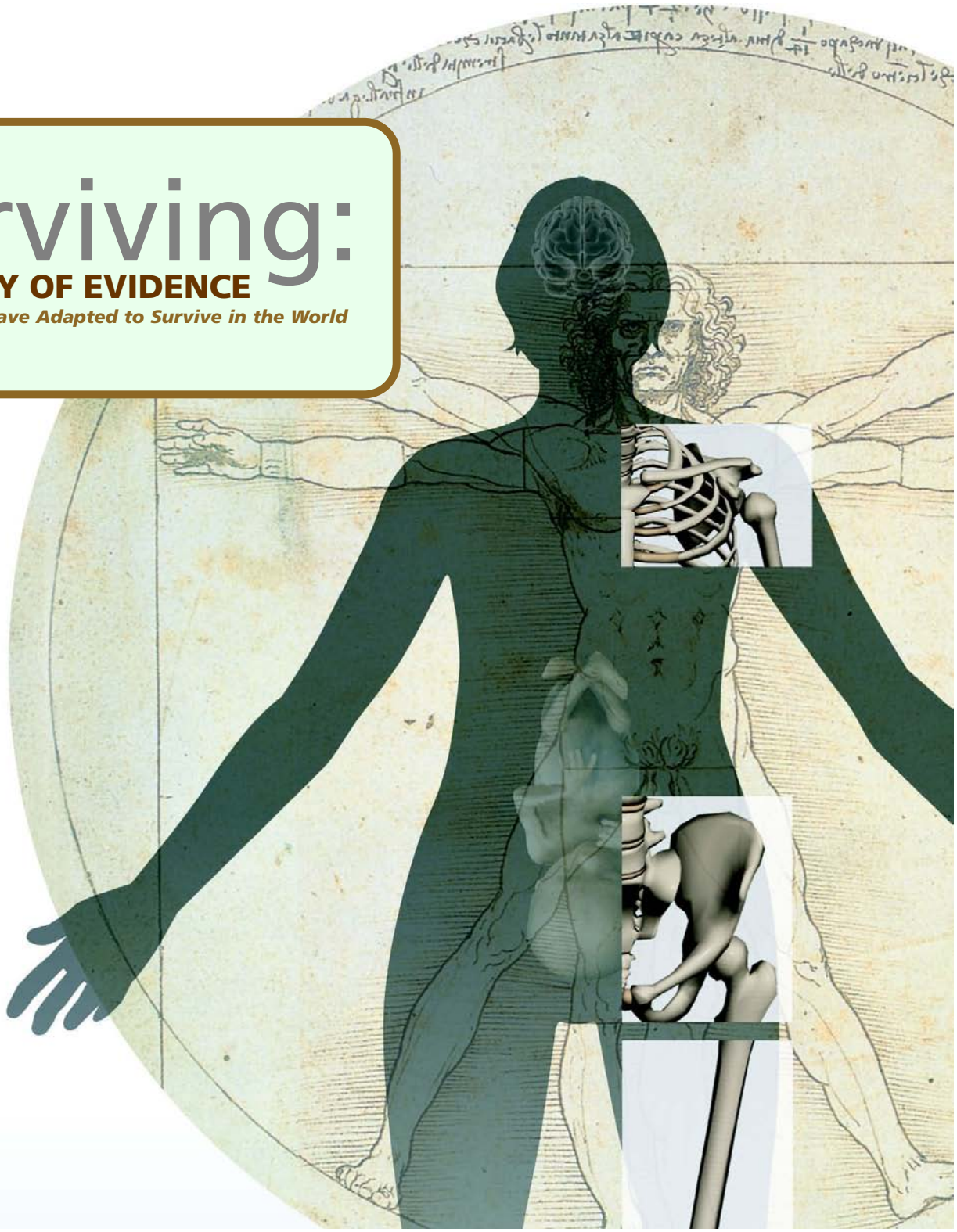
Surviving:

THE BODY OF EVIDENCE

How Humans Have Adapted to Survive in the World



Penn Museum
University of Pennsylvania Museum of Archaeology and Anthropology

DAILY NEWS The Inquirer
News In Education

Surviving: **THE BODY OF EVIDENCE**

Dear Students,

Some of you reading this will be familiar with the University of Pennsylvania Museum of Archaeology and Anthropology. You may have stood in the amazing Chinese Rotunda, soaring 90 feet to the second largest unsupported dome in the United States, and under that roof you may have gazed into the celebrated crystal ball that decorated the table of the last Manchu Empress. You may also have seen the treasures that were excavated from the royal tombs of Ur, in ancient Mesopotamia, or the Egyptian mummies, wrapped in linen and laid to rest thousands of years ago. You and your classmates may have photographed each other standing in front of the 12 ton granite sphinx that dominates the Lower Egyptian gallery, or the great Haida totem poles that stand in the Kress gallery in the Educational Entrance of the Museum.

Some of you may have enjoyed our annual summer camp, learning to excavate and record your findings or talked with Penn students who come from Africa, or India, or a hundred other places where the University of Pennsylvania has sent its archaeologists and anthropologists. You might have danced to the drummers at African Culture Day, seen your name painted by a Chinese calligrapher at Chinese New Year, or watched a theatrical version of the imaginary trial of the Pharaoh Akhenaten in our Amarna exhibit.

For all of you, including those who haven't visited us yet, let me invite you to visit and participate in our newest exhibit, opening on April 19, 2008. Several years in the making, it is going to be something very special and a new direction for Penn Museum. Instead of featuring magnificent ancient objects, the exhibit will be all about you, the visitor. The name of the show is "Surviving: The Body of Evidence." Over millions of years, humans have inherited characteristics that have helped them live successfully in environments around the world. In this exhibit you will find out what those characteristics are and how you are a part of this ongoing development; what physical changes have occurred in human beings in the last 10,000 years, and even more importantly, what the future may hold for us humans.

In this special student supplement, you can explore some of these ideas about how humans have changed and survived over time. You can also explore the new direction Penn Museum is moving with our new exhibit and how the exhibit builds on the museum's rich history. We are looking forward to welcoming you all to Penn Museum and the fascinating experience of "Surviving: The Body of Evidence."

Sincerely yours,

Richard Hodges
The Williams Director
Penn Museum

Credits

The Newspaper in Education curriculum "Surviving: The Body of Evidence" was created by the News In Education program of *The Philadelphia Inquirer*. Special thanks to The Harvey and Virginia Kimmel Arts and Education Fund and Annette Merle Smith.

The writer was Cynthia Leger of Hollister Kids, Wynnewood, PA.
The graphic designer was Aaron Sales of Hollister Kids.

Surviving: **THE BODY OF EVIDENCE**

Change Is All Around Us

Look around.

Everything around you is changing. Some things are changing very slowly, and you could live more than a hundred years without noticing a difference. Other things are changing more quickly, and within 10 or 20 years some aspects of the world will look different to you than they do now.

In modern history, we've seen many different kinds of changes in culture and technology. We have seen phones evolve from big, chunky rotaries to the sleek cell phones of today. Media has also evolved. News used to spread slowly by word of mouth. Then with the invention of the printing press, newspapers sprung up, informing the public faster than ever before. Next came radios and television that delivered the news right to people's living rooms, and now the Internet can report current events in minutes, or even less!

Virtually all scientists think that humans and other animals also have changed over time. This is called biological evolution. Unlike technology, human and animal changes are more complicated and have happened over the course of thousands and even millions of years. Since these changes are thought to have happened too slowly for humans to observe, scientists use evidence like fossil records and comparative anatomy to support their theory of this human and animal evolution.

However, there are groups that don't support this theory of biological evolution. Some critics argue that the current evolutionary model is faulty, while others believe that humans and animals were always present on Earth in their current forms.

This special student section was designed to explore and evaluate the body of evidence used to support evolution. It will give you the opportunity to critically look at the arguments that are at the heart of this current scientific debate and draw your own conclusions. You will also be able to use the newspaper as a resource to see how scientists, religious leaders and other public figures are discussing these issues today.

FACT *or* **Fiction**

Scientists claim humans will evolve into another species within a lifetime.

Fiction! Scientists think that animals evolve over a very long period of time.

Survival *IN THE* **NEWS**

Phones and media are two examples of things that have evolved in the last 200 hundred years. Look through today's Inquirer ***for another example of technologies or products that have evolved. Make a poster showing the different stages of the evolution.***

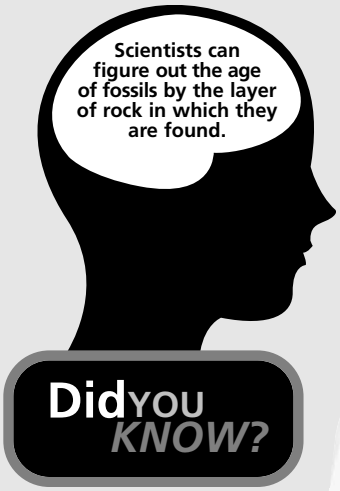
Surviving: **THE BODY OF EVIDENCE**

Witnessing Evolution

Science has a special way of looking at and explaining the world. By following specific steps, called the scientific method, scientists draw conclusions about how and why things are the way they are.

The first step of the scientific method is to look closely at or observe some specific aspect of the world and come up with a hypothesis or an educated guess to describe or explain that observation. Then scientists create tests or experiments to try to disprove their hypothesis. When a hypothesis has been tested many, many times and has consistently shown to be true, it is called a theory.

Two hundred years ago, no one had ever heard of "evolution." It wasn't something kids learned in school or read about in the news. Different scientists who were studying animals — where they lived, how they were built and how they compared to fossils — started to notice similarities among animals and began questioning whether all living things, past and present, were related somehow. Eventually, these observations resulted in a radical new hypothesis called evolution.



The Birth of a Theory

During the 18th and 19th centuries, scientists were finding fossils of extinct animals. These animals' remains looked similar to animals that were currently living but had key differences. Scientists began to wonder whether the fossils were of completely unrelated animals or whether some features in animal populations were changing over time.

Finding clues in fossils

Naturalists, people who study nature by direct observation, started comparing living animals to fossils.

Naturalists noticed that modern horses had only one toe, but the fossils of ancient horses had four. If that wasn't surprising enough, they made even stranger discoveries when comparing ancient whales to modern whales. Instead of finding fish-like fossils, scientists discovered the ancient whales had ankles that were similar to those of a deer. This startling observation led scientists to compare whale skeletons with both living and ancient animals that had hoofs, and they noticed a lot more similarities.

Careful observations like these helped scientists develop a system for organizing and comparing all life forms, living and extinct.

But why did these changes happen?

Scientists hypothesized that the changes they noticed were due to plants and animals adapting to their natural surroundings in order to better survive. For example, if there was an environmental change that affected food sources, animals would either have to adapt somehow to the change or risk starvation and eventual extinction.

The idea of adaptation for survival can help explain the changes scientists saw in horses and whales. Scientists speculate that horses' toes evolved to make it easier for them outrun their predators. Horses had to adapt to an environment that consisted mainly of flat, open grassland. If they were too slow, their entire species could have been eaten to the point of extinction. Instead, over time, their toes fused to make a solid, shock-absorbing surface that could help them use the energy in their muscles to move much faster.

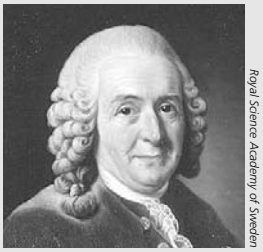
As for whales, scientists think they were originally land animals. Possibly whales started eating foods from the sea and over generations began to depend on these for survival. To further explore food options and to have enough to eat, they may have adapted to living in the water. Another possibility is that whales adapted to water to escape from predators.

While the details of adaptation are still being debated and worked out, facts collected by scientists and experiments done during the last 150 years have continuously supported evolution. It is now considered a theory that explains the diversity of life on Earth.

Surviving: **THE BODY OF EVIDENCE**

Evolutionary Scientists Hall of Fame

Many people contributed to the modern theory of evolution. However, there are a few scientists who really stand out in contributing ideas and evidence that helped shape our understanding of it.



Royal Science Academy of Sweden

Carolus Linnæus (1701–1778)

Carolus Linnæus was the king of classification. He was a naturalist who collected and studied plants and animals. Through careful observation and comparative anatomy, he was able to classify living things by their different physical similarities and behavioral patterns. He divided the living world into groups and sub-groups: kingdom, phylum, class, order, family, genus and species. His system of classification is still used today and helps show the evolutionary relationships between all animals, living and extinct.

Charles Darwin (1809–1882)

Charles Darwin was a naturalist who introduced the idea of natural selection in his landmark book *The Origin of Species*. From his observations of animals in England and in South America, he became aware of small differences among species. For example, he observed that finches, a specific type of bird, varied in the shapes of their beaks. These variations were not random, however. They were related to the environments in which the finches lived. Different environments had different foods, and the beaks adapted so that they were best-suited for eating the food in their environment.

KPA/United Archives/WHA

Darwin recorded similar patterns in other animals while doing his research. After years of compiling observations, he described how he thought animals adapted and evolved. His theory of natural selection is also commonly referred to as "survival of the fittest." According to this theory, animals that carry a mutation that helps them better survive in an environment will pass that trait on to their offspring. Animals that don't have such advantages to help them survive in an environment will be more likely to die off. Over generations, more and more animals with the mutation will be present in the population and fewer and fewer animals without it. The eventual result is that the animal population as a whole will have evolved.

Rosalind Franklin (1920–1958)

Rosalind Franklin broke ground in the scientific community by helping figure out the structure of DNA. She used X-ray images to show that DNA was spiral shaped. Using this information, other scientists were able to find out more about how DNA was structured and how genetic information was passed on through it. Her research, as well as information accumulated by many other scientists, laid the foundation for later discoveries that supported evolution by showing that all living things are made up of variations of the same molecular material.

Jewish Chronicle (London)

FACT *or* **Fiction**

Theories are guesses made by scientists that still need to be tested.

Fiction! *In science, a theory is something that has been thoroughly studied and has a lot of evidence to support it. It is generally considered an accepted idea.*

Survival *IN THE* NEWS

Many scientists today are trying to break new ground by testing original hypotheses. Look through today's Inquirer *for an article about some scientific research that is being done. Write out what the original hypothesis was and a short paragraph that explains how it was tested.*

Surviving: **THE BODY OF EVIDENCE**

Our Place in the Natural World

We humans are not alone. We are surrounded by plants, animals and other organisms. We are affected by hurricanes, droughts and earthquakes. And we use materials from our environment for food, clothing and shelter.

We are a part of a large, complicated, interconnected system.

So where do humans fit into this complicated system? How are we related to the other animals around us? What is our place in the natural world?

Humans as Mammals

At first glance, humans, kangaroos, pigs and whales don't seem to have a whole lot in common. But when we look closer, we can see that they have many common characteristics. They have similar skeletal structures, specialized teeth, hair and the ability to nurse their young.

In fact, animals like humans, whales and pigs are considered mammals. Scientists believe that mammals have similar traits because they descended from the same, very distant ancestor called *Morganucodon*. *Morganucodon* was a warm-blooded animal that lived 210 million years ago. It would sleep during the day, be active at night and eat insects.

Primitive mammals managed to survive whatever it was that wiped out the dinosaurs 65 million years ago. And, over millions of years, they adapted in different ways to gather food, escape predators, find mates and reproduce. Today, *Morganucodon* is extinct, but its probable descendants, the modern mammals, live on.

The Skeleton Inside

If you look at two or three types of mammals from the outside, it is easy to spot differences. However, if you look at how mammals are built on the inside, there are many common features. Mammals are part of a group called vertebrates that have a similar body structure: skull, flexible backbone, four limbs, shoulder, arm, hand/paw, pelvis, leg and foot.

Pearly Whites

Mammals have specialized teeth, which means that the number, shape and position of their teeth are designed to make eating easier. Below are some of the ways that a mammals' teeth are related to their diet.

Insectivores (insect eaters): Mammals that eat insects need to pierce through bugs' hard shells, so having teeth with sharp points or peaks is a must.

Carnivores (meat eaters): Slicing through flesh is no easy task, so a meat-eating mammal needs scissor-like molars.

Herbivores (veggie eaters): Plants are made up of lots of fibers, and in order to digest them, they need to be chewed up into small pieces. Plant-eating mammals have flat teeth with ridges, so that they can grind up their food.

Omnivores (everything eaters): For mammals that eat everything, a variety of teeth are needed. Omnivores have chisel-shaped incisors for cutting through mouthfuls of food and flat molars for grinding and crushing plant foods, such as seeds, nuts and fruits.

Hair, Hair, Hair

All mammals are covered in hair. It may be long or short, fine or coarse, light or dark. Hair is used both to keep mammals warm in winter and cool in the summer. Some hair, like whiskers and guard hair (coarse hair that makes up an animal's outer coat), help animals sense what is around them. Hair can also be used to attract a mate, like in the manes of lions.

It's All in the Family

All female mammals have mammary glands, which produce milk that can feed their young. Mammals are also unique because they have a close relationship with their offspring. Their young grow inside the mother and after birth are raised by their parents. Other animals, like fish and frogs, may lay eggs and leave their offspring before or soon after they hatch.

Surviving: **THE BODY OF EVIDENCE**

Humans as Primates

Which do you think are more alike — a human and a cat or a human and a monkey? How can you tell?

Most people would agree that monkeys and humans have more similarities. Even though cats are also mammals, they aren't as closely related to humans as monkeys. Humans, monkeys and all of the apes, including gorillas and chimpanzees belong to a sub-group of mammals called primates. To be classified as a primate an animal has to have mobile hands and feet, omnivore's teeth, forward-facing eyes, nails and big brains.

Hanging Around

Compared to other mammals, primates are flexible creatures. While apes can swing from tree to tree, walk short distances on two legs and grab objects, animals like cows have to stand on their four legs all the time. In fact, if a cow even tried to rotates its limbs, it would sprain them because some of their bones are fused together in the downward position.

In primates, the radius and ulna, which are arm bones, are not fused. Since they are separate, primates can turn their hands and rotate their arms and legs.

Chew on This

Primates aren't picky eaters. As long as the menu consists mostly of plant foods, they are eager to eat, and their teeth have adapted to the diet. Primates' teeth have flattened cusps and their jaws have heavy muscles for chewing.

Here's Looking at You

Mammals like dogs see the world very differently from you. While dogs can see things that are in the distance, they mostly can't judge depth or see color. Their eyes, which are set on the sides of their heads, are better suited for detecting movement.

Primates, on the other hand, have forward-facing eyes. They are able to see things up close with no problem, and make out faraway objects in depth and color.

Nailing It Down

Most mammals have claws for hunting or hooves to absorb the impact from the ground when running. Primates, however, don't have either. Instead, they have nails. Why are nails important? They protect the fingertips, which are unique to mammals and are used to gain information through the sense of touch.

FACT *or* **Fiction**

The ability to hold and grasp objects is a characteristic of primates.

Fact! *Almost all primates have five digits on their hands that allow them to hold and grasp objects with varying degrees of competence. With the exception of humans, primates also have feet that can effectively grasp things.*

Survival *IN THE* **NEWS**

Look through today's Inquirer *for photos of mammals and/or primates. Cut out the images and use them to create a poster. On your poster include an explanation of the characteristics of mammals and primates.*

Surviving: THE BODY OF EVIDENCE

Fit for Life

Humans are survivors. Over millions of years, humans have inherited characteristics that have helped help them successfully live in environments around the world. These features have allowed humans to easily find food, escape predators and work together.

What are some of the things that humans can do that other animals can't? What are the advantages of the way the human body is designed? What strengths and abilities do humans have that make them fit for life?

Endurance

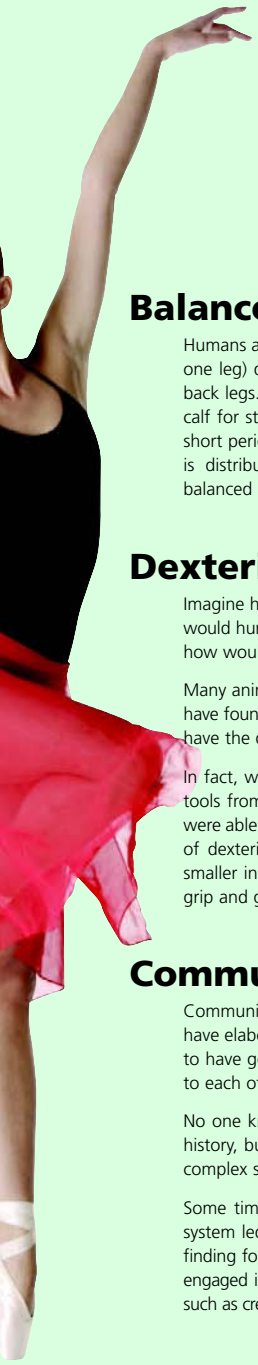
In a sprinting race against horses, cheetahs or dogs, humans are bound to come in last. One of the evolutionary trade-offs for walking on two legs was giving up the speed that four legs allowed. On the bright side, features like the way we store and release energy allow us to run for much longer periods of time than our four-legged friends. This probably gave our ancestors a competitive edge in the search for prey.

Flexibility

You may not realize it, but compared to non-primates you are very flexible. Stand up and swing your arms back and forth. Then try raising them above your head. Maybe even roll your shoulders in circles. Piece of cake, right?

That's because you have shoulder joints that can easily be moved and bones that are positioned in a way that makes the joints flexible. Many muscles, tendons and ligaments also help provide a wide range of movement without dislodging the upper arm bone (humerus) from the shoulder blade. Think about it: How many different ways can you move your arms from the shoulder joint? Your arms can go up, to the side, behind your back and more.

The shoulder joint can move in more directions than any other joint in the body. This makes it easy for you to reach above your head or even dangle from something. This may not seem like a special skill now, but it helped early humans reach for food and climb to avoid predators.



Balance

Humans are able to stay balanced on two legs (and for a short time on one leg) due to the position of our upper bodies over our pelvis and back legs. To stand like this, we need only to use some muscles in our calf for stability. Many other animals can stand on their back legs for short periods of time. However, since the weight in their upper bodies is distributed differently, they need to use more muscles to stay balanced and get tired quickly.

Dexterity

Imagine how difficult it would be to eat without the use of tools. How would humans hunt or fish? And once food has been scraped together, how would you crack open nuts or cut meat?

Many animals, like chimps and birds, use tools but only ones that they have found in nature and have only changed slightly. Humans, however, have the distinction of being able to create their own tools.

In fact, when chimps today are given stones and shown how to chip tools from them, they can't create the same types that early humans were able to make 2.5 millions years ago. Part of this is due to their lack of dexterity. Like humans, chimps have thumbs, but they are much smaller in relation to the rest of their hands. This makes it difficult to grip and grasp materials.

Communication

Communication has been key to human survival. Although all primates have elaborate ways of communicating with each other, humans seem to have gone beyond them. Humans can communicate complex ideas to each other and plan for the future.

No one knows when communication came about in our evolutionary history, but many of our ancestors had large brains and probably had complex systems of communiation.

Some time in our evolutionary history, the elaborate communication system led to the division of labor, allowing some people to focus on finding food, building shelter and protecting us from prey, while others engaged in pursuits that had more to do with enrichment than survival, such as creating art, music or dance.

Appetite

Anyone who has ever been on a diet knows how hard it Is to say "no" to a nice slice of chocolate cake or a Big Mac. But why is it so difficult to pass on the snacks?

Your body just might be hard-wired to crave foods high in calories. Your ancestors lived in an environment in which it was difficult to get enough calories to make it through the day, so when they did encounter high-calorie foods, their bodies urged them to eat as much as possible.

Fruits, which are full of natural sugar, offer a great concentrated source of energy, so having a sweet tooth definitely gave early humans an advantage in surviving. And the fatty acids found in meats are thought to be responsible for humans growing such big brains.

However, a balanced diet including a variety of foods from animal and plant sources may also be related to increases in brain size, since the brain uses so many of the nutrients and calories that you consume.

Survival IN THE NEWS

Look through today's Inquirer *for seven photos showing humans engaging in activities that represent inherited human strengths and capabilities on page 8–9. For each photo, write a caption that explains how this ability helped your human ancestors survive.*

Surviving: **THE BODY OF EVIDENCE**

Finding Your Human Ancestors

Scientists have found thousands of fossils of human bones and teeth in Africa, Europe and Asia. When finding fossils, scientists first try to determine the age of them. Sometimes scientists can tell the age by the layer of rock in which a fossil was found. They can also use a process called radiometric dating, which measures how much of certain elements are in a fossil compared to how long it normally takes those elements to decay.

By finding out the dates of fossils, scientist can see how humans split off from apes and how our anatomy has changed over millions of years.

Hominids: It's All in the Family

One of the features that make humans unique from other primates is the ability to walk upright on two legs. The earliest primate fossils that revealed this quality are from seven million years ago. All primates, living and dead, that are habitually two-legged walkers — or bipdedal — are called hominids.

7 to 3 Million Years Ago

The first human-like fossils were found in areas in East and Central Africa. Some of these fossils are bones and some others are footprints.

Remains found of femur bones (thigh bones) had a shape that suggested that they belonged to a primate that walked on two feet. Ancient footprints support this idea, as they show tracks of once living beings that had feet that were smaller but similarly shaped to the average person's foot today, with arches and large big toes.

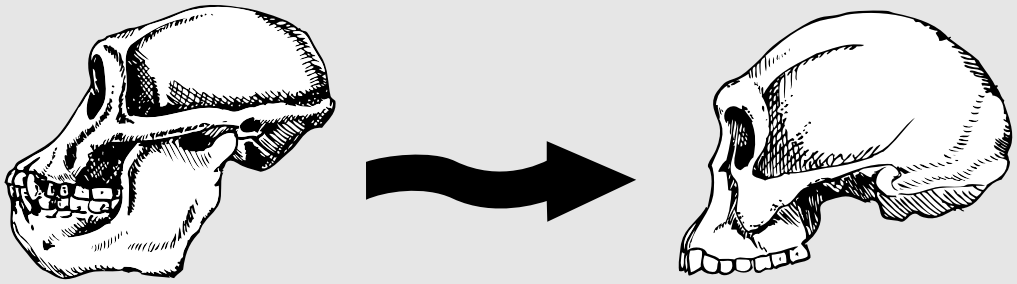
Despite these similarities, these early human ancestors looked very different from humans today. Their skulls and brains resembled those of apes and were much smaller than human skulls. Their skeletons also showed that they their legs were shorter, their arms longer and their toes more flexible. The teeth of these hominids were not like the teeth of apes or humans — they had small canines like later members of our lineage but with huge grinding molars.

2.5 to 1.5 Million Years Ago

Fossil skulls that date from this period had much larger brains than the early hominids. To make space for the bigger brains, faces, jaws and back teeth became smaller.

These early humans also seemed to be more industrious than their predecessors — they made tools to help them do work. Some of the oldest stone tools are very simple in design, such as rough pebbles with chips taken off the sides.

In the next millions year, however, the tools became more sophisticated. For example, a tool, called a handax from about 1.5 million years ago has a round end that could easily be gripped by a hand and a pointy end that could cut, scrape or dig.



Australophithecine Afarensis
3.2 million years ago

Homo Habililis
2-1.6 million years ago

The Road to Modern Humans

Perhaps you have heard humans referred to as *Homo sapiens*. *Homo* is the genus that humans belong to and *sapiens* is the species. The earliest evidence of others belonging to the *Homo* genus is from two million years ago in Kenya, and there were several different species of them.

Early forms of *Homo* showed variation in the size of their brain cases, teeth and jaws. For example, *Homo habilis* (which means "handy man") had a slightly larger brain size and smaller back teeth than earlier forms of hominids. *Homo erectus*, who lived at the same time as *Homo habilis*, had a much larger brain in addition to those somewhat smaller back teeth.

Approximately 1.8 million years ago, various forms of early *Homo* left Africa. Fossils of *Homo* forms dating from after this time period have been found in various parts of eastern Europe, eastern and western Asia and in Africa. One or more of these various forms eventually evolved into later forms of *Homo* including *Homo sapiens*.

Over the course of many hundreds of thousands of years and over this huge geographic area, brain sizes became larger, but the skull shape still remained somewhat different from the skull and face shape of modern humans.

These members of the genus *Homo* all used tools made out of stone, and over time the types and varieties of the tools became more elaborate. Eventually new raw materials were introduced to the tool kits including tools made of bone and wood.

Not only did anatomy change over this period, there is evidence of cultural adaptation as well. Hominids started deliberately burying their dead, controlling fire and later leaving traces of art.

While scientists don't know when our ancestors learned how to speak, their big brains seem to indicate that they were able to communicate complex ideas. It also tells us that they were able to think and therefore could possibly have shared their thoughts.

These big-brained, speaking hominids, living in many parts of the world by about 30,000 years ago were essentially us.

Who Were the Neandertals?

You may have heard the term "Neandertal" used to describe someone who is demonstrating aggressive behavior or who has an outdated mode of thinking. But who were the real Neandertals? And why have they gotten such a bad rap?

Neandertals are an extinct group of hominids that lived in Europe and the Middle East from 125,000 to 35,000 years ago. They are named after Neander Valley, Germany, the place where the first skeleton was found.

Since they are in the same genus as humans and possibly even the same species, they have many similarities to us. However, there are some differences. For example, Neandertals were shorter than modern Europeans, with sturdier and more powerful bodies.

Differences also exist in the skull. Neandertals had large faces with broad, low braincases. They also had large brow ridges. Humans, however, have faces that are below the expanded front part of the skull, and our brain cases are high and vertical.

FACT *or* Fiction

Scientists think that humans evolved from chimps.

Fiction! Evolutionary models show that humans and chimps probably shared a common ancestor. However, our ancient ancestor, who lived about 5 to 8 million years ago, split off into two separate lineages. One lineage evolved into chimpanzees and the other into humans.

Survival *IN THE* NEWS

Choose an animal that is pictured or described in today's Inquirer. *Do some research and find out the animal's kingdom, phylum, class, order, family, genus and species. Then name three other animals, living or dead, that belong to its order, family and genus.*

Surviving: **THE BODY OF EVIDENCE**

We Are Not Perfect, But We Are OK

Humans are born with many strengths and abilities that have developed as part of the evolutionary process. However, with some of these inherited strengths have come compromises. Many of the common health problems humans have to endure are due to trade-offs that happened over evolutionary time in our ancient ancestors involving large brains, bipedalism and flexible bodies.

Bigger Brains

One of human's greatest assets from the survival process are their large brains. Your brain makes up two percent of your body weight and is designed to deal with complex tasks efficiently. Your brain functions as the control center of your body, coordinating your senses and enabling you to move. Your brain also allows you to think, feel, communicate and remember.

However, your large brain came at a price: Your body has had to make trade-offs when it comes to your teeth, jaws and ability to produce young.

Teeth

As your ancestors brains got bigger, their faces became smaller and no longer projected forward. This had a serious effect on the teeth. Thirty-two adult teeth could not fit as easily in the space that was left for them.

As a result, your teeth are smaller than your ancestors', and yet some of them still may not fit. It's now common in societies like ours to see kids wearing braces because their teeth are crowded or don't fit properly in the jaw. And, many teens have their wisdom teeth removed, because when it's time for them to grow in, there's no space left in the mouth.

Hips and Pelvis

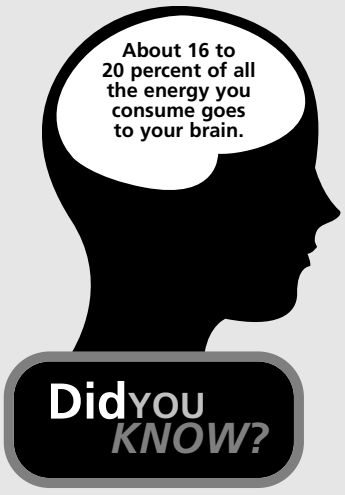
Fossils found all over Africa beginning in the early 20th Century have helped scientists figure out that your ancestors began walking upright first and then later developed larger brains. As brain size got larger, the pelvis got wider. Why did these two changes happen simultaneously?

For early hominids, childbirth was probably a cinch. Small-brained babies could easily pass through their mother's pelvis. However, as brains got larger, the pelvis needed to get wider to accommodate big-skulled infants. And even today, it's a tight fit.

Part of the reason childbirth continues to be a difficulty is because human pelvises can't get any wider. The thighbone connects both the pelvis and the knee, and if our pelvis got any wider, the angle of the thighbone would be too great for us to be able to balance ourselves.

However, other evolutionary compromises have allowed humans to have large brains. Unlike other primates, humans only carry their young until about 1/3 of full adult brain size is developed. Other primates, like chimpanzees, carry their young longer — until brain size is about 1/2 the size of adults. So while apes and chimps give birth to babies with more developed brains, human children are born immature and helpless.

A human child's brain grows rapidly after birth, doubling in size after the first year of life. It isn't until the age of six that the brain reaches 95 percent of its adult size.



Surviving: THE BODY OF EVIDENCE

Out of Joint

Human bodies are very flexible. Thanks to your joints, you can run, jump, climb and do many other physical activities. However, during the course of your life, some of these joint structures will begin to develop problems. Some of the problems will come from the normal wear and tear associated with your daily activities. Others will develop because of compromises that your ancestors made in the past.

Dislocated Shoulders

Shoulder joints are the most flexible joints in the body. This flexibility allows humans to reach and grab for things, but it also means that it's easy for the joint to come out of alignment.

As most athletes know, a blow to the shoulder can dislodge it from the socket. During childbirth, babies often dislocate their shoulders, too.

Tennis Elbow

You are able to move your body because of the interplay between bones, muscles and joints. Bones are connected to muscles by tough rope-like cords called tendons. When you contract a muscle, the tendon pulls on the bone and moves it.

A large number of tendons and muscles are located around the elbow, which leads to a high incidence of injuries. For example, tennis elbow is a common ailment that results from straining the tendons by repeatedly contracting the arm muscles.

Knobby Knees

The knee joint connects the thighbone, shinbone and kneecap. It is also surrounded by muscles, tendons, cartilage and ligaments. If the knee twists and flexes in the wrong way, cartilage or ligaments can easily rip or tear.

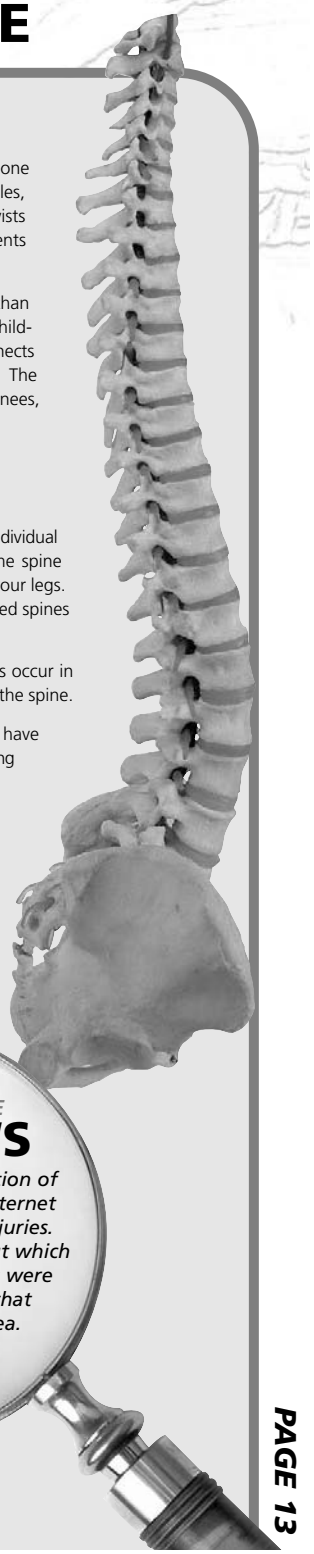
Women generally have more knee problems than men. Women have wider hips to help them in childbirth, and therefore the thighbone that connects their hips to their knees is at a greater angle. The angle of the thighbone causes instability in the knees, resulting in more injuries.

Bones and Backs

The human spine is S-shaped and made up of individual bones called vertebrae. The curved shape of the spine allows you to position your body centrally over your legs. Animals that walk on four legs do not have curved spines and therefore cannot habitually walk upright.

In humans, the greatest number of back injuries occur in the lower back — at the most extreme curve of the spine.

Another major bone problem that humans have is related to a disease called osteoporosis. Affecting mainly older adults, the disease causes bones to become porous and spongy. These fragile bones (mostly in the spine and hips) are much more likely to break than healthy bones. In fact, people with osteoporosis can break a bone from a minor fall or even a normal movement.



Survival IN THE NEWS

Look through the sports section of today's Inquirer *or on the Internet for articles about athletic injuries. Do some research and find out which joints, bones and/or muscles were affected. Draw a picture that illustrates the injured area.*

FACT *or* Fiction

The human brain is likely to continue to grow bigger and bigger over the next thousand years.

Fiction! With a bigger brain, humans would have difficulty giving birth because the baby could not fit through the mother's pelvis. Even today, some women have cesarean sections because infant brains are too large.

Surviving: **THE BODY OF EVIDENCE**

We Keep Evolving

Evolution is not a thing of the past. It's happening right now and will continue to happen in the future. Useful traits for survival will be passed on to your descendants and some will spread across the human population over time. There will also be both subtle and dramatic changes in the natural world to which humans will need to adapt or face extinction. What are some of these traits that are changing now? What environmental factors might affect humans?

While scientists have evidence that suggests evolution is currently happening, they can't predict how humans will adapt. Part of the process of evolution is random and unpredictable. However, some guesses can be made based on evolutionary patterns from the past and possible changes that may occur in the environment.

Patterns of Change

By studying human anatomy, scientists know that joints, muscles, birthing and dental issues have affected how humans evolved in the past. Scientists have also observed some recent, inter-related patterns of change that have occurred due to genetic, cultural and environmental factors.

Diet and Obesity

Early humans mainly hunted and gathered their food. Due to the scarcity of food, they couldn't be finicky eaters. They would eat whatever vegetables, fruits, nuts, insects, small animals and big game that they could get their hands on. The wide range in types of food they ate, provided the body with the variety of nutrients it needed.

However, when humans moved from hunting and gathering their food, to developing agriculture 10,000 years ago, the human diet greatly changed. The types of foods humans ate became limited to things that they could grow or a product of domesticated animals. Grains and carbohydrates became a staple in the human diet, and people stopped eating wild game, which is lower in fat.

Today, despite the availability of many types of foods, humans do not tend to eat a wide variety and therefore are deficient in some nutrients.

Like our ancestors, we eat a lot when food is available. However, food is easier for us to find and we are not doing much exercise to get it. Modern humans, with their big portions and lack of exercise, have a high incidence of obesity, which is related to diseases like diabetes, cancer, high blood pressure and heart disease.

Since overeating is linked to a number of diseases, it seems possible that the people in the population who carry "overeating genes" may be less likely to reproduce and pass the trait on to future generations. Another possibility is that nutrition education along with cultural and technological changes will slow down the trend and intervene in the evolutionary process.

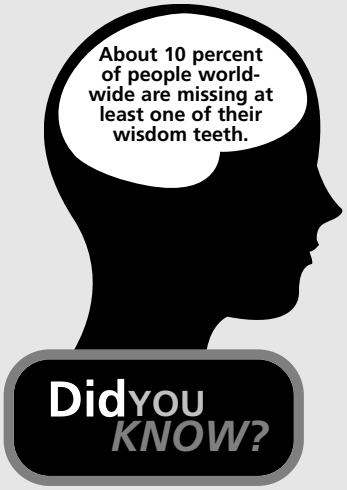
Suppressed Wisdom Teeth

For millions of years, all of the apes and many types of monkeys had 32 adult teeth, including four wisdom teeth. Wisdom teeth, located at the very back of the jaw, were necessary for early hominids to help them chew tough and fibrous food. But once they gained the brain-power to discover fire, they could cook their food and make it soft.

As the human brain got larger, the shape of the jaw changed and there was no longer room for wisdom teeth. When wisdom teeth would grow in, they become impacted, forming into the wrong position within the jaw or pushing into the teeth in front of them. This painful problem made it less likely for people to find mates and reduced fertility. Across the population, those who didn't have impacted wisdom teeth were more likely to reproduce than those who did.

Suppression of the wisdom teeth is an example of the process of evolution — increased numbers of people in the population have been passing on a lack of wisdom teeth to later generations.

However, this pattern is near its end. Medical technology has stalled this evolutionary process, because those who inherit wisdom teeth no longer have to suffer — doctors can extract the problem teeth and patients can live healthy, fertile lives.



Surviving: THE BODY OF EVIDENCE

Surviving in the Future

The current variety of human populations makes our species successful. Variation is the essence of our strength because it increases our potential to respond to change in the natural world. Because our species is large with populations in virtually every place in the world, it is likely that we will continue to evolve in the future. No one knows or can predict the influence of culture on this process, but we do know that the diversity of human culture has protected us against at least some features of our natural and man-made environments.

However, future changes to our environment and a loss of variety in humans may affect the ability of our descendants to survive.

Natural Disasters

Natural disasters like earthquakes, volcano eruptions, floods and fires can have a local impact on population and perhaps affect the evolutionary process. For example, the tsunami of 2004 in Indonesia killed a quarter of a million people. This was a large percentage of the local gene pool who will now not be passing on their genes. The impact on the worldwide population, however, was relatively small as it only involved 0.0002% of all humans.

Global Spread of Disease

With humans traveling from one far off locale to another, a deadly and highly contagious disease could easily spread to populations worldwide. If this were to happen, perhaps only 10 percent of people on the planet would have a natural immunity to it and would survive.

While deadly viruses are rare, the influenza pandemic of 1918 wiped out more than 600,000 Americans. The disease was first spotted in soldiers stationed in Fort Riley, Kansas. As these soldiers went into Europe to fight in World War I, the virus rapidly spread. Troops returning home from combat brought with them this killer disease.

Population Growth

Currently, there are seven billion people on Earth, and humans live in almost all the livable geographical areas. If the population continues to expand, it will undoubtedly affect the environment and in turn, future evolution.

Global climate change is one way that human populations have already influenced the environment. However, scientists still do not know how the rising temperatures will affect plant and animal species.

Massive War

Like natural disasters, massive war could result in several million deaths, which represents a large portion of the population that could not pass genes on to future generations.

Genetic Manipulation

Humans have been changing the genetic structure of many living things, particularly the plants and animals used for food. The short-term effect of genetically-modified food is positive, providing food to people around the world. However, the long-term effects are unknown and unpredictable.

Less Variety in Humans

Currently, humans who live in different regions of the world have genetic traits that help them best survive in their geographical areas. For example, Eskimos whose ancestors lived in Alaska for generations are better suited for the cold weather and diet of the region than a visitor from South Africa.

However, as technology increases and more and more people travel, settle in new geographic locations and inter-marry, these variations will be lost.

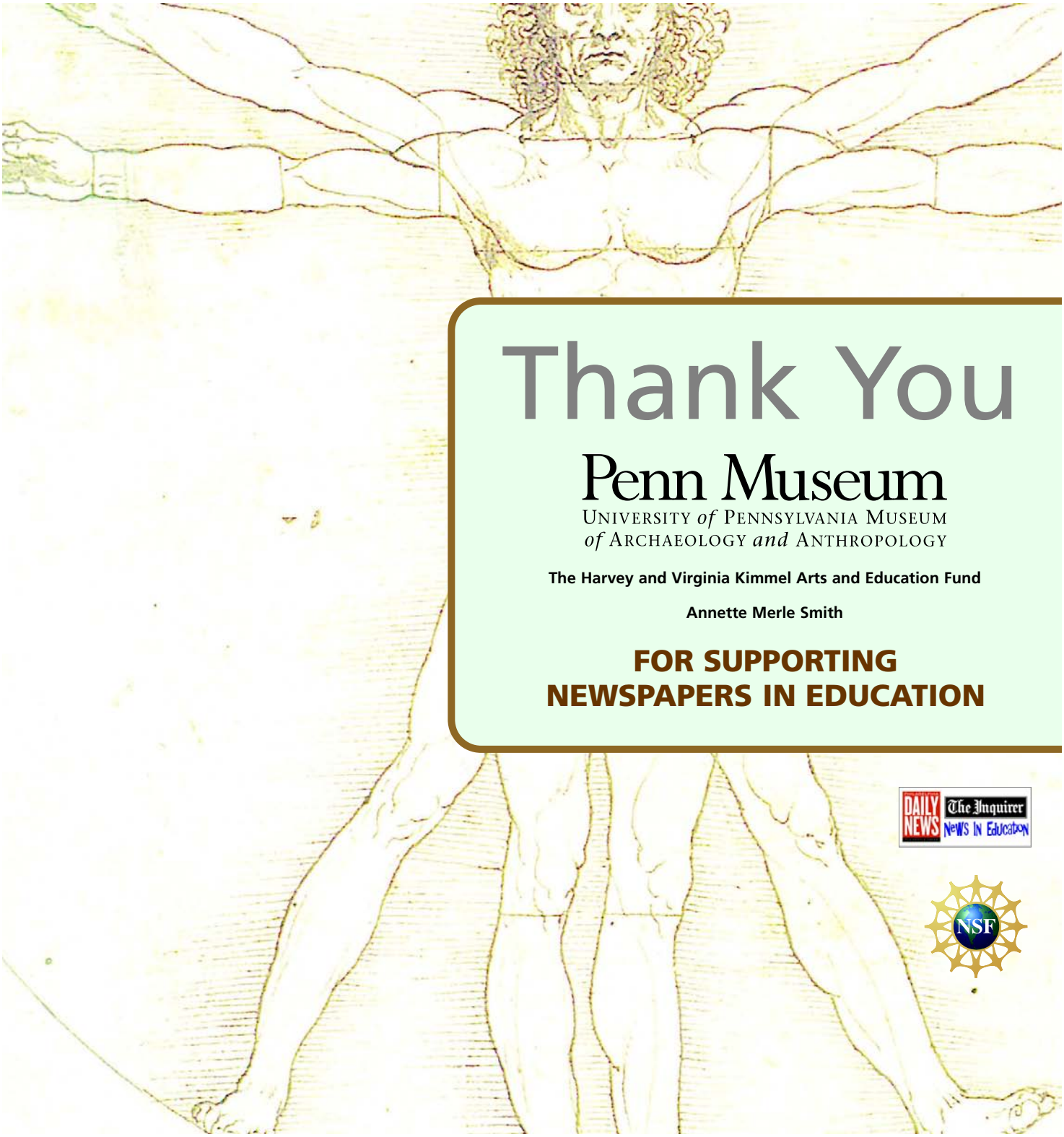
FACT *or* Fiction

Evolution affects human's daily lives.

Fact! The evolution of other living things affect humans every day. For example, the evolution of insects has greatly affected how farmers approach agriculture. While pesticides used to protect crops from pests, new generations of pesticide-resistant insects have been born. Harsher chemicals are now required to kill them, which takes its toll on the food that most humans eat.

Survival IN THE NEWS

Look through today's Inquirer, *or use the Internet, to find articles about evolution. As a class, create a list of modern arguments that are given in support of evolution and against. Then write a short essay describing your position on evolution. Use evidence from the newspaper or this student supplement as support.*



Thank You

Penn Museum

UNIVERSITY *of* PENNSYLVANIA MUSEUM
of ARCHAEOLOGY *and* ANTHROPOLOGY

The Harvey and Virginia Kimmel Arts and Education Fund

Annette Merle Smith

FOR SUPPORTING
NEWSPAPERS IN EDUCATION

DAILY NEWS The Inquirer NEWS IN EDUCATION

NSF