The Answer is ANTS, sir!

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WHY?

Ants! They are everywhere but they are notably humble in the minds of most people. So why teach ants? Why would a biology teacher with so much to cover want to spend a whole unit of precious teaching time on the little ant? It would take a book to list all the reasons, but let me just offer a few.

Ants are animals. They are unique in that they are the most numerous animals on the planet. Scientists believe that if all the ants were placed on one side of a balance and all the humans were placed on the other, it would be a perfect and equal match. Hard to believe? Think for a moment about walking outside from your home or your workplace. How far do you have to walk before you meet your first ant? Well, at the school where I teach you have to take maybe one step and there they are. That's on a good day. On a bad day they walk right in the building and make an attempt at ownership.

Ants are a phenomenal success story. You will not find them whining out at you from the pages of your local conservation publication. No. They will leave all those pages to the panda and the puma. Ants don't mind sidewalks and streets. Buildings don't bother them. Cars cannot deplete their ranks. In fact millions of dollars spent on poisons cannot thin their burgeoning populations.

Scientists believe that a large part of the magic of being an ant is the social organization they exhibit. Humanity centers history around one man who hung on a cross and died a terrible death for the good of His fellows. Ants consider such action to be all in a day's work. Altruism runs rampant among ants. They simply cannot do enough for each other. On the other hand, don't be on the short end of a fight with an ant. When provoked to war, they make Attila the Hun look like a Sunday school teacher.

Ants employ the most complex form of chemical communication of any animals. The typical worker ant is a walking battery of exocrine glands. Ants produce glandular secretions called pheromones, which act as signals to other ants, which then respond in an organized way.

Ant children are cared for by adults, and not old, worn-out adults either. The geriatric cases nobly offer themselves as soldiers when the need arises (after all, they have already lived good long lives), and they also go out foraging for food, which is one of the most dangerous jobs in ant culture. Becoming a victim on the way to the grocery store is a fact of life, or of death, as the odds might have it.

And for the ladies we have the ants making a downright fetish out of motherhood, with the queen mother being freed up from other responsibilities so that she might devote her full measure to the careful production of healthy offspring. And childcare? Right on the premises. And may we perhaps inappropriately note that there is a radical element here in that the males, after mating, become passé, and from then on, the women make it all happen. Starting a NOW chapter would be one of the least necessary things among these amazing animals.

Ants have adjusted well to even the most disturbed habitats. The only places free of ants are Antarctica (ironic, yes?), Iceland, and Greenland but lets face it, those three locales can't even pass cold viruses around because they freeze in the air. Ants are resistant to hard radiation, which means they will probably outlast us unless we in the very near future turn our backs on the nuclear option. In some cases, ants have survived under water for as long as fourteen days. Noah would have to be called in to wipe them out with aquatic submersion. The known living ants comprise 15,000 species. There's an ant for every occasion, or niche.

On a more serious note, we have to ask ourselves: what better organism to study? If you wanted to study how to build a successful computer empire why would you waste time attending to anyone but Bill Gates. And if you were going to learn boxing would you ignore the current champion in favor of a lesser model? Well here we are in the animal kingdom, starting to have reservations about our own longevity as we allow our environment to be irreparably altered, and whose name keeps popping up in the plus column? Yep. The ants.

We can benefit by poring over the annals of ant history. We can illuminate our path by sitting at the feet of the masters. We can glean wisdom by meticulously documenting the methods of the survivors. While we ourselves have piled high into cities, we can learn from the experiences of folk who have behemoths that make even our most populace hubs look rural.

Why ants? The more intelligent question would be, why anyone else? Especially since ants are available all year long at no cost. Especially since the Scientific Review Committee doesn't care what you do with ants. No animal rights activists will ever haunt your halls accusingly. Lab rats must have their cages cleaned regularly. Lab ants have only one weakness, and that is a penchant for squeezing out of tiny enclosures and heading for parts unknown. Those caught in the act, however, can draw the death penalty without a whimper from the civil libertarians.

What should be taught about ants? I am proposing in this unit to use ants to teach the nine characteristics of living things. This will put the ants at the very beginning of the year, where I need them to be. And, right after I teach the unit I will start my students on their year-long science investigation, which will hopefully culminate in science fair participation. Science fairs are the teacher's best friend. They actually give students a chance to really do science instead of just learning about what other scientists have done.

In the past I have taught the nine characteristics using the family dog. I wrote a stupid song which I make the kids sing ad nauseam or until they can easily recall all nine of the qualifications to look for before calling the subject a live specimen.

I have more than one cell, my cells are so swell!
I respond to a flea, if he stimulates me. (Frantic scratching required here.)
I develop and grow, as you probably know.
I'm a dog, the family dog. (Howling is required at this juncture)

I can move, but I'm slow, as you probably know.
I rely on the sun, to get strength to have fun. (use energy)
Someday I'll grow up, and give birth to a pup. (reproduce)
I'm a dog, the family dog.

I have one adaptation, that helps my frustration,
So that when it gets hot I shed fur on the spot.
I pant when I sweat. If I go to the vet
I could live 'til I'm twenty. My life span is plenty.
I adjust to each change. I try not to get mange.
I'm a dog, the family dog. (More howling here. Required.)

So great is my attachment to seeing my students abase themselves by scratching fleas and howling like a dog, I guess I could never give up the teaching of this song. So I'll have to start with this song, but then switch to ants for the specifics. It will be explained to the students that a thorough knowledge of dogs would not lead naturally to science projects since one must avoid the vertebrates at all costs when contemplating scientific exploration. One year I thought the Scientific Review Committee would approve a series of projects we had dreamed up that involved guppies. I was so dead wrong about that, the deadness of the wrong has stuck with me for many years. Just remember this when you next clean your fish tank, callously throwing away the guppy casualties: you may not see it as a big life crisis, but the Scientific Review Committee would frown on it with a capital "F."

Teaching the life characteristics from the ant perspective would serve me well on a number of counts. For one thing it would give me an excuse to introduce ants early in the year as opposed to late in the year, when we finally get to arthropods. Kids need to thoroughly know the organism they are going to study for independent investigation. There is nothing worse than air whizzing between the ears of a science fair presenter. I plan to write the ANT TEN COMMANDMENTS and make it a requirement for all students to be able to verbally elucidate the wisdom these commandments will embody.

The first commandment will simply be: **Ants are everywhere, but are only occasionally noticed**. The other nine commandments will serve to reiterate the nine characteristics of living things as specifically demonstrated in the humble ant. Reciting the Ant Ten Commandments will be a first step in putting words in the mouths of presenters. As I may not have mentioned, science projects must be defended verbally, unlike history projects, which can sit quietly at a fair waiting to be seen and not heard.

I have yet to find the student who eschews ants. If a jar of ants happens to be in the room, the students magnetically veer towards the jar as they come in the room and the questions start flying. That goes for all students, ages barely cognitive to one foot on the banana peel. And of course what's not to like about a group of organisms that seem to have been born schooled in the art of theatrics. You like action. Of course you do. That's why you find yourself glued to the tube until your better self objects. Ants never stop. They are in motion endlessly. If the light is on, they are on.

I used to tell my children in response to the ubiquitous "What are we going to do today?" question, "We are going to work like dogs." But now I always quickly correct myself and insert, "We are going to work like ants, not dogs. Dogs spend a great deal of time sitting around, storing up readiness for a few Herculean feats per day, which is a modus operandi not suited to the school routine." (Although, as we all know there is a segment of the student body that insists otherwise.)

When I first started to take an interest in the red imported fire ant, there were a number of good web sites, but that number has blossomed in recent years. Yahoo! has 8,000 sites currently, and many of them are excellent because the serious research concerning this organism has begun to thrive. Although most of the studies are still hostile, as in, "how do we get rid of this pest," there are a goodly number of sites that are not hostile. I do not encourage hostile research in my class. Instead I try to foster a respect, a fascination for this magnificently successful organism. This is what makes my proposed unit relevant to the seminar I have chosen. I think we can learn from an organism—any organism—that can withstand the environmental disruption we seem to be hell-bent on leveling against the delicately balanced orb we are dependent upon for existence.

Let's assume for the moment that we buy the notion that ants should by all means be studied. What about them should we study? In this unit I propose to introduce my students to the entire year through the hallway of the ant. Of course they come to us knowing that biology is the study of living things, but they do not arrive fully aware of what scientists mean when they slap the "ALIVE" label on an entity. And that bit of ignorance is the first dollop of innocent stupidity one must tackle.

Scientists generally agree that in order to qualify for the land of the living one must come equipped with at least one cell. This is the prejudice that shoulders out the viruses. I find that my students are less than sympathetic when confronted with the assertion that the virus is as dead as a doornail. But dead it is, due to its extreme lack of the basic unit of life...the cell. Bacteria slip in the door hiding their messy interiors that lack an organized nucleus, DNA rousting gamely about in the cytoplasm, but nonetheless with a primitive cell. Ants go first class with true cells that contain a host of intricate organelles, including nuclei that sport nuclear membranes.

The unit I am proposing will fall right in behind the unit on the methods of science. I teach the scientific method using a song. It is called the Science National Anthem, and it is sung with fanatic zeal until the steps in the method are at least as deeply ingrained as "Mary Had a Little Lamb." You can never know the scientific method too well. It is impossible to be too intimate with it. After all, it has raised us above the outside toilet, the handwritten curriculum unit, and the certain death that used to accompany pneumonia. For those readers who are hazy on this issue, notably because you did not endure my biology course, the steps are:

I. Define the problem
II. Collect information (about the problem, with the end in mind of forming a hypothesis)
III. Form a hypothesis
IV. Test hypothesis with an experiment
    A. Problem (the hypothesis stated as a question)
    B. Procedure (what you are physically going to do)
    C. Observation (after carrying out the procedure, what did you see, touch, taste, hear or smell?)
    D. Conclusion (based on the observations)
V. Accept or reject hypothesis
VI. Communicate the results (for the good of all humanity)

The scientific method, then, will be the form of the unit:
I. Define the Problem: Are ants living things?
II. Collect Information: Living things have cells, respond to stimuli, develop and grow, move, use energy, reproduce, have adaptations, have a definite lifespan, adjust to environmental changes. (Also under this heading would go the entire bibliography, including all Internet searches.)
III. Form a Hypothesis: Ants have cells, respond to stimuli, develop and grow, move, use energy, reproduce, have adaptations, have a definite lifespan, adjust to environmental changes.
IV. Test hypothesis with experiment(s) (There could be nine or more.)
    A. Experiment One
        1. Problem: Do ants have cells?
        2. Procedure: Using picks and tweezers, separate samples of ant materials for viewing under the microscope. Using glass slides and cover slips, search for

cell structures including cell membrane, nucleus, cytoplasm, and other organelles. View some prepared slides of animal cells for orientation purposes.
3. Observations: Record observations in the form of a number of drawings of cells in the ant material vs. animal cells in the prepared slides.
4. Conclusions: (Based on findings.)

B. Experiment Two
1. Problem: Do ants respond to a stimulus?
2. Procedure: Observe a number of ants in a petri dish. Record observations. Observe the same ants after adding a drop of rubbing alcohol to the petri dish. Record observations.
3. Observations: (In the form of written descriptions of behavior before and after introduction of alcohol.)
4. Conclusions: (Based on observations.)

C. Experiment Three
1. Problem: Do ants develop and grow?
2. Procedure: Collect a sample of ants that includes eggs, larvae, pupae, and adults. Provide adequate ventilation, water, and food. Observe and record observations, making note that size increase, either by mass or length-width-height, indicates growth, while structural and behavioral development constitutes development.
3. Observations: (In the form of numerical growth charts or drawings and descriptions of behavioral and structural changes.)
4. Conclusions: (Based on observations.)

D. Experiment Four
1. Problem: Do ants move?
2. Procedure: Collect several samples of ants. Observe for motion, with motion being a change of position over time. Using tracing paper, follow motion of individual ants in petri dish for a 10-second interval. Cut a piece of thread long enough to follow entire path. Straighten and measure thread and calculate speed (d/t).
3. Observations: (chart with distance, time, and speed for three ants)
4. Conclusions: (Based on observations.)

E. Experiment Five
1. Problem: Do ants use energy?
2. Procedure: Collect two equal ants samples. Supply energy in the form of carbohydrates, lipids, and proteins to one sample but not the other. Record observations.
3. Observations: Each sample will have a daily death rate, which can be recorded and charted.
4. Conclusions: (Based on observations.)

F. Experiment Six
1. Problem: Do ants reproduce?

2. Procedures: Collect samples of ants that include all members of the colony, including the queen. Observe and record observations.
3. Observations: Descriptive and numerical data.
4. Conclusions: Based on observations.

G. Experiment Seven

1. Problem: Do ants have adaptations?
2. Procedures: Collect and observe samples of ants for specific adaptations that relate to survival. For example, ants could be introduced into a container of water in order to observe their survival adaptation, which involves forming a living ball of ants that rotates on the water until landfall is made – at which time the ants simply walk from the survival ball onto the land. (Every time I have tried this experiment in the classroom, the ants pulled off a 100% survival rate. It is vastly impressive.)
3. Observations: Calculate survival rate and times.
4. Conclusions: Based on observations.

H. Experiment Eight

1. Problem: Do ants have a definite lifespan?
2. Procedure: More than likely his would have to be done on a case-by-case basis. Some ant queens have lived as long as 20 years in captivity. Obviously this would be a problematic number of years for a classroom demonstration. Also, perfecting a conducive environment in the classroom might have to be a goal, perhaps a year-long goal. But nothing ventured: nothing gained. Problems should never regulate what is attempted. Capturing and culturing an entire colony has been done, but not by me. The one time I came close was when I was teaching at Black Middle School and I took the students to the middle of the football field, where we imagined we had spotted the location of a colony of red ants (not the imported fire ant – just the big friendly red ants). We took a huge trashcan, borrowed a shovel from the custodian, and began to collect ants. We drilled holes in the can and provided transparent tubing so that the ants could climb all around numerous tubing sites. The results were that the group continued to sport live ants the entire year. Whether this meant that we had been fortunate enough to capture a queen we were never able to ascertain with any degree of scientific certainty. The ants did use the transparent tubing provided, but unfortunately they used it mainly as a gravesite. When we took off the lid and observed the colony directly, it was clear that the ants were using the trashcan for any vital operations, and there were several entrances to the subterranean locations of these operations. This of course indicated an apparatus design problem and it was ample evidence for the correctness of the many commercially available ant farms, none of which are large enough to house an entire colony. And, as I said earlier, constructing an ant-tight container of any sort is a challenge.

3. Observations: This would likely have to be a year-long investigation either for a group of students who were up for the challenge or for the entire class, with a few students from each class assigned to keep up the log book.
4. Conclusions: Based on observations and tempered with the knowledge that ants in captivity may have a longer lifespan, being free from predation and weather disasters, or maybe a shorter life span due to the difficulty of simulating favorable environmental conditions in the laboratory.

I. Experiment Nine

1. Problem: Can ants adjust to changes in the environment?
2. Procedure: Collect three equal samples of ants in three equal containers. Labels: Control, Experimental 1, and Experimental 2. Place them in the same location with equal access to sunlight, heat, cold, etc. Each day, turn the Exp. 1 container completely upside-down and then right side-up one time. Turn the Exp. 2 container upside-down three times. Do not disrupt the Control container at all. Observe and record behavior of ants in the three containers. Continue for a two-week period.
3. Observations: In the form of charts of reaction times for ants, descriptive behavior of ants, and also death rates of ants.
4. Conclusions: Based on observations.

V. Accept or Reject Hypothesis

VI. Communicate Results

Let me offer belated apologies for what might be boring for the non-science teacher. It is vital to apply the scientific method over and over and over again in class. The new TAKS test that Texas students must take is geared towards students who have had to think scientifically, as opposed to students who have learned about what others have thought. For example, the test might give a problem and some information about the problem, and then the student would have to choose the hypothesis that would be most appropriate based on the available information. Or, the students might be given an account of an experiment, including the observations, and then a choice as to which conclusion would be most defensible given the available data. That sort of thing can only be taught through experiences, and repeated ones at that, with the application of the method to anything and everything. This can pose a serious problem for the public schools like the one where I teach. The economic level of the supporting community is relatively low, and we are not exactly rolling in available funds for lab supplies. That is what makes ants so desirable as research subjects. They are so free. They give new meaning to the word. If you are looking for a way to provide a daily lab experience, then ants offer themselves quite nicely.

It is prescribed in the HISD curriculum that 40% of the science course be laboratory work, and here we see that no less than nine experiments could be generated that would be necessary to scientifically answer the question as to whether or not ants qualify for the living realm. But the good part is that hundreds of additional experiments might be suggested along these same lines that could be just as valid and thus lead to individual science investigations. For example, it could happen that a student might decide to investigate other adaptations besides flood survival behavior. The question could be asked, “How do ants respond to a reduced food supply?” In such a case, an experiment could be set up with some groups of ants having ample and excess food, compared to another group having minimal food. In this case experimental evidence might indicate that the ants are aided in their quest for survival by a supreme lack of regard for the dead, using them as a food source and in most cases actually preferring dead insects of any sort as a food source. This lack of cultural amenities could be then used to debate the bio-ethics of cannibalism in desperate conditions, etc. Ants are like that. They raise questions that might not otherwise come to mind unless we take the time to look at them from the point of view of their undeniable success.

Some of these labs could be done in twenty minutes. Some might take all year. But all would be an inquiring way to introduce scientific dogma that must be internalized thoroughly. Revisiting the experiments that take awhile would be a wonderful excuse to re-teach and re-teach. And many of these experiments could serve as a launching pad for the course as it unfolds. For example, the notion that living things use energy could be used to launch a discussion of exactly what we currently know about the biological pathway the sun’s energy takes as it travels through plants to the actual point of utilization in the animal cell. (Now that is a bit of animal arrogance, is it not?) The adaptation discussion could lead right into the understanding of natural selection being a driving force in the change in a species over time, and of course the ability of an organism to adjust to change could lead to the understanding of the fossil record as it displays mass extinctions, etc.

WHAT?

What are we teaching in this unit? We are teaching the nine characteristics of living things, and we are using the humble ant to demonstrate those characteristics via at least nine experiments. This learning will be assessed with a lab write-up for each experiment, following the six steps in the scientific method, with four steps in each experiment. It will also be assessed verbally when the student recounts the ANT TEN COMMANDMENTS from memory for the video camera. Some students of course demur and profess camera shyness, and those are the students who will not likely be district science fair candidates. It is very important to establish early on in the year that participating in the fairs requires a certain amount of extroversion, and that has to be coupled with something besides **air** whizzing about in the cranial cavity.

The commandments are flexible, but they might read something like this:

I. Ants are everywhere, but are only occasionally noticed.

II. Ants are made up of tiny living units called cells. Each cell has a nucleus, which contains the genetic material, DNA. The cells are eukaryotic (the nucleus is enclosed in a nuclear membrane.)
III. Ants respond to their environment, including the socio-chemicals called pheromones, which are secreted by their many glands. These substances are used to communicate with the members of the colony.
IV. Ants develop and grow, as evidenced by the fact that each ant starts life as a tiny fertilized egg, which then develops into a larger larval form, which becomes a pupa, which becomes the adult ant.
V. Ants move using six legs and a very flexible body, which has three segments: the head, the thorax, and the abdomen.
VI. Ants use energy from the sun that has been captured by the autotrophic plants and passed along to the heterotrophic animal kingdom.
VII. Ant reproduction is accomplished through the efforts of the entire colony, with the queen laying the eggs and the workers tending to the queen and the eggs. The workers are sterile females, and the males die after mating with the queen.
VIII. Ants are born with many adaptations that suit them for a variety of habitats. For example, they can endure flooding by forming a living, floating, rotating ball that takes them to dry land.
IX. Ants have a definite life span, with some queens living up to twenty years in captivity.
X. Ants adjust to environmental change really, really well, as evidenced by their large numbers in urban environments.

If students can bend themselves around this much doctrine, surely they can entertain a science fair judge for as much time as will be allowed. Not all students will memorize all en Commandments, but my philosophy is this: all students will memorize at least some and some students WILL memorize all. Either way, you can only gain through such an endeavor. Not only that, but look what you have done: you've introduced concepts that will be elaborated on later in the year, but at least by the time you get to them, students will have one foot in the door, and some students will have BOTH feet in the door.

In this unit we are re-teaching the scientific method. This is something that will have to be done throughout the year. Learning to think scientifically will be a process, and a slow one for some. The scientific method can be taught or demonstrated. I prefer doing both. Teach the students, and then allow them to demonstrate to themselves the efficacy of this method for dealing with issues that are limited to the physical realm. What happens if all the subjects of an inquiry suddenly die? Is it a problem? It is science. Record the event, go get more free ants, and repeat the experiment.

Finally, in this unit we are preparing for the science fairs. Students who are well prepared for the fairs will benefit from them in a number of ways. They will get a chance to interact with scientists who are very interested in their work, who have a lot of knowledge, and who are very challenging intellectually. Well-prepared students will be gratified because the judges will appreciate them and encourage them to go on in their studies. Of course, there is the tangible side of it too. One of my students this year won the Senior Division award given by the Mexican American Society for Scientists and Engineers. It was a thrill for her, but it was also a nice pile of loot. There was a big fancy calculator, the kind that wasn't invented yet when I was in school. There was a lifetime pen and pencil set from Pierre Cardin, the kind I would never even consider buying given my salary. There was also a big, beautifully engraved plaque and, most importantly, the right to include the event on her college applications. Colleges love to get applications from students who have won awards at the Houston Science and Engineering Fair.

An important benefit of the fair participation is the chance to meet other young people who are doing things besides putting on make-up, watching TV, and playing video games or, well the list could get worse, but you know what I mean. It can be very inspiring for students to be immersed in a culture of intelligent inquiry. By the end of a fair, everybody knows everybody's project and sometimes, everybody's phone number. There are vistas and horizons that have not been previously viewed.

HOW?

How this package is sold to the students will depend on the individual teacher, of course, but I find that the goals of each teacher are generally what dictate. Since my goal is to prepare students for the TAKS test via the lab, the fairs, the text, and whatever else I can employ, I am bound to somehow engage my students. When I took science, I had no television to go home to. I loved to listen to the teacher tell about scientific discoveries. We rarely did labs, if ever, and what I didn't have, I didn't miss.

Today the scene has dramatically changed. Students do not enjoy being told ANYTHING for more than 5 minutes. I'm not sure in some cases that students are even *capable* of being told anything for more than five minutes. I mean physically capable, as in having the neural pathways formed to handle the task. Scientists believe that the brain is formed in response to what is required of it, and in many cases children have never been required to sit tight and absorb the spoken word.

I thank God I teach science because it is so readily lent to the manipulation of the physical creation. I do not think I could bear teaching a more cerebral discipline. If I taught history, I'm afraid it would have to be one re-enactment after another. Philosophy? Don't even try to get me to go there.

For this reason I try to teach via the lab. I make students read and write every day when they first get to class. I always tell them that reading and writing are the main tenets of education. I explain that tests are written and read. The TAKS test is a written entity. I assign some pages for students to read, and I encourage them to jot down notes. Then, we close the books, and I give a little quiz over the reading, or so I tell the kids. It really isn't a quiz, however. It is the way I TELL them what I need them to know. None of them to date have been sufficiently suspicious about the unduly loquacious nature of my quizzes. I am steadily rapping it down to beat them band as I ask them, "Now who can find that in their notes? Oh, I hope someone thought this was important enough to jot it down?"

Thus, in order to get reading and writing onto the scene, I have to be very clever about it. If they don't read and write scientifically oriented material on a regular basis, then when the standardized test does come onto the scene, it is foreign. Likewise, the lab as a teaching tool cannot be overestimated. When I say nine labs for this unit I am really talking about situations in which I can coach, teach, and stimulate thought. If my students are looking at a jar of ants, they have more receptive ears for the dogma that I want them to really hear. When Jesus was here, he said, "He who has ears to hear, let him hear." Well, almost all of them had ears. My students all have ears, but when I tell them things, they do not hear me unless they have to.

I tell my students on the first day of school that the hypothesis is an educated guess. I tell them it has to be based on collected information. But most of them do not hear me. However, in the heat of an experiment, when I refuse to let them have any materials until they can come up with a hypothesis that is firmly rooted in the collected information, the *they* begin to ASK ME, "How do I form a hypothesis then? If this one isn't right, how do I form one that is right?" Ah, and that is the teachable moment. They need to know, and they are asking so that they can get to the good part, the touch part, the experiment part, where the ants are.

WHO?

This unit can be adapted to any student population. My school has 2,800 students, the vast majority of whom are Hispanic, coming from homes where English is a second language. (Unfortunately, the TAKS test is written only in English. If it were written in both languages, my students would have a bit of an edge.) My experience has been that ant fascination crosses class lines, cultural lines, and any other lines. Old people like ants, and the older they are, the longer they have liked ants. Young people like ants, and they want to see, touch, taste, hear, and smell them. Even people who make a career out of poisoning ants should like ants because their (the ants') ubiquity creates jobs. The only people who are even slightly leery of ants are those few who happen to be allergic to the ant sting, and even among that group you will find interest buried beneath the fear.

Ants are numerous and active. They are alive. We, too, are alive. In sixth grade, they only learn four characteristics of living things. Ants metabolize, grow, respond to the environment, and reproduce, so they qualify for the sixth graders. Just use four experiments instead of nine. Second graders probably have a simpler set of criteria for earmarking the living, so pare it down. The only thing to remember is that HISD does not like lawsuits, so get that parental permission form signed before requiring any kind of ant work. The school nurse is a good resource for finding out who might be allergic. Most young people who have resided in Houston for any length of time KNOW if they are allergic. It is hard to live in this city without having an occasional encounter with the red imported fire ant. They are the dominant species, and they are everywhere. They are the ones you will likely be using in the classroom. At first, some students will murmur about the possibility of being stung but it rarely happens. I immediately inflict the death penalty on any ant that finds itself outside the confines of the prescribed containers.

TIME LINE

Lesson plans imply the passage of time. How might this work out in real time? What happens first? Day one (of this unit) is the day you start to teach the characteristics of living things. I use my family dog song for this, and I introduce all nine characteristics in a short time, interspersing my remarks with the singing of the song. When students walk into class, they read a section of the text, and I give one of my phony baloney quizzes, which are really excuses to rap down dogma; then, the family dog song or whatever normal method of presentation you might devise; and then the experiments. The nine experiments can be big events or small events. That is why I am presenting these lesson plans as a time line rather than giving specific amounts of time.

The first experiment can be a big event or a small event. You could start with a pre-lab, in which you look at prepared slides of different types of cells. However, if you do not have any prepared slides, you can do what I do: at the beginning of each year, I order a lot of elodea from the Living Resource Center. This is a free service to all who teach in HISD. Elodea is an agreeable little water plant that will thrive and be available to you all year if you put it in a pickle jar full of water, with a small amount of dirt that will settle out (and mimic the bottom of a pond). Elodea has paper-thin leaves that can be pinched off from the main plant and pressed onto a slide. No cover slip is necessary. When you look at the leaf under the microscope, you will be stunned at the clarity of the picture. Little stacks of brick-shaped cells will be so clearly visible that it will thrill the students. There they are. The cells you have must be alive. There they are in living color.

The part that thrills the teacher is that a novice can prepare a great slide. No cover slip is necessary, even though I hope you learned years ago not to depend on those adorable little boxes of cover slips. They break too easily. Always cut up a piece of clear plastic like the stuff you use for the overhead projector. I am throwing in all these little no-cost tips because, if you are like me, those labs with the long lists of not-too-readily-available materials just don't happen. That is why I am offering you a life filled with ants. They are just a shout away.

In any case, after the students see the plant cells, explain to them that animals, being heterotrophic, must for the most part be motile, not sessile, and that therefore, with animals, little stacks of nice neat bricks are pretty much out of the question. You can use bricks to build plants and houses because plants and houses don't go anywhere. They stay put. But ants are on the move. They need a flexible body, and animal cells in general are quite different from plant cells. Most biology books will have a page where they have their general plant cell and their general animal cell. In the old days we used to give out toothpicks and have the students scrape the inside of their mouths to remove a few epithelial cells, which served quite nicely. Nowadays, as we battle new diseases, it is frowned upon to use any bodily tissues from humans.

You can bring a few teaspoons of hamburger meat from your refrigerator and let them see the muscle cells, teasing them apart carefully. Or you can go directly to the ants and have them tease apart the ants, looking for something besides the tough exoskeleton**,** like internal organs, glands, etc. I have found that some students are great with the scope, and others aren't. I have found that there are inevitably some students who are way more adept than I am in finding and identifying cells. Watch for the students who studiously try again and again until they succeed. Those are your science fair candidates. And when they succeed, praise them and let everyone benefit from their expertise.

I always have kids work in teams, making a large drawing of the generic plant and animal cells. Then I have them make little cards with the names of the structures and more little cards with the function of the structures, or more accurately, the organelles. Then I have teams compete to see who can correctly put the little cards on the drawing first. In other words, have them transfer the diagrams of the cells to large paper. Have them make a card that says "nucleus" and another card that says "the brain of the cell, where the DNA is," etc. When all teams are ready with all of the cards and drawings, holler, "Gentlemen start your engines, I mean, ladies and jelly beans, clear your game board!" Then holler, "Go!" and the teams throw their hands in the air when they think they are done. Hands must stay in the air until a winner is found. When you have a winning team, offer them an all-expense paid trip to the bathroom or the office or some other completely ridiculous place. (Or give them extra credit or whatever you like to do for your students.)

If you make a big deal out of all nine experiments, then the unit could take nine days, which is three weeks on block scheduling. You could just as easily set up all nine experiments within a few days and have the monitoring of the experiments be a small part of each ensuing class period until a conclusion is reached in all nine cases. We are getting a new textbook next year, but I assume that our curriculum, Project Clear, will remain the same. That means I could map out a specific course of action now, based on Project Clear, or I could wait until I see the new text, just in case it has something wonderful and memorable to offer to this unit.

Regardless of how you utilize the nine experiments, the key element is ants. I cannot stress enough the importance of this. Ants are the solution for a lab course in biology. They are up for the day-to-day labs, and they are there for the science fair projects. They are free. They are easy.

I personally have developed some lightning quick techniques for the acquisition of ants. Save your spaghetti jars, or save your 2-liter plastic soda bottles. If you are using a spaghetti jar, go to the ant pile, take the lid off the jar, use a long cooking spoon to scoop ants into the jar. Pop the lid back on the jar. Use a tack hammer and a sharp nail to put minuscule holes in the lid. Flick the stragglers off of the jar and zoom off to your lab. If you want to use the small-neck soda bottles, use a scissors to cut one of the bottles in half. Invert the half with the small neck and tape it to the small neck of the soda bottle you are using as a collection jar. Get your long spoon and start spooning away. If the small neck gets clogged with ants, break off a twig from the nearest tree and use it as a plunger. If ants start crawling up the spoon handle, rap the spoon sharply against the earth or a rock and the ants will fly off, obligingly following Newton's laws. If you want to be really fancy, put double-sided tape on the handle of the spoon, or a thick coating of Vaseline. This will keep the ants from reaching your skin. I do most of the ant collecting so that students do not get stung. For science fair projects I do ALL of the collecting so that the SRC (Scientific Review Committee) has nothing to fuss about.

I really don't think anyone has truly lived until he has filled a styrofoam cup half full of water and set it down in an anthill. Ants will swarm up over the sides, and by repeatedly flicking the sides of the cup you can get a nice group of them to hit the water surface and then, oh then, you can watch them form a floating ball of ants that rotates eerily towards the side of the cup where every one of them will disembark from the ball, crawl up the side of the cup and out to freedom without a single ant perishing. What a feat. What a cooperative feat! Add various concentrations of acids or bases to find out just how polluted the water has to be before the ants can no longer communicate the survival behavior. Come up with a hundred different questions. Live it up with ants. Do experiments. Learn to think scientifically. Be cost effective. The answer, my friend, is not blowin' in the wind. The answer is ants.

ANNOTATED BIBLIOGRAPHY

Books

The following texts were my main source of reference in developing this curriculum unit. From here it is possible to say that there is no such thing as a bad ant book. At least I haven't found one. Anything the library has will be helpful. I will list a few I have read that are great, but like I say, anything you find will be wonderful.

Holldobler, Bert and Edward O. Wilson. *The Ants.* Belknap Press/Harvard UP, 1990.
This is the ant bible. It is a huge, expensive book available from Amazon.com, but it is well worth the approximately 75 dollars you will invest. It was awarded the Pulitzer Prize for non-fiction, and rightly so. It contains hundreds of beautifully rendered drawings of the various species as they carry out their antly duties. There is also a colorful section of photographs, and the text is scientific, but not impossible for the layman. It does not cover EVERYTHING, but what it will do is give myriad jumping off places for additional research by students that will not be simply researching for the sake of getting a project done, but researching for the sake of adding to the body of knowledge. There is an additional volume by these two authors (they are considered by some to be the world's leading myrmecologists (ant studiers), which is paperback and is even more accessible to the layperson: *Journey to the Ants*. It will not set you back financially more than twenty bucks. It is a real bargain. Again, Amazon.com carries it. It was published in 1998.

Lisker, Tom. *Terror on the Tropics: The Army Ants.* Austin: Raintree Steck-Vaughn, 1992.
Of course the kids are horribly drawn to the tales, none of which are tall, of the army ants. Makes great horror story material and endears ants to the hearts of bored children.

Newman, L. Hugh, and Steven Dalton. *Ants from Close-up.* New York: Thomas V. Crowell Co., 1967.
Regardless of the year of publication, all ant books are wonderful. It seems that the authors who were moved into print were so moved by their love of ants. Ant watchers have shared their insights in literally hundreds of publications**.**

Ordish, George. *The Year of the Ant.* New York: Charles Scribner's Sons, 1978.
This is a thrilling book because it follows the life of one particular ant for a whole year. This ant resides in a forest on the east coast of the U.S. and it just answers one question after another. It is especially jolting to see her walk out of the mound after being holed up all winter and after having the rains and the snows erasing the pheromone trails and she walks right to the last food source visited before the

winter set in. Yep folks. There is a lot of evidence to suggest that they remember and that means by some definitions that they learn.

NOTE: For a more exhaustive reference bibliography, use the one in the book by Wilson and Holldobler, *The Ants*. It is mammoth, and it accommodates the beginning reader as well as the 500 myrmecologists that exist worldwide. Some of the books listed are more than likely out of print and probably not in most libraries. If you look at the Houston Public Library, you will find some ant books, but not too many at any one location. The ones they have are often found in the juvenile section, but do not let this throw you off if you are teaching high school. Even the "Magic School Bus" should be considered. Just think about it. You are out of high school and college, and yet you love to watch the "Magic School Bus." Don't rob the older kids just because they are older. That is age discrimination in its most virulent form.

Below I have listed some of the books in the Houston Public Library. There aren't too many. My guess is that the best collection would be in the Texas A & M library. They offer more entomology than most other Texas schools.

Brenner, Barbara. *If You Were an Ant*. Harper and Row, 1973.

Brian, M. V., ed. *Production Ecology of Ants and Termites*. New York: Cambridge UP, 1978.

Collins, Homer. *Control of Imported Fire Ants: A Review of Current Knowledge* (Microform). U.S. Dept. of Agriculture: Animal and Plant Health Inspection Service. Washington: GPO, 1992.

Cook, David. *A Closer Look at Ants*. Watts, 1975.

Cook, David and Swift, Tony. *Ants.* Watts, 1975.

Crompton, John. *Way of the ant*. New York: N. Lyons, 1988.

Duncan, Francis Martin. Bees, Wasps and Ants. London: Oxford UP, 1936.

Epple, Anne O. *The Beginning Knowledge Book of Ants*. Rutledge Books, 1969

Gold, Roger and Grady Glenn. *Carpenter Ants*. Texas A&M UP, 1999.

Gordon, Deborah. *Ants at Work: How an Insect Society is Organized*. New York: Free Press, 1999.

Hoyt, Erich. *The Earth Dwellers; Adventures in the Land of Ants*. New York: Simon Schuster, 1996.

Larson, Peggy P. and Martin W. *All About Ants*. New York: Crowell, 1976.

Maeterlinck, Maurice. *The Life of the Ant*. London: G. Allen & Unwin, 1938.

McCook, Henry C. *Ant Communities and how they are Governed*. Harper, 1909

Shuttlesworth, Dorothy Edwards. *The Story of Ants*. Doubleday, 1964.

Juvenile Literature

Here is a sample from the Houston Public Library's collection.

Brenner, Barbara. *Thinking About Ants*. Greenvale, NY: Mondo, 1997.
This book asks the reader what it would be like to be an ant, describing what ants look like, what they eat, where and how they live, and more.

Demuth, Patricia. *Those Amazing Ants*. New York: Macmillan, 1994.
This book describes ants in simple words and pictures.

Fowler, Allan. *Inside an Ant Colony*. Canbury, CT: Children's Press, 1998.
This book describes how these social insects work and live together in organized communities that are like bustling cities.

Internet Resources

The Internet is the best source for specifically the Red Imported Fire Ant (*Solenopsis invicta*), which is the ant you will be observing in Houston. This species arrived on a boat from South America sometime in the 30s in the ballast of a ship, and scientists believe the port of entry was Mobile, Alabama. Since then, the ant population has been radiating outward throughout most of the southeast quadrant of the U.S., and while the western flow has been hindered by a lack of rainfall in some areas, California has a population. The two native fire ant species have been displaced or, worse yet, annihilated, and also, the sweet little kind species have been shoved aside. Here I have listed a couple that may be of interest.

Gilbert, Larry. *Imported Fire Ant – FAQ*. 2001. University of Texas at Austin. June 2003. <http://uts.cc.utexas.edu/~gilbert/research/fireants/faq.html>
This is a seriously wonderful site. It has questions and answers. The questions have been sent in by readers of the site, and they are fascinating. They make you think about the breadth of interest in this creature. But of course the best thing is

that your students can send in questions and get them answered on the site. This would have to be done discreetly so as not to divulge the research projects to other science fair hopefuls reading the site. The host is the University of Texas, which would lend a goodly amount of credibility to the answers proffered.

Lockley, Timothy C. *Imported Fire Ants.* 1996. University of Minnesota. June 2003. <http://ipmworld.umn.edu/chapters/lockley.htm>.
This is one of the first sites that will pop up when you search "Red Imported Fire Ants." I run this off and make copies for every child. It has a history that is concise. It is very informative in terms of the biology of this organism. And, there is a not too lengthy section on control. And then, best of all, there is a lengthy bibliography that gives you a clear idea about where the scientific articles about the study of fire ants can be found. This is important for science fair participants.

Video Resources

Little Creatures Who Run the World. Green Umbrella Ltd. for WGBH Boston in association with BBC-TV. NDR International/Hamburg & Wild Media.

The Magic School Bus – Gets Ants in the Pants. Directed by Charles E. Bastien and Larry Jacobs. PBS, 1994. (30 minutes)