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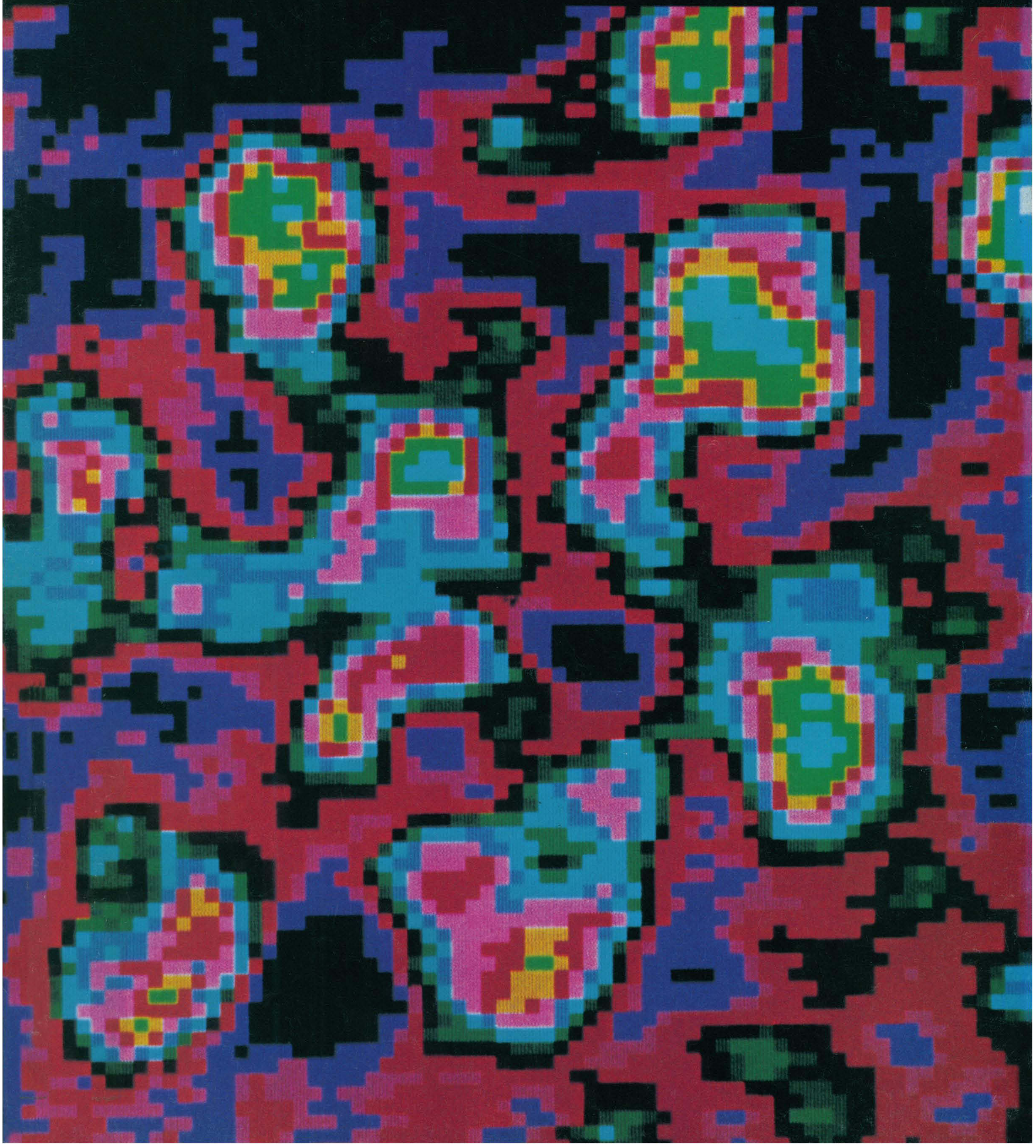

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COVER

Pseudocolor electron microscope tomograph displaying a 6-nanometer slice through a Balbiani ring gene transcription unit. The hexagonal pattern suggests a sixfold helical organization of nascent transcripts in situ. See page 498. [Donald E. Olins and Ada L. Olins, Oak Ridge Graduate School of Biomedical Sciences, Oak Ridge, Tennessee 37830]

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Glass Fiber Communication

Rapid progress is being made in research, development, and applications related to glass fiber communication systems. A number of companies are active in this field, but at present the Bell System, including Bell Laboratories, is the leader. In February of this year, the Washington–New York link of its Northeast Corridor Lightwave Communication System became operational. Shortly thereafter, the Sacramento–San José link of a Sacramento–San Diego system was placed in service. The remaining links in both systems are under construction and will be completed in 1984 and 1985, respectively. The communication capabilities of the links in service are impressive, but recent disclosures of the progress of R & D indicate that the capabilities of fiber systems can be improved by orders of magnitude.

The Washington–New York link contains 30,000 miles of tiny glass fibers. Communication through the fibers is by means of light pulses generated by lasers that can turn on and off 90 million times a second. The fibers, consisting mainly of pure SiO_2, transmit light with a wavelength of 1.3 micrometers. In repeater stations every 4 miles, light is converted to electric pulses that are amplified and then fed to lasers for injection of pulses into the next section of the line.

One measure of the capabilities of the existing systems is that a pair of fibers could transmit the entire *Encyclopedia Britannica* in 1 minute. But recent announcements make it evident that greater achievements will be forthcoming as a result of improvements in the fibers and especially in the lasers. The starting material for the fiber is a thick-walled tube of silica glass. During the manufacturing process, the tube is rotated while being heated. A mixture of $SiCl_4$, $GeCl_4$, and O_2 is introduced into the hot tube and SiO_2 and GeO_2 are formed and deposited on the inner surface of the silica. With further heating, the tube collapses into a solid rod. Later, the rod is pulled out into fibers with an outer diameter of 100 micrometers. The inner core, with a diameter of 5 to 10 micrometers, has an index of refraction greater than the remainder of the fiber. Light transmitted along the fiber is confined to the core.

A key breakthrough has been the development at Bell Laboratories of lasers that emit light which is practically monochromatic and free of side bands. The speed of light is dependent on the wavelength. Confusing signals would reach the detector from a source having a number of lines. At a wavelength of 1.3 micrometers, the difference in velocity is minimal. Hence, the earlier systems employing lasers with side bands were designed to use that kind of light. However, the absorption curve of light in silica has a minimum at about 1.55 micrometers that is considerably lower than the minimum at 1.3 micrometers. Development of monochromatic lasers at 1.55 micrometers has opened that part of the spectrum for use in transmission. With changes in the composition of the gallium-indium-arsenic-phosphorus lasers, the emitted wavelength can be controlled. In principle, it will be possible to transmit simultaneously hundreds of independent signals through a fiber. At the same time, the attenuation of the light with distance has decreased. This makes possible a much longer interval between repeater stations. Improvements in the lasers also make possible the use of shorter pulses. In one experiment conducted by Bell Laboratories, signals were successfully transmitted at the rate of 420 million per second through 73 miles of fiber with no intervening repeater stations.

Most of the equipment developed for long-distance transmission is applicable to local networks. Glass fiber loops have already been installed in a number of cities, including Los Angeles. With further R & D, costs will inevitably drop, and it will become practical to provide voice, data, and video services to offices, shops, and homes. Ian Ross, president of Bell Laboratories, has predicted that ultimately glass fibers carrying high-speed digital signals will make interactive video in color as widespread as today's telephone service.—PHILIP H. ABELSON