



Resources for Field – Organizations, Information, Education

What is Biomedical & Health Informatics?
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Resources for field

- Organizations
- Information
- Education

Professional organizations



- AMIA (formerly American Medical Informatics Association)
 - <https://www.amia.org/>
- Mission
 - AMIA advances the informatics professions relating to health and disease. To this end it advances the use of health information and communications technology in clinical care and clinical research, personal health management, public health/population, and translational science with the ultimate objective of improving health.

Other professional organizations

- Healthcare Information and Management Systems Society (HIMSS) – <https://www.himss.org/>
- American Health Information Management Association (AHIMA) – <http://www.ahima.org/>
- Association of Medical Directors of Information Systems (AMDIS) – <https://amdis.org/>
- Alliance for Nursing Informatics (ANI) – <https://www.allianceni.org/>
- Public Health Informatics Institute (PHII) – <https://phii.org/>
- International Society for Computational Biology (ISCB) – <http://www.iscb.org/>
- Society for Imaging Informatics in Medicine (SIIM) – <https://siim.org/>
- Association for Computing Machinery (ACM) – <https://www.acm.org/>
- Medical Library Association (MLA) – <https://www.mlanet.org/>

Medical and nursing specialty societies (non-exhaustive)

- American Medical Association (AMA) – <https://www.ama-assn.org/>
- American Nurses Association (ANA) – <https://www.nursingworld.org/>
- Association of American Medical Colleges (AAMC) – <https://www.aamc.org/>
- American College of Physicians (ACP) – <https://www.acponline.org/>
- American Academy of Family Physicians (AAFP) – <https://www.aafp.org/>

Where does one find more information?

Textbooks

- Hersh W, Ed. (2022). *Health Informatics: Practical Guide, 8th Edition*. Lulu.com
- Shortliffe, EH et al., Eds. (2021). *Biomedical Informatics: Computer Applications in Health Care and Biomedicine, 5th Edition*. Springer
- Finnell JT and Dixon BE, Eds. (2022). *Clinical Informatics Study Guide – Text and Review, 2nd Edition*. Springer

Where does one find more information (cont.)?

Many more textbooks

Unit	Textbook(s)
1	<p>Butler-Henderson, K., Day, K., Gray, K. (Eds.), 2022. <i>The Health Information Workforce: Current and Future Developments</i>, 1st ed. Springer.</p> <p>Kiel, J.M., Kim, G.R., Ball, M.J. (Eds.), 2022. <i>Healthcare Information Management Systems: Cases, Strategies, and Solutions</i>, 5th ed. Springer.</p> <p>Kulhanek, B., Mandato, K. (Eds.), 2022. <i>Healthcare Technology Training: An Evidence-based Guide for Improved Quality</i>. Springer.</p> <p>Berner, E.S. (Ed.), 2020. <i>Informatics Education in Healthcare: Lessons Learned</i>, 2nd ed, Health Informatics. Springer.</p> <p>Rivas, H., Wac, K. (Eds.), 2018. <i>Digital Health</i>, Health Informatics. Springer.</p> <p>Davis, N.A., 2019. <i>Foundations of Health Information Management - E-Book</i>, 5th edition. Elsevier.</p> <p>Skochelak, S. (Ed.), 2020. <i>Health Systems Science</i>, 2nd Edition. Elsevier.</p> <p>Askin, E.T., Moore, N., 2022. <i>The Health Care Handbook: A Clear and Concise Guide to the United States Health Care System</i>, 3rd edition. Wolters Kluwer Health.</p>
2	<p>Brookshear, G., Brylow, D., 2018. <i>Computer Science: An Overview</i>, 13th edition. Pearson.</p> <p>O'Regan, G., 2013. <i>Giants of Computing: A Compendium of Select, Pivotal Pioneers</i>. Springer.</p> <p>Shattell, M., Batchelor, M., Darmoc, R. (Eds.), 2022. <i>Social Media in Health Care: A Guide to Creating Your Professional Digital Presence</i>. SLACK Incorporated.</p>

Where does one find more information (cont.)?

Many more textbooks

Unit	Textbook(s)
3	Greenes, R., Del Fiol, G. (Eds.), 2023. <i>Clinical Decision Support and Beyond: Progress and Opportunities in Knowledge-Enhanced Health and Healthcare</i> , 3rd edition. Academic Press.
4	Benson, T., Grieve, G., 2021. <i>Principles of Health Interoperability: FHIR, HL7 and SNOMED CT</i> , 4th ed. Springer. Braunstein, M.L., 2022. <i>Health Informatics on FHIR: How HL7's API is Transforming Healthcare</i> , 2nd ed. Springer. Elkin, P.L. (Ed.), 2023. <i>Terminology, Ontology and their Implementations</i> , 2nd ed. Springer.
5	Chang, A.C., 2020. <i>Intelligence-Based Medicine: Artificial Intelligence and Human Cognition in Clinical Medicine and Healthcare</i> , 1st edition. Academic Press. Hoyt, R., Muenchen, R. (Eds.), 2019. <i>Introduction to Biomedical Data Science</i> . Lulu.com. Scarlat, A., 2019. <i>Machine Intelligence Primer for Clinicians: No Math or Programming Required</i> . Celi, L.A., Majumder, M.S., Ordóñez, P., Osorio, J.S., Paik, K.E., Somai, M. (Eds.), 2020. <i>Leveraging Data Science for Global Health</i> , 1st ed. Springer. Nguyen, A., 2022. <i>Hands-On Healthcare Data</i> , 1st edition. ed. O'Reilly Media. Cohen, T.A., Patel, V.L., Shortliffe, E.H. (Eds.), 2022. <i>Intelligent Systems in Medicine and Health: The Role of AI</i> . Springer. Aggarwal, C.C., 2022. <i>Machine Learning for Text</i> , 2nd ed. Springer. Deisenroth, M.P., Faisal, A.A., Ong, C.S., 2020. <i>Mathematics for Machine Learning</i> . Cambridge University Press. Branstetter, B.F., 2021. <i>Practical Imaging Informatics: Foundations and Applications for Medical Imaging</i> . Springer.

Where does one find more information (cont.)?

Many more textbooks

Unit	Textbook(s)
6	<p>Leape, L.L., 2021. <i>Making Healthcare Safe: The Story of the Patient Safety Movement</i>. Springer.</p> <p>Dixon, B. (Ed.), 2022. <i>Health Information Exchange: Navigating and Managing a Network of Health Information Systems</i>, 2nd edition. Academic Press.</p> <p>Nash, D.B., Skoufalos, A., Fabius, R.J., Oglesby, W.H., 2019. <i>Population Health: Creating a Culture of Wellness</i>, 3rd edition. Jones & Bartlett Learning.</p>
7	<p>Sayles, N.B., Kavanaugh-Burke, L., 2018. <i>Introduction to Information Systems for Health Information Technology</i>, 3rd edition. ed. AHIMA.</p> <p>Friedman, C.P., Wyatt, J.C., Ash, J.S., 2022. <i>Evaluation Methods in Biomedical and Health Informatics</i>, 3rd ed. Springer.</p> <p>Latifi, R., Doarn, C.R., Merrell, R.C. (Eds.), 2020. <i>Telemedicine, Telehealth and Telepresence: Principles, Strategies, Applications, and New Directions</i>, 1st ed. Springer.</p>
8	<p>Hersh, W., 2020. <i>Information Retrieval: A Biomedical and Health Perspective</i>, 4th ed, Health Informatics. Springer.</p> <p>Xia, J., 2021. <i>Predatory Publishing</i>, 1st edition. Routledge.</p>

Where does one find more information (cont.)?

Many more textbooks

Unit	Textbook(s)
9	<p>Richesson, R.L., Andrews, J.E. (Eds.), 2019. <i>Clinical Research Informatics</i>, 2nd ed. Springer.</p> <p>Lesk, A., 2019. <i>Introduction to Bioinformatics</i>, 5th edition. Oxford University Press.</p> <p>Baxevanis, A.D., Bader, G.D., Wishart, D.S. (Eds.), 2020. <i>Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins</i>. Wiley.</p> <p>Tiwary, B.K., 2021. <i>Bioinformatics and Computational Biology: A Primer for Biologists</i>. Springer.</p> <p>Bourn, D., 2022. <i>Diagnostic Genetic Testing</i>. Springer.</p> <p>Dessimoz, C., Skunca, N., 2020. <i>The Gene Ontology Handbook</i>. Saint Philip Street Press.</p> <p>Kappelmann-Fenzl, M., 2021. <i>Next Generation Sequencing and Data Analysis</i>. Springer.</p>
10	<p>Magnuson, J.A., Dixon, B. (Eds.), 2020. <i>Public Health Informatics and Information Systems</i>, 3rd ed. Springer.</p> <p>Hübner, U.H., Wilson, G.M., Morawski, T.S., Ball, M.J. (Eds.), 2022. <i>Nursing Informatics: A Health Informatics, Interprofessional and Global Perspective</i>, 5th edition. Springer.</p> <p>Saba, V., McCormick, K., 2021. <i>Essentials of Nursing Informatics</i>, 7th Edition, 7th edition. ed. McGraw-Hill.</p> <p>Hsueh, P.-Y.S., Wetter, T., Zhu, X. (Eds.), 2022. <i>Personal Health Informatics: Patient Participation in Precision Health</i>. Springer.</p> <p>Straus, S.E., Glasziou, P., Richardson, W.S., Haynes, R.B., 2018. <i>Evidence-Based Medicine E-Book: How to Practice and Teach EBM</i>, 5th edition. Elsevier.</p>

More information (cont.), Journals

- Journals of AMIA
 - JAMIA – <https://academic.oup.com/jamia>
 - JAMIA Open – <https://academic.oup.com/jamiaopen>
- Methods of Information in Medicine (MIM)
- International Journal of Medical Informatics (IJMI)
- Journal of Medical Internet Research (JMIR)
 - JMIR Medical Informatics
- Journal of Biomedical Informatics (JBI)
- Applied Clinical Informatics (ACI)
 - ACI Open
- BMJ Health & Care Informatics
- Bioinformatics
- Journal of Digital Imaging (JDI)
- Biomed Central (BMC, <https://www.biomedcentral.com/>)
 - BMC Medical Informatics and Decision Making
 - BMC Bioinformatics

More information (cont.), Meetings

- AMIA meetings
 - Annual Symposium
 - Informatics Summit
 - Clinical Informatics Conference
- Medinfo (biennial)
- Other clinical informatics meetings
 - HIMSS, national meeting and local chapters
 - AMDIS Physician-Computer Connection
- Bioinformatics meetings
 - Pacific Symposium on Biocomputing (PSB)
 - International Society for Computational Biology (ISCB)

More information (cont.), Web sites

- US government
 - HHS ONC – <https://www.healthit.gov/>
 - Health IT Playbook – <https://www.healthit.gov/playbook/>
 - ONC HIT curriculum – <https://www.healthit.gov/topic/health-it-resources/health-it-curriculum-resources-educators>
 - AHRQ Digital Healthcare Research – <https://digital.ahrq.gov/>
 - US Health Information Knowledgebase – <https://ushik.ahrq.gov/mdr/portals>
- Other
 - HealthIT Answers – <https://www.healthitanswers.net/>
 - Clinfowiki – <http://clinfowiki.org>

More information (cont.), email lists, blogs, and podcasts

- Email lists
 - HISTalk – <https://histalk2.com/>
 - HIT Strategist
 - From organizations such as AMIA, HIMSS, AMDIS, etc.
- Blogs
 - Geek Doctor (John Halamka, MD) – <https://geekdoctor.blogspot.com/>
 - Healthcare Standards (Keith Boone) – <https://motorcycleguy.blogspot.com/>
 - Health IT Buzz (ONC) – <https://www.healthit.gov/buzz-blog>
 - Informatics Professor (Hersh) – <https://informaticsprofessor.blogspot.com/>
- Podcasts
 - AMIA – <https://www.amia.org/amia-podcasts>
 - Women in AMIA
 - AMIA Clinical Informatics Fellows (ACIF) Go-Live
 - Kevin Johnson, Informatics in the Round, <https://kevinbjohnsonmd.podbean.com/>
 - Jason Moore, Biomedical Informatics Roundtable, <http://bmipodcast.org/>
 - Dirk Stanley, CMIO Podcast



More information (cont.), acronyms

- Always asked, so here is a list
 - Health IT Answers – <https://www.healthitanswers.net/health-it-key-acronyms/>
 - Shortliffe glossary, which includes acronyms (2014) – <http://people.dbmi.columbia.edu/shortliffe/docs/Glossary%20-%204th%20ed.pdf>
 - Wikipedia – https://en.wikipedia.org/wiki/List_of_abbreviations_used_in_health_informatics
 - AHIMA – <https://library.ahima.org/doc?oid=107443#.YZ05sC-B2M4>

More information: US government reports and plans

- *ONC Federal Health IT Strategic Plan 2020-2025*
 - <https://www.healthit.gov/topic/2020-2025-federal-health-it-strategic-plan>
 - Reducing burden of use of EHRs (2020)
 - Health IT priorities for research (2020)
- *National Library of Medicine Strategic Plan 2017-2027*
 - https://www.nlm.nih.gov/pubs/plan/lrp17/NLM_StrategicReport2017_2027.html

ONC Strategic Plan (2020)

Promote Health and Wellness

GOAL
1

Objective 1a: Improve individual access to health information

Objective 1b: Advance healthy and safe practices through health IT

Objective 1c: Integrate health and human services information

Enhance the Delivery and Experience of Care

GOAL
2

Objective 2a: Ensure safe and high-quality care through the use of health IT

Objective 2b: Foster competition, transparency, and affordability in healthcare

Objective 2c: Reduce regulatory and administrative burden on providers

Objective 2d: Enable efficient management of resources and a workforce confidently using health IT

Build a Secure, Data-Driven Ecosystem to Accelerate Research and Innovation

GOAL
3

Objective 3a: Advance individual- and population-level transfer of health data

Objective 3b: Support research and analysis using health IT and data at the individual and population levels

Connect Healthcare and Health Data through an Interoperable Health IT Infrastructure

GOAL
4

Objective 4a: Advance the development and use of health IT capabilities

Objective 4b: Establish transparent expectations for data sharing

Objective 4c: Enhance technology and communications infrastructure

Objective 4d: Promote secure health information that protects patient privacy

NLM Strategic Plan (2017)

GOAL 1

Accelerate discovery and advance health through data-driven research

- 1.1 Connect the resources of a digital research enterprise
- 1.2 Advance research and development in biomedical informatics and data science
- 1.3 Foster open science policies and practices
- 1.4 Create a sustainable institutional, physical, and computational infrastructure

GOAL 2

Reach more people in more ways through enhanced dissemination and engagement

- 2.1 Know NLM users and engage with persistence
- 2.2 Foster distinctiveness of NLM as a reliable, trustable-source of health information and biomedical data
- 2.3 Support research in biomedical and health information access methods and information dissemination strategies
- 2.4 Enhance information delivery

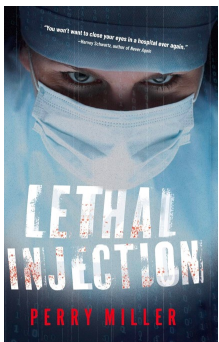
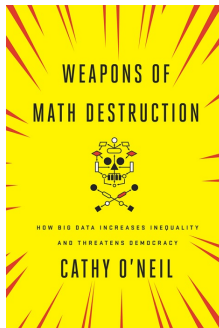
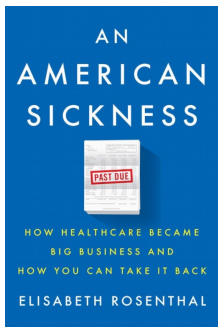
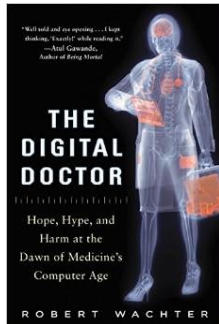
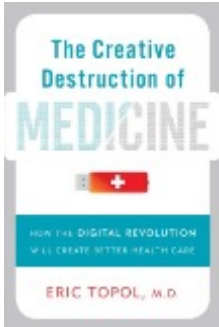
GOAL 3

Build a workforce for data-driven research and health

- 3.1 Expand and enhance research training for biomedical informatics and data science
- 3.2 Assure data science and open science proficiency
- 3.3 Increase workforce diversity
- 3.4 Engage the next generation and promote data literacy

Sampling from the popular press

- Topol, E., 2012. *The Creative Destruction of Medicine: How the Digital Revolution Will Create Better Health Care*. Basic Books.
- Topol, E., 2015. *The Patient Will See You Now: The Future of Medicine is in Your Hands*. Basic Books.
- Yom-Tov, E., 2016. *Crowdsourced Health: How What You Do on the Internet Will Improve Medicine*, Illustrated edition. MIT Press.
- Mukherjee, S., 2016. *The Gene: An Intimate History*. Scribner.
- O’Neil, C., 2016. *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Crown.
- Patashnik, E.M., Gerber, A.S., Dowling, C.M., 2017. *Unhealthy Politics: The Battle over Evidence-Based Medicine*. Princeton University Press.
- Rosenthal, E., 2017. *An American Sickness: How Healthcare Became Big Business and How You Can Take It Back*. Penguin Press.
- Steele, G., Feinberg, D., 2017. *ProvenCare: How to Deliver Value-Based Healthcare the Geisinger Way*. McGraw-Hill Education.
- Wachter, R., 2017. *The Digital Doctor: Hope, Hype, and Harm at the Dawn of Medicine’s Computer Age*. McGraw-Hill Education.
- Shapiro, N., Loberg, K., 2018. *Hype: A Doctor’s Guide to Medical Myths, Exaggerated Claims, and Bad Advice - How to Tell What’s Real and What’s Not*. St. Martin’s Press.
- Zuboff, S., 2019. *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*. PublicAffairs.
- Miller, P., 2019. *Lethal Injection*. Koehler Books.



Sampling from the popular press (cont).

- Mitchell, M., 2019. *Artificial Intelligence: A Guide for Thinking Humans*, Illustrated edition. Farrar, Straus and Giroux.
- Topol, E., 2019. *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Illustrated Edition. Basic Books.
- Marcus, G., Davis, E., 2019. *Rebooting AI: Building Artificial Intelligence We Can Trust*, Illustrated edition. Pantheon.
- Robertson, S., 2020. *B C, Before Computers: On Information Technology from Writing to the Age of Digital Data*. Open Book Publishers.
- Johnson, K.B., 2021. *I'm A Biomedical Informatics Expert Now!* Ws Education.
- Graham, S.S., 2022. *The Doctor and the Algorithm: Promise, Peril, and the Future of Health AI*. Oxford University Press.
- Shneiderman, B., 2022. *Human-Centered AI*. OUP Oxford.

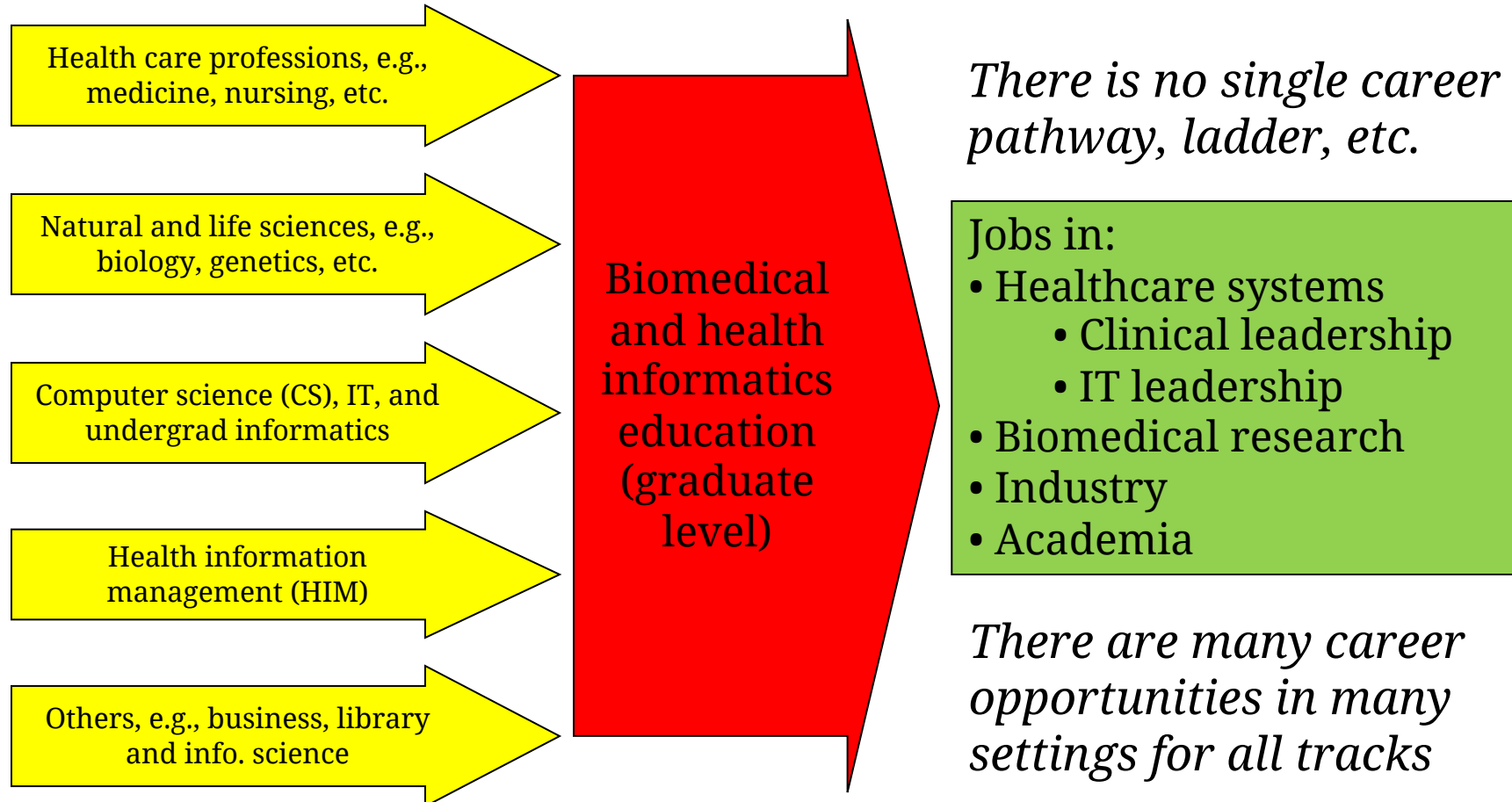
Education and training in informatics

- Inter-disciplinary field
 - Many programs with diverse curricula
 - Programs come in many flavors: clinical, biomedical, health, bio-, nursing, etc.
- Education historically focused on academics but expanded to meet needs and opportunities for practitioners and users
 - Large growth in applied master's degree programs – about 75-80 in US (Cox, 2021)
- Major funder of programs is NLM, which funds programs to train future researchers at doctoral (PhD) and postdoctoral levels at 16 universities
 - Also funding from other sources, including institutions funding clinical informatics subspecialty fellowships
- After general overview, description of OHSU program given as an example
 - Consult programs' Web sites for details

Academic programs

- List of US informatics programs on AMIA Web site
 - <https://amia.org/careers-certifications/informatics-academic-programs>
- NLM-funded programs (Greenes, 2022)
 - <https://www.nlm.nih.gov/ep/GrantTrainInstitute.html>

Career pathways have diverse inputs and outputs (Hersh, 2009)



Cardinal rule (formula) of informatics education

$$\begin{array}{c} \text{What you do} \\ \text{when you} \\ \text{get out} \end{array} = f \left(\begin{array}{c} \text{What you did} \\ \text{before you} \\ \text{started} \\ + \\ \text{What you} \\ \text{learned in the} \\ \text{program} \end{array} \right)$$

Key attributes of OHSU informatics educational program

- Building-block structure
 - Work done at one level can be carried forward to next, i.e., 10x10 → Graduate Certificate → MS (thesis or non-thesis) → PhD
- Majors
 - Health & Clinical Informatics (HCIN) – original program; focused on health and healthcare areas
 - Bioinformatics & Computational Biomedicine (BCB) – initial focus on genomics but has expanded to biomedicine

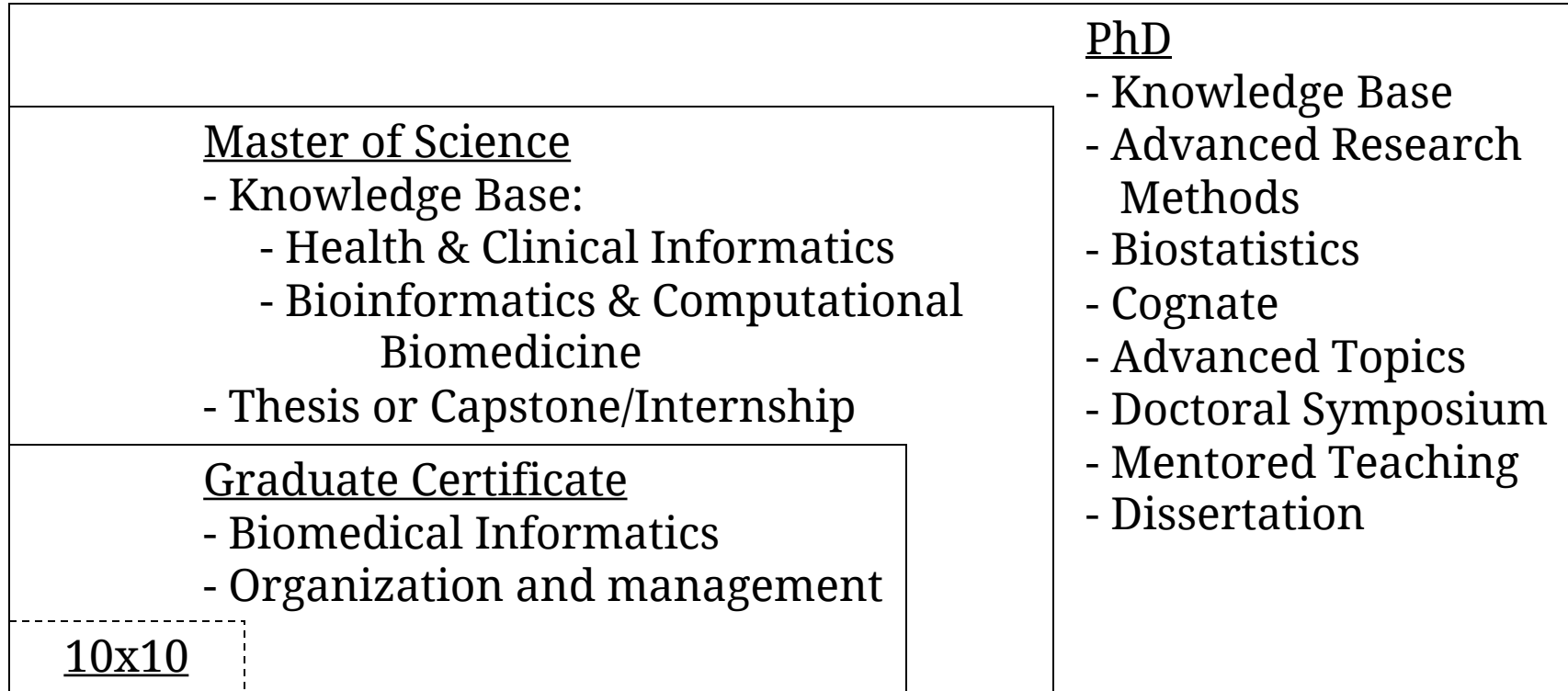
OHSU biomedical informatics core curriculum domains

High-Level Competency	Domain Names for Health & Clinical Informatics (HCIN)	Domain Names for Bioinformatics & Computational Medicine (BCB)
Apply core concepts of using data, information, and knowledge to advance health and biomedicine	Health & Clinical Informatics	Bioinformatics & Computational Biomedicine
Apply knowledge of appropriate area(s) of health and biomedicine to informatics practice and research	Health Care	Biomedical Science
Apply computing skills to biomedical informatics	Computer Science	Computer Science
Apply quantitative methods to biomedical informatics	Evaluative Sciences	Biostatistics
Apply people and organizational knowledge to informatics	Organizational Behavior and Management	N/A
Apply advanced scholarship to biomedical and health informatics	Thesis/Capstone/Dissertation Requirements	Thesis/Capstone/Dissertation Requirements

Application of curriculum to specific programs

- 10x10 program is version of introductory course in clinical informatics track
- Graduate Certificate program focuses mainly on first two domains of HCIN major
 - Biomedical informatics
 - Organizational and management sciences
- Master of Science adds other domains plus either
 - Thesis
 - Capstone or Internship – Non-thesis (formerly MBI)
- PhD program adds specialized research training, cognate area of interest, doctoral seminar, and dissertation

Another view of “building block” approach



<http://www.ohsu.edu/informatics-education>

Overview of programs available

Degree/Certificate Track	PhD	MS Thesis	MS Non-Thesis	Graduate Certificate
Health & Clinical Informatics (HCIN)	On-campus	On-campus	On-campus On-line	On-campus On-line
Bioinformatics & Computational Biomedicine (BCB)	On-campus	On-campus	On-campus	N/A

OHSU informatics – by the numbers



International students from: Argentina, Singapore, Egypt, Israel, Saudi Arabia, Zimbabwe, Thailand, China, and other countries

Degree	Total	BCB	HCIN
Grad Cert	483	0	483
MS	422	71	351
PhD	38	15	23
Total	943	86	857



How have OHSU students and graduates done?

- A quarter-century of experience...
- General observation: What people do when they graduate is partially dependent on what they did when they entered, e.g.,
 - Physicians, nurses, public health, etc. draw on their clinical/professional background
 - Information technology professionals draw on their unique background and experience
- Graduates have obtained jobs in a variety of settings, e.g., clinical, academic, and industry
- Some have obtained jobs before finishing the program

Conclusions

- These are exciting times for biomedical and health informatics, with many opportunities in a wide variety of settings
- Attention must also be paid to the professional practice and education of informaticians
- But the main focus of the field must be how to optimally use information and technology properly to advance human health