

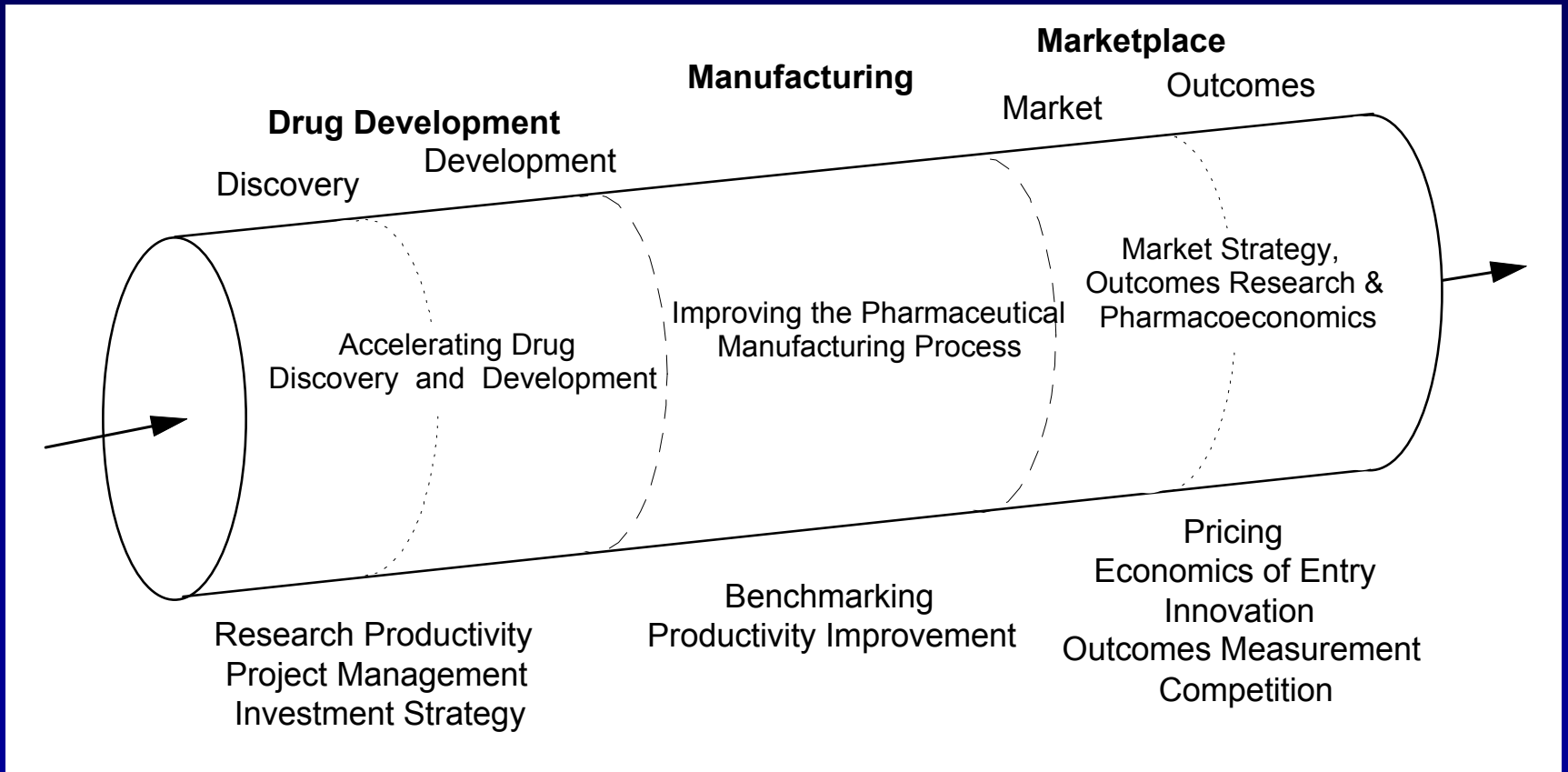
# Program on the Pharmaceutical Industry (POPI)

**Founded in 1991 with a major grant from the Alfred P. Sloan Foundation, POPI is a multidisciplinary research and educational program involving faculty from the MIT Schools of Engineering, Science, Humanities and Social Science, and the Sloan School of Management.**

# POPI Program Objectives

1. Develop pharmaceutical / biotechnology industry expertise among the faculty of the MIT Schools of Science, Engineering, Social Science and Humanities, and Management.
2. Support research which will contribute to the advancement of the disciplines represented among the faculty team.
3. Develop a deep understanding of the process of change in the pharmaceutical industry.
4. Understand the evolving role of the pharmaceutical industry in the delivery of health care.
5. Educate doctoral students to understand issues relevant to the industry, thereby exporting expertise to other universities.
6. Organize curricula and educational programs relevant to the industry.
7. Engage in a broader dialogue, including policy and management decision-makers about issues relevant to the industry.

# POPI Research



# POPI Sponsors

## CORE FUNDING

Alfred P. Sloan Foundation  
Merck Foundation  
Pfizer

## MAJOR IN-KIND SUPPORT

Aetna Health Plans  
IMS  
Medstat Group  
*Many* Pharmaceutical  
& Biotechnology Firms

## PROJECT SUPPORT (Cumulative)

Agency for Health Care  
Research and Quality  
Amgen  
Aventis  
Eli Lilly  
Genentech  
Johnson & Johnson  
Genzyme  
Merck  
Millennium  
Pfizer  
PhRMA  
Pharmacia  
Schering Plough  
Wyeth

# List of Other Sloan Foundation Industry Centers

<p>The Wharton Financial Institutions Center  <b>University of Pennsylvania</b></p>	<p>Center for Industry Studies  <b>University of Pittsburgh</b></p>	<p>Software Industry Center  <b>Carnegie Mellon University</b></p>
<p>The International Motor Vehicle Program  <b>Massachusetts Institute of Technology</b></p>	<p>Industrial Performance Center  <b>Massachusetts Institute of Technology</b></p>	<p>Information Storage Industry Center  <b>University of California, San Diego</b></p>
<p>Trucking Industry Program  <b>Georgia Institute of Technology</b></p>	<p>The Food Industry Center  <b>University of Minnesota</b></p>	<p>Competitive Semiconductor Manufacturing Program  <b>University of California, Berkeley</b></p>
<p>The Global Airline Industry Program  <b>Massachusetts Institute of Technology</b></p>	<p>Harvard Center for Textile and Apparel Research  <b>Harvard University</b></p>	<p>Columbia Institute for Tele-Information  <b>Columbia Business School</b></p>
<p>Managed Care Industry Research Center  <b>Harvard University</b></p>	<p>Center for Paper Business and Industry Studies, Institute of Paper Science and Technology  <b>Georgia Institute of Technology</b></p>	<p>Carnegie Mellon Electricity Industry Center  <b>Carnegie Mellon University</b></p>
<p>The Steel Industry Center  <b>Carnegie Mellon University (and)  The University of Pittsburgh</b></p>	<p>Printing Industry Center  <b>Rochester Institute of Technology</b></p>	<p>Center for Construction Industry Studies  <b>University of Texas at Austin</b></p>
<p>Powder Metallurgy Research Center  Metal Processing Institute  <b>Worcester Polytechnic Institute</b></p>		

# Consortium for Advancement of Manufacturing of Pharmaceuticals (CAMP)

**CAMP is dedicated to the identification, research and development of new manufacturing technology. Its objective is to improve healthcare delivery by lowering product costs, increasing quality and decreasing new product time-to-patient.**

# CAMP

## Member Companies

- **Abbott**
- **Aventis**
- **Bristol-Myers Squibb**
- **GlaxoSmithKline**
- **Hoffman LaRoche**
- **Johnson & Johnson**
- **Wyeth**

# POPI and Policy

- **Many POPI Faculty Have:**
  - Served as consultants or advisors to Government agencies.
  - Made presentations or given testimony to legislative or regulatory bodies.
  - Participated in or facilitated informal discussions involving senior Government and industry officials.
  - Provided “Background” interviews to the news media.
  - Presented their research at policy conferences organized by Washington “Think Tanks.”



# POPI “By The Numbers” 1991-2002

## Faculty

- MIT: 28
- Outside Collaborators: 21

## Doctoral Students

- Supported: 30
- Graduated: 27

## Research Fellows:

- Current: 3
- Total: 4

## MIT Classes and Curricula

- New Subjects Developed: 3
- Other Subjects Using POPI Material: 6
- New Curricula: 2
- Total Students Reached: ~1000

# POPI “By The Numbers” 1991-2002

*(continued)*

## Executive Education

- Number of Offerings: 8
- Total Attendees: ~200

## Policy / Management Conferences

- Meetings Held: 8
- Total Attendees: ~1000

## Publications and Working Papers

- Cumulative: 100+

# Other Associated POPI Faculty

**Dan Ariely, Ph.D. (*Marketing Group, Sloan School of Management*)**

**Cho Kyun Rha (*Biomaterials Science and Engineering*)**

**Iain Cockburn (*Economist, Boston University School of Management*)**

**Klaus F. Jensen, Ph.D. (*Department of Chemical Engineering*)**

**G. K. Raju, Ph.D., M.B.A. (*Research Affiliate*)**

**Peter K. Sorger, Ph.D. (*Department of Biology*)**

**Peter Szolovits, Ph.D. (*Department of Electrical Engineering and Computer Science*)**

# Post Doctoral Associates

**Thomas Roberts, MD, MBA** (*Clinical Oncology Fellow,  
Massachusetts General  
Hospital*)

**Asher Schacter, M.D.** (*Pediatric Nephrology Fellow,  
Children's Hospital*)

**Michael Silver, Ph.D.** (*Biochemistry Harvard*) & (*MIT  
Corporate Relations*)

**Sarah Stallings, Ph.D.** (*Molecular Biology Yale University*)  
& (*Sloan Foundation Postdoctoral  
Fellow at MIT*)

# POPI Publications

Cockburn, Iain M., Howard L. Bailit, Ernst R. Berndt, and Stan Finkelstein. “Loss of Work Productivity Due to Illness and Medical Treatment”, Journal of Occupational and Environmental Medicine. 41(11):948-953, November 1999.

Cockburn, Iain M. and Rebecca Henderson. "Absorptive Capacity, Coauthoring Behavior, and the Organization of Research in Drug Discovery", Journal of Industrial Economics. 46(2):157-182, 1998.

Finkelstein, Stan N., Ernst R. Berndt, Paul E. Greenberg, Rod Parsley, James M. Russell, and Martin B. Keller. “Improvement in Subjective Work Performance After Treatment of Chronic Depression: Some Preliminary Results”, Psychopharmacology Bulletin. 32(1):33–40, 1996.

Greenberg, Paul E., Laura E. Stiglin, Stan N. Finkelstein, and Ernst R. Berndt. “The Economic Burden of Depression”, Journal of Clinical Psychiatry. November 1993.

# POPI Publications

## *(continued)*

Healy, Paul M., Stewart C. Myers, and Christopher D. Howe. “R&D Accounting and The Tradeoff Between Relevance and Objectivity”, January 1999.

Henderson, Rebecca M., and Iain M. Cockburn. “Scale, Scope and Spillovers: Research Strategy and Research Productivity in the Pharmaceutical Industry”, Rand Journal of Economics. 1996.

Rosenthal, Meredith B., Ernst R. Berndt, Julie M. Donohue, Richard G. Frank, and Arnold M. Epstein. “Promotion of Prescription Drugs to Consumers”, The New England Journal of Medicine. 346(7):498-505, February 2002.

Stallings, Sarah C., Robert H. Rubin, Thomas J. Allen, Charles L. Cooney, Anthony J. Sinskey and Stan N. Finkelstein. “Technological Innovation in Pharmaceuticals”, Pharmaceutical Discovery and Development. pp. 12-16, 2001/02.

# Teaching Collaboration Leads to Research Collaboration

## “Principles and Practice of Drug Development”

- Launched Fall 1997
- Evolved From Weekly Seminar of Guest Speakers
- Weekly Three Hour Session, Split Between Faculty Presentation and Talk From Outside (Industry / Government) Speaker
- Students from 5 Departments / Schools
  - Sloan School of Management
  - Biology Department
  - Chemical Engineering Department
  - Harvard / MIT Health Sciences & Technology
  - Harvard Graduate School of Arts & Sciences
- Enrollment Reached 90 Students in Fall 2001
  - 63 Registered at MIT
  - 6 Registered at Harvard
  - 20+ Listeners
- Students Work in Multi-Disciplinary Teams, Developing Research Themes and Approaches

# “Principles and Practice of Drug Development”

## Themes Addressed by Student Working Groups Fall 2001

- Determining Unmet Medical Need for Pharmaceuticals
- Implementation of Personalized Medicine for Hepatitis C Virus
- Comparison of Manufacturing Technologies for Therapeutic Peptides
- Cancer Drug Development Technologies
- Analyzing the Impact of the Baycol Withdrawal
- Propulsid: A Drug Recall Case Study
- The PPA Recall: The High Price of Hemorrhagic Stroke for Users of Phenylpropanolamine
- Cancer Drug Development Technologies: Herceptin and Gleevec
- A Look at Arthritis
- Asthma: An Opportunity to Implement Personalized Medicine
- Impact and Trends in Pharmaceutical Product Withdrawals



# “Principles and Practice of Drug Development”

Topics Addressed by Faculty and Guest Speakers  
Fall 2001

History of Pharmaceuticals (*Sinskey*)

Overview of Drug Development (*Rubin*)

Cancer & Chemotherapy Overview – Gleevec Case Study (*Sinskey*)

Discovery: Innovation and Emerging Technologies (*Finkelstein; Sena Biswas – Merrimack Pharmaceuticals*)

Discovery: Business Development Issues (*Finkelstein; Gordon Fehr – Pfizer, Canada*)

Preclinical: Molecular Toxicology, Cytochrome P450s and Drug Response (*Sinskey*)

# “Principles and Practice of Drug Development”

Topics Addressed by Faculty and Guest Speakers  
Fall 2001

**Preclinical/Clinical History** (*Rubin*)

**Regulatory Issues** (*Stallings; Cheryl Anderson – Bristol-Myers Squibb*)

**Introduction to Pharmaceutical Manufacturing** (*Raju*)

**Biologics Manufacturing** (*Parrish Galliher – Millennium Pharmaceuticals*)

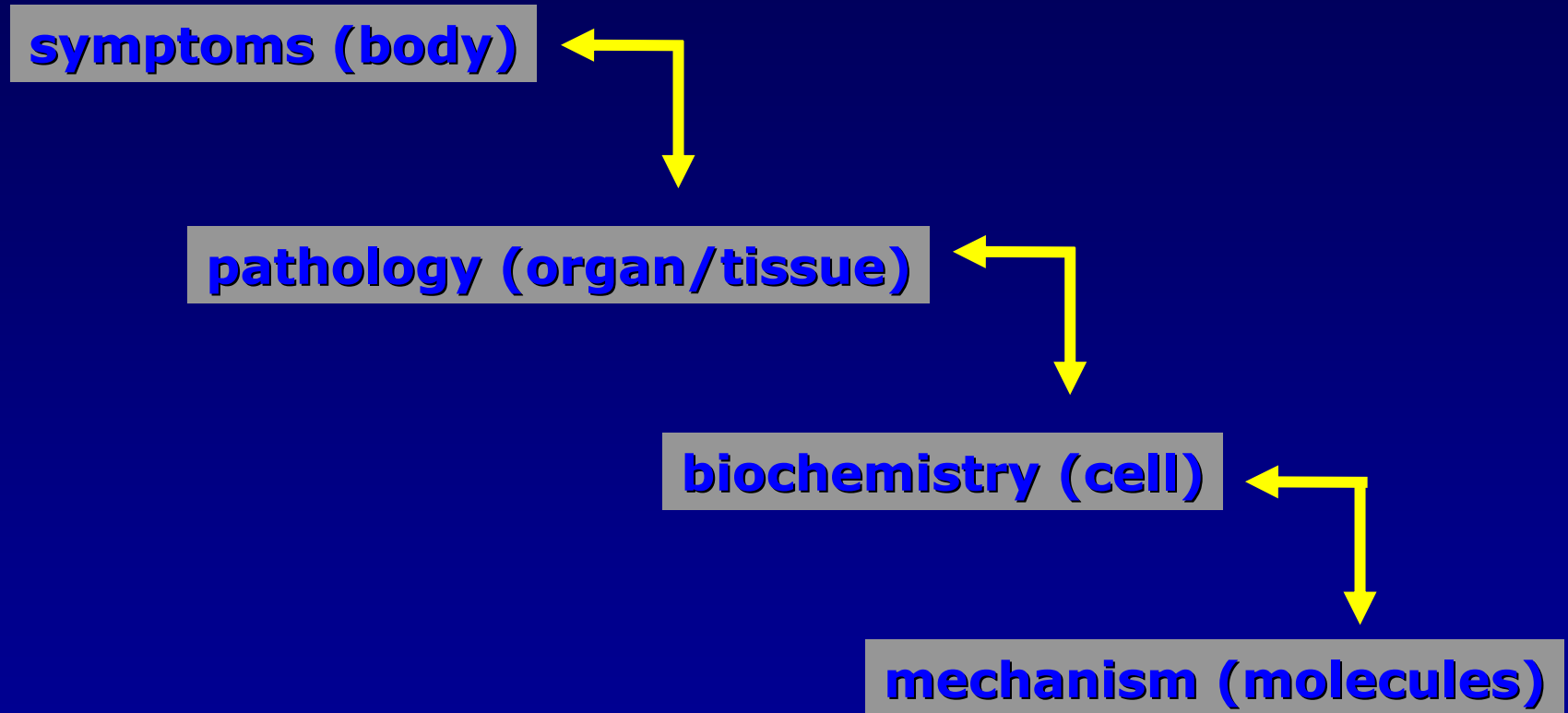
**Manufacturing Case Study** (*Raju*)

**International Regulation Issues** (*Mike O’Neill – Wyeth-Ayerst Global*)

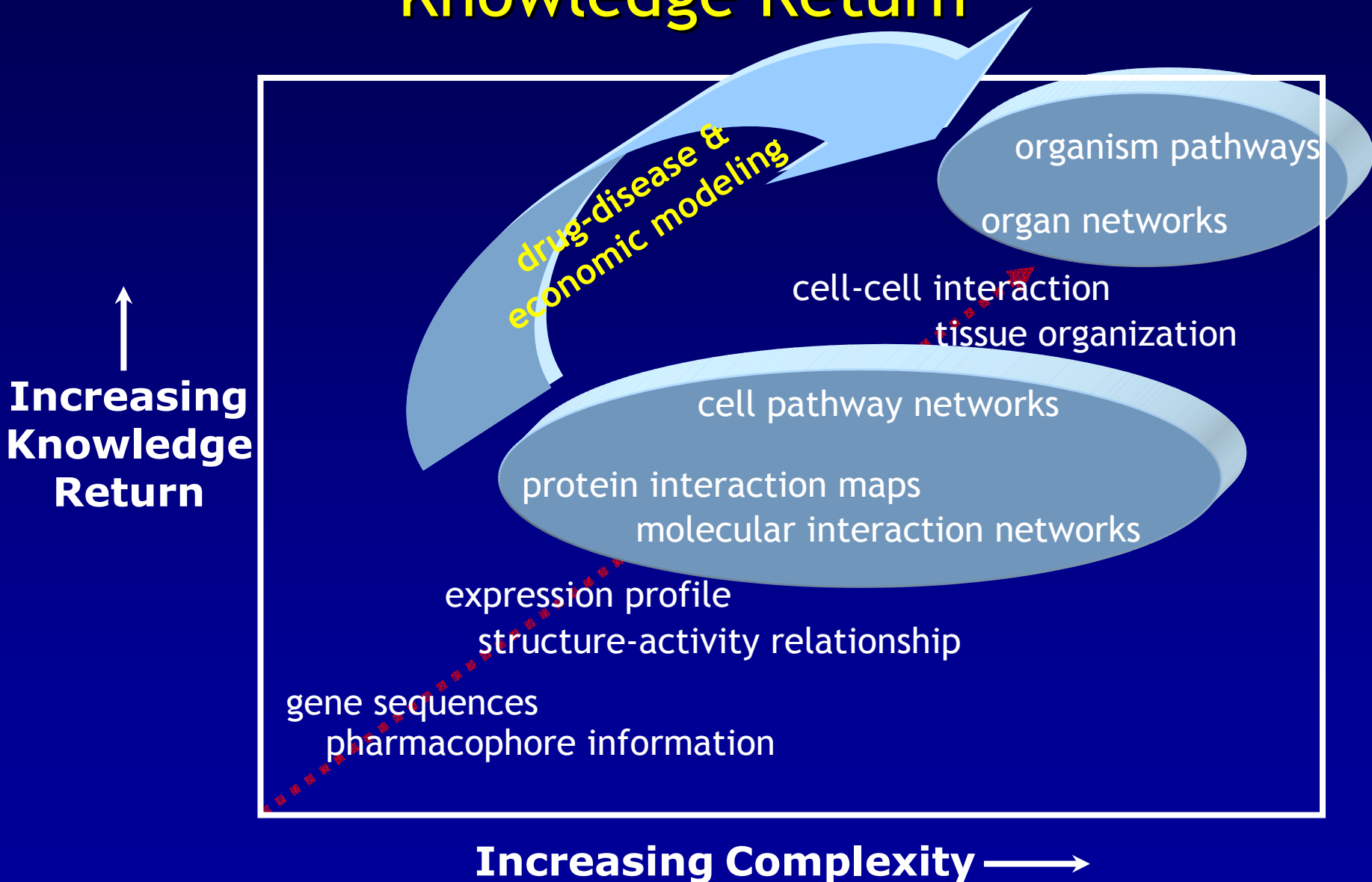
**Management of Product Development** (*Allen*)

**Entrepreneurial Activities in Biopharmaceuticals** (*Bob Mulroy – Merrimack Pharmaceuticals; Peter Hecht – Microbia*)

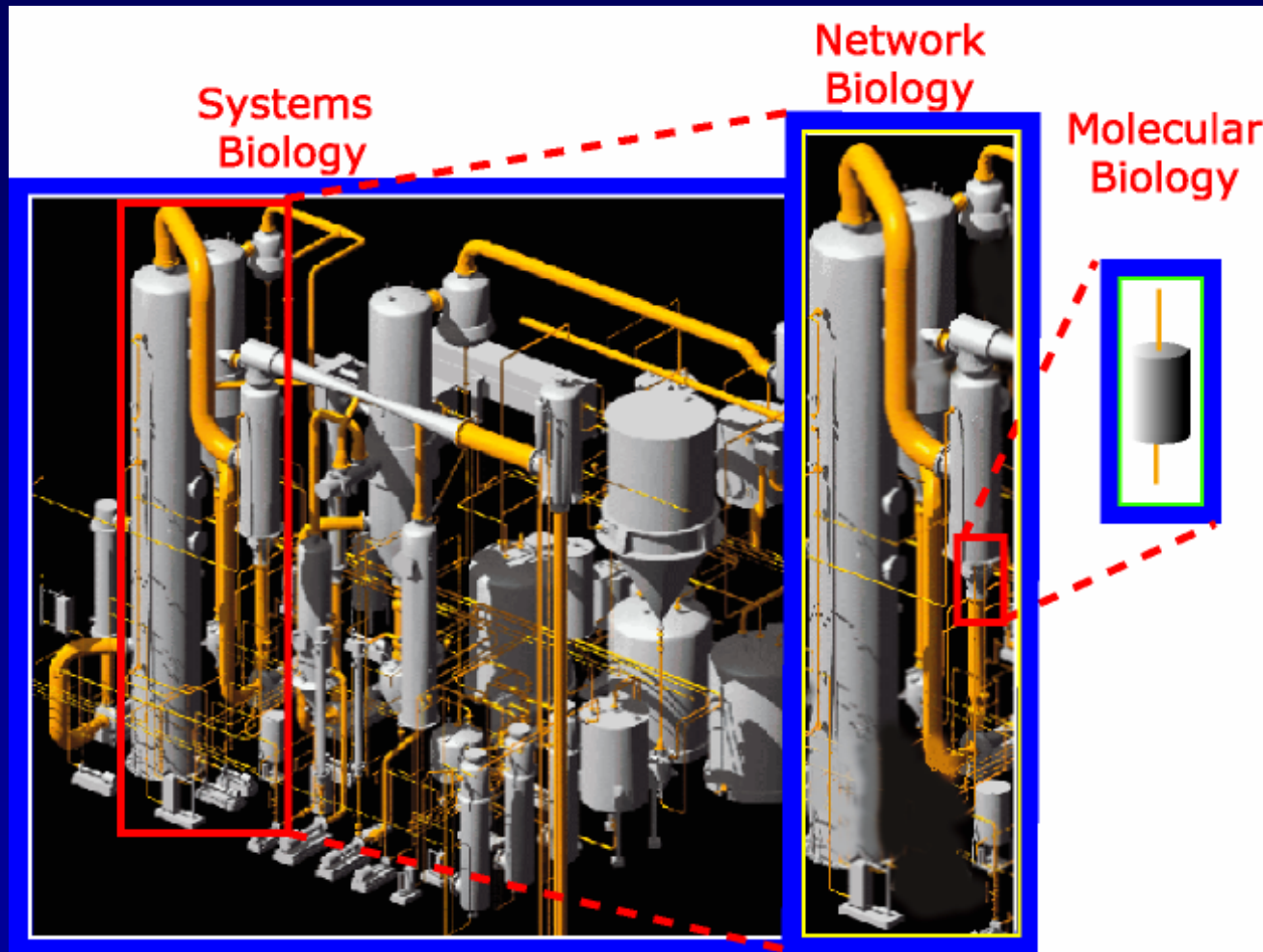
# Refining the Understanding of Pathogenesis



# Investigating Complex Systems Increases Knowledge Return



# Analogy between a cell and a chemical plant



# POPI SYMPOSIUM AGENDA

“Personalized Medicine and the Future of the  
Pharmaceutical Industry”

**December 9 – 10, 2003**

# POPI Symposium Agenda

## OVERVIEW OF SYMPOSIUM (*Tony Sinskey*)

- Purpose
- Issues
  - Science
  - Impact – Personalized Medicine
  - Clinical Trials
  - Implications

## Session I: **SCIENCE** (*Chair, Charlie Cooney*)

- Overview comments (*Charlie Cooney*)
- SNP's (*David Houseman*)
- Complex Biology (*Peter Sorger & Doug Lauffenburger*)
- Imaging (*Martha Gray*)
- Tissue Engineering (*Linda Griffith*)
- Panel – What do these developments mean for the pharmaceutical industry?

# POPI Symposium Agenda

## *(continued)*

### **Session II: DISEASE MECHANISMS & MODELS** (*Chair, Bob Rubin*)

- Overview Talk (*Kip Martha, MD, Interleukin Genetics*)
- Diabetes (*Alan Moses*)
- Cardiovascular Disease (*Geoff Ginsburg, MD, Millennium*)
- Cancer (*Tom Roberts, MGH*)
- Infectious Diseases (*Bob Rubin*)

### **Session III: DRIVING FORCES AND BARRIERS**

- Overview Talk (*Stan Finkelstein*)
- Clinical Trial Design (*Irving Fox, Millennium*)
- Health Economics (*Bill Marder or Bill Crown, Medstat*)
- PANEL:
  - Consumer Issues – (*Phil Reilly, American Society of Law and Medicine*)
  - FDA Perspective (*to be identified*)
  - Healthcare Payer Perspective (*Norman Payson, MD, Former CEO, Oxford Health Plan*)
  - Biotech Industry Perspective (*Robert McBurney, Beyond Genomics*)



# Selected POPI Research Projects

# Costs and Outcomes of Developing Innovative Therapies in the Era of the New Biology

## Research Projects

1. Advances in science and technology driving change in drug discovery and development.
2. Characterizing “Unmet Medical Needs” or “Undertreatment” as possible means to identify targets of drug discovery / development.
3. Impact of new therapies (**genomic, proteomic, other new science**) on clinical policies and health care economics.

# Advances in Science and Technology Driving Change in Drug Discovery and Development

## Underlying Research Questions

- Are advances in science and technology helping to make drug discovery / development more effective and efficient?
- Are the technologies that have revolutionized drug discovery having favorable “downstream” effects on decision-making?
- How quickly are these advances likely to lead to innovative new therapies?
- What are the implications for policy, related to assuring funding for innovative pharmaceutical R&D? In U.S. vs. European countries?

(Early funding provided to POPI by PhRMA and the Sloan Foundation)

# Two Alternative Research Approaches

## #1 Interviews

- Structured interviews with industry personnel in both scientific and business decision makers for drug R&D.
- Focus on key technologies of particular interest to study team.
- Pay particular attention to drug candidate failures, stage when failure took place and reasons for failure.

## #2 R&D Projects Databases

- Create database from large number of published abstracts of clinical trials.
- Access one or more of several commercially available drug R&D project datasets.
- Initial analysis to focus on factors differentiating early vs. late failures.

# Characterizing “Unmet Medical Needs” or “Undertreatment” as a Possible Means to Identify Targets of Drug Discovery / Development

## Research Question

Can retrospective administrative databases of medical services utilization and costs help to identify scenarios of “undertreatment” of disorders that are in need of new and innovative therapies?

## Illustrative Examples

Acute Renal Failure

Multiple Sclerosis

Crohn’s Disease

## Approach

- Create and analyze matched cohorts of patients, from claims data of those who may benefit from innovative therapies vs. others.
- Search for possible utilization differences and possible drivers of those differences.

**(Early funding provided to POPI by Wyeth)**

# Impact of New Therapies (Genomic, Proteomic, Other New Science) on Clinical Policies and Health Care Economics

## Research Questions

How will new therapies based on genetic or other biomarkers change the nature of medical practice?

Will “personalized” therapies reach large enough markets and have sufficiently favorable benefits (medical cost offsets, etc.) to prove “cost effective”?

## Approach

- Develop decision analytic or simulation model framework that draws parameter estimates from published literature and/or retrospective datasets.
- Work with commercially available simulation models (such as Entelos’ asthma model, for which MIT holds an educational license.)

## Plans

Initial study in context of asthma shows promising results.

# New Initiatives:

## Workshops Planned for 2003 to Identify New Areas of Research and Team Members

- Impact of advancing science and technology in therapy areas:
  - Diabetes management
  - Pain management
- “Behavioral Economics” – Incorporating patient preferences into therapeutic decision-making.
- Medicines – quality and access in developing countries.

# Dissemination

- Published articles in peer reviewed academic journals.
- Focused workshops involving outside experts in topics directly related to the research.
- Biennial POPI Symposia.
- Executive Education / short courses.
- Alliance with magazine group to publish bimonthly columns reporting on POPI research / insights (Advanstar Group, Publisher of PharmaGenomics, Pharmaceutical Executive and Applied Clinical Trials).



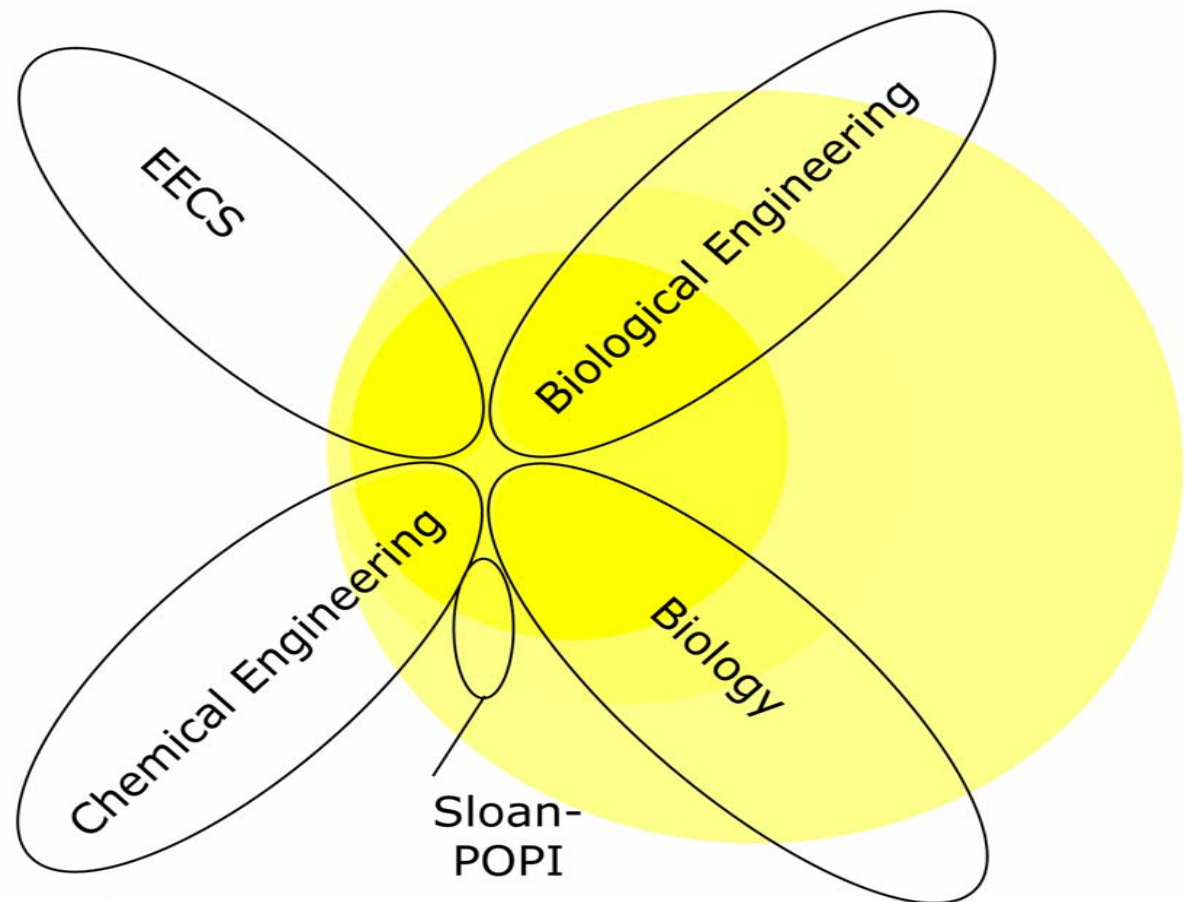
# Summary

- **Interdisciplinary Team**
- **Effective Educational Program**
- **New Intellectual Questions Formulated**
- **Integration with Science and Engineering Initiatives at MIT**

# Computational and Systems Biology at MIT

## A "big tent" with an active core

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Core Participation

Significant Participation