alam Design Architecture)



Fig. 5. OCEANIX Busan, concept rendering, BIG & SAMOO (2022) (source: courtesy of BIG-Bjarke Ingels Group)

Il. 5. OCEANIX Busan, wizualizacja koncepcji, BIG & SAMOO (2022) (źródło: dzięki uprzejmości BIG-Bjarke Ingels Group)

cepts of capsules and various mobile modular units. These are portable homes designed for the scenario in which society, due to catastrophe, reverts to a nomadic lifestyle. An example of such a concept is the *Adaptive Cell* project by Karolina Kosmowska, Benjamin Walecki, and Anna Wojtynia (2022), developed under the supervision of Roman Czajka. It presents a capsule inspired by the structure of a plant cell, designed to serve simultaneously as a shelter and a means of transport for humans. As the authors observed, the pandemic experience, along with the rise of remote work, has prompted reflection that one's dwelling could be mobile. An interesting concept for floodprone African areas is *Puffer Village* (project by S. Navidi, 2021) – a set of houses that inflate as water levels rise. Among biomimetic dwelling units one should also mention the work of Terreform ONE, e.g., *Home Alive* and *Fab Tree House*, described by their creators as “multispecies living structures”. The essence of Terreform ONE's projects lies in engineer-designed “living” materials – built from living cells, self-sustaining, and capable of growth and self-regulation.

Conclusions

The presented compilation of selected projects that meet the criteria defined in the study for biomimetic architecture allows for drawing synthetic conclusions regarding this type of residential architecture.

What purposes in residential architecture are served by the use of biomimetic elements?

The following goals of residential architecture can be achieved through the application of biomimetic forms and ideas:

1. Creating a comfortable and healthy living environment for humans. These qualities are achieved by providing residents with thermal comfort, clean air, access to sunlight, a space that can be arranged and adapted according to individual needs, as well as direct contact with nature through the presence of plants and trees within the building's space.
2. Building community and creating spaces for interpersonal relationships. This is achieved through the arrangement of shared spaces that foster neighbourhood interactions.
3. Positive impact of human habitation on the natural environment. A shift away from buildings that drain natural resources and produce waste towards habitats that generate energy from renewable sources, operate in closed loops based on recycling, and are capable of independently purifying the air and adapting to external conditions.
4. Protecting people from the consequences of natural and anthropogenic disasters; ensuring survival in extreme situations.
5. Adapting residential environments to unfavourable and extreme climatic and geographical conditions.
6. Enabling the development of society by ensuring decent living conditions for all social groups.

What characteristic features of contemporary collective housing projects result from the implementation of biomimetic criteria?

The presented biomimetic residential architecture projects exhibit the following characteristic features:

1. In collective housing, a dominance of megastructures and vertical constructions that occupy limited ground area yet can accommodate very large populations.
2. Multifunctional buildings, combining residential, office, and commercial functions, often with cultivated gar-

dens. This reflects the changing lifestyle in a post-industrial society, where the boundaries between residence and workplace are blurring.

3. Flexible solutions enabling customization to individual needs and arrangements of personalized spaces.

4. Designing residential buildings as autonomous, energy-self-sufficient structures, capable of producing energy, using mechanical ventilation, water recovery and waste recycling systems, with the model assumption being a building functioning analogously to a living organism – metabolising, reacting to changing environmental conditions and adapting to them.

5. The use of technologically advanced solutions supporting or controlling the functioning of a building, enabling the transformation of its structure and adaptation of parameters to external conditions, including the development of parametric design and modern methods of fabricating building elements (e.g., 3D printing), as well as the search for experimental, innovative solutions, often going beyond current technical possibilities.

6. Use of synthetic materials exhibiting properties of living organisms; integration of biological structures and forms in the building process (growing trees, algae); popularity of wood in the form of CLT panels.

7. Inspiration from nature, most often expressed by imitating specific biological functionalities, primarily in structural and façade systems; morphological imitation is less common.

8. Morphology shaped by two dominant tendencies: on the one hand curvilinear, irregular, non-geometric forms (since right angles and straight lines scarcely occur in nature) and structures imitating organic growth; on the other hand regularity based on repetitive patterns (modules), referencing the cellular and atomic structure of the universe.

9. Adapting the functionality of the building to environmental conditions, with an emphasis on resilience to climate and natural hazards (e.g., floods, earthquakes).

10. Emphasis on biodiversity. The presence of bioactive greenery serves a dual purpose: plants incorporated into the building's structure regulate interior temperature, absorb CO₂ and pollutants, and, by enabling people to directly interact with nature in their living environment, positively impact their mental well-being and health.

11. Designing biomimetic residential buildings as a response to the specific needs of wealthy metropolises in highly developed countries, cities with high population density or for particularly neglected areas (e.g., in Africa), with the simultaneous dominance of conceptual designs often created by students and novice young architects, which demonstrates the simultaneous interest in the idea of biomimetic architecture and the real difficulties in its implementation.

The presented conclusions can be further dissected and formulated separately for urban architecture and architecture designed outside urban areas. The analysis of biomimetic housing can be further deepened by studying a larger number of cases, enriched by considering the concept of local context and its impact on biomimetic designs. In the field of urban construction, an interesting issue is the relationship between contemporary biomimetic architecture (including futuristic urban concepts) and the existing architectural fabric of cities, including historic buildings. Another crucial issue, open to further research and analysis, concerns the problems of contemporary collective housing in a social context and how to address them through the use of biomimetic elements.

Summary

The first observation that comes to mind after analyzing the presented material is the clearly visible discrepancy between the scope of the concept and the impossibility of its implementation. The presented designs are visionary and futuristic in nature. The architects propose technological and material innovations that require advanced interdisciplinary research. Even if these technologies were developed, the cost would likely be so high that their implementation on a larger scale would be impossible. The ecological functioning of the designed structures also remains in the realm of plans and assumptions. We lack any specific figures that would allow us to properly assess the actual energy and water consumption, carbon footprint, or life-cycle costs of these buildings. It seems, therefore, that biomimetics remains a concept that is definitely capturing the imagination of architects, which is a positive development, but we are still a long way from the actual implementation of biomimetic residential architecture.

The fundamental challenge facing contemporary architects is making comfortable and healthy living spaces accessible to everyone. Therefore, housing, especially multi-family housing, should be treated as the most important tissue of the urban organism. Architectural solutions for affordable housing are urgently needed. In this search, we can certainly draw on some of the ideas emerging from biomimetic designs, such as modular, prefabricated housing units manufactured using 3D printing. For economic reasons, it is crucial to implement sustainable solutions in multi-family housing, including energy efficiency, water management, and material recycling, while for the health and well-being of residents, it is crucial to incorporate the elements that comprise the concept of biophilia. Architects should also focus on urban recycling, i.e., the revitalization of existing architecture and the regeneration of damaged areas, such as post-industrial areas. This is a broad topic that requires further in-depth analytical and comparative research.

References

Akbarian, Mohamed Reza, and Mahdis Kolivand Salooki. "Explaining the Model of Biomimetic Architectural Indexes in Sustainable Building Design in Residential Buildings." *Journal of Urban Management and Energy Sustainability* 6, no. 1 (2025): 47–57. <https://doi.org/10.22034/ijumes.2025.2048790.1282>.

Ali Hussein, Ebtihal, and Oday Abbas Abbood. "Biomimicry as a Sustainable Solution in Architecture: Analytical study." *BIO Web of Conferences* 97, no. 00015 (2024): 1–13. <https://doi.org/10.1051/bioconf/20249700015>.

Barry, Siobhan, and Greg Keeffe. "Biomimetic Architecture: Ecotonic Transmutations across the Urban Membrane." In *SB10 Finland Sus-*

- tainable Community – buildingSMART Conference, 22 September 2010–24 September 2010, Espoo, Finland.* Finnish Association of Civil Engineers RIL, 2010. <https://e-space.mmu.ac.uk/622247/>.
- Benyus, Janine M. *Biomimicry. Innovation Inspired by Nature.* William Morrow, 1997.
- Bijari, Maryam, Ardalan Aflaki, and Masoud Esfandiari. “Plants Inspired Biomimetics Architecture in Modern Buildings: A Review of Form, Function and Energy.” *Biomimetics* 10, no. 2 (2025): 1–26. <https://doi.org/10.3390/biomimetics10020124>.
- Borham, Omar, Ben Croxford, and Duncan Wilson. “Biomimetic Strategies for Sustainable Resilient Cities: Review across Scales and City Systems.” *Biomimetics* 9, no. 9 (2024): 1–30. <https://doi.org/10.3390/biomimetics9090514>.
- Chayaamor-Heil, Natasha. “From Bioinspiration to Biomimicry in Architecture: Opportunities and Challenges.” *Encyclopedia* 3, no. 1 (2023): 202–23. <https://doi.org/10.3390/encyclopedia3010014>.
- Dicks, Henry. “The Philosophy of Biomimicry.” *Philosophy and Technology* 29 (2016): 223–43. <https://doi.org/10.1007/s13347-015-0210-2>.
- Djukanovic, Mina, Alexandra Alegre, and Francisco Teixeira Bastos. “Prefabricated Solutions for Housing: Modular Architecture and Flexible Living Spaces.” *Buildings* 15, no. 6 (2025): 1–22. <https://doi.org/10.3390/buildings15060862>.
- Fishman, Robert. “The Global Crisis of Affordable Housing: Architecture Versus Neoliberalism.” *Architectural Design* 88, no. 4 (2018): 22–9. <https://doi.org/10.1002/ad.2317>.
- Gerola, Alessio, Zoë Robaey, and Vincent Blok. “What Does it Mean to Mimic Nature? A Typology for Biomimetic Design.” *Philosophy and Technology* 36 (2023): 1–20. <https://doi.org/10.1007/s13347-023-00665-0>.
- Hernández Falagán, David. “Review of Design of Collective Housing in the 21st Century.” *Buildings* 11, no. 4 (2021): 1–22. <https://doi.org/10.3390/buildings11040157>.
- Ilieva, Lazaara, Isabella Ursano, Lamiita Traista, Birgitte Hoffmann, and Hanaa Dahy. “Biomimicry as a Sustainable Design Methodology – Introducing the ‘Biomimicry for Sustainability’ Framework.” *Biomimetics* 7, no. 2 (2022): 1–13. <https://doi.org/10.3390/biomimetics7020037>.
- Klochko, Asmik Rubenovna. “Visions of the Future of Post-Industrial and Post-Pandemic Housing Architecture”. In *IOP Conference Series: Earth and Environmental Science*, no. 988 (2022). <https://doi.org/10.1088/1755-1315/988/4/042077>.
- Liu, Yiqi. “Analysis of the Vertical Forest of Milan in Terms of High-Rise Architecture and Biodiversity.” *Highlights in Art and Design* 3, no. 2 (2023): 47–52. <https://doi.org/10.54097/hiaad.v3i2.10043>.
- Mazur, Łukasz K. “Circular Economy in Housing Architecture: Methods of Implementation.” *Acta Scientiarum Polonorum: Architectura* 20, no. 2 (2021): 65–74. <https://doi.org/10.22630/ASPA.2021.20.2.15>.
- Mitxelena Etxeberria, Alex, and Enkarni Gómez Genua. “From Ecological Architecture to Biomimicry.” *Journal of Sustainable Architecture and Civil Engineering* 20, no. 3 (2017): 68–74. <https://doi.org/10.5755/j01.sace.20.3.19295>.
- Nachtigall, Werner, and Göran Pohl. *Bau-Bionik: Natur – Analogien – Technik.* Springer, 2013.
- Onyszkiewicz, Jakub. *Elementy biomimetyki w projektowaniu architektury w środowisku zrównoważonym. Ewolucja i interpretacja bioniki na przykładzie polskich i zagranicznych konkursów architektonicznych.* PhD diss., Politechnika Wrocławska, 2019.
- Paulichen Luana, Raquel M. Leite, and Silvia A. Mikami G. Pina. “Resilience in Architecture: Housing as a Process.” *Strategic Design Research Journal* 12, no. 2 (2019): 383–401. <https://doi.org/10.4013/sdrj.2019.123.06>.
- Pawlyn, Michael. *Biomimicry in Architecture.* RIBA Publishing, 2011.
- Pedersen Zari, Maibritt. *Regenerative Urban Design and Ecosystem Biomimicry.* Routledge, 2018.
- Pedersen Zari, Maibritt, and Katharina Hecht. “Biomimicry for Regenerative Built Environments: Mapping Design Strategies for Producing Ecosystem Service.” *Biomimetics* 5, no. 2 (2020): 1–17. <https://doi.org/10.3390/biomimetics5020018>.
- Pohl, Göran, and Werner Nachtigall. *Biomimetics for Architecture and Design: Nature – Analogies – Technology.* Springer, 2015.
- Sanglier Contreras, Gastón, Roberto Alonso González Lezcano, Eduardo José López Fernández, and María Concepción Pérez Gutiérrez. “Architecture Learns from Nature. The Influence of Biomimicry and Biophilic Design in Building.” *Modern Applied Science* 17, no. 1 (2023): 58–70. <https://doi.org/10.5539/mas.v17n1p58>.
- Sedira, Naim, Jorge Pinto, Isabel Bentes, and Sandra Pereira. “Bibliometric Analysis of Global Research Trends on Biomimetics, Biomimicry, Bionics, and Bio-inspired Concepts in Civil Engineering Using the Scopus Database.” *Bioinspiration and Biomimetics* 19, no. 4 (2024). <https://doi.org/10.1088/1748-3190/ad3ff6>.
- Seruga, Waclaw. “Architektura mieszkaniowa XXI wieku. Prognozy rozwoju.” *Czasopismo Techniczne. Architektura*, 1-A (1) (2014): 209–39. <https://doi.org/10.4467/2353737XCT.14.013.2463>.
- Speck, Olga, David Speck, Rafael Horn, Johannes Gantner, and Klaus Peter Sedlbauer. “Biomimetic Bio-inspired Biomorph Sustainable? An Attempt to Classify and Clarify Biology-derived Technical Developments.” *Bioinspiration and Biomimetics* 12, no. 1 (2017). <https://doi.org/10.1088/1748-3190/12/1/011004>.
- Stefano Boeri Architeti. Accessed January 3, 2025, at <https://www.stefano-boeriarchitetti.net/en/project/vertical-forest/>.
- Stoiljković, Branislava, Nataša Petković-Groždanović, and Goran Jovanović. “Individualization Concept in Housing Architecture.” *Facta Universitatis: Architecture and Civil Engineering* 13, no. 3 (2015): 207–18. <https://doi.org/10.2298/FUACE1503207S>.
- Uchiyama, Yuta, Eduardo Blanco, and Ryo Kohsaka. “Application of Biomimetics to Architectural and Urban Design: A Review across Scales.” *Sustainability* 12, no. 23 (2020): 1–16. <https://doi.org/10.3390/su12239813>.
- Verbrugge, Nathalie, Eleonora Rubinacci, and Ahmed Z. Khan. “Biomimicry in Architecture: A Review of Definitions, Case Studies, and Design Methods.” *Biomimetics* 8, no. 1 (2023): 1–29. <https://doi.org/10.3390/biomimetics8010107>.

Streszczenie

Definiowanie biomimetycznej architektury mieszkaniowej: wyznaczniki i wybrane projekty

W artykule podjęto temat współczesnych projektów wykorzystujących elementy biomimetyczne w architekturze mieszkalnictwa zbiorowego. Autorka ukazała, w jaki sposób realizacja kryteriów definiujących architekturę biomimetyczną wpływa na kształt, funkcjonowanie i idee tych obiektów. Przedstawione przez nią koncepcje charakteryzują się dominacją megastruktur i konstrukcji wertykalnej, wielofunkcyjnością, elastycznością przestrzeni oraz dążeniem do energetycznej samowystarczalności. Biomimetyka przejawia się w nich zarówno w zaawansowanych systemach technologicznych, inspiracjach biologicznymi procesami i materiałami, jak i w formach architektonicznych nawiązujących do struktur naturalnych. Na podstawie przeprowadzonej analizy autorka wskazała na potencjał biomimetycznych rozwiązań w poprawie komfortu życia mieszkańców, budowaniu relacji społecznych, zwiększaniu odporności budynków na zmiany klimatyczne oraz w ograniczaniu negatywnego wpływu na środowisko. Jednocześnie podkreśliła, że biomimetyczne mieszkalnictwo zbiorowe pozostaje w dużej mierze w sferze projektów koncepcyjnych, co odzwierciedla zarówno rosnące zainteresowanie tą ideą, jak i istotne wyzwania związane z jej realizacją.

Słowa kluczowe: biomimikra, biomimetyka, bioinspiracja, biofilia, architektura mieszkaniowa

