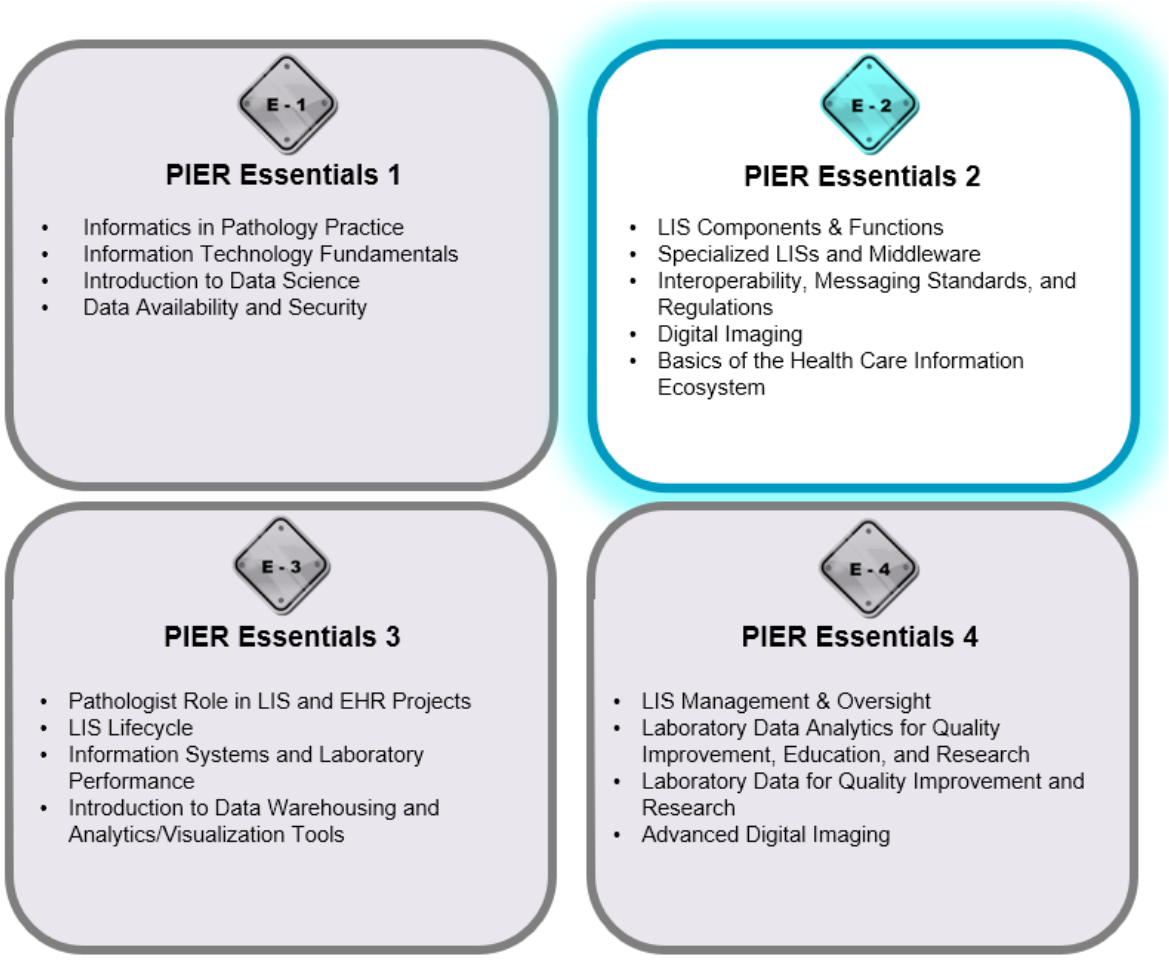
Pathology Informatics Essentials for Residents

PIER Essentials 2 Resource Toolkit



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APC Association of Pathology Chairs

COLLEGE of AMERICAN PATHOLOGISTS

api PATHOLOGY INFORMATICS

Access PIER releases at the Association of Pathology Chairs website.
http://www.apcprods.org/pier

PIER RESOURCE LIBRARY

This section provides information about resources that can be used to teach informatics topics.

College of American Pathologists (CAP) Online Activities

The CAP has developed several online informatics activities about fundamental informatics concepts. See list below. These activities are free. A login is required to access the activities and can be created by clicking on the **LOG IN** button on the CAP website. There is no charge for creating an account.

- Tackling Today's Technology: A Pathologist's Guide to Health IT Basics
- Working With Electronic Health Records: Practical Insights for Pathologists
- Medical Coding Basics
- LIS Fundamentals
- Telepathology and Whole Slide Imaging
- Interfaces and Middleware: LIS Connectivity Options That Can Improve and Streamline Laboratory Operations

Essentials 2 Recommended Resources Requiring Advanced Purchase/Login Access

1. de Baca ME, Spinosa JC, Aller R, Badizadegan K, Blouin AG, Castellani W, Chen P, Gilbertson J, Harrison J, Henricks W, Kennedy M, Knapik C, Pantanowitz L, Reichard RR, Robb J, Stram M. CAP Pathology Resource Guide: Clinical Informatics. Version1.2.0.0. Northfield, IL: College of American Pathologists; 2018.
    a. To Access: https://www.cap.org/member-resources/pathology-resource-guides.
    b. Click on the "Online Versions" link under the "Member-only Benefits" header.
2. Farahani N, Pantanowitz L. Overview of Telepathology. *Clin Lab Med*. 2016 Mar;36(1):101-12.
3. Hipp J, Bauer TW, Bui MM, Cornish TC, Evans AJ, Glassy EF, Lloyd M, McGee RS, Murphy D, O'Neill DG, Pantanowitz L, Parwani AV, Rampy BA, El-Sayed Salama M, Waters, R Westfall K. Digital Pathology Resource Guide. Northfield, IL: College of American Pathologists; 2017.
    a. To Access: https://www.cap.org/member-resources/pathology-resource-guides.
    b. Click on the "Online Versions" link under the "Member-only Benefits" header.
4. Naragyan R. Encyclopedia of Biomedical Engineering. Elsevier. 2018.
5. Pantanowitz L, Tuthill JM, Balis UJ, eds. Pathology Informatics: Theory & Practice. American Society of Clinical Pathology Press; 2012.
6. Park SL, Pantanowitz L, Sharma G, Parwani AV. Anatomic pathology laboratory information systems: a review. *Adv Anat Pathol*. 2012;19(2):81-96.
7. Witte AK. A Review on Digital Healthcare Ecosystems Structure: Identifying Elements and Characteristics. Presented at: PACIS Proceedings 2020. 228. AIS eLibrary website.
8. The Association for Pathology Informatics website is a good source for material that can be used to teach PIER concepts.
    a. From the main menu, select "Education and Resources" then "PIER Education".
    b. Access to PIER-specific content may require an API membership. API has options for teaching institutional memberships that will give access to all your faculty and residents.

Quick Access Menu

Essentials 2 – PIER Resource Options, Topic 1

Topic 1:	LIS Components & Functions
Rationale	The LIS is mission-critical to the management of the day-to-day practice of pathology and functioning of laboratories.
PIER Outcome Statements (OS) ➔ Indicates high priority OS	**OS1** Describe the LIS and the role that it plays in the efficient operation of the lab and delivery of patient care. ➔ **OS2** Define the core LIS elements: dictionaries, worksheets, and interfaces. **OS3** List the other major information systems within a health system to which the LIS is connected or interfaced. ➔ **OS4** Describe patient and asset identification standards and tracking and how they are used in lab workflows to improve patient safety. ➔ **OS5** Explain the need for and the key aspects of a positive patient identification process/protocol.
Subtopics (Content covered within topic)	1. Definition and major features of the LIS 2. Role of the LIS 3. AP and CP LIS similarities and differences 4. Asset tracking systems 5. Positive patient identification

Recommended Resources

OS	Resource
OS1, OS2, OS3	Pantanowitz L, Tuthill JM, Balis UGJ, editors. *Pathology Informatics: Theory And Practice*. Chicago, IL: American Society for Clinical Pathology; 2012. • Chapter 5: Laboratory Information System Overview
OS2, OS3	Park SL, Pantanowitz L, Sharma G, Parwani AV. Anatomic pathology laboratory information systems: a review. *Adv Anat Pathol*. 2012;19(2):81-96.
OS5	Aller RD, Weiner H, Eds: Positive Patient Identification Products. *CAP Today*. July 2012; 26(7):100-104.
OS5	Aller RD: Tightening the reins on positive patient ID. *CAP Today*. July 2012; 26(7):98.

➔ Additional Learning Resources

Practical Exercises

OS	Exercise
OS2	LIS Specimen Processing
OS4, OS5	Patient Identification

Essentials 2 – PIER Resource Options, Topic 2

Topic 2:	Specialized LISs and Middleware
Rationale	Specialized areas and devices in the laboratory require specialized information system capabilities.
PIER Outcome Statements (OS) ➔ Indicates high priority OS	**OS1** List and characterize the specialty LISs (eg, blood bank, molecular) utilized in the laboratory. ➔ **OS2** Describe middleware, how it relates to the LIS, and roles for middleware in laboratory operations. ➔ **OS3** Understand capabilities and limitations of electronic interfaces between the LIS and instrumentation, middleware, and other information systems.
Subtopics (Content covered within topic)	1. Specialized LIS (ie, reasons, distinctions and uses) 2. Specific specialized LISs (transfusion medicine, molecular pathology) 3. Middleware definitions, types, and roles in the lab 4. Interface engines and lab data transmission

Recommended Resources

OS	Resource
OS1, OS3	Pantanowitz L, Tuthill JM, Balis UJ, eds. *Pathology Informatics: Theory & Practice*. American Society of Clinical Pathology Press; 2012. • Chapter 8: Information Systems Interfaces and Interoperability; 135-146. • Chapter 10: Information Systems for Specialized Laboratories; 157-178.
OS2, OS3	de Baca ME, Spinosa JC. Section 5: Integration and Management of Information Systems. In: de Baca ME, Spinosa JC, eds. *Clinical Informatics Resource Guide*. College of American Pathologists; 2018. • 5.1 Interfaces and Middleware

➔ Advanced Learning Resources

Practical Exercises

OS	Exercise
OS1, OS2, OS3	Working with a Specialized LIS
OS2	Working with Middleware
OS3	Orders and Test Validation

Essentials 2 – PIER Resource Options, Topic 3

Topic 3:	Interoperability, Messaging Standards, and Regulations
Rationale	Standards enable sharing of data among health care information systems (ie, interoperability) which is necessary for patient care.
PIER Outcome Statements (OS) ➔ Indicates high priority OS	➔ **OS1** List the key features of communication standards used in pathology (eg, HL7). ➔ **OS2** Describe the characteristics and appropriate applications of standard terminologies (eg, CPT, ICD, SNOMED CT, DICOM and LOINC) used to represent pathology data in the LIS and EHR. **OS3** Recognize the advantages of standardized terminology for creating data interoperability. **OS4** Understand the basics of the standards development process.
Subtopics (Content covered within topic)	1. Features of communication and terminology standards 2. Standards development process (eg, HL7, ISO, IHE, ONC) 3. Application of standards (eg, CPT, ICD, SNOMED CT, DICOM, and LOINC)

Recommended Resources

OS	Resource
OS1, OS2	US National Library of Medicine. Newborn Screening Coding and Terminology Guide. NLM website. Last updated: May 14, 2018.
OS3	Centers for Disease Control and Prevention. National Center for Health Statistics ICD-10-CM Browser tool. CDC website.
OS3, OS4	Digital Imaging and Communications in Medicine. DICOM Whole Slide Imaging (WSI). DICOM website. Last updated: May 8, 2020.
OS2, OS3	Stram M, Gigliotti T, Hartman D, Pitkus A, Huff SM, Riben M, Henricks WH, Farahani N, Pantanowitz L. Logical Observation Identifiers Names and Codes for Laboratorians. *Arch Pathol Lab Med*. 2020 Feb;144(2):229-239.

➔ Advanced Learning Resources

Practical Exercises

OS	Exercise
OS1, OS2	Working with HL7 messaging
OS2, OS3, OS4	Browsing, Lookup, and Automatic Coding
OS2, OS3	Working with LOINC Codes

Essentials 2 – PIER Resource Options, Topic 4

Topic 4:	Digital Imaging
Rationale	Digital imaging is a fundamental tool of pathology practice.
PIER Outcome Statements (OS) ➔ Indicates high priority OS	➔ **OS1** Describe the impact of image format and resolution on the value of and uses for pathology images. ➔ **OS2** Articulate the uses and limitations of whole slide image (WSI) in the practice of pathology. **OS3** Determine the appropriate telepathology technology to use in a particular situation. ➔ **OS4** Explain the potential role of image analysis for patient care and pathologist productivity.
Subtopics (Content covered within topic)	1. Imaging process and image management (eg, capture, storage, retrieval, viewing) 2. Types of digital images (eg, static, dynamic, WSI) 3. Digital pathology applications (eg, telepathology) 4. Image analysis

Recommended Resources

OS	Resource Citation
OS1	Naragyan R. Encyclopedia of Biomedical Engineering. Elsevier. 2018. • Hanna MG, Pantanowitz L. Digital Pathology. Imaging Basics. 524-535. All about images. University of Michigan. Library Research Guides. 2018.
OS2, OS4	Hipp J, Bauer TW, Bui MM, et al. Section 1: The Basics. In Hipp J, Bauer TW, Bui MM, et al, eds. *Digital Pathology Resource Guide*. College of American Pathologists; 2017. de Baca ME, Spinosa JC. Section 9: Futermatics. In: de Baca ME, Spinosa JC, eds. *Clinical Informatics Resource Guide*. College of American Pathologists; 2018.
OS3	Meyer J, Paré G. Telepathology Impacts and Implementation Challenges: A Scoping Review. *Arch Pathol Lab Med*. 2015;139(12):1550-1557.
OS4	Madabhushi A, Lee G. Image analysis and machine learning in digital pathology: Challenges and opportunities. *Med Image Anal*. 2016 Oct;33:170-175.

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Practical Exercises

OS	Exercise
OS1	Navigating a WSI
OS1	Image Editing
OS2	Presenting with a WSI
OS4	Image Analysis

Essentials 2 – PIER Resource Options, Topic 5

Topic 5:	Basics of the Health Care Information Ecosystem
Rationale	Integrating pathology data into the health care enterprise is necessary for high quality patient care.
PIER Outcome Statements (OS) ➔ Indicates high priority OS	**OS1** List the elements of the health care information ecosystem. ➔ **OS2** Explain the value of integrating pathology with other health data. **OS3** List the impact on data integration of the LIS that is an integral part of the EHR versus one that is free standing.
Subtopics (Content covered within topic)	1. Elements of the health care information ecosystem 2. How and why pathology shares data within the health care information ecosystem 3. Enterprise LIS versus a "Best of Breed" LIS

Recommended Resources

OS	Resource Citation
OS1	Witte AK. A Review on Digital Healthcare Ecosystems Structure: Identifying Elements and Characteristics. Presented at: PACIS Proceedings 2020. 228. AIS eLibrary website.
OS2	Ginsburg GS, Phillips KA. Precision Medicine: From Science To Value. *Health Aff* (Millwood). 2018 May; 37(5): 694–701.
OS3	Pascual C. Selecting a laboratory information system: enterprise-wide vs. best-of-breed solutions. *MLO Med Lab Obs*. 2014 Nov;46(11):24, 26.

➔ Advanced Learning Resources

Practical Exercises

OS	Exercise
OS1, **OS**2, **OS**3	LIS Environment

Appendix A: Practical Exercises

Appendix A provides a practical exercise worksheet for the topics with specific exercises. Note: Not all topics may have an exercise and topics may combine exercises with two or more topics. Many of the exercises are case based to provide the resident with real life situations where informatics tools are needed to solve a problem or confirm a diagnosis. Outcome measurements are intended to demonstrate the resident has sufficient knowledge related to the topic content. They are usually a demonstration format (eg, presentation, demonstration of skill, short written report).

Essentials 2 Topic 1 Practical Exercises (Return to E2T1)

Practical Exercise 1: LIS Specimen Processing	**Exercise Type: Hands on, Research**
PIER Outcome Statement	OS2
Setup	On at least one AP and/or CP rotation, have the resident follow a specimen from receipt through to final report generation, noting each instance how a person or device (eg, lab instrument) interacts with the LIS in processing that specimen. For each step, identify the key data elements involved and the user type(s)/role(s) involved.
Informatic Tools	Access to LIS and data reports.
Resources	
Activity Time	2-3 days.
Completion Proof	The proof of completion could be taking a snapshot of the tracking from the LIS and then manually entering your initials at each step that you verified.

Practical Exercise 2: Patient Identification	**Exercise Type: Hands on, Research**
PIER Outcome Statements	OS4, OS5
Setup	Study how your lab and institution positively identifies patients prior to obtaining a specimen, compare to other existing methods of positive patient identification, and discuss with a faculty member.
Informatic Tools	Access to LIS.
Resources	IT staff/faculty for questions/discussion.
Activity Time	1 day
Completion Proof	The proof of completion could be taking snapshots of the various types of barcodes that are used in your institute from patient to laboratory results.

Essentials 2 Topic 2 Practical Exercises (Return to E2T2)

Practical Exercise 1: Working with a Specialized LIS — Exercise Type: Hands on

PIER Outcome Statements	OS1, OS2, OS3
Setup	Have the resident visit an area of the laboratory that utilizes a specialized LIS or specialized module of the LIS and identify what features/functions are unique or special to that area of the laboratory (eg, blood bank, molecular lab). Alternatively, have the resident do this on any rotation in a laboratory that utilizes a specialized LIS or specialized LIS module.
Informatic Tools	Access to specialized LIS or specialized module of an LIS.
Resources	
Activity Time	1-2 days
Completion Proof	Written document in which the resident: • Identifies the specialized LIS or LIS module investigated. • Lists each special/unique function that the specialized LIS or LIS module provides, its benefits to the laboratory and/or patient care, the impact that not having this function would have, and whether the main LIS is capable of performing this function.

Practical Exercise 2: Working with Middleware — Exercise Type: Research

PIER Outcome Statement	OS2
Setup	Have the resident select a middleware system actively used by your laboratory (eg, middleware is often found in core laboratories for chemistry and/or hematology analyzers, for point of care systems, and sometimes in blood bank). For the selected middleware, have the resident determine what functions it provides (eg, autoverification, reflex testing), whether or not the main LIS could be used for these functions, and why these functions are beneficial to the laboratory.
Informatic Tools	Access to LIS and middleware system
Resources	
Activity Time	1-2 days
Completion Proof	Written document in which the resident: • Identifies the middleware system investigated. • Lists each special/unique function that the middleware provides, its benefits to the laboratory and/or patient care, the impact that not having this function would have, and whether the main LIS is capable of performing this function.

Practical Exercise 3: Orders and Test Validation	Exercise Type: Research
PIER Outcome Statement	OS3
Setup	Have the resident review laboratory procedures and documentation applicable to meeting requirements for testing/validation of interfaced orders and results between the LIS and EHR and then inquire with faculty and/or LIS support staff about common errors detected and fixed during validation. Where applicable for the resident, it is recommended to include both clinical and anatomic pathology LISs since the issues can be different.
Informatic Tools	Access to LIS and EHR
Resources	Faculty and/or LIS support staff
Activity Time	1-2 days
Completion Proof	Written document in which the resident: • List of the applicable regulations (e.g., CLIA, FDA) and laboratory accreditation standards (eg, CAP, AABB, etc.) that require LIS to EHR validation. • List of reasons why validation across interfaces is important.

Essentials 2 Topic 3 Practical Exercises (Return to E2T3)

Practical Exercise 1: Working with HL7 Messaging	Exercise Type: Hands on
PIER Outcome Statements	OS1, OS2
Setup	Review the National Library of Medicine (NLM) Guidance for "Sending Electronic Newborn Screening Results with HL7 Messaging". After reading about HL7 messaging standards in the NLM Guidance, open the "Raw HL7 NBS example message" and answer the following: • What is the field called where the infant's mother's name appears? (Answer: NK1 – Next of Kin 1) • What is the address of the birth hospital, and which segment of the message does this information appear in? (Answer: 211 Small Street, Anytown, Tennessee 55555; OBX|16|TX and ORC|RE)
Informatic Tools	None
Resources	See above
Activity Time	1 day
Completion Proof	Have the resident create or test a new HL7 message or troubleshoot a bad message.

Practical Exercise 2: Browsing, Lookup and Automatic Coding	Exercise Type: Hands on
PIER Outcome Statements	OS2, OS3, OS4
Setup	This exercise covers browsing, lookup, and automatic coding using standard terminologies in the NCBO BioPortal: http://bioportal.bioontology.org. Have the resident: • Code a set of AP and/or CP pathology reports that contain a range of procedures and clinical concepts of varying complexity. • Compare ICD code options to match the text of the diagnosis. • Compare text diagnoses with the respective code descriptions.
Informatic Tools	None
Resources	See above link.

Activity Time	1 day
Completion Proof	Show evidence of completion of the following: • Code a set of AP and/or CP pathology reports with a range of procedures and clinical concepts of varying complexity. • Compare ICD code options to match the text of the diagnosis. • Compare text diagnoses with the respective code descriptions.

Practical Exercise 3: Working with LOINC Codes **Exercise Type: Hands-on**

PIER Outcome Statements	OS2, OS3
Setup:	After reading about LOINC codes, identify all of the LOINC codes in the Raw HL7 NBS example about cystic fibrosis. (Answer: 54078-1 Cystic fibrosis newborn screening panel, 46769-6 Cystic fibrosis newborn screen interpretation, 57707-2 Cystic fibrosis newborn screening comment-discussion). Identify which of the LOINC codes in the raw HL7 message should be used for the interpretation. (Answer: 46769-6) For the code identified the above question, what would the correct answer ID be for a "borderline" result? (Answer: LA4259-3)
Informatic Tools	None.
Resources	See above links.
Activity Time	1 day
Completion Proof	Have the resident provide an example of a limitation of attempting to use a LOINC code for communicating lab data to an HIE or from a reference lab.

Essentials 2 Topic 4 Worksheets (**Return to E2T4**)

Practical Exercise 1: Navigate a WSI **Exercise Type: Hands-on**

PIER Outcome Statement	OS1
Setup	Navigate a WSI (eg, pan, zoom) and if possible compare a WSI to glass slide in a microscope.
Informatic Tools	None
Resources	Access to WSI and glass slide
Activity Time	1-3 hours
Completion Proof	Use open access applications such as PathPresenter, QuPath, or a digital pathology system application (eg, Imagescope, CaseViewer) to review a whole slide image.

Practical Exercise 2: Image editing — Exercise Type: Hands-on

PIER Outcome Statement	OS1
Setup	Didactic demonstration session (or a “hands-on” workshop session) using basic image editing software (eg, Preview, Photoshop Elements) to edit a digital image (eg, crop, resample, adjust colors). Take a digital gross or microscopic image and save copies of it with different levels of lossless and lossy compression, then compare the sizes of the files and perceived resolution loss.
Informatic Tools	Basic image editing software.
Resources	None
Activity Time	2 hours
Completion Proof	Faculty review of demonstration or workshop session where trainee understands how to crop, resize, brightness, contrast, and change image resolution of a static image.

Practical Exercise 3: Presenting with a WSI — Exercise Type: Hands-on

PIER Outcome Statement	OS2
Setup	Use WSIs (if available) for any application, such as a tumor board presentation or other educational activity.
Informatic Tools	Publicly available WSI can be found at OpenSlide or the DPA WSI Repository.
Resources	None
Activity Time	2-5 hours
Completion Proof	Use PowerPoint to create a presentation. Upload and intersperse the presentation in PathPresenter with WSI.

Practical Exercise 4: Image Analysis — Exercise Type: Hands-on

PIER Outcome Statement	OS4
Setup	Use static images or WSIs (if available) for applying an image analysis tool.
Informatic Tools	Requires QuPath download.
Resources	None
Activity Time	3 hours
Completion Proof	Use QuPath to quantify positive cell counts in a nuclear IHC image. Capture an image or use a publicly available static image from the Internet to follow these directions and quantify the positive cell counts.

Essentials 2 Topic 5 Worksheets (Return to E2T5)

Practical Exercise 1: LIS environment	**Exercise Type: Hands-on**
PIER Outcome Statement	OS1, OS2, OS3
Setup	Have the resident sketch out a relatively high level diagram of information systems in your environment with which your LIS exchanges data. This should include names of key systems such as the EHR in use.
Informatic Tools	Access to LIS and EHR systems.
Resources	None
Activity Time	2-3 days
Completion Proof	Submission of institution's information systems diagram.

Appendix B: Additional Learning Resources

Appendix B contains resources for those residents who are looking for additional content on a particular topic or want to expand their knowledge related to informatics.

(Return to E2T1)

Topic 1: LIS Components & Functions

Sinard JH. *Practical Pathology Informatics: Demystifying Informatics for the Practicing Anatomic Pathologist*. Springer; 2006.

Sepulveda JL, Young DS. The ideal laboratory information system. *Arch Pathol Lab Med*. 2013 Aug;137(8):1129-1140.

(Return to E2T2)

Topic 2: Specialized LISs and Middleware

Myers C, Swadley M, Carter AB. Laboratory Information Systems and Instrument Software Lack Basic Functionality for Molecular Laboratories. *J Mol Diagn*. 2018;20(5):591-599.

U.S. Department of Health and Human Services Food and Drug Administration. *Guidance for Industry: Blood Establishment Computer System Validation in the User's Facility*. FDA website.

(Return to E2T3)

Topic 3: Interoperability, Messaging Standards, and Regulations

Herrmann MD, Clunie DA, Fedorov A, et al. Implementing the DICOM Standard for Digital Pathology. *J Pathol Inform*. 2018 Nov 2;9:37.

Pantanowitz L, Tuthill JM, Balis UJ, eds. Pathology Informatics: Theory & Practice. American Society of Clinical Pathology Press; 2012.

de Baca, ME, Spinosa JC. Section 5: Integration and Management of Information Systems. In: de Baca ME, Spinosa JC, eds. *Clinical Informatics Resource Guide*. College of American Pathologists; 2018.

(Return to E2T4)

Topic 4: Digital Imaging

Farahani N, Pantanowitz L. Overview of Telepathology. *Clin Lab Med*. 2016 Mar;36(1):101-112.

(Return to E2T5)

Topic 5: Basics of the Health Care Information Ecosystem

None at this time.