Introduction to Biology

Weeks 1-3

Content focus: What is biology?
READI practice focus: Building classroom routines to support science literacy and meaning making

Students begin to see text as a part of scientific practice, and that scientific knowledge is built through close reading of text and through class-wide, knowledge-building discourse. Students begin to see themselves as readers of science, increasingly interact with texts, and view the classroom as a place where their knowledge is valued. To accomplish this, teachers and students will build the following routines:

Classroom routines to support science literacy and meaning making	Resources in READI PD and *Reading for Understanding* (page numbers are from *RfU* unless otherwise noted)
Establishing norms for sense-making in science: reading, writing, and talking (small group and whole class).	• Norms: 58-64 • Small groups: 126, 332 • Text-Based Seminar Guidelines: Binder Res. Tab p21 • "Numbered heads" small group spokespersons: Day 4
Using talk stems as scaffolds for talking, responding, and following up on one another's ideas to support science knowledge building.	• Scaffolding talk/talk stems: 66-67, 99-100 • Think-Write-Pair-Share: 121 • Science talk stems: READI materials
Introducing and practicing routines for metacognitive conversation about science reading. Discussions support sense-making and meta-comprehension of texts.	• Capture the reading process: 96 • Think Aloud: 83, 93-94, 105 • Metacognitive bookmark: 106 • Talking to the Text: 108-109 • Metacognitive Double-Entry Journal 110-118, 164-165
Building practices of posing questions about texts, surfacing prior knowledge, noticing and handling roadblocks, and constructing a model while reading.	• Questioning: 210-216 • Surfacing prior knowledge: 240-243 • Noticing and handling roadblocks: 203-205, 264, 267, 271-272 • Model construction: Day 2

Developing dispositions about scientific knowledge as being conjectural and revisable, as one gains more information through text and investigations.	• Using evidence: 216-217 • Building and revising explanations: 243-250 • Science practices: 274-276
Utilizing texts with multiple levels of difficulty, supporting a variety of learning goals.	• Vertical text sets: 144, 147 • Science in the news: 158-159 • Diagram dialogues/visual texts: 208-210
Engaging students in ongoing reflection on their science reader identity: preferences, accomplishments, challenges, goals, etc.	• Developing engagement: 56-57 • Why read: 73-78 • Personal Reading History: 79 • Student learning goals: p299-305
READI provides six recommended texts and the READI Reading Science Models Module.	• See next table for texts.

This table describes each of the six texts we recommend for this unit and offers READI/Reading Apprenticeship routines and practices to support student reading development and learning.

Text	Content and Practice Learning Goals	READI/Reading Apprenticeship Practices and Routines
"Here's what might happen to local ecosystems if all the rhinos disappear" *Smithsonian.com* 2014 3 pages	Understanding how disturbances to single organisms can have complex impacts on the ecosystem. Highlights interdependence of biological systems.	• Introduce Think Aloud foregrounding intellectual engagement (always the goal!) • Metacognitive Conversation and begin the Reading Strategies List • Co-construct initial norms for reading, writing, thinking, and talking
"These mad scientists want to replace solar panels with potted plants" *Wired Science* 2014 2 pages + video	Plants as "battery-like" energy producers, eco-friendly alternatives to energy production, drawing on nature's method of creating energy as inspiration for new technologies.	• Introduce Talk to the Text foregrounding: cool to be confused (normalizing struggle), noticing new words/usages & questioning • Metacognitive Conversation and update Reading Strategies List • Refine norms • Begin Word Wall

"Growth and Reproduction" *Biologyreference.com* 1 page	Bacteria, like other living organisms, engage in cell division to produce offspring.	• Talking to the Text foregrounding: visualization/margin modeling, mathematical reasoning, getting the gist • Metacognitive Conversation and Reading Strategies List • Add to Word Wall
"Human Evolution: The Neanderthal in the family" *Nature* 2014 2 page excerpt	DNA plays an increasing role in surfacing new knowledge about extinct species and human origin; scientific data is often constrained/advanced by technology.	• Talking to the Text foregrounding: noting and handling roadblocks, making connections (text-schema, text-text), questioning, reading diagrams, attending to scale (time) and/or role of technology in science research • Metacognitive Conversation and Reading Strategies List • Add to Word wall, begin an E/I poster for the word "evolution"
"Study: Humans can smell 1 Trillion Scents" *The Atlantic Monthly* 2014 2 pages	Specialization of cells, cellular function and communication; tentative nature of science and role of data in advancing knowledge.	• Talking to the Text foregrounding: questioning, making connections to schema, science knowledge as tentative and based on evidence • Metacognitive Conversation and Reading Strategies List • Revisit/refine classroom norms for reading, writing, thinking, and talking
"Humans Can Discriminate More than 1 Trillion Olfactory Stimuli" *Science* 2014 1 page excerpt	Scientific practice of presenting data in representational forms, designing and conducting studies that address specific research questions.	• Talking to the Text foregrounding: Reading diagrams/data tables, noting and handling roadblocks, role of data in science • Metacognitive Conversation and Reading Strategies List

Smithsonian.com

Here’s What Might Happen to Local Ecosystems If All the Rhinos Disappear

African landscapes may become very different places if rhinos aren't there to diversify plant life and create prime grazing spots for other animals

White rhinos help shape the ecosystem by increasing plant diversity and providing grazing patches for other animals. (Photo: Zigomar)

By Rachel Nuwer

smithsonianmag.com
February 27, 2014

Some large animals influence their surroundings more than others. Elephants are known as ecosystem engineers for their tendency to push over trees and stomp shrubby areas in the savannah into submission. This keeps forests at bay, which otherwise would overtake open grasslands. Wolves, on the other hand, are apex predators. They keep other species like deer in check, preventing herbivore populations from getting out of hand and eating all the plants into oblivion. Both elephants and wolves are keystone species, or ones that have a relatively large impact on their environment in relation to their actual population numbers.

African rhinos, it turns out, also seem to be a keystone species. According to a recent study published by Scandinavian and South African researchers in the *Journal of Ecology*, rhinos maintain the diverse African grasslands on which countless other species depend.

Surprisingly, prior to this study no one had looked closely rhinos’ roles in shaping the ecosystem. Most researchers focused on elephants instead. Suspecting that these large animals influence their environment, the authors took a close look at rhinos in Kruger National Park in South Africa.

Today, around 10,500 white rhino live in the park, but that was not always the case. In 1896, rhinos went extinct there due to overzealous trophy hunting. In the 1960s, conservationists began reintroducing the animals back into the park. The population rebounded over the decades, although the rhinos haven't distributed themselves around the 7,500-square mile area equally. As a result, Kruger acts as a sort of "well-documented natural experiment," the researchers write, showing what happens when an animal is excluded from and then put back into an environment.

The authors first examined a 30-year aerial survey record (beginning in 1980) of where the rhinos did and did not live around Kruger. This record also showed how rhino distributions varied over time as they slowly expanded into new areas. So, by studying these surveys, the researchers could identify and compare places where rhinos had inhabited the longest or the shortest.

After pinpointing high- and low-density sites, the authors went into the field and recorded the plant species found along 40 sections of the park, totaling just under 20 miles. They built a statistical model to analyze the results and controlled for factors such as soil content and the presence of other large grazers, including impala, warthog and wildebeest.

The places where the fewest rhinos lived, they found, had 60 to 80 percent less short grass cover than places where rhinos frequently hung out. "Short grass" is a catch-all metric commonly used to approximate plant diversity in grassy areas in Africa, referring to a number of munchable species. Rhino-inhabited areas also had about 20 times more grazing lawns, or patches where specific grass species grow that are prime eating for not only rhinos but also smaller grazing animals such as zebra, gazelle and antelope.

Based on these findings, the authors think that the rhinos are probably playing a role in controlling the make-up of the park's grasslands. Rhinos, like other grazing species, selectively browse on certain grass species, which leaves room for others that otherwise could not compete to move in and promotes a diverse mosaic of edible plants. As a science writer for the University of Washington put it, "Think of them less as lawnmowers and more as...selective lawnmowers."

Rhinos have only been around the park for a relatively short amount of time, so future studies will have to confirm whether their presence leads to even more substantial ecosystem changes. Examining other places in Africa will also help confirm whether or not rhinos have the same influence wherever they go.

Rhinos are one of the few megaherbivores—plant-eaters that weigh more than 2,000 pounds—that still live in the world. Most others have long gone extinct, many of which were victims to human hunting and expansion. Rhinos' continued existence, however, is questionable. Poachers killed nearly 1,000 rhinos in South Africa alone last year—an almost 50 percent increase from 2012—so as things now stand, rhinos may very likely go the way of so many other species before them.

If the rhinos do disappear from Africa, the authors warn, the savannah will likely become a distinctly different place—in addition to an emptier one.

Source: http://www.smithsonianmag.com/articles/heres-what-might-happen-local-ecosystems-if-all-rhinos-disappear-180949896/#jfSyybEzHZAcTFT6.99

Growth and Reproduction

Growth and Reproduction

Bacterial cells grow by a process called binary fission: One cell doubles in size and splits in half to produce two identical daughter cells. These daughter cells can then double in size again to produce four sibling cells and these to produce eight, and so on. The time it takes for a bacterial cell to grow and divide in two is called the doubling time. When nutrients are plentiful, the doubling time of some bacterial species can be as short as twenty minutes. However, most bacterial species show a doubling time between one and four hours. A single bacterial cell with a one-hour doubling time will produce over 1 million offspring within twenty hours. If left unchecked, a single E. coli bacterium replicating once every twenty minutes could replicate equal to over 3 times the population of Chicago in 24 hours! The enormous increase in cell numbers that accompanies this exponential growth provides these simple unicellular organisms with an incredible growth advantage over other unicellular or multicellular organisms.

Adapted from source: http://www.biologyreference.com/Ar-Bi/Bacterial-Cell.html#ixzz1RG7ByBLw

These Mad Scientists Want to Replace Solar Panels With Potted Plants

BY JOSEPH FLAHERTY 03.12.14 | 6:30 AM

Designer Fabienne Felder wants to reupholster jumbo jets with moss. In her vision, passengers will sit on verdant tufts while the bryophytes purify the air and use electrons captured during photosynthesis to power the Direct TV panels on the seat backs. Many would think Felder was crazy, but biochemist Dr. Paolo Bombelli and plant scientist Ross Dennis from the University of Cambridge were impressed with her brio and offered her the opportunity to collaborate with their lab.

The scientists are researching the potential of photo microbial fuel cells, or photo-MFCs, which are essentially potted plants that act like miniature power plants and transform sunlight into electricity that can power iPads. They aren't as efficient as traditional photovoltaic solar cells, but are more eco-friendly to manufacture.

Bombelli and Dennis have worked with designers previously and created a concept design called the Moss Table—a surface covered in photo-MFCs that could supposedly power a lamp. In reality, all the prototype cells could power was a small LCD display, but it illustrated the potential. While they appreciated Felder's gonzo vision, the scientists proposed a project that would be possible this year instead of a decade in the future and decided to build a humble FM radio.

The result is a sound system comprised of ten photo-MFCs housed in a frame meant to evoke the feel of a biochemistry lab. It looks like a science experiment, but Felder's biophilic boombox can generate enough power to play a short song. The array and a hidden capacitor can only power the radio for a few minutes at a time, and listening to an entire baseball game would require hundreds of plants, but she's still bullish on the potential of truly green energy. "Give the researchers a few more years and it will all change," says Felder. "But despite these little steps forward, the breakthrough we've had with the radio is not to be underestimated."

The University of Cambridge holds a patent on this technology and they're finalizing an educational kit that will surely replace potato clocks in 3rd grade classrooms around the country. Beyond that, stabilizing the technology and expanding its efficiency is the next order of business. Finding the perfect moss and growing them directly onto conductive surfaces could lead to efficiency gains, but more experiments are required. There are over 20,000 species of moss growing in Britain alone and aside from their ability to produce electricity they also insulate, muffle noises, filter the air, and have anti-fungal/bacterial properties.

"On a small scale I think we could soon-ish convert people's normal houseplants into little power-generators for charging phones," says Felder. "On a large scale, especially outdoors, the right mix of plants will be crucial and that will need more research, both in terms of plants and irrigation systems, maintenance, etc."

The team's well aware that it may take years before the technology is viable in the market. Even at maturity it might only make sense in developing countries. Despite the challenges, Felder is excited by the fact that current setups only convert approximately 0.1% of the electrons the mosses are exposed to. Even with that meager efficiency, if a quarter of London's residents used moss to charge their mobile phones for 2 hours every other day, it would save 42.5 million kilowatt hours, nearly $12 million dollars per year, and keep approximately 40 tons of carbon dioxide from the environment.

"I like the idea of getting closer to nature again and to use it in ingenious ways, without exploiting it," says Felder. "I am a designer by trade, but a scientist at heart."

Source: *Wired Science*. http://www.wired.com/2014/03/moss-solar-panels-power-pocket-radio/#slide-id-609946

nature International weekly journal of science

Human evolution: The Neanderthal in the family

Thirty years after the study of ancient DNA began, it promises to upend our view of the past.

Ewen Gallaway

26 March 2014

An equine oddity with the head of a zebra and the rump of a donkey, the last quagga (*Equus quagga quagga*) died in 1883. A century later, researchers published[1] around 200 nucleotides sequenced from a 140-year-old piece of quagga muscle. Those scraps of DNA — the first genetic secrets pulled from a long-dead organism — revealed that the quagga was distinct from the mountain zebra (*Equus zebra*).

More significantly, the research showed that from then on, examining fossils would no longer be the only way to probe extinct life. “If the long-term survival of DNA proves to be a general phenomenon,” geneticists Russell Higuchi and Allan Wilson of the University of California, Berkeley, and their colleagues noted in their quagga paper[1], “several fields including palaeontology, evolutionary biology, archaeology and forensic science may benefit.”

A million-year-old genome

Ludovic Orlando, an evolutionary biologist at the University of Copenhagen, had low expectations when he started sequencing DNA from a 560,000-to-780,000-year-old horse leg bone. His colleague, Eske Willerslev, had discovered the bone buried in the permafrost of the Canadian Yukon in 2003. Then he had chucked it into a freezer, waiting for technological improvements that would allow the bone's degraded DNA to be read. (Freezers in ancient-DNA labs brim with such 'wait and see' samples.)

On a Sunday evening in 2010, Willerslev called Orlando to say that the time had come. Orlando was unconvinced: “I started the project with the firm intention of proving that it was not possible,” he says.

Sequencing ancient DNA is a battle against time. After an organism dies, the long strands of its DNA fissure into ever shorter pieces, helped along by DNA-munching enzymes. Low temperatures slow this process, but eventually the strands become so short that they contain little information.

To read the horse's genome, Orlando needed to shepherd useful DNA fragments through the harsh enzymatic treatments used to extract them and ready them for sequencing. Orlando and his team found that the preparation lost vast quantities of fragments. But with a few tweaks to the experimental protocol, such as reducing the extraction temperature, the researchers captured ten times more scraps of DNA than before — and produced a draft of the oldest genome on record[2].

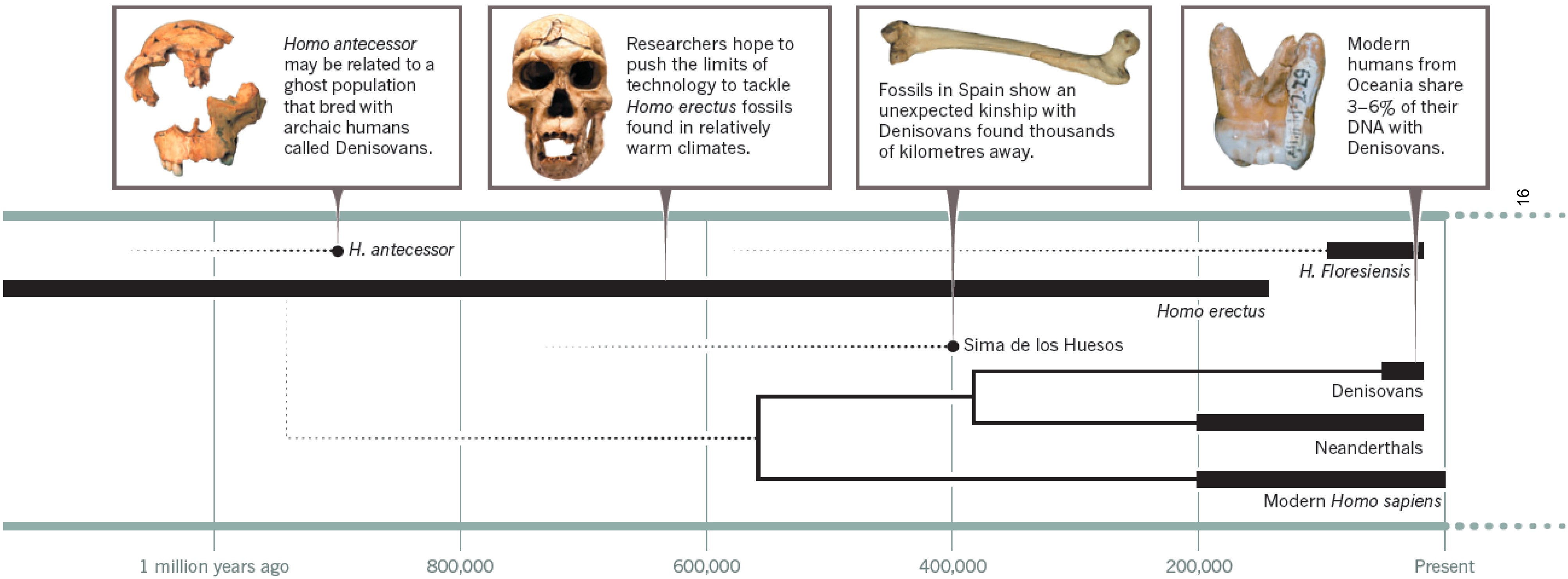
References:
[1] Higuchi, R. Bowman, B., Freiberger, M., Ryder, O. A. & Wilson, A. C. *Nature* **312**, 282–284(1984).
[2] Orlando, L. et al. *Nature* 499, 74–78 (2013).
Source: excerpt from Nature. *Nature* **507**,414–416 (27 March 2014) doi:10.1038/507414a
http://www.nature.com/news/human-evolution-the-neanderthal-in-the-family-1.14932

nature International weekly journal of science

Human evolution: The Neanderthal in the family

HIDDEN HERITAGE

The study of ancient DNA is revealing connections between archaic humans — and the traces they left behind in modern genomes.



The Atlantic

Study: Humans Can Smell 1 Trillion Scents

Researchers say our sense of smell is stronger than previously thought.

DANA SMITHMAR 25 2014, 5:00 PM ET


A woman smells the roses at a flower show in Essen, Germany. (Michael Sohn/AP)

Smell always seems to get the short shrift of the sensory world. We don't rely on it to navigate and communicate like we do sight and sound; it doesn't send shivers up our spine like a caress; and no one's ever claimed a whiff of roses to be orgasmic, like they might a bite of chocolate peanut butter cheesecake.

This may be due to the notion that our powers of smell just aren't that strong, conventional wisdom being that we are only able to detect a paltry 10,000 odors, compared with 2 to 7 million different colors.

But new research published in *Science* reveals that our olfactory abilities are far stronger than anyone had previously imagined, enabling us to detect more than 1 trillion different scents.

A team of researchers from Rockefeller University and the Howard Hughes Medical Institute set about to debunk this science myth by testing peoples' powers of olfaction on a variety of different odor combinations. Unlike sight, where there are only a set number of light wavelengths that we can (or cannot) see, scents are made up of hundreds of different molecules, so the number of odor combinations is practically infinite. This means that it is very difficult to test our capacity for smell, so although the assumption was capped at 10,000 odors, it was never actually tested.

To get around this problem, the researchers combined 128 common scents, like orange and peppermint, into new smells containing 10, 20, and 30 of these different odor molecules. They then had participants compare three vials of these odor combinations, two of which were the same and one that was different, and try to pick out which one was not like the other.

Even when more than 50 percent of the odor molecules in two scents were identical, participants were still able to distinguish between the two smells.

Even when more than 50 percent of the odor molecules in two scents were identical, participants were still able to distinguish between the two smells.

By comparing participants' abilities to discern the different odor on more than 250 sets of three, researchers were able to extrapolate our total ability for smell. Study author Dr. Leslie Vosshall explained, "It's like the way the census works: to count the number of people who live in the United States, you don't knock on every single door, you sample and then extrapolate. That's how I like to think of this study. We knocked on a few doors."

For example, even when more than 50 percent of the odor molecules in two scents were identical, participants were still able to distinguish between the two smells. While this may not sound that impressive, when you consider the sheer number of possible odor combinations available, this indicates we're actually pretty good at telling them apart.

Dr. Andreas Keller, the lead author on the paper, surmised, “The message here is that we have more sensitivity in our sense of smell than we give ourselves credit for. We just don't pay attention to it and don't use it in everyday life."

So next time you stop and smell the roses, breathe deep. There may be more in there than you thought.

Source: The Atlantic. http://www.theatlantic.com/health/archive/2014/03/study-humans-can-smell-1-trillion-scents/359505/

Humans Can Discriminate More than 1 Trillion Olfactory Stimuli

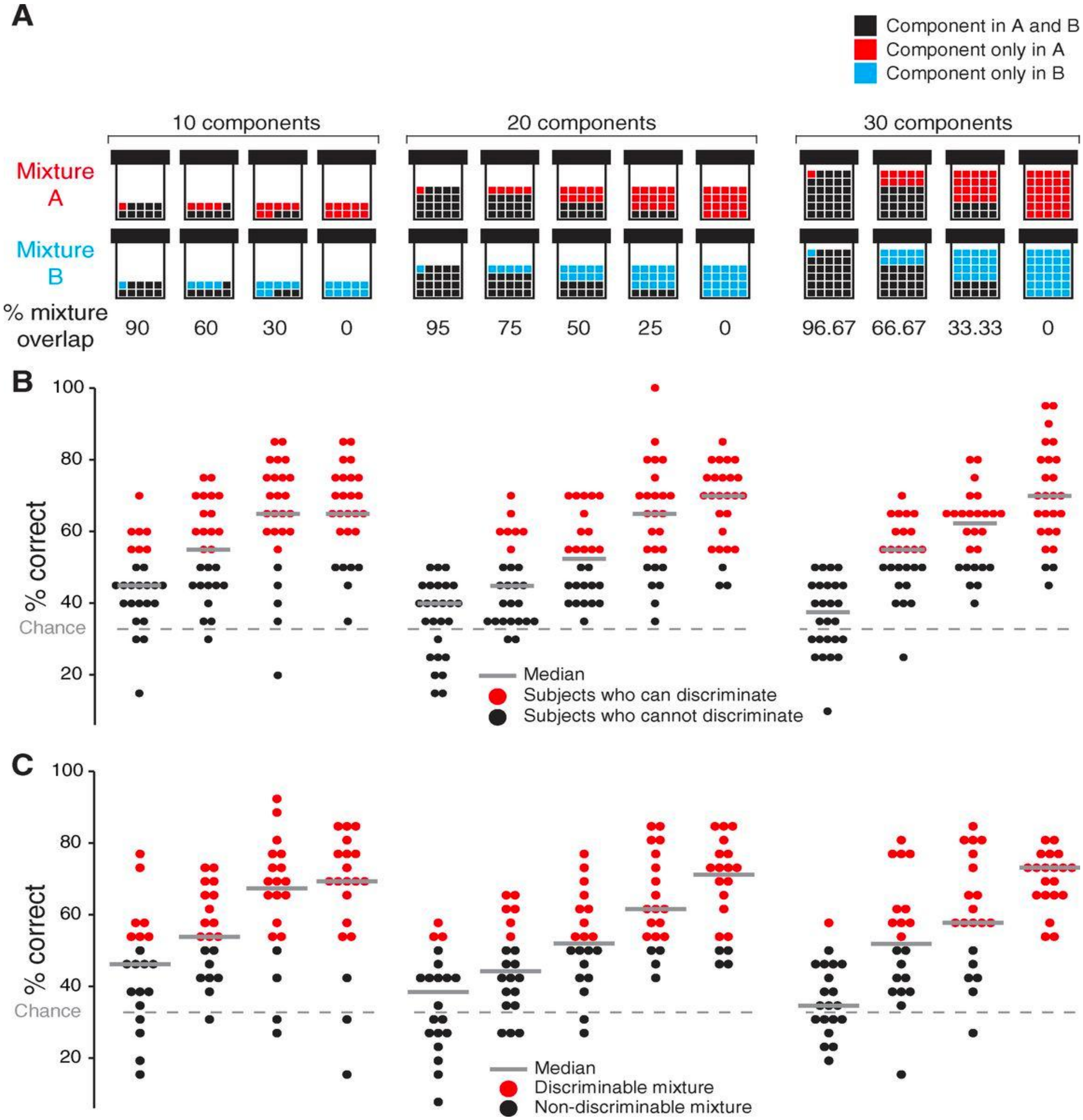


Fig. 2 An empirical investigation of the resolution of the human olfactory system. (**A**) Schematic of the discrimination tests carried out for mixtures of 10, 20, or 30 odorous molecules. (**B** and **C**) Results of discrimination tests with 26 subjects asked to discriminate mixtures of 10 (left), 20 (middle), or 30 (right) components with decreasing overlap from left to right. The dotted line represents the chance detection level (33.3%). For (B), dots represent performance of individual subjects across 20 mixture pairs. For (C), dots represent average performance of all 26 subjects for a given mixture pair. Statistically significant discriminability (red dots) was assessed with a χ^2 test; $P < 0.05$.

Source: *Science* 21 March 2014:
Vol. 343 no. 6177 pp. 1370-1372
http://www.sciencemag.org/content/343/6177/1370.full