Science & Math CESE Education

The BEACON

News from

The Coalition for Excellence in Science and Math Education

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PRESIDENT'S MESSAGE

What has happened since the last *Beacon*? Most people are probably interested in what happened to the two creationist bills and two memorials that were introduced into the state legislature. You may recall that these bills were intended to protect teachers who taught evidence against evolution or new views on "creation science," which is counter to the Public Education Department's (PED) instructions to school districts. Well, they did not pass. The only ones heard in committee were on the House side. The memorial was tabled in the Judiciary Committee, which is a death sentence, and the bill itself was tabled on a motion by the bill's own sponsor, Representative "Dub" Williams, after significant negative comments from the public were heard in the House Education Committee. The Senate versions never made it to a committee hearing. We sincerely do wish to thank Representative Williams for recognizing, and acting on the fact that there was no public support for his bill. He was very gracious in moving to table the bill himself. I do not think the majority of people would have the kind of courage and character to do something similar. Thank you, Representative Williams.

The PED, the legislature, the Attorney General's office, the Governor's office, etc., seem to be onto the creationists. All the ploys trying to change and manipulate wording, and the pleas for fairness, academic freedom, teach the controversy, let the students decide, and so on,- all seem to be pretty well understood by the above agencies for what they really are. Sure, there are individual school teachers and even individual school boards that may not have caught on to the fact that creationist activists are basically lying about their motives, but most people have caught on. Does that mean we can let down a little? Not really. There is evidence that the young earth creationists may be teaming with the intelligent design creationists here in New Mexico to further their goal of getting the Bible into the science classroom. This seems to be the opposite of what is happening in much of the rest of the country after the Dover trial in 2005. We shall see.

Also, we are carefully watching for the appearance of a new book from the Discovery Institute crowd that is intended to be a supplemental textbook for biology classes. The book is rather disingenuously titled Exploring Evolution. According to early reviews, it avoids any use of the terms intelligent design and creationism. Instead, it attacks evolution – you guessed it— "strengths and weaknesses." It seems the creationists think they can get around the constitutional barriers against teaching religion in the science classroom simply by continuing to reword or change emphasis for the same old stuff. This time, they apparently simply repeat the same unscientific arguments they have been using for years – many of the same that were used in Of Pandas and People which was shown in the Dover trial in great detail to be nothing but a religiously motivated attack on science.

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Webmaster: Jesse Johnson

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Teachers, please be watching for this book. And if it shows up in your inbox at school, let me or some other board member know. Hey – these people are not going to give up, but neither are we. We simply cannot afford to do so, we are trying to help stop the retrograde performance of our students in science and math. We certainly do not need retrograde materials introduced into the science classroom. Of course, this would be true even if there were no constitutional issue of concern.

In other news, CESE member Eva Thaddeus has received a grant from the Templeton Foundation for development of curriculum concerning climate change. The grant was awarded through CESE since we are a 501(c)3 educational non-profit. We are very glad to see Eva get this grant and will help her in any way we can. Congratulations!

Also, what would we do without Walt Murfin? He continually analyzes educational data looking for trends and better ways of doing things and reports on it in such a way as to make people think. Walt presented a detailed analysis to Rio Rancho Public Schools in an attempt to help them pinpoint specific areas in need of improvement and corresponding areas where they could search for specific ways to improve. It sounds simple, but is a lot of work. Walt, many thanks.

Finally, I have spent three terms as CESE president. That's quite a bit of time and energy. But with many of us working together, I believe we have accomplished much. I wish to thank all for your help and trust. Now please go forth and recruit new young members!

Kim Johnson
CESE President

A short business session will be held during the Annual Meeting (see page 10). Any who may be interested in being on the board of directors, please contact Kim Johnson at 897-3364 or e-mail him at kimber@comcast.net

AN INTRODUCTION TO EVOLUTIONARY THEORIES OF AGING—Part 2

By
Brian D. Berman, M.D.

Life is what happens to you while you're busy making other plans.—John Len-

Antagonistic Pleiotropy Theory

The American evolutionary biologist George Williams raised many objections against the Mutation Accumulation Theory, and in 1957 he posited his own theory known as the Antagonistic Pleiotropy Theory of aging. Williams proposed that if we assume that for a particular organism a single gene may have an effect on more than just one trait (*pleiotropy*), and if these pleiotropic effects affect individual fitness in opposite (*antagonistic*) ways, then late-acting deleterious genes may actually be favored by selection and actively accumulate in populations.

In other words, Williams theorized that certain genes may exist that provide favorable effects on fitness early in life, only to become detrimental later in life and ultimately resulting in what we observe as the aging process. An example in humans might be sex hormones, which are crucial for normal development and may increase the sex drive and reproductive success early in life only to go on to contribute to the etiology of prostate, ovarian, and breast cancer in old age.

Lifespan is species-specific because it is largely a function of survivability and reproductive strategy in their particular competitive environment. Consequently, one prediction of the Antagonistic Pleiotropy Theory is that successful selection for increased longevity should result in the decreased vigor and vitality of the young.

Interestingly, the general finding from laboratory experiments with the fruitfly Drosophila have shown that increased longevity is associated with depression of fitness in early life and an evolutionary decline in fertility in adult life. These data help support the prediction of the Antagonistic Pleiotropy Theory, however they are often not considered conclusive due to various experimental difficulties when selecting for the late reproduction of the flies.

Experiments with long-lived mutants of soil-dwelling round worms (the nematode Caenorhabditis elegans) reared together with normal worms under conditions meant to mimic nature (cycles of feeding alternating with starvation) found that the normal worms could out-compete the long-lived mutant. And in some mice, the lifespan of the female has been shown to increase linearly up to the threshold of starvation (about 30% of their free-feeding levels).

How can it be that animals can lengthen their life span under stress, but fail to do so without stress? The Antagonistic Pleiotropy Theory suggests the finding may arise from stress changing the relative values of the fundamental tradeoff, and leading to pressures that cause the animal to sacrifice fertility for longevity.

Of course, the relationship between longevity and fecundity is not absolute. Indeed, some long-lived Drosophila strains have been shown to have no loss in reproductive capacity. Furthermore, the adaptation of some animals that evolve in environments where they escape predation might actually favor the selection of both longevity and fecundity. For example, a queen ant, protected from the environment and cared for by her worker ants, can give rise to hundreds and even thousands of offspring each day and live for up to 30 years while the lifespan of the assiduous worker ants is measured in weeks to months. And there are the long-lived three-toed box turtles that can continue to reproduce for more than 60 years.

Epidemiologic data on humans have not borne out a relationship between lifespan and reproductive fitness, and early studies which claimed that long-lived women had impaired fertility were found to have serious methodological flaws and to be inconsistent with the findings of many other researchers.

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Disposable Soma Theory

Living organisms use food for a variety of processes including energy, cell repair, maintenance, and replication, as well as for reproduction. During times when resources are scarce, one or more of these functions will likely be compromised, which could ultimately lead to a gradual deterioration of the organism or even death.

In 1977, the English geneticist Thomas Kirkwood, with the distinguished English geneticist Robin Holliday, developed the Disposable Soma Theory and proposed that the allocation of energy to the function of cellular repair may underlie the gradual deterioration of the body. Kirkwood postulated a hypothetical class of gene mutations that provide a selective advantage by promoting energy conservation to accelerate development and reproduction at the cost of partially disabling molecular proofreading mechanisms in replicating somatic cells, leading to their eventual deterioration and death. Thus, the basic idea of the Disposable Soma Theory of aging argues that the somatic organism is effectively maintained only for the goal of reproductive success, and then afterward is essentially disposable.

Inherent in this theory is the idea that longevity comes at a cost; a concept of an evolutionary tradeoff such as described by the Antagonistic Pleiotropy Theory. Indeed, the Disposable Soma Theory is considered by most researchers to represent a special case of the Antagonistic Pleiotropy Theory where the pleiotropic gene is responsible for controlling the switch to reduce accuracy in somatic cells.

Although the concepts of the Disposable Soma Theory appear reasonable, there have been significant criticisms. For instance, the presence of food shortages and caloric restriction are so ubiquitous in nature that the compromise should be more severe. However, numerous experiments have demonstrated that animals live longer when they are fed less. Still, many scientists defend the Disposable Soma Theory as a viable evolutionary theory of aging and argue that the concept of cellular energy may represent a broader sense of whatever the body does not have enough of, rather than strictly a restriction of calories; that there exists some tradeoff that causes repair functions to be shortchanged, even if what it is being traded has not been clearly identified yet.

And in the end, it's not the years in your life that count. It's the life in your years
—Abraham Lincoln

Conclusion

As modern biological science makes numerous advances identifying the underlying cellular processes that lead to degenerative changes, there is a growing interest in the field of aging based on evolutionary and genetic mechanisms. Aging, in essence, is a product of biological evolution by natural selection—a Darwinian phenomenon—and a complete explanation of what aging is and why and how it happens will require an incorporation of this fact.

Evolutionary biologists do not expect to find a single theory of aging that provides all of the answers, but rather see the process of aging as involving a combination of theoretical causes. Evolutionary theories of aging have helped contribute to our knowledge of aging by forming testable predictions, and they have helped create a wealth of new research opportunities.

Currently, the most viable evolutionary theories are the Mutation Accumulation Theory and the Antagonistic Pleiotropy Theory, but these theories are neither complete nor mutually exclusive. They are a set of ideas that require further elaboration and validation. The actual relative contribution of each evolutionary mechanism to species aging is not known and is the subject of ongoing research, but elements of both theories are likely to become part of a future unified evolutionary theory of aging.

Enthusiasm and excitement for the field of aging research is exploding as we have begun to unravel the mystery of why we age. And as this information helps us learn how to prolong life, perhaps a sip from the Fountain of Youth won't always remain so elusive.

I*n a man's middle years there is scarcely a part of the body he would hesitate to turn over to the proper authorities*
—E.B. White

THE SCARY SCIENCE OF SIR FRANCIS GALTON AND JONATHAN WELLS

By
Dr. Rebecca Reiss
Associate Professor of Biology
New Mexico Tech

Although I respect Jonathan Wells' right to make the statement below, and Starbucks' right to use this quote as part of the 'The Way I See It' campaign (#224), it is scientifically and morally offensive:

"*Darwinism's impact on traditional social values has not been as benign as its advocates would like us to believe. Despite the efforts of its modern defenders to distance themselves from its baleful social consequences, Darwinism's connection with eugenics, abortion and racism is a matter of historical record. And the record is not pretty."*

True, the history of the eugenics movement is not pretty; it's downright hideous. While it is true that Cold Spring Harbor Laboratory, a premier Molecular Research Lab on Long Island, was once the Eugenics Record Office, they have a web site dedicated to the American Eugenics movement (http://www.eugenicsarchive.org). Rather than distancing themselves, they confront their history so it will not be repeated. The historical records in this eugenics archive document the role of fundamentalist religion in the rise of eugenics and the dismissal of eugenics by respected scientists of the time.

Sir Francis Galton (1822-1911), a half-cousin of Charles Darwin, coined the term in 1883 to mean well-bred. His idea was that humans could be bred, just like cows, to produce a stronger, healthier human race. His vision was that the "best" from all levels of society could be identified and encouraged to breed within their own level. By all accounts, Galton was a brilliant man; he developed statistical tests, such as regression analysis, that are still in use today; he is credited with producing the first weather forecasts; and he coined terms such as allele (originally alleomorph) that we still use in genetics to refer to the variation in genes responsible for the genetic diversity we see every day. Among his writings that are available on http://galton.org/ is an article entitled "Eugenics, its definition, scope, and aims": in the May, 26, 1904 issue of *Nature* (Volume 70, no 1804, page 82). In it, Galton makes this statement:

"*I see no impossibility in eugenics becoming a religious dogma among mankind, but its details must be worked out sedulously in the study. Overzeal leading to hasty action would do harm, by holding out expectations of a near golden age, which will certainly be falsified and cause the science to be discredited*."

What is prophetic about this statement is that this is exactly what happened in the American eugenics movement. It was embraced by religious fundamentalists who used it to justify their own agenda. The American eugenics movement began with the establishment of the Eugenics Record Office (ERO) in 1910 in Cold Harbor Spring, New York. The ERO was closed in 1939 when the primary funding organization, the Carnegie Institution of Washington, withdrew support. In 29 years of operation, Charles Davenport, director, and Harry Laughlin, assistant director, promoted Galton's idea with such zeal that it eventually led to the discrediting of the theory, but not before the forced sterilization of over 60,000 Americans, the criminalization of interracial marriage, enactment of restrictive immigration laws, and the transfer of eugenical thinking to the Nazi regime.

Davenport and Laughlin were both trained scientists, and prominent supporters of the American eugenics movement included Alexander Graham Bell, among others. Despite the lack of scientific evidence, the idea that the human race could be improved by selective breeding gained support, and by 1914 Harvard, Cornell, Columbia, and Brown Universities all had courses in eugenics. Eugenics also made its way into the political arena, and by 1915 there were 28 states with "racial purity" laws that outlawed interracial marriage. Laughlin proposed his "Law for the Prevention of Defective Progeny" that justified forced sterilization for those deemed "unfit" to reproduce. In 1924 Virginia passed such a law that was upheld in a 1927 Supreme Court decision written by Justice Oliver Wendell

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Holmes Jr.

"*It is better for all the world, if instead of waiting to execute degenerate offspring for crime or let them starve for their imbecility, society can prevent those who are manifestly unfit from continuing their own kind."*

By 1928 there were 376 college courses in eugenics that served 20,000 students. It was not until 1967 that the Supreme Court struck down the last law restricting interracial marriage in Virginia.

There was criticism of eugenics from the scientific community. Thomas Hunt Morgan, who won the Nobel prize in 1933 for his elucidation of inheritance in the fruit fly *Drosophila melanogaster*, felt that too little was known about genetics to make uninformed judgments about the inheritance of "traits" such as "feeblemindedness." A great deal of important scientific research was going on at this time, but there were also many individuals, such as insurance salesmen, publishing in eugenics journals. The conclusions were often that families living in poverty were there due to genetics and not to environmental conditions.

The idea that reproduction by those who are similar to us is to be encouraged, and by those who are perceived to be a burden on society is to be discouraged, was not a new one, but eugenics provided a scientific justification. Although eugenics was rejected by the Catholic church, it was accepted and turned into dogma by other segments of the religious community. The use of scare tactics (society is being overrun by "defectives") proved effective in promoting eugenical thinking in the general public. The American Eugenics Society sponsored an annual sermon contest in which prizes were given for the sermon that best promoted eugenics. Edwin Bishop of the Plymouth Congregational Church of Lansing, Michigan won third place for a sermon, later published as an article, entitled "Eugenics and the Church" in 1929 in which he makes the following statement:

"*That the program of Jesus and the capacity of self-fulfillment for the individual and for race, and the program of the Christian Church following after him, can hardly be accomplished without more knowledge and practice of simple eugenic laws."*

In 1933, Germany adopted Laughlin's "Law for the Prevention of Defective Progeny." In 1936, Laughlin was awarded an honorary degree from the University of Heidelberg for his contributions to the "science of racial cleansing."

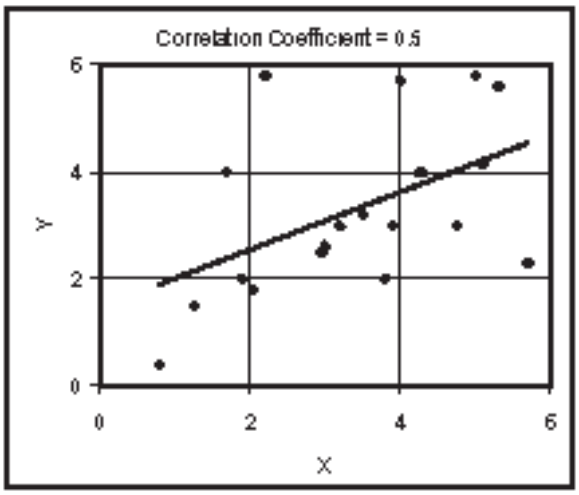
The Eugenic Record Office was closed in 1939 due to the unscientific nature of the work, the same year that World War II began. Since then, eugenics has been discredited. This aspect of genetics history is ignored in today's textbooks, but I include a discussion of Sir Francis Galton in my college-level genetics course because it is critical for today's students to understand the importance of scientific reasoning and the danger of using science to advance any agenda that can't be subjected to logical scrutiny.

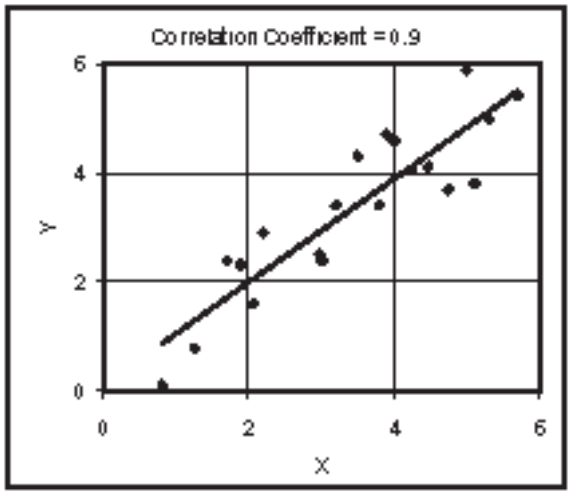
If "Darwinism" is responsible for the eugenics movement, as Jonathon Wells contends, then he must also accept that the church embraced this movement because it helped them to advance their own agenda. Many scientists rejected eugenics because it was not based on scientific evidence and this eventually led to the closure of the eugenics record office.

Sir Francis Galton's theory of eugenics is scary because of the lack of scientific evidence and its justification of human suffering. Jonathan Wells' attempt to denigrate modern evolutionary science by blaming it for the eugenics movement is disingenuous because it leaves out the role of the church. Yes, eugenics is a very sad part of genetic history but we dare not forget, lest it be repeated. This is why the "Intelligent Design" movement supported by Wells is as scary as Galton's ideas. The eugenics movement shows how dangerous it is to provide scientific justification for any religious perspective, which is the source of my scientific outrage. Not only am I a geneticist, but some of my ancestors were among the 12 million people exterminated in Germany; this is the source of my moral outrage.

CORRELATIONS

The word gets thrown around a lot, without much attention to the exact meaning. There are several kinds of correlation, and they differ in the details, but not in the real guts. We're usually talking about the **Pearson correlation coefficient**. It is a measure of the strength of the linear relationship between two variables. That certainly doesn't tell you much. It gets a little better when we know that a perfect positive linear relation has a correlation coefficient of 1.0, and no relation at all has a correlation coefficient of 0.0. In between those two, it gets a little harder to visualize. We can say that the square of the correlation coefficient is the fraction of the total variance explained by the linear relation. That still doesn't mean much. Here are two graphic examples of correlation coefficients





The heavy dark line shows what a perfect linear relation would look like. You see that a correlation coefficient of 0.5 doesn't mean a lot. It can be a **significant** correlation if there are lots of points, but it still wouldn't be much of a relation, would it?

Here are a couple of things to remember. The Pearson coefficient only applies to linear relationships. A perfect quadratic relationship might have a Pearson coefficient of zero. Another point is that the data should be **homoscedastic** (whew!) That means the points should be evenly spread out along the line. They actually never are in real life, but we should get a queasy feeling if most points are bunched at the ends and there are very few points in the middle.

Formally, the Pearson coefficient is the mean z-score cross product. The z-score is the distance from the mean in standard deviation units:
z = (x – mean)/SD, and the correlation coefficient is:
r = Sum [z(x)z(y)]/N.

How can less than honest people improve the correlation coefficient? One way is to take a wider range. If you want to get a correlation between height and IQ, go from very short jockeys to very tall basketball players There is no reason to expect a correlation, but you are more likely to find an accidental correlation with a wide range of variables. Another way is to select the variables. If math scores don't give you a nice correlation, try reading scores.

Higher sample sizes (more points) might not give you a higher correlation coefficient, but the value is more likely to be significant. It's almost mandatory to have significance if results are to be published. If your correlation is small, use a huge sample and improve the significance if you need to impress the editors.

Conversely, selecting only part of the range almost guarantees you a low correlation. In the data for the correlation of 0.9 above, the

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range of data from 4 to 6 only gives a coefficient of 0.46. There is a high correlation between IQ and school success in elementary school. The correlation for graduate school is poor. The lower part of the IQ range seldom gets into graduate school, so only the upper part is selected.

A positive correlation says that Y tends to increase as X increases. A negative correlation says that Y tends to decrease as X increases. A negative correlation is just as strong as a positive correlation. For example, average school test scores are negatively correlated with the fraction of minority students at the school. As the fraction increases, the scores tend to decrease. It is a fairly strong correlation, typically about -0.7.

School demographic variables tend to be correlated with each other. For example, the fraction of poor students is correlated with the fraction of minority students. Low economic status tends to go with minority status. In New Mexico, being an English language learner (ELL) almost automatically means being either Hispanic or Native American. Minority status automatically includes ELL status, and ELL status never shows up as a predictor of grades if minority status is also used as a predictor.

The table following shows correlations between minority fraction, ELL fraction, fraction of students with disabilities (SD) and economically disadvantaged fraction (FRPL) in the 365 largest New Mexico elementary schools. The data are for the 2005-2006 school year. The number in each cell is the correlation between the column variable and the row variable. For example, the correlation between percent minority and percent ELL is 0.744. Bold faced values are significant. Contrary to popular belief, poor or minority or English deficient students are not disproportionately assigned to special education
status; the correlation coefficients are so feeble as to suggest no relationship at all.

	MIN	ELL	SD	FRPL
MIN	*****	**0.744**	0.036	**0.830**
ELL	**0.744**	*****	-0.052	**0.604**
SD	0.036	-0.052	*****	0.020
FRPL	**0.830**	**0.604**	0.020	*****

There is a special correlation coefficient for ranked variables. This is the **Spearman rank order correlation**. It compares the rank of one variable to the rank order of another. If there are no ties, it is identical to the Pearson coefficient. If there are only a few ties in a large sample, the difference between the Spearman and Pearson coefficients is insignificant.

The coefficient of concordance is a measure of the reliability of ranking by several methods. For example, suppose that students have been ranked by their scores on several different tests of math ability. The coefficient of concordance tells us whether the various tests are causing students to be ranked nearly the same way.

Finally, there is the **multiple correlation**. If we perform multiple regression with several independent variables, the multiple correlation tells us how closely the dependent variable follows a linear combination of the independent variables. The square of the multiple correlation is the fraction of variance of the dependent variable explained by all the independent variables acting together. If the independent variables are correlated with each other, simple correlations of each independent variable with the dependent variable can lead to completely erroneous conclusions. The multiple correlation is more meaningful.

Never forget the following important rules. Correlation does not imply causality! Even a significant correlation does not always tell you anything! Correlations between independent variables can confuse important relations with the dependent variable! And the most important rule of all: **suspect research that hinges solely on correlation!**

Walt Murfin
CESE Statistician

(Dues and Donations cheerfully accepted year round)

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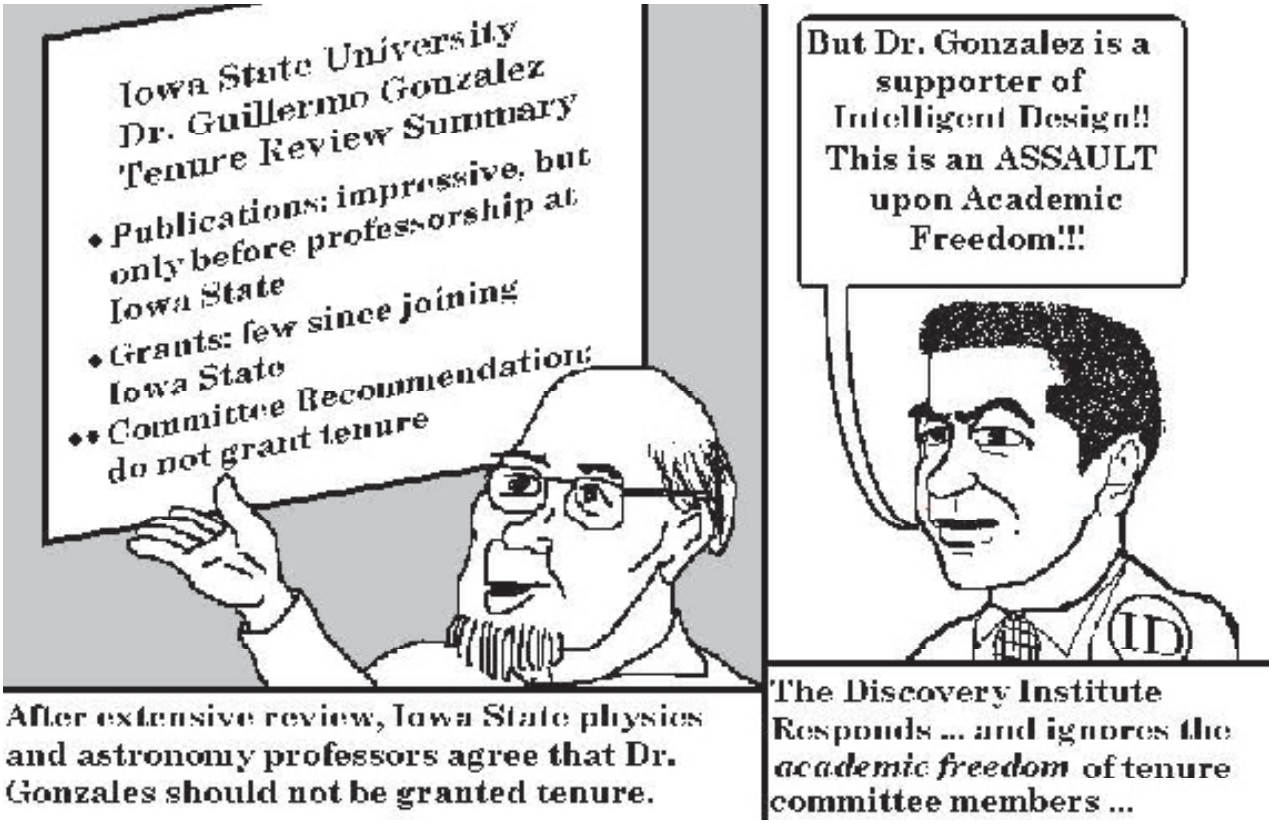

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Annual Meeting *(Bring a friend)*

Saturday June 16, 1:00 PM
UNM Maxwell Museum lecture hall

Guest Speaker; Dr. David L Goodstein

"The end of the age of oil."

The world will soon start to run out of cheap, easily produced oil. If we turn to the other fossil fuels to replace the missing oil, we might do incalculable damage to the climate of our planet, and we are likely to start running out of all fossil fuels, coal included, by the end of this century. We will take a careful look at this situation and all of its ramifications.

David Goodstein is vice provost and a professor of physics and applied physics at the California Institute of Technology (Caltech). See his impressive resume at
http://www.its.caltech.edu/~dg/