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Presents

THE LOUISVILLE ZOO
BACKYARD ACTION HERO
2015 GUIDEBOOK 2016

SCIENCE IN THE WILD

STEM

SCIENCE
TECHNOLOGY
ENGINEERING AND
MATH

theZOO
LOUISVILLE

Welcome Future Heroes!

At Toyota Motor Manufacturing, Kentucky, Inc. (TMMK), we believe that protecting the environment is part of our mission to be a good neighbor across Kentucky. As we build cars in our plant in Georgetown, we are committed to protecting the environment, following environmental laws, preventing pollution and continuously improving our processes. Our commitment doesn't stop there — and neither should yours! It is everyone's responsibility to protect the environment.

By becoming a Backyard Action Hero, you commit yourself to taking an active step to coexist and learn about nature and wildlife. Once you have learned about some of the things in this book, you will be ready to take conservation action to your backyard and beyond. Good luck Heroes!

Sincerely,

Your Friends at

Toyota Motor Manufacturing, Kentucky, Inc.

Adults Can Be Backyard Action Hero Mentors!

Hello teachers and parents! In this issue of Backyard Action Hero, you'll find content written just for you so that you can help your kids on the path to becoming Backyard Action Heroes. Please use the resources within for guided lessons, activities and fun experiments. Further parent/ teacher resources are available online at **louisvillezoo.org/BAH**

The Louisville Zoological Gardens, a non-profit organization and state zoo of Kentucky, is dedicated to its mission to "Better the Bond Between People and Our Planet" by providing excellent care for animals, a great experience for visitors, and leadership in conservation education. The Zoo's collections which include botanical gardens are accredited by the Association of Zoos and Aquariums (AZA) and the American Alliance of Museums (AAM). The Louisville Zoo is also an agency of Louisville Metro Government.

2015–16 Backyard Action Hero Guidebook

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Science, Technology, Engineering and Math

IN THE WILD

In this guidebook, you'll learn about science outside the lab. Sometimes animals and nature seems worlds away from science-based subjects like technology, engineering and math — but they often work together in surprising ways.

Just the way that you perform experiments in school by observing and writing a conclusion on what you see, there are researchers who work by observing nature and then finding ideas based on what they see. Coming up, you'll see some examples of how nature and science often collide with exciting and unexpected results.

You'll meet the Louisville Zoo's Aquatic Life Support Specialist who incorporates knowledge of many different fields of science to monitor and adjust the Zoo's water. His job ensures that the many different animals at the Zoo have a comfortable habitat with the right water needed for drinking of swimming! There's also fun information about research performed right here at the Louisville Zoo that helps ensure our animals are healthy mentally and physically.

Learn about how technology, engineering and nature combine using "biomimicry." Today, many researchers and scientists are taking their cues from nature to engineer new technological wonders and innovations never seen before! These natural inspirations have been around us all along, but we've just begun to consider how they can apply to our day-to-day activities and help improve our quality of life.

You can learn so many wonderful things from nature — just another reason being a Backyard Action Hero is important to preserve our precious planet. From chimps with behaviors that introduce us to new medicinal cures to trains inspired by bird biology — you'll learn about it all in this Guidebook! You can be a Backyard Action Hero and a scientist all at the same time! What can you learn from the creatures in your own backyard?

Imitating Natural Life Leads to

INNOVATION

TECHNOLOGY

At the Louisville Zoo MetaZoo, families learn about animals practically every day. But what if instead of learning about animals, we tried to learn from them. That's exactly what many engineers and researchers around the world are trying to do through biomimicry. Biomimicry is a way to solve human problems by creating usable products that are inspired by nature. After all, animals have been surviving on the earth and using their complex adaptations for much longer than we have. The prefix "bio" means life and "mimicry" means to imitate. As engineers, architects, and chemists brainstorm new ideas that benefit humans, they are looking more and more toward nature to influence their blueprints. You too can become a problem-solver through the study of nature! Below are a few examples of biomimicry at work in our world today:

Morpho Butterflies

Did you know morpho butterfly wings are actually transparent? Small fragile scales cover butterfly wings and give them coloration. Depending on how each scale absorbs the light, it can cancel out certain colors and reflect others! Researchers are working to develop cell phone screens that use less energy by harnessing the iridescence of these scales to create colors. Just imagine — a cell phone with a screen colored by reflected light. You could text your friends for days without charging your phone!

Kingfishers

The Bullet Train in Japan was well known for being one of the fastest trains in the world, but it still had room for improvement. Designers were inspired to model the nose of the train after the head and beak of a kingfisher bird, whose shape helps it to glide easily from air into water with hardly any friction at all. Now the trains are faster than ever, reaching over 200 miles per hour!

Burrs

Before you could tie your shoes, you likely had Velcro straps that were easy for your preschool-hands to secure. George de Mestral's invention of Velcro was inspired by prickly plant burrs that stuck to his clothing and his dog's fur as they walked through tall grass.

Lotus Leaves

When water hits the leaf of a lotus flower, it beads up and rolls right off the surface — carrying dirt and debris with it. The lotus's ability to repel liquid and stay clean has inspired engineers to create coatings that can cover fabrics and keep upholstery and carpets clean. In the future, it may save you grief the next time you spill soda on the sofa!

Shark Skin

Some species of sharks, like the Shortfin Mako, can reach underwater speeds of around 50 mph. Researchers have discovered that the positioning of the bumps on shark's skin helps reduce drag and lets the animal slide through the sea. Researchers at Speedo have created sharkskin-inspired bodysuits for Olympic swimmers.

Chimpanzee

Did you ever think that a chimpanzee could be a doctor? Researchers have discovered plants with possible medicinal applications to humans by observing how chimps and other species cope with illness. Chimps will seek out certain flowering trees (Veronica genus) when they are ill. It turns out, these trees contain chemical compounds that may treat intestinal illness-causing parasites in humans. Those are some smart chimps!

Hagfish:

A Slimy Solution

SCIENCE

You're probably thinking, "Ew! Did somebody sneeze? Because that is a lot of snot!"

No, that slimy mucus isn't from a human. It was created by a hagfish. Hagfish are ancient creatures with fossil evidence dating back over 300 million years! These jawless fish resemble eels and live in cold ocean waters. Hagfish are detritivores which means they eat dead organisms (sometimes called carrion). They can use their tooth-like structures to bite off chunks of food or burrow deep into animal carcasses. Scientists believe that hagfish are even able to absorb nutrients through their gills/skin after burrowing into the body of dead animals on the seafloor. Remarkably, these creatures can go months without eating and have very slow metabolisms.

Perhaps the most incredible adaptation of hagfish is their ability to ward off predators by producing a thick slime when attacked. As a larger fish bites down on a hagfish for a meal, it gets an unappetizing mouthful of slime and the hagfish gets away. To produce this sticky substance, the glands lining their bodies secrete proteins that mix with saltwater to quickly make slime. To prevent choking on its own slime, hagfish will wrap its body into a knot to prevent the slime from dripping on its own face.

When dried out, the slime created by hagfish becomes tiny protein-threads (similar to spider silk). Recently scientists have been studying the properties of the slime and researching ways it can be useful to humans. Some believe that the threads can be turned into clothing for athletes or even bullet-proof vests! Currently, fibers like spandex or nylon are made from oil — which is a ***non-renewable resource***. Non-renewable resources cannot be replaced after use. Although there is still plenty of research to be done, scientists are hoping that hagfish slime will eventually be a more natural and renewable alternative for a number of practical applications. Who knows? Maybe one day you will play a game of soccer or go for a jog in a shirt made from hagfish slime! Sounds cozy!

Hagish photos provided by the Oregon Coast Aquarium

Vocabulary Answers: 1. Burrs 2. Pinnipeds 3. Morpho 4. Ichthyologist 5. Detritivores 6. Kingfishers 7. Cortisol 8. Biomimicry 9. Setae
Jumble Answer: A Super Scientist!

Career Spotlight

SCIENCE

Having a career in science doesn't always mean you'll be working in a lab. Meet these two field scientists who can prove it!

Dr. Matt Thomas : Ichthyologist (Fish biologist)

Dr.Thomas is field biologist with the Kentucky Department of Fish and Wildlife Services. He explores streams, rivers, wetlands and other aquatic habitats to study many species of freshwater fish. He has to spend lots of time outdoors keeping track of where and how many fish there are, their habitat conditions and even their life history! All of this research helps to create conservation strategies used to protect rare or declining species.

Like many people in his profession, Dr. Thomas has been interested in animal sciences since childhood. He earned his undergraduate degree in Environmental Science. A few of his professors noticed his interest in ichthyology and encouraged him to continue study as a graduate student. He went on to earn his Masters of Science in Biology and afterward a doctorate in Zoology. But Dr. Thomas loves his work because it allows him to be outdoors and see animals in their natural habitats. It also gives him the opportunity to help conserve and protect aquatic animals right here in Kentucky.

Dr. Julie Ter Beest : Associate Veterinarian

Dr. Ter Beest is the associate veterinarian at the Louisville Zoo. She works with our hospital team and is responsible for the welfare of more than 1500 animals that call the Louisville Zoo home. Her job includes hands-on work like animal exams, medical treatments, performing surgery or even trimming armadillo teeth!

An early interest in animal science influenced her path. First, Dr. Ter Beest volunteered at an animal hospital. Then, she moved on to working with horses. After that, she volunteered at the Louisville Zoo. She gained lots of experience with animals early on. Dr. Ter Beest earned her undergraduate degree in Biology and completed internships in wildlife rehabilitation and wildlife research. Her graduate degree was in Forestry (with an emphasis in wildlife). She also completed a doctorate in Veterinary Medicine. Lots of education is a must when you want to be a vet! While in Veterinary school, she spent two summers Wildlife Safari animal park in Oregon learning about Zoo and wildlife medicine. It was there that she realized she wanted to spend her career treating wildlife species like those at the Louisville Zoo.

Gecko Ingenuity

Sometimes one animal can inspire many ideas. Look at all of the wonderful things inspired by unique gecko features!

Pictured: leopard gecko on branch

Geckos also have a series of distinct zones in their eyes that make it possible for them to see colors at night. These zones have different refractive powers. This makes gecko eyes 350 times more sensitive than human's eyes. They can also focus on objects of different distances at the same time. The discovery of this ability may allow engineers to develop more effective cameras and possibly even multi-focal contact lenses.

Scientists have developed "gecko tape," a dry unidirectional adhesive, based on the gecko's remarkable "toe fuzz." When you pull the tape one direction, it sticks. When you pull it another direction, it releases!

Numerous researchers have gone gaga over gecko feet while creating new robotics. These robotic inventions can climb slick surfaces using dry microbes modeled after gecko toe hair. From miniature tanks that can climb walls to legged gecko-bots that may be able to climb hulls in space — inventions based on gecko feet are going to amaze the world!

One day, we may have tires that grip smooth surfaces, climbing gloves and boots that grip rocks, and even Spider-Man suits could be a reality. Seriously, researchers are working on a suit right now!

On the bottom of their toes, geckos have millions of microscopic setae. Sort of like specialized hairs, these setae help the gecko scale smooth walls and scamper across ceilings. Influenced by this ability, researchers have developed tapes, adhesives and other tools that can support several hundred pounds of weight. Wouldn't you like to climb walls like this lizard? It may happen someday soon!

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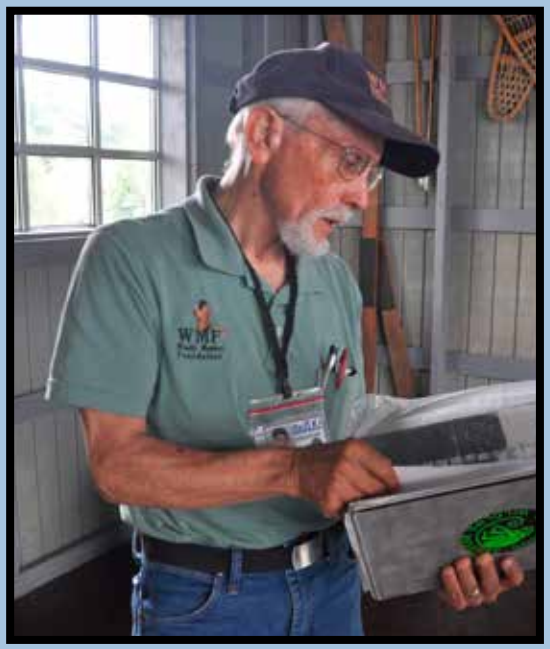
Stinky Science

Research at the Zoo

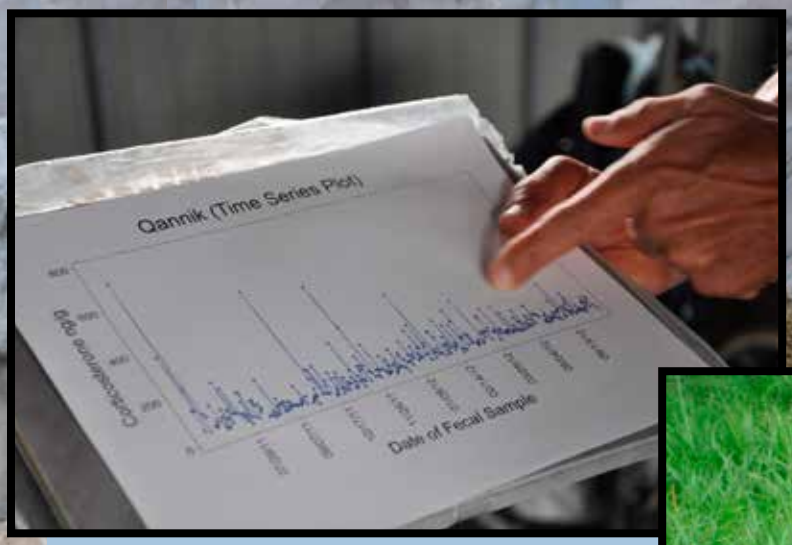
We've been talking a lot about science outside the lab in this Guidebook. Are you amazed yet by all of the interesting places you can do research? Did you know — the Louisville Zoo has a research study going on right now too? You'll never guess what the subject matter is. Animal poop!

It sounds a bit gross and stinky, right? But the Louisville Zoo has been researching the levels of a chemical called cortisol in Zoo animals like elephants, woolly monkeys, gorillas, and even in our brown bears and polar bears since 2011.

So, what's the big deal about cortisol, and why is it so important? Cortisol is a chemical that mammals produce in response to stress. It's normal for an animal to produce small amounts of cortisol for short periods. However, it's very important to track cortisol levels, because if an animal experiences high levels of constant stress over a long time, that degree of stress can become dangerous to the animal and lead to physical and mental illnesses.



To check cortisol levels, scientists can use hair and blood, but sometimes animal feces are the best and easiest source to check cortisol levels for different animals. One of the researchers working on this study is Dr. Brent White. Dr. White has been on the faculty at Centre College since 1971 and is an Emeritus professor of psychology and animal behavior. He said that for this study, researchers measure the amount of cortisol for each bear from a feces sample taken every day. But with two polar bears and three brown bears, how



MATH

do you know that you are getting the right fecal sample from the right bear? Dr. White said that the zoo keepers in Glacier Run feed each bear corn as part of their daily diet, but the corn is a different color for each bear. That way the zoo keepers know they are getting the right sample for each of their bears. A bit corny — but pretty smart!

Zoo keepers collect the samples to be tested and note daily observations on the animal. The most powerful tool in determining the cause of stress is observing the animal in its surroundings. Once the test results are received, if a cortisol spike is noted, keepers can review their observations to figure out what was happening that may have caused the animal stress. For example, when Quannik first came to the Zoo, a young orphaned bear rescued from a life-threatening scenario in Alaska, researchers measured her cortisol levels and found a spike of cortisol production. But, it began to drop off with time as she became more accustomed to her new environment!

By measuring and knowing the level of cortisol in each of our polar bears, our zoo keepers can make changes in their daily routines to reduce that stress if needed. Stress isn't always evident in behavior or easily interpreted as stress. For example, gorillas are usually social animals. However, during one Louisville Zoo study, data showed that a gorilla who preferred to be alone was in fact stressed around other gorillas — especially silverback gorillas! As it was abnormal for a gorilla to be solitary, it wasn't a conclusion easily reached without data. As a consequence, keepers rearranged the family groups of gorillas to accommodate and were able to provide better care for their animals.

In addition, the wildlife community receives information about the researched species that may never be possible outside of a managed environment. For example, the research performed at the Zoo in the past indicated that young female bears generally have a higher cortisol level than other bears. Who would think you could learn so much helpful information from animal poop? What will we learn from next?

A Career in Science:

Just Add Water!

Did you ever wonder what it's like to work in a science-based field? One of our own employees here at the Louisville Zoo has a career that is focused in science, technology, engineering, and math! His job also requires scientific work outside of a lab and is extremely important to the health of many of the Zoo's animals. Lonnie Lamb is the Aquatic Life Support Specialist (ALSS) at the Louisville Zoo.

Hi Lonnie! How would you describe your position as ALSS?

I manage the water treatment systems in Zoo areas like Glacier Run, Gorilla Forest, Penguin Coast, Tiger Tundra and the Papa John's Splash Park to provide clean, safe, water for the animals, and guests.

Cool! That's really important. How did you get interested in science?

For my 8th birthday, I received two particular presents: a telescope and a microscope. They were great gifts, especially since one allowed me to see things really far away, and one allowed me to see things that were really small. So I was immediately exposed to two "worlds" that I really didn't know anything about.

How did your interest in science play a part in your career path?

In college, most of the classes that I took were chemistry, hydrology, and computer systems. I earned two college degrees, one in chemistry and the other in environmental sciences. I became interested in water treatment and water quality while I was there.

Where did that lead you before coming to the Louisville Zoo?

For the last ten years, I was the Senior Water Scientist with Walt Disney World in Florida. Before that, I managed the water treatment system for the drinking water supply for the city of Milwaukee, Wisconsin.

How is science involved in your everyday work?

Part of my job involves monitoring and maintaining an automated water treatment system modulated by a complex computer setup, and part of it involves hands-on problem solving and a critical-thinking approach to managing water filters, pumps, chemicals, and samples to monitor the water quality at these exhibits. Some animals/exhibits require different things (like fresh water versus salt water) — so that adds to the complexity!

ENGINEERING

What do you find to be the most challenging aspect of your work?

That's a good question, and to me the answer isn't what you'd expect. Seeing all of the water filters, pumps and computer systems that make up the water treatment system — it looks really complicated. That's actually the easy part. The real learning curve is figuring out the needs of the animals in the exhibits that I monitor. You have to start with each different species of animal and work backwards. How does this particular animal use the water? To swim in? To drink? Do they defecate in it? To catch or find food? Does this animal have any particular sensitivity? In our Glacier Run exhibit, the pinnipeds (seals & sea lions) are more sensitive to the water quality than our brown bears and polar bears. The pool for the pinnipeds is filled with salt water that helps them maintain good vision. They can develop eye injuries if they stay in an exhibit with fresh water for a prolonged period.

What do you think of the water treatment systems here at the Louisville Zoo?

I have helped design water treatment systems all over the world. Usually I have suggestions to help improve them, but the system at Glacier Run is one of the nicest water treatment systems I've ever used. It's like receiving a Cadillac. It's well constructed and very logically thought out.

What is the most rewarding part of your job as ALSS at the Louisville Zoo?

Water is our most important resource on the planet and it can be harmful to animals and people if it isn't treated correctly. You have to be committed to doing it right. Being able to provide safe, clean, water for the animals here at the Zoo is what gives me the most rewarding feeling for my job. It makes me proud to see people playing, drinking and animals using the water I've provided.

Do you have any advice for students thinking of a career in the STEM field?

I would advise young people to choose a career in a field they really enjoy. Also, choose something to help take care of the planet. They can learn so much from the world. They should get out there learn how amazing the natural world is!

ACTIVITIES

Citizen Science Project

SCIENCE

The Louisville Zoo's mission is to "better the bond between people and our planet." Now students at home, school or anywhere, can participate actively in animal conservation by taking part in Citizen Science projects developed by research teams and universities from around the globe.

Field researchers from around the world study scientific populations of animals, investigate their behavior and observe the ecosystems in which they live. This research often involves teams of scientists and data collection that can be very time consuming. Now, by using Citizen Science projects, students of all age levels can help scientists gather important data through online programs.

Citizen Science projects like Zooniverse (zooniverse.org) can introduce your students to the scientific research that's occurring around the world and allow them to participate in projects. Their feedback, observations and data collection can help field research scientists learn more about specific animal populations, track their behavior, movements and discover how they live.

Try these projects in your classroom and introduce your students to data collection, research and the world of Citizen Science.

Penguin Watch (penguinwatch.org)

Help field researchers who have traveled to some of the coldest regions in the world learn more about penguin behavior by allowing your students to annotate images of penguins in Antarctica and the Sothern Ocean. Count penguins, eggs, adults and chicks!

Chimp & See (chimpandsee.org):

Watch videos taken by camera traps set up in 14 countries in Africa to track the behavior of chimpanzees and other native animals. Classify, count and observe animal behavior to help inform scientists about their lives.

Vocabulary Jumble

Write the correct word next to the description. Each blank space is one letter. Rearrange the circled letters and find the fun answer to the final question!
(Answers on page 6)

1. ___ ___ ___ ___ ___: the inspiration for Velcro

2. ___ ___ ___ ___ ___ ___ ___ ___ ___ : seals and sea lions

3. ___ ___ ___ ___ ___ ___ : these butterflies have transparent wings covered in small scales

4. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ : another word for a fish biologist

5. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ : species who eat dead organisms

6. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ : the inspiration for the nose of bullet trains

7 . ___ ___ ___ ___ ___ ___ ___ ___ : a chemical mammals produce in response to stress

8. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ : a way to solve human problems by creating usable products that are inspired by nature

9. ___ ___ ___ ___ ___ : specialized hairs on gecko toes

Unscramble the Letters

Question: What do you call a Backyard Action Hero with the power of Observation?

ANSWER *(two words)*

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ !

What is a BACKYARD ACTION HERO?

A Backyard Action Hero — or BAH for short — is a kid or adult who really cares about wildlife and habitats and is ready to take action to protect them. They think being "green" is awesome and know that to make a real difference it's important to both learn and act. BAHs care about animals and habitats in their own backyards along with ecosystems all around the world.

Since the Louisville Zoo is a great place to learn about all kinds of plants and animals, we'll share what's going on there and introduce you to some of the Zoo's real-life conservation heroes!

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Present this coupon and receive

ONE FREE CHILD'S ADMISSION

With the purchase of one regular adult general admission to the Louisville Zoo.

Valid during regular Zoo hours. Not valid with other offers, for ticket packages, "The World's Largest Halloween Party!" presented by Meijer or other after-hours events. One ticket per transaction. Expires 6/30/2016

REGISTER FOR TEACHER EMAIL UPDATES

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