Human/Humane: The BioArt of Frank H. Netter, M.D.

April 22 to July 21, 2005
Frank Henry Netter (1906-1991) studied at the National Academy of Design and the Art Students’ League, and by the mid-1920s he was a successful commercial artist for publications such as *The Saturday Evening Post* and *The New York Times*. At his mother’s urging to follow a more ‘serious’ career, he entered medical school at New York University, where he received his M.D. degree in 1931. During his student years, Netter’s notebook sketches caught the attention of various medical professors, allowing him to supplement his income by illustrating lectures, articles and textbooks. In private surgical practice he accepted art commissions, but eventually this artist-cum-surgeon gave up his medical practice altogether, in favor of a full-time commitment to art. The result was Netter’s legendary ability to comprehend thoroughly as a physician before liberating the potent creative forces of the artist.

As an army officer in WWII, he illustrated several manuals on first-aid for combat troops, sanitation in the field, and survival in the tropics. In the late 1930s, shortly before his military duty, he had already begun a rewarding and prolific 45-year partnership with the Ciba Pharmaceutical Company (later Ciba-Geigy, which in 1996 became Novartis), which resulted in thousands of designs for the serial *Clinical Symposia* and what has become his opus magnum, *The Ciba Collection of Medical Illustrations* (13 volumes). The latter illustrates the most important systems and diseases of the body in painstaking, brilliant detail and remains one of the most famous medical works ever produced. Netter’s *Atlas of Human Anatomy*, first published in 1989 (and translated into eleven languages) presents anatomical paintings largely culled from *The Ciba Collection* and is currently the anatomy atlas of choice among medical and health professionals the world over. Nearly all the original works in the current exhibition originate from these published sources. Although created for their intellectual content, Netter’s paintings are appreciated for their aesthetic qualities, such as their ability to depict the functionality of organs in a strikingly animated manner. Although the study of anatomy dates to the ancient Egyptians, the art of medical illustration did not truly emerge until the Renaissance, when artists such as Leonardo da Vinci and Michelangelo created drawings based on cadaveric dissections. The stringent clarity, stunning accuracy, and beauty of the works of this ‘Michelangelo of Medicine’—as a 1976 *Saturday Evening Post* article described Netter—follow solidly in the tradition of this marriage of science and art.

“I try to depict living patients whenever possible. After all, physicians do see patients, and we must remember we are treating whole human beings.”

— Frank H. Netter, M.D.
One of the most important blends of this tradition occurred in the sixteenth century, with the publication of *De Humani Corporis Fabrica* in 1543. A collaboration between the anatomist-physician Andreas Vesalius and the artist Jan Stefan van Kalkar of Flanders, *De Fabrica* was the standard anatomy atlas for centuries, to be enhanced or supplanted only when technological discoveries (such as the invention of the compound microscope in the 17th century, or the discovery of X-rays in the 19th century) revealed new knowledge about human anatomy. In the spirit of collaboration, it is useful to recall that although a physician/surgeon himself, Netter consulted dozens of medical experts throughout his career as he conceptualized his paintings. This is especially true for design projects documenting new discoveries in medicine, such as computerized axial tomography (CAT) scanners, joint replacements, and the first artificial heart transplant.

Always drawn to the complexity and diversity of people, Netter strived to create faces and bodies in his work that mirrored their individual personalities. The result was that disease and trauma are viewed humanely, that is, as a complex life challenge faced by people rather than an isolated intellectual puzzle. Netter’s sense of humanity and empathy for patients is one of the most distinguishing features of his paintings; as he said, “I always tried to make [the subject] look like a living patient, with proper facial expression and so forth, to show that this is not a machine we are dealing with. We’re not repairing a television set when we’re treating these patients.”

Netter spent far more time researching a subject and planning an illustration than in executing it. After absorbing from a multitude of sources as much information as necessary, he typically created pencil sketches, which were then copied and transformed into finished designs in gouache—a watercolor technique—to which he often added opaque paints, colored pencils, or pastels, for shading and fine detail. Nearly half of the works in the current exhibition appear with their Mylar overlays which contain text and additional graphics that supplemented or completed the paintings in their final, printed form.

Michael J. Brody
*Director and Curator, Marvin Samson Center for the History of Pharmacy*
Checklist of the Exhibition

All original illustrations are owned by Novartis Pharmaceuticals and are executed in a gouache/watercolor technique. Those exhibited with their Mylar overlay(s) are marked (o) next to their title.

Abbreviations:
CCMI = The Ciba (now Netter) Collection of Medical Illustrations (13 vols.; various dates, 1953–1993; the CCMI compilation vol., 1948)
CS = Clinical Symposia (serial published 1948–1998)

1. Woman with Dermatosis
Reproduced in CS, vol. 3, no. 5, 1951, cover illustration. The editorial accompanying this 1951 image stated that with the inclusion of the camera Netter was “pay[ing] tribute to the rival art of color photography.” The dermatosis (skin disease) depicted is probably atopic dermatitis, an inflammation of the skin also known as eczema, caused by low levels of the protein cytokine in the immune system.

2. External Rotation-Abduction Ski Injury (o)
Reproduced in CS, vol. 29, no. 1, 1977, p. 5, pl. 1. Abduction refers to the lateral movement of a limb (here the ankle) away from the medial plane of the body. In this scene the heavy, wet snow has caused a ski to ‘catch an inside edge.’

3. Ski Injury Fractures
Reproduced in CS, vol. 29, no. 1, 1977, p. 10, pl. 5. The blank space to the left of these renderings is for the later insertion of two radiographs illustrating fracture of the lateral malleolus (left) and spiral fracture of the tibia and fibula (right).

4. Acromegaly (o)
Reproduced in CCMI, Vol. 4: Endocrine System, 1965, sec. I, p. 29, pl. 27. Acromegaly is usually caused by a benign tumor that compresses the pituitary gland, which produces an excess of growth hormone (GH). If left untreated, the disorder is marked by progressive enlargement of the hands, feet, and face.

5. Gigantism (o)

6. Tongue
Reproduced in CS, vol. 10, no. 3, 1958, p. 69, and CCMI, Vol. 3, Digestive System: Pt. I, Upper Digestive Tract, 1959, sec. I, p. 10, pl. 8; see AHA, pl. 54 (copy exhibited). Dorsum view (top); schematic stereogram (middle); and section of a taste bud (bottom). The various taste papillae house nearly 10,000 taste buds and help provide a grip on food. In addition to the four major forms of taste (sweet, sour, salty, and bitter), researchers have recently recognized a fifth taste, umami, that is often described as ‘meaty’ or ‘savory.’

7. Heart
Reproduced in CS, vol. 17, no. 3, 1965, p. 73, pl. IV and CCMI, Vol. 5, Heart, 1969, sec. I, p. 7, pl. 6; see AHA, pl. 210 (copy exhibited). Posterior view of the base of the heart (top); and postero-inferior view, i.e. the heart viewed from below and behind (bottom). The average adult heart is about the size of a clenched fist and weighs about eleven ounces; its shape approximates an upside-down pear.

8. Pathway of Sound Reception (o)

9. Some Common Poisonous Plants (o)
First published in 1951 and reproduced in CS, vol. 30, no. 2, 1978, p. 29, pl. 13 and CS, vol. 36, no. 5, 1984, cover illustration (with orientation of the images changed). This painting illustrates plants found ‘in home, garden, and field’ for an article on the treatment of poisoning. Contrary to common belief, there is no safe rule-of-thumb to differentiate poisonous from edible mushrooms. One of the species that potentially could cause death if only a single mushroom is eaten is the ‘destroying angel’, shown here young and fully developed (bottom right pair).

10. Scuba Diving, I: Decompression Sickness
Reproduced in CS, vol. 10, no. 4, 1958, cover illustration. In Decompression Sickness, one of the more serious illnesses associated with pressure reduction during diving, nitrogen gas bubbles are released into the bloodstream and tissues, which can cause numbness, dizziness, weakness, nausea, pain, headaches, itching, and visual disturbances.
11. Scuba Diving, II: Extravasation of Blood
Reproduced in CS, vol. 10, no. 4, 1958, p. 107, fig. 2.
According to the text that accompanied this image, “failure to equalize pressure of air beneath the mask with the water pressure may result in extravasation of blood into the conjunctivae,” i.e. a discharge of blood into the delicate membrane that covers the eyeballs.

12. Scuba Diving, III: Barotrauma (o)
Reproduced in CS, vol. 10, no. 4, 1958, p. 111, pl. III.
One hazard of a diver’s too-swift return to the water’s surface is pulmonary barotrauma (or ‘lung burst’), where the alveoli expand until they rupture.

13. Child Playing with Matches
This scene, which originally accompanied an article on the management of burns in children, shows a girl playing with matches, one of the leading causes of a thermal burn.

14. Ether and Alcohol
A procedure, new in the 1950s, for diagnosing stomach cancer was the use of a rotating gastric brush. The brush was inserted into the esophagus and stomach to collect friable cancerous cells along the gastric lining. Illustrated here is the transfer of cells from the brush to slides, which were then examined under a microscope.

15. Removal of Foreign Body from the Eye
Reproduced in CS, vol. 14, no. 4, 1962, p. 120, pl. III.
The two upper images show removal of foreign body from inside the lid; the lower ones, from the cornea, using a small needle for scraping, but only after a topical anesthesia is instilled through a small dropper.

16. Examination of the Nasal Cavity
Reproduced in CS, vol. 6, no. 3, 1954, cover illustration.
Netter’s empathy for children is illustrated by the tear escaping the boy’s eye during this uncomfortable procedure for diagnosing nasal allergies. Such allergies are a reaction to air-borne proteins and result in the discharge of histamine, which causes symptoms such as congestion, runny nose, sneezing, coughing, post nasal drip, itching within the ear, and itching, watery, red eyes.

17. Ophthalmodynamometry (o)
In this procedure to determine retinal arterial pressure, pressure (or suction) is applied to the eyeball by a dynamometer while the optic nerve is observed through an ophthalmoscope.

18. Stretching Exercises (o)
The article on running injuries in which this image (and its companions, cat. 19 and 20) appeared evidence the popularity of jogging in the 1970s and 80s. The aims of stretching exercises are to relax the muscles and increase blood flow, helping the runner achieve maximum range of motion.

19. Phases of Running Gait (o)

20. Good and Bad Running Form (o)
Reproduced in CS, vol. 32, no. 4, 1980, p. 34, pl. 20 (also upper image, in reverse and without overlay, as cover illustration) and CS, vol. 39, no. 3, 1987, p. 9, pl. 4.

21. Electronystagmographic Recording (o)
This illustration accompanied an article on vertigo (dizziness) and shows a patient undergoing an electronystagmographic (ENG) recording. The device
electronically records nystagmus (involuntary eye movements of the eyeballs) through changes in potential between the cornea and retina induced through application of hot and cold stimuli—usually water—to the ear. The test helps determine whether a patient's vertigo is the result of damage to the acoustic, or inner ear, nerve.

22. Hemodialysis
Reproduced in CS, vol. 25, no. 1, 1973, cover illustration. Chronic kidney disease and acute renal failure cause the kidneys to lose their ability to filter and remove waste and extra fluid from the body. In hemodialysis, a man-made membrane (dialyzer) clears wastes, such as urea, from the blood, and restores the proper balance of electrolytes.

23. Temperature Biofeedback Training

The text that accompanies this images explains how by merely reading phrases focused on warmth and relaxation, a patient with migraine can increase blood flow in the hands, which can diminish the severity of a headache, or stop its onset altogether.

24. Hormonal Fluctuations in Pregnancy

There are three main hormones produced during the development of a fetus: beta human chorionic gonadotropin (b-HCG)—the hormone seen in a pregnancy test—encourages the placenta to develop the other two, progesterone and estrogen.

25. Control of Pain During Birth: Episiotomy
The mother pictured here has just undergone an episiotomy, a surgical incision into the perineum and vagina to prevent traumatic tearing during delivery; this procedure results in a larger birth canal.

26. Skeleton of Full-Term Newborn

Most bones begin as chondroblasts (connective tissue cells) that build cartilage, which eventually becomes ossified. In the newborn, all bones contain bone marrow, but by adulthood, most of the marrow in the long bones is replaced by fat.

27. Growth and Development
Here Netter depicts three stages of growth in the female in a format reminiscent of Leonardo da Vinci's well-known 'Vitruvian Man,' with arms outstretched against a geometric point of reference.

28. Use of Obstetric Forceps
Obstetric forceps are used in birth under specific circumstances, such as fetal distress, or when a mother has had an epidural and loses her urge to push, or she has a heart condition or very high blood pressure, in which case pushing is harmful. The blades of this instrument have two curves: the cephalic curve that fits the baby's head, and the pelvic curve that conforms to the curve of the birth canal.

29. Hydrocephalus

Hydrocephalus (literally 'watery head') is a condition marked by dilatation of the cerebral ventricles (cavities), most often caused by obstruction of the cerebrospinal fluid (CSF) pathways. It can occur before birth or any time after it, and its causes include birth defect, brain hemorrhage, infection, meningitis, tumor, or head injury. The images beneath the infant contrast a normal section through the brain (left) with one affected by hydrocephalus (right).

30. Placenta Previa

Placenta previa is a placenta that develops in the lower uterine segment and covers, to varying degrees, the cervix. The condition results from the embryo attaching itself to the lower uterus, and its most common symptom is painless hemorrhage in the last trimester of pregnancy.

31. Spirochetal Infections: Weil's Disease and Syphilis
Both Weil's disease (top) and syphilis (bottom) are caused by spirochetes, a form of bacterium notable for its large size and corkscrew shape (see insets). Rodents are the most usual carriers of leptospirosis, or Weil's disease, while syphilis is a sexually transmitted disease. Left untreated, both infections can cause significant damages to multiple organs, particularly the liver, which in later stages of syphilis can become severely deformed (bottom left).

32. Goiter
Reproduced in CCMI, Vol. 4, Endocrine System and Selected Metabolic Diseases, 1965, sec. II, p. 62, pl. 22. Goiter is the medical term for enlargement of the thyroid gland, which is often merely a symptom of a more serious thyroid condition such as hyper- or hypothyroidism, i.e. an overactive or under active thyroid. In underdeveloped parts of the world, goiter is often brought on by a lack of iodine in the diet (found in table salt and many fish products), which is essential for the production of thyroid hormone.

33. Thiamine Deficiency (Beriberi) (o)
Reproduced in CCMI, Vol. 4, Endocrine System and Selected Metabolic Diseases, 1965, sec. X, p. 253, pl. 3. Beriberi (Singhalese for “I cannot,” signifying the infected person is too ill to do anything) is a disease caused by a deficiency of thiamine (vitamin B1). Its two major manifestations are ‘dry’ beriberi (flaccid paralysis and muscular atrophy) and ‘wet’ beriberi (cardiac failure and edema), the latter named for its presence among patients with chronic alcohol abuse, which can lead to malnutrition and poor absorption of thiamine. ‘Wet’ beriberi can cause Wernicke's syndrome, a neurological disorder characterized by confusion, apathy, drowsiness, and involuntary movements of the eyeballs (bottom right).

34. Control of Pain: Nupercaine (o)

35. Stroke Rehabilitation
Reproduced in CCMI, Vol. 8, Musculoskeletal System, Part III: Trauma, Evaluation, and Management, 1993, sec. IV, p. 202, pl. 8. These images show the proper procedure for a stroke victim’s self-transfer from bed to wheelchair. Note the patient’s flaccid arm is supported by a sling, and the wheelchair is positioned at about a 45-degree angle to the bed.

36. Turning a Quadriplegic Patient (o)
Reproduced in CS, vol. 34, no. 2, 1982, cover illustration (without overlay) and p. 25, pl. 17. This illustration appeared in an article on the comprehensive management of spinal cord injury. With the aid of a drawsheet, health professionals turn a quadriplegic, i.e. a patient with paralysis of all four limbs.

37. Tetanus (o)
Reproduced in CCMI, Vol. 1, Nervous System, Part II: Neurologic and Neuromuscular Disorders, 1986, sec. VIII, p. 165, pl. 8. Tetanus is an acute, sometimes fatal, disease of the central nervous system caused by the tetanus bacterium, which usually enters the body through an open wound. Due to widespread immunization—the combination Td (tetanus and diphtheria) vaccine, with booster shots recommended every ten years—tetanus is now a rare disease in the United States.

38. Leprosy (o)
Reproduced in CCMI, Vol. 1, Nervous System, Part II: Neurologic and Neuromuscular Disorders, 1986, sec. XI, p. 223, pl. 19. Leprosy can be transmitted through coughing and sneezing, as its bacteria are discharged into the air and then inhaled. Historically, it was thought to be a mysterious disease associated with some type of curse, and sufferers were ostracized and isolated due to the disfigurement caused by bacteria attacking their nerve endings. Today, leprosy can be treated with a multi-drug therapy (MDT), consisting of a combination of antibiotics.

39. Typhoid Fever (o)
Reproduced in CS, vol. 12, no. 4, 1960, p. 108, pl. 1 and CS, vol. 36, no. 2, 1984, p. 8, pl. 3 (with modifications). Typhoid fever is caused by a unique human strain of the salmonella virus called Salmonella typhi. This acute, life-threatening infection is typically contracted while traveling abroad, via contaminated food and water. Symptoms include persistent high fever, headache, malaise, abdominal pain, skin rash, and constipation or diarrhea.

40. Amputation of the Lower Extremity
Reproduced in CS, vol. 6, no. 5, 1954, cover illustration and CS, vol. 16, no. 1, 1964, cover illustration (left side only). The article for which this illustration was created states: “The modern unilateral amputee can be fitted with a prosthesis which will allow him to return to nearly any type of work.” After surgery, some patients experience ‘phantom sensation,’ a feeling as if the amputated leg is still there; this phenomenon usually disappears over time.

41. Gunshot Wounds
Reproduced in CCMI, compilation vol., 1948, p. 64, pl. 48. Rendered here are various scenarios for bullet trajectories, including deflections due to bone (B and C), and the non-axial path of shrapnel (D). Bullets,
like all projectiles, follow the principles of physics, so velocity \(v\) — rather than mass \(m\) or caliber — is the most important factor in determining its power or energy \(E\) to destroy tissue: 

\[ E = m v^2. \]

Unless a bullet hits a vital organ, the most common mechanism of death is not fatal blood loss, but rather shock, when the body shuts down in a more or less conscious realization that the damage to the circulatory system is too great for the body to repair itself.

42. Blast Injury
Reproduced in CCMI, compilation vol., 1948, p. 63, pl. 47.
Blast injuries result from the complex pressure wave generated by an explosion. Air-filled organs such as the ear, lung, and gastrointestinal tract and organs surrounded by fluid-filled cavities such as the brain are especially susceptible to injury. Here, Netter depicts hemorrhaging in the lung and its alveoli ('blast lung'), the most common fatal primary blast injury among initial survivors.

43. Progressive Spinal Deformity in Osteoporosis
Osteoporosis is a progressive reduction in bone mass over many years, leading to fragility and susceptibility to fracture. Women are at a greater risk than men, especially those of petite stature or postmenopausal women with decreased estrogen levels. The three skeletons represent progressive spinal deformities in an osteoporotic woman aged, from left to right, 55, 65, and 75.

44. Clinical Manifestations of Osteoporosis (o)
Insufficient calcium and phosphate absorption by the body leads to weak and fragile bones susceptible to breakage. Spinal fractures are one of the most common complications of osteoporosis. Often these fractures cause in women the stooped posture commonly called ‘dowager’s hump,’ a result of several vertebrae collapsing. Over time, a sufferer loses height and her abdomen begins to protrude.

45. General Management Principles for the Asthmatic Patient (o)
Reproduced in CS, vol. 27, nos. 1-2, 1975, p. 64, pl. 32.
Asthma refers to recurrent episodes of respiratory distress, with airway inflammation and wheezing due to spasmodic contraction of the bronchi. Some cases are allergic manifestations in sensitized persons (extrinsic asthma) caused by environmental triggers such as dust mites, animal dander, pollen, medications, and certain foods; others are induced by factors such as vigorous exercise and psychological stress (intrinsic asthma).

46. Extrinsic Asthma
Reproduced in CS, vol. 14, nos. 1-2, 1975, p. 4, pl. 1; the lower portion (the asthmatic girl) also used as the cover illustration for the same issue.
In extrinsic asthma, environmental allergens induce the body to produce antibodies, which bind to the allergens, ultimately decreasing the sufferer’s lung function. These asthmatics commonly have other allergy-related problems (like hay fever, hives, and eczema), and respond well to inhaled steroids that suppress the immune system response in the lungs, where the reaction is strongest.

47. Survival in Nuclear War
The stated purpose of the 1962 article in which this painting appeared was “to provide our first line of civilian defense, [that is] members of the medical profession, with data that will enable them to estimate the potential dangers at various distances from ground zero, …” In the post-WWII age of thermonuclear weapons, there was no shortage of information regarding nuclear war, its devastating effects, and—at a more practical level—how to prepare for the cataclysmic event in order to increase one’s chance of survival. In this disturbing scene, Netter conveys a physician’s horror at witnessing the familiar mushroom cloud of a nuclear explosion.

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