

Biomedical Sciences and Health IT

CS 570C1/EL

Course Format (On Campus/Blended)

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Course 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 specialty. 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 inviting two to three guest lecturers to share their first-hand experience with students. In the past, these lecturers have covered areas such as the interface between clinical laboratory systems and the centralized electronic health record, the introduction of wireless patient information transfer in hospital-wide IT systems and extensive overviews on health care and insurance reimbursement models in the U.S.

Books

Required text book:

- I. Edward Alcamo, Barbara Krumhardt. (2010) E-Z Anatomy and Physiology (Barron's E-Z Series). Barron's Educational Series; 3rd edition. ISBN-13: 978-0764144684

Note: this book can also be downloaded from Amazon as a Kindle e-book (currently \$9.99; the paperback costs ~\$15). This e-book 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. In the open-book final exam, only paper books and lecture notes are allowed.

Recommended text book:

- Jane Rice. (2014) Medical Terminology for Health Care Professionals. 8th Edition. Prentice Hall. ISBN 978-0133429541

Course Learning Objectives

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

Class Policies

- 1) **Attendance & Absences** – Full attendance and participation is expected. If there is a reason to miss a session, advanced notice through email should be sent to the lecturer.
- 2) **Assignment Completion & Late Work** – All assignments should be submitted on time. If there is a delay, the student must be in touch with the instructor. Late submissions without reasons will result in grade deduction.
- 3) **Academic Conduct Code** –Cheating and plagiarism will not be tolerated in any Metropolitan College course. They will result in no credit for the assignment or examination and may lead to disciplinary actions. Please take the time to review the Student Academic Conduct Code:
http://www.bu.edu/met/metropolitan_college_people/student/resources/conduct/code.html.

NOTE: [This should not be understood as a discouragement for discussing the material or your particular approach to a problem with other students in the class. On the contrary – you should share your thoughts, questions and solutions. Naturally, if you choose to work in a group, you will be expected to come up with more than one and highly original solutions rather than the same mistakes.]

Grading Criteria

- Quizzes - This course will have 4 to 5 graded quizzes.
- Assignments - This course will have 4 to 5 graded assignments.
- Discussions – There are 5 graded discussion forums that involve posting and reviewing the answers to the discussion topics.
- Class Project – The class project will test students' overall understanding and grasp of the course content.
- Final Examination – The final exam will be comprehensive and will cover material from the entire course. It will be an open-book proctored exam consisting of questions similar to the ones in the assignments and the class project.

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

Deliverable Weight

- Quizzes 25%
- Assignments 30%
- Participation 10%
- Final Exam 35%

Class Meetings, Lectures & Assignments

Lectures, Readings, and Assignments subject to change, and will be announced in class as applicable within a reasonable time frame.

Date	Lecture	Case Study
January 21 2015	01. Introduction to Biomedicine	Case Study
January 28 2015	02. Laboratory Medicine	Case Study
February 4 2015	03. Skin, Bones and Muscle (Dermatology, Orthopedics, Rheumatology)	Case Study
February 11 2015	04. The Digestive System (Gastroenterology)	Case Study
February 18 2015	Guest Lecture A	Case Study
February 25 2015	05. The Cardiovascular System (Heart and Circulation)	Case Study

March 4 2015	06. The Pulmonary System (Respiratory)	Guest Lecture B
March 18 2015	07. The Nervous system (Neurology)	Case Study
March 25 2015	08. Immunity (Allergy, Immunology)	Case Study
April 1 2015	Guest Lecture C	Case Study
April 8 2015	09. The Renal system (Nephrology)	Case Study
April 15 2015	10. Endocrinology A (Reproduction, Obstetrics)	Case Study
April 22 2015	11. Endocrinology B (Homeostasis)	Case Study
April 29 2015	12. Cancer (Oncology)	Case Study

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 01: Introduction to Biomedical Science

Lecture 02: Introduction to Laboratory Medicine

Learning Objectives:

- 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.
- How things go wrong – genetics of individual difference, developmental problems, the effects of aging, infectious disease, cancer.
- 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 03: Muscular, Skeletal, and Integumentary Systems

Lecture 04: The Digestive System

Reading:

Course textbook:

Chapter 5: The Integumentary System

Chapter 6: Bones and Joints

Chapter 7: The Skeletal System

Chapter 8: Muscle Tissues

Chapter 9: The Muscles

Chapter 18: The Digestive System

Chapter 19: Metabolism and Nutrition

Learning Objectives:

- General understanding of the structural organization of the human body and the functionality of the digestive system.
- Exploration of diagnostic methods and imaging procedures to identify disorders.
- The role of IT in data and image analysis, transfer and presentation.

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 05: The Cardiovascular System

Lecture 06: The Pulmonary System

Reading:

Course textbook:

Chapter 15: The Cardiovascular System

Chapter 17: The Respiratory System

Learning Objectives:

- Attain a basic understanding of the structure, function and interdependency of heart and lung function.
- 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.
- Appreciation of the imaging techniques and therapeutic options available to diagnose and repair cardiovascular and respiratory problems.

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 07: The Nervous System

Reading:

Course textbook:

Chapter 10: Nervous Tissue

Chapter 11: Nervous system Organization

Chapter 12: The Special Senses

Learning Objectives:

- Recognition and understanding of the basic structure and functionality of the nervous system.
- An understanding of the pathophysiology of the nervous system together with common diagnostic methods and treatments

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 08: The Immune System

Reading:

Course textbook:

Chapter 14: The Blood

Chapter 16: The Lymphatic and Immune Systems

Learning Objectives:

- 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.
- The immune response to infection
- An understanding of the pathophysiology of the immune system together with common diagnostic methods and treatments

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 09: The Renal and Urinary system

Reading:

Course textbook:

Chapter 20: The Urinary System

Chapter 21: Fluid, Electrolyte, and Acid/Base Balance

Learning Objectives:

- The structure, function and basic physiology of the renal and urinary systems
- Have a basic appreciation of the means to measure and image function in these systems

- An understanding of therapies available and possible medical interventions

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 10: The Endocrine System in control of reproduction and development

Lecture 11: The Endocrine System in control of normal physiology

Reading:

Course textbook:

Chapter 13: The Endocrine System

Chapter 22: The Male Reproductive System

Chapter 23: The Female Reproductive System

Learning Objectives:

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

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 12: 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:

- Understand the basics of how tumors arise: disposition and multi-step insults to the cell
- Identify common diagnostic methods, treatments, and procedures associated with these disorders
- Imaging techniques to aid differentiation of normal tissue from neoplastic tissue

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:

- An understanding of the structure of the U.S. Healthcare System
- 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
- Recognition that the IT management of clinical data is a sensitive area touching upon privacy, patients' rights and legal ownership.

Instructor Biographies

Jonathan S. Duke-Cohan, Ph.D.

Dr. Jonathan Duke-Cohan is a Principal Associate in Medicine at Harvard Medical School and the Dana-Farber Cancer Institute. After receiving his B.Sc. from the University of London, UK, and his Ph.D. from the Institute of Cancer Research of the University of London, he spent a brief period at the Ontario Cancer Institute in Toronto, following which he became junior faculty in the Department of Immunology of the Hebrew University-Hadassah Hospital in Jerusalem, Israel. At the Dana-Farber/Harvard for more than 25 years, his research focuses upon the molecular interactions that control development and function of the human immune system. In addition to postgraduate qualifications in Software Engineering (with a focus on cryptology, logic and algorithmic analysis) from Harvard University, he also undertakes teaching of physiology and molecular/cell biology to the 1st year students at Harvard Medical School.

Guanglan Zhang, Ph.D.

Dr. Guanglan Zhang holds Masters degrees in Biomedical Engineering (M.Eng., Nanyang Technological University, Singapore) and Automatic Control Theory and Application (M.Eng., Northwestern Polytechnic University, China). She received a Ph.D. (Nanyang Technological University, Singapore) for doctoral work in bioinformatics. She is an Assistant Professor in Computer Science at Boston University Metropolitan College, where she teaches Health Informatics subjects and is a member of the Health Informatics Laboratory. She is also holding an adjunct position at Dana-Farber Cancer Institute and Harvard Medical School.

Dr. Zhang has worked in the biomedical informatics field since 1998. The most important aspects of her work include development and implementation of biomedical databases, computational simulations of laboratory experiments, development of diagnostic methods for tissue typing, and computational support for vaccine development. Computational tools that she developed are used in the study of immunology, vaccinology, infectious disease, and cancer. She has authored 40 peer-reviewed scientific journal publications and developed dozens of biomedical specialist databases and computational systems.

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Once in the library system, you can use the links under “Resources” and “Collections” to find databases, eJournals, and eBooks, as well as search the library by subject. Go to <http://www.bu.edu/library/research/collections> to access eBooks and eJournals directly. If you have questions about library resources, go to <http://www.bu.edu/library/help/ask-a-librarian> to email the library or use the live chat feature.

To locate course eReserves, go to <http://www.bu.edu/library/services/reserves>.

Please note that you are not to post attachments of the required or other readings in the water cooler or other areas of the course, as it is an infringement on copyright laws and department policy. All students have access to the library system and will need to develop research skills that include how to find articles through library systems and databases.