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# MEDICAL INFORMATICS

A Course for Health Professionals



## Educational Objectives and Outlines

**Day 1 - Monday, May 27, 2002**

**Session 1: 8:30 - 9:00 AM**

What is Medical Informatics?

**Faculty**

[James Cimino, M.D.](#)

**Educational Objectives**

The class will develop its own definition of Medical Informatics and discuss the personal qualities and skills needed for success.

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**Session 1A: 9:00 - 10:00 AM**

HPCC, NII, Current Issues in Medical Informatics

**Faculty**

[Donald A.B. Lindberg, M.D.](#)

**Educational Objectives**

This lecture will summarize the federal interagency High Performance Computing and Communications program accomplishments in non-medical and health related aspects and will enumerate some past, current, and future research funding sources.

At the completion of the session, participants will:

- Understand the "interagency model" and the government-industry-university approach to the HPCC work.
- Understand the initial opportunities in biomedical applications of the NII.
- Have a beginning set of funding contacts.

**Session Outline**

1. High Performance Computing and Communications federal program
  - Background and Legislation
  - Objectives and Organization
  - Phase 1
    - Accomplishments - Grand Challenges
    - Progress on Grand Challenge Problems
  - Phase 2
    - National Information Infrastructure
    - National Challenge Applications
      - Non-medical
      - Medical
2. NLM Role in the NII
  - Intramural Research
    - UMLS
    - Visible Human

- Extramural Research
  - NII medical testbed
  - Telemedicine
  - Computer-based patient record
- Public Policy Issues
  - Medical Data Privacy
  - National Security
  - Intellectual Property Rights
    - Traditional Copyright Demands
    - Today's Revolution in Electronic Publishing
- Federal Research Funding Sources for Medical Informatics
  - NLM Programs
  - Other HHS Programs
  - Other federal agency support

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## **Session 2: 10:30 AM - 12:00 N**

Telemedicine

### **Faculty**

[Michal Ackerman, Ph.D.](#)

### **Educational Objectives**

This lecture will summarize the NLM's historical involvement in telemedicine and discuss the concept of telemedicine as an information process. The need for medical data privacy and the role of HIPAA will be discussed.

At the completion of the session, the participant will:

- Understand telemedicine as an information process
- Become familiar with HIPAA and the misconceptions associated with its implementation
- Be familiar with the NLM Telemedicine Program as a demonstration of how information can influence health outcomes.

### **Session Outline**

1. History
2. Definition
  - Information to support medical decision making
  - Signal processing and imaging
  - Arrangements to practice medicine at a distance
3. Security and privacy of medical records
4. HIPAA
5. NLM's National Telemedicine Initiative

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## **Session 3: 1:30 PM - 3:00 PM**

Healthcare and the Next Generation Internet

### **Faculty**

[Michal Ackerman, Ph.D.](#)

### **Educational Objectives**

This lecture will summarize the concepts of a next generation internet and discuss the federal interagency Next Generation Internet program as well as the academic Internet2 Project. The application of NGI technology to healthcare will be demonstrated through the NLM Next Generation Internet Program.

At the completion of the session, the participant will:

- Understand the national need for a high-speed/high-reliability network and its relevance to healthcare
- Be familiar with the federal Next Generation Internet Program and the academic Internet2 Program, and how the two are inter-related.
- Be familiar with the NLM/NGI Program as a demonstration of the relevance of NGI technology in healthcare.

### **Session Outline**

1. The National Challenges
2. Current Internet vs. NGI
  - Passive vs active
  - "Quality of Service" (QoS)
  - Priority services
3. Federal Next Generation Internet Program
  - Agencies
  - Goals and metrics
  - Applications areas
4. Academic Internet2 Project
  - Project goals
  - Corporate partners
  - Applications and application areas
  - Middleware
  - Abilene Network
5. NGI and Internet2
  - Joint engineering objectives
6. NLM/NGI Program
  - "Networking Health: Prescriptions for the Internet"
  - Needed NGI services
  - Phase I: Planning (FY-99)
  - Phase II: Implementation (FY-00/02)
  - Phase III: Scaling (FY-03/05)

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### **Session 4: 3:30 PM - 5:00 PM**

[Workshop: Class of 2002 Personal Web Pages](#)

#### **Faculty**

David Remsen, MBL staff

#### **Educational Objectives**

This hands on laboratory will introduce participants to WYSIWYG HTML editing, basic digital image editing and compositing, and publishing web pages to a server.

At the completion of the session, participants will:

- Have created a personal web page with one or more images, and hyperlinks using free HTML editor (Netscape Composer)
- Have a basic understanding of digital image editing software (Photoshop).
- Have created a class resource that enables participants to know one another better

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### **Evening Session**

[Principles of Web page design](#)

#### **Faculty**

David Remsen, MBL staff

## **Educational Objectives**

At the completion of this session, participants will have an understanding of Hypertext Markup Language (HTML) and its application in the creation of World Wide Web pages.

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## **Day 2 - Tuesday, May 28, 2002**

### **Session 1: 8:30 AM - 10:00 AM**

Encryption and public policy issues

### **Faculty**

[Donald A.B. Lindberg, M.D.](#)

## **Educational Objectives**

This lecture and discussion will present the theoretical and practical bases for recommendations concerning medical data privacy, data encryption technology, and some of the national security considerations.

At the completion of the session, participants will:

- Know the issues facing the US regarding copyright and database protection world-wide
- Know if they support or do not support federal privacy legislation, and its features
- Understand the basis for current data encryption methods.
- Will have tested at least two Security Token Authentication devices.
- Know if they prefer to operate Challenge Response or Time Synchronous security devices.

## **Session Outline**

1. Intellectual Property Rights
  - WIPO Treaty proposals
  - Pub Med Plans
2. Encryption
  - Basic concepts
  - DES Public-Private Key
  - Implementation and Devices
  - a) Data Encryption Technology
    - Private Key Encryption
      - Digital Encryption Standard
      - Kerberos
    - Public-Private Key Encryption
  - b) System Considerations
    - Length of Cipher Keys
    - Security Token Authentication
  - c) Devices
    - Challenge - Response
    - Time Synchronous
3. Medical Data Privacy
  - Requirements
  - Legislation
    - Overview
    - Status of Federal Privacy Legislation
    - Contentious Issues
  - Initial Practical Experience with Medical Data Privacy Assurance

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### **Session 2: 10:30 AM - 12:00 N**

## Faculty

[Lawrence C. Kingsland, III, Ph.D.](#)

## Educational Objectives

This lecture has two independent segments. The first segment introduces the Unified Medical Language System (UMLS) project initiated by the National Library of Medicine in 1986. The second segment discusses several aspects of upcoming technologies that are having and will have an impact on the way we view and use the Internet. At the completion of the session, participants will:

- Have received an introduction to the history of the Unified Medical Language System
- Be introduced to the content of the UMLS Knowledge Sources: the Metathesaurus, the Semantic Network and the SPECIALIST lexicon
- Have viewed a demonstration of the UMLS Knowledge Source Server
- Have viewed a demonstration of the UMLS Metathesaurus browser application in the Internet Grateful Med program, including the introduction of related concepts and co-terms
- Have received an introduction to technologies that are shaping the further development of the Internet and the ways we use it.

## Session Outline

- Unified Medical Language System
  - History
  - The UMLS Metathesaurus
  - The UMLS Semantic Network
  - The SPECIALIST lexicon
  - The UMLS Knowledge Source Server
  - The Internet Grateful Med Metathesaurus browser as an example of a UMLS application, with emphasis on related concepts and co-terms
- Internet Futures
  - Context
  - Internet Protocol (IP)
  - IPv6
  - Quality of Service (QOS)
  - Optical switching
  - Virtual Private Networks (VPNs)
  - Digital Spread Spectrum
  - Bluetooth
  - Wireless Access Protocol (WAP)
  - Ubiquity (wearable computing)
  - Dynamic content
  - Standards/open source

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## Session 3: 1:30 - 3:00 PM

[Introduction to Personal Databases](#)

## Faculty

David Remsen

## Educational Objectives

This hands on workshop will create sample databases and discuss the implications of different data models.

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## Session 4: 3:30 - 5:00 PM

PubMed and the NLM Gateway

## Faculty

[Kathi Canese](#)

## Educational Objectives

This lecture and lab session will discuss the National Library of Medicine's PubMed interface for searching MEDLINE. Searching techniques will be presented as well as a review of recent enhancements including the new "Cubby" feature. There will also be a demonstration of NLM's Gateway system which will provide an interface for searching multiple NLM products. Students will be provided with hands-on lab time.

## Session Outline

1. PubMed Overview
2. Automatic Term Mapping
  - o Search Formulation and Retrieval
  - o Search Refinement
  - o Feature's Bar (Limits, Preview/Index, History and Clipboard)
3. Related Articles
4. LinkOut
5. Cubby
6. NLM's Gateway Overview
7. Searching Multiple Databases
8. Using MeSH
9. Define Your Own Display Format
10. Hands on lab time

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## Evening Session

Principles of Database Design

## Faculty

[James Cimino, M.D.](#)

## Educational Objectives

This lecture and lab session will introduce basic principles of organization of data in computerized systems. At the completion of the session, participants will:

- Understand the historical evolution of computerized data handling methods
- Know the relative strengths and weaknesses of hierarchical, relational, information network, and object-oriented database systems
- Understand the process of development of a set-theory-based relational data model, including entity-relationship definitions, principles of fully normalized relational models, state transitions and data flow diagrams.
- Understand the design principles involved in the transformation of a flat file record structure to a normalized relational structure (lab exercise).

## Session Outline

- Database definitions and paradigms
  - o What is a Database?
  - o Historical Evolution of data management techniques
  - o General benefits of Database Management Systems (DBMSs)
  - o DBMS types
    - Heirarchical
    - Information Network (linked lists and pointers)
    - Relational
    - Object-oriented
    - XML

- Principles of Relational database design
  - Representation of real world objects and their attributes
  - Relationships between objects
  - Table notation formalisms
  - Relationships: one-to-one, one-to-many, many-to-many
- System design and building methods
  - Entity-relationship diagrams
  - State Transition Models
  - Data Flow Diagram
- Transforming flat files to tables
- A sample problem in database design

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## Day 3 - Wednesday, May 29, 2002

**Sessions 1 and 2: 8:30 AM - 12:00 N**

Evaluation Methods in Medical Informatics

### Faculty

[Charles P. Friedman, Ph.D.](#)

### Session Outline

This section of the course examines medical informatics as an empirical science. As such, the section will focus on formal studies of applications of information technology in medicine. We refer to these applications generically as information resources. Studies can be conducted while information resources are under development as well as after they are in routine service. Studies typically address questions such as: Is the resource functioning as anticipated? How can it be improved? Does it make a difference? Are the differences it makes beneficial?

Within medical informatics, there is increasing interest in evaluation and empirical studies. From an administrative perspective, as institutions invest in new technology, it is critical for them to know how these systems can contribute to health care, education, and research so they can set develop plans and set priorities. From a more academic perspective, research projects in informatics, including doctoral dissertations and masters theses, now often include an evaluation or empirical study component. Much of the funded research in informatics is required to have such a component.

This day-long session on evaluation will provide participants with an understanding of the range of evaluation methods that are used in informatics and will address how studies are designed as well as how data for these studies are collected, analyzed, and reported. We will address during the day many of the challenges that make evaluation difficult, emphasizing those challenges that are particular to medical informatics, and we will discuss methods that have been developed for addressing many of these challenges.

### Educational Objectives:

At the completion of the session, participants will be able to:

1. Describe the purposes of evaluation in medical informatics.
2. List several factors that can make it difficult to do evaluation in medical informatics effectively, as well as strategies that can be employed to address these difficulties.
3. Distinguish objectivist (quantitative) and subjectivist (qualitative) approaches, describe the assumptions that underlie them, and explain why both methods are used.
4. Identify the major steps in the process of conducting objectivist and subjectivist studies.
5. Identify the individuals or groups comprising the “audience” for an evaluation study.
6. Describe how the methods and purposes of a study can be matched the level of maturity of an information resource.
7. Frame many of the recurring difficulties of evaluation in medical informatics as problems of measurement.
8. Distinguish between measurement errors that are issues of reliability from those that are issues of validity. Distinguish between different types of validity.
9. Explain how “measurement studies” can be conducted to identify the sources of error in any measurement process, and to estimate the magnitude of these errors.
10. Explain what is meant by a “gold standard” in the framework of a measurement study.

Identify measurement methods and features of measurement instruments that can be employed to reduce measurement errors.

11. Identify some specific evaluation questions or issues that lend themselves particularly well to subjectivist approaches.
12. Explain how the questions and key issues of a study arise through the process of immersion.
13. Describe the major data collection strategies in subjectivist research, how these are used in a complementary way within a study, and how the data generated by each are analyzed.
14. Explain the steps a researcher can take to ensure the veracity of the findings of a subjectivist study.
15. Describe some of the barriers to combining objectivist and subjectivist methods within a single study.

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### **Session 3 - 1:30 - 3:00 PM**

Data Capture and Speech Recognition

#### **Faculty**

[Justin Starren, M.D., Ph.D.](#)

Goals:

1. Understand the major sources of Biomedical Informatics Data
2. Be able to list 3 approaches to data acquisition
3. Be able to describe two types of ASR systems
4. Understand the role of NLP in structuring information

Outline:

1. Sources of Data
2. Signal Acquisition
3. Image Acquisition
4. Collecting Data from People
5. Speech Recognition
6. What is NLP?
7. Medical Sublanguage
8. NLP Challenges

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### **Session 4 - 3:30 - 5:00 PM**

Human Computer Interaction

#### **Faculty**

[Justin Starren, M.D., Ph.D.](#)

#### **Educational Objectives**

Goals:

1. Be able to describe importance of formal HCI design.
2. Be able to identify major trends and themes in the field
3. Be able to list and apply heuristic interface principles
4. Understand importance and fundamentals of accessible design.

Outline:

1. What is HCI?
2. Psychology of User Interfaces
3. Psychology of Perception
4. Basic HCI Principles
5. Information Design
6. Web Usability
7. Accessibility
8. Evaluating User Interfaces

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MBL Clambake (no evening workshop)

## **Day 4- Thursday, May 30, 2002**

**Sessions 1 and 2: 8:30 AM - 12:00 N**

Principles of Controlled Terminology

### **Faculty**

[James J. Cimino, M.D.](#)

### **Educational Objectives**

This session examines medical data, where they come from, how they are represented, and how they are used. In order for a computer to manipulate data symbolically, the data must be represented in a way that the computer can "understand"; this is generally accomplished through the use of controlled terminologies. The objectives for these sessions are:

- Define medical terminologies and their attributes
- Review the state of the art
- Examine advanced uses of medical data through the use of advanced terminologies

### **Session Outline**

- Examination of typical medical data
- Uses of medical data
- Terminology characteristics
- Terminology desiderata
- Survey of what's available
  - ICD9-CM and ICD-10
  - DRGs
  - NDC Codes
  - SNOMED
  - Read
  - Nursing terminologies
  - MEDCIN
  - LOINC
  - MeSH
  - UMLS
- The Medical Entities Dictionary
- Case studies of advanced uses of data
  - Summary reporting
  - HCFA requirements
  - Clinical research
  - Expert systems
  - Automated decision support
  - Linking to on-line information sources
- Learning more

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**Sessions 3 and 4: 1:30 - 5:00 PM**

### **Decision-Analytic Methods for Evidence-based Practice**

### **Faculty**

[Suzanne Bakken, RN, DNSc](#)

### **Educational Objectives**

At the conclusion of the workshop, the learner will be able to do the following:

1. Define evidence-based practice.
2. Describe the informatics foundation for evidence-based practice.
3. Identify the components of expected value decision making.
4. Construct and solve a decision tree using a decision analysis software package.

## Outline

1. Definitions of Evidence-based Practice
2. Information Foundation for Evidence-based Practice
3. Introduction to Probabilistic Reasoning
4. Expected Value Decision Making
  1. Building and solving a decision tree using DATA
  2. Web-based utility assessment

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## Evening Workshop: 7:00 - 9:00 PM

### [Building Web Interfaces to Databases](#)

#### Faculty

David Remsen, MBL staff

#### Educational Objectives

This workshop will give participants hands-on experience in serving databases to the web. In this session they will learn the different necessary components of a database web server. They will create their own interface to a database and learn how to conditionally format the results in HTML. They will get an understanding how HTML form elements translate to database calls, how an HTML form translates to a database query, and how a query is processed and the results are returned.

#### Session Outline

1. Present an overview of a generic database web serving system. This overview will consist of identifying and defining the function of the the different elements that compose a database server.
2. A brief introduction to a few of the different database solutions to show how different vendors address the model described in 1.
3. Create an interactive web database using Filemaker Pro 4.0 with a sample database which will address the following: Querying the database using FORM and embedded URLS
4. Editing a Record via the web
5. Adding/Deleting Records
6. Processing results with format files.
7. Understanding how HTML and database meta tags can interact by:
  - a. Listing multiple records
  - b. Formatting a single record
  - c. Using conditionals to selectively format records
  - d. Using color and graphics with numeric content

Creating embedded links to Entrez, PubMed, others

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## Day 5 - Friday, May 31, 2002

### Session 1: 8:30 - 10:00 AM

Digital Library Research

#### Faculty

[Alexa T. McCray, Ph.D](#)

#### Educational Objectives

This lecture presents the basic principles and practices involved in designing and implementing a digital library, as well as the research issues that need to be addressed. Two case studies are introduced, and participants are given an opportunity to do a short exercise

- Understand the basic principles that underlie the design, implementation, and maintenance of a successful digital library.
- Have an understanding of digital library research issues.
- Have pointers to useful resources in digital library research.

### Session Outline

1. Informatics Research Agenda for Digital Libraries
2. Basic Principles in the Design and Implementation of a Digital Library
  - System Design Principles and Practices
    - Standards
    - Modularity
    - Extensibility
    - New technologies
  - Content and Collection-based Principles and Practices
    - Data acquisition and selection
    - Metadata
    - Intellectual property
    - Permanence and persistence of digital objects
  - Human Factors Principles and Practices
    - Accessibility, usability
    - Automation of manual tasks
3. Case Study
  - [Profiles in Science](#)
  - [ClinicalTrials.gov](#)
4. Hands-on Exercise
  - Assigning metadata tags

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### Session 2: 10:30 AM - 12:00 N

Genomics

#### Faculty

[Issac Kohane, M.D., Ph.D.](#)

#### Educational Objectives

1. Learn how to interpret a the results of a functional genomics study written in publication
2. Learn how to view the impact of genomics on individualized medicine

### Session Outline

1. Why bioinformatics is central to the genomics revolution
  - Brief refresher on basic genomic biology
2. What is functional genomics and what are the principal bioinformatics techniques used in elucidating the function of genes?
3. Shared themes in clinical informatics and bioinformatics; why these are two sides of a single discipline.

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### Sessions 3 and 4: 1:30 -5:00 PM

Clinical Information Systems

#### Faculty

[W. Edward Hammond, Ph.D](#)

#### Educational Objectives

## Session Outline

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### Day 6 - Saturday, June 1, 2002

#### Session 1: 8:30 - 10:00 AM

Education Informatics - Technology, Objectives, and the Learning Environment

#### Faculty

[Christopher Cimino, M.D.](#)

#### Educational Objectives

This session will look at the application of technology to teaching health care and the integration of medical informatics teaching in the educational environment. At the completion of this session participants will

1. have an understanding of the basic building blocks of the educational interaction: communication, assessment, role-modeling, skills development, and dialogue.
2. be exposed to an example of Medical Informatics objectives with a focus on distinguishing skills, knowledge and attitudes.
3. understand how Informatics skills, knowledge, and attitudes relate to different educational interactions; particularly role-modeling and skill development.
4. understand how specific Medical Informatics objectives relate to specific types of educational technology
5. be exposed to several types of educational technology and understand how each complements or complicates each type of interaction
6. understand how Informatics teaching can be integrated with other medical education.

#### Outline

- How Does Education Occur?
  - How do we teach?
  - How do we choose what to teach?
  - What is the educational environment?
- How does teaching occur?
  - Where does teaching occur?
  - What passes between teacher and student
  - Benefits of Integrated Education
  - Obstacles to Integrated Education
  - Where does technology fit in?
- How do we decide what to teach?
  - Mission
  - Needs
  - Goals
  - Objectives
  - Solutions
- How do we decide what to teach?
  - Knowledge Objectives
  - Skill Objectives
  - Attitude Objectives
- IMIA Medical Informatics Objectives
  - Organizing principles
  - Domain topics
  - IT User vs. IT Specialist
  - Degree of career progression
- Examples of teaching and assessing Informatics objectives
  - Skills
  - Knowledge
  - Attitude
- Technology as a teaching tool
  - Infrastructure needed to teach skills
  - Role models needed for teaching attitude
  - Integration into work-flow needed to develop role models

- How do we decide what to teach?
  - Student Evaluation
  - Program Evaluation
- Evaluation of educational technology
  - Education success as measured by science
  - Cost
  - Satisfaction
  - Social Change
- Changing the environment
  - What kind of institution are you at?
  - Your setting determines stakeholders
- Stakeholders
  - Who determines educational approach?
  - Who determines educational content?
  - Who supports technology?
- Instigating Change
  - Innovation
  - Long term growth
  - "Willing" but cautious participants
- Implementing Change
  - Make use of power of iteration
  - Conserve support effort
  - Shape user expectations to be reasonable
  - Making use of early failure

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## **Session 2: 10:30 AM - 12:00 N**

Education Informatics - Faculty Development

### **Faculty**

[Christopher Cimino, M.D.](#)

### **Educational Objectives**

This session will look at the adaption of clinical faculty to teaching medical informatics. Using specific examples on the internet, participants will face and overcome some of the common obstacles. At the completion of this session participants will have

1. gained practical skills in finding informatics information geared to education.
2. understand the obstacles to motivating faculty to integrate informatics teaching into other disciplines
3. know the types of behaviors that promote positive attitudes among colleagues and students

### **Session Outline**

Each exercise will be followed by a group discussion of the results of the exercise and concrete lessons learned.

Exercise 1:

Internet resources to enhance the teaching of a skill objective  
Examining learning curve obstacles.

Exercise 2:

Internet resources to enhance the teaching of a knowledge objective  
Examining quality obstacles

Exercise 3:

Internet resources to enhance the teaching of a attitude objective  
Examining reliability obstacles

Other obstacles:

Social obstacles  
Work flow obstacles  
Resource obstacles

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**Session 3: 1:30 - 3:00 PM**

Designing a medical informatics curriculum

**Faculty**

Faculty Panel

**Educational Objectives**

At the completion of this session, participants should have an understanding of issues attendant to the development and implementation of a medical informatics curriculum at the fellows' home institutions.

**Session Outline**

This session will be an interactive discussion among faculty and fellows. It will review the topics covered at the MBL course and promote discussion regarding future changes.

**3:00 PM**

Course Wrap-Up and Farewell

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*Last Updated: 13 May 2001*