Science Magazine Podcast
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Music

Host – Robert Frederick
Hello and welcome to the *Science* Magazine Podcast for January 29th, 2010. I'm Robert Frederick. This week: dealing with parasites in the absence of sex; the advent of quantum machines; and we read from your Letters to *Science* Magazine. All this, plus a wrap-up of some of the latest science news—including a story about running barefoot—from our online daily news site, *Science*NOW.

Promo
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Music ends

Host – Robert Frederick
In evolutionary terms, lack of sexual reproduction is typically a dead end for animals, resulting in extinction. That's because their enemies, including parasites, would evolve faster than their asexual, genetically identical counterparts and so outcompete them. Despite this, tiny, freshwater invertebrates called bdelloid rotifers haven't had sex for millions of years. And still, even though people have been observing the rotifers for three centuries, no one has ever recorded seeing either a male rotifer or any meiotic eggs that would indicate a sexual partner. Now, in a paper in this week's *Science*, Chris Wilson and Paul Sherman report how the rotifers may have been able to last so long without sex: when water is scarce, the bdelloid rotifers dry up and blow away, killing or leaving any parasites behind. I spoke with Wilson from Cornell University in New York.

Interviewee – Christopher Wilson
The hypothesis we tested is that rather than coevolving with their parasites and pathogens genetically, the genetically identical invertebrates have managed to escape them in space and time through losing all the water in their bodies, entering a complete state of desiccation that's called anhydrobiosis, and then blowing away on the wind as little particles smaller than dust to pristine new habitats where the parasites have not yet colonized. And in this way they're effectively playing a never-ending game of "hide and seek" with their parasites, never staying long enough in the same place that they can all be wiped out by one that has cracked their genetic code.

Interviewer – Robert Frederick
Where does the bdelloid rotifer live?

Interviewee – Christopher Wilson
The more appropriate question might be where doesn't the bdelloid rotifer live? They're extremely versatile, as far as freshwater habitats go, and because of their tiny body size – remember, these animals are less than half a millimeter in length – they can inhabit and reproduce in microhabitats as small as the film on a patch of moss or in a puddle of rainwater, not to mention any freshwater streams, lakes, and so on. And so, they live in these constantly fluctuating freshwater habitats that are always drying out and potentially forming dust particles that can then blow and colonize new habitats – they're amongst the most highly dispersive of all animals in their lifestyles. And so, the conditions we represented in this experiment we think fairly closely approximate what the bdelloids would be experiencing in nature.

Interviewer – Robert Frederick
In your team's experiments, how long do the bdelloid rotifers need to remain dried up to kill off the pathogens?

Interviewer – Christopher Wilson
Well, in our experiments we infected almost 100 populations of bdelloid rotifers and dried them for various amounts of time, rehydrating them after one week, two weeks, and so on, to see whether the parasite was still present. Turned out that after one week or two weeks, the parasites just bounced right back along with the rotifers and resumed their destruction of these genetically identical populations. But, after three weeks over 60% of the populations had completely lost the parasites, and the rotifers went on to reproduce in those populations relatively normally. And after four and five weeks of desiccation the results were even more dramatic – we had a 90% reduction in the rates of parasitism after five weeks of desiccation, and the rotifers endured pretty much normal growth period.

Interviewer – Robert Frederick
And these parasites are fungi?

Interviewee – Christopher Wilson
Yes. A whole range of really nasty little soil micro fungi that reproduce with tiny little infectious spores that the rotifers filter into their mouths and swallow, where on they get lodged in the throat, germinate, and produce little digestive cells that eat the rotifer from the inside out and eventually produce more spores at the water's surface to infect all the rotifers – sisters, mothers, cousins, and so on.

Interviewer – Robert Frederick
Now, I can see why the fungus itself might not be able to survive this desiccation. What about the spores, though, can they survive the drying up and blowing away too?

Interviewee – Christopher Wilson
This result was somewhat surprising for us, since the parasite appears to have all the advantages in this system. The parasite can produce thousands of spores, whereas there may be only a few hundred rotifers. And these spores are produced in little trees at the water's surface that look maybe a little bit like dandelion clocks, so you would expect

them to be able to blow around very widely and infect a broad range of habitats in the locality. But it turns out that actually the little spores are not resistant to desiccation at all – even in the shortest periods of desiccation, we couldn't get the spores themselves to reinfect the rehydrated populations. It turns out it's the feeding cells inside the rotifers that are doing the surviving, and they're really not that good at it – they seem somewhat fragile. And so, long periods of desiccation or blowing around really seem to break them up and prevent them from regenerating after the water returns to the habitat.

Interviewer – Robert Frederick
So, when the bdelloid rotifer's habitat dries up, then it just dries up too and can blow away to a new habitat.

Interviewee – Christopher Wilson
Yes, that's correct.

Interviewer – Robert Frederick
And if this happens when its population is infected with this fungal pathogen, the fungus can't survive being dried up as long, and even if it does, it might be blown away somewhere else from the bdelloid rotifers.

Interviewee – Christopher Wilson
Yes, that's correct. So, we found actually that after three weeks – just looking at individual plates – the bdelloids were four times as good at surviving desiccation as the parasites. And after four and five weeks it was a 10-fold difference in the survival of the rotifer over the parasite. And in the wind condition, when we blew around the parasites and the rotifers to see whether the parasite could accompany the rotifer, the rotifers escaped without the parasites in the majority of cases. So, even though the parasite has some limited capacity for dispersalm it doesn't seem to be doing so at the same rate as the rotifers.

Interviewer – Robert Frederick
Does the bdelloid rotifer somehow sense its fungal infection and dry itself up, even when water is available?

Interviewee – Christopher Wilson
This is a interesting speculation that we've been musing over in the lab. Anhydrobiosis—the process of surviving desiccation—is essentially passive: When water is removed from the habitat, the bdelloid can protect itself from the complete loss of this cellular water. To the extent that it has a choice, it could perhaps behaviorally move to an edge of a water body, or area of higher concentration of solutes, which would indicate that desiccation is more likely to happen. So, perhaps they have some control over the positioning, whether or not an infected rotifer can adjust its behavior in that way, we're still investigating – it's one of the things we're curious about.

Interviewer – Robert Frederick

Now, is this strategy enough – of drying up and blowing away – to explain the bdelloid rotifers and how they've managed to survive, even without the evolutionary advantages of sexual reproduction?

Interviewee – Christopher Wilson
This depends somewhat on your views of the evolution of sex itself. There are a variety of hypotheses that explain how sexual reproduction may have been maintained despite its huge inefficiency relative to asexual reproduction. Our work focuses on one of the leading hypotheses, which invokes co-evolving parasites and pathogens as the driving force behind the need for genetic variation. Under that hypothesis, our work and the theory behind it would provide the foundation of a fairly satisfying solution to the bdelloid exception. However, bdelloids have lots of other unusual characteristics at the genetic level, for instance, and perhaps some of those might be compatible with other views of sex. But as far as the conjecture that sex is maintained by parasites goes, the bdelloid rotifers may well have found their way around that particular problem.

Interviewer – Robert Frederick
How many species of bdelloid rotifers are there?

Interviewee – Christopher Wilson
There are over 450 species that have been described. There's an awful lot of cryptic diversity in this group, because it's very difficult when something reproduces asexually to distinguish among all the essentially similar, very similar clones.

Interviewer – Robert Frederick
So, it's some other method of diversification, speciation other than through sexual reproduction.

Interviewee – Christopher Wilson
Yes, it turns out that actually sexual reproduction may not be as important as has previously been thought in the process of speciation, because even though these organisms are completely asexual they still evolve into fairly distinct niches and show the characteristics we would expect to find of genetically isolated sexual species. And this in itself is an interesting evolutionary observation, as it suggests that natural selection can maintain morphologically distinguished species even without genetic isolation through sex.

Interviewer – Robert Frederick
Chris Wilson, thank you very much.

Interviewee – Christopher Wilson
Thank you very much.

Host – Robert Frederick
Chris Wilson of Cornell University is lead author of a paper on how anciently asexual bdelloid rotifers escape lethal fungal parasites by drying up and blowing away.

Music

Host – Robert Frederick
If a machine's movement obeyed the weird rules of quantum mechanics...

Interviewee – Adrian Cho
... it could only absorb energy in discrete quanta and it could literally be in two places at the same time.

Host – Robert Frederick
Science's Adrian Cho reports in this week's issue on the advent of quantum machines: tiny, vibrating devices that make the slightest possible movement.

Interviewee – Adrian Cho
Physicists are trying to make tiny little machines whose movement obeys the weird rules of quantum mechanics. They haven't quite gotten there yet, but their first goal is to make a machine that literally makes the smallest possible movement allowable, like quantum mechanics. And there are a number of groups who've just about reached it, and according to a number of researchers, there's in fact one group that seems to have done the trick. And that's the first step towards making these little mechanical devices that do much stranger things.

Interviewer – Robert Frederick
Who's working on these quantum machines and why?

Interviewee – Adrian Cho
So, there are a number of different groups working on this. This is an effort that's been going on for a decade or more. And about seven years ago it appeared that researchers were just about there – they had just about reached this state of minimal motion called the ground state – but it turned out to be harder to do than they had thought, and at the time there were mostly condensed-matter physicists working on this with tiny little beams of semiconductor, and there were maybe a half a dozen groups pushing at this. Now, the field has gotten quite a bit more diverse, and there are a number of groups working on optical methods to achieve this, and they've brought in all the tools from quantum optics, and people working on gravity wave detectors are pushing in this direction. So, the field has actually gotten much more diverse.

Interviewer – Robert Frederick
And what will quantum machines be useful for?

Interviewee – Adrian Cho
Well, that's a good question. Nobody's quite sure yet. These little machines are machines in a kind of very abstract sense, you know, they're really tiny little beams, like diving boards perhaps, made out of semiconductors that vibrate up and down or side to side. Others are little rings of glass that light can circulate through that expand and

contract radially. So, they're machines in the sense that they move, but the first goal has, of course, been to reach this ground state of motion, where all but the last little half quantum of energy, which can never come out, has been sucked away, and you see this minimal so-called "zero point motion". But, once that's been achieved, the hope is that you can make stranger states of motion, for instance, where one of these tiny little vibrating beams is vibrating around two different positions at the same time. And once you can do that, it's pretty much up to researchers' imaginations what you might try with this. Some obvious things are that a little vibrating beam in its ground state would be a very sensitive force detector, perhaps the most sensitive force detector that you can come up with. So, an immediate use for this might be some sort of very delicate force probes for basic research. Beyond that, since there's so much interest in using light to manipulate these tiny little vibrating machines, it's possible that they'll become elements in optical experiments. So now, physicists need elements called nonlinear optical elements that will do things like take in a photon of one higher energy and split it into two photons of lower energy, and that's currently done by shooting light through certain crystals. There's a problem with that, in that the crystals tend to soak up a lot of the light, so they're not particularly efficient. And so, one hope is that these little quantum machines will actually work as nonlinear optical elements, so that you can induce some of the same things that you do with these crystals but with much smaller losses. Beyond that, it seems probable that once physicists can control motion in this quantum mechanical way, that they'll start to blend these tiny little devices in with electronic devices and optical devices in a way that they could become, you know, very complicated – where they all work together. So, for instance, one could imagine using one of these tiny little vibrating devices to, say, take signals that are conveyed in the quantum states of optical photons and convert them into microwaves or into electrical signals and to sort of pull all of these together in one technology. There are already proposals, for instance, to use these tiny little vibrating beams in experiments that would make a quantum connection between their motion and the internal states of individual atoms.

Interviewer – Robert Frederick
And how close are physicists to this goal – in the published literature?

Interviewee – Adrian Cho
Well, so, they're pretty close. In the last six months, about four teams have gotten within a few dozen quanta of reaching this ground state, this state of minimal energy. Three of them have used optical techniques – and this is quite clever: Physicists have actually developed a technique whereby they can shine light on a little vibrating object and extract energy from it. And the basic idea is that the vibrating element makes one end of a so-called "optical cavity". If you will, it's sort of an organ pipe for light, right? So, it's two mirrors that light waves can bounce between in much the same way that sound waves resonate in an organ pipe. And the idea is that one of these mirrors is on your little vibrating widget, and if you tune the light that you're shining into this thing down just a little bit off the frequency that this cavity would like to resonate at, if you tune it down just a little bit, they can pick up energy from this vibrating widget and actually make the widget lose energy. And so, three different groups have tried that basic optical technique and have gotten within a few dozen quanta of the ground state. And there was a fourth

group that did a similar technique using microwaves in a smaller resonator, smaller oscillating beam, and they actually got to within four quanta. So, there are a number of groups right on the doorstep.

Interviewer – Robert Frederick
So, there's another team out there, though, that has actually achieved this ground state?

Interviewee – Adrian Cho
That appears to be the case. The results aren't published yet, but a number of researchers who've seen the paper say that – the papers describing the work – say that it seems to be pretty convincing, and this work by Andrew Cleland and John Martinis and their colleagues at the University of California, Santa Barbara.

Interviewer – Robert Frederick
Are they using the same kind of approach?

Interviewee – Adrian Cho
So, they actually are using a somewhat more old-fashioned approach where they have a little beam that they've etched out of a material that can vibrate, and they put it in a liquid helium refrigerator and make it as cold as possible and just passively draw the energy out of it that way, and they're trying to draw all the energy out of it and get it down to its ground state of motion. But, they have some tricks, because that way proved difficult a number of years ago, and so they've improved on this sort of basic straightforward approach. And the real key to their work is that they use a widget called a phase qubit to actually read out the motion of this little vibrating beam. Seven years ago, researchers were basically trying to do this by putting a voltage between the vibrating beam and a nearby electrode, and that voltage would vary as the beam moved, and they were trying to use that to track the motion of the beam. To get to the ground state of motion, you have to drive the frequency of the motion up as high as you possibly can. And the problem is, when they would drive the frequency up, the amount of motion actually got smaller and smaller, so they had a hard time tracking this. So, Cleland and Martinis have used this qubit to overcome this. Essentially what happens is that the qubit itself is an electronic system, and it's a quantum system with a couple of states, a ground state and a more energetic state, and basically what they can do is that they can feed one quantum of energy into this electronic phase qubit and then make it talk to the moving beam and then shuffle that quantum of energy over to the moving beam. So, once they can show they can do that, they can just run the whole process backwards and extract the energy one quantum at a time out of the beam. And essentially what they were able to show is that they'd gotten the beam so cold that there were no quanta of energy to take out at all – it was simply in its ground state. So, other researchers seem to think that they've shown this – that they can actually get a beam to make the slightest motion possible.

Interviewer – Robert Frederick
Adrian Cho, thank you very much.

Interviewee – Adrian Cho

Well, thanks very much, Rob.

Host – Robert Frederick
Science's Adrian Cho on the advent of quantum machines: tiny, vibrating devices that make the slightest possible movement.

Music

Host – Robert Frederick
Now, David Grimm, editor of *Science*'s online daily news site, *Science*NOW, is here with a wrap-up of some of the latest science news, including a story about running barefoot. Not something I'd want to do on my street.

Interviewee – David Grimm
Well, Rob, it's something that humans have been doing for two million years. In fact, running shoes have only been around for about a hundred years, and they only really became popular in the 1970s. And so, in this study, researchers were wondering, you know, "If we've been running that long on bare feet, is it better to run on bare feet? Is it possible that running with shoes on is actually hurting our bodies?"

Interviewer – Robert Frederick
I would assume that the answer is "yes," although the glass and other things that are on my street, I'm not really sure I would want to have my bare feet exposed to.

Interviewee – David Grimm
That's true, there are definitely some advantages to running shoes, like the ones you just mentioned. But, in this study researchers found that there's a lot of disadvantages, as well. They looked at about 200 people – both from the U.S. and Kenya, which is famous for producing a lot of long-distance runners – and they looked at people who had worn running shoes all their life, who had never worn shoes at all, and people in between. And they had them run on treadmills and things like that, and they measured how much impact the running was having on their feet and on the rest of their body. And the first interesting thing that they noticed was that people that wore shoes, when they ran, they tended to land on the heel of their foot, whereas barefoot runners tended to land on the ball of their foot. So, that was sort of an interesting finding. But the real interesting finding came when they looked at what the impact of these two different running styles had on the body. And what they found is that the people without shoes on – they were seeing a lot more flex in the foot, in the arch to the foot, in the ankle, in the knee, and even in the calf muscle. So, the body was absorbing a lot more of the impact of the running, which is a good thing, because you don't want all that impact focused on one place. Versus the people with shoes on – they were experiencing a lot more shock to their body – up to four times more shock than the people that were running barefoot.

Interviewer – Robert Frederick
So, the heel/toe-heel/toe strategy of running around with shoes on is not so good.

Interviewee – David Grimm
Well, that's what this study seems to indicate.

Interviewer – Robert Frederick
So, what's the solution? Is it to run differently?

Interviewee – David Grimm
Well, I mean, on the face of it, the solution is for all of us to run barefoot, but as you mentioned earlier, there's a lot of glass on the ground and other things that would make that a bad idea, at least in urban environments. Even the research team isn't advocating barefoot running because of that reason – and because it's also just one study. But, the author of this study is actually a runner himself and has, since conducting this study, has begun to start running barefoot, so that may tell you something. But, he says, you know, if people are interested in running barefoot they shouldn't just go cold turkey with their running shoes – they should gradually transition to make sure that their bodies adjust properly.

Interviewer – Robert Frederick
Okay. So, what other stories have you brought with you this week?

Interviewee – David Grimm
Well, Rob, from feet to feathers – this next story is about whether dinosaurs had feathers, and if so, what color they were. And Rob, believe it or not, despite all of our scientific advances we still don't know what color dinosaurs were. All these movies you see, like Jurassic Park, that's just the CGI artist's imagination. And actually people that study dinosaur have said, "We'll never know what color dinosaurs were." But, some of them are actually changing their tune now that this new study has come out.

Interviewer – Robert Frederick
Some new evidence, then.

Interviewee – David Grimm
Exactly. This study looks at fossilized dinosaurs and looks specifically at organelles – which are these tiny compartments in a cell – fossilized organelles called melanosomes. And melanosomes contain melanin, and you may know that melanin is responsible for giving us our skin color and also tanning and things like that. Well, it's also responsible for color, in general. And researchers, if they do electron microscopy on these melanin compounds, these group of pigment compounds, even though the compounds themselves are not colored, if you look closely enough at them, the compounds have different structures, depending on what their color is. So, even though it looks black and white under a scanning electron microscope, you can say, "Hey, this particular tissues or this particular feather, in this case, must have been white, or it must have been gray, or even orange."

Interviewer – Robert Frederick
So, which particular dinosaur are we talking about here, and what color was it?

Interviewee – David Grimm
Well, Rob, for this study they looked at two creatures – one was a Cretaceous bird called Confuciusornis and this was a 125 million year old bird. And the researchers detected two types of melanosomes in its fossilized feathers – one which gave rise to a black-gray color and another one that gave rise to a reddish-brown color. And you can see a reconstruction of what this ancient bird looked like on the site – we have a nice slideshow that has this and pictures of this dinosaur, which was called Sinosauropteryx. And this is a dinosaur that also lived in the Cretaceous period. And the researchers found that the structures of its pigments compounds indicated that it had reddish-brown stripes covering the tail and that there was areas of it that were completely missing these melanosomes, which indicates that these areas of the animal were white.

Interviewer – Robert Frederick
And this is convincing scientists not only of the color, but that at least for one particular dinosaur, it had feathers?

Interviewee – David Grimm
Right. And the reason scientists say that is because all of this material they're studying would be much better preserved if it was part of the feathers. If it was part of the skin, it would have decayed very quickly – it would not have been fossilized well. So, they're just saying just the very fact that these melanosomes are preserved indicates that it must have been part of a structure like a feather.

Interviewer – Robert Frederick
What are other researchers saying about this?

Interviewee – David Grimm
Well, first of all, researchers think it's really cool that we can actually perhaps get a sense for what dinosaurs looked like, but this whole idea of whether dinosaurs had feathers or not is still very contentious – it's been one of the most contentious topics in dinosaur science. So, the people that fall down on the side that dinosaurs never had feathers aren't convinced by this study – they're saying that perhaps the melanosomes actually didn't come from the dinosaur all, maybe they were just bacteria that somehow were part of the fossil, and that's what the researchers are looking at. So, that particular debate rages on, but at least for now we've got some nice colorful pictures of dinosaurs that are more accurate than they've ever been before.

Interviewer – Robert Frederick
Okay, so last story. What's this last one about?

Interviewee – David Grimm
Well, Rob, from tiny pigments to tiny particles. This last story is about tiny particles crashing together and forming black holes.

Interviewer – Robert Frederick

This is some sort of concern about the Large Hadron Collider?

Interviewee – David Grimm
Well, yes, tangentially. The Large Hadron Collider is this giant multibillion-dollar physics experiment happening in Switzerland where researchers are zooming particles through these tunnels at enormous speeds and enormous energies, and crashing them into each other hoping to produce new particles and potentially even something called the "God particle," which would explain why objects have mass. But, one concern about smashing these particles together at such energy is that it can create black holes, and there's actually even been groups that have petitioned to shut down the LHC because they say it's going to create a black hole that's going to swallow the world. Now, physicists says that's impossible that the LHC could create a black hole that's going to swallow the world, but it is theoretically possible that it could create these tiny black holes. But, nobody had actually shown that this could actually happen, and that's what this new is about – can smashing these tiny particles together actually create a black hole?

Interviewer – Robert Frederick
So, some kind of computer simulation – the LHC isn't up to speed yet.

Interviewee – David Grimm
Exactly. And this all has to do with a theory that Einstein had – which is, basically, if you put too much mass or too much energy into a extremely small volume, you'll create a black hole, because, essentially, putting too much mass and energy into this very small space warps space-time, and space-time can be warped so much that nothing – not even light – can escape, and essentially you have a black hole. But again, researchers actually never ran a simulation to show that this could actually happen, and that's what they did in this study. So, what researchers did was they took hundreds of computers, and they modeled these two tiny particles, they had them smash into each other at tremendous energies and they observed doing a bunch of very complicated physics equations that indeed smashing these two particles together would create a very small black hole.

Interviewer – Robert Frederick
Is the LHC capable of producing that much energy and smashing these things together that fast?

Interviewee – David Grimm
Well, what the researchers say is that the LHC would need to produce a quintillion times more energy than it does right now to even have the prospect of something like this happening.

Interviewer – Robert Frederick
A quintillion – how many zeros is that?

Interviewee – David Grimm

That's a lot, Rob. It's actually 10 to the 18th as much power that the LHC will produce when it maxes out. Although there is one possibility, Rob. There is a theory that's been going around actually in physics for a long time, that there are extra dimensions of space that we can't see. And if these extra dimensions actually exist, then they could potentially significantly lower the amount of energy needed to create a black hole by smashing two particles together. But physicists say even if that happened, even if all this stuff came to pass, these black holes that would be produced by the LHC would, first of all, be extremely tiny, and second of all, they would harmlessly decay almost immediately, so they wouldn't pose a threat to anything.

Interviewer – Robert Frederick
Okay, well, thanks, Dave.

Interviewee – David Grimm
Thanks, Rob.

Interviewer – Robert Frederick
So, what other stories are you looking into for *Science*NOW or on the policy blog, *Science*Insider?

Interviewee – David Grimm
Well, Rob, while we're still on the astronomy kick, we've got a story about how heavyweight stars are born just like our Sun, and also a story about altruism in chimpanzees. And on *Science*Insider, *Science's* policy blog, we've got a story about the end of the line for Mars' Spirit Rover – it's become stuck in the sand, and it looks like it's the end of the mission, although scientists says it may still have a few more experiments left in it. And there's also a story about Bill Gates getting into the geoengineering game. Geoengineering is this whole idea that we can somehow combat global warming by doing various things like launching mirrors into space to block the Sun or seeding the ocean with iron to increase the uptake of carbon dioxide. So, be sure to check out all of these stories on the site.

Host – Robert Frederick
David Grimm is the editor of *Science*NOW, the online daily news site of *Science*. You can check out the latest science news, plus find a link to the science policy blog, *Science*Insider, at sciencenow.sciencemag.org.

Music

Host – Robert Frederick
Finally today, we read from your Letters to *Science* magazine. Joining me is our Letters editor, Jennifer Sills.

Letters Editor – Jennifer Sills
This month, we start with a Letter in response to the October 30th News of the Week story by Yudhijit Bhattacharjee, titled "Study Finds Science Pipeline Strong, but Losing

Top Students." In the January 1st issue, Guruprasad Madhavan from the National Academy of Sciences here in Washington, D.C., and Barbara Ann Oakley from Oakland University in Minnesota write in, asking, "Why not let these talented, scientifically trained human catalysts shift gears and move into areas such as public policy, legislation, law, finance, economics, public relations, and, yes, even entertainment – that seemingly silly place where ideas and visions are formed?"

Host – Robert Frederick
The authors continue, "It would help to have scientifically trained policy makers and legislators who truly understand the scientific and technologic issues they are voting on, with enough clout to get others on board. It would also help to have management consultants and financial analysts who avoid entrenched mindsets and realize that some 'visionary' business approaches are de facto Ponzi schemes."

Letters Editor – Jennifer Sills
The authors conclude, "A protectionist attitude that expects the best students to stay within their formative disciplines has pernicious consequences. Top students in science and engineering form a gift to society—and to the scientific enterprise—when they fly forth to pollinate areas of vital importance to the public discourse. Cross-disciplinary ambassadors should be encouraged, not discouraged, if we are to build a bright new, sustainable future."

Host – Robert Frederick
Our next Letter comes in response to the January 1st editorial, "Promoting Scientific Standards," by *Science*'s editor-in-chief, Bruce Alberts. In that Editorial, Alberts discusses two authorship issues. First, that new procedures at *Science* magazine will discourage what are called "honorary authorships," and that "each author will be required to identify his or her contribution to the research." Second, that "*Science* will require that the senior author for each laboratory or group confirm that he or she has personally reviewed the original data generated by that unit, ascertaining that the data selected for publication in specific figures and tables have been appropriately presented."

Letters Editor – Jennifer Sills
Zen Faulkes of The University of Texas-Pan American writes in response to say that "The new *Science* policies described by Alberts do not follow the Vancouver guidelines," also known as The International Committee Medical Journal Editors guidelines on authorship, and that, in turn, writes Faulkes, "suggests that we need a new model for assigning credit to scientific projects." Faulkes's suggestion: that films might provide that model. Faulkes writes, "Movie productions, like large scientific projects, represent the collaborative efforts of large teams, often working semi-independently of each other. The credits spell out who did what – director, cinematographer, screenwriter, and so on. There is no pretense that everyone who contributed to the film is an author of the film."

Host – Robert Frederick
Faulkes concludes, "Honorary authorships are often given to principal investigators who provide resources, but minimal scientific input. Such investigators are analogous to film

producers, who often set up financing and handle administration. It is appropriate that this important work receives due credit, but that credit should not imply involvement in the creative process. Such contributions would probably not be recognized if the film industry were using, as science still does, the blunt instrument of authorship."

Letters Editor – Jennifer Sills
You can read the whole Letter in this week's issue. Our final Letter is also in this week's issue: Marion Nestle from New York University writes in to respond to the December 18th Random Samples article, "Science for the Fair Sex," which highlights the "Girls Night Out" series at The New York Academy of Sciences. The series features "women scientists speaking on topics 'close to women (and the people who love them).'" The Random Samples article then lists out the talks – one on "Lust, Romance and Attachment," one on nutrition and diet, one on "our intimate connections to trees," and finally, one titled "Survival of the Prettiest: Evolution, Beauty, and Human Happiness." The Random Samples article concludes, "Guess girls are interested in science only if you can find a link to food, love, or makeup."

Host – Robert Frederick
Nestle writes, "As a longtime reader of *Science*, and the invited food speaker to the New York Academy of Science's series "Girls Night Out," I take exception to the idea that the choice of topics condescends to women. When I see the statement 'Guess girls are interested in science only if you can find a link to food, love, or makeup,' I see the attitude—all too familiar to those of us whose work crosses into social science—that nothing but cell biology and genetics constitute real science. The statement suggests that work dealing with quotidian matters such as food, love, or even makeup cannot possibly be scientifically rigorous or interesting."

Letters Editor – Jennifer Sills
"I would argue instead," Nestle continues, "that rigorous scientific thinking thoroughly informs my research on the influence of politics on agricultural production and consumption, particularly with respect to obesity and food safety. My lecture to the 'girls' on 16 February will be much the same as the talks I give to mixed-gender audiences of researchers, university professors, health professionals, government officials, and business leaders. I am curious to know whether social scientists are as tired as I am of colleagues characterizing our work as insufficiently scientific to be taken seriously."

Host – Robert Frederick
You can find the Letter in this week's issue of *Science*. Thanks, Jennifer!

Letters Editor – Jennifer Sills
Thanks, Rob!

Host – Robert Frederick
Jennifer Sills is the Letters editor of *Science* magazine.

Music

Host – Robert Frederick
And that wraps up the January 29th, 2010, *Science* Magazine Podcast. If you have any comments or suggestions for the show, please write us at sciencepodcast@aaas.org. The show is a production of *Science* Magazine with the support of AAAS – the Science Society. Jeffrey Cook composed the music, and I'm Robert Frederick. On behalf of *Science* Magazine and its publisher, the American Association for the Advancement of Science, thanks for joining us.

Music ends