Tiny nanometer-scale structures are responsible for this baby tarantula’s brilliant blue color.

LEARNING FROM NATURE
TINY BIO-MOTORS
BLUE SPIDERS
DNA BUILDING BLOCKS
Welcome to Nanoze!
What is a Nanoze? Sounds like nah-noze. Nanoze is not a thing. Nanoze is a place to hear about the latest exciting stuff in science and technology. What kind of stuff? Mostly nanotechnology, the latest trends in fashion, and even important stuff like bicycles and tennis rackets. Nanoze was created for kids, so inside you’ll find interesting articles about what nanotechnology is and what it might mean to your future. Nanoze is online at www.nanoze.org, or just Google “Nanoze”—you’ll find interviews with real scientists, the latest in science news, games and more!

All about the things too small to see
The latest trends in fashion, and even important stuff like bicycles and tennis rackets. Nanoze was created for kids, so inside you’ll find interesting articles about what nanotechnology is and what it might mean to your future.

How can I get Nanoze in my classroom?
Copies of Nanoze are FREE for classroom teachers. Please visit www.nanoze.org for more information or email a request for copies to info@nanoze.org.

What is biomimetics?
Ever look at a bug and wonder how that tiny little critter manages to do things like climb up walls and survive long periods of time without food or water? Life on Earth is full of examples of plants and animals that have evolved to do amazing things. They have evolved to function in environments as hot as the Death Valley or as cold as the Antarctic.

The field of biomimetics is the use of biology to help guide the design of man-made things.
These biological models involve moving parts and special materials, so the challenge for researchers is to create those parts in the lab. In this issue we look at different kinds of biomimetic inspirations such as the sticky feet of geckos and water-repellent materials found on the wings of beetles that live in the deserts of Namibia. Part of the mystery is figuring out how these mechanisms work, and the other part is building them to function as well as the ones found in nature. The field is revolutionizing the division between life and inanimate objects.

Q&A with nanoscientist
Tak-Sing Wong

What is your current job and what do you like about it?
I am currently an assistant professor of mechanical and biomedical engineering. My research involves the study of natural and biological systems and translating their clever strategies into synthetic materials for various industrial and biomedical applications.

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What is the latest in science news?
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On the cover
This tiny blue tarantula is a baby Caribbean venomoso, also known as the Arctitis Pintoo. It lives in trees on the Caribbean island of Martinique. As it grows, its color changes from bright blue to a pattern of green, pink and purple.

TARANTULA SAFETY
I have had both people and pets attack this pinktoe. This is a dangerous spider and should not be kept as a pet. Remember, all spiders have venom.

Learning about nano stuff is fun but it can be complex, so it helps to keep these four important facts in mind:
1. All things are made of atoms.
2. At the nanometer scale, atoms are in constant motion.
3. Molecules have size and shape.
4. Molecules in their nanometer-scale environment have unexpected properties.

Tak-Sing studies nanoscale structures on the surfaces of plants. Liquid-Infused Porous Surfaces (LIPS) that can virtually repel anything. After my postdoctoral research, I began my professorship at Penn State, where I continue to do research in nature-inspired engineering. Tell us something fun about yourself? And it doesn’t have to be about science! I love watching science fiction and futuristic movies. And sometimes I get my “crazy” research ideas from them!

When you were a kid, what did you want to be? And if it wasn’t a scientist, what was it and why did you change your mind?
When I was a kid, I dreamed of becoming an architect one day. I was amazed by how people can build large and beautiful buildings. I also dreamed of becoming a mechanic who could build many different things—specifically racing cars! That was mostly influenced by my father, who builds simple furniture from scratch when needed. I did also enjoy reading about stories of scientists when I was a kid, where I started to have early appreciation of their work. I guess because of a combination of these childhood dreams and experiences, I became a mechanical engineer and a professor!

What did you do to get your current job, and what kind of education did you need for it?
I did my undergraduate degree in automation and mechanical engineering at The Chinese University of Hong Kong, where I began my research in micro- and nanomachines and sensors since freshman year. Then I was given an opportunity to study at UCLA, where I eventually obtained my PhD in micro- and nanotechnology from literature. After my PhD post, I went on to conduct postdoctoral research at the Wyss Institute of Biologically Inspired Engineering at Harvard University. Over there, I developed a pitcher plant-inspired surface called Slippery...
Learning from Nature

**A gecko’s sticky feet**

These lizards have feet covered with little nanometer-sized structures that can adhere to a lot of different surfaces. Since they stick to all sorts of stuff, they can even climb walls. Spiderman climbing the walls? Maybe someday!

**Brilliant blue butterfly wings**

The nanometer-sized ridges on this butterfly’s wings diffract specific wavelengths of light, making them look blue. These structures found in nature might be the inspiration for a whole new class of fabrics that have color without using any chemical dyes.

**A pitcher plant’s slippery inside**

The inside of the pitcher plant is filled with super-slippery nanomaterial—when a bug lands on it, it slides down into the flower to its doom. Knowing how plants make this material will help scientists design new motors that don’t require lubrication.

**Iridescent tarantulas**

Some tarantulas have tiny nanometer-sized structures that diffract only a narrow wavelength of light, so they look blue. Some day scientists hope to use these designs from nature to make materials that have different “colors” but don’t involve dyes. These materials might even have the ability to change color—your blue shirt could suddenly turn red in the blink of an eye.

**Water-capturing beetles**

The surface of the desert-dwelling Namibia beetle (Stenocara gracilipes) is superhydrophobic and can collect moisture from the air. Water drops form until they are big enough for the beetle to drink. With similar technology, we could make big sheets of superhydrophobic materials and collect water in the desert.

**Super-slick shark skin**

Sharks are very efficient swimmers and need a lot less energy to slide through the water than people do. Scientists are re-creating shark skin in the laboratory to help us move through the water faster and easier.

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*Shinya Yoshioka, Osaka University*  
*Cliff Mathisen, FEI Company*  
*H.F. Bohn, W. Federle*  
*Andrew Parker, AMNH Microscopy / Rebecca Rudolph*  
*Hans Hillewaert / Wikipedia*
A TINY MOTOR CHALLENGE
Back in 1959, Richard Feynman, one of the most famous nanotechnologists on the planet, challenged the world to build a motor that was less than 1/64 in. That is about the volume of 3–4 drops of water. There was no such thing as nanotechnology then, at least the way we now make tiny nanometer-sized parts like computer chips. Feynman was hoping for some revolutionary breakthrough, but the man who won the contest, Bill McLellan, was just a very skilled machinist who used tiny tools, including feathers, to make a very, very small but conventional motor.

FLAGELLA-INSPIRED
Today, biology is being studied to find new types of motors that can be built on a nanometer scale. In nature, there are a lot of tiny motors. For instance, bacteria have motors that whip hair-like things called flagella in a rotary motion, which help bacteria move through liquids. Flagella are only about 20 nanometers across. Many types of bacteria move around using a strong flagellum, a long tail that moves in either a rotary or bending motion.

POWERFUL FLAGELLA
Many types of bacteria move around using a strong flagellum, a long tail that moves in either a rotary or bending motion.

HARNESSING ATP
Scientists have made motors in the laboratory similar to the ones that power flagella. These are hybrid motors—part biology, part man-made—and they do simple things like spin around or move from one place to another. Instead of using electricity to make them work, they use ATP (that’s adenosine triphosphate), which is nature’s chemical energy supply. Some day scientists think that they can use these little bio-motors to move tiny little devices that might be able to go into very small spaces. The big challenge is how to power them—some scientists think we might be able to harness energy from the environment to help propel them along. It would be great to have these tiny motors use some energy source that is found in the environment instead of relying on a battery.

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WHAT IS DNA MADE OF?
Deoxynucleic acid (DNA) is where the blueprint of life is encoded. Seemingly simple, it consists of four basic molecules called nucleotides: adenine, guanine, cytosine, and thymidine. Virtually everything that a cell needs to do is coded in its DNA. In your average bacteria there are about three million nucleotides, and in your average human cell there are about a thousand times that.

THE DOUBLE HELIX AND MOLECULAR ORIGAMI
Like all molecules, DNA has a shape that comes from the various interactions between the atoms making up the nucleotides, which then makes up a strand of DNA. Back in the 1950s, Francis Crick and James Watson—with a lot of help from other folks, including Rosalind Franklin—figured out the basic structure of double-stranded DNA, the famous double helix. That discovery was just the beginning and, using a lot of tricks that involve enzymes, scientists have been able to make more complicated structures than just the plain, old double helix. It turns out that DNA is a pretty predictable building block to make all sorts of structures in various shapes. They fold up all by themselves, a kind of molecular origami.

DESIGNING WITH DNA
What is really cool is that you can design these structures on a computer and make almost exactly the structure that you want. This de novo (Latin for “from new”) approach has been used to make structures ranging from a few nanometers up to hundreds or even thousands of nanometers that can release medicines in the human body on demand. Scientists have made a number of different DNA-based structures that are not just shapes with different sizes, but that also do some pretty amazing stuff. What would you make?