SCIENCE NEWS of the week

Antibody Scrabble: Two Genetic Players Proposed

Just as the millions of words in the English language arise from rearrangements of only 26 letters, the body's billions of different antibodies come from an alphabet of a few hundred genes. Two years ago, the discovery that certain white blood cells recombine these "letters" using a genetic cut-and-paste technique garnered a Nobel prize (SN: 10/17/87, p.244). But exactly how the cells do this remains unclear.

Researchers now report they have identified two genes apparently involved in the puzzling permutation. At the Whitehead Institute for Biomedical Research in Cambridge, Mass., David G. Schatz, Marjorie A. Oettinger and David Baltimore cloned a gene that activates recombination when injected into muscle cells, which normally don't tamper with DNA. And a group headed by Tasuku Honjo of Japan's Kyoto University found a gene that encodes a protein similar to DNA-cutting enzymes in viruses, bacteria and yeast. Those enzymes belong to a class called the recombinases, which recombine specific portions of DNA.

The Whitehead and Kyoto teams report their findings in the Dec. 22 CELL and the Dec. 21/28 NATURE, respectively.

Although the Whitehead researchers do not yet know the exact function of their new find — which they have named *RAG-1*, for recombination activating gene — they suspect it might encode a recombinase that reshuffles antibody genes. Humans, mice, chickens and frogs share similar *RAG-1* genes, they report.

"We don't actually know if *RAG-1* is the [gene for] recombinase, or if it's some sort of genetic switch that turns on other genes," Oettinger says. However, the gene does behave as they would expect a recombinase gene to act, she adds. For example, it is active in young B- and T-cells — the white blood cells that recombine DNA to produce antibodies — but not in mature ones.

The group used "a mixture of perseverance and a creative assembly of existing techniques" in making its discovery, comments molecular biologist Michael R. Lieber of Stanford University. First, Schatz and Baltimore developed a way to put genes into young muscle cells called fibroblasts. To determine whether an inserted gene prompted recombination, they added on a short DNA segment containing a scrambled gene that would enable a fibroblast to resist a cell-killing drug — but only if the fibroblast first restored the gene's proper DNA sequence.

Whereas the Whitehead group started with a gene and looked for clues to its function, the Kyoto researchers started with a function and looked for a gene. They purified a protein that binds to a "signal sequence" of DNA — a segment that tells the cell where antibody recombination should occur — and then used information about that protein to find two genes, which they dubbed *RBP-1* and *RBP-2*. Parts of these genes code for an amino acid sequence resembling that of the recombinases found in viruses, bacteria and yeast.

The results from the two labs raise as many questions as they answer, says molecular biologist George D. Yancopoulos, who coauthored an editorial on the U.S. and Japanese findings in the Dec. 21/28 NATURE. "Even after the cloning of these genes, no one knows anything about the actual mechanism" of antibody recombination, he says. *RAG-1* could represent the main switch that controls the recombination, or it might encode just one of many enzymes that are controlled by some other gene. The only known function of the *RBP* genes is to encode a protein that binds to DNA, but that protein's role in recombination is likewise a mystery. "It could be that the Baltimore [group's] gene is a gene that turns on many other genes, one of which is the Honjo [group's] gene," Yancopoulos says. "There are loads of possibilities."

— *A. McKenzie*

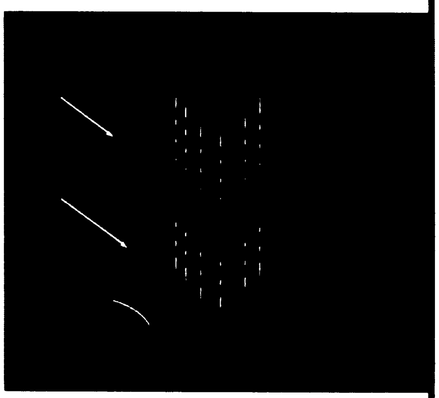
Shaking raindrops wash out rainbows

Not every raindrop contributes to a rainbow's appearance. For instance, large drops, which get flattened by air pressure into a shape resembling a hamburger bun, are too distorted to add significantly to the colors seen in a rainbow's upper portion. The recent discovery that small, nearly spherical drops can oscillate has now led scientists to add a further restriction on the sizes of raindrops that help create a rainbow.

"Our discovery of the natural oscillations [of raindrops having diameters between 1 and 1.5 millimeters] would seem to exclude most raindrops from contributing to the rainbow," says Kenneth V. Beard of the University of Illinois at Urbana-Champaign. That means raindrops less than 1 mm in diameter — practically drizzle — must be the major contributors. "They don't suffer from the distorting effects of oscillations, and they are nearly spherical," Beard told SCIENCE NEWS.

The brilliant, multicolored arc of a rainbow represents the combined effect of reflections within innumerable raindrops. Different colors of light emerge from each drop at different angles, spraying reflected light over a large part of the sky opposite the sun. As raindrops fall, they flash different colors toward a stationary observer, who sees the scattered light as a band of colors spread across the sky.

Raindrop oscillations complicate this picture. As a drop's shape changes, the angles at which it reflects particular colors change, and because the oscillations of all the drops aren't coordinated, the observer sees a mix of colors coming from any given position in the sky. Any rainbow colors produced by oscillating drops are in effect washed out.



Beard

Beard and his colleagues discovered the natural oscillations of small raindrops by photographing the changing rainbow reflections of white light scattered by individual drops as they fell. Each oscillating drop produces a colored streak on the film (center), with dark bands corresponding to drop shapes (right) that momentarily scatter visible light away from the camera. The left-hand column shows how a spherical raindrop reflects and spreads out white light to create the full spectrum of rainbow colors. A single internal reflection produces the primary rainbow (bottom left) while a double internal reflection produces the secondary rainbow (top left).

"When you add all this up, you get some scattered light — a whiteness — but no colors," Beard says. "Droplets that create rainbows can't be oscillating and must be quite small."

Calculations based on theory suggest that droplets between 0.5 and 1 mm in diameter create the most brilliant colors. It's not surprising, then, that Hawaii — with its abundance of light showers — is one of the best places to see rainbows.

— *I. Peterson*