

▶ INNOVATIVE MEDICAL EDUCATION

Molecular and Cellular Foundations of Medicine

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ABSTRACT

After six years and six medical school classes, the course leader of Molecular and Cellular Foundations of Medicine reflects on how the course began and where it is going.

HISTORICAL BACKGROUND

At the end of the 1995-1996 academic year, Dean Dominick Purpura instituted the Division of Education (DOE) to coordinate educational changes at the Albert Einstein College of Medicine (AECOM). This Division is a committee network in which clinicians and basic scientists interact to plan and implement the education of twenty-first century physicians. Educational planning for the basic sciences had to reckon with the recent explosion of the biomedical database. Pervasive applications of molecular biology techniques were blurring traditional divisions between disciplines. Bench-to-bedside applications of basic science to clinical practice were occurring with increased frequency. The educational strategy selected by the DOE and the Dean to address this basic science cornucopia was to combine previously separate basic science courses, thus emphasizing the cross-disciplinary application of basic science information in medical practice.

Albert Kuperman, Associate Dean for Educational Affairs, commissioned two task forces to institute this strategy. The first task force chaired by Barbara Birshtein, Professor of Cell Biology, was charged with designing a first year course integrating material from Immunology, Genetics, Cell Biology, and Biochemistry courses. The second task force chaired by Steven Walkley, Professor of Neuroscience, was charged with designing a second year course integrating material from Neuroscience, Principles of Pharmacology, Nervous System Pathology, and Introduction to Clinical Medicine (ICM) courses. From these task forces the courses of Molecular and Cellular Foundations of Medicine (MCFM) and Nervous System and Human Behavior (NSHB) were respectively conceived. Steven Walkley became leader of the NSHB course and Howard Steinman, a member of the MCFM Task Force, became leader of MCFM. In the 2002-2003 academic year, MCFM and NSHB completed their sixth year in the AECOM curriculum. This article discusses the evolution of MCFM over that time.

EDUCATIONAL PHILOSOPHY

The MCFM Task Force had two goals, one in the arena of curricular content and the other dealing with educational process. In the curricular arena, we needed to review the content of the existing Genetics, Immunology, Cell Biology, and Biochemistry courses, and then merge subject matter from those discrete courses into the integrated course of MCFM. In the educational process arena, we needed to evaluate the existing lecture mode of teaching and the emerging use of small group teaching.

Curricular change was facilitated by Dean Purpura. Through his efforts, responsibility for basic science teaching was transferred from chairpersons of the Departments of Genetics, Cell Biology, and Biochemistry to representatives of those and other departments on the MCFM Task Force. This transfer and the consequent meetings of the MCFM multi-disciplinary Task Force made it easier to see connections between subjects that were previously departmentally segregated. For example, dominant and recessive inheritance, previously the domain of the Genetics course, is vital to the mechanism of action of oncogenes and tumor suppressor genes and is therefore taught as well in the cell growth unit of MCFM. Signal transduction leading to changes in transcriptional activity, traditionally taught in the Cell Biology course, is fundamental to the action of cytokines and is therefore also taught in the Immunology unit of MCFM. The genetics of mitochondrial inheritance is really an adjunct of mitochondrial generation of energy and is taught in the Biochemistry unit of MCFM. The immunology of Type I diabetes, as an autoimmune disorder, is relevant to the biochemistry of glucose homeostasis. In these ways, the MCFM Task Force was moving the interdisciplinary character of the current biomedical research into medical school basic science teaching.

Integration remains an ongoing challenge for MCFM. How to balance the need for discipline-specific bodies of information with the need for formulating medical problems in a cross-disciplinary manner? On the one hand, immersion in a single subject can be critical for learning the fundamentals of a discipline. On the other hand, reintroducing discipline-specific fundamentals in a different context strengthens retention of the subject

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matter by showing its relevance in new clinical arenas. In the physician's office patients do present with an interaction of genetic, cell biological, immunological, and metabolic effects on their physiology. In MCFM various approaches have been used to maintain this balance. The individual parts need to be evident but the whole must be seen as greater than the sum of its parts. The lecture guides for all units of MCFM conform to the same template, creating a concrete image that everything lies under the same umbrella. The schedule is kept flexible so a topic from one discipline may be moved into the context of a different discipline for revisiting and reinforcing fundamental concepts. The advantage of dispersing discipline-specific information into related areas is promoted by discussions among the leaders of the MCFM units so that each discipline-specific leader is aware of the communal nature of MCFM. In the final analysis, it is the teaching faculty of MCFM, the veritable corps in the teaching trenches, who bring this integration home to our students. Thus, the last piece of the process is insuring that the lecturers and conference leaders are aware of MCFM cross-disciplinary connections so they can be mentioned and reinforced in the actual teaching process.

The second goal of the MCFM Task Force was to design a course that would train our students for the medicine of the twenty-first century. Biomedical research is generating new information on a daily basis. How could we prepare our students for a profession that is changing at such a rapid pace? The MCFM answer is to instruct them in critical thinking and teach them to critically evaluate information. If the sources of data are expanding, our students must be able to critique different sources. Our students need to become independent learners. MCFM has decided that survival in an information explosion requires us to be increasingly critical about what constitutes data rather than increasing our information consumption.

How are critical thinking and analysis skills encouraged and taught? The case presentations in the clinical years are a major arena for these processes. In the pre-clerkship years, small group conferences had been used towards the same end. When MCFM was being planned, small group teaching was already being used in Cardiovascular Physiology, Principles of Preventative Medicine, and Renal Physiology in the first year and in the Microbiology and Infectious Diseases, Endocrinology, and Hematology courses in the second year. MCFM embraced the philosophy that interactive participation of students in the small group discussion as a means of honing critical thinking. In small group conferences, a faculty member facilitates the discussion rather than professing answers to the questions. In fact, it is the students who formulate the questions and generate the answers. The goals of these conferences are for students to learn from one another, to not be intimidated by asking questions, to express alternative viewpoints, and to realize that some

questions do not have unique answers. In educational jargon, students become active learners and take ownership of the learning process.

Most small group conferences in MCFM discuss a disease process, emphasizing the basic science underpinnings rather than diagnosis and treatment. MCFM lectures deliver the background basic science principles and vocabulary. MCFM conferences ask the students to apply this background to a clinical scenario. Examples from the current MCFM schedule illustrate this philosophy. One conference requires students to perform a literature search for current research articles on gene therapy. Two others require students to read a literature article on HIV and related articles on an inherited susceptibility to atypical mycobacterium infections. These conferences show our first year students that not all knowledge is found in textbooks, therefore instructing them in analyzing data and drawing conclusions from those data. Conferences on colorectal cancer, Type I diabetes, familial hypercholesterolemia, as well as vitamin B₁₂ and folate deficiency require the students to relate basic science information to etiological aspects and symptoms of those disorders. The current standard of care and the savvy of clinical decision making will principally come later in the clerkship years.

EDUCATIONAL PRACTICE

MCFM generally begins in the last week of August and ends in early March. The course is preceded by two days of Introduction to Cell Structure, four 90-minute lectures jointly sponsored by MCFM and the Histology course. MCFM is divided into eight units: Genetics and Gene Expression; Immunology; Cell Growth and Cancer; four units of metabolism—Energy Generation; Carbohydrate Metabolism; Lipid Metabolism; and Nitrogen Metabolism; and a final unit entitled Integration of Basic Science and Disease. The first two units of MCFM overlap with Histology and the remainder of the course overlaps Clinical and Developmental Anatomy. The Introduction to Clinical Medicine course runs throughout MCFM and continues through the end of the first year.

In a typical year, the MCFM schedule lists 81 hour long lectures, 9 hour long reviews, and 11 conferences that last 1.5 to 2 hours each, for a total of about 115 contact hours. There are six examinations; two are paired with Histology exams and three with Clinical and Developmental Anatomy exams. There are approximately 30 faculty lecturers. Of these, 23 to 25 faculty members give 1 or 2 lectures each. Six faculty members give the remaining approximately 55 lectures and reviews. An additional approximately 45 faculty members serve as facilitators of small group conferences. The total faculty roster is about 75 to 80 per course cycle. The major differences in lecture time and faculty involvement between these data and the corresponding statistics for

Student Evaluations of the MCFM Course: Classes of 2001-2006

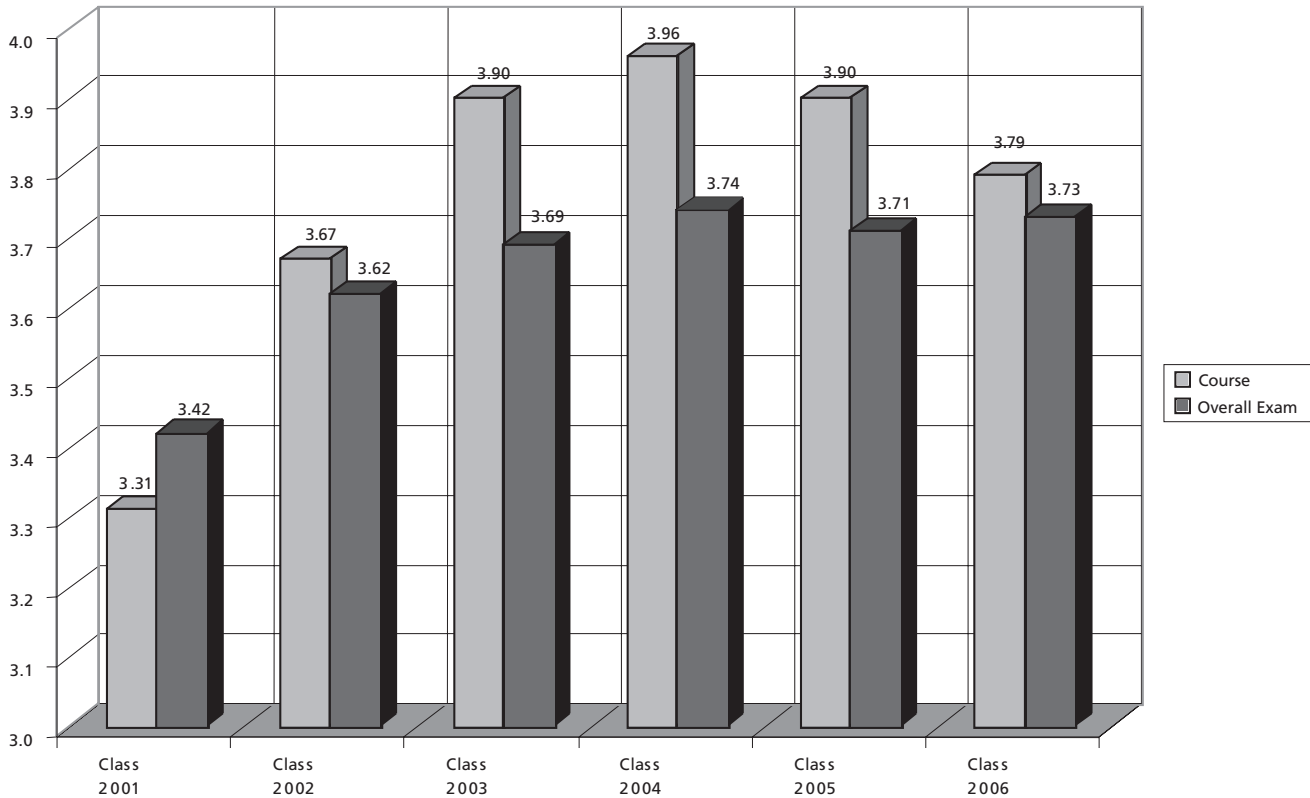


FIGURE 1 | Mean evaluation of the overall course (left bar) and the last MCFM exam (right bar) are plotted for the indicated medical school classes. The overall course and the last exam were evaluated "as a learning experience" on a scale of 1 = unsatisfactory, 2 = marginal, 3 = adequate, 4 = good, and 5 = excellent.

the separate discipline-specific courses in the pre-MCFM era are due to the small group conferences in MCFM. The number of lecture hours in MCFM is about 20% less than pre-MCFM, but the total contact hours in MCFM is comparable to pre-MCFM. The difference reflects the hours given to conferences, which were absent from most of the constituent pre-MCFM courses. The total faculty involvement in MCFM is more than twice that of the constituent separate courses from the additional faculty required to facilitate the small group conferences.

In the beginning, changes in MCFM from year to year were largely organizational. In those years considerable energy went into logistics and administrative matters. The goal was to create a working system with consistency in lectures, conferences, and examinations. While logistics and administration remain major sinks of time and energy, it has become possible in recent years to increase the focus on changes in content and sequence of topics. MCFM must be able to incorporate new topics and shift the order and emphasis of topics as the information base of the integrated sciences expands and evolves. This must happen on a regular basis. Examples

piloted with the Classes of 2005 and 2006 were new lectures on vegetarian diets, the biology of aging, and the metabolic basis of fad diets.

EDUCATIONAL RESULTS

In an age of standardized tests and standardized ratings, it is natural to ask how MCFM rates with our first year medical students. The Office of Educational Resources under the direction of Penny Grossman tabulates data from evaluations of each unit filled out by students after each of MCFM examination. On a scale of 1 (unsatisfactory) to 5 (excellent), the Class of 2006 ranked the overall learning experience of each of the eight units of MCFM from 3.3 to 4.4, with a mean for all eight units of 3.79. Figure 1 shows the mean ratings of the entire MCFM course and the last examination, which tests on integration of basic science concepts, evaluated for their "overall learning experience." After increasing in the first two years, the ratings of the entire course and the last exam appear to have reached a plateau of 3.8 to 3.9 and 3.7, respectively.

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Indirect measures of the educational effectiveness of MCFM are the pass rate and mean score of AECOM students on Part 1 of the National Board of Medical Examiners Medical Licensing Examination. These parameters reflect the entire pre-clerkship experience, of which MCFM is but one component. The first year Part 1 was taken by students who took MCFM was 1999. In 1999, 2000, and 2001, the pass rate for AECOM students taking Part 1 for the first time was 98-99%, compared to 90-93% nationally. Thus, MCFM and other changes instituted by the DOE correlate with a time of excellent performance of AECOM students in this measure of basic science competence. In 2002, the pass rate for first time AECOM takers dropped to 93% compared to 91% nationally. Concerted attention is being given to the origins of this drop and whether the scores for the 2003 takers will continue or reverse this trend.

Additional feedback on MCFM is obtained from Focus Group meetings. Every year, 24 randomly chosen medical students are invited to attend discussion meetings, 3 during and 1 after completion of the MCFM, with Penny Grossman, Barbara Birshtein, and Howard Steinman. These have been a source of insight on the numerical ratings in the evaluation forms and on issues not included on evaluation forms. Each year, suggestions from the Focus Group contribute to the evolution of MCFM. Some suggestions are organizational (e.g., the number of Powerpoint images to print on each page of the lecture guide). Others relate to teaching styles and facilitator styles, which lead to suggestions for individual faculty and to suggestions on what constitutes an effective lecturer or facilitator. Still others raise issues about scheduling of exams and balancing study commitments to the ongoing first year courses. A side benefit of the Focus Group is the active involvement of certain students in the educational process. Some students from MCFM Focus Groups become members of DOE committees. Others work with faculty mentors on curriculum development during the summer.

THE FUTURE OF MCFM

MCFM faces challenges in three areas. One area is the teaching faculty. How can the motivation of the teaching faculty be sustained from year to year, to not merely participate but to improve participation? How is staffing maintained when faculty availability may change in a given year due to obligations to research programs and clinical duties? How are faculty rewarded for their efforts in teaching? In this area, maintaining an influx of new faculty is seen as a critical factor. Our medical school and its affiliated hospitals are a rich source of individuals interested in teaching first year medical students. A cardiologist at Bronx Lebanon, genetic counselors from Montefiore, and newly appointed assistant professors in a basic science departments have recently joined the MCFM ranks. These newcomers are brought

into the MCFM team by participating in organizational meetings that plan lectures and conferences. Not uncommonly, these organizational meetings are "meeting grounds" for faculty. New colleagues are met and contacts are made. Possible consultants and collaborators are identified. Not infrequently, discussions go beyond the scope of MCFM and translation between clinicians and basic scientists is enhanced. This process creates an AECOM community spirit that melds MCFM participants and sustains their involvement in the course. In addition, bringing in new participants balances the attrition from research and clinical obligations.

A second area is administrative support. How is a support staff molded to meet the evolving needs of the course? How is an infrastructure created with sufficient conference rooms, Internet access, lecture hall time and all the other accoutrements of twenty-first century education? These issues have been addressed via the DOE. Since these needs—adequate secretarial support, assistance with computer based education modes, lecture hall and conference room scheduling—are shared by many courses, they are not infrequently raised at DOE meetings. Organizational and staffing changes have been made in the various offices that assist course leaders with teaching responsibilities. Revamping conference rooms in the Belfer Building and renovating the Riklis Auditorium for the Class of 2006 are some of the more visible signs of the commitment to medical student education. Additionally, much needed changes in the infrastructure of our institution are in progress.

The third area is translating basic science learning into the clinical years. How can the importance of basic science learning be revived and maintained in our third and fourth year students? How can the relevance of basic science learning be reinforced in their clerkship years? Medical students must be convinced that application of basic science principles is critical to the solution of difficult clinical problems even though the majority of problems may be solved with the current standards of clinical care. In addition, our clinical faculty is challenged to maintain their knowledge base with the rapid growth of biomedical information. In the first six years of MCFM, a major goal was communicating the educational benefits of integration and interaction between basic science disciplines. With the benefits of integration now widely accepted, a major goal of the next six years will be integration with the clerkship years so the molecular and cellular foundations of medicine can be reinforced in the clinical training of our medical students.

With the honeymoon over, these three areas will be increasingly important for sustaining momentum in MCFM. A committed involvement of our entire school—students, administration, and faculty—will be required.

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Junior faculty should be made aware of opportunities for medical school teaching and its spin off of interacting professionally with a broader range of AECOM colleagues. Continued participation of senior faculty needs to be encouraged, especially in the newly instituted teaching modes of small group conferences and multimedia lecture presentations. Our administration, continually pressed by bottom line issues, needs to realize that our institution is a medical school and that amidst other priorities, recruiting and maintaining an educational faculty as well as providing adequate space and resources for teaching needs to be a continuing priority. Finally, our students, who are the immediate beneficiaries of this educational juggernaut, must know that they are a critical part of improvements in the program, initially as recipients, then later as critics, consultants, and possibly even as facilitators in MCFM small group conferences.

At the end of the day, it really is our students who drive the MCFM machinery. It is the students who are our captive audience. It is the students who are our critics. It is the students whom we must inspire for perpetuation of the academic process. It is the students who can often inspire us. The first year medical student who beams about a *New England Journal of Medicine* article, about a one-hour PBS show, or about a case presented by an ICM preceptor, saying that the course content of MCFM made it understandable—these are the vignettes suggesting that MCFM may be on the right track.

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