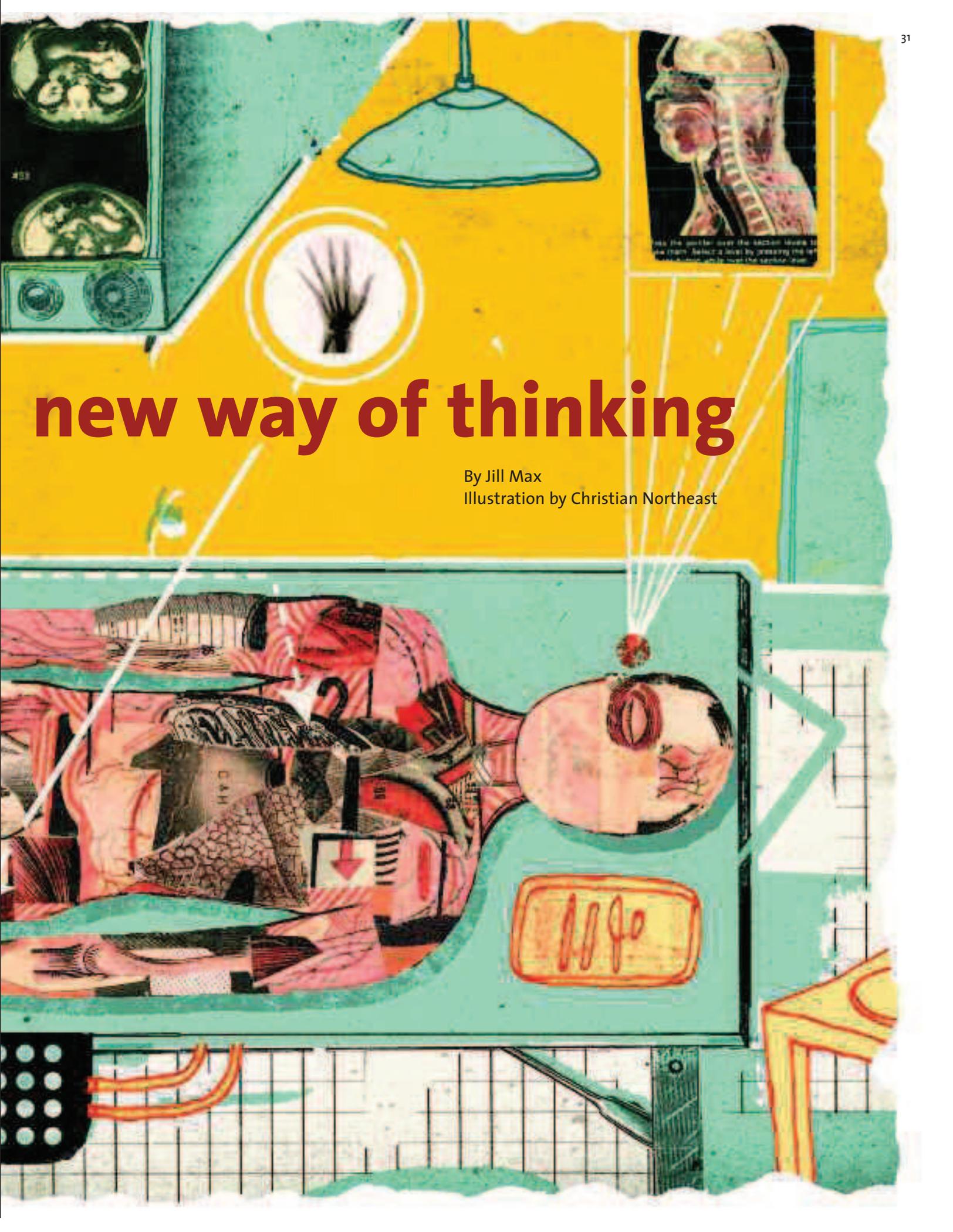


# In the anatomy lab, a

Scarce instructors, new tools and a boom in knowledge have led to an ongoing experiment in anatomy teaching. Structure remains important, but the new paradigm is functionality.



# new way of thinking

By Jill Max  
Illustration by Christian Northeast



Yale's fall semester has only been in session for about six weeks, but first-year medical student Jason Frangos is about to attempt surgery for a thoracic aortic aneurysm. He dons an apron and gloves, picks up a scalpel and prepares to make the first incision. "I'm afraid of cutting something I don't want to cut," he says. It's a real concern, not because this is real surgery, but because it is an opportunity to learn: Frangos and his classmates are "operating" on cadavers for "Human Anatomy and Development," a course that is a rite of passage for medical students across the country. But while many of the basic elements of the course—preparation, dissection and lecture—have been in place for years, Yale's class of 2008 will learn anatomy in a way that is significantly different from that of past years.

The reasons for the shift are both practical and philosophical. Thanks to advances in medicine, students have more to learn in just about every field, and curricula are becoming more streamlined. While a classically taught anatomy course used to consist of upwards of 200 hours spread over two semesters, today's course is half that. At the same time, the pool of anatomy professors nationwide is dwindling, as young scientists turn to other disciplines in the life sciences where there are more abundant discoveries still to be made. According to a survey by the American Association of Anatomists (AAA), more than 80 percent of anatomy-related department chairs anticipate having "great" or "moderate" difficulty finding qualified faculty in the next few years. In response, medical schools have recruited professors from other departments, as well as physicians in the community. And a new concept has emerged to play an increasingly pivotal role in medical education at Yale—functionality. "The notion of a functional approach is a philosophy we've developed for dealing with the staggering amounts of information students have to learn," says Herbert S. Chase Jr., M.D., deputy dean for education.

In the past, students memorized anatomical features that they either would forget by the time they needed the information or never needed to know in the first place. "Given the myriad anatomical details, rather than examine every structure, we ask 'What does a physician who interacts with

human anatomy need to know?'" says Chase, adding that surgeons need to know the anatomy of operations they perform, radiologists need to know anatomy to identify abnormalities and disease and emergency physicians and anesthesiologists need to know anatomy to perform essential procedures.

Even more important is finding ways for students to retain what they've learned so they can apply it when treating patients. Accordingly, the new focus of the course is not on information, but on transformation—a change in the students' thinking process. No one learns a foreign language by memorizing a dictionary and rules of grammar; fluency occurs only when one begins to think in the new language, says Lawrence J. Rizzolo, PH.D., associate professor and course director. Similarly, students learn the language of medicine not by memorizing anatomical details, but by learning to think anatomically. "What we're trying to do is prepare students for lifelong learning," explains Rizzolo. "We're trying to give them the tools and skills so when they see new information they have a way to assimilate and acquire that information."

To achieve that goal, the course addresses four areas: clinical reasoning, visual reasoning, structure/function relationships and knowledge of anatomy. The tools used to achieve proficiency in those areas have been constructed to reinforce different skills and learning styles.

#### A clinical context

Dissection remains at the heart of the course, but it is now anchored in clinical medicine. Previously students studied structures in terms of their relationship to other structures. Now every dissection is a clinical case, and surgeons specializing in that day's procedure are brought in as guest instructors. Instead of telling his clinical colleagues what anatomy he wanted to teach and asking them to come up with clinical cases, Rizzolo was asking them to teach cases that students were likely to see, along with the anatomy behind those cases. It was a sea change in how anatomy courses have been organized. Using real surgical instruments, the students are practicing actual surgical procedures under the assumption that they will better retain information that they learn in a practical context.

While other medical schools use some surgical cases to teach anatomy, Yale is the only medical school in the country that uses surgery as the basis for the course for first-year students, according to Rizzolo, who sits on the educational affairs

committee of the AAA. Both students and faculty say the method works. “In a lot of anatomy programs you just dissect,” says student Judah D. Weathers. “Here we relate to disease and surgery.” Even mistakes offer moments of insight. “When you make one and understand it, you never forget it,” says Alicia Little. Instructors accustomed to the old system are already converts to the new approach. Shukrulla Ghofrany, M.D., a retired surgeon who has taught anatomy for the past four years, thought clinical cases would be confusing to students who have little knowledge of medicine. But feedback from students and his own observations have changed his mind. “I have to admit that I was totally wrong,” he says. Using a clinical outcome as the basis for teaching anatomy is bound to work, according to Chase. “If students can identify every important anatomical structure while doing a hysterectomy, then they know the relevant anatomy of the pelvis,” he says.

Another new aspect of the course is the expanded use of computers and the Internet. In the year-old anatomy labs at the Anlyan Center, each dissection table has its own workstation suspended from the ceiling. These computers are meant to be used during labs: the keyboards are made of soft rubber that is washable and virtually indestructible, and the course’s dissection manual, *Anatomy Clinic*, is distributed online. The manual, an interactive tutorial developed by Yale faculty, prods students with questions, and if they answer at least partially correctly, it supplies the full answer. If not, it directs them to resources with the correct information. Students can also access the Visible Human Dissector, a simulator based on the National Library of Medicine’s Visible Human Project and developed by researchers at the University of Colorado. This software allows students to view thousands of three-dimensional images of the human body in which each anatomical feature is color-coded and can be isolated, rotated, eliminated or viewed in cross section.

“We try and supply a variety of different learning modalities and teaching styles,” says William B. Stewart, PH.D., associate professor and chief of the Section of Anatomy and Experimental Surgery. “Some students love computers, others always look at the dissection, others always have their nose in the manual.” Some schools have abandoned cadavers in favor of virtual dissections done via computers. Encouraging that trend are the scarcity of cadavers as well as instructors, and, in part, scandals at Tulane University and the University of California, Los Angeles, where employees sold cadavers or

body parts to body-brokerage and research companies. But these computer programs haven’t been successful, because students need to learn in three dimensions. “It’s like having a map and directions,” says Frangos. “You can study it, but once you drive it, you never forget it.”

The tools of diagnostic imaging also help students visualize the inner workings of the human body. In the past, imaging was used intermittently, but in the new course it’s used during each lab. Groups of students gather around Michael K. O’Brien, M.D., PH.D., who is both an active surgeon and an anatomy professor. Using X-rays and CT and MR scans, students learn basic principles of radiology as well as the concepts of anatomy. O’Brien asks them to sketch structures and leads them to answers to their questions. Students say radiology allows them to make two-dimensional images three-dimensional, helping them visualize what may be difficult or too messy to see in the dissection lab.

### **Learning as a group**

Under the Yale System of Medical Education, students are expected to be independent learners who seek out information and take responsibility for their education. Yale students tend to be highly motivated to study on their own, but Rizzolo has found that they learn anatomy better in small groups. For the past two years, students have formed “learning societies” of 20 students divided into four groups, with a mentor for each. Students prepare for class individually, then meet with their societies to explore unresolved questions. Individual students become experts in their assigned areas and, at conferences, pool information and teach their classmates. Each group explores the core principles of clinical anatomy by combining different perspectives on a problem.

Even lectures, one of the traditional pillars of the anatomy course, utilize group dynamics. Students often break into groups at the beginning of a lecture to take a test, first individually and then, following a discussion, as a group. Lectures often come after a dissection, a policy that some students find perplexing. But according to Rizzolo, “The documented reality is the lecture doesn’t make sense unless you struggle with the material first.” This year’s students will find that less time is spent in the lecture hall. “It’s a difficult transition going from receiver of information to seeker of information,” Stewart points out, but an important one for the students to make.

The anatomy course guides students through the process of acquiring information they will need. But it's also an introduction to death and dying, and the course strives to make students comfortable with these topics. For most students, Rizzolo says, the dissecting lab will be the first encounter with a dead person or the first observation of the ravages of disease. In a 2002 paper published in *The Anatomical Record*, he maintained that it is an ideal place to introduce concepts of humanistic care. "The lab evokes the students' memories, speculations, and fears about serious illness in themselves, their families, and loved ones," he wrote. He tells the class that to be able to help their future patients and their families, they have to confront their own emotions first. He encourages students not to suppress their emotions, but to express them freely, and not to be embarrassed in front of their peers or professors.

For the last several years students have channeled their feelings through a memorial service, called a service of gratitude. Those who participate spend about half a semester on the project, in which they express themselves through whatever means they choose, including poetry, music and art. In the anatomy hallway hang two contributions from past years: an intricate and beautiful drawing called *Handed*, by Brent Schultz '06, and a quilt assembled by the medical school Class of 2006 and the physician associate Class of 2004, with panels dedicated to each donor in the course.

### State of the art

The anatomy course's new direction is largely due to Rizzolo's efforts to study and implement methods of teaching anatomy in a way that will allow students to recall information when they need it. A 10-day course for medical educators at the Harvard Macy Institute in Boston in 2003 was the genesis of a grant proposal to the Fund for the Improvement of Postsecondary Education (FIPSE), a program of the U.S. Department of Education. A \$400,000 grant to the anatomy program was approved and funded in 2003, and proposes a "modular, multimedia, multidimensional approach" to teaching anatomy from high school through college and clinical education. The course has been developed and used at the medical school since the fall of 2003, when students benefited from a pilot program that included some of the new features, such as interactive Web versions of sections of the dissection manual. This year it will be further refined before being rolled out to the physi-

cian associate and assistant programs at Yale and Quinnipiac University and the medical schools at UCLA, the University of Utah, the Mayo Clinic, the University of North Carolina and the University of Connecticut. "The FIPSE idea is a national solution to a national problem," says Rizzolo, referring to shrinking anatomy resources. "I think there are many schools that would want to do this," adds Chase, "but they need a blueprint and Larry and Bill are creating it."

William C. Rando, PH.D., director of the McDougal Graduate Teaching Center at Yale, surveyed last year's anatomy students to get their feedback and find out how they spent their time doing course work. "I was amazed at the overall positive response, but what was even more amazing was how easily students could articulate what it was about this course that was working for them," he told instructors at a faculty meeting at the beginning of the fall semester. Students said that dissection, conferences and computer-based learning played a major role in helping them learn anatomy. Students also said that the course offers more ways to learn and has helped them become more independent thinkers. "The way they learn anatomy is structured in a way that's more like how they work when they get on the floor—combining knowledge to solve problems and knowing where to go to get additional information," says Rando.

Meanwhile, Rizzolo has been studying the connection between Web-based activities and learning. Last year, he kept track of how much students used computer-based instruction and asked them to take an exam at the end of the course. On questions where Web activities had been available, he found that students who used them far outperformed those who didn't. If more Web activities were available (as they are in this year's course), those students may have scored much higher on the exam.

Redesigning the course has been a huge undertaking, one that is ongoing. Rizzolo asks faculty members to meet weekly to discuss what is or isn't working in the course, and find ways to improve and develop it. "What I'm most excited about is the reaction of the students when they hear what the course will be like," says Stewart, who wishes that he could have taken the course when he was a student. "I'm enthusiastic, but at the same time I'm a little jealous." **YM**

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