# BIOMIMETICS: PRESENT TECHNOLOGIES AND FUTURE CHALLENGES


**Kamal Jaiswal**

**Professor**

**Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.)**

# Nature's secrets –

- lead to revolutionary ideas , especially in biotechnology and medicine.
- Help to design/identify a new drug or gene
- Improve the quality of life.

By

***"taking design ideas from nature"***

# What is 'Biomimetics'?

**"*Bios*" means life & "*mimesis*" means to imitate.**

**Defined** ***as "Emulating Nature's genius to inspire true innovation"***

**Biomimetics is a creative form of technology, a discipline that studies nature's best designs and then uses or imitates these designs and processes to solve human problems or improve human lives.**

- Schmitt first coined the term 'biomimetics' in 1957
- Jack E Steele of NASA, who coined the word bionics in 1960, first used the word biomimetics in a paper in 1969

# Concept of 'Biomimetics'?

**"Biomimetics is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology"**

***"Biomimetic refers to human-made processes, materials, devices, or systems that imitate nature."***

- also known as **Bionics, Biognosis, Biomimicry or Bionical Creativity Engineering**
- called **"intellectual structure"** in Japan and **"smart material"** in the USA.

**(From Wikipedia)**


Why pay attention to nature?

*Evolution provides that*

**3.85 billion years of trial and error, research and development, and rigorous quality control testing resulted in a 99.9% failure rate**

**So that the estimated 30 million different species of organisms living on earth today are success stories.**

They have designed materials, forms, processes, systems, and *strategies needed to sustain themselves in the conditions on earth as it is today –*

**the very same conditions in which humans too must sustain themselves.**

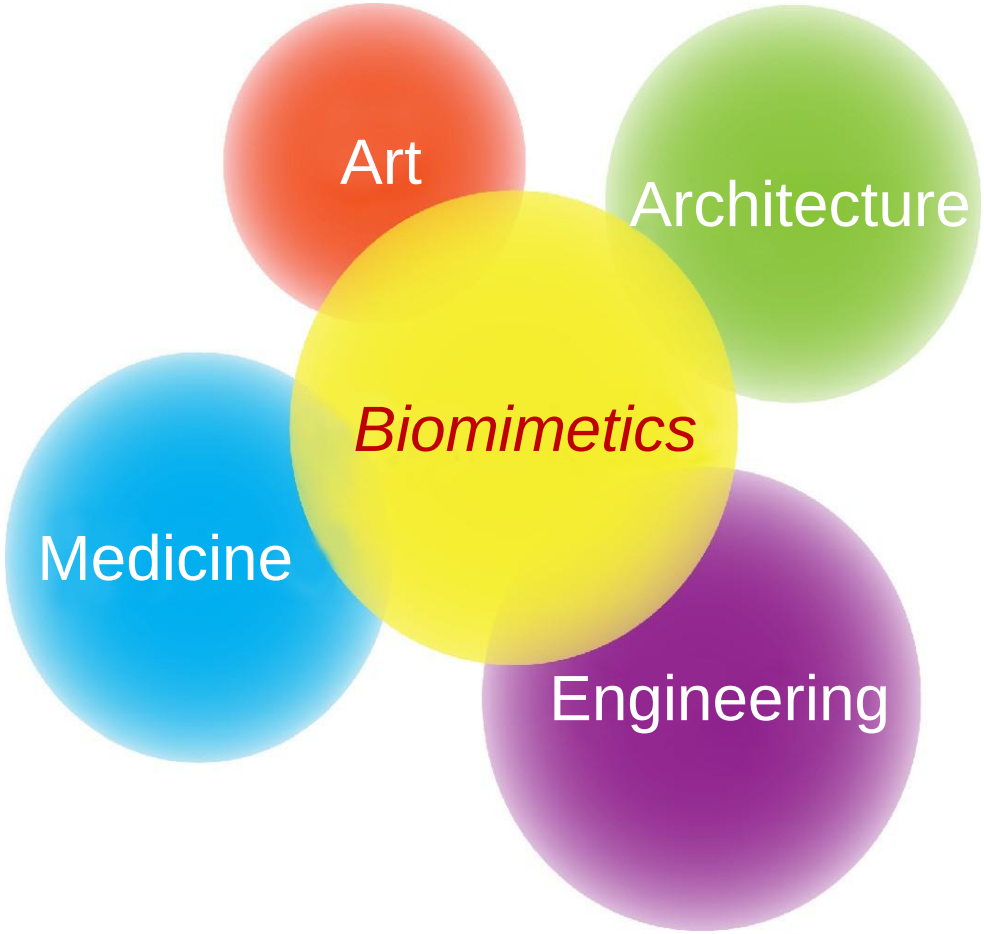
# Nature's Coping Strategies

form process ecosystem

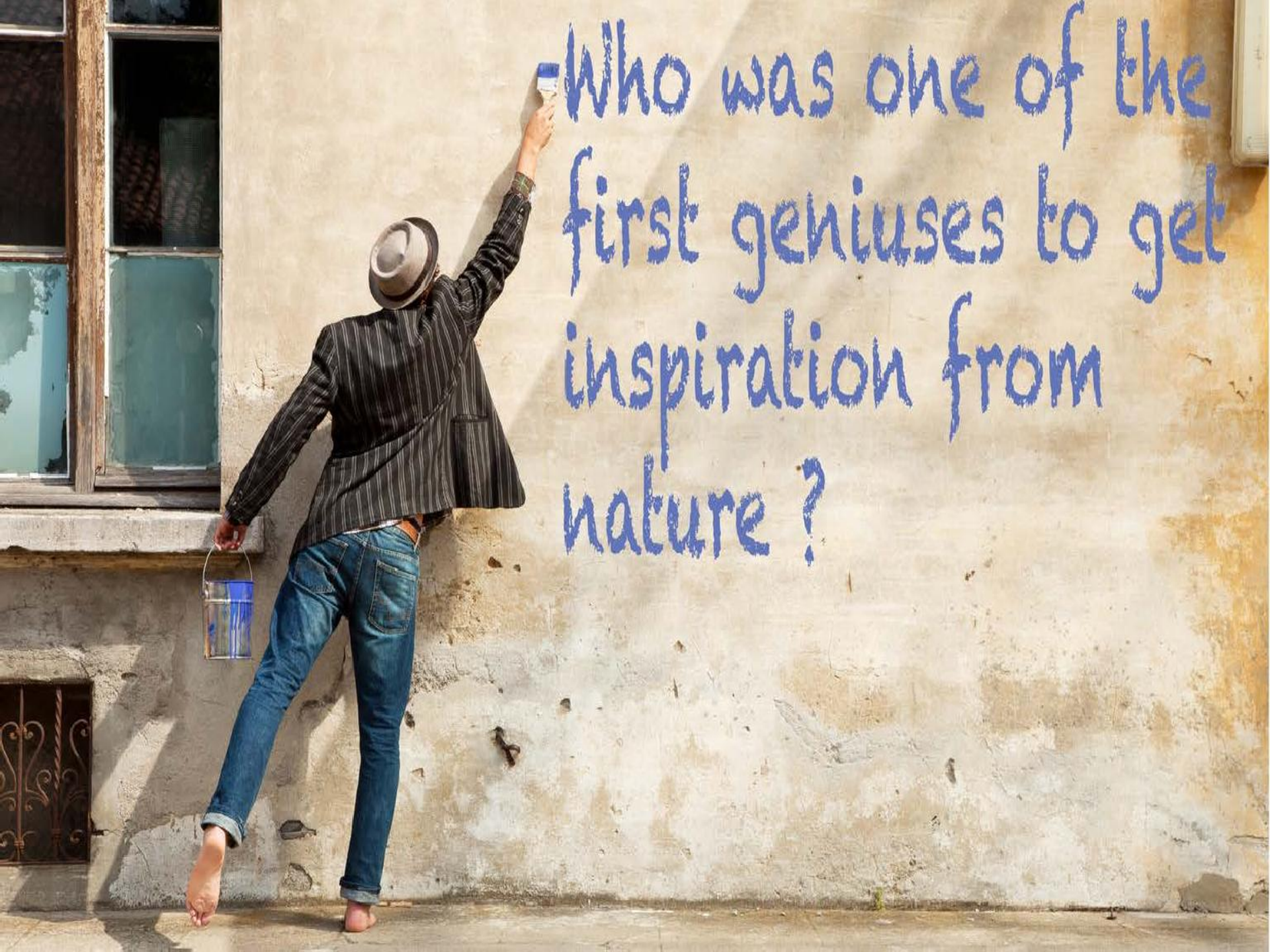
# Biomimetics is a broad field with a long history…..

From knives and axes inspired by the dental structures of currently extinct animals to the strongest cutting-edge carbon nanomaterials we have come a long way

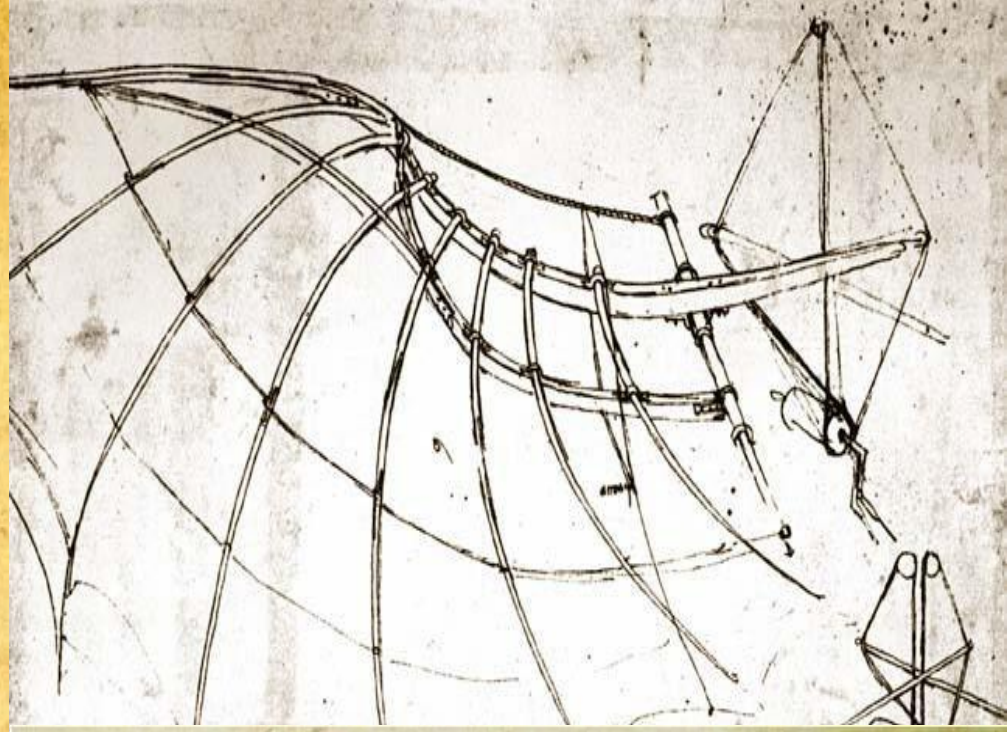
Bioengineering has always evolved along with human history.

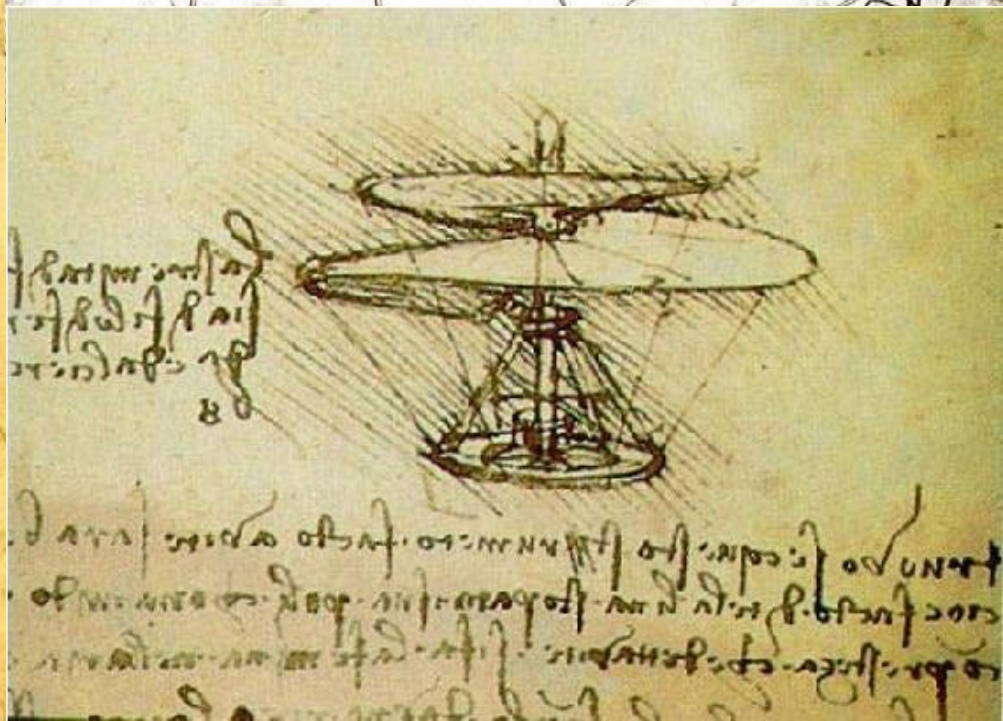



Biomimetics : Fields of Applications


-Who was one of the first geniuses to get inspiration from nature ?

Leonardo da Vinci (1452–1519)



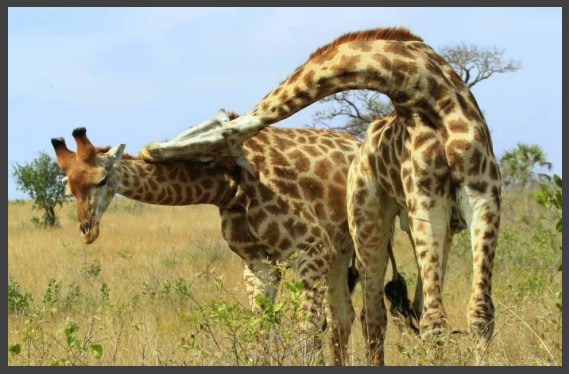


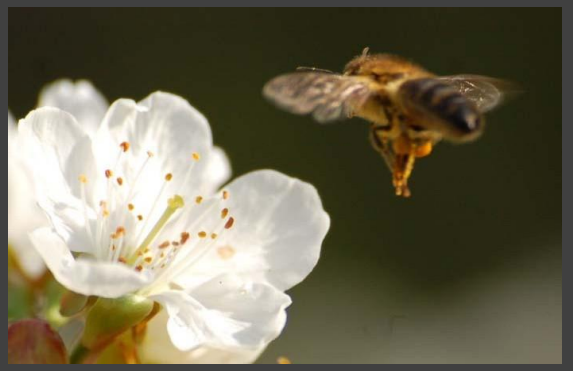
**Leonardo da Vinci's** (1452–1519) work is a fundamental example of biomimicry. He designed a "flying machine" inspired by a bird.

In the Far East, **General Yi Sun-sin** built the turtle-ship, a warship modeled after a turtle, to fight Japanese raiders during invasions

The **Wright brothers** (1867–1948) took note of the wings of eagles and made a powered airplane that succeeded in human flight for the first time in 1903.

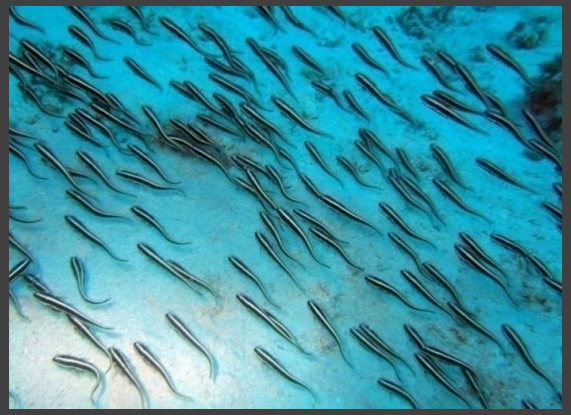
# Marvels from Nature Inspiring Technology

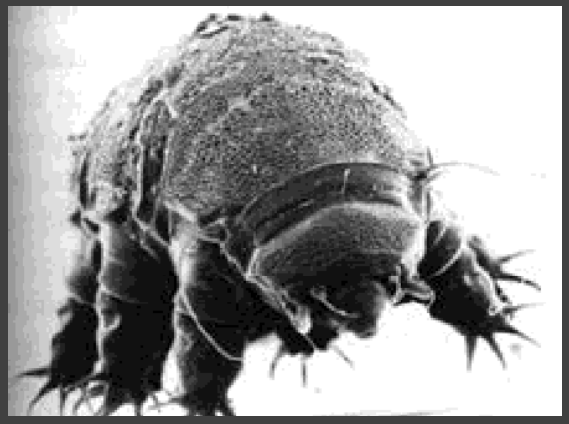




**“Each species is a masterpiece…”**

E.O. Wilson

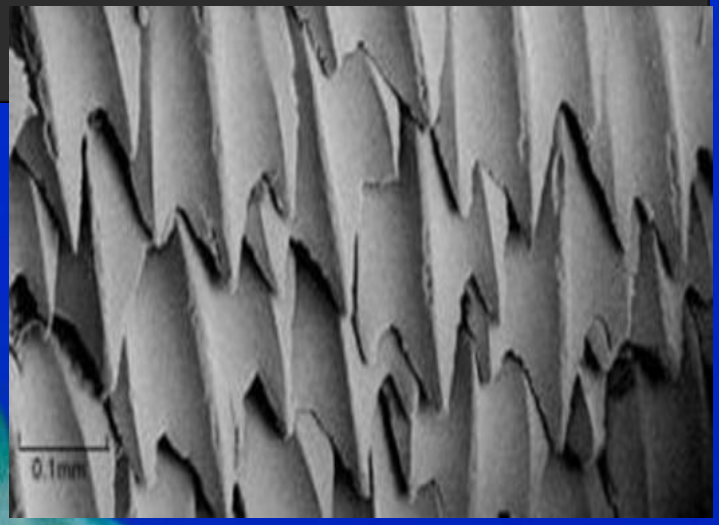




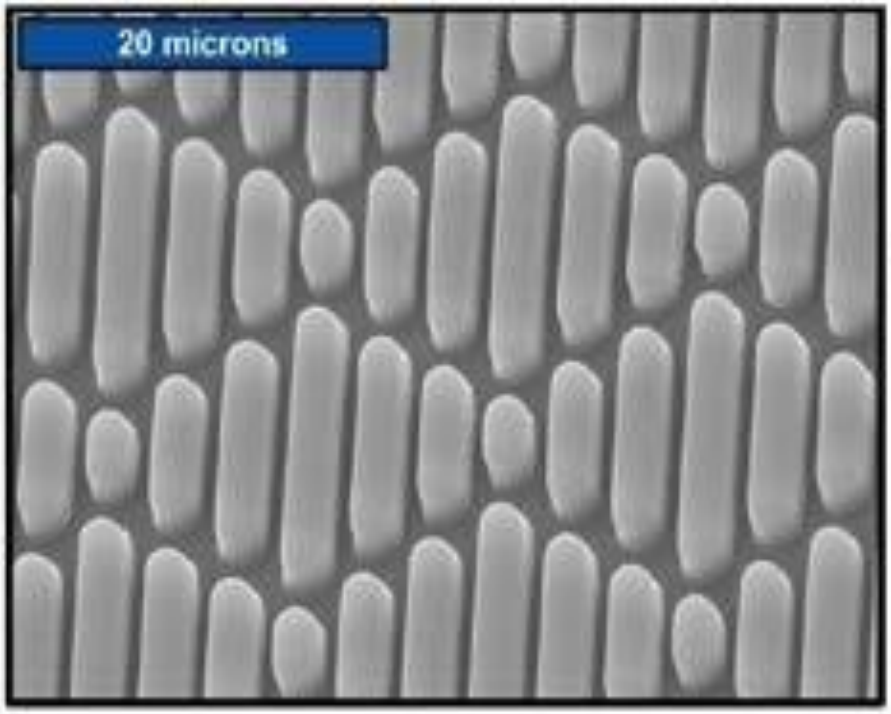
Images courtesy of the Biomimicry Institute

# GALAPAGOS SHARK

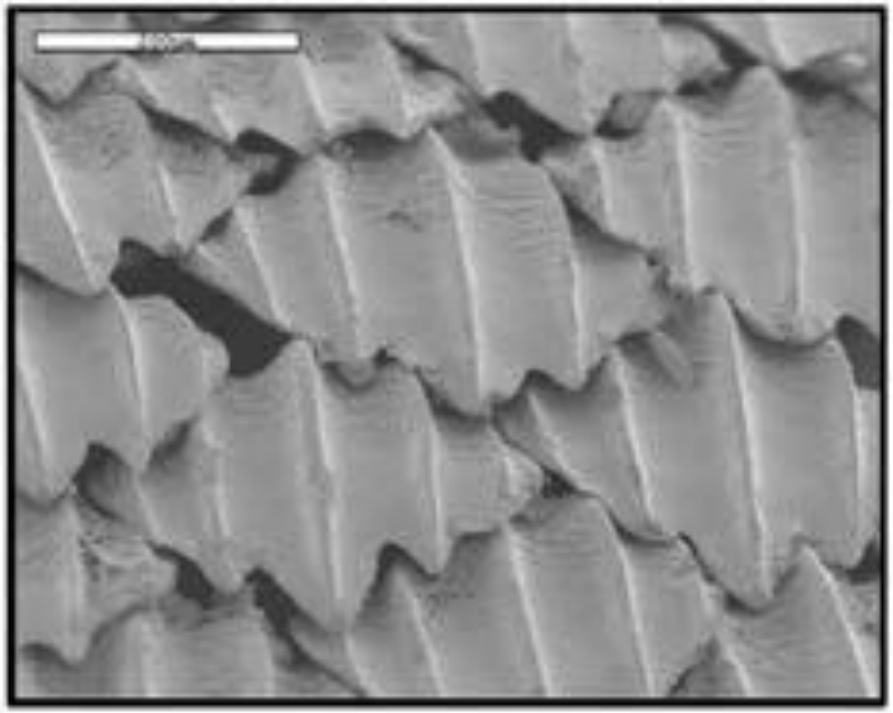
Particular kind of pattern on it's skin repels bacteria.



This technology is being put on the surfaces in hospitals to keep bacteria from landing.




*Sharklet™ Surface Technology*



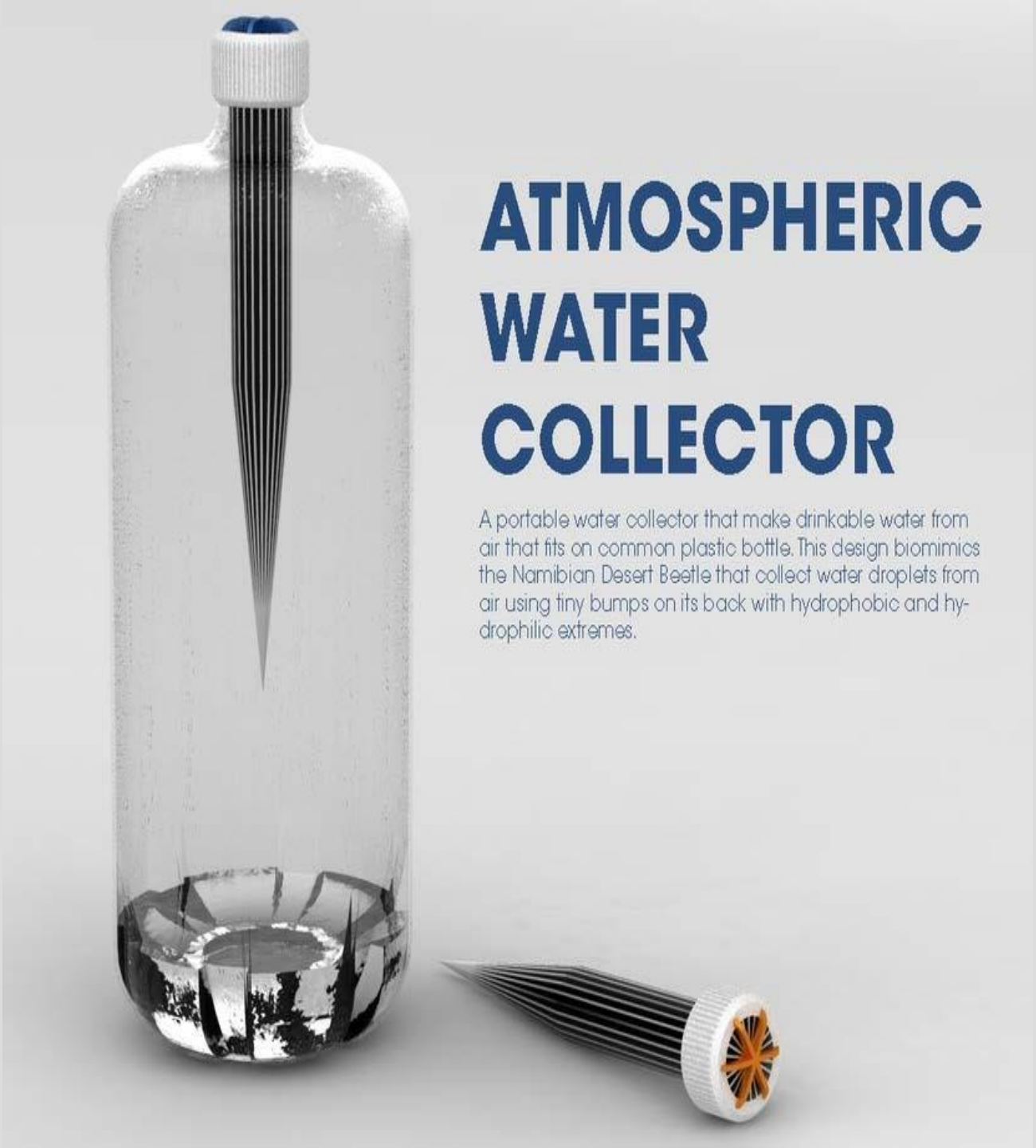
*Galapagos Shark Skin*

Bullet train (Japan Railway) had a design problem. Every time it went into a tunnel it would build up a pressure wave and then it would create a loud sonic boom at its exit.

One of the engineers was a birder. He studies the King Fish and relalized “They go from one density of medium, the air, into another density of medium, water, without a splash”.

Look how the new design took inspiration on the King Fish.
Not only it quieted the train, the new design made it go 10 percent faster on 15 percent less electricity.

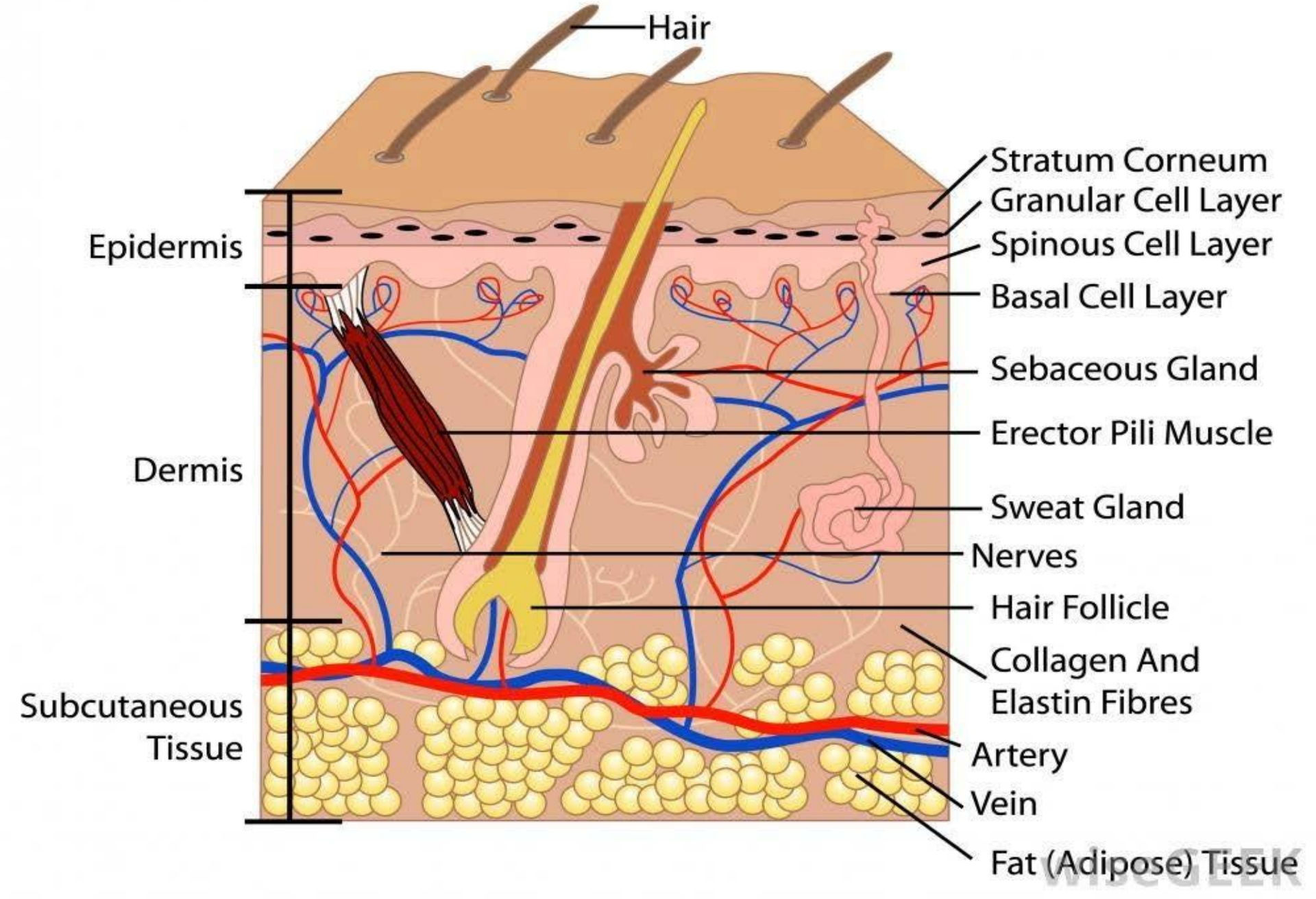

STENOCARA
This beetle from Namib desert manages to stay hydrated in a place receiving only 1.4 centimetres (0.55 in) of rain per year



# ATMOSPHERIC WATER COLLECTOR

A portable water collector that make drinkable water from air that fits on common plastic bottle. This design biomimics the Namibian Desert Beetle that collect water droplets from air using tiny bumps on its back with hydrophobic and hydrophilic extremes.

# Human Skin Diagram



# SMART MATERIALS

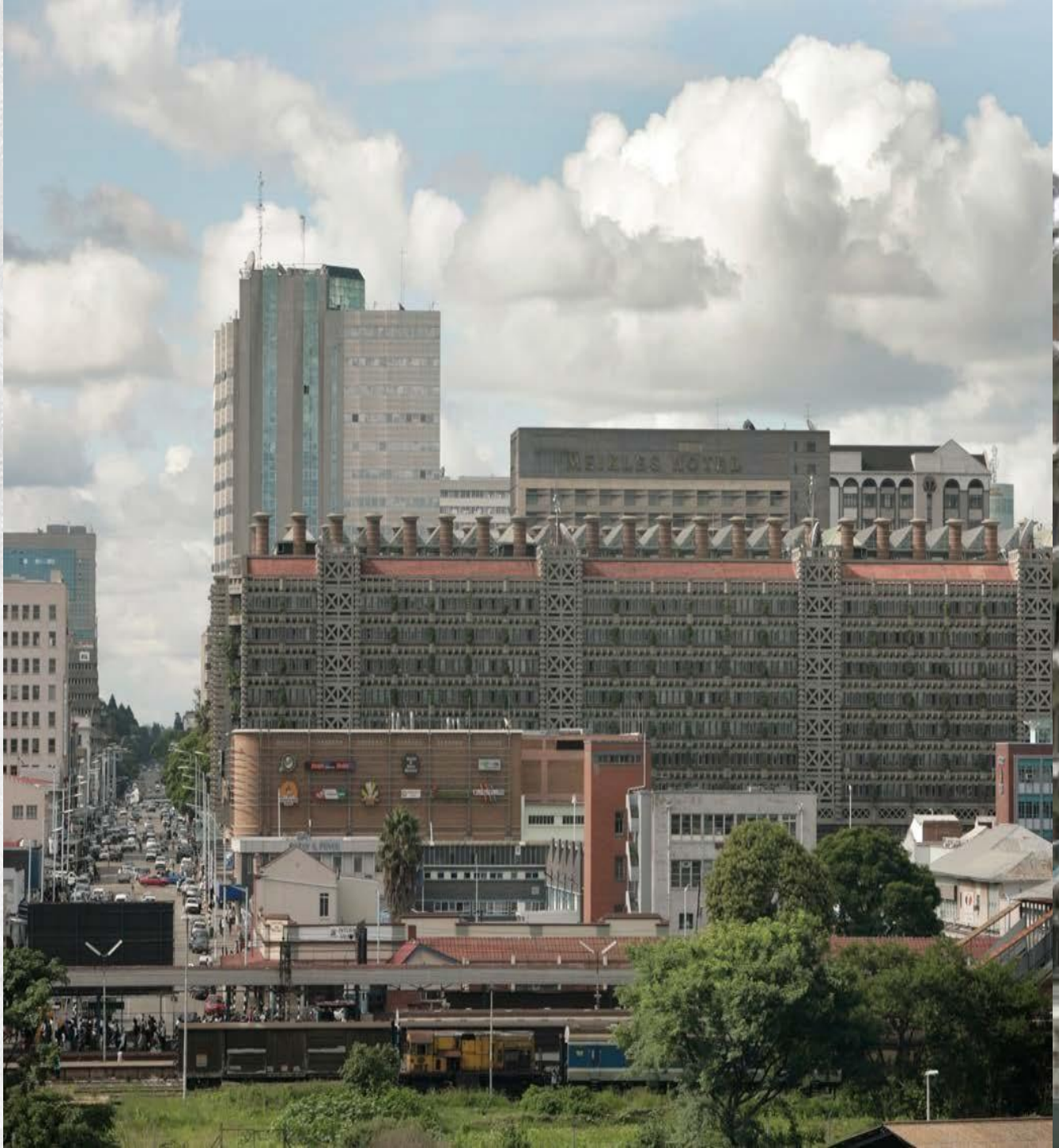
What if building materials could mimic skin temparature auto-regulation and waste management?


eSkin

# TERMITE MOUNDS

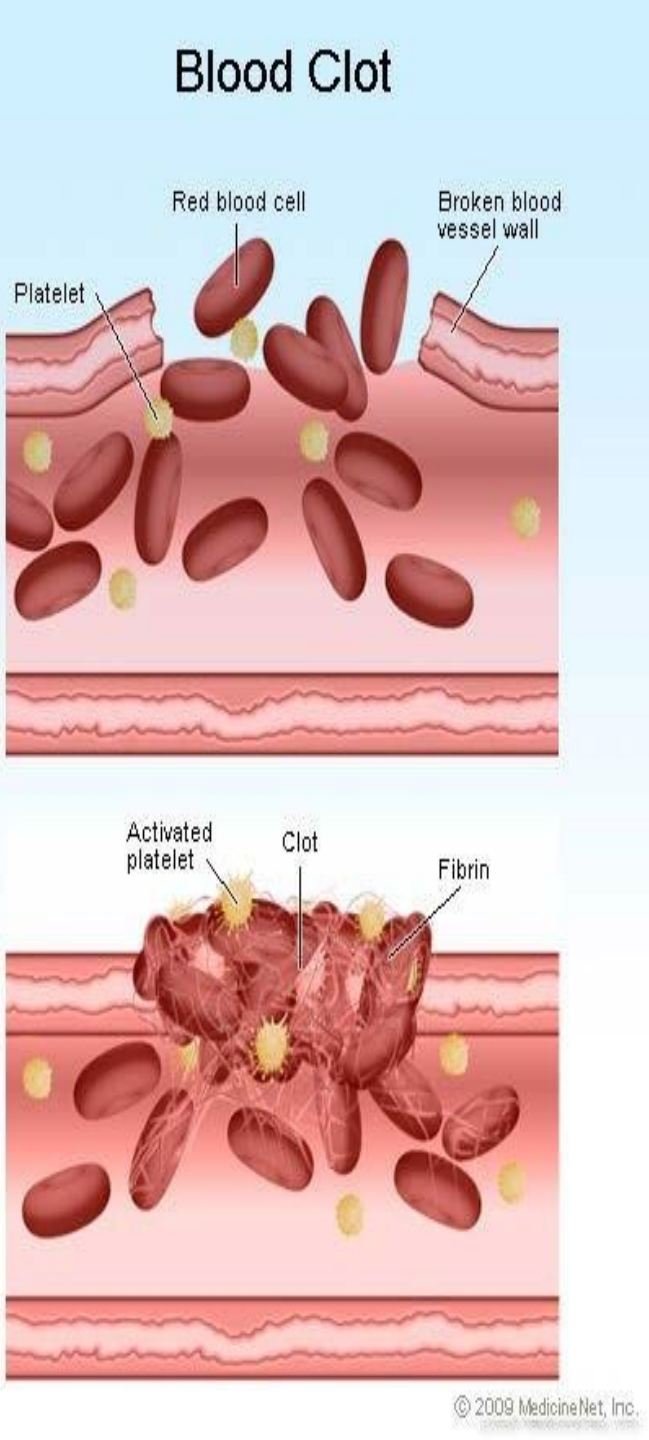
They maintain the temperature inside their nest to within one degree of 31 °C, day and night. This building by architect Mick Pearce mimics the process. It has no no air-conditioning.


Eastgate Building, an office complex in Harare, Zimbabwe

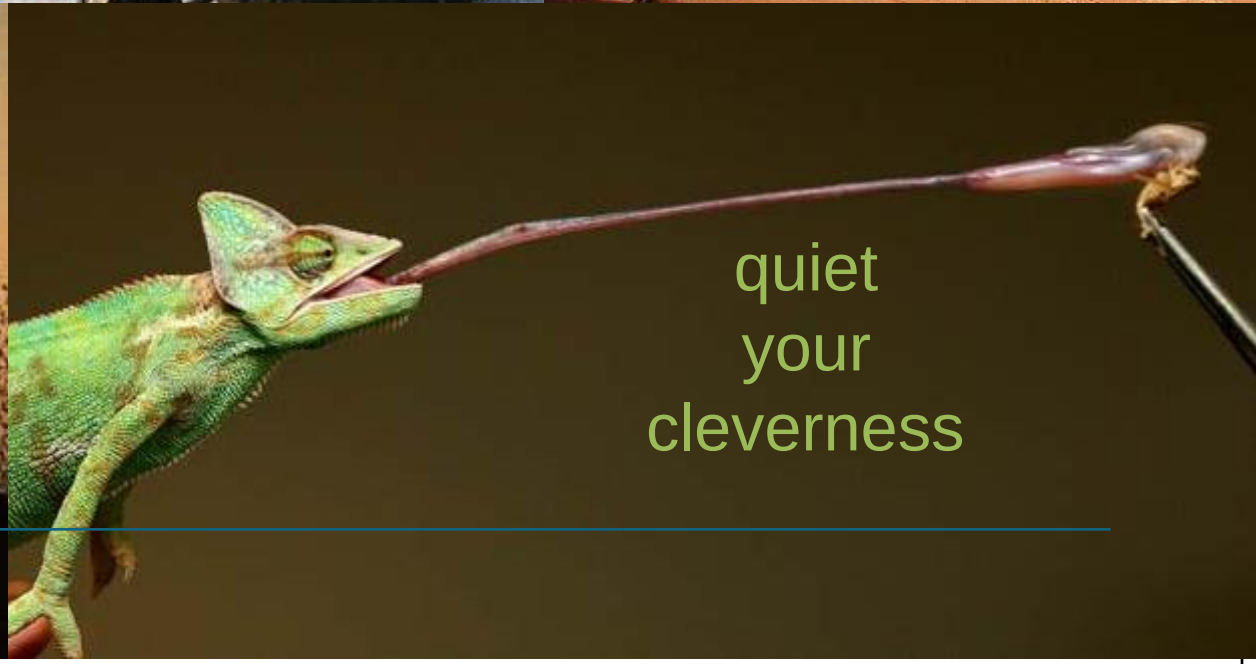

WELLAS HOTEL

# LEAKING PIPELINES

Engineers at a company in Aberdeen, Scotland, have developed a novel way to solve the leaking issue. It involves using artificial platelets inspired by the way our blood clots when we get cut.



# Nature as MENTOR

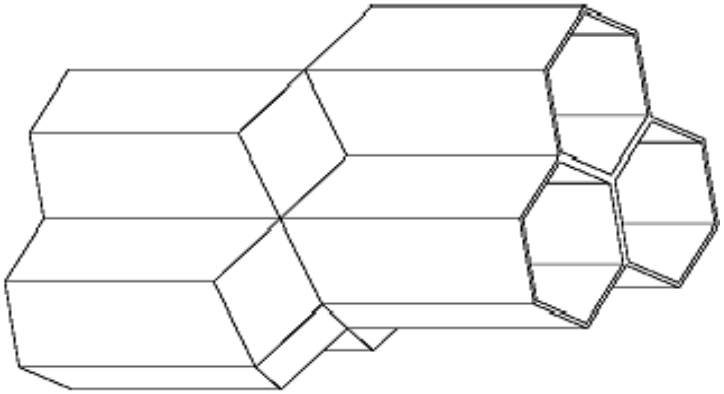


quiet
your
cleverness

Images courtesy of the Biomimicry Institute

# Nature as MODEL

# Mimicking Form

Hexagonal structure uses the least material to create a lattice of cells with minimal surface area and the largest possible volume.

**Application Ideas:**

- building structural stability
- minimizing material

# Mimicking Process

**Application Ideas:**

- organizational / change management
- transportation systems

It is believed that social insects have been so successful – they are almost everywhere in the ecosphere – because of three characteristics:

- flexibility (the colony can adapt to a changing environment
- robustness (when one or more individuals fail, the group can still perform its task
- self-organization (activities are neither centrally controlled nor locally supervised)

# ECOSYSTEMS

Nature creates specific environments where lots of experimentation and innovation takes place.
Modern companies should put in place this kind of laboratories (Amazonian labs)

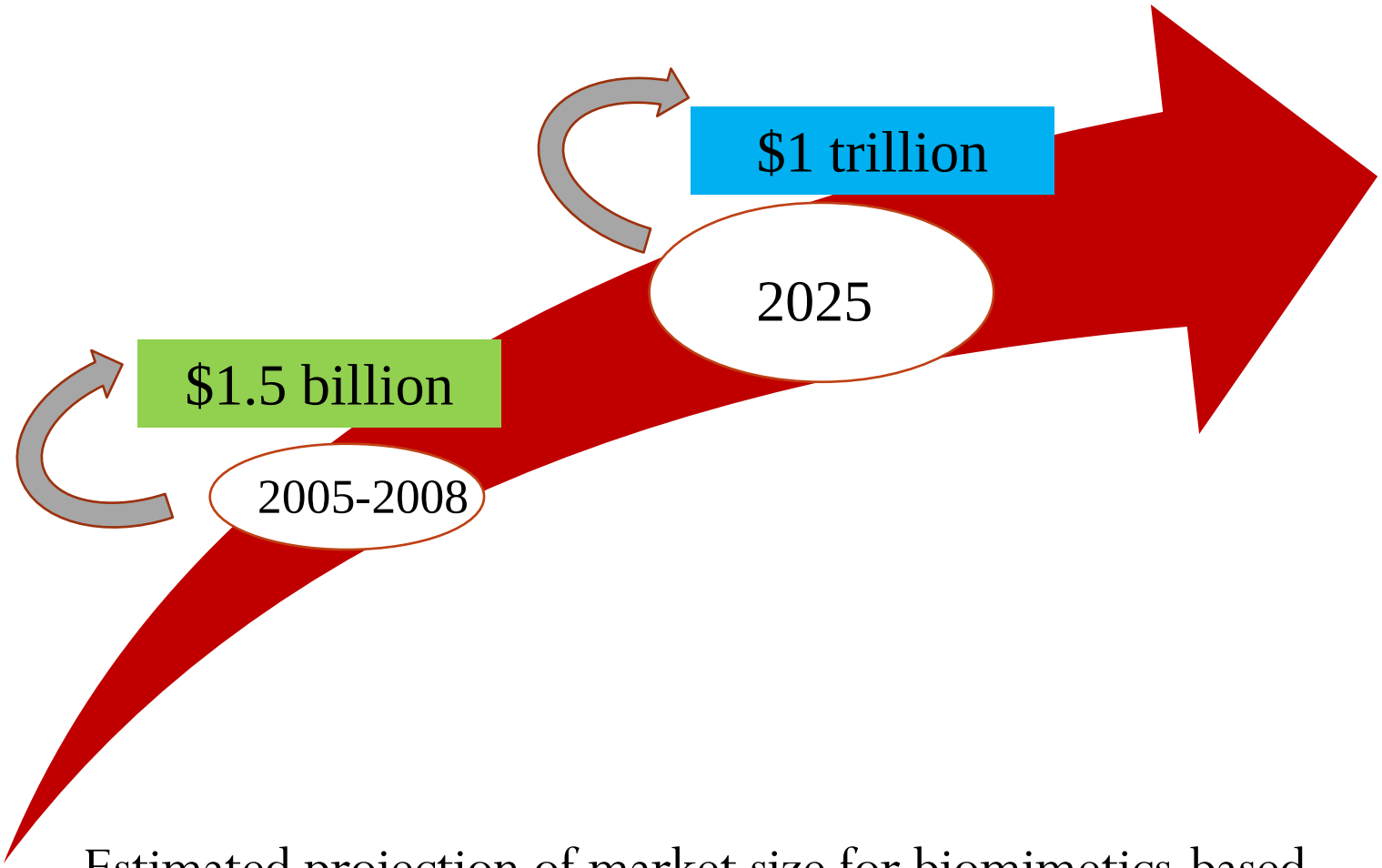
“ Humans will be truly sustainable
when our cities are
functionally indistiguishable
from our forests.”

Janine Benyus

# BIOMIMETICS: GENERATING INTEREST?

- Europe, Japan, and the USA show increasing interest and funding
- Global companies Ford, General Electric, Herman Miller, HP, IBM, and Nike collaborating with scientists and designing laboratories to explore novel technologies.
- New York State Energy Research and Development Authority (NYSERDA) is enforcing the use of biomimicry to solve various problems in energy.
- BIOKON (collaboration of 28 research centers studying biomimetics) established in Germany conducting 35 projects.
- Century Center of Excellence, graduate program on *monozukuri* (biomimetic manufacturing) and novel uses of biotic resources in the field of agriculture established in Japan

# BIOMIMETICS: TECHNOLOGY OF FUTURE !




Estimated projection of market size for biomimetics-based products and construction projects

*Thank you*