

MET CS 570 Biomedical Sciences and Health IT



Syllabus Fall 2014

Location: Fuller Building, 808 Commonwealth Avenue

Room: 247 lab 5

Day and Time: Wednesday, 6:00 – 9:00 pm

Instructor:

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Computer Science Department
Metropolitan College
Boston University

MET CS-570
Biomedical Sciences and Health IT

Syllabus - Fall 2014

Prerequisites: None

Boston – Charles River Campus

Description: This course is designed for IT professionals, and those training to be IT professionals, who are preparing for careers in healthcare-related IT (Health Informatics). This course provides a high-level introduction into basic concepts of biomedicine and familiarizes students with the structure and organization of American healthcare system and the roles played by IT in that system. The course introduces medical terminology, human anatomy and physiology, disease processes, diagnostic modalities, and treatments associated with common disease processes. IT case studies demonstrate the key roles of health informatics and how IT tools and resources help medical professionals integrate multiple sources of information to make diagnostic and therapeutic decisions.

Each session will consist of an initial lecture examining biological function, pathology, laboratory medicine, diagnostic imaging and therapeutic intervention covering a specific medical speciality. On this basis the student will gain an understanding as to the types of information being gathered and what is important to the clinical professional. The second part of each session will consist of a case study where aspects of health informatics related to the handling of the gathered medical information is examined.

To reinforce the lecture and case study material, we anticipate 3 guest lecturers covering the following material:

- a) A Senior Systems Engineer from the Clinical Information System Industry presenting a hands-on demonstration of the interface between clinical laboratory systems and the centralized electronic health record.
- b) A Chief Technology Officer of a company installing complete wireless patient information transfer in hospital-wide systems presenting the benefits and obstacles, particularly relating to protection of patient privacy, for such a system.
- c) A Chief Scientific Officer of a major Harvard-affiliated Hospital Department who has been intimately involved in Health Care Reform both in Massachusetts and nationally will present an update on the economic and medical issues needing to be addressed in bringing affordable health care to all.

Course Texts (recommended but not essential):

1. The Human Body – An Introduction to Structure and Function by Adolf Faller and Michael Schuenke; 1st English edition. Thieme Publishers (2004) ISBN 978-1588901224.

Note: this book can also be downloaded from Amazon as an e-book. This is recommended only if you have the Amazon Kindle Fire, the iPad running the Kindle App, or notebook PC or Mac

running the Kindle application. Due to the color illustrations, this download is not recommended for monochrome tablets/e-readers.

http://www.amazon.com/Human-Body-Introduction-Structureebook/dp/B005NA3B9E/ref=tmm_kin_title_0?ie=UTF8&m=AG56TWVU5XWC2

It is expected that the reading assignments from this course book should be introductory; to give a "feel" for what will be presented during each module. Full comprehension is not the aim; rather, the readings should form the basis for discussion within the class.

2. The Terminology of Health and Medicine: A Self-Instructional Program
by Jane Rice;
Prentice Hall (2002) ISBN 978-0130423337

Course Learning Objectives:

1. Identify the anatomy, physiology, and pathophysiology of human body systems
2. Recognize common diagnostic methods, treatments, and medical procedures
3. Understand medical decision making in the diagnosis and treatment of human organ system disease
4. Predict the IT needs of healthcare providers as they diagnose and treat common diseases
5. Describe IT systems needed to support modern diagnostic imaging
6. Understand the transfer of information from various sources to the centralized electronic health record
7. Learn the basic delivery, financial and legal aspects of the American healthcare system

Evaluation and Grading

The final grade for this course will be based on the following:

Assignments 30%

Quizzes 25%

Final Exam 35%

Participation 10%

Course structure:

We anticipate meeting on the following dates (although all are subject to change depending on alterations to lecturer schedules):

September 3 2014	01. Introduction to Biomedicine	Case Study
September 10 2014	02. Laboratory Medicine	Case Study
September 17 2014	03. Skin, Bones and Muscle (Dermatology, Orthopedics, Rheumatology)	Case Study
September 24 2014	04. The Digestive System (Gastroenterology)	Case Study

October 1 2014	05. The Cardio-Vascular System (Heart and Circulation)	Case Study
October 8 2014	06. The Pulmonary System (Respiratory)	Guest Lecture B
October 15 2014	07. The Nervous system (Neurology)	Case Study
October 22 2014	08. Immunity (Allergy, Immunology)	Case Study
October 29 2014	Guest Lecture C	Case Study
November 5 2014	09. The Renal system (Nephrology)	Case Study
November 12 2014	10. Endocrinology A (Reproduction, Obstetrics)	Case Study
November 19 2014	11. Endocrinology B (Homeostasis)	Case Study
December 3 2014	12. Cancer (Oncology)	Case Study

Description of Modules and Learning Objectives:

Module One – Introduction to Biomedicine

Module Overview: The integration of the human body – what biological principles might underlie why we have so many components? How do we maintain homeostasis; how does “homeostasis imbalance” lead to disease; what is “normal” and the concept of renewal and degeneration with age will be addressed. Variation between ethnic groups, variation within populations and between individuals, and the role of genetics and of the environment in metabolic and clinical diversity will be examined.

Concepts of laboratory medicine will be introduced – an examination of the types of data used by health professionals to determine that a state is abnormal and how the IT professional plays a key part in maximizing the accessibility of this data, both in terms of ease of use as well as in terms of extracting information.

Lecture One: Introduction to Biomedical Science

Lecture Two: Introduction to Laboratory Medicine

Learning Objectives:

1. The human body comprises many components that are interdependent. This interdependency is very finely balanced and requires constant data sampling of its environment and numerous feedback mechanisms.
2. How things go wrong – genetics of individual difference, developmental problems, the effects of aging, infectious disease, cancer.
3. The basis of measuring what is wrong when things go wrong – laboratory medicine, data generation and imaging enabling arrival at a diagnosis.

Module Two – How we are structured – the Muscular, Skeletal, Skin, and Digestive Systems

Module Overview: The concept of epithelial barriers insulating us from the outside world; the composition of skeletal structure, joints and the importance of calcification; muscle organization and attachment; the importance of connective tissue. The components of the digestive system – maximizing useful materials from what we ingest; the symbiotic relationship with gut bacteria; the gut as a sensor for provision of feedback for energy homeostasis. Secondary functions associated with skeletal tissue – calcium homeostasis and the key functions of the bone marrow.

Lecture Three: Muscular, Skeletal, and Integumentary Systems

Lecture Four: The Digestive System

Reading:

Course textbook:

Chapter 3: Connective and Supporting tissue, Muscle tissue

Chapter 4: The Locomotor system (Musculoskeletal System)

Chapter 9: Overview of the digestive Processes.

Chapter 16: The Skin and Its Appendages

Learning Objectives:

1. General understanding of the structural organization of the human body and the functionality of the digestive system.
 2. Exploration of diagnostic methods and imaging procedures to identify disorders.
 3. The role of IT in data and image analysis, transfer and presentation.
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Module Three – Energy, Energy Distribution and Product Disposal: the Cardiovascular and Respiratory Systems

Module Overview: The cardiovascular system conceived as the body's communication system, delivering nutrients/fuel from the respiratory system and the digestive system, removing waste products for disposal by the respiratory system and the renal/urinary system. The tightly coupled regulation of the heart activity, arterial and venous structural properties, and respiratory activity to maintain normal metabolism will be addressed. Pathologies of the cardiovascular and respiratory system will be examined, with particular focus on integrating data based on very physical properties (elasticity, pressure, compression, flow, turbulence, valves, resistance, gas exchange and fluid balance).

Lecture Five: The Cardiovascular System

Lecture Six: The Pulmonary System

Reading:

Course textbook:

Chapter 5: The Heart and Blood Vessels

Chapter 8: The Respiratory System

Learning Objectives:

1. Attain a basic understanding of the structure, function and interdependency of heart and lung

- function.
2. A basic comprehension of the multiple cardiovascular and respiratory regulatory checkpoints and how aberrations in a single functionality can cascade to generate a complex pathology.
 3. Appreciation of the imaging techniques and therapeutic options available to diagnose and repair cardiovascular and respiratory problems.
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Module Four – The Nervous System

Module Overview: Our central and peripheral nervous systems will be examined from a functional point of view rather than a strict anatomical description. The Central and Peripheral Nervous systems are geographically defined but a useful differentiation is between the Somatic system, controlling functions of which we are mostly aware, and the Autonomic Nervous system that is primarily involved in maintaining homeostasis through control of internal organ function. Nervous system pathologies and their consequences will be examined. In particular, we will examine the association of behavioral traits, skills, physiological functions with particular parts of the central nervous system (CNS) and how this can be monitored. In particular, we will examine the various biophysical techniques used to image the CNS and how software analysis can maximize interpretation.

Lecture Seven: The Nervous System

Reading:

Course textbook:

Chapter 13: The Central and Peripheral Nervous Systems

Chapter 14: The Autonomic Nervous System

Learning Objectives:

1. Recognition and understanding of the basic structure and functionality of the nervous system.
 2. An understanding of the pathophysiology of the nervous system together with common diagnostic methods and treatments
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Module Five – The Blood, the Immune System and Lymphoid Organs

Module Overview: Our immune systems will be examined from a functional point of view rather than a strict anatomical description. Immune system pathologies, such as autoimmune diseases and immunodeficiencies, and their consequences will be examined. We will define the basic responses to infectious diseases, and how the body has to maintain a balance between too little reactivity, that will increase likelihood of infection or even tumor development, while not expressing too much activity that could lead to autoimmune disease. The importance of immune cell mobility through the circulatory system will be described as well as the varying functions of the different types of immune (white blood) cells that circulate. This will lead to an overview of the importance of vaccination.

Lecture Eight: The Immune System

Reading:

Course textbook:

Chapter 6: Blood, the Immune System, and Lymphoid Organs

Learning Objectives:

1. An understanding of the development of the various cells of the blood, their relation to immunity, and to the established lymphoid structures including the lymphatics, lymph nodes, spleen, tonsils and thymus. The integration of the immune system with the barriers to the outside world: the skin, gut and respiratory epithelial tissues.
 2. The immune response to infection
 3. An understanding of the pathophysiology of the immune system together with common diagnostic methods and treatments
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Module Six – The Renal, Urinary and Reproductive Systems

Module Overview: The renal and reproductive systems are usually grouped together as the genitourinary system. This grouping is an accident of common tissue origin, similar geographical location and the sharing of some structural elements for both urinary excretion and the process of germ cell fertilization. In this module, an overview will be provided of kidney function and pathology, including its key importance for maintaining normality for the entire body.

Lecture Nine: The Renal and Urinary system

Reading:

Course textbook:

Chapter 10: The Kidneys and Urinary Tract

Learning Objectives:

1. The structure, function and basic physiology of the renal and urinary systems
 2. Have a basic appreciation of the means to measure and image function in these systems
 3. An understanding of therapies available and possible medical interventions
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Module Seven – The Endocrine System

Module Overview: The endocrine system is the grand communicator – and co-ordinates with the nervous system to maintain homeostasis and internal function. The endocrine system consists of a vast array of ductless glands that secrete chemical signals (hormones) that communicate between tissues. Hormones control every major aspect of digestion, energy metabolism, reproduction, behavior, growth and development. The differing organs and tissues responsible for hormone production will be described and the complex and remarkable pathologies that can develop will be examined. The hormonal pathologies offer a fascinating insight into differential diagnosis and case studies will be presented for class analysis including approaches to assisted reproduction.

Lecture Ten: The Endocrine System in control of reproduction and development

Lecture Eleven: The Endocrine System in control of normal physiology

Reading:

Course textbook:

Chapter 7: The Endocrine System

Chapter 11: The Reproductive Organs

Chapter 12: Reproduction, Development and Birth.

Learning Objectives:

1. Recognition of the fundamental importance of endocrine messaging to every stage of human development, subsequent homeostasis and reproduction.
 2. An appreciation of cascading errors of varying severity depending upon the level at which an endocrine pathway is disturbed.
 3. Diagnostic assays to assess endocrine disturbance; integration of physical changes and biochemical parameters to arrive at a differential diagnosis
 4. Therapeutic options and measures of success
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Module Eight – Neoplastic Disease

Module Overview: The word cancer strikes fear into many; nevertheless, the advances in diagnosis and treatment over the last 40 years have made it a much more manageable process prolonging not only life but the quality of life for survivors. We will address the differences between benign and malignant tumors; how diagnoses may be made; how therapies may be targeted, and how normal tissue may also be damaged. Additionally, we will address how the tissue origin of a tumor may preserve some of the functionality of the originating tissue with profound consequences for physiological homeostasis. Although the role of the immune system in infectious disease will be covered in large part in Module 5, not only can viral infection be associated with subsequent tumor development, but the immune system itself helps eradicate potential cancerous cells from the body. The contribution of immunity and infectious disease to cancer will also be addressed. Much like endocrine pathologies, neoplastic disease has metabolic consequences often far beyond the original insult, thus efficient and accurate information transfer between specialist members of a team dealing with a particular patient places a heavy responsibility upon the IT infrastructure. Case studies will be used to exemplify this issue.

Lecture Twelve: Cancer

Reading:

<http://www.cancer.gov/cancertopics/cancerlibrary/what-is-cancer>

and whatever else you might find of interest at:

<http://www.cancer.gov/cancertopics>

Learning Objectives:

1. Understand the basics of how tumors arise: disposition and multi-step insults to the cell
 2. Identify common diagnostic methods, treatments, and procedures associated with these disorders
 3. Imaging techniques to aid differentiation of normal tissue from neoplastic tissue
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Module Nine – The American Healthcare System and the roles of IT

Module Overview: In this module students will be introduced to the basic structure and functioning of the American Healthcare System. A review of Healthcare Reform models under consideration at the State and Federal levels will be reviewed together with financial and legal implications. An overview of the history and current roles of IT in the healthcare system will be presented; the issue of HIPAA regulations, patients' rights and ownership of medical records/patients' data, particularly from clinical trials, will be addressed. Now and the future: How will genetic counseling be modified in the context of genomic sequencing where vast amounts of personal data will be generated? Can disease be predicted from genome sequences and how might this affect insurance coverage? The critical role that IT now plays in the daily running of a hospital pharmacy will be examined introducing current practice for software-driven medical oversight and error catching.

Guest lecturers

Reading:

United States Department of Labor, Bureau of Labor Statistics, Career Guide to Industries, 2010-11; Edition Healthcare, <http://www.bls.gov/oco/cg/cgs035.htm>

CRS Report for Congress, Government spending on Health Care, Benefits and Programs: A Data Brief; Jennifer Jenson; June 16, 2008; <http://aging.senate.gov/crs/medicaid7.pdf>

Learning objectives:

1. An understanding of the structure of the U.S. Healthcare System
2. An appreciation of the varying levels at which an IT individual is likely to interact with health professionals and associated clinical data, images, medical records
3. Recognition that the IT management of clinical data is a sensitive area touching upon privacy, patients' rights and legal ownership.