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The BioTECH

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BIOMEDICAL ENGINEERING SOCIETY *QUARTERLY*

Creating a Foundation, Establishing a Legacy

By *Alexis DeSieno*, *PRESIDENT*

This year will be momentous in BMES history.

We will celebrate our 10th anniversary as an MIT chapter, at the same time that we will oversee, with great excitement, the birth of a new Biological Engineering major.

This year, BMES will serve not only as the nexus of communication between students and faculty regarding the new undergraduate degree in BE, but will be the first to hear about the latest course offerings and possible implementation of the degree into the curriculum.

In this role, BMES will become a foundational part of history in shaping the future of engineering at MIT and in the world.

For this reason, it is important that this year the BMES builds a strong foundation for the future and current students of the biological engineering department. We must prepare for membership growth and increased student interest, but we must also foresee and implement programs that will directly benefit the students who will enroll in the new major, such as a tutoring program for bioengineering classes.

> *"We will celebrate our 10th anniversary as an MIT chapter, at the same time that we will oversee, with great excitement, the birth of a new Biological Engineering major."*

It will be important to develop lasting programs and give BMES the momentum it needs to become the strongest undergraduate organization at MIT.

We must continue the effort to better define "what a biomedical engineer is and what we can do for the world." As the President of the National BMES Kyriacos Athanasiou says, "When people realize what we, the members of BMES, are capable of doing in helping humankind, BME will reach a level of unprecedented admiration and its concomitant benefits."

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Meritorious Achievement Award Winner

MIT BMES selected as ***Chapter of the Year*** '03-'04

Award to be presented at the National BMES Fall Conference on October 14, 2004 in Franklin Plaza in Philadelphia, PA

Biological Engineering Major to be Launched

By *Prof. Linda Griffith*, *FACULTY ADVISOR, CHAIR OF BE UNDERGRAD PROGRAM COMMITTEE*

A curriculum for an SB degree in Biological Engineering (BE) has been developed and will be undergoing review by MIT administrative committees in the 2004-2005 academic year.

The curriculum focuses on engineering based on the science of molecular cell biology, and is intended to provide a strong foundation for careers in biotechnology, pharmaceuticals, materials synthesis and other areas where engineering analysis, design, and synthesis can help translate discoveries in basic biology into practical use and help build new tools to advance basic biology.

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The *BioTECH* is a quarterly bulletin published by the MIT Biomedical Engineering Society as a vehicle to inform, involve, and mobilize our membership regarding the complex and evolving bioengineering landscape at MIT and nationwide. Founded in Spring 2003, the *BioTECH* has grown from a campus publication to one with wider constituencies, a bridge for inter-chapter relations and a catalyst to spark discussions on the national scene — the BMES Bulletin, for example, recently printed our *Letter to the Editor* in a full page coverage on page 3 of its summer 2004 issue <http://www.bmes.org/pdf/vol28_2.pdf>.

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Biological Engineering SB curriculum shapes up for review

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Updated information can be found on the Biological Engineering (BE) website <http://web.mit.edu/be/>.

Many departments in the School of Engineering now also include options that emphasize biological applications of the departmental discipline (e.g., 2A, 10B).

Students interested in biomedical engineering – i.e., applications of engineering to problems in clinical medicine – are advised to pursue an engineering discipline combined with elective subjects in their area of interest, as biomedical engineering is extremely broad and does not yield a single set of subjects that can be considered as an SB at the undergraduate level at MIT.

Until the SB is approved, no definitive information will be available about the enrollment possibilities for freshmen entering in Fall 2004.

The core subjects in the BE SB are being offered as part of the BME minor, and also fulfill some departmental major requirements. Approval status will be provided on the BE website and through the BMES email list.

In anticipation that the SB might be approved by the end of Spring 2005, informational sessions about the BE curriculum and how to prepare for enrollment will be held throughout the year and advertised on the BMES email list and on the BE website.

Informational sessions will also include descriptions of bioengineering options within various departments in the School of Engineering. Advising materials are available in BE Headquarters, Room 56-651.

Sample Biological Engineering SB Roadmap

Fall	Spring
Year 1	
Calculus I	Calculus II
Physics I	Physics II
Chemistry I	Biology I
Humanities	*Elective, unrestricted* (BE.010 intro BE, optional)
Year 2	
BE.110* Stat Thermo	**BE.113* Genetics**
Organic Chemistry	**BE.320 Mol & Cell Kinetics**
Differential Equations	**BE.180 Programming**
Humanities	**BE.109 BE Lab I (CIM)**
	Humanities
Year 3	
BE.310* Biomechanics	**BE.330* Transport**
BE.181 Computation	Cell Biology
Biochemistry	*Elective, unrestricted*
Elective, unrestricted	*Humanities*
Humanities	
Year 4	
BE.309* BE Lab II	**BE Senior Design (CIM)**
BE Elective	**BE Elective**
Humanities	*Elective, unrestricted*
Humanities	*Humanities*

* denotes subjects cross-listed with one or more departments — see catalogue for details

BME Information & advising sessions

Date: Sept. 7 (Reg Day)
Time: 3-5 pm
Place: 56-514
Format: overview of BME Minor for freshmen & sophomores, updates on subjects (3-4 pm); M. Eng Program Chair, BME Minor Advisors (4-5 pm).

Date: Tues, Sept. 14
Time: 3-5 pm
Place: 56-514
Format: overview of BME Minor for freshmen & sophomores (3-3:30 pm), updates on new core and elective subjects and schedules (3:30-4 pm); Enroll in Minor/Advising (4-5 pm).

BME Peer Advisors Recruited

Interested in advising and mentoring prospective BME Minor students?

Contact Professor Schauer <schauer@mit.edu> or Ms. Suzette Clinton <sclinton@mit.edu> if you are interested in participating in upcoming information sessions this fall, sponsored by the MIT Chapter of BMES.

This will be a fun and rewarding experience for you, and it will be incredibly helpful for students trying to decide if the BME Minor is right to them.

BE vs. BME: *"Bio" + "Engineering" landscape @ MIT*

Definition of "Bio" + "Engineering" terms from the MIT Biological Engineering (BE) Division:

Bioengineering (BioE) — an APPLIED FIELD of engineering in biological materials and systems.

Biomedical Engineering (BME) — an APPLIED FIELD of engineering in medicine and biomedicine, generally inter-disciplinary in nature.

Biological Engineering (BE) — a new engineering DISCIPLINE grounded in biology, particularly mechanistic biology at the molecular and cellular levels, with novel applications to biomedicine as well as biotechnology; it also enables new approaches to fundamental discoveries in bioscience.

BE vs. BME at MIT — The crucial distinction is that Biological Engineering (BE) is a new engineering discipline, distinguished by having biology (particularly molecular cell biology) as its foundation science, just as Mechanical Engineering and Chemical Engineering, for example, have theirs in physics and chemistry. Biomedical Engineering (BME) and Bioengineering (BioE), on the other hand, are application fields for any engineering disciplines. This is why MIT will be offering a MAJOR in BE, but only a MINOR in BME (or could call it BioE) for students majoring in other departmental disciplines.

Biological Engineering & the BE SB Degree:

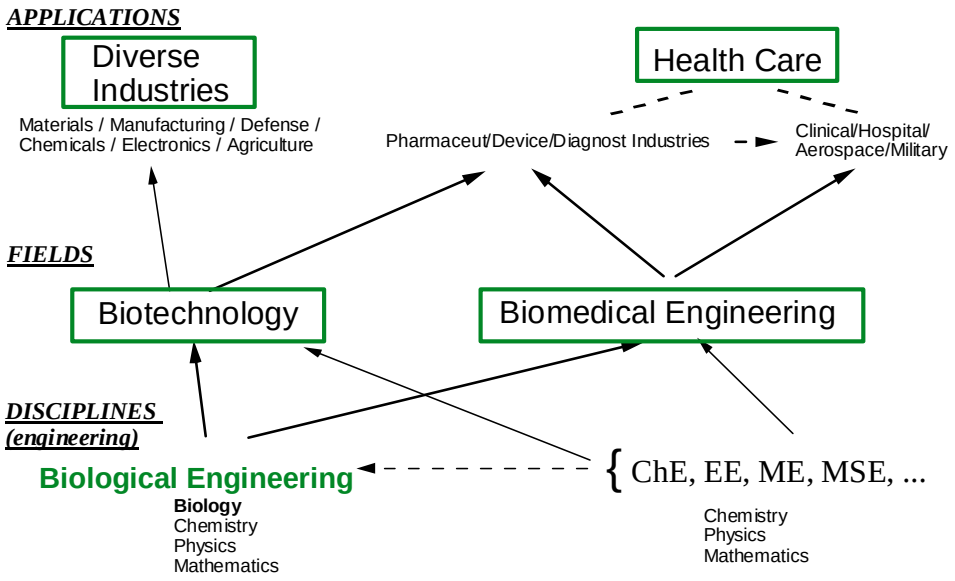
Philosophy & Plans with Prof. Doug Lauffenburger, Director of BE Division

Date: Tues, Sept. 14
and Wed, Sept 15
(repeat session)
Time: 7-8:30 pm
Place: 56-614

Presentation will illustrate the definitions of "Biomedical Engineering" (BME) "Bioengineering" (BioE), and "Biological Engineering" (BE) using examples.

The content of the proposed BE SB curriculum will be presented and discussed in the context of evolving needs in industry and in biology. Discussion and student feedback are encouraged.

Biological Engineering as a Biology-Based Fundamental Discipline



"Bio" + "Engineering" Options: *BE Major & much more*

Bioengineering Undergraduate Degree Options at MIT:

Faculty from several MIT departments and BE will present the degree options that emphasize bioengineering.

Date: Tues, Oct. 12
and Wed, Nov. 10
(repeat session)
Time: 7:00-8:30pm
Place: 56-614

In addition to the anticipated Biological Engineering major, there are many other "Bio" + "Engineering" options offered at MIT. Here is a sample of student perspectives from different departments:

A wealth of bioengineering opportunities: *look beyond the obvious*

By *Dawn Wendell '04*, *MECHANICAL ENGINEERING & BIOLOGY*, *BME MINOR*

For those entering MIT with an interest in Bioengineering, choosing a major is often difficult because of the lack of a Bioengineering degree.

But instead of a disadvantage, this is a great opportunity because choosing a major outside of bioengineering gives you an opportunity to explore other interests, and enhance your bioengineering classes through the resources of an additional department.

Numerous departments have majors with a reduced number of classes required beyond the core classes to allow students to focus in other areas. Whether it is course 2A, 10B, 7A, 8B, or others, these majors make it easier to find room in your schedule for classes in the Biomedical Engineering minor.

So with all these choices, how do you choose a major? First of all, remember that you will be taking a lot of classes in this area, so look though the Course Guide and see which majors offer classes that interest you.

Also, talk to students and professors to get information about what sorts of research opportunities or job experience you can get with that degree. Also, some departments offer classes in the spring that are geared towards freshmen who are considering that major.

> *"Choosing a major outside of bioengineering gives you an opportunity to explore other interests, and enhance your bioengineering classes through the resources of an additional department."*

Make your choice based on your interests and passions. However, also be reassured that your decision is not set in stone.

I began my career at MIT interested in Bioengineering but I found my own path through the Mechanical Engineering department.

I love building things, and the Mechanical Engineering classes let me develop my interest in design. However, I always found classes in the biology department intrigued me, so I took many of those too.

Then I began doing a UROP in the BioInstrumentation Lab after junior year, and I absolutely loved it! Although the lab is officially in the Mechanical Engineering department, it combines many of the areas I find fascinating, like engineering, biology, and computer science. It was the perfect way to study in the Bioengineering field in my own way.

Although all of these class and major choices can be a bit intimidating, they are a great chance for you to tailor your degree to your interests and leave MIT with a well-rounded experience. Your education is truly what you make of it!

***Dawn Wendell** graduated in 2004 with degrees in Course 2 and Course 7A, with a minor in Biomedical Engineering. She is beginning her Masters in Course 2 in the fall.*

"Bio" + "Engineering" Options: *BE Major & much more*

A look at Bioelectrical Engineering & Computational Biology

By *Yin Ren '06*, *EECS, BME MINOR*

Electrical Engineering and Computer Science (EECS), as unrelated as it may sound to Biomedical Engineering, actually has a tremendous amount of biomedically related applications and offers plenty of research opportunities as well.

For an electrical engineer, the first image that conjures up in one's mind is most likely someone working on circuits and making gizmos.

Indeed, making advanced medical instruments for doctors had been the traditional application of EE in BME. One of the most intensely studied fields of current medical engineering – imaging technologies in radiology such as MRI – has everything to do with signal processing of Course VI.

Electrophysiology is another example, where interactions and behaviors of molecules and tissues are examined through electromagnetic fields and electrostatic interactions.

In computer science, much research is currently devoted to bioinformatics and computation. The MIT Computational and Systems Biology Initiative (CSBi, http://csbi.mit.edu), for example, "links biologists, computer scientists, and engineers in a multi-disciplinary approach to the systematic analysis of complex biological phenomena."

Overall, EECS offers an enormous amount of opportunities for research in biomedically related areas, most of them at the Master's and PhD levels.

So, everything sounds good thus far. Connections between the two disciplines make plenty of research opportunities available. This is especially true at MIT, where undergraduates can take on projects without being limited by their own majors.

I work with Professor Jongyoon Han in the Research Lab of Electronics, analyzing separations of biomolecules such as proteins and DNA on a nanoscale. Much of our work is done on MEMS (Micro-Electrical-Mechanical Devices) such as microfluidic chips. Many other students from Course VI are doing UROP's in bioengineering and computational biology labs.

> *"Would I have majored in BE instead of EECS if it was available? Probably not, just because I can take classes in both disciplines regardless, and I enjoy Course VI classes in general. BME is connected with so many other majors, sometimes it doesn't really matter what Course you choose to be in."*

When one takes a look at the Course VI curriculum, however, the undergraduate courses do not offer adequate preparation for BME related research.

Yes, there is an area of concentration in VI-1 (EE), known as Bioelectrical Engineering. Under that heading, however, only three or four courses are offered: 6.021, 6.022 (biophysics and physiology), 6.024 (biomechanics), and 6.121 (bioelectronics lab).

A new course is planned to be taught next spring, an undergraduate version of "BE.430, Fields, Forces, and Flows in Biological Systems," which fills the current gap in some ways. There are quite a few CS/computational biology courses offered jointly through other departments such as HST, but only on the graduate level at this point.

In a way, the Course VI curriculum is "falling behind" in updating its undergraduate courses to reflect and keep pace with the changes in Biomedical Engineering.

When one takes a look at some of the other Engineering Departments at MIT, there is Mechanical Engineering Biotrack (2A), where "students pursuing this curriculum will be educated in bioengineering subjects with a strong mechanical engineering disciplinary background." Chemical Engineering also has Course 10B for Chemical-Biological Engineering.

Course VI, however, has yet to formulate a biotrack. There are only three available options: VI-1 for EE, VI-2 for EECS, VI-3 for CS; no VI-4 for Bioelectrical Engineering yet.

As the new Biological Engineering (BE) major is being finalized, we will face even more options in choosing our majors.

Would I have majored in BE instead of EECS if it was available? Probably not, just because I can take classes in both disciplines regardless, and I enjoy Course VI classes in general. BME is connected with so many other majors, sometimes it doesn't really matter what Course you choose to be in.

Yin Ren '06 *would like to give special thanks to his advisor, Prof. Alan Grodzinsky, for providing many insightful comments and suggestions during the discussions. Yin can be reached at <yinren@mit.edu>.*

"Bio" + "Engineering" Options: *BE Major & much more*

A taste of integration of Biology with Chemical Engineering

By *Priya Shah '05*, *CHEMICAL ENGINEERING, BME MINOR*

When I declared my major to be Course 10, I wasn't really sure what a chemical engineer did.

I knew I liked chemistry and math, and I also knew that I wanted to pursue engineering because I wanted to be able to think like an engineer, so chemical engineering was a logical choice.

At first the classes were very difficult, as I believe any beginning engineering classes would be, since engineering is an entirely new way of thinking. I enjoyed the challenge, however, and I am extremely happy with my decision.

Many students in Course 10 tend to be very interested in biology and bioengineering. They often ask why they should attend MIT since it doesn't even have a biomedical engineering (BME) major for undergraduates.

I admit, if MIT had a BME program as a major when I was declaring my major, I would have chosen it without thinking twice.

However, now that I am thinking about grad school applications, I am very glad that MIT doesn't offer a BME degree for undergraduates. BME programs at almost all other schools leave students with a general understanding of all aspects of engineering and biology, but no in-depth knowledge of any particular field.

I believe that the field is still developing and it is too early to create a strong curriculum that provides a solid base in BME.

> *"As a chemical engineering student, it was eye-opening to see the application of basic mass transfer to drug transport in the brain or learn a little mechanical engineering for a change. I don't think, however, that these classes should be a means of learning the basics of engineering and biology."*

MIT, instead of offering a degree that would leave students with a partial degree of engineering and biology, encourages students to pursue a conventional engineering degree supplemented with biology and bioengineering courses specific to traditional engineering fields.

I believe that the Chemical Engineering department has done an excellent job in integrating biology into chemical engineering with courses such as 10.28, 10.29, 10.441/BE.361, and even core Course 10 classes such as 10.302, 10.32, and 10.37.

The new Chemical-Biological Engineering major (Course 10B) is a culmination of this integration of biology and chemical engineering. It offers a great option for students very interested in biology, but still want a strong base in engineering.

Having taken several bioengineering classes such as 2.797, 10.441, and 10.28, I believe they offer a great overview of engineering applications to biology. As a chemical engineering student, it was eye-opening to see the application of basic mass transfer to drug transport in the brain or learn a little mechanical engineering for a change. I don't think, however, that these classes should be a means of learning the basics of engineering and biology.

The process to choosing a major can be quite confusing, but MIT offers many strong programs with a lot of flexibility. What you have to keep in mind are your interests and whether you want a strong engineering or science background as an undergraduate.

Additional Perspectives on Bioengineering Options

Here is a directory of people who would be happy to share their BME experience in the context of their majors:

Anna Bershteyn '06
Materials Science & Engineering
<fiend@mit.edu>

Additional Info: MIT-EMS; UROP with Prof. Darrell Irvine, helping with the designs of synthetic lymph node scaffolds and templates for scaffolds.

Delphine Dean
EECS BS '01, with BME Minor;
EECS MEng '01, EECS PhD (current)
<finou@mit.edu>

Additional Info: Bioengineering Undergrad Research Award ('99), Whitaker Foundation Fellowship ('01-present), 6.021 TA (fall '02).

David Yin
ChemE BS '03, BME MEng '04
<dyin@alum.mit.edu>

Additional Info: American Institute of Chemical Engineers (AIChE) President '02-'03, Biomedical Engineering Society (BMES) Vice President '01-'02.

"Bio" + "Engineering" Options: *BE Major & much more*

BME & Toxicology Minor open doors to engaging research

By *Issel Lim '05*, *BIOLOGY*, *BME & TOXICOLOGY MINOR*

MIT: the global hub for science, technology, and that elusive concept – research.

Arriving as a bright-eyed, naïve freshman at this breeding ground for innovation, I had no idea what "research" entailed. What was this mysterious idea for which intelligent people would stop eating, sleeping, and socializing? And when could I try it out?

During my second semester here, I found Dr. David Schauer.

Shortly thereafter, I was ripping the skin off mouse legs, extracting femoral bone marrow, and culturing the macrophages. Infection studies and biological protocols fit my wondering hands like proverbial gloves, and I reached out with latex-covered fingers to the *in vivo* experiments.

After introducing *Citrobacter rodentium* to immunodeficient mice, I labeled plates for a few days and hypothesized about what exactly "animal work" would entail. I never dreamed that so many hours would be spent staring expectantly at a mouse's rear end.

Who'd have thought that infection studies relied so much on excremental data? Fecal plating, genotyping, smearing stool to detect occult blood . . . And yet – far from having a stinky time at MIT, I've loved it.

Academically here, I've majored in biology, with minors in biomedical engineering and toxicology, along with a concentration in technical writing.

After having experienced 18.03 and 2.005, I realized that heavy mechanical calculations were not my cup of tea – I loved pure science, but I needed to see the numbers with respect to real life. Instead of pondering the S-world and the entropy of an engine, I wanted to explore the resting potential of a cellular membrane or learn the principles of human disease by measuring cytokine levels.

I gleaned a huge wealth of knowledge from genetics and immunology, but courses like BE.105J (Biotechnology and Engineering), BE.104J (Toxicology and Public Health), and 22.01 (Introduction to Ionizing Radiation) also whetted my academic appetite: I realized the importance of quantitative results in assessing the benefits of treatment, as well as the biological application of technical data.

> *"I was ripping the skin off mouse legs, extracting femoral bone marrow, and culturing the macrophages. Infection studies and biological protocols fit my wondering hands like proverbial gloves, and I reached out with latex-covered fingers to the in vivo experiments."*

The BME minor here provides an apt petri dish in which to culture an understanding of engineering and how to apply it to the many facets of life. One of the initial challenges of engineering is learning the basics; it's tough to learn about various orbitals or equations if you never see how to apply them.

In BE.105J, we examined the marketing, clinical, production, and ethical aspect of a particular medical treatment. I explored the biocompatibility of stents, then TA'd the marketing and clinical components of Avastin, and saw how the calculations contributed to the overall product.

In 22.01, a component of the engineering core, we learned about various imaging techniques and ideas like hormesis – for example, did you know that small levels of radiation exposure might actually be good for you?

The toxicology minor develops an understanding of how various environmental factors affect human health. For example, since I had never taken a statistics course, I tried out 18.05 (Probability and Statistics) during my junior year. It was overwhelmingly theoretical, and I couldn't see how to apply the initial "counting methods" in probability to the results of my infection studies.

I was also taking BE.104J at the time, and there we learned more useful tools in statistical analysis – the t test, assessing p-values, and variation in a population. These basic principles were taught alongside toxicological mechanisms and environmental standards; connecting them all in a scientific context really brought the lessons home. The classes in each minor program are very application-based, providing a context for people from a wide variety of backgrounds.

I eventually want to use clinical data to cultivate new ideas and enhance existing medical options. However, to thoroughly understand how organisms function, we should work from the inside out, applying the basics of biomechanics, kinetics, and cellular dynamics to living models.

The technical knowledge in-

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"Bio" + "Engineering" Options: *BE Major & much more*

BME Minor augments pure science education with engineering

By *Christina Fuentes '05*,
BRAIN & COGNITIVE SCIENCES, BME MINOR

Just when you're relieved to have selected a college, you're seemingly forced to decide what you want to do with the rest of your life. No matter how many people tell you it's not the end of the world, selecting a major is still frightening.

The advice that was given to me, and the advice I now pass on, is to select a major you're interested in without concerning yourself too much with future uncertainties.

I had always been interested in psychology and neuroscience but was terrified of committing myself to a field with no set career path; brain and cognitive sciences (BCS) seemed perfect for me, yet I was hesitant. The looming question on my mind, and most likely on the minds of many incoming freshmen, was "How am I going to make money after I graduate?" I decided to go for it and see how I liked my classes. To help make myself more well-rounded I chose to minor in biomedical engineering (BME).

I consider myself extremely lucky to have chosen the correct major/minor combination on my first try. I love my major and will be applying to PhD programs in neuroscience this year.

> *"I got a taste of MIT's engineering excellence and in the process reconfirmed my decision to focus on science."*

I also found that people who are more passionate about pure science and research can still benefit from a BME minor. Minoring in BME has provided me with a great general biology foundation that I otherwise wouldn't have gotten with just my BCS curriculum. The engineering classes that were required for the minor were also beneficial – I got a taste of MIT's engineering excellence and in the process reconfirmed my decision to focus on science.

While trying to survive your freshman year and at the same time plan your field of study for the next three years, I suggest doing a few things to help make the process smoother. Educate yourself on the different majors and minors you're interested in and on what each of them offers – base your decision on what program focuses most on your interests.

Don't be scared of the possibility of change – rather than being frightened by the thought of possibly switching majors, you should take comfort in the reversibility of your decisions. And above all else, be excited – you're at MIT, surrounded by endless opportunities.

(Continued from page 8)
herent to earning an MIT degree in Biological Engineering will enable students to predict and understand their future experimental data. Nowhere else in the world has such a rigorous and research-oriented atmosphere.

Biological Engineering for me combines the basics of life science with "real life" applications. The only problem that might emerge with the new "Course 20" is its breadth, a double-edged sword: when combining these different facets of technology, how can an employer determine what this "Biological Engineering Major" applicant knows?

It's up to MIT, however, to cut through the various other programs and set the universal standard on a biological engineering curriculum. Students then entering the major, minor, or master's degrees can pick their own specializations.

Right now, it's "so far, so good" at MIT: the basic tenets of biochemistry and cell biology, combined with advanced engineering concepts of fluid dynamics and kinetics, will create strong candidates for analytical research.

Whether honing in on toxicological mechanisms or mashing up mice feces, the vast field of biomedical research holds a challenging and never-ending plethora of information.

Conquer more problems via research. Work up from a microscopic level to macroscopic applications. Explore MIT and BME – you'll learn a lot about life.

Issel Lim '05 *can be reached via email: issel@mit.edu.*

*If you've got research to share, please submit to the **MIT Undergraduate Research Journal (MURJ)** – we're specifically looking for lab reports with quantitative data or 200-400 word summaries about UROP research. Or join our staff, editing and writing research once per semester. This fall, submissions are due on Sept 12th. Email murj-public@mit.edu for more information.*

"Bio" + "Engineering" Options: *BE Major & much more*

BE enables one to answer biological questions in a new light

By *Brian Chase '06*, *BIOLOGY & BIOLOGICAL ENGINEERING (PLANNED)*

MIT is a place of infinite variety, be it in living arrangements, activities, or courses. Nowhere is that truer right now than in the burgeoning field of bioengineering and biology-related fields.

Currently, several different majors at MIT, such as Electrical Engineering and Computer Science (EECS), Mechanical Engineering (MechE), and Chemical Engineering (ChE), offer curricular paths that link to biology, not to mention the new Biological Engineering (BE) major itself.

It may be somewhat confusing trying to determine which one is the correct choice for any given student; I know I had to dig a little myself when I first arrived here. So to help out students who may be interested in BE, I'm going to explain why I chose the double major in Biology and BE, and point out other alternatives that may be better suited to a different situation from my own.

When I first came to MIT, I had the notion firmly in mind that I wanted to be a biologist. To this end, I searched around for a UROP to enhance my skills. The one I eventually got was in the BE Department, and that was my first exposure to the field.

To me, Biological Engineering represents a new set of tools and skills I could learn in order to make myself a better researcher. It allows me to ask research questions I couldn't before, especially quantitative ones, and gives me new ways to answer questions I could only approach through Biology before.

Once I had determined I wanted to learn BE, I had to figure out the best way to do it.

What I eventually settled on was the double major. I ruled out the minor because the curriculum for it was not that close to the major as yet, as it was still primarily a Biomedical Engineering (BME) minor, not BE.

Besides, I might as well have taken the BE major anyway, because the MIT Biology curriculum is specifically designed, by the staff's admission, to let students participate in a lot of extra research or double major.

> *"A student might want to look at what [other departments have] to offer, but I would still recommend taking at least part of the BE curriculum . . . nowhere else in the university do I feel that there is the same integration of engineering and biology as in the major itself."*

I found I could fit the BE major into my schedule because of this.

The problem I had with the 10B option is that none of the teaching really seemed that integrated. Sure, you get engineering classes and biology classes, but in the BE major you learn engineering that specifically relates to biology, and how to apply it. In addition, I would have had to give up the Biology major if I took 10B, which was not something I was willing to do.

The icing on the cake for future students looking at Biology with BE is that the computation taught to students in BE will be focused on applications to the problems at hand, and will not contain extraneous material. This is good news for those biology students who may be afraid that BE will contain computation they don't want to deal with, but it still leaves a lot of interesting material for more technical students.

Of course, my choice of a curriculum might not be suitable for someone looking to explore a different area of the bioengineering space.

For example, I have a friend taking several bioengineering classes who is also taking a MechE major. This is the side of bioengineering that involves mechanical constructs applied to biology for research purposes or otherwise, rather than just manipulation and study of purely biological constructs.

For this kind of research, a student might want to look at what the MechE department has to offer, but I would still recommend taking at least part of the BE curriculum, for the same reason I stated before: nowhere else in the university do I feel that there is the same integration of engineering and biology as in the major itself.

The same argument applies to people looking into EECS and bioinformatics as well. And of course, taking BE in its own right is an option, and one which will probably open up a lot of opportunities for graduates of MIT in the future.

Brian Chase '06 *is currently a Biology major, and he plans to double-major in Biological Engineering (BE) as well, once the proposed BE major receives Institute approval. He can be reached at <bcc93@mit.edu>.*

Interview with Professor David Schauer: *impact of BE on BME*

Professor David Schauer

Recently, *BioTECH* representative Nupur Garg had the opportunity to interview BE Professor David Schauer, also the BE UROP Coordinator and the Director of Undergraduate Minor Programs in BE. She inquired about the impact of the developing BE major on the BME minor, as well as about the progress of the BE UROPs over the years.

By *Nupur Garg '07*, *VP OF CAMPUS RELATIONS*

BioTECH: *Will the development of the BE major impact the BME minor program? If so, how?*

Prof. Schauer: It has already impacted the Minor Program. Because we are in the process of developing a new BE Major curriculum, professors are developing new subjects for the Major that are applicable to the BME minor curriculum.

This year, three additional new subjects that will be part of the new Major curriculum are being offered, including BE.309 Biological Engineering Laboratory II: Instrumentation and Measurement (Fall), BE.320 Biomolecular Kinetics and Cell Dynamics (Fall), and BE.330J Fields Forces and Flows in Biological Systems (Spring). One subject that would normally be offered this year (BE.360J, Cell and Tissue Engineering) is deferred to next year.

Students should check online (web.mit.edu/BE) for updates about changes in subject availability. After next year, there will be more options, both for taking different subjects and in selecting a major and/or areas of study.

The development of the BE Major, as well as many bioengineering tracks and options now offered by departments in the School of Engineering, also affects the long term future of the BME program.

We are committed to offering a biomedical engineering minor degree, but a stand-alone, separate BME program is not the only option. Bioengineering tracks and options in other departments could be complemented by a BE Minor degree program that could encompass different aspects of the BME degree program.

> *"Many subjects in the BE Major curriculum, including the restricted electives, will be very interdisciplinary. In some cases, subjects will be team-taught by a scientist and an engineer . . . It's fun to see the unexpected interactions and how individuals solve the same problems with different approaches."*

BioTECH*: One of many people's concerns is that by developing the BE Major, the interdisciplinary nature of BME will be lost. How would you respond to this? How do you think joint teaching between the Courses has impacted BE research?*

Schauer: The BE Major will offer training and education in an integrated way rather than having it in pieces in the BME Minor program.

For students who want great breadth in many subjects, it may be harder to achieve, but there are still many options, and the development of this Major gives them yet another option.

An additional solution could be the eventual creation of a BE Minor, so students would have more of a choice: to immerse themselves in BE, or to take a bioengineering track or option in other disciplines.

Importantly, cross-disciplinary education will continue to be very important in BE. Many of our faculty hold dual appointments in BE and in other departments, including Mechanical Engineering, Materials Science and Engineering, Electrical Engineering & Computer Science, and Chemical Engineering.

Many subjects in the BE Major curriculum, including the restricted electives, will be very interdisciplinary. In some cases, subjects will be team-taught by a scientist and an engineer.

I think students will really enjoy these subjects, and I know the instructors enjoy teaching them as well. It's fun to see the unexpected interactions and how individuals solve the same problems with different approaches.

One example is the popular BE.105J, Biotechnology and Engineering (cross listed as 5.22J and 10.02J). This class has been co-taught by Professor Essigmann and Professor Langer for some time and has been very successful. We want to have even more subjects like that.

(Continued on page 12)

Interview with Prof. Schauer

BME enrollment climbs, curriculum expansion underway

(Continued from page 11)

BioTECH: *What will change about the courses offered?*

Schauer: We will always offer subjects in certain key areas, such as tissue engineering, biomechanics, and biomaterials, and hope to continue to offer subjects in other areas of Biological Engineering as well.

Some specific subjects temporarily won't be offered, and others will be discontinued. This may impact the seniors of 2005, who may not be able to take the subjects they might have planned on taking. In all cases, we have identified appropriate subjects that can be substituted for those that are not being offered this academic year.

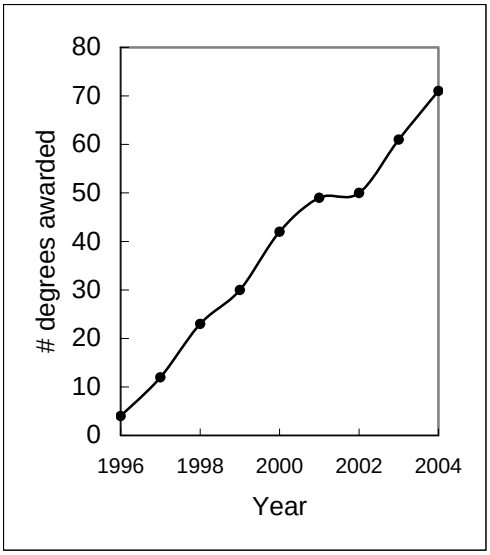
BioTECH: *Speaking of students not being able to take classes, there are many rising sophomores interested in BE but will not be able to major in it. What are some of their options in choosing classes if they want to take the BE version of something?*

Schauer: Well, the BME Minor is something that can be done with any major. Documents on which subjects and when you should take them can be found on-line at <http://web.mit.edu/be/> and in the BE headquarters office (56-651).

I would recommend that incoming freshman, who don't really know about BE or what to major in, take BE.010, a non-required introductory course that offers broad exposure to BE.

Also, I would highly recommend that those who are interested in BE consider taking BE.110, a sophomore level subject on statistical thermodynamics. This subject can be used to satisfy part of the BME Core requirement for the Minor.

BioTECH: *Will transferring credit between departments remain such a problem with the development of the BE Major?*



Growth of BME Minor at MIT

> *"A lot of different parameters can be used to judge the growth and vitality of a program on campus. By all of these criteria, BE is growing, and growing fast."*

Schauer: In some cases transferring credit, or satisfying departmental requirements with subjects taught outside the Major department, will become easier as the BE Major continues to evolve.

Course VII (Biology) already accepts certain BE subjects, such as BE.110. While the decision to accept BE subjects is up to each department, many subjects have been jointly developed, so they typically provide credit that can be used interchangeably.

BioTECH*: You've taken quite an administrative role here as head of the BME Minor program and BE UROP Coordinator. How long have you held these positions?*

Schauer: I began serving as the UROP Coordinator for what was then called Bioengineering & Environmental Health (now BE) since June of 1995. I've only been responsible for Undergraduate Minor programs in BE for a year now.

BioTECH*: So you've been able to view the growth of the BE program since its initial stages. Can you shed some light on the future of the growth of BE here at MIT? Has it been reaching a level of constancy?*

Schauer: A lot of different parameters can be used to judge the growth and vitality of a program on campus.

By all of these criteria, BE is growing, and growing fast. There is no indication of it slowing in the near future. Some of the key indicators of growth are the enrollment in the BME Minor, which is increasing every year, and the fact that so many departments are involved in joint teaching BE faculty. Potentially, it can grow even faster once we have a Major.

BioTECH: *As UROP coordinator for BE, what are the statistics on the number of UROP proposals you see each year and the number you accept versus reject?*

Interview with Prof. Schauer

BE UROP figures reflect steady increase in research activities

Schauer: As UROP coordinator, I don't take responsibility for evaluating the quality of the proposals. I leave that to the UROP advisor, but I don't sign proposals unless they are signed by both the advisor and the student.

What I do is oversee more administrative aspects of the proposal, making sure the student is working for pay, credit, or as a volunteer; if it's for pay, what the source of funding is and amount; and if it's for credit, how many units and whether or not it's for a grade.

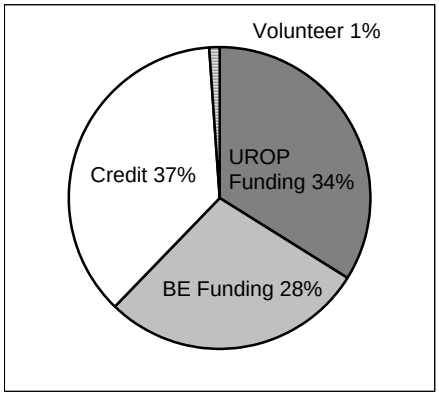
I don't reject proposals based on scientific content, but I do make sure students will get the pay or the credit that they are hoping to get.

BioTECH: *What kind of trends do you see in the UROPs of BE? Are there more than before? Are they focused in a field? Are they mostly upperclassmen?*

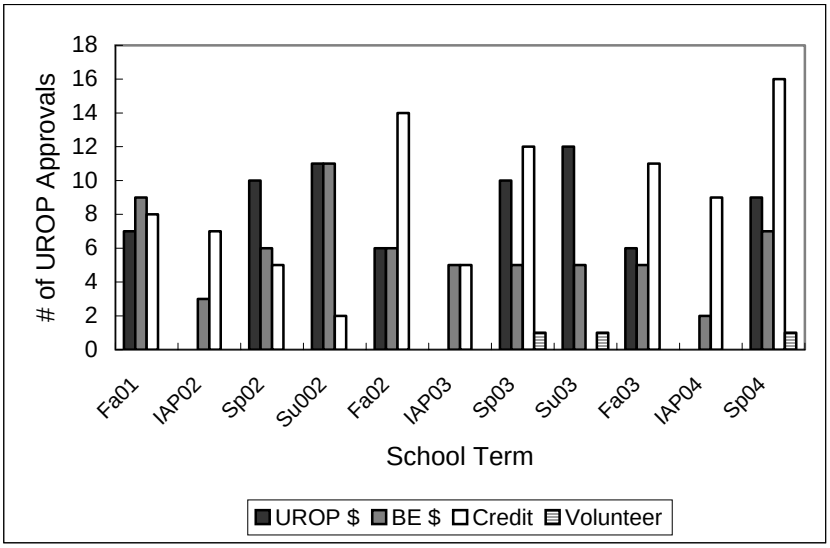
Schauer: The number of UROP proposals I get per year is definitely increasing. I have no doubt that this trend will continue. We may be seeing this increase in the number of UROPs for a number of reasons.

Students may be becoming more interested in BE; professors may be expanding labs over the years, and one reason for sure is that as the number of BE professors increases per year, so does the number of UROPs. BE is definitely expanding.

BioTECH*: Do you expect that the development of the BE Major will affect the qualities of the UROPs you receive?*



BE UROP Distribution
Fall 2001 to Spring 2004



Distribution of BE UROP by term over time

Schauer: I can't say there won't be any difference. If anything though, I think the students will be better prepared for being a BE UROP, mainly because BE.109 and BE.309 are two lab subjects that will give them the expertise they need to be successful as BE UROP students.

Otherwise, I think the UROP students who major in BE will be similar to the BME Minor students, who make significant contributions to BE labs with their problem solving and technical skills. Many of the UROPs working in BE labs are enrolled in the BME Minor.

BioTECH*: What are some resources available to students?*

Schauer: The BE academic headquarters (56-651) has a lot of information for interested students. Also, students can look online at <http://web.mit.edu/be> for subject descriptions, listings of research being done in BE labs, excellent resources for anyone looking for a BE UROP, updates on the availability of subjects for the BME Minor program and the Toxicology & Environmental Health Minor program, and a list of Minor advisors for the different Major departments.

Statistical data were obtained from:
** Undergraduate Research Opportunity Program's Office (7-104)*
** Biological Engineering headquarters office (56-651)*
** Professor David Schauer's office (56-787).*

BMES-J&J Research Award winners showcased their research

BMES-Johnson & Johnson Research Prize winners showcased their research at the award ceremony held on May 6, 2004. From left to right (winners' name in bold): Lili Peng, VP of Special Projects '03-'04, **Max Cohen '05**, Teresa Toole, J&J Representative, **Amy Shi '04**, **Julie Tse '06**, **Woon Teck Yap '05**, **Sid Puram '05**, Alexis DeSieno '05, President.

BMES-Johnson & Johnson Excellence in Biomedical Engineering Research Prize

Thanks to the collaborative support of the Division of Biological Engineering at MIT and generous funding from Johnson & Johnson, five of these prizes are granted each year to MIT bioengineering students for outstanding research conducted at the undergraduate and Masters' (M.Eng./S.M.) degree levels. Each winner receives a cash prize as well as a chance to present his/her research at an MIT BMES general body meeting in the spring.

BMES-J&J Research Award Winners 2004

Max Cohen '05, Physics, Biology. "Altered kinetics of platelet adhesion with stenting." HST Biomedical Engineering Center, Prof. Elazer Edelman.

Sid Puram '05, Biology, Brain & Cognitive Sciences. "Poly beta-amino ester microspheres as a specific and controlled DNA delivery vector." MIT Chemical Engineering Robert Langer Laboratory, Steven Little.

Amy Shi '04, Chemical Engineering. "Demonstration of cell density effects on stem cell kinetics symmetry." MIT BE Division Sherley Laboratory, Prof. James Sherley.

Julie Tse '06, Chemical Engineering. "Biocompatibility of polymeric microspheres for intraperitoneal drug delivery." MIT Chemical Engineering Langer Lab, Dr. Daniel Kohane.

***Woon Teck Yap* '05**, Biology. "Synthesis of novel hydrogel particles for antigen delivery to and activation of dendritic cells." Biomaterials and Immune System Bioengineering Lab, Prof. Darrell Irvine.

BMES-J&J Winner: *Max Cohen* — *Altered kinetics of platelet adhesion with stenting*

Endovascular stents are thin metal tubes implanted into the coronary artery to stabilize damaged vessel walls, largely replacing the older technique of balloon angioplasty.

Platelet adhesion to damaged vessel walls is a key step in the development of coronary thrombosis, but it is not well understood how post-interventional geometries (ie, the presence of a stent) affect platelet interactions with the damaged vascular wall.

We have used a bidirectional, pulsatile, closed-loop flow system to investigate the relationship between stent geometry and platelet adhesion under a variety of coronary flow-like conditions.

By comparing results from both an experimental fluid-mechanical model and computation finite-element simulations, we've been able to examine the delicate and important interplay of flow, transport, and geometry.

> *"My experience with biomedical engineering research has shown me that there are many different ways to approach each problem. I have enjoyed the variety of disciplines I've been exposed to, but most of all this project has solidified my interest in a career as a biomedical researcher."*

Feedback from BMES-J&J Review Committee

The overall applicant pool, although not as large as we had hoped, contained breadth in projects, wonderful letters of recommendation, and showed the overall high quality of research conducted by undergraduate students in BME here at MIT. The task of selecting the winners is always difficult, yet the committee after careful review of the applicants is left with astonishment at the overall excellence of the applicant pool.

The winners specifically . . .

***Max Cohen**'s* deep interest and dedication to his project are immediately apparent in his application. With a background in basic sciences, he nevertheless delves into biomedical engineering-oriented research with extraordinary passion.

***Sid Puram**'s* research is strongly supported by experimental data and results, and his application reflects well on his solid background as a double major in Biology and Brain & Cognitive Sciences.

***Amy Shi**'s* application is concise and well-organized, specifically tailored to the BMES-J&J award requirements as a solid representation of research on the interface between biology and engineering.

***Julie Tse**'s* entry stands out with a very strong letter of recommendation, which highlights with vivid details her persistence in research, her record of staying in lab past midnight to carry out time-sensitive experiments.

Woon Teck Yap demonstrates unusual independence in his research, finishing his major in Biology in 3 years, and for his 4th year he is continuing his project in Materials Science & Engineering in the Irvine Lab for the Master of Engineering in Biomedical Engineering (MEBE) Program.

BMES–J&J Research Award

How: submit an application package, consisting of
1) completed application form
2) 1-page abstract
3) advisor nomination

Semi-finalists will be interviewed by the BMES-J&J Review Committee; finalists will present research at a BMES general body meeting in the spring.

When: applications will be distributed in Fall 2004, and completed entries will be collected in Spring 2005. Contact Jonathan Wu <jonwu@mit.edu>, VP of Special Projects, for further details.

Selection Criteria:
1) Quality of the applicant's written and oral communication skills, as demonstrated by the submitted research abstract and interview performance;
2) Overall impact of the research in biomedical engineering, as demonstrated by the faculty advisor nomination and selection committee oversight.

BMES-J&J Winner: *Sid Puram* — *Microspheres as a controlled DNA delivery vector*

I work on research using polymer microspheres as a DNA delivery vector. These microspheres are tested on cultured murine and dendritic cells with transfection effeciency studies such as the luciferase assay. Additional work involves activation studies and release characterization for our particles.

We have also used 3-D Deconvolution to confirm the intracellular release of DNA from our microspheres. These spheres, approximately 1-10 um in diameter, appear to have great promise for use within the clinical setting.

> *"BME research has exposed me to new problems that are and will continue to be persistent problems without continued research and focused exploration of all possible solutions. The experience in Langer's Lab has been one of the most important aspects of my time at MIT."*

BMES-J&J Winner: *Amy Shi* — *Cell density effects on stem cell kinetics symmetry*

The potential of adult stem cells (ASCs) for medical and research advances is evident.

> *"The potential contribution of stem cells to research and cell-based therapies in regenerative medicine is enormous, and right now the rate-limiting factor lies in the amount of information we have about the biology as well as initiating innovative engineering methods to understand the question of what causes stem cells to behave the way they do. This area, as with many area of BME, benefits from taking an interdisciplinary approach, and as a BME student, this synergy of biology, medicine, and engineering fascinates me."*

However, the isolation and propagation of pure ACS populations needed for research and therapeutics have proven to be difficult. Instead of dividing exponentially, ASCs cycle with asymmetric kinetics whereby cell division gives rise to (1) another stem cell and (2) a transit cell destined to produce a terminally differentiated lineage.

Even starting with a pure population of stem cells, transit cells are soon produced and eventually dominate the cell culture flask. This kinetic barrier to ASC propagation must be overcome in order to successfully maintain wild-type stem cell strains *in vitro*.

The goal of this study is to overcome this barrier through investigating a cell-density in-

duced phenomenon observed in the laboratory, where p53-dependent growth regulation is observed to be sensitive to cell density.

The purpose of our research is to determine if cell density effects cell kinetics symmetry, and to understand the molecular mechanisms in the hopes of producing on-demand ASC propagation.

(Continued from page 17)

Peritoneal tissue harvested from mice injected with PLGA microspheres varying in size (5 µm to 250 µm) and amounts (25 mg to 100 mg) contained inflammation and adhesions.

Nodules of particle residue and adhesions were found in tissue harvested both two days and two weeks following injection. Two different types of sterilization, ethylene oxidation and ethanol wash, were used on the particles prior to injection; neither method mitigated peritoneal adhesions caused by the particles.

The fact that PLGA microspheres of various sizes and quantities can cause inflammation and peritoneal adhesions leads us to conclude that PLGA microspheres are not biocompatible in the peritoneum.

Furthermore, nodules of aggregated particles found in the peritoneum upon dissection suggest that PLGA microspheres are too dense and not buoyant enough to be dispersed within the peritoneum without unwanted settling.

Based on our findings, we determined that a PLGA microspheres-based drug delivery system for the peritoneum is neither biocompatible nor effective.

BMES-J&J Winner: *Julie Tse* — *Biocompatibility of microspheres for drug delivery*

Past studies have found encapsulation of drugs in poly (lactic-co-glycolic) acid (PLGA) microspheres to be a safe and effective drug delivery system.

PLGA degrades by hydrolysis into lactic and glycolic acids, which are products of human metabolism and do not cause toxic effects. As the PLGA encapsulation slowly degrades, drug is released over time in a controlled fasion.

It is hoped that a drug delivery system based on PLGA microspheres will be an effective method of treating ailments in the peritoneum. Drug delivery to the peritoneum is difficult because the peritoneal space is used for dialysis, so drug clearance is rapid.

A polymeric microspheres-based drug delivery system would allow for the slow and continual release of medication into the peritoneum. However,

it is uncertain whether PLGA microspheres are biocompatible in the peritoneum.

Our study will attempt to determine the histological effects of PLGA microspheres in the peritoneum, and to assess the effectiveness of a PLGA microspheres-based drug delivery system for the peritoneum.

(Continued on page 16)

> *"My involvement with this project has allowed me to learn many of the things necessary to be a successful scientist/engineer. The skills I have learned – how to plan experiments, organize and analyze data, and problem-solve — are essential for whatever career I choose to pursue. Winning the Johnson & Johnson BME Research Prize is definitely only one of the many benefits I've been fortunate to achieve through my research work!"*

BMES-J&J Winner: *Woon Teck Yap* — *Novel hydrogel particles for antigen delivery*

Several types of vaccines currently exist, among which are the live/live attenuated vaccines and the subunit vaccines. The main impetus for the development of subunit vaccines stems from the limitation that certain live/live attenuated pathogens are unsuitable for use as vaccines, due to large associated risks.

Current research in Irvine Lab deals with the synthesis of novel hydrogel particles for the delivery of subunit antigens concurrent with activation signals to dendritic cells (DCs), the immunological sentinels which reside in all tissues of the body and prime naïve T cells at the initiation of an immune response.

DC activation is known to be enhanced by unmethylated CpG oligodeoxynucleotide sequences. As such, selected CpG sequences were conjugated to hydrogel particles via methacrylic acid linkers to enhance both the processing of the model antigen ovalbumin (OVA) within DCs and the activation of DCs.

DC activation was monitored by means of fluorescent flow cytometry (FACS) and enzyme-linked immunosorbent assays (ELISAs). In particular, DCs secreted much higher levels of IL12-p40 when incubated with the CpG-conjugated OVA hydrogel particles than when they were incubated with OVA hydrogel particles.

Furthermore, upon incubation of $CD4^+$ OT-II transgenic TCR T cell blasts with DCs that had been pre-incubated with CpG-conjugated OVA hydrogel particles, relatively high levels of IFN-g and IL-2 secretion were observed compared to those with soluble antigen.

Our work suggests and supports the principle that with the conjugation of suitable ligands to our hydrogel antigen particles, different desired immunological effects can be achieved. This would in turn allow for the development of a novel vaccine that combines both the safety of subunit vaccines and the efficacy of live/live attenuated vaccines.

> *"Working in this field of research has opened my eyes to the wonderful things that can be achieved when two very different fields, immunology and engineering, come together. BME research is thus extremely interesting to me as it combines cutting edge technology from both biology and engineering so as to improve human health."*

BMES Chapter Goals & Checklist for 2004-2005

Administration & Membership

❑ *New Committees*
Description: Create new committees such as publicity, lecture series, community service, and *BioTECH* staff in order to increase membership involvement and contact with exec.
Contact: Stephanie Reed, Joia Ramchandani, Alexis DeSieno, Judy Yeh.

❑ *Officers' Log*
Description: compile an officer's log for each exec position, detailing duties involved, protocols followed, suggestions/advice for next term's officers, etc.
Contact: George Eng.

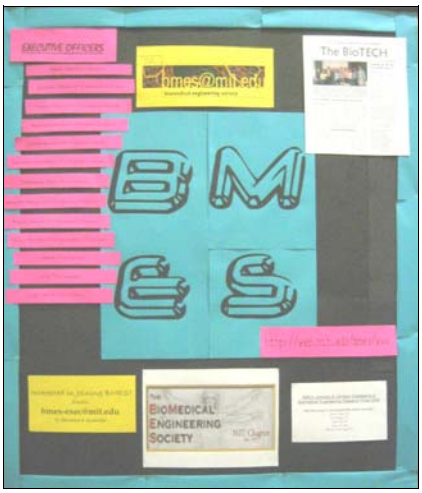
❑ *Online Discussion Forum*
Description: promote membership dialogues by creating an online discussion forum where the MIT Community as well as interested individuals worldwide can discuss BE related topics, exchange news, follow-up on inter-chapter developments, etc.
Contact: Alexis DeSieno, Emily Pfeiffer.

❑ Bible Collection & Resources Organization
Description: Collect course bibles for BE/BME classes to share among members; compile BME resources in the BE/BME Student Office.
Contact: Alexis DeSieno, Lili Peng.

Programs

❑ *BMES-J&J Research Prize*
Description: Maintain the BMES-Johnson & Johnson Excellence in Biomedical Engineering Research Prize Program; assemble a new BMES-J&J Review Committee; implement changes voted on in Spring '04.
Contact: Jonathan Wu.

❑ *Monthly Lecture Series*
Description: Continue the EMBS-BMES Distinguished Lecture Series, targeting a larger undergraduate audience and engage members in selecting future lecture topics of interest to students.
Contact: Joia Ramchandani.



BMES Bulletin Board
~ designed by Stephanie Reed, VP of Publicity ~
in the Infinite Corridor, next to the Coffee Shop.

❑ *BMES Buddies Mentorship*
Description: Maintain the big-little sibling program, recruit new members, host follow-up events, collect feedback about how to improve the program.
Contact: Nupur Garg and Aparna Rao.

❑ *Panel Discussions*
Description: Host several panel discussions per year regarding relevant issues in BME, such as the pharmaceutical industry and the definition of BE/BME.
Contact: Lili Peng, Joia Ramchandani, Alexis DeSieno.

❑ *Industrial Site Tours*
Description: Host at least one tour of a local biotech company.
Contact: Jennifer Fang and Prachi Jain.

❑ *Career Fair*
Description: Increase the representation of biotech companies at MIT recruiting events, either by sponsoring our own career fair or by working with the Fall Career Fair committee; create a career fair committee.
Contact: Lili Peng, Ojonimi Oncholi, Nupur Garg.

❑ *Technology Fair*
Description: BMES will co-host the Technology Fair planned for this January by contacting BME companies to attend.
Contact: Alexis DeSieno.

❑ *Tutoring Program*
Description: Develop a student-to-student tutoring program for BE/BME courses.
Contact: Alexis DeSieno, Nupur Garg, Aparna Rao.

❑ *Mixers & Study Breaks*
Description: Host several mixers & study breaks, some of them possibly with other engineering societies, such as Tau Beta Pi.
Contact: Nupur Garg, Aparna Rao, Alexis DeSieno.

Professional Development

❑ *Abstract Submission to National Conference*
Description: Invite members to submit abstracts to the National Conference and attend.
Contact: Alexis DeSieno.

❑ *Student Research Symposium*
Description: Host a student poster session in which students can share their research.
Contact: Joia Ramchandani, Jonathan Wu.

BMES Chapter Goals & Checklist for 2004-2005

❑ *Summer Internship Program*
Description: Help create a summer internship program for BMES members; work with Dan Darling in BPEC on establishing contacts.
Contact: Jennifer Fang and Prachi Jain.

❑ *Resume Book*
Description: Create a resume book for BMES members to be published on a CD and distributed to biotech companies.
Contact: Jennifer Fang and Prachi Jain.

Public Relations

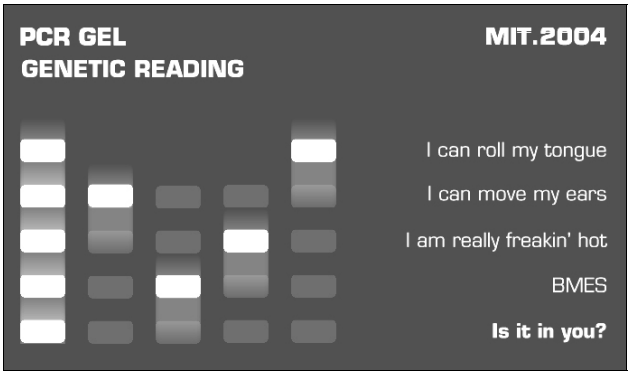
❑ *MIT Webpage Spotlight*
Description: Develop a webpage and apply for an MIT spotlight to increase membership and forum use.
Contact: Emily Pfeiffer, Alexis DeSieno.

❑ *BMES 10th Anniversary Celebration*
Description: Host a large celebration and publicity blitz to increase visibility of BMES on campus.
Contact: Stephanie Reed, Alexis DeSieno.

❑ *BMES Bulletin Board*
Description: Maintain and update the BMES board in the Infinite Corridor.
Contact: Stephanie Reed.

❑ *BMES T-Shirt Design*
Description: Design a T-shirt for BMES members.
Contact: Stephanie Reed, Julie Tse, Alexis DeSieno.

❑ *Inter-Chapter Relations*
Description: contact other BMES chapters and invite them to write for the *BioTECH*; possibly host an inter-chapter event.
Progress: 16 chapter contacts have been made: Brown, BU, Case Western, Columbia, Drexel, IL Inst. of Tech., Johns Hopkins, Rice, RPI, Berkeley, UCSD, UPenn, U. of Michigan, U. of Virginia, U. of Washington, U. of Wisconsin-Madison.
Contact: Judy Yeh.



VOTE on these two potential T-shirt designs!

Email bmes-request@mit.edu with your preference — either DNA strand (top) or PCR gel (bottom). Also specify if you would prefer a black or white t-shirt.

❑ *Prospective Students Host Interface Program*
Description: follow-up with requests from prospective students and facilitate meetings with faculty and/or students with BME experience to share.
Contact: Nupur Garg and Aparna Rao.

❑ *Community Service & Outreach Projects*
Description: Host a community outreach program by maintaining our contacts at Roxbury Prep Charter School. Also create a video about BME professions for high school students.
Contact: Alexis DeSieno.

Department Development

❑ *Updates on New BE Major*
Description: Keep membership updated on progress of the new major; serve as a liaison between the BE Division and incoming/prospective students
Contact: Nupur Garg, Aparna Rao, Judy Yeh.

❑ *Student Guide to MIT BE*
Description: Publish an underground guide to BE and MIT.
Contact: Jonathan Wu.

❑ *Research Opportunities*
Description: Maintain a website with current UROP opportunities; facilitate the UROP process; create a form for opportunities to be submitted directly to the website; make contacts.
Contact: Ojonimi Oncholi.

❑ *Applying to Graduate School Seminar*
Description: Plan an applying-to-grad-school-in-BME seminar, led by Professor Linda Griffith.
Contact: Alexis DeSieno.

❑ *Student-Faculty Lunches*
Description: Host several informal and formal faculty student lunches.
Contact: Alexis DeSieno, Jonathan Wu.

Inter-chapter Relations: *letter from Berkeley Bioengineering Chronicle*

By *UC Berkely Bioengineering Chronicle Staff*

Dear MIT BMES members,

We would like to thank the *BioTECH* staff for providing valuable help during the launch of our own newsletter here at the University of California, Berkeley.

The *BioTECH* clearly stands out as a top-notch undergraduate biomedical newsletter. The in-depth, well-written articles provide a unique MIT perspective to biomedical engineering.

The strength of the newsletter reflects the highly motivated and dedicated biomedical engineering students at MIT. We admire the fact that the current development of your undergraduate program is largely the result of student-driven efforts.

The students at Cal Berkeley share MIT's strong student interest in the direction of the biomedical engineering program.

Berkeley's bioengineers are, by far, the most active student leaders on the College of Engineering campus. Bioengineers hold five of the twelve positions in the officer corps of the Engineers' Joint Council, the governing body for all engineering societies at Cal. These students serve as the liaison between the students at Cal and the College administration.

In addition to this, four of the ten recently appointed student members on College faculty committees are bioengineers, the largest proportion from any major in the College. These members offer a student perspective on issues ranging from curriculum changes to the choice of Commencement speaker.

The high level of involvement at the College level demonstrates the Berkeley bioengineering undergraduates' commitment to guiding the direction of the College.

At the student society level, bioengineers also hold positions in a variety of organizations. In the Society of Women Engineers, for example, ten of the twenty-one officers (including those in the top executive positions) are bioengineers.

The Engineering in Medicine and Biology Society's (EMBS) strong officer corps of 25 highly motivated men and women work on a number of activities, similar to those offered by MIT's BMES: student/faculty mixers, faculty talks, peer course advising, career fairs, and research information sessions.

> *"Peer interaction . . . is the basis for the development of the bioengineering newsletter here at Cal. We wish to offer students a forum to discuss issues and challenges facing bioengineering. We hope to bring these issues to the eyes of the department as well as the wider community."*

This September, the student chapter looks forward to helping run the 26th Annual International Conference of EMBS in San Francisco. The Bioengineering Honor Society, in only its third year, is preparing to join the national bioengineering honor society.

Student leaders in bioengineering are also in the process of starting a BMES chapter here at Berkeley. These activities all showcase the high motivation of the Berkeley bioengineering undergraduates.

As bioengineering continues to expand at Berkeley and elsewhere, the need for interaction between different campuses and societies is increasing. Bioengineering is a discipline that requires one to integrate knowledge from a variety of areas.

Peer interaction is an integral part of this process. That is the basis for the development of the bioengineering newsletter here at Cal. We wish to offer students a forum to discuss issues and challenges facing bioengineering. We hope to bring these issues to the eyes of the department as well as the wider community.

By doing so, we would like to encourage interaction among Berkeley Golden Bears as well as between Bears and members of other campuses. We especially look forward to increased involvement with the MIT campus as its biomedical engineering program continues to strengthen and grow.

Best regards,
UC Berkeley Bioengineering Chronicle staff

UC Berkeley's undergraduate bioengineering program is currently undergoing major changes. Proposed guidelines will require students to take a number of core upper-division bioengineering classes, a departure from the greater flexibility in coursework selection previously afforded to students majoring in bioengineering.

Student and faculty reflection of this move can be found in their newly launched newsletter — UC Berkeley Bioengineering Chronicle.

Inter-chapter Relations: *letter from UCSD BMES President*

By *Shirley Lee*, *UCSD BMES PRESIDENT*

Dear MIT students,

Welcome back to school!

Having lived in California my whole life, this summer in Cambridge has been a great and exciting adventure for me.

Interning at a local company, I was able to experience Boston life first hand – enjoying the scenic Charles, rides on the T, walking through Downtown, and exploring the many college campuses in the area.

Being here all summer, I wasn't about to let the opportunity of meeting some MIT BMES officers slip by. Alexis and I began to correspond through e-mails (since we had apparently switched coasts) and I was able to attend an officer meeting.

*MIT BMES President **Alexis DeSieno** met with UCSD BMES Executive Board over dinner at Friday's in San Diego this summer.*

We have exchanged many thoughts, including ideas on how to promote membership and how to link our chapters in a productive and meaningful way.

Without saying more, let me introduce you to the BMES chapter at University of California — San Diego (UCSD) with the following piece:

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Biomedical Engineering Society at UCSD

***Shirley Lee '06**, BMES PRESIDENT 2004–05*
***Eun Hee Han '04**, BMES PRESIDENT 2003–04*

The UCSD Biomedical Engineering Society undergraduate chapter was established in 1985. Since then, UCSD BMES has been active in promoting biomedical engineering among the undergraduate students.

Our chapter of BMES has been rapidly expanding throughout the last few years and offers students a broad range of activities to enrich their social, academic, and professional development.

We have established an outreach program that allows students to inspire elementary school children to develop interests in science and engineering and a mentor program that matches freshmen and sophomores with upperclassmen who can provide guidance and advice.

We also sponsor quarterly Industry Nights that expose students to company profiles and possible career paths, graduate student and alumni panels that provide insights into grad school and industry, and graduate school application workshops for those who have decided to apply.

These events and programs would not have been successful without the support of the Bioengineering Department.

Some of these events started out as grand ideas that we dreamed about. But our faculty advisor Dr. Sah, undergraduate advisor Margene Wight, and Department Chair Dr. Chien enabled us to turn these visions into reality. They helped us with contacts, locations, A-V equipment, publicity, food for hungry students and constant encouragement.

We have been able to accomplish much in the last few years, but like any other organization, we are always looking for ways to improve.

Some of our chapter's goals for the coming years include strengthening student membership, fostering professor/student relations, increasing inter-organization collaborations, and solidifying national involvement.

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I hope you enjoyed learning a bit about the BMES chapter at UCSD and invite you to visit our website for more information <http://bmes.ucsd.edu>.

Your officers have worked hard to make a discussion board on your website, and we should work hard to use it to its fullest for inter-chapter discussions.

I encourage you to take advantage of this opportunity to network with fellow bioengineers across the country, and who knows what type of collaborations we can make and what we can achieve if we work together?

It's been a pleasure to be here in Boston, and I'd like to thank the MIT BMES officers for their great communication and camaraderie. I sincerely look forward to continuing this rewarding relationship between our chapters.

Best regards,
Shirley H. Lee
President, UCSD BMES

Host-Interface Program: *note from prefrosh on visit to MIT BE*

By *the Trachenberg family*, *MIT BE VISITORS*

Matt, Ruth and I want to thank you for coordinating our recent tour of Bioengineering at MIT, on August 13, 2004. As a High School senior, Matt is targeting his college search at those schools who have prominent programs in Bio(Medical) Engineering.

The high points of our visit were:

* meeting Professor Lang, and getting an overview of the curriculum in the new BE major. He gave us an awesome tour of the lab facilities in building NE47. We had a look at the research labs, and were particularly impressed to see the custom-built laser-augmented microscopes on huge floating tables.

* speaking with a second year ChE major (and BME minor), Napur Garg.

* speaking with a fourth year EE/CS major (and BME minor), Ojonimi Ocholi.

The students showed us their labs and work locations, and described their specific UROP projects. They also showed us different ways to weave a BME minor into diverse engineering studies.

***Ojonimi Ocholi**, VP of Research Activities, met with prospective student Matt Trachtenberg and his parents on August 13, 2004, and showcased his research at the newly built Stata Center.*

Of course, we were aware of MITs reputation for providing a superb undergraduate Engineering education, but had questions regarding BE, especially with the ongoing change in MITs BE degree offerings. Frankly, we were concerned that MIT did not appear on the list of schools that are accredited by ABET, for Bioengineering/Biomedical Engineering.

After our meetings, we came away with a powerful message that MIT is laying the groundwork for a BE Major curriculum that will provide a solid basis for a life-long career in either Bio-Technology or Bio-Engineering.

The BMES is providing a great service for students who are considering undergraduate admission to MIT. We commend you for your efforts and thank you again for an unforgettable visit.

Bob, Ruth, and Matt Trachtenberg, Mountain Lakes, NJ.

President's Column: *we invite you to join us, the MIT BMES*

(Continued from page 1)

The BMES at MIT already is a solid program, which the National Organization has recognized as one of the leading college chapters.

We have worked towards our founders' goal of providing students with research, employment, and educational opportunities in biomedical engineering through maintaining the monthly lecture series, the Johnson and Johnson award for excellent student research in biomedical engineering, the big-little sibling program, and the *BioTECH* among others.

But our success in achieving these goals depends on you, on your active involvement and your input.

It is for that reason that in this first issue of the *BioTECH* for this academic year, I would like to encourage you to join us,

> *"It is a prime time to become involved in the fastest growing industry in the nation, and in a new and exciting major at MIT."*

the MIT BMES. It is a prime time to become involved in the fastest growing industry in the nation, and in a new and exciting major at MIT.

Regardless of your major or career interests, join BMES to become informed about an industry that will only continue to lead biomedical developments in the business world. Whether directly or not, progress in biomedical engineering will affect you as new therapies are developed and new drugs are discovered.

As a member of the MIT BMES, you will not only be at the forefront of biomedical engineering research, learning from faculty who are leaders in the field, but you will also be setting the stage for the future of the undergraduate curriculum and programs at MIT, and ultimately the nation.

(Continued on page 23)

Where BME research can take you: *work/study abroad in Singapore*

By *Lili Peng*, *STUDENT ADVISOR*

Thinking about doing biomedical research? As MIT students we often strive to get that elusive summer internship at a biotech company or a BME UROP.

I always thought that BME research opportunities only existed within the confines of industry or academia in the USA – until this summer. Along with 9 other ChemE students, I took the opportunity to travel abroad to Singapore to do research at Singapore's Bioprocessing Technology Institute (BTI) under the guidance of Prof. Daniel Wang (ChemE).

My experienced exposed me to the differences between doing research in the same field (BME), yet in two very different environments.

Coming from a highly intense, fast-paced environment at MIT, I was surprised to find that this was not so at BTI. People do not seemed as stressed in Singapore. They tended to take their time at work, yet they were capable of fulfilling their assignments on time.

The laboratory facilities at BTI were also different from those at MIT. Contrary to the densely packed research labs at MIT, BTI consisted of ample amounts of open lab space. The labs were also replete with high-technology equipment, perhaps newer and even more state-of-the-art than those at MIT.

Despite the differences I observed in Singapore, there were also similarities that I encountered.

First, there were no language barriers between me and my co-workers, as English is one of Singapore's official languages. Furthermore, the directors and managers at BTI all hold graduate or professional degrees, similar to the practice in the US, where leadership positions such as principal investigators are usually held by people with doctoral and/or professional degrees. Finally, student interns or "internship attachment" students from local universities were also common.

Overall, my experience in Singapore affirmed that BME research is not only limited to the United States. In fact, BME research, or all scientific research for that matter, is a global effort!

Acknowledgements: ***Lili Peng*** *would like to thank Prof. Daniel Wang, Susan Lanza, and BTI employees for supervising her summer experience.*

Bioprocessing Technology Institute (BTI) *is one of the five main research institutes in Biopolis, a research complex created by the Singapore's Agency for Science, Technology, and Research (A*STAR) in effort to fulfill Singapore's vision and commitment to the biomedical sciences.*

The Biopolis serves as the 'central hub' that accommodates the entire spectrum of biomedical science research and development activities, ranging from drug delivery, medical devices, and clinical research. It serves as a liaison between private industries, academic institutions, and BME research institutes, seeding the growth of a vibrant research community in Singapore, Asia, and the world.

(Continued from page 22)

MIT's bioengineering program forges new ground in the field by emphasizing the connection between engineering and biology, rather than between engineering and medicine. As bioengineering continues to grow worldwide, other universities will look to us, the members of the top engineering campus in the world, to set a precedent for how bioengineering programs should be run and what issues bioengineering can best address.

I urge you to join us and secure your place in the biomedical engineering world today. I hope you will look through this issue of the *BioTECH* to see just some of the things that BMES can offer you.

Please feel free to contact me at any point with questions or suggestions. I look forward to your active participation this year!

Sincerely,
Alexis DeSieno
President, BMES
<alexisd@mit.edu>

Student Research Spotlight

Why? Research is an ongoing dialogue — share your work and get feedback from faculty and peers with similar interests and different backgrounds!

How? Submit a concise and informative description of research in a BME-related field.

Interested? Contact TheBioTECH@mit.edu for more details. We hope to hear from you soon!

MIT BMES 10th Year Anniversary: *reflection from alum*

By *Melissa Kemp*, *Ph.D.*
B.S. '97, NUCLEAR ENGINEERING

Congratulations on your 10th anniversary, BMES!

BMES now — I can't believe how organized and extended BMES has become over the years — your website looks great, and you clearly have a large working agenda. It was all we could do to muster a career fair and get UROP positions online!

It is nice to see that the same faculty that were so instrumental in assisting BMES in the beginning are still active advisors — Professors Griffith, Kamm, and Lauffenburger as well as strong faculty support and fresh enthusiasm from Professors Sherley and Lang.

BMES then — in some ways, the reason we started BMES is still very pertinent today — without a major, an organizing body is really needed to bring students together with common academic interests. It's still really the only way for students across the whole campus to congregate as a discipline.

A difference today is that there are more class offerings to bring together students from the different majors, whereas we were much more scattered across different courses and only really found one another late in our junior & senior years with the 6.021/6.022 series.

I think that once a major is available, BMES will be more useful in the standard roles like other academic societies, providing intercollegiate, extracurricular, and professional opportunities.

Defining BME — that's a tough one! (see page 4) Especially as I was not aware of the BioE vs. BME distinction in my undergrad days. My Ph.D. is in bioengineering, and at University of Washington (where I attended graduate school), they used that title to encompass applications beyond those that are strictly medical.

"A difference today is that there are more class offerings to bring together students from the different majors, whereas we were much more scattered across different courses and only really found one another late in our junior & senior years with the 6.021/6.022 series."

The growth within the field has been huge over the last decade, and students today have so many more options for graduate programs than I did.

I think faculty from different sub-specialties of BME were originally excited to have cohesion with other cross-disciplinary people and were eager to band together under the label BME.

However, the challenges remain in reaching a consensus as to what is an appropriate curriculum in BME/BE, and what an employer can expect in background from a person hired with a BME/BE degree. This is not just an MIT-specific issue.

My BME Experience — after working for a protein crystallography physicist over my freshman summer, I decided that it might be nice to be in another discipline and apply it to biology rather than be a bio major. I selected the Nuclear Eng. major sort of by default, looking for what I wanted for coursework and finding the course number that best fit with its requirements.

Course 22 has a radiation science track focused on medical/biological applications, allowing me to get a great engineering background with individual attention as well as take many pre-med/BME like classes.

When the BME minor was started my junior year, I hardly had to add any classes to fulfill it, and I was fortunate enough to UROP in the lab of Prof. Yanch, who is affiliated with HST and focuses on radiation applications in medicine.

I'm now back at MIT as a postdoc in Prof. Doug Lauffenburger's lab, and am happy to talk to BMES members about their choices in major and career options.

Melissa Kemp
<mlambeth@mit.edu>