PERCEPTIONS OF SCIENCE

Beyond the Visible—Microscopy, Nature, and Art

Advances in microscopy in the 19th century revealed a new world of tiny organisms, cells, and microbes that continues to inspire artists, architects, and the general public.

Lynn Gamwell

When microscopes were invented by 17th-century Dutch lens makers, the images they produced had colored fringes of light at the edges of the magnified object. This chromatic distortion occurred because the waves comprising the beam of sunlight passing through their lens was refracted to different extents—producing not one focused image, but superimposed images in red, orange, yellow, green, blue, and violet wavelengths.

The development of the achromatic lens in the 1830s eliminated this distortion by combining layers of glass with different rates of refraction. Overnight, a crystal-clear window opened into the microscopic realm. For the first time, microorganisms were seen in brilliant natural color and immaculate detail. Earlier naturalists had barely been able to make out cell walls. But in 1838, the German physiologist Theodor Schwann and botanist Matthias Scheiden could see details of intercellular bodies so clearly that they confidently announced a fundamental fact of biology—all living tissue is composed of cells.

During the first decade of the achromatic microscope, pictures of sea creatures invisible to the naked eye were engraved after drawings made by the German biologist C. G. Ehrenberg while looking through a microscope (see the first figure) (*1*). The subtle coloring and fine detail of these famous pictures proclaimed the fascinating world that now opened before scientists, artists, architects, and the general public.

The French chemist Louis Pasteur soon discovered that the invisible substructure of nature contained not only beautiful little organisms, but also disease-causing microbes ("germs") that had cursed mankind for millennia. In 1862, he announced the germ theory of disease that revolutionized hygiene and medicine. Over the next two decades, journalists reported the isolation of each new microbe by Pasteur and German physician Robert Koch as if they were war correspondents at a battlefront: leprosy (1873), anthrax (1876), typhoid fever (1880), bacterial pneumonia (1881), tuberculosis (1882), diphtheria (1883), cholera (1884), and tetanus (1889). Within decades, in homes from Moscow to San Francisco, children drank cow's milk that had been heated to destroy bacteria ("pasteurized"), and adults disinfected every scratch and scrape with iodine.

C. G. Ehrenberg, "Astasiaea," Plate 7 in (*1*).

Images of microorganisms made with an achromatic microscope became for the mid- to late-19th-century public what celestial images recorded by the Hubble Space Telescope are today: They offered an extraordinary sense of being transported to another scale—an exotic place tinged with danger, they were exquisitely beautiful, and they were reproduced everywhere. Images in the popular press of microbes in a drop of public drinking water reminded people to boil water; pictures of germs floating in the air encouraged urban dwellers to get fresh air. A crusade for hygiene encouraged individuals to clean as never before, and artists turned their attention to subjects related to cleanliness and disease, from the French realist Edgar Degas's bathers to the Norwegian symbolist Edvard Munch's sickrooms.

In the wake of the industrial revolution, late-19th-century architects and designers wanted to create a new style—an Art Nouveau—and like architects of the past, they turned to nature for inspiration. But unlike their predecessors, Victor Horta in Brussels and Louis Sullivan in America knew leaves and flowers down to the cellular level. Thus they abstracted from the substructure of nature a new design vocabulary of biomorphic forms—curved, flat shapes, as in a stained, transparent slice of tissue prepared between glass plates for viewing with a microscope.

Abstracted amoebas, protozoa, and cells replaced acanthus leaves on the banisters, pilasters, and lintels of Horta's Tassel House (1893–95, Brussels) and Sullivan's Guaranty Building (1894–95, Buffalo, New York). Enthusiasm for Art Nouveau reached its epitome at the great world's fair of 1900, the Exposition Universelle in Paris, where René Binet modeled the multi-story main entrance to the fair on the form of microscopic radiolaria (a creature with a striking crystalline exoskeleton). Binet was familiar with C. G. Ehrenberg's classic 1838 *Infusionstierchen* (Infusion animals), as well as late-19th-century publications illustrating marine microorganisms, as the architect described in his book *Esquisses décoratives* (Decorative sketches) (*2*).

With the establishment of neurology and psychiatry as medical specialties in the late 19th century, bizarre mental states were brought to public attention. The microscope again provided artists with the new vocabulary they needed to symbolize the insights into dreams and fantasies issuing from the asylum and the consulting room.

French Symbolist Odilon Redon's difficult childhood in Bordeaux, possibly including a nervous disorder (epilepsy), may account for his melancholic, introspective personality, and his lifelong search for visual metaphors for

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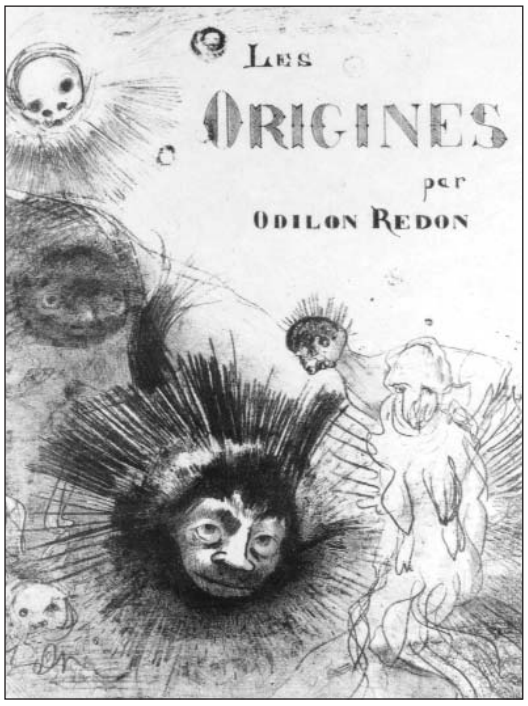

Odilon Redon, Frontispiece for *Les Origines*, lithograph, 1883.

somber moods and haunting reveries. In his twenties, the young artist was befriended by the botanist Armand Clavaud, keeper of the Bordeaux Botanical Garden, who became Redon's lifelong intellectual mentor. Redon recalled: "Clavaud was extraordinarily gifted. He was both a savant and an artist (which is rare), always moved by the revelations of his microscope, ceaselessly visiting, caring for, and classifying his collection of plants" (*3*). Clavaud introduced Redon to the revelatory experience of looking at nature through a microscope. The artist responded by drawing an analogy between his subjective moods and microorganisms—both hidden and potentially morbid.

After Redon settled in Paris in 1870, when he was in his early thirties, he was continually reminded of lethal microbes because Pasteur's battle against infectious disease was being dramatized in the popular press. In 1883, the year the diphtheria bacteria was isolated, Redon created a suite of lithographs on the origin of life, entitled *Origins*. The title page is covered with microbes emerging from the darkness, some with human faces (see the second figure).

Pasteur had disproved the spontaneous generation of life in 1860, showing that one microbe always originated from another. But Charles Darwin's *Origin of Species* (1859) had reopened the question as regards the past. If species had evolved from simpler life forms, maybe there was a moment when the first life emerged from nonliving matter. In *Origins*, Redon created a gloomy view of life emerging from dark, primordial slime where dwell lethal bacteria. Redon never met Pasteur, but in admiration for the renowned chemist he sent him a copy of *Origins*. The artist treasured the doctor's response: "Only Redon's pencil could give life to these monsters" (*4*).

Early 20th-century architects began to use the new steel-reinforced concrete to cast whole buildings as a biomorphic free-form derived from the microscopic world. In the Theater Werkbundaustellung (Theater for the German Work Federation Exhibition, Cologne, 1914), Belgian architect Henry Van de Velde created walls that seem to swell as if they were breathing, and a roof that undulates as if it were alive. Design concepts from the microscopic world were extended to domestic building by Frank Lloyd Wright, who found inspiration in viewing living cells multiplying and inorganic crystals growing. Wright designed the walls and roof of a single-family home so that it appears to emerge from its landscape site, like fungus growing on tree bark or ice crystals forming on a frozen rock.

The word "cell" literally means "room". The term was first used in biology by the 17th-century British physicist Robert Hooke after he looked through a microscope at a slice of cork (which is composed of dead, dried-out plant cells) and saw rows of square holes lined up like monks' rooms—cells—in a monastery. Even when Hooke viewed living cells, he was unable to see the complex fluids therein because of chromatic distortion. But Wright saw the fluids very well because he looked with an achromatic microscope. In Willits House (Highland Park, Illinois, 1902), Wright conceived the interior spaces of the living room, dining room, and kitchen not as rigid enclosures shut off from each other by closed doors (like Hooke's desiccated cells), but as spaces flowing into each other like protoplasm in living cells or light moving through a crystal.

Ross Bleckner, "In Sickness and in Health," oil on linen, 1996.

Between the first and second world war, many architects countered with a less organic, more antiseptic aesthetic, designing apartment complexes and office buildings with pure white slabs of concrete and plain sheets of glass in a style as pristine as an operating room—the International Style. But the organic impulse remains alive and well in contemporary architecture such as Frank Gehry's Guggenheim Museum Bilbao (Bilbao, Spain, 1997). Through the center of the city of Bilbao flows the Nervión River, out of which grows Gehry's curvaceous volume of limestone, sprouting membranes of glass and titanium-sheathed biomorphic forms.

The electron microscope was invented in the 1930s and soon outperformed the light microscope. Waves of visible light have an average wavelength of 500 nanometers, whereas electrons can be accelerated to wavelengths on the order of 0.005 nanometer (an average atom is about 0.2 nm wide). Today, observers looking at the invisible world with an electron microscope see it magnified 100,000 times greater than Pasteur did with his light microscope, and researchers are now able to see viruses that remained invisible to Pasteur.

Contemporary artists continue to be inspired by the beauty and mystery of the microscopic world, such as *In Sickness and in Health* (1996) by the American painter Ross Bleckner (see the third figure). Just as Redon dreaded the invisible diphtheria and cholera bacteria, so Bleckner expresses the contemporary fear that the lovely pastel-colored cells of one's partner, whom one is committed to love in sickness and in health, may be invaded by the lethal HIV virus.

References and Notes

1. C. G. Ehrenberg, *Die Infusionstierchen als vollkommene Organismen* (Infusion animals as complete organisms) (Leopold Voss, Leipzig, 1838).
2. R. Binet, *Esquisses décoratives* (Librarie Centrale des Beaux-Arts, Paris, 1902).
3. Letter from Redon to A. Bonger, May 1909, in *À Soi-même* (To myself) (H. Floury, Paris, 1922), pp. 19–20. All translations by Lynn Gamwell.
4. "Il aurait fallu le crayon d'Odilon Redon pour donner la vie à ces monstres;" according to Redon's wife, Pasteur made the remark after looking at Redon's *Origins* with great curiosity for a long time. She relayed the anecdote to André Mellerio, who included it in his *Odilon Redon: Peintre, Dessinateur et Graveur* (H. Floury, Paris, 1923), p. 155.
5. This essay is based in part on Lynn Gamwell's book *Exploring the Invisible: Art, Science, and the Spiritual* (Princeton Univ. Press, Princeton, NJ, 2002).