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https://www.100test.com/kao_ti2020/237/2021_2022__E5_A4_A7_E5_AD_A6_E8_8B_B1_E8_c82_237599.htm Do animals think? How could the earth show so many signs of design and purpose and yet be random? Our best scientists are heatedly debating both sides of these and other scientific questions. In the following essay, the author takes a look at science education and argues that as well ass telling students the facts and theories that have already been proved and accepted, science teacher should spend more time introducing their students to the many mysteries that remain unsolved and the arguments taking place between scientists. What better way, he argues, to stimulate their interest in thing scientific?DEBATING THE UNKNOWABLELewis ThomasThe greatest of all the accomplishment of twentieth-century science has been the discovery of human ignorance. We live, as never before, in puzzlement about nature, the universe, and ourselves most of all. It is a new experience for the species. A century ago, after the turbulence caused by Darwin and Wallace had subsided and the central idea of natural 0selection had been grasped and accepted, we thought we knew everything essential about evolution. In the eighteenth century there were no huge puzzles. human reason was all you needed in order to figure out the universe. And for most of the earlier centuries, the Church provided both the questions and the answers, neatly packaged. Now, for the first time in human history, we are catching glimpses of our incomprehension. We can still make up stories to explain the world,

as we always have, but now the stories have to be confirmed and reconfirmed by experiment. This is the scientific method, and once started on this line we cannot turn back. We are obliged to grow up in skepticism, requiring proofs for every assertion about nature, and there is no way out except to move ahead and plug away, hoping for comprehension in the future but living in a condition of intellectual instability for the long time.It is the admission of ignorance that leads to progress, not so much because the solving of a particular puzzle leads directly to a new piece of understanding but because the puzzle -- if it interests enough scientists -- leads to work. There is a similar phenomenon in entomology know as stigmergy, a term invented by Grasse, which means "to incite to work." When three or four termites are collected together in a chamber they wander about aimlessly, but when more termites are added, they begin to build. It is the presence of other termites, in sufficient numbers at close quarters, that produces the work: they pick up each others fecal pellets and stack them in neat columns, and when the columns are precisely the right height, the termites reach across and turn the perfect arches that form the foundation of the termitarium. No single termite knows how to do any of this, but as soon as there are enough termites gathered together they become flawless architects, sensing their distances from each other although blind, building an immensely complicated structure with its own air-conditioning and humidity control. They work their lives away in this ecosystem built by themselves. The nearest thing to a termitarium that I can think of in human behavior is the making of language, which we do by keeping at each other all

our lives, generation after generation, changing the structure by some sort of instinct.Very little is understood about this kind of collective behavior. It is out of fashion these days to talk of "superorganisms", but there simply arent enough reductionist details in hand to explain away the phenomenon of termites and other social insects: some very good guesses can be made about their chemical signaling systems, but the plain fact that they exhibit something like a collective intelligence is a mystery, or anyway an unsolved problem, that might contain important implications for social life in general. This mystery is the best introduction I can think of to biological science in college. It should be taught for its strangeness, and for the ambiguity of its meaning. It should be taught to premedical students, who need lessons early n their careers about the uncertainties in science.College students, and for that matter high school students, should be exposed very early, perhaps at the outset, to the big arguments currently going on among scientists. Big arguments stimulate their interest, and with luck engage their absorbed attention. Few things in life are as engrossing as a good fight between highly trained and skilled adversaries. But the young students are told very little about the major disagreements of the day. they may be taught something about the arguments between Darwinians and their opponents a century ago, but they do not realize that similar disputes about other matters, many of them touching profound issues for our understanding of nature, are still going on and, indeed, are an essential feature of the scientific process. There is, I fear, a reluctance on the part of science teachers to talk about such things, based on the belief that before

students can appreciate what the arguments are about they must learn and master the "fundamentals". I would be willing to see some experiments along this line, and I have in mind several examples of contemporary doctrinal dispute in which the drift of the argument can be readily perceived without deep or elaborate knowledge of the subject.There is, for one, the problem of animal awareness. One school of ethologists devoted to the study of animal behavior has it that human beings are unique in the possession of consciousness, differing from al other creatures in being able to think things over, capitalize on past experience, and hazard informed guesses at the future. Other, "lower", animals (with possible exceptions made for chimpanzees, whales, and dolphins) cannot do such things with their minds. they live from moment to moment with brains that are programmed to respond, automatically or by conditioning, to contingencies in the environment, Behavioral psychologists believe that this automatic or conditioned response accounts for human mental activity as well, although they dislike that word "mental". On the other side are some ethologists who seems to be more generous-minded, who see no compelling reasons to doubt that animals in general are quite capable of real thinking and do quite a lot of it thinking that isnt as dense as human thinking, that is sparser because of the lack of language and the resultant lack of metaphors to help the thought along, but thinking nonetheless.The point about this argument is not that one side or the other is in possession of a more powerful array of convincing facts. quite the opposite. There are not enough facts to sustain a genuine debate of any length. the

question of animal awareness is an unsettled one.Another debatable question arises when one contemplates the whole biosphere, the conjoined life of the earth. How could it have turned out to possess such stability and coherence, resembling as it does a sort of enormous developing embryo, with nothing but chance events to determine its emergence? Lovelock and Margulis, facing this problem, have proposed the Gaia Hypothesis, which is, in brief, that the earth is itself a form of life, "a complex entity involving the Earths biosphere, atmosphere, oceans and soil. the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet." Lovelock postulates, in addition, that "the physical and chemical condition of the surface of the Earth, of the atmosphere, and of the oceans has been an is actively made fit and comfortable by the presence of life itself."This notion is beginning to stir up a few signs of storm, and if it catches on, as I think it will, we will soon find the biological community split into fuming factions, one side saying that the evolved biosphere displays evidences of design and purpose, the other decrying such heresy. I believe that students should learn as much as they can about the argument.One more current battle involving the unknown is between sociobiologists and antisociobiologists, and it is a marvel for students to behold. To observe, in open-mouthed astonishment, one group of highly intelligent, beautifully trained, knowledgeable, and imaginative scientists maintaining that all behavior, animal and human, is governed exclusively by genes, and another group of equally talented scientists asserting that all behaviors is set and

determined by the environment or by culture, is an educational experience that no college student should be allowed to miss. The essential lesson to be learned has nothing to do with the relative validity of the facts underlying the argument. It is the argument itself that is the education: we do not yet know enough to settle such questions.