Basic concepts of medical informatics

Medical informatics is the study and application of methods to improve the management of patient data, clinical knowledge, population data, and other information relevant to patient care and community health. It is a young science, which emerged in the decades after the invention of the digital computer in the 1940s. Mechanical computing in medicine had a much earlier origin, in the 19th century, with Herman Hollerith's "punched-card data-processing system" originally used for the US census and subsequently developed to support surveys in public health and epidemiology. This example reflects the multidisciplinary nature of medical informatics, which interacts with various fields, including the clinical sciences, the public health sciences (for example, epidemiology and health services research) as well as cognitive, computing, and information sciences.

Healthcare informatics combines the fields of information technology and health to develop the systems required to administer the expansion of information, advance clinical work flow, and improve the security of the healthcare system. It involves the integration of information science, computer technology, and medicine to collect, organize, and secure information systems and health–related data. The extraordinary explosion of medical knowledge, technologies, and ground-breaking drugs may vastly improve healthcare delivery to consumers, and keeping the information related to these advancements organized and accessible is key.

Healthcare informatics utilizes computer hardware, specialized software, and communication devices to form complex computer networks to collect, analyze, and transmit medical processes. The tools for creating health information systems are not limited just to information technology. These systems should also allow for the assimilation of clinical directives, understanding of formal medical jargon, storage of data, and transmission of clear communication. Medical informatics can be applied in all types of health environments, including primary care, general practice, hospital care, and rehabilitation. It is also inclusive of many of the specialties within the healthcare field.

Information systems may used to create greater operating efficiencies in three basic functions of healthcare: clinical, administrative, and financial. For example, healthcare informatics is pivotal in the movement to cut costs and enhance patient care by implementing a standardized system for electronic medical records. It is also a key to expanding the development health information systems for billing, clinical research, client scheduling, and the exchange of medical information.

Physicians can avail themselves of the growing knowledge base and make better decisions bolstered by computer software called clinical decision support systems (CDSS). Other computer systems, called electronic prescribing systems, eliminate the need for hand-written prescriptions and minimize errors. Informatics also allow for data mining to determine the effectiveness of drugs. This may reduce the cost of treatments, lessen mistakes, and help further advancements in the quality of care.

One of the major objectives of healthcare informatics is to formulate a standard approach for healthcare internationally. The idea is for researchers, providers, and patients to benefit from the informatics tools, techniques, concepts, and protocols that transform healthcare delivery, and to promote best practices in the healthcare field. As a result of evolving and complex legal issues related to information technology and health-related fields, healthcare informatics is also important in health law as it relates to ethical, operational, and privacy concerns.

Many experts agree that one of the main challenges of healthcare informatics is to get medical providers committed to the widespread implementation of the various information technology components. Healthcare informatics may not only create a seamless and comprehensive healthcare system, but can assist industry professionals to solve problems, make decisions, and provide better customer service. It may help professionals process multiple functions that will enable them to perform their duties more effectively and efficiently.

Biomedical and Health Informatics

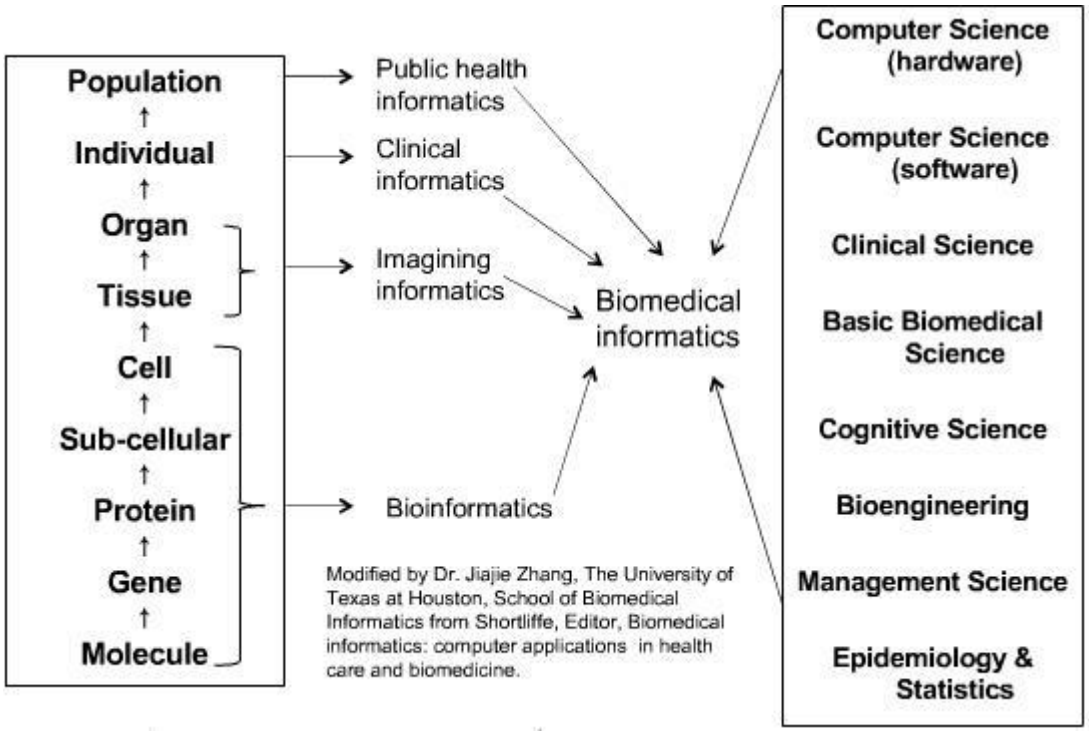
While various perspectives of informatics and its application to health care have been published, two have been chosen for review and discussion because of their significance within the field.

The first definition comes from the American Medical Informatics Association or AMIA. AMIA is a non-profit organization dedicated to the development and application of medical informatics in the support of patient care, teaching, research, and health administration. They are seen as the prominent informatics organization in the US.

According to their Web site, "AMIA is the professional home for biomedical and health informatics. For over thirty years the members of AMIA and its honorific college, the American College of Medical Informatics (ACMI), have sponsored meetings, education, policy and research programs. The federal government frequently calls upon AMIA as a source of informed, unbiased opinions on policy issues relating to the national health information infrastructure, uses and protection of personal health information, and public health considerations, among others." AMIA's definition therefore is essential to understand. Accordingly, "Biomedical and health informatics has to do with all aspects of understanding and promoting the effective organization, analysis, management, and use of information in health care.

While the field of biomedical and health informatics shares the general scope of these interests with some other health care specialties an disciplines, biomedical and health informatics has developed its own areas of emphasis and approaches that have set it apart from other disciplines and specialties."

Biomedical Informatics



The second definition comes from another highly respected source for biomedical informatics material, the textbook *Biomedical informatics: computer applications in health care and biomedicine*. Shortliffe defines biomedical informatics as ""the scientific field that deals with biomedical information, data, and knowledge – their storage, retrieval, and optimal use for problem solving and decision making." As a field of study, Shorliffe states biomedical informatics is "concerned with the broad range of issues in the management and use of biomedical information, including biomedical computing and the study and nature of biomedical information itself."

The chapter *The computer meets medicine and biology: the emergence of a discipline*, from the textbook *Biomedical informatics: computer applications in health care and biomedicine* edited by Edward Shortliffe with James Cimino as associate editor contains a description of biomedical informatics which is represented by the diagram shown above.

Informatics is viewed as four subfields, public health informatics, clinical informatics, imaging informatics, and bioinformatics each with a specific focus as represented by the left hand side. The right hand side lists the component sciences in biomedical informatics which includes computer science, clinical science, basic biomedical science, cognitive science, bioengineering, management science, epidemiology, and statistics.

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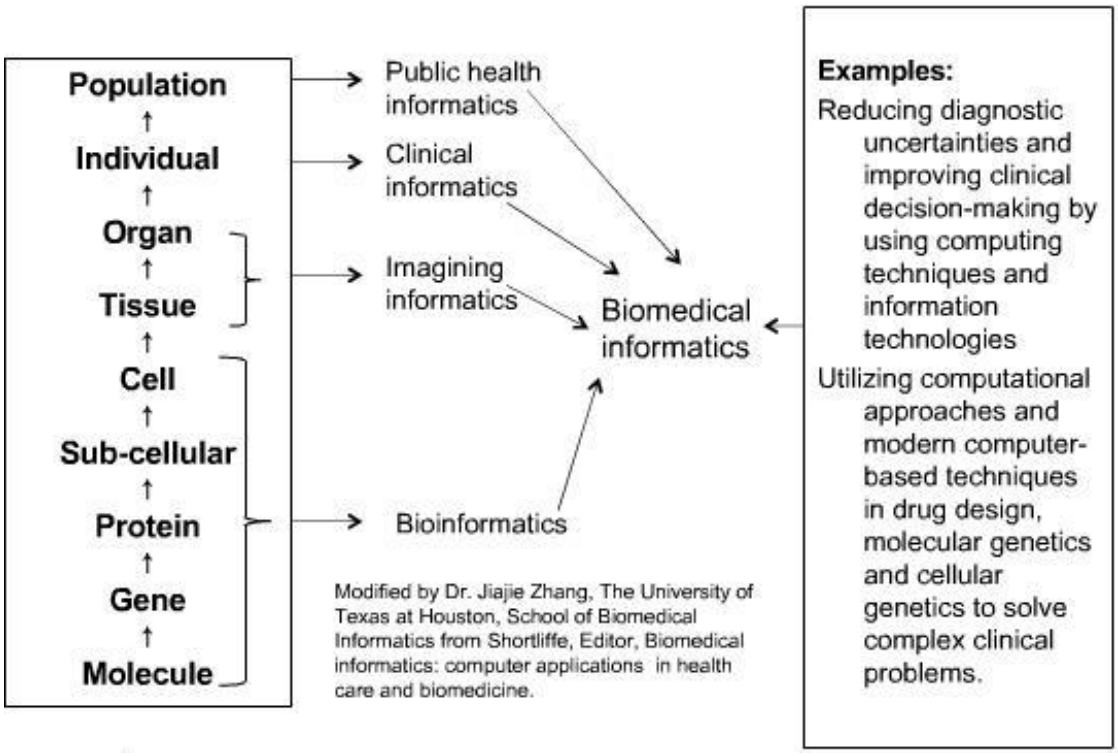


Biomedical informatics encompasses public health, clinical, and imaging informatics as well as the biological and biomolecular informatics domains.

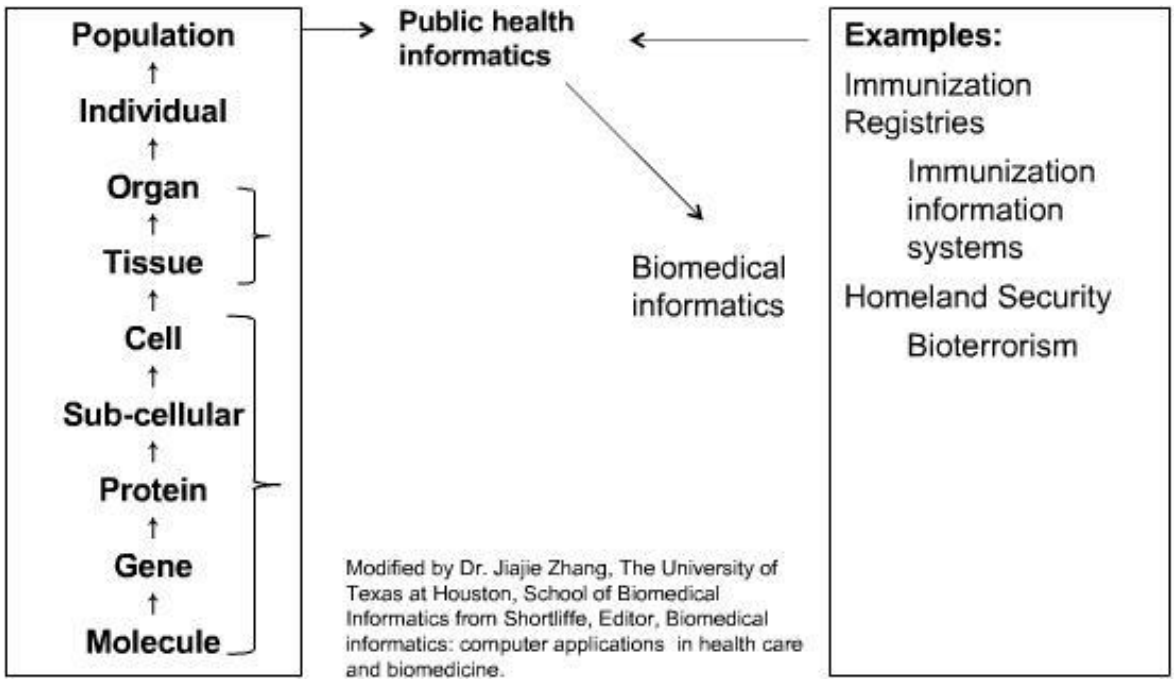
Some examples of a biomedical informatics application drawn from a brochure published by the University of Medicine & Dentistry of New Jersey include:

- Reducing diagnostic uncertainties and improving clinical decision-making by using computing techniques and information technologies.
- Utilizing computational approaches and modern computer-based techniques in drug design, molecular genetics and cellular genetics to solve complex clinical problems.
- Designing large databases of digitized medical images for use in medical decision-making, teleradiology, or teleconsultation.

These four subfields, public health informatics, clinical informatics, imaging informatics, and bioinformatics where the informatics applications are geared toward a specific area such as the individual in the case of clinical informatics.

The following sections provide additional information for each subfield.

Public Health Informatics



The first informatics segment is *public health informatics*. As defined in the textbook *Biomedical informatics: computer applications in health care and*

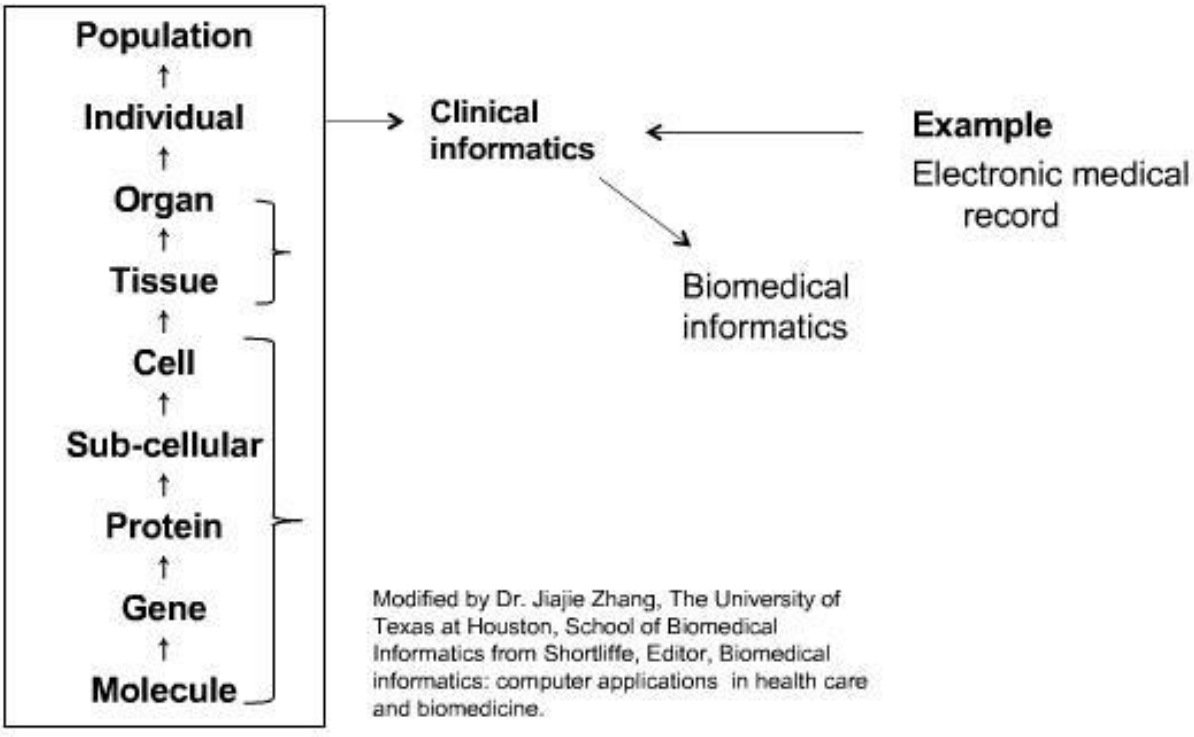
biomedicine, public health informatics is an application area of biomedical informatics in which the field's methods and techniques are applied to problems drawn from the domain of public health.

Public health informatics is population- and society-focused.

Examples of public health informatics applications include:

- National Notifiable Disease Surveillance System
  - The National Electronic Telecommunications System for Surveillance (NETSS)
- Immunization registries
  - Immunization information systems
- Homeland Security
  - Bioterrorism

Clinical Informatics



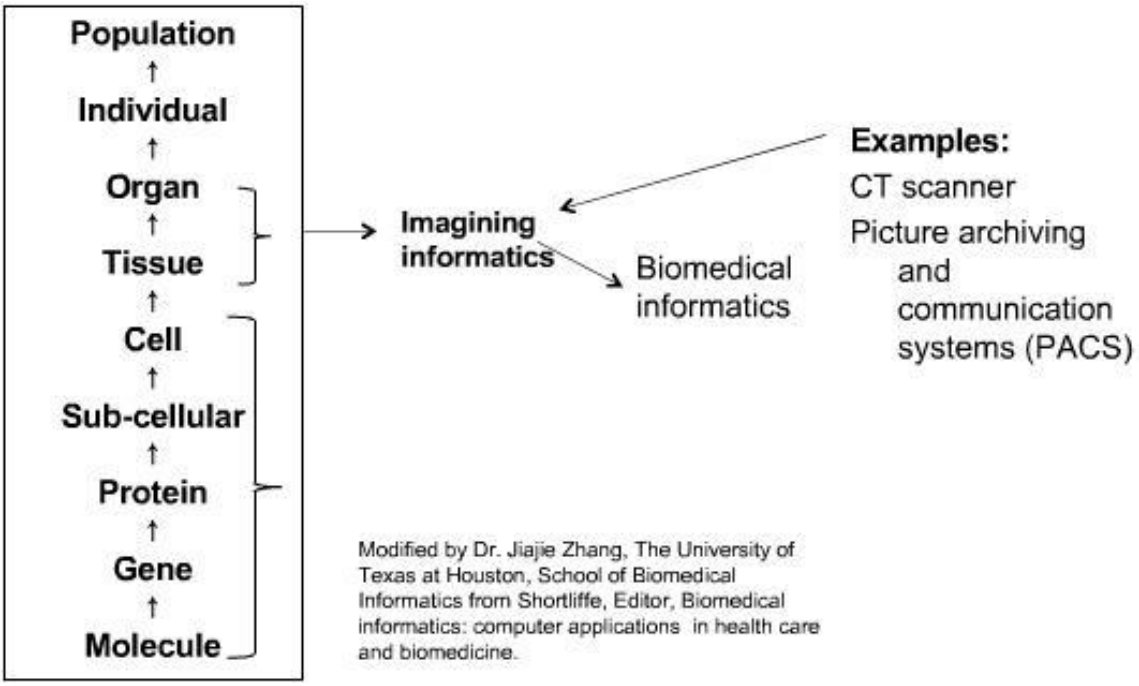
The second informatics segment is *clinical informatics*. As defined in the textbook *Biomedical informatics: computer applications in health care and*

biomedicine, clinical informatics is the application of biomedical informatics in the patient care domain. It is a combination of computer science, information science, and clinical science designed to assist in the management and processing of clinical data, information, and knowledge to support clinical practice.

Clinical informatics is individual (patient-oriented) focused.

An example of clinical informatics applications would be the electronic medical record.

Imaging Informatics



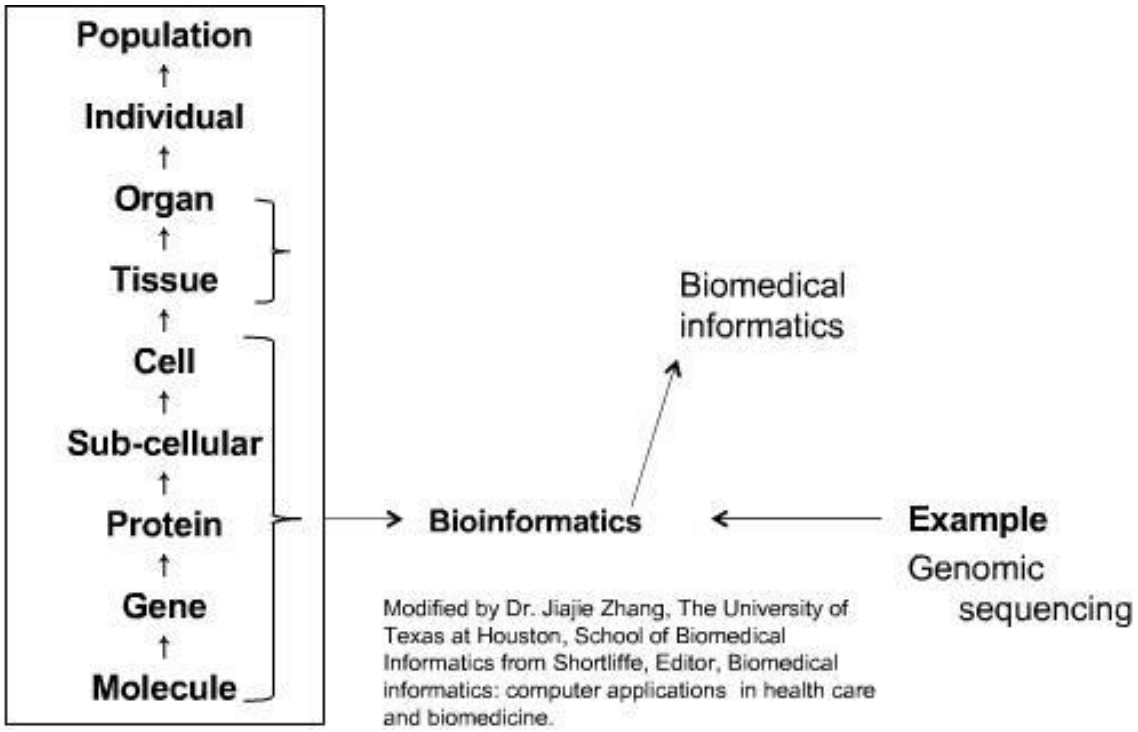
The third informatics segment is *imaging informatics*. As defined in the textbook *Biomedical informatics: computer applications in health care and biomedicine*, imaging informatics is concerned with the common issues that arise in all image modalities, relating to the acquisition of image in, or conversion to, digital form, and the analysis, manipulation, and use of those images once they are in digital form.

Imaging informatics is tissues- and organs-focused.

An example of imaging informatics applications is a CT scanner, which uses software algorithms to recreate a three-dimensional image of the body parts. Another

example are *Picture Archiving and Communication Systems* (PACS) which are a combination of hardware and software dedicated to the short- and long-term storage, retrieval, management, distribution, and presentation of images.

Biomedical Informatics

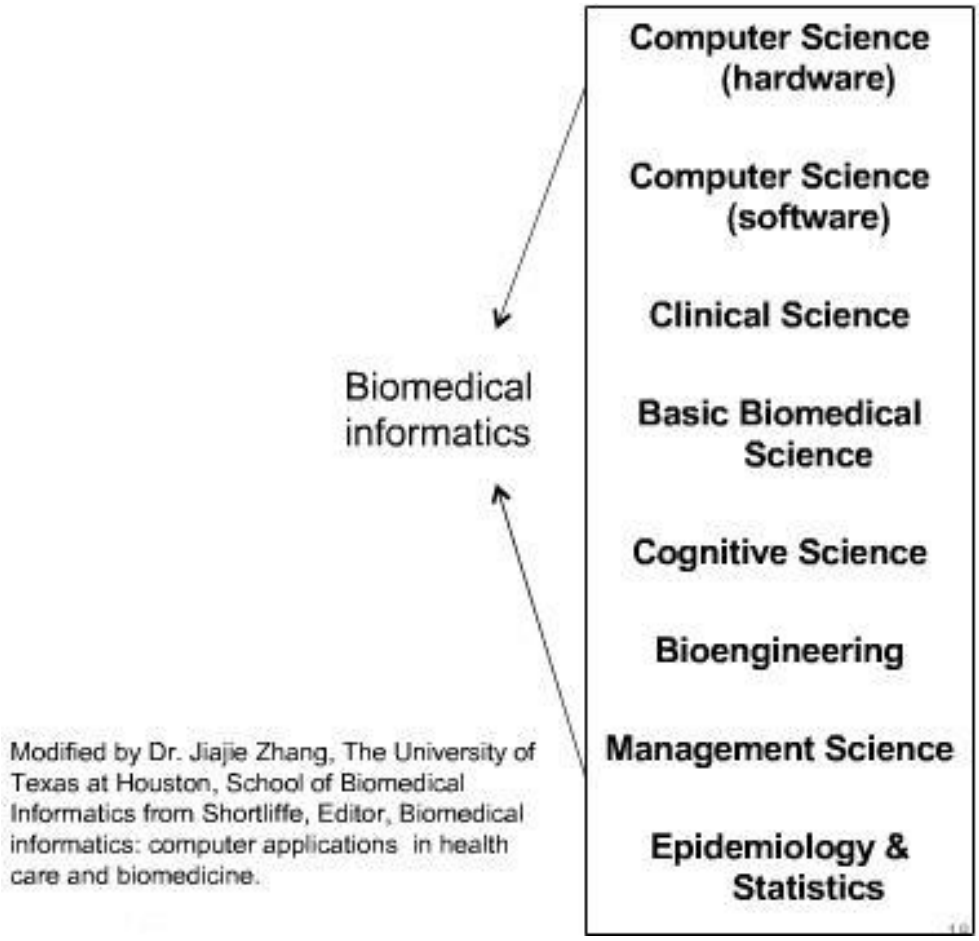


The final informatics segment is *bioinformatics*. As defined in the textbook *Biomedical informatics: computer applications in health care and biomedicine*, bioinformatics is the study of how information is represented and transmitted in biological systems, starting at the molecular level.

Bioinformatics is molecular and cellular processes focused.

An example of bioinformatics applications is genomic sequencing.

Biomedical Informatics



Having covered the subdiciplines of biomedical informatics, Shortliffe addresses the component sciences that biomedical informatics draws on and contributes to. These include computer science, clinical science, basic biomedical science, cognitive science, bioengineering, management science, epidemiology, and statistics.

Following are some brief definitions of each. All are from *Answers.com*

- *Computer science*: The study of computation and computer technology, hardware, and software.
- *Clinical science*: the practical study of medical principles or investigations using controlled procedures to evaluate results.
- *Biomedical science*: the application of information technology to the fields of biomedical research and health care.

- *Cognitive science*: The study of the nature of various mental tasks and the processes that enable them to be performed.
- *Bioengineering*: The application of engineering principles to the fields of biology and medicine, as in the development of aids or replacements for defective or missing body organ.
- *Management science*: school of management emphasizing the use of mathematics and statistics as an aid in resolving production and operations problems.
- *Epidemiology & Statistics*: the branch of medical science dealing with the transmission and control of disease and the mathematics of the collection, organization, and interpretation of numerical data, especially the analysis of population characteristics by inference from sampling.

Course outcomes

The outcomes for this course are to enable you to gain:

– An understanding of the basic informatics principles.

– Knowledge on how to structure, record and model clinical data in a form appropriate for the clinical task, for communication with colleagues, or for communication with computer application developers.

– Essential information skills and ability to use information technology to access, assess, select and apply available information.

– Knowledge of some existing computerized systems in health care and how they improve health care delivery.

– An understanding of the advantages, capabilities and limitations of information technologies when applied to health.

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