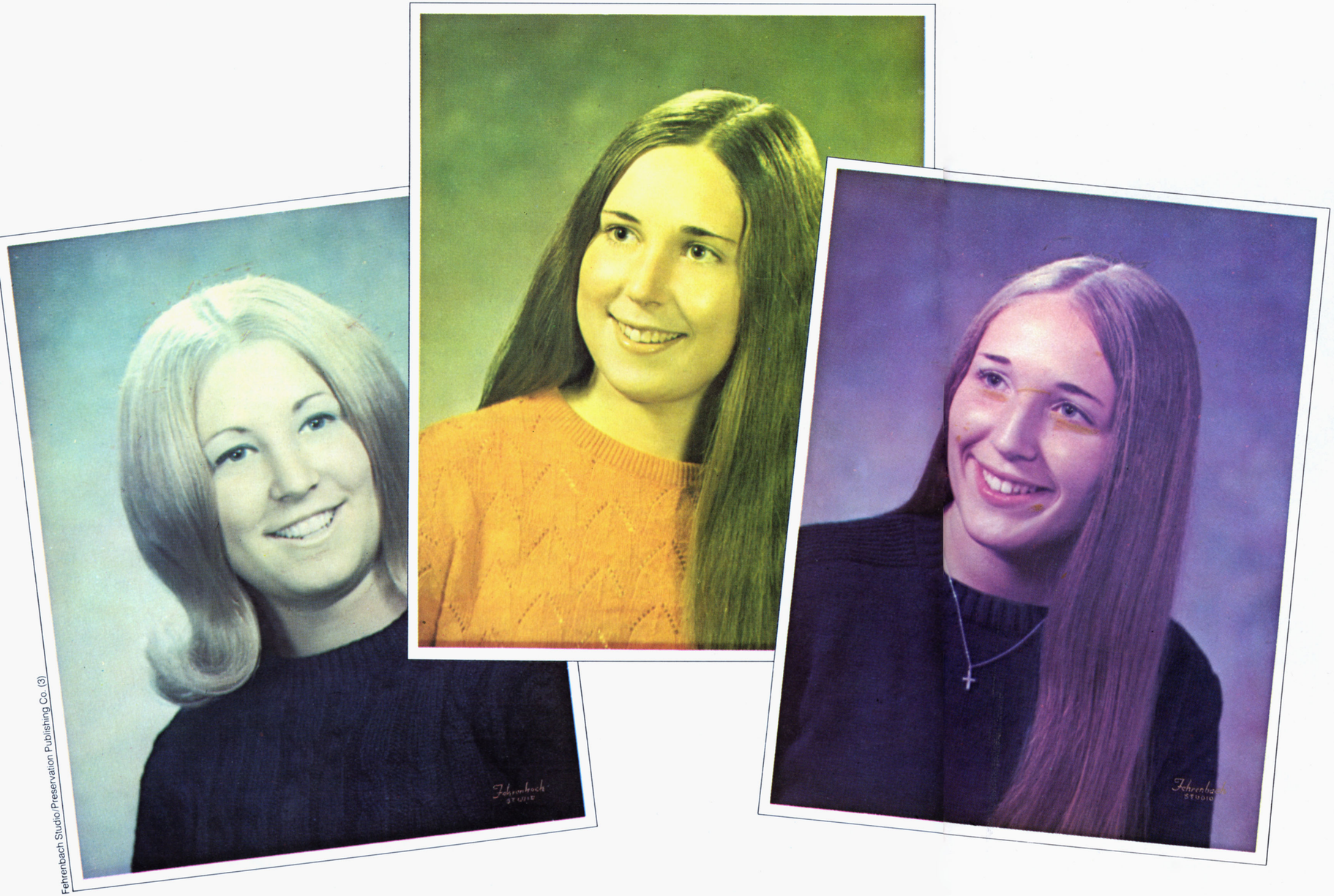

Fehrenbach Studio/Preservation Publishing Co. (3)

MEMORIES THAT LOSE THEIR COLOR

Old snapshots never die, they just fade away.

by Ellen Ruppel Shell

It was bad enough when Theresa's turned blue and Carla's yellowed. But when Rhea's high school graduation picture faded to a murky shade of purple after only eight years, the girls' mother, Judy Corwith, marched it back to the photography studio and demanded retribution.

"In a small town like Reedsburg [Wisconsin] word gets around fast," says studio owner Robert Fehrenbach, who reprinted the Corwith photos and hundreds of others. "We lost a lot of customers."

Fehrenbach figures thousands of photographs produced in his studio have suffered from fading or cracking. This came as a shock to him and his wife, Bernice, who have operated a successful business since 1963. But it is no surprise to Henry Wilhelm.

"Compared with most other types of artistic media, color photographs generally fade fairly rapidly when displayed," says Wilhelm, a color image preservation expert. "Since people tend to display their best or favorite photos, they actually single them out for destruction."

Unwitting consumers are not the only ones affected by this phenomenon. Professional photographers throughout the country have watched in horror as their best work fades into oblivion. Some museum curators who have seen acquisitions of a decade ago fade are refusing to purchase photographs printed on the most widely used paper. Others demand storage facilities costing $50,000 to $100,000 to protect what stock they have.

Theresa's, Carla's, and Rhea's graduation portraits, left to right, were printed on different papers, giving each its very own fading hue. The yellowish-brown spots on Rhea's face are the result of the photographer's retouching.

"The changes in these photographs are erratic and unpredictable," says James Enyeart, director of the Center for Creative Photography at the University of Arizona, home of one of the world's largest and most distinguished 20th-century collections. "We have color prints dating back to 1956 that are in fine condition. But we have others that have changed so dramatically in eight to 10 years that they bear absolutely no resemblance to the original."

If photographs maintained by professional archivists can suffer such a fate, what hope is there for that album of wedding or travel shots you've stored in the attic or shoved to the back of the bedroom closet? That depends on the kind of photographic paper used and the temperature, humidity, and light intensity in your closet. It also hinges on the type of paper or plastic sheets holding the photos in the album, on whether the prints were treated

That bridesmaid's dress will be more vivid in memory than in a 10-year-old color print.

Fehrenbach Studio/Preservation Publishing Co. (4)

Copies of the photo at top left were put through accelerated fading tests that try to duplicate the ravages of light and dark. After simulating roughly six years, center, and 15 years, right, of display in a bright room, only the bridal veil gives away the bride, thanks to the loss of magenta dye. After an estimated 30 years in the dark (in an album or box), the photo at lower left has lost cyan (blue) dye.

with lacquers or sprays after processing, even on whether you use a gas stove. Chances are, though, that unless you live in a frost-free igloo, that bridesmaid's dress or Hawaiian shirt will be much more vivid in memory than in a 10-year-old color print.

Anyone who has ever washed a pair of madras shorts or replaced a set of faded curtains knows how labile color dyes can be. But it was not until the 1980s that the major photographic manufacturers were willing to bear witness to that fact. With advertising slogans like Kodak's "take a moment out of time . . . and make it last forever," and "wedding candids to last a lifetime," the last thing the industry wanted consumers to think about was the longevity—or lack of it—of their products. But pressure from professional photographers, archivists, and film makers has dragged the issue of image stability out of the closet and into the limelight. It can be a very unflattering light indeed.

"The majority of color photographs are not suitable for display," says Klaus B. Hendriks, director of picture conservation at the Public Archives of Canada. "Unfortunately, industry didn't feel responsible for the fate of a photograph once it was finished. They couldn't make money telling people how to preserve their pictures."

Truth is, manufacturers haven't had to worry much about image stability until now because few consumers have made it an issue. After all, that picture of grandma on her wedding day that graces your mantle is still in great shape. That's because black-and-white photographs aren't really affected by light and heat. But black-and-white took a backseat to color in the early 1960s, and today at least 90 percent of the photographic market lies in color prints. More than 11 billion amateur color photographs are snapped every year in this country alone.

But not all color photographs are created equal. In the more stable color processes, dyes that form the final image are layered into the paper. These dyes respond proportionally to the amount of red, blue, or green light that strikes them. (Blue light creates yellow dye; green, magenta; and red, cyan). Your average, everyday print made from a negative, however, does not have image dyes already imbedded in the paper. Instead, the paper used in this popular process, called chromogenic development, contains dye precursors. These precursors can only form dyes after light converts silver halide crystals in the paper to metallic silver, which then reacts with the developer. The products of this reaction then combine with the precursors to form the magenta, cyan, and yellow dyes. The density of the resulting dyes, and the concentration of each color in the photograph, is again proportional to the amount of light that hits the film when the picture is snapped and then the paper when it is developed.

The trouble with many of the dyes generated in this miniature color "factory" is that they are unstable. Light, especially ultraviolet and blue light, contains enough energy to cause chromogenic dyes to disintegrate into colorless fragments. Worse, the dyes can react with water vapor, oxygen, or contaminants in the air to wither even in the darkest recesses of the most carefully stored album.

"Color photographs are the first colored materials known to fade in the dark," Hendriks says. "And this is especially true of chromogenic materials." Even the new enhanced stability paper Kodak introduced this summer will only delay the inevitable.

That doesn't keep professional photographers who know this from using chromogenic products. Nor does it put a dent in the enormous amateur market. With the notable exception of instant films, virtually all products made for the snapshot set are chromogenic. This is what Kodak hoped for when it introduced Kodacolor, the first widely available chromogenic print system, in 1942. The idea was to create a color film suitable for use in box cameras that could be quickly mass processed into prints for wall or wallet. The original Kodacolor was a stability disaster—just about every print made with the process before 1953 is now a faded orange blur. But it made color photography a reality for millions, and Kodak processing became so widespread that manufacturers were forced to come out with products compatible with it or go out of business.

"For all practical purposes," says Donald Hotchkiss, a 3M physicist, "the

People recall the sky as bluer and fire engines as redder than they really are.

differences in stability among brands of chromogenic papers are trivial." That means the most expensive family portrait taken by studio photographers is printed on essentially the same material as the cheapest dimestore rendition. And the costly print will fade as quickly as any 88-cent special.

Industry has long been aware of this irony. While saying stability is "not really a problem" and that they "get virtually no complaints" from consumers about it, Polaroid and Kodak maintain extensive color stability laboratories, as do the Japanese companies of Fuji and Konishroku, Germany's Agfa-Gevaert, and Ciba-Geigy of Switzerland. But the companies kept test results pretty quiet until 1979, when a group of very vocal still and motion picture professionals and museum curators formed an international committee to look into the stability question. "It's a very difficult issue," Hotchkiss says, "because it's so hard to determine the point at which a color photo is no longer acceptable."

Not surprisingly, Kodak led the way in research into color perception and the degree and types of fading that the human eye can and cannot ignore. It turns out that human memory is highly selective and usually inaccurate when it comes to colors. In fact, many precisely reproduced hues are actually offensive to the eye. Most people recall the sky as bluer, the grass as greener, and fire engines as redder than they really are. Film manufacturers actually build their products around these prejudices, with bluer-than-blue blues, lush greens, and sizzling reds.

According to Charleton Bard, supervisor of image stability at Kodak's Photo Technology division, inherent limitations in the three-dye system make it impossible to duplicate in a photograph all real-world colors simultaneously. "From a practical standpoint, though, this is not a problem," he says. "Our job is to make colors that people like, and what people like is significantly different from actual color."

Complicating things still further is the fact that different cultures demand different deceptions. Westerners, for instance, tend to dislike sallow skin tones, so prints made here give people a ruddy, outdoor look. The Japanese prefer their skin tones slightly whiter, while in India the preference is for skin with a slightly green tint, so pictures processed there make people appear a bit sickly by American standards. Even within this country, the color labs respond to different cultural preferences: People's skin tones in the western United States, for example, should be just a bit rosier than in the east.

While color "quality" is a very subjective notion, color concentration—the amount of dye in a given photograph

Accelerated fading tests demonstrate the difference between a typical chromogenic print, left, and a more stable Cibachrome print, right. Copies of the two photos, top, were subjected to an estimated 25 to 30 years in the dark. The Cibachrome, bottom right, will probably look this way a hundred years from now, while the chromogenic print, bottom left, has already lost quite a bit of its cyan dye.

Rob Hodierne/Preservation Publishing Co. (4)

International Museum of Photography at George Eastman House

Printed more than 40 years ago using a process known as Azochrome, this Kodak print "takes a moment out of time and makes it last forever." Kodak abandoned this type of photo in favor of cheaper chromogenic prints in the early 1940s.

—is an absolute. A 30 percent fading of any one of the three dyes or a 15 percent loss of two is generally regarded to be unacceptable by photographic film and paper manufacturers. Since balance is actually more critical to human perception than concentration, however, a 15 percent loss of two dyes may not be nearly as offensive as a 30 percent loss of one.

And, of course, anything is preferable to an actual color shift. "People are very sensitive to color changes," says Kodak's Thomas Hutteman, explaining that most consumers will put up with a faded red rose but never a green one. Most companies make a stab at better defining the delicate distinctions between a "good" and "bad" print with accelerated aging tests that compress the effects of years of storage or exposure into a few days or months.

Kodak's color stability labs, housed in a drab glass building in the company's Rochester, New York, headquarters, is a series of what appear to be tanning salons and test kitchens. The former, some so bright visitors must don sunglasses to enter them, contain either lamps rigged with special filters to mimic high noon in Rochester on the longest day of the year, or the high-intensity fluorescent lights found in brightly lit office interiors. Color photographs taken with various films and printed on different papers line the walls, where they are systematically bleached by the rays.

High-energy ultraviolet radiation like that emitted by sunlight and fluorescent bulbs fades color photographs fairly quickly, despite the ultraviolet filters manufacturers build into the coating of photographic papers. Kodak reports that prints subjected day and night to 500 footcandles of fluorescent light (about five times the amount found in the normal inner office, but only about a tenth of the intensity of direct sunlight) show a noticeable decrease in dye density in 40 days and a dramatic loss of dye in about four months. How that translates into real life exposure is unclear, but Wilhelm, who maintains his own stability laboratory, says a chromogenic print hung on the wall will fade noticeably in a few years, significantly in 25. "These are not things you can pass on for generations," he says.

To test fading in the dark, Kodak uses small ovens set at temperatures ranging from 75 to 199 degrees Fahrenheit and humidities that run from a desert-dry two percent to a tropically drenched 100 percent. Wilhelm reports just noticeable decreases or changes in color density at a projected 10 years of a photograph's life in an album, dramatic changes in fewer than 30 years. Since stability doubles with every 10-degree decrease in temperature, fading in the dark can be significantly slowed by cold storage—or sped up by a trip to the tropics, where high heat, humidity, and film emulsion-eating fungi can consume chromogenically produced images in months.

Fading is also hastened by exposure to a number of air pollutants, such as sulfur dioxide emitted by gas stoves or automobiles, or by contact with certain plastics, such as glassine and cellulose nitrate, the very stuff of which some photo albums are made. Almost any postprocessing treatment, particularly lacquer sprays made with commonly used solvents, will shorten a color photo's life. And the so-called magnetic photo albums, the kind with slightly tacky leaves, sometimes stain the pictures or stick to the prints long after you want them to. But putting photos in a frost-free refrigerator will increase their stability by at least a factor of 10, and photos frozen in a low-humidity freezer appear to last indefinitely.

While freezing your favorite prints and negatives may seem a bit compulsive, it is one way to make sure that your great-grandchildren will know what

"People aren't aware of color stability. All they care about is having a pretty picture now."

you looked like on graduation day. The U.S. Library of Congress, the John F. Kennedy Presidential Library, the Art Institute of Chicago, Harvard's Peabody Museum, and Time Inc. all have hefty cold storage vaults for color photo and motion picture collections. But most photographers, professional or otherwise, do not. And some archivists complain that keeping photos in a deep freeze defeats their purpose. "I do not see it as appropriate to have a meat locker here because this particular institution is devoted to having works of art available for immediate access by our patrons," says Center for Creative Photography's James Enyeart. Several hours are required to warm a box of photos taken from cold storage to room temperature without cracking them, and this, Enyeart says, makes for very cumbersome viewing.

Probably the best known alternative to the deep freeze is the instant color systems, such as Polaroid's SX-70 and 600 and Kodak's PR 10 and Trimprint. These products are made with dyes that are significantly more stable in the dark than chromogenic dyes. Unfortunately, chemicals in the lower layer of instant prints often migrate into the visible image, causing the picture to yellow in the dark. This problem is mitigated in the case of Trimprint, which allows users to peel off the back layer containing the undeveloped chemicals. But all instant prints are so unstable in light that Ronald Cieciuch, a chemist at Polaroid, suggests they not be displayed at all. Since instant photography produces no negatives, he recommends framing a chromogenic copy of an instant print and keeping the original in a cool, dry place.

Another alternative is the dye transfer process, which produces prints with projected lifetimes of 300 years in the dark that are so vivid and sharp that many advertising agencies and some professional photographers swear by them. In the dye transfer process, separate relief images are made out of hardened gelatin for each color, then soaked with the appropriate dye and pressed into the photographic paper. The process requires at least three days of a highly skilled technician's attention and costs about $300 per 8-by-10-inch original print, more than most people pay for their cameras.

Black-and-white family portrait circa 1900 has lasted almost a century because neither light, heat, nor humidity affect it.

Bettmann Archive

The best bet for that special graduation day picture is probably to print it on Cibachrome paper, which is made and marketed by Ilford Inc. Unlike chromogenic papers, in which dyes are formed during processing, Cibachrome stock has fully formed dyes built into it. Unwanted portions of the dyes are washed away during processing, leaving a glossy, high-contrast image. Henry Wilhelm's research shows that Cibachrome prints made on glossy paper are the most stable color print on the market. But Cibachrome papers and chemicals cost about twice as much as chromogenic materials, though at about $20 for an 8-by-10-inch custom print, Cibachrome is far cheaper than dye transfer. There is one small catch: Cibachrome prints can only be made from slides. And shooting slides requires far more exacting camera settings than do prints made from negatives, which can be adjusted during development for under- or overexposure.

It's little wonder, then, that Kodak, a company committed to reaching the broadest of mass markets, chose not to introduce a Cibachrome-like product called Azochrome it had patented in 1941. A small selection of the few prints made with Azochrome before it was abandoned can be seen at the George Eastman House in Rochester. They are in excellent condition. But, according to Kodak spokesman Henry Kaska, "no one was really interested in Azochrome, and no one asks about it now."

Still, Kodak scientists say they are always investigating alternatives to chromogenic materials. Wilhelm suggests that one of these may be an Azochrome type process that can print off color negatives. Meanwhile, Fuji has hinted it may have a similar product out within the next few years.

Max Brown/Preservation Publishing Co.

In a particularly bad case of instability, an oval mat reveals the drastic fading of a wedding portrait that was displayed for only seven years. The exposed portion lost mainly magenta and yellow dyes to the light, while the part hidden by the mat remains truer to their wedding day.

This flurry of activity in color stability is a response to increasing demand for photographs that live up to company claims. Consumers complain to studio owners and professional photographers; they in turn complain to Kodak. Manufacturers have long had the means to produce products with enhanced stability but say their customers are generally unwilling to pay for a feature that might take years to show itself.

"Our industry depends on people accepting what's not exactly on target," says Peter Krause, retired president of Ilford Inc. "Most people don't even notice when a photo is faded unless it's severely deteriorated." Kodak's Bard agrees. To illustrate he reaches into a box and pulls out a completely faded print taken in 1953. "A woman sent me this and told me we should use it in our promotional material," he says. "People aren't even aware of color stability. All they care about is having a pretty picture now." Of course, this hasn't kept studio owners like Robert Fehrenbach from having to replace faded prints. "When you pay $1,500 for a set of wedding photographs," he says, "you sure as heck care if they last." S

Ellen Ruppel Shell is a Vannevar Bush fellow at MIT and a free-lance science writer.

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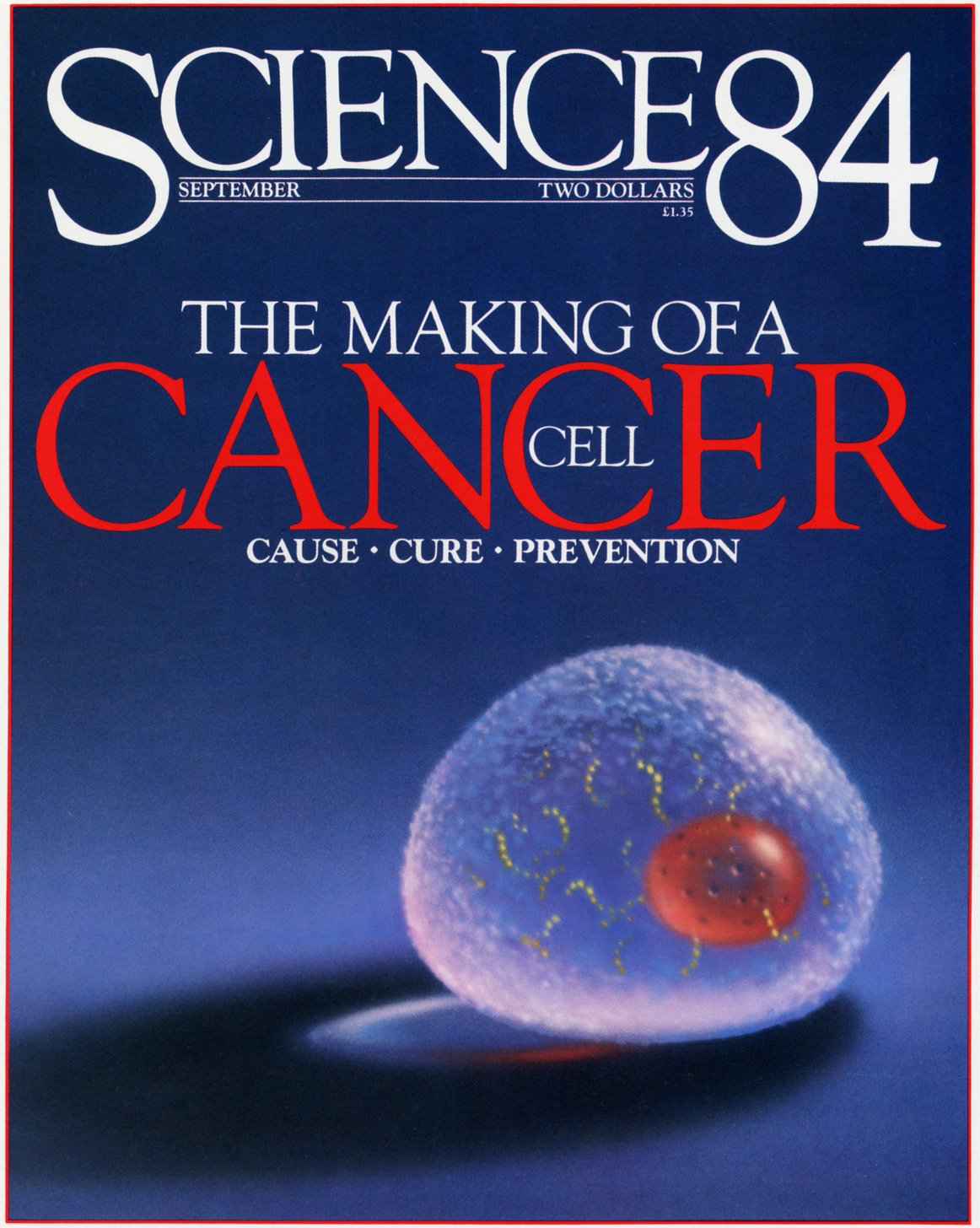

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Cancer begins in a cell when altered genes in the nucleus (red) direct ribosomes (yellow) to make the wrong kinds or amounts of proteins. Illustration by Rob Wood.

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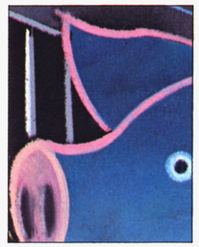

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