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SNOMED CT Implementation Guide for the LOINC Ontology

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This implementation guide is intended to help users effectively utilize the new extension that integrates LOINC with SNOMED CT, a collaborative effort between SNOMED International and the Regenstrief Institute. The guide offers detailed instructions and strategies for leveraging this extension, designed to enhance interoperability and facilitate global health data exchange.
This living document will follow the current state of the LOINC Extension, beginning with the first official release, published in March 2025 and based on the 2.80 release of LOINC expected mid February 2025.
The guide explains the purpose and functionality of the LOINC extension, which aligns with the SNOMED CT concept model to offer a consistent representation of clinical information. It covers the creation of SNOMED CT concepts for LOINC terms, reducing duplication and fostering collaborative efforts. Users will learn how to implement both LOINC and SNOMED CT standards, enabling them to meet clinical and regulatory requirements efficiently.
Key sections of the guide provide insights into mapping strategies, data integration workflows, and use cases to demonstrate real-world applications. This guide aims to help users achieve greater accuracy and consistency in clinical data management, ultimately improving the delivery of healthcare globally.

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Executive Summary

The SNOMED CT Implementation Guide for the LOINC Ontology provides essential guidance for implementing and utilizing the LOINC Ontology, an extension to SNOMED CT that enables LOINC users to leverage SNOMED CT's structured design while also allowing SNOMED CT users to utilize LOINC. Developed through a collaboration between SNOMED International and the Regenstrief Institute, this guide supports terminology implementers, system developers, and clinical informaticians in adopting the LOINC Ontology for interoperable, standardized, and computable healthcare data.

The LOINC Ontology was established to bridge the gap between structured clinical terminologies and laboratory/observation data, ensuring that LOINC-coded tests and observations can be used within SNOMED CT's concept model. By aligning these terminologies, the extension enhances data interoperability, standardization, and semantic precision. This guide explains the structure and content of the LOINC Extension, offering practical guidance on its implementation, data integration, and clinical applications.

The guide provides an overview of LOINC's structure, purpose, and integration into SNOMED CT, detailing how LOINC-coded observations are structured using hierarchical relationships, attributes, and classification models. It introduces the LOINC Extension, explaining how it enhances LOINC's computability within SNOMED CT. Clinical use cases demonstrate how the LOINC Ontology supports standardized laboratory results, decision support, and structured clinical documentation. Examples include ordering and reporting laboratory tests, interoperability between laboratory and clinical data systems, and integration with decision support systems to improve diagnostics and treatment pathways.

A key section covers how LOINC terms are represented within SNOMED CT, using its concept model, attributes, and relationships. It outlines strategies for incorporating LOINC attributes, the templated approach for structuring LOINC concepts, and the management of orderable and observable LOINC terms within SNOMED CT. To ensure compatibility across electronic health records (EHRs), laboratory systems, and clinical applications, the guide discusses logical modeling, terminology binding best practices, and HL7 FHIR-based approaches for laboratory data representation, including FHIR resources for test ordering, result structuring, and interoperability frameworks.

From a technical perspective, the guide provides practical steps for deploying the LOINC Ontology within SNOMED CT-enabled systems. It explains methods for accessing the LOINC Ontology, such as through a FHIR Terminology Server or relational databases, and best practices for querying, retrieving, and maintaining LOINC data. It also addresses managing references to inactive concepts, version control considerations, and impact assessment to ensure alignment with SNOMED CT updates and national extensions.

By implementing the LOINC Ontology within SNOMED CT, organizations can achieve greater interoperability, enhance the accuracy of laboratory result standardization, improve data consistency and analytics, and support terminology-driven decision support for a more structured and precise representation of clinical data. This guide serves as a comprehensive resource for ensuring the effective implementation, maintenance, and utilization of the LOINC Ontology within SNOMED CT, supporting a more standardized and interoperable healthcare ecosystem.

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1. Introduction

Background

The LOINC Ontology developed through a collaborative initiative between the Regenstrief Institute and SNOMED International was established under a cooperative agreement signed in October 2022 which built upon previous agreements between the two organizations. This partnership aims to reduce duplication between the two terminologies and enhance their interoperability, enabling stakeholders to use LOINC and SNOMED CT together more effectively. This initiative builds on the strengths of both terminologies, aiming to streamline clinical data exchange and enhance the utility of standardized healthcare information.

A key deliverable of this collaboration is an extension that integrates LOINC's granular laboratory observables into SNOMED CT's framework, increasing LOINC's computability in a SNOMED-compatible structure. By aligning these terminologies, the extension supports data harmonization, advanced analytics, and improved patient care. The first production version of the LOINC ontology, released in March 2025 focuses on laboratory observables, covering terms representing at least 75% of test volume based on LOINC's Top 20,000 usage rankings, derived from U.S. data.

More information about this project can be found at https://loincsnomed.org/ along with downloadable content and the LOINC Ontology Browser.

Objective

The harmonization of LOINC and SNOMED CT helps tackle inconsistent coding, interoperability issues, and data silos that make it difficult to share and use healthcare information effectively. Without this alignment, lab results and clinical data are often recorded in different formats, leading to errors, redundant mappings, and gaps in patient care and research.

The overall clinical and practical objective of the LOINC Ontology and the harmonization of LOINC and SNOMED CT is to support a more interoperable, standardized, and semantically precise healthcare data ecosystem. This harmonization effort aims to bridge the gap between structured clinical terminologies and laboratory/observation data to enhance patient care, research, and data exchange across healthcare system

The objective of the SNOMED CT Implementation Guide for the LOINC Ontology is to describe the structure and content of the LOINC Extension for SNOMED CT and provide practical guidance for its application. The guide explains how the integration of LOINC and SNOMED CT works in both directions, supporting standardized representation of observations in SNOMED CT while also enhancing the clinical utility of LOINC.

Scope

The scope of this guide is to provide a foundational framework for understanding and implementing the LOINC Extension to SNOMED CT, addressing both conceptual and practical aspects of its use.

As a dynamic document, its content will evolve in alignment with updates to the extension, ensuring it remains current and relevant. This adaptability allows the guide to incorporate new features, use cases, and advancements as the extension develops, supporting users in effectively applying the latest capabilities.

By remaining flexible and responsive, the guide ensures ongoing alignment with the evolving needs of healthcare interoperability and data standardization.

This guide outlines the foundational framework for understanding and implementing the LOINC Extension for SNOMED CT, focusing on both conceptual and practical aspects.

The document will evolve alongside updates to the extension, incorporating new features and use cases to ensure relevance. This adaptability supports users in leveraging the latest capabilities for healthcare data standardization and interoperability.

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Audience

This guide is designed for a diverse range of stakeholders involved in the implementation and application of the LOINC Extension to SNOMED CT. It provides practical insights and best practices tailored to specific user groups, helping them understand and utilize the extension effectively in their respective domains:

- **SNOMED International Members** seeking clear guidance and uniform best practices for implementing and documenting the integration of LOINC and SNOMED CT, ensuring consistent application across healthcare systems.
- **Clinicians** interested in understanding how the integration can enhance clinical data collection, improve patient care workflows, and support comprehensive clinical documentation.
- **Information Managers** responsible for incorporating SNOMED CT into health information models and workflows, aiming to optimize data standardization and interoperability in laboratory and clinical settings.
- **Software Developers** focused on embedding SNOMED CT and LOINC integration into healthcare applications, ensuring robust support for interoperability and seamless data exchange.
- **Researchers** normalizing data to support population analytics within a given organization and across multiple organizations as part of multisite clinical trials.
- **Healthcare Organizations** in various scenarios:
  - Those evaluating coding systems for capturing laboratory data.
  - Organizations already using SNOMED CT but needing to support or report using LOINC.
  - Current LOINC users considering migration to SNOMED CT.
  - Organizations with established systems using either SNOMED CT or LOINC that now seek to enhance data exchange with other entities by supporting both terminologies.

Attribution

This SNOMED CT Implementation Guide and the development of the LOINC Extension to SNOMED CT are the result of a collaborative effort between key contributors from SNOMED International and the Regenstrief Institute. Their expertise and dedication have been critical in establishing the cooperative agreement and advancing the extension.

Attributions

- **Name**: Collaborative Team from SNOMED International and Regenstrief Institute
  - **Affiliation**: SNOMED International and Regenstrief Institute
  - **Description**: This team was responsible for establishing the cooperative agreement in October 2022 and leading the development of the LOINC Extension to SNOMED CT. Their contributions include identifying overlapping terminologies, minimizing duplication, and designing an integrated extension to improve interoperability and usability.

Guide Overview

This SNOMED CT Implementation Guide is specifically designed to support the implementation of the LOINC Ontology within SNOMED CT. The guide provides a structured framework for understanding the integration of LOINC's granular laboratory observables into SNOMED CT's Logical design. It is organized into five main chapters:

- Chapter 1: Introduction - This chapter provides an overview of the LOINC Ontology, including its development through the collaboration between SNOMED International and the Regenstrief Institute. It outlines the objectives, scope, and intended audience of this guide.
- Chapter 2: **What is LOINC?** - This chapter provides a foundational understanding of LOINC, detailing its purpose, structure, and role in healthcare data standardization. It explains how LOINC supports the representation of laboratory tests, clinical observations, and other coded health data. Additionally, the

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chapter introduces the LOINC Extension within SNOMED CT, outlining how it enhances interoperability and aligns with broader clinical terminology standards.

- Chapter 3: Clinical Use Case - This chapter describes key use cases that demonstrate the value of integrating LOINC into SNOMED CT. It covers scenarios where the LOINC Extension enhances data interoperability, improves laboratory result standardization, and facilitates clinical decision support.
- Chapter 4: **Content Development Principles** - This chapter explains how SNOMED CT incorporates LOINC content, detailing the structure and organization of LOINC concepts within SNOMED CT. It describes the approach used for modeling LOINC codes and representing this in compliance with the SNOMED CT Extension mechanism.
- Chapter 5: **Information Models and Terminology Binding** - This chapter explores the integration of the LOINC Ontology with various health information models. It provides an in-depth discussion on logical modeling, terminology binding strategies, and best practices for aligning LOINC observables with information model structures. Additionally, it examines the application of HL7 FHIR for laboratory data representation, covering FHIR resources used for ordering laboratory tests and structuring laboratory results in a standardized manner.
- Chapter 6: **Technical Application** - This chapter provides technical implementation guidance, including best practices for integrating the LOINC Extension into SNOMED CT-enabled systems. It includes practical strategies for adoption, system configuration, and real-world application examples.

Review

We encourage and welcome feedback from all readers to ensure this guide remains accurate, relevant, and useful. The review process is an ongoing effort to engage the community in improving the content. A feedback button is provided on each page of the guide, allowing readers to share their comments and suggestions directly related to the content.

Comments or inquiries that are not relevant as feedback on specific page content should be directed to info@snomed.org for further assistance.

All feedback will be carefully reviewed, and updates will be incorporated as appropriate. The guide will be revised and updated with every new release of the LOINC Extension to SNOMED CT, ensuring it reflects the latest developments and enhancements. Your input is invaluable in helping us maintain a resource that meets the needs of its users and supports the effective implementation of this extension.

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2. What is LOINC?

Purpose and Scope

LOINC (Logical Observation Identifiers Names and Codes) is the international terminology standard for identifying health observations, measurements, and document types in healthcare information systems, such as electronic health records (EHRs)

LOINC provides a set of universal codes and names for laboratory and clinical observations, including measurements like blood pressure and cholesterol levels, and clinical assessments like standardized questionnaires and surveys that collect comprehensive information from patients to diagnose their health and are used to determine their appropriate treatment plan. These codes allow for interoperability between different healthcare systems, enabling seamless exchange and aggregation of health data.

LOINC Basics

- A LOINC concept is represented by a code and a corresponding name, e.g. 8480-6 Systolic blood pressure.
- LOINC codes are unique and permanent, though codes can be deprecated or discouraged and replaced by an alternate concept.
- There are over 100,000 concepts represented in LOINC, each distinguishing the given observable.
- There are two releases of LOINC each year in February and August. It is strongly recommended that the most current version of LOINC is used, and that it is implemented within 90 days of release.
- LOINC use is bound by the LOINC License. In general, LOINC codes are licensed free-for-use for all purposes except the creation of a competing code system.

Please see further details on LOINC and the LOINC Ontology in these pages:

LOINC Resources

- LOINC Primer
- LOINC User Guide
- LOINC Knowledge Base
- SearchLOINC
- LOINC Hierarchy Browser
- LOINC Terminology Service using HL7 FHIR
- LOINC Community Forum

2.1 LOINC Features

This section contains a high-level overview of LOINC with some additional information in areas of direct relevance to subsequent chapters of this guide. For a more complete introduction to LOINC and supporting resources see http://loinc.org/get-started.

Logical Observation Identifiers Names and Codes (LOINC®) is a terminology standard for identifying laboratory tests and other measurements. It specifies universal codes, names, and other attributes for laboratory results as well as clinical reports, physical exam findings, survey instruments and other observations. It was developed to enable the exchange and pooling of results from diverse sources in order to enhance clinical care, outcomes management and research.

Scope

LOINC codes include laboratory and other clinical observations. The laboratory portion of LOINC includes measurements made on specimens, such in chemistry, hematology, serology, microbiology (including parasitology and virology), toxicology, cell counts, antibiotic susceptibilities, and more. The clinical portion of LOINC includes codes for observations made on patients and populations. LOINC has codes for observations like vital signs and a

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wide range of other clinical observations. Vital signs and anthropomorphic measurement are included in the scope of the cooperation agreement. Other clinical domains are not currently included in the scope of the agreement with IHTSDO.

LOINC includes codes that identify test observations (e.g. blood culture, antibiotic sensitivity)**.** Other code systems, including SNOMED CT, often provide values that can be applied to represent results (e.g. Staphylococcus, amoxicillin). If we consider the observation as a question and the observation values as answers, LOINC provides codes for the questions and SNOMED CT provides codes for many of the non-numeric answers.

Maintenance, Governance and Licensing

LOINC is owned, maintained, and licensed by the Regenstrief Institute, Inc. (RII). RII is a non-profit medical research organization associated with Indiana University School of Medicine. LOINC is available free of charge subject to the license conditions and terms of use http://loinc.org/terms-of-use. Updated versions are released twice a year. The LOINC web search tool is available at http://search.loinc.org The LOINC database and a free browsing and mapping program, the Regenstrief LOINC Mapping Assistant (RELMA®), can be downloaded from https://loinc.org/relma.

Usage

LOINC is widely adopted, and the user community continues to grow rapidly. The worldwide LOINC community presently has more than 34,000 users in 195 countries (see http://loinc.org/atlas).

Within the USA, LOINC has been adopted by large reference laboratories, health information exchanges, healthcare organizations, insurance companies, research applications, and several national standards initiatives and programs. In particular, LOINC was adopted as the standard for laboratory orders and results as part of the Centers for Medicare and Medicaid Services Electronic Health Record (EHR) "Meaningful Use" incentive program as specified in the Standards and Certification Criteria.

Outside the USA, LOINC has also been adopted as a national standard in more than 25 countries. In addition, there are many large data exchanges using LOINC around the world.

Structure

Each test is represented by a formal six-part LOINC name and assigned a LOINC code, which is a number with a check digit (see Table 1). Each code is also assigned an observation class (e.g., chemistry, hematology, and radiology); related names (to assist searches of the database); and other attributes.

For most classes of laboratory observations, there is also a "short name" (less than 40 characters long), and a Long Common Name that is more clinician friendly.

LOINC Terms, Codes and Axes

LOINC fully-specified names (including laboratory test results, clinical measurements, and results of other diagnostic studies) are defined in terms of six major axes as described in Table 2: 1. Component name, 2. Property, 3. Time, 4. System, 5. Scale, and 6. Method. The fully-specified (formal) LOINC name must include entries for the first five major axes; the method axis is included only when the method distinction makes an important difference to the clinical interpretation of the result.

Four additional minor axes are challenge information; adjustments; supersystem, e.g., fetus, blood product; and time operators (maximum, minimum, last, first), which are only used when relevant. The challenge axis is the most complex of the minor axes and includes the amount, route, and timing (e.g., oral glucose tolerance test). The details about these other axes can be found in the LOINC Users 'Guide.

Examples of LOINC terms are shown in this table

LOINC Code	LOINC name (Componentname:Property:Time:Specimen:Scale:Method)
2951-2	SODIUM:SCNC:PT:SER/PLAS:QN

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2955-3	SODIUM:SCNC:PT:UR:QN
2956-1	SODIUM:SRAT:24H:UR:QN
2164-2	CREATININE RENAL CLEARANCE:VRAT:24H:UR:QN
1514-9	GLUCOSE^2H POST 100 G GLUCOSE PO:MCNC:PT:SER/PLAS:QN
3665-7	GENTAMICIN^TROUGH:MCNC:PT:SER/PLAS:QN
17863-2	CALCIUM.IONIZED:MCNC:PT:SER/PLAS:QN
2863-9	ALBUMIN:MCNC:PT:SNV:QN:ELECTROPHORESIS

Axis Name	**Description/Example**
Component name	The analyte or attribute being measured or observed. E.g., sodium, body weight.
(Kind of) Property	Differentiates kinds of quantities relating to the same substance. E.g., mass concentration, catalytic activity.
Time (Aspect)	Identifies whether the measurement is made at a point in time or a time interval. E.g. 24H for a urine sodium concentration.
System	The specimen, body system, patient, or other object of the observation. E.g. cerebral spinal fluid, urine, radial artery.
(Type of) Scale	The scale or precision that differentiates among observations that are quantitative, ordinal (ranked choices), nominal (unranked choices), or narrative text.
(Type of) Method	An optional axis that identifies the way the observation was produced. It is used only when needed to distinguish observations that have clinically significant differences in interpretation if made by different methods.

LOINC creates only those combinations that have clinical relevance in laboratory medicine. Terms are not created by blind permutations. Regenstrief (with guidance from the LOINC committee) reviews new code requests carefully to make sure that only meaningful LOINC codes that can be pragmatically used by the LOINC community are added to the database.

LOINC Parts

The atomic elements that comprise a fully-specified LOINC name are called LOINC "Parts". Each fully-specified name will consist of 5 or 6 parts (depending on whether the Method is important for interpreting the result), each with a part type corresponding to one of the major axes described above. Each LOINC Part is also assigned an identifier (that begins with the prefix "LP"), and internally Regenstrief maintains links between the full LOINC term and the Parts that comprise it. Regenstrief uses LOINC Parts in many aspects of LOINC development, such as: adding synonymy, building hierarchies, creating alternate display names, linking descriptive text, and more.

The Parts and their linkages are not distributed as part of the main LOINC table, but they are part of the content used by the RELMA program.

LOINC "part" concepts (e.g. *sodium*) serve as building blocks for the description of tests and observations, in association with a set of semantic relations. For example, *Sodium:SCnc:Pt:Ser/Plas:Qn*, the laboratory test in which the molar concentration of sodium is measured in the plasma (or serum) is identified by 2951-2.

The list of relations of this concept to other concepts ("parts") is shown in the examples below. For example, the "part" concept *Sodium* is linked to this test by the relationship *component*.

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	LOINCCode	LOINC Name
LOINCTerm	2951-2	**Sodium [Mass or Moles/volume] in Serum or Plasma**
Part Type	**Part No.**	**Part Name**
Component	LP15099-2	Sodium
Property	LP6860-3	SCnc [Substance Concentration]
Time	LP6960-1	Pt [Point in time (spot)]
System	LP7576-4	Ser/P1as [Serum or Plasma]
Scale	LP7753-9	Qn
Method		

	LOINCCode	LOINC Name
LOINC Term	5778-6	**Color of Urine**
Part Type	**Part No.**	**Part Name**
Component	LP28806-5	Color
Property	LP6886-8	Type
Time	LP6960-1	Pt [Point in time (spot)]
System	LP7681-2	Urine
Scale	LP7750-5	Nom [Nominal]
Method		

The LOINC terminology does not use description logic. However, the formal definitions provided by LOINC all conform to the 6-axis template (described in Table 2) and make use of named semantic relations.

In addition to creating codes for single tests, measurements, or observations, LOINC also defines concepts to represent collections of discrete elements such as panels (batteries), forms, and answer lists.

For example, a CBC/FBC test (complete/full blood count) is expected to deliver a set of results for different components including leukocytes, erythrocytes, hemoglobin, hematocrit, etc.

Hierarchy Tree Structure

Regenstrief creates hierarchies to organize LOINC terms based on a structured arrangement of LOINC elements (also known as parts).RELMA has 5 selectable hierarchy trees that are commonly used to narrow the search limits returned:

- Class
- Multiaxial (component/system)
- System (specimen)
- Component
- Method

The LOINC hierarchy group LOINC concepts by specifying the parent-child relationship between the elements used in one (or more of the axes).

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Most often, the hierarchies are used to restrict searches performed using RELMA.

The Multiaxial hierarchy organizes LOINC codes based on more than one of the LOINC name axes. For laboratory tests, it organizes first by the Component and then by the System. The Multiaxial Hierarchy is distributed as an accessory file that is part of the LOINC release.

View of the Class Hierarchy - Click here to expand...

Search Constraints | Class Hierarchy | Multi-axial Hierarchy | Component Hierarchy | System Hierarchy | Method Hierarchy

Row	Category orName	Component	Property	Timing	System	Scale	Method	ExUnits	DocSection	Rank	Code
1	Laboratory Categories										LP29693-6
2	Antibiotic Susceptibilities										LP7755-4
1772	Allergy Testing										LP7756-2
5729	Blood Bank Tests										LP7776-0
6649	Cardiopulmonary										LP172861-9
6657	Cell Markers										LP7783-6
8149	Challenge chemistry tests										LP7784-4
11878	Chemistry non challenge tests										LP7786-9
21306	Coagulation Tests										LP7788-5
22122	Cytology Studies										LP7789-3
22200	Drug toxicology tests										LP7790-1
29518	Drug Doses										LP7791-9
29925	Fertility Testing										LP7798-4
30166	Hematology/Cell counts										LP7803-2
32338	HLA Antigens										LP7806-5
32765	History relevant to laboratory testing										LP175679-2
32773	HNA										LP158133-1
32790	HPA antigen										LP65557-8
32807	Laboratory orders										LP94892-4
32830	Microbiology Tests (Culture, DNA, Ag, and Ab)										LP7819-8
43701	Miscellaneous tests										LP7820-6
43956	Molecular pathology tests										LP7822-2
45303	Deletions										LP7823-0
45337	Inversions										LP146061-9
45342	Mutations										LP7824-8
46273	Rearrangements										LP7825-5
46304	Translocations										LP7828-9
46416	Trinucleotide Repeats										LP7826-3
46467	Trisomy repeats										LP7827-1
46487	Miscellaneous molecular pathology										LP121011-3
46500	HL7 genetics										LP70593-6
46555	HL7 Cytogenetics										LP111381-2

View of the Multi-axial Hierarchy - Click here to expand...

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Search Constraints | Class Hierarchy | Multi-axial Hierarchy | Component Hierarchy | System Hierarchy | Method Hierarchy |

Row	Category orName	Component	Property	Timing	System	Scale	Method	ExUnits	DocSection	Rank	Code
1	Microbiology										LP31755-9
2	Microorganism										LP14559-6
3	Bacteria										LP98185-9
4	Bacteria										LP14082-9
34	Bacteria biotype | Isolate										LP180118-4
36	Bacteria identified										LP37205-9
338	Bacterial genes										LP135277-4
359	Bacteria Identification tests										LP40282-3
388	Antibody coated bacteria										LP14327-8
395	Actinobacillus sp										LP28877-6
396	Actinobacillus sp Identified | XXX										LP49251-9
398	Actinobacillus pleuropneumoniae										LP14066-2
399	Actinobacillus pleuropneumoniae 1 Ab | Bld-Ser-Plas										LP47652-0
402	Actinobacillus pleuropneumoniae 3 Ab | Bld-Ser-Plas										LP47653-8
405	Actinobacillus pleuropneumoniae 5 Ab | Bld-Ser-Plas										LP47654-6
408	Actinobacillus pleuropneumoniae 7 Ab | Bld-Ser-Plas										LP47655-3
411	Actinobacillus pleuropneumoniae biovar 2 | XXX										LP47656-1
413	Actinobacillus pleuropneumoniae Ab | Bld-Ser...										LP46416-1
418	Actinobacillus pleuropneumoniae | Isolate										LP46415-3
420	Actinobacillus pleuropneumoniae | XXX										LP47657-9
422	Actinobacillus suis | Isolate										LP47658-7

View of the System Hierarchy - Click here to expand...

Search Constraints | Class Hierarchy | Multi-axial Hierarchy | Component Hierarchy | System Hierarchy | Method Hierarchy |

Row	Category orName	Component	Property	Timing	System	Scale	Method	ExUnits	DocSection	Rank	Code
1	Specimen										LP7593-9
71	Serum, Plasma or Blood										LP7579-8
98	Serum or Blood										LP7575-6
106	Blood										LP7057-5
5155	Blood arterial										LP7067-4
5258	Blood capillary										LP7068-2
5399	Blood venous										LP7073-2
5459	Blood mixed venous										LP7071-6
5501	Blood arterial + Blood venous										LP101985-2
5502	Blood special sources										LP40337-5
5503	Dried blood spot										LP21304-8
5948	Blood cord										LP7069-0
6086	Blood central										LP40338-3
6113	Blood drawn from CRRT circuit										LP63632-1
6115	Blood peripheral										LP7072-4
6118	Positive blood culture										LP183539-8
6136	Plasma										LP7479-1
15833	Platelet poor plasma or blood										LP135710-4
15835	Serum or Plasma										LP7576-4
24439	Serum or Plasma + Blood venous										LP100815-2
24441	Serum										LP7567-3
44222	Aspirate										LP7037-7
44240	Bartholin cyst										LP175662-8
44242	Blood cellular components										LP40340-9
46551	Body fluid										LP7238-1
47816	Body Site Specimen										LP30569-5
49167	Breast source fluid										LP40344-1
49232	Ear fluid										LP157723-0
49234	Calculus (stone)										LP7096-3
49314	Cell types										LP30570-3

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Other Features

Panels

A LOINC panel is a grouping of related laboratory tests or observations often performed together or reported as a single entity.
Components of a LOINC panel include:

- **Panel name:** Describes the group of tests or observations being measured
  - Example: "Basic Metabolic Panel"
- **Component tests:** Lists individual tests or observations included in the panel, each with its corresponding LOINC code.
  - Example: "Glucose", "Electrolytes", "Kidney function tests", etc.
- **LOINC code:** Provides a unique identifier for the entire panel, facilitating standardized reporting and integration into electronic health records (EHRs) and healthcare information systems.
  - Example:
    - Code: 32451-7
    - Term: Basic Metabolic Panel
    - *Properties*:
      - Component: Intravascular systolic
      - Property: Pres (Pressure)
      - Time: Pt (Point in time)
      - System: Arterial system
      - Scale: Qn (Quantitative)

Example

This example demonstrates how LOINC codes, panels, and their respective parts and terms work together to identify and describe medical measurements and observations in a standardized and easy-to-understand manner.

- **LOINC Code**: 8480-6 (Systolic blood pressure)
- **LOINC Panel**: Basic Metabolic Panel (LOINC Code: 32451-7)
  - **Component Tests**: Glucose (LOINC Code: 2345-7), Electrolytes (LOINC Code: 3456-8), Kidney function tests (LOINC Code: 4567-9), etc.

LOINC Answer List

A **LOINC Answer List** is a predefined set of possible answers associated with a LOINC term, typically used for representing qualitative or categorical results. These lists are often tied to laboratory tests, surveys, or other clinical observations where the result is selected from a finite set of options. For example, the LOINC code **4544-3** (Rhesus factor) uses an answer list that includes values such as **“Positive”** and **“Negative”** to indicate the presence or absence of the Rh antigen on red blood cells. LOINC Answer Lists help standardize the possible responses for specific clinical concepts, ensuring consistency in how test results or observations are recorded and interpreted across systems.

LOINC Answer Values

LOINC Answer Values are the specific entries or responses within a LOINC Answer List. These values represent the standardized options clinicians or systems can choose from when documenting the result of a test or clinical observation. For example, in a LOINC Answer List for the code **32623-1** (Smoking status), possible answer values might include **“Never Smoked”**, **“Former Smoker”**, and **“Current Smoker”**. These predefined answer values

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ensure that responses are recorded uniformly, reducing ambiguity and facilitating the comparison of data across different systems and contexts.

LOINC Groups

LOINC Groups are collections of related LOINC codes that are grouped together based on common clinical characteristics or use cases, such as a specific type of test or panel of tests. They simplify the management and retrieval of LOINC-coded data by allowing a single group code to represent multiple individual LOINC codes. For example, the LOINC Group **LG51000-9** represents the **Complete Blood Count (CBC) panel**, which includes codes for related measurements like hemoglobin, hematocrit, white blood cell count, and platelet count. LOINC Groups make it easier to organize and query sets of related tests or observations in clinical systems.

https://loinc.org/groups/

2.2 LOINC Extension to SNOMED CT

The LOINC Ontology is represented as an **Extension to SNOMED CT**, which provides a way to integrate LOINC (Logical Observation Identifiers Names and Codes) codes into SNOMED CT, enhancing interoperability between these two major terminologies in clinical and laboratory domains. The extension ensures that LOINC codes can be used as identifiers for relevant SNOMED CT concepts, allowing consistent and standardized data exchange across different healthcare systems

Overview

The diagram below how the **LOINC Ontology** extends the **SNOMED CT International Edition**, enabling the representation of LOINC-coded laboratory observations within SNOMED CT's logical framework.

The **SNOMED CT International Edition** consists of core international components, structured under:

- 900000000000207008 | SNOMED CT core module (core metadata concept)|
- 900000000000012004 | SNOMED CT model component module (core metadata concept)|

The **LOINC Ontology** builds on SNOMED CT by incorporating **Alternate Identifiers**, aligning LOINC codes with SNOMED CT concepts. Its content resides within the 11010000107 | LOINC Extension module (core metadata concept) |.

Each version of the LOINC Ontology depends on a specific version of the SNOMED CT International Edition, and the LOINC Ontology cannot function independently. Any implementation of the LOINC Ontology requires the SNOMED CT International Edition for proper use.

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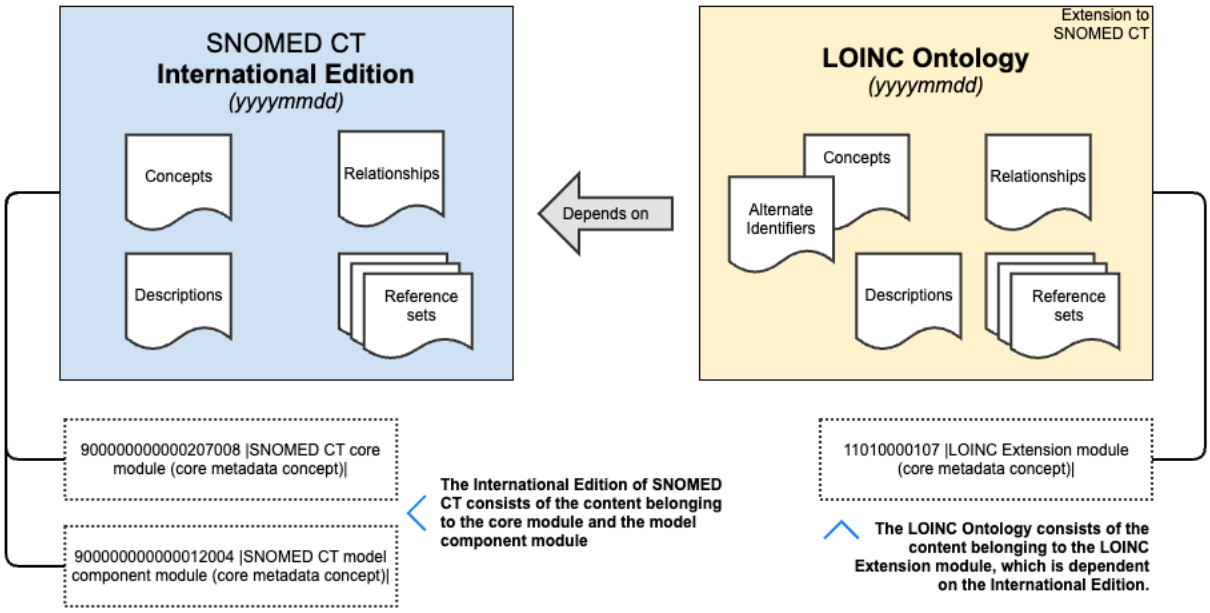

Key Features of the LOINC Extension

1. **SNOMED CT Extension Format**:
    - The extension is published as a **standard SNOMED CT extension** and adheres to the format specifications outlined by SNOMED International (at snomed.org/rfs and snomed.org/extpg).
    - This ensures that the extension maintains consistency with the core SNOMED CT release format and other compatible extensions.
2. **LOINC Codes Modeled as SNOMED CT Concepts**
    - LOINC terms are integrated into the extension ensuring a precise **semantic alignment** between the two terminologies.
    - Each LOINC term included in the LOINC Ontology is represented as a **SNOMED CT concept**, with its properties explicitly defined according to SNOMED CT's logical framework and concept model.
3. **Alternative Identifiers**:
    - The LOINC codes are assigned as **alternative identifiers** to the SNOMED CT concept representing the equivalent meaning as the LOINC code.
    - These alternative identifiers are maintained in the **Identifier File** of the extension in compliance with the SNOMED CT Identifier File Specification.
        - **Identifier File Structure**:
            - The Identifier File associates LOINC codes to semantic equivalent SNOMED CT concepts.
            - Each entry in the Identifier File specifies:
                - The SNOMED CT concept ID.
                - The corresponding LOINC code as the alternate identifier.
                - Metadata such as effective dates, active status, and module identifiers.

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3. Clinical Use Case

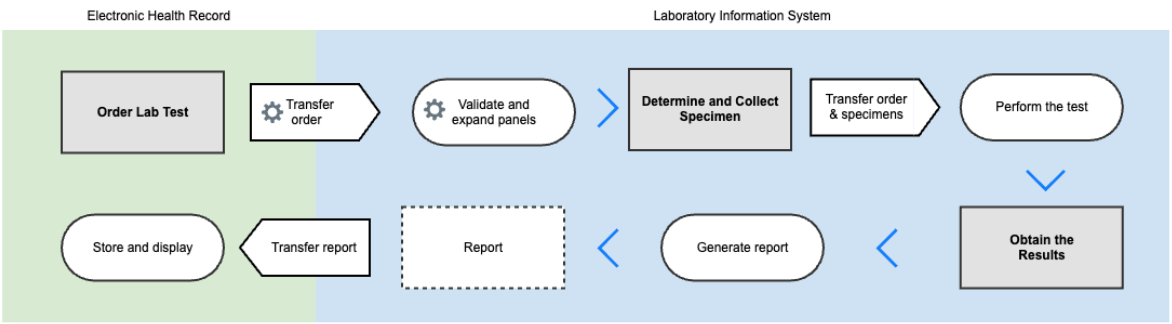
This chapter explores clinical use cases that demonstrate how the LOINC Ontology, as an extension to SNOMED CT, supports standardized data exchange and interoperability. It outlines clinical workflows where the integration of LOINC and SNOMED CT enhances laboratory reporting, diagnostics, and clinical documentation. The use case scenarios illustrate how this combined terminology framework improves data consistency, decision support, and system integration in healthcare.

3.1 Clinical Workflow

This page outlines the key clinical scenario/workflow where SNOMED CT and the LOINC Ontology are essential for standardizing and structuring healthcare data.

The integration of laboratory test data between Electronic Health Records (EHR) and Laboratory Information Systems (LIS) is crucial for ensuring efficient, accurate, and consistent patient care. To achieve this, healthcare systems leverage standardized coding systems such as SNOMED CT and LOINC. SNOMED CT provides a comprehensive clinical terminology for describing patient data, while LOINC offers a universal standard for identifying lab tests and their results.

1. **Ordering Lab Tests**
    a. Clinicians use SNOMED CT codes to search and select tests in the EHR system.
    b. The selected tests are associated with LOINC codes, ensuring standardized data for lab orders.
2. **Transferring Orders to the Lab**
    a. The EHR system sends lab orders to the LIS using a structured message format (e.g., FHIR or similar standards), including SNOMED CT and LOINC codes.
    b. This ensures the lab receives clear and consistent instructions on the required tests.
3. **Performing the Tests**
    a. The lab uses the LOINC codes to identify the exact tests to be performed.
    b. SNOMED CT is used to provide detailed descriptions, such as specimen types and any relevant clinical observations.
4. **Generating and Analyzing Test Results**
    a. The lab performs the tests and records results, standardizing the data using LOINC codes.
    b. SNOMED CT may be used to document clinical conditions or observations associated with the results.
5. **Transferring Results Back to the EHR**
    a. Test results, along with associated LOINC and SNOMED CT codes, are transferred from the LIS to the EHR using a structured message format.
    b. This allows for seamless integration of lab results into the patient's records.
6. **Using Lab Data**
    a. The standardized lab data is then used for clinical decision-making, research, and analytics, such as evaluating the effectiveness of treatments for conditions like diabetes.



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3.2 Use Case Scenarios

This page provides an overview of key use cases for the LOINC Ontology

Use Case 1: Ordering Lab Tests

Description: When clinicians order laboratory tests, ensuring clarity and accuracy is essential to avoid errors, miscommunication, and delays in patient care. Clear identification of tests and consistent communication between systems are crucial for seamless workflows.

Clinical Example: A physician orders a blood glucose test for a patient. The test is selected using a SNOMED CT code in the EHR and the corresponding LOINC code is automatically derived to ensure accurate transmission to the laboratory using a code system applied by the Laboratory Information System.

Clinical Benefits:

- **Precision** in test ordering and communication.
- **Standardized data** reduces ambiguity and errors.
- Improved workflow efficiency and **patient safety**.

Use Case 2: Standardizing Laboratory Test Results from SNOMED CT to LOINC

Description: The integration of LOINC with SNOMED CT enables the standardization of laboratory test results by converting SNOMED CT-encoded data to corresponding LOINC codes. This ensures uniform reporting across healthcare systems and facilitates seamless data exchange between different terminologies.

Clinical Example: A clinician orders a lipid panel test using SNOMED CT codes. When the lab completes the test, the results are encoded in SNOMED CT and automatically converted to LOINC codes for consistent reporting and sharing with other healthcare providers.

Clinical Benefits:

- Enhanced **data interoperability** between healthcare systems.
- Consistent and accurate **lab test reporting**.
- Reduces discrepancies in data representation.
- Improves **clinical decision-making** and patient care by ensuring standardized results.

Use Case 3: Cross-Terminology Navigation, Querying and Retrieval of Laboratory Data

Description: The integration of SNOMED CT and LOINC empowers healthcare professionals to perform seamless cross-terminology queries for laboratory data. SNOMED CT's formal definitions and hierarchical structure serve as the engine that enables effective retrieval and interpretation of LOINC-encoded data. This allows healthcare systems to access relevant lab information regardless of whether the data was initially recorded in SNOMED CT or LOINC.

Clinical Example: A researcher studying diabetes queries electronic health records for glucose-related tests. Using SNOMED CT's hierarchical definitions, the system identifies and retrieves all relevant lab data encoded in both SNOMED CT and LOINC. This ensures a comprehensive dataset for analysis, capturing tests, measurements, and observations related to glucose levels.

Clinical Benefits:

- Efficient **retrieval** of lab data across different coding systems, powered by SNOMED CT's formal definitions and hierarchies.
- Supports **comprehensive research and analysis** by ensuring no relevant data is overlooked.
- Facilitates **data-driven insights** and evidence-based care by integrating diverse datasets.

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- Enhances **data interoperability** for healthcare applications through the alignment between SNOMED CT and LOINC.

Use Case 4: Standardized Reporting of Laboratory Procedures and Observations

Description: Linking SNOMED CT and LOINC ensures standardized reporting of laboratory procedures and observations. This consistency improves documentation, communication, and compliance with reporting requirements across healthcare organizations.

Clinical Example: A hospital uses SNOMED CT to document lab procedures during diagnostic tests. The LOINC codes are automatically derived for standardized reporting to insurance providers and public health agencies.

Clinical Benefits:

- Improves accuracy and consistency in lab reporting.
- Facilitates clear communication among healthcare stakeholders.
- Supports regulatory compliance and reimbursement processes.
- Reduces variability and ambiguity in lab documentation.

Use Case 5: Integration of Clinical Decision Support Systems for Laboratory Data

Description: Integrating LOINC with SNOMED CT enhances Clinical Decision Support Systems (CDSS) by ensuring seamless use of laboratory data. This integration allows CDSS to generate accurate, evidence-based recommendations and alerts for clinicians.

Clinical Example: In a primary care setting, a CDSS uses SNOMED CT-encoded patient diagnoses to identify potential issues. It retrieves relevant lab results encoded in LOINC to generate alerts for abnormal findings and provides clinical recommendations.

Clinical Benefits:

- **Enhances clinical decision-making** with timely alerts and recommendations.
- Supports **interoperability** between diagnostic and decision-support systems.
- Improves patient safety by ensuring abnormal results are identified promptly.
- Facilitates **evidence-based interventions** for better patient outcomes.

Use Case 6: Facilitation of Interoperable Health Information Exchange for Laboratory Results

Description: The alignment between SNOMED CT and LOINC supports the seamless interoperability of tests and results using a single ontology, regardless of whether the source is LOINC or SNOMED CT. This linkage enables the standardized exchange of laboratory results across different healthcare systems, promoting continuity of care, improving coordination, and enhancing population health management.

Clinical Example: A patient's lab tests are ordered using LOINC codes to specify the tests, while the results are captured using SNOMED CT codes for findings. Because the source data can be represented in either SNOMED CT or LOINC, systems that utilize either code system can seamlessly share data. This integration allows healthcare providers to analyze test results within a unified, common ontological framework, ensuring consistency and accuracy in clinical decision-making and follow-up care.

Clinical Benefits:

- **Promotes interoperability** by enabling consistent data exchange.
- Supports **care coordination** across different healthcare providers.
- Facilitates **population health management** through standardized data.
- Ensures **continuity of care** by providing accurate and timely lab results.

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2.7 Use Case: Follow-ups

Description: Effective follow-up care is essential for managing chronic conditions and ensuring patients receive timely monitoring. Automating follow-up processes reduces missed appointments and improves health outcomes.

Clinical Example: A patient diagnosed with hyperlipidemia is scheduled for follow-up lipid panel tests at regular intervals. The initial diagnosis (SNOMED CT) and follow-up tests (LOINC) are linked to automate scheduling.

Clinical Benefits:

- **Automated follow-ups** ensure continuity of care.
- Reduces missed appointments.
- Improves patient compliance and **health outcomes**.

2.8 Use Case: Financial Logic

Description: Accurate coding of lab orders and diagnoses is crucial for insurance processing, reimbursement, and financial management in healthcare. Standardized data helps ensure efficient claim approvals and billing.

Clinical Example: A clinician orders a diagnostic test for anemia. The diagnosis (SNOMED CT) and corresponding test result (LOINC) facilitate accurate insurance claim submission.

Clinical Benefits:

- **Efficient reimbursement** and claims processing.
- Reduces coding errors and **claim denials**.
- Ensures financial transparency and **compliance**.

2.9 Use Case: Efficient Searching

Description: The design of SNOMED CT, combined with available terminology services, enables systems to efficiently and accurately support the entry of both LOINC and SNOMED CT content. This integration enhances data entry, search capabilities, and the standardized storage of lab data, improving the accuracy and efficiency of clinical workflows.

Clinical Example: A clinician uses a system powered by SNOMED CT's advanced search and terminology services to quickly identify and select appropriate lab tests. The system leverages the integration between SNOMED CT and LOINC, allowing the clinician to find tests using intuitive search terms while capturing the test orders with associated LOINC codes and storing the results using codes from either or both SNOMED CT and LOINC. This ensures standardized, accurate, and efficient data entry, facilitating seamless clinical documentation and interoperability.

Clinical Benefits:

- **Improves data entry** accuracy and efficiency.
- Facilitates **consistent storage** and retrieval of lab results.
- Enhances overall **workflow efficiency** in clinical settings.

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4. Content Development Principles

LOINC Terms and SNOMED CT Observable Entities

LOINC Terms are primarily represented within the Observable Entity hierarchy of SNOMED CT for several reasons. Firstly, LOINC terms predominantly capture observable clinical phenomena, such as laboratory test results, measurements, observations, and assessments, which align closely with the scope of observable entities in SNOMED CT. This conceptual alignment ensures that many LOINC terms fit naturally within SNOMED CT's structure, facilitating their integration into the broader clinical terminology framework. Additionally, LOINC terms often require a detailed representation of properties, scales, units, methods, and other attributes associated with clinical observations.

However, it is important to note that certain areas of LOINC, such as document-related terms or results of observations, may be more appropriately represented in other SNOMED CT hierarchies.

SNOMED CT's structured framework supports this flexible approach, enabling precise representation of LOINC concepts and ensuring that all relevant attributes are accurately documented.

LOINC Parts as SNOMED CT Attribute Values

LOINC Parts are represented as SNOMED CT attribute values to enable the definition of LOINC Terms using SNOMED CT's logical foundation while retaining the meaning represented in LOINC. This approach ensures a granular representation of defining attributes like properties, scales, methods, components, and systems, facilitating precise documentation of clinical concepts. Additionally, leveraging SNOMED CT's semantic framework maintains consistency, accurately associating each component with the appropriate context and contributing to standardized clinical information representation.

Development Process

To express LOINC terms as SNOMED CT concepts, a structured process was established. This ensures efficient development efforts resulting in content with a high level of consistency and accuracy throughout.

Here's a breakdown of the process and its objectives:

1. **Utilizing latest LOINC Parts**: The process begins by utilizing the latest list of LOINC Parts, which are relevant for the preview.
2. **Mapping LOINC Parts**: LOINC Terms are modeled based on various LOINC Parts, with specific instructions provided for each property type.
3. **Assigning Attributes**: Attributes necessary for modeling LOINC Terms are determined based on the LOINC Property type. Templates are provided for different scenarios, such as observable with component, observable with component and relative to, observable with inheres in, and susceptibility observable. These templates and their criteria for selection are described in the sub-pages listed below.
4. **Modeling**: LOINC axes (Property, Scale, Time, System, Method, Component, etc.) are mapped to appropriate SNOMED CT attributes.
5. **Terming and Description**: Fully Specified Name (FSN) and a SNOMED-compliant acceptable description are created based on a defined set of rules.
6. **Validation**: Where a mapped attribute is not available for a given LOINC Part, depending on the axes it may be that the concept can be considered valid (although primitive and not fully defined), or in the case of some essential part like 'component', the concept cannot be considered fit for use and is suppressed - not included in the output of the process.
7. **Creation and Review**: New observable entity concepts are created in the LOINC Extension project (and updates are made to previously modeled content as required), and they undergo quality assurance (QA) review, classification, validation, etc., to ensure accuracy and consistency.
8. **Modeling Examples**: Examples are provided to illustrate how the content should be structured and how LOINC identifiers and descriptions should be integrated into SNOMED concepts.

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Conversion of LOINC Terms to SNOMED CT Concepts - A Templated Solution

The following pages describe the applied templates and provide examples.

Additional SNOMED CT Concepts Required

The driving philosophy of the SNOMED LOINC Extension is to faithfully translate LOINC content into a SNOMED CT representation without adding, removing or modifying any term, and without the need for additional manual intervention. However, there are a small number of additional SNOMED CT concepts that were required in order to make the transition from a LOINC structure to a SNOMED one:

SCTID | FSN |	Description
11010000107 |LOINC Extension module (core metadata concept)|	This is the concept that represents the LOINC Extension module itself. All SNOMED CT components are considered to be "in" a module, and every RF2 row in the LOINC Extension release files will show this identifier in the moduleId column.
30051010000102 |LOINC code identifier (core metadata concept)|	This concept is used in the alternate identifier file to indicate that the code appearing in the first column of that file is a LOINC Term identifier.
540131010000107 |Ratio observable (observable entity)|	It was decided that observables that represented a ratio between two quantities needed a primitive grouper.
635111010000100 |Logical Observation Identifiers Names and Codes Orderable Reference Set (foundation metadata concept)|	This concept represents the simple reference set (or ValueSet) of the LOINC Terms which are considered orderable. That is, the LOINC.csv file ORDER_OBS column holds a value of either "Orderable" or "Both" for this term. "Both" here means that the LOINC Term is both orderable and observable, and - in our implementation - this means that it will appear in both of these reference sets.
635121010000106 |Logical Observation Identifiers Names and Codes Observation Reference Set (foundation metadata concept)|	This concept represents the simple reference set (or ValueSet) of the LOINC Terms which are considered observable.

4.1 Alternate Identifiers - Identifying LOINC Terms in SNOMED CT

More than an Equivalent Map

When a concept in one system can be considered equivalent to some other code in another code system, we can express that in a mapping between those two code systems. However, in the case of the SNOMED LOINC Extension we are not saying that two separate codes can be *considered* equivalent, we are instead stating that the SNOMED CT concept is *exactly the same entity* as the LOINC Term that it is expressing. The SNOMED CT concept is an *alternative representation* of the LOINC Term, and can be considered to have two identifiers - a SNOMED CT SCTID and a LOINC code - which could theoretically be used interchangeably; software challenges notwithstanding.

The LOINC identifier in this case is called an Alternate Identifier in the SNOMED CT LOINC Extension. This is an RF2 file that specifies the LOINC identifier for each LOINC Term that has been expressed in a SNOMED CT format, along with the SCTID which has been assigned. The two identifiers are considered to be of equal standing and are displayed, for example, with equal prominence in the SNOMED CT Browser.

Note that the link between the entity expressed as LOINC and expressed in a SNOMED CT format remains true even if a LOINC Term should be deprecated.

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Representation in RF2

The Alternate Identifier is populated in the LOINC Extension and will be named something like Snapshot/Terminology/sct2_Identifier_Snapshot_INT_20250321.txt

The layout of the file is described in the RF2 Specification here: 4.2.4 Identifier File Specification

Example

alternateIdentifier	effectiveTime	active	moduleId	identifierSchemeId	referencedComponentId
100042-1	20250321	1	11010000107	30051010000102	480111010000101
100046-2	20250321	1	11010000107	30051010000102	480121010000107
100057-9	20250321	1	11010000107	30051010000102	480131010000105
100058-7	20250321	1	11010000107	30051010000102	480141010000102
100059-5	20250321	1	11010000107	30051010000102	480151010000100

SNOMED Identifiers for LOINC concepts

SNOMED CT identifiers are not random numbers, they follow a number of rules in their format and a well trained eye can determine a lot of information about them. This topic is discussed fully in the RF2 Release Specification : 6 SNOMED CT Identifiers

If we consider the identifier for the LOINC Extension module - 11010000107, we can split that up into 4 parts: 1 | 1010000 | 10 | 7 which take the following meanings reading from right to left:

- The number 7 here is the Verhoeff checksum digit, which will alert systems to any simple mistakes in manual entry or spreadsheet mangling of SCTIDs
- The partition identifier identifier 10 tells us firstly that the next 7 numbers will indicate a namespace identifier and secondly that this SCTID was created to be applied to a concept, rather than a description or relationship
- 1010000 is the Namespace given to the LOINC Extension. Every SNOMED component created for the LOINC project which is assigned an SCTID will contain this namespace sequence. That is bound to that component for its lifetime, so even if a concept should subsequently be promoted up to the International Edition (through some agreement between Regenstrief and SNOMED International), that identifier would remain unchanged, and its origin in the LOINC Extension would remain clear.
- The most lefthand set of numbers after the namespace represent a sequence number. In this case the first concept created for the SNOMED LOINC Extension was the module concept itself - this is extremely satisfying to those of us who care about such attention to detail.

4.2 Template Based Content Creation

LOINC Terms are expressed as SNOMED CT concepts by following a transformation algorithm detailed in pseudocode. This has been implemented as a number of Java classes, freely available in this package in the SNOMED International GitHub Reporting Engine project.

Overview

The processing algorithm follows these high level steps

1. The Java class loads the Loinc.csv and Part.csv file from the LOINC release

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2. A part detail file is also supplied, which specifies part identifiers ("LP") for each part used in each LOINC Term
3. The process works through the part detail file, selecting a template based on the 'Property' part of each LOINC Term
4. Each part is mapped to a SNOMED CT Attribute where:
    a. The Part Type maps to a SNOMED Attribute type as specified in the template and
    b. The Part Number maps to a SNOMED Attribute value as specified via the Part/Attribute Map (maintained in the Snap2Snomed tool)
5. The terms for each concept are then completed, using the preferred terms of the attribute values that have been modelled.
6. The entire set of modelled concepts is the compared against the LOINC Extension in the SI Authoring Platform
7. A delta archive is produced which details changes required from the previous state of the content.

In addition, LOINC Panels are created as primitive concepts, where the individual tests in each panel are available as transformed SNOMED CT concepts.

The templates used for the various LOINC Properties are as follows:

See LOINC Morning Presentation

4.2.1 Quality Observable with Component

Quality Observable with Component

This template is utilized when the LOINC term represents a quality observable with a component. It's suitable for measurements or observations that involve a specific component.

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Represents the specific component being measured or observed.

LOINC Properties currently supported: "ACnc", "CCnc", "CCnt", "LaCnc", "LnCnc", "LsCnc", "MCnc", "MCnt", "MoM", "NCnc",
"Naric", "PPres", "PrThr", "SCnc", "SCnt", "Titr"

Template

Model

```
=== 363787002 |Observable entity (observable entity)| :
    {
        246093002 |Component (attribute)| -> 120771002 |Antibody to Trypanosoma cruzi
(substance)|,
        246501002 |Technique (attribute)| -> 726449005 |Immunoassay technique
(qualifier value)|,
        370130000 |Property (attribute)| -> 118569000 |Arbitrary concentration
(property) (qualifier value)|,
```

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```
        370132008 |Scale type (attribute)| -> 30766002 |Quantitative (qualifier
value)|,
        370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        704327008 |Direct site (attribute)| -> 119364003 |Serum specimen (specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

[PROPERTY] of [COMPONENT] in [SYSTEM] at [TIME] by [METHOD] using [DEVICE] [CHALLENGE]481191010000118

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 481171010000119 [138811010000103] US: P Arbitrary concentration of Trypanosoma cruzi antibody in serum at point in time by immunoassay (observable entity) [cI],
- 481191010000118 [138811010000103] US: P Trypanosoma cruzi Ab [Units/volume] in Serum by Immunoassay [CS],
- 481201010000115 [138811010000103] US: A Trypanosoma cruzi Ab:ACnc:Pt:Ser:Qn:IA [CS],
- 2196621010000117 [138811010000103] US: A T. cruzi Ab IA Qn (S) [CS]
- 481191010000118 [138811010000103] US: A Arbitrary concentration of Trypanosoma cruzi antibody in serum at point in time by immunoassay [cI]

Examples

LOINC Term 100091-8

Loinc Parts

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Component	Trypanosoma cruzi Ab	LP40073-6	246093002 |Component (attribute)| -> 120771002 | Antibody to Trypanosoma cruzi (substance)|
Property	ACnc	LP6773-8	370130000 |Property (attribute)| -> 118569000 | Arbitrary concentration (property) (qualifier value)|
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 | Single point in time (qualifier value)|
System	Ser	LP7567-3	704327008 |Direct site (attribute)| -> 119364003 | Serum specimen (specimen)|
Scale	Qn	LP7753-9	370132008 |Scale type (attribute)| -> 30766002 | Quantitative (qualifier value)|
Method	IA	LP217197-5	246501002 |Technique (attribute)| -> 726449005 | Immunoassay technique (qualifier value)|

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4.2.2 Quality Observable with Inheres in (System, no Component)

Quality Observable with Inheres in (System, no Component)

This template is employed when the LOINC term involves an observation that is specified with a system, but not a component

This template is documented in Confluence here: Quality observable with Inheres in (System, no Component) for LOINC (observable entity) - v1.0

The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/develop/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/LoincTemplatedConceptWithDirectSite.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Specifies what the observation inherently exists within or is associated with.

LOINC Properties currently supported when LOINC Component is 'Observation': "Aper", "Color", "Rden", "Source","SpGrav","Temp"

Template

Model

```
=== 363787002 |Observable entity (observable entity)| :
    {
        [S1] 370130000 |Property (attribute)| -> 718498007 |Appearance (property)
(qualifier value)|,
        [S1] 370132008 |Scale type (attribute)| -> 117362005 |Nominal value
(qualifier value)|,
        [S1] 370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        [S1] 704319004 |Inheres in (attribute)| -> 258450006 |Cerebrospinal fluid
specimen (specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

[PROPERTY] of [COMPONENT] in [SYSTEM] at [TIME] by [METHOD] using [DEVICE] [CHALLENGE]

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

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In the case of the example below, this results in the following terms:

- 2211761010000110 [481481010000105] US: P Appearance of cerebrospinal fluid at point in time (observable entity) [ci]
- 2211751010000113 [481481010000105] US: P Appearance of Cerebral spinal fluid [ci]
- 2211771010000117 [481481010000105] US: A Appearance (CSF) [CS]
- 2211781010000119 [481481010000105] US: A Observation:Aper:Pt:CSF:Nom [CS]
- 2211741010000111 [481481010000105] US: A Appearance of cerebrospinal fluid at point in time [ci]

Examples

LOINC Term 10333-3

Loinc Parts mapped to SNOMED Attributes

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Property	Aper	LP6779-5	370130000 |Property (attribute)| -> 718498007 | Appearance (property) (qualifier value)|
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 | Single point in time (qualifier value)|
System	CSF	LP7156-5	704319004 |Inheres in (attribute)| -> 258450006 | Cerebrospinal fluid specimen (specimen)|
Scale	Nom	LP7750-5	370132008 |Scale type (attribute)| -> 117362005 | Nominal value (qualifier value)|

4.2.3 Quality Observable with Inheres In

Quality Observable with Inheres In

This template is employed when the LOINC term involves an observation that inherently exists within or is associated with something else.

This template is documented in Confluence here: Quality observable with Inheres in for LOINC (observable entity) - v1.0

The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/develop/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/LoincTemplatedConceptWithInheres.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Specifies what the observation inherently exists within or is associated with.

LOINC Properties currently supported when LOINC Component is not 'Observation:' "Anat", "DistWidth", "EntMCnc", "EntMeanVol", "ID", "Morph", "Prid", "Type", "Vol"

Template

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Model

```
=== 363787002 |Observable entity (observable entity)| :
    {
        370130000 |Property (attribute)| -> 410656007 |Type (property) (qualifier
value)|,
        370132008 |Scale type (attribute)| -> 117362005 |Nominal value (qualifier
value)|,
        370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        704319004 |Inheres in (attribute)| -> 16951006 |Antigen in Rh blood group
system (substance)|,
        704327008 |Direct site (attribute)| -> 119297000 |Blood specimen (specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

[PROPERTY] of [COMPONENT] in [SYSTEM] at [TIME] by [METHOD] using [DEVICE] [CHALLENGE]

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 2211701010000114 [481471010000107] US: P Type of antigen in Rh blood group system in blood at point in time (observable entity) [cI],
- 2211691010000114 [481471010000107] US: P Rh [Type] in Blood [CS],
- 2211721010000118 [481471010000107] US: A Rh:Type:Pt:Bld:Nom [CS]
- 2211711010000112 [481471010000107] US: A Rh Nom (Bld) [CS]
- 2211681010000111 [481471010000107] US: A Type of antigen in Rh blood group system in blood at point in time [cI],

Examples

LOINC Term 10331-7

Loinc Parts mapped to SNOMED Attributes

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Component	Rh	LP14541-4	704319004 |Inheres in (attribute)| -> 16951006 | Antigen in Rh blood group system (substance)|
Property	Type	LP6886-8	370130000 |Property (attribute)| -> 410656007 |Type (property) (qualifier value)|
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 | Single point in time (qualifier value)|
System	Bld	LP7057-5	704327008 |Direct site (attribute)| -> 119297000 | Blood specimen (specimen)|

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Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Scale	Nom	LP7750-5	370132008 |Scale type (attribute)| -> 117362005 |Nominal value (qualifier value)|

4.2.4 Quality Observable with Process

Quality Observable with Process

This template is employed when the LOINC term involves an observation that specifies a process or an outcome of a process

This template is documented in Confluence here: Process Observable for LOINC (observable entity) - v1.0

The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/npu/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/LoincTemplatedConceptWithProcess.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Specifies what the observation inherently exists within or is associated with.

LOINC Properties currently supported: "ArVRat", "CRat", "MRat", "RelTime", "SRat", "Time", "Vel", "VRat"

Template

Model

```
<<< 363787002 |Observable entity (observable entity)| :
    {
        [S1] 370130000 |Property (attribute)| -> 118544000 |Mass rate (property)
(qualifier value)|,
        [S1] 370132008 |Scale type (attribute)| -> 30766002 |Quantitative (qualifier
value)|,
        [S1] 704323007 |Process duration (attribute)| -> 123027009 |24 hours
(qualifier value)|,
        [S1] 704321009 |Characterizes (attribute)| -> 718500008 |Excretory process
(qualifier value)|,
        [S1] 704322002 |Process agent (attribute)| -> 64033007 |Kidney structure
(body structure)|,
        [S1] 704324001 |Process output (attribute)| -> 24427005 |Metanephrine
(substance)|,
        [S1] 704327008 |Direct site (attribute)| -> 122575003 |Urine specimen
(specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

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[PROPERTY] of [COMPONENT] in [SYSTEM] at [TIME] by [METHOD] using [DEVICE] [CHALLENGE]

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 2220831010000114 [483131010000100] US: P Mass rate of excretion of metanephrine in 24 hours in urine by lC/MS/MS (observable entity) [cI]
- 2220821010000111 [483131010000100] US: P Metanephrine [Mass/time] in 24 hour Urine by LC/MS/MS [CS]
- 2220851010000116 [483131010000100] US: A Metanephrine:MRat:24H:Urine:Qn:LC/MS/MS [CS]
- 2220841010000118 [483131010000100] US: A Metanephrine LC/MS/MS (24H U) [Mass/Time] [CS]
- 2220811010000117 [483131010000100] US: A Mass rate of excretion of metanephrine in 24 hours in urine by lC/MS/MS [cI]

Examples

LOINC Term 104629-1

Loinc Parts mapped to SNOMED Attributes

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Property	Type	LP6886-8	370130000 |Property (attribute)| -> 118544000 | Mass rate (property) (qualifier value)|
Time	24H	LP6924-7	704323007 |Process duration (attribute)| -> 123027009 |24 hours (qualifier value)|
			704322002 |Process agent (attribute)| -> 64033007 | Kidney structure (body structure)|
			704321009 |Characterizes (attribute)| -> 718500008 |Excretory process (qualifier value)|
Component	Metanephrine	LP14463-1	704324001 |Process output (attribute)| -> 24427005 |Metanephrine (substance)|
System	Urine	LP7681-2	704327008 |Direct site (attribute)| -> 122575003 | Urine specimen (specimen)|
Scale	Qn	LP7753-9	370132008 |Scale type (attribute)| -> 30766002 | Quantitative (qualifier value)|

4.2.5 Quality Observable with Ratio

Quality Observable with Ratio

This template is used when the LOINC term involves a component and is relative to something else as a ratio, such as a reference point or another component.

Note that Ratio concepts are given a parent of 540131010000107 |Ratio observable (observable entity)| to group them together.

This template is documented in Confluence here: Quality observable with Component and Relative to for LOINC Ratios (observable entity) - v1.0

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The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/develop/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/LoincTemplatedConceptWithRelative.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Represents the specific component being measured or observed.
- **LOINC Relatie To**: Specifies what the observation is relative to.

LOINC Properties currently supported: "MRto", "Ratio", "SRto"

Template

Model

```
=== 540131010000107 |Ratio observable (observable entity)| :
    {
        [S1] 246093002 |Component (attribute)| -> 1166006 |Titanium (substance)|,
        [S1] 370130000 |Property (attribute)| -> 118545004 |Mass ratio (property)
(qualifier value)|,
        [S1] 370132008 |Scale type (attribute)| -> 30766002 |Quantitative (qualifier
value)|,
        [S1] 370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        [S1] 704325000 |Relative to (attribute)| -> 15373003 |Creatinine
(substance)|,
        [S1] 704327008 |Direct site (attribute)| -> 122575003 |Urine specimen
(specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

```
[PROPERTY] of [COMPONENT] + SEPARATOR + [DIVISORS] in [SYSTEM] at [TIME] by [METHOD]
using [DEVICE] [CHALLENGE]
```

Some slots are optional, and are then tidied up along with any linking words (eg 'using'). The SEPARATOR is determined programatically and might be "to" or a "/" symbol.

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 2216711010000115 [483251010000104] US: P Mass ratio of titanium to creatinine in urine at point in time (observable entity) [ci]
- 2221411010000114 [483251010000104] US: P Titanium/Creatinine [Mass Ratio] in Urine [CS]
- 2221431010000117 [483251010000104] US: A Titanium/Creatinine (U) [Mass ratio] [CS]
- 2221441010000113 [483251010000104] US: A Titanium/Creatinine:MRto:Pt:Urine:Qn [CS]

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- 2221391010000114 [483251010000104] US: A Mass ratio of titanium/creatinine in urine at point in time [ci]
- 2221401010000111 [483251010000104] US: A Mass ratio of titanium to creatinine in urine at point in time [ci]

Examples

LOINC Term 104656-4

Loinc Parts

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Component	Titanium	LP16839-0	246093002 |Component (attribute)| -> 1166006 | Titanium (substance)|
Divisors	Creatinine	LP32035-5	704325000 |Relative to (attribute)| -> 15373003 | Creatinine (substance)|
Property	MRto	LP6834-8	370130000 |Property (attribute)| -> 118545004 | Mass ratio (property) (qualifier value)|
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 | Single point in time (qualifier value)|
System	Urine	LP7681-2	704327008 |Direct site (attribute)| -> 122575003 | Urine specimen (specimen)|
Scale	Qn	LP7753-9	370132008 |Scale type (attribute)| -> 30766002 | Quantitative (qualifier value)|

4.2.6 Quality Observable with Relative to

Quality Observable with Relative to

This template is used when the LOINC term involves a component and is relative to something else, such as a reference point or another component.

This template is documented in Confluence here: Quality observable with Component and Relative to for LOINC (observable entity) - v1.0”

The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/develop/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/LoincTemplatedConceptWithRelative.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Represents the specific component being measured or observed.
- **LOINC Relative To**: Specifies what the observation is relative to.

LOINC Properties currently supported: "NFr", "MFr", "CFr", "AFr", "VFr", "SFr"

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Template

Model

```
=== 363787002 |Observable entity (observable entity)| :
    {
        246093002 |Component (attribute)| -> 55918008 |Monocyte (cell)|,
        246501002 |Technique (attribute)| -> 708058007 |Flow cytometry technique
(qualifier value)|,
        370130000 |Property (attribute)| -> 118552002 |Number fraction (property)
(qualifier value)|,
        370132008 |Scale type (attribute)| -> 30766002 |Quantitative (qualifier
value)|,
        370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        704325000 |Relative to (attribute)| -> 52501007 |Leukocyte (cell)|,
        704327008 |Direct site (attribute)| -> 119297000 |Blood specimen (specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

[PROPERTY] of [COMPONENT] to [DIVISORS] in [SYSTEM] at [TIME] by [METHOD] using [DEVICE] [CHALLENGE]

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 2199641010000117 [480621010000102] US: P Number fraction of monocyte to leukocyte in blood at point in time by flow cytometry (observable entity) [ci],
- 2199631010000113 [480621010000102] US: P Monocytes/Leukocytes in Blood by Flow cytometry (FC) [CS],
- 2199651010000115 [480621010000102] US: A Monocytes/Leukocytes FC (Bld) [CS],
- 2199661010000118 [480621010000102] US: A Monocytes/Leukocytes:NFr:Pt:Bld:Qn:Flow cytometry [CS],
- 2199621010000110 [480621010000102] US: A Number fraction of monocyte to leukocyte in blood at point in time by flow cytometry [ci]

Examples

LOINC Term 101147-7

Loinc Parts

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Component	Monocytes	LP14313-8	246093002 |Component (attribute)| -> 120771002 | Antibody to Trypanosoma cruzi (substance)|
Divisors	Leukocytes	LP157588-7	704325000 |Relative to (attribute)| -> 52501007 | Leukocyte (cell)|
Property	NFr	LP6838-9	370130000 |Property (attribute)| -> 118552002 | Number fraction (property) (qualifier value)|

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Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 | Single point in time (qualifier value)|
System	Bld	LP7057-5	704327008 |Direct site (attribute)| -> 119297000 | Blood specimen (specimen)|
Scale	Qn	LP7753-9	370132008 |Scale type (attribute)| -> 30766002 | Quantitative (qualifier value)|
Method	Flow cytometry	LP6274-7	246501002 |Technique (attribute)| -> 708058007 | Flow cytometry technique (qualifier value)|

4.2.7 Quality Observable with Susceptibility

Quality Observable with Susceptibility

This template is utilized for LOINC terms representing susceptibility observations, such as microbial susceptibility tests.

This template is documented in Confluence here: Susceptibility observable for LOINC (observable entity) - v1.0

The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/develop/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/LoincTemplatedConceptWithSusceptibility.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Specifies the target organism or substance towards which the susceptibility is observed

LOINC Properties currently supported: "Susc"

Template

Model

```
<<< 363787002 |Observable entity (observable entity)| :
    {
        370130000 |Property (attribute)| -> 118588007 |Susceptibility (property)
(qualifier value)|,
        370132008 |Scale type (attribute)| -> 117365007 |Ordinal OR quantitative
value (qualifier value)|,
        370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        704319004 |Inheres in (attribute)| -> 410607006 |Organism (organism)|,
        704320005 |Towards (attribute)| -> 372840008 |Ciprofloxacin (substance)|
    }
```

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⚠ Note the three angle brackets at the start of this concept expression, indicating that the concept is primitive.
This will be because no attribute mapping was available for the "system" part.
This is also reflected in the terms below, where the LOINC system "Isolate.meningitis" has been used directly.

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

[PROPERTY] of [COMPONENT] in [SYSTEM] at [TIME] by [METHOD] using [DEVICE] [CHALLENGE]

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 2213311010000110 [481741010000108] US: P Susceptibility to ciprofloxacin in isolate.meningitis at point in time (observable entity) [ci],
- 2213301010000112 [481741010000108] US: P Ciprofloxacin [Susceptibility] for meningitis [CS],
- 2213331010000118 [481741010000108] US: A Ciprofloxacin:Susc:Pt:Isolate.meningitis:OrdQn [CS],
- 2213321010000116 [481741010000108] US: A Ciprofloxacin (Isolate.meningitis) [Susc] [CS],
- 2213291010000111 [481741010000108] US: A Susceptibility to diprofloxacin in isolate.meningitis at point in time [ci]

Examples

LOINC Term 103653-2

Loinc Parts mapped to SNOMED Attributes

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Component	Ciprofloxacin	LP15380-6	704320005 |Towards (attribute)| -> 372840008 |Ciprofloxacin (substance)|
Property	Susc	LP6870-2	370130000 |Property (attribute)| -> 118588007 |Susceptibility (property) (qualifier value)|
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 |Single point in time (qualifier value)|
Scale	OrdQn	LP7752-1	370132008 |Scale type (attribute)| -> 117365007 |Ordinal OR quantitative value (qualifier value)|

4.2.8 Quality Observable with Process (No Process output, With Time aspect)

Quality Observable with Process (No Process output, With Time aspect)

This template is employed when the LOINC term involves an observation that specifies an aspect of a process at a point in time where the process output is not included.

This template is documented in Confluence here: Process Observable for LOINC - No Process output, With Time Aspect (observable entity) - v0.1

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The java implementation of this template can be found: https://github.com/IHTSDO/reporting-engine/blob/npu/script-engine/src/main/java/org/ihtsdo/termserver/scripting/pipeline/loinc/template/LoincTemplatedConceptWithProcessNoOutput.java

Attributes

- **LOINC Property**: Represents the property of the observation, such as mass concentration or presence.
- **LOINC Scale**: Describes the scale type, like quantitative or qualitative.
- **LOINC Time**: Indicates the time aspect of the observation, e.g., single point in time.
- **LOINC System**: Specifies the direct site of the observation.
- **LOINC Method**: Describes the technique used for the observation.
- **LOINC Component**: Specifies what the observation inherently exists within or is associated with.

LOINC Properties currently supported: "RelVel," "RelTime," “Time, “Vel"

Template

Model

```
<<< 363787002 |Observable entity (observable entity)| :

    {
        [S1] 370130000 |Property (attribute)| -> 762636008 |Duration (property)
(qualifier value)||,
        [S1] 370132008 |Scale type (attribute)| -> 30766002 |Quantitative (qualifier
value)|,
        [S1] 370134009 |Time aspect (attribute)| -> 123029007 |Single point in time
(qualifier value)|,
        [S1] 704321009 |Characterizes (attribute)| -> 737097002 |Intrinsic pathway
coagulation process (qualifier value)|,
        [S1] 246501002 |Technique (attribute)| -> 702946003 |Coagulation technique
(qualifier value)|,
        [S1] 704327008 |Direct site (attribute)| -> 119297000 |Blood specimen
(specimen)|
    }
```

Terming

Template slots are filled by taking the preferred term of the relevant value from the model and making the initial character lower case, if allowed by the case significance setting of the preferred term.

[PROPERTY] of [COMPONENT] at [TIME] in [SYSTEM] by [METHOD] using [DEVICE] [CHALLENGE]

Some slots are optional, and are then tidied up along with any linking words (eg 'using')

The LOINC Long Common Name is specified as the Preferred Term and the LOINC Short Common Name is also included unchanged as an acceptable synonym. Finally a terse form of the LOINC Parts is added, with all part names specified, separated by colons.

In the case of the example below, this results in the following terms:

- 2611621010000114 [526891010000104] US: P Duration of intrinsic pathway coagulation process at point in time in blood by coagulation (observable entity)) [ci]
- 2611611010000115 [526891010000104] US: P aPTT in Blood by Coagulation assay [CS]
- 2611641010000116 [526891010000104] US: A Coagulation surface induced:Time:Pt:Bld:Qn:Coag [CS]
- 2611631010000112 [526891010000104] US: A aPTT Coag (Bld) [Time] [CS]

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- 2611601010000118 [483131010000100] US: A Duration of intrinsic pathway coagulation process at point in time in blood by coagulation [ci]

Examples

LOINC Term 3173-2

LOINC Parts mapped to SNOMED Attributes

Part Type	LOINC Part Name	LOINC Part Num	Mapped to Attribute Type / Value
Property	Time	LP6879-3	370130000 |Property (attribute)| -> 762636008 | Duration (property) (qualifier value)|
Time	Pt	LP6960-1	370134009 |Time aspect (attribute)| -> 123029007 |Single point in time (qualifier value)|
Component	Coagulation surface induced	LP15957-1	704321009 |Characterizes (attribute)| -> 737097002 |Intrinsic pathway coagulation process (qualifier value)|
System	Bld	LP7057-5	704327008 |Direct site (attribute)| -> 119297000 | Blood specimen (specimen)|
Scale	Qn	LP7753-9	370132008 |Scale type (attribute)| -> 30766002 | Quantitative (qualifier value)|
Method	Coag	LP6186-3	246501002 |Technique (attribute)| -> 702946003 | Coagulation technique (qualifier value)|

4.3 Orderable and Observable LOINC Terms

The LOINC release specifies whether each LOINC term is Orderable, Observable, or Both in the ORDER_OBS column of the Loinc.csv file. This classification helps healthcare systems determine which terms can be used for test orders versus those that are strictly for observations. In the LOINC Ontology, this information is provided in two simple type reference sets.

Reference Sets for Orderable and Observables

In SNOMED CT, subsets are represented using simple reference sets (Refsets), allowing implementers to filter and retrieve LOINC terms based on their orderability or observability. This structured approach facilitates the integration of LOINC terminology within SNOMED CT implementations.

For example, implementers can query:

- “Show all LOINC terms that are Orderable.”
- “Show all LOINC terms that are Observable.”

To support this, the LOINC Ontology includes two distinct reference sets:

- **635121010000106 | LOINC Observation Reference Set |** – Contains LOINC terms classified as Observable.
- **635111010000100 | LOINC Orderable Reference Set |**– Contains LOINC terms classified as Orderable.

The reference sets are distributed in a file named according to SNOMED CT conventions: *der2_Refset_SimpleRefsetSnapshot_INT_20250321.txt*

Example

Each row in this file corresponds to a LOINC term and includes a refsetId that determines whether the term belongs to the Orderable or Observable subset.

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Some LOINC terms are classified as both Orderable and Observable. In such cases, the term will appear in both reference sets, ensuring that it is available in queries for either category.

LOINC Observation Reference Set (first 4 rows, total 24829)

id	effectiveTime	active	moduleId	refsetId	referencedComponentId
16864455-3679-4543-a360-1f0b5f5dca1d	20250321	1	11010000107	635121010000106	226581010000109
faf3eff6-5c15-4b9d-ae72-953d06a80391	20250321	1	11010000107	635121010000106	189881010000107
781fbd14-8883-456a-a324-3d56584edf8e	20250321	1	11010000107	635121010000106	179681010000102
8286c793-0c9b-434e-a4c4-f3ca1d79d67a	20250321	1	11010000107	635121010000106	200271010000103

LOINC Orderable Reference Set (first 4 rows, total 34791)

id	effectiveTime	active	moduleId	refsetId	referencedComponentId
565a60d6-7ee2-4699-a62a-3b1228761693	20250321	1	11010000107	635111010000100	189881010000107
ccabfb4b-2353-4a8e-bdd7-2e75d9759e62	20250321	1	11010000107	635111010000100	200271010000103
699290e8-15bc-4895-ad9b-fda371465526	20250321	1	11010000107	635111010000100	617571010000101
33a2cb27-47fa-4751-9f6e-8e580cba17f5	20250321	1	11010000107	635111010000100	189931010000103

View Members in the Browser

The counts for the Observation and Orderable Reference Sets can be seen in the browser, in the left-hand panel, and clicking on the "Refset" tab:

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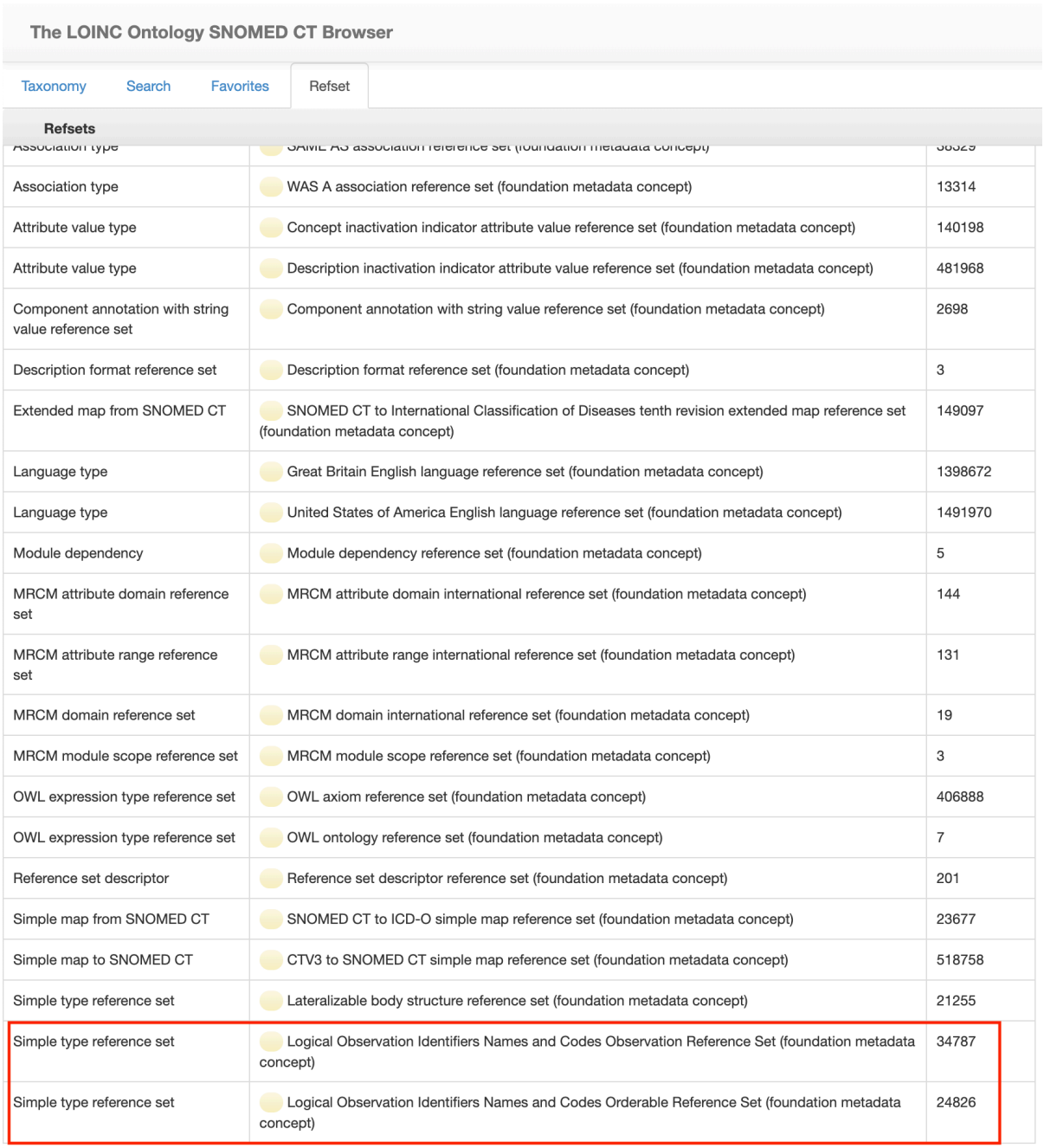

The LOINC Ontology SNOMED CT Browser

Taxonomy | Search | Favorites | Refset

Refsets

Association type	WAS A association reference set (foundation metadata concept)	13314
Attribute value type	Concept inactivation indicator attribute value reference set (foundation metadata concept)	140198
Attribute value type	Description inactivation indicator attribute value reference set (foundation metadata concept)	481968
Component annotation with string value reference set	Component annotation with string value reference set (foundation metadata concept)	2698
Description format reference set	Description format reference set (foundation metadata concept)	3
Extended map from SNOMED CT	SNOMED CT to International Classification of Diseases tenth revision extended map reference set (foundation metadata concept)	149097
Language type	Great Britain English language reference set (foundation metadata concept)	1398672
Language type	United States of America English language reference set (foundation metadata concept)	1491970
Module dependency	Module dependency reference set (foundation metadata concept)	5
MRCM attribute domain reference set	MRCM attribute domain international reference set (foundation metadata concept)	144
MRCM attribute range reference set	MRCM attribute range international reference set (foundation metadata concept)	131
MRCM domain reference set	MRCM domain international reference set (foundation metadata concept)	19
MRCM module scope reference set	MRCM module scope reference set (foundation metadata concept)	3
OWL expression type reference set	OWL axiom reference set (foundation metadata concept)	406888
OWL expression type reference set	OWL ontology reference set (foundation metadata concept)	7
Reference set descriptor	Reference set descriptor reference set (foundation metadata concept)	201
Simple map from SNOMED CT	SNOMED CT to ICD-O simple map reference set (foundation metadata concept)	23677
Simple map to SNOMED CT	CTV3 to SNOMED CT simple map reference set (foundation metadata concept)	518758
Simple type reference set	Lateralizable body structure reference set (foundation metadata concept)	21255
Simple type reference set	Logical Observation Identifiers Names and Codes Observation Reference Set (foundation metadata concept)	34787
Simple type reference set	Logical Observation Identifiers Names and Codes Orderable Reference Set (foundation metadata concept)	24826

Clicking on either of these concepts will bring them up in the *right-hand* panel:

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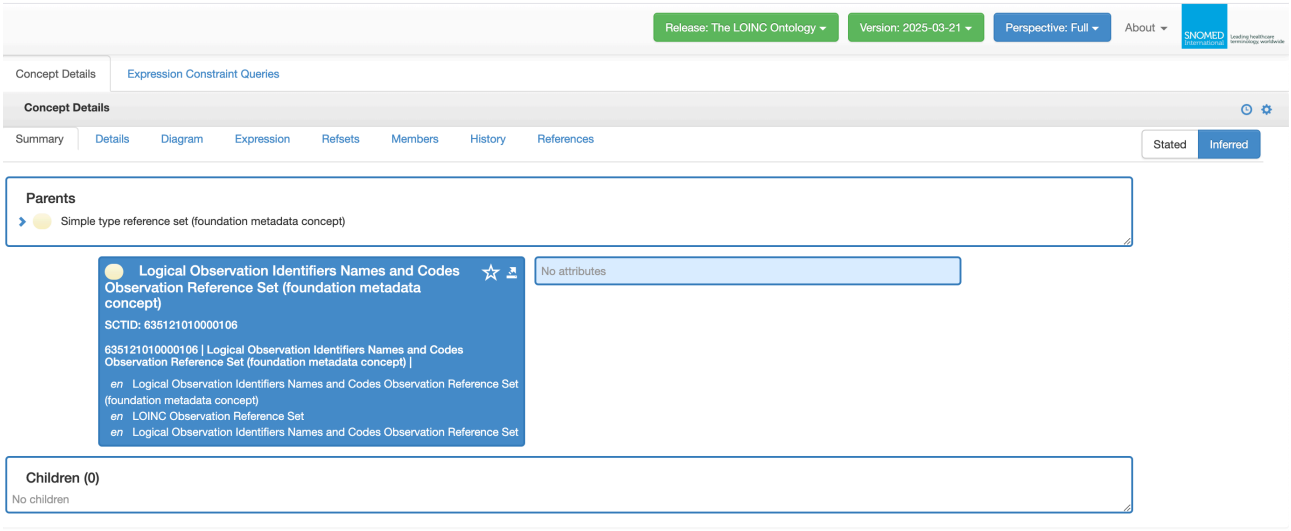
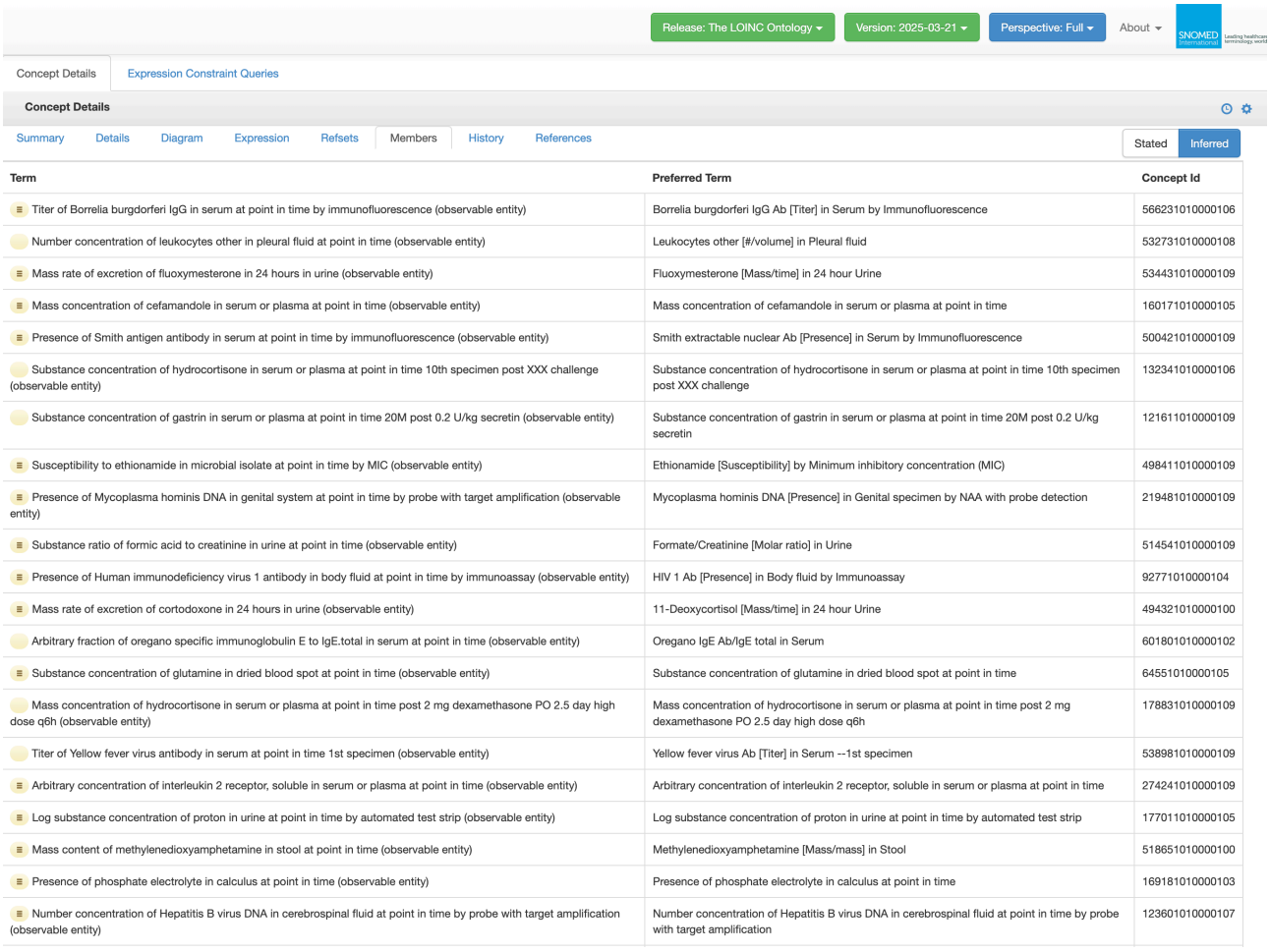


Note that the concept that *represents* the reference set does not have any children (these would be different, more specialised reference sets if they existed), but the reference set does have *members*. These can be listed by clicking on the members tab:



Term	Preferred Term	Concept Id
Titer of Borrelia burgdorferi IgG in serum at point in time by immunofluorescence (observable entity)	Borrelia burgdorferi IgG Ab [Titer] in Serum by Immunofluorescence	566231010000106
Number concentration of leukocytes other in pleural fluid at point in time (observable entity)	Leukocytes other [#/volume] in Pleural fluid	532731010000108
Mass rate of excretion of fluoxymesterone in 24 hours in urine (observable entity)	Fluoxymesterone [Mass/time] in 24 hour Urine	534431010000109
Mass concentration of cefamandole in serum or plasma at point in time (observable entity)	Mass concentration of cefamandole in serum or plasma at point in time	160171010000105
Presence of Smith antigen antibody in serum at point in time by immunofluorescence (observable entity)	Smith extractable nuclear Ab [Presence] in Serum by Immunofluorescence	500421010000109
Substance concentration of hydrocortisone in serum or plasma at point in time 10th specimen post XXX challenge (observable entity)	Substance concentration of hydrocortisone in serum or plasma at point in time 10th specimen post XXX challenge	132341010000106
Substance concentration of gastrin in serum or plasma at point in time 20M post 0.2 U/kg secretin (observable entity)	Substance concentration of gastrin in serum or plasma at point in time 20M post 0.2 U/kg secretin	121611010000109
Susceptibility to ethionamide in microbial isolate at point in time by MIC (observable entity)	Ethionamide [Susceptibility] by Minimum inhibitory concentration (MIC)	498411010000109
Presence of Mycoplasma hominis DNA in genital system at point in time by probe with target amplification (observable entity)	Mycoplasma hominis DNA [Presence] in Genital specimen by NAA with probe detection	219481010000109
Substance ratio of formic acid to creatinine in urine at point in time (observable entity)	Formate/Creatinine [Molar ratio] in Urine	514541010000109
Presence of Human immunodeficiency virus 1 antibody in body fluid at point in time by immunoassay (observable entity)	HIV 1 Ab [Presence] in Body fluid by Immunoassay	92771010000104
Mass rate of excretion of cortodoxone in 24 hours in urine (observable entity)	11-Deoxycortisol [Mass/time] in 24 hour Urine	494321010000100
Arbitrary fraction of oregano specific immunoglobulin E to IgE.total in serum at point in time (observable entity)	Oregano IgE Ab/IgE total in Serum	601801010000102
Substance concentration of glutamine in dried blood spot at point in time (observable entity)	Substance concentration of glutamine in dried blood spot at point in time	64551010000105
Mass concentration of hydrocortisone in serum or plasma at point in time post 2 mg dexamethasone PO 2.5 day high dose q6h (observable entity)	Mass concentration of hydrocortisone in serum or plasma at point in time post 2 mg dexamethasone PO 2.5 day high dose q6h	178831010000109
Titer of Yellow fever virus antibody in serum at point in time 1st specimen (observable entity)	Yellow fever virus Ab [Titer] in Serum --1st specimen	538981010000109
Arbitrary concentration of interleukin 2 receptor, soluble in serum or plasma at point in time (observable entity)	Arbitrary concentration of interleukin 2 receptor, soluble in serum or plasma at point in time	274241010000109
Log substance concentration of proton in urine at point in time by automated test strip (observable entity)	Log substance concentration of proton in urine at point in time by automated test strip	177011010000105
Mass content of methylenedioxyamphetamine in stool at point in time (observable entity)	Methylenedioxyamphetamine [Mass/mass] in Stool	518651010000100
Presence of phosphate electrolyte in calculus at point in time (observable entity)	Presence of phosphate electrolyte in calculus at point in time	169181010000103
Number concentration of Hepatitis B virus DNA in cerebrospinal fluid at point in time by probe with target amplification (observable entity)	Number concentration of Hepatitis B virus DNA in cerebrospinal fluid at point in time by probe with target amplification	123601010000107

Now we can also obtain this list, or even something more interesting, by going into the "Expression Constraint Queries" tab. For this example, we're going to look for the intersection of these two sets. That is, the LOINC

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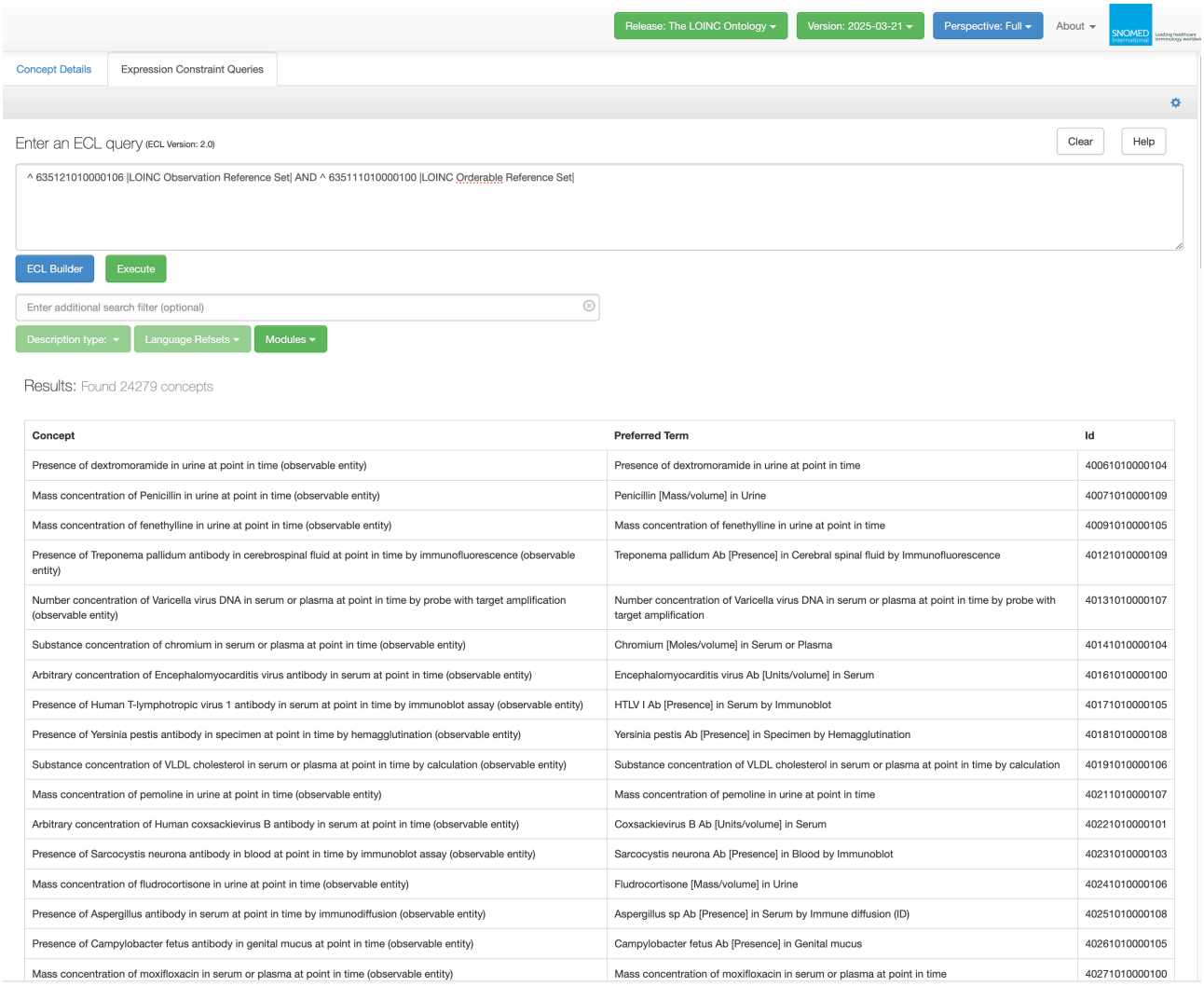
concepts which are BOTH orderable AND observables. The ECL for this query is: ^ 635121010000106 |LOINC Observation Reference Set| AND ^ 635111010000100 |LOINC Orderable Reference Set|

And here we see that, of the 34787 codes used for observation and the 24826 used for ordering, 24279 can be used for both. So the vast majority.



Concept	Preferred Term	Id
Presence of dextromoramide in urine at point in time (observable entity)	Presence of dextromoramide in urine at point in time	40061010000104
Mass concentration of Penicillin in urine at point in time (observable entity)	Penicillin [Mass/volume] in Urine	40071010000109
Mass concentration of fenethylline in urine at point in time (observable entity)	Mass concentration of fenethylline in urine at point in time	40091010000105
Presence of Treponema pallidum antibody in cerebrospinal fluid at point in time by immunofluorescence (observable entity)	Treponema pallidum Ab [Presence] in Cerebral spinal fluid by Immunofluorescence	40121010000109
Number concentration of Varicella virus DNA in serum or plasma at point in time by probe with target amplification (observable entity)	Number concentration of Varicella virus DNA in serum or plasma at point in time by probe with target amplification	40131010000107
Substance concentration of chromium in serum or plasma at point in time (observable entity)	Chromium [Moles/volume] in Serum or Plasma	40141010000104
Arbitrary concentration of Encephalomyocarditis virus antibody in serum at point in time (observable entity)	Encephalomyocarditis virus Ab [Units/volume] in Serum	40161010000100
Presence of Human T-lymphotropic virus 1 antibody in serum at point in time by immunoblot assay (observable entity)	HTLV I Ab [Presence] in Serum by Immunoblot	40171010000105
Presence of Yersinia pestis antibody in specimen at point in time by hemagglutination (observable entity)	Yersinia pestis Ab [Presence] in Specimen by Hemagglutination	40181010000108
Substance concentration of VLDL cholesterol in serum or plasma at point in time by calculation (observable entity)	Substance concentration of VLDL cholesterol in serum or plasma at point in time by calculation	40191010000106
Mass concentration of pemoline in urine at point in time (observable entity)	Mass concentration of pemoline in urine at point in time	40211010000107
Arbitrary concentration of Human coxsackievirus B antibody in serum at point in time (observable entity)	Coxsackievirus B Ab [Units/volume] in Serum	40221010000101
Presence of Sarcocystis neurona antibody in blood at point in time by immunoblot assay (observable entity)	Sarcocystis neurona Ab [Presence] in Blood by Immunoblot	40231010000103
Mass concentration of fludrocortisone in urine at point in time (observable entity)	Fludrocortisone [Mass/volume] in Urine	40241010000106
Presence of Aspergillus antibody in serum at point in time by immunodiffusion (observable entity)	Aspergillus sp Ab [Presence] in Serum by Immune diffusion (ID)	40251010000108
Presence of Campylobacter fetus antibody in genital mucus at point in time (observable entity)	Campylobacter fetus Ab [Presence] in Genital mucus	40261010000105
Mass concentration of moxifloxacin in serum or plasma at point in time (observable entity)	Mass concentration of moxifloxacin in serum or plasma at point in time	40271010000100

Note that the counts here refer purely to those LOINC concepts that successfully translated into The LOINC Ontology at time of publication. The full LOINC release in it's original format contains additional codes for each.

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5. Information Models and Terminology Binding

Effective utilization of the LOINC Extension to SNOMED CT requires a well-defined information model that structures and organizes data consistently. An information model is essential because it provides a framework for accurately capturing, storing, and sharing data across healthcare systems. By establishing clear guidelines for how data elements are related and represented, the information model ensures that laboratory data is consistently documented and understood, facilitating seamless communication between healthcare providers and enabling reliable data analysis. Additionally, this structured approach supports interoperability, allowing different systems to work together efficiently and ensuring that health information can be exchanged and utilized effectively.

The integration of SNOMED CT and LOINC through the development of the LOINC extension to SNOMED CT has gained significant momentum in recent years, owing to its ability to complement and extend the capabilities of healthcare information systems. This section of the guide delves into the information models and terminology bindings that enable the precise documentation and utilization of laboratory data within electronic health records (EHRs). Emphasis is placed on HL7 FHIR as a prime example, showcasing how it can be leveraged to support the integration of SNOMED CT and LOINC, thereby ensuring accurate and standardized data representation in clinical workflows.

5.1 Logical Model

Introduction

This part represents the key entities and relationships within a laboratory order entry system specifically designed to support the integration of the **LOINC Extension** with **SNOMED CT**. The model focuses on standardizing and structuring laboratory data for test ordering, specimen management, and result reporting. While not exhaustive or fully detailed for implementation, it highlights critical components necessary to ensure interoperability and consistency in healthcare systems.

By focusing on test identification, specimen management, and result reporting, the model helps support the use of **LOINC** for laboratory test coding and **SNOMED CT** for representing clinical concepts such as specimens and test outcomes. This approach promotes efficient data exchange and interoperability in healthcare settings.

Diagram

The diagram illustrates the relationships between the three main entities in the model: **Laboratory Order**, **Specimen**, and **Result**. Each entity is represented as a rectangular block, with its attributes listed inside. Arrows and cardinalities between the entities indicate how they relate to one another, providing a clear visual of the logical structure of the system.

Key relationships include:

- A **Laboratory Order** can result in one or more **Results**.
- A **Result** must be associated with a single **Specimen**.
- A **Specimen** is optionally linked to a **Laboratory Order**, offering flexibility in how samples are managed.

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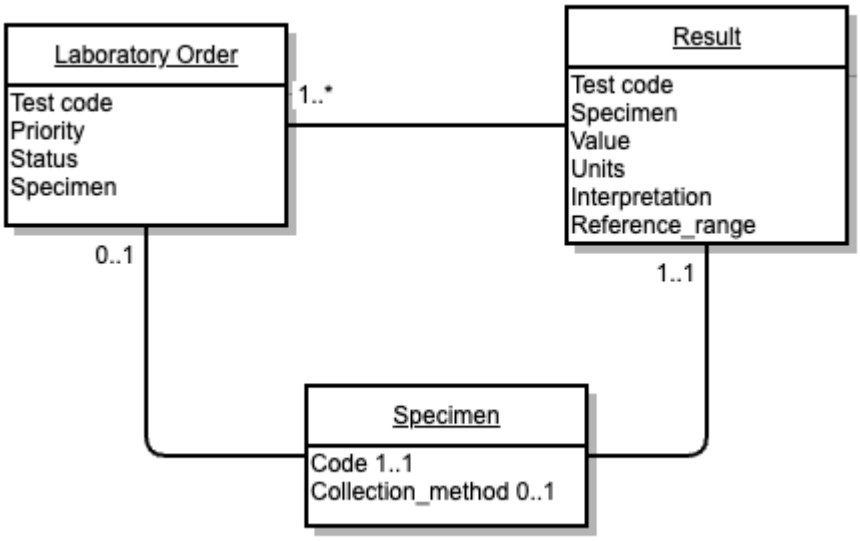

Entities

- **Laboratory Order**:
  - Represents the details of a requested laboratory test.
  - Acts as the starting point for test processing and result generation.
- **Specimen**:
  - Refers to the physical sample collected for testing.
  - Plays a central role in linking the laboratory order with test results.
- **Result**:
  - Captures the outcomes of the requested laboratory test, including measured values and clinical interpretations.

Attributes

- **Laboratory Order Attributes**:
  - ***code***: The identifier for the laboratory test being ordered
  - ***priority***: Indicates the urgency of the test request
  - ***status***: Reflects the current state of the order (e.g., pending, completed)
  - ***specimen***: Links the order to the specimen being tested
- **Specimen Attributes**:
  - ***code***: Identifies the type of specimen (e.g., blood, urine)
  - ***method***: Optionally specifies how the specimen was collected
- **Result Attributes**:
  - ***code***: Identifies the test linked to the result
  - ***specimen***: References the specimen used for the test
  - ***value***: The measured value or observation from the test
  - ***units***: Specifies the units of the test result value
  - ***interpretation***: Qualitative assessment of the result (e.g., normal, high)
  - ***reference range***: Indicates the expected range for the result value

5.2 Terminology Bindings

This chapter defines the model meaning binding and value set binding between data elements in the Logical Model and their corresponding SNOMED CT concepts and value sets. These bindings ensure precise alignment between the Logical Model and SNOMED CT, supporting consistent and interoperable representation of laboratory orders, specimens, and results.

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Laboratory Order

The laboratory orders represent the request that starts the laboratory process. In the context of this implementation guide for the LOINC Ontology, the recommendation is to use Observable entities for this purpose, selected from a subset that is marked as "Orderable" entities by LOINC.

Attribute	Type	Value Set Binding
code	Structured	< 363787002 |Observable entity (observable entity)| {{ C moduleId = 11010000107 }} AND ^ |Orderable LOINC Concepts|
priority	Structured	< 272125009 |Priorities (qualifier value)|
status	Structured	< 288532009 |Context values for actions (qualifier value)|

Specimen

SNOMED CT includes a hierarchy of specimens and is used to define observable entities in the LOINC Ontology. The specimens used in the LOINC Ontology can be extracted using the SNOMED CT Expression Constraint Language by selecting concepts used as values for the 704327008 |Direct site (attribute)| within the LOINC Ontology.

Attribute	Type	Value Set Binding
code	Structured	(< 363787002 |Observable entity (observable entity)| {{ C moduleId = 11010000107 }} . (704327008 |Direct site (attribute)| OR 704319004 |Inheres in (attribute)|)) AND (<< 123038009 |Specimen (specimen)|)
collection method	Structured	<<(<<17636008 |Specimen collection (procedure)|.260686004 |Method (attribute)|)

Result

In the results, the codes for tests can be different from those ordered. In cases like "panels", the order concepts are transformed into a set of observable concepts that can be reported as results. The LOINC Ontology identifies a subset of observable concepts that are valid to report as "observed" results.

Attribute	Type/Note	Value Set Binding
Test code	Structured	< 363787002 |Observable entity (observable entity)| {{ C moduleId = 11010000107 }} AND ^ |Observable LOINC Concepts|
Value	Unstructured	N/A
	Structured	Variable: depends on each observable.
Reference Range	Unstructured	N/A
Units	Structured	<< 767525000 |Unit (qualifier value)|
Interpretation	Structured	Variable: depends on each observable.
Status	Structured	< 288532009 |Context values for actions (qualifier value)|

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5.3 HL7 FHIR and Laboratory Data

What is FHIR?

HL7 FHIR is a modern standard designed to facilitate the exchange of healthcare information electronically.

- **Consistency**: With standardized resources and robust semantics, FHIR ensures uniformity in healthcare data representation. This consistency supports accurate data exchange and enables healthcare providers to make informed decisions based on reliable information, ultimately enhancing patient care quality.
- **Modularity**: FHIR's flexible architecture allows its resources to be used independently or in combination to meet specific healthcare needs. This modular approach supports adaptability across diverse healthcare contexts, enabling tailored solutions without overhauling entire systems.
- **Interoperability**: FHIR facilitates seamless data exchange between different healthcare systems and applications, enhancing communication and collaboration among healthcare providers. By standardizing data formats and protocols such as RESTful APIs and JSON/XML, FHIR promotes interoperability, improving patient care coordination and information sharing.
- **Standardization**: FHIR leverages contemporary web standards to ensure compatibility with existing IT infrastructures. By defining well-structured resources like Patient, Observation, and Medication with clear semantics, FHIR fosters consistency in how healthcare data is represented and interpreted across various systems.
- **Scalability**: Designed to accommodate evolving healthcare requirements and technological advancements, FHIR is scalable for both current and future healthcare needs. Its flexible architecture and support for extensibility allow healthcare systems to grow and adapt without compromising interoperability or data integrity.

HL7 FHIR plays a crucial role in linking healthcare data with standard terminologies, including SNOMED CT. By integrating FHIR with terminologies like SNOMED CT, more precise and standardized documentation and communication of clinical information can be achieved. This linkage enhances interoperability by enabling seamless exchange of structured clinical data, supporting accurate clinical decision-making, and promoting continuity of care for patients across various healthcare settings.

FHIR Resources

For the purpose of representing the laboratory data workflow, we can use the following FHIR resources:

- **ServiceRequest**: Represents laboratory orders or requests for specific diagnostic tests or procedures.
- **DiagnosticReport**: Captures the overall results or findings of the laboratory tests as a summarized report.
- **Observation**: Provides detailed data points or specific results associated with the laboratory tests.

Examples:

Map between the Generalized Logical Model FHIR Resources

The image below illustrates how FHIR resources can be used to represent the generalized logical model for laboratory data. It outlines the relationships between key FHIR resources (highlighted in red) and logical model entities (depicted in gray), offering a structured approach to representing laboratory orders, individual results, and specimen information.

- **Laboratory Order**: Mapped to the **FHIR ServiceRequest** resource, representing the clinical request for laboratory testing. It includes details such as test code, priority, status, and the specimen to be tested.
- **Result**: Mapped to the **FHIR DiagnosticReport** resource, summarizing the findings of the laboratory tests based on the order. The DiagnosticReport serves as a container for individual results.
- **Individual Results**: Represented by the **FHIR Observation** resource, where each Observation provides specific result details such as:
    - Result values
    - Units of measurement

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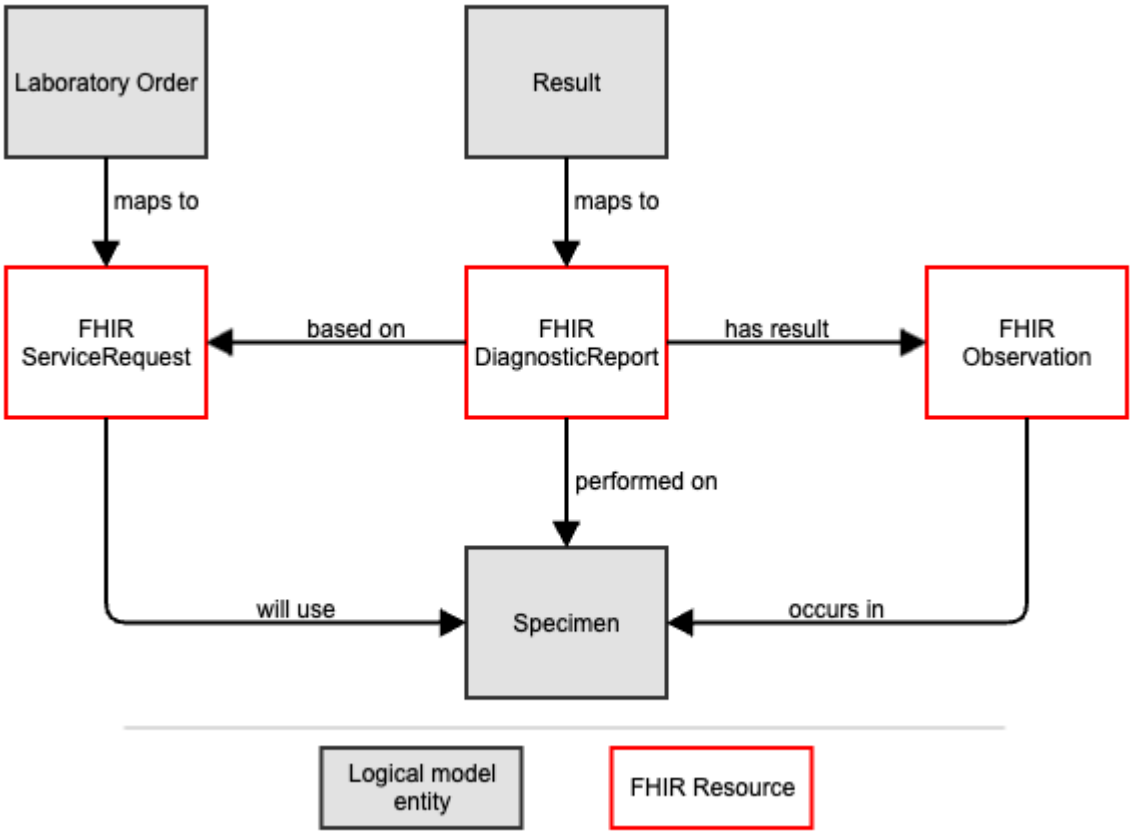
    - Clinical interpretation (e.g., normal, abnormal)
    - Reference ranges
    - Link to the associated specimen
- **Specimen**: Mapped to the **FHIR Specimen** resource, which defines the type and method of specimen collection. This resource connects all entities within the generalized logical model.



Relationships

- The **FHIR ServiceRequest** initiates the laboratory process and forms the basis for the **FHIR DiagnosticReport**.
- The **FHIR DiagnosticReport** includes one or more **FHIR Observations**, each representing an individual result.
- The **FHIR Specimen** resource is central to the model, linking the order, results, and observations to the biological material tested.

5.3.1 FHIR Resources for Ordering Laboratory Tests

When ordering laboratory tests, FHIR provides specific resources to support this process. This page outlines the key FHIR resources involved in ordering laboratory tests, focusing on how SNOMED CT and/or LOINC can be bound to these resources to ensure standardized and accurate documentation within electronic health records (EHRs) and other clinical systems. These resources help ensure that lab test orders are transmitted, processed, and documented consistently across different healthcare systems.

The diagram below illustrates how the integration of SNOMED CT and LOINC can be utilized in laboratory test ordering and processing, using FHIR ServiceRequest to support interoperability between SNOMED CT-enabled Electronic Health Records (EHRs) and LOINC-enabled Laboratory Information Systems (LIS).

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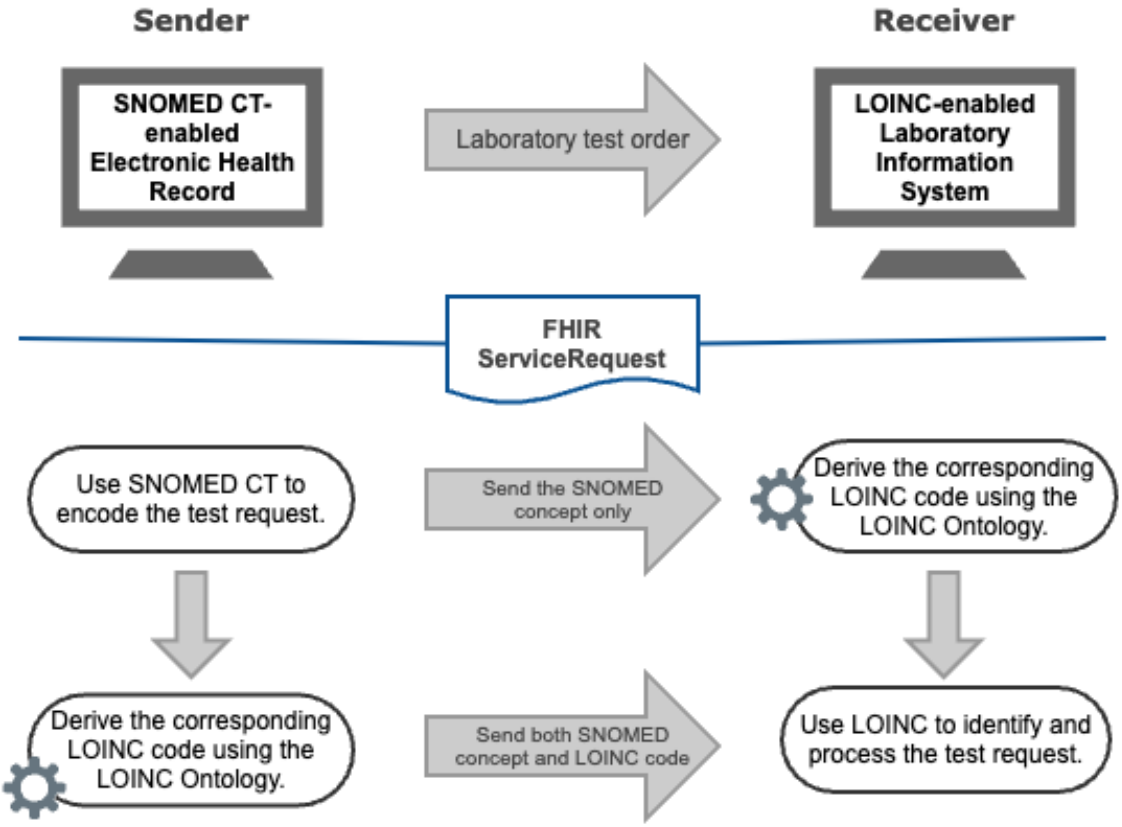
In this process, a laboratory test request is encoded using SNOMED CT within the EHR system. If needed, the corresponding LOINC code is derived using the LOINC Ontology. The request is then transmitted via FHIR ServiceRequest, containing either the SNOMED CT concept alone or both the SNOMED CT concept and its corresponding LOINC code.

On the receiving end, if only the SNOMED CT concept is provided, the LIS derives the appropriate LOINC code using the LOINC Ontology. The laboratory system then identifies and processes the request based on LOINC.



FHIR Service Request Resource

The **FHIR ServiceRequest** resource is used to represent a request for a service to be performed, such as laboratory tests, imaging studies, or procedures. It facilitates standardized communication between healthcare systems, ensuring that test orders and service requests are accurately transmitted and processed.

In the context of laboratory test ordering, the **ServiceRequest.code** element is used to specify the requested test. This field can contain either a **SNOMED CT code**, a **LOINC code**, or both, depending on how the ordering system captures and transmits test requests.

- When **SNOMED CT** is used, the **code element** holds the SNOMED CT concept representing the requested test.
- When **LOINC** is used, the **code element** contains the appropriate LOINC code that corresponds to the requested laboratory test.
- In cases where both SNOMED CT and LOINC are included, SNOMED CT provides a structured clinical representation, while LOINC ensures compatibility with laboratory systems that primarily use LOINC for test identification.

By supporting both SNOMED CT and LOINC within the **ServiceRequest.code** element, FHIR enables flexible and interoperable test ordering workflows, ensuring accurate and efficient exchange of laboratory test requests across healthcare systems.

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More information on the FHIR Service Request Resource can be found here: https://hl7.org/fhir/R4/servicerequest.html

Terminology Binding

Data element	Binding	Comment
serviceRequest.code	^ 635111010000100 |LOINC Orderable Reference Set|	Binds to the members of the simple type reference set containing the references to the SNOMED CT concepts representing a LOINC Orderable term

Example

Below is an example of a FHIR **ServiceRequest** resource that uses both the SNOMED CT concept 72641010000107 | Arbitrary concentration of antibody to hepatitis E virus in serum at point in time (observable entity)| and the associated LOINC code 51459-6 for a request to measure the arbitrary concentration of antibodies to hepatitis E virus in serum:

```
{
  "resourceType": "ServiceRequest",
  "id": "service-request-hev-antibody-test",
  "status": "active",
  "intent": "order",
  "priority": "routine",
  "code": {
    "coding": [
      {
        "system": "http://snomed.info/sct",
        "code": "72641010000107",
        "display": "Arbitrary concentration of Hepatitis E virus antibody in serum at
point in time by immunoassay (observable entity)"
      },
      {
        "system": "http://loinc.org",
        "code": "49776-8",
        "display": "Hepatitis E virus Ab [Units/volume] in Serum by Immunoassay"
      }
    ],
    "text": "Hepatitis E Virus Antibody Concentration Test"
  },
  "subject": {
    "reference": "Patient/example",
    "display": "John Doe"
  },
  "authoredOn": "2025-01-28",
  "requester": {
    "reference": "Practitioner/example",
    "display": "Dr. Smith"
  },
  "performer": [
    {
      "reference": "Organization/lab-example",
      "display": "Example Diagnostic Laboratory"
    }
```

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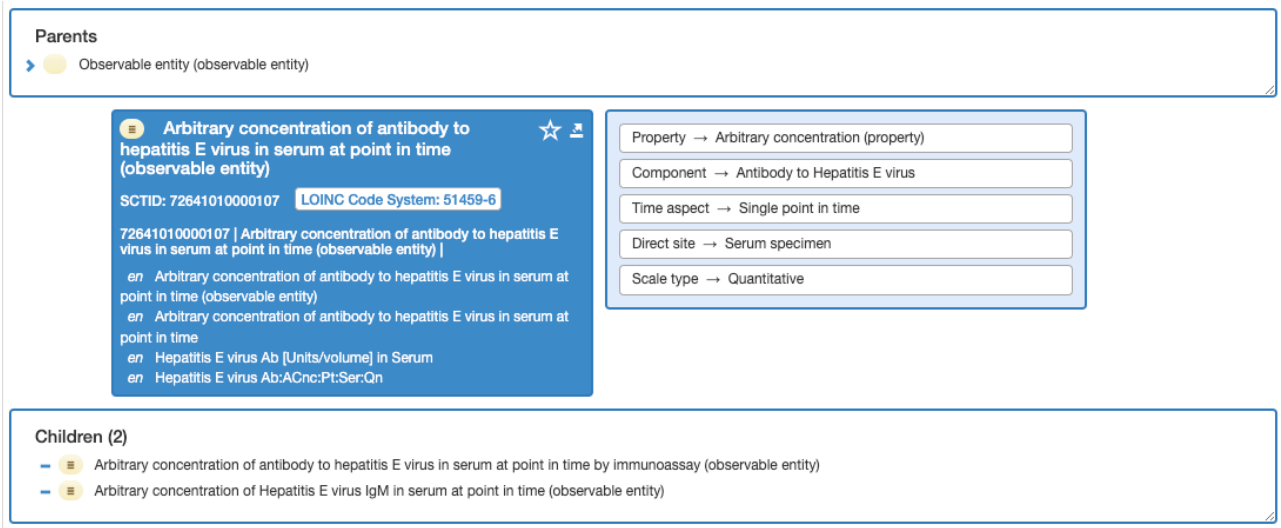
```
  ],
  "specimen": [
    {
      "reference": "Specimen/example-serum",
      "display": "Serum Sample"
    }
  ],
  "note": [
    {
      "authorString": "Dr. Smith",
      "time": "2025-01-28T10:00:00Z",
      "text": "Please measure the concentration of antibodies to hepatitis E virus."
    }
  ]
}
```

Explanation:

- **status**: Set to “active,” indicating that the request is currently in progress.
- **intent**: “order” reflects that this is a formal request.
- **code**:
  - **coding**: Uses the SNOMED CT conceptId 72641010000107
  - **coding**: Uses the LOINC code 51459-6
- **subject**: Refers to the patient for whom the test is being ordered.
- **requester**: Indicates the practitioner making the request.
- **performer**: Specifies the organization or laboratory that will perform the test.
- **specimen**: Points to the serum sample to be tested.
- **note**: Includes additional instructions or details related to the test.

By leveraging the LOINC Ontology, it is possible to automatically derive the corresponding LOINC code for the SNOMED CT concept 72641010000107 |Arbitrary concentration of antibody to hepatitis E virus in serum at point in time (observable entity)|, see image below. The corresponding LOINC code is **51459-6**, which represents the same clinical concept in the LOINC terminology system.



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5.3.2 FHIR Resources for Representing Laboratory Results

Represent Laboratory Results with FHIR

In the context of managing lab result data, FHIR (Fast Healthcare Interoperability Resources) offers two key resources: the **Observation** resource and the **DiagnosticReport** resource. Each plays a distinct role in representing and conveying lab results, and together they provide a comprehensive view of the lab data.

FHIR Observation

The Observation resource is used to represent the actual result of a laboratory test. It includes details such as:

- **Test Results**: The specific findings or measurements from the test (e.g., blood glucose levels, cholesterol levels).
- **Units of Measurement**: How the results are quantified (e.g., mg/dL).
- **Reference Ranges**: Normal value ranges for comparison.
- **Observation Date and Time**: When the result was recorded.
- **Use**: This resource focuses on the raw data from the test, providing a granular view of each result.

Terminology Binding

Data element	Binding	Comment
observation.code	^ 635121010000106 |LOINC Observation Reference Set|	Binds to the members of the simple type reference set containing the references to the SNOMED CT concepts representing a LOINC Observable term
observation.interpretation	< 404684003 |Clinical finding (finding)|	Ensures that the interpretation uses concepts from the clinical finding hierarchy, which includes concepts representing the results of an observation.

Example

```
{
  "resourceType": "Observation",
  "id": "obs001",
  "status": "final",
  "code": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "15074-8",
        "display": "Glucose [Moles/volume] in Blood"
      },
```

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```
      {
        "system": "http://snomed.info/sct",
        "code": "2345610100000108",
        "display": "Substance concentration of glucose in blood at point in time
(observable entity)"
      }
    ],
    "text": "Blood glucose measurement"
  },
  "subject": {
    "reference": "Patient/m001",
    "display": "Noah Lee"
  },
  "effectiveDateTime": "2024-02-20T09:15:00+00:00",
  "issued": "2024-02-20T10:00:00+00:00",
  "performer": [
    {
      "reference": "Practitioner/p005",
      "display": "O. Wilson"
    }
  ],
  "valueQuantity": {
    "value": 6.3,
    "unit": "mmol/L",
    "system": "http://snomed.info/sct",
    "code": "258813002",
    "display": "Millimole/liter (qualifier value)"
  },
  "interpretation": [
    {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "444780001",
          "display": "Glucose in blood specimen above reference range (finding)"
        }
      ]
    }
  ],
  "referenceRange": [
    {
      "low": {
        "value": 3.1,
        "unit": "mmol/L",
        "system": "http://snomed.info/sct",
        "code": "258813002",
        "display": "Millimole/liter (qualifier value)"
      },
      "high": {
        "value": 6.2,
        "unit": "mmol/L",
        "system": "http://snomed.info/sct",
        "code": "258773002",
        "display": "Millimoles per liter (qualifier value)"
```


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```
        }
      }
    ]
}
```

FHIR DiagnosticReport

The DiagnosticReport resource adds additional context and information to the results presented by the Observation resource. It includes:

- **Summary of Results**: An aggregated view of all related observations and their interpretations.
- **Clinical Interpretation**: Comments or interpretations provided by the laboratory or a medical professional, which may help in understanding the results in a clinical context.
- **Report Status**: Indicates whether the report is final, preliminary, or in draft form.
- **Test Details**: Information about the test performed, including the test code, description, and any relevant procedural details.
- **Ordering Information**: References to the original order request and any relevant patient and provider details.

Terminology Binding

Data element	Binding	
DiagnosticReport.code	^ 635121010000106 |LOINC Observation Reference Set|	Enforce reporting using the observable entity
DiagnosticReport.conclusionCode	404684003 |Clinical finding (finding)|	Enforce reporting using the clinical findings to report the result of the test(-s).

Example

This **FHIR DiagnosticReport** example below demonstrates how multiple **Observation** resources can be referenced within a single diagnostic report, specifically for a **blood glucose test panel**. It provides a structured approach to representing laboratory results using both **LOINC and SNOMED CT codes**.

In this example, the primary focus is on a blood glucose measurement **(Observation/Obs001 exemplified above)**, but the report also includes **other relevant tests** commonly performed in diabetes assessment and metabolic health monitoring. These additional observations help provide a **comprehensive clinical picture** and are essential in diagnosing and managing conditions such as **diabetes mellitus**, **insulin resistance**, and **cardiovascular risk factors**.

Key Features of the Example

- **References multiple Observation resources** related to metabolic and cardiovascular health.
- **Uses both LOINC and SNOMED CT codes** in the code field to enhance compatibility.
- I**ncludes SNOMED CT codes for interpretation and conclusion**, making the report machine-readable and clinically relevant.

```
{
  "resourceType": "DiagnosticReport",
  "id": "dr001",
  "status": "final",
  "category": [
```

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```
    {
      "coding": [
        {
          "system": "http://terminology.hl7.org/CodeSystem/v2-0074",
          "code": "LAB",
          "display": "Laboratory"
        }
      ]
    }
  ],
  "code": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "11502-2"????,
        "display": "Glucose panel - Blood"
      },
      {
        "system": "http://snomed.info/sct",
        "code": "????",
        "display": "Blood glucose test report (observable entity)"
      }
    ],
    "text": "Blood Glucose Test Report"
  },
  "subject": {
    "reference": "Patient/m001",
    "display": "Noah Lee"
  },
  "effectiveDateTime": "2024-02-20T10:30:00+00:00",
  "issued": "2024-02-20T11:00:00+00:00",
  "performer": [
    {
      "reference": "Practitioner/p005",
      "display": "O. Wilson"
    }
  ],
  "result": [
    {
      "reference": "Observation/obs001",
      "display": "Blood glucose measurement"
    },
    {
      "reference": "Observation/obs002",
      "display": "HbA1c (Glycated Hemoglobin)"
    },
    {
      "reference": "Observation/obs003",
      "display": "Serum Insulin Level"
    },
    {
      "reference": "Observation/obs004",
      "display": "C-Peptide Measurement"
    },
    {
```

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```
      "reference": "Observation/obs005",
      "display": "Blood Ketones (Beta-hydroxybutyrate)"
    },
    {
      "reference": "Observation/obs006",
      "display": "Lipid Panel"
    },
    {
      "reference": "Observation/obs007",
      "display": "Blood Pressure"
    }
  ],
  "conclusion": "This diagnostic report integrates multiple laboratory observations,
including blood glucose, HbA1c, serum insulin, and lipid profile. The blood glucose
level is above the reference range, suggesting potential hyperglycemia. Further
evaluation of HbA1c and lipid parameters is recommended.",
  "conclusionCode": [
    {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "444780001",
          "display": "444780001 |Glucose in blood specimen above reference range
(finding)|"
        }
      ]
    }
  ]
}
```


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6. Technical Application

This chapter provides practical guidance on implementing and utilizing the **LOINC Ontology** in various technical environments. It covers key considerations for deployment, access methods, and integration approaches, ensuring seamless adoption within healthcare and clinical information systems.

This chapter serves as a comprehensive resource for developers, system architects, and implementers looking to leverage the LOINC Ontology effectively.

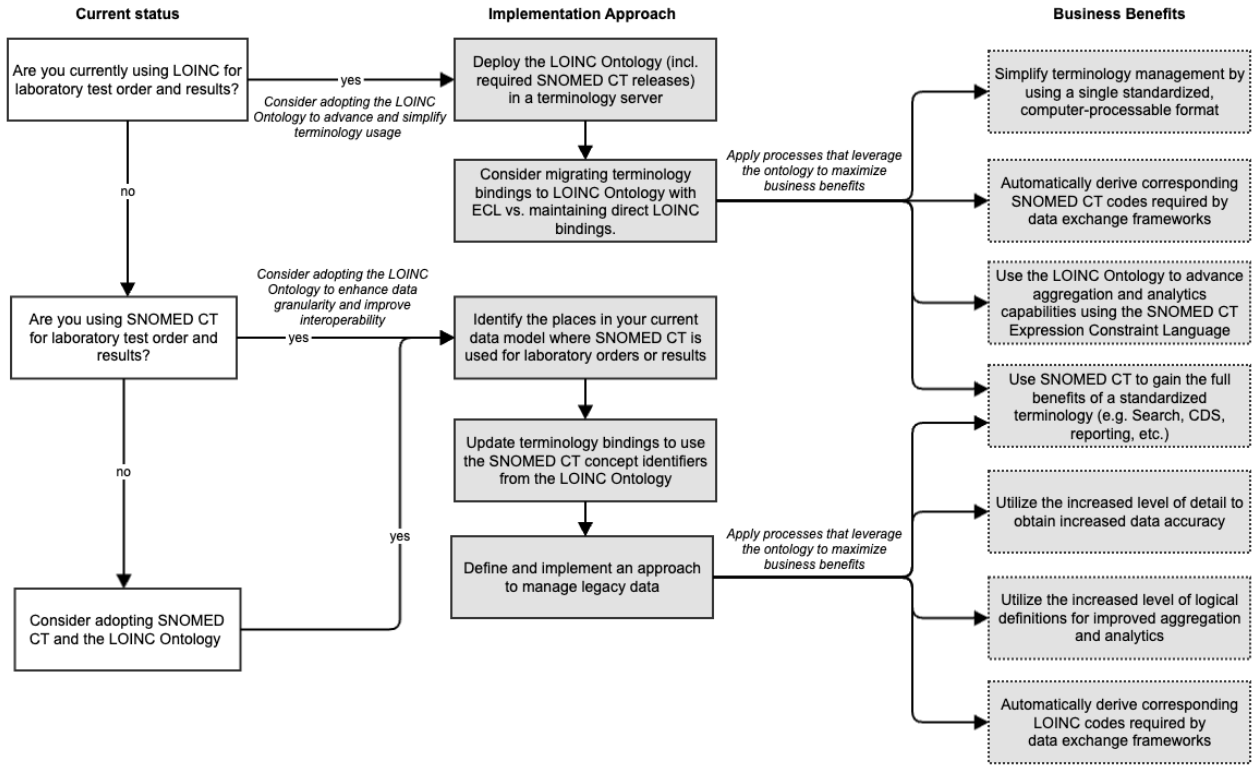
6.1. Implementation Approaches and Considerations

Determine the Appropriate Approach

The workflow below outlines key considerations for adopting the SNOMED CT Ontology for laboratory test orders and results. A thorough understanding of how lab tests are currently ordered and recorded, along with the specific benefits sought, is essential before making this decision.

The process begins by evaluating the organization's use of LOINC or SNOMED CT and determining whether transitioning to the LOINC Ontology would improve standardization and interoperability. It then provides a structured implementation approach, including deploying terminology servers, updating terminology bindings, and managing legacy data.

By adopting the SNOMED CT Ontology, organizations can streamline terminology management, enhance data accuracy, improve analytics, and facilitate seamless data exchange. This structured approach supports informed decision-making and ensures alignment with organizational goals.



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Implementation Approaches

Deploy the LOINC Ontology (including required SNOMED CT releases) in a terminology server

The first step in setting up the LOINC Ontology is to install it in a SNOMED CT-enabled terminology server. The deployment process includes loading the latest release of the LOINC Ontology including required versions of the international and/or national edition, as described in 6.3 Deploying the LOINC Ontology. Using standardized APIs like FHIR Terminology Services ensures smooth data exchange between different systems, making lab test orders and results more standardized and interoperable.

Migrate terminology bindings to LOINC Ontology with ECL vs. maintaining direct LOINC bindings

Most healthcare systems currently use direct LOINC codes for lab tests. However, moving to the LOINC Ontology with SNOMED CT improves flexibility and automation. The SNOMED CT Expression Constraint Language (ECL) allows dynamic queries to fetch relevant codes instead of manually mapping them one by one. To migrate, organizations should first identify where LOINC codes are used and create ECL rules that match appropriate SNOMED CT concepts included in the LOINC Ontology. This approach reduces manual work, improves consistency, and makes terminology updates easier to manage in the future. Chapter 5.2 Terminology Bindings suggests bindings that may be relevant for such migration.

Analyze the current data model where laboratory orders or results are represented

To ensure a smooth transition to the LOINC Ontology, it is crucial to first analyze how your system currently represents laboratory test orders and results. This involves identifying all locations in the data model where SNOMED CT, LOINC, or other code systems are applied and understanding how they interact with existing workflows and data exchange processes. By mapping out these connections, organizations can determine whether the current implementation is consistent, accurate, and aligned with best practices.

The goal of this analysis is to identify whether these codes should be updated to use concepts from the LOINC Ontology. This step helps optimize terminology bindings, improve interoperability, and ensure a more structured approach to laboratory data management. Using terminology auditing tools and automated reports can assist in detecting inconsistencies, redundant mappings, or areas where refinements are needed.

Update terminology bindings to use the SNOMED CT concept identifiers from the LOINC Ontology

Once the LOINC Ontology is deployed, the next step is to evaluate the benefits of replacing direct LOINC terminology bindings with updated LOINC Ontology / SNOMED CT bindings that can take advantage of techniques like ECL Expressions. This is an optional step that can facilitate the maintenance and precision of the bindings.

Define and implement an approach to manage legacy data

Older lab test records still contain historical LOINC codes or SNOMED CT identifiers, so ensuring they remain usable after the transition is important. This means mapping old codes to their closest equivalent in the LOINC Ontology while keeping track of changes for future reference. Automated conversion tools can help in bulk updating records while maintaining historical integrity. A phased approach, starting with testing in a controlled environment before full deployment, ensures a smooth transition while avoiding data loss or inconsistencies.

6.2 Accessing the LOINC Ontology

The LOINC ontology is represented as a SNOMED CT extension and is distributed as an independent package.

Each version of a SNOMED CT extension depends on a specific version of the International Edition (refer to section 4.2.2 Module Dependencies for more details). Therefore, deploying the LOINC ontology requires access to both the LOINC ontology release package and the corresponding International Edition release package, upon which the specific version of the LOINC ontology is dependent.

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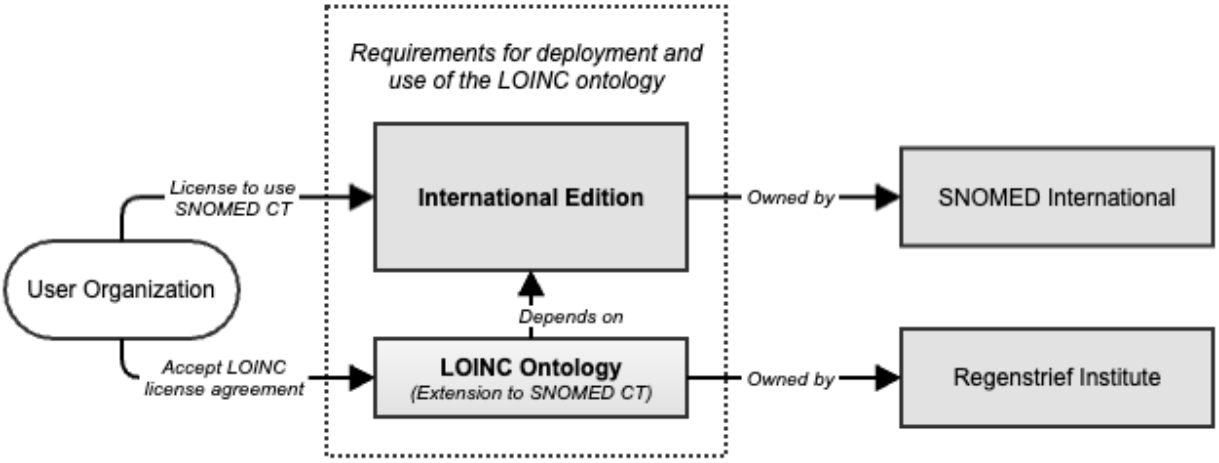

License to Use SNOMED CT

To access and use the LOINC ontology, users must have a valid Affiliate License for SNOMED CT. SNOMED CT is a globally recognized clinical terminology standard, and its usage is governed by strict licensing agreements to ensure compliance and proper utilization. Licensing ensures that users are authorized to access and implement SNOMED CT in their systems.

Individuals or organizations interested in using SNOMED CT must obtain an Affiliate License through their National Release Center (NRC) or SNOMED International.

More information can be found here: https://www.snomed.org/get-snomed

The following points outline the key aspects of member licensing:

- **Member Countries:** Member countries have a national licensing arrangement with SNOMED International. Healthcare professionals and organizations within these countries can usually access SNOMED CT through their NRC without additional licensing fees.
- **Access via NRCs:** National Release Centers are responsible for distributing SNOMED CT within their respective countries. They provide access, support, and updates to licensed users. Users should contact their NRC for specific details on how to access the LOINC Extension to SNOMED CT.
- **Non-Member Countries:** In countries that are not members of SNOMED International, individuals and organizations must directly approach SNOMED International to obtain the necessary licenses. This may involve additional costs and compliance with international licensing requirements.

Accessing the LOINC Extension

The LOINC Extension can be accessed via its main website hosted by Regenstrief:

https://loincsnomed.org/downloads

6.3 Deploying the LOINC Ontology

Introduction

Effective deployment of the **LOINC Ontology** requires efficient access to the content in ways that take advantage of the features of both terminologies. A **terminology service** is a software function that interfaces with, and provides

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access to, one or more representations of a terminology, allowing for streamlined retrieval and management of terminology data.

Various technical options are available for implementing terminology services, including relational databases, graph databases, and predefined services accessible via APIs (e.g., **SNOMED International's Snowstorm**). Selecting an appropriate approach for deploying the LOINC Extension depends on factors such as existing infrastructure, integration complexity, and the level of flexibility required. Whether using a local database or a cloud-based solution, the choice should ensure effective access, updating, and management of the terminology content.

Regardless of the platform chosen, the deployment of the LOINC Extension involves importing a SNOMED CT Edition and the LOINC Extension into the selected database or server.

Required Release Packages

To deploy the LOINC Ontology, the following RF2 packages are necessary:

- The latest version of the national release available
- For national extension packages, the corresponding SNOMED CT International Edition (the version on which the national extension is dependent)
- The latest version of the LOINC Extension package, where the International Edition dependency aligns with the version being used

Release notes accompanying the LOINC Extension package detail the International Edition dependency, helping to ensure compatibility.

Understanding Releases and Dependencies

The LOINC Ontology aligns with specific releases of the SNOMED CT International Edition. Each version of the LOINC Extension is updated in sync with the International Edition to ensure consistent compatibility.

The LOINC Ontology is planned for biannual releases, occurring in March and September, following the LOINC release from the preceding month.

National Editions follow independent release cycles, which vary by country or member organization, and may be released monthly, quarterly, or biannually. SNOMED CT is designed to handle these variations, using comprehensive history tracking to manage discrepancies that may arise from differing release cycles.

For example, if a National Edition is released in May based on the March International Edition, and the LOINC Extension is based on the February International Edition, there may be references to inactive concepts between releases. SNOMED CT enables easy identification and resolution of these references, maintaining the LOINC Extension's consistency across different release schedules.

Scenario 1: The National Edition dependent on the same version of the International Edition than the LOINC Ontology

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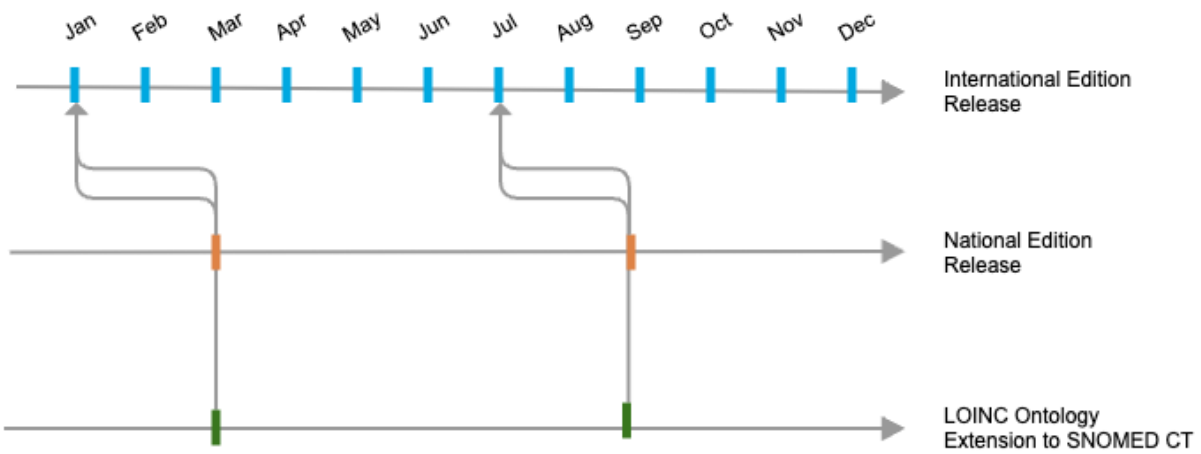
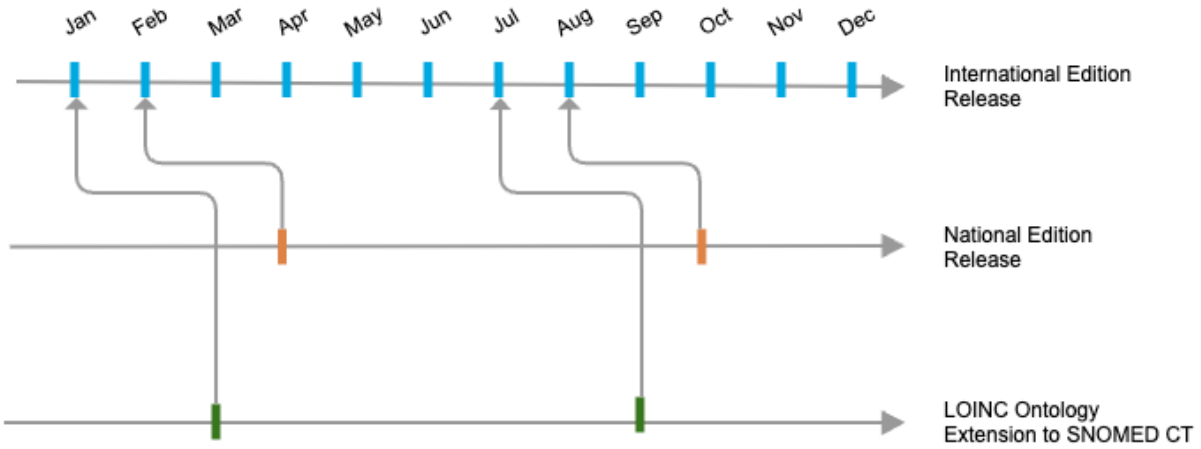


No potential implementation issues can be described for this scenario. In this case, the National Edition and the LOINC Ontology follow the same release cycle and depend on the same version of the International Edition. This alignment simplifies implementation by eliminating version discrepancies. Any changes made to the International Edition that impact both the LOINC Ontology and the National Edition will be managed by their respective owners.

Scenario 2a: The National Edition dependent on a different version of the International Edition than the LOINC Ontology



In this example, an implementer in November may select to use the October release of the National Edition with the latest LOINC Ontology release available, the September release.

The National Edition is the primary resource that determines the selection of dependency. As a derivative, the LOINC Ontology must align with the dependencies of the National Edition.

When deployed in an implementation terminology server, the configuration will be as follows:

- **International Edition (August release)** – The version on which the National Edition depends.
- **LOINC Ontology (September release)** – Originally dependent on the July version of the International Edition, which is no longer available.
- **National Edition (October release)** – The authoritative edition dictating dependencies.

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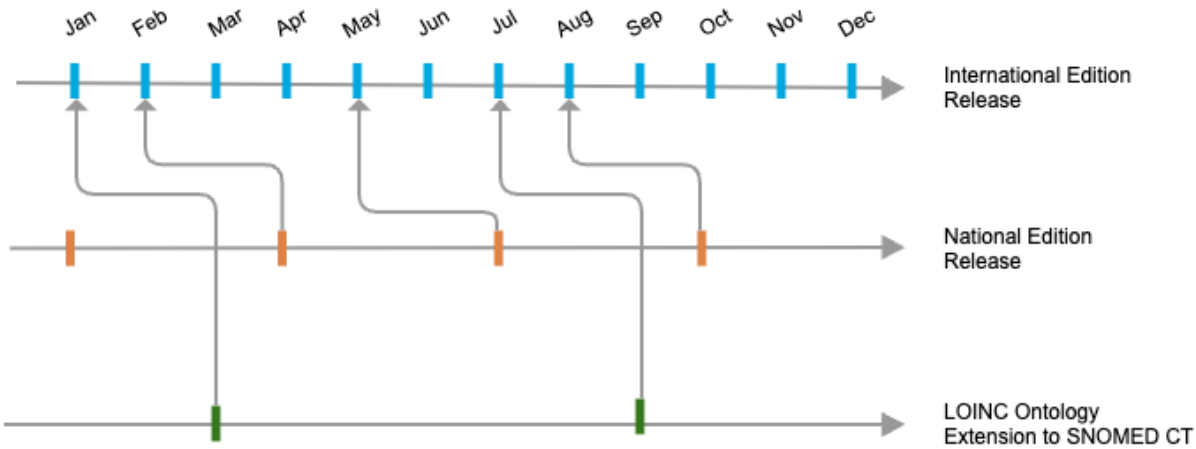
In this setup, any changes made to the International Edition between July and August may impact the LOINC Ontology, as outlined below.

Scenario 2b: The National Edition doesn't follow the same release schedule as the LOINC Ontology



In this example, an implementer in September may select to use the July release of the National Edition with the latest LOINC Ontology release available, the September release.

When deployed in an implementation terminology server, the configuration will be as follows:

- **International Edition (May release)** – The version on which the National Edition depends.
- **LOINC Ontology (September release)** – Originally dependent on the July version of the International Edition, which is unavailable.
- **National Edition (July release)** – The authoritative edition dictating dependencies. The latest available National Release is in September.

Here, the LOINC Ontology may refer to an International Edition Concept created after the May release and, therefore, it would be unavailable in this environment.

Potential Issues

Using a version of the LOINC Ontology that relies on a different version of the International Edition than the one used by the National Edition may lead to the following errors:

- **Inactive or Unknown Parent Concepts** – A LOINC Ontology concept may reference a parent that is no longer active or is unrecognized.
- **Inactive or Unknown Attribute Values** – International Edition concepts used as attribute values for LOINC Ontology concepts may be inactive or unknown.

These issues can arise in two ways:

- **Inactive Concepts** – If a concept has been inactivated in the International Edition after the release of the LOINC Ontology, but the National Edition is using a more recent version, the referenced concept may no longer be valid.
- **Unknown Concepts** – If the National Edition depends on an older version of the International Edition than the one used by the LOINC Ontology, some referenced concepts may be missing or unrecognized.

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Consequences

When discrepancies exist between the National Edition and the LOINC Ontology dependencies, several issues may arise:

- **ECL selections may fail for concepts with version errors**
  - For example, If a parent of a LOINC Ontology concept has been inactivated, then aggregations using the '<' operator (or other ECL hierarchy selections) will not include the child concept
  - ECL queries referencing inactive concepts directly are invalid
- **Data Inconsistencies**: If the National Edition and LOINC Ontology reference different versions of the International Edition, inconsistencies in data representation can occur, leading to errors in reporting and analytics.
- **Decision Support Errors**: Clinical decision support tools may provide incorrect or outdated recommendations if they refer to inactive or changed concepts.
- **Reporting errors**: missing the inclusion of concepts that do not match ECL selections

Mitigation Strategies

To minimize disruption from dependency discrepancies, users can adopt several strategies:

- **Regular monitoring of concept status:** Use SNOMED CT tools to track inactive and replaced concepts.
- **Automated mapping and remediation:** Utilize historical associations and mapping tables to replace inactive concepts with suitable alternatives.
- **Pre-implementation impact assessment:** Before deploying the LOINC Ontology, run queries to identify any inactive concepts and resolve dependencies.
- **Interoperability testing:** Conduct validation tests between systems using different SNOMED CT versions to identify and address inconsistencies.
- **Stakeholder collaboration:** Work with national health agencies, SNOMED International, and terminology service providers to ensure smooth transitions and updates.

Impact Assessment

Evaluating the impact of discrepancies between the dependency for the National Edition and the dependency for the LOINC Ontology is important for maintaining data consistency, usability, and interoperability. Users can assess the impact through several key factors:

1. **Concept availability and integrity**
   - If the National Edition is based on a different version of the SNOMED CT International Edition than the LOINC Ontology, there may be concepts referenced in the LOINC Extension that are inactive or unavailable in the National Edition.
   - Users should assess whether key concepts required for coding, reporting, and decision support are missing or have been replaced with new concepts.
2. **Reference set consistency**
   - National Extensions often include locally defined reference sets that may be linked to specific versions of the SNOMED CT International Edition.
   - If the LOINC Extension relies on an older or newer International Edition, these reference sets may contain outdated or inactive concepts, impacting decision support systems and automated processing.
3. **Historical tracking and concept mapping**
   - SNOMED CT provides robust historical tracking mechanisms, allowing users to identify inactive concepts and their replacements.
   - Using built-in SNOMED CT tooling, users can identify whether any inactive concepts within the LOINC Extension need to be mapped to newer active concepts in the National Edition.
4. **Data interoperability and exchange**
   - Differences in dependencies can affect interoperability between systems using different National Editions and LOINC Extensions.

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- Users should evaluate whether discrepancies lead to misinterpretation of coded data in electronic health records (EHRs), data analytics, or interoperability workflows.

5. **Impact on Clinical Decision Support (CDS)**
   - If SNOMED CT concepts referenced by the LOINC Ontology are inactive in the National Edition, decision support tools relying on those concepts may malfunction or provide inaccurate suggestions.
   - Organizations should review decision support rules that involve LOINC Ontology concepts and adjust them accordingly.
6. **Workflow and implementation strategies**
   - Organizations deploying the LOINC Ontology should determine whether discrepancies require immediate resolution or can be addressed through routine updates.
   - Depending on the workflow, a decision should be made whether to accept inactive concepts temporarily or proactively align the National Edition with the latest SNOMED CT International Edition.

Summary of Actions

Category	Action	Query Example	Description
1. **Concept Availability and Integrity**	Identify concepts with inactive parents and check if replacements are available.	<! (* {{ C effectiveTime>=	**Identify concepts with inactive parents** This query is satisfied by the direct parents (<!) of any (*) concept in the substrate , where those concepts have an effectiveTime greater than or equal to the specified date, and an active value of false (i.e. only inactive concepts are returned) Note that 20250101 is just provided here as an example.
2. Reference Set Consistency	Analyze reference sets to identify outdated or inactive concepts.	^ (< 446609009 |Simple type reference set (foundation metadata concept)|) {{ C active=0}}	*Note that this ECL only retrieves the members of simple type reference sets. If other types are required, the concept id for those types can be applied.*
3. Historical Tracking and Concept Mapping	Identify inactive concept references in maps.	^ (< 900000000000496009 |Simple map from SNOMED CT type reference set (foundation metadata concept)|) {{ C active=0}}	*Note that this ECL only retrieves the members of simple map from SNOMED CT type reference set. If other types are required, the concept id for those types can be applied.*
4. Data Interoperability and Exchange	Assess interoperability risks due to dependency mismatches.	N/A	Based on historical interoperability data, it would be possible to verify the recorded frequency of use of the concepts with incorrect references. Finding that a very common concept has incorrect references with the new dependencies might lead to the need to take remedial actions in a new local release.
5. Impact on Clinical Decision Support (CDS)	Identify inactive or missing concepts in CDS rules.	N/A	Existing Clinical Decision Support rules should be analyzed to identify if they directly reference an inactive concept or a concept affected by references to inactive concepts.
6. Workflow and Implementation Strategies	Decide whether to temporarily accept inactive concepts or proactively align the National Edition with the latest SNOMED CT version.	N/A	It is possible to include fixes in a new release of the national or local extension for mismatches between the LOINC Extension and the International Edition. However, after careful evaluation of the existing mismatches, implementers can decide to go forward with a deployment

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			of the terminology that includes a limited number of incorrect references.

Identifying References to Inactive Concepts

Inactive concepts within the LOINC Ontology can be managed effectively using the SNOMED CT Expression Constraint Language, which allows you to extract inactive components and reference set members.

Retrieve inactive concepts from all SNOMED CT hierarchies belonging to the LOINC Ontology module:

```
* {{ C moduleId = 11010000107 active=0}}
```

Retrieve inactive concepts from the Observable entity hierarchy belonging to the LOINC Ontology module:

```
< 363787002 |Observable entity (observable entity)| {{ C moduleId = 11010000107
 active=0}}
```

This query identifies all concepts within the LOINC Extension that are currently inactive (active = false). It is useful for reviewing or managing outdated concepts.

Working with Active Components Only

If you prefer to work exclusively with active concepts, you can use the inverse ECL query.

Retrieve active concepts from all SNOMED CT hierarchies belonging to the LOINC Ontology module:

```
* {{ C moduleId = 11010000107 active=1}}
```

Retrieve active concepts from the Observable entity hierarchy belonging to the LOINC Ontology module:

```
< 363787002 |Observable entity (observable entity)| {{ C moduleId = 11010000107
 active=1}}
```

This query returns only those concepts that are currently active, ensuring that you are working with up-to-date information. You can further refine this query by adding hierarchical filters, such as focusing on concepts within a particular clinical hierarchy.

Implementation Considerations

Despite these potential issues, the actual risk of problems is considered low due to the design of the LOINC Ontology. The LOINC Ontology has a flat hierarchical structure, therefore the number of International Edition parents is very low. These parent concepts are stable groupers in the International Edition, minimizing the risk of inactivation. The concepts used as attribute values come from a recent mapping effort between LOINC parts and SNOMED CT concepts, meaning most have been reviewed recently. As a result, a degree of stability is also expected for the attribute values. Using a newer version of the International Edition with the LOINC Ontology has a lower risk of inconsistencies than using an older version of the International Edition. This due to the fact that attribute concepts could be created during the process of updating the LOINC Ontology to a new version.

When deploying the LOINC Extension to SNOMED CT, you have two main options:

1. **Use the Extension as-is, accepting that some components may reference inactive concepts**
    - **Benefit**: Minimal setup time and resource use.
    - **Challenge**: Potential use of inactive concepts, which may affect coding accuracy.
    - This approach is commonly used because it offers quick deployment, and SNOMED CT provides methods for managing inactive content, such as historical associations. The best practice is to use

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the latest version of the published LOINC Extension, ensuring alignment with a current SNOMED CT International Edition.

2. **Conduct pre-implementation processing to resolve references to inactive concepts**
   - **Benefit**: The LOINC Extension will fully align with the current SNOMED CT version.
   - **Challenge**: Requires SNOMED CT expertise, services for identifying replacements, and services for publishing the updated extension.

6.4 Using the LOINC Ontology

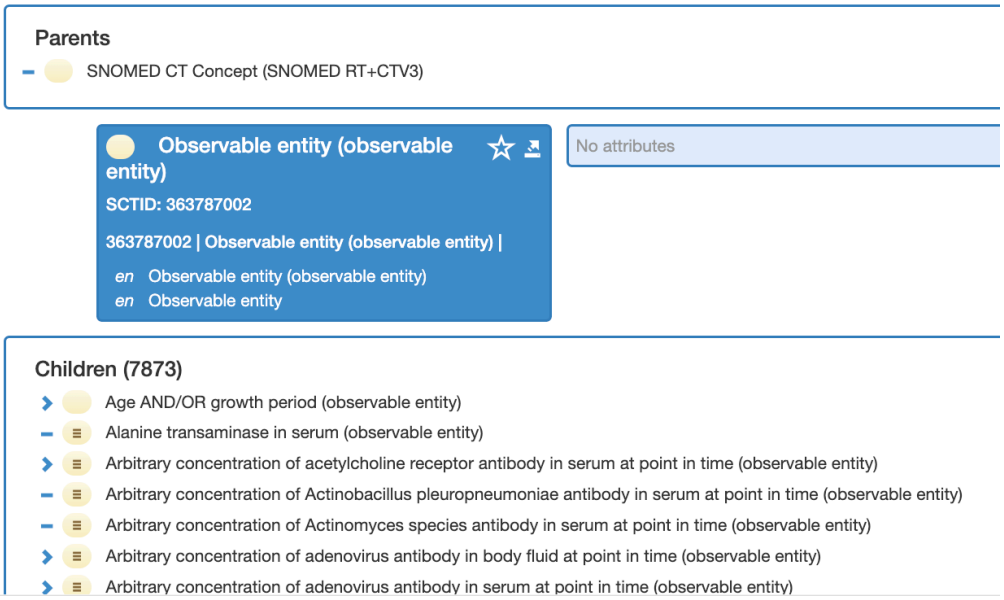
When working with the LOINC Ontology, it's essential to have efficient access to the content through various systems, regardless of the technology used.

This chapter provides practical guidance on how the LOINC Ontology can be used effectively in clinical applications to support the use cases outlined in 3. Clinical Use Case.

6.4.1 Querying the LOINC Ontology

The integration of LOINC observable entity concepts into SNOMED CT follows a structured yet distinct approach, wherein LOINC concepts are incorporated as subtypes of |Observable entity| but maintain a flat hierarchical structure.

In the LOINC Ontology browser, the flat structure becomes evident, when searching for the concept |observable entity| and then exploring the large number of direct children of this concept.



While this design ensures comprehensive coverage of LOINC concepts, it inherently limits the effectiveness of simple subsumption-based retrieval, as concepts are not deeply nested within a hierarchical framework. However, this challenge is mitigated by the rich semantic modeling of LOINC concepts within SNOMED CT, which includes well-defined attributes and explicit logical definitions.

To facilitate efficient retrieval of LOINC concepts within SNOMED CT, the Expression Constraint Language (ECL) serves as a robust querying mechanism. ECL enables users to construct precise and attribute-driven queries, leveraging core LOINC attributes such as component, property, system (specimen), time aspect, and method. This capability allows for highly granular and targeted data extraction, supporting advanced clinical decision-making, analytics, and interoperability within healthcare systems.

> For a detailed introduction and guidance to the SNOMED CT Expression Constraint Language, please refer to Expression Constraint Language.

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Simple Expression Constraints

The simplest form of an expression constraint consists of a focus concept, optionally preceded by a constraint operator. The focus concept represents a specific SNOMED CT term, while the constraint operator refines the selection. Simple expression constraints enable precise retrieval of concepts based on hierarchical relationships, making them fundamental for querying SNOMED CT data.

Examples

174771010000107 |Mass concentration of glucose in blood at point in time (observable entity)|

→ *Retrieves the exact concept |Mass concentration of glucose in blood at point in time (observable entity)|*

<< 174771010000107 |Mass concentration of glucose in blood at point in time (observable entity)|

→ *Retrieves the exact concept |Mass concentration of glucose in blood at point in time (observable entity)|* ***and*** *all its descendants*

Key Operators for Simple Expression Constraints

Operator	Name	Description	Example (LOINC Observable Entities in SNOMED CT)
Self	The expression constraint is satisfied only by the specified concept	*Retrieves only the specified concept*	593081010000107 |Aldosterone and renin activity panel - Plasma (observable entity)|
*	Any	*Any concept in the substrate*	All LOINC Ontology concepts (incl. concepts in dependent modules)
<	Descendant of	*Retrieves all descendants (subtypes) of the specified concept*	< 540081010000107 |Panel (observable entity)|
<<	Descendant or self of	*Retrieves all descendants (subtypes) of the specified concept including the concept itself*	<< 363787002 |Observable entity (observable entity)| → Includes all Observable entities
<!	Child of	*Retrieves all children (immediate subtypes) of the specified concept excluding the concept itself*	<! 363787002 |Observable entity (observable entity)| → Direct children like "Laboratory test result"
<<!	Child or self of	*Retrieves all children (immediate subtypes) of the specified concept including the concept itself*	<<! 363787002 |Observable entity (observable entity)| → "Laboratory test result" and itself
>	Ancestor of	*Retrieves all ancestors (supertypes) of the specified concept excluding the concept itself*	> 234567001 (Hemoglobin measurement) → Retrieves "Laboratory test result"
>>	Ancestor or self of	*Retrieves all ancestors (supertypes) of the specified concept including the concept itself*	>> 234567001 (Hemoglobin measurement) → Retrieves itself and ancestors
>!	Parent of	*Retrieves all parents (immediate supertypes) of the specified concept excluding the concept itself*	>! 123456001 (Blood glucose level) → Retrieves "Laboratory test result"
>>!	Parent or self of	*Retrieves all parents (immediate supertypes) of the specified concept including the concept itself*	>>! 123456001 (Blood glucose level) → Retrieves itself and immediate parent

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Operator	Name	Description	Example (LOINC Observable Entities in SNOMED CT)
^	Member of	*Retrieves the referencedComponentId of all (active) members of a reference set*	^ 735981007 (LOINC Reference Set in SNOMED CT) → Retrieves all members of the LOINC refset

Expression Constraints with Refinements

Expression constraints with refinements extend simple expression constraints by specifying additional criteria to refine the selection of concepts. A refinement consists of an attribute-value pair, where the attribute represents a defining characteristic, and the value specifies the required condition. This allows for more precise querying of SNOMED CT concepts.

In the LOINC Ontology, expression constraints with refinements allow for more precise retrieval of LOINC terms based on specific attributes, such as Component, Site, or Technique. A refinement consists of an attribute-value pair, where the attribute defines a characteristic, and the value specifies the required condition.

Refinement Example

<< 363787002 : 370130000 = 117363000

→ Retrieves all **Observable entity** (363787002) terms where **Property** (370130000) is **Mass concentration** (117363000), such as *Glucose [Mass/volume] in Blood*.

The following page of the Expression Constraint Language Specification and Guide details the different kinds of refinements that are supported by the Expression Constraint Language: Refinements

Refinement Examples

By applying refinements, users can precisely query **LOINC-based Observable entities** in SNOMED CT, ensuring they meet specific laboratory or clinical criteria.

The table below lists example ECL queries that can be performed to retrieve a set of concepts that matches the criteria delineated in the ECL expression.

ECL Query	Text Description of Query	Example Results
< 363787002 |Observable entity (observable entity)| : 246501002 |Technique (attribute)| = *	**Query for all observable entity concepts which have a** 246501002 |Technique (attribute)|	>7000 concepts including: 154831010000100 |Substance concentration of pro-brain natriuretic peptide in serum or plasma at point in time by immunoassay (observable entity)|
<< 363787002 |Observable entity (observable entity)| : 246093002 |Component (attribute)| =<< 68498002 |Antibody (substance)| AND 704327008 |Direct site (attribute)| =<< 122592007 |Acellular blood (serum or plasma) specimen (specimen)|	**Query for all observable entity concepts where** 246093002 |Component (attribute)| **is a subtype of** 68498002 |Antibody (substance)| **and** 704327008 |Direct site (attribute)| **is a subtype of** 122592007 |Acellular blood (serum or plasma) specimen (specimen)|	>3000 concepts including: 204371010000103 |Presence of Aspergillus fumigatus serotype 3 antibody in serum at point in time (observable entity)|

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ECL Query	Text Description of Query	Example Results
<< 363787002 |Observable entity (observable entity)| : 246093002 |Component (attribute)| = << 68498002 |Antibody (substance)| AND 704327008 |Direct site (attribute)| = 122592007 |Acellular blood (serum or plasma) specimen (specimen)|	**Query for all observable entity concepts where** 246093002 |Component (attribute)| **is a subtype of** 68498002 |Antibody (substance)| **and** 704327008 |Direct site (attribute)| **is exactly** 122592007 |Acellular blood (serum or plasma) specimen (specimen)|	>200 concepts including: 59001010000108 |Mass concentration of complement C3 nephritic factor in serum or plasma at point in time (observable entity)|
> 80151010000108 |Mass concentration of monoclonal IgG in serum at point in time (observable entity)|	**Query for all ancestors of** 80151010000108 |Mass concentration of monoclonal IgG in serum at point in time (observable entity)|	3 concepts including: 132201010000103 |Mass concentration of immunoglobulin G in serum or plasma at point in time (observable entity)|
>! 176671010000107 |Arbitrary concentration of Afipia felis IgG in serum at point in time (observable entity)|	**Query for parent of** 176671010000107 |Arbitrary concentration of Afipia felis IgG in serum at point in time (observable entity)|	253191010000109 |Arbitrary concentration of immunoglobulin G in serum at point in time (observable entity)|
< 96371010000104 |Arbitrary concentration of alphafetoprotein in body fluid at point in time (observable entity)|	**Query for all descendants of** 96371010000104 |Arbitrary concentration of alphafetoprotein in body fluid at point in time (observable entity)|	4 concepts including: 137271010000105 |Arbitrary concentration of alphafetoprotein in pleural fluid at point in time (observable entity)|
<< 363787002 |Observable entity (observable entity)| : 370130000 |Property (attribute)| = << 705057003 |Presence (property) (qualifier value)|	**Query for all observable entity concepts where** 370130000 |Property (attribute)| **is a subtype of** 705057003 |Presence (property) (qualifier value)|	>1000 concepts including: 157591010000108 |Presence of Influenza A virus RNA in microbial isolate at point in time by probe with target amplification (observable entity)|
< 363787002 |Observable entity (observable entity)| {{ C definitionStatus = defined }}	**Query for all sufficiently defined observable entity concepts**	>18000 concepts including: 219541010000104 |Presence of hepatitis B virus rRNA in specimen at point in time by nucleic acid hybridization probe (observable entity)|
< 363787002 |Observable entity (observable entity)| {{ C definitionStatusId = 900000000000074008 | Primitive| }} : 370130000 |Property (attribute)| = << 705057003 |Presence (property) (qualifier value)|	**Query for all primitive observable entity concepts where** 370130000 |Property (attribute)| **is a subtype of** 705057003 |Presence (property) (qualifier value)|	>1000 concepts including: 192351010000101 |Presence of opioid receptor agonist in unknown substance at point in time (observable entity)|
<< 363787002 |Observable entity (observable entity)| : 246093002 |Component (attribute)| = << 29246005 |Immunoglobulin G (substance)| OR 246093002 |Component (attribute)| = << 74889000 |Immunoglobulin M (substance)|	**Query for all observable entity concepts where** 246093002 |Component (attribute)| **is a subtype of** 29246005 |Immunoglobulin G (substance)| OR 74889000 |Immunoglobulin M (substance)|	>1500 concepts including: 171561010000105 |Presence of Borrelia burgdorferi 30kD IgG in serum at point in time by immunoblot assay (observable entity)|
<< 363787002 |Observable entity (observable entity)| : 246093002 |Component (attribute)| = << 29246005 |Immunoglobulin G (substance)| AND 246093002 |Component (attribute)| != << 712606001 |Monoclonal immunoglobulin G (substance)|	**Query for all observable entity concepts where** 246093002 |Component (attribute)| **is a subtype of** 29246005 |Immunoglobulin G (substance)| **AND is not a subtype of** 712606001 |Monoclonal immunoglobulin G (substance)|	>900 concepts including: 143701010000100 |Presence of Hepatitis C virus IgG in plasma or serum or whole blood at point in time by rapid immunoassay (observable entity)|

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Expression Constraints with Filters

Expression constraints with filters enhance concept selection by applying additional conditions based on metadata or external attributes rather than defining characteristics. Filters enable more flexible and targeted queries by constraining results based on criteria such as term status, module, effective time, or description type.

In the LOINC Ontology, expression constraints with filters allow for refined retrieval of LOINC terms based on metadata attributes such as versioning, language, or active status. By applying filters, users can narrow down results to match specific implementation requirements, ensuring more relevant and precise data retrieval.

The following pages of the Expression Constraint Language Specification and Guide details the different kinds of filters that can be used to refine a query:

- Description Filters
- Concept Filters
- Member Filters
- History Supplements

The table below provides some examples of key filters for querying the LOINC Ontology content

Filter	ECL Query	Text Description of Query
Module Filter	<< 363787002 |Observable entity (observable entity)| {{ C moduleId = 11010000107 |LOINC Extension module| }}	This ECL is satisfied by all concepts that are descendants or self of observable entities belonging to the LOINC extension module. Applying this module filter will ensure that only concepts belonging to the LOINC extension are returned.
Description Filter	<< 363787002 |Observable entity (observable entity)| {{ term = "glucose"}} {{ C moduleId = 11010000107 |LOINC Extension module| }}	This ECL adds the description filter {{ term = "glucose"}}. This ECL is satisfied by all concepts that are descendants or self of observable entities belonging to the LOINC extension module and has a description including the term 'glucose'
Description Filter Word-prefix-any-order	<< 363787002 |Observable entity (observable entity)| {{ term = "hydr uri"}} {{ C moduleId = 11010000107 |LOINC Extension module| }}	This ECL adds the description filter {{ term = "hydr uri"}}. This example demonstrats the word-prefix-any-order search that is the default behaviour: *By default, term filters match using a word-prefix-any-order match technique. This means that each string value in the search term must match the start of a word in the concept's description term, but that these words may appear in any order.*

Query using the SNOMED CT Browser

To execute expression constraints using the SNOMED LOINC Browser, please follow these instructions:

1. Navigate to the LOINC Ontology browser: https://browser.loincsnomed.org/

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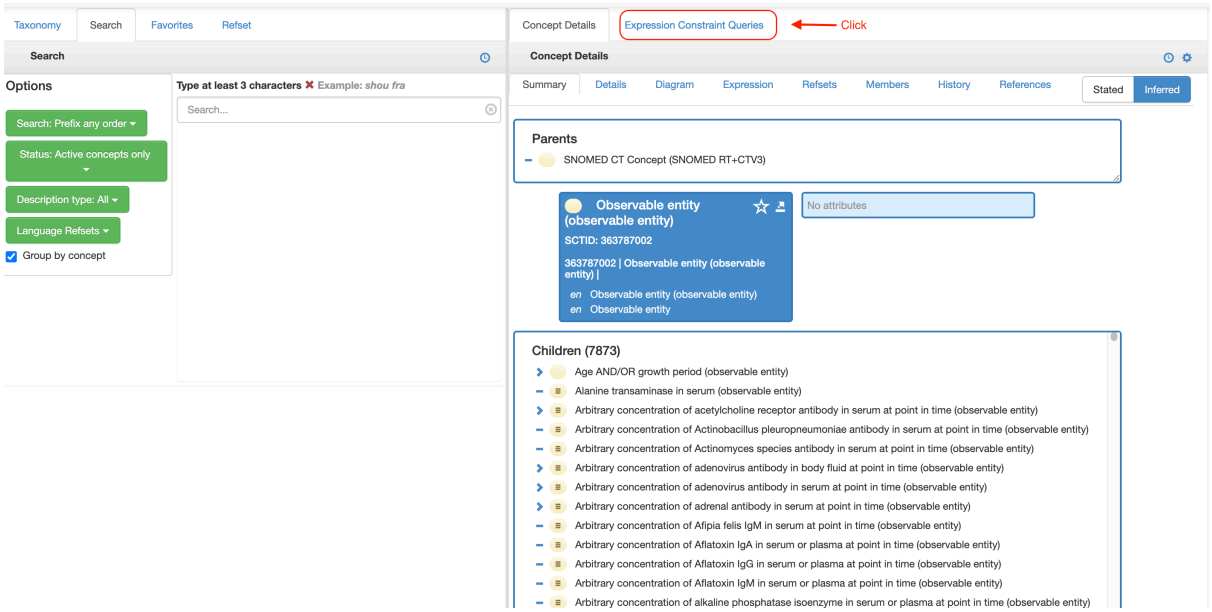
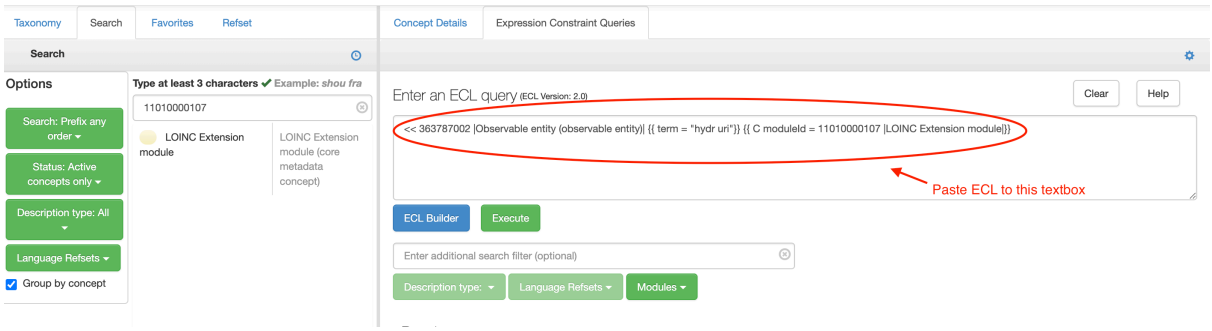
2. Enter the "Expression constraints Queries" in the panel to the right, as shown here:



3. Copy an expression constraint from the examples above
4. Paste the expression constraint into the Expression Constraints Query text box, as shown here:



5. Click Execute (green button below the textbox)

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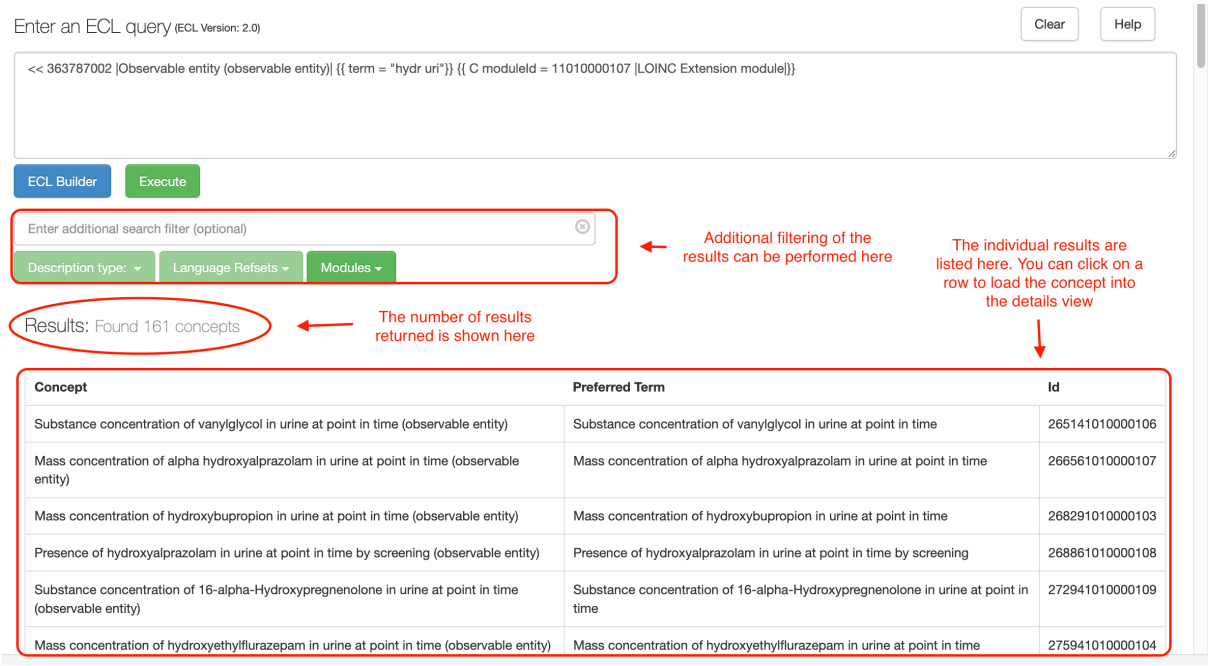
6. View results



6.4.2 Accessing the LOINC Ontology from a FHIR Terminology Server

When working with the LOINC Ontology, leveraging a FHIR terminology server can simplify access and management. The server allows you to handle the content as a specific CodeSystem version, providing access to all FHIR Terminology operations.

LOINC Extension FHIR URIsing

The SNOMED International URI standard specifies that identify unversioned editions (i.e. editions) and versioned editions (i.e. versions) take the following respective forms:

- http://snomed.info/sct/{sctid}
- http://snomed.info/sct/{sctid}/version/{timestamp}

These URIs apply to the 'version' element of codes and the 'URL' parameter in FHIR Operations. The 'system" element value is always 'http://snomed.info/sct' for all SNOMED editions. For more information on the URI Specification, please refer to the URI Standard document.

Examples

The following table shows some examples of URIs for editions and versions relevant when working with the LOINC Ontology.

Resource	URI
SNOMED CT International Edition	http://snomed.info/sct/900000000000207008
SNOMED CT International Edition, 20250101	http://snomed.info/sct/900000000000207008/version/20250101
SNOMED CT-LOINC	http://snomed.info/sct/11010000107
SNOMED CT-LOINC, 31 March 2025	http://snomed.info/sct/11010000107/version/20250531

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FHIR Operations

The following table lists a few key requests relevant for retrieving content from the LOINC Ontology using the FHIR Terminology services API.

Service Name and Status	Input	Output
$lookup	A conceptId and a CodeSystem url	• Concept metadata, including status, designations, etc.
$expand **Get all members of the reference set** **REQUIRED**	• A reference set specified by its refsetId, in this case the identifiers for the set of Orderable and Observable LOINC Terms: 635111010000100 |LOINC Orderable Reference Set| 635121010000106 |LOINC Observable Reference Set|	• A list of concept or description IDs • Option to include additional information about each concept or description
$validate-code **Test if a concept or description is a member of a specified reference set** **REQUIRED**	• A reference set specified by its refsetId • A candidate concept.id	• If the candidate concept is a member of the reference set: TRUE • Otherwise: FALSE

Please refer to the SNOMED CT Terminology Services Guide for a comprehensive guidance on SNOMED CT enabled terminology services.

Example FHIR Requests

These examples use the concept 635111010000100 |LOINC Orderable Reference Set| as the refsetId.

Service Name	API Call

Get concept metadata	`GET fhir]/ValueSet/$expand`
	`?url=http://snomed.info/sct?fhir_vs=refset/[refsetId]`
	`&code=537131010000109`

Get all members of the reference set	`GET [fhir]/ValueSet/$expand`
	`?url=http://snomed.info/sct?fhir_vs=refset/[refsetId]`
	`&count=10`
	for example
	`GET [fhir]/ValueSet/$expand`
	`?url=http%3A%2F%2Fsnomed.info%2Fsct%3Ffhir_vs%3Drefset%2F635111010000100&co`
	An alternative solution is to use the expression constraint language, as shown here:
	`GET [fhir]/ValueSet/$expand`
	`?url=http%3A%2F%2Fsnomed.info%2Fsct%3Ffhir_vs%3Decl%2F%5E%5B635111010000100`
	`&count=10`

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	`GET [fhir]/ValueSet/$expand ?url=http%3A%2F%2Fsnomed.info%2Fsct%3Ffhir_vs%3Decl%2F%5E635111010000100&co`

Test if a concept is a member of the reference set	`GET [fhir]/ValueSet/$validate-code ?system=http://snomed.info/sct&code=537131010000109 &url=http://snomed.info version/[effectiveTime]?fhir_vs=refset/[refsetId]`
	for example
	`GET [fhir]/ValueSet/$validate-code ?system=http://snomed.info/sct&code=537131010000109 &url=http://snomed.info 900000000000207008/version/20200131?fhir_vs=refset/635111010000100`

6.4.3 Accessing the Reference Set in a Relational Database

If the LOINC Ontology has been loaded in a relational database using a model that complies with the RF2 specification for tables and column names, the content can be accessed using SQL queries in line with the examples below. To Set up SNOMED CT in a relational database, please follow the guidance and instructions provided in the SQL Practical Guide.

SQL Examples

Service Name	SQL Query [6]	Result

Get all members of the reference set
The reference set used in this example is:
635111010000100 | Logical Observation Identifiers Names and Codes Orderable Reference Set (foundation metadata concept)|
	`SELECT referencedComponentId FROM snap_refset_simple WHERE active=1 AND refsetId=[refsetId];`
	for example
	`SELECT referencedComponentId FROM snap_refset_simple WHERE active=1 AND refsetId=635111010000100 ;`
		Returns the ids of all the concepts or descriptions that are the members of the reference set.

Test if a concept is a member of the reference set **The concept used in this example is:** 141951010000102 |Mass concentration of neopterin in urine at point in time (observable entity)|	`SELECT count(referencedComponentId) FROM snap_refset_simple WHERE active=1 AND refsetId=[refsetId] AND referencedComponentId=[candidateComponentId];` for example	Returns: • 0 : if the candidate component is not in the reference set. • 1 : If the candidate component is a member of the reference set ▪ Some types or reference set can include the same component more than once, so any value greater than zero indicate the component is a member of the references set.

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```
SELECT
count(referencedComponentId)
    FROM snap_refset_simple
    WHERE active=1 AND
refsetId=635111010000100
        AND
referencedComponentId=
141951010000102;
```

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