SCIENCE

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NATURE'S BLUEPRINTS

Executive producers: **Sabine Holzer, Walter Köhler**

3 × 50 min., 4K, 5.1 + Stereo

TERRA MATER STUDIOS

Turn on the national or international news and it seems that our planet is facing overwhelming problems. Record-breaking floods devastate some parts of the world while others suffer unprecedented droughts. Waste material clogs rivers and threatens ocean life. We're running short on energy and most of the energy we produce makes things worse by releasing carbon dioxide. Technological fixes haven't worked. We need a different approach!

Luckily for our future survival, nature's research and development department has been operating for three and a half billion years. In that time, it has solved all the problems we now face and hasn't killed the planet in the process.

This series investigates the new concept of *biomimicry* – exploring nature's blueprints to solve problems, from better robots to amazing new materials and radically new ways to produce energy.

In the last few decades, the science of biomimicry has really advanced. Scientists have realized that biomimicry is far more relevant than originally thought. It's already generating safer cars and more economic buildings, but it can also tell us how to better work together and how to improve democratic politics. The answers to our problems are out there in nature – all we have to do is look.

The series explores three areas – challenges that we must overcome urgently, if we're to reduce our impact on our own home planet. How to move around, how to create materials without trashing the environment and how to generate and use energy without compounding climate change.

We explore developments in robotics that create robots that can explore environments that we can't and have implications for new developments in medicine with prosthetic limbs. We investigate new materials that are lighter and stronger, are more flexible when needed, are more transparent if required to let light through, and can shed dirt – self-cleaning to save time, material, and cost. And we discover ways to generate clean energy that don't involve burning fossil fuels and are renewable. From heat exchange systems to ventilation techniques that maintain appropriate temperature and humidity, from heat sensors to carbon dioxide removal, we look at how nature generates and recycles energy with minimum waste and pollution. Nature can provide blueprints that will totally revolutionise engineering as we try to find ways to accommodate our place on Earth, with minimum disruption and damage and go some way towards repairing some of the damage already created. Biomimicry is the science of the future.

Episode 1 – Moving around

Robots are a mainstay of science fiction but now science fact is catching up. Inspired by nature, engineers have designed some astonishing new designs for robots – some extraordinarily life-like, others more like aliens combining combine features of different animals.

In Germany, automation and robotics company Festo have a whole zoo of realistic robotic animals, from kangaroos and dragonflies to manta rays and spiders. In 2021 they unveiled their robotic swift – an agile flying robot.

The Massachusetts Institute of Technology's Biomimetic Robot Lab has developed the world's fastest robot – a "robo-cheetah" that looks less realistic than Festo's animals but is a highly versatile and seriously cool robot with huge potential. Recently they revealed a family of nine 'cheetahs' that all work together, interacting and collaborating.

At Boston Dynamics, the focus is on humanoid robots – stunt robots that can perform extraordinary feats of strength and agility.

Even micro-organisms can provide inspiration. Scientists have now made tiny robots that can propel themselves through liquid with artificial cilia – in the same way that a single-celled *Paramecium* uses its tiny, hair-like cilia to swim.

In the past, robots were powered by conventional motors but now scientists are developing artificial biomimetic muscles which will have important applications in medicine as well as in new designs for robots.

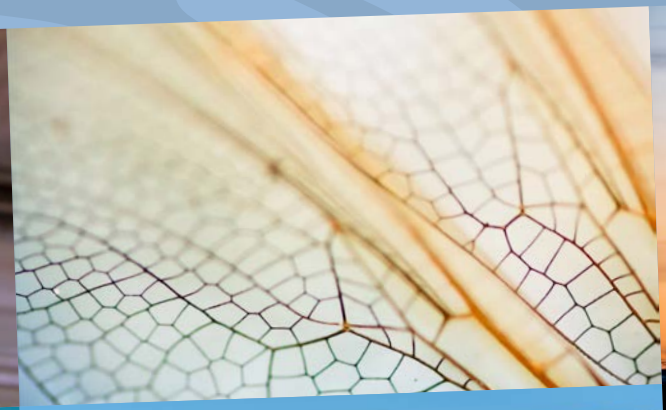
Apart from inspiring hardware, nature also suggests ways to rethink software!

Episode 2 – Building Materials

We live in a world of steel, glass and concrete, all materials that take a lot of energy to make. And they're much heavier and more cumbersome to use than nature's building materials. Weight for weight, nature's materials are much stronger than ours. Lightweight panels built of a honeycomb structure use minimal amounts of material but are still three times weaker than the wing cases that cover the delicate wings of beetles. The strongest beetle, the aptly named "ironclad beetle", can even survive being trodden on; its wing cases are made of one of the most crush-resistant materials ever discovered. Scientists are now looking at how to adapt this to planes, trains and automobiles.

But it's not just about strength.

Our efforts to harness solar energy are often hampered by local conditions. To harvest enough light in less sunny northern climes, solar panels have to cover



huge areas but it's a problem that's already been solved by a plant called *Anthurium* which lives on the dimly lit floor of rainforests. It has leaves covered in microscopic lenses that focus the little light it has available to allow it to photosynthesize in its gloomy world. Scientists are looking closely at how it achieves this so they can design a new generation of super-efficient solar panels.

Nature's materials are often so sophisticated that they can perform several tasks at once. A dragonfly's wing provides a complex flight surface but also has tiny nano-structures that kill bacteria mechanically to keep the wing clean. Inspired by this, scientists have recently created a material made from black silicon that has bactericidal properties – a self-sterilising surface which, since it doesn't use antibiotics, doesn't contribute to creating antibiotic-resistant bacterial strains.

Episode 3 – Power to the Planet

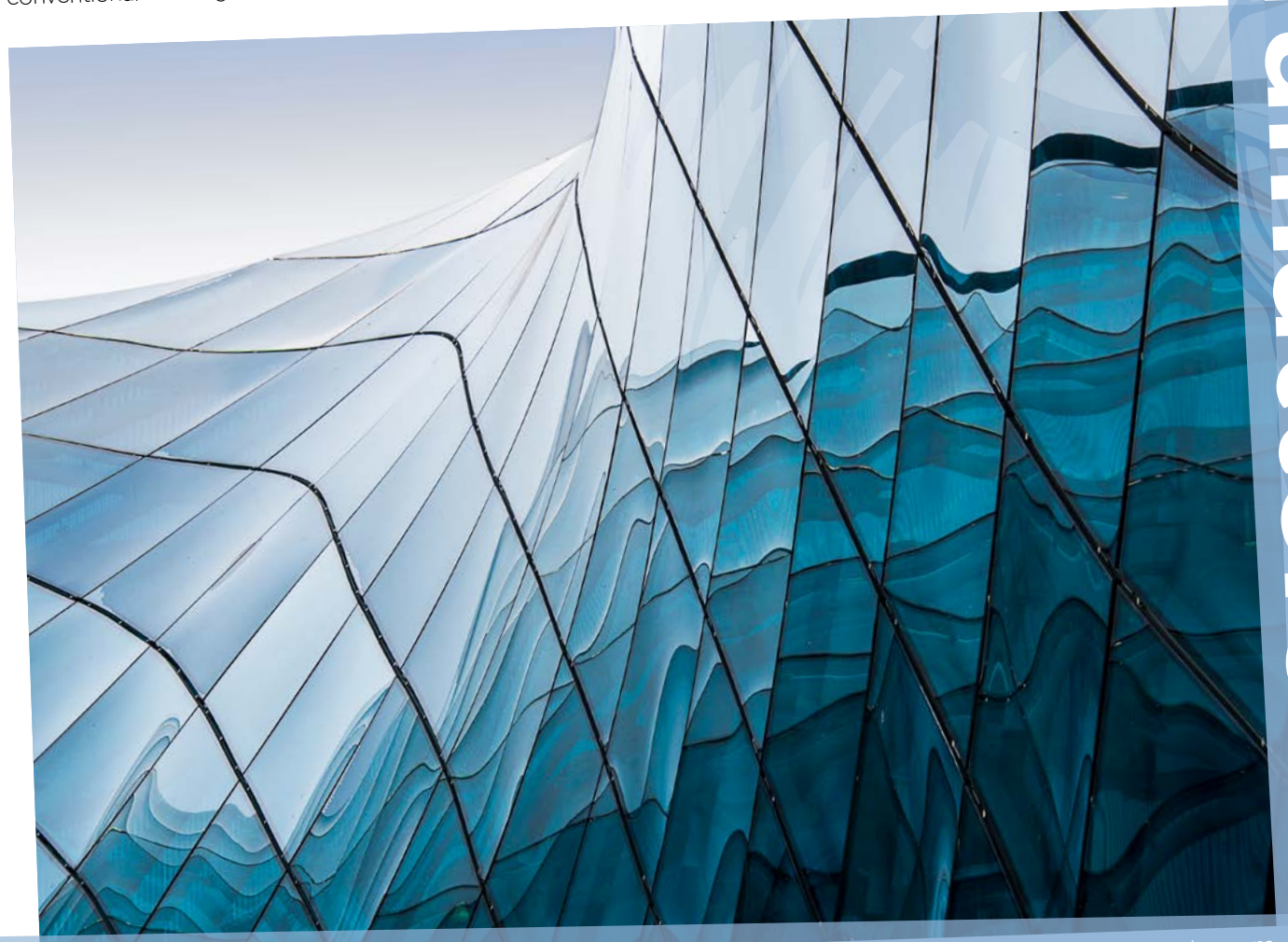
For billions of years, Planet Earth has been running on renewable resources. Materials are recycled in many ingenious ways while energy burnt in respiration is balanced by energy created by photosynthesis. The goal of a biomimetic society is to do the same – to ensure that all resources are used in a closed loop, where there's no waste, just raw materials for another process. One organism's waste is another's food.

Energy can be recycled in a similar way. Termite mounds have sophisticated ways of controlling their internal environment. They've provided inspiration for our buildings for the last two decades in ever more inventive ways. Singapore's famous mechanical Supertrees capture solar energy and have air venting ducts that feed into nearby conservatories, and which work in a similar way to termite mounds.

Barossa termites use evaporation of water to keep their nests within a comfort zone accurate to one degree. To do this, they tunnel tens of metres below the surface to reach the deep water table. Inspired by this, Melbourne's Council House 2 pumps waste-water through ceiling panels to absorb heat, then dissipates the heat at night in massive evaporators on the roof. The building is 85 % more efficient than conventional buildings of the same size.

The Holy Grail of 'green energy' is artificial photosynthesis, which uses sunlight to create food and fuel from nothing more than water and carbon dioxide – and the only waste is oxygen.

But nature still keeps some secrets. It's going to take all our ingenuity to crack the key to unlimited clean energy even though, in nature, the problem was solved by a primitive single-celled cyanobacterium.



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