

Biomimicry



Erasmus +

Perfunctory

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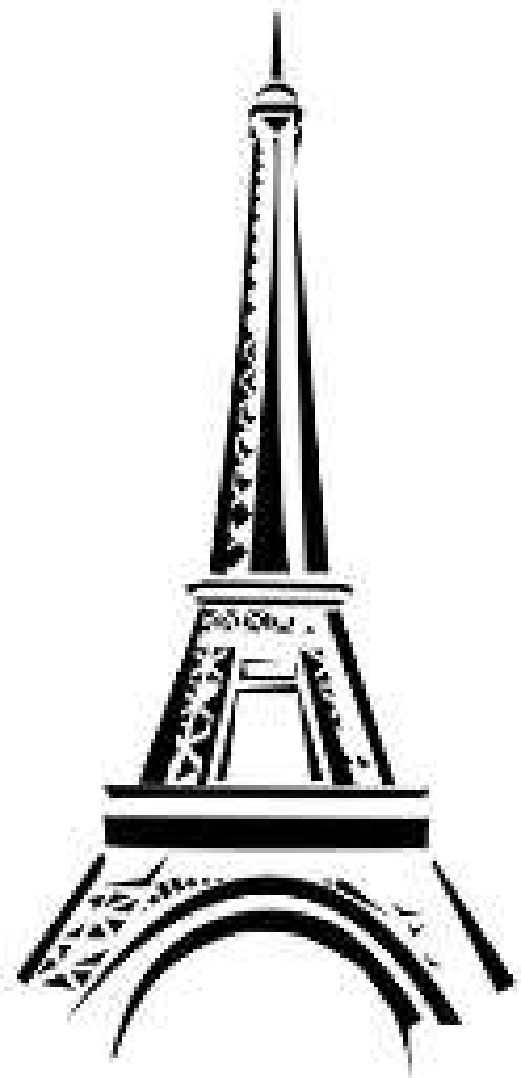
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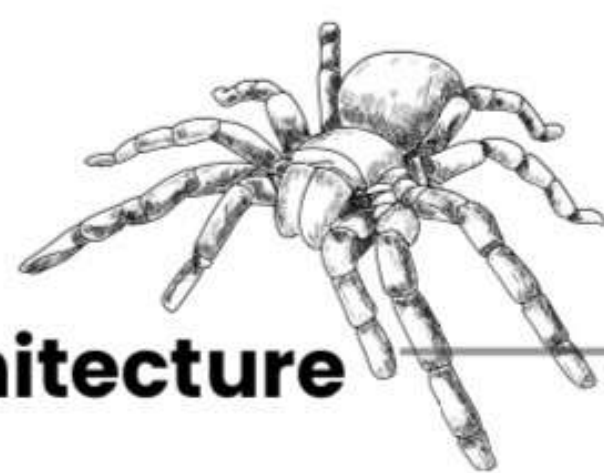
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BIOMIMICRY

france





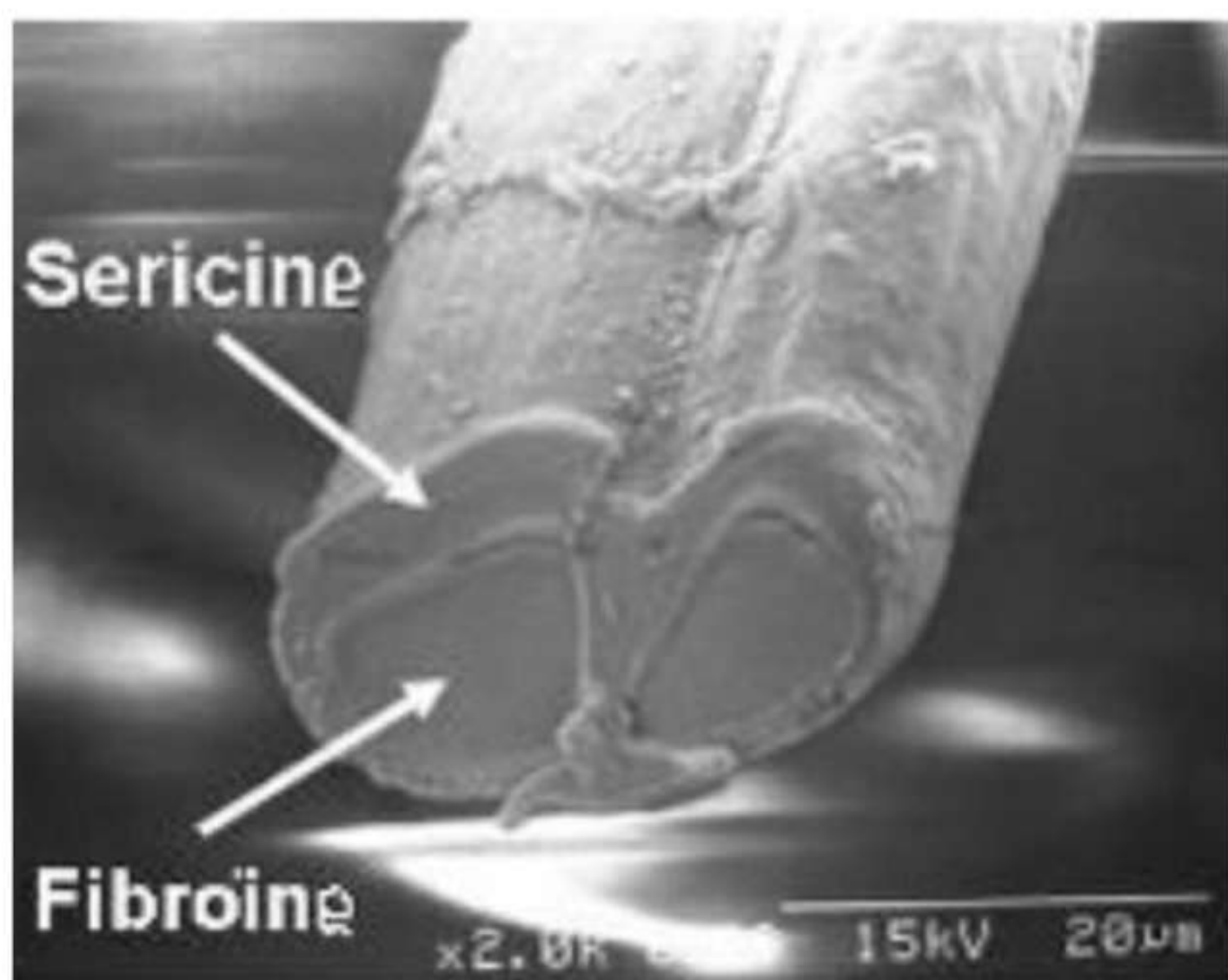
SPIDERWEB

Spiderweb :

If spiders are often regarded with fear, scientists know the impressive peculiarities of the threads produced by these arachnids.

Indeed, these fabrics made to capture preys have assets of solidity and remarkable elasticity: lightness, very great capacity of absorption of the shocks, flexibility. It is necessary to produce 10 times more energy to break a spider's web than for any other similar biological materials

The spider web is more resistant than the known synthetic fibers. Of all the spiders, the *Nephila clavipes* produces the strongest matter. The researchers therefore focused on this species to use its characteristics.



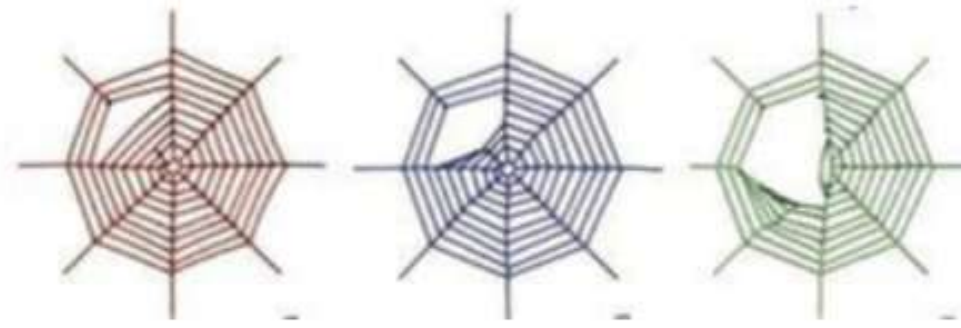
Composition :

Scientists have discovered what makes spider silk thread very strong and flexible: these are two proteins, 63.5% fibroin and 22.5% sericin. The rest of the silk is simply made up of fat, minerals and water. Sericin gives color to silk. It is on the outside of the strand to give the thread its impermeability. This is in fact what we see. The strength of spider silk is therefore based on fibroin surrounded by sericin. Alanine and glycine are mainly responsible for the strength of fibroin.



Benefits :

The spider web owes its strength not only to the qualities of the spider silk thread but also to its intelligent structure. When it building its web, the spider spends a lot of energy. It frequently happens that a projectile comes to be caught in the trap of the canvas and the sticky threads. However, when there is an impact on the web, it is partially destroyed and the spider will have enough energy to rebuild it. This allows it to repair his web rather than reassemble it.



Architecture :

Today we are looking to build more natural buildings. We want more lightness, energy saving, mobility and adaptability. The structure of a spider's web is optimized to cover the largest area with as few materials as possible. Some buildings are inspired by this structure.

Steel cables are used by architects instead of spider threads. This allows them to make roofs with a light frame, covered with a thin membrane laid down. Thanks to this system, so-called modern membrane buildings have roofs that have many advantages. First, there is lightness. Indeed, the load-bearing structure made up of steel cables is much lighter than a traditional frame. Then there is the solidity. The structure and the membrane being very light, the assembly is not subjected to great forces and thus benefits from great solidity. Safety is also an important point. Unlike a classic roof which, when it collapses, creates great damage, a modern membrane roof is less destructive if it is torn off or collapses, because of its lightness. In addition, if part of the roof is destroyed, the other areas of the roof are not weakened and it is not necessary to rebuild all of them. Finally, the last advantage is the speed of assembly. A classic roof takes much longer to build than a modern membrane roof.

munich stadium



Laplata Argentina

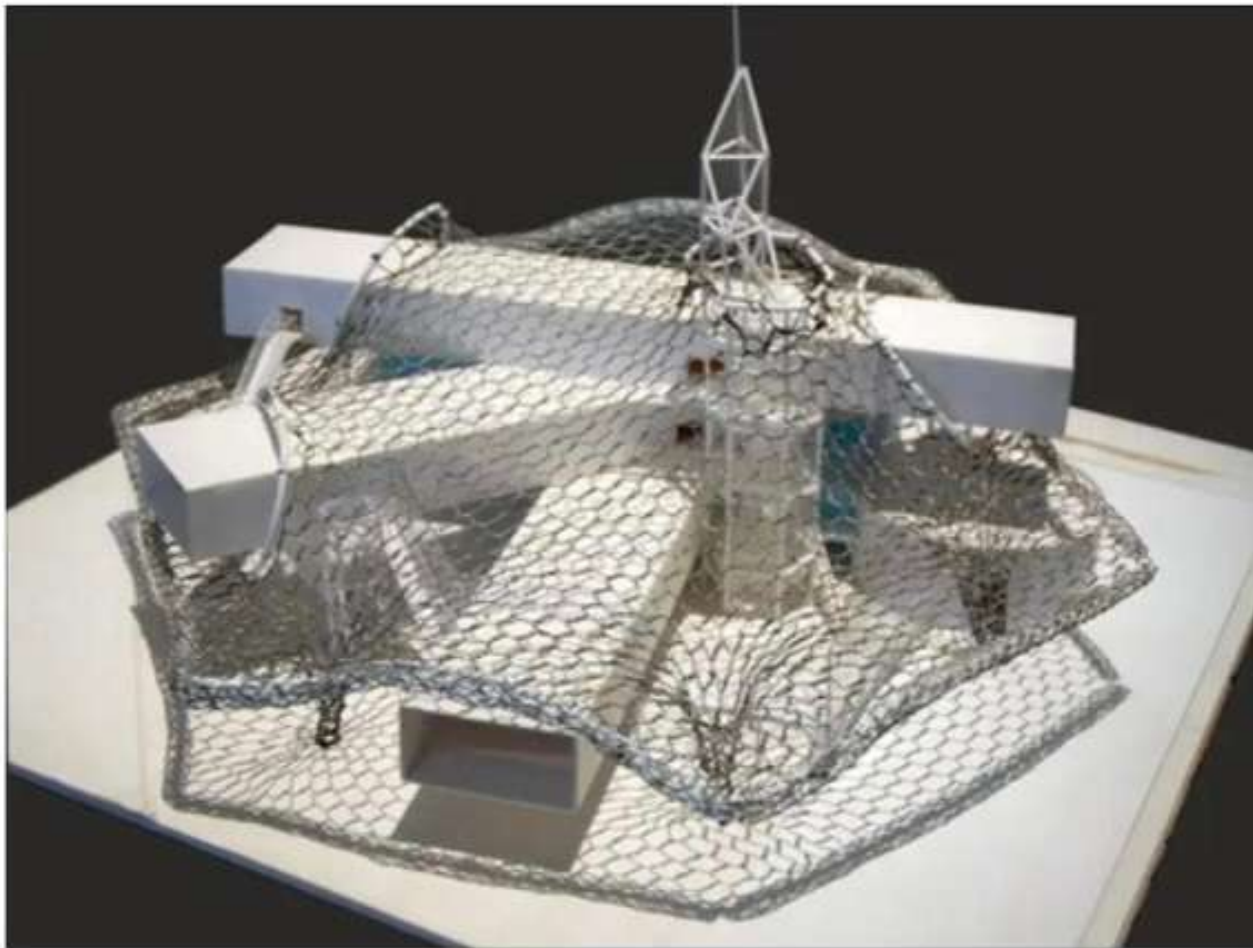


The steel cable structure can be replaced by steel beams and the membrane by glass tiles as in the Fiera Milano shopping center in Milan, Italy.

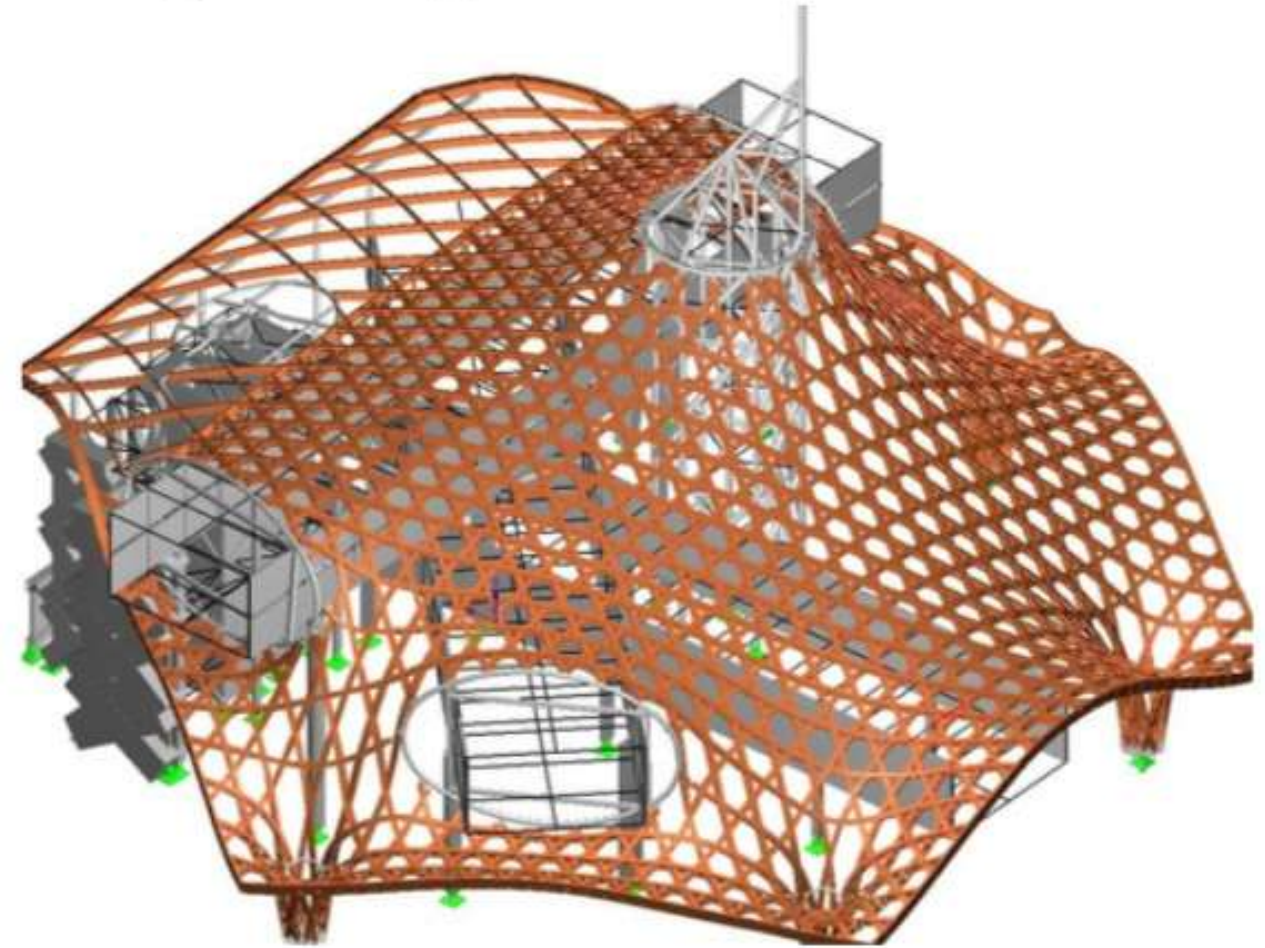


Or by a wooden trellis for the magnificent Pompidou Center in Metz.

model



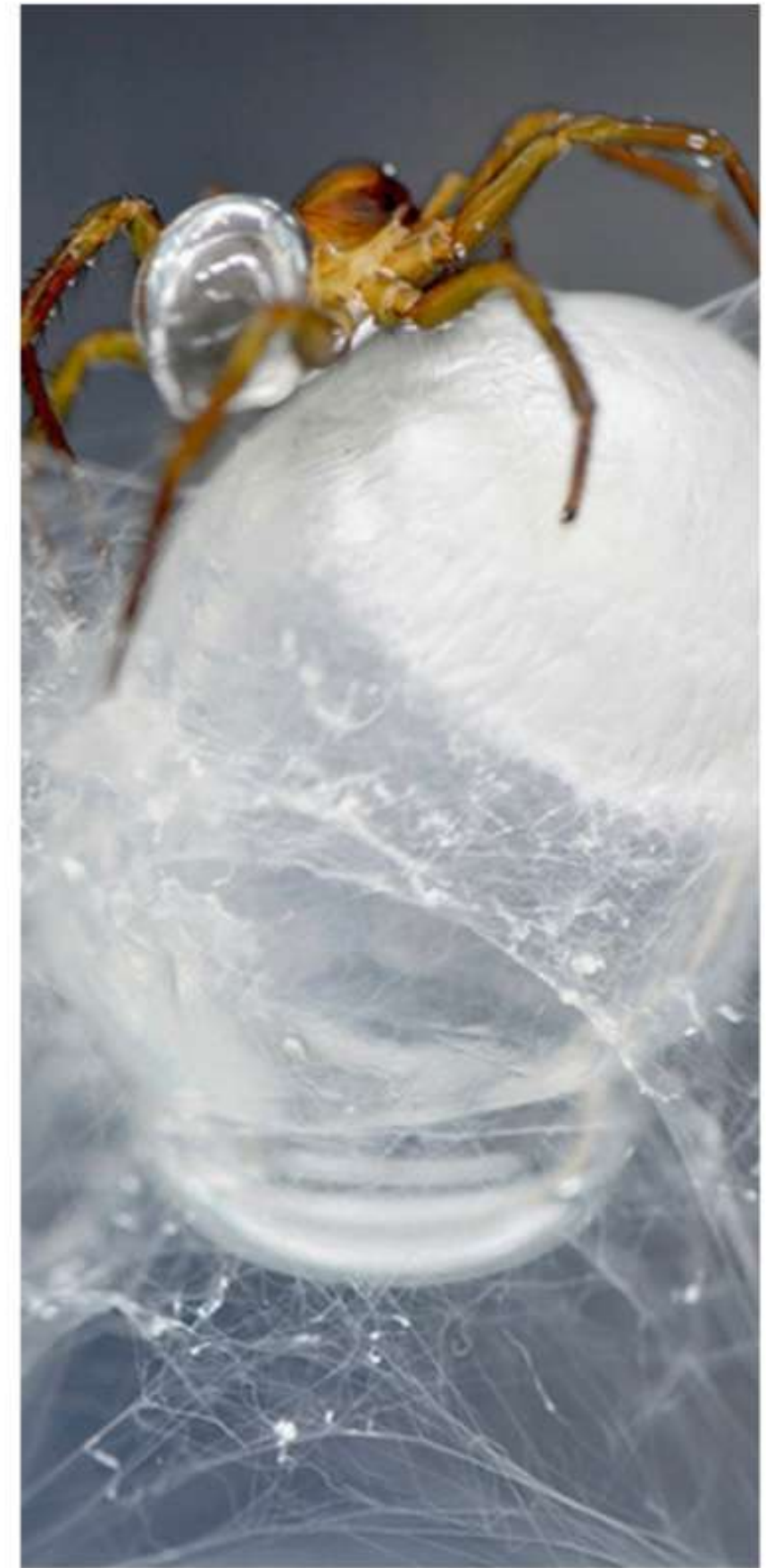
digital production



final achievement



Architects are also inspired by aquatic spiders. This is the case of the Argyronete, this spider living under water uses its web to store air reserves in the form of an air pocket that it traps in its web. It maintains its air supply by supplying it with regular trips to the surface where it traps air bubbles using the hydrophobic hairs of its abdomen. The air trapped in the canvas gives it its shape by putting it under tension like a balloon. The spider then reinforces its web with silk fibers giving it a structure that takes exactly the shape of the air pocket. This structure is very resistant to the whirlpools and eddies of the aquatic environment. It is a three-step construction; the spider first weaves its web then puts it in tension using the air trapped under it and finally consolidates the structure using additional silks. The architects Franck Gehry and Santiago Calatrava were inspired by these stages of construction to create their air bubble pavilion. A first structure consisting of a waterproof membrane is inflated by pressurized air. The structure is then reinforced by a robot arm using carbon fibers.



in Construction

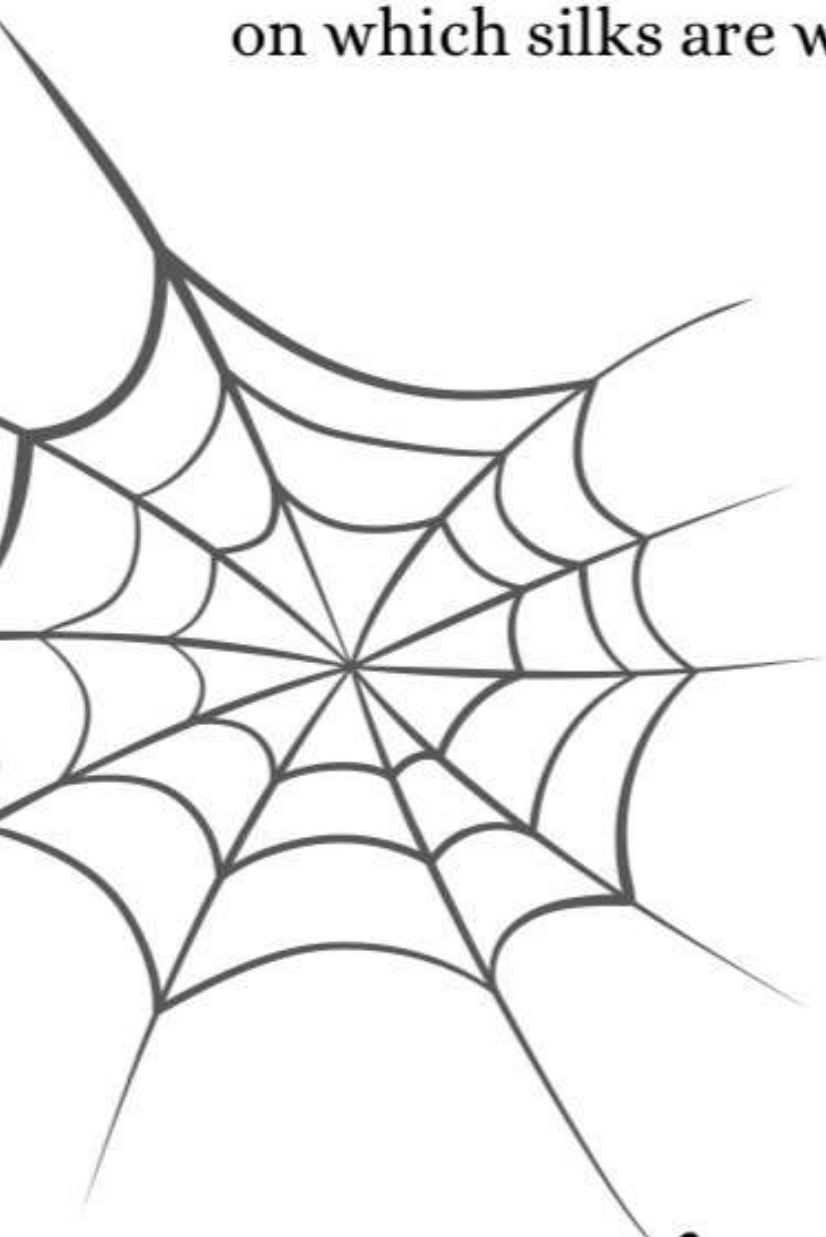


final achievement



The latest habitat innovations inspired by cobwebs are still in the experimental stage. They are a break with the current habitat and its method of construction. A collective of architects based in London, the Softkill Design collective presented their work consisting of a habitat entirely built using a 3D printer. This housing of the future, very inspired by cobwebs and cocoons, includes a rigid frame of biological inspiration on which silks are woven.

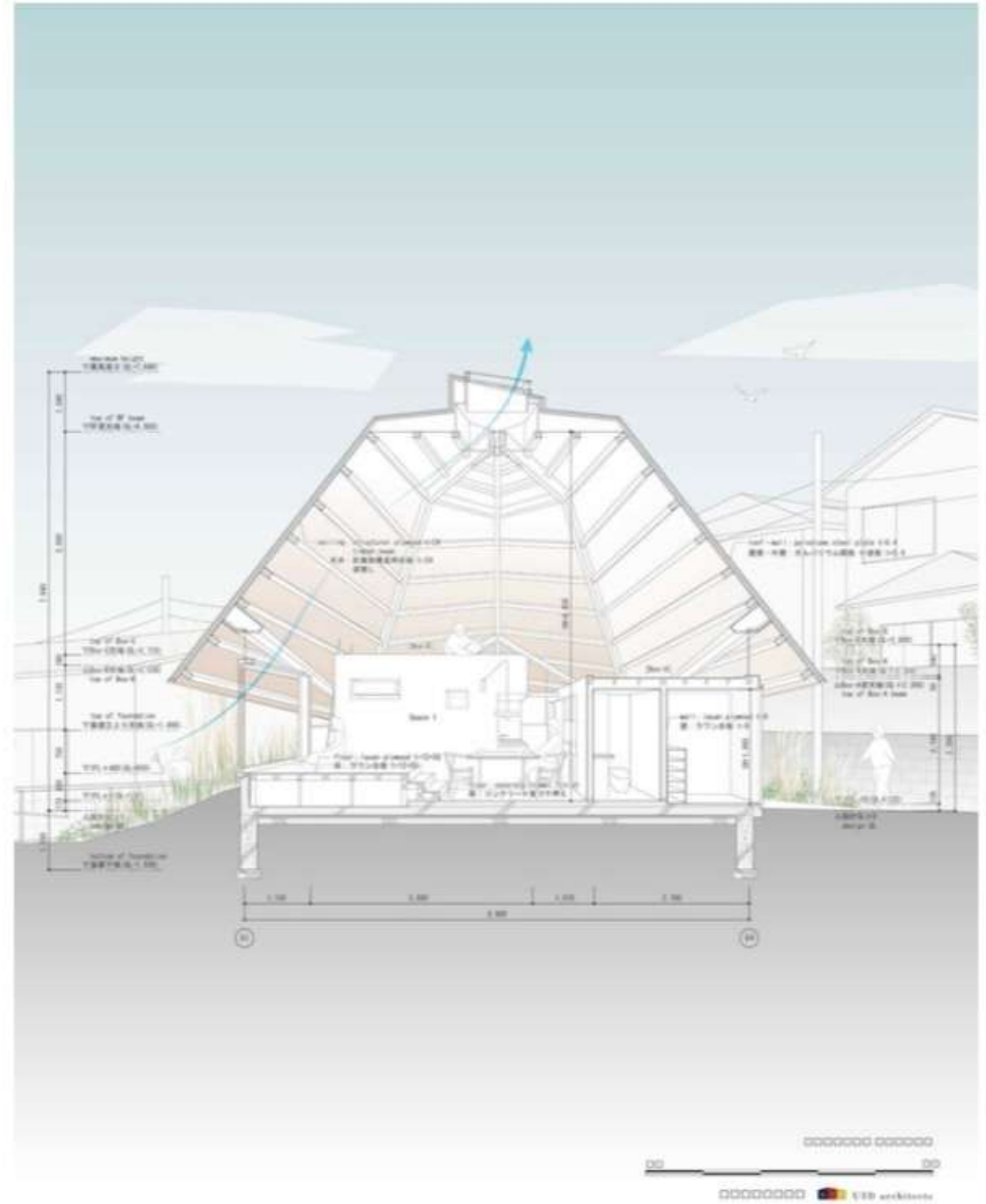
3D printer



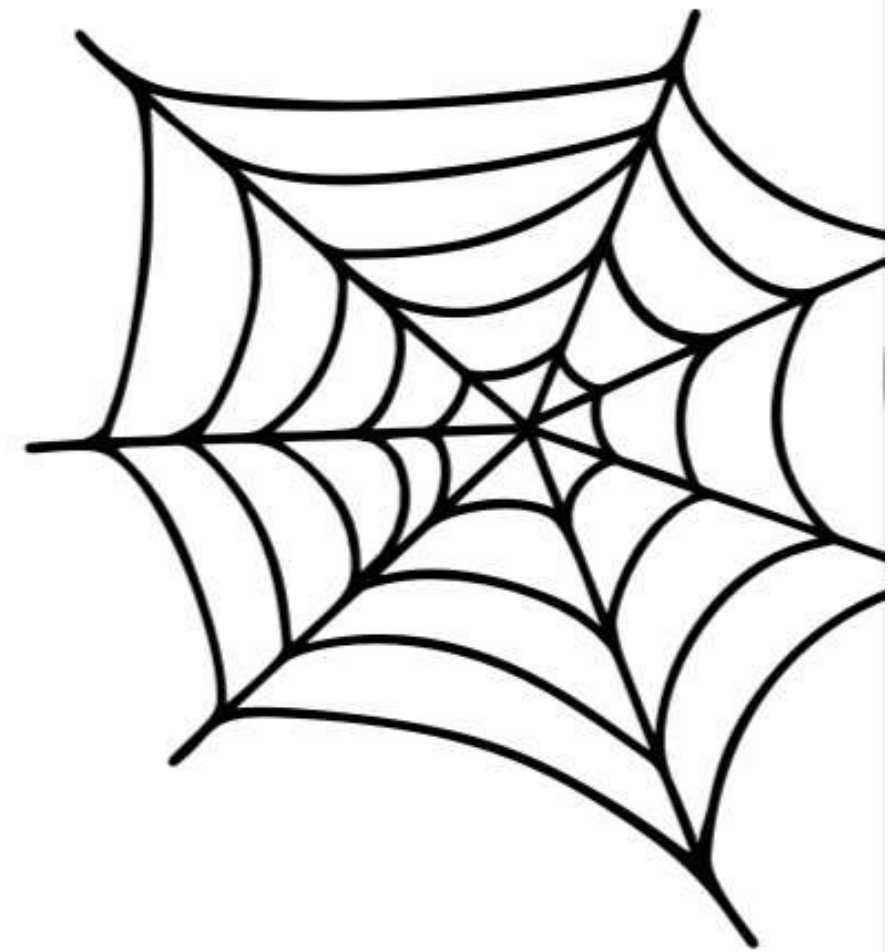
3D printer & Green screen



UID Architects has designed a new home in Fukuyama, Japan with a unique octagonal shape inspired by a spider's web. The house serves as a living space for a family, a couple and their two children. The structure has a 45 degree pitched roof in order to create a spacious interior with views to the outside, optimal ventilation, natural light and privacy for its occupants. The interior of the house comprises 77m² of open space, with four separate boxes, which are arranged to create an area that functions as a family room and living area. Since no structure defines a given area as a room, areas and patterns in space will likely change over time as children grow and with other changes in family life. Integrated elements, such as the desk and a raised seating platform, create separate spaces that adapt to the singular shapes of the house. The open dining area is positioned below the center of the "cobweb", while the boxes feature curved corners, softening the interior. The small kitchen is located next to the dining room and highlights a different wood from the rest of the house.



plan



interior & outside



A photograph of the Supertrees at Gardens by the Bay in Singapore. The trees are tall, slender structures with green, leaf-like canopies and are connected by a yellow walkway. The sky is blue with some clouds.

BIOMIMICRY BUILDING

Biomimicry is the design and production of materials, structures, and systems that are modelled on biological entities and processes.

A decorative illustration of a green vine with heart-shaped leaves and small flowers, curving across the right side of the page.

The Gardens by the Bay

A simple illustration of a green stem with three leaves, located in the bottom left corner.

SINGAPORE

A simple illustration of a brown branch with three green leaves, located in the bottom right corner.

Supertree Grove



The Supertree Grove are eighteen towers covered by vegetation. They are inspired by the shape of Vanda Miss Joaquim which is a typical flower of Malaysia.

It's inspired by the way of this plant harvest water to stock it in tanks.

Then, water is broadcast in tower and create a tropical climate. This climate favors the grows of plants situated in the tower. They are two thousand species of plants.

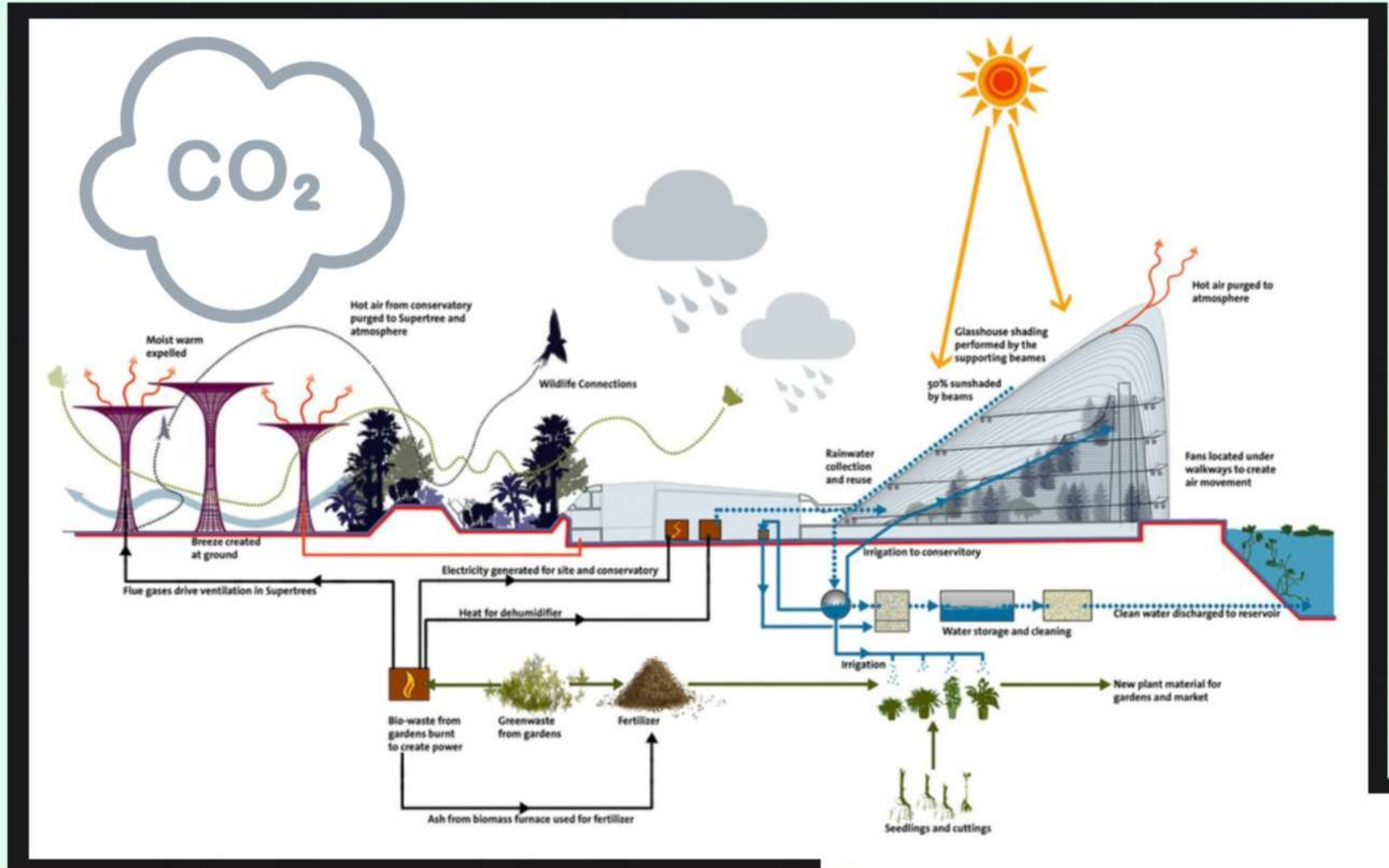
System of evaporation situated in branches of trees allows the temperature's regulation and the creation of different atmospheres.

Vanda Miss Joaquim

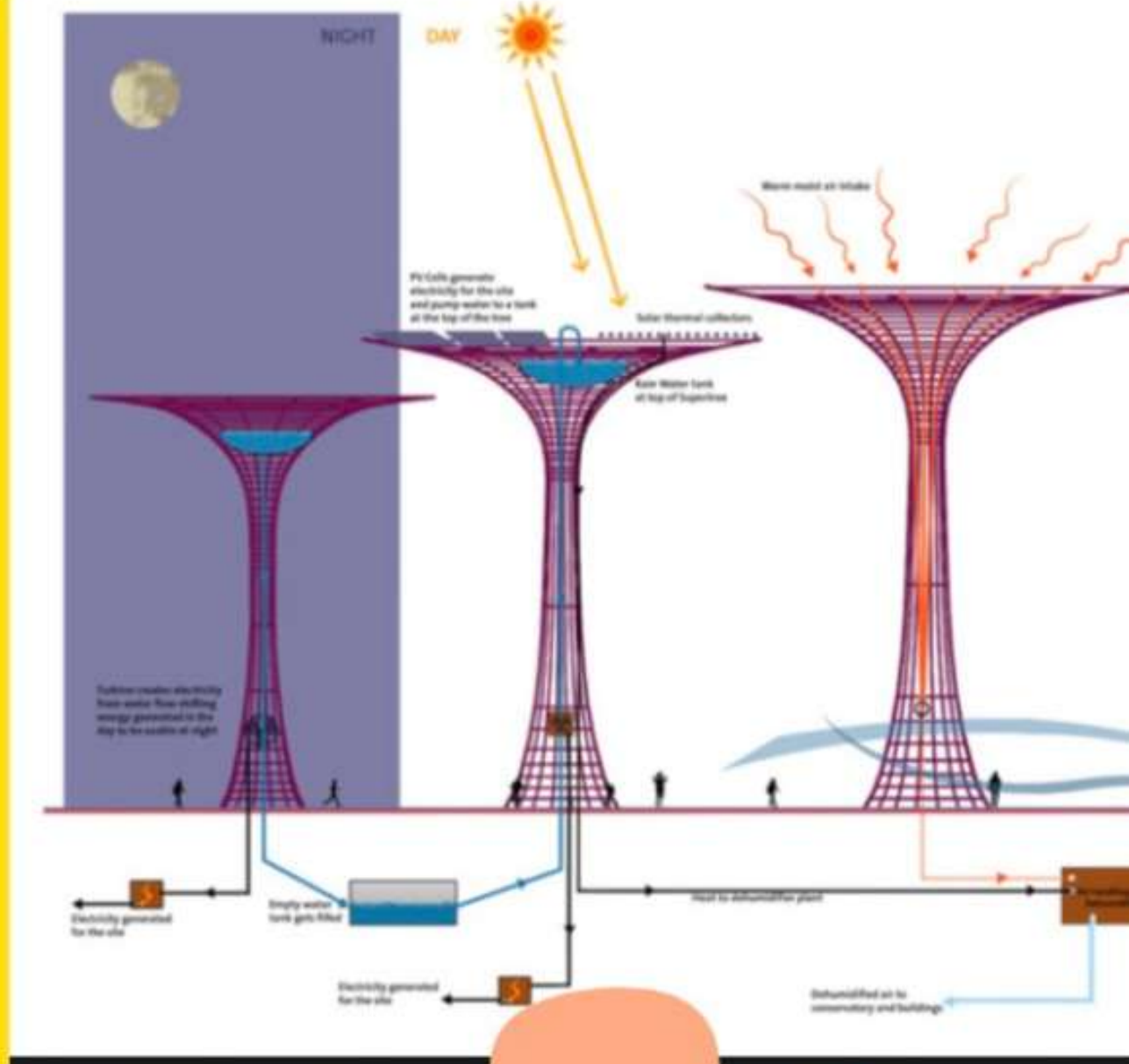




The Irrigation

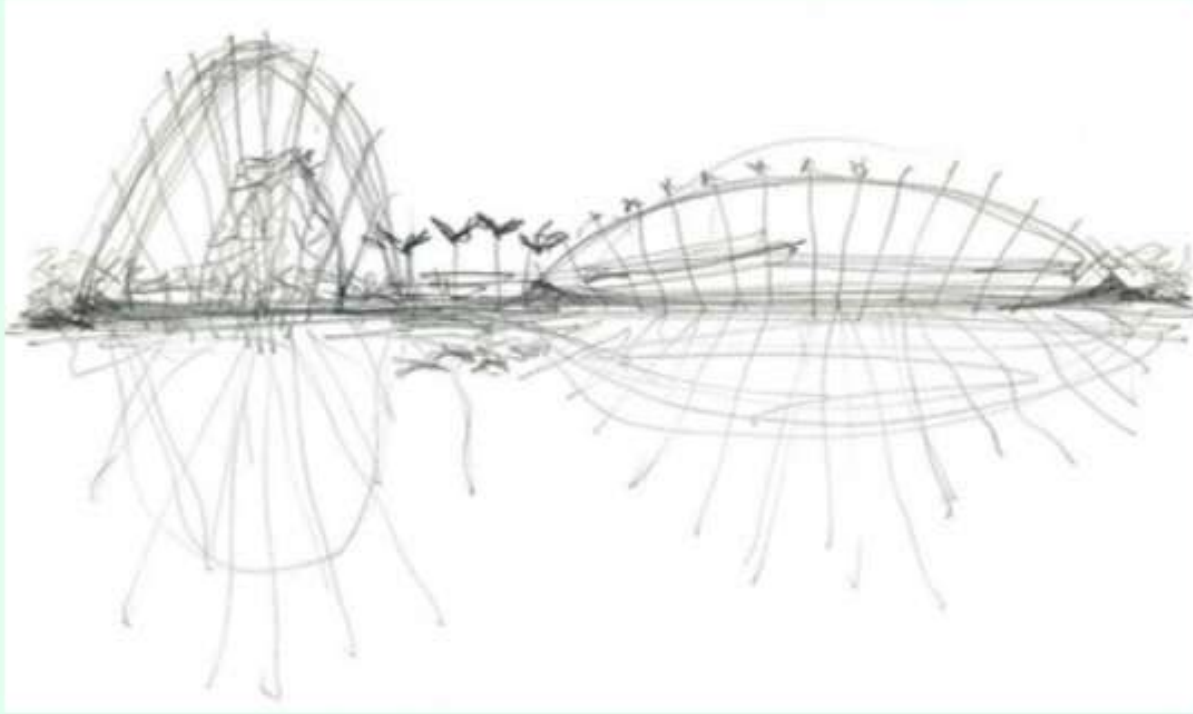


Rain water is cleaned by roots of plants. Then, the collected water by the tower is shared in pipe water for other plants. So it's impossible to know how liters of water that diffuse, cause its depends of the rain.



Cloud Forest and

Flower Dome



The domes was made in the form of leaf to resist to the hard north wind of Singapore. This gigantic greenhouse accommodates more than 32,000 plants.

Flower Dome has a temperature around 24°C and a humidity between 60% and 80%. There are over 100 different species spread over 1.2 hectares. The climate is Mediterranean with plants from all over the world.



Flower Dome

Cloud Forest has a Tropical climate of altitude, 2000m, and has a temperature of 24°C and a humidity of 90%, spread over 0.8 hectares. It protect tropicals plants.

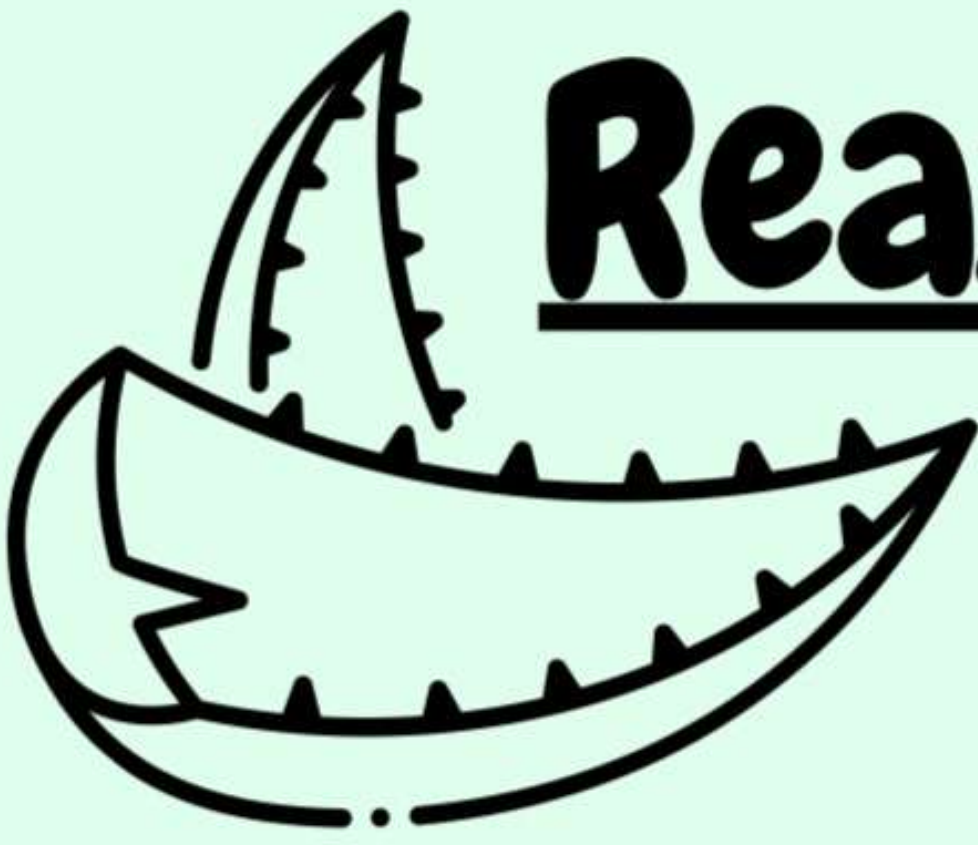


Cloud Forest



Research about

plants



If we can now build such structures, it is thanks to the many discoveries related to plants.



Research on some has thus led to many innovations such as breathable and waterproof textiles, the improvement of the road network on the fluidity of traffic or even the way to collect water.

Scientists were inspired by the family of succulents that harvest rainwater. This makes it easier to hydrate and means that it no longer needs to collect water from the ground. The architects thus used this innovation to build the towers and therefore use the water harvesting system to redistribute it via pipes, like the roots of a plant.

The SmartFlower

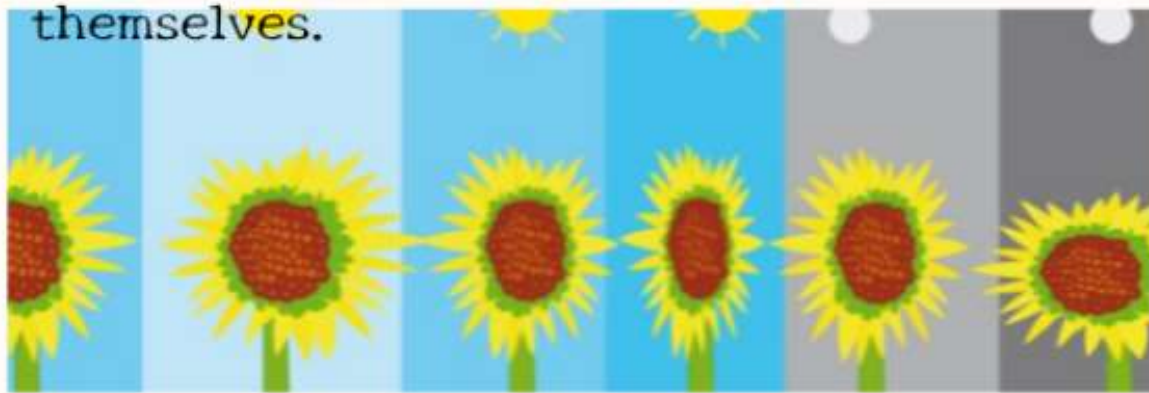


The Sunflower is a flower with an amazing characteristic, which has earned it its name: its stem moves, and turns on itself, throughout the day! So, the flower always stays in front of the sun, so that insects find them more easily. The name "sunflower" means "spinning with the sun". That is what we call phototropism.

Plants can't move, but some can still move. Sunflower is a good example. That is what inspired the « SunFlower », a good example of bio mimicry in innovation in the sector of energies

PHOTOTROPISM

Phototropism is the growth of the plant that is oriented according to the origin of the light. They can orient themselves throughout the day thanks to their rods that rotate on themselves.



THE SMARTFLOWER

Inspired by the sunflower, Austrian engineers have developed the smartflower, a mechanical flower equipped with solar panels that can follow the sun from morning to night. What increase the production power of this photovoltaic system and facilitate the self-consumption. Sunflower captures the sun. It is a combination of performance and aesthetic for the environment. The Smartflower is an intelligent and fully autonomous system.

Fixed on a vertical and horizontal axis, the device is built to withstand weather, wind and extreme temperatures (-20° C to 60° C).



In fact, the SmartFlower has power production performance between 3200 and 6400 kwh/year, depending on the degree of sunshine in your region. The price is estimated between 15000 and 20000€. It has multiple advantages. It is easy to install and easy to move, sustainable and aesthetic. The photovoltaic cells attached to the 12 petal-shaped blades are cleaned automatically thanks to the «smart cleaning» system. Unfortunately, it also has some Disadvantages. In fact, the sunflower is heavy to install, quite expensive and not very productive if there is not enough sunshine.

The Smartflower contains a control box which is the brain of the system and controls the other equipments and also the movement of the flower to be in front of the sun. Then, the inverter converts the solar energy in electric energy. Finally, the energy is stocked in the batteries at the bottom.



The shinkansen train

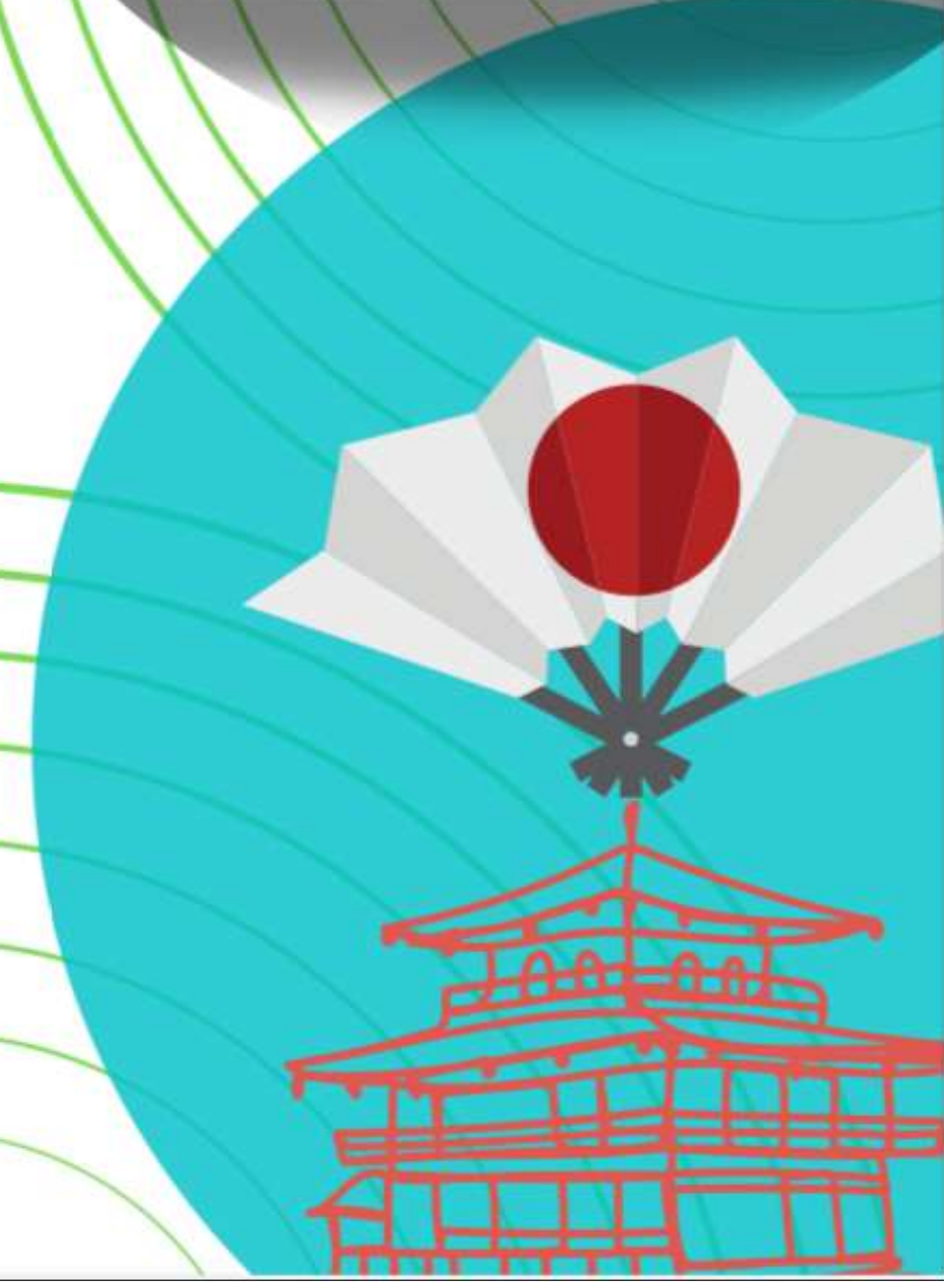


PRESENT IN JAPAN

In the late '90s, Japanese engineers modeled the Shinkansen bullet train after Kingfisher birds to solve one of their biggest problems... tunnel sonic booms.

Tokaido Shinkansen is one of the world's busiest high-speed rail lines. Having moved almost 5 billion passengers from its opening in 1964 for the 2010 Tokyo Olympiad, it was fast, well-known, and ready to expand. Unfortunately, at the time when it was first designed, it was also well-known for disturbing thousands of nearby residents as it emerges from tunnels.

The bullet train travels throughout Japan at speeds of 150-200mph to support millions of passengers yearly. However, its first design didn't consider how the train's high speed would cause atmospheric pressure waves to build up in front of the train as it passes through tunnels.



biomimicry

THE SHINKANSEN TRAIN

Nakatsu's design is a flawless example of biomimicry, the case where we use observations of the structures and systems of organisms from nature to mimic strategies and solve design challenges faced. Nature created the Kingfisher, Nakatsu had to design a train that can adapt to sudden changes in air resistance, and Nakatsu mimicked the Kingfisher's beak to launch a design that not only solved a big problem the Shinkansen trains were against but changed the ways Japan's Tokaido Shinkansen trains are designed forever.





History and design of the train

THE SHINKANSEN TRAIN

The Shinkansen, the « kingfisher train »

The Shinkansen (新幹線) is the high-speed train of Japan. In 60's it was the fastest train in the world. Thanks to successive improvements, its top speed went from 210 to 405 km/h. So, its cruising speed is 320 km/h, which is considerable.

Japan being a mountainous country, the trains must often use tunnels. When it circulates at a high speed, it compresses and move out a air.

Eiji Nakatsu, the engineer who led the Japanese train tests, took an interest to the fact that the kingfisher can dive in the water with provoking the minimum of whirlpool. Indeed, this bird is the most effective on earth to passe through two different environments of density. Eiji Nakatsu had the idea to imitate the shape of the kingfisher spout for the front of the Shinkansen's trains, so that it can pass through to an environment less dense outside of the tunnel to an environment more dense inside of the tunnel without emit a noisy song.

The results of the experiences made on the first trains using this particular shape have been really satisfying. This one being not compressed anymore inside the tunnel, the "boom" no longer happens.

Also, this shape permit to reduce the pain felt in the ears of the passengers, which was from the abrupt changes of pressure inside the train when it enters or exit the tunnel.

The sharp shape of the front of the Shinkansen reduce its energy consumption of 16% and increase its speed of approximately 10%.



Evolution



Shinkansen 0 (1963) 220 km/h



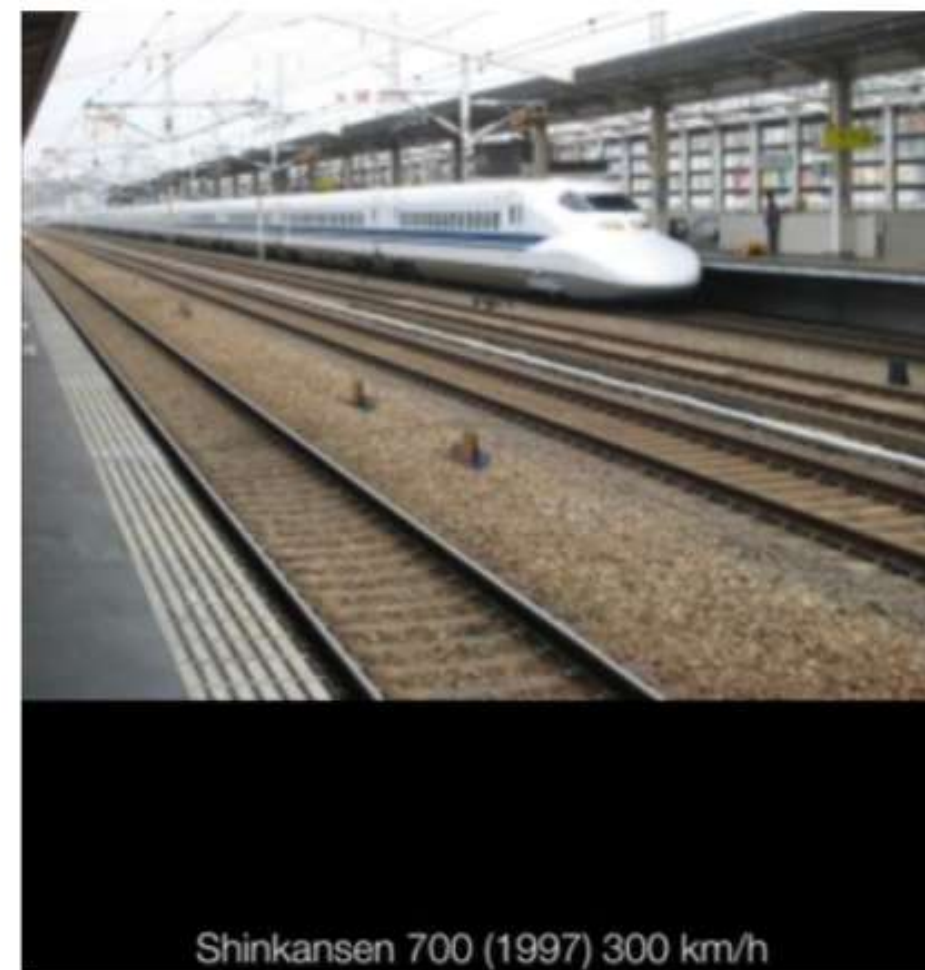
Shinkansen 100 (1984) 230 km/h



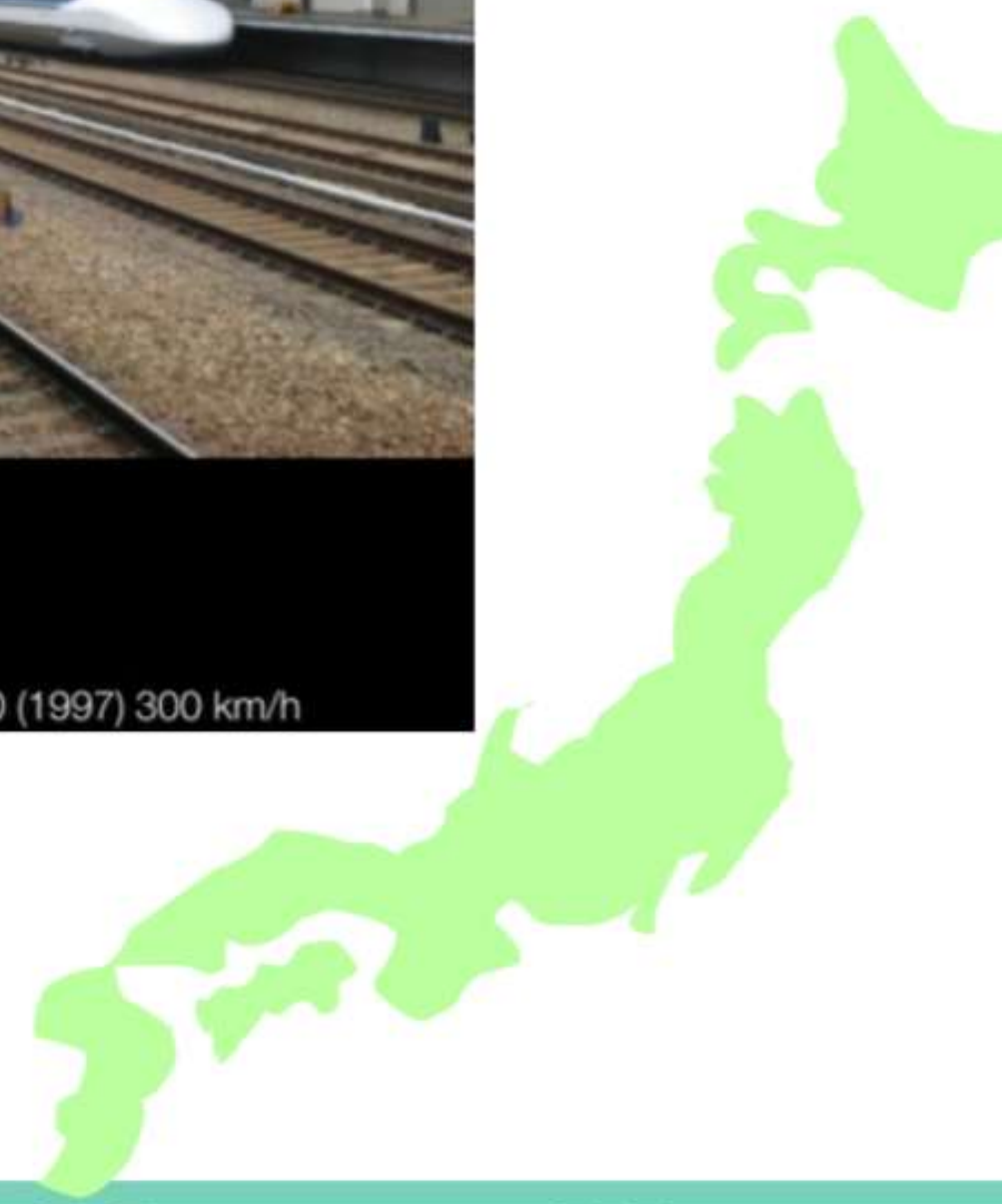
Shinkansen 300 (1990) 270 km/h



Shinkansen 500 (1995) 285 km/h



Shinkansen 700 (1997) 300 km/h

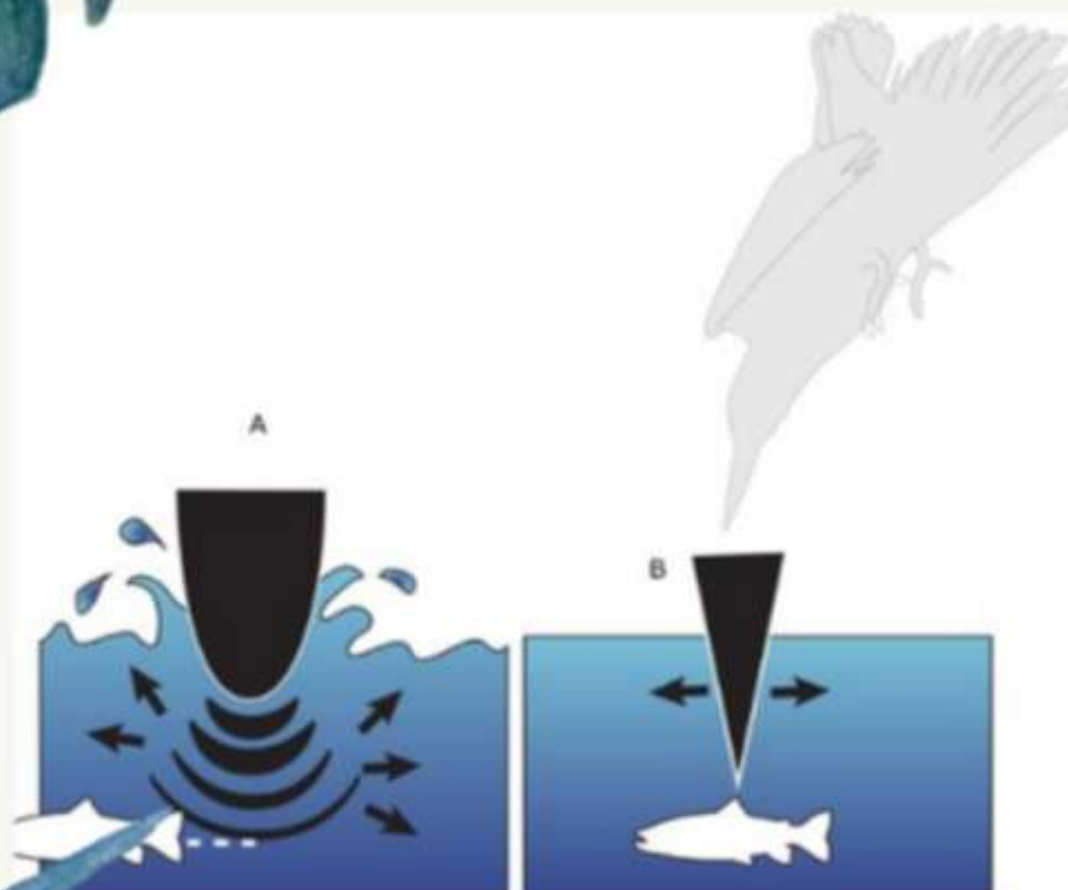


The Kingfisher

is a small bird with bright and vivid colors: turquoise blue on the back and orange under the belly it can be found along rivers, lakes and ponds of low altitudes



To feed, this small bird must enter the water with the least possible loss of speed and the least possible movement of the water to catch the fish. Its beak is therefore aerodynamic to pass from the air to the water efficiently.



Indeed, with a more rounded bill (A), when entering the water, the bird would be slowed down and would cause whirlpools that would make the fish run away. With a pointed bill (B), the kingfisher can enter the water without losing speed and without swirling, making it easier to catch its prey.

The kingfisher can thus easily move from one environment to another that does not have the same density. The shape of its body, reduces the aerodynamic drag.



ITALY!



BIOMIMICRY IN HEALTH AND PHARMA INDUSTRY



EDIZIONE SECONDA



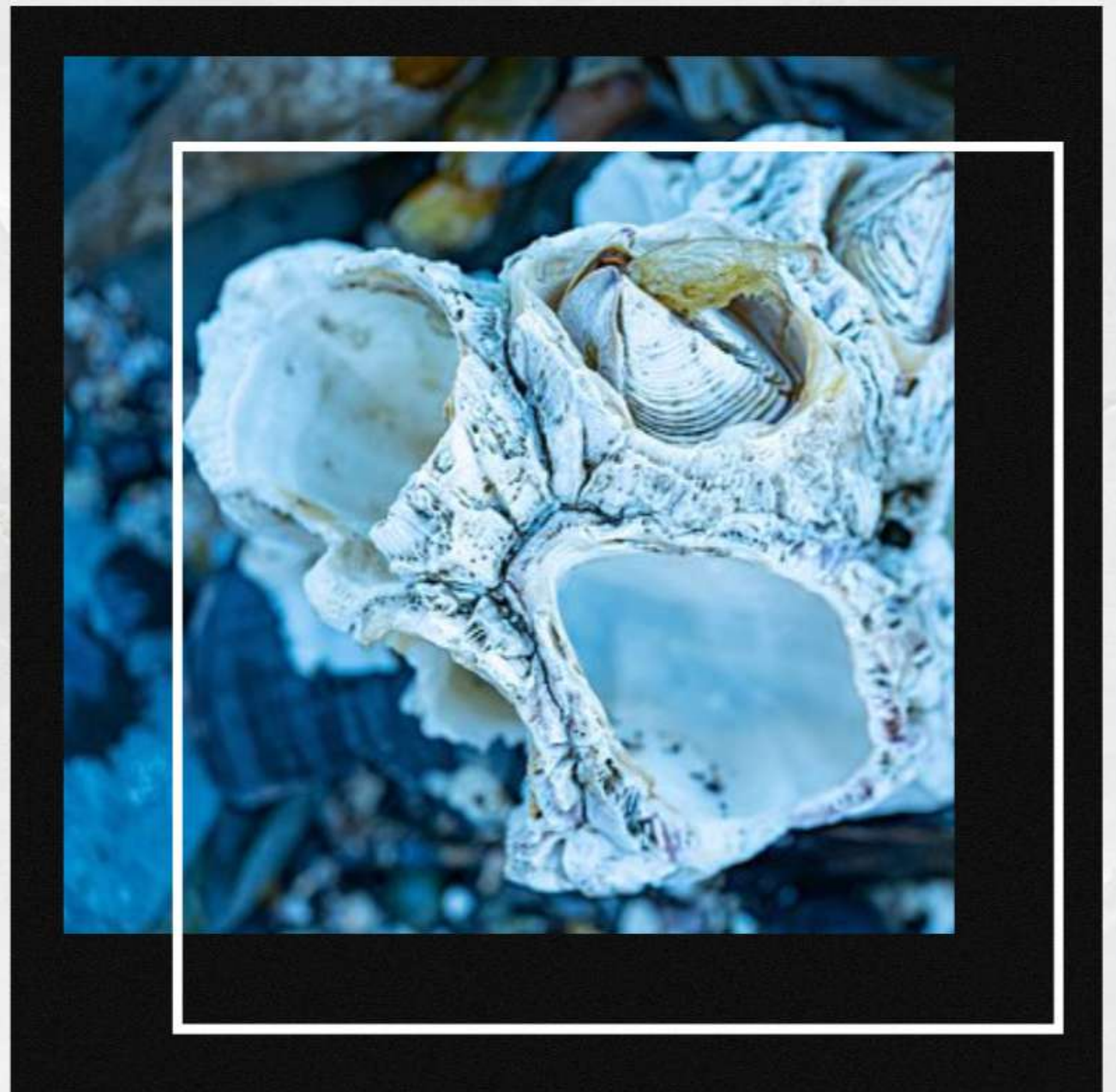
SETTIMANALE • €2,50 • MARZO 2023

SURGICAL GLUE

This product is inspired by the cement used by Barnacles and Mussels to remain attached to the cliffs.

It is so strong that it allows them to remain attached to the rocks despite the strength of the waves and the sea currents.

It's a biocompatible paste that is also used on wet tissues, so it's perfect for applying to wounds with blood.



ORGAN PRESERVATION



Scientists are looking for new organ preservation systems and they are inspired by the wood frog.

When it gets cold, this animal does not hibernate but freezes and blocks the functioning of its organs without damaging the tissues.

PACEMAKER

Many researchers are copying the pumping system of the heart muscle of the humpback whale and are working on more advanced versions of pacemakers. This innovative system is based on nerve impulses.



MEDICAL NEEDLES



In Japan some researchers are creating micro needles copying the sting of mosquitoes so that patients do not feel the pain of the needle.

BIOMIMICRY

THE SCIENCE THAT COPIES NATURE



25

IN THE TEXTILE INDUSTRY

EXAMPLES OF THEMES FROM THE BIOMIMICRY HIGH FASHION INDUSTRY



This is an Australian dress made out of wine!

WATERPROOF FABRIC

The water resistant material like animal hair.

VELCRO

Our **hook and loop closure** comes from nature.

STELLA MCCARTNEY

The stylist who used **mushrooms**.

SALVATORE FERRAGAMO

"Responsible passion" with **oranges**.

WATERPROOF MATERIAL



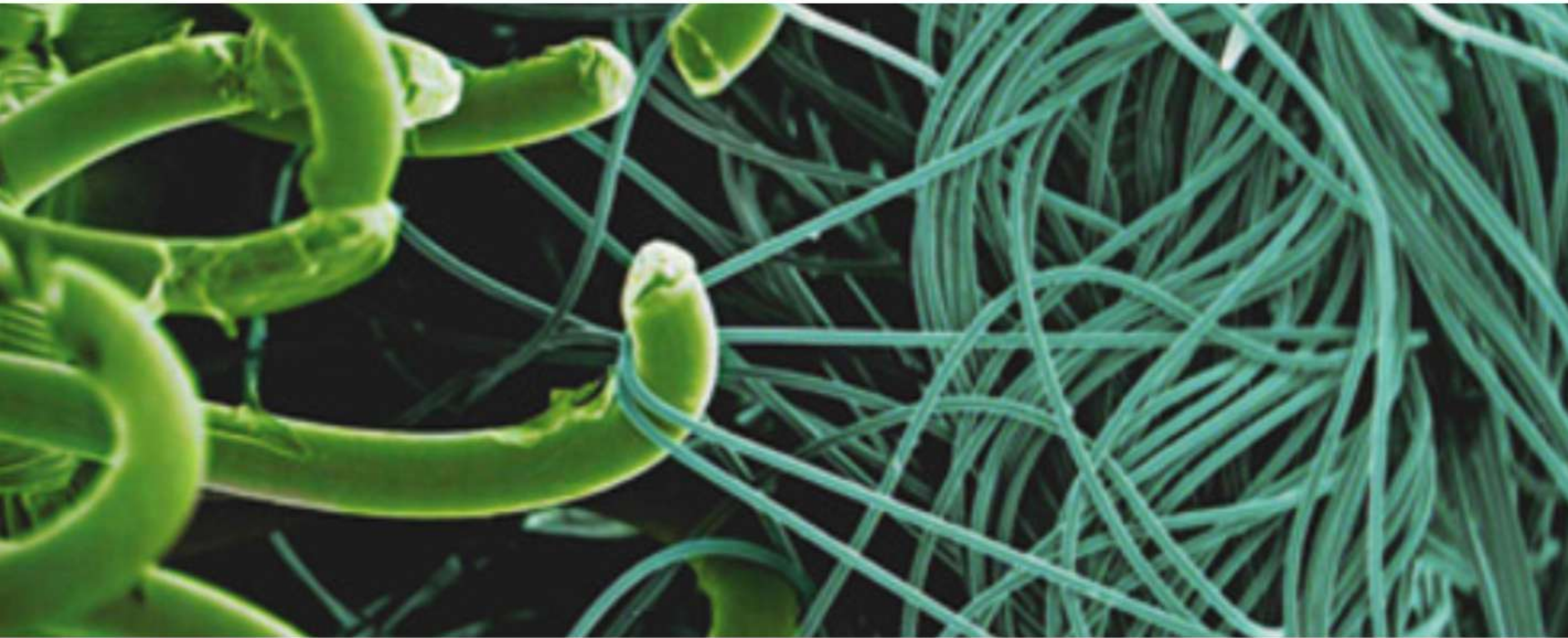
Nikwax is a company that started with the study of nature and has created fabrics that make people more comfortable and protected when outdoors. For instance, **Nikwax Waterproof** is a **fabric that mimics animal fur**. The fabric protects from rain, condensation, and perspiration by **repelling water** away from the body exactly as fur does.

VELCRO

Even Velcro, our hook and loop closure, a material we deal with on a daily basis, actually comes from nature. Did you know that?

Georges de Mestral was a Swiss engineer. Lived in Aubonne, he was the inventor of the Velcro closure.

On August 2, 1955, walking with his dog, the engineer noticed that burdock flowers, which have small hooks, stick to tissue and are difficult to remove; he copies nature and creates a support with micro-hooks and one made of furry fabric and patents it. He created Velcro from the initials of Velours (velvet) and Crochet (hook).





STELLA MCCARTNEY

Also the english stylist Stella McCartney has taken a step towards sustainable fashion and she created a prototype of her renowned bag in mushrooms skin (with mycelium, a vegan substance deriving from the roots of the mushrooms themselves), called Frayme Mylo.

“

RESPONSABLE PASSION



This is the motto of Salvatore Ferragamo, an Italian brand; it reflects a commitment to innovative design through the use of the fibers derived from oranges ("Orange Fiber collection").

From the love for innovation, design and Italian creativity, the first fashion collection made with citrus fabrics was born in 2017.

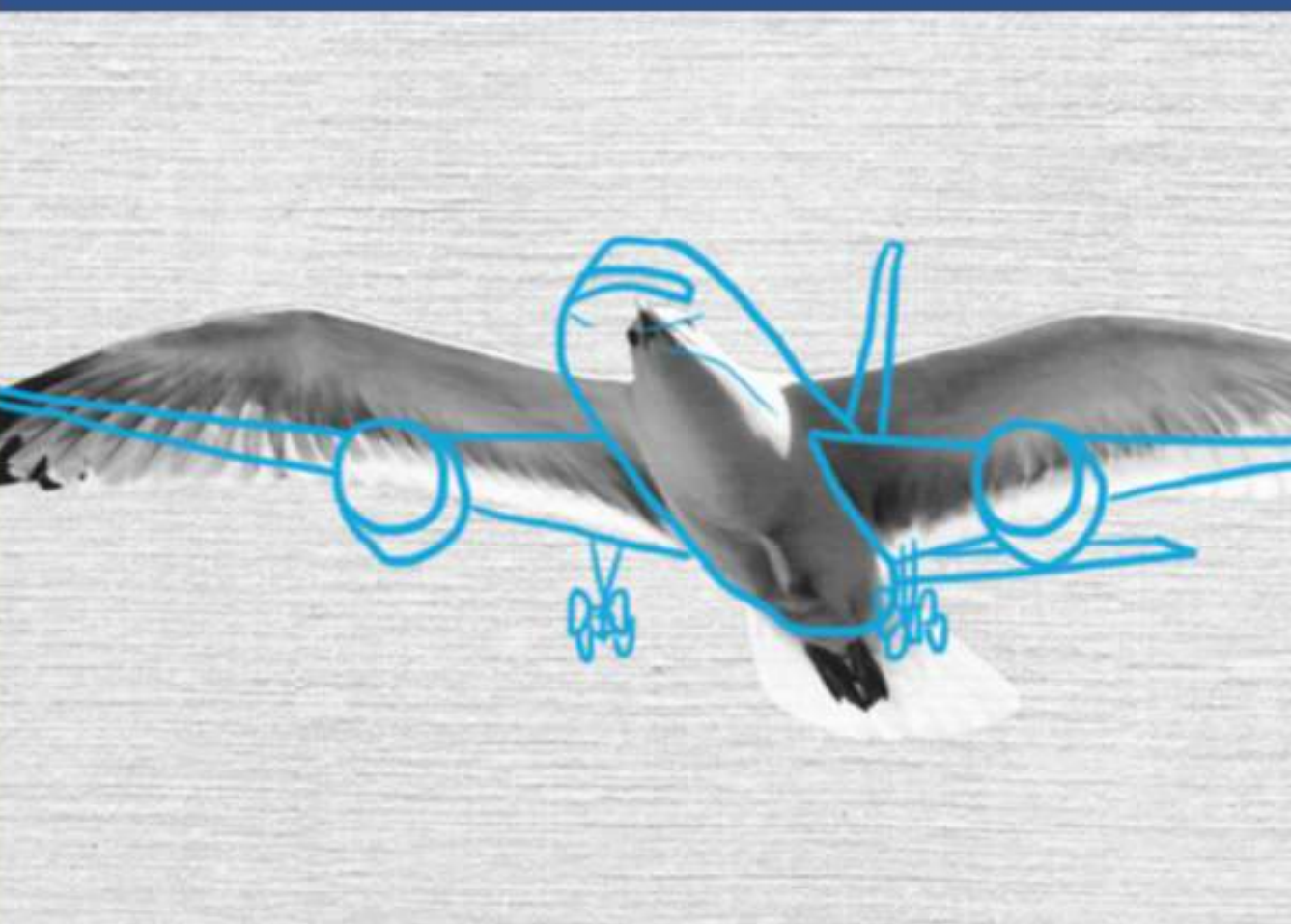
BIOMIMICRY

in the aerospace industry



WHAT IS THIS?

It indicates the transfer of biological processes from the natural to the artificial world: "mimicking" the mechanisms that govern nature.



WHY MIGHT IT BE USEFUL?

Biomimicry draws lessons from nature to develop artificial materials or structures, in fact, it has been applied for many years in industrial design, although it has only had a rapid development in the last 10 years.



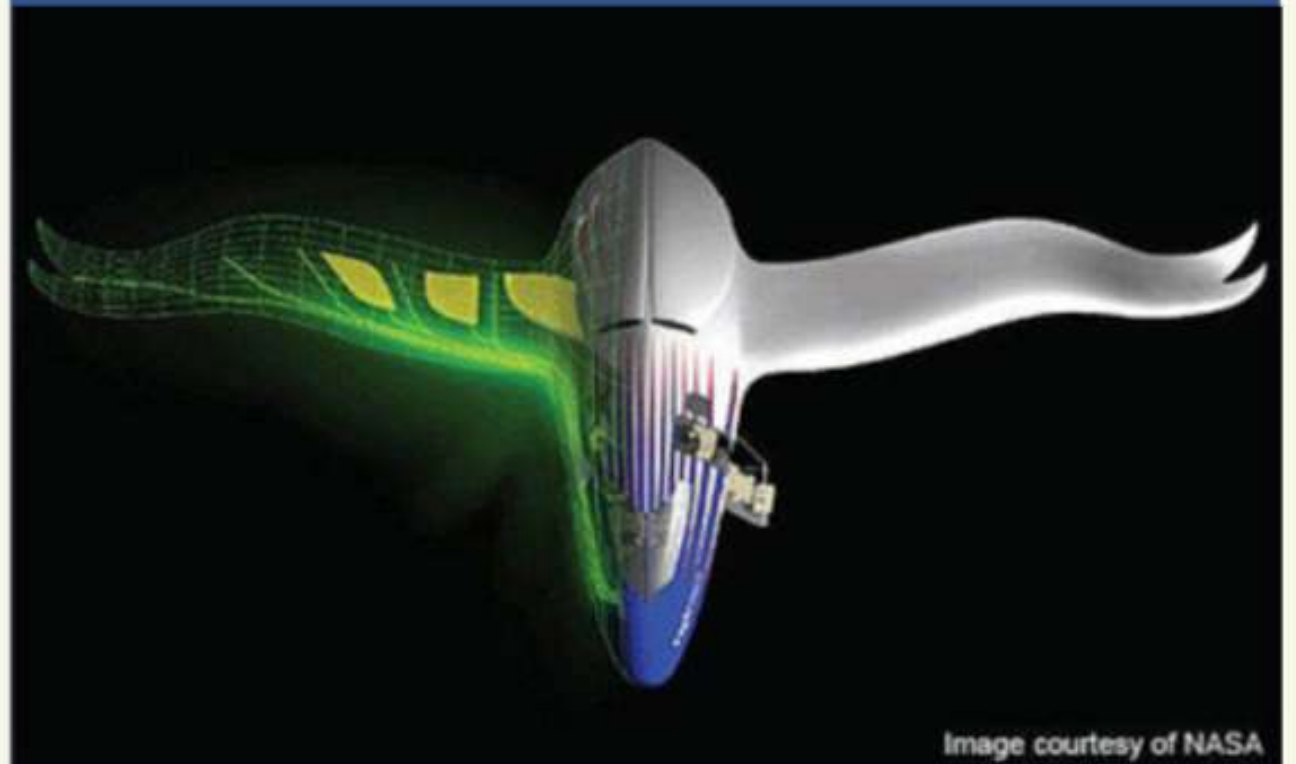
EXAMPLES OF BIOMIMICRY IN AERONAUTIC INDUSTRY



Birds have smooth and sometimes glossy surface. Birds groom their feathers with their beaks to make sure that their body is smooth as they fly. Airplanes also have polished surfaces, and this prevents air resistance.



Birds use a concept where they fly in a V shape when they are in a flock, this helps them go for long distances without tiring. There are some researchers from Stanford University who utilised this trait and found out that if jets use the same trait, they can save on fuel.



In 2008, an engineer said that when birds are in the air, they extend their wings so far, and this helps them to stay high and to reduce the air drag. He also says that when birds want to move faster, they close their wings and planes can use the same concept that he calls 'wing morphing'.

HUNGARY



Biomimicry in Agriculture and Agro-Industry

In India sewage is a big problem



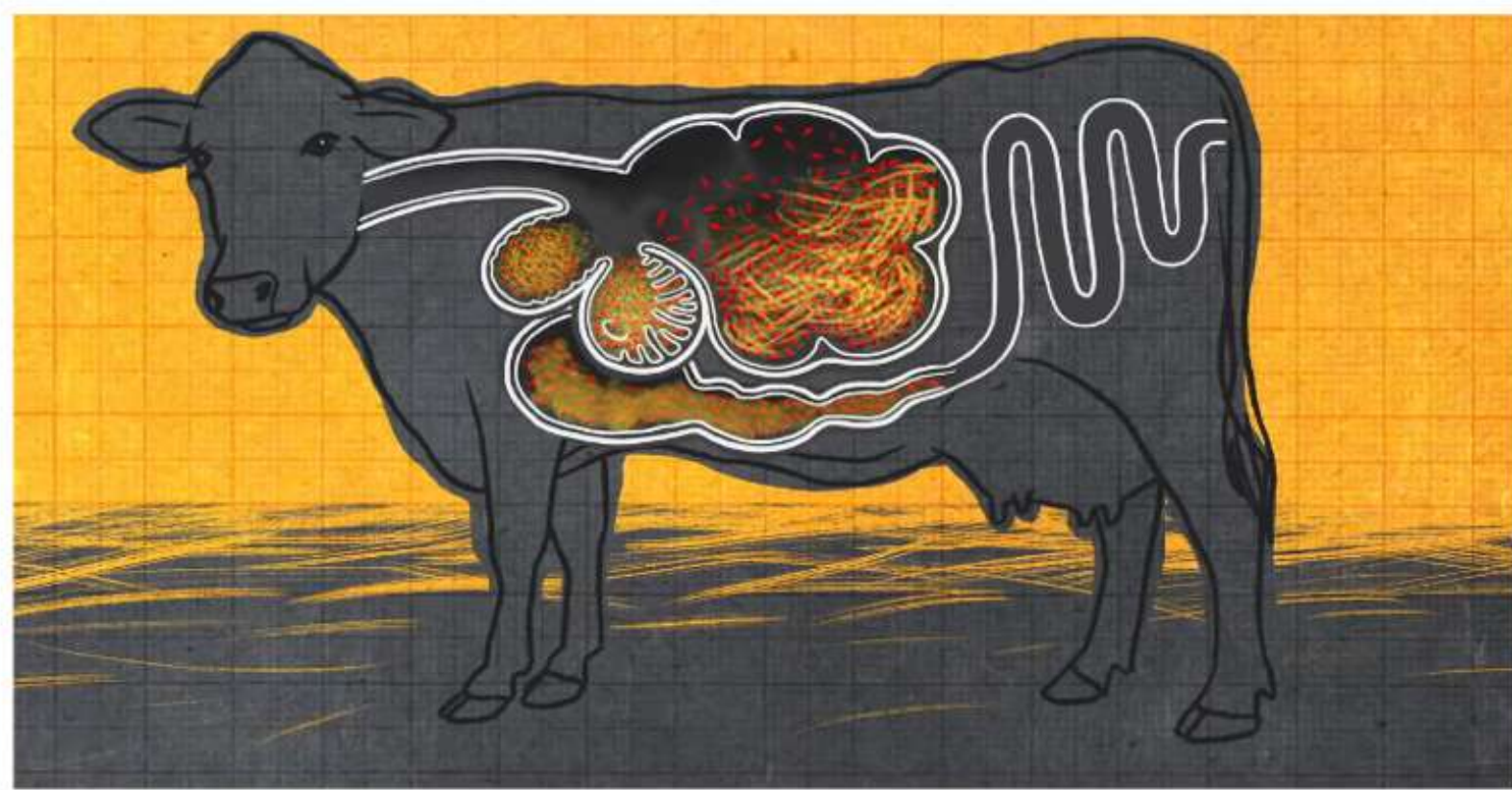
**Because of the
sewage lakes started
burning.**



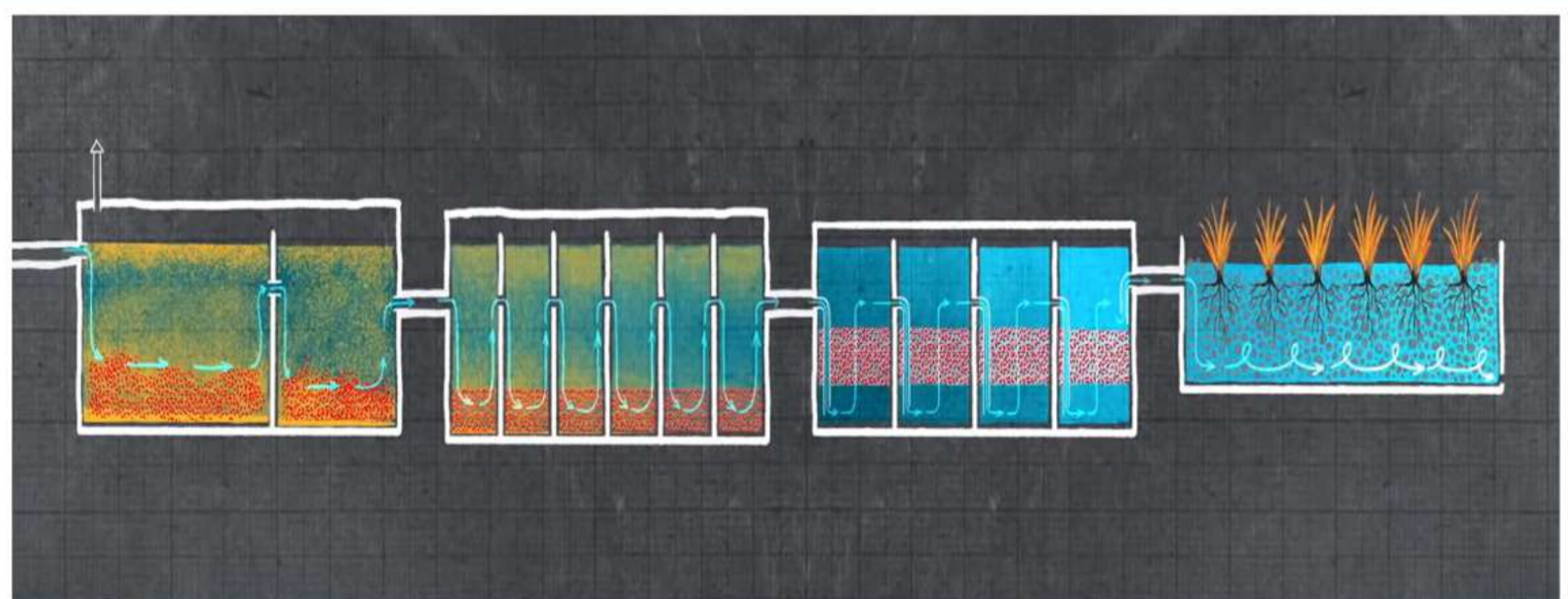
A Better Sewage Treatment System, Inspired by Cow Stomachs

ECOSTP

They have found an environmentally friendly solution to this problem:



They have made a wastewater treatment plant, copying the system of the cows' organs, that doesn't need a blower motor.





Synthetic meat

People eat too much meat nowadays.
It is not sustainable at all!

Terrible Conditions in Factory Farming:

- ❖ Animals are suffering and being abused
- ❖ These silent victims have been converted into machines that generate meat, milk, and eggs

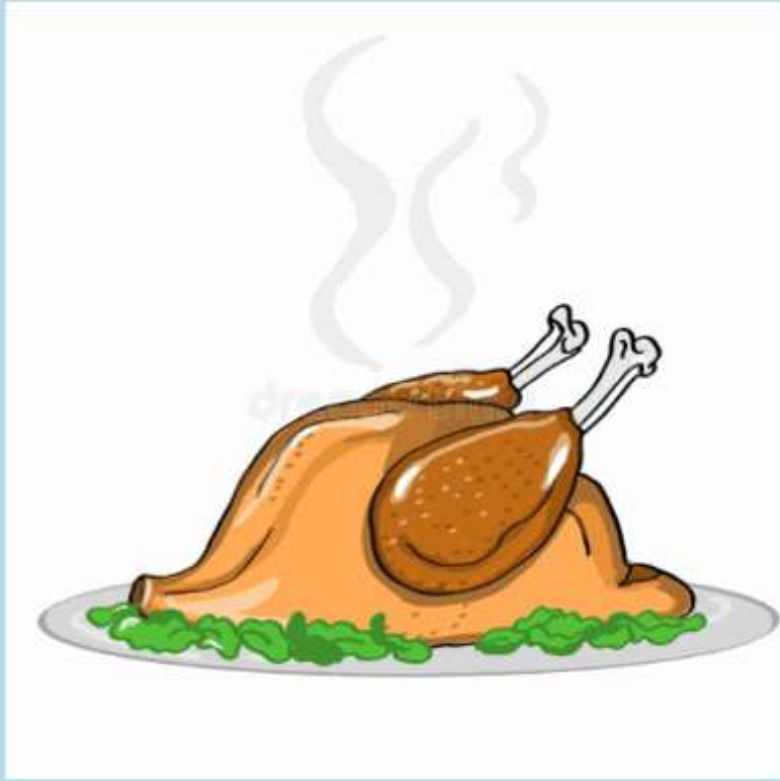


Meat production requires a lot of resources:

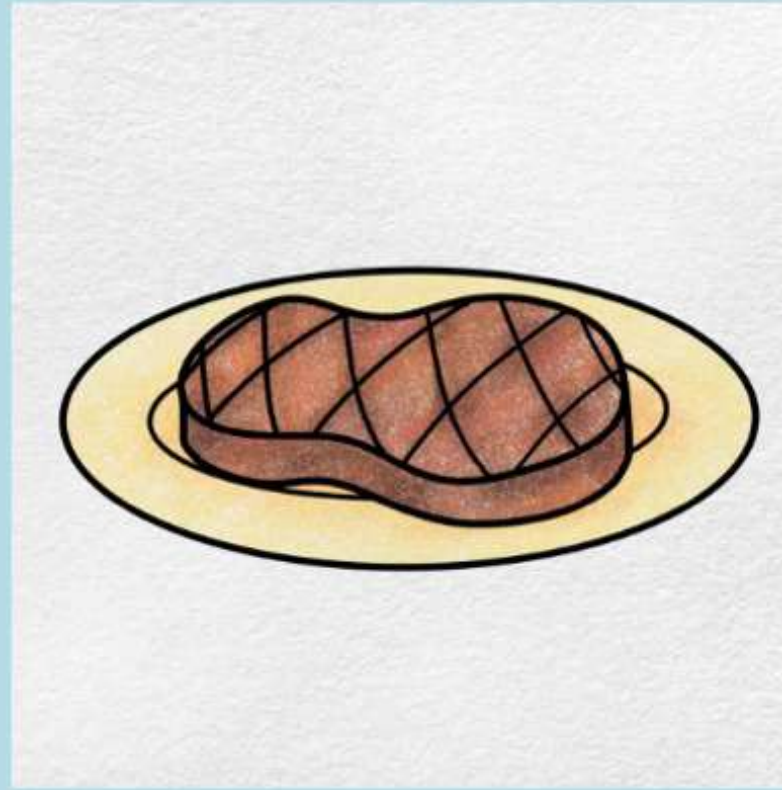
4000 L
water



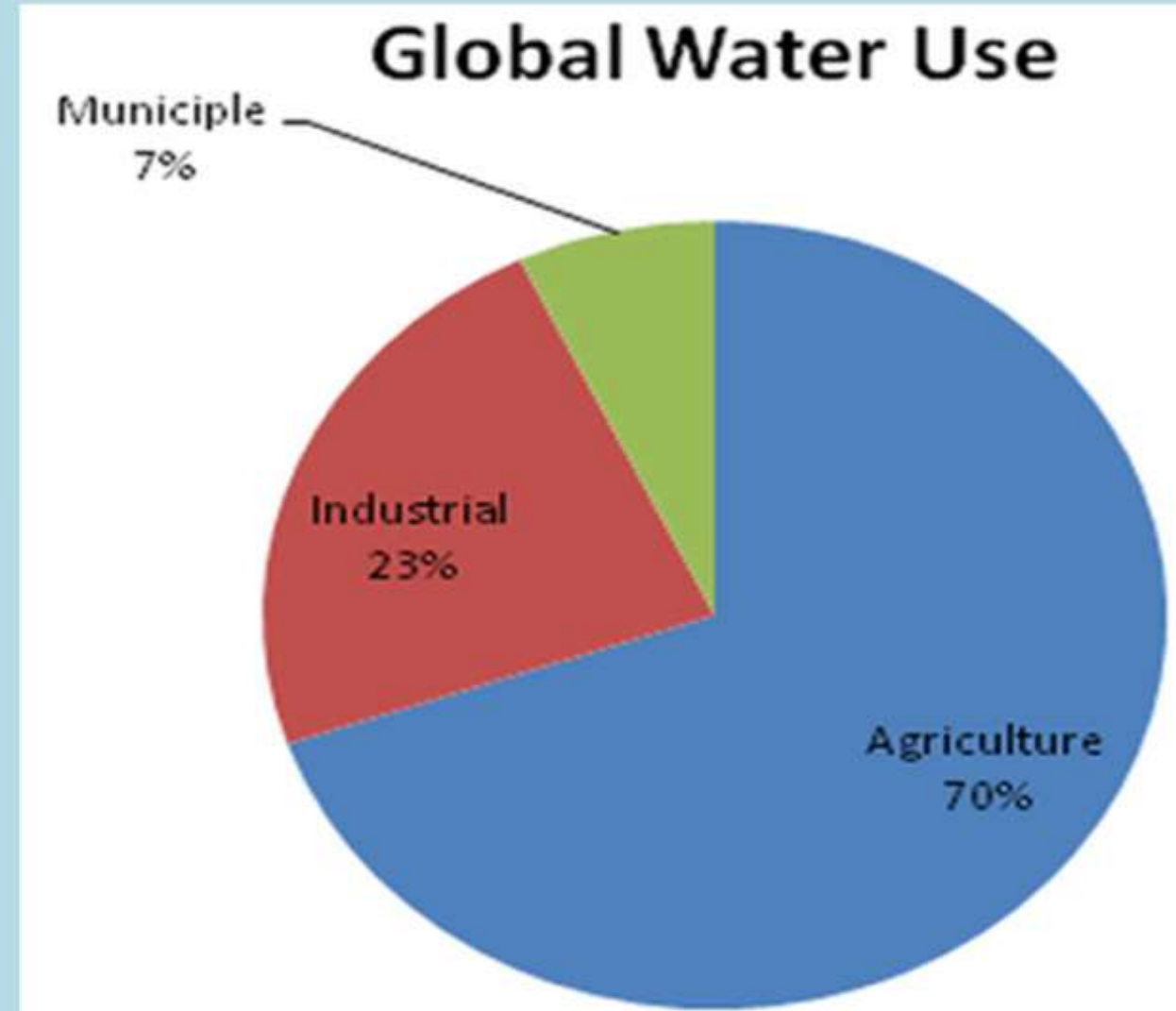
13000 L
water



100 kg poultry

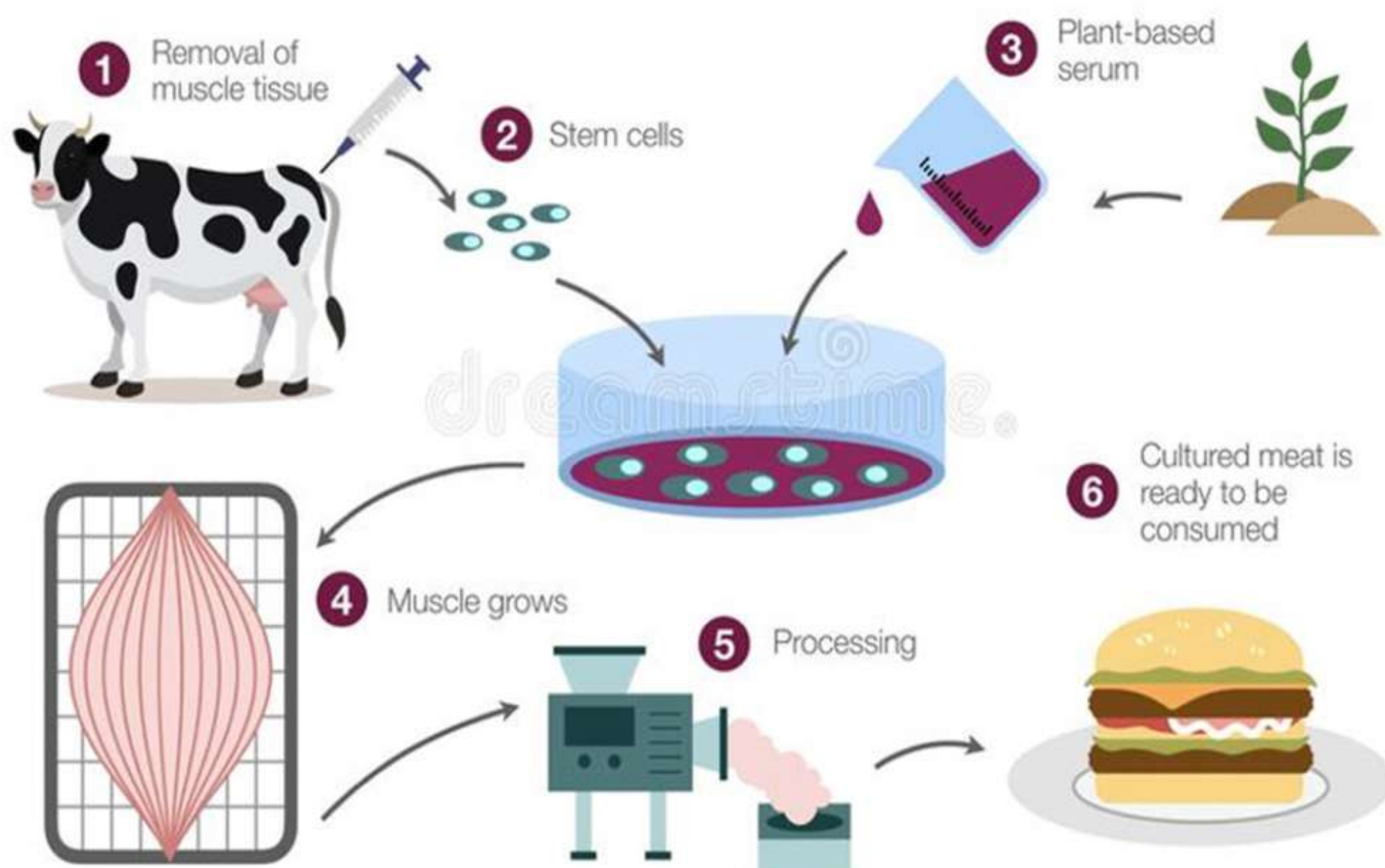


100 kg beef



The basis of the technology is that muscle cells, taken from an animal using biopsy which does not cause pain to the animal, are multiplied in laboratory conditions.

How cultured meat is made



Advantages of synthetic meat:

- its composition can be adjusted according to needs
- no diseases
- no parasites
- no living animals needed
- reducing the use of different energy sources and the emission of greenhouse gases



Maple Seeds

1 Wind Turbines

They both have the very same aerodynamic shape



2 Maple seed inspired drones used in agriculture



Organic fertilizer contains a lot of **vitamins** that are necessary for plant growth. However, due to the increasing production, there is not enough organic fertilizer, which is why **artificial fertilizer was created**, which contains different chemical substances. This makes it a less healthy option, so you have to be aware of its correct use.

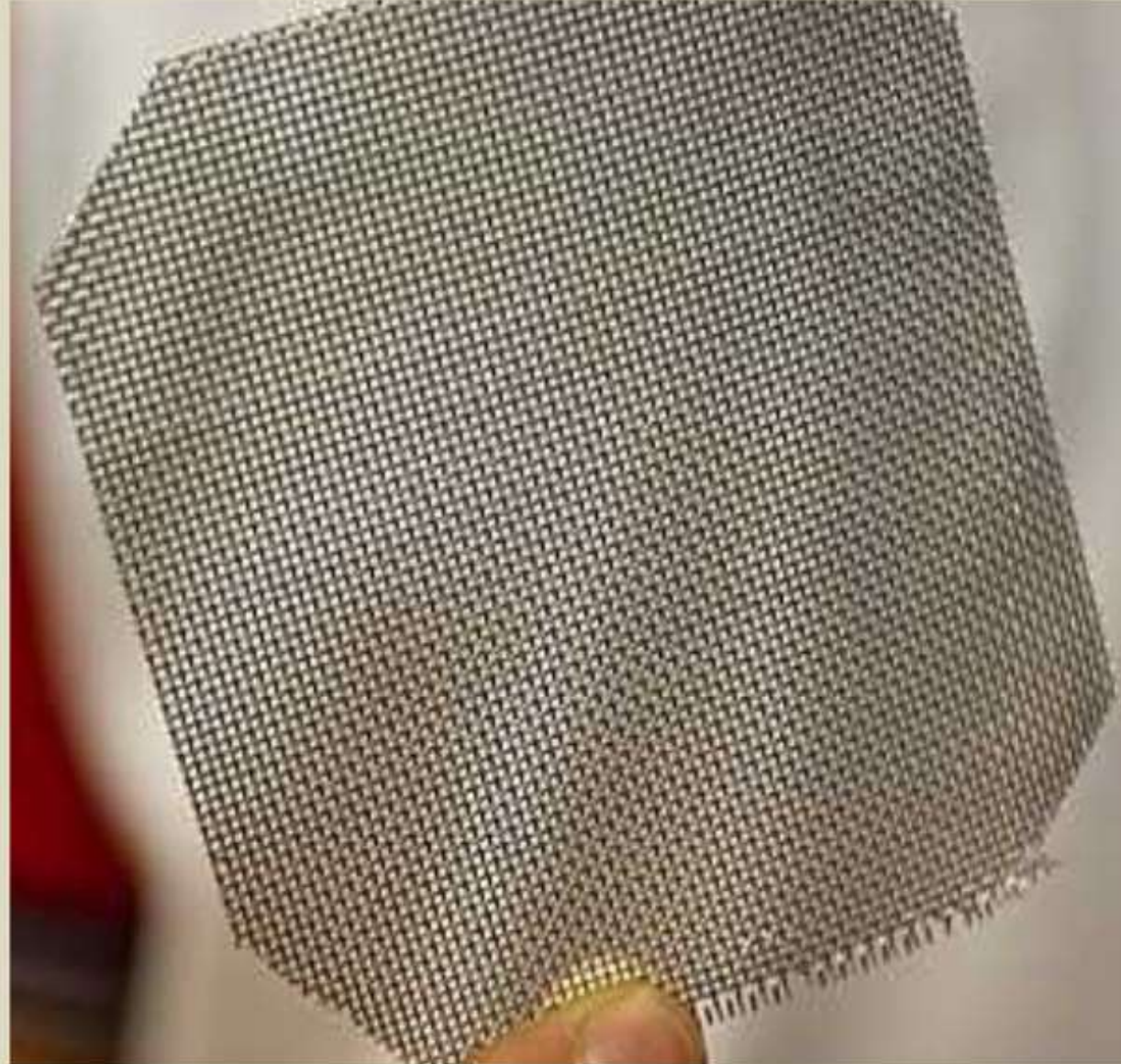


Water Collection Inspired by beetles

This small black bug lives in a harsh, dry desert environment and is able to survive thanks to the unique design of its shell. The Stenocara's back is covered in small, smooth bumps that serve as collection points for condensed water or fog. It's entire shell is covered in a Teflon-like wax and it helps them to collect water from the morning fog.



This material inspired by *Stenocara's* back collects water from the air more efficiently than existing designs.



They are trying their best to make water available for the poor of the world by refining the tools and techniques of fog harvesting.

Mussels glue

Blue mussels spend their days being struck by the waves. They manage to stay stuck to rocks or to each other because of the highly effective underwater glue they produce.



Scarecrow:



Biomimicry
in
Digital
and
Telecommunication

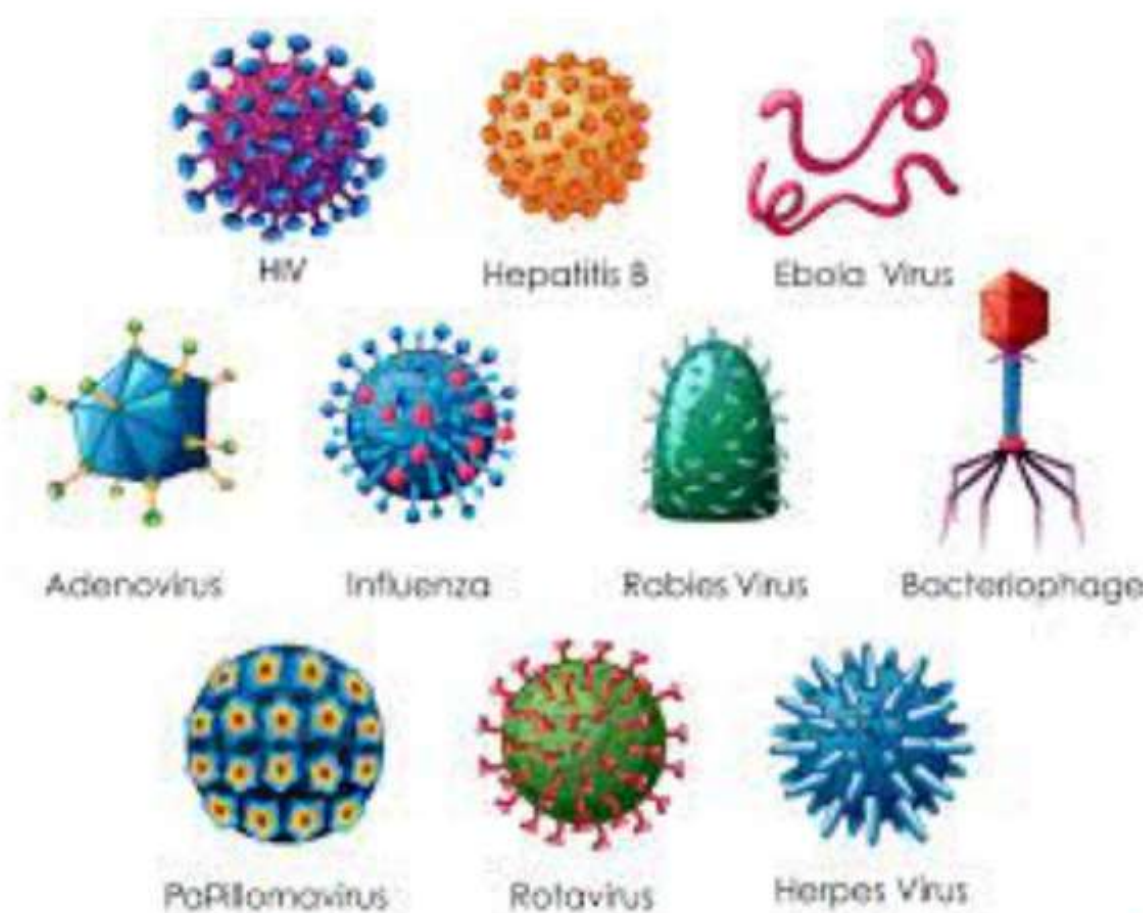
Like the butterfly's wings, the display is taking the white ambient light around us, white light or sunlight, and through interference is going to send us back a color image. Unlike conventional LCD screens, the Mirasol monitor doesn't have to generate its own light. The display brightness just automatically scales with ambient light. As a result, the Mirasol monitor consumes a tenth of the power of an LCD reader.



Viruses

In nature:

In computers:



**HARMFUL
DANGEROUS
INFECTIOUS
HARD TO GET RID OF**

Biomimicry in Defence

Chiton inspired body armor

- When it comes to body armor, there's typically a trade-off – it can either be highly impact-resistant or flexible, but not both.
- According to recent studies there is a mollusc which has a very strange exterior. It consists of many small scales which together are **both impact resistant and flexible**. If there is an external influence it makes it much stronger.
- The material is still being developed.





Color-Changing Film Inspired by Chameleon Skin

What is it?



Scientists are trying to imitate chameleon skin in various materials. Now a flexible film, made of cellulose nanocrystals that changes color when stretched, has been developed.

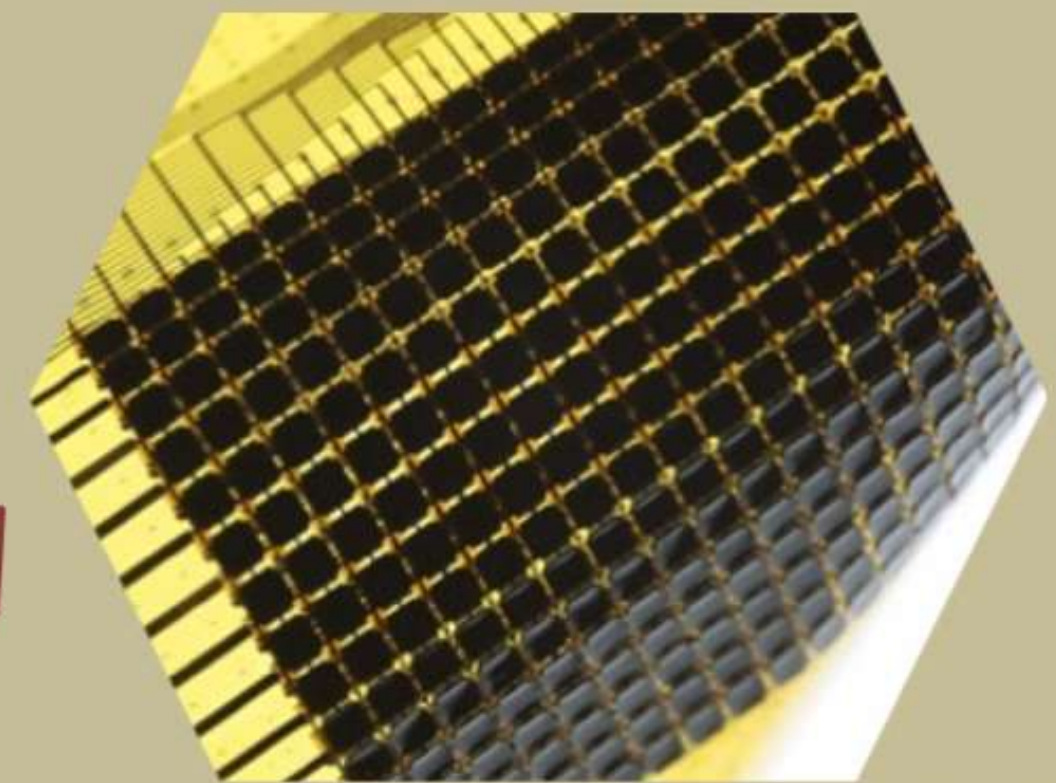


If you are interested in the details watch this video:

[CLICK!3Я3H](#)

Cephalopod camouflage

Squids are capable of glowing (bioluminescence) as well as changing their skin color. This camouflaging capacity enables them **to hide** from predators while the bioluminescence allows them **to communicate** with and/or attract a mate.



Researchers has developed a similar device that can detect your environment and adapt it in seconds. This prototype uses a flexible, pixelated grid with actuators, light sensors and reflectors. As the light sensors detect changes in the environment, they send a signal to the appropriate diode. This generates heat in the area and the thermochromatic grating then changes colour. **This artificial "skin" can have military and commercial applications in the future.**

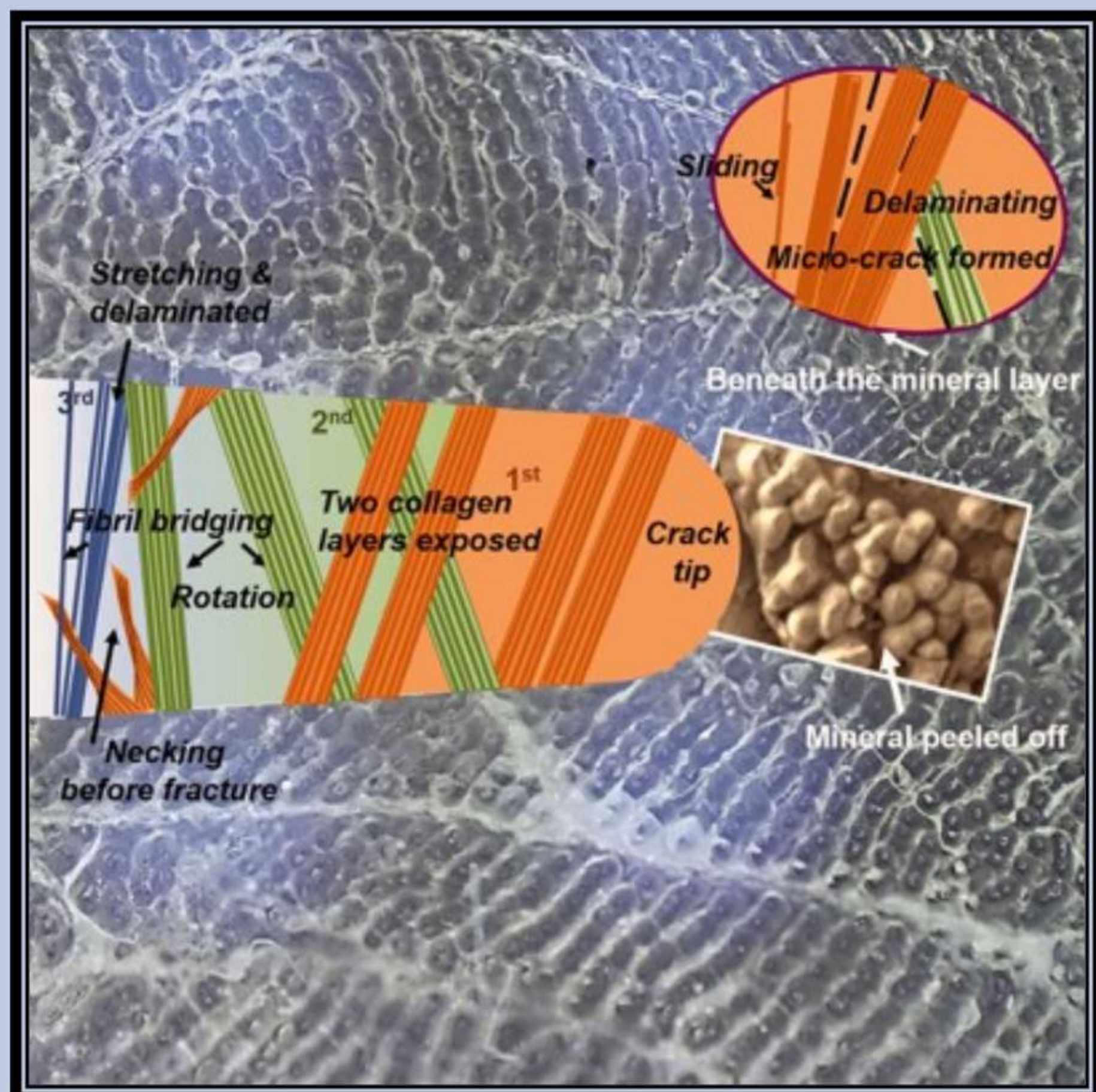


Arapaima fish

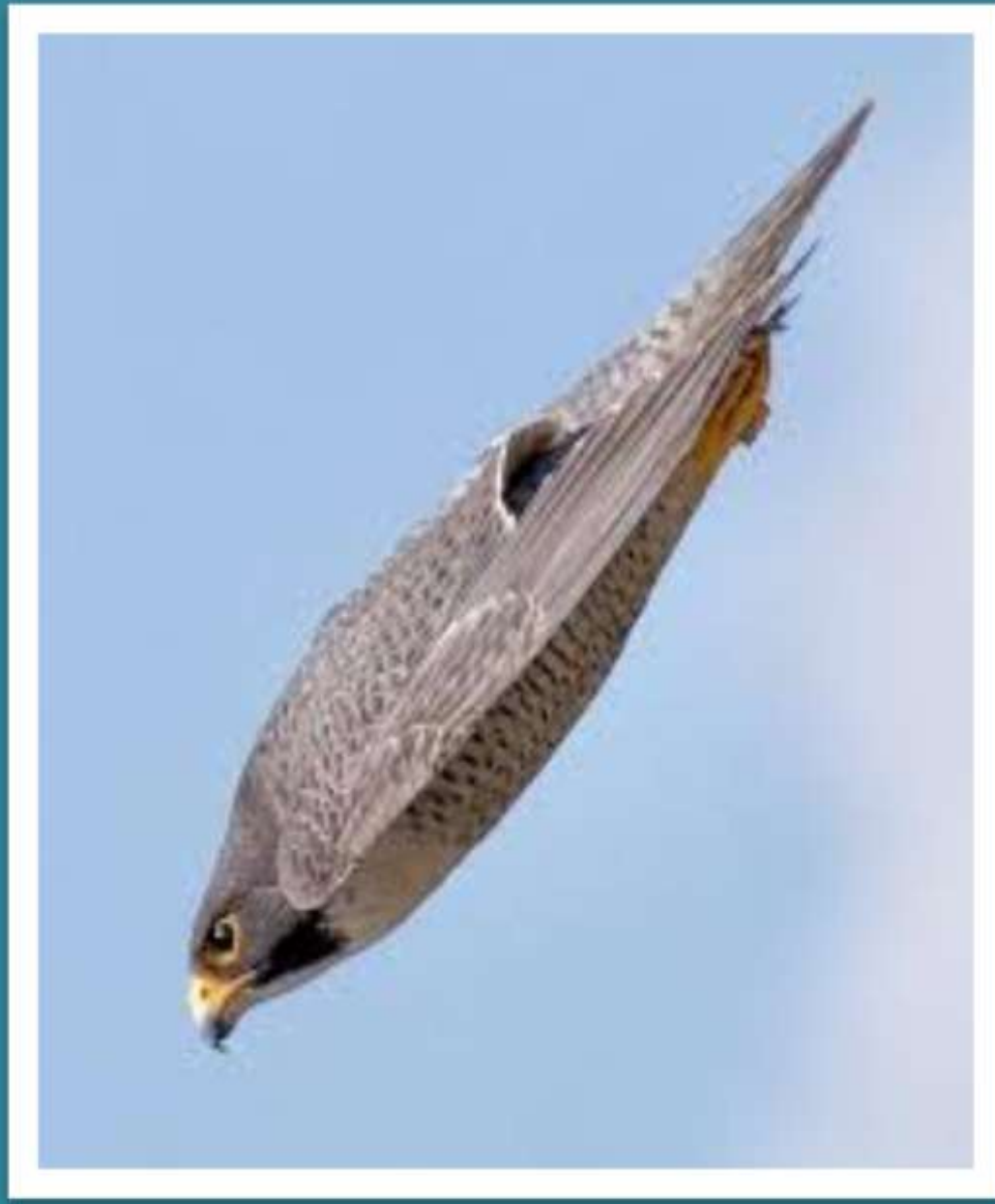


They have found out that the Arapaima fish's scales can withstand even piranha bites, because they consist of two layers: a **hard outer layer**, and a **soft but flexible inner layer**.

An artificial material is still being developed from it.



They figured out that the shape that the falcon has while diving makes it extremely **aerodynamic** so the falcon doesn't need to be heavy to dive fast



The American engineers studied how such a light animal can dive at 300km/h



With this information they created the B2 spirit heavy stealth bomber

Unfortunately, many birds are killed or injured while flying into a window. That's why people invented **bird-shaped, black-colored stickers** to stick on transparent glass surfaces. It is important to depict a bird that is predatory and dangerous to other birds, thereby they will not fly in that direction.

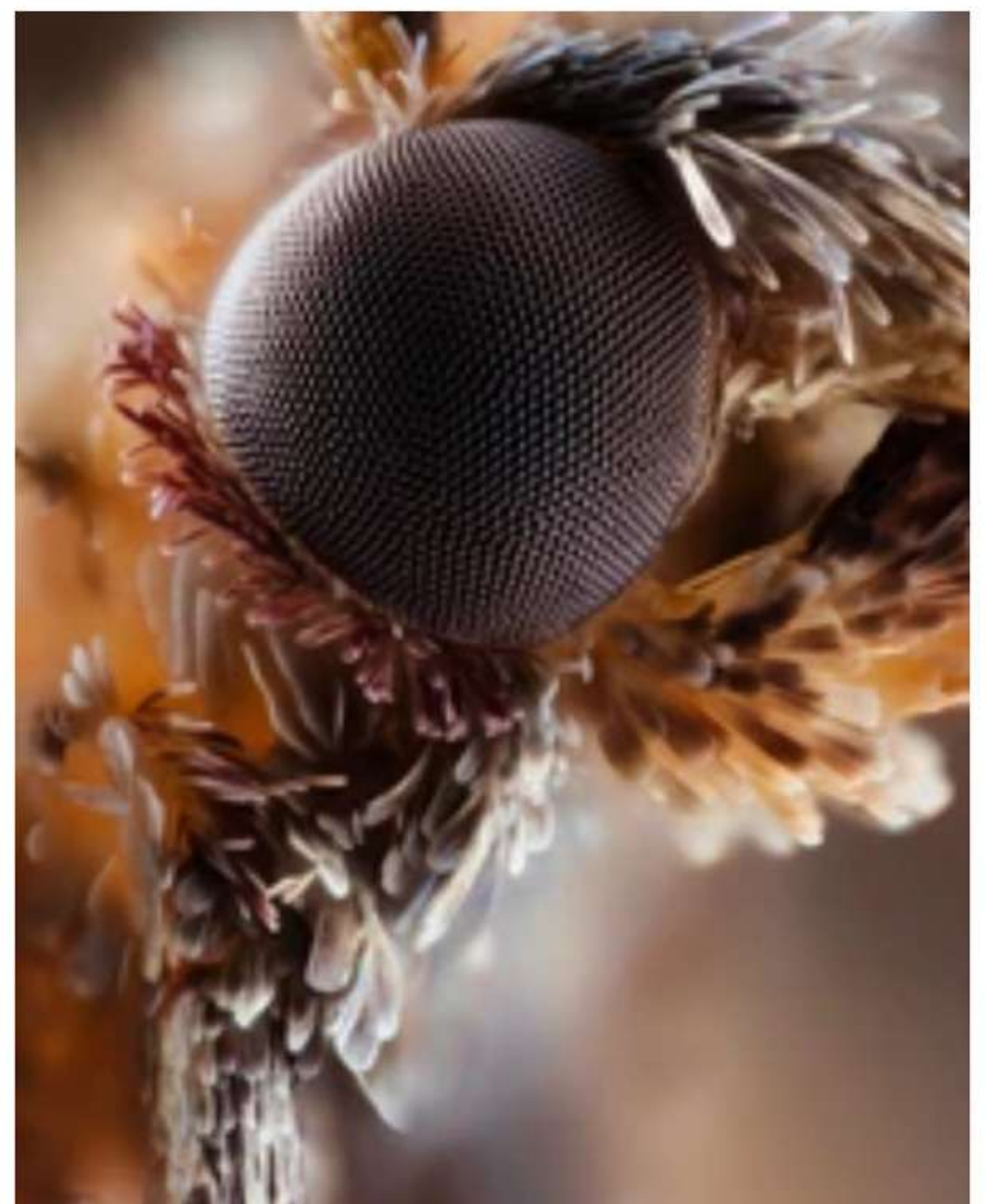
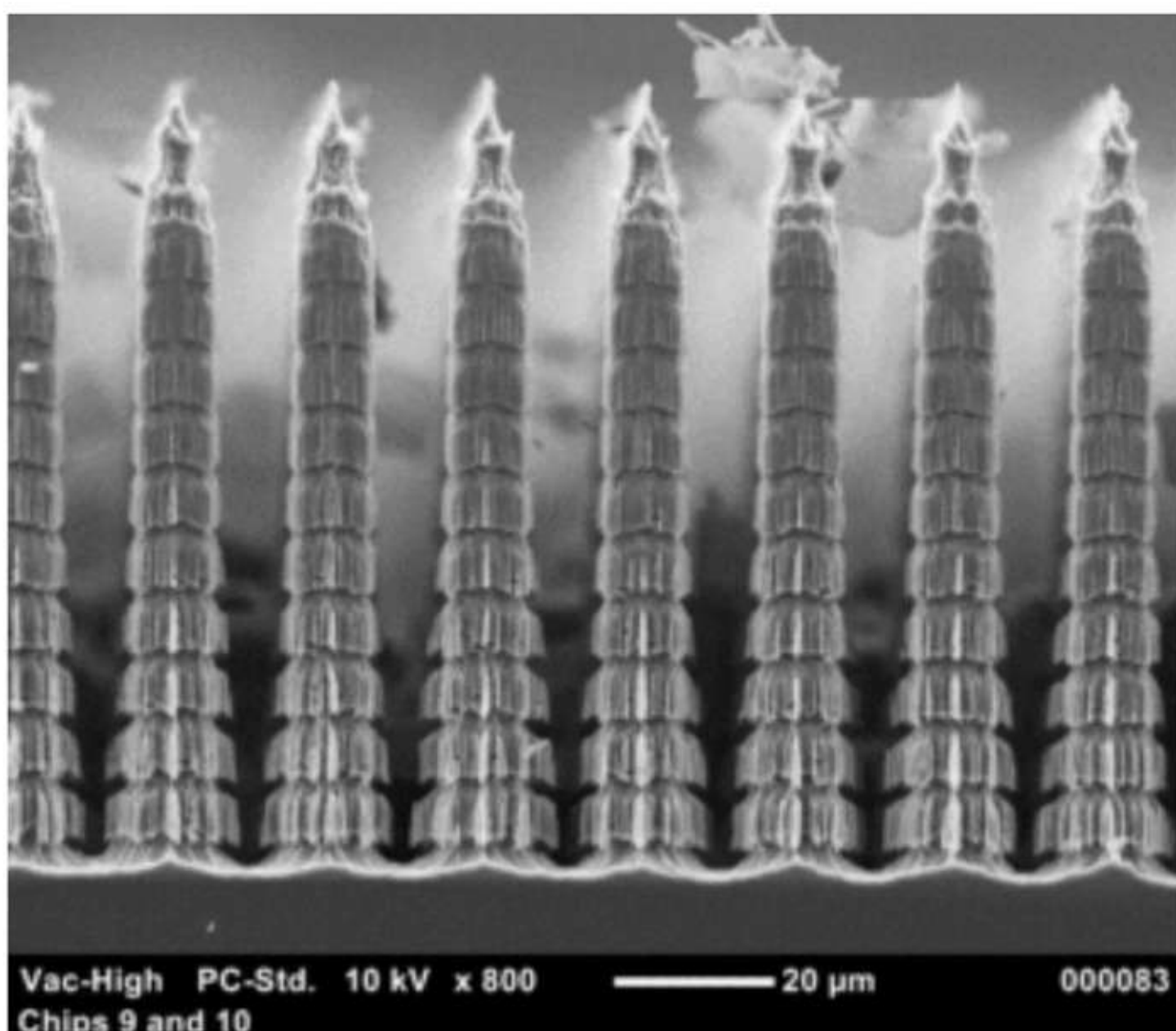


HAWC+ cameras

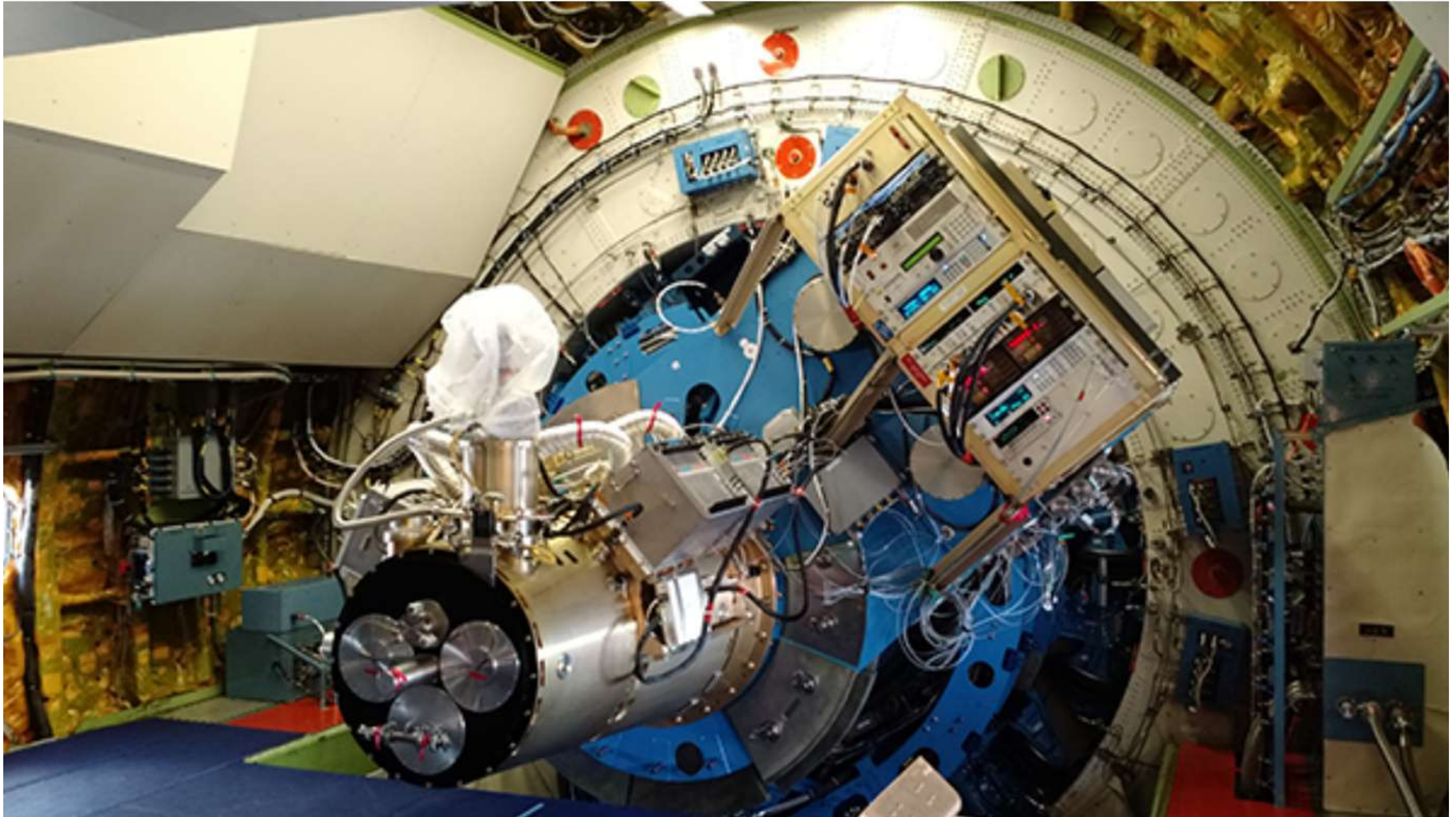


inspired by
the eyes of moths

These are scanning electron microscope images of the HAWC+ surface. The "spikes" are inspired by the structure of the eyes of moths:



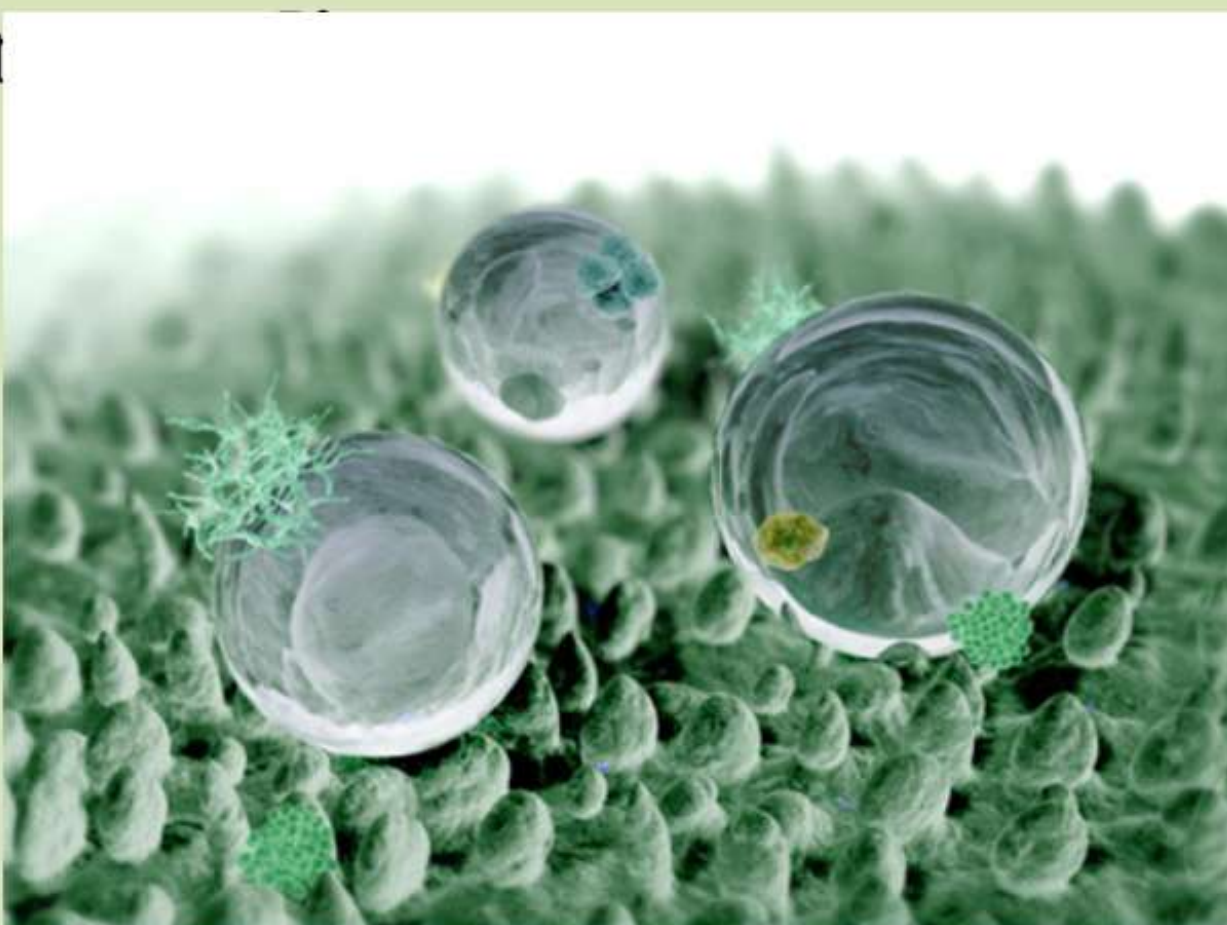
These structures dramatically minimise light reflection over a wide wavelength range. This is because the bumps are not polished, but graded, so that most of the incoming light is bent on the surface and passes through the eye rather than reflecting off it.



Lotus effect

Lotusan is an American company which created its products by copying a particular property of the lotus leaf. Lotus is an aquatic marsh plant whose leaves do not stick to the surface of water and other liquids, but roll off it, removing dust contamination from the plant. This is called the lotus effect, or the ability of water-repellent surfaces to self-clean. The company uses this phenomenon to **produce coatings that can be applied to different surfaces to repel water and thus**

rei





There are countless applications of the lotus effect:

- car windscreens
- paintwork
- cookware
- contact lenses
- building cladding
- building glass



Snakes only see the heat of other creatures. The researchers studied this ability and based on this, they made the **thermal imaging camera and glasses.**

They are very helpful for the army and the police.

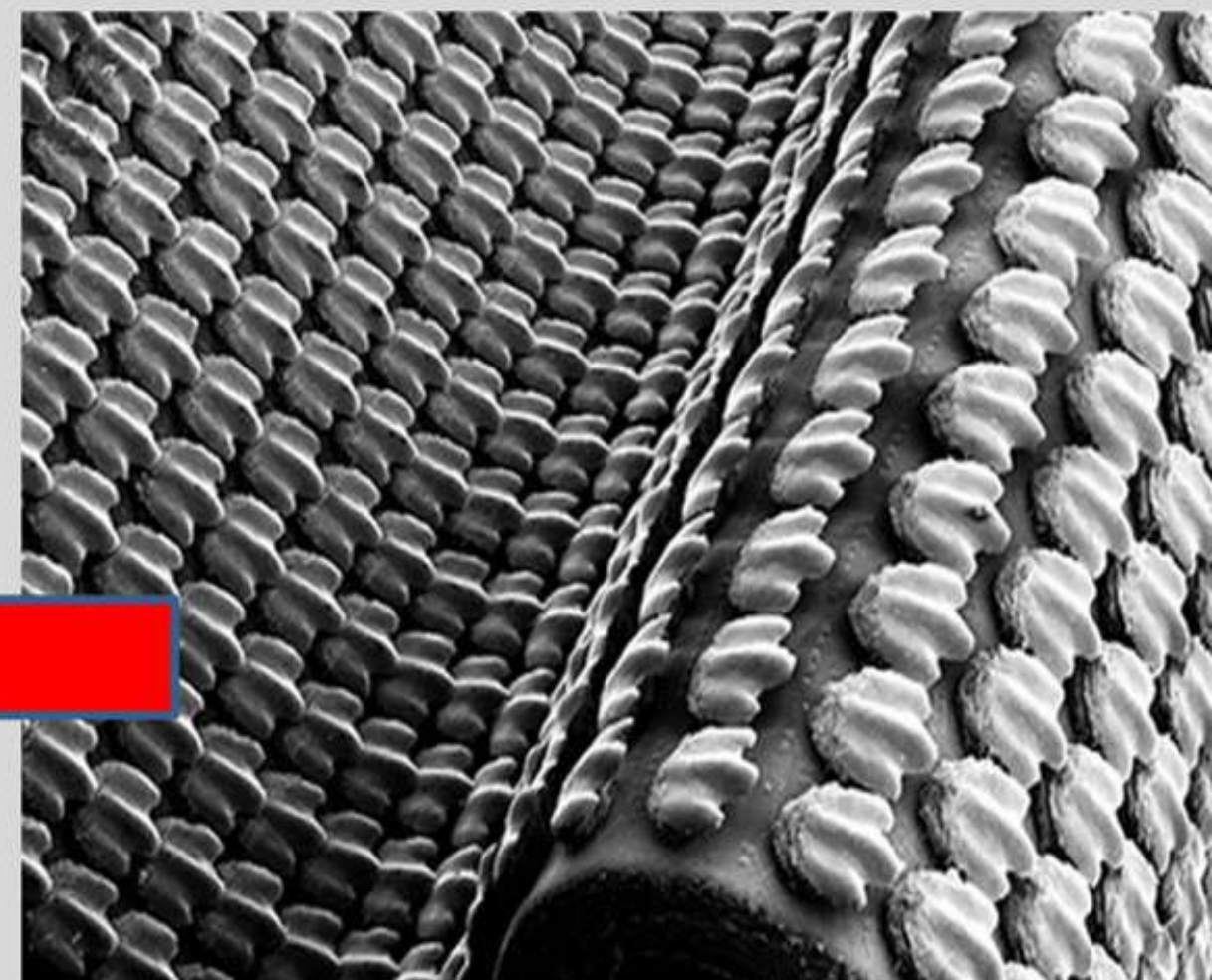
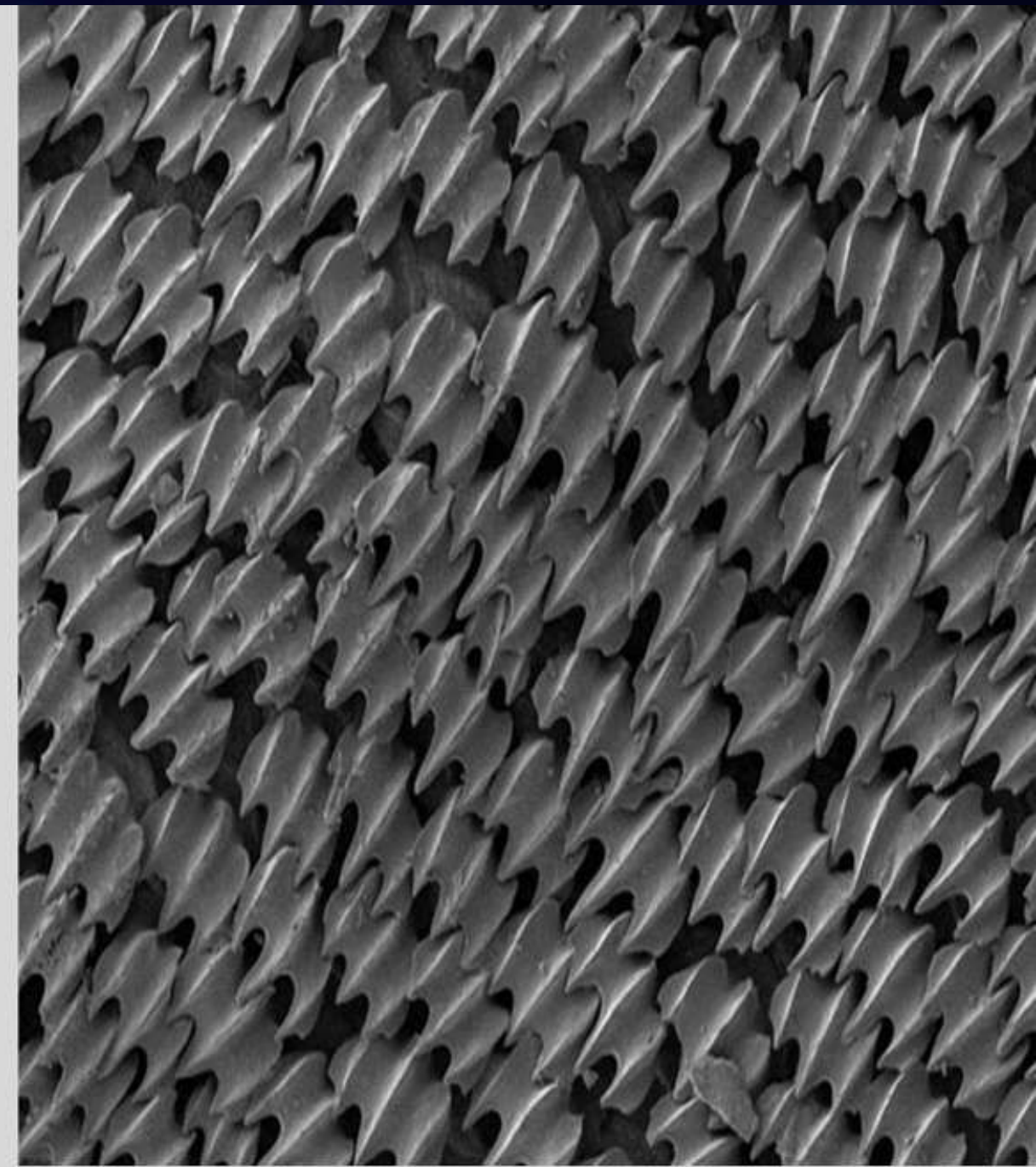


Shark skin



The surface of the skin of sharks is covered with a special pattern, and thanks to this special pattern, **bacteria and dirt cannot stick to it.**

It can protect against microbes in a natural way, without the use of chemicals.





Croatia



Erasmus+



Participants

Students:

Josipa Katarina Svalina

Silvija Tkalec

Lea Matulić

Petar Abramac

Antonio Stupalo

Ena Đelilović

Ivna Sučić

Antonio Savić Padovan

Petra Okmažić

Hana Višić

Roko Radošević

Lovre Delić

Dora Utrobičić

Marko Mađor Božinović

Marija Dolores Bojčić

Teachers:

Vedrana Verbanac

Andrea Bilandžić

Sandra Rautalin

Ivana Bubrić Buzov

Marija Oklopčić

B I O M I M I C R Y

Using biomimicry and mirroring nature has been helping to improve our technology for hundreds of years

Biomimicry is the emulation of the models, systems and elements of nature for the purpose of solving complex human problems.

Biomimicry has enabled people to make their lives easier since ancient times.

EXAMPLES OF BIOMIMETIC INVENTIONS INSPIRED BY PLANTS



Burr = Velcro

- Velcro was inspired by the way burrs stick to animal fur, and its hook-and-loop fastening system has revolutionized the way we fasten clothing, footwear, and other objects.

Corals = Reflecting lamps

- The design of reflecting lamps was inspired by the way corals reflect and diffuse light in the ocean, leading to more efficient and sustainable lighting solutions for homes and businesses.



Photosynthesis = Solar panels

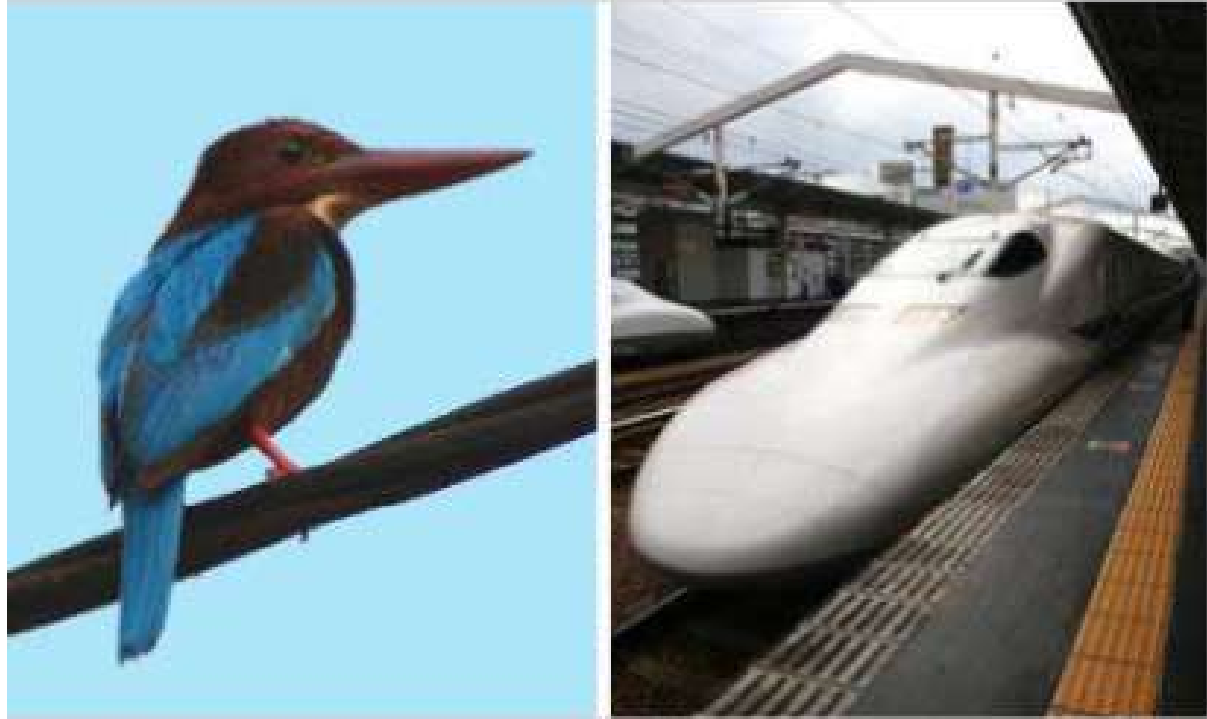
- Solar panels mimic the process of photosynthesis, converting sunlight into usable energy, and have become a critical technology in the transition to renewable energy sources.

Lotus = Paint

- Hydrophobic paint was inspired by the lotus leaf's ability to repel water, resulting in a coating that can be used to protect surfaces from water damage, corrosion, and other environmental factors.



EXAMPLES OF BIOMIMETIC INVENTIONS INSPIRED BY ANIMALS



Bird beak = Faster vehicles

- The design of some high-speed trains and Formula One cars has been inspired by the streamlined shape of bird beaks, which reduces air resistance and increases speed, resulting in more efficient and faster vehicles.

Whale = Turbine

- The design of wind turbines was inspired by the fins of humpback whales and the tail of a fish, leading to more efficient and sustainable energy production.



Sharkskin = Swimsuit

- The texture of sharkskin inspired the design of swimsuits that reduce drag and improve swimmer's performance, resulting in world records being broken in the pool.

Birds = Jets

- The ability of birds to fly inspired the Wright brothers to design the first airplane, resulting in a breakthrough in aviation technology and changing the way we travel forever.

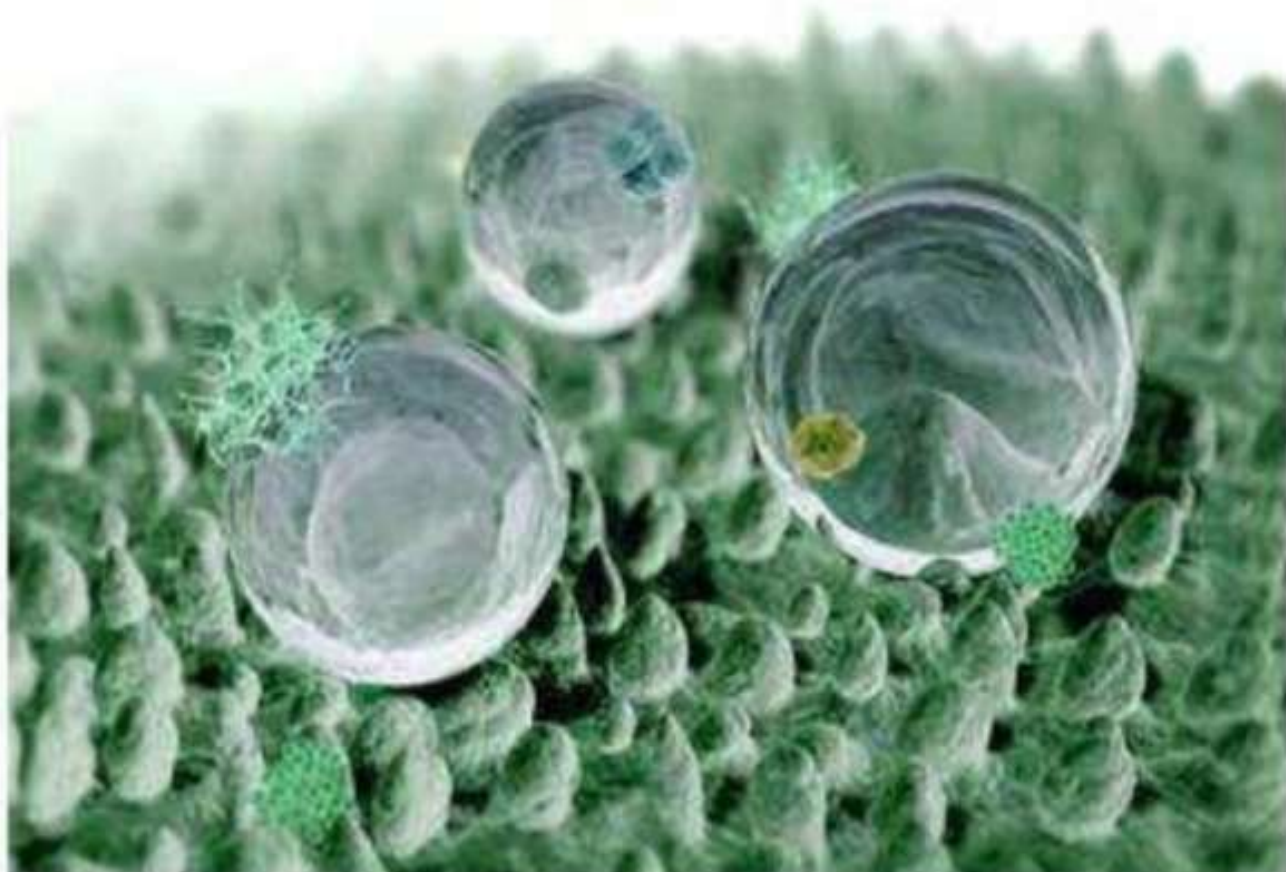


Lotus



Lotus effect

Lotusan is an American company based in Atlanta. The company created its products by copying a particular property of the lotus leaf. Lotus is an aquatic marsh plant whose leaves do not stick to the surface of water and other liquids, but roll off it, removing dust contamination from the plant. This is called the lotus effect, or the ability of water-repellent surfaces to self-clean. The company uses this phenomenon to produce coatings that can be applied to different surfaces to repel water and thus remove dirt



Falcons

- Here you can see a falcon diving towards its prey at 300km/h. Amazing, isn't it? The United States Of America think so!



The American engineers studied how such a light animal can dive at 300km/h

- They figured out that the shape that the falcon has while diving makes it extremely aerodynamic so the falcon doesn't need to be heavy to dive fast

*17 July 1989
1,010 km/h*



With this information they created the B2 spirit heavy stealth bomber

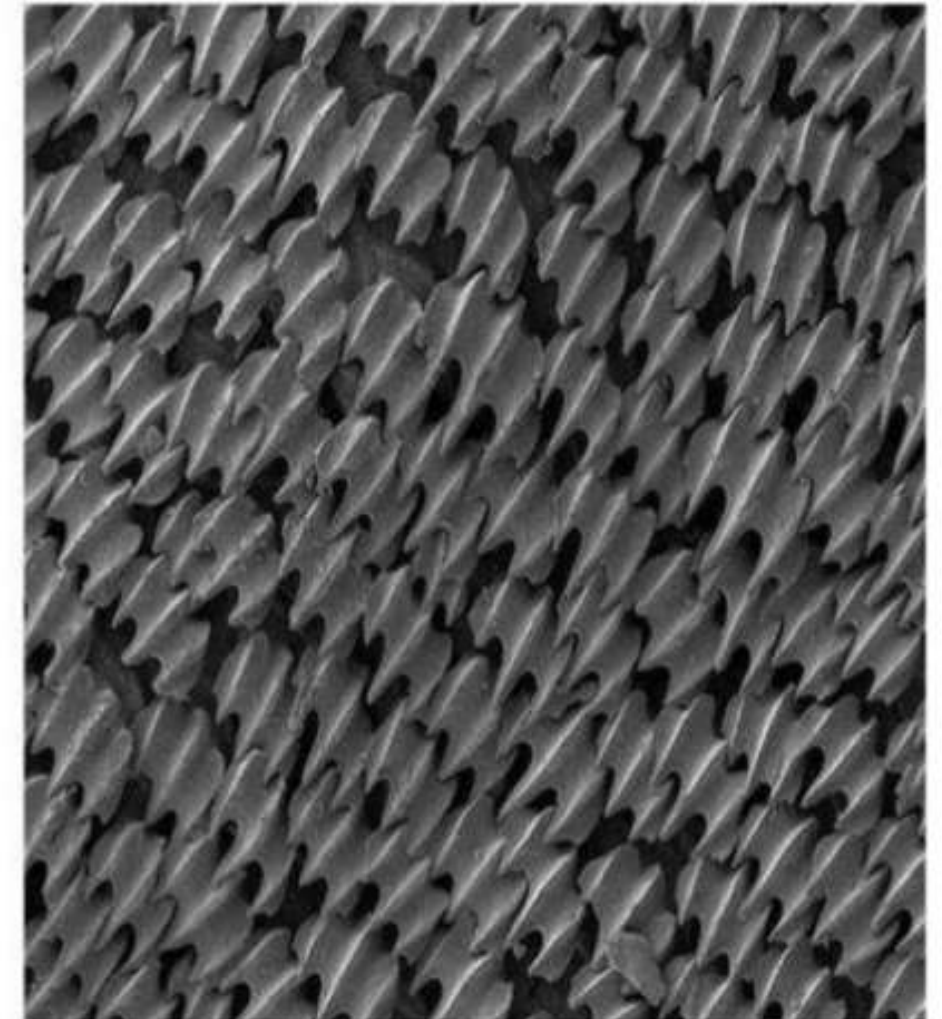
Shark skin



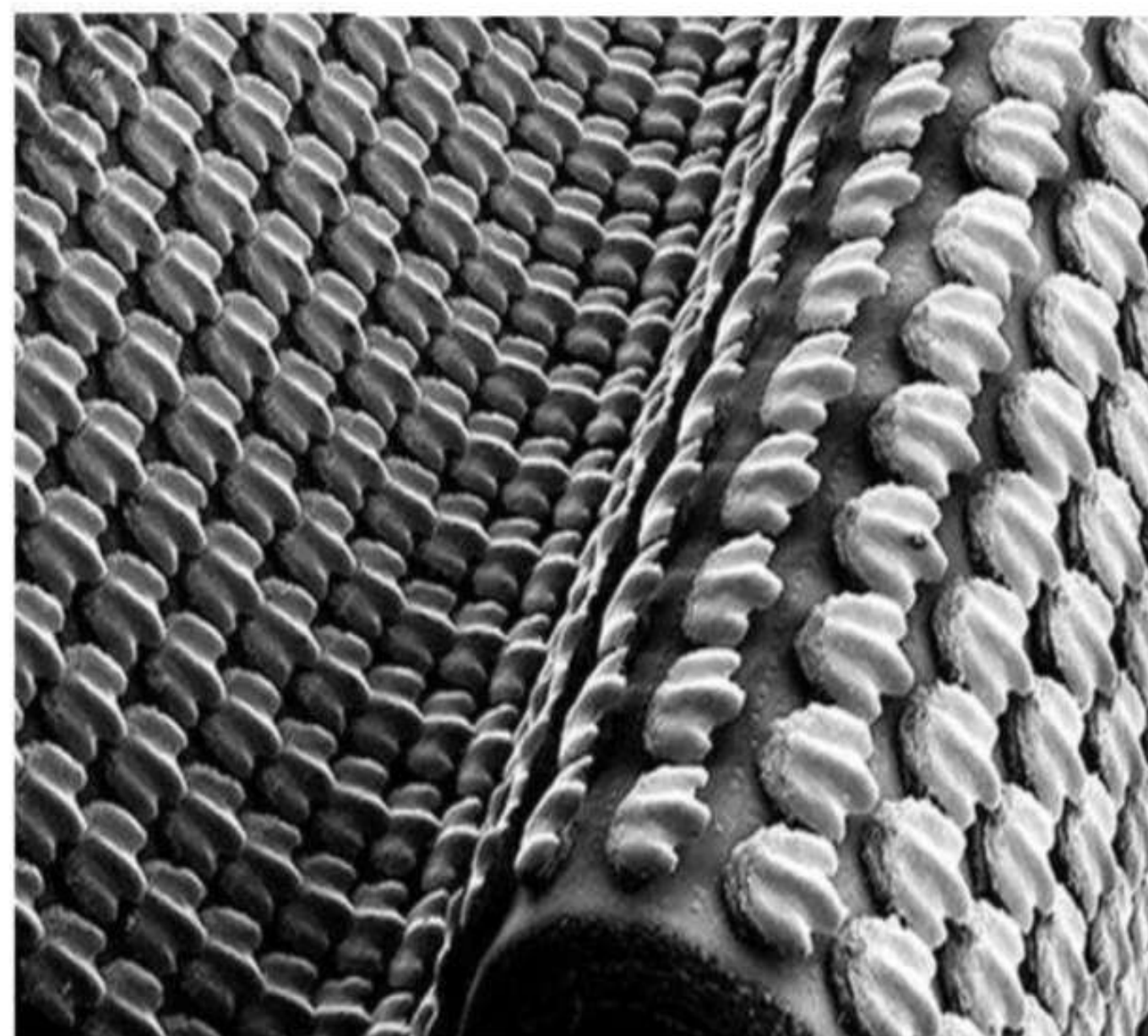
The researchers are confident that this new material will spread in hospitals, because the number of infections acquired in hospitals is extremely high. Covering the equipment in the hospital with a sharkskin pattern that bacteria cannot colonize is a much better solution than antibiotic or harsh chemical treatment



Researchers at the University of Florida have begun intensively researching the skin of sharks. They were simply intrigued by the fact that bacteria, dirt and shellfish do not stick to it. It can protect against microbes in a natural way, without the use of chemicals.



The surface of the skin of sharks is covered with a special pattern, and thanks to this special pattern, bacteria cannot stick to it.



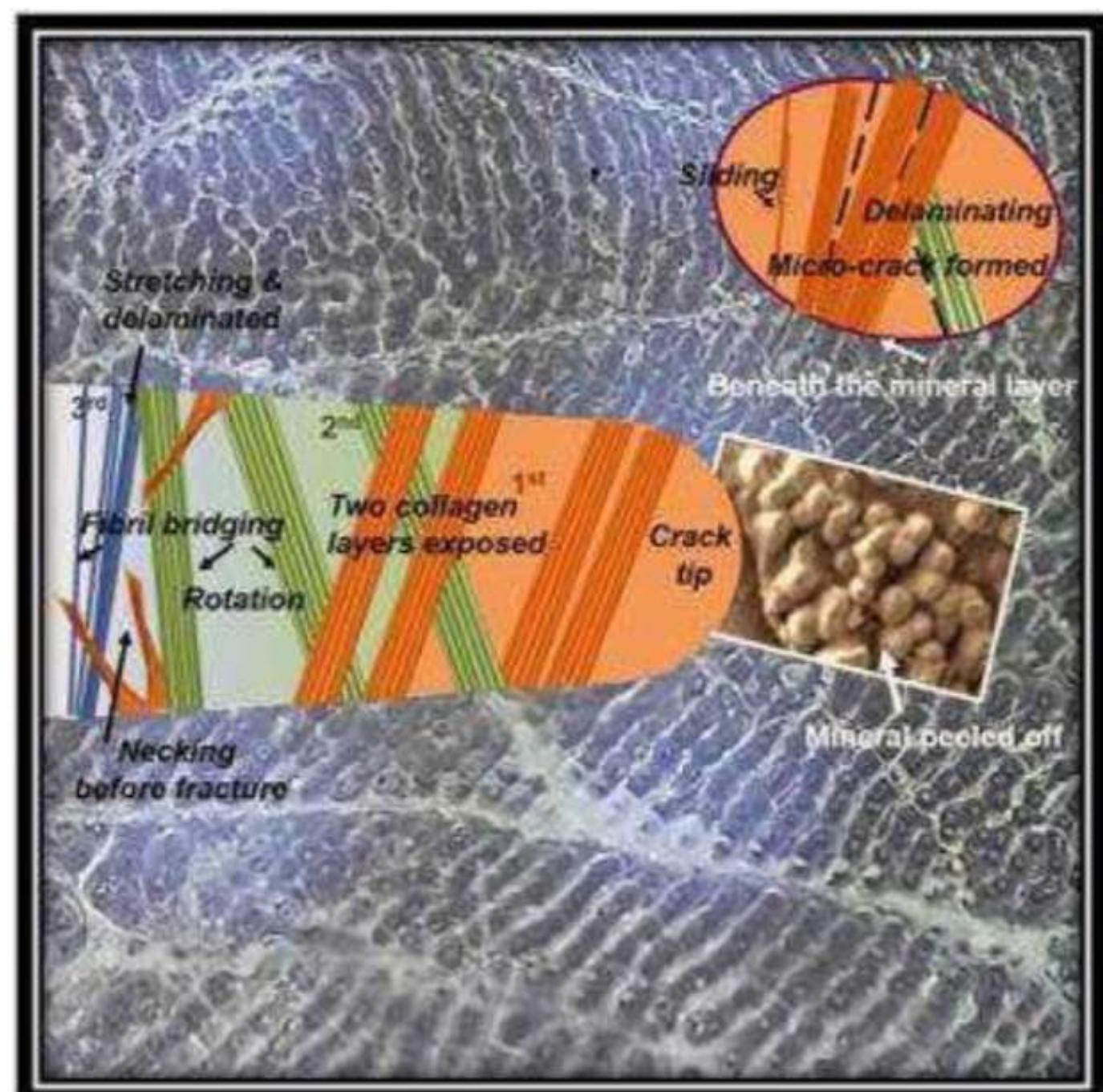
Arapaima fish



Scale armor - An interesting concept

They have found out that the Arapaima fish's scales can withstand even piranha bites, because they consist of two layers: a hard outer layer, and a soft but flexible inner layer. It is still being developed.

Scales have been studied by scientists because they wanted to know how they can withstand damage.

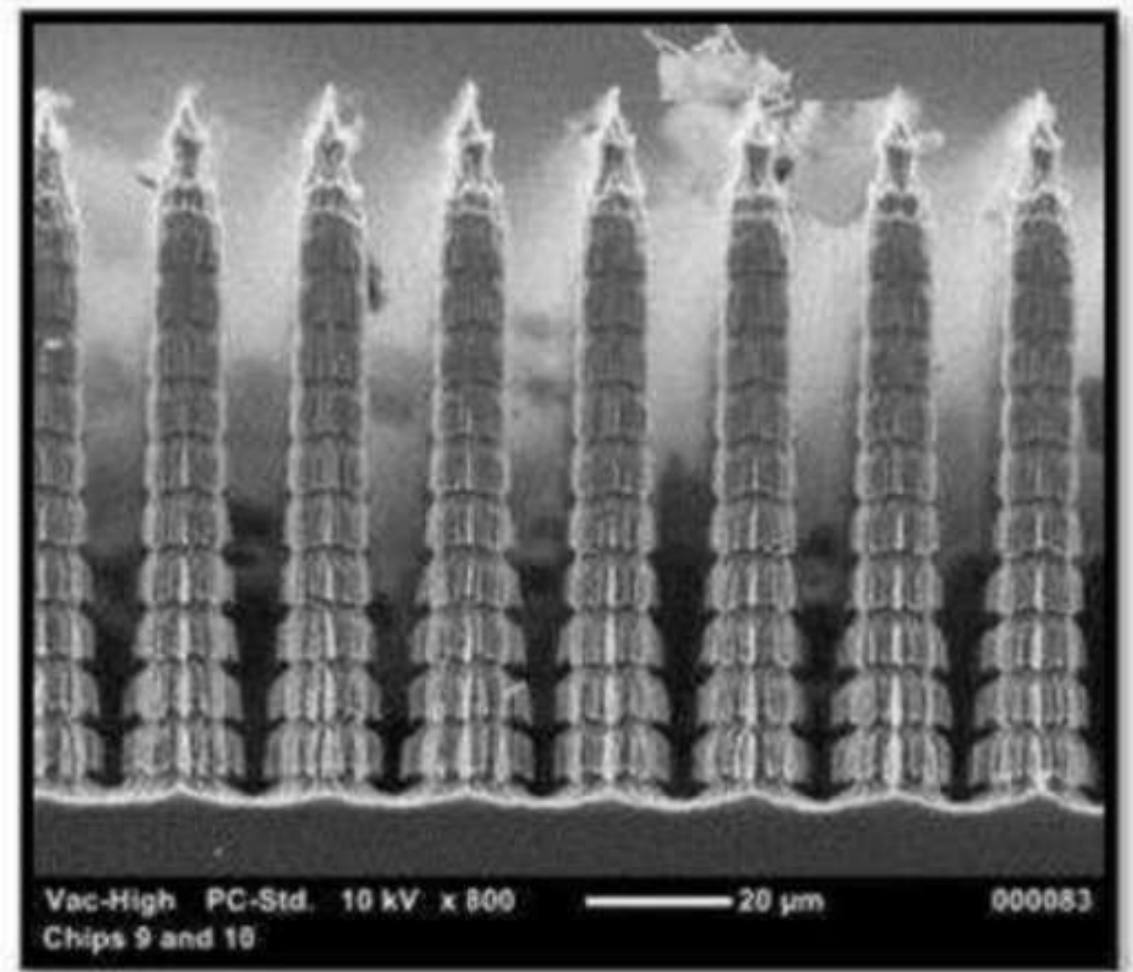


Moths



HAWC + Cameras

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These are scanning electron microscope images of the HAWC+ surface. The "spikes" are inspired by the structure of the eyes of moths. Photo by NASA.

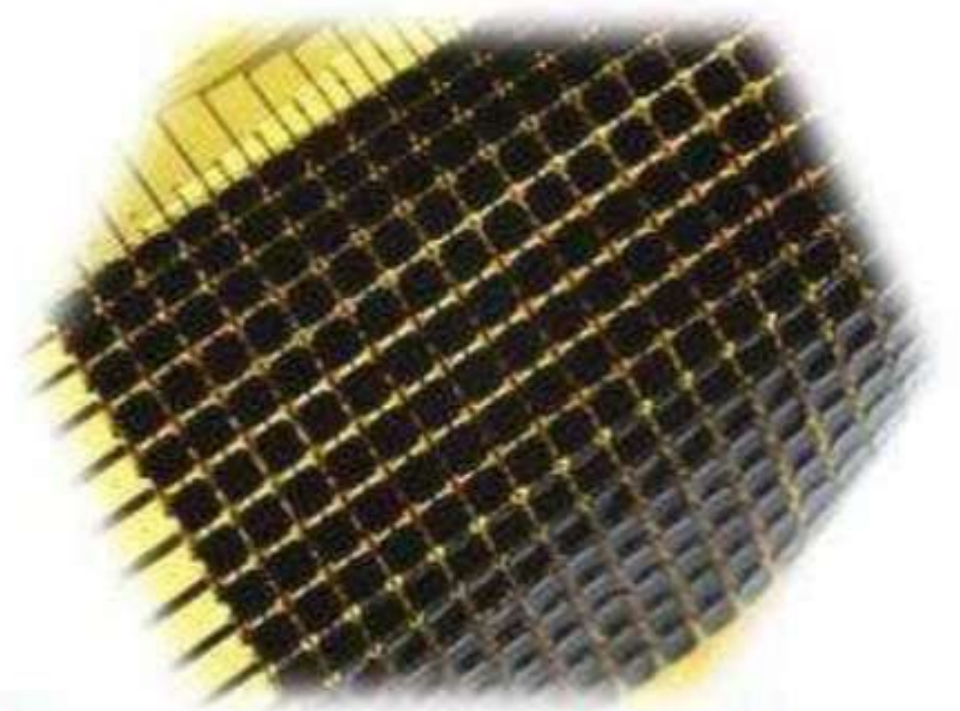
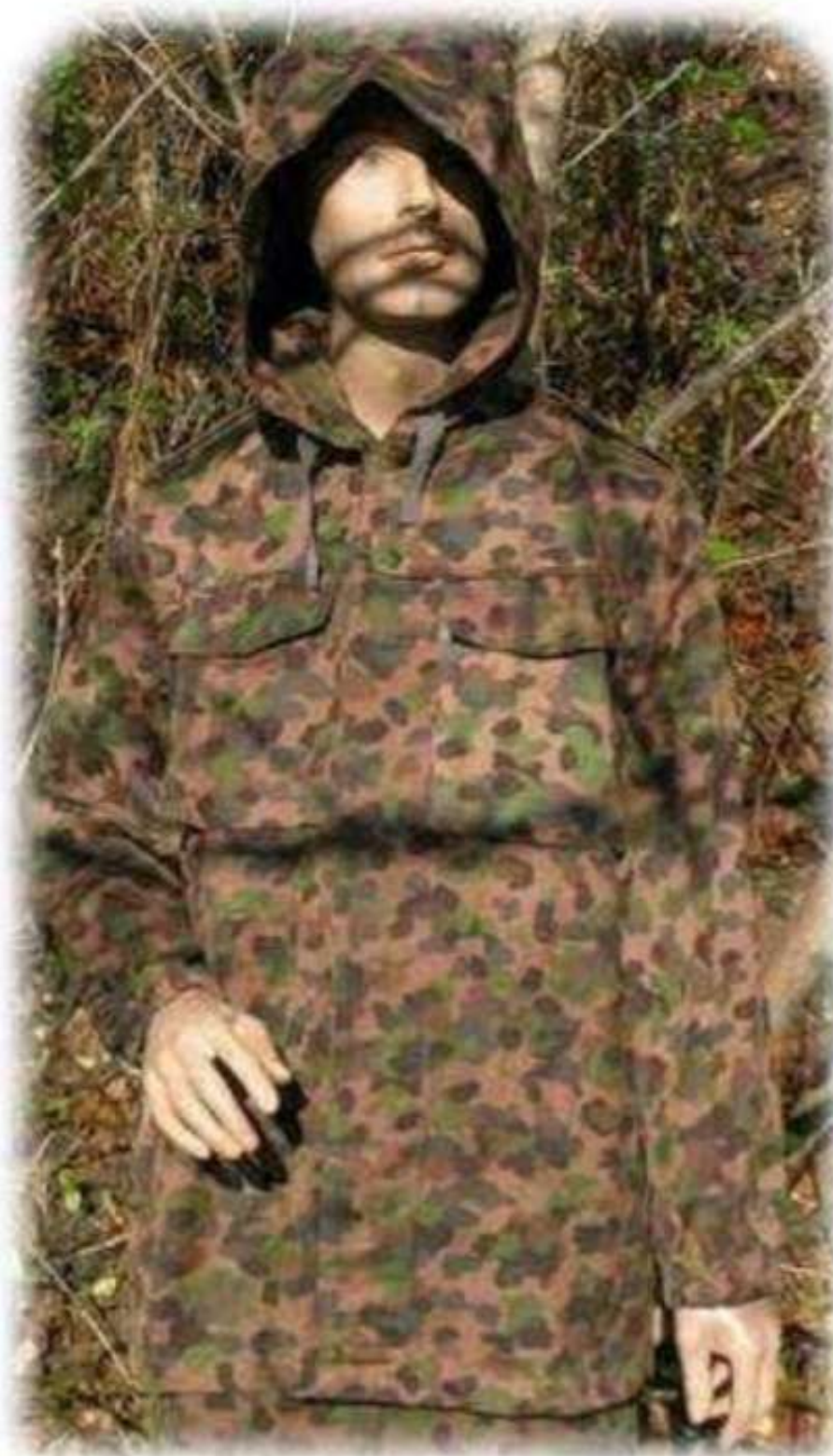


Squids



Cephalopod camouflage

Squids are capable of glowing (bioluminescence) as well as changing their skin color. This camouflaging capacity enables them to hide from predators while the bioluminescence allows them to communicate with and/or attract a mate.



A team of researchers has developed a similar device that can detect your environment and adapt it in seconds. This early prototype uses a flexible, pixelated grid with actuators, light sensors and reflectors. As the light sensors detect changes in the environment, they send a signal to the appropriate diode. This generates heat in the area and the thermochromatic grating then changes colour. This artificial "skin" could have military and commercial applications in the future.

Mussels



Mussels glue

Blue mussels spend their days being struck by the waves. They manage to stay stuck to rocks or to each other because of the highly effective underwater glue they produce.



It's hard to achieve adhesion underwater but scientists were interested in producing effective adhesives for use in wet environments and they turned to mussels for inspiration.

Butterfly



Like the butterfly's wings, the display is taking the white ambient light around us, white light or sunlight, and through interference is going to send us back a color image. Unlike conventional LCD screens, the Mirasol doesn't have to generate its own light. The display brightness just automatically scales with ambient light. As a result, the Mirasol consumes a tenth of the power of an LCD reader.

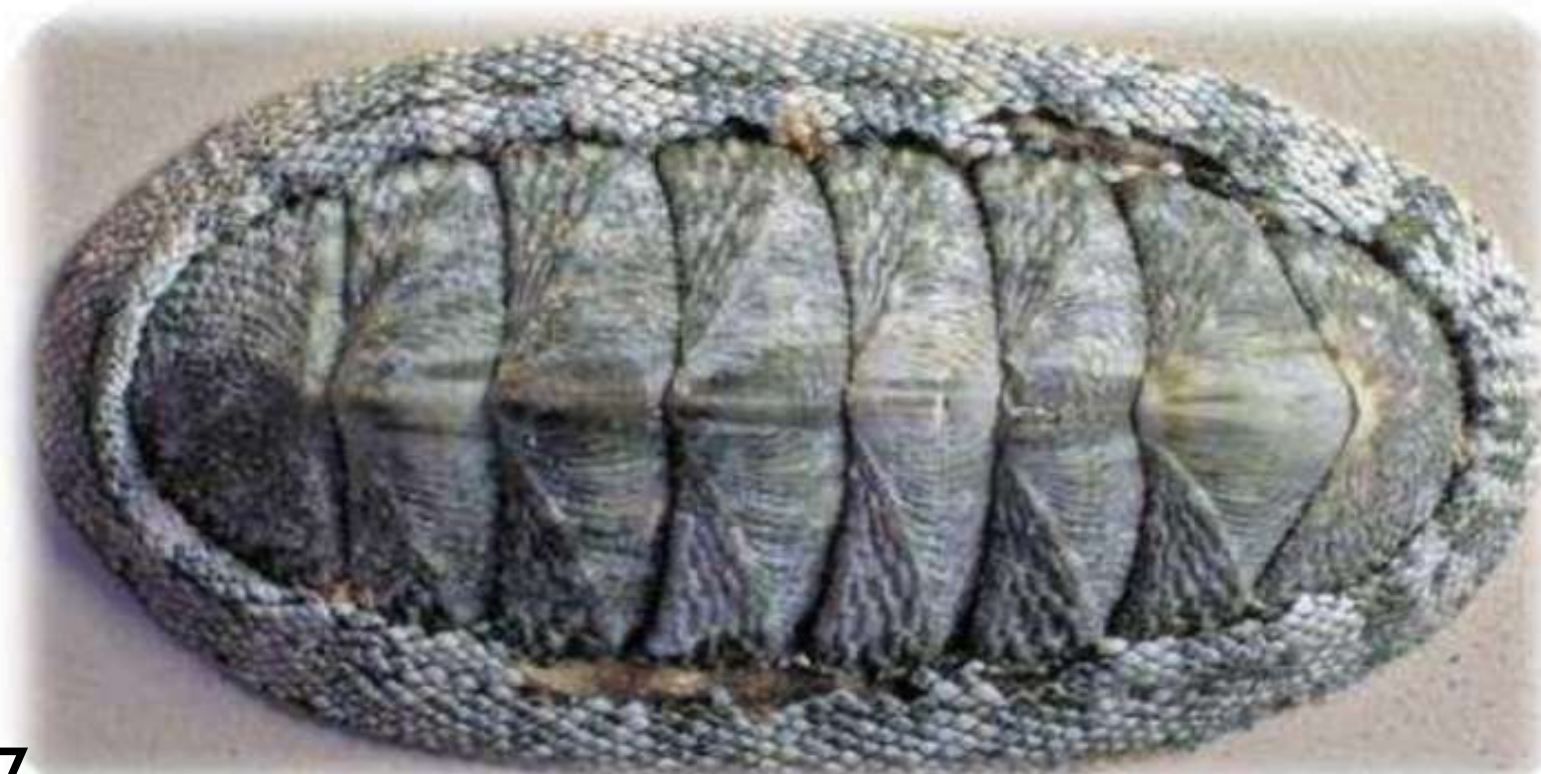
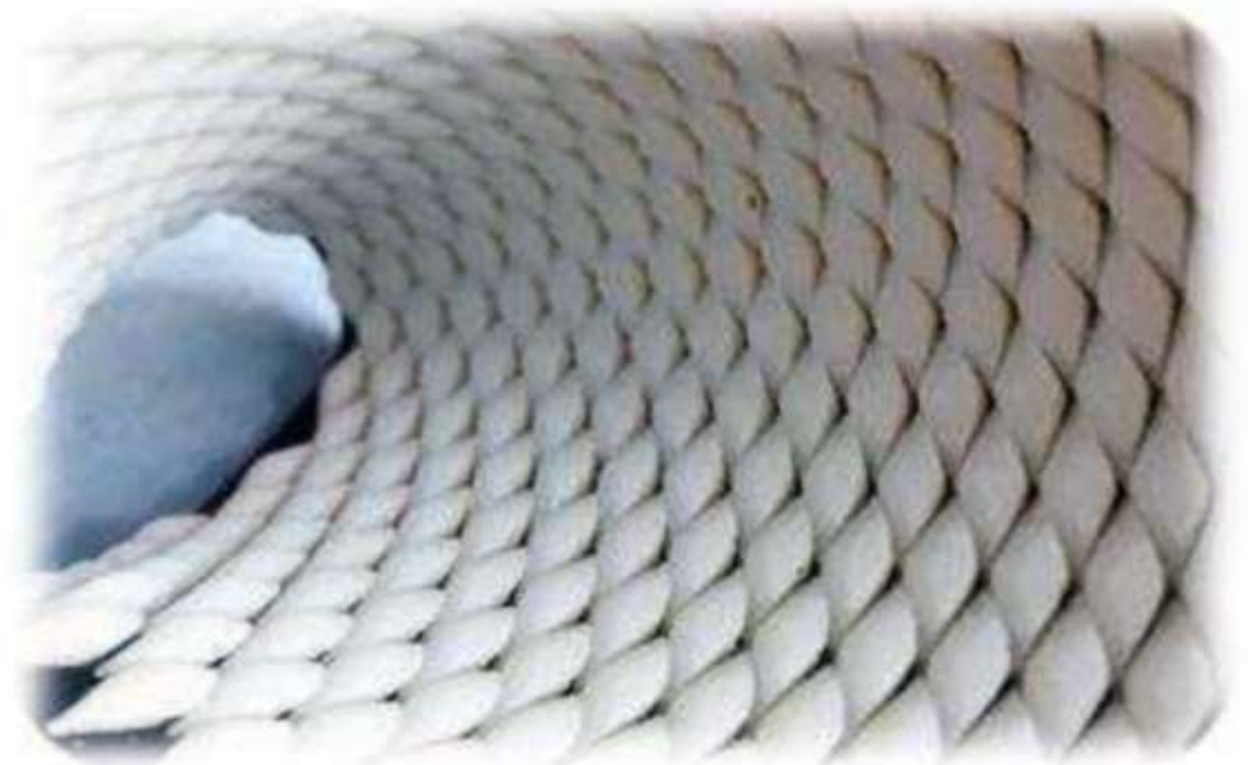


Chiton



Chiton inspired body armor

- When it comes to body armor, there's typically a trade-off – it can either be highly impact-resistant or flexible, but not both.
- According to recent studies there is a mollusc which has a very strange exterior. It consists of many small scales which together are both impact resistant and flexible. If there is an external influence it makes it much stronger.
- The material is still being developed.



Maple seeds



Wind Turbines

They both have the very
same aerodynamic shape



Stenocara



Water Collection

Inspired by beetles

- This small black bug lives in a harsh, dry desert environment and is able to survive thanks to the unique design of its shell. The Stenocara's back is covered in small, smooth bumps that serve as collection points for condensed water or fog. It's entire shell is covered in a Teflon-like wax and it is help them to collect water from the morning fog.





A Better Sewage Treatment System, Inspired by Cow Stomachs

ECOSTP

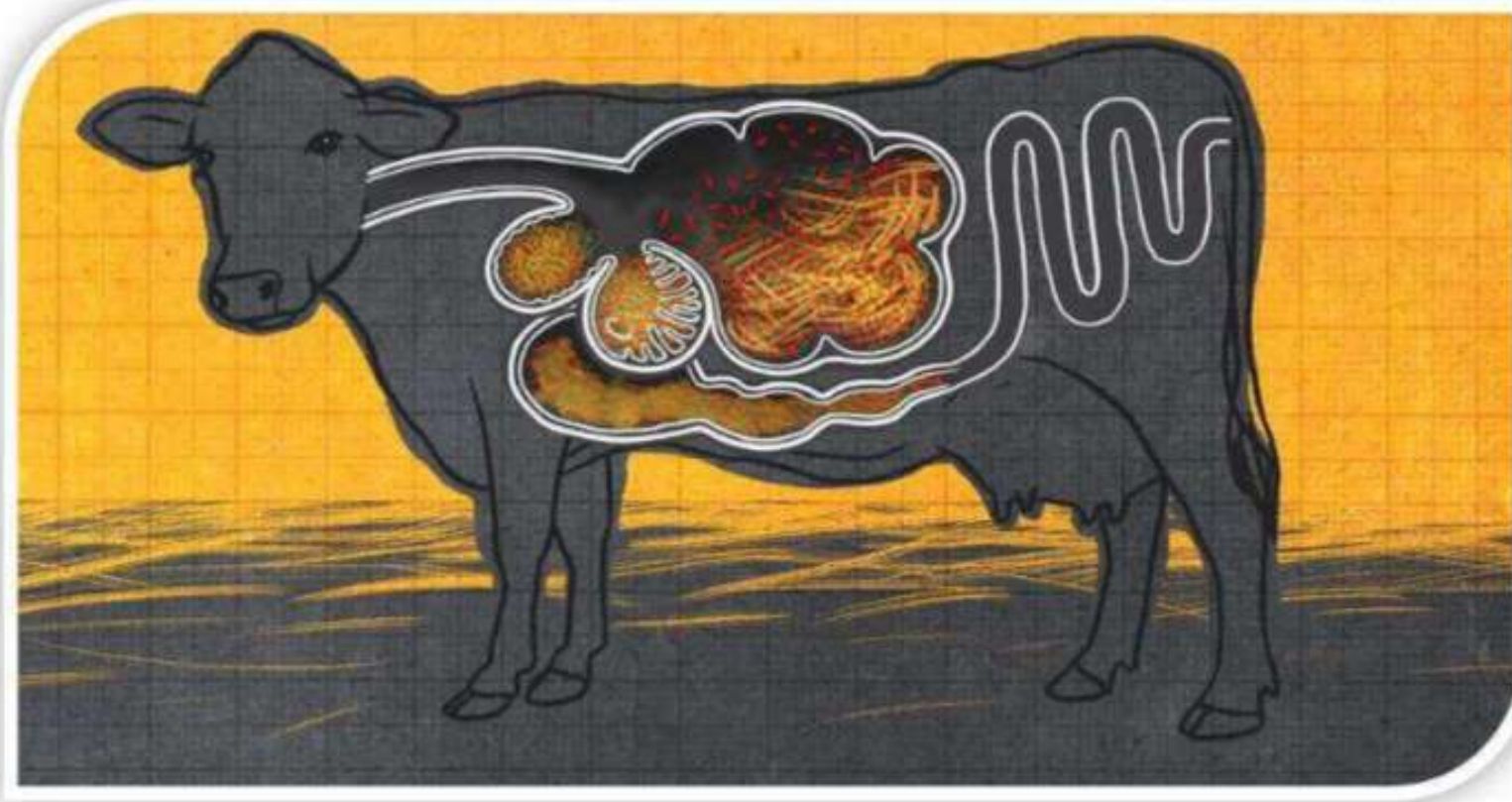
In India sewage is a big problem



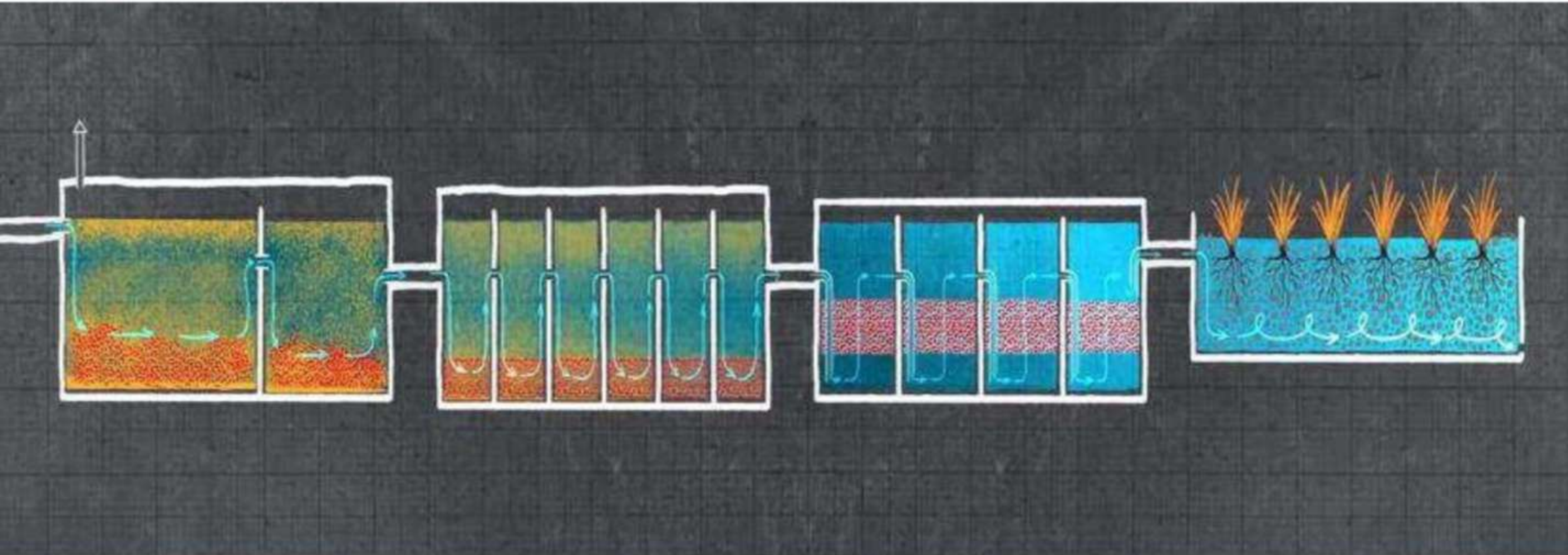
They have found a great, environmentally friendly solution to this problem:



Because of the sewage lakes started burning.



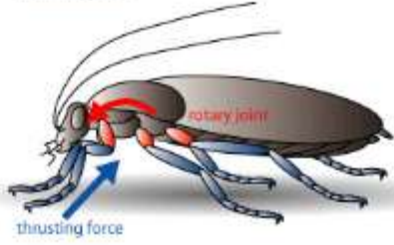
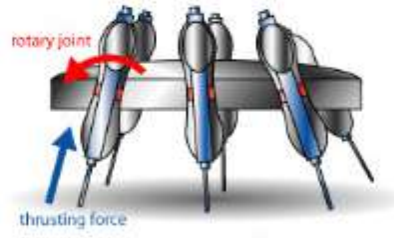
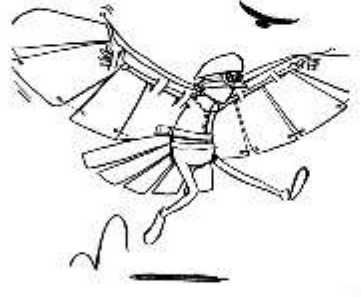
They have made a wastewater treatment plant - copying the system of the cows' organs - that doesn't need a blower motor.



WHAT IS BIOMIMICRY?



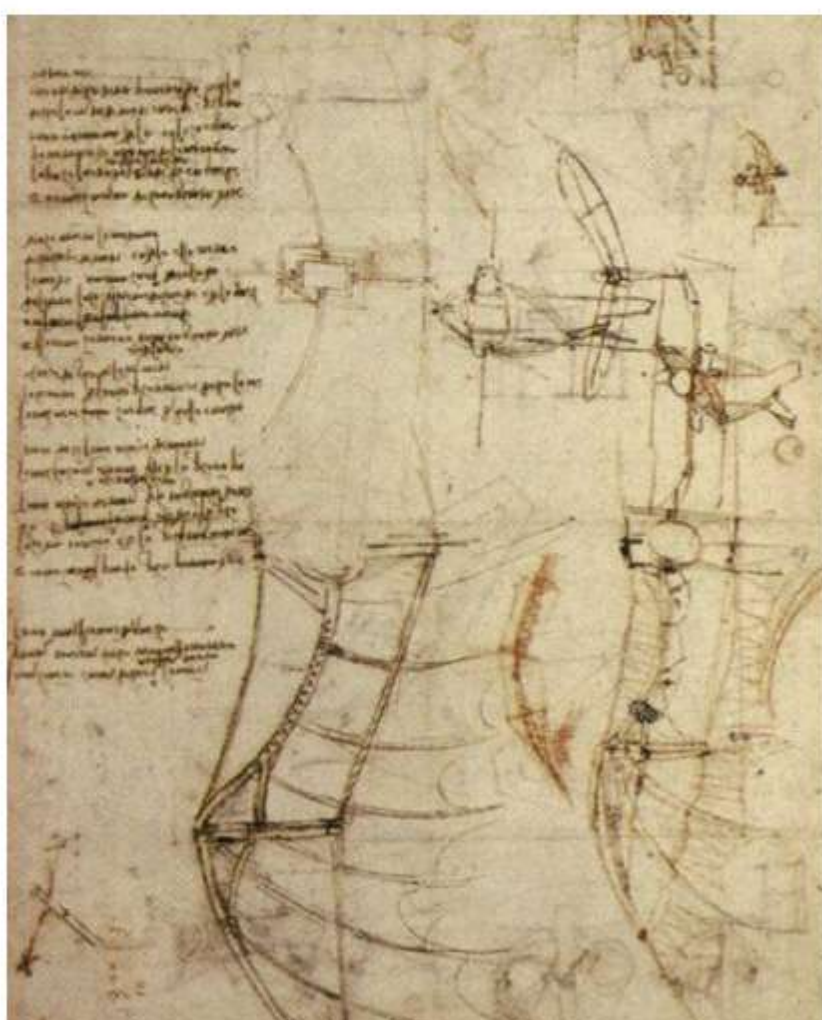
- BIO (nature) MIMIC (to imitate)
- It is a method that seeks to copy or imitate nature to create sustainable solutions to human problems
- Biomimicry offers solutions that can keep going without damaging the environment
- It improves the sustainability of human existence and supports the planet as a whole
- It is used by professionals, such as scientists, engineers, designers and business people to create new ideas



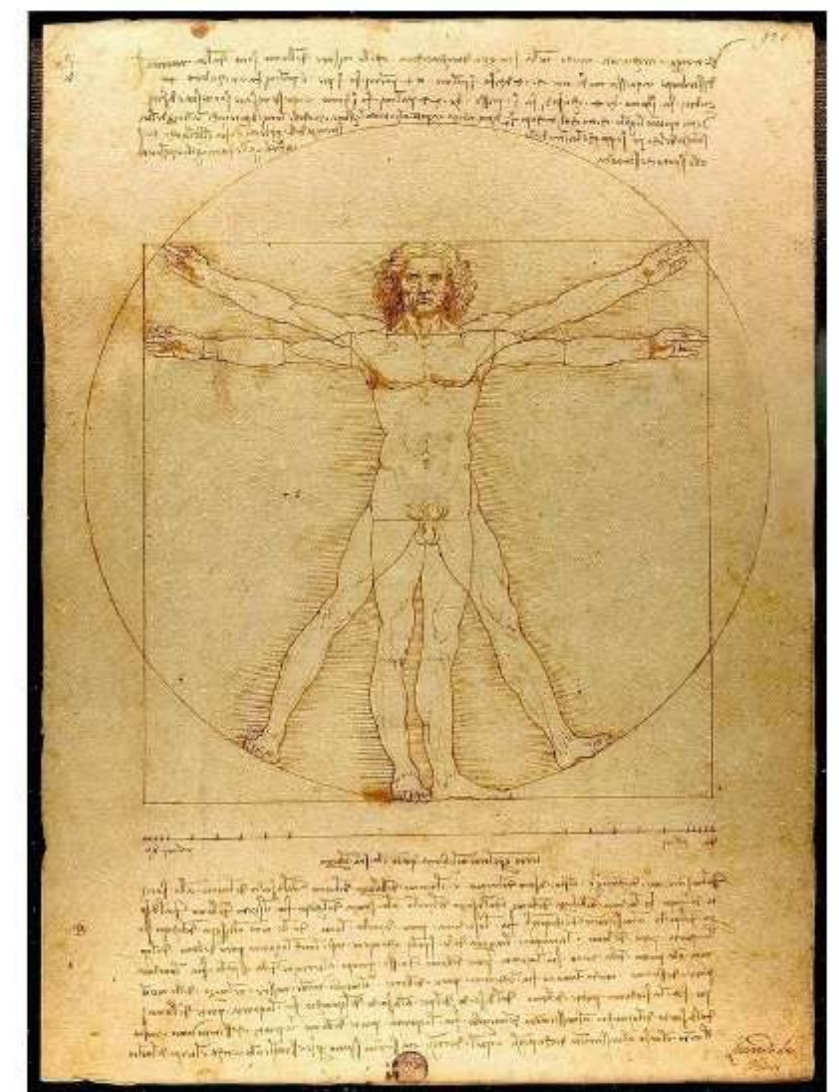
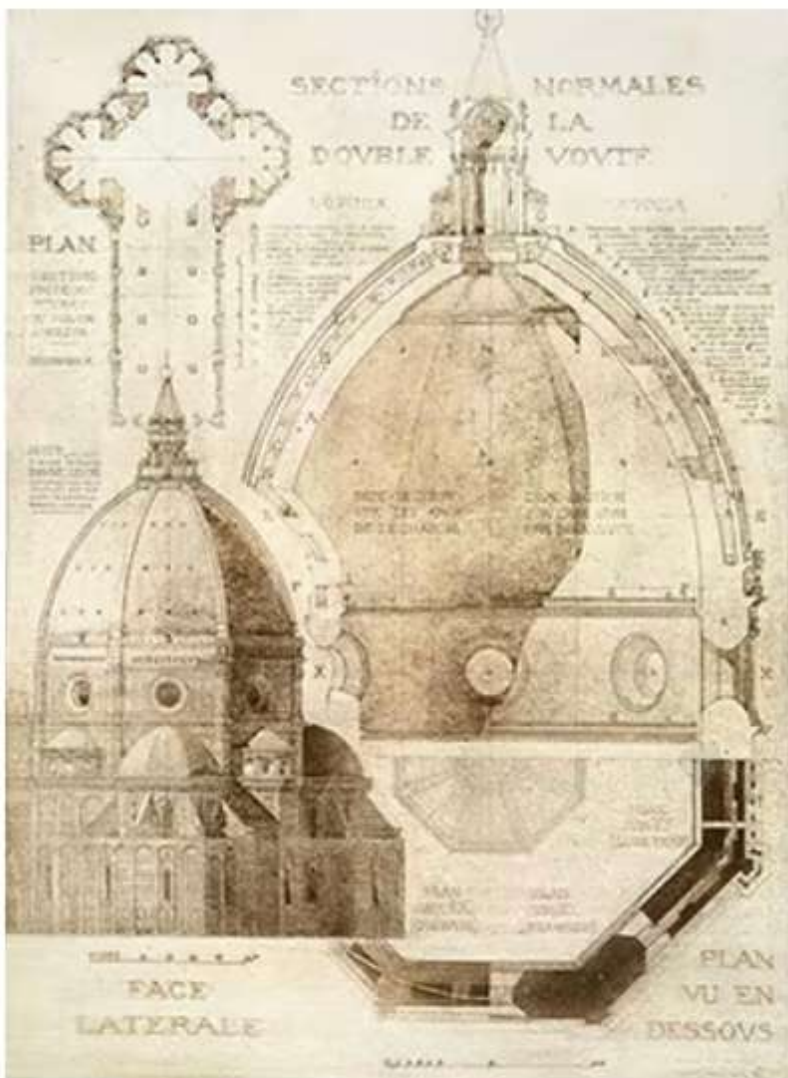
- Biomimicry allows employees the creativity to find restorative solutions to environmental problems
- BIOMIMIES - people who use or practice biomimicry
- Our world has many kinds of biological processes which can humans learn and borrow ideas from



HISTORY

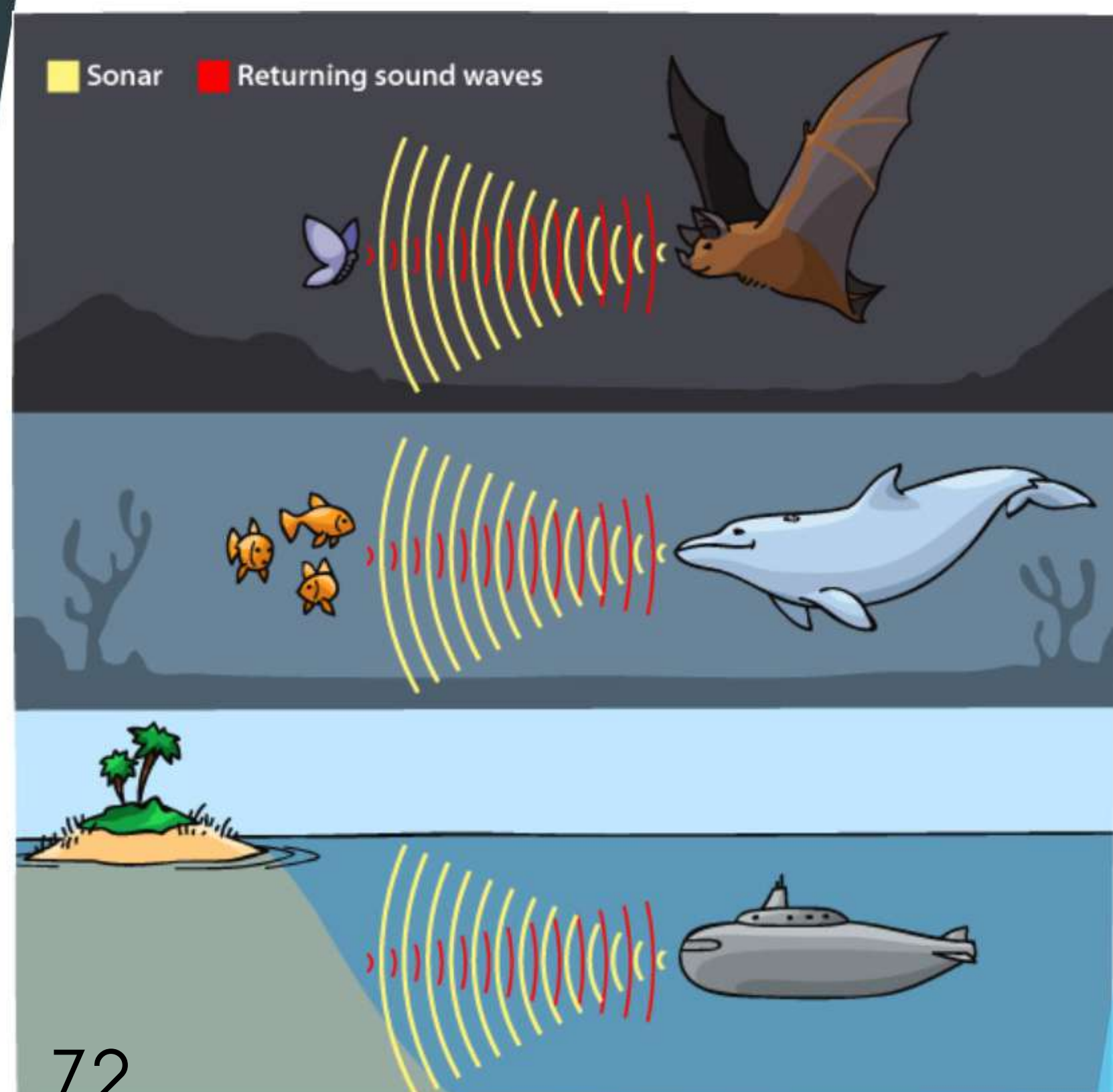


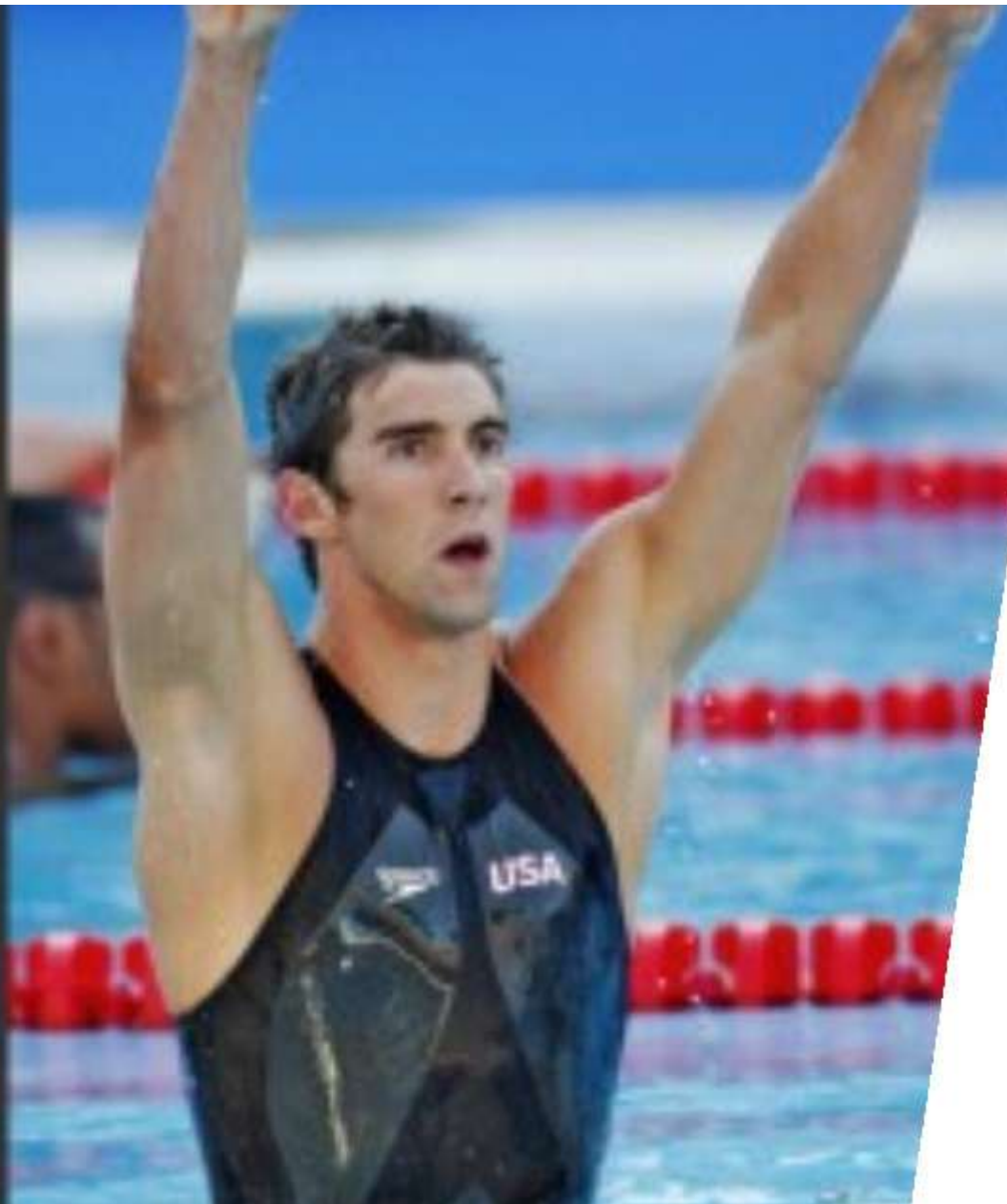
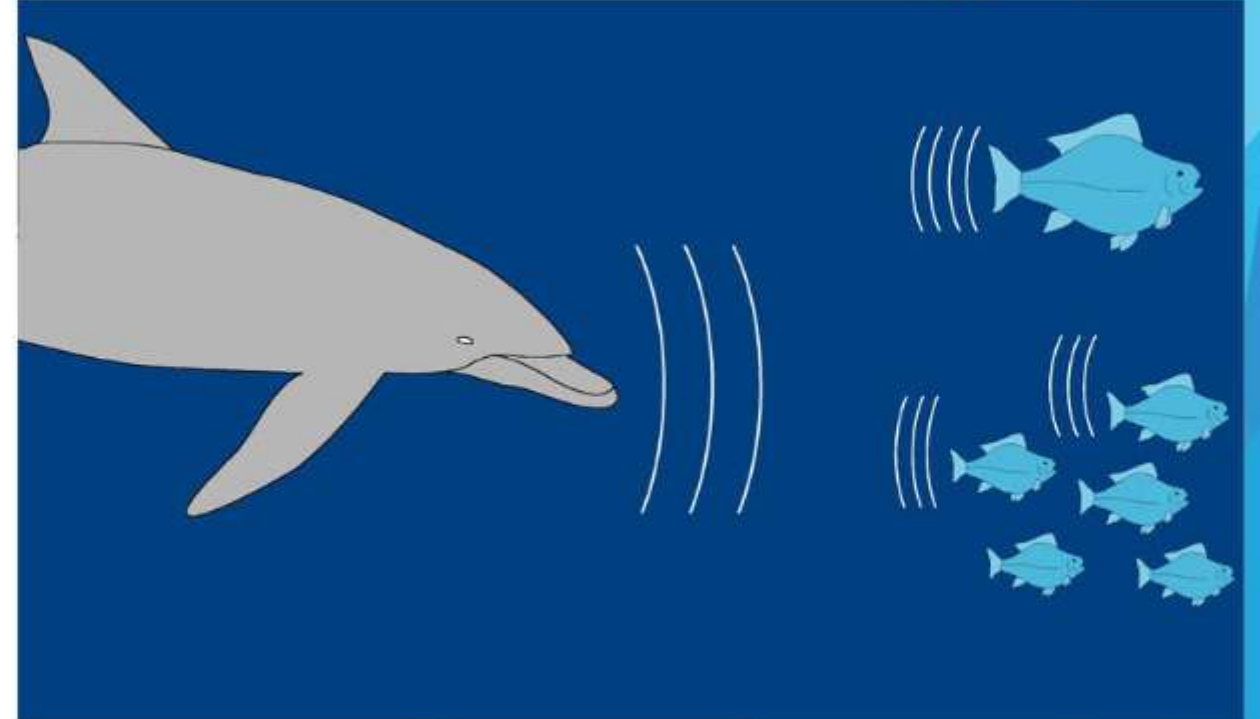
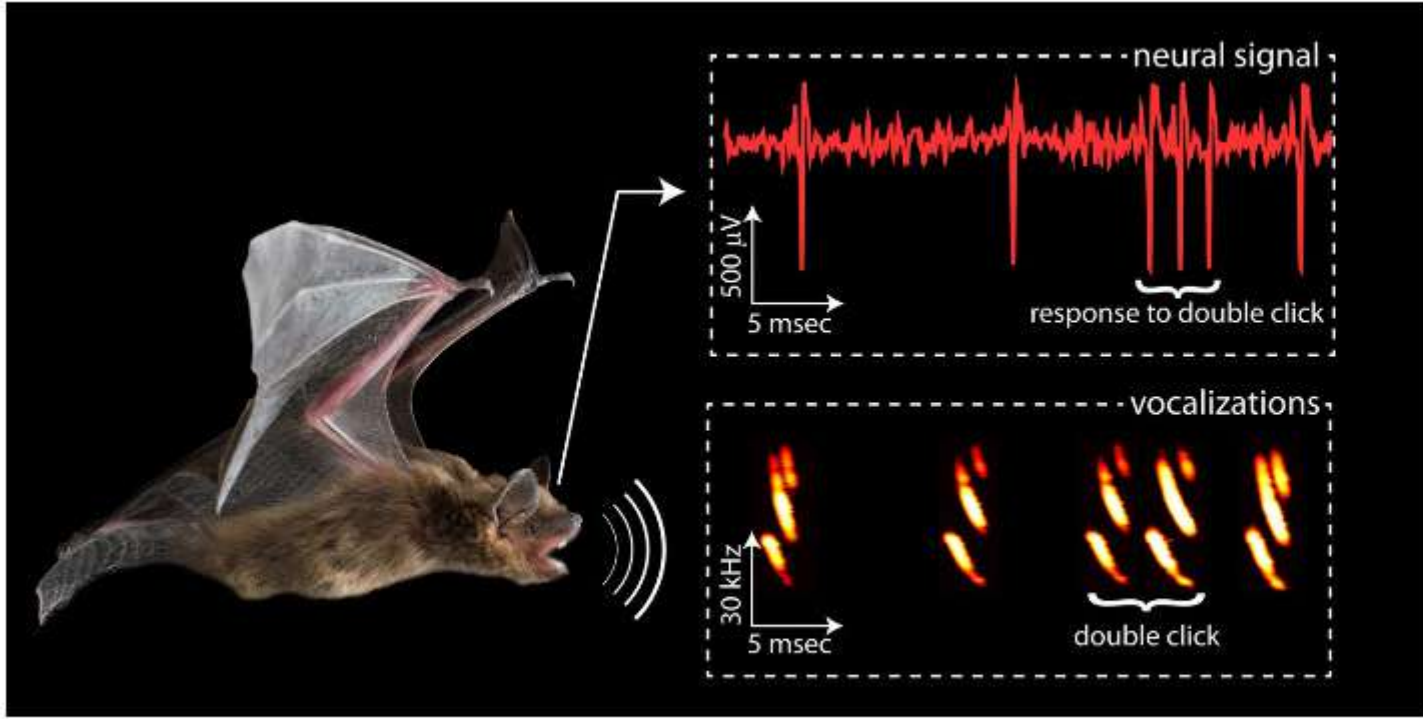
- Biomimicry has only been studied for the past half century, but people have been using it for a much longer period of time
- One of the early uses of biomimicry was the study of birds to enable human flight
- Although "flying machine" was never successful, Leonardo da Vinci made numerous notes and sketches where he applied biomimicry to the study of birds in hope of enabling human flight



EXAMPLES OF BIOMIMICRY

- ECHOLOCAION is the use of sound waves and echoes to determine the location of objects
- Dolphins and bats use it to find food
- Scientists studying echolocation in animals developed sonar and radar technologies that today are widely used in the ocean, on land and in outer space to navigate and find objects

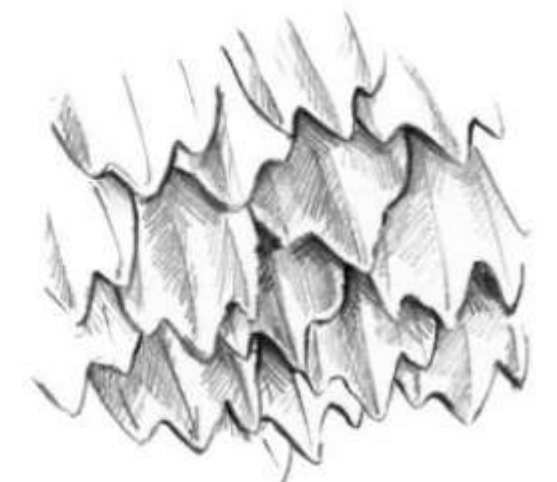
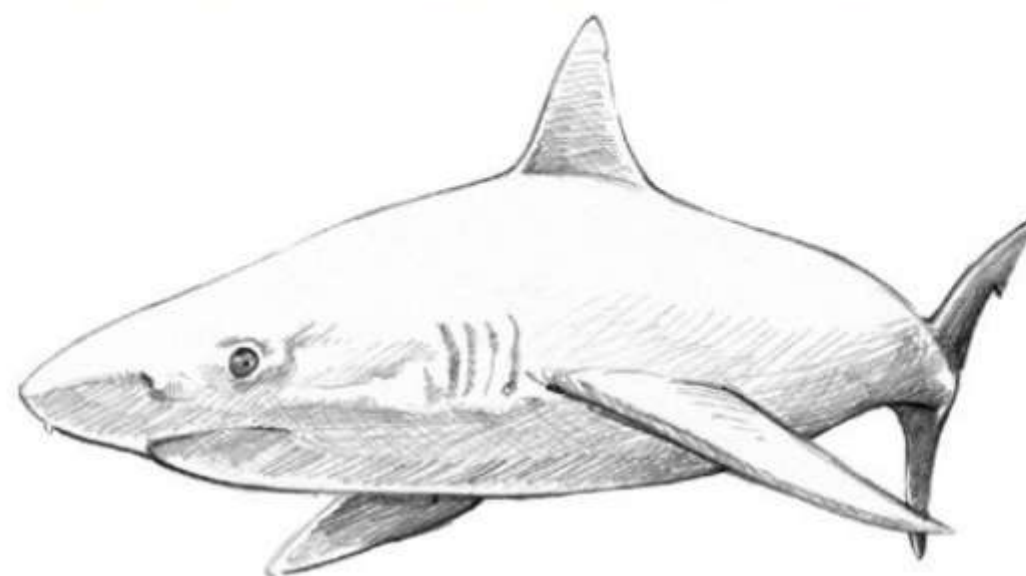




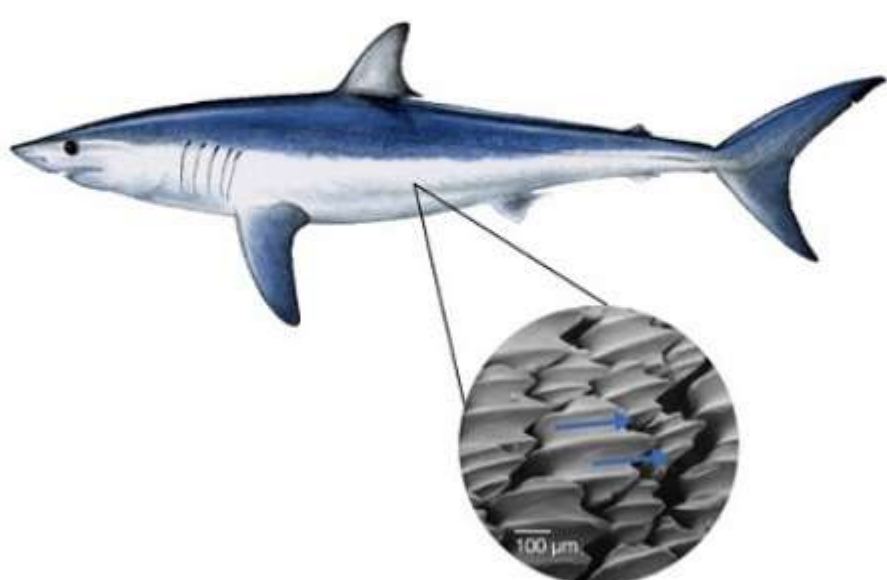
- Designers at Speedo were inspired by the mosaic-like layering of shark skin to create a swimsuit fabric that could reduce "drag" on the swimmer
- Sharkskin is made of countless overlapping scales called denticles or little skin teeth
- Denticles have grooves running down their length in alignment with water flow
- That helps with making the water pass by faster
- It also discourages parasitic growth such as algae and bacteria because of the rough surface



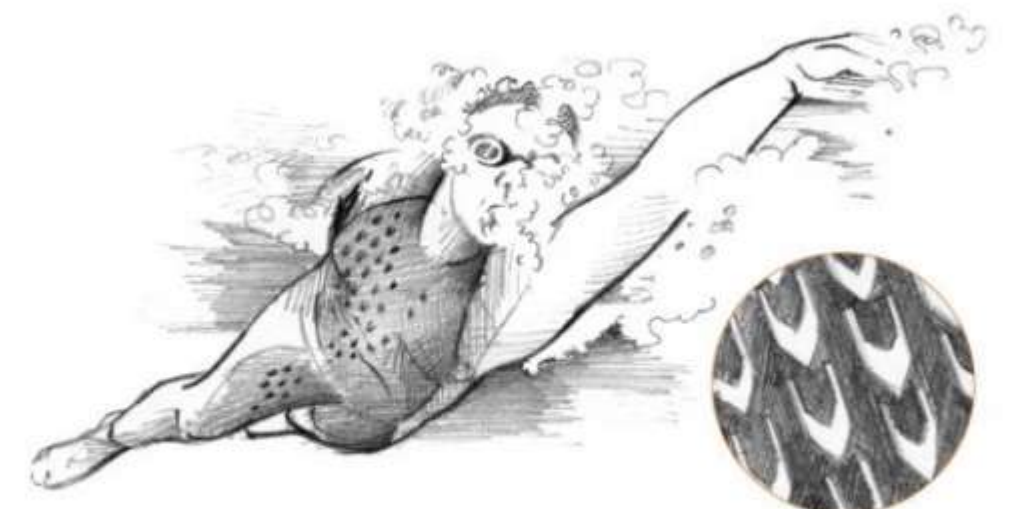
SHARK SKIN INSPIRED SURFACES



micrograph of shark skin denticles



Sharklet™ antibacterial surface



Speedo fastskin swimsuit



- The structure for this tent are modeled after a leaf, with the veins forming the primary support structure for the tent
- Except the beautiful structure it also offers great deal of added functionallity
- It is able to deal with wind storms more effectively than a more traditional design
- It also sheds water more effectively and it is lighter and more durable



BIOMIMICRY IN TRANSPORT

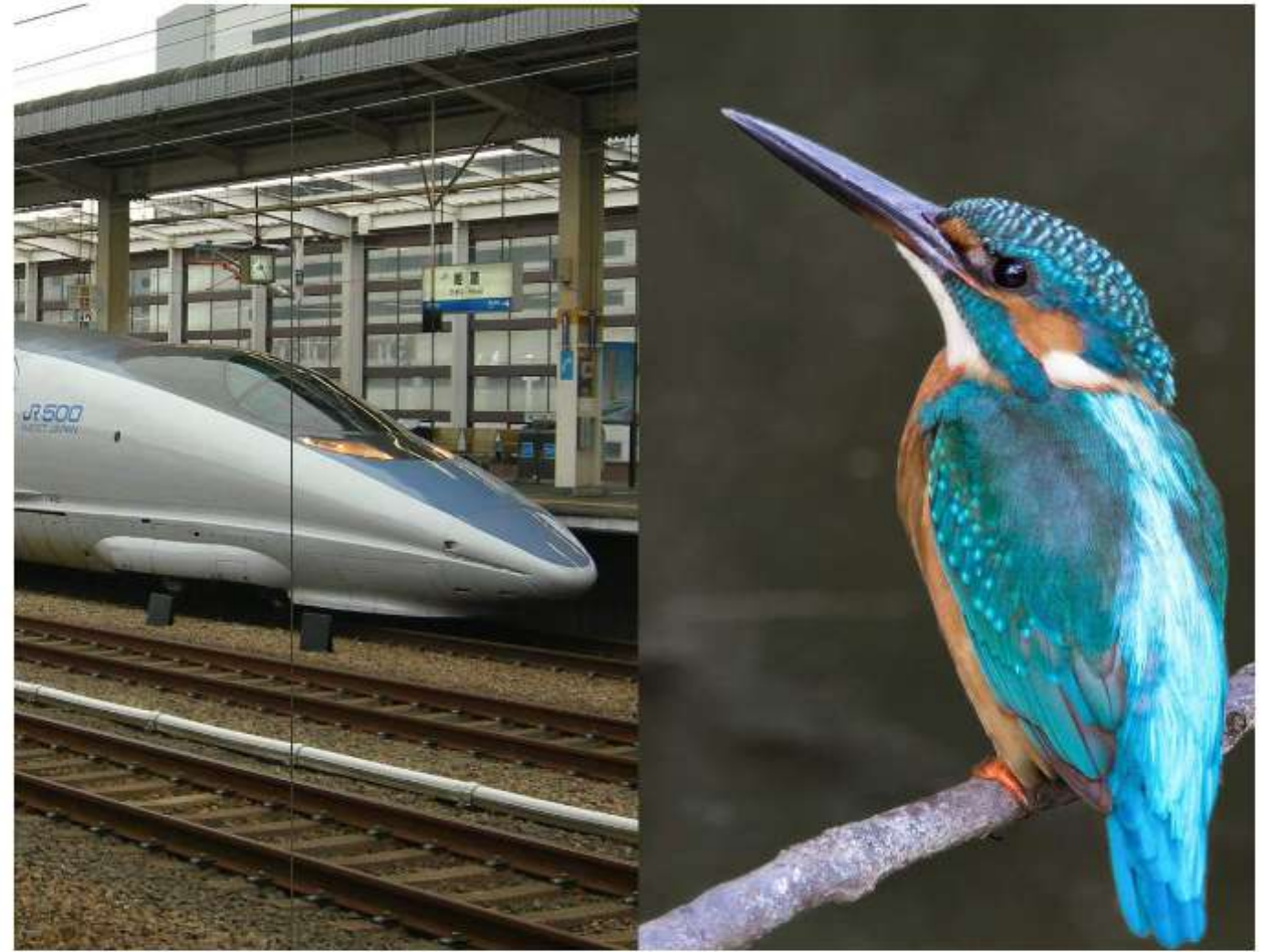
- Various transportation systems are influenced trough the observation and study of animals
- Biomimicry has long accompanied the development of complex technologies
- *"Life has been evolving for 3,8 billion years, and in that time, it has found what works and what lasts. By looking to all that experience that nature has accumulated, we can learn from its blueprints and apply the way that it does things to the way that humans create things, move things and live their lives"* - Megan Schuknecht, Director of Design Challenges at the Biomimicry Institute in Montana in the UK



□ SHINKANSEN BULLET TRAIN

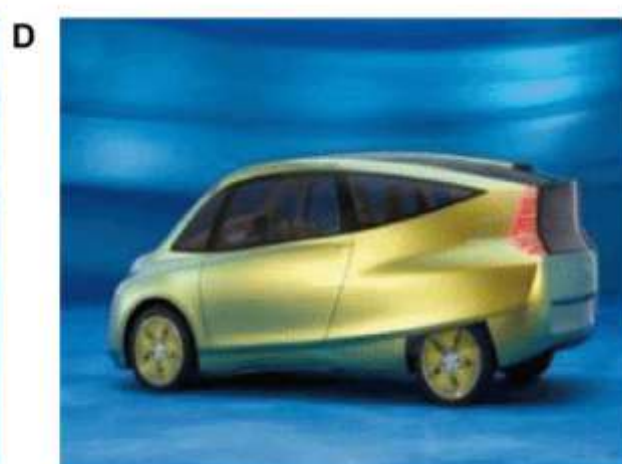
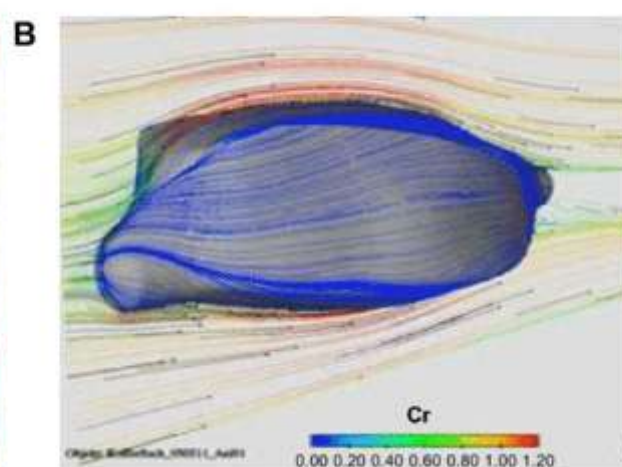
- Japans train is travelling over 200 miles per hour and it is fastest in the world
- It had the problem that the train was producing an extremly loud noise every time it came out of a tunnel because of the change in air pressure
- Scientists found a solution with redesigning the front end of a train using the beak of the kingfisher as a model
- That way they created much quieter train and redesign also helped the train to go even faster with using less energy





❑ BIONIC CONCEPT VEHICLE

- ❑ Mercedes-Benz engineers were trying to design new aerodynamic concept car and they were looking underwater to find an inspiration in the form of fish
- ❑ They focused on the ostracion cubicus, also known as the boxfish
- ❑ The fish has a rather large body but is able to swim very fast because of its low co-efficient of drag and rigid exoskeleton
- ❑ By identifying similarities between boxfish and cars, they started designing a new vehicle
- ❑ The design was unusual, but after testing it proved to be one of the lowest co-efficient of drag ever tested



INDUSTRY

- ▶ Bio-inspired design (BID) has the potential to evolve the way engineers and designers solve problems.
- ▶ Several tools have been developed to assist one or multiple phases of the BID process
- ▶ These tools, typically studied individually and through the performance of college students, have yielded interesting results for increasing the novelty of solutions.
- ▶ However, not much is known about the likelihood of the tools being integrated into the design and development process of established companies.



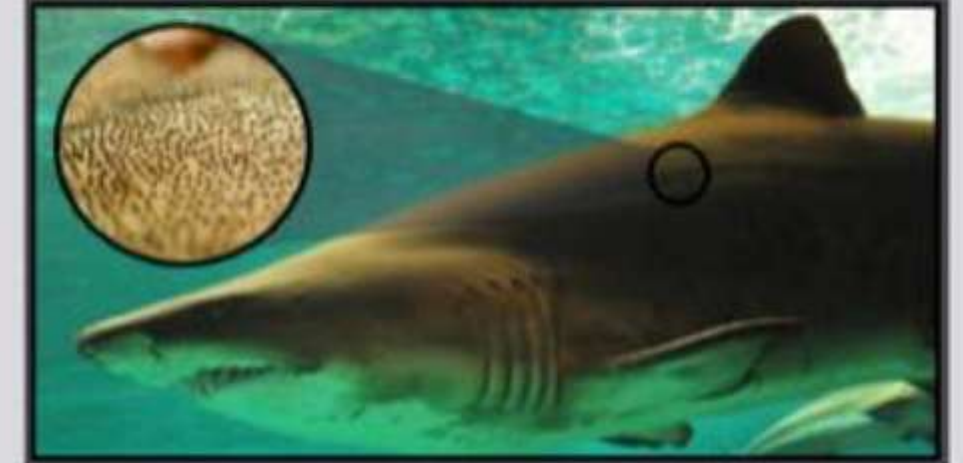
CONSTRUCTION: Termite Den = Self Cooling Office Building



ENERGY: Whale Edged Fins = Energy Efficient Turbine Blades



MEDICAL: Shark Skin Structure = Anti-bacterial Surface



PACKAGING: Burrs of Burdock = Velcro (hook and loop fastener)



MOBILITY: Kingfisher beak = Low resistance/noise Train Design

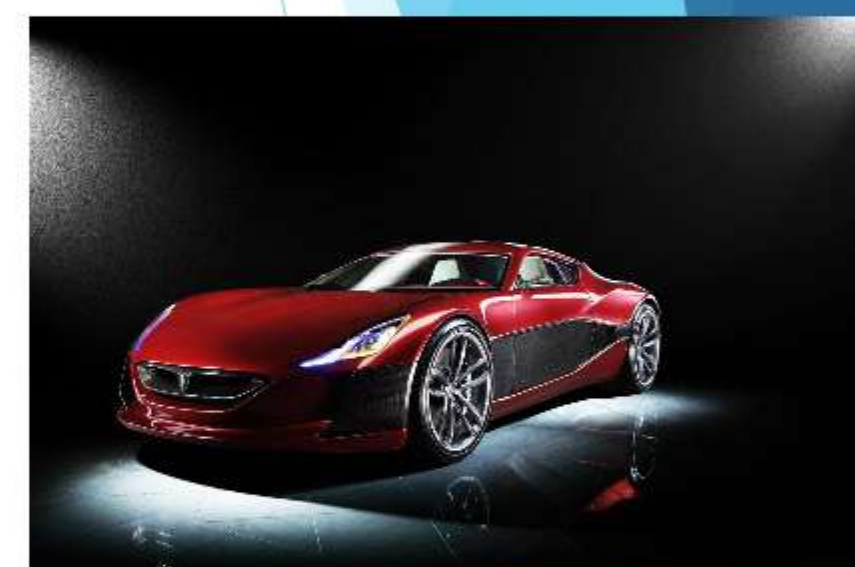


SELF-CLEANING: Lotus Leaves = Hydrophobic Paints/Surfaces

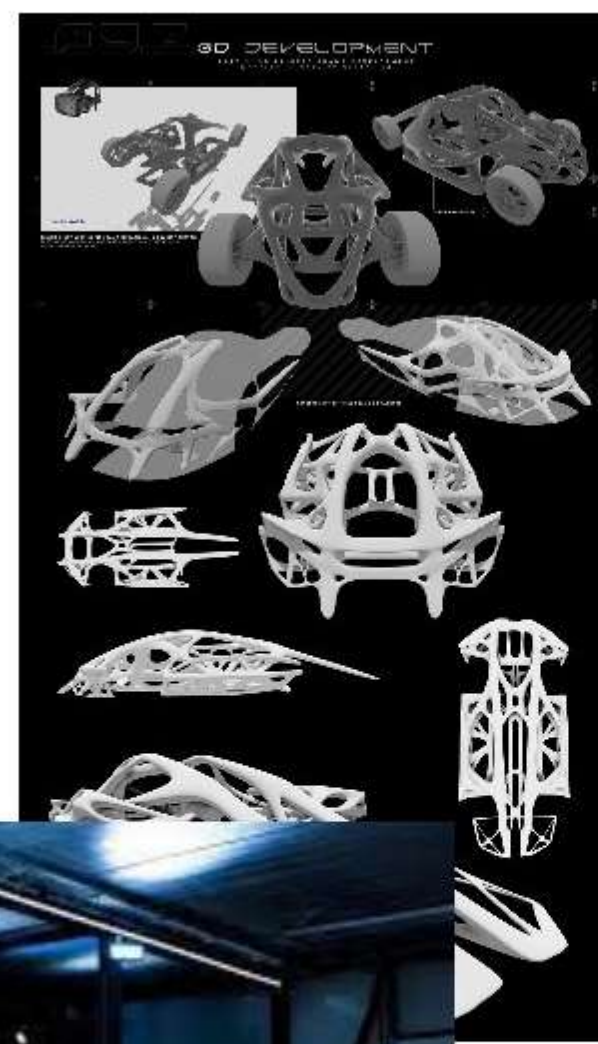


RIMAC

- Rimac Automobili was founded in 2009 from a love for automotive and with the vision to create high-performance cars for the electric era.
- Mate Rimac, born 12 February 1988, is a Croatian innovator, entrepreneur, and founder of the Croatian electric sports car company Rimac Automobili and Greyp Bikes, a high-tech eBike and eBike technology company
- During his high-school years, Rimac won local, national and international competitions for electronics and innovation



- ▶ Rimac car is a technology powerhouse manufacturing electric hypercars and providing full technology solutions to global manufactures
- ▶ It is owned by 34 year old Mate Rimac
- ▶ He created spin-off brand for high performance electric bicycles and launching of the first two wheel product
- ▶ Development of new models and powetrain technologies
- ▶ <https://www.rimac-automobili>



ADVANTAGES OF BIOMIMICRY

- To create new ways of living
- To create suitable products with great performance
- To save energy and cut material costs
- To redefine and eliminate waste
- To solve human problems
- Employment

SUMMARY

- Biomimicry is a concept of imitating nature to solve human problems
- It has only been studied for half past century
- Echolocation and shark skin swimsuits are some examples of biomimicry
- Many people use it in transport, logistics and industrial goods also in many other aspects
- It has lot of advantages for example it saves energy, cuts material costs and creates new ways of living