This guy knows a lot about biology too:

an interview with Graham Johnson '95, who uses his unique blend of talents in biology and art as a medical illustrator

by Lee Capristo

Title: Coversyl Arteryman

Description: Rainbow-colored human, composed solely of blood vessels.

Graham completed this piece as his first major professional work for a pharmaceutical ad campaign while working for Levent Efe in Melbourne, Australia. The illustration was made difficult because it involved hours of research and sketching to correctly position the major arteries in the imaginary 3D space of a figure drawing, and the client required that the final character be ready to print (on black, white, and teal backgrounds) in only four days from the initiation of the project...what illustrators call a "rush" job. Pencil sketch rendered in color using the Photoshop airbrush tool. (1996, Servier Pharmaceutical.)

A native of Joppa, Maryland, Graham Johnson '95 grew up near the headwaters of the Chesapeake Bay. Playing along local rivers and streams and canoeing its marshlands and estuaries, he developed an affection for the beauty and variety of life along the water's edge. You'd think this might have led him straight to a biology major at St. Mary's, where he could have participated from freshman year with the St. Mary's River Project, studying sea grasses and water quality.

However, Graham claims he was adrift in general education requirements with no idea whatsoever as to his major. In the spring semester of sophomore year he signed up for a half-credit class called "Career Indecision" offered by Jan Van Dyke, director of the Career Office. As part of the class he took a battery of aptitude tests, and each test produced the same recommendation — combine art and science in a field such as medical illustration. The next step in "Career Indecision" was to research the recommended career path and conduct an informational interview with someone in the field. In the career services office, Graham happened upon a brochure from the Johns Hopkins School of Medicine on its Department of Art as Applied to Medicine; he called the school and decided that medical illustration sounded like the perfect combination of art, science, and teaching.

That summer he took his first drawing class at the Maryland Institute College of Art in Baltimore. When he returned to St. Mary's in the fall he went full throttle for genetics, physics, chemistry, calculus, and drawing. He needed to cram three years' worth of graduate school prerequisites into two years. No more career indecision for Graham; he was on a mission to get his portfolio prepared for admission to the Hopkins program he'd researched.

He signed on with biology professor Karen Crawford who helped him navigate his way through the process of getting a self-designed major approved. "The biology faculty bent over backwards to help me design my own major and incorporate it into their classrooms," credits Graham. Biology professor Bill Williams provided a class on the ecology and diversity of Maryland plants, and an experimental class in scientific illustration taught by biology professor Chris Tanner and art professor Sue Johnson gave Graham the opportunity to apply the scientific side of his studies to the artistic. A new cover for the chemistry department's lab manual was Graham's first published piece of art in 1994. In his senior seminar with biology professor Walter Hatch, Graham began the design of a computerized frog dissection lab tutorial that he would evolve into his graduate thesis at Hopkins two years later.

"My first art class at St. Mary's was with Sue Johnson, and it turned out to be one of my most important," he says. "Her non-traditional drawing class introduced me to the language of composition and showed me how to teach a concept without saying a word." Graham also enjoyed art professor Jeff Carr's monologues on how art correlates to daily life. "Whether or not it was his intent, Jeff's monologues solidified a sense of purpose both in my life and my deeply intertwined career goals in art and science."

It is to art professor Tom Rowe, however, that Graham says he "owes everything." "From teaching me to work with speed and gesture in his watercolor and figure drawing classes to sitting with me for hours in his home studio where I could work on a pair of cast drawing still lifes in chalk and charcoal for weeks of undisturbed meditative appreciation of light and shadow, Tom took me under his wing and helped to keep me focused on my goal." Both men being fans of lacrosse, Tom came to the field during Graham's senior year to watch him play every home game.

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Graham described for me his program of study in the Department of Art as Applied to Medicine at the Johns Hopkins School of Medicine, which is one of six such programs offered in the United States. Not surprisingly, the field is a narrow one, so narrow that there are fewer than 1,500 medical illustrators in

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the United States today. When Graham told me about his study program at Hopkins, I had a hard time believing there would be even 15 people left after such an ordeal.

Year one of the two-year program consisted of back-to-back sessions of human anatomy. One session, "Principles of Anatomical Sketching and Dissection" taught by his medical art professors, introduced Graham and his classmates to their fist cadaver. They followed this course immediately with a second and more rigorous exposure, "Human Anatomy," which they took with the regular medical school students. They followed up the day's lab work with another departmental course, "Illustrating Anatomy," where again, the medical art students drew what they'd dissected, often into the wee hours of the morning, and always in a windowless basement lab during that first semester. In addition to human anatomy, the artists and the medical school students also took histology, cell biology lab, and pathology together that first year. With just five other medical art students in his class, they quickly bonded and became midnight poets of vascular nomenclature, opera singers of dissection particulars, and sleep-starved philosophers. Occasionally they emerged from their underground classroom for a quick game of hackeysack.

The drawings he'd created in *Cell Biology* were the first visualizations many had seen in a field where research techniques in the last 10 years have made entire new worlds of visualization possible.

Year two took Graham and his classmates away from the program followed by the medical school students to a four-month intensive program of surgical illustration. Surgical illustration class required the art students to stand over a surgeon in the operating room and draw everything happening under the knife with rapidity and accuracy. From the four months of work, each student picked favorite procedures to draw from start to finish, with the end result being able to explain the entire surgical process through visuals alone. One of Graham's favorites was eye surgery.

Graham spent the summer between year one and two in Melbourne, Australia in an internship with a freelance medical illustrator. He began researching his thesis and studying the art of 3D computer modeling and animation. His graduate thesis, "3D Applications in an Archetype for Education: A Multimedia Computer Frog Dissector with Accompanying Plastic Model," brought him back to frog dissection and his undergraduate senior seminar topic of how to teach frog dissection better through technology. Graham describes it as "a prototype for a functional student-centered learning kit where I applied everything I had learned while writing the undergraduate paper for Walter Hatch." You can see the conceptual model for the frog kit, along with other examples of his work at www.fiVth.com.

Graham graduated with a master of arts in medical illustration in May 1997. He then followed one of his Hopkins professors, cell biologist Tom Pollard, out to the Salk Institute in La Jolla, California, where Pollard had just been appointed president. Pollard and colleague Bill Earnshaw began coauthoring a book on cell biology and asked Graham to be its sole illustrator. Working at the Salk Institute under the direction of its president was an experience never to be forgotten. "Here I was, on my very first outing as a freelance medical illustrator, feeling like I was truly in the 'king's court,'" he remembers. "I had an office with unobstructed views of the Pacific and enjoyed absorbing the world-renowned architecture of the profound structure during all imaginable weather and lighting conditions."

Though he'd spent two years and most waking hours studying human anatomy and surgical illustration, Graham's knowledge of cell biology was limited to the Biology 101 class he'd had at St. Mary's. For months, his bedside reading was cell and molecular biology. For Graham, it was infinitely worth it. "I owe my new-found love for cell biology to the inspirational character of Dr. Pollard," he says. "For the first few months while I struggled to catch up, Tom would sit and patiently explain each illustration, studying my face to make sure I fully grasped the concepts before releasing me to create a figure. By the end of the project, however, he and Bill [Earnshaw] trusted my developed knowledge enough to allow me to write the narration and scripts for the 16 animations that accompanied the first edition, and they rewarded my efforts to improve the book's teaching ability by making me an official coauthor."

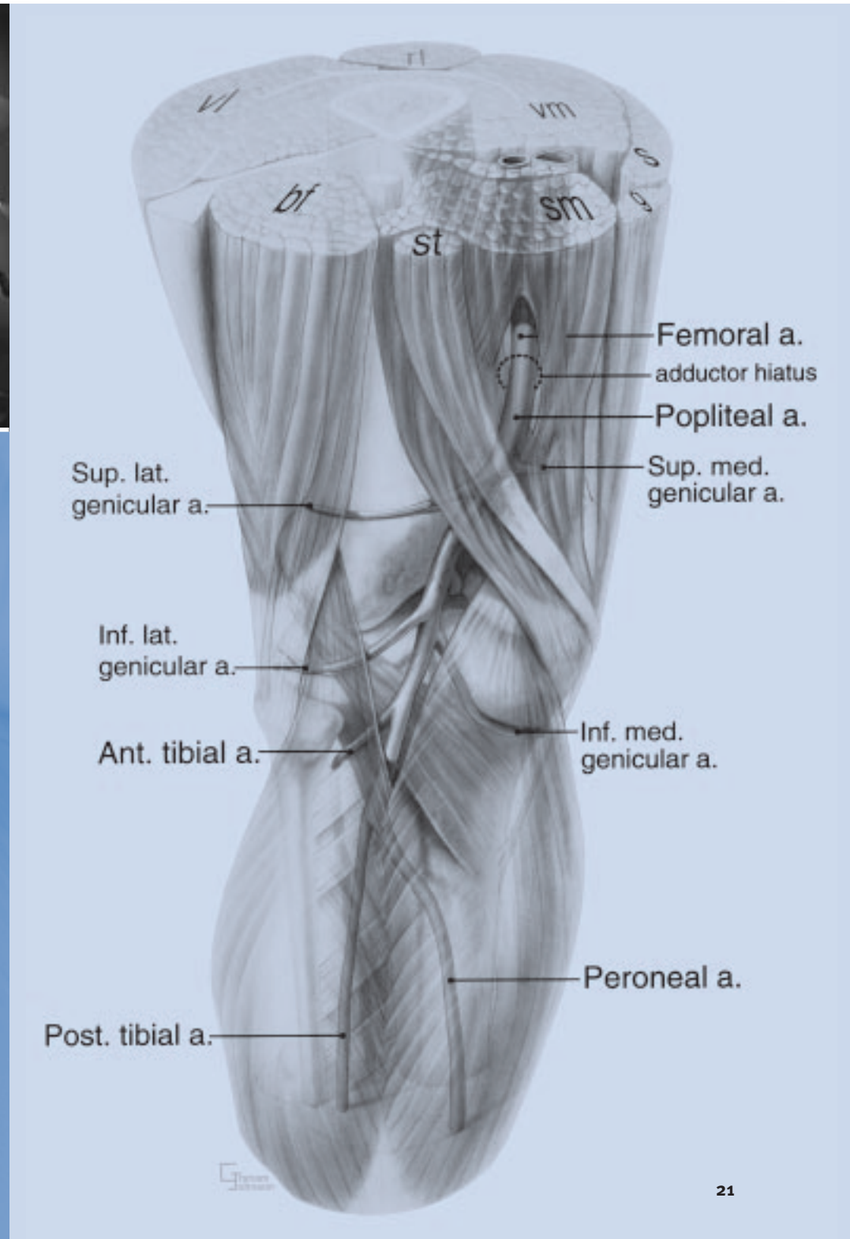
The book, *Cell Biology*, wrapped up in fall 2001 and was published in spring 2002. It is an 850-page book with 400 full-color illustrations, all drawn by Graham. Instantly, Graham became known among his peers as an expert illustrator of molecular biology. The drawings he'd created in *Cell Biology* were the first visualizations many had seen in a field where research techniques in the last 10 years have made entire new worlds of visualization possible. In a review, Nature Publishing Group had this to say about Graham's work on *Cell Biology*: "Perhaps the most stunning feature of the book is its illustrations. Molecules leap out from every page. Proteins, DNA, membranes and small molecules are all beautifully rendered by Graham Johnson." The Association of Medical Illustrators gave his work in the textbook its Award of Excellence.

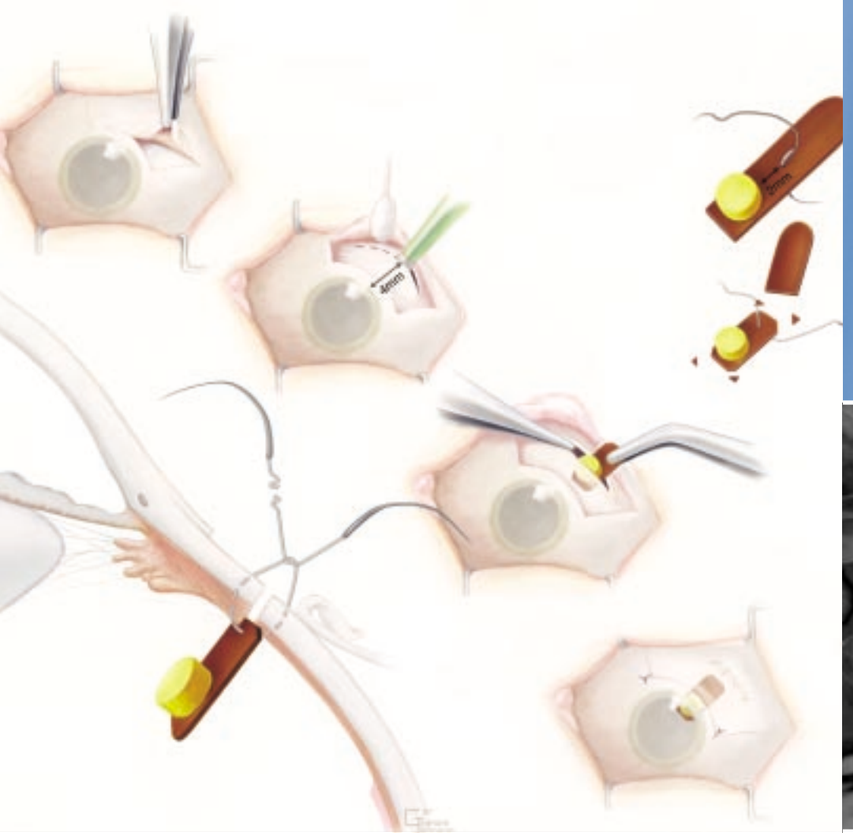
The scientific illustration class that began for Graham Johnson back in '94-'95 continues to be offered by art professor Sue Johnson and biology professor Chris Tanner. This year's class uses *The Guild Handbook of Scientific Illustration*, which happens to include an illustration by Graham Johnson. On left, Rachael Lashof '06 measures the beetle she's preparing to sketch; on right, students survey the choices from an insect tray.

The illustrator recommended cAMP-dependent protein kinase-mediated breakdown of glycogen to serve as the quintessential example of cell signaling for this special issue of the journal. He combines known molecular structures from the protein data base with 3D rendering and 2D painting techniques to describe the cellular interior with relatively accurate dimensions and approximate concentrations of involved proteins.

Title: Dynamic Vasculature of the Popliteal Fossa.

Description: Transparent rendering used to show the complex anatomical relationships of structures in the back of the knee. Created by airbrushing lamp-black watercolor paint onto laserline board with pencil touchup for the courses Illustrating Anatomy and Visual Concepts (1995).



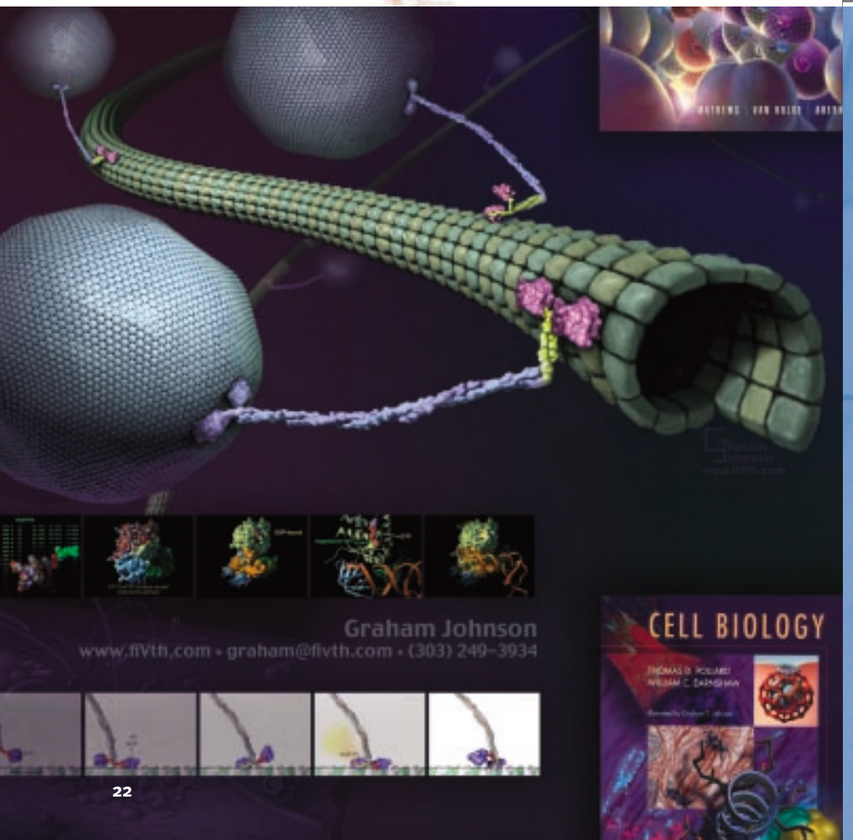


Title: Ganciclovir insertion.

Description: Eye surgery illustration based on sketches made in the operating room. Ganciclovir (the yellow disk) is a drug used to fight retinal infection in patients with AIDS. The drug damages the liver, so inserting it directly into the vitreous chamber isolates it from the bloodstream. Created with watercolor paint and colored pencils on watercolor paper for the course Ophthalmological Illustration, 1997.

A classmate of Graham's is photographed while sketching over the surgeon's shoulder during opthalmological illustration.

Photo credit: U.S. National Library of Medicine/NIH



This montage shows a collection of some of Graham's more noteworthy publications. Cover art from the *Journal of Cell Biology* fills the background (Rockefeller Press, San Francisco, November 27, 2000). In the upper right corner, a cover illustration Graham created for the textbook *Biochemistry* by Mathews and Van Holde (Addison Wesley Longman, 1999). In the lower right corner, the cover for *Cell Biology* by Pollard and Earnshaw (W.B. Saunders, 2002). The five-pane animation strips in the lower left show (top) animations Graham created for Peter Walters for use in the textbook *Molecular Biology of the Cell 4e* by Alberts et. al. (Garland Science, 2002) and (bottom) the background image as it shows kinesin molecules carrying cargo along microtubule filaments for Ron Vale and Ron Milligan's article "The way things move" in *Science*, April 7, 2000. These images and animations can be viewed at www.fiVth.com.

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Now a known entity in the world of scientific illustration, Graham quickly picked up full-time freelance work following the wrap of the book project and moved from California to Boulder, Colorado. A typical day for a freelancer like Graham is "anything but typical," he says. "I might spend two hours working on a simple illustration for a scientist who's publishing an article in a journal, or a month of 12-hour days working on a chapter for a book." Graham draws on what he calls "a big plastic drawing tablet" connected to his computer and Adobe Photoshop, using traditional techniques in a digital medium. With four Hopkins classmates, he created a company in 1999 that he says "exists only in name and as a unifying Website." FiVth is a loose association of medical illustrators who share work when they need to and build off one another's strengths. The clients of FiVth range from big publishing companies like Addison Wesley to individual scientists who need an illustration for a journal article. For example, Graham and Steve Graepel (who also works at the Mayo Clinic) illustrated a *Life Science* text (by Krogh) together, with Steve creating the ink drawings and Graham painting them with watercolor fills. "Working together, we were able to significantly upgrade the quality of the text's artwork for the new edition, and do it quickly. We completed 33 chapters in only four months."

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While I kept thinking about the artistic talent required to draw the kinds of things Graham does, I hadn't considered the amount of knowledge he'd have to have about the subject in order to draw it. And when I asked him about this I was surprised by the answer. "I need to know as much about the subject I'm illustrating as the scientist does, if only temporarily," he says. "I start out any drawing project by researching the topic extensively through primary source material, review articles, and invaluable collections like the Protein Data Bank (a collection of files describing the precise relative 3D positions of every atom in a protein). I have to understand how the illustrated item integrates with other structures or processes because that can impact how I choose to most clearly represent it in the final illustration. Detail required to fill out an animation at 30 frames per second, for example, often forces my clients to stretch their knowledge and do more fact checking. My subtle discoveries may either force them to modify their theory, or may happily support their work."

So what's next for a man who's gone from career indecision to being a nationally recognized specialist in illustrating cell biology? It seems to me that his life in Colorado retains the sweet elements of his childhood days in Maryland: of course he has to work for a living, but he enjoys that living (with the company of Flower, his five-year old Siberian Husky) with all that Colorado has to offer — hiking, skiing, snowboarding, mountain biking. He's also a soccer fanatic and plays six days a week. But Graham has big plans. He wants "to bring cell biology to the masses . . . at least to the Scientific American/Discovery Channel crowd." He has begun coursework to help him prepare for a Ph.D. program in molecular biology, and these days his bedside reading is *Physical Chemistry 7e* by Atkins and dePaula. Does he intend to become a full-time scientist and give up illustration? "Not at all," says Graham. "I see a Ph.D. as a natural extension of my current career." Five ("or maybe six") years from now, he plans to have the degree completed and

Sitting just above Thunder River on the Grand Canyon's North Rim on decent to the Colorado River in 2003.

hopes to have others working for him. He wants to return to California and work at the Scripps Research Institute with his mentor, scientist-turned-illustrator (more precisely, scientist-turned-molecular visualizer) David Goodsell, at the Kellog School of Science and Technology. He hopes that a Ph.D. in molecular biology will bring the depth and breadth of his scientific knowledge up to par with his artistic skills so that he can elevate the language of molecular visualization to higher artistic and scientific levels.

He has an idea for incorporating as much current kinetic and structure data as possible into a series of simple cell event animations. These animations (or movies), he says, could be presented on the Web to invite critique and comment from the scientific community to help fill in the gaps and correct errors. "Once refined, the movies could be adapted for use in teaching, and the Web-based presentation might become the foundation for a new scientific database where highly refined cell events could be assembled to illustrate entire cellular processes, ultimately leading the way for the world's first 'live' virtual cell."

It sounds like career indecision is no longer a problem.

See more of Graham's work at www.fiVth.com.