Science Magazine Podcast

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Music

Host – Robert Frederick
Hello and welcome to the *Science* Magazine Podcast for May 20th, 2011. I'm Robert Frederick. This week: diet's effect on the microbiome in your belly; teaching writing by teaching science; and transmuting the reputation of alchemists—scholars are coming to realize that the medieval alchemists were real scientists after all.

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Host – Robert Frederick
We never dine alone. There are trillions of microbes that share components of our diet with one another and with us. And the question is, What is the relationship between the composition of our diets and the composition of this enormous microbial community living inside us, and how does that influence our nutritional health? Researchers have been trying to understand all the factors for how we're able to extract energy and nutrients from our diet. And in two papers published this week by *Science*, Jeff Gordon, Brian Muegge, Jay Faith and colleagues report that microbial communities in the guts of different mammals reproducibly adapt to the diet of the various mammals. The researchers also report that in a model of a human gut, they could predict the microbiota's response to diet. The research suggests that someday we might use bacteria as a therapeutic intervention to improve our nutritional health. I spoke with Gordon, Muegge, and Faith from St. Louis, Missouri, where they work at Washington University Center of Medicine. Here's Jeff Gordon.

Interviewee – Jeffrey Gordon
The first paper turns to other mammalian species to try to get an idea of the interrelationship between diet and a microbial community structure and function related at all to their evolutionary history? Is the structure and function of their microbial communities determined primarily by the diets that they consume? And, if so, what types of trends do we see between diet and their community? The question that motivated the second paper is, "What is the code that relates components of diets and the representation of different microbes in gene function, and can we identify particular components of a diet that drive the representation of specific microbes and specific functions?"

Host – Robert Frederick

Previous research you've done showed that the genetic makeup of gut bacteria in mammals was more closely "associated" with the diet of the mammal rather than with the species. Now, it sounds like you are concluding that diet isn't just "associated" more closely, but that it actually "drives" which bacteria are in a mammal's gut. What, if any, light does this shed on our co-evolution with our gut bacteria if I – or any mammal, it sounds like – can change diet and so change the composition of the gut microbiome?

Interviewee – Jeffrey Gordon
Well, I think that the word should be "co-adaptation." There is a dynamic and reciprocal relationship between what we eat and the configurations of our gut microbial community. That means that the nutritional value of foods maybe not be fixed across all people, but rather influenced by our microbial communities. How well are our communities prepared to consume the foods that we eat? Are there certain individuals who are more capable of accessing certain types of components of our diet? And how can we match diet to the consumers' gut microbial ecology. And I think we have to think of it as a very dynamic and very reciprocal set of relationships.

Host – Robert Frederick
Now, to Brian Muegge, first author of this paper on how diet drives convergence in gut microbiomes, did you and your team alter the diets of various species of mammals, or how did you get at diet driving the convergence of gut microbiomes?

Interviewee – Brian Muegge
In this study, we used mammals who were living at two zoos and in the wild, and we did not manipulate their diets in any way. We selected mammals from those locations that would represent a range of different kinds of diets – herbivory, omnivory, carnivory – and we just asked, "Given the background of the things that they're eating in a healthy, captive, or wild diet, how does their diet history influence the microbes that we can find in their gut?" It's an open question and something that other people are looking at, which is asking, "If you deliberately manipulate a diet or change it, how does that influence a community that's been established?" But, for this study we just asked at a high level, "If we take mammals representing a huge range, a huge swath of the mammalian evolutionary tree – with lots of different diets and lots of different mammalian orders and families – how does the diet, as one of the markers of their physiology, map on to their microbial communities?"

Host – Robert Frederick
Now, you mentioned carnivore, omnivore, and herbivore. Did it matter between, especially the herbivores, how many stomachs they had or how they fermented the foods that they ate?

Interviewee – Brian Muegge
Yeah, that's an excellent question. So we found that the biggest difference was between herbivores and carnivores. There were definitely differences between different kinds of herbivores. For instance, some herbivores ferment their foods with bacteria before digestion occurs – and that's known as a "foregut fermenter." They actually anatomically

have a fermentation chamber that occurs before the digestive organ. There are other animals that are hindgut fermenters where fermentation occurs after digestion. And so, we found, especially at the level of bacterial species, there are differences in the species that you can detect between foregut and hindgut fermenting herbivores. But the difference between those groups was smaller than the difference separating the meat-eating carnivores from the collective group of plant-based diets with the herbivores.

Host – Robert Frederick
Now, you also looked at people, as well, and the diets within people. How closely did those microbiomes match the microbiomes of any of these mammals in this study?

Interviewee – Brian Muegge
Right. We extended our study of free-living mammals to look at free-living human beings and asked, you know, if human beings representing omnivores or a primate – depending on how you want to bend them – asking do they look like their mammalian relatives? And so, when you looked at the humans compared to the animals, in general, they were like other omnivorous primates. So humans, even if they ate meat, did not look like lions, in terms of their microbial communities, they looked like other omnivorous primates. But the specific question we wanted to ask was not, "Where did they cluster in this large space of different kinds of mammals," but also, when you looked at the range of diets within a single species and the range of diets within these humans, "How does their diet influence the community and their guts?" And so, when we looked at these calorie restricted human beings, who kept meticulous and fantastic records of what they ate, what we could show is that we could relate the amount of protein that those humans were eating to the differences in their microbial communities in terms of the functions present. And so, to rephrase that a different way – even in the background of a shared profile as omnivorous primates, human beings eating a diet of their own choosing had reproducible differences where the amount of protein that they ingested was related to the functional profile of the microbes in their gut.

Host – Robert Frederick
And it didn't matter what type of protein it was?

Interviewee – Brian Muegge
Right. So, in our study, we had a few individuals who had more meat in their diet compared to some others who either had no animal based products or very low levels. And we didn't find that the type of protein was terribly significant but instead just the total amount of protein that was consumed. The question you're asking is a wonderful follow-up, and I think it's one that this work and many other research projects are continuing to address, which is really getting at the functional components of the food. So this project is really looking at sort of a high level, the macronutrient characteristics, and then other projects are starting to ask questions about the specific functional properties of those foods – maybe different kinds of proteins or different amino acids might have more influence than sort of a collective bin of all protein.

Host – Robert Frederick

Are there are any particular gene functions in the bacteria – functions that are common to all of the mammal hosts?

Interviewee – Brian Muegge
So one of the conclusions from our study is that there are many microbial gene functions that are found in all the mammalian gut. And we think that these core functions are probably involved in necessary functions that a bacteria needs for survival, and in particular survival in the gut. But, even though many genes are found everywhere, there are definitely differences in the proportional representation of those genes in the guts of animals with different kinds of diets. And so, we specifically tried to ask, "What are the differences in the gene representation in the guts of carnivores compared to herbivores?" And one of the major differences that we found is that there's a huge difference between the two types of animals, in terms of how their bacteria are used and processed amino acids. So, for instance, carnivores--their microbial genetic profiles were specialized to degrade amino acids. On the other hand, there's an enrichment in the herbivore microbes compared to the carnivore microbes that allow the herbivorous bacteria to synthesize amino acids *de novo*. And so, when you're trying to make sense of this, in terms of the host diet, it makes sense that a carnivore – perhaps eating lots of protein and making peptides that are presented to the microbes – those bacteria would have an advantage if they could use the peptides and the protein by-products for their food source. And just the opposite is true in the herbivores, where maybe there aren't as many proteins in the diet or they're inaccessible behind plant cell walls. Those microbes would have an advantage if they could make their own amino acids and use that to carry out essential biosynthesis. And so, what we found again is that they're in the background of a large number of functions that are found in lots of places you can find physiological differences in the representation of those functions that makes sense, in terms of host biology and the microbial biology.

Interviewee – Jeffrey Gordon
An extension of what Brian just said is that…

Host – Robert Frederick
Jeff Gordon, go ahead.

Interviewee – Jeffrey Gordon
…if we see protein being an important regulator of the structure and functional properties of the gut community, then we can take a simpler model of the human gut community and ask, "What is the effect of different types of proteins on the representation of organisms that are capable of either breaking down or synthesizing specific amino acids? And can we understand the role – the profession or niches – of different types of microbes in these model systems and then extrapolate the information we have to much more complicated, complete communities with the hope of understanding how different dietary components influence the representation and express functions of different microbes in our gut microbial community?"

Host – Robert Frederick

Now, to Jay Faith, lead author of the paper on predicting a human gut's microbiota response to diet. As I understand it, your team took human gut bacteria and introduced them into gnotobiotic mice – mice without any microorganisms in them. How did you and your team vary the diet?

Interviewee - Jeremiah Faith
So, for the original diet every two weeks we would switch the diets randomly, so we had a set of around 17 total diets. And every week we would just give to the mice a random one of these diets. And then, we did that for two weeks, and we would sample them along the way, and then we would switch again just to try to give a nice diversity of diet to each individual mouse.

Host – Robert Frederick
Did you use all of the bacterial varieties found in peoples' guts?

Interviewee - Jeremiah Faith
So we tried to be as diverse as possible while keeping the community size limited, right? So, for example, all of the calorie-restricted individuals that Brian studied they all have a hundred or more species, which is a bit of a difficult problem to tackle as your first problem. So what we did was there's four major phyla in the gut, and we took a few species from each of those phyla to try to have a small but representative set of gut bacteria from humans.

Host – Robert Frederick
And so, you were able to model these changes in these diets with these particular gut bacteria and then could predict the relative abundance of different bacteria in feeding mice a new diet?

Interviewee - Jeremiah Faith
Yeah, that's correct. So we would take the same ingredients, and we would put them in at new concentrations that we had never seen before, and we could predict fairly well – we could explain more than half of the changes in these bacterial abundance's just by knowing the concentration of the ingredients that we were changing.

Host – Robert Frederick
Jeff Gordon, back to you. As senior author of both papers, to what extent are the results of your team's papers mesh with those of Arumugam and colleagues, the *Nature* paper published last month, that concluded that there are three types of microbiomes in peoples' guts, three enterotypes that are not nation or continent specific?

Interviewee – Jeffrey Gordon
Well, I think it's a fascinating question about how many enterotypes there are. And I think we are just beginning the journey of looking at the configurations of different gut communities in people of different ages living under distinct cultural conditions. And I think that the studies that Brian and Jay have directed certainly highlights the important interrelationship between food and food ingredients and the structure and configurations

of gut communities. The extent to which these community configurations vary is still a open question I think. I think the larger goal is to try to better understand the nutritional needs of humans at various stages of human development and in various cultural settings. You want to try to enhance the nutritional value of food, and part of that enhancement, we believe, requires an understanding of our gut communities – their structures and their functions. We also think that food itself may be able to shape microbial communities in ways that further enhance their benefit to their human hosts and perhaps extending this work to animals as well. And finally, we want to understand how gut communities may contribute to risk for malnutrition. And by malnutrition, I mean more generally the excessive or inadequate consumption of nutrients leading to disease, so that would cover both obesity and under-nutrition. But food is critical to human health, and a global human health problem is how well we're nourished.

Host – Robert Frederick
Do you think in the future there will be microbiome directed therapeutic interventions then?

Interviewee – Jeffrey Gordon
Yes. And I think that some of those interventions may be to add species of microbes with embedded functions that are missing or underrepresented from certain individuals' gut community to further enhance the digestive or nutrient-processing capabilities of our gut. This may have to be individualized. It may have to be very well coordinated with the cultural traditions and hence the diets of people in different parts of the world. But I think that we should perhaps think of our gut microbial community as a metabolic organ charged in part with the task of processing, metabolizing our diets and our dietary ingredients. And how will this community look like, how will it appear, when our diets evolve? And how it is being shaped by our modern lifestyles? And what is the impact of this relationship between our evolving cookery, our microbiota, and our human biology?

Host – Robert Frederick
Jeff Gordon, Jay Faith, and Brian Muegge, thank you very much.

Interviewees - Jeremiah Faith, Brian Muegge, Jeffrey Gordon
Thank you, Robert.

Host – Robert Frederick
Jeff Gordon, Jay Faith, and Brian Muegge of Washington University Center of Medicine in St. Louis are authors of two papers on the effects of diet on microbiomes in mammalian guts. Read how diet drives convergence in gut microbiome functions in this week's *Science*, and online at sciencexpress.org, read about predicting a human gut microbiota's response to diet.

Music

Host – Robert Frederick

Also in this week's *Science*: Japan's earthquake. The March 11 earthquake off the coast of northern Japan shattered many researchers expectations as to how faults behave and the limitations of using onshore observations to gauge an offshore fault. In three papers published online this week, researchers help make sense of why the earthquake did not behave as expected and why onshore monitoring fell short. In this week's magazine, find a package of news articles about the harsh lessons being learned in geosciences, predicting earthquakes in the future, and ongoing radiation concerns. Find it all freely available online, as well as all of our previous coverage of the earthquake and nuclear crisis in Japan, at sciencemag.org/hottopics/japanquake.

Music

Host – Robert Frederick
Perhaps the best people to evaluate student science writing are the scientists who are their teachers or professors. But at least in the United States, scientists tend to grade or evaluate what students write rather than truly *read* it—in a scientific sense—reading whether what the students write is persuasive. As Cary Moskovitz and David Kellogg explain in the Education Forum in this week's *Science*, that's because what most U.S. students write in their lab reports is already known to the scientists who grade them because the experiments most U.S. students conduct are essentially recipes from a cookbook in which students just go through the motions of laboratory work. While many undergraduate programs in the United States have adopted an inquiry-based approach to get away from that type of recipe-based lab, the writing components haven't yet followed suit. I spoke with Moskovitz, from his office at Duke University, about the recommendations that he and his co-author make for inquiry-based writing programs.

Interviewee – Cary Moskovitz
The attention to scientific laboratory education has resulted in a lot of gains over the past 20 or 30 years with particular attention to the kinds of activities students are doing in the labs, primarily to give them experience in doing work more like what scientists do, to learn more about scientific processes, and to help reinforce the content that they're learning in courses. However, the actual writing that tends to be done in association with these labs still tends to be limited more to versions of the traditional school lab report, which is a kind of writing that scientists don't do and typically has not been as productive as other kinds of writing might be to help students become better scientific writers.

Host – Robert Frederick
Before we get to the writing, how do these inquiry-based approaches to laboratory work differ from the repeating of experiments that others have already done – the typical lab course?

Interviewee – Cary Moskovitz
Sure. The inquiry-based laboratory movement of the last 20 years has emphasized putting students in situations where they actually have to do some kind of scientific reasoning – giving them tasks for which the outcomes were not known or known precisely. But basically the difference was that in inquiry-based labs students are asked

to do tasks which require them to engage in some of the thinking or reasoning processes that working scientists would use rather than being merely kind of a rehearsal of experiments that have been done before just to see what they look like.

Host – Robert Frederick
And so, what's different then about writing up these inquiry-based lab reports compared to writing up the lab reports from the "old cookbook recipes," if you will?

Interviewee – Cary Moskovitz
We feel that in order to take full advantage of the laboratory – as an opportunity for students to become better at scientific communication – students need, first of all, to get some experience doing kinds of writing that working scientists actually do. Second, that students need to be given writing tasks for which their laboratory experiments prepare them to have something to say. So we believe that a number of the tasks that have been continued to be asked of students in science lab situations put them in positions to write things for which they really don't have anything meaningful to say, and so the writing becomes just a continuation of the make-work kind of process that they know from previous lab experiences that they've done. So that's the second thing. The third issue that we bring up in the article is one that is no way unique to scientific writing or lab writing, but shows up there in, I think a meaningful way, in that students in lab courses are often writing without a real sense of purpose or audience. That they're trying to guess what their instructors want, or the lab TA wants, but generally the students know that whoever is reading their work already understands what they've done, because those were the people who assigned them to do it, and whatever results are presented this instructor, or graduate teaching assistant, knows what those results are supposed to be. And so, the instructor is put in a position really of a "grader" rather than of a "reader." And students know this, so they're not empowered as scientists or novice scientists trying to engage in acts of scientific communication, but instead trying to put down on the page what they think the instructors are looking for.

Host – Robert Frederick
Do you have an example what students would write up – in which the instructor, the professor, the lab teaching assistant – is the audience the reader?

Interviewee – Cary Moskovitz
In our article, we give an example of a very standard kind of chemistry lab in which students are asked to do a titration. And the first step of such a lab, which has been historically one of the labs that students have done taking chemistry for decades, is to give some of the students reagents, which are in some way contaminated, not what they think they were supposed to get; others not, and make sure that the students know that some of the reagents are contaminated, others are not, and that none of the students know who got which. So the first step then is to make sure that the students have to actually try to figure out whether or not their reagents are contaminated, which requires that they take things like air analysis and careful measurement very seriously. If the instructor also does not know who got which – in a sense this is analogous to a double-blinded medical study – then the instructor is reading students' reports as a reader. So, in this case, the

students don't just have to go through the motions of making a scientific argument they actually have to make that argument. And the instructors can read that argument, as a scientist, trying to determine if they think the students made a strong case for the conclusions that they draw rather than just checking off yes, they got the right answer or not, and identifying various kind of errors, grammatical mistakes, whether or not sentences are put in the right section, and so forth.

Host – Robert Frederick
So students at this point in this simple titration experiment are really just writing up the data and their analysis of it.

Interviewee – Cary Moskovitz
Okay. So depending on where students are in their education they will be heading laboratory experiences that range from being given experiments to do, later on in their education given some latitude in the design of those experiments, and then ideally, by the time their seniors, at least, undertake research of their own under the guidance of faculty.

Host – Robert Frederick
So the students don't write up a whole research report until they, as students, are actually doing original research and designing experiments and perhaps even using their own methods.

Interviewee – Cary Moskovitz
That's our idea – that we think instructors should think about the instruction of scientific writing longitudinally throughout the curriculum rather than for each lab or even individual course. And that, if each lab course students take help students get better at some fundamentals of scientific communication in that setting, students can take those onto the next setting and then can build on what they've learned. So, when students are in a classroom context that makes certain kinds of scientific communication that make those make sense for that work, that's when they're going to be able and motivated to learn to do that part of scientific writing.

Host – Robert Frederick
Are there colleges or universities that are employing this approach to teaching scientific writing?

Interviewee – Cary Moskovitz
Different pieces are now showing up in different places. We mentioned one particular instance, one of our citations, there's a team of people at the University of Seattle, a chemistry team led by a faculty member in chemistry, Peter Alaimo, and the director of their writing across the curriculum program, John Bean, and others who have worked hard to make the switch from traditional laboratory report writing to having students do something more like journal articles. So, for instance, that step is now taking place at some different institutions. The other steps are things that David and I have been kind of wrestling with on theoretical grounds for quite a while. But I've been starting to get some faculty members at Duke University to try some of these things out. I think one of

the biggest challenges – just like the introduction of inquiry-based labs into undergraduate education – is it involves a mental shift and reconsidering what the actual task is and what the goals of that experience are.

Host – Robert Frederick
To convince people to make that mental shift and beyond the anecdotal evidence is there any research out there to suggest that you and your coauthor's argument – you and David Kellogg's argument, writing up these inquiry-based approaches to laboratory work – will lead to better scientific writing?

Interviewee – Cary Moskovitz
There's no literature out on there yet, although this is on our own research agenda. I think the argument is best made in terms of appealing to science faculty's understanding of what they know and what they want their students to learn. And I think a shared recognition that a lot of the writing that gets done in science labs really has little pedagogical value. And I'm not saying this is universally true for all labs. But having looked not only at institutions I've been at the writing, but at many other U.S. institutions, faculty will readily say, "There's a lot of writing here that I really don't want to read. TAs, you know, have to process stacks of papers that really students write it without a sense of authorship." And I think that's the key.

Host – Robert Frederick
Cary Moskovitz, thank you very much.

Interviewee – Cary Moskovitz
Sure thing.

Host – Robert Frederick
Cary Moskovitz of Duke University is co-author of an Education Forum in this week's *Science* on inquiry-based writing to match an inquiry-based approach to laboratory coursework.

Music

News Writer – Sara Reardon
So when we usually think of alchemists and the study of alchemy, which primarily focused on trying to turn base metals into gold….

Host – Robert Frederick
Science's Sara Reardon reports in this week's issue on how scholars are coming to realize that medieval alchemists were real scientists after all.

News Writer – Sara Reardon
… we tend to think of them as sort of these silly magicians who didn't know what they were talking about or pursuing these impossible quests by mixing these chemicals together and searching for the philosopher's stone. And for many, many years science

has kind of looked at these people and said, "Oh, these silly magicians – they cast a bad name on science, we don't want anything to do with them." But, in the last 20 years, there have been a growing number of science historians who think that these alchemists were not magicians but actually scientists. They were doing the best with what they had at the time. You've got to remember they didn't have any understanding of atomic theory; they didn't have any understanding of conservation of matter or energy. And so, they were just trying to understand nature the best they could. So, if you think about what defines a scientist it's someone who does experiments, follows the scientific method, and then records the results in a way that's repeatable. And so, there's a few science historians at different universities now who are looking back at the notes that the alchemists left and trying to recreate their experiments. And they're having success.

Host – Robert Frederick
What, if any, scientific discoveries are alchemists being credited with as a result of these scientists going back and recreating alchemists' experiments?

News Writer – Sara Reardon
What the alchemists were doing was kind of blue sky research – they didn't have to worry about funding. They just kind of set off to study the nature of matter any way they wanted. But, just like any sort of basic science today, there's a lot of very tangible outcomes that can come from that. And so, there are a number of chemical medicines that were produced as a result. There were perfumes, dyes, pigments. And then some other theories, modern scientific theories, kind of grew out of some of the discoveries that the alchemists made, such as one German alchemist named Daniel Sennert who did an experiment, which you may have done in college chemistry nowadays, where you dissolve silver in nitric acid and then after a series of steps are able to get solid silver back out. And so, what Sennert believed was that silver was composed of what he called "corpuscles" that even if after they were dissolved they kind of kept their essence. And so that led – eventually, many years later – to atomic theory.

Host – Robert Frederick
You said that it's only been in the past couple of decades that historians have gone back and looked at alchemists' records. Was there something 20 years that prompted them to do so, or why hadn't alchemists received this kind of credit before?

News Writer – Sara Reardon
Well, at first during the course of my reporting and talking to several of these researchers, I heard several different ideas. They don't really know. But the publishers of some of the history of science journals really, really hated alchemy for a variety of reasons. And so they deliberately kept any historians of science who wanted to write about alchemy from publishing in their journals. And I think that kind of a reversal in that thinking has happened. And then it's also been the contribution of these particular historians too who have been able to argue successfully that these alchemists were very serious scientists and not just charlatans trying to trick people into thinking they could make gold. And then a final thing that's been discovered in the last half century is that some of our most famous scientists, including Isaac Newton and Robert Boyle, were alchemists in their

spare time. They weren't public about it because they would be laughed out of the Royal Academy, but certainly there's no argument that they were trying to make gold.

Host – Robert Frederick
Beyond giving credit to alchemists then for scientific discoveries and shedding new light on a history of science, did you discover whether modern scientists are learning anything new that has import scientifically in recreating the work of alchemists?

News Writer – Sara Reardon
Well, whether there are still scientific discoveries out there – maybe, maybe not. One of the problems with trying to understand what the alchemists were doing was that they coded many of their protocols in this kind of metaphorical language referencing Roman gods and the alignment of the planets. And so, it's taken a long time for some of these historians to be able to figure out what exactly they were talking about, much less be able to reproduce the experiments. And so, there certainly could be some very interesting discoveries still out there buried that no one's been able to reproduce or even understand yet. But many of these historians believe that the more important aspect of this is sort of the philosophical one – just coming to realize that we're not smarter than the people of the past; we're not better scientists than they are; we just know more because we have accumulated so much knowledge over time. They were doing research with the best tools they had the same way we do today, and who knows hundreds of years from now people will look back at us the same way we look back at the alchemists.

Host – Robert Frederick
Now, you mentioned that they were doing blue sky scientific investigations – researching whatever it was they wanted. What about the funding for this research? Were these alchemists all independently wealthy or using their legitimate science to earn money so that they could pursue their alchemy in secret?

News Writer – Sara Reardon
Well, it's a combination of both of them. Some of them were independently wealthy; some of them had jobs, as being the official chemists of certain societies. Very often, though, they would have a royal patron or someone who was very wealthy and wanted the secret of gold – how to make gold. And so, they would give, these kings or dukes, would give money to the alchemists and have them be their own little pet and do experiments for them. Now, this was not necessarily the best situation for the alchemists. If they didn't succeed in making gold, then they could be in a lot of trouble. And, if they claimed that they could make gold – falsely claimed that they could make gold – that could often carry a death penalty. And so, this is one of the reasons why they may have written in code was that their patrons didn't want the secret to get out either. If you could start making gold, many of the patrons were even worried that their currency of their countries would be devalued.

Host – Robert Frederick
Sara Reardon, thank you very much.

News Writer – Sara Reardon
Thank you, Rob.

Host – Robert Frederick
Science's Sara Reardon reports in this week's issue on how scholars are coming to realize that medieval alchemists were real scientists after all.

Music

Host – Robert Frederick
If you missed our regular ScienceNOW segment, it will be back next week. In the meantime, you can check out the latest science news, plus all the stories on the *Science* policy blog, *Science*Insider, and join a live chat, *Science*Live – on the hottest science topics every Thursday at 3 p.m. U.S. Eastern time –find it all at news.sciencemag.org.

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Host – Robert Frederick
And that wraps up the May 20th, 2011, *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. Jeffrey Cook composed the music and I'm Robert Frederick. On behalf of *Science* Magazine and its publisher, AAAS, thanks for joining us.

Music ends