

**Ascending sequential Historical Trajectory of Biomimicry
In Architectural Buildings Through the Ages Between
Strength and Weakness**

Dr. Amal R. Tantawy

Lecturer of Architecture, Dept. of Architecture, Future Higher Institute of
Engineering, Fayoum, Egypt

Abstract:

Proposing and designing an ascending sequential historical path for imitating nature in architectural buildings across the ages between strength and weakness, which is addressed in this research paper, contributes to investigating the extent to which it is possible to determine the quality and degree of presence of the concept of biomimicry throughout history in these different architectural eras in the work. Architectural research, monitoring and documenting the relationship between historical architectural stations and the effects of nature on them in all their architectural aspects. The research methodology is based on defining the research problem, then presenting the importance of the research field, defining the objectives, then studying previous literature related to the research, introducing the applied study cases, choosing the proposed measurement method, and the reasons for choosing the applied study samples. Then he made questionnaire forms to conduct the research survey. The sample of the research study was chosen from 75 people, including architects, designers, specialists in the field of architecture, and students of the Department of Architecture in a number of universities with different schools and architectural orientations. The random method was excluded because it is not suitable for research and does not obtain misleading opinions or answers for reasons. Outside the scope of research, such as the weakness of culture or the spread of misconceptions about the concept of living tradition, or what is known as biomimetic, and its mutual relationship with the building over the ages among the public, or the lack of understanding of the criteria presented in the questionnaires, then monitoring the results and observations and it was noted that many historical examples of architectural stations for inspired buildings From nature, it has failed the test when compared to modern-day examples of imitating nature in architecture, such as green sustainable architecture, because it lacks the features of imitating nature in appearance and content. The most notable finding in the results is that sustainable architecture (green bio) obtained an average of (5) and a percentage reached (23%). It is the architecture with the highest majority in the other architectural stations in the application of Biomemicy, while it was found that Islamic architecture received an average score of (2.3) and a percentage of (11%), and it is the least architecture in the other

architectural stations in the application of Biomimicry. The research paper recommends and proposes the application of the applied research study on a large scale. Wider and on a larger scale to all segments of society in order to better understand the public's sense and interpretations of the value of architectural biomimicry with different types of buildings throughout the ages and civilizations of historical practice, to measure the extent of their awareness and to become familiar with information for general users, which has been proven from previous studies that it often differs from the information and study of architects and specialists in this field.

Keywords: Bioarchitectural history, biomimicry, bioarchitecture, biomimicry between strength and weakness, an upward historical path.

Research problem:

In the current era, it has become a basic requirement for architectural design to be sustainable and considerate of the surrounding natural environment. In light of this goal, nature has always been the first teacher for humans historically in their designs and buildings throughout the various architectural eras. However, despite this, scientific research studies are now lacking in the field of bioarchitecture. To the possibility of designing a proposal for a clear sequential path that traces the concept of biomechanics and the extent of its application between strength and weakness in previous historical buildings from the beginning of creation until the current era of modern architecture. Researchers paid attention to this problem and worked to solve it through study, research, experimentation, and the method of statistical measurement to determine the extent to which this can be achieved based on From the point of view of designers and researchers specialized in the field, and because of the weakness and scarcity of scientific research in this field, the necessary need has arisen to propose a sequential and progressive historical path to imitate nature in architectural buildings throughout the ages, showing the extent to which the concept of biomimicry has been achieved between strength and weakness.

Objectives:

1. Finding close examples of the concept of bio-imitation in architectural history before formulating the concept of bio-imitation and identifying what modern examples lack.
2. Activating the concept of sustainability through the trend of simulating nature as a development and modernization tool.
3. The possibility of benefiting from biomimicry as a tool and strategy to achieve sustainability.
4. Reaching an innovative design idea that achieves a balanced and sustainable environment.
5. Studying the applications of simulating nature in the fields of design and architecture.
6. Exchange of science and experiences inspired by simulating nature.
7. A proposed design for an ascending sequential historical path to imitate nature in architectural buildings through the ages between strength and weakness

Research Methodology:

To achieve the main objective of the research, the research study relies on the following

Research methodology:

- Determine the research problem
- Importance of the research field of study.
- goals and assignments
- Study of literature and previous theoretical studies related to the research topic.
- Introducing applied case studies and choosing the proposed research measurement method.
- Reasons for choosing samples for the applied study
- Making and designing questionnaire forms to conduct the survey in the field of research.
- Results.
- Interpreting and analyzing the results in light of theories, hypotheses and previous studies.
- Necessary scientific recommendations.

Introduction:

By studying examples of historical precedents in the field of biomimicry, we find that man has always looked at nature as a guiding light for architectural possibilities, as the human eye and brain developed over the course of previous architectural eras and civilizations, most of which were within the components and natural landscapes surrounding him, and man has always looked To nature in search of solutions to his problem, and historical attempts and observation of various man-made structures and inventions, especially in architecture, reveal important developments contributed by the study and observation of nature. Such historical studies help us understand what is and what was, and accordingly environmental architecture appeared in Ancient civilizations are in the form of man's attempt to adapt and coexist in his environment. The forms of this adaptation varied from the use of materials available in the local environment in urbanism, through the methods of using them, and ending with the methods he followed to deal with the elements of the environment and their determinants. The idea of biomicroarchitecture depends on establishing a creative dialogue between the origin (the natural element) Its reformulated image is that it is a simulation that adapts to its surroundings, allowing room for creativity, innovation, and arriving at the best solutions. It is capable of absorbing the environmental changes occurring in its surroundings. It is a new innovation inspired by natural examples. It goes through several stages before it reaches the final product, and with the negative deterioration of the environment that has occurred recently, due to climate changes that have occurred globally, resulting from years of human intervention in the natural environment through fuel consumption. Fossil, to advocate a more sustainable approach to modern living conditions, and then adopt different approaches to sustainability to better improve climate conditions. Many of these methods and ideas point to one truth; That nature itself was the bedrock of sustainability. With a continuous adjustment process.

1- Theoretical and analytical study:

1-1- The concept of being inspired by nature:

Biomimicry is an approach to innovation that seeks to find sustainable solutions to human challenges by simulating nature's time-tested patterns and strategies [1]. It can be described as the imitation of models, systems, and elements of nature for the purpose of solving complex human problems. in Webster's Dictionary. In 1997, the term biomimicry became a more popular scientific term, after the publication of the first book to delve into this science. It was called *Innovation Inspired by Nature*, by the American scientist and writer Janine Benius. [2]

1-2- Biomimetic architecture:

It is a contemporary philosophical concept of modern architecture that seeks to find solutions to achieve sustainability in nature, not by following the approach of directly replicating natural forms only, but by understanding the rules that govern those forms. It can be defined as an interdisciplinary approach to sustainable design that follows a set of principles rather than just superficial stylistic codes and is part of a larger movement known as biomimicry, which is the examination of nature and its models, systems and processes with the aim of obtaining inspiration for the solution of man-made problems, keeping in mind that biomimicry is not limited to merely helping In discovering new and sustainable solutions in architecture but also that can be implemented in other ways to help meet human needs, the goal is to create products, processes and policies (new ways of living) that are sustainable, solve our greatest design challenges and support all life on Earth [3]

1-3- Biomimicry:

Since 1982, new scientific studies and research began to inaugurate and formulate a new scientific concept and term, which is (Biomimicry). In 1997, the biologist Janine Benyus wrote a book specifically for this new scientific field (Biomimicry) and defined this term as “innovation inspired by Nature is a new science that studies models of nature and then imitates or takes inspiration from these designs as a model and measurement directed to solving human problems.” She is also the founder of the biomimicry movement and a certified science writer who looks to nature as a major source of inspiration through biomimicry for three types of biological entities into which technology can be modeled: natural methods of (chemical) manufacturing; mechanisms and structures found in nature; and regulatory principles in the social behavior of animals, so centers for the study of biomicrobiomes have emerged in recent years at universities around the world, under names such as the Laboratory for Biologically Inspired Systems in Sweden. [4]

1-4- Historical precedents in the field of drawing inspiration from nature:

When we study the historical precedents in the field of biomimicry, we find that before the widespread spread of the concept of biomimicry currently in contemporary architecture, it was clear throughout the history of the architecture of civilizations that a group of practices similar to this concept had been practiced throughout previous historical eras, such as designs inspired by nature that were present in Ancient Egyptian architecture, for example, or Greek architecture, Islamic architecture, or Mesopotamian architecture. One example of this is the first model of an aerial plane designed by Leonardo da Vinci, which was inspired by the flight of birds. In this research paper, we seek to

uncover similar examples of inspired designs. From nature in architecture to a group of the most important stations of previous architectural civilizations through a sequential ascending presentation, by displaying and analyzing examples, noting an important conclusion, which is that this study not only helps us in identifying these examples and linking them to the current concept of imitating nature, but also gives us an understanding Better the concept of biomimicry in architecture by pointing out what ancient practices lack, which the modern concept of biomimicry takes care of. [5]

1-5- Vital architecture vocabulary throughout the ages (the most prominent stations in the history of architectural civilizations from the oldest to the newest):

1-5-1- The architecture of Mesopotamia from the year (4000 BC - 3500 BC):

Mesopotamia or Mesopotamia is a region located in southwest Asia on the Tigris and Euphrates rivers, which benefited from the climate and geography of the region to advance the beginnings of human civilization, and its history is characterized by many important inventions that changed the world, as humans settled for the first time in Mesopotamia. In the Paleolithic Age, by 14,000 BC, the inhabitants of the region lived in small settlements with circular houses. These houses then formed agricultural communities after the domestication of animals and the development of agriculture, most notably irrigation techniques that took advantage of the proximity of the Tigris and Euphrates rivers. It is worth noting that nature had An important role in the architecture of Mesopotamia, as it was one of the restrictions imposed on artists and engineers in terms of climate and geography. [6] The columns and walls differed in Mesopotamian architecture with different buildings and different time periods, and the bio-traditional tradition in Egyptian architecture was very clear in the formal patterns of the columns and walls. They came in floral patterns inspired by nature or in the form of a human head and the body of animals, as appears. In Table (1).



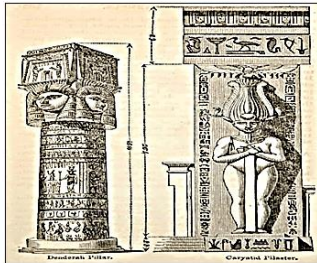

NO.	Architectural elements	Applying the concept of biomimicry	Image
1	Walls	In the Assyrian architecture of Mesopotamia, the walls were decorated and the bio-imitation was applied in them with engravings that represent images of hunting, wars, animals and plants. The tablets tell stories of their military and sporting heroism, religious myths and gods	
2	Columns	The use of columns was rare in Mesopotamia, except in Assyrian architecture. The Assyrian column contained the base and the body, which contained cavities. The lively tradition was applied to it, in which the capital had circular decorations bearing animal heads or human heads. The use of columns was aesthetic, not structural	




Table (1): Shows the different types of columns and walls inspired by nature in Mesopotamian architecture, source (researcher).

1-5-2- Ancient Egyptian (Pharaonic) architecture from 300 BC to 3100 BC:

The system of government in ancient Egypt was associated with the religious beliefs that prevailed in the country, and these beliefs were of great importance in the stability of the system of government and the spread of security and safety. The Egyptian believed that there were powers that symbolize God, represented by birds, animals, and stones, so he turned to sanctifying and worshipping these creatures. It should be noted that ancient Egyptian architecture laid the foundations for architecture and its style in the world. The ancient Egyptian developed the supports into columns that were built in proportion to the human need, and his thought in that era is considered one of the most prominent signs of development in the construction of columns in ancient Egypt is the building of the Step Pyramid in Saqqara; The pyramid took an amazing gradient until it ended in the form of columns that contain channels, and the columns differed in the ancient Pharaonic architecture with different buildings and different time periods, and the types of columns multiplied, and the vital tradition in Egyptian architecture was very clear in the formal patterns of the columns, so it came in patterns Vegetal, inspired by nature, or in the shape of a human head, as shown in Table (2). Likewise, the uses of columns among the Pharaohs were numerous, not limited to loads only, but were sometimes for aesthetic purposes. [7]

Table (2): Shows the different types of columns inspired by nature in ancient Egyptian architecture, source (researcher)

NO.	Architectural elements	Applying the concept of <u>biomimicry</u>	Image
1	Hathor columns	They were called the <u>Hathor</u> columns in relation to the presence of the god <u>Hathor</u> , and the vital tradition was applied in them by making the column head in the shape of the head of the god <u>Hathor</u> . Sometimes the facade of the temple was engraved above the head of this god, and the lower part of the column was round and called (<u>cistron</u>), and the column was used In the Temple of Philae and the Temple of <u>Hathor</u> .	
2	Palm columns	The botanical-style columns were called palm-tree columns, and bio-tradition was applied to them. The overlapping of the column leg and the head of the column gives the shape of a palm tree. The section of the column is ribbed and decreases in drop as we move downward. The column had a circular base. The head of the column resembles the interconnection between palm fronds. Below the head of the column there are five colored circular strips indicating the method of connecting palm fronds with ribbons. Palm columns were used in the Temple of the <u>Ramesseum</u> , the Temple of Philae, and the Temple of the Pyramids of Abu Sir. Egypt.	

3	Lotus columns	<p>It is one of the botanical-style columns, and bio-imitation was applied to it because the head of the column resembles an open lotus flower. The head of the column was colored green, and below the head of the column there are five colored circular slices indicating the method of interconnecting the stems of the lotus flower. The stem of the column is circular and smooth, and inscriptions are written on it. Drawings: The column had a circular base, and there was another type of lotus column with an inverted head (meaning that the lotus flower was in an upside-down shape), as found in the <u>Karnak</u> Temple, and that column was used in the Temple of <u>Edfu</u> (Temple of Horus) and the Temple of Philae.</p>	
4	Papyrus columns	<p>It is a botanical-style column, and bio-imitation has been applied in it because the column head is a grouping of papyrus plants interconnected from the bottom by slices, and below the head of the column there are five colored circular slices indicating the method of interconnecting the stems of the papyrus plant, the stem of the papyrus plant is a grouping of Papyrus stems, and sometimes the stem was round and smooth.</p> <p>The stem sector has three different areas, as it starts from the bottom with a small area sector, then a large area sector, then a relatively small area sector. The columns are used from real plants, and therefore the columns had a crooked shape due to the loads, which prompted the ancient Egyptian sculptor to simulate the ancient plant columns, and this appeared in the stone columns, and the column had a circular base, and the column was used in the Luxor Temple.</p>	
5	Composite columns	<p>Composite Columns The compound column is a mixture of several columns (the lotus column and the papyrus column). Bio-imitation was applied to it because the column head was a crown of lotus flower surmounted by a lily crown, then a crown of papyrus; Between the lily crown and the papyrus crown there are leaves of ripe lotus in the form of a knot. As for the stem of the column, it was the stem of the simple column, and the area of the cross section decreases from the bottom to the top. The base of the column is circular, and the bottom of it is another square base. <u>Velai</u> Temple.</p>	

1-5-3- Greek architecture from 3000 BC to 146 BC:

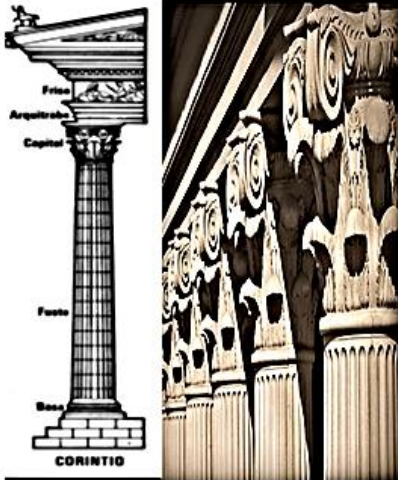

The first primitive Greek civilization was during the Bronze Age, where it began and settled around the Aegean Sea, and was called the Cycladic civilization, in reference to the Cyclades islands that arose around it, and which lasted from 3000 to 2000 BC, and Greek arts are considered among the first arts that were concerned with accuracy in drawing, And the design, in all shapes and drawings drawn on the walls of temples, takes into account precision in sculpture. Therefore, the vital tradition has become clear and evident in the art of Greek sculpture in architectural buildings, where Greek sculptures are characterized by beauty and charm mixed with delicacy and balance, and are often realistic and dignified, inspired by humans. Or the animal element has multiple movements, so we find sculptures with different movements and poses. The completeness of this reality makes the sculpture full of life, and there are many types of columns. The bio-tradition in Greek architecture

**INTERNATIONAL JOURNAL OF
ARCHITECTURAL ENGINEERING AND URBAN RESEARCH**

Volume 7, Issue 1, 2024. 87 – 108

was very clear in the formal patterns of the columns, so they came in floral patterns inspired by nature, such as the Corinthian columns, as shown in Table (3). It is worth noting that the most important What distinguishes Greek civilization are the three lineages that are taken into consideration while drawing: (Doric, Ionic, and Corinthian), and each of them has its own style, in terms of drawing on walls, columns, and ceilings. [8]

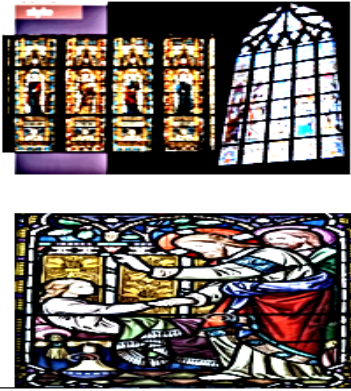

Table (3): Shows the different types of columns inspired by nature in Greek architecture. Source (researcher).

1	Corinthian Columns	<p>The Corinthian column in Greek civilization - which flourished in Corinth, has Egyptian influences, and is very similar to the Ionic column, but its capital is in the form of two arrangements of Acanthus leaves. The sculptors found in the pediment the best opportunities to show their art, and they could engrave pictures in great relief, and so large that those standing at the bottom of the building could see them; The lively imitation was applied to the Corinthian Ionic column, but the capital is derived from the bell-shaped Egyptian columns, and the Greeks replaced the lotus flower and used the Greek thistle leaf. It has a compound base, a body and a crown in the shape of plants, but the height of the Corinthian column is 10 times its diameter.</p>	
2	Sculptures	<p>Greek sculpture exudes grace and charm mixed with delicacy and poise, often realistic and solemn. Multi-movement, we find sculptures in all kinds of movements and poses. Highly realistic integration which makes the sculpture full of life. Diversity of tools such as marble, bronze and other metals. The most prominent examples are: the statue of the god of love and beauty Venus, the statue of the discus thrower, and the statue of the god Zeus. The columns of the temples are in the form of women, and what the Greek sculptors are most famous for is that in the year 500 BC, they broke the rigid rules in art and carved sculptures that were close to reality in their details and size, and glorified the human body. Therefore, the vital tradition appeared clearly in the sculptures of the Greek era.</p>	

1-5-4- Gothic architecture from 1000 AD to 1500 AD:

The Gothic style originated in the Ile-de-France region in northern France during the first half of the twelfth century. The Gothic style spread from the Ile-de-France to other cities in northern France from the end of the twelfth century until the middle of the thirteenth century. The halls were usually decorated with statues of angels, which became an important decorative element in the High Gothic styles, and the use of supporting shoulders appeared in churches and cathedrals, which made the building strong and simple. The types of architectural vocabulary multiplied in this era, and the lively tradition in Gothic architecture became very clear in the styles. The formality of the drawings on the windows and statues came in human and animal patterns inspired by nature, as shown in Table (4). It is worth noting that the most prominent feature of Gothic architecture is the presence of stylized and precise decorative elements. These include columns and decorations, sculptural moldings, and statues of saints and historical figures. [9]



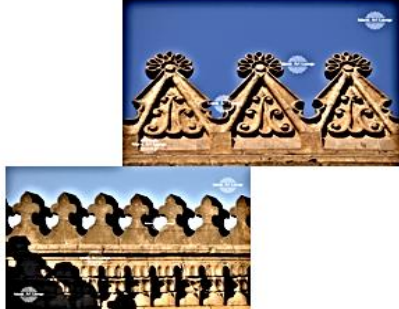
Table (4): Shows the different architectural vocabulary inspired by nature in Gothic architecture, source (researcher).

1	Windows	<p>Stained glass windows are found in many places of worship, but they are particularly prevalent in Gothic cathedrals. These windows feature finely cut stained glass which are usually either tall, arched windows or round rose windows larger than those found in other types of churches of the arts. The glass allows more dazzling light to enter. Gothic stained glass windows also frequently feature tracery, a decorative type of stone support, and the vivid imitation is evident through drawings of sacred figures and detailed scenes from Bible stories.</p>	
2	Sculptures	<p>Gothic architecture was characterized by refined and meticulously crafted decorations. It included all the internal and external elements of the building. It began to borrow from Roman architecture, as well as drawing inspiration from the surrounding nature. Despite the limited technical capabilities of materials and equipment that were available at this time, it can be said that Gothic architecture fulfilled its spiritual purposes. It is required to move toward the sky with lightness and grace, even though it is one of the heaviest materials, which is stone.</p>	

1-5-5- Islamic architecture from 639 AD to 1850 AD:

The history of Islamic architecture began with the migration of the Prophet - may God bless him and grant him peace - and his companions to Medina and the building of the Quba Mosque, then the construction of the Noble Prophet’s Mosque. The Messenger, may God bless him and grant him peace, participated in its construction to establish in turn one of the doors of Islamic civilization, which is Islamic architectural civilization, and these are the structural characteristics that The Muslims used it to be their identity, and that architecture arose thanks to the Muslims in the areas it reached, and as shown in Table (5), the vital tradition in Islamic architecture was very clear in the formal patterns of the drawings on the windows (parasols) and the roundabouts of the mosques (the brides of the sky). And Salsabil (Shaduran) came on plant patterns inspired by nature, [10], [11]

Table (5): Explains the different architectural vocabulary inspired by nature in Islamic architecture, the source (researcher)

NO.	Architectural elements	Applying the concept of biomimicry	Image
1	Windows	They are partitions made of gypsum that are decorated using a hollow-out method, then their spaces are filled and covered with colored glass. These spaces create decorations inspired by natural plant shapes. These barriers are then placed after they are completely manufactured in the windows, windows, and openings that are often in the upper parts of the walls or the tops of the doors. And the windows. Bio-imitation is evident through decorations inspired by natural plant motifs.	
2	Salsabil (Al-Shazuran)	It is an engraved or wavy marble slab with images of animals, fish, and natural plants engraved on its edges, with water flowing on it. <u>Biomimicry</u> is clearly evident through these decorations inspired by natural plant forms.	
3	Erayis alsama' (alsharafati)	They are repetitive geometric units surrounding the highest circles of buildings in Islamic architecture, including botanical ones. This means that the bio-imitation was designed and the bio-imitation appears clearly in these units with shapes inspired by natural plants.	

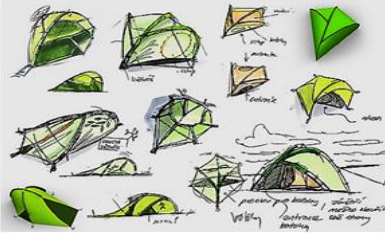


1-5-6- Sustainable architecture (bio-green) from 1970 (International Union for Conservation of Nature Conference) until the present era:

Sustainable architecture or biogreen architecture is a general term that describes environmentally conscious design techniques in the field of architecture. It is the process of designing buildings in a manner that respects the environment, taking into account reducing the consumption of energy, materials and resources while reducing the effects of construction and use on the environment while organizing harmony with nature. The concept of sustainable architecture can be formulated as one of the modern trends of architectural thought that emerged in the twenty-first century, which is concerned with the relationship Between the building and the environment, whether natural or manufactured. Sustainability means low cost, continuity, and interaction with the environment. Sustainable development takes into account the current needs of society without affecting the rights of future generations to meet their needs. Among the concepts of bio-green architecture came the term biomemory, where nature is used as a metaphor. In form and quality, the degree of similarity of the design to the original source varies according to the controls and rules of design of the product or building itself, so that nature is used as a metaphor for design according to the different standards of buildings and cities in societies and environmental and climatic conditions. That is, it is similar to nature, but in a different way in the formal production, and as shown in Table (6), biomimicry in bio-green architecture was very clear in the formal and applied mechanical patterns in many examples of buildings, [12], [13], [14]

INTERNATIONAL JOURNAL OF ARCHITECTURAL ENGINEERING AND URBAN RESEARCH

Volume 7, Issue 1, 2024. 87 – 108







Table (6): Shows the different architectural vocabulary inspired by nature in sustainable (green) (architecture, source (researcher

NO.	Architectural elements	Applying the concept of biomimicry	Image
1	Camping houses (tent)	It is a tent inspired by waxed tree leaves that are highly resistant to fires and weather factors. Nature was used as a metaphor in form and style, and the degree of similarity of the design to the original source varies according to the controls and rules of designing the product (the tent). The essence of the form has been reconstructed and built from the original source to produce works that are appropriate. Given the nature of the environment in a larger way, the idea of recomposition lies in simulating parts of the original source while formulating it according to the needs of the design and the surrounding environment.	
2	Theater buildings	The esplanade theater or the commercial district in Singapore, which was designed by Michael Wilford in 2002 AD, so that it was possible to design an envelope associated with lighting the various interior spaces in the building, and the design was inspired by the multi-layered Durian fruit covered with a shell of thorns.	
3	Ministry of Municipality and Urban Planning building project in Doha, Qatar (Al-Sabar	The building is considered able to provide all its energy needs through clean energy sources such as solar energy, in addition to containing an internal plant dome inside it, and the bio-imitation is evident in this example through the fall of sun shades on the windows where the openings can be opened or closed in an automatic way to suit the prevailing temperature, simulating the activity of cacti that perform transpiration at night instead of during the day in order to conserve water dynamically.	

**INTERNATIONAL JOURNAL OF
ARCHITECTURAL ENGINEERING AND URBAN RESEARCH**

Volume 7, Issue 1, 2024. 87 – 108

Table (7) compiled for comparison between examples of biomechanical architecture elements in the most prominent stations of previous architectures, from oldest to newest, source: researcher.

NO.	Civilization	Example	Image	Notes
1	Architecture of Mesopotamia from (4000 BC - 3500 BC)	Walls		In the Assyrian architecture of Mesopotamia, the walls were decorated and the bio-imitation was applied in them with engravings that represent images of hunting, wars, animals and plants. The tablets tell stories of their military and sporting heroism, religious myths and gods.
2	Ancient Egyptian (Pharaonic) architecture from 300 BC to 3100 BC	Hathor columns		They were called the Hathor columns in relation to the presence of the god Hathor, and the vital tradition was applied in them by making the column head in the shape of the head of the god Hathor. Sometimes the facade of the temple was engraved above the head of this god, and the lower part of the column was round and called (cistrion), and the column was used In the Temple of Philae and the Temple of Hathor.
3	Greek architecture from 3000 BC to 146 BC	Corinthian Columns		The Corinthian column in Greek civilization - which flourished in Corinth, has Egyptian influences, and is very similar to the Ionic column, but its capital is in the form of two arrangements of Acanthus leaves. The sculptors found in the pediment the best opportunities to show their art, and they could engrave pictures in great relief, and so large that those standing at the bottom of the building could see them; The lively imitation was applied to the Corinthian Ionic column, but the capital is derived from the bell-shaped Egyptian columns, and the Greeks replaced the lotus flower and used the Greek thistle leaf. It has a compound base, a body and a crown in the shape of plants, but the height of the Corinthian column is 10 times its diameter.
4	Gothic architecture from 1000 AD to 1500 AD	Sculptures		Gothic architecture was characterized by refined and meticulously crafted decorations. It included all the internal and external elements of the building. It began to borrow from Roman architecture, as well as drawing inspiration from the surrounding nature. Despite the limited technical capabilities of materials and equipment that were available at this time, it can be said that Gothic architecture fulfilled its spiritual purposes. It is required to move toward the sky with lightness and grace, even though it is one of the heaviest materials, which is stone.
5	Islamic architecture from 639 AD to 1850 AD	Eraiyis alsama' (alsharafati)		They are repetitive geometric units surrounding the highest circles of buildings in Islamic architecture, including botanical ones. This means that the bio-imitation was designed and the bio-imitation appears clearly in these units with shapes inspired by natural plants.
6	Ministry of Municipality and Urban Planning building project in Doha, Qatar (Al-Sabar)	Ministry of Municipality and Urban Planning building project in Doha, Qatar (Al-Sabar)		The building is considered able to provide all its energy needs through clean energy sources such as solar energy, in addition to containing an internal plant dome inside it, and the bio-imitation is evident in this example through the fall of sun shades on the windows where the openings can be opened or closed in an automatic way to suit the prevailing temperature.

2-Applied study:

The imitation of nature is a solution-based approach that is best used when problems that require practical solutions arise. The applied study of this research is achieved by designing a proposal for an upward sequential historical path to measure natural imitation in various architectural buildings through the ages between strength and weakness:

Objective of the applied study:

Measuring the rates and rates of investigation into the extent of the possibility of determining the quality and degree of presence of the concept of biomimicry throughout history in these different architectural eras in architectural work by conducting a survey. This applied research study is considered an important step towards a deeper understanding that goes beyond only the external formal application of the concept of imitation. Biomimetics and the desire to improve the apparent aesthetics of the architectural product. Rather, it requires the need to create actual structures that make the architect's work among the real additions in the field of biomimetics. Therefore, the research necessity came to formulate a proposed methodology to measure the extent of the impact of this concept's reflection in historical architectural civilizations from the beginning of creation until the present day. And the extent of the gradation of their levels between strength and weakness, through analyzing and monitoring some examples. Among the reasons for choosing the examples are:

- Examples of buildings and architectural vocabulary influenced by nature from different architectural historical eras.
- Pictures of buildings were chosen for realistic examples.
- The most representative examples of the selected controversial point under applied research study were chosen.

The applied study was conducted in successive stages as follows:

- 1- The stage of selecting the study sample.
- 2- The stage of conducting the survey and questionnaires and designing the proposed methodology.
- 3- The statistical measurement and calibration stage using the SPSS statistics program.
- 4- The stage of comparison, evaluation, and formulation of results.

1-The stage of selecting the study sample:

The sample of the research study was chosen from 75 people, including architects, designers, specialists in the field of architecture, and students of the Department of Architecture in a number of universities, regardless of their schools and architectural orientations to which the study sample belongs. The random method was excluded because it was not suitable for the research and did not obtain misleading opinions or answers for reasons beyond its scope. The scope of the research, such as weak culture, the spread of misconceptions about the concept of biomimicry in the architectural field among the public, or a lack of understanding of the standards presented in the questionnaires.

2- The stage of conducting the survey and questionnaires and designing the proposed methodology:

More than 42 diverse images were chosen as examples of the various bio-architecture vocabulary of about six (6) types of the most prominent previous architectural stations, from the oldest to the newest, which were previously explained and analyzed in the analytical part of the research. It was taken into account that the images include the use of nature. In architecture as a metaphor, whether in form or quality, with all its types, plant,

animal, or human. Then, questionnaire forms were designed in which the study sample was asked to evaluate the examples and conduct an upward measurement of the extent to which natural imitation has been achieved in architectural buildings throughout the ages, between the strength and weakness in each example. It was necessary It should be noted that the researcher has listed the most prominent historical architectural stations used in the applied study according to the types mentioned in previous theoretical and analytical studies by researching the concept of biomimicry and its development from the past to the present.

3- The statistical measurement and calibration stage using the SPSS statistics program: A five-point scale was used as shown in the questionnaire form in the appendices part and as shown in Table (8) as follows:

(Very strong): It is opposite the number (5) as its meaning. (Strong): It is opposite the number (4) as its meaning. (Medium): It is opposite the number (3) as its meaning. And (Weak): It is opposite the number (2). As its meaning and (very weak): It is matched by the number (1) as its meaning.

Table 8: Levels of statistical measurement and calibration and their equivalent as a numerical meaning. Source: Researcher.

the level	Grade given
Very strong	5
strong	4
middle	3
weak	2
Very weak	1

This is to identify the degree of percentages and rates of the presence of biomimicry in the representative images of buildings in different historical civilizations. The questionnaires were unloaded, the inputs were included in the SPSS statistical analysis program, the necessary data tables and graphs were made, and the results were formulated.

4- Results:

Comparing the averages, percentages, and the extent of the arrangement of the center of influence for applying biomicrography in historical architectural stations, ascending from oldest to newest, for the types selected in the research study:

From the outputs of the statistical analysis program SPSS for the survey questionnaire study, the researcher counted several average values of the extent of the effect of applying biomicrography in historical architectural stations, ascending from the oldest to the newest. The results varied and graduated from strength to weakness. Then the researcher made a comparison of the selected types, their percentages, and their percentage indicators (%)) and formulate the results with explanation and analysis as shown in the following Table No. (9):

**INTERNATIONAL JOURNAL OF
ARCHITECTURAL ENGINEERING AND URBAN RESEARCH**

Volume 7, Issue 1, 2024. 87 – 108

Table 9: Comparison between the averages, percentages, and the extent of the ranking of the center of influence for the application of biometrics in historical architectural stations, ascending from oldest to newest. Source: Researcher.

N O .	Civilization	Percentage of the biometric value of the architectural era in ascending order from the oldest to the newest	Average biometric value by architectural era, ascending from oldest to newest	Arrangement of types of historical architectural civilizations In terms of the most application of biomimicry in the building	Conclusions
1	Architecture of Mesopotamia from (4000 BC - 3500 BC)	14%	3	5	It was found from the statistical analysis that the architecture of Mesopotamia obtained fifth place in the ranking of the centers of types of historical architectural civilizations, according to the strength and weakness of the indication of biomimicry, as it came with a small amount of influence of the application of biomimicry on its architectural vocabulary from the point of view of the selected research sample, where its average score is (3), with a percentage of 14%.
2	Ancient Egyptian (Pharaonic) architecture from 300 BC to 3100 BC	16%	3.5	4	It was found from the statistical analysis that ancient Egyptian (Pharaonic) architecture ranked fourth in the ranking of the centers of types of historical architectural civilizations, according to the strength and weakness of the indication of biomimicry, as it came in a relatively moderate degree, tending to weaken the effect of applying biomimicry on its architectural vocabulary from the point of view of the research sample. Selected, where the average grade is (3.5), with a percentage of 16%.
3	Greek architecture from 3000 BC to 146 BC	19%	4.2	2	It was found from the statistical analysis that Greek architecture obtained second place in the ranking of the centers of types of historical architectural civilizations, according to the strength and weakness of the indication of biomimicry, as it came with a relatively high degree of influence tending to the strength of the application of biomimicry on its architectural vocabulary from the point of view of the selected research sample. Its average grade is (4.2), with a percentage of 19%.
4	Gothic architecture from 1000 AD to 1500 AD	17%	3.8	3	It was found from the statistical analysis that Gothic architecture obtained third place in the ranking of the centers of types of historical architectural civilizations according to the strength and weakness of the indication of biomimicry, as it came with an average degree of influence of the application of biomimicry on its architectural vocabulary from the point of view of the selected research sample, where its average score in it is (3.8) , with a percentage of 17%.
5	Islamic architecture from 639 AD to 1850 AD	11%	2.3	6	It was found from the statistical analysis that Islamic architecture obtained sixth place in the ranking of the centers of types of historical architectural civilizations, according to the strength and weakness of the indication of biomimicry, as it came with a very weak degree of influence of the application of biomimicry on its architectural vocabulary from the point of view of the selected research sample, where its average score in it is (2.3), with a percentage of 11%.
6	Sustainable (bio-green) architecture from 1970 until now	23%	5	1	It was found from the statistical analysis that sustainable architecture (bio-green) obtained first place in the ranking of centers of types of historical architectural civilizations, according to the strength and weakness of the indication of biomimicry, as it came with a very strong degree of influence of the application of bio-mimicry on its architectural vocabulary from the point of view of the selected research sample, where it amounts to His average grade was (5), with a percentage of 23%.

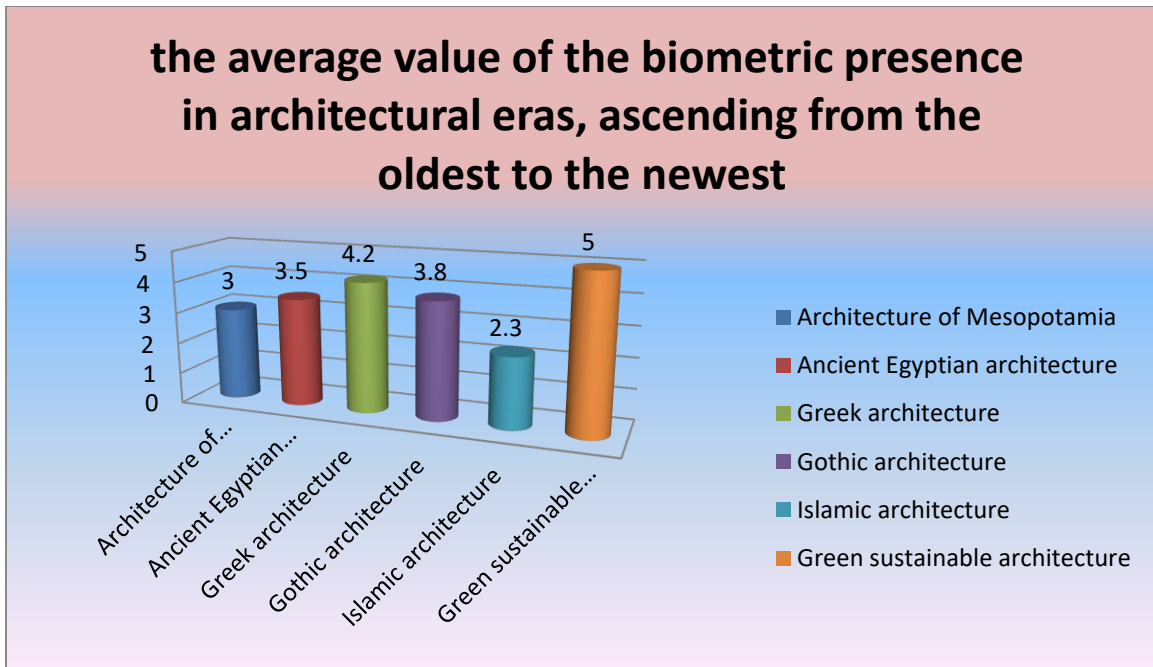


Figure 1: A graph showing the average value of the biometric presence in architectural eras, ascending from the oldest to the newest. Source: Researcher

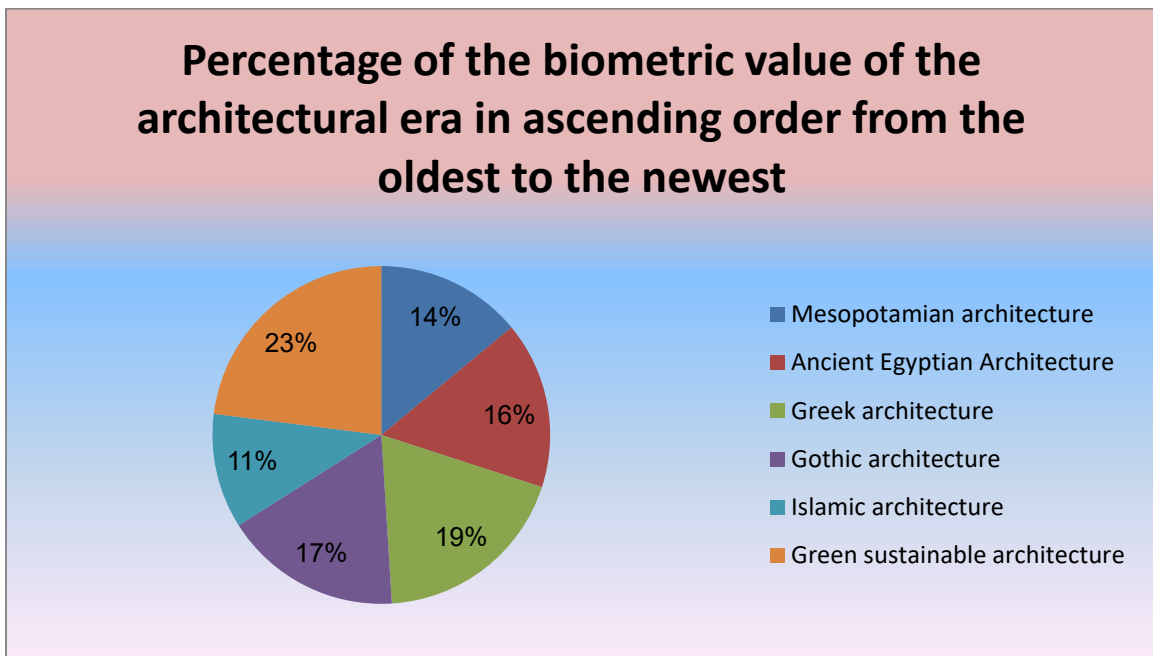


Figure 2: A graph showing the comparison between the percentages of the effect of biomimicry on the architectural elements of the selected types. Source: Researcher.

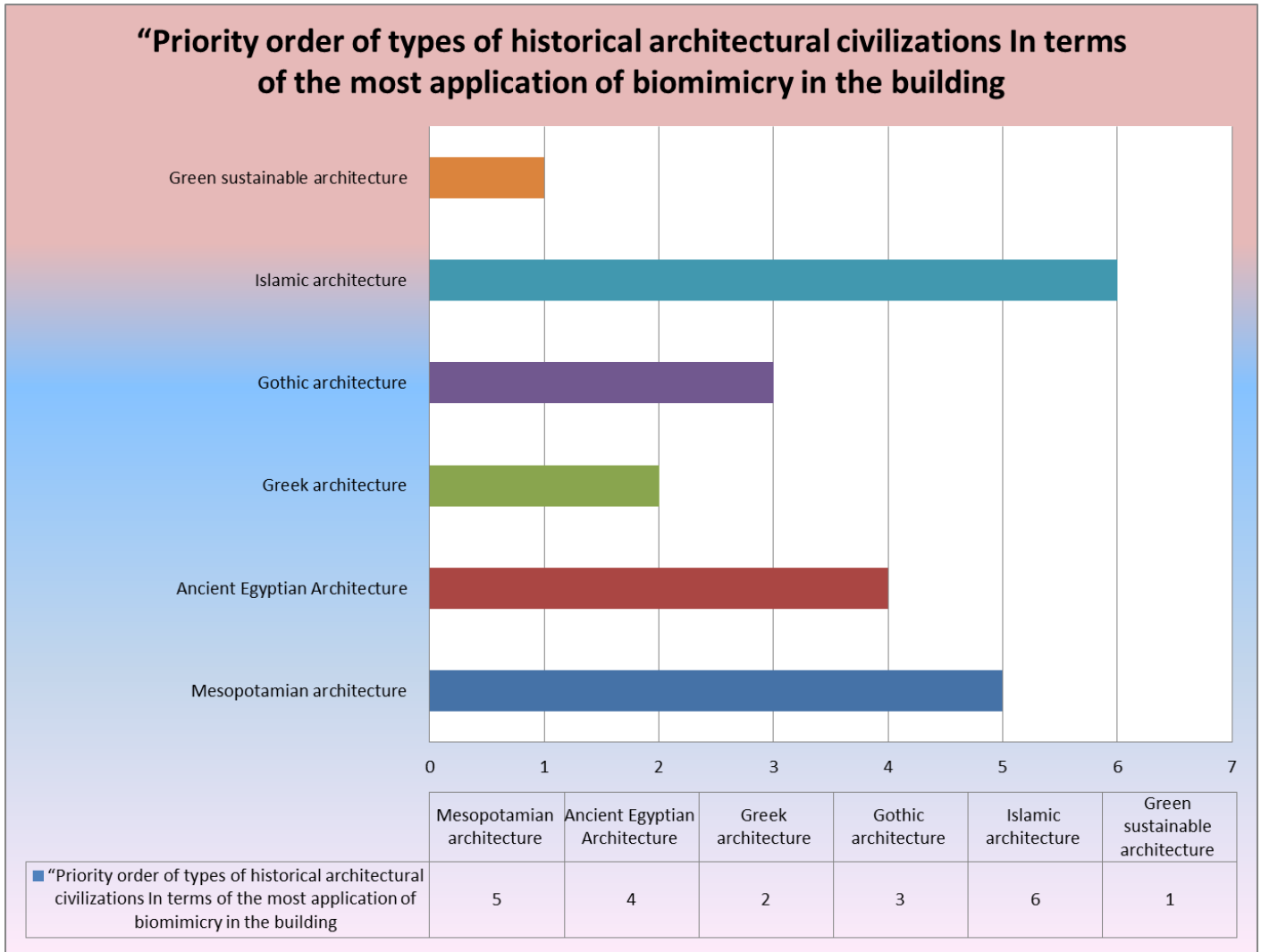


Figure 3: A graph showing “Priority order of types of historical architectural civilizations In terms of the most application of biomimicry in the building”, source: researcher

3- Discussion and general conclusions:

Similar examples of designs inspired by nature were revealed in previous buildings, which gave the researcher a better understanding of the concepts of bio-imitation in the field of architecture. With examples of the modern era of imitating nature in architecture such as green sustainable architecture, because it lacks the features of simulating nature in appearance and content, because when analyzing and studying modern architectural examples of imitating nature, we can notice that the design solutions that were obtained produced less waste, in terms of Energy and materials, and in some cases the cost, which support the environmental system and the concept of sustainability, and this is evident as follows:

1- After conducting a comparison and comparison between the averages of the effect of the reflection of the bio-imitation of the selected types of historical architectural stations on the level of their buildings and their architectural vocabulary separately, they can now be arranged from the point of view of the selected study sample in descending order from highest to lowest in presence in buildings as follows:

- Sustainable architecture (bio green) got an average of (5).
- Greek architecture (Greek) got an average of (4.2)
- Gothic architecture got an average of (3.8).
- Ancient Egyptian architecture (Pharaonic) got an average of (3.5).
- The architecture of Mesopotamia got an average of (3).
- Islamic architecture received an average of (2.3).

2 - After conducting a comparison between the percentages of the impact of the reflection of the bio-imitation of the selected types of historical architectural stations on the level of their buildings and architectural vocabulary separately, they can now be arranged from the point of view of the selected study sample in descending order from highest to lowest in presence in buildings as follows:

- Sustainable (green and bio) architecture received a percentage of (23%).
- Greek architecture received a percentage of (19%).
- Gothic architecture received a percentage of (17%).
- Ancient Egyptian (Pharaonic) architecture received a percentage of (16%).
- Mesopotamian architecture received a percentage of (14%).
- Islamic architecture received a percentage of (11%).

3 - After conducting a comparison between the arrangement of the centers of the types of historical architectural stations according to the strength or weakness of the indication of the presence of the vital tradition in them for each separately, it can now be arranged from the point of view of the selected study sample in descending order from the strongest to the weakest in presence in the buildings as follows:

- Sustainable architecture (bio-green) won first place.
- Greek architecture ranked second.
- Gothic architecture ranked third.
- Ancient Egyptian (Pharaonic) architecture ranked fourth.
- Mesopotamian architecture ranked fifth.
- Islamic architecture ranked sixth.

4- Future studies and suggested recommendations:




- 1- The research proposes applying the applied research study on a wider scale and on a larger scale to all segments of society in order to better understand the public's sense and interpretations of the concept of bio-imitation in architecture, as it is reflected in the selected types of historical architectural stations at the level of their buildings and architectural vocabulary each separately, with the aim of measuring the extent of their awareness And identifying the understanding and awareness of the general users, which has been proven from previous studies that it often differs from the understanding, analysis, interpretation and preference of architects and specialists in this field.
- 2- The need to increase cultural and scientific awareness among designers and the community of the concept and application of biomechanics in architectural buildings.
- 3- The necessity of applying and including what has been reached from the results of this important applied research study and adding it to the academic curricula in colleges specialized in architecture so that students can keep up with the findings of scientific research studies and recent experiences in this field.

5- References:

- 1- <https://www.ecomena.org/biomimicry-ar/>
- 2- <https://ar.wikipedia.org/wiki>
- 3- Jump up^ David Pearson, *New Organic Architecture: the breaking wave* (Los Angeles: University of California Press, 2001),
- 4- Maglic, Michael J., "Biomimicry: Using Nature as a Model for Design." Masters Theses 1911 February 2014.
- 5- Emmanuel K. Bright, Warebi G. Brisibe, *Biomimicry in Architecture; a Study of Historic and Modern Precedents*, paper, 2021, IOSR Journal of Environmental Science, Toxicology and Food Technology.
- 6- <https://www.philadelphia.edu.jo/academics/aahmad/uploads/>
- 7- Jimmy dun; Egypt: the columns of ancient Egypt. [Weblog] Available from: <http://www.touregypt.net/featurestories/columns.htm> [Accessed June 12, 2020]
- 8- https://www.uotechnology.edu.iq/depararchitecture/lectures/second_class/history_of_architecture/history_of_architecture_p2.pdf
- 9- <https://www.hisour.com/ar/gothic-revival-architecture>.
- 10- Islamic architecture - Wikipedia (wikipedia.org)
- 11- Peter J. Lu¹ & Paul J. Steinhardt. "Decagonal and Quasi-Crystalline Tilings in Medieval Islamic Architecture". *Science Magazine*. 2013-09-22.
- 12- Mohsen Mohamed Ibrahim, 2006, *Sustainable Architecture*, the first scientific conference, Architecture and Urbanism in the framework of development, the first axis, architectural and urban development and sustainability, Egypt.
- 13- 8-10 May 2008, *Sustainable Buildings*, The Third Forum for Architecture and Sustainable Development, Biskra 2008 Strategies and Prospects, Algeria
- 14- <https://tasmeemblog.wordpress.com/2015/11/25/biomimicry/>

6- Appendix:

Questionnaire forms Source: Researcher:

<u>Questionnaire form</u>				
<p>Through a research study on a topic that deals with the progressive historical path of imitating nature (biomimicry) in architectural buildings across the ages between strength and weakness, specialists in the field are requested to complete the following questionnaire:</p>				
<p><u>Personal Data:</u></p>				
<p>Name: (optional), Degree , Occupation:</p>				
<p>In your opinion, which of the following historical architectural civilizations is most influenced by nature, whether by humans, animals, or plants (biomimicry), in terms of external appearance or the dynamism of the way of working, whether in buildings or architectural elements, in terms of five levels between strength and weakness?</p>				
<p>1- Mesopotamian architecture:</p>				
				
<p>Very strong strong medium..... very weak weak.....</p>				
<p>2- Ancient Egyptian Architecture</p>				
				
<p>Very strong strong medium..... very weak weak.....</p>				
<p>3- Greek architecture</p>				
				

INTERNATIONAL JOURNAL OF
ARCHITECTURAL ENGINEERING AND URBAN RESEARCH

Volume 7, Issue 1, 2024. 87 – 108

Very strong strong medium..... very weak weak.....

4- Gothic architecture:



Very strong strong medium..... very weak weak

5- Islamic architecture:



Very strong strong medium..... very weak weak.....

6- Green sustainable architecture:



Very strong strong medium..... very weak weak.....