Mullis

Chapter 2 ~~**ADLECENTS**~~
Childhood & Adolescence

Chapter 2: Childhood

Bliss is the plaything of the child –

The secret of the man

The sacred stealth of Boy and Girl

Rebuke it if we can

--Emily Dickinson

Childhood—the age of discovery where kids possess boundless energy, an untamed imagination and a million questions. From this stage of life nothing is impossible except arriving at a destination during a LONG (five to ten minute) car ride to visit family or friends. In the eyes of a child, second in-command to the fearless superheroes who laugh in the face of danger on Saturday morning cartoons are none other than their parents who come to the rescue with bandages when children fall on the playground. Unlike adults, children see the world through a very young and optimistic scope. This youthful and innocent view of life and having a simplistic mindset is the sole reason why adults and elders wished they hadn't rushed their youth away when a hug and a warm smile made every worry dissipate. Of the million traits kids are known to have, five characteristics that set childhood apart from any others include children's crazy imagination, their eagerness to obtain knowledge, boundless energy, unmatched trustworthiness towards everyone and of course innocence.

Ages ago, in the time of the dinosaurs it seems when I was in elementary school, the teacher asked the class what the future would be like. The class took this assignment to heart and put every effort and every ounce of brain power into imagining what the next

one hundred years would look like and how technology would change over time. The class envisioned a world filled with hovercrafts traveling at the speed of light through cities in the sky. Sure, it is not utterly impossible, but our ideas were without a doubt "out of this world". But who is to blame—we could always dream. Plus, we just based our conclusions off of "Jimmy Neutron". Popular movies and television shows geared towards children such as "Fairly Odd Parents", "Barney" and many others encourage children to stretch their imaginations to new unexplored heights because the human mentality knows no boundaries. Aside from the media, books and poems also introduce children of all ages into coloring outside the lines. In Jack Prelutsky's poem "A Very Boring Day", he shows how adventure can be in one's backyard and also how things can be overlooked.

Linking to imagination, a child's mind will never become stagnant like a motionless pond in the middle of a hot, muggy summer day. The world in the eyes of a child is an endless place of discovery and opportunity. Their young minds are like a blank slate and they have the unsurpassed eagerness to find out everything and fill up that slate with all the wonders of the earth. It is somewhat amusing yet intriguing to watch a child the morning of the first day of school. Most likely the child picked out a school outfit with utmost care the previous night and made sure everything was packed in the book bag, including the shiny crisp red apple for the teacher. Throughout elementary school a detectable urge to learn and succeed grows as children frequently bring home tests with a red A+ and a gold star to hang on the refrigerator to be awed by family members who stroll in to the kitchen to procure nourishment.

One of the more obvious traits children have is limitless energy—its like they are offspring of the Energizer bunny. Springing out of bed like a speeding bullet at seven in the morning to watch Saturday cartoons and not stopping to take a breath until bedtime, this is the basic day in the life of a child. Parents always sit back and wonder if what they feed their kids is the problem. Maybe the sugar rush plays some crucial factor in the child constantly being in hyper speed, but for the most part the answer lies simply in the fact that children were just wired this way. Having exceedingly more energy than older humans is extremely frustrating for parents and guardians especially when trying to chase them around the house to give them a bath. The only time that kids loose their stamina is when they are the most venerable. Envied by many people, this bottomless pit of energy is best exemplified in the childhood stage of development unless it is mimicked by consuming several Red Bulls.

Similar to associating adolescence with a ton of energy and exuberance, children also trust everyone, especially close family and friends to no end. Where children loose this trait is highly disputable, but the world would be in a better position if this trait was irreversible and permanent. Trusting people to no boundaries can be harmful however, but children do not yet know to form their opinion. For example, what older sibling did not try to scare their younger sibling in telling them that monsters under the bed and in the closet really existed? I know I am guilty of this crime. This frame of mind is admirable to some extent though.

Innocence, the prize possession children have and they do not know they hold this valuable key. Similar to the old phrase "Innocence is bliss", innocence is along the lines of that concept. In this blissful state of not knowing, all corruption of the world is

nonexistent. Being in this "bubble", some say is harmful for a child because they need to know of the evils that are present and to be cautious and aware that all people are not good. Religion plays an important role in hanging on to one's innocence. Having a structured set of values to abide by acts as sturdy, safe haven in times of tribulation and chaos. Moreover, children of all ages have the sense to be less skeptical of everything like adults tend to be.

The simplicity of the world viewed mainly by children and taking a man's word as gold is an admirable attribute. Famous English poet Francis Thomson sums it up I better terms. She said, "Know you what it is to be a child? It is to be something very different from the man of to-day. It is to have a spirit yet streaming from the waters of baptism; it is to believe in love, to believe in loveliness, to believe in belief; it is to be so little that the elves can reach to whisper in your ear; it is to turn pumpkins into coaches, and mice into horses, lowness into loftiness, and nothing into everything, for each child has its fairy godmother in its own soul." Somewhere in the scheme of things, this angelic element of the human nature is lost, and this link is unfortunately one of man's greatest blemishes.

Childhood seems to be a distant place in the cobwebs of my existence, but back then I believed that the Tooth fairy slipped a surprise under my pillow in exchange for my baby tooth, and that Santa kept up with which children who were naughty and nice. That blissful stage of development seems almost magical in a sense that everyone at one point were so trusting of everyone and had such a great disposition of the world and of people. As children mature and grow up, these five characteristics seem to fade as new ones dominate. Innocence, as well as a positive outlook of the world and its inhabitants turns

from a fairy tale perspective into a harsh reality as drama tragedy and heartbreak takes the stage in one way or another. None the less, childhood is a rapid moving phase of maturity in which children and teens learn many valuable life lessons through unique experiences.

The following article, taken from the June 2, 2001 edition of *Science News*, discusses the potential benefits of child fossils to evolutionary though. According to the article, scientists now believe that analysis of infant, toddler, and teenaged fossils can provide a tremendous amount of insight into the developmental stages of Homo Sapiens which could lead to a better understanding of modern man as well as his ancestors. The article illustrates that understanding children, both living and dead, can have a profound impact on human knowledge.

Evolution's Youth Movement

Anthropologists usually don't find the skeletons of long-dead toddlers when digging into ancient ground. But at Syria's Dederiyah Cave, they did just that in 1993 and again in 1997.

Excavations at this approximately 60,000-year-old site yielded the partial remains of one small child and the nearly complete skeleton of another. Researchers estimate that both died at around age 2.

The Dederiyah youngsters are part of a growing contingent of fossil kids attracting scientific interest. Fossils of children had previously been treated more as oddities than as beacons of evolutionary insight. Now, however, these ancient youths are revealing aspects

of human evolution that had evaded scientists studying fossil elders from various Homo species, the first of which appeared around 2.5 million years ago.

In particular, infant and juvenile fossils hold clues to a critical issue: the evolution of distinctive patterns of growth in modern Homo sapiens and our immediate ancestors. Understanding individual development may for the first time delineate pivotal differences among Neanderthals and several Homo species.

Scientists agree that people grow to adulthood over a longer period and across more developmental stages than apes and monkeys do. A consensus also holds that australopithecines, members of an early genus in the human evolutionary family that lived from around 5 million to 2 million years ago, followed a developmental pattern closer to that of modern apes than that of humans.

Yet relatively little is known about the evolution of individual growth patterns in Neanderthals and other members of the Homo genus. Research into growth and development has long taken a back seat to detailed analyses of skeletal traits of adult Homo fossils.

Adult skulls look enough alike to form a hazy continuum among specimens assigned to modern, early, or archaic H. sapiens or to other Homo species. Without clear dividing lines among skulls and teeth, the most abundant fossils, some researchers identify a dozen or more Homo species, while other scientists propose that only anatomically diverse forms of H. sapiens have roamed the Earth during the past 2 million years or so.

Recent discoveries in developmental biology have begun to influence this debate. For instance, in animals ranging from sea urchins to mice, early development may proceed differently for closely related species that end up looking much the same.

Development may also take unexpected turns for members of a species exposed to minor changes in diet or social organization, with dramatic consequences for body shape. Finally, genetically mediated shape changes in certain parts of the skeleton may trigger developmental processes that lead to extensive remodeling elsewhere.

These findings indicate that anthropologists' small but growing collection of fossil infants, children, and teenagers may hold untapped clues to humanity's origins, says Steven R. Leigh of the University of Illinois at Urbana-Champaign. Leigh and other like-minded anthropologists presented their latest findings at the annual meeting of the American Association of Physical Anthropologists, held in Kansas City in March.

On the other hand, the twists and turns of individual development can sometimes hide more than they reveal about evolution, Leigh notes. It's time however, to drop the assumption that evolutionary forces primarily affect the shape and function of adults' bodies rather than how youngsters grow, he contends.

"There's a fair amount of chaos right now regarding how to look at individual development and ancestral patterns of growth," Leigh remarks. It's clear that developmental patterns evolve much more rapidly and profoundly than has often been assumed, he says.

Several research milestones have inspired current explorations of growth and development in fossil species, said Barry Bogin of the University of Michigan-Dearborn at the March meeting. In 1917, D'Arcy Thompson used mathematical models to show that different patterns of growth from a common fetal form could produce the contrasting skull shapes of adult chimpanzees and humans. In 1924, Adolph Schultz used eruption times of permanent teeth to mark off three primate life stages: infantile, juvenile, and adult.

Two decades later, Samuel Brody showed that a juvenile phase occurs in people and chimps, but not in cattle and other farm animals. Since then, researchers examining teeth and other characteristics have identified a juvenile stage in wolves, elephants, whales, and other highly social mammals.

Another research milestone was reached in 1975, when researchers began to study tooth growth in australopithecines. The closest parallel today to the pattern of dental development of these ancient, two-legged creatures is not in people but in common chimpanzees.

Since then, the scientific focus has shifted to Homo species. By examining teeth and other body parts of living populations, Bogin identifies five human growth stages after birth: infant, child, juvenile, adolescent, and adult. Childhood and adolescence don't appear in any other living species, he asserts.

Several researchers have explored the possibility that Homo erectus individuals also passed through childhood and adolescence. This potential ancestor of H. sapiens lived from around 1.6 million to perhaps 100,000 years ago.

H. erectus fossils, such as a nearly complete skeleton of a solidly built boy in his early teens, indeed reflect an extended childhood growth period, says Susan Anton of Rutgers University in New Brunswick, N.J.

Earlier studies had disagreed on whether H. erectus experienced a cardinal feature of human adolescence, the sudden growth spurt. Anton's latest investigation indicates a teenage growth surge in H. erectus slightly smaller than that in H. sapiens. Jaw and facial heights of H. sapiens typically increase 15 to 20 percent during their teens. Anton's analysis of seven H. erectus fossils finds that during the teen years, H. erectus increases 80 to 90 percent as much. However, this statistical finding remains tentative.

"We need to use caution in talking about an adolescent growth spurt for Homo erectus and wait for more fossil finds," she says.

H. erectus also plays into a long-running debate over whether modern humans have evolved so that adults, at least from the neck up, now look like juveniles in ancestral Homo species did. Scientists refer to this phenomenon as neoteny.

Preliminary data indicate that the rounded cranial shape of adult H. sapiens resembles that of juvenile H. erectus, according to Leigh. He compared measurements of 70 modern human skulls from people of various ages with those of two adult and one juvenile H. erectus skulls.

Neoteny in the skull may have been an evolutionary compromise, Leigh theorizes. This process made room for the larger brains in H. sapiens without remodeling many facial and cranial traits from H. erectus, in his view.

This brain growth may have sparked changes in diet and social life that enabled humans to exploit diverse habitats, Leigh suggests. For instance, hunting techniques may have changed to provide more meat to pregnant and nursing mothers of large-brained babies.

H. erectus apparently had a narrower repertoire of behaviors, Leigh adds. This fossil species exhibits cranial evidence of slower brain growth than that found in modern humans. It also shows marked changes in brain shape during development, Leigh says. The rounded brain cases of H. erectus youngsters become longer and narrower in adults.

Intriguing developmental evidence about two other ancient Homo species comes from excavations in Spain's Atapuerca Mountains.

As early as 800,000 years ago, a Homo species living in this region displayed a prolonged pattern of tooth growth, as seen in modern humans, says Jose M. Bermudez de Castro of the National Museum of Natural Sciences in Madrid (SN: 4/3/99, p. 212). Bermudez de Castro and his coworkers unearthed nearly all the teeth for three children. The team assigns these ancient fossils to a new species, Homo antecessor. Other researchers, however, regard the finds as representing an undetermined Homo species.

Bermudez de Castro's group also excavated teeth from a child at another, approximately 300,000-year-old Atapuerca site. This child comes from a collection of fossils that Bermudez de Castro assigns to Homo heidelbergensis, a species first discovered in Germany.

For each of the four Atapuerca fossil children, the Spanish team noted the maturity of teeth at the front and the back of the mouth. These areas follow different patterns of dental growth. The researchers then compared the data with patterns of dental maturity in modern apes and people, as well as australopithecines.

"Both Homo antecessor and Homo heidelbergensis shared with modern humans a prolonged pattern of dental maturation," Bermudez de Castro says. This suggests that both species were direct ancestors of H. sapiens, in his opinion.

Expanded tooth development of this magnitude indicates that the life histories of these ancient species included an adolescent phase, he adds.

Elsewhere in their bodies, Neanderthal kids also show signs of having grown in a humanlike way. These observations give ammunition to those who suggest that, in essence, Neanderthals were us, rather than a separate species.

Preliminary comparisons indicate that Neanderthal and prehistoric H. sapiens children have similarly shaped hipbones, report Tona Majo and Anne-Marie Tillier, both of the University of Bordeaux in France. Moreover, their fôssil hipbones look much like those of today's children. Where differences from the modern human bone occur, they're shared by Neanderthals and ancient H. sapiens, the researchers say

Majo and Tillier examined pelvic remains of three Neanderthal children from La Ferrassie, a roughly 70,000-year-old French site, and of three H. sapiens youngsters from Qafzeh, a 90,000-year-old Israeli site. Fossil individuals ranged from infancy to age 6 at the time of their deaths.

The length and thickness of the Dederiyah toddlers' leg bones also fall within the range of the H. sapiens, says Osamu Kondo of the University of Tokyo. Kondo and his coworkers had excavated these Neanderthal youngsters' remains.

Finally, the upper arm and upper leg bones of a Neanderthal baby found in Israel's Amud Cave appear nearly human, says Hartley Odwak of University College London. He compared computed tomography scans of the Amud limb bones and those of modern infants' bones. Like the Dederiyah toddlers, the infant's bones show no evidence of having been as thick, relative to body size, as those of adult Neanderthals.

Only one or two pivotal changes in skull development may distinguish modern H. sapiens from closely related predecessors such as the Neanderthals, suggests Daniel E. Lieberman of George Washington University in Washington, D.C. Even if development looks similar in Neanderthals and modern humans, small but critical changes could still mark them as separate species, he argues.

Lieberman analyzed data on skull growth from infancy to adulthood in 12 Denver-area residents. A defining feature of human anatomy is that the floor of the skull flexes up near the front as a child grows, Lieberman says. This opens up the vocal tract and enables people to make a variety of speech sounds. As the skull flexes, the cranium becomes rounder and the face shortens and retracts until it's directly under the brain case.

Flatter skull bases and brain cases combine with longer, more protruding faces in adult Neanderthal and archaic H. sapiens fossils, he notes.

A preliminary comparison of skulls from Neanderthal and human children, conducted by Gail E. Krovitz of George Washington University, finds that the shape differences described by Lieberman appear by age 3.

Subtle, genetically mediated shifts in the development of the skull base and perhaps the cranium may have been enough to trigger the evolution of modern H. sapiens from its most recent ancestors, such as Neanderthals, Lieberman and Krovitz theorize.

While their scenario is possible, comparisons of fossil youngsters with modern children are difficult to make with any precision, according to Bogin. As recently as 15,000 years ago, the hunting and gathering way of life sparked developmental processes that yielded adults of markedly larger stature and with denser bones than observed in people today, he says.

"Lifestyle greatly shapes how people grow and develop," Bogin says. "We need to know a lot more about the lifestyles of creatures such as Neanderthals and Homo erectus before we can understand how they developed and compare them to us."

Another problem, says Leigh, is that developmental differences between species sometimes hide more than they reveal about evolutionary relationships. For instance, Leigh finds that within the papionin family of monkeys, only a baboon undergoes the bulk of its brain growth early in life. Mangabeys, which display many genetic similarities to baboons, grow their brains at a slower pace and bear little resemblance to baboons as adults.

Yet adult mandrills, which possess fewer genetic similarities to baboons than mangabeys do, have an extended muzzle and a relatively large brain case that gives them a baboon like look. This convergence of skull shapes occurs because mandrills, after a slow period of mangabey like brain growth, experience rapid brain expansion before entering adulthood, Leigh says.

The moral of this tangled developmental tale is a cautionary one: Give fossil kids due respect when investigating human origins.

Just don't expect them to blurt out any precocious evolutionary insights.

As the following article states, very few people are aware of the virus that causes infant diarrhea and how prevalent it actually is in the world. "New Hope for Defeating Rotavirus," taken from a 2006 edition of *Scientific American*, addresses the World Health Organization's concern with designing a vaccine for the deadly rotavirus. The article provides the history of the virus as well as the progress of creating a suitable vaccine. The author, Roger I. Glass, is chief of the Viral Gastroenteritis Section at the CDC and is an adjunct professor of pediatrics and international health at Emory University.

New Hope for Defeating Rotavirus

Although its name is unfamiliar to many, rotavirus is the leading cause of severe childhood diarrhea worldwide and a frequent killer of young children in developing nations. Now after 30 years of investigation--vaccines that may well conquer it are ready for market

The thought of a murderous virus often conjures images of patients suffering from Ebola virus in Africa, SARS in Asia or Hantavirus in the U.S. Yet those evildoers have taken far fewer lives than rotavirus, whose name is virtually unknown. This virus infects nearly all children in their first few years of life. It causes vomiting followed by diarrhea. The diarrhea is often so severe that, if left untreated, it can lead to shock from dehydration and then death. Worldwide, rotavirus kills an estimated 610,000 children every year, accounting for about 5 percent of all deaths among those younger than five years. In the

U.S., few children perish from the virus, but as many as 70,000 require hospitalization for it annually, and several million suffer quietly at home.

Scientists, though, are now about to break the grip of this devastating disease. In January-some three decades after investigators first identified the pathogen--researchers reported that two rotavirus vaccines had proved successful in massive clinical trials. The process of developing rotavirus vaccines has been more difficult and complicated than anyone imagined, full of setbacks and surprises. But today both the World Health Organization and the Global Alliance for Vaccines and Immunization consider rotavirus vaccine a top priority, and the final battle to get immunizations to the young children who so desperately need them has begun.

Identifying the Contagion

ROTAVIRUS was first identified as a cause of human disease in 1973 by Ruth Bishop, a young microbiologist working on gastrointestinal diseases at the Royal Children's Hospital in Melbourne, Australia. At the time, investigators were perplexed by diarrhea in children. Although the disorder was common and frequently severe, the causative agent was rarely identified. Searching for clues, Bishop's group looked through an electron microscope at biopsied tissue from the duodenum, or small intestine, of acutely sick children. What they saw astounded them: an infestation of wheel-shaped viruses in the epithelial cells that form the intestinal lining.

My own involvement with rotavirus began in 1979, when my wife and moved to Bangladesh to work at the International Center for Diarrheal Disease Research. Young and idealistic, we were drawn by the prospect of helping children in a country where severe

diarrhea was a leading cause of death. The center's hospital in Dhaka admitted so many patients with unspecified "intestinal" flu annually that some had to be cared for in hallways and in tents outside. Believing the cause of their diarrhea to be bacterial, we were surprised to find many of the children were suffering not from cholera, salmonella, shigella or Escherichia coli but from rotavirus, about which we knew little. With the help of a simple test, we determined that rotavirus was responsible for the admittance of between 25 and 40 percent of all children younger than five to our hospital for diarrhea.

Studies from around the globe yielded similar results. What is more, they revealed that rotavirus was not only widespread but a major cause of death in the poorest nations. By 1985 such data compelled the Institute of Medicine to put rotavirus infection atop a list of diseases for which vaccines were urgently needed in the developing world.

At the same time, surprisingly little was known about the incidence and distribution of rotavirus in the U.S. In 1986, when returned to the U.S. Centers for Disease Control, the disease was rarely diagnosed and, in fact, was not even listed in the International Classification of Diseases. Having seen the impact of the disease overseas, my co-workers and were intent on finding out whether it was affecting many people in the states.

But how does one assess the burden of a disease that is rarely diagnosed, is never listed as the cause of hospitalization in discharge records, and goes unrecognized by a majority of pediatricians who commonly treat it? My colleague, Mei-Shang Ho, began by looking at U.S. data on childhood hospitalizations. She found that diarrhea was a common cause of hospital stays, accounting for 12 percent of hospitalizations in children younger than five, and that most cases were coded as being of unknown etiology. Further studies

revealed that a lion's share of the undiagnosed cases were attributable to rotavirus. Three other interesting facts about rotavirus in the U.S. emerged as well. First, infection follows a distinctly seasonal pattern, peaking from December to March; second, the vast majority of children hospitalized for this virus are younger than five years; and third, regardless of season, rotavirus causes most cases of severe diarrhea in young children.

Epidemiologists now know that rotavirus is far and away the leading cause of childhood diarrhea worldwide, infecting virtually all children between the ages of three months and five years. Unlike bacteria that spread via contaminated food and water and thus disproportionately affect people in poor regions, rotavirus shows no regard for geographic borders. Indeed, the very ubiquity of the pathogen with Americans facing the same risk of infection as Bangladeshis--suggests the virus is highly contagious, spreading as easily as, say, a cold virus. And, as is true of cold viruses, sanitation and clean drinking water have little power to block transmission.

Molecular and clinical studies bear witness to its virulence. Just 10 virus particles can start trouble in a young child. A virus-laden droplet landing on a baby's thumb or toy is all it takes. Popped into the mouth, the virus makes its way to the epithelial cells lining the small intestine, where it replicates at astonishing speed: within 24 hours, 10 viruses become millions, filling and killing the cells with their proteins, toxins and newly made particles. Soon the gut epithelium sloughs, and a flood of fluids and electrolytes exits the body in diarrheal bursts. Without rehydration therapy, a child can lose as much as 10 percent of his or her body weight and go into shock in just one or two days.

Fortunately, children who survive their first infection suffer no long-term consequences, and few ever experience another bout of rotavirus diarrhea. They have natural immunity-that is, their immune system has become primed to quickly recognize and prevent replication of rotavirus when it next invades. But because so many children become severely ill with the first infection, scientists consider a vaccine that could mimic this natural immunity to be the best hope for saving lives.

Quest for a Vaccine Begins

VACCINES are powerful weapons in the human arsenal against infectious disease and among the most effective interventions in public health. Made from either live or killed microorganisms or from their key proteins, vaccines trick a recipient's immune system into believing it is under attack. In response, the immune system produces antibodies against the vaccine (which poses no biological threat), just as it would against the virus itself. And as in natural immunity, should the disease-causing agent ever invade, the immune system is fully primed, ready to pump out antibodies to immobilize it.

Twenty years ago several pharmaceutical companies became interested in developing a vaccine against rotavirus. With a potential market both large in size and global in scope, the high costs of vaccine development appeared reasonable. In addition, distribution would be easy even in remote places: rotavirus vaccine could be added to the Universal Program for Childhood Immunization, which under the auspices of the WHO and UNICEF already delivers routine vaccines to about 80 percent of the world's children.

Although different approaches to vaccines have been considered--human versus animal strains, live versus killed viruses, whole virus or protein subunits--rotavirus