Specimen, Biological Structure, and Spatial Ontologies in Support of a Human Reference Atlas

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Abstract

The Human Reference Atlas (HRA) is defined as a comprehensive, three-dimensional (3D) atlas of all the cells in the healthy human body. It is compiled by an international team of experts that develop standard terminologies linked to 3D reference objects describing anatomical structures. The third HRA release (v1.2) covers spatial reference data and ontology annotations for 26 organs. Experts access the HRA annotations via spreadsheets and view reference models in 3D editing tools. This paper introduces the Common Coordinate Framework Ontology (CCFO) v2.0.1 that interlinks specimen, biological structure, and spatial data together with the CCF API which makes the HRA programmatically accessible and interoperable with Linked Open Data (LOD). We detail how real-world user needs and experimental data guide CCFO design and implementation, present CCFO classes and properties together with examples of their usage, and report on technical validation performed. The CCFO graph database and API are used in the HuBMAP portal, Virtual Reality Organ Gallery, and other applications that support data queries across multiple, heterogeneous sources.

Background & Summary

The Human BioMolecular Atlas Program (HuBMAP)[1] is developing a human reference atlas (HRA) of the trillions of cells in the human body in close collaboration with 16 other consortia[2]. The HRA aims to serve the needs of biomedical researchers, practitioners, teachers and learners. It attempts to capture healthy human diversity (e.g., the location and type of cells and associated biomolecular data), and it will be useful to biomedical experts for many purposes. One major use case is allowing researchers to assess changes in the numbers and types of cells due to aging and disease.

The third HRA (v1.2) was released in June 2022, and it includes 26 organ-specific Anatomical Structures, Cell Types plus Biomarkers (ASCT+B) tables and 53 associated 3D reference organ models, among other features. On June 23, 2022, the HRA had been successfully used across four consortia to register 350 tissue blocks. On September 1, 2022, the count had increased to 364 tissue blocks and these tissue blocks link to 5,000 biomolecular datasets derived from these tissue samples.

Human Reference Atlas. To construct the HRA, it is necessary to standardize experimental specimen metadata and to have a common coordinate framework (CCF)[3] that provides a biological structure vocabulary linked to 3D spatial data for every organ, tissue, and cell in the human body[4]. To construct the CCF for the HRA, we assume that (1) anatomical structures are composed of cells that have different types (i.e., cell types are located in anatomical structures), combinations of biomarkers characterize different cell types, and experts are interested in querying for those entities (i.e., we need standardized terminology to query for anatomical structures, cell types, and biomarkers). We call this biological structure information. (2) The 3D space in which anatomical structures, cells of different types, and biomarkers operate does matter. We call this spatial information. (3) Human sex, age, and ethnicity impacts the structure and function of anatomical structures, cells, and biomarkers. We call this specimen information and use it to capture human diversity and its impact on body functions.

Biological structure information. Anatomical structures, cell types, and biomarkers (ASCT+B) tables record the biomarker sets that characterize cell types within the nested anatomical structures that compose an organ. The ASCT+B tables are authored by human experts using templated Google Sheets—see standard operating procedure (SOP) entitled “SOP: Authoring ASCT+B Tables”[5]. The biomarkers, cell types, and anatomical structures are mapped to existing ontologies if they are available (e.g., to Uberon[6,7]). An exemplary ASCT+B table with an anatomical structure partonomy (in red on left) linked both to cell types (in blue in middle) and biomarkers (in green on right) is shown in **Fig. 1a**. All existing ASCT+B tables can be interactively explored in the ASCT+B Reporter[8].

Spatial information. The 3D Reference Object Library captures the shape, size, location, and rotation of major anatomical structures. They are authored by medical illustrators following the “SOP: 3D Reference Object Approval”[9]. For each organ, there exists a digital representation of the so-called scene graph that represents all 3D objects (i.e., anatomical structures) and interobject relationships (e.g., what object is inside or next to which other object). There exists a crosswalk table that associates 3D object names with the anatomical structure terms in the ASCT+B tables that link to terminology in existing ontologies whenever possible. **Fig. 1a** depicts how Visible Human Project data (VHP)[10] (a high-quality, whole-body dataset published by the National Library of Medicine) is used to create reference organs (different anatomical structures of a kidney are shown) and how resulting data is uniformly represented using the spatial and specimen ontology. All reference organs can be interactively explored in the Exploration User Interface (EUI)[11] and the Virtual Reality Organ Gallery[12], both of which are detailed in the Applications section. The spatial size, shape, location, and rotation of experimental tissue data is captured relative to the organs in the 3D Reference Object Library. Uniform tissue registration is facilitated by the Registration User Interface (RUI) (**Fig. 2b, right**).

Specimen information. Data capturing the sex, age, and other information on donors that provided tissue data used in the construction of the HRA are tracked. For the HRA (v1.2), data from the Visible Human Project was used in the construction of the 3D reference organs—the male was white, 180.3 cm (71 inch) tall, 90 kg (199 pound) and was 38 years old; the female was white, 171.2 cm (67.4 inch) tall, obese (weight unknown), and 59 years old.

Provenance. We track scholarly publications and experimental studies that provide evidence for entities in the HRA (e.g., for what cell types have what gene expressions in which tissues). In addition to data provenance, we capture data processing provenance so the HRA can be recomputed, as needed, when new data and algorithms become available.

HRA construction versus usage. Just as with geospatial maps, there is a difference between atlas creation (i.e., defining the reference space) and atlas usage (e.g., finding a place in the reference space or a pathway between two locations). **Fig. 1** provides an overview of HRA construction and usage by experts (e.g., anatomists, pathologists, surgeons, single cell researchers). We show real-world entities on the left, standardized data in the middle, and CCF ontologies and value-added services on the right. **Fig. 1a** shows HRA construction that includes the creation, validation, and publishing of the CCFO and associated APIs and tools. It starts with the creation of ASCT+B tables by experts with decades of expertise in surgery, pathology, anatomy, single-cell analysis, consulting textbooks, Wikipedia, and published experimental data. In parallel, professional medical illustrators create 3D spatial reference organs in support of tissue registration (e.g., the resulting reference organs have anatomical structures that serve as landmarks when registering virtual tissue blocks and can be used to assign semantic tags). Last but not least, crosswalks are compiled that link all 3D reference objects to anatomical structures in the ASCT+B tables (see details in Börner et al., 2021[4]). **Fig. 1b** details HRA usage—e.g., the mapping of new experimental tissue data into the HRA so it can be compared across tissue donors, laboratories, assay types or by using the HRA to query for cell types and the genes they express in different locations of the 3D human body. We show how tissue blocks are cut from human organs (and possibly further cut into tissue sections). The tissue blocks are then spatially registered into 3D reference organs using the Registration User Interface[13], shown on right (and discussed in the Applications section), that assigns anatomical structure annotations (Uberon IDs and labels) via 3D object collision detection (see papers[14,15] and the Applications section);

Assigned anatomical structures and data in the ASCT+B tables are then used to predict cell types and gene expressions for a tissue block. HRA-predicted data can then be compared to experimental data and the HRA data is revised as needed to capture healthy human diversity. Note that only the highest quality experimental data is used for HRA construction; all CCF-registered data can be explored within the HRA.

Common Coordinate Framework Ontology. The CCF Ontology (CCFO) detailed in this paper formalizes and interlinks major classes that describe biological structure, spatial, and specimen information captured in the HRA. It thus provides a unifying vocabulary for HRA construction and usage—making it possible to ingest external data sources; supporting uniform tissue sample registration that includes the spatial positioning and semantic annotations within the 3D reference organs; and supporting user-formulated cross-domain queries over tissue donor properties, anatomical structures, cell types, biomarkers, and 3D space. The CCFO makes it possible to publish HRA data in the Linked Open Data (LOD) cloud[16] in a Findable, Accessible, Interoperable and Reusable (FAIR)[17] manner; the CCF API supports programmatic access to HRA data. We provide templates via data specifications so that other consortia can easily publish their data in a HRA-compatible manner.

This paper presents user needs that guide HRA and CCFO development. We then detail CCFO modeling and implementation as well as validation.

Methods

HRA Needs That Guide CCF Ontology Modeling

As stated above, there is a major difference between (1) the construction of the HRA (i.e., developing a latitude/longitude-like system) and agreeing on a way to map new data onto it and (2) the usage of the HRA to run different semantic and spatial queries. It is critically important to understand the goals and user needs for both parts to guide CCF Ontology design and HRA tool development (see examples in the Applications section). At their core, HRA queries act as competency questions[18,19] that inform the modeling of the CCF Ontology.

HRA construction. Both human expertise and the highest quality experimental data are used to construct the HRA. Some data exists only at the gross anatomy level (e.g., data covered in anatomy books or Visible Human Project data), while other data covers single-cell data for micro-anatomical structures (e.g., gene expression data for cells). All data—not only human expertise but also experimental data across different levels of resolution—must be registered into the very same HRA CCF. To register experimental data, hundreds of thousands of tissue blocks (currently ca. 5,000) collected from thousands of human donors (currently ca. 200) must be uniformly registered and annotated in terms of biological structure, spatial, and specimen data. HRA terms should link to existing ontologies whenever possible. If HRA terms do not exist in reference ontologies, then a GitHub issue is submitted to the respective ontology for eventual inclusion of these anatomical structures and cell types into existing ontologies and can be tracked[20,21]. Collision detection at the mesh level using the 3D Geometry-Based Tissue Block Annotation tool[14] (see Applications section) needs to be run to identify what type and volume of anatomical structures a tissue block contains (this step is necessary as most tissue samples cover cells from multiple anatomical structures). Datasets for these tissue blocks (e.g., cell-type name annotations computed using the Azimuth[22] tool or gene-expression values measured for cells in experiments) must be mapped to anatomical structures—so it becomes possible to show cell-type populations (i.e., the number of cells per type within an anatomical structure) inside of each 3D anatomical structure. For each HRA entity, all data and code needed to recompile it must be tracked to ensure reproducibility. A new HRA is computed over the course of several days using massive storage and computing resources every six months. Upon each successful recompilation, baseline HRA statistics such as entity and relationship counts, cell-type populations, or query-performance test results are computed and published.

HRA usage. Some users are interested to understand in which 3D spatial locations or in what anatomical structures cells of a certain type (e.g., immune cells) can be found or what biomarkers are available or common for a certain cell type (e.g., are there differences in gene expression values for a certain cell type across organs). Other users would like to compare their very own experimental data to the growing set of HRA compatible data (e.g., to understand how diseased cell-type populations or biomarker-expression values differ from a healthy reference). A third set of users is interested in transferring cell-type annotations from the HRA to a new experimental dataset (e.g., using the Azimuth[22] tool that automates the analysis, interpretation of single-cell RNA-seq experiment data and transfers cell annotations from the reference map to new experimental data). If new data is uploaded, it needs to be registered and analyzed at scale; 3D exploration requires that 3D reference organ files are loaded efficiently and spatial and other queries are run fast using specimen, biological structure, and/or spatial metadata. For example, a user might like to see all tissue blocks for 50-year-old females or search for cell types in a specific spatial location that have high gene-expression values in experimental datasets. The interlinkage of spatial reference objects and ASCT+B tables makes it possible to associate cell-type and biomarker data from experimental data to 3D anatomical structure data and to compute how many cells of what type are commonly found in which anatomical structures and what their typical biomarker expression values are. As the number of HRA-registered datasets increases, prediction accuracy will increase. As the HRA is spatially explicit, the spatial location of cell-type populations can be visually presented in 3D. Initially, cells are placed randomly; as more data on cell-neighborhoods becomes available[23,24], cells can be placed in spatially explicit patterns. Usage statistics must be captured to identify bottlenecks (e.g., long loading or computing times) and to improve application performance.

Note that the HRA is continuously evolving as new, higher-quality datasets become available for an increasing number of organs. HRA construction and optimization for different use cases will likely take decades. As with any atlas, the availability of the HRA will inspire qualitatively novel questions and queries that are hard to envision today.

CCF Ontology Modeling and Design

The CCFO v2.0.1 focuses on the subset of the third HRA (v1.2) release that is currently used for tissue registration and exploration in the HuBMAP[25] and GTEx[26] data portals and in other tools and services discussed in the Applications section.

CCFO Modeling Assumptions and Goals

The CCFO is modeled to serve the needs of HRA construction and usage. It formally defines the three interlinked parts of the HRA via three interlinked ontologies called Biological Structure, Spatial, and Specimen Ontology (see **Fig. 1**). Here, we discuss CCFO modeling assumptions, goals, and desirable properties.

FAIR and interoperable. We want the HRA to be findable and interoperable with other high-quality data sources outside the HRA. Therefore, HRA terms should be linked, whenever possible, to existing, widely used ontologies. For example, HRA anatomical structures are linked to Uberon[6,7] (and FMA[27–29] as needed) and cell types are linked to the Cell Ontology[30,31]. These two ontologies are used extensively to annotate single-cell transcriptomics data[32,33] and are cross integrated with each other and with other widely used ontologies (e.g., the Gene Ontology [GO][34], the Human Phenotype Ontology[35], and the Mondo Disease Ontology[36]). HRA gene and protein biomarkers are linked to HUGO Gene Nomenclature Committee (HGNC)[37] and crosswalks exist to Ensembl[38] for genes and to UniProt[39] for proteins.

Limitations of existing ontologies. Uberon and CL are overly complex for the needs of the HRA as they cover multiple species and developmental stages, and both ontologies lack some terms needed by the HRA. FMA can be hard to query due to inconsistent application of ontology design patterns, and it does not link to other ontologies. Existing reference ontologies cannot represent the spatial size, location, and rotation of 3D human reference organs and experimental data relative to the HRA and to each other; e.g., such as Uberon and FMA, have incorporated anatomical location descriptors using spatial properties (e.g., *anterior_to, posterior_to, left_of, right_of, opposite_to*, etc.), but these are often too general (e.g., in Uberon the location descriptors are for multiple species).

Use existing standards. CCFO defines a common vocabulary to annotate data in an HRA-compliant manner using several well-known biomedical ontologies, such as Uberon, FMA, CL, HGNC, and other semantic web vocabularies, such as the Dublin Core™ Metadata Initiative (DCTERMS)[40] and RDFS[41]. The CCFO uses some Dublin Core properties for providing provenance information, such as the data publisher, creator, and creation date. The CCFO uses the Open Biological and Biomedical Ontology (OBO) for properties such as *Definitions* for anatomical structures, cell types, and biomarkers. CCFO is published using the standard Semantic Web technology OWL which is built on the Resource Description Framework (RDF) data format that was designed for interoperability and supporting inference capabilities that can be used for consistency checking in the future.

Validation. The anatomical structures and cell types in the ASCT+B tables are validated against reference ontologies on a weekly basis (see Technical Validation section). Validation results are used to improve the ASCT+B tables and to issue ontology change requests to slowly and steadily modify existing reference ontologies (e.g., Uberon and CL) so they accurately represent healthy human adult data. When completed, the CCFO will be a proper, HRA-labeled subset (using the *human_reference_atlas* subset tag) of major reference ontologies that are widely used by a diverse range of bioinformatics applications.

HRA will evolve over time. As new experimental datasets and analysis results become available, the HRA data structures and the CCFO will need to be updated to capture new entity types and linkages and to serve qualitatively new user needs.

CCFO Classes and Properties

The CCF ontology published as CCF.OWL v2.0.1[42] comprises three interlinked ontologies that capture Biological Structure, Spatial, Specimen data (see **Fig. 1**). The names of the three ontologies, their classes, properties, and definitions can be found in **Table 1**.

The Biological Structure Ontology has three main classes: *Anatomical Structure*, *Cell Type*, and *Biomarker* that are derived from the ASCT+B tables for HRA construction. During HRA usage, *Anatomical Structure* data is captured via collision events and from running different assay types. In the ASCT+B tables, *Anatomical Structure* terms are linked to Uberon (supplementing with FMA[27–29] as needed). *Cell Type* terms link mainly to CL[30,31] (supplementing with Provisional Cell Ontology (PCL) for brain[43] and Human Lung Maturation (LungMAP Human Anatomy (LMHA)[44] for lung. Note that Uberon and CL are already widely used by the single-cell research community making them an obvious choice. *Biomarker* terms are linked to HGNC[37] standard pipeline developed by the brain data standards initiative[43] and is used to link these to cell-type terms.

The Spatial Ontology has four main classes: *Spatial Entity*, *Spatial Placement*, *Spatial Object Reference*, and *Extraction Set*. HRA Construction uses all four classes, while HRA Usage uses the first two only. Terms for anatomical structures from the Biological Structure Ontology are linked to 3D reference data in a CCF in support of spatial registration, spatial search among others. Concretely, each object in a 3D organ is annotated with the appropriate anatomical structure term from the partonomy tree in the Biological Structure Ontology. Lastly, each 3D organ object instance in the ontology receives a set of spatial placement parameters that states its position, size, and orientation in relation to the HRA coordinate space.

The Specimen Ontology has four main classes: *Tissue Block*, *Tissue Section*, *Dataset*, *Donor*. Only donor is used for HRA construction; all four are used for HRA usage. For HRA construction, we keep track of the Visible Human Project specimen data. For HRA usage, we record *Tissue Block, Tissue Section, Dataset, Donor* info for each tissue block. In terms of *Donor* data that is collected by independent laboratories, we capture sex and age, among other properties.

CCFO Examples

This section presents examples of how the ASCT+B tables, 3D reference organs, landmarks, and experimental tissue block data are represented using CCFO classes and properties. We render ontology class names in mixed case *italics* (e.g., *Spatial Entity*, where the first letter of each compound word is capitalized), set ontology properties in lower-case *italics* with underscores between words (e.g., *part_of* or *has_object_reference*), and use bold italics for OWL Web Ontology Language reserved words (e.g., ***SubClassOf***). We use normal orthography to describe what a class or property represents.

HRA reference organs. An excerpt of how a reference organ is represented using the CCFO is shown in **Fig. 2**. The middle panel text details how the Visible Human Project female left kidney (#VHFLeftKidney) reference organ is represented as a *Spatial Entity*. This *Spatial Entity* has well-defined 3D spatial dimensions and a link to a GL Transmission Format Binary (GLB) object file of type *Spatial Object Reference* that captures the 3D shape of this anatomical structure. The reference object is properly placed within the female reference body via a *Spatial Placement* that defines 3D scaling among others. Highlighted in orange are *representation_of* and *organ_owner_sex* that are encoded as Annotation Properties (in lower left) with persistent uniform resource locator (PURL) links to Uberon ID 0004538 for “left kidney” in the Biological Structure Ontology (top right) and to the Bioontology Logical Observation Identifier Names and Codes ID LA3-6 for “female” sex in the Specimen Ontology (in lower right).

Experimental tissue data. The CCFO is also used to represent experimental data. **Fig. 3** exemplifies how data for a *Sample* of type *Tissue Block* that was provided by a *Donor* which is a *Person* in the Specimen Ontology (in lower right). The *Tissue Block* inherits the *has_registration_location* from a *Spatial Entity* with property *has_placement* inside of the #VHFLeftKidney reference organ given in **Fig. 2**. 3D object collision events (commonly used in computer games to compute spatial relationships among moving objects) are used to compute which anatomical structures are inside of a tissue block (see Applications section for details). Using annotation property *collides_with* (in lower left), we get PURL links to three anatomical structures—UBERON:0002015 (kidney capsule), UBERON:0001225 (cortex of kidney), and UBERON:0002189 (outer cortex of kidney)—which have corresponding GLB files that define their shape as well as their size, location, and rotation in relationship to the HRA 3D reference system. If anatomical structures have cell types and biomarkers listed in the ASCT+B table, it is possible to generate lists of cell types and biomarkers commonly found in these colliding anatomical structures. Note that the anatomical structure partonomy makes it possible to retrieve all sub-anatomical structures together with all the cells found in these.

Landmarks and extraction sites. There exist two types of spatial objects that ease tissue registration via the RUI (see **Fig. 1** and the Applications section). Landmarks such as the ‘bisection line’ for the kidney help align tissue blocks with real-world or man-made objects. Predefined tissue extraction sites used in GTEx can be assigned to many tissue blocks (e.g., in situations when tissue is always extracted from the very same spatial location in a human donor body). Both types of spatial objects are represented as a *Spatial Entity* that has been tagged as a member of an *Extraction Set*. Each *Spatial Entity* is associated with a 3D reference organ that has properties such as 'organ owner sex' and 'left/right' which uniquely identifies the organ. Examples of 43 extraction sites from four consortia are given in **Table 3**.

ASCT+B partonomy. The *'part_of' (BFO:0000050)* property is used to define the partonomy of anatomical structures and cell types. For example, in the kidney ASCT+B table (v1.2), we find *part_of* relationships between 1) anatomical structures:

cortex of kidney ***SubClassOf*** *part_of* ***some*** *kidney*
outer cortex of kidney ***SubClassOf*** *part_of* ***some*** *cortex of kidney*

and 2) between a cell type and an anatomical structure, for example,

glomerular mesangial cell ***SubClassOf*** *part_of* ***some*** *glomerular mesangium*

Note that the ASCT+B tables use *located_in* relationships between cells and anatomical structures to make the tables easier to author. In CCFO, *ccf_located_in* is the annotation property recording what the authors say. If this relationship validates when compared to existing ontologies, then *part_of* is added as the formalized relationship. Some partonomies are more than 10 levels deep. Note that *part_of* is transitive (i.e., it applies between successive members of a sequence but also between any two members taken in order; e.g., if A is *part_of* B, and B is *part_of* C, then A is *part_of* C) making ontology reasoning very efficient.

ASCT+B biomarker set. If cell types have biomarkers that *characterize* them listed in the ASCT+B tables, then the class *Sequence Collection (SO:0001260)* and the properties *has_characterizing_marker_set (RO:0015004)* and *has_marker_component* are used to construct the ontology statement in CCFO, for example,

glomerular mesangial cell ***SubClassOf*** *has_characterizing_marker_set* ***some*** *(*
Sequence Collection ***and***
(has marker component ***some*** *periostin)* ***and***
(has marker component ***some*** *PIEZO2)* ***and***
(has marker component ***some*** *ROBO1)* ***and***
(has marker component ***some*** *ITGA8)* ***and***
(has marker component ***some*** *PDGFRB)* ***and***
(has marker component ***some*** *SYNPO2))*

The interpretation of this statement is that the six cell-type markers *periostin* (HGNC:16953), *PIEZO2* (HGNC:26270), *ROBO1* (HGNC:10249), *ITGA8* (HGNC:6144), *PDGFRB* (HGNC:8804), and *SYNPO2* (HGNC:17732) together are sufficient to distinguish cells of type *glomerular mesangial cell* (CL:1000742) from others found in the same anatomical context (here, the anatomical structure *glomerular mesangium* [UBERON:0002320]). This assertion might be made based on human expertise or on experimental data. An example of the latter is the lung atlas work by Travaglini et al.[45] that found that a minimum of 3-6 differentially expressed gene biomarkers is sufficient to uniquely identify 58 transcriptionally unique cell types in the lung for the spatial locations and demographic groups that were sampled. Note that tissue samples from different spatial locations (e.g., those not yet sampled at single-cell level) or donor populations (older donors or different ethnicities) might have different cell-type populations and characterizing biomarker sets.

CCFO Data Specifications

The CCF ontologies provide the vocabularies for data specifications that ease data exchange across consortia (e.g., see HRA reference organ description example in **Fig. 2** or HRA tissue block description in **Fig. 3**).

The data specification diagram of major CCFO classes and interlinkages is shown in **Fig. 4**. Some class pairs are linked through inverse relationships (e.g., a *Donor provides Sample*; *Sample comes_from Donor*). Most relationships are of single cardinality (indicated by a 1 on the arrow), whereas some are of multiple cardinality (indicated by an asterisk). Examples of multiple cardinality include: a donor can provide multiple tissue samples, a sample can be used to generate multiple datasets, a tissue block can be subdivided into multiple tissue sections.

The class *Spatial Entity* conceptualizes the notion of 3D objects in the CCFO. The coordinate framework for placing the 3D objects relative to each other is modeled through the class *Spatial Placement*. A 3D reference organ is a *Spatial Object Reference* with a *Spatial Placement* inside of the 3D HRA coordinate system (see example in **Fig. 2**). A *Tissue Block* is a *Sample* that *has_registration_location* defined via the *Spatial Entity* class relative to a *Spatial Object Reference* (see example in **Fig. 3**).

CCFO Editing, Building, and Release

A new release of the HRA is published every six months. The CCFO derived from the HRA data is published as a CCF.OWL graph database and associated CCF API shortly thereafter. Experimental datasets compliant with earlier versions of the HRA might need to be re-registered (e.g., if ASCT+B table terminology or 3D reference organs changed).

The "Standard Operating Procedure (SOP) Document for Ontology Editor"[46] details how to (1) download and setup the development environment using Git, (2) add new reference organs to the CCFO, (3) update an existing reference organ in the CCFO, (4) build the CCFO, and (5) release the CCFO.

The general CCFO generation pipeline is shown in **Fig. 5**. The ASCT+B tables (in top left) are read by an external *Validation Tool*[47] that compares whether anatomical structure and cell type terms are valid and if these relationships are true according to Uberon and CL/PCL using UberGraph[48]. All terms and relationships that already exist in Uberon and CL/PCL are added to the Biological Structure Ontology. When a term or relationship does not validate, the closest alternative match to another term in the ASCT+B Table is found and added. If no match is found, then ontology change request tickets (GitHub issues) are generated for missing anatomical structures, cell types, and relations for inclusion in existing ontologies. The result is a "partonomy" that reports *part_of* relationships between each pair of terms (anatomical structures to anatomical structures; cell types and anatomical structures (called *located_in* in the ASCT+B tables). A second pipeline uses the ROBOT tool[49] to read the ASCT+B tables, augment them with information from reference ontologies (e.g., it adds metadata such as synonyms, definitions, or class hierarchies), and adds this additional data to the Biological Structure Ontology. Both processes generate weekly reports that are used to improve ASCT+B tables and to generate ontology change requests. Next, the *asctb2ccf*[50] tool reads the validation tool report together with the original relationships from the ASCT+B table and generates a characterizing biomarker set for each cell type. *Spatial Object Reference* data (in middle left) is read by the *spatial2ccf*[51] tool that generates instances of *Spatial Entity*, *Spatial Object Reference*, and *Spatial Placement* classes defined by the CCF Spatial Ontology. *Sample* registration data (in lower left) from HuBMAP, SPARC, KPMP, GTEx is available as LOD (see **Table 3** for examples). Each *Extraction Set* has a well-defined *Spatial Placement* (e.g., using the Registration User Interface in Applications section). Multiple tissue blocks can be associated with the same *Extraction Set* (e.g., GTEx has 29 *Extraction Sets* for more than 5,000 tissue blocks). The *asctb2ccf* tool reads the anatomical structure tags and generates Biological Structure Ontology data (e.g., predictions of cell types commonly found in these anatomical structures). The *spatial2ccf* tool reads spatial data and generates Spatial Ontology data. The *specimen2ccf*[52] reads *Donor, Tissue Block,* and *Sample* data and generates Specimen Ontology data.

The CCF-Slim Ontology (ccf-slim.owl) captures HRA data exclusively (no experimental data), and it is used in the Registration User Interface (see Applications section).

Data Records

The CCF.OWL v2.0.1 is available through the NCBI BioPortal Ontology Browser (https://bioportal.bioontology.org/ontologies/CCF) and the EBI OLS Ontology Browser (https://www.ebi.ac.uk/ols/ontologies/ccf). It is findable via https://purl.org/ccf/ccf.owl.

There are 266,576 triples in the graph database that holds the content of the CCF.OWL v2.0.1. The size of all 3D object GLB files is 2.56 GB.

CCF.OWL v2.0.1 represents major digital objects of the HRA v1.2, including 26 ASCT+B tables, 53 3D reference objects, and a crosswalk that associates anatomical structures in both.
In addition, the data covers landmark organ sets which are used in the tissue registration user interface to facilitate tissue block placement in 3D organ models; these were not published with DOIs, but do appear in the CCFO.

CCFO classes and properties are listed in **Table 1**. Spatial entities representing 54 3D reference organs, 8 extraction sites, and 35 landmark extraction sites for a total of 97 are listed in **Table 2**. Experimental tissue data comprises 364 tissue blocks or registration sites and links to more than 5,000 tissue blocks and many more single-cell datasets, see **Table 3**.

Weekly run term and relationship validation reports are available at https://github.com/hubmapconsortium/ccf-validation-tools/tree/master/reports.

Documentation and standard operating procedures have been published via the HRA Portal, https://hubmapconsortium.github.io/ccf.

Technical Validation

Source materials

The third HRA (v1.2) was authored by 114 unique experts that listed 185 publications with Digital Object Identifiers (DOIs). The 3D reference organs in this HRA were modeled using textbooks such as Gray's Anatomy[53], Netter's Atlas of Human Anatomy[54] and similar sources that are cited in the 3D model metadata. We hosted more than 50 organ-specific meetings with subject matter domain experts to discuss and review the evolving HRA. Experimental data generated by four consortia (HuBMAP, SenNet, KPMP, and GTEx) was mapped onto the HRA using 364 registered extraction sets that link to more than 5,000 tissue blocks.

Comparison to Uberon, FMA, CL, HGNC

When comparing the ASCT+B tables on June 13, 2022 with Uberon (May 17, 2022 version) and Cell Ontology (CL, Feb 16, 2022 version), there were 1,620 terms that do not validate; 1,290 of these are from blood vasculature and peripheral nervous system. Many of the *part_of* relationships between anatomical structures validate, but few of the anatomical structures to cell type relationships validate (a large proportion is due to immune cells, which may or may not be tissue specific making it hard to model location in ontologies). For the extended blood vasculature tables, only 390 (41%) of the final 953 vessels in the HRA database are in Uberon. The FMA ontology has many terms that are missing in Uberon and we are in the process of adding those to Uberon. All 1,397 unique anatomical structures in the 26 organs 3D Reference Library link either to Uberon or FMA.

We use the CL as the main cell-type reference ontology. Recent technological advances in single-cell analysis make it possible to classify cell types based on their biomolecules in addition to their morphological attributes. This resulted in a large number of new cell types that are not yet recorded in CL. For example, there are 953 cell types covered by HRA (v1.2) that do not have a CL ID. We are using provisional cell-type terms and submitting new term request tickets so new terms can be added to CL.

As for biomarkers, the 3rd HRA features 2,842 total with 1,959 of type gene, 878 proteins, 3 proteoforms (in eye), 1 lipid (in placenta), and 1 metabolite (in eye). Of these, 447 biomarkers have provisional ontology IDs. Other gene and protein biomarkers are linked to HGNC.

Applications

The CCF.OWL v2.0.1 and the CCF API are used by different applications. Four applications are detailed here and shown in **Fig. 6**. Each uses interlinked specimen, biological structure, and spatial data to provide unique functionality to users.

HuBMAP Portal. The Tissue Registration User Interface (RUI, see **Fig. 6a**) was integrated into the HuBMAP Ingest Portal to support the HRA-compliant registration of tissue samples[55]. RUI users first pick a 3D reference object that matches the organ from which tissue was extracted; then, they change the 3D size, position, and rotation of a virtual cube (in yellow) such that the values match the real-world tissue block properties—in relation to a 3D reference organ. Collision detection (i.e., the intersection of the virtual cube with the reference organ anatomical structures is used to assign anatomical structure tags (see lower right of RUI). Spatial, biological structure, and specimen data is generated in JSON format. A stand-alone version of the RUI is available[13] and data can be downloaded locally and shared freely as LOD so it becomes available via the CCF-API. The Exploration User Interface (EUI, see **Fig. 6b**) uses the CCF-API to let users explore RUI-annotated data using specimen, biological structure, and spatial attributes. For example, it is possible to filter tissue data collected by different consortia from different donors using properties such as donor sex and age, cell types, or spatial location. The code for both applications is freely available[11]. The EUI has been successfully integrated into the GTEx portal[26].

Mesh-level collision detection. The current RUI performs collision detection at the bounding box level, generating more anatomical structure tags than desirable. Mesh-level collision detection checks if a tissue block collides with the 3D triangular meshes that define the surface of each reference anatomical structure. **Fig. 6c** shows an example of a tissue block (in yellow) colliding with three different renal pyramids in the female right kidney. Using bounding box collision, all three renal pyramids collide. Using mesh-level collision, only the two pink colored but not the blue colored renal pyramids collide. The data table shows Boolean values for collision detection using a traditional minimal bounding box (MBB)-based approach vs. mesh-based collision—differences are highlighted in green. The two columns on the right show the percentage and volume of different anatomical structures inside of the tissue block using mesh-level collision. Note that the sum total of AS volumes inside the tissue block is less than 100% as there is empty space between anatomical structures in the current 3D Reference Object Library.

To automate mesh-level collision detection, the HRA 3D Reference Objects were reviewed and re-meshed as needed to produce watertight meshes. For example, holes were filled using hole filling algorithms[56] and non-manifold meshes were detected automatically but corrected manually by professional medical illustrators using 3D tools such as Zbrush[57] and Maya[58]. Next, a multi-level spatial index[59] was computed for each anatomical structure (i.e., the primitives such as faces, vertices and edges of each mesh) improving query performance by a factor of 10 compared with the traditional filter-refine paradigm used by PostGIS[60]. An in memory on-demand approach was used for data management, and an efficient collision detection algorithm[15] was employed to compute the type and volume of anatomical structures within each tissue block. Last but not least, we computed the volume that is not inside any existing anatomical structures (e.g., that is outside of the organ, possibly indicating that a re-registration via the RUI is needed). All code was made available on GitHub[14].

CCF Virtual Reality (VR) Organ Gallery. The VR Organ Gallery lets users explore the male and female human reference bodies in a 3D virtual environment using an Oculus Quest 2 virtual reality headset. The VR setup makes it possible to explore the HRA data across different scales—from encountering a whole body in real size (see **Fig. 6d**), zooming into single organs and studying their many anatomical structures, or examining cell-type populations within specific anatomical structures[12]. The Organ Gallery utilizes the CCF API to retrieve all 53 reference organs published in the third HRA release and 306 HuBMAP tissue blocks publicly available on August 25, 2022 (see **Table 3**). While the male and female reference body share many organs (such as brain, kidneys, colon), the male has the prostate, while the female body features the ovaries, fallopian tube, uterus, and placenta. Using HuBMAP IDs associated with each tissue block, additional specimen, provenance, and other data can be retrieved via the HuBMAP Entity API[61] and made available via the application available on GitHub[62].

Limitations and future directions

The CCF.OWL v2.0.1 and the CCF API are used both in several production applications across consortia and in research and training. Yet, the current ontology model and API code have a number of limitations that have become obvious when using them in different contexts and for different use cases. Some modeling decisions (e.g., representing spatial entities and relationships using 3D meshes registered into a common coordinate system) have proven valuable while other decisions (e.g., representing landmarks as an *Extraction Site*) have been confusing for our team and other users and will be revised in future iterations. We discuss key limitations, lessons learned, and next steps here to empower other investigators who work on atlas design and/or applications that aim to facilitate access to large amounts of heterogeneous data.

Coverage. CCF.OWL v2.0.1 does not cover all digital objects published in HRA v1.2. CCF.OWL v3.0 will aim to capture cell-type typologies, OMAPs, FTUs, and information on supporting scholarly publications and experimental data. We will model organs that have branching relationships with anatomical structures (e.g., blood vasculature, lymph vasculature, and peripheral nervous system) differently from those that have partonomic relationships (e.g., kidney or heart). We will add and expand the definitions of ontology classes and properties. In v3.0, all original entities and relationships from the ASCT+B tables will be preserved (as ccf property triples) as annotation property relationships, i.e., the can be queried separately from relationships derived from Uberon/CL or other reference ontologies.

Improved validation. Currently, biological structure is validated against Uberon and CL. Going forward, we also validate biomarkers against HGNC and UniProt. References to entities that cannot be mapped will be added to issue trackers for eventual inclusion into existing ontologies.

For example, since the publication of HRA v1.2, 127 terms from the provisional CL have been included and are now properly validating, and all 127 will be published in HRA v1.3. Note that the current set of 26 ASCT+B tables features links to LMHA for lung cell types and Provisional CL (PCL) for brain cell types; future revisions of the HRA will aim to replace them by links to CL.

Data provenance. Novel experimental data can substantially change the HRA reference and mapping procedure. Hence, it is of utmost importance to capture the provenance of all data and code used in atlas creation and to recompile the HRA when new evidence becomes available. Going forward, we expect to see multiple biomarker sets (e.g., generated using different cell-type annotation tools) per cell-type population; these can be encoded using Boolean AND between all required biomarkers from one set and OR between biomarker sets; this will likely lead to ontology reasoner scaling issues. Future CCF.OWL versions will support complete provenance chains for all digital objects and code using W3C Provenance[63,64].

Spatial accuracy. To understand the limitations of tissue registration using the Registration User Interface (RUI), we performed a user study with 42 subjects[55]. Results show that RUI users can perform tissue block matching tasks at an average of 5.88 degrees rotation accuracy and 1.32 mm position accuracy (at an average of 22.6 seconds per task after 8.3 tasks in a series of 30 identical tasks). Going forward, we will implement Stage 2 registration using biomolecular data that is only now becoming available for some anatomical structures. Over time, with sufficient high-quality data from thousands of human donors, the HRA will become more stable and data registration more accurate.

Proper separation between ontologies and data instances. CCF.OWL v3.0 will model HRA-relevant vocabularies, application ontologies, and references using the LinkML[65] general purpose modeling language. The HRA will use CCFO to detail all specimen-related, structural biology, and spatial data. Experimental data from various consortia will be modeled using LinkML and advertised as 5-star Linked Open Data[66]. That is, the CCFO defines the vocabularies shared by HRA and experimental data; LinkML is used for the data specification. Digital objects (also called data instances) will not be part of the CCFO but will be made available via a separate data management system.

Novel use cases. A series of qualitatively new use cases will be developed to showcase the value of combining HRA with other LOD data—e.g, from the Gene-Centric Common Fund Data Ecosystem (CFDE) Knowledge Graph[67], the STRING - Protein-Protein Interaction Networks Functional Enrichment Analysis database[68], and the Scalable Precision Medicine Oriented Knowledge Engine (SPOKE) graph database that federates more than 30 open datasets into a public data commons of health relevant knowledge[16,69].

Scaling up. Efficient data management, spatial queries and algorithm implementations are needed to scale up to the 37 trillion cells that make up the human body[2] and to truly capture human diversity. CCF data is a core component that will be accessed highly frequently by many database queries. To guarantee fast, real-time query response of CCF data, we will continue to monitor and improve the implementation through techniques such as in-memory data management, hybrid relational and graph-based storage, and parallel processing.

Documentation and training. This paper details the CCFO and the CCF API for the first time. Going forward, we plan to publish simple examples of how the CCFO is currently used (or will be used) in different applications. We will organize hands-on workshops that train other experts to run proper SPARQL queries against the CCF.OWL graph database or use the standard HTTP CCF-API to support a whole ecosystem of collaborative and compatible APIs, libraries, and user interfaces.

Usage Notes

The CCF API supports programmatic access to CCF.OWL v2.0.1 data; for exemplary queries see the companion website at https://cns-iu.github.io/ccf.owl-paper-supporting-information.

The CCF.OWL v2.0.1 data and API are used in the HuBMAP and GTEx portals, the Registration and the Exploration User Interfaces, 3D mesh-level collision detection, and the VR Organ Gallery.

We welcome others to join our effort in constructing a user-friendly and useful HRA. Please sign up for the ASCT+B Working Group at https://iu.co1.qualtrics.com/jfe/form/SV_bpaBhIr8XfdiNRH to receive updates and meeting invites.

Code Availability

All data and standard operating procedures are released under Creative Commons Attribution 4.0 International (CC BY 4.0). All code was released under the MIT License and can be accessed in GitHub at https://github.com/hubmapconsortium/ccf-ontology.

ASCT+B APIs:
API Endpoint (includes interactive documentation): https://asctb-api.herokuapp.com
API Documentation: https://hubmapconsortium.github.io/ccf-asct-reporter/docs/api
OpenAPI specification: https://asctb-api.herokuapp.com/asctb-api-spec.yaml

CCF-API:
API Endpoint (includes interactive documentation): https://ccf-api.hubmapconsortium.org
API Documentation and OpenAPI specification: https://ccf-api.hubmapconsortium.org
API Database backend is N3.js: https://github.com/rdfjs/N3.js
Code to instantiate/use CCF Database: https://github.com/hubmapconsortium/ccf-ui/tree/main/projects/ccf-database

CCF-User Interfaces:
https://github.com/hubmapconsortium/ccf-ui

Validation Tools:

https://github.com/hubmapconsortium/ccf-validation-tools

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Acknowledgments

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Author contributions

BWH, JH, EMQ, DOS, MAM, KB designed the CCF ontologies; BHW, JH, DOS implemented the ontology generation pipeline; JH, MAM validated the specimen ontology; EMQ, DOS, ARC validated the biological structure ontology; BWH, AB, CH, FW used the CCF ontology in different applications; BWH, JH, EMQ, AB, LC, FW, DOS, MAM, KB wrote the paper.

Competing interests

None

Figures

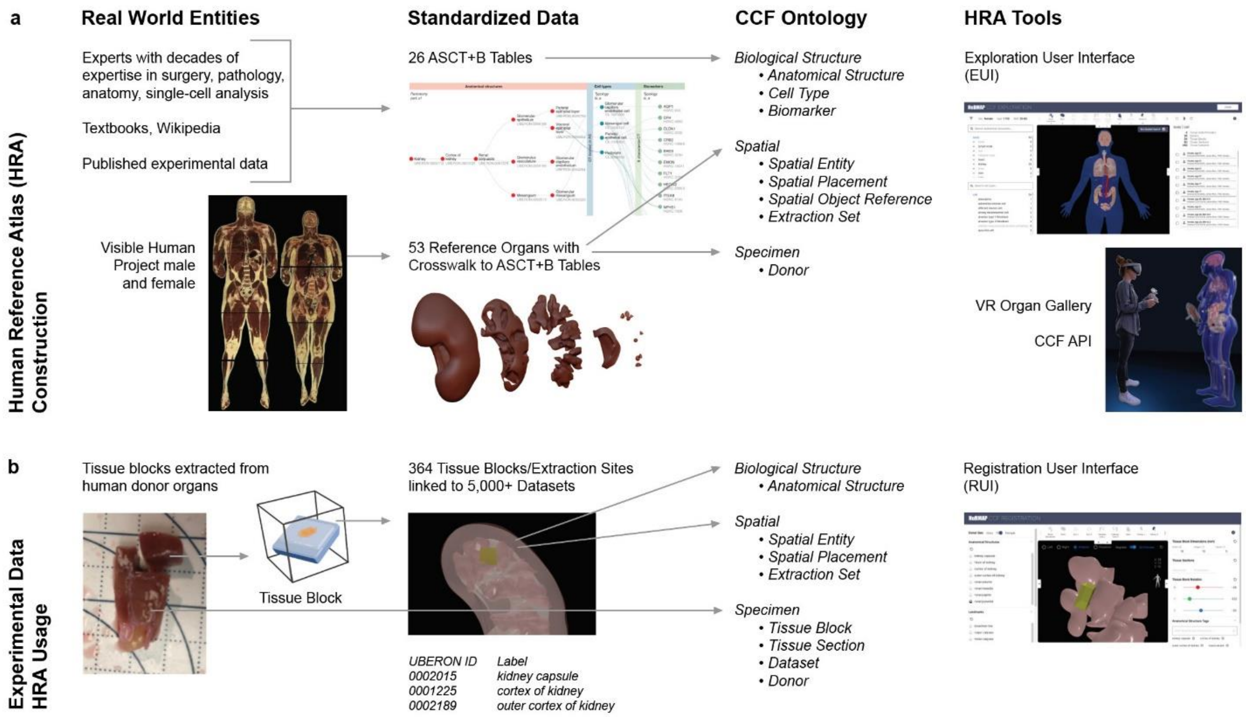


Figure 1. From real-world entities, to standardized data, to ontology. a. Human Reference Atlas construction takes real-world data and represents it in standardized data structures that are defined by the interlinked Biological Structure, Spatial, and Specimen ontologies. Anatomical structures in the ASCT+B tables are linked via *part_of* relationships resulting in a partonomy; they are crosswalked to 3D reference organs in support of spatial queries and exploration using different tools shown on the right. **b.** HRA usage includes search for specific cell types or biomarker expression values across organs in a 3D reference space. Users can also upload new experimental data (e.g., a new tissue block from a human donor specimen); the tissue is registered into the HRA by spatially mapping it to a 3D reference organ. If the Registration User Interface (RUI) shown on left is used, anatomical structure tags (see UBERON ID and Label) are automatically assigned based on collision events; spatial search becomes possible in the Exploration User Interface (EUI); and cell types or biomarkers associated with the colliding anatomical structures can be retrieved via ASCT+B tables.

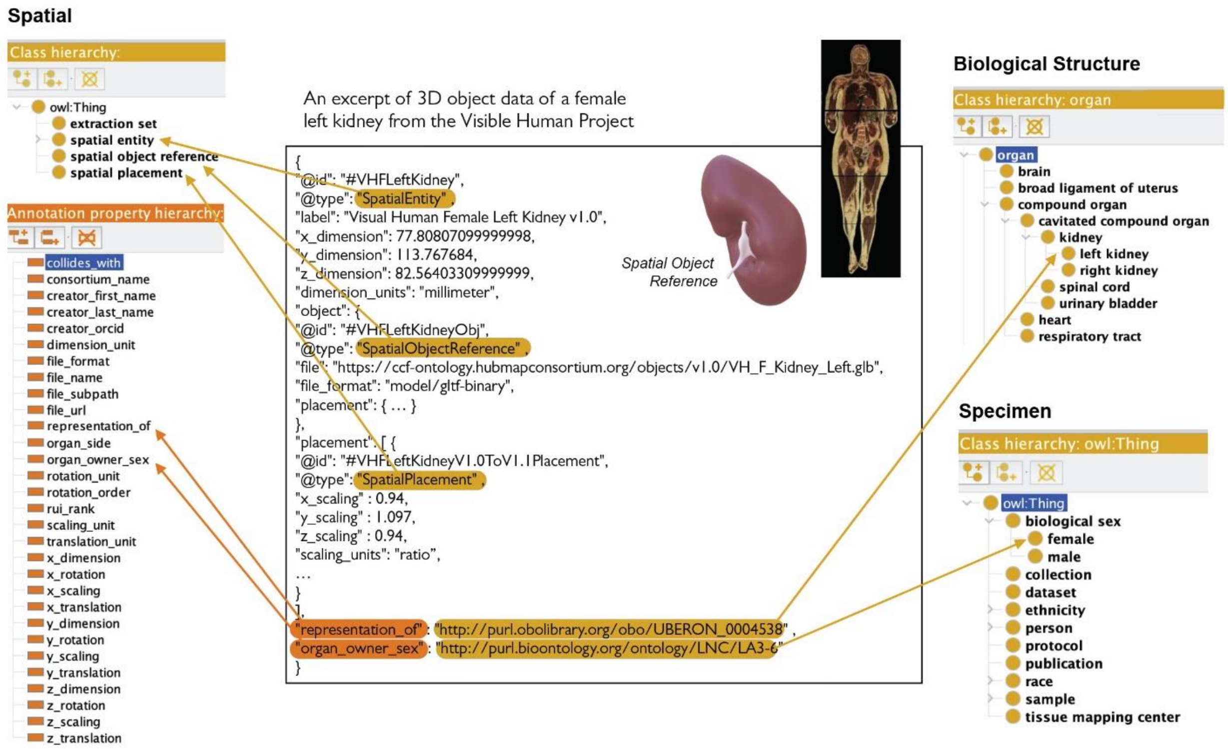


Figure 2. HRA Reference Organ Description. The Visible Human Project female left kidney (#VHFLeftKidney) reference organ is represented as a *Spatial Entity* class of type *Spatial Object Reference*, and with a *Spatial Placement*. Properties such as *representation_of* with PURL link to Uberon:0004538 (left kidney) refer to Biological Structure data, whereas properties such as *organ_owner_sex* with PURL link to LNC:LA3-6 (female) refer to Specimen data.

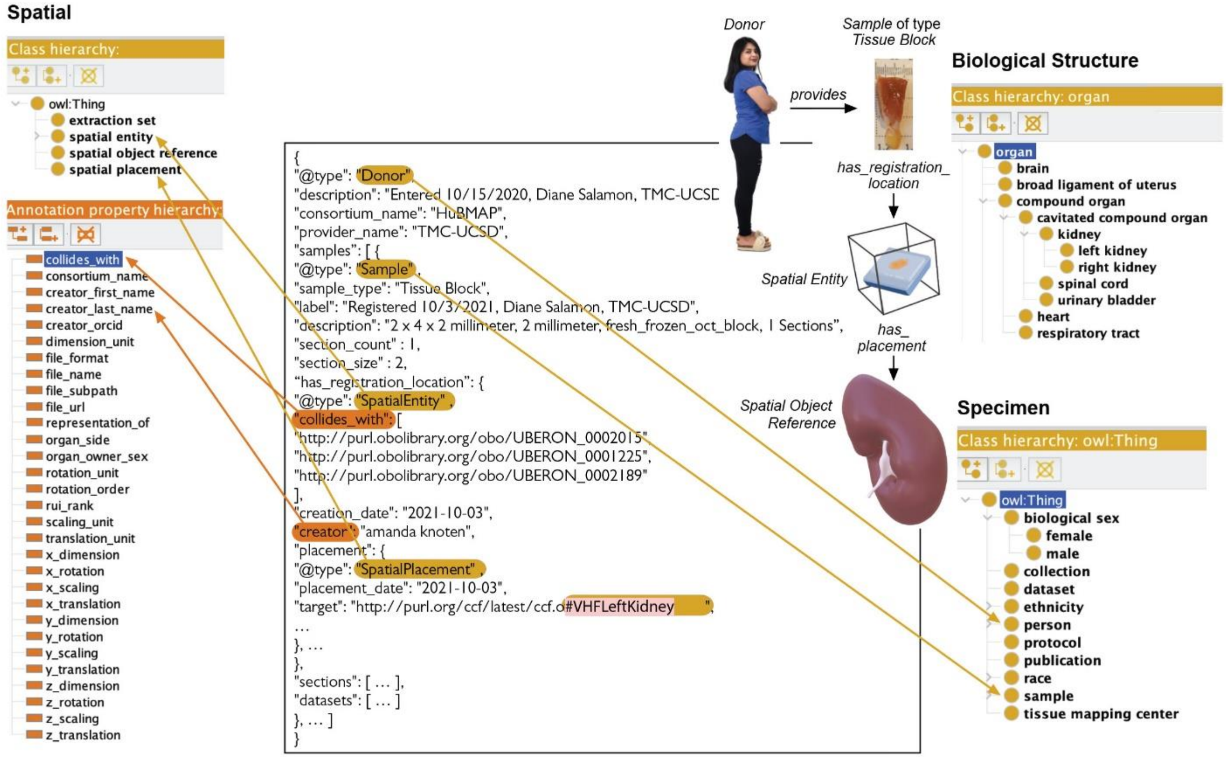


Figure 3. HRA Tissue Block Description. A *Donor* (which *is_a Person*) provides a *Sample* of type *Tissue Block* with properties such as *Biological Sex* and annotation properties such as *Creator* to keep track of provenance. The *Tissue Block* is registered with the Biological Structure Ontology using annotation property *collides_with* with three PURL links to UBERON:0002015 (kidney capsule), UBERON:0001225 (cortex of kidney), and UBERON:0002189 (outer cortex of kidney) that all have GLB files with proper *Spatial Placement* in the 3D Reference Object Library.

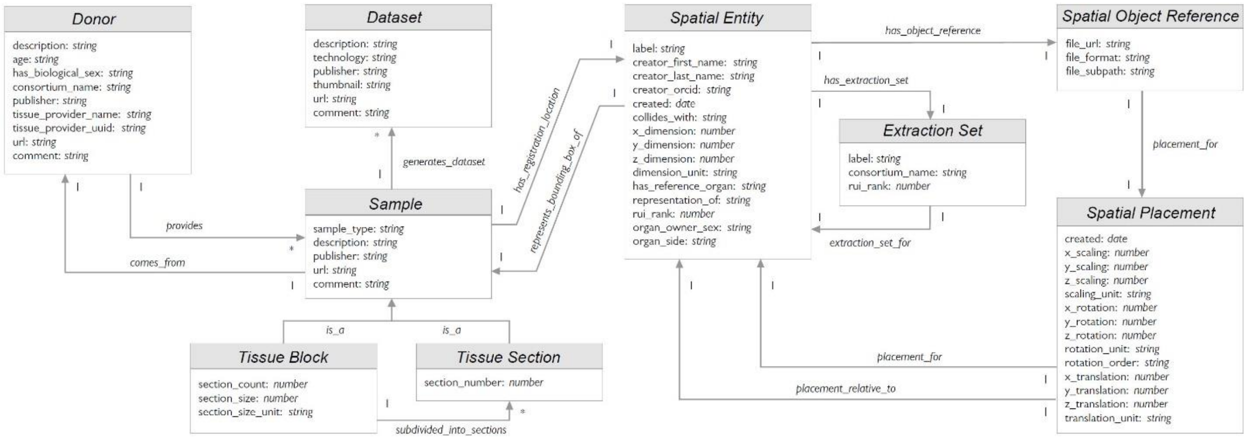


Figure 4. Data Specification Diagram. Major entities and their relationships are shown as used in JSON-LD. Note that a *Sample comes_from* a *Donor*; it is either a *Tissue Block* or a *Tissue Section*. A *Dataset* might be generated from a *Sample*. A *Sample* typically has a *Spatial Entity* which defines its size in relation to a *Spatial Object Reference* via a *Spatial Placement*.

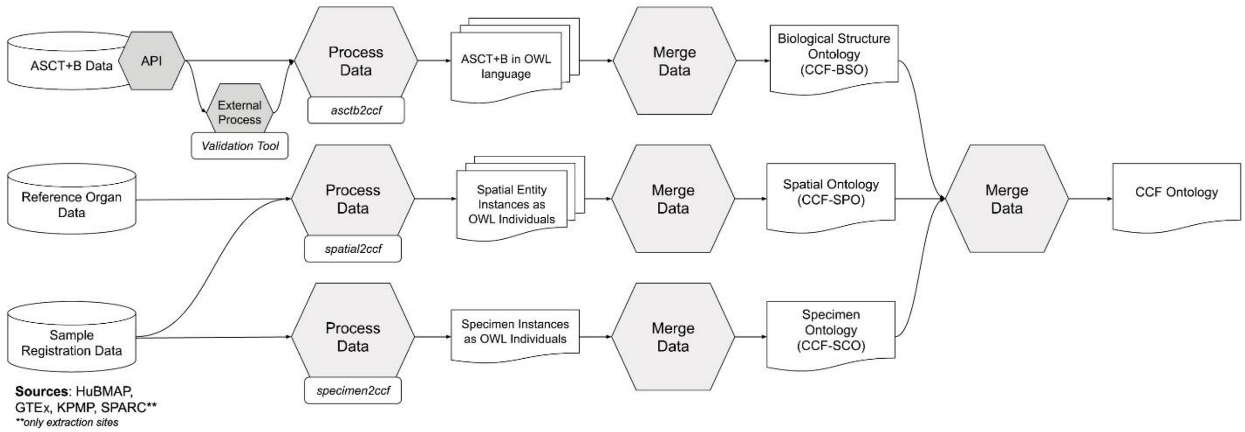
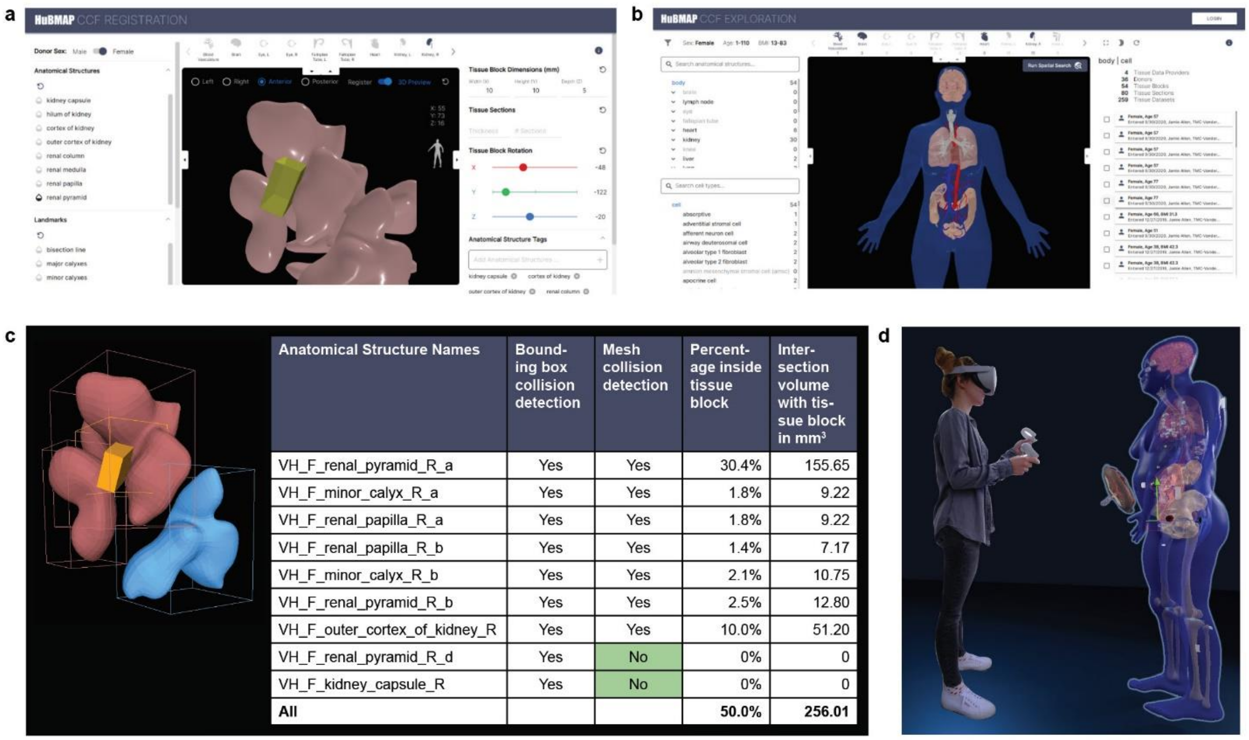


Figure 5. CCF Ontology Generation Pipeline. ASCT+B tables are validated and semantically enriched using the Validation Tool; in parallel, 3D Reference Organ data and crosswalk to ASCT+B tables are processed to compute the HRA. Sample Registration Data tissue blocks with RUI locations and anatomical structure tags can be retrieved for HRA construction or during HRA usage.



Anatomical Structure Names	Bounding box collision detection	Mesh collision detection	Percentage inside tissue block	Intersection volume with tissue block in mm³
VH_F_renal_pyramid_R_a	Yes	Yes	30.4%	155.65
VH_F_minor_calyx_R_a	Yes	Yes	1.8%	9.22
VH_F_renal_papilla_R_a	Yes	Yes	1.8%	9.22
VH_F_renal_papilla_R_b	Yes	Yes	1.4%	7.17
VH_F_minor_calyx_R_b	Yes	Yes	2.1%	10.75
VH_F_renal_pyramid_R_b	Yes	Yes	2.5%	12.80
VH_F_outer_cortex_of_kidney_R	Yes	Yes	10.0%	51.20
VH_F_renal_pyramid_R_d	Yes	No	0%	0
VH_F_kidney_capsule_R	Yes	No	0%	0
All			**50.0%**	**256.01**

Figure 6. Applications. a. Registration User Interface (RUI) can be used to assign specimen, biological structure, and spatial metadata. **b.** Exploration User Interface (EUI) supports specimen, biological structure, and spatial search and exploration. **c.** Mesh-level collision detection improved semantic tagging. **d.** VR Organ Gallery with life-size 3D representations of the Visible Human Project dataset.

Tables

Table 1. CCF Specimen, Biological Structure, and Spatial Ontology. For each ontology, we provide all class names, property names, entity Internationalized Resource Identifier (IRI), definition when available, and entity type.

Table 1. Common Coordinate Framework Ontology

Ontology Name	Entity Name	Entity IRI	Definition	Entity Type
CCF Specimen Ontology	Biological Sex	http://purl.org/ccf/biological_sex	Refers to a biological sex.	Class
	Female	http://purl.bioontology.org/ontology/LNC/LA3-6	Refers to a female person.	Class
	Male	http://purl.bioontology.org/ontology/LNC/LA2-8	Refers to a male person.	Class
	Collection	http://purl.org/ccf/collection	Refers to a data collection.	Class
	Dataset	http://purl.org/ccf/dataset	Refers to a dataset.	Class
	Ethnicity	http://purl.org/ccf/ethnicity	Refers to an ethnicity group.	Class
	Hispanic or Latino	http://purl.bioontology.org/ontology/LNC/LA6214-6	A person of Cuban, Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race. The term, Spanish origin, can be used in addition to Hispanic or Latino.	Class
	Not Hispanic or Latino	http://purl.bioontology.org/ontology/LNC/LA19555-4	A person of Cuban, Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race. The term, Spanish origin, can be used in addition to Hispanic or Latino.	Class
	Person	http://purl.org/ccf/person	Refers to a person entity.	Class
	Donor	http://purl.org/ccf/donor	Refers to a donor entity.	Class
	Operator	http://purl.org/ccf/operator	Refers to an operator entity.	Class
	Principal Investigator	http://purl.org/ccf/principal_investigator	Refers to a pricipal investigator entity.	Class
	Protocol	http://purl.org/ccf/protocol	Refers to a protocol entity.	Class
	Publication	http://purl.org/ccf/publication	Refers to a publication entity.	Class
	Race	http://purl.org/ccf/race	Refers to a race group.	Class
	American Indian or Alaska Native	http://purl.bioontology.org/ontology/LNC/LA6155-1	A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.	Class
	Asian	http://purl.bioontology.org/ontology/LNC/LA6156-9	A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.	Class
	Black or African American	http://purl.bioontology.org/ontology/LNC/LA10610-6	A person having origins in any of the black racial groups of Africa. Terms such as Haitian or Negro can be used in addition to Black or African American.	Class
	Native Hawaiian or Other Pacific Islander	http://purl.bioontology.org/ontology/LNC/LA10611-4	A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.	Class
	White	http://purl.bioontology.org/ontology/LNC/LA4457-3	A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.	Class
	Sample	http://purl.org/ccf/sample	Refers to a sample entity.	Class
	Tissue Block	http://purl.org/ccf/tissue_block	A tissue specimen that is preserved in a tissue block form.	Class
	Tissue Section	http://purl.org/ccf/tissue_section	A thin slice of tissue, usually for examination by microscopy.	Class
	Tissue Mapping Center	http://purl.org/ccf/tissue_mapping_center	Refers to a tissue mapping center entity.	Class
	comes_from	http://purl.org/ccf/comes_from	Refers to the donor person who donates the specimen.	Property
	created_by	http://purl.org/ccf/created_by	Refers to the creator person.	Property
	extracted_by	http://purl.org/ccf/extracted_by	Refers to the extrator person.	Property
	generates_dataset	http://purl.org/ccf/generates_dataset	Refers to the dataset that was generated from analyzing the tissue block.	Property
	has_biological_sex	http://purl.org/ccf/has_biological_sex	Refers to the biological sex of the donor.	Property

	has_dataset_item	http://purl.org/ccf/has_dataset_item	Refers to the dataset item linkage.	Property
	has_ethnicity	http://purl.org/ccf/has_ethnicity	Refers to the ethnicity linkage.	Property
	has_race	http://purl.org/ccf/has_race	Refers to the race linkage.	Property
	has_registration_location	http://purl.org/ccf/has_registration_location	Refers to the spatial entity instance that captures the tissue block location in the human body.	Property
	part_of_tissue_block	http://purl.org/ccf/part_of_tissue_block	Refers to the tissue block instance where the tissue section was coming from.	Property
	provided_by	http://purl.org/ccf/provided_by	Refers to provider linkage.	Property
	provides	http://purl.org/ccf/provides	Refers to sample provision linkage.	Property
	subdivided_into_sections	http://purl.org/ccf/subdivided_into_sections	Refers to tissue blocks consist of tissue sections linkage.	Property
	age	http://purl.org/ccf/age	Refers to the donor's age.	Property
	age_range	http://purl.org/ccf/age_range	Refers to the donor's age range.	Property
	age_unit	http://purl.org/ccf/age_unit	Refers to the age unit of measurement.	Property
	assay_type	http://purl.org/ccf/assay_type	Refers to the assay type.	Property
	bmi	http://purl.org/ccf/bmi	Refers to the BMI measurement.	Property
	consortium_name	http://purl.org/ccf/consortium_name	Refers to the consortium name that affiliates with the donor.	Property
	description	http://purl.org/ccf/description	Refers to the description of the tissue block specimen (e.g., size, thickness, preservation method, etc.).	Property
	height	http://purl.org/ccf/height	Refers to the donor's height.	Property
	height_unit	http://purl.org/ccf/height_unit	Refers to the height unit of measurement.	Property
	section_count	http://purl.org/ccf/section_count	Refers to the number of tissue sections that the tissue block instance has.	Property
	section_number	http://purl.org/ccf/section_number	Refers to the ordering number from a sequence of tissue sections.	Property
	section_size	http://purl.org/ccf/section_size	Refers to the thickness size of the tissue section.	Property
	section_size_unit	http://purl.org/ccf/section_size_unit	Refers to the unit of measurement for the tissue block section size.	Property
	technology	http://purl.org/ccf/technology	Refers to the technology that generates the dataset. Options for the values are: [CODEX, PS, LC, AF, MALDI, IMC, 10x, OTHER].	Property
	thumbnail	http://purl.org/ccf/thumbnail	Refers to the image resource to depict the technology icon.	Property
	tissue_provider_name	http://purl.org/ccf/tissue_provider_name	Refers to the tissue mapping center name.	Property
	tissue_provider_uuid	http://purl.org/ccf/tissue_provider_uuid	Refers to the tissue mapping center UUID.	Property
	url	http://purl.org/ccf/url	Refers to the tissue block metadata located on the Web (i.e., a data portal).	Property
	weight	http://purl.org/ccf/weight	Refers to the donor's weight.	Property
	weight_unit	http://purl.org/ccf/weight_unit	Refers to the weight unit of measurement.	Property
CCF Spatial Ontology	Extraction Set	http://purl.org/ccf/extraction_set	Refers to the extraction set entity.	Class
	Spatial Entity	http://purl.org/ccf/spatial_entity	Refers to the spatial entity.	Class
	Retired Spatial Entity	http://purl.org/ccf/retired_spatial_entity	Refers to the unused spatial entity.	Class
	Spatial Object Reference	http://purl.org/ccf/spatial_object_reference	Refers to the spatial object reference entity.	Class
	Spatial Placement	http://purl.org/ccf/spatial_placement	Refers to the spatial placement entity.	Class
	extraction_set_for	http://purl.org/ccf/extraction_set_for	Refers to the anatomical structure that mainly the site of the extraction.	Property
	has_extraction_set	http://purl.org/ccf/has_extraction_set	Refers to the has extraction set linkage.	Property
	has_object_reference	http://purl.org/ccf/has_object_reference	Refers to the spatial object reference that represents the 3D spatial object.	Property

	has_placement	http://purl.org/ccf/has_placement	Refers to the spatial rotation, translation, and scaling required to place one spatial entity relative to another.	Property
	has_reference_organ	http://purl.org/ccf/has_reference_organ	Refers to the has reference organ linkage.	Property
	placement_for	http://purl.org/ccf/placement_for	Refers to the spatial entity which this spatial placement is applied.	Property
	placement_relative_to	http://purl.org/ccf/placement_relative_to	Refers to the spatial entity which this spatial placement is positioned relatively to.	Property
	represents_bounding_box_of	http://purl.org/ccf/represents_bounding_box_of	Refers to the bounding box of a sample registration.	Property
	collides_with	http://purl.org/ccf/collides_with	Refers to anatomical structures that collide with the sample registration.	Property
	creator_first_name	http://purl.org/ccf/creator_first_name	Refers to the first name of the person who register the spatial entity.	Property
	creator_last_name	http://purl.org/ccf/creator_last_name	Refers to the last name of the person who register the spatial entity.	Property
	creator_orcid	http://purl.org/ccf/creator_orcid	Refers to the creator ORCID.	Property
	created	http://purl.org/dc/terms/created	Refers to the creation date.	Property
	label	http://www.w3.org/2000/01/rdf-schema#label	Refers to the name of the spatial entity.	Property
	file_format	http://purl.org/ccf/file_format	Refers to the format of the 3D object file.	Property
	file_name	http://purl.org/ccf/file_name	Refers to the 3D object file name.	Property
	file_subpath	http://purl.org/ccf/file_subpath	Refers to the subpath to locate the 3D object file.	Property
	file_url	http://purl.org/ccf/file_url	Refers to the location of the 3D object file.	Property
	organ_owner_sex	http://purl.org/ccf/organ_owner_sex	Refers to the biological sex of the tissue donor.	Property
	organ_side	http://purl.org/ccf/organ_side	Refers to the side of the organ.	Property
	representation_of	http://purl.org/ccf/representation_of	Refers to the one anatomical structure that represented by the spatial entity.	Property
	rui_rank	http://purl.org/ccf/rui_rank	Refers to the Registration UI ranking number.	Property
	x_dimension	http://purl.org/ccf/x_dimension	Refers to the dimension measurement in the x-axis.	Property
	y_dimension	http://purl.org/ccf/y_dimension	Refers to the dimension measurement in the y-axis.	Property
	z_dimension	http://purl.org/ccf/z_dimension	Refers to the dimension measurement in the z-axis.	Property
	dimension_unit	http://purl.org/ccf/dimension_unit	Refers to the unit of measurement for a dimension.	Property
	x_rotation	http://purl.org/ccf/x_rotation	Refers to the rotation measurement in the x-axis.	Property
	y_rotation	http://purl.org/ccf/y_rotation	Refers to the rotation measurement in the y-axis.	Property
	z_rotation	http://purl.org/ccf/z_rotation	Refers to the rotation measurement in the z-axis.	Property
	rotation_unit	http://purl.org/ccf/rotation_unit	Refers to the unit of measurment of the rotation.	Property
	rotation_order	http://purl.org/ccf/rotation_order	Refers to the rotation order.	Property
	x_scaling	http://purl.org/ccf/x_scaling	Refers to the scaling measurement in the x-axis.	Property
	y_scaling	http://purl.org/ccf/y_scaling	Refers to the scaling measurement in the y-axis.	Property
	z_scaling	http://purl.org/ccf/z_scaling	Refers to the scaling measurement in the z-axis.	Property
	scaling_unit	http://purl.org/ccf/scaling_unit	Refers to the unit of measurment of the scaling.	Property
	x_translation	http://purl.org/ccf/x_translation	Refers to the translation measurement in the x-axis.	Property
	y_translation	http://purl.org/ccf/y_translation	Refers to the translation measurement in the y-axis.	Property
	z_translation	http://purl.org/ccf/z_translation	Refers to the translation measurement in the z-axis.	Property
	translation_unit	http://purl.org/ccf/translation_unit	Refers to the unit of measurment of the translation.	Property
CCF Biological Structure Ontology	Anatomical Structure	http://purl.org/ccf/anatomical_structure	Refers to the human anatomical structures that are specified by the domain experts in the ASCT+B table.	Class

	Biomarker	http://purl.org/ccf/biomarker	Refers to the human biomarkers that are specified by the domain experts in the ASCT+B table.	Class
	Cell Type	http://purl.org/ccf/cell_type	Refers to the human cell types that are specified by the domain experts in the ASCT+B table.	Class
	Sequence Collection	http://purl.obolibrary.org/obo/SO_0001260	A collection of discontinuous sequences.	Class
	has_characterizing_marker_set	http://purl.obolibrary.org/obo/RO_0015004	A relation that applies between a cell type and a set of markers that can be used to uniquely identify that cell type.	Property
	has_marker_component	http://purl.org/ccf/has_marker_component	Refers to the biomarker that is part of a biomarker set to identify a cell type.	Property
	has_gene_marker	http://purl.org/ccf/has_gene_marker	Refers to the gene marker that is part of a biomarker set to identify a cell type.	Property
	has_protein_marker	http://purl.org/ccf/has_protein_marker	Refers to the protein marker that is part of a biomarker set to identify a cell type.	Property
	part_of	http://purl.obolibrary.org/obo/BFO_0000050	A core relation that holds between a part and its whole.	Property
	ccf_asctb_type	http://purl.org/ccf/ccf_asctb_type	Refers to the ASCT+B column type. In this case the type is "AS".	Property
	ccf_characterizes	http://purl.org/ccf/ccf_characterizes	Refers to the ASCT+B characterizing biomarker relationship.	Property
	ccf_located_in	http://purl.org/ccf/ccf_located_in	Refers to an anatomical structure where the cell type is located.	Property
	ccf_part_of	http://purl.org/ccf/ccf_part_of	Refers to another anatomical structure that part of this anatomical structure.	Property
	ccf_ct_isa	http://purl.org/ccf/ccf_ct_isa	Refers to the ASCT+B sub-class of relationship.	Property
	ccf_is_provisional	http://purl.org/ccf/ccf_is_provisional	Refers to a boolean flag whether it is a provisional term or not.	Property
	ccf_pref_label	http://purl.org/ccf/ccf_pref_label	Refers to the ASCT+B preferred label.	Property

Table 2. 3D Reference Objects. The 3rd HRA release features 53 *Spatial Entities* of type *Spatial Object Reference* that are linked to anatomical structures in the ASCT+B tables plus 43 *Spatial Entities* of type *Extraction Site*. For each entity, we provide the spatial entity name, 3D object file name, ID and version number, organ label, sex, and type. Note that a landmark is a *Spatial Entity* that has been tagged as an *Extraction Set* for a specific *Extraction Site*, see **Table 3**.

Table 2. 3D Reference Objects

Spatial Entity	3D Object File Name	@ID	Label	Sex	Type
#VHFemaleOrgans_Allen_brain	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/Allen_F_Brain.glb	#VHFAllenBrain	Brain	Female	Reference Organ
#VHFemaleOrgans_VH_F_blood_vasculature	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Blood_Vasculature.glb	#VHFBloodVasculature	Blood Vasculature	Female	Reference Organ
#VHFemaleOrgans_VH_F_colon	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb	#VHFLargeIntestine	Large Intestine	Female	Reference Organ
#VHFemaleOrgans_VH_F_eye_L	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Eye_L.glb	#VHFLeftEye	Left Eye	Female	Reference Organ
#VHFemaleOrgans_VH_F_eye_R	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Eye_R.glb	#VHFRightEye	Right Eye	Female	Reference Organ
#VHFemaleOrgans_VH_F_fallopian_tube_L	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Fallopian_Tube_L.glb	#VHFLeftFallopianTube	Left Fallopian Tube	Female	Reference Organ
#VHFemaleOrgans_VH_F_fallopian_tube_R	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Fallopian_Tube_R.glb	#VHFRightFallopianTube	Right Fallopian Tube	Female	Reference Organ
#VHFemaleOrgans_VH_F_heart	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb	#VHFHeartV1.1	Heart	Female	Reference Organ
#VHFemaleOrgans_VH_F_knee_L	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Knee_L.glb	#VHFLeftKnee	Left Knee	Female	Reference Organ
#VHFemaleOrgans_VH_F_knee_R	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Knee_R.glb	#VHFRightKnee	Right Knee	Female	Reference Organ
#VHFemaleOrgans_VH_F_left_kidney	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	#VHFLeftKidneyV1.1	Left Kidney	Female	Reference Organ
#VHFemaleOrgans_VH_F_left_ovary	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ovary_L.glb	#VHFLeftOvary	Left Ovary	Female	Reference Organ
#VHFemaleOrgans_VH_F_left_ureter	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_L.glb	#VHFLeftUreter	Left Ureter	Female	Reference Organ
#VHFemaleOrgans_VH_F_liver	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Liver.glb	#VHFLiver	Liver	Female	Reference Organ
#VHFemaleOrgans_VH_F_pancreas	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Pancreas.glb	#VHFPancreas	Pancreas	Female	Reference Organ
#VHFemaleOrgans_VH_F_pelvis	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Pelvis.glb	#VHFPelvis	Pelvis	Female	Reference Organ
#VHFemaleOrgans_VH_F_placenta	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Placenta.glb	#VHFPlacenta	Placenta	Female	Reference Organ
#VHFemaleOrgans_VH_F_respiratory_system	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Lung.glb	#VHFLungV1.1	Lung	Female	Reference Organ
#VHFemaleOrgans_VH_F_right_kidney	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb	#VHFRightKidneyV1.1	Right Kidney	Female	Reference Organ
#VHFemaleOrgans_VH_F_right_ovary	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ovary_R.glb	#VHFRightOvary	Right Ovary	Female	Reference Organ
#VHFemaleOrgans_VH_F_right_ureter	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_R.glb	#VHFRightUreter	Right Ureter	Female	Reference Organ
#VHFemaleOrgans_VH_F_skin	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb	#VHFSkinV1.1	Skin	Female	Reference Organ
#VHFemaleOrgans_VH_F_small_intestine	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	#VHFSmallIntestine	Small Intestine	Female	Reference Organ
#VHFemaleOrgans_VH_F_spinal_cord	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spinal_Cord.glb	#VHFSpinalCord	Spinal Cord	Female	Reference Organ
#VHFemaleOrgans_VH_F_spleen	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb	#VHFSpleenV1.1	Spleen	Female	Reference Organ
#VHFemaleOrgans_VH_F_thymus	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb	#VHFThymusV1.1	Thymus	Female	Reference Organ
#VHFemaleOrgans_VH_F_urinary_bladder	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Urinary_Bladder.glb	#VHFUrinaryBladder	Urinary Bladder	Female	Reference Organ
#VHFemaleOrgans_VH_F_uterus	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Uterus.glb	#VHFUterus	Uterus	Female	Reference Organ
#VHFemaleOrgans_Yao_lymph_node	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb	#VHFLymphNode	Lymph Node	Female	Reference Organ
#VHMaleOrgans_Allen_brain	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/Allen_M_Brain.glb	#VHMAllenBrain	Brain	Male	Reference Organ
#VHMaleOrgans_VH_M_blood_vasculature	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Blood_Vasculature.glb	#VHMBloodVasculature	Blood Vasculature	Male	Reference Organ
#VHMaleOrgans_VH_M_colon	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb	#VHMColon	Large Intestine	Male	Reference Organ
#VHMaleOrgans_VH_M_eye_L	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Eye_L.glb	#VHMLeftEye	Left Eye	Male	Reference Organ
#VHMaleOrgans_VH_M_eye_R	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Eye_R.glb	#VHMRightEye	Right Eye	Male	Reference Organ
#VHMaleOrgans_VH_M_heart	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	#VHMHeart	Heart	Male	Reference Organ
#VHMaleOrgans_VH_M_knee_L	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Knee_L.glb	#VHMLeftKnee	Left Knee	Male	Reference Organ
#VHMaleOrgans_VH_M_knee_R	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Knee_R.glb	#VHMRightKnee	Right Knee	Male	Reference Organ
#VHMaleOrgans_VH_M_left_kidney	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb	#VHMLeftKidney	Left Kidney	Male	Reference Organ
#VHMaleOrgans_VH_M_liver	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Liver.glb	#VHMLiver	Liver	Male	Reference Organ
#VHMaleOrgans_VH_M_male_reproductive_syster	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Prostate.glb	#VHMProstate	Prostate	Male	Reference Organ
#VHMaleOrgans_VH_M_pancreas	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Pancreas.glb	#VHMPancreas	Pancreas	Male	Reference Organ
#VHMaleOrgans_VH_M_pelvis	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Pelvis.glb	#VHMPelvis	Pelvis	Male	Reference Organ
#VHMaleOrgans_VH_M_respiratory_system	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb	#VHMLung	Lung	Male	Reference Organ
#VHMaleOrgans_VH_M_right_kidney	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb	#VHMRightKidney	Right Kidney	Male	Reference Organ
#VHMaleOrgans_VH_M_skin	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb	#VHMSkinV1.1	Skin	Male	Reference Organ

#VHMaleOrgans_VH_M_small_intestine	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb	#VHMSmallIntestine	Small Intestine	Male	Reference Organ
#VHMaleOrgans_VH_M_spinal_cord	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spinal_Cord.glb	#VHMSpinalCord	Spinal Cord	Male	Reference Organ
#VHMaleOrgans_VH_M_spleen	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	#VHMSpleen	Spleen	Male	Reference Organ
#VHMaleOrgans_VH_M_thymus	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb	#VHMThymus	Thymus	Male	Reference Organ
#VHMaleOrgans_VH_M_ureter_L	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Ureter_L.glb	#VHMLeftUreter	Left Ureter	Male	Reference Organ
#VHMaleOrgans_VH_M_ureter_R	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Ureter_R.glb	#VHMRightUreter	Right Ureter	Male	Reference Organ
#VHMaleOrgans_VH_M_urethra	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Urethra.glb	#VHMUrethra	Urethra	Male	Reference Organ
#VHMaleOrgans_VH_M_urinary_bladder	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Urinary_Bladder.glb	#VHMUrinaryBladder	Urinary Bladder	Male	Reference Organ
#VHMaleOrgans_Yao_lymph_node	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	#VHMLymphNode	Lymph Node	Male	Reference Organ
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Colon_Extraction_Sites.glb		Colon	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Eye_L_Landmarks.glb		Eye	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Eye_R_Landmarks.glb		Eye	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Fallopian_Tube_L_Landmarks.glb		Fallopian Tube	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Fallopian_Tube_R_Landmarks.glb		Fallopian Tube	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart_Extraction_Sites.glb		Heart	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart_Landmarks.glb		Heart	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_Extraction_Sites.glb		Kidney	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L_Landmarks.glb		Kidney	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R_Landmarks.glb		Kidney	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Knee_L_Landmarks.glb		Knee	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Knee_R_Landmarks.glb		Knee	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Large_Intestine_Landmarks.glb		Large Intestine	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Liver_Landmarks.glb		Liver	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ovary_L_Landmarks.glb		Ovary	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ovary_R_Landmarks.glb		Ovary	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Pancreas_Landmarks.glb		Pancreas	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine_Landmarks.glb		Small Intestine	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spinal_Cord_Landmarks.glb		Spinal Cord	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen_Extraction_Sites.glb		Spleen	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen_Landmarks.glb		Spleen	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_Landmarks.glb		Ureter	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Urinary_Bladder_Landmarks.glb		Urinary Bladder	Female	Extraction Site
#VHFemaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Uterus_Landmarks.glb		Uterus	Female	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Colon_Extraction_Sites.glb		Colon	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Eye_L_Landmarks.glb		Eye	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Eye_R_Landmarks.glb		Eye	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart_Extraction_Sites.glb		Heart	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart_Landmarks.glb		Heart	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_Extraction_Sites.glb		Kidney	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L_Landmarks.glb		Kidney	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R_Landmarks.glb		Kidney	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Knee_L_Landmarks.glb		Knee	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Knee_R_Landmarks.glb		Knee	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Large_Intestine_Landmarks.glb		Large Intestine	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Liver_Landmarks.glb		Liver	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Pancreas_Landmarks.glb		Pancreas	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine_Landmarks.glb		Small Intestine	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spinal_Cord_Landmarks.glb		Spinal Cord	Male	Extraction Site

#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen_Extraction_Sites.glb		Spleen	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen_Landmarks.glb		Spleen	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Ureter_Landmarks.glb		Ureter	Male	Extraction Site
#VHMaleOrgans	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Urinary_Bladder_Landmarks.glb		Urinary Bladder	Male	Extraction Site

Table 3. Registered Tissue Data. This table shows 364 *Extraction Site* entities that either represent the registration location for *Tissue Blocks* or *Registration Sites*. For each, we provide consortium name and entity ID, HuBMAP ID if available, and experimental data donor sex as well as HRA data such as organ name, sex, Uberon ID, and GLB file. The data comes from four consortia. HuBMAP data includes 306 tissue blocks, and many of these have derived tissue sections with one or more associated datasets. The 29 well-defined GTEx extraction set sites link to 5,397 datasets. The 26 SPARC blocks link to one paper while the three KPMP tissue blocks link to two data publications.

Table 3. Extraction Sites

Experimental Data				HRA Data			
Consortium name	**Entity ID**	**HuBMAP ID**	**Tissue Block Sex**	**Organ**	**Sex**	**Uberon ID**	**HRA GLB File**
KPMP	http://dx.doi.org/10.1681/ASN.2016091027		Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
KPMP	http://dx.doi.org/10.1681/ASN.2016091027		Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
KPMP	http://dx.doi.org/10.1016/j.trsl.2017.07.006		Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock1		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock10		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock11		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock12		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock13		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock14		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock15		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock16		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock17		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock18		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock19		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock2		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock20		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock21		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock22		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock23		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock24		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock25		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock26		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock3		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock4		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock5		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock6		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock7		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock8		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
SPARC	https://doi.org/10.1161/CIRCRESAHA.120.318458#TissueBlock9		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
GTEx	https://gtexportal.org/home/tissue/Artery_Coronary#FTissueBlocks		Female	VH_F_blood_vasculature	Female	http://purl.obolibrary.org/obo/UBERON_0004537	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Blood_Vasculature.glb
GTEx	https://gtexportal.org/home/tissue/Artery_Coronary#MTissueBlocks		Male	VH_M_blood_vasculature	Male	http://purl.obolibrary.org/obo/UBERON_0004537	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Blood_Vasculature.glb
GTEx	https://gtexportal.org/home/tissue/Colon_Sigmoid#FTissueBlocks		Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
GTEx	https://gtexportal.org/home/tissue/Colon_Sigmoid#MTissueBlocks		Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
GTEx	https://gtexportal.org/home/tissue/Colon_Transverse#FTissueBlocks		Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
GTEx	https://gtexportal.org/home/tissue/Colon_Transverse#MTissueBlocks		Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
GTEx	https://gtexportal.org/home/tissue/Heart_Atrial_Appendage#FTissueBlocks		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
GTEx	https://gtexportal.org/home/tissue/Heart_Atrial_Appendage#MTissueBlocks		Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
GTEx	https://gtexportal.org/home/tissue/Heart_Left_Ventricle#FTissueBlocks		Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
GTEx	https://gtexportal.org/home/tissue/Heart_Left_Ventricle#MTissueBlocks		Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
GTEx	https://gtexportal.org/home/tissue/Kidney_Cortex#FTissueBlocks		Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
GTEx	https://gtexportal.org/home/tissue/Kidney_Cortex#MTissueBlocks		Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
GTEx	https://gtexportal.org/home/tissue/Liver#FTissueBlocks		Female	VH_F_liver	Female	http://purl.obolibrary.org/obo/UBERON_0002107	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Liver.glb
GTEx	https://gtexportal.org/home/tissue/Liver#MTissueBlocks		Male	VH_M_liver	Male	http://purl.obolibrary.org/obo/UBERON_0002107	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Liver.glb
GTEx	https://gtexportal.org/home/tissue/Lung#FTissueBlocks		Female	VH_F_lung	Female	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Lung.glb
GTEx	https://gtexportal.org/home/tissue/Lung#MTissueBlocks		Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb
GTEx	https://gtexportal.org/home/tissue/Ovary#FTissueBlocks		Female	VH_F_left_ovary	Female	http://purl.obolibrary.org/obo/FMA_7214	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ovary_L.glb
GTEx	https://gtexportal.org/home/tissue/Pancreas#FTissueBlocks		Female	VH_F_pancreas	Female	http://purl.obolibrary.org/obo/UBERON_0001264	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Pancreas.glb
GTEx	https://gtexportal.org/home/tissue/Pancreas#MTissueBlocks		Male	VH_M_pancreas	Male	http://purl.obolibrary.org/obo/UBERON_0001264	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Pancreas.glb
GTEx	https://gtexportal.org/home/tissue/Prostate#MTissueBlocks		Male	VH_M_male_reproductive_system	Male	http://purl.obolibrary.org/obo/UBERON_0000079	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Prostate.glb
GTEx	https://gtexportal.org/home/tissue/Skin_Not_Sun_Exposed_Suprapubic#FTissueBlocks		Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
GTEx	https://gtexportal.org/home/tissue/Skin_Not_Sun_Exposed_Suprapubic#MTissueBlocks		Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
GTEx	https://gtexportal.org/home/tissue/Skin_Sun_Exposed_Lower_leg#FTissueBlocks		Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
GTEx	https://gtexportal.org/home/tissue/Skin_Sun_Exposed_Lower_leg#MTissueBlocks		Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
GTEx	https://gtexportal.org/home/tissue/Small_Intestine_Terminal_Ileum#FTissueBlocks		Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
GTEx	https://gtexportal.org/home/tissue/Small_Intestine_Terminal_Ileum#MTissueBlocks		Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
GTEx	https://gtexportal.org/home/tissue/Spleen#FTissueBlocks		Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
GTEx	https://gtexportal.org/home/tissue/Spleen#MTissueBlocks		Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
GTEx	https://gtexportal.org/home/tissue/Uterus#FTissueBlocks		Female	VH_F_uterus	Female	http://purl.obolibrary.org/obo/UBERON_0000995	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Uterus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/00bf92f03e3eadf91552850d32eff9e4	HBM589.RBJF.235	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e4ee92c09a755f8889cb8c37a669e160	HBM588.GSHN.453	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/0101a0807f72d7028231205d5062910a	HBM894.MPVN.828	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/017eccf19e93969ce5cd8f30f78bab67	HBM756.LVDR.338	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/01a8403d440c80ca216100f11668c9ac	HBM768.VJJG.336	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/01f48b43d1440fe7d441cd0a8eb74482	HBM436.GHWX.449	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/020cef5bba09c038fa3ff0dabc60a624	HBM428.SLLW.585	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/03947098fe5b5ec44d67ec9d65a391d5	HBM797.KHRN.366	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a6255c16876d9c9d6229414c59fff534	HBM379.WHSK.294	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/042c6334e6b47083cf871bd5802bd460	HBM399.LMLR.539	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/062bd84696d51e02f670f064879b562d	HBM998.TTXD.949	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ffc79ba8af543395bfbcd753f86f4379	HBM886.HXFS.654	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb

HuBMAP	https://entity.api.hubmapconsortium.org/entities/06f2cc3fbcae1ceb3ea331e591f75ab5	HBM374.XJNM.984	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/074c96e0c614d3f8132a60afdd536db4	HBM372.BQSR.778	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/07ae6e4862e0f332ad49550b6871f5ac	HBM769.GQBZ.382	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/07c995983aac113b442c0dc0c0b42ae5	HBM652.VRLD.292	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/0a558711c6b9d5b9029717d722a2c31c	HBM964.XZCR.478	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/0aae451b843a6ac8de1794b2b093ecc5	HBM668.NQKV.963	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/0b43d8d0dbbc5e3923a8b963650ab8e3	HBM945.PZHJ.983	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/35e16f13caab262f446836f63cf4ad42	HBM229.NKWB.488	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/0ccf43ecc685e2ce2bd339fb87a240a2	HBM663.CXTS.935	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/0cd06b4b12d923d76990283878b382c6	HBM342.PTWT.238	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4f4caa49a9a75256184304591a293621	HBM294.RZFN.624	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/1000eb86d522a8e5505b8e07e2dc16a3	HBM442.JGVQ.472	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/10959ad9dcddc069beca474736e9b13b	HBM392.LRRZ.326	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/265d3bbfe919b3d04f08a53eaeff0ce7	HBM887.MWNM.832	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/1176b219b9ca81e0c5adef05ce695302	HBM669.GWVL.893	Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/117f50e0c71afde9435365f1a7ebe612	HBM247.KQXN.358	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/11d794402e067e54888bb8a4af4184e0	HBM734.MCNP.326	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/13900f28089c3f38cafdbd89272f5db1	HBM665.ZHCG.473	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/14eced66165e2bc1357c1c32115e1e97	HBM469.PLNV.544	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9d1412bb63341df32e4851693cbfe409	HBM368.ZXKL.785	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/173fbebb10c3af766e26b1d6c9c8d563	HBM897.MZNC.757	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/19c2383e305f364d25f019d0995656c8	HBM658.NKSZ.578	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/19d486f0d168ef0d02291972fb669996	HBM223.WQVG.533	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3d0e6983c0c7e8354cb4bded851b15b1	HBM827.VSGK.934	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/1b03bee1f9dc106b25b6120b237ad99a	HBM932.XWHK.748	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/1c1745a49b81662ab955765cb1159bab	HBM323.JDXK.437	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f0e6590d29514aa3edde3223aeb512d5	HBM797.VZJD.683	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/1de4ad9bd516660043b8e190e8978045	HBM294.KLBX.557	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/855045d4390dfa55cb95435eb9c3bcd0	HBM595.QBKS.265	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/221340e997dc0f2bf94e735098b148fe	HBM867.KTVV.927	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2256c64aacd92af7028ffb33e478cf46	HBM339.DBQF.784	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2283c507fdbb47ae8981f9e5d3fc7364	HBM863.HZBL.628	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5f043da4d6347e2b6f93509c000804d1	HBM562.NTMH.548	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/229a581f348ad1d5ce2bba31bda20078	HBM445.VZZW.354	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7eb535fdb3711a8138dfd9d88ab5d882	HBM837.WJCN.372	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/23f012ad7b5fe0e3f3c19186de7c4ea4	HBM687.HPMQ.796	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/243c742cc28978c406d650984d6eeffd	HBM547.QLDF.845	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5f8bd79354b14fc35466221b875bb030	HBM536.CCHF.977	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/263854e0346766efa516bd69bfc1e035	HBM347.DKWD.579	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2656c76dce594e00489964705b5d1744	HBM573.VPZH.456	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/268e8fb044f82a1497b5fd17918500ea	HBM365.LNPG.969	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/26c7a3b619c37b2d1ff3413b29cb220d	HBM336.FKTQ.774	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/850653bb4a374dad3dd1c8fa977cf0c5	HBM448.NSSK.723	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/26d28342879bc2b31983c4083a46bc1f	HBM655.RKDX.442	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/27bf04501f9e6142e0f4e777c7493ff4	HBM498.GTFD.948	Female	VH_F_lung	Female	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Lung.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/27d32c5c8e5af5bef285fa773beee5b6	HBM969.VNQL.553	Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/28a3bf68c312d5fcfd6abe101261b880	HBM473.VKCM.878	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2957761e1ed24c63f53714bd0d9bf25f	HBM496.GJFX.393	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2a3b7a201db7e590f8578b2d7c558f9b	HBM824.BLXF.883	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2c43806e840ffc9861abadf827c292fc	HBM833.VZTL.864	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2c4ed25579a369af5ae8f7523038235f	HBM896.ZPRW.239	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/edd2898e222ee5103b97084e3a528fd8	HBM463.FBXN.343	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2ce02a8007277336b4522db806cedafd	HBM554.ZRCG.496	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2dbbe0a335c233801e860414d9b974a9	HBM739.PLSN.745	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2ef7c7f89e172641c5f7c643d8a9c13d	HBM662.ZXJN.782	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/932a048745b3d30bacd0cfc9ba692136	HBM823.KKKP.894	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2f80f6cc0090e4ced8db6fb1a7cbc9f3	HBM643.RBNF.882	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f5efe120b07a958a3e8d20202dfb6670	HBM676.BLTC.766	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/2fd5e2341c703ca534aba69cb96dcf17	HBM838.DLMJ.782	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/326cdb183a9aef6b1a26c4885444b2e1	HBM536.HTQR.233	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f50b8ce55392beae9fa0547a81288f25	HBM337.QDTN.869	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6890cd54f99e6396694e64ee2bb53b3c	HBM396.JRWZ.394	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/37646b6f78075c99f09af04142ac39f4	HBM845.DZJK.226	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3838f4672dd3d3d1ee6cb0809cf1ea03	HBM438.KRHX.325	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3d742332ef8ca26f34f7ee5b9da3381c	HBM875.RVTT.868	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/386c2f0387641f395fe040546e05abf5	HBM288.QGDM.696	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/38980e9bcbf6a6bd9c6789ee4a45eea5	HBM656.GPNS.556	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/39edd934db23370ba003c0606b66ed9d	HBM682.WKXK.867	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3a4b8bfca8e842cae400f49e19987c7c	HBM579.GDJB.858	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3b20d9aa8a3a412a73a883e07d86d889	HBM265.JPJM.574	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/402bced53653cb2a89af6a5432bc8cbb	HBM526.VCST.839	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3b33a40cb465c55d060c3b0aba0ab455	HBM357.PJDL.372	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/54cde3b0621ca934c6028d504714b5cb	HBM255.SRPR.985	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3b4fda75a1185356b6c85965a4b61530	HBM463.KRJL.858	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb

HuBMAP	https://entity.api.hubmapconsortium.org/entities/3d2bc79885fc7720f77fddd2c23f02e5	HBM769.QPWZ.976	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3d74b962e316efbfba104370f5c87e2d	HBM979.SSNH.934	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/3e6656c98631005ca35a5cb29a7622f2	HBM287.TLBJ.556	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/409aca4cacf7542734d56af77622986f	HBM399.RNVS.838	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/826538065d76829c8770725514c454b7	HBM977.QHXW.349	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4183d2843c53482e94455468c7264de8	HBM536.BQGV.594	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/41e6526c796c3d2a975b28349b6c923e	HBM269.XSXP.962	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/76a721f5c92163e02bf2811ed276ed0b	HBM947.VLDP.894	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/454f281ae77ccd7a1e2ab86f90c07263	HBM667.TFXK.856	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/46168dd8aab589ce7edfa4beeaed773e	HBM355.SRXZ.437	Male	VH_M_liver	Male	http://purl.obolibrary.org/obo/UBERON_0002107	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Liver.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/46a4eaa8de7078fa4037c08cbc83ec95	HBM373.FMWH.928	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/46f5c8d7dc8d545c540748347d20a9b7	HBM242.XXTB.333	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/474657175c19641a1138d87f90d35fa5	HBM673.ZRWW.589	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4a2192a850916486de88f258f5b001ad	HBM794.JCHR.674	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/497f8aa9cb247e825e8227d6fa70f7a1	HBM545.TFNG.256	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ce91014999057077fd56011672b97315	HBM432.KLVR.258	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4ab6fc6dab8e5ede99acbeaf77cb984b	HBM669.BJNH.498	Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4b080d5c3c61100ff442700a5bc9e3ea	HBM973.XXKM.696	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4cdc311cdb07ab1a49cc4ad1e4e8d4da	HBM633.PRRH.456	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4d750b2cdad1579bb3bd5d89b9223431	HBM459.PPCQ.388	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4f6cc0da643e061d49c7baeb32a8e522	HBM388.HCNZ.783	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/4fb887c5b17d203e20143d9044c0bf94	HBM489.LMMT.845	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/512108a2c671e73858834cb5a7b8db80	HBM389.FFSZ.986	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/507bb20f36adc8a513fe31a913bcfde6	HBM369.JRRC.377	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8332815c55f72e2aec5610dcb4eab9d7	HBM649.SRZW.542	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/512108a2c671e73858834cb5a7b8db80	HBM389.FFSZ.986	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/513ceb231c3406e87abddcf7bae9b5aa	HBM585.HGJZ.542	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/539d08c341db65d371ae0687bb314bb3	HBM562.WMRL.498	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/539f15ce78fc8696e99c9d575be864be	HBM536.BHKD.628	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/555c2eabb62d8c3d38770f6e1f9fd7e8	HBM623.SWRP.833	Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/557b1690e60fab7ae503bdedec423a8e	HBM424.MVPW.359	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5590f1212159e1a53b045e7bedafc562	HBM495.RJQQ.292	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5a6a241eb7c95279801c758766bacfd8	HBM874.GRPV.923	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5bbf6c322b1d01653e50d8fc7c4c9337	HBM568.JNZB.938	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/685927dd48481648b1e7defddae5194d	HBM748.WTHS.663	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5d37e301409de226c25cc3d61a1ce089	HBM572.BLTL.799	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5d53bd5a71569c59c90d1608cd3da5c9	HBM636.XRCL.997	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5ded68dde822d1c03ee04fe58b978a7e	HBM853.QPTX.552	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5e84677c3dc53f5fd10dbd4c0c707121	HBM796.DQCS.798	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/988d21f5795b193ba51a7e00b1574ddf	HBM646.FSBQ.966	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a481a72a4f0877f177b5c47f033bea88	HBM536.LDTZ.757	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5ee67ff9d6876ce210f68a79751330a7	HBM838.WXVW.284	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d7331bf82cc73c5fcc4f42b555402c3a	HBM395.SKTC.472	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/5f8bd79354b14fc35466221b875bb030	HBM536.CCHF.977	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/60282a6fe6045167528b1f98b983b5d7	HBM358.NWPX.662	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e9b990a54c0dbd47ea9504f06934dc0f	HBM427.JWVV.723	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/60da3463ccefe031ad887014140a341e	HBM892.RFCC.476	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/647db48ac7407caf7c3fb8ef0c6da12e	HBM946.ZWHV.257	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/64e13907edf7eba3099d130c27278fa2	HBM448.CWPG.327	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d093d6563dad2457356074c3781d9bea	HBM383.TRQG.424	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6563fb50b78d550893e1eb7a38a4ea04	HBM586.JRXG.769	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6585f87d93fe9621d151f0f225a8edc2	HBM543.NGQC.475	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/661925b48ab59bcd33f02e984d9aae16	HBM527.QHZQ.526	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/681f7f1d0a87427cf182f231a01ca6f0	HBM788.KSZC.942	Male	VH_M_renal_pelvis_ureter_L	Male	http://purl.obolibrary.org/obo/UBERON_0001223	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Ureter_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/682ab44e00e97bd81b17b0004601c8da	HBM258.DDTW.423	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6890cd54f99e6396694e64ee2bb53b3c	HBM396.JRWZ.394	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/69b7f03c30bc3489a0b827864f7933c9	HBM764.FQJK.692	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6c717082627f452935b9f63d2d93f023	HBM789.XWDB.222	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6dfb4bf4c1b1086c3bfa260c5d8b8f79	HBM275.JLDD.367	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6e23ef9bbe7940257bbc9383bf05b546	HBM338.TDRB.772	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8d912783076037b57986afa62162f41d	HBM688.DQGM.882	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6e5e5be224d88f38aa390d0c389839c7	HBM279.ZBSM.472	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/6fa00091ad90ecf573e86506eacea923	HBM882.ZQCC.693	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7000456f479ecdd3a5c7f4ba70ada709	HBM772.TKGJ.794	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7027e24a3ef6e076ea45f4ad9d88b810	HBM433.RVMH.946	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7113f174c5b0da705b126129dff02f80	HBM682.TMBK.865	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d0cb764459fd1d1c6f04fdce2e982831	HBM488.XJKW.383	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/721dd6498cf02a198d15b0779345440e	HBM435.GXPF.329	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/726f5d11ea3999141d7c3c37ec267d8b	HBM253.HFDZ.866	Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/750691876232b043dd3b6e2b0098bdbf	HBM683.LPTG.838	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e80cd8fab25ec8e9cb41e3872e2129c7	HBM555.LQJW.397	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/76a721f5c92163e02bf2811ed276ed0b	HBM947.VLDP.894	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/78181ed33a22ce843cada4581c78ef63	HBM992.NHXV.663	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb	
HuBMAP	https://entity.api.hubmapconsortium.org/entities/79ee4df9ebae6f2dc297ed939cd43d3d	HBM294.SZND.926	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb	

HuBMAP	https://entity.api.hubmapconsortium.org/entities/7b7f0c98e666fbbcbc25391bbe12edea	HBM755.MZNB.996	Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7e54c74b70ad6e71177f1705f2eecafe	HBM894.PGJZ.258	Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7fd7eedb4f588e7c7da4dbf91024bcab	HBM936.THPV.749	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/7fdeb73d27a0bcb5de128cee4100f95b	HBM976.HCCV.642	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/804aa1a7fcdf319c206808c106f67008	HBM342.BQPD.849	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8050909abab1d44f6a310d1f2dd9ec21	HBM446.HQRF.573	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/80cd48a30567c0e5d5520e47dd4b3560	HBM587.VWCF.356	Female	VH_F_renal_pelvis_ureter_L	Female	http://purl.obolibrary.org/obo/UBERON_0001223	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8113a08108f2d3174b7baf988aa18c95	HBM464.RHLH.686	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8124e9475115786c1fae3683a6714c32	HBM578.GHNR.755	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/82f8ca025a918872d7b3bec389e3b9e7	HBM629.PPWR.872	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8360fe86ced2d235571ebcd59ec2d545	HBM229.HKHH.537	Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/84ee6955a5ddab4aee0f467609e96c2f	HBM686.NRXW.383	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/852a0b118adee651a66a63a189dcbc4b	HBM253.MVCZ.759	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/86e1dc729929d042cf13749fd6ca8b29	HBM748.ZDKH.494	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/88bbee4413cbab461685c6430d67afb5	HBM892.HRLX.747	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f98af9cbc9208a37ac2e900eaadbff8e	HBM289.BWJW.663	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8914ee0fd2e790f56b722640397bfb4d	HBM389.MGXT.546	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8b09621e0749c27758b3a4e208488181	HBM999.LPNZ.694	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8d593ea6872956bb98ced0e9b8fda5c8	HBM239.CBWR.263	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8b0a4cc904cadaccddd37633411fdbdd	HBM874.QHNS.972	Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8b675fffca25c82c530bea18d7b6294e	HBM354.VCFV.796	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8be6856befaf18068b9e9fc7e3da1dea	HBM972.DJHQ.877	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b6f4ccbaeed5944f509474b04aa0210d	HBM458.FPRQ.298	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8be83d4cdaf00b040835c83f5ad25750	HBM775.KDDL.468	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8cc62fd7d6c1f9d6f597aaa7f8687274	HBM238.QPLB.494	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8cdf44a106338aada6da04c71eeb767e	HBM773.SCDC.559	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/96d320ccb24a968bc32571895cf1b05e	HBM924.ZPQN.563	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8cfd588e5bc4a31ea61d3a11eae0cf61	HBM865.PBJW.845	Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/8d2acd5b31c953a5507da41df918ec2e	HBM498.KBVQ.446	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/92db984e67e05befc9c3d7567ba8333c	HBM432.ZMWW.498	Female	VH_F_renal_pelvis_ureter_L	Female	http://purl.obolibrary.org/obo/UBERON_0001223	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a85a325cfed5d998289565eba4f4028c	HBM566.KXSQ.967	Female	VH_F_renal_pelvis_ureter_L	Female	http://purl.obolibrary.org/obo/UBERON_0001223	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9442ad62814729abd33d5810383201b5	HBM784.GSBZ.598	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/960f1766a95573bb5ccd5e45c81a7e1b	HBM878.HDGF.983	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9778e9d083094862b2874f3007f8fe76	HBM396.WPKL.954	Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/97bf795bf495df7e9dab1b0dac7b914f	HBM338.MNSC.953	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9ca2e95cb56ac36d43dcbb3dc4e7860d	HBM734.XPFM.799	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a216f4fd6f96b64de6f3242eceebf4c6	HBM465.VKHL.532	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9d100e858da59cd250f0471e56b7e62c	HBM592.KNRW.784	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9d1412bb63341df32e4851693cbfe409	HBM368.ZXKL.785	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/9f87133a040070ff261384ec21c61c26	HBM678.BGNX.633	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b4a8f10ee89e856650f7b637d89a6fd3	HBM722.FRFS.774	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e6d334be3235f314f1e6126e7d830c81	HBM387.CCPR.595	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a1b167178431608b253c4a07ae18e5d9	HBM479.CHXG.876	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a216f4fd6f96b64de6f3242eceebf4c6	HBM465.VKHL.532	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a2cc35adf80400c16f940b3707ff3c40	HBM693.HFFJ.752	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a481a72a4f0877f177b5c47f033bea88	HBM536.LDTZ.757	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a596becf59c13e14a6489fb97fcdd2c9	HBM777.LKTF.999	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a5a5a3bff1df2a6c378d85316161bd5b	HBM974.MTJZ.548	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a5a884c221de042e3e2471c6d7dff529	HBM882.DNWX.356	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a6255c16876d9c9d6229414c59fff534	HBM379.WHSK.294	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a7c3ea8269b3a97ac9f39cb4a970666c	HBM538.RWLX.332	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a84a10c41fa408714f1510569a138b08	HBM556.TZZN.242	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a90f1880982cff8bd1628a6e0bac564c	HBM334.GCCX.874	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/a96d7a2687372052a139c4f3cf6b6864	HBM628.JGMX.559	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/aa77a4be1ddf5034539e0923735d94a4	HBM655.MKZV.728	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/aadeb3ec91f8886051108dbb45ddec76	HBM853.SNJJ.892	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ab957eb5a977b2eeb8817bc180bde4df	HBM386.CMDS.872	Female	VH_F_liver	Female	http://purl.obolibrary.org/obo/UBERON_0002107	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Liver.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/abe01e040eecba80c655fbca3aba165a	HBM544.CZWL.784	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ac972fb45d1dc05548ecf400229a8038	HBM363.KHLF.497	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/adb403564adb4657d3a50d41236869cc	HBM326.ZQWP.629	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/af309417792d635f8ffbe55e6a1147e6	HBM454.CJSX.364	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/fae3b22bf30dd4ed42b85a03224ca4a1	HBM765.HLTK.256	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/af99fe7abd9466881e22d3b8b9107bd5	HBM284.LKZT.268	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/aff08197f187418318e12cd70c9a6e3d	HBM288.MHXG.854	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b086daf9da374bb5422e64326c26012e	HBM467.BPFL.284	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/bdcc96e3882ddcdd1de604d2e2453106	HBM944.KDNK.782	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b1185b32c4aba932d85a564007eff904	HBM522.BTXN.792	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/be90ed4c3b0f90a71533e308c20e0f50	HBM382.KGWK.435	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b2362226c142a855ddaa0fba0db29b95	HBM695.TGJS.338	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b3d2d191603dfd4586181d62ad151b63	HBM957.MCFG.236	Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b40570529f88ddc2742b183843091cd5	HBM657.MNWD.445	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b40a2e7df7f1b804c0f0f2efeb449688	HBM774.WDWS.247	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ba72efbbf51de49ebc5013a2f5f3f4b4	HBM346.ZDRW.475	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c6c0f9588bd279bc30141ae255959d81	HBM522.DRFG.579	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb

HuBMAP	https://entity.api.hubmapconsortium.org/entities/b6283c0391ae1f184e1b818af81ea52d	HBM776.PKJF.786	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b6293bba61e3956b6546f4e6f47c8c3c	HBM453.BKZB.338	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b73c3e4e34b41af7d20694f05ece6a71	HBM635.JSBK.626	Female	Yao_lymph_node	Female	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_F_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b8304e1f4c94f2f8659a6f46719ac792	HBM293.XRCC.846	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/b8ee0a5027728fe5f5c70478e3d5aa95	HBM284.BTVB.232	Female	VH_F_heart	Female	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/bb13cfc2a76e97c613f2e789ce914252	HBM438.RKKD.789	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/bb2f22ab105c49476def20e47e9c1206	HBM622.DQNP.599	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/bbddf229fe06be8c7fd22c46af7e835b	HBM446.JLWV.234	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d79ce93ac1dd690ebf8e486f43b4fa0f	HBM756.BTCK.366	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/bf1db74f40506e87055eda7b84a79174	HBM457.CGXD.357	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e1e1c07203b6c09477e8bbaef8dd48bb	HBM969.HPBJ.369	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/bf7db5748c79ce21ff2fbdea95643a0e	HBM877.GTKS.653	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c0555e61bbd0e308d4231406accb4ec6	HBM939.GHBT.939	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c1cdc5b5cabbe591f63e78273abe1206	HBM228.BBHS.986	Female	VH_F_skin	Female	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c1f0cc0152231ce6276475b3ea800aab	HBM724.ZQKX.379	Male	VH_M_heart	Male	http://purl.obolibrary.org/obo/UBERON_0000948	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Heart.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c46f3ffa2ad148019ee983453d06b745	HBM978.CQCD.687	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c5bd4ae9a43b580f821c5d499953bdec	HBM743.BZVB.466	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c8a7cb9e644eb7bf0a5015eeee0f24c5	HBM683.GZRK.436	Male	VH_M_pancreas	Male	http://purl.obolibrary.org/obo/UBERON_0001264	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Pancreas.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/c923734ef4ab0da8f7928d4486dacc92	HBM922.CBTS.647	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ca14a67219e3548a6b55d7b163ee3dae	HBM974.NDXT.675	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ca56e9953739a00c2e5b1979a7831d2d	HBM286.LQFR.435	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/cbd2aa0f95af49579a3802b0ce155c1e	HBM536.LQPT.972	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e1da86b7cc2f1108877b1603623fbe93	HBM598.KHTX.275	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/cc2fae3cc7d376805a2854a442d1320a	HBM327.SDJD.338	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e78d2ae31c19988a948ccda59e7f4b06	HBM269.XWZK.324	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/cc5da33c5239011f75c06918dad38914	HBM937.HPQL.829	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/cc85586061c13a5fb6adf72c75a32cf9	HBM733.NFWS.792	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/cdd62f7264902447922147c3098ecd6a	HBM534.KCDB.944	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e5f2cb399e7e8885134c1b1a2b6acc9a	HBM474.BBPW.665	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/cfb75894a2611aeee77bb45760f2a4d2	HBM288.TQPD.747	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d0cf2383cd05565c1ccd8b4817f2effd	HBM557.SSSH.298	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d1a6c08673e5d707d2f06ef75b8e6594	HBM656.KGMN.542	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d3525d35f6d5ee3dc3186613b0ab1762	HBM526.ZWKZ.578	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d5ed99bb117cc5926f6c75c2dda38713	HBM787.DGRJ.473	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d730affb4c14b85473ee837586cdbe46	HBM845.XGSX.364	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f81107e2ab183f87f019a8eb2f1112d2	HBM936.XMNF.773	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d78afa907431bb4c943e39de3e994c27	HBM654.BKGL.942	Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/d79ce93ac1dd690ebf8e486f43b4fa0f	HBM756.BTCK.366	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/dec30248dca3262a3e59460c882f7091	HBM793.HSTZ.834	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/df96f02667e0a3b40332dcaa6a91f850	HBM965.TTFH.425	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/df9e95091537023967fce48b0fdd7384	HBM628.KVPD.267	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e33dbdec521d4ffe9958b2888c3c3a4b	HBM647.FPJZ.936	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e03c30230e3405eb6855a91cdc3197a8	HBM895.KJBW.679	Male	VH_M_colon	Male	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_M_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e06ead205555141de119caa8f5c990d4	HBM863.FZKT.367	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e258d717ddad14bfe1794690ae96d52e	HBM285.XMBT.542	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e3b74d607c3b20c9c2349d98c235ce72	HBM876.SJWP.278	Female	VH_F_renal_pelvis_ureter_L	Female	http://purl.obolibrary.org/obo/UBERON_0001223	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Ureter_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e43867e45f2036c91a538b07f765ff7d	HBM983.SRWC.777	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e5f2cb399e7e8885134c1b1a2b6acc9a	HBM474.BBPW.665	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e6a61a2aaec9809abf19f1f7b562f237	HBM639.SGGN.469	Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e76e073b21e99c230e0ee376722c041d	HBM662.LCNF.582	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/e92386147334ee241991e25d8ae3e04f	HBM224.HCFB.249	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ecca7757c924f2380669a15555d35a5d	HBM555.RTWS.767	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ed12b3e37fc8dcc4287f4f209eef9c4b	HBM259.JWWT.889	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/eeda1db47240d5ef91ad1023e65a6ec4	HBM648.WZPV.278	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/efbf777d8d36f03cebe957e02eb9f8fe	HBM896.LDWJ.896	Male	VH_M_small_intestine	Male	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f187ff9a4631540a9aced9086c512d5e	HBM297.VBLS.984	Male	VH_M_skin	Male	http://purl.obolibrary.org/obo/UBERON_0002097	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Skin.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f1ac23ea89f1364febce7b6435e2f49c	HBM842.QNVH.828	Female	VH_F_thymus	Female	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f202f2c7fbe92f78292acef7fafbdc7c	HBM682.PRLT.374	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f2d94e194470a4d748fb388db47f9598	HBM223.KDVZ.277	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f3406a8958fa8cbac26307725316362d	HBM526.QTJL.823	Male	VH_M_left_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f44e0ee8c75dfe89f8ec0f02c1780c21	HBM353.HDWB.922	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f53621bf6e120c11dd9a1e11d586d656	HBM695.THKG.748	Female	VH_F_colon	Female	http://purl.obolibrary.org/obo/UBERON_0000059	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/SBU_F_Intestine_Large.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f547dd2314220d545cd16c5dc41197f6	HBM989.ZFVH.366	Male	VH_M_right_kidney	Male	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f61c2bb9fdb631b4e110e8aa214dc774	HBM563.XSRN.647	Male	VH_M_spleen	Male	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f7b37eff8a36eb3852a373cc4878f50e	HBM997.BFCV.489	Female	VH_F_small_intestine	Female	http://purl.obolibrary.org/obo/UBERON_0002108	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Small_Intestine.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/f7c5d23701bf7e9fd88b93aa0f48443d	HBM534.PQDR.545	Female	VH_F_left_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004538	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_L.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/fba9c5e0758d0edd70b2661df94cbaa9	HBM756.WPHD.865	Male	VH_M_thymus	Male	http://purl.obolibrary.org/obo/UBERON_0002370	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Thymus.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/fc0711fa8f09cc48d596020fe816338a	HBM638.WKWF.434	Female	VH_F_right_kidney	Female	http://purl.obolibrary.org/obo/UBERON_0004539	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Kidney_R.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/fdcce615984a0d7ab4e86ae89d8a67ed	HBM733.DFXR.335	Female	VH_F_pancreas	Female	http://purl.obolibrary.org/obo/UBERON_0001264	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Pancreas.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/fe80275c62a586010d5093d980f80c34	HBM524.PBKM.993	Female	VH_F_spleen	Female	http://purl.obolibrary.org/obo/UBERON_0002106	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_F_Spleen.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/fed53eab5847287de706a8dafa6faf8f	HBM825.KBPF.658	Male	VH_M_lung	Male	http://purl.obolibrary.org/obo/UBERON_0001004	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/VH_M_Lung.glb
HuBMAP	https://entity.api.hubmapconsortium.org/entities/ff70986a4cf46640b165e38a536aed4f	HBM255.DZTZ.982	Male	Yao_lymph_node	Male	http://purl.obolibrary.org/obo/UBERON_0002509	https://ccf-ontology.hubmapconsortium.org/objects/v1.2/NIH_M_Lymph_Node.glb