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ABSTRACT

The New Opportunities in Animal Health Sciences (NOAHS) Center at the National Zoological Park in Washington, DC. is dedicated to expanding understanding of the biological factors, including the critical role of biodiversity, that influence animal survival. This set of activities includes a description of NOAHS and the NOAHS mission, and letters from NOAH staff members to students. Background information reviews the importance of animal reproduction, the genetics of endangered species, and the career of veterinary medicine. Seven classroom activities cover the following topics: (1) the importance of biodiversity, genetic diversity, and cultural diversity in the environment; (2) a programmed lesson in lion survival; (3) the problems zoos face in breeding animals in captivity and how they go about solving these problems; (4) the ways habitat loss and human activity can affect the behavior of a wild animal (Florida panther); (5) personal actions that contribute to solving these problems; and (6) different jobs that involve work with animals. (LZ)

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Electronic Field Trip

Produced by Fairfax County Public Schools

The New EXPLORERS

Smithsonian's NOAH'S KEEPERS OF THE ARK

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VSEN Virginia Satellite Educational Network

in cooperation with the Virginia Department of Education

NOAH'S: KEEPERS OF THE ARK

Contributing organizations:

Hattie M. Strong Foundation

United States Department of Energy

Howard Hughes Medical Institute

Smithsonian's Women's Committee

Smithsonian's Outreach Fund

Smithsonian's Office of Elementary and Secondary Education

National Science Foundation

British Airways

The New

EXPLORERS

A co-production of WTTW/Chicago and Kurtis Productions, Ltd.

made possible by grants from

AMOCO Waste Management, Inc. DURACELL

About Bill Kurtis and The New Explorers

The New Explorers, a public television series that has carried millions of viewers from their homes and classrooms to the modern frontiers of science, is hosted and produced by Bill Kurtis. Through four successful seasons, Bill Kurtis has tracked the explorations of scores of remarkable scientists. Each episode presents the personality and interests of a scientist at work. These pioneers of science are not always found in the laboratory. They are found on the Siberian wetlands, the desert badlands of Argentina, among Maya ruins in Honduras, exploring the oceans, and even in amusement parks.

The New Explorers underscores the fact that science is not merely confined to labs and classrooms, but lives with us each day. "Its been quite an adventure," says Kurtis, "From the Amazon to Yellowstone, each exploration is filled with the thrill of observing the scientific process at work. But the greatest adventure is the expedition into the minds of young potential scientists, with the reward of knowing each story might send their imagination on an unending journey of discovery."

Of all the travels of **The New Explorers**, host Bill Kurtis likes to say, perhaps the most important has been into the classroom. "We started out to chronicle the scientists and their work," says Kurtis, "never realizing that these simple stories would form the centerpiece of a revolutionary way to teach science."

The New Explorers shares a unique collaboration with the U.S. Department of Energy providing a new approach to teaching science in the classroom. Built from a revolutionary partnership of government, corporations, and science institutions, **The New Explorers** educational outreach program has become one of the top science teaching initiatives in the country. In use as part of the curriculum of the Chicago Public School System since 1991, it has been adopted by several other communities across the nation including Washington, D.C., Cincinnati, Boston, Berkeley, Atlanta and Somerville, N.J. Reaching well over 100,000 students across the country, this program teaches the adventure of science using **The New Explorers** videos, teachers' guides, related experiments and field trips.

This successful approach to presenting science on television has been appropriately awarded over its past three seasons. Among its many honors, **The New Explorers** has been presented with: The Peabody Award; three Ohio State Awards; The National Education Association (NEA) Award for the Advancement of Learning through Broadcasting; the AAAS-Westinghouse Award; twelve Chicago Emmy Awards and the Parent's Choice Award.

If you would like more information on how to order **The New Explorers** videotapes and curriculum guides, please call 1-800-621-0660.

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What is NOAHS?

NOAHS stands for the **N**ew **O**pportunities in **A**nimal **H**ealth **S**ciences Center at the National Zoological Park in Washington, D.C. Established for endangered wildlife, NOAHS Center is a cooperative program between the Smithsonian Institution's National Zoological Park and the National Institutes of Health, dedicated to advancing biological knowledge relevant to species conservation. The associated scientists are leaders in their research fields: genetics, reproductive physiology, veterinary medicine, and infectious disease. Since 1986 the NOAHS group has worked on over 100 species in 30 countries around the world. Each member of NOAHS Center is a pioneer, advancing the frontiers of scientific research in order to redirect the path of extinction.

NOAHS Mission

NOAHS provides information for conservationists making management decisions directly affecting species survival. The center is dedicated to expanding our understanding of the biological factors, including the critical role of biodiversity, that influence animal survival.

Often unknowingly, humans have severely tilted nature's delicate balance. Our generation has witnessed numerous extinctions; several large species survive today only in captivity. World wildlife is now so endangered that active intervention is necessary to save it.

The center's objectives involve preserving species, advancing basic knowledge about endangered wildlife, and training future conservation bioscientists. Building on decades of research in human health sciences and biomedical technology, NOAHS Center's researchers develop and use modern biotechnology to study, manage, breed, and save endangered species and to ensure genetic diversity in rare animal populations.

As an integral part of the National Zoo, NOAHS Center combines field studies of free-ranging fauna with studies of captive populations in zoological preserves throughout the world. Four sites provide sophisticated biomedical analyses and training: National Zoo in Washington, D.C.; National Zoo's Conservation and Research Center near Front Royal, Virginia: National Institutes of Health's Animal Research Center in Poolesville, Maryland; and National Cancer Institute's Laboratory for Viral Carcinogenesis in Frederick, Maryland.

NOAHS Center
New Opportunities in Animal Health Sciences

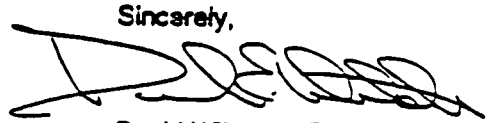
National Zoological Park·Smithsonian Institution·Washington, D.C. 20008

Dear Students:

Sometimes it is all too easy to forget about the danger of doing research with wild animals. About 10 years ago, the National Zoo's annual FONZ calendar had a picture of me kneeling down between what looked like two very tame cheetah cubs. The photograph had been taken at a cheetah breeding station in South Africa where NOAHS scientists were working. The photograph showed me petting one cheetah while the other cheetah stood very close to my back. Immediately after the "famous" picture was snapped, what the photographer missed was one cub taking a bite out of my back, along with a piece of my shirt! What I remember most is how impressed my daughter, Chelsea (about 5 at the time), was, not with her Dad's wound, but with the ripped shirt, which she kept in her room and showed to her friends.

This episode made me have even greater respect for the strength of the cheetah and to understand better how it is such an effective hunter. This is one of the many things that I enjoy about my job as a NOAHS researcher. Every day there is something new to learn about some of the most unusual and magnificent creatures on Earth. When most scientists are interviewed about their jobs, they almost always say that they especially like the idea of discovering. For scientists involved with wildlife species, they not only have the benefit of discovery, but also the satisfaction of knowing that their new findings may well ensure preserving an endangered species from extinction.

Sincerely,



David Wildt, Ph.D.
Head, Reproductive Physiology, NOAHS Center
National Zoological Park

Note: Dr. David Wildt has 11 researchers in his program. Dr. Terri Roth, an embryologist, will appear in the live, interactive program.

NOAHS Center
New Opportunities in Animal Health Sciences

National Zoological Park·Smithsonian Institution·Washington, D.C. 20008

Dear Student:

In preparing the upcoming teleconference with you, my friends at NOAHS Center have posed a difficult question for me. What is the most memorable experience I have had while working as a veterinarian in a zoo? I usually try to ignore this question when it's asked by press and/or television reporters, because it is extremely difficult to relate to people what I remember and value since it may not have the "showmanship" the press wants.

In order to understand my selection of memorable events, you must first realize that I have a unique relationship with my patients. My patients do not appreciate my efforts to provide them with the state-of-the-art health care; instead, they remember me as the "bad guy" who darts them with an anesthetic, so I can work with them, or who darts them with various medications or vaccines. This results in a population of patients that do not like me! When I walk through the zoo on rounds, various animals (primates and large carnivores) recognize me and watch me very closely. I have had other friends, who are also veterinarians, tell me that they could not work in this environment, but this is how it is in a zoo.

There have been occasions when the aversion that my patients have toward me has been beneficial. Once on a Sunday I received a call that the orangutans were out of their exhibit because the electrical wire that keeps them in was not working. I drove through the large crowd in the veterinary van and, when I arrived at the exhibit, I saw several orangs out in the public area. I was not sure what to do at first, since the orangs could get very excited when they saw me and could hurt someone or attack me. I very, very slowly got out of the van and although there were over 100 visitors around, the Orangs saw me at once! Their first reaction was surprise. They all ran and jumped to get back in the exhibit—even the ones who were sharing a coke with a visitor and the mother with an infant that had climbed on the roof. This was unexpected, but it worked to my advantage. I was able to position myself around the exhibit in such a manner that all the orangs returned to their own cages within 15 to 20 minutes, and I did not have to dart them.

Other memorable moments are small victories when a patient I have worked on is able to return to the exhibit and subsequently raise a youngster.

The field studies are also exciting. They are the culmination of years of study and work on captive animals and offer a unique opportunity to learn more about these species in the free-living state. Applying knowledge of captive zoo species to individuals in the field brings veterinarian medicine full circle in its contribution to conservation biology.

Sincerely,

Mitchell Bush, DVM
Senior Research Veterinarian, NOAHS Center,
National Zoological Park

Note: The National Zoo veterinarian appearing on the live, interactive program will be Dr. Lisa Tell.

NATIONAL INSTITUTES OF HEALTH

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Director/Chief
STEPHEN J. O'BRIEN

Laboratory of Viral Carcinogenesis
National Cancer Institute
Frederick, Maryland 21702-1201

To the students of the teleconference:

As you grow, you will be asked to make choices about the direction of your life and what you will do to earn a living as an adult. I would like to say that it is never too soon to practice those choices and to see how they feel to you, your family, and your friends. Choices you make now will influence your life as an adult. This is why older people ask you two questions all the time: "How old are you?" and "What do you want to do when you grow up?" You do not know the right answer now, and you will change your mind many times during the following years, but take a moment and think about what you like to do with your free time, what your favorite classes are, and the type of kids and adults you like to spend your time with. Choices you make now in all these parts of your life will help form your future as a college student and an adult.

When I was younger, my first choice was to become a professional baseball player, but I didn't have the ability to bat .300 or to hit baseballs pitched at 100 mph. My second choice was to be a musician; indeed I remember the fun I had playing in a rock band in high school. But again, there is enormous talent in the world, and many very talented people never get the break they need to get into big-time show business. Since my own musical talent was not the best, I went to my third choice, biology, or, more precisely, molecular genetics. I did this because I enjoyed asking questions that no one—not even the experts—could answer. I wanted to be able to try to find the answers to some very difficult but important questions—questions like, "Why do some people get cancer while other people do not?" or "Why did measles kill so many Indians in South America while people from Europe did not get very sick?" I also wanted to ask questions about why some animals do so well while other animal species get sick and die, or even are threatened with extinction.

I also chose this area because I was good at it and might face less frustration than I would if I spent 15 years in minor league baseball! The field of biology, particularly molecular biology, has undergone a huge growth spurt since I was a student, and I cannot think of any area more personally gratifying. I am almost embarrassed to be paid for it.

Because of my curiosity and background in biology, molecular genetics, and medicine, my world has involved humans and animals, pets and wildlife. I can jump from the medical school to the veterinary hospital to the jungles of Africa and South America in search of the missing links. I have learned about endangered species, and the scientific information we have collected has helped in setting up conservation programs. I have seen our ideas appreciated and applied by others, and I have watched my own students carry on in the important work to avoid extinctions. My profession has taken me to all the places you read of in National Geographic and allowed me to hold a koala, to track a mountain lion, to dream to the music of the humpback whale's song, and to grin at a giant panda cub in an alpine bamboo forest. To be a scientist in pursuit of understanding wildlife and ecology is to touch the hand of an angel for a moment. If Indiana Jones were real, he would have a life like mine. And it never stops being exciting, but you do need to face the career choice and then pursue it until you reach your goals.

You can do it if you want to. It will not be easy, but nothing worth having is. Good luck and best wishes.

Sincerely,

Stephen J. O'Brien

Stephen J. O'Brien
Chief, Laboratory of Viral
Carcinogenesis

THE NUMBERS GAME:

Why Reproduction is so Important?

The ability to reproduce is essential to the survival of all species and is of particular importance to those species whose survival is threatened with extinction. The future of many endangered species is threatened not only by habitat destruction, pollution, and hunting, but also by internal forces such as high infant mortality, genetic abnormalities, lower reproductive success rates, and decreased ability to ward off disease.

All of these things are common in animal populations whose numbers are very small, such as endangered species. They are often the result of inbreeding, which occurs when individual animals in small populations mate with family members and have offspring that are all related to each other. An example of this is the cheetah, whose population sharply decreased in numbers (population bottleneck) 10,000 years ago. As a result, every cheetah in the world today is (genetically) as closely related to every other cheetah as are twins.

Animals that are struggling to overcome the hardships that challenge their survival often face reproductive difficulties and must fight even harder to stay alive. Without the ability to produce more offspring, species are doomed to follow the path to extinction that many other species have been forced to take before their time.

NOAHS scientists, called reproductive physiologists, are helping to ensure the survival of much of the world's endangered wildlife. They do this by studying the reproductive biology of these animals in order to understand why problems exist and to find solutions to these problems. Both zoo and wild populations can benefit from assisted reproductive technology such as in vitro fertilization and artificial insemination. Originally developed for humans, these techniques are now being adapted and successfully used by NOAHS scientists for use in endangered species.

NOAHS reproductive physiologists travel around the country and around the world to bring the latest in scientific and medical technology to the animals who need it most. Through the use of assisted reproduction, they have produced a total of 34 babies from 8 different species such as cheetah, tiger, clouded leopard, Eld's deer, and black-footed ferrets.

DO ANIMALS WEAR JEANS?

The Genetics of Endangered Species

Genetic research involves the study of biological inheritance. DNA is the "blueprint of life" that is passed from generation to generation. DNA is packaged into functional units, called genes, which store the inherited information. Geneticists are scientists who study DNA—how it is organized into genes and how the DNA sequence of one gene in one animal varies from the same gene in another animal of the same species. By looking at the amount of variation present in genes of many animals of a population, geneticists can begin to understand something about the relationships of animals within a population and how susceptible the population may be to infectious diseases. Comparing the level of variation between animals of different species can help scientists understand the evolutionary process (which animals are closely related by virtue of the fact that they share a common ancestor). Genetic research can also help fill the gaps in the fossil record and is necessary in studying hereditary diseases (diseases resulting from defective genes).

The cheetah is a good example of an endangered species whose genetic makeup shocked scientists and made them realize just how important their work really is. A few years ago, the captive cheetah population was found to suffer from several problems: many cubs died very young, the sperm quality of the males was very poor, and many cheetahs died from infection. Geneticists looked at the variation within many genes of the cheetah and found that they exhibited much lower levels of diversity than other mammals. The lack of genetic variation was like that found among human twins. It is known that high infant mortality, poor sperm quality, and unusual susceptibility to certain viruses are some of the consequences of inbreeding. The cheetahs were not intentionally inbred, so NOAHS scientists hypothesized that the wild population had, at some time in its history, undergone a drastic reduction in the number of animals available for breeding. There were so few cheetahs left that future generations of animals were very closely related, resulting in a modern-day population with greatly reduced genetic variation. Analysis of the genetic studies tells us that this population "bottleneck" occurred several thousand years ago, but the effects are still evident today. Today, when animals are bred in zoos, great care is taken to make sure that only unrelated animals mate.

VETERINARY MEDICINE:
Dr. Doolittle Does A Lot These Days!

Veterinary medicine is the science of preventing and treating disease in animals. Doctors of veterinary medicine provide medical services and care for all animals great and small. Their patients include many animal species in various groups including domestic animals (cats, dogs, horses), exotic animals (zoo, birds, reptiles), wildlife (ducks, wolves, deer), and food animals (cows, pigs, chickens). There are a wide variety of occupations in veterinary medicine and its related fields. There are also many veterinary specialists who specialize in fields such as anesthesiology, internal medicine, epidemiology, microbiology, pharmacology, dentistry, surgery, nutrition, parasitology, radiology, toxicology, and ophthalmology.

Veterinarians affect many areas of our lives without us ever knowing it. Whenever you eat a hamburger or drink a glass or milk, veterinarians have been involved in keeping the food animals healthy and guaranteeing that food produced from them is safe to eat. This also affects the industries that use by-products of the livestock such as leather and wool. Even pet foods are prepared under the supervision of veterinarians who are specialists in the field of nutrition. Some of the medical procedures and drugs that your doctor uses on human patients may have been developed and tested by research veterinarians. Veterinary epidemiologists involved in disease control programs help create vaccines to prevent the transmission of disease between animals and humans.

When we bring a sick animal to the veterinarian, he or she is called a clinical veterinarian. Clinical medicine is a very challenging field in which the veterinarian must rely on expertise and extensive medical background to diagnose and treat his or her patients. A veterinarian may often confer with experts in other fields to diagnose and correct what is wrong with an animal.

Zoo and wildlife veterinarians can have very exciting and challenging careers, because their patients come in many different shapes and sizes. A zoo and wildlife veterinarian has be familiar with all animal species instead of just cats and dogs. Unfortunately, much of the information that is known about domestic animals is still unknown about many of the zoo and wildlife species. When working on exotic animals, veterinarians are often finding out information for the first time and must rely on their good judgment to make the right decisions.

There are many reasons why veterinarians enjoy their work. One of the greatest rewards is the ability to help save an animal or an entire species.

Vocabulary

aggressive interactions	the use of threats and/or hostile acts between individuals; males are often very aggressive in protecting their territories
AIDS	acquired immunodeficiency syndrome, a disease caused by the HIV virus which lowers your body's ability to fight other diseases
anesthetize	to cause a loss of sensation, locally or throughout the body, before medical treatment
antibiotic	a substance made from mold or bacteria that inhibits the growth of other microorganisms that may or may not cause disease
assay	a series of specific experiments
biopsy	the study of tissue taken from a living organism, especially in examination for presence of disease
blood pressure	the pressure that forces blood to move through the bodys arteries and veins; he heart is the major pump, forcing blood through the body
bottleneck	a severe population reduction, possibly resulting in inbreeding of the remaining animals
captive population	a group of animals maintained in zoos, wildlife parks, etc.
conservation	taking care of our environment by wisely managing its resources

deforestation	process of clearing away small groups of trees or whole forests; major cause of destruction of animal habitats
DNA	Deoxyribonucleic Acid; a substance found in the chromosomes of every cell; DNA is organized into genes, which form the genetic code (or "blueprint" of life); individuals receive half of their DNA from their mothers and half from their fathers
EKG	electrocardiogram; a record of the electrical activity of the heart
endangered species	organisms, plants, or animals that are threatened with extinction
Endangered Species Act	passed in 1973; the law that controls trade of endangered and threatened species in the United States
epidemic	a rapidly spreading outbreak of contagious disease
extinct	a species that no longer exists, (e.g. dinosaurs)
FIV	feline immunodeficiency virus; a virus found in cat species that is very closely related to the human AIDS virus
gene	a functional unit of DNA responsible for determining a specific heritable trait (e.g., blue eyes)
genetic diversity	the occurrence of different forms of inherited traits within a population (blue, green, grey, and brown eyes); identical twins do not have any genetic diversity because all of their genes are identical; a group of students has a lot of genetic diversity because they are unrelated

geneticist	a scientist who studies how traits are passed from parents to offspring by looking at their chromosomes and the DNA that they contain
habitat	the environment in which an animal lives
hereditary	refers to a trait that is passed from parents to their offspring through DNA
hormone	a chemical produced by the body which regulates the functioning of a system
immune system	made of specialized white blood cells and chemicals, it is the body's army against specific invading organisms that may cause disease; its memory allows it to remember which organisms it attacks and to react very quickly if they ever invade again.
inbreeding	occurs when close relatives (father and daughter or brother and sister) mate
lesion	a wound or injury
migratory lifestyle	to change location periodically, especially to move seasonally from one region to another
neurology	the study of the nervous system and its disorders
NOAHS Center	the New Opportunities in Animal Health Sciences Center; a program at the National Zoological Park in Washington, D.C., consisting of veterinarians, reproductive physiologists and geneticists, where scientific technology to help the conservation of endangered species is developed

pathogen	any virus, bacterium, or other substance causing disease
poach	to illegally kill or take animals that are protected by law
pride	a group of lions
propagate	to multiply or breed
reproductive physiologists	scientists who study the biology of reproduction
savannah	a flat, treeless grassland
silicon	a compound that can be used as a lubricant
tuberculosis (TB)	a bacterial infection that affects the lungs and is passed between individuals by droplets exhaled by infected animals
territorial region	an area inhabited by an individual or by a group of animals that may be vigorously defended
veterinarian	a medical doctor who specializes in the treatment of disease in animals
virus	a group of infectious microbes that invade the cells of the host organism and take over normal cell functions in order to replicate
x-ray	a picture of the inside of our bodies that is made by passing x-rays (invisible light) through the body to expose a sheet of film on the other side

The Importance of Being Different

OBJECTIVES: ***To help conceptualize the importance of biodiversity, genetic diversity, and cultural diversity in our environment***

PART 1

DIVERSITY TO SUPPORT LIFE: BIODIVERSITY

Diversity is the state of being different. Our world is filled with many kinds of diversity. For one, there are many different species of plants and animals. This is called biodiversity. Imagine what the world would be like if all trees were apple trees; all flowers were daisies; all animals, save humans, were raccoons; and every person looked exactly the same. In the morning you would wake up, have an apple for breakfast, play with your pet raccoon, and jump on the bus, where the bus driver would look like an older version of you!

That world doesn't exist because each species of plants and animals has slightly different living habits and uses natural resources in a slightly different way. This allows many different kinds of species to exist in the same place at the same time. What if all animals ate the same thing? They would soon die of starvation because they would all be competing for the same food. Because there are species that eat different foods and live in different places, Earth is able to support more life overall. It is the diversity among the types of life forms that makes this possible.

ACTIVITIES:

A. Divide the class into groups of four. Give each group pictures of two different animals that live in the same habitat. Direct students to list all of the differences and similarities they can find between their two animals.

Question: How do their differences allow them to live together?

B. Direct students to collect leaves from various trees in their neighborhoods. Ask students to make a chart listing all the differences including color, shape, size, and texture. The same exercise can be done using flowers, fruits (you can use taste as a distinct attribute), metals, and rocks.

PART 2

DIVERSITY FOR SURVIVAL: GENETIC DIVERSITY

Diversity cannot always be seen on the outside. Some forms of diversity are internal and only appear when your body reacts to outside influences. For example, when bacteria and viruses get into your body, some people get sick and others do not. This is due to another type of diversity, genetic diversity! Genetic diversity is when the traits one person has inherited are different from the traits another person has inherited. This can be seen physically in eye color or height, but it also includes internal characteristics, such as the way your immune system works.

Your immune system is the special way your body fights viruses and bacteria. You have white blood cells that go after any bacteria or viruses that sneak into your body to make you sick. These cells try to kill the bacteria and viruses before they can hurt you. In your blood, you also have chemicals that attack viruses. They are called antibodies. This ferocious army of defenders, made up of antibodies and white blood cells, is your immune defense system. Everyone has one! This is a natural protection system that defends us against the viruses and bacteria that can cause diseases. If we did not have this protection, we would become ill constantly.

Every person's immune system is different, because each person is different. This means that if two people catch the same cold virus, their immune systems may respond differently. One person may come down with a cough and a headache, the other with a mild runny nose. Both immune systems will be fighting the same virus, just in different ways. Two different people have two different systems of defense. This is diversity! Let's go back to that world where everyone is the same.

Because you are all so similar, your immune systems would also be similar. If virus X entered your school and one person got very, very sick from it, everyone else who caught the virus would soon show the same symptoms. This would not be because your immune systems were not working properly. Instead, it would be because your immune systems were like identical machines, all built to perform the same task in the same way. This means they would use the same strategy to fight the disease. If your friend had a 102° fever when ill with virus X, and you caught the same virus, your immune system would fight it in the same way and you would end up with a 102° fever as well. In reality, your immune system is somewhat flexible and the way it reacts depends on the different diseases it has come into contact with.

When NOAHS Center studied the cheetah using DNA fingerprinting, scientists compared genetic diversity and found that all cheetahs were as closely related as twins. They were not genetically diverse at all. This means that their immune systems were very similar, which puts cheetahs, as a species, at great risk. If one cheetah dies from a virus, it is likely that all other cheetahs in that population will be affected similarly. Genetic diversity gives a species enough variation in its immune systems that the population on the whole can survive this type of epidemic.

ACTIVITY:

A. Divide the students into groups of four. Instruct each group to do the activity "Ch'rrg" from this curriculum guide, writing down each decision they make in order. Once they reach an endpoint, direct the group to select a representative to share, with the class, the course the group followed.

Questions: *Did all groups follow the same path?*
If each group were a lion, would the whole pride (class) be alive?
Would some representatives of the pride be alive?
What would have happened if all groups followed the same path?

(Note: The immune system requires teamwork from many different parts of your body and, like team problem-solving in this exercise, helps to keep individuals of a species alive.)

B. Divide students into groups of two. Direct students to play tick-tack-toe. Instruct students to number each move that they make. When the game is over, direct the same pairs to play again. This time instruct the student who is X to make the same moves in the same order that he or she did the first time. The student who is O may vary his or her moves. Have them play a number of times. Did either one win all the time? Was O able to vary the strategy to win once he or she knew X's moves?

(Note: In this activity, the Xs represent the strategy of the virus, and the various strategies used by the Os represent the different ways genetically diverse individuals can respond to the same virus.)

PART 3

DIVERSITY THAT IS LEARNED: CULTURAL DIVERSITY

Genetic diversity gives us strength as a species, and biodiversity helps all species to survive. These two types of diversity are inherited through genes. Are there types of diversity that are not fixed in your genetic code? Yes! In fact, there are many. One of these is cultural diversity. There are many different cultures throughout the world and each has its own cultural tradition, language, living habit, style of dress, and diet. These characteristics are all learned gradually as one grows up as part of a community.

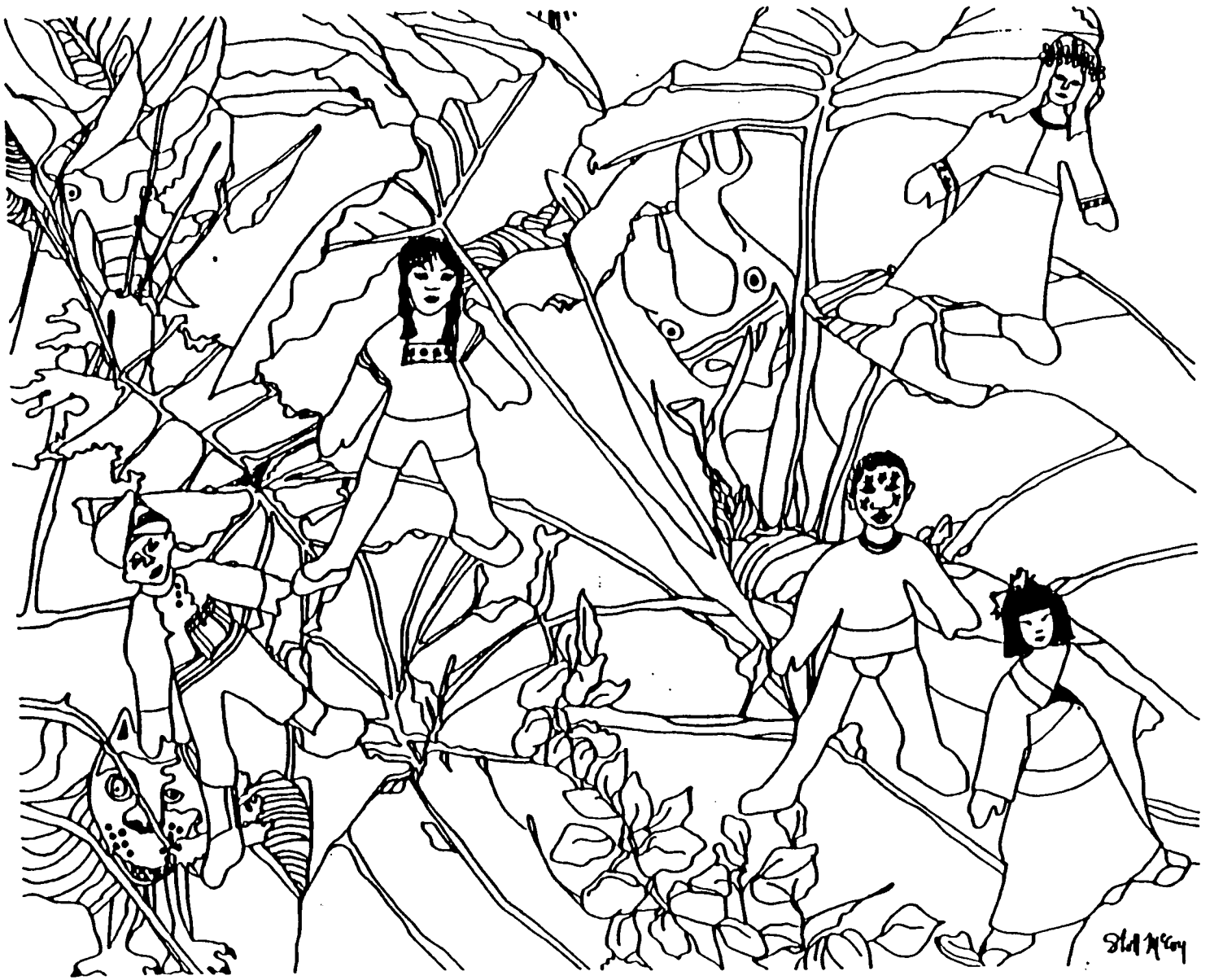
The accompanying illustrations will help students visualize cultural diversity and lack of diversity. The illustration that depicts the different children gives you the opportunity to discuss the strengths that cultural diversity offers. Each person not only looks different, acts differently, and speaks differently, but each person brings different cultural ideas and strengths. If everyone were the same, as illustrated in the second drawing, how would this lack of diversity affect us? Imagine once again the world in which we all thought the same way. How long would we survive as a species?

ACTIVITY A:

1. Direct each student to draw a self-portrait.

2. Instruct each student to write down one thing that he or she shares with the other students in the class (that makes them the same as each other), and one thing that makes each student different than the other children in the class (Do they play the piano; are they on a special team; do they have a special hobby?).

3. Ask each students to write down one strength that he or she brings to the classroom (tolerance, humor, sensitivity, imagination).



CH'RRG: Your Life as a Lioness

OBJECTIVE: ***This activity is a programmed lesson in lion survival.***

You start at step 1, make a decision, and then go to the numbered section that corresponds to the number of your selection. For example, if you go to step 1 and decide to go north to hunt you would proceed to step 12. At step 12, if you decide to follow the gazelles, you go to step 43. If you would like hints, go to the end of this adventure. Good luck hunting!

ACTIVITY:

1. You are Ch'rrg, a 7-year-old lioness with three cubs. Your cubs are only 4 weeks old, hungry, and unable to follow you when you go hunting. You are in a pride of two males and five females. You've not eaten in over a week and soon will be unable to nurse your cubs.

If you stay at home and wait for someone to bring you food, go to 17.
If you go north. Go to 12.
If you go hunting with the other lionesses. Go to 48.
If you go hunting with the male lions. Go to 41.

2. They chase you.

You turn and try to kill them. Go to 15.
You run away. Go to 9.

3. It's down.

You slash at its belly. Go to 52.
You go for its throat. Go to 42.

4. You're headed west. You see water buffalo.

You stalk. Go to 49.
You retreat. Go to 9.

5. A horn catches you and tosses you in the air. Go to 15.

6. You're headed south. You see a strange wooden enclosure.

You approach the enclosure.	Go to 46.
You go around.	Go to 32.

7. You jump and are on its back. It bolts away.

You claw at it.	Go to 44.
You go for the throat.	Go to 10.

8. It has jumped away from your bite; with a leap and a burst of speed it is gone.

You pursue.	Go to 12.
You go west.	Go to 4.

9. You see another herd of gazelles.

You pursue them.	Go to 43.
You go east.	Go to 45.

10. The beast rolls.

You stay on.	Go to 15.
You jump off.	Go to 51.

11.

You charge the baboons.	Go to 16.
You stalk closer.	Go to 40.

12. You see a herd of gazelles. They go northeast.

You follow.	Go to 43.
You go north.	Go to 27.
You go west.	Go to 4.
You go south.	Go to 6.
You do none of the above.	Go to 1.

13. You hit your top speed of 35 mph.

The gazelle leaves you.	Go to 35.

14. With a burst of speed, you're on it as it runs into you.

You go for its throat as it jumps around.	Go to 8.
You bring it down.	Go to 18.

15. You are savagely attacked and die. Go to 23.

16. They scatter into the trees. Go to 20.

17. One of your cubs starves to death.

You continue waiting. Go to 31.
Otherwise. Go to 1.

18. You lunge for the throat and strangle the victim. Go to 26.
You rake its belly. Go to 52.

19. You easily subdue it. Something on two legs with a stick is running toward you.

You run with the prey. Go to 50.
You run and leave the prey behind. Go to 32.
You attack the animal with two legs. Go to 54.

20. A zebra herd!

You stalk. Go to 36.
You rush. Go to 33.
You encircle. Go to 24.

21. One of them is running directly toward you.

You run away. Go to 6.
You continue creeping toward it. Go to 14.

22. A large wildebeest is very close.

You charge. Go to 47.
You retreat. Go to 35.

23. Your cubs starve and die. Life in the wild isn't always easy.

24. Despite the noise of the wind, they seem to sense you, and they flee north.

You follow. Go to 27.
You do otherwise. Go to 4.

25. Two gazelles appear close to you. Which do you run toward?

The big one.	Go to 13.
The small one.	Go to 34.

26. It's dead. The other lionesses join you. You eat and know there will now be milk for your cubs. Well done!!

27. You smell the scent of a strange lion on a bush.

You go north to investigate.	Go to 37.
You do otherwise.	Go to 12.

28. It shakes you free and gets away.Go to 35.

29. You're behind it.

You attack it.	Go to 7.
You keep circling.	Go to 49.

30. Other lionesses in your pride join you.

You hunt with them.	Go to 48.
You hunt alone.	Go to 25.

31. Another cub starves to death.

You continue waiting.	Go to 23.
You do otherwise.	Go to 1.

32. You've headed south.

You see baboons.	Go to 11.
You see zebra.	Go to 20.

33. They easily outrun you. Go to 1.

34. It runs away. However, you see vultures circling.

You investigate.	Go to 53.
You do otherwise.	Go to 6.

35. You see a pack of hyenas coming.

You attack them.	Go to 15.
You walk away.	Go to 2.
You stalk away.	Go to 9.
You run away.	Go to 6.

36. You get close. You attack. The zebra kicks you hard.

You attack again, though slower now.	Go to 15.
You leave.	Go to 1.

37. The feline scent is completely new to you. Five lionesses approach.

You hunt with them.	Go to 15.
You do otherwise.	Go to 12.

38. Several lionesses attack the gazelles. The herd of gazelles bolts in your direction.

You run away.	Go to 6.
You continue creeping.	Go to 25.
You stay.	Go to 21.

39. In the middle of your attack, a two-legged creature with a stick runs toward you.

You attack it.	Go to 54.
You run away with out the prey.	Go to 32.

40. Three young male lions (about 4 years old) burst out of the brush, scatter the baboons, and kill one.

You challenge the strangers for a share.	Go to 15.
You leave.	Go to 20.

41. They do not seem inclined to go hunting right now.

You wait for them.	Go to 17.
You do otherwise.	Go to 1.

42. It's dead. The noise has attracted something.

You run away.	Go to 4.
You stay.	Go to 35.

43. A strong wind is blowing.

You circle.	Go to 24.
You stalk closer.	Go to 30.

44. The animal bucks.

You continue clawing.	Go to 10.
You jump off.	Go to 51.

45. Wildebeest!

You stalk closer.	Go to 22.
You run away to the south.	Go to 6.
You run away to the north.	Go to 12.
You run away to the west.	Go to 4.

46. Two tiny horned creatures are inside. You easily leap the fence.

You take the big one.	Go to 39.
You take the small one.	Go to 19.
You run south.	Go to 32.

47. You're on the wildebeest.

You attempt to bring it down.	Go to 3.
You go for the throat.	Go to 28.

48. You have come to a herd of gazelles. The other lionesses look at you and then start circling the herd.

You go off by yourself.	Go to 43.
You wait and then creep closer to the gazelles.	Go to 6.

49. One turns and stares at you.

You attack.	Go to 5.
You circle around through the brush.	Go to 29.
You slink away.	Go to 38.

50. You easily get away, but your two-horned prey is making a lot of noise.

You bite its throat and strangle it. Go to 35.

51. Its hooves hit you viciously.

You slowly reattack. Go to 15.
You do otherwise. Go to 6.

52. It rolls over, delivers two vicious kicks, and escapes.
You pursue. Go to 6.
You do otherwise. Go to 1.

53. A large, strange male lion has driven the vultures off and is eating the remains of a giraffe.

You chase him out of your pride's territory. Go to 15.
You do otherwise. Go to 6.

54. You hear a gun shot.

Your leg hurts. Go to 15.

Hints:

Male lions are considerably bigger and stronger than the females. However, the females are usually the hunters, leaving the males to hunt only when they are alone. Compared to other big cats, lions are relatively slow animals, and the wind may carry their scent, alerting their prey before the attack even begins. Lionesses hunt best in groups by creeping up and encircling their prey. They bring their prey down and then choke the prey by biting at the neck. Lion prides are territorial and will attack nonmembers of the pride. Death may come from an animal's hoof or horn, a pack of scavengers, or human beings.

DNA Fingerprinting

OBJECTIVE: ***To learn the problems zoos face in breeding animals in captivity and how they go about solving these problems***

BACKGROUND INFORMATION:

As in the original story of Noah's ark, zoos once thought that two of each animal species were sufficient to maintain a population. But inbreeding can occur if related animals mate and produce offspring. The resulting young have many similarities in their genes, and several generations of inbreeding can result in birth defects, more deaths of young animals, difficulty in reproducing, and an increased chance of all animals in a group suffering from an infectious disease. Unrelated individuals breeding in a population increases the level of diversity in the genes. Higher levels of genetic diversity lead to a healthier population and increased adaptability for species survival.

A single zoo, may not have enough of one type of animal to prevent inbreeding. Therefore, zoos work together with each other to increase the amount of genetic diversity within a population. Let's look at an example. A zoo wants to breed the Gir lions, which are the Asiatic subspecies of lions. But the zoo and other zoos do not have enough lions to prevent inbreeding. Even outside the zoo, in the wild, these lions have trouble maintaining genetic diversity. In 1912, due to the actions of trophy hunters, the Gir lions were reduced to about 16 animals! Today, the Gir lions have only 3 percent genetic diversity. This means that there is a high degree of relatedness between the Gir lions. This lack of genetic diversity is one of the reasons that some lions have been placed on the endangered species list.

In order to increase the genetic diversity of the lions, zoos can breed their lions with lions from the wild. But, they do not have to transport the whole lion! Zoos can use artificial insemination by following a procedure developed by the NOAHS Center scientists. Artificial insemination is making it easier for zoos to breed lions that are not genetically alike, thus increasing genetic diversity. Increased genetic diversity means the lions will have a higher chance of survival. Maybe someday there will be enough lions that they can be taken off the endangered species list! But, how do zoos know if lions are genetically alike or different?

We know that lions have DNA. You also have DNA! You get your DNA from your mom and dad. Scientists have developed a way to look at DNA. It is called DNA fingerprinting. DNA fingerprints are like fingerprints with additional information. DNA is the substance of heredity and contains the genetic information necessary for the duplication of cells and for the production of proteins. To produce a DNA fingerprint, the DNA is broken into fragments and placed at the end of a rectangular gel in an electronic field. The electric field causes the DNA pieces to separate according to their size (large fragments do not travel as far as smaller ones). You can't see the DNA until it is stained and photographed under ultraviolet light. Then you can see a series of bands of DNA making up the DNA fingerprint. Since every DNA band must come from either the mother or the father you might be able to determine the parents of a lion if you don't know already! This can be hard because lions live in prides that have two to five males, all of whom mate with the lioness. You can also tell if one lion is similar to another by comparing the DNA fingerprints of each lion. The more bands shared by individuals, the more closely related they are. And remember, if the lions are related, zoos do not want to breed them because of the problems the offspring will have.

ACTIVITY

Scientists are not the only people who can read DNA fingerprints; you can give it a try! What if you worked at a zoo and were going to breed your lions?

1. Look at the following DNA fingerprint patterns for MALE 1 and MALE 2 and decide who is the father of the offspring. Each band of the offspring can be traced back to either the mother or the father.

2. Try to decide who you would mate with the female. Remember, you want to find a male that does not have bands in the same places as the female.

3. Which male, if mated to the female, would be considered inbreeding?

4. Does the offspring get all of the father's DNA bands?

5. Are several of the DNA bands identical for the mother and each of the prospective fathers?

ANSWERS

1. The father is MALE 1.
2. MALE 4 would be the best mate for the female next time, because they have the greatest genetic diversity relative to each other.
3. If the female is mated to MALE 3, it would be considered inbreeding. This is because they have the lowest genetic diversity relative to each other.
4. The offspring does not get all the bands from the father. There is only a 50 percent chance that the offspring will get a particular DNA band from a parent. However, if the bands appear on the offspring's fingerprint, the corresponding band must appear in the fingerprint of the parents.
5. Several of the DNA bands are identical for the mother and the prospective fathers, possibly because they include the DNA characteristics that make a lion a lion.

DNA Fingerprinting

Living on the Edge

OBJECTIVE: ***To show the ways habitat loss and human activity c an affect the behavior of a wild animal. In the case of the Florida panther, continuing loss of habitat has caused many problems that have led the species toward extinction.***

Do NOAHS scientists work with endangered species in the United States? Yes! One of these is the critically endangered Florida panther. There are now fewer than 30-50 panthers left in the Florida Everglades. The following activity illustrates some of the reasons for their decline.

ACTIVITY:

1. Make a spinner using the pieces on the following page. Cut out the title box (including the arrow) and glue it across the top of a large rectangular piece of poster board (at least 9" x 12"). Then cut out the pie chart and glue it to a corresponding circle of poster board. Following the configuration on the next page, attach the pie chart loosely to the rectangular poster board using a brass paper fastener through its center. Make sure it can spin freely.

2. Direct the students to take turns using the spinner and ask them to determine the various influences causing each outcome. Choices should include:

   a. Habitat loss due to human activity

   - Less space for Florida panthers
   - Less space for prey of Florida panthers

   b. Direct human contact

   c. Indirect human contact

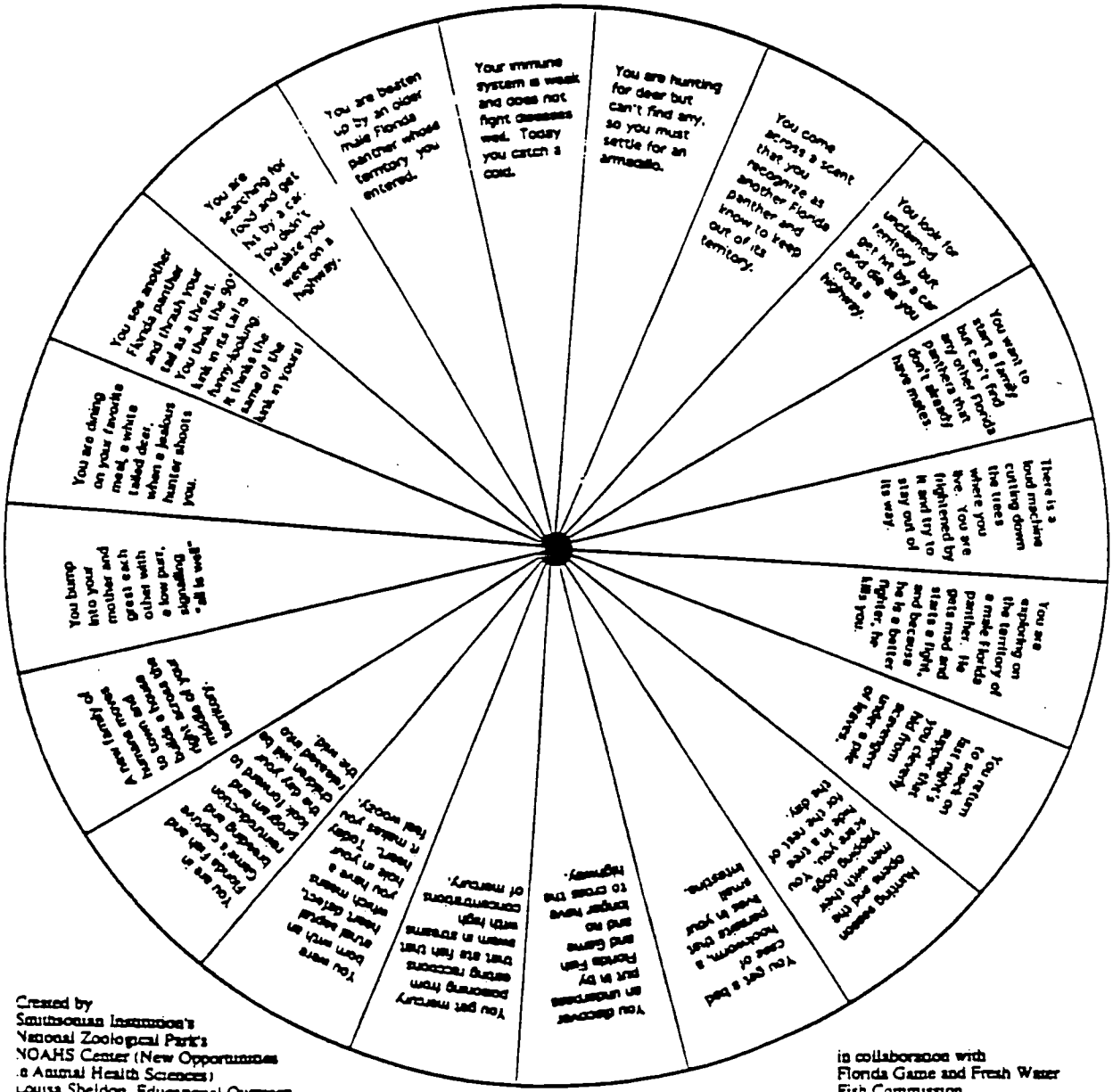
   d. Natural behavior

   e. Inbreeding

Some situations involve more than one influence.

Living on the Edge

The swamps of Florida hold many perils for young Florida panther cubs, especially now that humans are using more and more of the land. Imagine that you are a young Florida panther cub leaving your mother for the first time to strike out on your own. These are some of the encounters you could experience on any given day. Spin the wheel to determine which will happen to you.



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in collaboration with
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Fish Commission
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Living on the Edge:

ANSWERS AND EXPLANATIONS

You are searching for food and get hit by a car. You didn't realize you were on a highway.

Habitat loss, direct human contact. Many Florida panthers were killed in highway accidents because humans did not realize that the highways they were building went right through some of the most traveled habitat of the Florida panther.

You are beaten up by an older male Florida panther whose territory you entered.

Habitat loss. There is so little land left for the Florida panther that they must fight for the space that remains.

Your immune system is weak and does not fight diseases well. Today you catch a cold.

Inbreeding. Because the population of Florida panthers has decreased, they are forced to breed with closely related individuals. This can cause many health problems, such as a weakened immune system.

You are dining on your favorite meal, a white-tailed deer, when a jealous hunter shoots you.

Direct human contact. Shooting Florida panthers is now illegal, although in the past, the United States government did sponsor programs to wipe out all predators. However, some animals are still killed illegally every year.

You get mercury poisoning from eating raccoons that ate fish that swam in streams with high concentrations of mercury.

Indirect human contact (pollution). Because Florida panthers are top predators on the food chain, they are subject to the buildup of toxins like mercury. It is likely that these toxins occur in nature in higher concentrations than normal due to human activity.

You look for unclaimed territory but get hit by a car and die as you cross a highway.

Habitat loss, direct human contact. Highway accidents were once one of the major causes of death for the Florida panther.

You want to start a family but can't find any other Florida panthers that don't already have mates.

Habitat loss. There are now so few Florida panthers left that the ones that remain must struggle to find not only food and space, but also mates.

There is a loud machine cutting down the trees where you live. You are frightened by it and try to stay out of its way.

Direct human contact. Panthers have a reputation for being shy and retiring and will generally try to avoid humans.

You are exploring on the territory of a male Florida panther. He gets mad and starts a fight, and because he is a better fighter, he kills you.

Habitat loss. Because so much habitat is being lost to humans, Florida panthers are coming into contact with one another more often than they would normally. Territorial conflicts are now the leading cause of death in young male Florida panthers.

You return to snack on last night's supper that you cleverly hid from scavengers under a pile of leaves.

Natural behavior.

Hunting season opens and the men with their yapping dogs scare you. You hide in a tree for the rest of the day.

Direct human contact. Because panthers are so shy, they are easily driven into trees. In the past, using aggressive, barking hunting dogs to tree panthers was a very effective means of capture.

You get a bad case of hookworm, a parasite that lives in your small intestine.

Habitat loss. Hookworm and other parasites spend a part of their life cycle living off the wastes of other animals. Because Florida panthers have less space to live in, it is more likely that they will come into contact with these parasites.

You discover an underpass put in by Florida Fish and Game and no longer have to cross the highway.

Indirect human contact. Because so many highway deaths were occurring, Florida Fish and Game constructed underpasses at the sites that were being used most frequently to cross the highway. The number of highway deaths has since decreased.

You come across a scent that you recognize as another Florida panther and know to keep out of its territory.

Natural behavior. However, as available land is used by humans, this type of encounter would become more common.

You were born with an atrial septal defect, which means you have a hole in your heart. Today it makes you feel woozy.

Inbreeding. When closely related animals mate, a host of reproductive and health-related problems may occur. This is one that occurs in Florida panthers.

You are captured by Florida Fish and Game to become part of their captive breeding and reintroduction program.

Direct human contact. Florida Fish and Game has started a captive breeding and reintroduction program in order to help maintain a genetically healthy population. If more than one cub is present in a litter, one may be captured to use in this program.

A new family of humans moves to town and builds a house right across the middle of your territory.

Habitat loss, direct human contact. When a territory is cut in half because of human activity, a panther will have more difficulty hunting for food and will have more hostile encounters with other panthers.

You are hunting for deer but can't find any, so you must settle for an armadillo.

Habitat loss. Loss of habitat affects not only Florida panthers but also their preferred prey. With fewer white-tailed deer available, Florida panthers switch to second-rate prey such as raccoons, armadillo, and alligators.

You eat a wild hog and catch pseudorabies from it.

Natural behavior. Eating infected prey is one of the risks a predator must face.

You see another Florida panther and thrash your tail as a threat. You think the 90° kink in its tail is funny looking. It thinks the same of the kink in yours!

Inbreeding. Skeletal abnormalities are one of the problems that can occur when closely related individuals mate. In the Florida panther population, the frequency of kinked tails is greater than in other panther subspecies, which indicates that Florida panthers are more closely related than would be expected in a normal population.

In the Wild

Crossword Puzzle

Across

1. A chemical acid found in the chromosomes of cells
7. The environment in which an animal lives
8. A physical characteristic determined by a gene
10. One of two seasons on the African Savannah
11. Type of animals who prefer to live in a group with their species
14. A functional unit of DNA responsible for determining a specific heritable trait
15. To cause a state characterized by a loss of sensation
18. The social grouping of lions
20. One of the large group of infecting agents that cause disease
22. Illegally taking or killing animals that are protected by law
23. Poisonous to most plants; but required by most animals
24. Type of animals who prefer to live alone without members of their species

Down

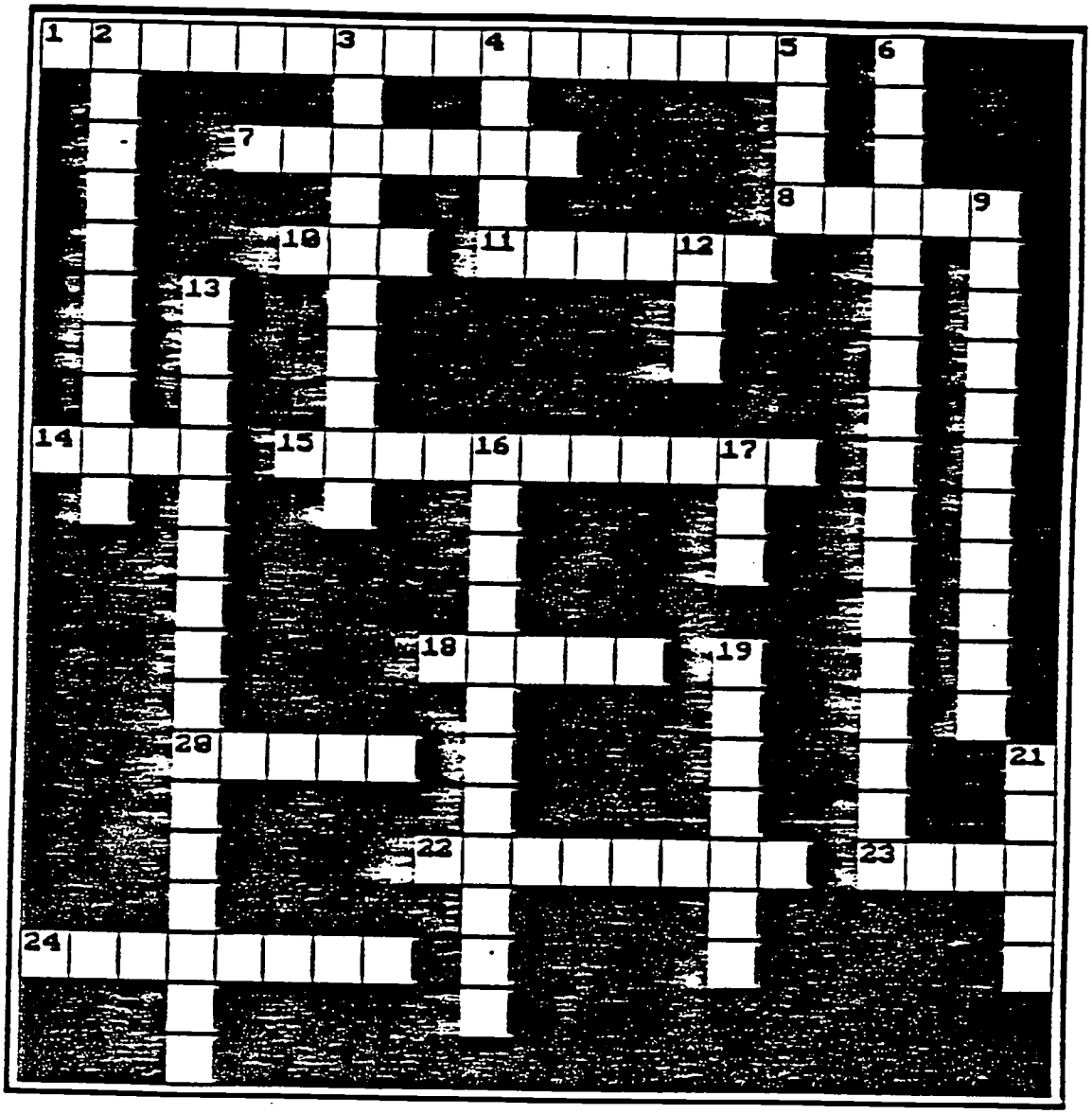
2. Habitat of the alligator, spoonbill, manatee, and Florida panther
3. Occurs when close relatives breed, resulting in poor reproductive traits, ill health, and short life spans
4. The New Opportunities in Animal Health Science Center; a program at the National Zoological Park in Washington, D.C., to help conserve endangered species
5. Is better worn by an animal than a human
6. Organisms, plants, or animals that are threatened with extinction (2 words)
9. A ___ region inhabited by an individual animal that is often vigorously defended by other animals
12. Endangered Species __ passed in 1973 to control trade in endangered and threatened species
13. When DNA fingerprints have very different patterns of bands, they show a lot of _____ _____ (2 words)
16. An infectious disease characterized by the formation of tubercles in the tissues
17. A place where animals are kept captive so that humans may study them and learn about them
19. Habitat of the zebra, lion, rhinoceros, and cheetah
21. In ___ fertilization equals "test-tube" embryo

Across Answers
1.deoxyribonucleic 7.habitat 8.trait 10.wet 11.social 14.gene 15.anesthetize 18.pride 20.virus 22.poaching 23.salt 24.solitary

Down Answers
2.everglades 3.inbreeding 4.NOAHS 5.coat 6.endangered species 8.territorial 12.act 13.genetic diversity 16.tuberculosis 17.zoo 19.savannah 21.vitro

In the Wild

Crossword Puzzle



What Can You Do?

OBJECTIVE: To understand that everyone can help

The problems that threaten many animal species with extinction will not disappear without a lot of effort by concerned citizens of the world like you. While some species eventually become extinct due to the forces of nature (i.e. dinosaurs), the fast rate at which species are currently being threatened with extinction is primarily due to human destruction. The human population explosion is placing demands on the natural world (for food, water, land, gas, oil, etc.) without concern for the balance of nature.

In order to save the diversity of life on Earth, including our own species, we need to change our way of life. You can help to change our path of destruction by doing some of the following:

1. Be a responsible shopper and ask what items are made of and where they come from.
2. Join conservation groups and support zoos and wild animal parks that protect endangered species.
3. Make sure your pets do not have babies if there is no home for them. Ask your veterinarian for advice.
4. Encourage your school and your parents to set aside some land for wildflowers or birds and butterflies. Start a butterfly garden.
5. Take responsibility for caring for your local countryside, staying on trails, taking litter home, and not disturbing the wildlife.
6. Leave wild animals alone. Even if animals such as snakes or spiders frighten you, don't try to hurt them where they live. They have as much right to live in woods and fields as we do in our homes and cities.
7. Discourage pet stores from selling wild-caught animals that may have been illegally brought into the United States. Ask for captive-bred animals, especially birds and fish.

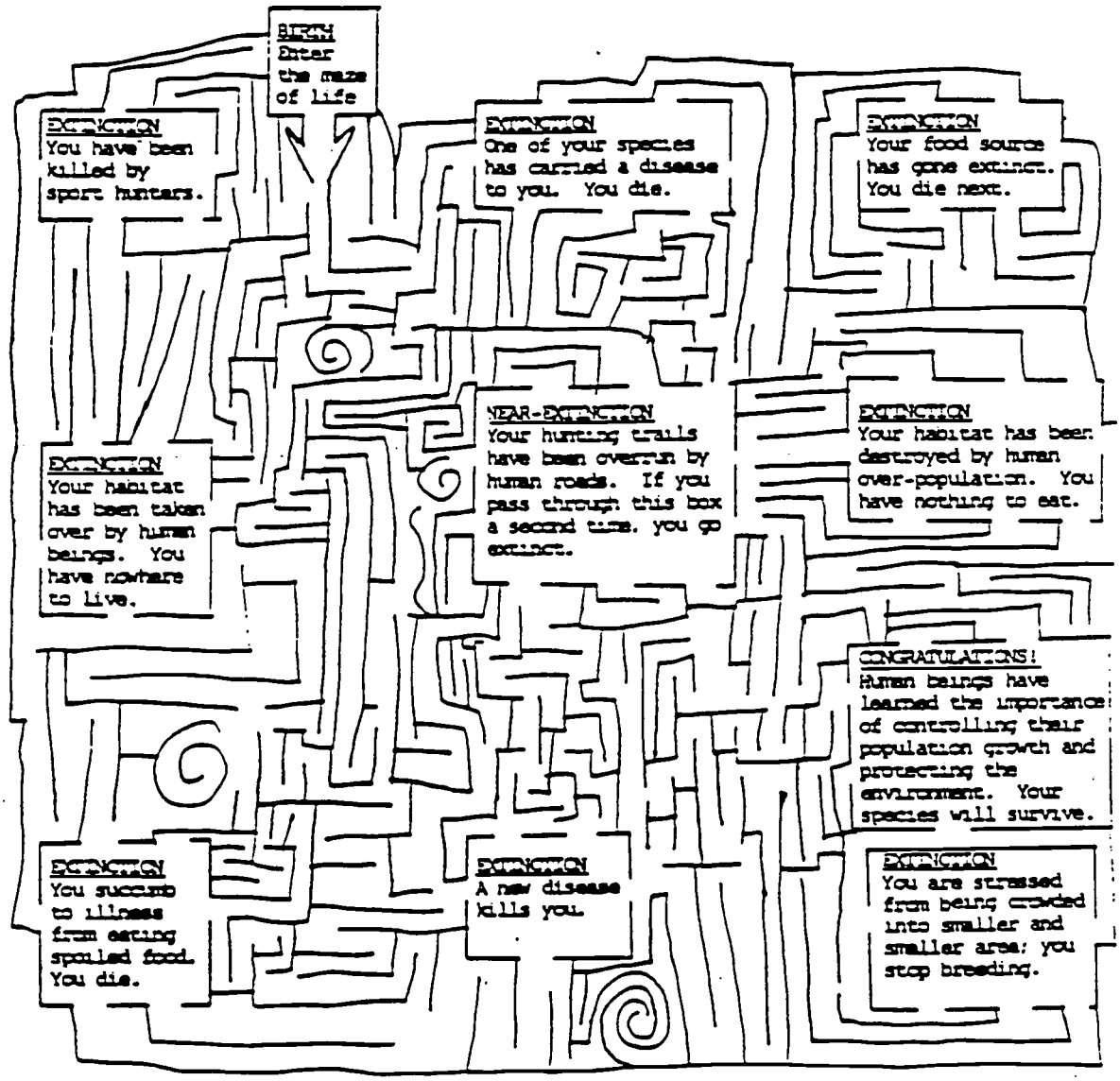
8. Write to people like the President, your congressman, etc., and encourage them to support laws protecting wildlife and land.

9. Reduce your use of chemicals that pollute the environment; be sure to properly dispose of any chemicals you do use.

10. Use natural resources sparingly (oil, water, wood, gas) and recycle everything you can (paper, plastic, glass, car oil, tires, Christmas trees).

11. Learn as much as you can about conservation and share your information with your friends, family, or class to make them aware.

Can You Avoid the Path to Extinction?



Job Descriptions

OBJECTIVES: ***To learn about different jobs that involve work with animals.***

Wildlife Biologist

Recently wildlife biologists such as Jane Goodall and Dian Fossey have gained notoriety due to major films about their lives. Like these popular scientists, wildlife biologists may decide to spend their lives conducting field research about topics like animal behavior, social structure, distribution, communication, and predation. Other wildlife biologists may choose to divide their time between conducting research in the laboratory and applying this information to wild populations. Whether the species studied are game animals like deer, or animals threatened with extinction, like the bald eagle, the objective is to collect, analyze, and interpret biological data for the preservation and control of wild populations.

Wildlife biologists may work for the U. S. Fish and Wildlife Service, state fish and game departments, zoological parks, universities, or wildlife parks and conservation organizations.

Zoo Keeper

At zoological parks and aquariums, zoo keepers are the primary animal caretakers. They are responsible for the daily feeding of animals and the cleaning of their enclosures, as well as the eduction of the public. Zoo keepers must be very perceptive and able to observe and interpret slight changes in behavior, moods, and habits, which may signal underlying medical problems. In such cases, zoo keepers may help the veterinarians in administrating medications or in capturing animals for treatment. In large zoos, zoo keepers may work with only one type of animal, whereas small zoos may allow for work with a variety of species. Zoology or biology degrees are becoming more common among zoo keepers but may not always be necessary.

Veterinarian

A veterinarian is an animal doctor trained to prevent, diagnose, and treat animal health problems. Typically, veterinarians are responsible for the health of small animals (dogs and cats), large animals (horses and cows), and livestock (pigs and chickens), but more and more veterinarians are

choosing careers involving zoo and exotic animals, medical research, food inspection, and teaching and are even advising Congress on laws involving animal and human welfare. After finishing college and veterinary school, some veterinarians decide to specialize in areas such as surgery, opthamology, dermatology, or reproductive physiology, and many more.

Geneticist

A geneticist is a scientist who studies how traits are passed from parents to offspring. Specialties include animal, plant, and microbial genetics. Within each specialty there are different types of scientists who concentrate on answering many different questions.

Molecular geneticists study DNA, how it is organized into chromosomes and how the basic units are arranged. This can tell us how some diseases are inherited and may lead to the treatment of these diseases. Population geneticists specialize in understanding patterns of variation in groups of plants or animals. These studies can help wildlife biologists understand more about how organisms interact with each other and with the environment. There are also evolutionary geneticists who study the patterns of how DNA changes. Recent technical advances allow geneticists to study extinct species as well as living ones and to learn about the relationships between them.

To become a geneticist, a Ph.D. or masters degree is necessary after getting a college degree in biology or chemistry.

Reproductive Physiologist

Reproductive physiologists are scientists who try to understand the biology of reproduction. Some of these scientists are using their knowledge of reproduction to improve zoo animal breeding and to understand why some animals do not breed well. Their research may be used to develop medical technologies that will increase the reproductive success of endangered species. Artificial insemination and in vitro fertilization are examples of reproductive technologies that have been developed to produce offspring in endangered species like the cheetah, tiger, and black-footed ferret. Some reproductive physiologists also are endocrinologists, which means that they study how chemicals produced by the body (hormones) control reproduction. Both captive and wild populations of endangered species can benefit from this research.

These print materials were developed and written by the staff at the National Zoological Park's (NZP) NOAHS Center. This publication was edited and designed by Fairfax County Public Schools (FCPS).

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