COE 2011 Strategic Planning
Faculty Resource Planning - Five Years

FINAL

RESEARCH CROSS-CUTTING COMMITTEES

DUE: April 30, 2011
Along with Final Draft Strategic Plan in Detailed Bullet Points

Committee Name: Bioengineering
Chair(s): M.L. Shuler

Priorities listed are from initial bioengineering lunch discussion with departments

Priority Area	# Lines	Possible Depts.	Description
1. Biomedical			
a) Neural Tissue Engineering	1	BME, MSE	Cell delivery to brain or spinal cord; biomaterials for delivery of trophic factors. Fits BME focus areas of cell, molecular, tissue engineering, micro/nanobiotechnology, biomaterials. Medical application in neurology.
b) Myocardial Engineering	1	BME, M&AE, CBE	Cell delivery for repair of heart muscle; mechanical conditioning of myocardial grafts. Fits BME areas of cell, molecular, tissue engineering, biomaterials/drug delivery, and biomedical mechanics. Medical application in cardiovascular systems.
c) Multi-modality imaging for small animals	1	BME, AEP, ECE	Use of techniques to measure several properties in biological materials simultaneously. Examples are techniques such as OCT or SPECT. Longitudinal data from living systems. Fits BME focus area of imaging. Medical application areas in neurology, cardiovascular, musculoskeletal systems and cancer.
d) Molecularly and physically-targeted imaging probes.	1	BME, MSE, AEP, ECE, CBE	Development of labeled nanoparticles, targeted fluorophores, adhesion molecules (e.g., protein engineering). Fits BME focus areas: imaging; micro/nano-biotechnology; biomaterials/drug delivery; medical applications in neurology; cancer; cardiovascular and musculoskeletal systems.

e) Stem Cell Engineering	1	BME/CBE	Control and utilization of various stem cells, particularly induced pluripotent stem cells for regenerative medicine; understand role of stem cells in cancer. Fits BME focus area: cell, molecular and tissue engineering. Medical applications in: neurology, cancer, cardiovascular and musculoskeletal systems.
f) Viral or viral-like particle engineering	1	BME, CBE, MSE	Improved vectors for gene therapy, theranostics or drug delivery. Fits BME focus areas of: biomaterials/drug delivery and micro-nanobiotechnology. Medical applications areas: neurology, cancer, cardiovascular and musculoskeletal systems.
g) Novel biomaterials synthesis and development/particularly bioactive materials	2	BME, MSE, CBE, MAE	Scaffolds for tissue engineering, drug delivery systems, materials that actively guide tissue development in space and time. Fits BME focus areas of cell, molecular and tissue engineering, biomaterials/drug delivery, micro-nanobiotechnology. Fits all four medical applications areas: neurology, cancer, cardiovascular and musculoskeletal systems. Maybe discipline-based BME.
h) Biofluid mechanics and transport	2	BME, MAE, CBE	Modeling blood flow, interstitial fluid flows, fluid dynamics on microdevices that mimic biological systems. Fits BME focus areas of biomedical mechanics, drug delivery. Maybe discipline-based BME.
i) Molecular/Cellular level mechanics	1	BME, MAE, CBE	Understanding the dynamics of cell interaction with the extracellular matrix; understand how adhesion molecules and their mechanics alters cell physiology. Fits BME focus areas of biomedical mechanics and micro-nanobiotechnology. Fits medical application areas of cardiovascular and musculoskeletal systems.
j) In vitro model systems	1	BME	Develop alternatives to animal and human testing for drug development overall discovery; systems biology of the human body. Fits BME focus area of drug delivery. Fits medical application in neurology, cancer, cardiovascular and musculoskeletal systems.
k) Bioinspired materials for medical and non-medical applications	1	MSE	Developed novel synthetic materials based on nature's solutions to need for specialized functional materials. Fits BME focus area biomaterials but discipline specific BME. Could fit any medical applications area plus non-medical needs.

l) Advanced imaging and image processing techniques	2	ECE, BME, AEP	Many medical advances as well as gains in fundamental insight into biological systems have made use of non-invasive image processing which requires advances in image processing techniques. Fits BME focus area of imaging. Fits all medical application areas, but most likely to be disciplined based BME.
m) Biophysics	1	AEP	Development of novel techniques to probe biological systems at a basic level. Discipline based BME.
n) Biosensors and Actuators	2	AEP, ECE, MAE, CBE	Devices to detect biological molecules or function. Particular emphasis on embedded devices combining sensing, processing, and actuators. Application to neural systems, but potentially broader. Discipline based BME.
o) Health systems policy	1	ORIE, ECE	Make cost effective use of biomedical resources to improve human health. Understanding of large scale, high-dimensional data sets. Not in BME focus.
2. Bioprocess			
a) Systems Biology/Metabolic Engineering of Industrial Processes (also fits in bioenvironmental)	1	CBE, (ECE?), CEE	Someone to use a combination of experimental and computational approaches at a “system” scale to understand the results of potential genetic and non-genetic manipulations to alter production of an industrial chemical or destruction of a toxic waste material.
b) Cell Culture Engineering	1	CBE	Idea is to improve the “quality” of products from cell culture. Metabolic engineering/systems engineering applied to specific problems using eucaryotic cells.
c) Focus on downstream process	1	CBE, CEE	Development of bioseparations, purification, and product formulation techniques to recover products from bioprocesses.
3. Bioenvironmental Engineering			
a) Monitoring/Mitigating Chemical Release	1	CEE, CBE	Monitor and mitigate chemicals released into the environment for pharmaceutical manufacture, exploitation of energy reserves, and other processes releasing other organics.

b) Advanced Metabolic Engineering	1	CEE, CBE	Advanced metabolic engineering of simplier (e.g. microbial) cells for efficient industrial production of chemicals, particularly in terms of production of biofuels; may use techniques of synthetic or systems biology.

Thoughts beyond year five: The BME undergraduate curriculum will be only partially developed in a five year period. It will be completed in 2017. There will be some retirements and losses in the bio areas. Engineering in World Health would be one or two additional faculty hires in ECE, MAE, AEP, CBE, or BME. Particular emphasis on approaches to infectious disease in emerging countries.

Other comments:

1. Completion of this form is complicated as the faculty additions must not only fill the requirements for enhanced research impact but also must support the establishment of an undergraduate major in BME. Thus, the faculty must support a teaching mission as well as research.
2. An important distinction is between BME centric and discipline focused BME faculty. These differences are articulated in the strategic plan, but BME centric faculty will be characterized by the multiscale nature of their work, the depth of biology integrated into their research/teaching, and their ability to act as an active intellectual bridge between engineering and physical sciences to medicine and biology.
3. In some cases dual appointments between two departments may be advantageous. Appointments at 75/25 or 25/75 have worked well.
4. Systems biology as a distinct area was not identified by the bioengineering committee as an important area for investment, but rather as a tool to be applied to a variety of problems. Some departments have specific aims for systems biology but the aims differ so much it is not clear that a non-disciplinary broader focus makes sense.
5. In BME each position should map to a medical area as well as a technological area if we are going to link effectively with Weill Cornell Medical College.