

LANL T-6 HIV DATABASES

HIV IMMUNOLOGY WEB APP

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1

Immunology API - API access for the LANL HIV Molecular Immunology Database

1.1 *VERSION*

This documentation refers to API version v1.0.2.

1.2 *SYNOPSIS*

```
wget -O- 'https://www.hiv.lanl.gov/mojo/immunology/api/v1/epitope/ctl?id=42'
```

1.3 *DESCRIPTION*

The HIV Immunology API provides a public interface to retrieve data from the LANL HIV Molecular Immunology database. The returned data are formatted as JSON.

1.4 *ENDPOINTS*

All endpoints are relative to the server installation path. For example, if the API is installed at *https://www.hiv.lanl.gov/mojo/immunology* , then the full path of */api/v1/epitope/ctl* would be *https://www.hiv.lanl.gov/mojo/immunology/api/v1/epitope/ctl* .

The following endpoints are available:

/api/v1/epitope/{table}

Search *{table}* in the immunology database and return the matching epitope records.

Search parameters The *{table}* and at least one search parameter must be supplied; otherwise an error occurs. If multiple search parameters are supplied, then all of them must be satisfied.

- `table`

One of `ctl`, `helper`, or `ab`. The HIV Molecular Immunology Database is organized into three main tables according to the immune response: CTL/CD8+ (`ctl`), T-helper/CD4+ (`helper`), and Antibodies (`ab`). The T-cell tables are `ctl` and `helper`; the antibody table is `ab`.

- `author`

Search for epitopes by the name of an author of a reference.

- `author_first author_last`

Restrict search by author to only first authors or only last authors respectively.

- `au_filter`

Filter the results to include only notes and references with the matching author. Requires `author`. Antibody only.

- `binding_type`

Search for epitopes by ID of the antibody binding type. See `"/api/v1/list/binding_type/{table}"` to obtain the list of binding types and IDs. Antibody only.

- `cite`

Search for epitopes by the citation key of a reference, *E.g.*, `Doe2008`.

- `dna_end`

Search for epitopes before this DNA location.

- `dna_start`

Search for epitopes after this DNA location.

`dna_start` and `dna_end` search for epitopes by DNA location. The epitope is matched if the contig overlaps `dna_start`–`dna_end`.

- `end`

Search for epitopes before this protein location; requires `protein` or `protein_name`. See also `start`.

`start` and `end` search for epitopes by protein location. The epitope is matched if the location overlaps `start`–`end`.

- `epitope`

Search for epitopes by epitope amino acid sequence. The match succeeds if the query sequence is in the epitope sequence. The wildcard characters `?` and `*` may be used to specify one or any number of arbitrary amino acids respectively.

- `epitope_name`
Search for epitopes by name.
- `hla`
Search for epitopes by MHC/HLA. T cell only.
- `hla_id`
Search for epitopes by MHC/HLA ID. T cell only. See *"/api/v1/list/hla/{table}"* to obtain the list of HLAs and IDs.
- `id`
Search for epitopes by database ID.
- `immunogen`
Search for epitopes by immunogen ID. See *"/api/v1/list/immunogen/{table}"* to obtain the list of immunogens and IDs.
- `isotype`
Search for epitopes by isotype ID. See *"/api/v1/list/isotype/{table}"* to obtain the list of isotypes and IDs. Antibody only.
- `keyword`
Search for epitopes by keyword ID. See *"/api/v1/list/keyword/{table}"* to obtain the list of keywords and IDs.
- `kw_filter`
Filter the results to include only notes and references with the matching keyword . Requires `keyword` . Antibody only.
- `mab_name`
Search for epitopes by the name (or alias) of the monoclonal antibody (mAb). Antibody only.
- `note`
Search for epitopes by the text in a note. The search is limited to a single word or phrase. Full-text search is not supported.
- `note_filter`
Filter the results to include only notes and references matching `note` . Requires `note` . Antibody only.
- `outcome`
Search for epitopes by outcome (experimental methods or outcomes measures) ID. See *"/api/v1/list/outcome/{table}"* to obtain the list of outcomes and IDs. T cell only.

- **protein**
Search for epitopes by protein ID. See *"/api/v1/list/protein/{table}"* to obtain the list of proteins and IDs.
- **protein_name**
Search for epitopes by protein name.
- **pubmed_id**
Search for epitopes by the PubMed ID of a reference.
- **spans**
Search for epitopes at this protein location; requires **protein** or **protein_name**.
- **species**
Search for epitopes by the species ID the immune response was observed in. See *"/api/v1/list/species/{table}"* to obtain the list of species and IDs.
- **start**
Search for epitopes after this protein location; requires **protein** or **protein_name**. See also **end**.
- **subtype**
Search for epitopes by viral subtype ID. See *"/api/v1/list/subtype/{table}"* to obtain the list of subtypes and IDs.
- **vaccine_adjuvant**
Search for epitopes by vaccine adjuvant ID. Requires that the immunogen be a vaccine. See *"/api/v1/list/vaccine_adjuvant/{table}"* to obtain the list of vaccine adjuvants and IDs.
- **vaccine_component**
Search for epitopes by vaccine component ID. Requires that the immunogen be a vaccine. See *"/api/v1/list/vaccine_component/{table}"* to obtain the list of vaccine components and IDs.
- **vaccine_strain**
Search for epitopes by vaccine strain ID. Requires that the immunogen be a vaccine. See *"/api/v1/list/vaccine_strain/{table}"* to obtain the list of vaccine strains and IDs.
- **vaccine_type**
Search for epitopes by vaccine type ID. Requires that the immunogen be a vaccine. See *"/api/v1/list/vaccine_type/{table}"* to obtain the list of vaccine types and IDs.

/api/v1/list/binding_type/{table}

Retrieve the list of antibody binding types and IDs present in {table} .
Antibody only.

/api/v1/list/country/{table}

Retrieve the list of country names and ISO country codes present in {table}

/api/v1/list/hla/{table}

Retrieve the list of HLA/MHC types and IDs present in {table} . T cell only.

/api/v1/list/immunogen/{table}

Retrieve the list of immunogens and IDs present in {table} .

/api/v1/list/isotype/{table}

Retrieve the list of isotypes and IDs present in {table} . Antibody only.

/api/v1/list/keyword/{table}

Retrieve the list of keywords and IDs present in {table} .

/api/v1/list/outcome/{table}

Retrieve the list of outcomes (experimental methods and outcomes measured) and IDs present in {table} .

/api/v1/list/protein/{table}

Retrieve the list of proteins and IDs present in {table} .

/api/v1/list/species/{table}

Retrieve the list of species and IDs present in {table} .

/api/v1/list/subtype/{table}

Retrieve the list of subtypes and IDs present in {table} .

/api/v1/list/vaccine_adjuvant/{table}

Retrieve the list of vaccine adjuvants and IDs present in {table} .

/api/v1/list/vaccine_component/{table}

Retrieve the list of vaccine components and IDs present in {table} .

/api/v1/list/vaccine_strain/{table}

Retrieve the list of vaccine strains and IDs present in {table} .

/api/v1/list/vaccine_type/{table}

Retrieve the list of vaccine types and IDs present in {table} .

/api/v1/patient

Search the patient table in the immunology database and return the matching patient records.

/api/v1/patient_list/ethnicity

Retrieve the list of patient ethnicities.

/api/v1/patient_list/hla

Retrieve the list of patient HLA/MHC types and IDs.

/api/v1/patient_list/infection_country

Retrieve the list patient infection country names and codes.

/api/v1/patient_list/infection_year

Retrieve the list of patient infection years.

/api/v1/patient_list/progression

Retrieve the list patient HIV progression codes and names.

/api/v1/patient_list/risk_factor

Retrieve the list patient HIV risk factor codes and names.

/api/v1/patient_list/sex

Retrieve the list patient sexes.

/api/v1/patient_list/species

Retrieve the list patient species.

Search parameters At least one search parameter must be supplied; otherwise an error occurs. If multiple search parameters are supplied, then all of them must be satisfied.

- `ethnicity`
Search for patients by ethnicity.
- `id`
Search for patients by database ID.
- `infection_country`
Search for patients by country where infected.
- `infection_year`
Search for patients by year when infected.
- `note`
Search for patients by the text in a note. The search is limited to a single word or phrase. Full-text search is not supported.
- `patient_code`
Search for patients by code as published in the literature.
- `patient_code_exact`
If true, find only exact matches to `patient_code`.
- `patient_hla_id`
Search for patients by MHC/HLA ID.
- `patient_sex`
Search for patients by sex.
- `progression`
Search for patients by HIV progression status.
- `risk_factor`
Search for patients by HIV risk factor.
- `species`
Search for patients by species.

1.5 DATABASE ORGANIZATION

The information below explains what the database contains and the meaning of terms used in the search interfaces.

HIV T-Cell Epitopes

T-cell epitopes are categorized into cytotoxic T lymphocytes (CTL/CD8+) and helper T lymphocytes (T-helper/CD4+). The database organization for CTL/CD8+ and T-helper/CD4+ is identical, so they are described together.

T Cell Summary The T cell databases include tables and associated references of HIV-specific T-cell epitopes arranged according to the location of the proteins in the HIV-1 genome. We attempted to make this section as comprehensive as possible, requiring that the epitope be contained within a defined region of a maximum of 30 amino acids, but not that the optimal boundaries be defined. Studies that were based on the analysis of whole proteins are described at the end of each protein section. The same epitope can have multiple entries, and each entry represents a single publication in this section of the database.

Recent studies utilize multiple functions attributed to T cells to define responses, and the simple distinctions of cytotoxic T cells and helper T cells have become blurred as more is learned about the range of responses triggered in CD4- and CD8-positive T cells responding to antigenic stimulus. When adding the most recent studies, we have tried to place T-cell responses in a reasonable manner into our traditional CTL and helper T-cell sections, and to specify the assay used to measure the response in each study.

T Cell Epitope Tables Each T cell epitope has a multi-part basic entry:

- **Record number**

A unique number assigned by the database, in approximate order of entry. Please refer to this number if you have any comments or questions about an entry.

- **HXB2 Location**

The viral strain HXB2 (GenBank Accession Number K03455) is used as a reference strain throughout this publication. The position of the defined epitope location relative to the sequence of the HXB2 protein is indicated. The numbering in this table corresponds to the protein maps. Because of HIV-1 variation the epitope may not actually be present in HXB2, rather the position in HXB2 indicates the position aligned to the epitope. HXB2 was selected as the reference strain because so many studies use HXB2, and because crystal structures for HXB2-related proteins are available.

- **Author Location**

The amino acid positions of the epitope boundaries and the reference sequence are listed as given in the primary publication. Frequently, these positions as published are imprecise, and do not truly correspond to the numbering of the sequence, but they provide a reasonable guide to the

peptide's approximate location in the protein. Also, in many cases the reference sequence identification was not provided, and in such cases it is not possible to use these numbers to specify precise locations.

- **Subtype**

The subtype under study, generally not specified for B subtype.

- **Epitope Sequence**

The amino acid sequence of the epitope of interest as defined in the reference. On occasions when only the position numbers and not the actual peptide sequence was specified in the original publication, we try to fill in the peptide sequence based on the position numbers and reference strain. If the sequences were numbered inaccurately by the primary authors, or if we made a mistake in this process, we may misrepresent the amino acid sequence. Because of this uncertainty, epitopes that were not explicitly written in the primary publication are followed by a question mark (?) in the table.

- **Epitope Name**

If the epitope has a name attributed by the publication, it is recorded here, *e.g.* "SL9".

- **Species (MHC/HLA)**

The species responding and MHC or HLA specificity of the epitope.

- **Immunogen**

The original stimulus of the T-cell response. Often this is an HIV-1 infection. If a vaccine was used as the original antigenic stimulation, not a natural infection, this is noted on a separate line, and additional information about the vaccine antigen is provided as available.

- **Keywords**

The keyword field helps identify entries of particular interest.

- **Reference**

The primary reference (sometimes two or more directly related studies are included).

- **Notes**

Brief comments explain the context in which the epitope was studied and what was learned about the epitope in a given study.

HIV Antibody Binding Sites

Antibody Summary The antibody database summarizes HIV-specific antibodies (Abs) arranged sequentially according to the location of their binding domain, organized by protein. We attempted to make this section as comprehensive as possible. For the monoclonal (MAbs) capable of binding to linear peptides, we require that the binding site be contained within a region of 30 or so amino acids to define the epitope, but not that the precise boundaries be defined. MAbs that do not bind to defined linear peptides are grouped by category at the end of each protein. Antibody categories, for example CD4 binding site (CD4BS) antibodies, are also noted in the index at the beginning of this section. Studies of polyclonal Ab responses are also included. Responses that are just characterized by binding to a protein, with no known specific binding site, are listed at the end of each protein.

Antibody Tables Each MAb or polyclonal response has a multi-part basic entry:

- **Record number**

A unique number assigned by the database, in approximate order of entry. Please refer to this number if you have any comments or questions about an entry.

- **MAb name**

The name of the monoclonal antibody with synonyms in parentheses. MAbs often have several names. For example, punctuation can be lost and names are often shortened (“M-70” in one paper can be “M70” in another). Polyclonal responses are listed as “polyclonal” in this field.

- **HXB2 Location**

Position of the Ab binding site relative to the viral strain HXB2 (GenBank Accession Number K03455), which is used as a reference strain throughout this publication. The numbering in this table corresponds to the protein maps. Because of HIV-1 variation the epitope may not actually be present in HXB2, rather the position in HXB2 indicates the position aligned to the epitope. HXB2 was selected as the reference strain because so many studies use HXB2, and because crystal structures for HXB2-related proteins are often available.

- **Author Location**

The amino acid positions of the epitope boundaries and the reference sequence used to define the epitope are listed as given in the primary publication. Frequently, these positions as published are imprecise, and do not truly correspond to the numbering of the sequence, but they provide a reasonable guide to the peptide’s approximate location in the protein. Also,

in many cases, position numbers were provided but the reference sequence identification was not. Because of HIV-1's variability, position numbers require a reference strain to be meaningful. Binding sites that cannot be defined through peptide binding or interference studies are labeled as discontinuous. The approximate location on the protein, sequence number, and reference sequence are listed.

- **Sequence**

The amino acid sequence of the binding region of interest, based on the reference strain used in the study defining the binding site. On occasions when only the position numbers and not the actual peptide sequence was specified in the original publication, we tried to fill in the peptide sequence based on the position numbers and reference strain. If the sequences were numbered inaccurately by the primary authors, or if we made a mistake in this process, we may have misrepresented the binding site's amino acid sequence. Because of this uncertainty, epitopes that were not explicitly written in the primary publication, that we determined by looking up the reference strain and the numbered location, are followed by a question mark in the table.

- **Neutralizing**

- *L* : neutralizes lab strains.
- *P* : neutralizes at least some primary isolates or pseudoviruses.
- *P (tier 1)* : neutralizes tier 1 isolates (easily neutralized strains).
- *P (tier 2)* : neutralizes at least some tier 2 isolates (moderately difficult strains).
- *no* : does not neutralize.

No information in this field means that neutralization was either not discussed or unresolved in the primary publications referring to the MAb.

- **Immunogen**

The antigenic stimulus of the original B cell response. Often this is an HIV-1 infection. If a vaccine was used as the original antigenic stimulation, not a natural infection, this is noted on a separate line, and additional information about the vaccine antigen is provided as available.

- **Species(Isotype)**

The host that the antibody was generated in, and the isotype of the antibody.

- **Donor**

Information about an antibody or how to obtain it, as well as to provide credit.

- **References**

All publications that we could find that refer to the use of a specific monoclonal antibody. First is a list of all references. Some of the earlier references include notes with additional details, although we have tried to keep the entries self-contained since 1997.

- **Notes**

Describe the context of each study, and what was learned about the antibody in the study.

Database Fields

This is a brief description of the database fields in the search and results pages. Please see above for more details.

- **HIV protein**

The protein for which the epitope was defined.

- **Defined epitopes**

Epitopes or reactive peptides that have a known protein sequence.

- **Undefined epitopes**

Reactive peptides or proteins for which the binding site is not exactly known. This could either be because it was unspecified by the authors (e.g., a polyclonal response to Env) or because it is a conformational epitope for an antibody that binds to discontinuous amino acids in the folded protein.

- **HXB2 protein location**

The HXB2 protein coordinates within the protein selected in the “HIV protein” field above. Be sure to enter a HIV protein when using protein location search. This finds epitopes that overlap any residue of the specified location. To find epitopes that contain a single specific residue, you can enter the same coordinate number in both boxes.

- **HXB2 DNA location**

The HXB2 DNA coordinates. Results will include all epitopes that overlap the coordinates of the query. If multiple proteins overlap at the DNA coordinates selected, you can use the “HIV protein” field to narrow the search to the protein of interest.

- **Epitope**

The amino acid sequence of the epitope or short reactive peptide. Finds epitopes that contain the query sequence. Results will be the same length or longer than the query.

- **Epitope name**
Epitope name as reported by the authors.
- **Record number**
A unique number assigned by the database, in approximate order of entry. Please refer to this number if you have any comments or questions about an entry.
- **Subtype**
The subtype under study, generally not specified for B subtype.
- **Immunogen**
The stimulus of the original immune response under study.
- **Vaccine details**
Data included only if the immunogen was a vaccine.
- **Vaccine type**
The vaccine construct and boost.
- **Vaccine strain**
The strain of HIV or SHIV used for the vaccine antigen.
- **Vaccine component**
The HIV protein (complete or partial) included in the vaccine.
- **Adjuvant**
Traditional adjuvants or chemokines.
- **Species**
The species in which the immune response was stimulated.
- **MHC/HLA**
The MHC (or HLA) presenting molecules as described by the primary authors.
- **Author**
Any one author from primary publication. Specify as Surname and Initials, *e.g.* , “Brander C”, “Korber BT” or “Haynes”.
- **Country**
The country where the samples were obtained.
- **Keywords**
Searchable topics that can be used to narrow your search. Each reference is assigned one or more keywords that characterize the information provided in that paper.

- **Experimental methods (outcome)**

Methods used by the authors to test the immune response.

- **MAb name**

Name of monoclonal antibody or “polyclonal” if a general response is being studied. The name is usually given as the authors defined it in the paper that described the antibody’s isolation.

- **HXB2 location**

Epitope position numbers in the HXB2 reference strain.

- **Author location**

Epitope location as reported by the authors. Includes strain and subtype from which the epitope was derived.

- **Epitope name**

Epitope name as reported by the authors.

- **Ab binding type**

Classes of antibodies have shared properties with regard to their binding site and can be grouped; for example they might bind to a similar region (like V3) or near a common functional domain (like the CD4 binding site, CD4BS).

- **Neutralizing**

Neutralizing properties of the antibody—often different studies involving the same antibody will report this differently, so this classification is somewhat subjective.

- **Research contact (donor)**

The person or lab that generated or provides the antibody.

- **Notes**

Brief comments explain the context in which the epitope was studied and what was learned about the epitope in a given study.

1.6 API REFERENCE

The formal OpenAPI specification for this API is available via *”api/v1”* , E.g. , <https://www.hiv.lanl.gov/mojo/immunology/api/v1> . An HTML rendering is available via *”api/v1.html”* , E.g. , <https://www.hiv.lanl.gov/mojo/immunology/api/v1.html> .

1.7 *BUGS AND LIMITATIONS*

There are no known bugs in this app. Please report problems to the author at <mailto:immuno@lanl.gov>

1.8 *SEE ALSO*

HIV Molecular Immunology website <https://www.hiv.lanl.gov/content/immunology>

Immunology

OpenAPI/Swagger <https://swagger.io>

1.9 *AUTHOR*

LANL T-6 HIV Databases <mailto:immuno@lanl.gov>

1.10 *LICENSE AND COPYRIGHT*

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2

immunology - The Mojolicious command system for the HIV immunology app

2.1 SYNOPSIS

```
$ script/immunology --help
```

2.2 DESCRIPTION

List and run *Mojolicious* commands as described in *Mojolicious::Commands* .

2.3 SEE ALSO

Mojolicious , *Mojolicious::Commands* , *Mojolicious::Guides* , <https://mojolicious.org> .

2.4 AUTHOR

LANL T-6 HIV Immunology Database <mailto:immuno@lanl.gov>

2.5 LICENSE AND COPYRIGHT

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3

Immunology - Mojolicious Immunology App

3.1 SYNOPSIS

```
Mojolicious::Commands->start_app('Immunology');
```

3.2 DESCRIPTION

Mojolicious application class for the immunology app.

3.3 ATTRIBUTES

Immunology has the following attributes:

pg_immuno

Mojo::Pg object used to connect to the database.

3.4 METHODS

startup

Sets up the Mojolicious app at startup.

3.5 CONFIGURATION

secrets

secrets for *Mojolicious* , used for signed cookies and the like.

immuno_connect

PostgreSQL connection URL to the HIV Immunology Database.

3.6 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

3.7 *SEE ALSO*

Mojo::Base , *Mojo::Home* , *Mojo::Pg* , *DBD::Pg*

Mojolicious::Plugin::Config , *Mojolicious::Plugin::OpenAPI*

Immunology::Controller::List , *Immunology::Controller::Search* , *Immunology::Controller::Patient* , *Immunology::Model* , *Immunology::Model::List* , *Immunology::Model::Search* , *Immunology::Model::Search::Epitope* , *Immunology::Model::Patient::List* , *Immunology::Model::Patient::Search* , *Immunology::Plugin::MenuHelpers* , *Immunology::Plugin::ModelHelpers* , *Immunology::Plugin::ViewHelpers* , *Mojo::Pg::Results::Role::Util.pm* .

Mojolicious , *Mojolicious::Guides* , <https://mojolicious.org> .

3.8 *AUTHOR*

LANL T-6 HIV Databases <mailto:immuno@lanl.gov>

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4

Immunology::Controller::List - *Mojolicious* controller for immunology lists

4.1 SYNOPSIS

Used automatically by *Mojolicious*

4.2 DESCRIPTION

Mojolicious controller for immunology lists.

4.3 ATTRIBUTES

None.

4.4 METHODS

These methods are thin wrappers around the corresponding methods in *Immunology::Model::List*.

binding_types

Returns the list of antibody binding type ids and types. Antibody only.

countries

Returns the list of country codes and names.

hla

Returns the list of HLA ids and names. T-cell only.

hxb2protein

Return the list of HXB2 ids and proteins.

immunogen

Returns the list of immunogen ids and immunogens.

isotype

Returns the list of isotype ids and isotypes.

keyword

Returns the list of keyword ids and keywords.

outcome

Returns the list of outcome ids and outcomes.

species

Returns the list of species ids and species.

subtype

Returns the list of subtype ids and subtypes.

vaccine_adjuvant

Returns the list of vaccine adjuvant ids and adjuvants.

vaccine_component

Returns the list of vaccine component ids and components.

vaccine_strain

Returns the list of vaccine strain ids and strains.

vaccine_type

Returns the list of vaccine type ids and types.

4.5 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

4.6 *SEE ALSO*

Immunology , *Immunology::Model* , *Immunology::Model::Lists*
Mojolicious , *Mojolicious::Controller* , *Mojo::Base* , *Mojolicious::Plugin::OpenAPI* .

4.7 *AUTHOR*

LANL T-6 HIV Databases *mailto:immuno@lanl.gov*

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5

Immunology::Controller::Search - Mojolicious controller for immunology search

5.1 SYNOPSIS

Used automatically by *Mojolicious*

5.2 DESCRIPTION

Mojolicious controller for immunology search.

5.3 ATTRIBUTES

None.

5.4 METHODS

form

Presents the search form. Uses *Immunology::Model::Lists* to populate the menus.

results

Presents the results. Uses *Immunology::Model::Search* to perform the search and obtain the results.

epitope

Presents the results for OpenAPI. Uses *Immunology::Model::Search* to perform the search and obtain the results.

5.5 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

5.6 *SEE ALSO*

Immunology , *Immunology::Model* , *Immunology::Model::Lists* , *Immunology::Model::Search*

Mojolicious , *Mojolicious::Controller* , *Mojo::Base* , *Mojolicious::Plugin::OpenAPI* .

5.7 *AUTHOR*

LANL T-6 HIV Databases <mailto:immuno@lanl.gov>

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6

Immunology::Controller::Patient - Mojolicious controller for immunology patient search

6.1 SYNOPSIS

Used automatically by *Mojolicious*

6.2 DESCRIPTION

Mojolicious controller for immunology patient search.

6.3 ATTRIBUTES

None.

6.4 METHODS

form

Presents the search form. Uses *Immunology::Model::Patient::Lists* to populate the menus.

results

Presents the search results. Uses *Immunology::Model::Patient::Search* to perform the search and obtain the results.

details

Presents the details for a single patient record. Uses *Immunology::Model::Patient::Search* to perform the search and obtain the results.

api

Presents the results for OpenAPI. Uses *Immunology::Model::Patient::Search* to perform the search and obtain the results.

list_ethnicity

Returns the list of patient ethnicities.

list_hla

Returns the list of patient HLA ids and names.

list_infection_country

Returns the list of infection country codes and names.

list_infection_year

Returns the list of infection country years.

list_progression

Returns the list of HIV progression codes and names.

list_risk_factor

Returns the list of HIV risk_factor codes and names.

list_sex

Returns the list of patient sexes.

list_species

Returns the list of patient species ids and names.

6.5 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <immuno@lanl.gov>

6.6 *SEE ALSO*

Immunology , *Immunology::Model::Patient::Lists* , *Immunology::Model::Patient::Search*

Mojolicious , *Mojolicious::Controller* , *Mojo::Base* , *Mojolicious::Plugin::OpenAPI* .

6.7 *AUTHOR*

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7

Immunology::Model - Model for the immunology Mojolicious app

7.1 SYNOPSIS

```
use Immunology::Model;
my $model = Immunology::Model->new(
    pg_immuno => $app->pg_immuno,
    log => $log
);
my @tables = Immunology::Model::db_tables;
my @tcell_tables = $model->Immunology::Model::tcell_tables;
my @ab_tables = $model->Immunology::Model::ab_tables;

my $is_db_table = Immunology::Model::check_db_table('foo');
$model->table( 'ctl' );
$is_db_table = $model->check_db_table;
$is_tcell_table = $model->check_tcell_table;
$is_ab_table = $model->check_ab_table;

say "The current table is ", $self->db_table_name;
```

7.2 DESCRIPTION

Base class for accessing the immunology database. This provides a framework for the tables and database connection.

7.3 ATTRIBUTES

pg_immuno

Mojo::Pg object for working with the database. Must be defined.

log

Mojo::Log object for logging. Will be created automatically if needed and not defined.

table

The 'main' database table to work with. *I.e.* , one of `qw(ctl helper ab)` .

7.4 CLASS METHODS

db_tables

Returns the list of 'main' tables. *I.e.* , `qw(ctl helper ab)` .

tcell_tables

Returns the list of T-cell tables. *I.e.* , `qw(ctl helper)` .

ab_tables

Returns the list of antibody tables. *I.e.* , `qw(ab)` .

check_db_table (\$self, \$table=\$self->table)

Returns true if `$table` is one of the main database tables; False otherwise. Can also be use as an instance method to check the `table` attribute.

db_table_name (\$self, \$table=\$self->table)

Returns the human-friendly name of `$table` . Can also be use as an instance method to return the name of the `table` attribute.

check_id_type (\$self, \$id)

Returns true if `$id` is positive integer; false otherwise.

7.5 INSTANCE METHODS

check_tcell_table (\$self)

Returns true if the `table` attribute is a T-cell table; False otherwise.

check_ab_table (\$self)

Returns true if the `table` attribute is an antibody table; False otherwise.

7.6 *DIAGNOSTICS*

- *PostgreSQL* is required . Fatal error if the `pg_immuno` attribute is not set when used.

7.7 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

7.8 *SEE ALSO*

Immunology , *Immunology::Model::List* , *Immunology::Model::Search*
Mojolicious , *Mojo::Base* , *Mojo::Log* , *Mojo::Pg*

7.9 *AUTHOR*

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8

Immunology::Model::List - Retrieve list for the pull-down menus.

8.1 SYNOPSIS

```
$app->helper(  
  model_lists => sub ($) {  
    Immunology::Model::List->new(  
      pg_immuno => $app->pg_immuno,  
      log => $log  
    );  
  }  
);  
my $results = model_lists->country_list->select_field_list;
```

8.2 DESCRIPTION

This class has methods to retrieve the lists to populate the pull-down menus.

8.3 ATTRIBUTES

pg_immuno, table, log

Inherited from *Immunology::Model* .

8.4 PUBLIC METHODS

All methods return a *Mojo::Pg::Results* object with the *Mojo::Pg::Results::Role::Util* rôle.

binding_type_list (\$self)

Returns the list of antibody binding type ids and types. Antibody only.

country_list (\$self)

Returns the list of country codes and names.

hla_id_list (\$self)

Returns the list of HLA ids and names. T-cell only.

hla_list (\$self)

Returns the list of HLA names. T-cell only.

hxb2_protein_list (\$self, \$table=\$self->table, \$defined = ”)

Return the list of HXB2 ids and proteins. If \$table or the table is not defined then return the list of all valid HXB2 proteins; otherwise, return only those proteins that are in table . If defined is set to 'defined' then return the list of proteins with defined epitopes, else if defined is 'undefined' the return the list of proteins with undefined epitopes, else return the list of proteins for all epitopes.

immunogen_list (\$self)

Returns the list of immunogen ids and immunogens.

isotype_list (\$self)

Returns the list of isotype ids and isotypes.

keyword_list (\$self)

Returns the list of keyword ids and keywords.

outcome_list (\$self)

Returns the list of outcome ids and outcomes.

species_list (\$self)

Returns the list of species ids and species.

subtype_list (\$self)

Returns the list of subtype ids and subtypes.

vaccine_adjuvant_list (\$self)

Returns the list of vaccine adjuvant ids and adjuvants.

vaccine_component_list (\$self)

Returns the list of vaccine component ids and components.

vaccine_strain_list (\$self)

Returns the list of vaccine strain ids and strains.

vaccine_type_list (\$self)

Returns the list of vaccine type ids and types.

8.5 *DIAGNOSTICS*

Invalid table

Fatal error if a method is called on an incorrect table .

8.6 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at *mailto:immuno@lanl.gov*

8.7 *SEE ALSO*

Immunology::Model Mojo::Base Mojo::Pg Mojo::Pg::Results::Role::Util

8.8 *AUTHOR*

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9

Immunology::Model::Search - Search the HIV immunology database.

9.1 SYNOPSIS

```
$app->helper(  
  search => sub ($) {  
    Immunology::Model::Search->new(  
      pg_immuno => $app->pg_immuno,  
      log => $log  
    );  
  }  
);  
  
my $search = $c->app->search;  
my $v = $c->validation;  
$search->params( $v)->validate;  
my $epitopes => $search->find_epitopes;
```

9.2 DESCRIPTION

Search the HIV immunology database. Validate the search parameters and return the list of matching epitopes. Uses *Immunology::Model::Search::Epitope* to retrieve the epitopes.

9.3 ATTRIBUTES

params

A *Mojolicious::Validator::Validation* object to hold the input and validated search parameters.

pg_immuno, table, log

Inherited from *Immunology::Model* .

9.4 PUBLIC METHODS

validate (\$self)

Validates input parameters via *Mojolicious::Validator::Validation* . Validated parameters are stored in `$self->params->output` .

find_epitopes (\$self)

Searches the immunology database using the validated parameters. Returns the list of matching epitopes as a *Mojo::Collection* ; returns undef if no matching epitopes are found.

9.5 INTERNAL METHODS

Internal methods are an implementation detail and are subject to change without notice. Please notify the author if you wish to use these as public methods.

_find_ids (\$self)

Returns the list of epitope ids matching the search terms.

_wheres (\$self)

Returns a list of SQL WHERE clauses to select epitopes according to the search parameters.

_ab_note_where (\$self)

Returns a SQL WHERE clause to match by the note parameter. Antibody only.

_author_subselect (\$self)

Returns a SQL sub-select to get bibliography entries matching the author , `author_first` , and `author_last` parameters.

_author_where (\$self)

Returns a SQL WHERE clause to match by the author , `author_first` , and `author_last` parameters.

_binding_type_where (\$self)

Returns a SQL WHERE clause to match by the `binding_type` parameter. Antibody only.

_brander_where (\$self)

Returns a SQL WHERE clause to match by the `brander` parameter. CTL only.

_cite_where (\$self)

Returns a SQL WHERE clause to match by the `cite` parameter.

_country_where (\$self)

Returns a SQL WHERE clause to match by the `country` parameter.

_dna_overlaps_where (\$self)

Returns a SQL WHERE clause to match by the `dna_start` and `dna_end` parameters.

_epitope_name_where (\$self)

Returns a SQL WHERE clause to match by the `epitope_name` parameter.

_epitope_where (\$self)

Returns a SQL WHERE clause to match by the `epitope` and `epitope_exact` parameter.

_hla_id_where (\$self)

Returns a SQL WHERE clause to match by the `hla_id` parameter. T-cell only.

_hla_where (\$self)

Returns a SQL WHERE clause to match by the `hla` parameter. T-cell only.

_id_where (\$self)

Returns a SQL WHERE clause to match by the `id` parameter.

_immunogen_where (\$self)

Returns a SQL WHERE clause to match by the `immunogen` parameter.

_inrange_where (\$self)

Returns a SQL WHERE clause to match by the start , end , and range_span parameters.

_isotype_where (\$self)

Returns a SQL WHERE clause to match by the isotype parameter. Antibody only.

_keyword_where (\$self)

Returns a SQL WHERE clause to match by the keyword parameter.

_mab_name_where (\$self)

Returns a SQL WHERE clause to match by the mab_name and <mab_name_exact> parameters. Antibody only.

_note_where (\$self)

Returns a SQL WHERE clause to match by the note parameter. T-cell only.

_protein_id_by_name (\$self)

Returns the protein ids matching the protein_name parameters

_protein_where (\$self)

Returns a SQL WHERE clause to match by the protein , protein_names , start , end , range_span , and spans parameters.

_pubmed_where (\$self)

Returns a SQL WHERE clause to match by the pubmed_id parameter.

_spans_where (\$self)

Returns a SQL WHERE clause to match by the spans parameter.

_species_where (\$self)

Returns a SQL WHERE clause to match by the species parameter.

_subtype_where (\$self)

Returns a SQL WHERE clause to match by the subtype parameter.

_vaccine_where (\$self)

Returns a SQL WHERE clause to match by the vaccine_adjuvant , vaccine_component , vaccine_strain , and vaccine_type parameters. Only if the immunogen parameter is a I>vaccine>.

_wildcard2sql (\$self, \$str)

Converts the * and ? wildcards in \$str to % and _ for use in a SQL LIKE expression. Returns the modified \$str .

*9.6 DIAGNOSTICS**Invalid table*

Fatal error if a method is called on an incorrect table .

9.7 BUGS AND LIMITATIONS

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

9.8 SEE ALSO

Immunology::Model Immunology::Model::Search::Epitope Mojo::Base Mojo::Pg

9.9 AUTHOR

LANL T-6 HIV Databases <mailto:immuno@lanl.gov>

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10

Immunology::Model::Search::Epitope - Retrieve an epitope from the database

10.1 SYNOPSIS

```
use Immunology::Model::Search::Epitope;
my $epitopes = $ids->map(
    sub{
        Immunology::Model::Search::Epitope
            ->new($self)
            ->id($_)
            ->get_epitope;
    }
);
```

10.2 DESCRIPTION

Retrieves the database record for table and id .

10.3 ATTRIBUTES

id

The database ID of the epitope record. Required.

patient_search

Immunology::Model::Patient object to retrieve patient data.

params, pg_immuno, table, log

Inherited from *Immunology::Model* .

10.4 PUBLIC METHODS

get_epitope

Return a *Mojo::Collection* object representing the database record specified by `table` and `id` . The returned object is empty if no matching record is found.

10.5 INTERNAL METHODS

Internal methods are an implementation detail and are subject to change without notice. Please notify the author if you wish to use these as public methods.

_get_core_record (\$self)

Return the core epitope record from the base table and simple lookup tables.

_get_ab_cites (\$self)

Return the list of citations for the record. Antibody only.

_get_ab_in_catnap (\$self)

Return a boolean whether the record is in Catnap. Antibody only.

_get_ab_in_feature_db (\$self)

Return a boolean whether the record is in the Antibody Feature database. Antibody only.

_get_ab_keywords (\$self)

Return the list of keywords for the record. Antibody only.

_get_ab_note_keywords (\$self, \$note_no)

Return the list of keywords for the note specified by `$note_no` . Antibody only.

_get_ab_notes (\$self)

Return the list of notes with keywords for the record. Antibody only.

_get_authors (\$self, \$cite)

Return the list of authors for the citation specified by `$cite` .

_get_binding_types (\$self)

Return the list of binding types for the record. Ab only.

_get_cite_count (\$self)

Return the total number of citations for the record.

_get_cites (\$self)

Return the list of citations for the record.

_get_countries (\$self)

Return the list of countries for the record.

_get_hlas (\$self)

Return the list of HLAs for the record. T-cell only.

_get_immunogens (\$self)

Return the list of immunogens for the record.

_get_isotypes (\$self)

Return the list of isotypes for the record. Antibody only.

_get_note_count (\$self)

Return the total number of notes for the record.

_get_notes (\$self)

Return the list of notes for the record. T-cell only.

_get_outcomes (\$self)

Return the list of outcomes measured for the record.

_get_species (\$self)

Return the list of subtypes for the record.

_get_subtypes (\$self)

Return the list of subtypes for the record.

_get_tcell_keywords (\$self)

Return the list of keywords for the record. Antibody only.

_get_vac_adjuvants (\$self)

Return the list of vaccine adjuvants for the record.

_get_vac_components (\$self)

Return the list of vaccine components for the record.

_get_vac_strains (\$self)

Return the list of vaccine strains for the record.

_get_vac_types (\$self)

Return the list of vaccine types for the record.

_get_variant_mutations (\$self, \$variant_id)

Return the list of variant mutations for the variant identified by \$variant_id . T-cell only.

_get_variants (\$self)

Return the list of epitope variants for the record. T-cell only.

10.6 *DIAGNOSTICS*

id is required

Fatal error if id is not defined.

Invalid table

Fatal error if a method is called on an incorrect table .

10.7 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

10.8 *SEE ALSO*

Immunology::Model *Immunology::Model::Search* *Mojo::Base*
Mojo::Collection *Mojo::Pg*

10.9 *AUTHOR*

LANL T-6 HIV Databases *mailto:immuno@lanl.gov*

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11

Immunology::Model::Patient::List - Retrieve lists for the patient search pull-down menus.

11.1 SYNOPSIS

```
$app->helper(  
  model_patient_lists => sub ($c) {  
    Immunology::Model::Patient::List->new(  
      pg_immuno => $app->pg_immuno,  
      log => $log  
    );  
  }  
);  
my $results = model_patient_lists->patient_hla_id_list->select_field_list;
```

11.2 DESCRIPTION

This class has methods to retrieve the lists to populate the pull-down menus for the patient search.

11.3 ATTRIBUTES

pg_immuno, table, log

Inherited from *Immunology::Model* .

11.4 METHODS

All methods return a *Mojo::Pg::Results* object with the *Mojo::Pg::Results::Role::Util* rôle.

patient_ethnicity_list

Returns the list of patient ethnicities.

patient_hla_id_list

Returns the list of HLA ids and names for the patient table.

patient_infection_country_list

Returns the list of country codes and names for the patient table.

patient_infection_year_list

Returns the list of infection years for the patient table.

patient_progression_list

Returns the list of progression codes and and names for the patient table.

patient_risk_factor_list

Returns the list of risk_factor codes and and names for the patient table.

patient_sex_list

Returns the list of patient sexes.

patient_species_list

Returns the list of patient species.

11.5 *BUGS AND LIMITATIONS*

There are no known bugs in this module. Please report problems to the author at <immuno@lanl.gov>

11.6 *SEE ALSO*

Immunology::Model , *Mojo::Base* , *Mojo::Pg* , *Mojo::Pg::Results::Role::Util*

11.7 *AUTHOR*

LANL T-6 HIV Databases <immuno@lanl.gov>

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12

Immunology::Model::Patient::Search - Search the HIV immunology database patient table.

12.1 SYNOPSIS

```
$app->helper(  
  patient_search => sub ($c) {  
    Immunology::Model::Patient::Search->new(  
      pg_immuno => $app->pg_immuno,  
      log => $log  
    );  
  }  
);  
  
my $search = $c->app->patient_search;  
my $v = $c->validation;  
$search->params( $v)->validate;  
my $patients => $search->find_patients;
```

12.2 DESCRIPTION

Search the HIV immunology database patient table. Validate the search parameters and return the list of matching epitopes.

12.3 ATTRIBUTES

params

A *Mojolicious::Validator::Validation* object to hold the input and validated search parameters.

pg_immuno, table, log

Inherited from *Immunology::Model* .

12.4 PUBLIC METHODS

validate (\$self)

Validates input parameters via *Mojolicious::Validator::Validation* . Validated parameters are stored in `$self->params->output` .

find_patients (\$self)

Searches the immunology database using the validated parameters. Returns the list of matching patients as a *Mojo::Collection* ; returns undef if no matching patients are found.

get_patient_detail (\$self, \$id)

Returns a hashref with the patient details for the given patient id.

get_patient_alias (\$self, \$pid)

Return the list of aliases for the patient identified by `$pid` .

get_patient_hla (\$self, \$pid)

Return the list of HLAs for the patient identified by `$pid` .

get_epitope_patients (\$self, \$id)

Return the list of patient details for the epitope record specified by `$self->table` and `$id` .

12.5 INTERNAL METHODS

Internal methods are an implementation detail and are subject to change without notice. Please notify the author if you wish to use these as public methods.

_find_patient_ids (\$self)

Returns the list of patient ids matching the search terms.

_wheres (\$self)

Returns a list of SQL WHERE clauses to select patients according to the search parameters.

_ethnicity_where (\$self)

Returns a SQL WHERE clause to match by the ethnicity > parameter.

_infection_country_where (\$self)

Returns a SQL WHERE clause to match by the infection_country parameter.

_infection_year_where (\$self)

Returns a SQL WHERE clause to match by the infection_yearly parameter.

_patient_code_where (\$self)

Returns a SQL WHERE clause to match by the patient_code and <patient_code_exact> parameters.

_patient_hla_where (\$self)

Returns a SQL WHERE clause to match by the patient_hla_id parameter.

_patient_id_where (\$self)

Returns a SQL WHERE clause to match by the id parameter.

_patient_sex_where (\$self)

Returns a SQL WHERE clause to match by the patient_sex parameter.

_progression_where (\$self)

Returns a SQL WHERE clause to match by the progression parameter.

_risk_factor_where (\$self)

Returns a SQL WHERE clause to match by the risk_factor parameter.

_species_where (\$self)

Returns a SQL WHERE clause to match by the species parameter.

_get_patient_epitopes (\$self, \$table, \$id)

Return the epitope record IDs for \$table and patient ID \$id .

_get_patient_ab_epitopes (\$self, \$table, \$id)

Return the antibody epitope record IDs and mAb names for \$table and patient ID \$id .

12.6 BUGS AND LIMITATIONS

There are no known bugs in this module. Please report problems to the author at <immuno@lanl.gov>

12.7 SEE ALSO

Immunology::Model

Mojo::Base , Mojo::Collection , Mojo::Pg

12.8 AUTHOR

LANL T-6 HIV Databases <immuno@lanl.gov>

12.9 LICENSE AND COPYRIGHT

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13

Immunology::Plugin::MenuHelpers - Immunology menu helper plugin

13.1 SYNOPSIS

```
# Mojolicious
$app->plugin('Immunology::Plugin::MenuHelpers');

# Mojolicious::Lite
plugin 'Immunology::Plugin::MenuHelpers';
```

13.2 DESCRIPTION

Immunology::Plugin::MenuHelpers is a collection of plugins for the the navigation menus of the immunology Mojolicious app.

13.3 HELPERS

Immunology::Plugin::MenuHelpers implements the following helpers.

immuno_top_menu

```
my $menu = $c->menu->immuno_top_menu
```

Data structure for the top navigation menu.

13.4 METHODS

Immunology::Plugin::MenuHelpers inherits all methods from *Mojolicious::Plugin* and implements the following new ones.

register

```
$plugin->register(Mojolicious->new);
```

Register helpers in *Mojolicious* application.

13.5 *SEE ALSO*

Mojolicious , *Mojolicious::Plugin*

13.6 *AUTHOR*

LANL T-6 HIV Databases *mailto:immuno@lanl.gov*

13.7 *LICENSE AND COPYRIGHT*

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14

Immunology::Plugin::ModelHelpers - Immunology model helper plugin

14.1 SYNOPSIS

```
# Mojolicious
$app->plugin('Immunology::Plugin::ModelHelpers');

# Mojolicious::Lite
plugin 'Immunology::Plugin::ModelHelpers';
```

14.2 DESCRIPTION

Immunology::Plugin::ModelHelpers registers helpers to access the model objects.

14.3 HELPERS

Immunology::Plugin::ModelHelpers implements the following helpers.

model

An *Immunology::Model* object.

model_lists

An *Immunology::Model::List* object.

model_patient_lists

An *Immunology::Model::Patient::List* object.

patient_search

An *Immunology::Model::Patient::Search* object.

search

An *Immunology::Model::Search* object.

14.4 METHODS

Immunology::Plugin::ModelHelpers inherits all methods from *Mojolicious::Plugin* and implements the following new ones.

register

```
$plugin->register(Mojolicious->new);
```

Register helpers in *Mojolicious* application.

14.5 SEE ALSO

Mojolicious , *Mojolicious::Plugin*

Immunology::Model , *Immunology::Model::List* *Immunology::Model::Search* *Immunology::Model::Patient::List* *Immunology::Model::Patient::Search*

14.6 AUTHOR

LANL T-6 HIV Databases <immuno@lanl.gov>

14.7 LICENSE AND COPYRIGHT

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15

Immunology::Plugin::OpenAPI - Immunology OpenAPI setup plugin

15.1 SYNOPSIS

```
# Mojolicious
$app->plugin('Immunology::Plugin::OpenAPI');

# Mojolicious::Lite
plugin 'Immunology::Plugin::OpenAPI';
```

15.2 DESCRIPTION

Immunology::Plugin::OpenAPI is a *Mojolicious* plugin to set up the OpenAPI routes.

15.3 METHODS

Immunology::Plugin::OpenAPI inherits all methods from *Mojolicious::Plugin* and implements the following new ones.

register

```
$plugin->register(Mojolicious->new);
```

Register plugin in *Mojolicious* application.

15.4 SEE ALSO

Mojolicious , *Mojolicious::Plugin*

15.5 *AUTHOR*

LANL T-6 HIV Databases *mailto:immuno@lanl.gov*

15.6 *LICENSE AND COPYRIGHT*

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16

Immunology::Plugin::ViewHelpers - *Immunology view helpers plugin*

16.1 SYNOPSIS

```
# Mojolicious
$app->plugin('Immunology::Plugin::ViewHelpers');

# Mojolicious::Lite
plugin 'Immunology::Plugin::ViewHelpers';
```

16.2 DESCRIPTION

Immunology::Plugin::ViewHelpers is a collection of plugins for the view of the immunology Mojolicious app.

16.3 HELPERS

Immunology::Plugin::MenuHelpers implements the following helpers.

is_ab_table

```
my $bool = $c->is_ab_table
```

Check if the current table is an antibody table.

is_tcell_table

```
my $bool = $c->is_tcell_table
```

Check if the current table is a T-cell table.

view.format_ab_keyword

```
$c->view->format_ab_keyword( $epitope)
```

Format the keywords for an antibody record.

view.format_ab_note

```
$c->view->format_ab_note( $epitope, $note)
```

Format a note for an antibody record.

view.format_ab_species

```
$c->view->format_ab_species( $epitope)
```

Format the species and isotypes for an antibody record.

view.format_binding_type

```
$c->view->format_binding_type( $epitope)
```

Format the binding type for an antibody record.

view.format_cite

```
$c->view->format_cite( $epitope, $cite)
```

Format a citation for web display.

view.format_country

```
$c->view->format_country( $epitope)
```

Format the country list.

view.format_epitope_links

```
$c->view->format_epitope_links ( $table, $ids)
```

Format links to the epitopes in table C{\$table} with IDs \$ids .

view.format_ab_epitope_links

```
$c->view->format_epitope_ab_links ( $table, $epitopes)
```

Format links to the antibody epitopes in table C{\$table} described by \$epitopes .

view.format_hxb2_loc

```
$c->view->format_hxb2loc( $epitope)
```

Format the HXB2 protein and DNA locations.

view.format_immunogen

```
$c->view->format_hxb2loc( $epitope)
```

Format the immunogen list.

view.format_mab_name

```
$c->view->format_mab_name( $epitope)
```

Format the mAb name and aliases.

view.format_orig_loc

```
$c->view->format_orig_loc( $epitope)
```

Format the authors' (original) location.

view.format_outcome

```
$c->view->format_outcome( $epitope)
```

Format the experimental outcomes.

view.format_patient_hla

```
$c->view->format_patient_hla( $epitope)
```

Format the patients' codes and HLAs.

view.format_subtype

```
$c->view->format_subtype( $epitope)
```

Format the subtype list.

view.format_tcell_keyword

```
$c->view->format_tcell_keyword( $epitope)
```

Format the keywords for a T-cell record.

view.format_tcell_note

```
$c->view->format_tcell_note( $epitope, $note)
```

Format a note for a T-cell records.

view.format_tcell_species

```
$c->view->format_tcell_species( $epitope)
```

Format the species and HLA/MHC for a T-cell record.

view.format_vaccine_adjuvant

```
$c->view->format_vaccine_adjuvant( $epitope)
```

Format the vaccine adjuvant list.

view.format_vaccine_component

```
$c->view->format_vaccine_component( $epitope)
```

Format the vaccine component list.

view.format_vaccine_strain

```
$c->view->format_vaccine_strain( $epitope)
```

Format the vaccine strain list.

view.format_vaccine_type

```
$c->view->format_vaccine_type( $epitope)
```

Format the vaccine type list.

view.external_url

```
$c->view->external_url
```

Returns the base URL for the main HIV web site. Smart about the reverse proxy.

view.link_ab_by_name

```
$c->view->link_ab_by_name
```

Create a link to the Ab by name index

view.link_ab_by_type

```
$c->view->link_ab_by_type
```

Create a link to the Ab by type index

view.link_catnap

```
$c->view->link_catnap( $epitope)
```

Create a link to catnap for the epitope.

view.link_epilign

```
$c->view->link_epilign( $epitope)
```

Create a link to the epitope alignment.

view.link_epitope

```
$c->view->link_epitope( $table, $id)
```

Create a link to the epitope \$id in table \$table .

view.link_epitope_json

```
$c->view->link_epitope_json( $epitope)
```

Create a link to the epitope JSON representation..

view.link_epitope_logo

```
$c->view->link_epitope_logo( $epitope)
```

Create a link to the epitope WebLogo.

view.link_epitope_map

```
$c->view->link_epitope_map( $epitope)
```

Create a link to the epitope map.

view.link_feature_db

```
$c->view->link_feature_db( $epitope)
```

Create a link to the feature database for the epitope.

view.link_patient

```
$c->view->link_patient( $patient)
```

Create a link to the patient details.

view.link_seq_db

```
$c->view->link_seq_db( $epitope)
```

Create a link to the sequence database for the epitope's accession number, it known.

view.link_seq_db_patient

```
$c->view->link_seq_db_patient( $patient)
```

Create a link to the patient details in the sequence database.

view.link_variant_by_epitope

```
$c->view->link_variant_by_epitope( $epitope)
```

Create link to the epitope's variant details.

view.link_variant_by_variant

```
$c->view->link_variant_by_variant( $variant)
```

Create link to the variant's details.

16.4 METHODS

Immunology::Plugin::ViewHelpers inherits all methods from *Mojolicious::Plugin* and implements the following new ones.

register

```
$plugin->register(Mojolicious->new);
```

Register helpers in *Mojolicious* application.

16.5 SEE ALSO

Mojolicious , *Mojolicious::Plugin*

16.6 AUTHOR

LANL T-6 HIV Databases <mailto:immuno@lanl.gov>

16.7 LICENSE AND COPYRIGHT

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17

Mojo::Pg::Results::Role::Util - Utility methods to extend Mojo::Pg::Results

17.1 SYNOPSIS

```
my $pg = Mojo::Pg->new;  
my $results = $pg->db->query( $sql)->with_roles('+Util');
```

17.2 DESCRIPTION

Utility methods to extend *Mojo::Pg::Results*

17.3 PUBLIC METHODS

select_field_list

Restructure the results for a "*select_field*" in *Mojolicious::Plugin::TagHelpers*

17.4 BUGS AND LIMITATIONS

There are no known bugs in this module. Please report problems to the author at <mailto:immuno@lanl.gov>

17.5 SEE ALSO

"*Mojo::Base Mojo::Collection*" *Mojolicious::Plugin::TagHelpers*
Mojo::Pg::Results Role::Tiny

17.6 AUTHOR

LANL T-6 HIV Databases <mailto:immuno@lanl.gov>

17.7 LICENSE AND COPYRIGHT

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openapi.json

```
1 {  
  "components": {  
    "schemas": {  
      "AbTable": {  
        "description": "The main immunology tables for antibodies",  
        "enum": [  
          "ab"  
        ],  
        "type": "string"  
      },  
11  "AuthorRecord": {  
    "description": "Record describing an author",  
    "properties": {  
      "abbrev": {  
        "type": "string"  
      },  
      "author_no": {  
        "minimum": 0,  
        "type": "integer"  
      },  
21  "given_name": {  
    "nullable": true,  
    "type": "string"  
  },  
  "junior": {  
    "nullable": true,  
    "type": "string"  
  },  
  "surname": {  
    "type": "string"
```

```
31     },
    "von": {
      "nullable": true,
      "type": "string"
    }
  },
  "required": [
    "abbrev",
    "author_no",
    "surname"
41  ],
  "type": "object"
},
"BindingTypeRecord": {
  "properties": {
    "binding_type": {
      "type": "string"
    },
    "binding_type_id": {
51     "$ref": "#/components/schemas/IdType"
    }
  },
  "required": [
    "binding_type_id",
    "binding_type"
  ],
  "type": "object"
},
"CiteRecord": {
  "description": "Record describing a bibliographic reference. Based on BibTeX",
61  "properties": {
    "authors": {
      "items": {
        "$ref": "#/components/schemas/AuthorRecord"
      },
      "type": "array"
    },
    "bibtype": {
      "type": "string"
    },
71  "bibtype_id": {
    "$ref": "#/components/schemas/IdType"
  },
  "booktitle": {
```

```
      "nullable": true,  
      "type": "string"  
    },  
    "chapter": {  
      "nullable": true,  
      "type": "string"  
    },  
    "cite": {  
      "type": "string"  
    },  
    "cite_no": {  
      "description": "Ab only",  
      "minimum": 0,  
      "nullable": true,  
      "type": "integer"  
    },  
    "doi": {  
      "nullable": true,  
      "type": "string"  
    },  
    "edition": {  
      "nullable": true,  
      "type": "string"  
    },  
    "editor": {  
      "nullable": true,  
      "type": "string"  
    },  
    "howpublished": {  
      "nullable": true,  
      "type": "string"  
    },  
    "html": {  
      "type": "string"  
    },  
    "isbn": {  
      "nullable": true,  
      "type": "string"  
    },  
    "isolation_ref": {  
      "description": "Ab only",  
      "nullable": true,  
      "type": "boolean"  
    },  
  },
```

```
121     "issn": {
        "nullable": true,
        "type": "string"
    },
    "journal": {
        "nullable": true,
        "type": "string"
    },
    "modifydate": {
        "$ref": "#/components/schemas/TimeStamp"
    },
    "month": {
131     "nullable": true,
        "type": "string"
    },
    "number": {
        "nullable": true,
        "type": "string"
    },
    "pages": {
141     "nullable": true,
        "type": "string"
    },
    "publisher": {
        "nullable": true,
        "type": "string"
    },
    "pubmed_id": {
        "maximum": 999999999,
        "minimum": 1,
        "nullable": true,
        "type": "integer"
151     },
    "title": {
        "nullable": true,
        "type": "string"
    },
    "volume": {
        "nullable": true,
        "type": "string"
    },
    "year": {
161     "maximum": 2100,
        "minimum": 1950,
```

```

        "nullable": true,
        "type": "integer"
    }
},
"required": [
    "authors",
    "bibtype",
    "bibtype_id",
171    "cite",
    "html",
    "modifydate"
],
"type": "object"
},
"CountryRecord": {
    "properties": {
        "code": {
181    "description": "2 character ISO country code",
        "maxLength": 2,
        "minLength": 2,
        "type": "string"
    },
        "name": {
            "description": "Country name",
            "type": "string"
        }
    },
    "required": [
191    "code",
    "name"
],
    "type": "object"
},
"EpitopeRecord": {
    "description": "Database record describin an epitope",
    "properties": {
        "accession": {
201    "nullable": true,
        "type": "string"
    },
        "alt_names": {
            "description": "Ab only",
            "nullable": true,
            "type": "string"
        }
    }
}

```

```
    },  
    "binding_type": {  
      "description": "Ab only",  
      "items": {  
211         "$ref": "#/components/schemas/BindingTypeRecord"  
      },  
      "type": "array"  
    },  
    "cite": {  
      "items": {  
        "$ref": "#/components/schemas/CiteRecord"  
      },  
      "type": "array"  
    },  
    "country": {  
221     "items": {  
        "$ref": "#/components/schemas/CountryRecord"  
      },  
      "type": "array"  
    },  
    "dis": {  
      "description": "Ab only",  
      "nullable": true,  
      "type": "boolean"  
231    },  
    "disrange": {  
      "description": "Ab only",  
      "nullable": true,  
      "type": "string"  
    },  
    "donor": {  
      "description": "Ab only",  
      "nullable": true,  
      "type": "string"  
241    },  
    "epitope": {  
      "nullable": true,  
      "type": "string"  
    },  
    "epitope_name": {  
      "nullable": true,  
      "type": "string"  
    },  
    "hla": {
```

```
251     "description": "T cell only",
      "items": {
        "$ref": "#/components/schemas/HLARecord"
      },
      "type": "array"
    },
    "hxb2_contig": {
      "nullable": true,
      "type": "string"
    },
261    "hxb2loc2end": {
      "description": "Ab only",
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "hxb2loc2start": {
      "description": "Ab only",
      "minimum": 1,
      "nullable": true,
271     "type": "integer"
    },
    "hxb2locend": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "hxb2locstart": {
      "minimum": 1,
      "nullable": true,
281     "type": "integer"
    },
    "hxb2protein": {
      "type": "string"
    },
    "hxb2protein_id": {
      "$ref": "#/components/schemas/IdType"
    },
    "id": {
      "$ref": "#/components/schemas/IdType"
291   },
  "immunogen": {
    "items": {
      "$ref": "#/components/schemas/ImmunogenRecord"
```

```
    },  
    "type": "array"  
  },  
  "in_catnap": {  
    "description": "Ab only",  
    "nullable": true,  
301    "type": "boolean"  
  },  
  "in_feature_db": {  
    "description": "Ab only",  
    "nullable": true,  
    "type": "boolean"  
  },  
  "is_adcc": {  
    "description": "Ab only",  
    "nullable": true,  
311    "type": "boolean"  
  },  
  "isotype": {  
    "description": "Ab only",  
    "items": {  
      "$ref": "#/components/schemas/IsotypeRecord"  
    },  
    "type": "array"  
  },  
  "keyword": {  
321    "items": {  
      "$ref": "#/components/schemas/KeywordRecord"  
    },  
    "type": "array"  
  },  
  "mab_name": {  
    "description": "Ab only",  
    "nullable": true,  
    "type": "string"  
  },  
331  "modifydate": {  
    "$ref": "#/components/schemas/TimeStamp"  
  },  
  "neutralizing": {  
    "description": "Ab only",  
    "nullable": true,  
    "type": "string"  
  },  
}
```



```
341 "note": {
    "items": {
        "$ref": "#/components/schemas/NoteRecord"
    },
    "type": "array"
},
"origlocend": {
    "minimum": 1,
    "nullable": true,
    "type": "integer"
},
351 "origlocstart": {
    "minimum": 1,
    "nullable": true,
    "type": "integer"
},
"origprotein": {
    "nullable": true,
    "type": "string"
},
"origprotein_id": {
    "$ref": "#/components/schemas/IdType"
361 },
"outcome": {
    "items": {
        "$ref": "#/components/schemas/OutcomeRecord"
    },
    "type": "array"
},
"patient": {
    "items": {
        "$ref": "#/components/schemas/PatientRecord"
371 },
    "type": "array"
},
"sp2_end": {
    "nullable": true,
    "type": "string"
},
"sp2_end_id": {
    "minimum": 1,
    "nullable": true,
381 "type": "integer"
},
```

```
    "sp2_loc_end": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "sp2_loc_start": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "sp2_start": {
      "nullable": true,
      "type": "string"
    },
    "sp2_start_id": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "sp_end": {
      "nullable": true,
      "type": "string"
    },
    "sp_end_id": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "sp_loc_end": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "sp_loc_start": {
      "minimum": 1,
      "nullable": true,
      "type": "integer"
    },
    "sp_start": {
      "nullable": true,
      "type": "string"
    },
    "sp_start_id": {
      "minimum": 1,
```

```
    "nullable": true,
    "type": "integer"
  },
  "species": {
431   "items": {
      "$ref": "#/components/schemas/SpeciesRecord"
    },
    "type": "array"
  },
  "strain": {
    "nullable": true,
    "type": "string"
  },
  "subprotein": {
441   "description": "Ab only",
    "nullable": true,
    "type": "string"
  },
  "subprotein_id": {
    "$ref": "#/components/schemas/IdType",
    "description": "Ab only"
  },
  "subtypes": {
451   "items": {
      "$ref": "#/components/schemas/SubtypeRecord"
    },
    "type": "array"
  },
  "table": {
    "$ref": "#/components/schemas/Table"
  },
  "total_cite_count": {
461   "description": "Ab only",
    "minimum": 1,
    "nullable": true,
    "type": "integer"
  },
  "total_note_count": {
    "description": "Ab only",
    "minimum": 0,
    "nullable": true,
    "type": "integer"
  },
  "variants": {
```

```
471     "items": {
        "$ref": "#/components/schemas/VariantRecord"
    },
    "type": "array"
}
},
"required": [
    "cite",
    "country",
    "id",
481    "immunogen",
    "keyword",
    "note",
    "species",
    "subtype",
    "table"
],
"type": "object"
},
"EpitopeResponse": {
491    "properties": {
        "epitopes": {
            "description": "List of matching epitope records",
            "items": {
                "$ref": "#/components/schemas/EpitopeRecord"
            },
            "type": "array"
        },
        "error": {
            "description": "Error messages",
501            "items": {
                "type": "string"
            },
            "type": "array"
        },
        "params": {
            "description": "Valid input parameters",
            "type": "object"
        },
        "timestamp": {
511            "$ref": "#/components/schemas/TimeStamp"
        }
    },
    "required": [
```

```

        "epitopes",
        "params",
        "timestamp"
    ],
    "type": "object"
},
521 "HLARecord": {
    "properties": {
        "hla": {
            "type": "string"
        },
        "hla_id": {
            "$ref": "#/components/schemas/IdType"
        }
    },
    "required": [
531     "hla_id",
        "hla"
    ],
    "type": "object"
},
"IdType": {
    "minimum": 1,
    "type": "integer"
},
541 "ImmunogenRecord": {
    "properties": {
        "immunogen": {
            "type": "string"
        },
        "immunogen_id": {
            "$ref": "#/components/schemas/IdType"
        }
    },
    "required": [
551     "immunogen_id",
        "immunogen"
    ],
    "type": "object"
},
"IsotypeRecord": {
    "properties": {
        "isotype": {
            "type": "string"
        }
    }
}

```

```
    },
    "isotype_id": {
561       "$ref": "#/components/schemas/IdType"
    }
  },
  "required": [
    "isotype_id",
    "isotype"
  ],
  "type": "object"
},
"KeywordRecord": {
571   "properties": {
    "keyword": {
      "type": "string"
    },
    "keyword_id": {
      "$ref": "#/components/schemas/IdType"
    }
  },
  "required": [
581     "keyword_id",
    "keyword"
  ],
  "type": "object"
},
"NoteRecord": {
  "description": "Record describing a note",
  "properties": {
    "cite": {
591       "description": "Ab only",
      "items": {
        "type": "string"
      },
      "type": "array"
    },
    "keyword": {
      "description": "Ab only",
      "items": {
601         "$ref": "#/components/schemas/KeywordRecord"
      },
      "type": "array"
    },
    "note": {
```

```
        "type": "string"
      },
      "note_no": {
        "minimum": 0,
        "type": "integer"
      }
    },
    "required": [
      "note",
      "note_no"
    ],
    "type": "object"
  },
  "OutcomeRecord": {
    "properties": {
      "outcome": {
        "type": "string"
      },
      "outcome_id": {
        "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "outcome_id",
      "outcome"
    ],
    "type": "object"
  },
  "PatientEthnicityRecord": {
    "type": "string"
  },
  "PatientHLARecord": {
    "properties": {
      "hla": {
        "type": "string"
      },
      "hla_id": {
        "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "hla_id",
      "hla"
    ],

```

```

        "type": "object"
    },
    "PatientInfectionCountryRecord": {
        "properties": {
            "code": {
                "description": "2 character ISO country code",
                "maxLength": 2,
                "minLength": 2,
                "type": "string"
            },
            "name": {
                "description": "Country name",
                "type": "string"
            }
        },
        "required": [
            "code",
            "name"
        ],
        "type": "object"
    },
    "PatientInfectionYearRecord": {
        "type": "integer"
    },
    "PatientProgressionRecord": {
        "properties": {
            "progression_code": {
                "description": "HIV progression code",
                "maxLength": 6,
                "minLength": 1,
                "type": "string"
            },
            "progression_name": {
                "description": "HIV progression name",
                "type": "string"
            }
        },
        "required": [
            "progression_code",
            "progression_name"
        ],
        "type": "object"
    },
    "PatientRecord": {

```



```
691 "description": "Record describing a patient",
"properties": {
  "ab_epitopes": {
    "description": "Ab IDs and names",
    "items": {
      "properties": {
        "id": {
          "$ref": "#/components/schemas/IdType"
        },
        "mab_name": {
701 "type": "string"
        }
      },
      "type": "object"
    },
    "type": "array"
  },
  "aliases": {
    "items": {
      "type": "string"
711 },
    "type": "array"
  },
  "code": {
    "nullable": true,
    "type": "string"
  },
  "ctl_ids": {
    "description": "CD8/CTL IDs",
    "items": {
721 "$ref": "#/components/schemas/IdType"
    },
    "type": "array"
  },
  "ethnicity": {
    "nullable": true,
    "type": "string"
  },
  "helper_ids": {
    "description": "CD4/T-helper IDs",
731 "items": {
      "$ref": "#/components/schemas/IdType"
    },
    "type": "array"
  }
}
```

```
    },  
    "hla": {  
      "items": {  
        "type": "string"  
      },  
      "type": "array"  
    },  
741  },  
    "infection_city": {  
      "nullable": true,  
      "type": "string"  
    },  
    "infection_country": {  
      "maxLength": 2,  
      "minLength": 2,  
      "nullable": true,  
      "type": "string"  
    },  
751  },  
    "infection_country_name": {  
      "nullable": true,  
      "type": "string"  
    },  
    "infection_year": {  
      "maximum": 2100,  
      "minimum": 1967,  
      "nullable": true,  
      "type": "integer"  
    },  
761  },  
    "infection_year_upper": {  
      "maximum": 2100,  
      "minimum": 1967,  
      "nullable": true,  
      "type": "integer"  
    },  
    "note": {  
      "nullable": true,  
      "type": "string"  
    },  
771  },  
    "patient_id": {  
      "$ref": "#/components/schemas/IdType"  
    },  
    "progression_code": {  
      "nullable": true,  
      "type": "string"  
    },  
  },  
},
```

```
781     "progression_name": {
        "nullable": true,
        "type": "string"
    },
    "risk_factor_code": {
        "nullable": true,
        "type": "string"
    },
    "risk_factor_name": {
        "nullable": true,
        "type": "string"
    },
791     "seqdb_pat_id": {
        "minimum": 1,
        "nullable": true,
        "type": "integer"
    },
    "sex": {
        "nullable": true,
        "type": "string"
    },
    "species": {
801     "nullable": true,
        "type": "string"
    },
    "species_id": {
        "minimum": 1,
        "nullable": true,
        "type": "integer"
    }
},
"required": [
811     "patient_id"
],
"type": "object"
},
"PatientResponse": {
    "properties": {
        "error": {
            "description": "Error messages",
            "items": {
                "type": "string"
            },
821     },
        "type": "array"
```

```

    },
    "params": {
      "description": "Valid input parameters",
      "type": "object"
    },
    "patients": {
      "description": "List of matching patient records",
      "items": {
831       "$ref": "#/components/schemas/PatientRecord"
      },
      "type": "array"
    },
    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
    }
  },
  "required": [
841   "patients",
   "params",
   "timestamp"
  ],
  "type": "object"
},
"PatientRiskFactorRecord": {
  "properties": {
    "progresssion_name": {
      "description": "HIV risk_factor name",
      "type": "string"
851    },
    "risk_factor_code": {
      "description": "HIV risk_factor code",
      "maxLength": 6,
      "minLength": 1,
      "type": "string"
    }
  },
  "required": [
861   "risk_factor_code",
   "risk_factor_name"
  ],
  "type": "object"
},
"PatientSexRecord": {
  "maxLength": 9,

```

```
    "minLength": 1,
    "type": "string"
  },
  "PatientSpeciesRecord": {
871    "properties": {
      "species": {
        "type": "string"
      },
      "species_id": {
        "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
881      "species_id",
      "species"
    ],
    "type": "object"
  },
  "ProteinRecord": {
    "properties": {
      "protein": {
        "type": "string"
      },
      "protein_id": {
891      "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "protein_id",
      "protein"
    ],
    "type": "object"
  },
  "SpeciesRecord": {
901    "properties": {
      "species": {
        "type": "string"
      },
      "species_id": {
        "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "species_id",
```

```

911     "species"
    ],
    "type": "object"
  },
  "SubtypeRecord": {
    "properties": {
      "subtype": {
        "type": "string"
      },
      "subtype_id": {
921       "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "subtype_id",
      "subtype"
    ],
    "type": "object"
  },
  "TCellTable": {
931   "description": "The main immunology tables for T-cell epitopes",
   "enum": [
     "ctl",
     "helper"
   ],
   "type": "string"
  },
  "Table": {
941   "description": "The main immunology tables",
   "enum": [
     "ab",
     "ctl",
     "helper"
   ],
   "type": "string"
  },
  "TimeStamp": {
    "description": "When the results were generated",
    "format": "date-time",
    "type": "string"
951  },
  "VaccineAdjuvantRecord": {
    "properties": {
      "vaccine_adjuvant": {

```

```
        "type": "string"
      },
      "vaccine_adjuvant_id": {
        "$ref": "#/components/schemas/IdType"
      }
    ],
    "required": [
      "vaccine_adjuvant_id",
      "vaccine_adjuvant"
    ],
    "type": "object"
  },
  "VaccineComponentRecord": {
    "properties": {
      "vaccine_component": {
        "type": "string"
      },
      "vaccine_component_id": {
        "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "vaccine_component_id",
      "vaccine_component"
    ],
    "type": "object"
  },
  "VaccineStrainRecord": {
    "properties": {
      "vaccine_strain": {
        "type": "string"
      },
      "vaccine_strain_id": {
        "$ref": "#/components/schemas/IdType"
      }
    },
    "required": [
      "vaccine_strain_id",
      "vaccine_strain"
    ],
    "type": "object"
  },
  "VaccineTypeRecord": {
    "properties": {
```

```
    "vaccine_type": {
      "type": "string"
    },
1001  },
    "vaccine_type_id": {
      "$ref": "#/components/schemas/IdType"
    }
  },
  "required": [
    "vaccine_type_id",
    "vaccine_type"
  ],
  "type": "object"
1011 },
  "VariantRecord": {
    "description": "Record describing an epitope variant",
    "properties": {
      "epitope": {
        "type": "string"
      },
      "epitope_subtypes": {
        "items": {
          "type": "string"
1021        },
        "nullable": true,
        "type": "array"
      },
      "methods": {
        "items": {
          "type": "string"
        },
        "nullable": true,
        "type": "array"
1031      },
      "mutation_codes": {
        "items": {
          "type": "string"
        },
        "nullable": true,
        "type": "array"
      },
      "mutation_types": {
        "items": {
1041          "type": "string"
        },
      },
    },
  },
}
```



```
    "nullable": true,
    "type": "array"
  },
  "mutations": {
    "items": {
      "properties": {
        "epitope_position": {
1051     "type": "string"
        },
        "hxb2_position": {
          "type": "string"
        },
        "mutation": {
          "maxLength": 1,
          "minLength": 1,
          "type": "string"
        },
1061     "original": {
          "maxLength": 1,
          "minLength": 1,
          "type": "string"
        }
      },
      "required": [
        "epitope_position",
        "hxb2_position",
        "mutation",
        "original"
1071     ],
      "type": "object"
    },
    "type": "array"
  },
  "note": {
    "nullable": true,
    "type": "string"
  },
  "variant_epitope": {
1081     "type": "string"
  },
  "variant_id": {
    "$ref": "#/components/schemas/IdType"
  },
  "variant_subtypes": {
```

```
        "items": {
          "type": "string"
        },
        "nullable": true,
        "type": "array"
      }
    },
    "required": [
      "epitope",
      "methods",
      "mutation_codes",
      "mutation_types",
      "mutations",
      "variant_epitope",
      "variant_id",
      "variant_subtypes"
    ],
    "type": "object"
  },
  "listBindingTypeResponse": {
    "properties": {
      "binding_type": {
        "items": {
          "$ref": "#/components/schemas/BindingTypeRecord"
        },
        "type": "array"
      },
      "table": {
        "$ref": "#/components/schemas/Table"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "binding_type",
      "table",
      "timestamp"
    ],
    "type": "object"
  },
  "listCountryResponse": {
    "properties": {
      "country": {
```

```
1131     "items": {
        "$ref": "#/components/schemas/CountryRecord"
    },
    "type": "array"
},
"table": {
    "$ref": "#/components/schemas/Table"
},
"timestamp": {
    "$ref": "#/components/schemas/TimeStamp"
1141 }
},
"required": [
    "country",
    "table",
    "timestamp"
],
"type": "object"
},
"listHLAResponse": {
1151     "properties": {
        "hla": {
            "items": {
                "$ref": "#/components/schemas/HLARecord"
            },
            "type": "array"
        },
        "table": {
            "$ref": "#/components/schemas/Table"
        },
1161     "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
    }
    },
    "required": [
        "hla",
        "table",
        "timestamp"
    ],
    "type": "object"
1171 },
"listImmunogenResponse": {
    "properties": {
        "immunogen": {
```

```
        "items": {
          "$ref": "#/components/schemas/ImmunogenRecord"
        },
        "type": "array"
      },
      "table": {
1181     "$ref": "#/components/schemas/Table"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "immunogen",
      "table",
      "timestamp"
1191  ],
    "type": "object"
  },
  "listIsotypeResponse": {
    "properties": {
      "isotype": {
        "items": {
          "$ref": "#/components/schemas/IsotypeRecord"
        },
        "type": "array"
1201     },
      "table": {
        "$ref": "#/components/schemas/Table"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
1211     "isotype",
      "table",
      "timestamp"
    ],
    "type": "object"
  },
  "listKeywordResponse": {
    "properties": {
      "keyword": {
```

```
    "items": {
      "$ref": "#/components/schemas/KeywordRecord"
    },
    "type": "array"
  },
  "table": {
    "$ref": "#/components/schemas/Table"
  },
  "timestamp": {
    "$ref": "#/components/schemas/TimeStamp"
  }
},
"required": [
  "keyword",
  "table",
  "timestamp"
],
"type": "object"
},
"listOutcomeResponse": {
  "properties": {
    "outcome": {
      "items": {
        "$ref": "#/components/schemas/OutcomeRecord"
      },
      "type": "array"
    },
    "table": {
      "$ref": "#/components/schemas/Table"
    },
    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
    }
  },
  "required": [
    "outcome",
    "table",
    "timestamp"
  ],
  "type": "object"
},
"listPatientEthnicityResponse": {
  "properties": {
    "ethnicity": {
```

```
        "items": {
          "$ref": "#/components/schemas/PatientEthnicityRecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "ethnicity",
      "timestamp"
    ],
    "type": "object"
  },
  "listPatientHLAResponse": {
    "properties": {
      "hla": {
        "items": {
          "$ref": "#/components/schemas/PatientHLARecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "hla",
      "timestamp"
    ],
    "type": "object"
  },
  "listPatientInfectionCountryResponse": {
    "properties": {
      "infection_country": {
        "items": {
          "$ref": "#/components/schemas/PatientInfectionCountryRecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    }
  }
}
```

```
    },
    "required": [
      "infection_country",
      "timestamp"
    ],
    "type": "object"
  },
  "listPatientInfectionYearResponse": {
    "properties": {
      "infection_year": {
        "items": {
          "$ref": "#/components/schemas/PatientInfectionYearRecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "infection_year",
      "timestamp"
    ],
    "type": "object"
  },
  "listPatientProgressionResponse": {
    "properties": {
      "progression": {
        "items": {
          "$ref": "#/components/schemas/PatientProgressionRecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "progression",
      "timestamp"
    ],
    "type": "object"
  },
  "listPatientRiskFactorResponse": {
```

```
1351     "properties": {
      "risk_factor": {
        "items": {
          "$ref": "#/components/schemas/PatientRiskFactorRecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
1361  },
  "required": [
    "risk_factor",
    "timestamp"
  ],
  "type": "object"
},
"listPatientSexResponse": {
  "properties": {
    "sex": {
1371     "items": {
          "$ref": "#/components/schemas/PatientSexRecord"
        },
        "type": "array"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
1381     "sex",
    "timestamp"
  ],
  "type": "object"
},
"listPatientSpeciesResponse": {
  "properties": {
    "species": {
      "items": {
1391     "$ref": "#/components/schemas/PatientSpeciesRecord"
      },
      "type": "array"
    },
    "timestamp": {
```



```
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "species",
      "timestamp"
    ],
    "type": "object"
  },
  "listProteinResponse": {
    "properties": {
      "protein": {
        "items": {
          "$ref": "#/components/schemas/ProteinRecord"
        },
        "type": "array"
      },
      "table": {
        "$ref": "#/components/schemas/Table"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    },
    "required": [
      "protein",
      "table",
      "timestamp"
    ],
    "type": "object"
  },
  "listSpeciesResponse": {
    "properties": {
      "species": {
        "items": {
          "$ref": "#/components/schemas/SpeciesRecord"
        },
        "type": "array"
      },
      "table": {
        "$ref": "#/components/schemas/Table"
      },
      "timestamp": {
        "$ref": "#/components/schemas/TimeStamp"
      }
    }
  }
}
```

```
    }
  },
  "required": [
1441     "species",
     "table",
     "timestamp"
  ],
  "type": "object"
},
"listSubtypeResponse": {
  "properties": {
    "subtype": {
1451     "items": {
        "$ref": "#/components/schemas/SubtypeRecord"
      },
      "type": "array"
    },
    "table": {
      "$ref": "#/components/schemas/Table"
    },
    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
1461    }
  },
},
"required": [
  "subtype",
  "table",
  "timestamp"
],
"type": "object"
},
"listVaccineAdjuvantResponse": {
1471  "properties": {
    "table": {
      "$ref": "#/components/schemas/Table"
    },
    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
    },
    "vaccine_adjuvant": {
      "items": {
1481        "$ref": "#/components/schemas/VaccineAdjuvantRecord"
      },
      "type": "array"
    }
  }
}
```

```
    }
  },
  "required": [
    "vaccine_adjuvant",
    "table",
    "timestamp"
  ],
  "type": "object"
},
1491 "listVaccineComponentResponse": {
  "properties": {
    "table": {
      "$ref": "#/components/schemas/Table"
    },
    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
    },
    "vaccine_component": {
1501   "items": {
      "$ref": "#/components/schemas/VaccineComponentRecord"
    },
    "type": "array"
  }
},
  "required": [
    "vaccine_component",
    "table",
    "timestamp"
1511 ],
  "type": "object"
},
"listVaccineStrainResponse": {
  "properties": {
    "table": {
      "$ref": "#/components/schemas/Table"
    },
    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
1521   },
    "vaccine_strain": {
      "items": {
        "$ref": "#/components/schemas/VaccineStrainRecord"
      },
      "type": "array"
    }
  }
}
```

```

    }
  },
  "required": [
    "vaccine_strain",
1531    "table",
    "timestamp"
  ],
  "type": "object"
},
"listVaccineTypeResponse": {
  "properties": {
    "table": {
      "$ref": "#/components/schemas/Table"
    },
1541    "timestamp": {
      "$ref": "#/components/schemas/TimeStamp"
    },
    "vaccine_type": {
      "items": {
        "$ref": "#/components/schemas/VaccineTypeRecord"
      },
      "type": "array"
    }
  }
},
1551 "required": [
  "vaccine_type",
  "table",
  "timestamp"
],
  "type": "object"
}
}
},
1561 "info": {
  "contact": {
    "email": "immuno@lanl.gov",
    "name": "LANL HIV Molecular Immunology Database",
    "url": "https://www.hiv.lanl.gov/content/immunology/index.html"
  },
  "termsOfService": "https://www.lanl.gov/resources/web-policies/copyright-legal.php",
  "title": "HIV Molecular Immunology API",
  "version": "v1.0.2",
  "x-copyright": "Copyright ©- 20202021 Triad National Security, LLC",
  "x-mojoc": "♥ mojolicious"
}

```

```

1571 },
    "openapi": "3.0.3",
    "paths": {
      "/epitope/{table}": {
        "get": {
          "operationId": "getEpitopes",
          "parameters": [
            {
              "description": "Which table to search",
              "in": "path",
1581 "name": "table",
              "required": true,
              "schema": {
                "$ref": "#/components/schemas/Table"
              }
            },
            {
              "description": "Antibody binding type ID",
              "in": "query",
              "name": "binding_type",
1591 "schema": {
                "$ref": "#/components/schemas/IdType"
              }
            },
            {
              "description": "Search for epitopes before this DNA location",
              "in": "query",
              "name": "dna_end",
              "schema": {
                "maximum": 12000,
1601 "minimum": 1,
                "type": "integer"
              }
            },
            {
              "description": "Search for epitopes after this DNA location",
              "in": "query",
              "name": "dna_start",
              "schema": {
                "maximum": 12000,
1611 "minimum": 1,
                "type": "integer"
              }
            }
          ]
        }
      }
    }
  },

```

```
{
  "description": "Search for epitopes before this protein location; requires protein",
  "in": "query",
  "name": "end",
  "schema": {
    "maximum": 1200,
1621    "minimum": 1,
    "type": "integer"
  }
},
{
  "description": "Epitope HLA/MHC ID",
  "in": "query",
  "name": "hla_id",
  "schema": {
    "$ref": "#/components/schemas/IdType"
1631  }
},
{
  "description": "Epitope ID",
  "in": "query",
  "name": "id",
  "schema": {
    "$ref": "#/components/schemas/IdType"
1641  }
},
{
  "description": "Immunogen ID",
  "in": "query",
  "name": "immunogen",
  "schema": {
    "$ref": "#/components/schemas/IdType"
1651  }
},
{
  "description": "Isotype ID",
  "in": "query",
  "name": "isotype",
  "schema": {
    "$ref": "#/components/schemas/IdType"
1661  }
},
{
  "description": "Epitope keyword ID",
```

```
    "in": "query",
    "name": "keyword",
1661   "schema": {
        "$ref": "#/components/schemas/IdType"
    }
},
{
    "description": "Outcome ID",
    "in": "query",
    "name": "outcome",
    "schema": {
1671   "$ref": "#/components/schemas/IdType"
    }
},
{
    "description": "Epitope is from this protein ID",
    "in": "query",
    "name": "protein",
    "schema": {
        "$ref": "#/components/schemas/IdType"
    }
},
1681 {
    "description": "PubMed ID of epitope references",
    "in": "query",
    "name": "pubmed_id",
    "schema": {
        "$ref": "#/components/schemas/IdType"
    }
},
{
1691   "description": "Search for epitopes at this protein location; requires protein",
    "in": "query",
    "name": "spans",
    "schema": {
        "maximum": 1200,
        "minimum": 1,
        "type": "integer"
    }
},
{
1701   "description": "Immune response observed in this species ID",
    "in": "query",
    "name": "species",
```

```
    "schema": {
      "$ref": "#/components/schemas/IdType"
    }
  },
  {
    "description": "Search for epitopes after this protein location; requires protein",
    "in": "query",
    "name": "start",
1711   "schema": {
      "maximum": 1200,
      "minimum": 1,
      "type": "integer"
    }
  },
  {
    "description": "Virus subtype ID",
    "in": "query",
    "name": "subtype",
1721   "schema": {
      "$ref": "#/components/schemas/IdType"
    }
  },
  {
    "description": "Vaccine adjuvant ID",
    "in": "query",
    "name": "vaccine_adjuvant",
    "schema": {
      "$ref": "#/components/schemas/IdType"
1731   }
  },
  {
    "description": "Vaccine component ID",
    "in": "query",
    "name": "vaccine_component",
    "schema": {
      "$ref": "#/components/schemas/IdType"
    }
  },
1741  {
    "description": "Vaccine viral strain ID",
    "in": "query",
    "name": "vaccine_strain",
    "schema": {
      "$ref": "#/components/schemas/IdType"
```



```

    }
  },
  {
    "description": "Vaccine type ID",
1751    "in": "query",
    "name": "vaccine_type",
    "schema": {
      "$ref": "#/components/schemas/IdType"
    }
  },
  {
    "description": "Author of a reference",
    "in": "query",
    "name": "author",
1761    "schema": {
      "maxLength": 100,
      "minLength": 2,
      "type": "string"
    }
  },
  {
    "description": "Citation key of a reference",
    "in": "query",
    "name": "cite",
1771    "schema": {
      "maxLength": 30,
      "minLength": 6,
      "type": "string"
    }
  },
  {
    "description": "Epitope sequence",
    "in": "query",
    "name": "epitope",
1781    "schema": {
      "maxLength": 20,
      "minLength": 6,
      "pattern": "^[A-Za-z]+$",
      "type": "string"
    }
  },
  {
    "description": "Epitope name",
    "in": "query",

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```
1791     "name": "epitope_name",
      "schema": {
        "maxLength": 30,
        "minLength": 3,
        "type": "string"
      }
    },
    {
      "description": "MHC/HLA of the epitope. T cell only",
      "in": "query",
      1801     "name": "hla",
      "schema": {
        "maxLength": 20,
        "minLength": 2,
        "type": "string"
      }
    },
    {
      "description": "Name of the monoclonal antibody (mAb)",
      "in": "query",
      1811     "name": "mab_name",
      "schema": {
        "maxLength": 30,
        "minLength": 3,
        "type": "string"
      }
    },
    {
      "description": "Text in a note",
      1821     "in": "query",
      "name": "note",
      "schema": {
        "maxLength": 30,
        "minLength": 3,
        "type": "string"
      }
    },
    {
      "description": "Epitope is from this protein",
      "in": "query",
      1831     "name": "protein_name",
      "schema": {
        "maxLength": 30,
        "minLength": 3,
```

```
        "type": "string"
    }
},
{
    "description": "Restrict author search to first authors",
    "in": "query",
    "name": "author_first",
    "schema": {
        "nullable": true,
        "type": "boolean"
    }
},
{
    "description": "Restrict author search to last authors",
    "in": "query",
    "name": "author_last",
    "schema": {
        "nullable": true,
        "type": "boolean"
    }
},
{
    "description": "Show only this 'authors references (Ab only)",
    "in": "query",
    "name": "au_filter",
    "schema": {
        "nullable": true,
        "type": "boolean"
    }
},
{
    "description": "Show only notes containing selected keyword(s) (Ab only)",
    "in": "query",
    "name": "kw_filter",
    "schema": {
        "nullable": true,
        "type": "boolean"
    }
},
{
    "description": "Show only notes matching this text (Ab only)",
    "in": "query",
    "name": "note_filter",
    "schema": {
```

```

        "nullable": true,
        "type": "boolean"
1881     }
    }
  ],
  "responses": {
    "200": {
      "content": {
        "application/json": {
          "schema": {
            "$ref": "#/components/schemas/EpitopeResponse"
1891         }
      }
    },
    "description": "Epitopes"
  },
  "summary": "Finds epitope records in the database"
},
"/list/binding_type/{table}": {
  "get": {
1901    "operationId": "listBindingType",
    "parameters": [
      {
        "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/AbTable"
1911        }
      }
    ],
    "responses": {
      "200": {
        "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listBindingTypeResponse"
1921            }
          }
        },
        "description": "Binding types"
      }
    }
  }
}

```

```

    },
    "summary": "List binding types in the database"
  }
},
"/list/country/{table}": {
  "get": {
    "operationId": "listCountry",
    "parameters": [
1931     {
        "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      }
    ],
    "responses": {
1941     "200": {
        "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listCountryResponse"
            }
          }
        },
        "description": "Countries"
      }
1951     },
    "summary": "List countries in the database"
  }
},
"/list/hla/{table}": {
  "get": {
    "operationId": "listHLA",
    "parameters": [
1961     {
        "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/TCellTable"
        }
      }
    ]
  }
}

```

```

    ],
    "responses": {
      "200": {
        "content": {
          "application/json": {
1971         "schema": {
            "$ref": "#/components/schemas/listHLAResponse"
          }
        }
      },
      "description": "HLAs"
    }
  },
  "summary": "List HLAs in the database"
1981 }
},
"/list/immunogen/{table}": {
  "get": {
    "operationId": "listImmunogen",
    "parameters": [
      {
1991         "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      }
    ],
    "responses": {
      "200": {
        "content": {
          "application/json": {
2001         "schema": {
            "$ref": "#/components/schemas/listImmunogenResponse"
          }
        }
      },
      "description": "Immunogens"
    }
  },
  "summary": "List immunogens in the database"
}
},

```

```
2011  "/list/isotype/{table}": {
      "get": {
        "operationId": "listIsotype",
        "parameters": [
          {
            "in": "path",
            "name": "table",
            "required": true,
            "schema": {
              "$ref": "#/components/schemas/AbTable"
2021          }
          ]
        },
        "responses": {
          "200": {
            "content": {
              "application/json": {
                "schema": {
                  "$ref": "#/components/schemas/listIsotypeResponse"
2031                }
              }
            },
            "description": "Isotypes"
          }
        },
        "summary": "List isotypes in the database"
      }
    },
    "/list/keyword/{table}": {
      "get": {
2041        "operationId": "listKeyword",
        "parameters": [
          {
            "in": "path",
            "name": "table",
            "required": true,
            "schema": {
              "$ref": "#/components/schemas/Table"
2051          }
          ]
        },
        "responses": {
          "200": {
            "content": {
```

```

        "application/json": {
          "schema": {
            "$ref": "#/components/schemas/listKeywordResponse"
          }
        }
      },
      "description": "Keywords"
    },
    "summary": "List keywords in the database"
  },
  "/list/outcome/{table}": {
    "get": {
      "operationId": "listOutcome",
      "parameters": [
        {
          "in": "path",
          "name": "table",
          "required": true,
          "schema": {
            "$ref": "#/components/schemas/TCellTable"
          }
        }
      ],
      "responses": {
        "200": {
          "content": {
            "application/json": {
              "schema": {
                "$ref": "#/components/schemas/listOutcomeResponse"
              }
            }
          },
          "description": "Outcomes"
        }
      },
      "summary": "List outcomes in the database"
    },
    "summary": "List outcomes in the database"
  },
  "/list/protein/{table}": {
    "get": {
      "operationId": "listProtein",
      "parameters": [

```



```

    {
      "in": "path",
      "name": "table",
      "required": true,
      "schema": {
        "$ref": "#/components/schemas/Table"
      }
    }
  ],
  "responses": {
    "200": {
      "content": {
        "application/json": {
          "schema": {
            "$ref": "#/components/schemas/listProteinResponse"
          }
        }
      },
      "description": "HXB2 protein"
    }
  },
  "summary": "List HXB2 proteins in the database"
},
}
},
"/list/species/{table}": {
  "get": {
    "operationId": "listSpecies",
    "parameters": [
      {
        "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      }
    ],
    "responses": {
      "200": {
        "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listSpeciesResponse"
            }
          }
        }
      }
    }
  }
}

```

```
    }
  },
  "description": "Species"
}
},
"summary": "List species in the database"
}
},
2151 "/list/subtype/{table}": {
  "get": {
    "operationId": "listSubtype",
    "parameters": [
      {
        "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
2161       }
      }
    ],
    "responses": {
      "200": {
        "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listSubtypeResponse"
2171           }
          }
        }
      },
      "description": "Subtypes"
    }
  },
  "summary": "List subtypes in the database"
}
},
"/list/vaccine_adjuvant/{table}": {
2181  "get": {
    "operationId": "listVaccineAdjuvant",
    "parameters": [
      {
        "in": "path",
        "name": "table",
        "required": true,
```

```

        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      },
2191 ],
      "responses": {
        "200": {
          "content": {
            "application/json": {
              "schema": {
                "$ref": "#/components/schemas/listVaccineAdjuvantResponse"
              }
            }
          },
2201 },
          "description": "Vaccine adjuvants"
        }
      },
      "summary": "List vaccine adjuvants in the database"
    }
  },
  "/list/vaccine_component/{table}": {
    "get": {
      "operationId": "listVaccineComponent",
      "parameters": [
2211 {
        "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      }
    ],
    "responses": {
2221 "200": {
      "content": {
        "application/json": {
          "schema": {
            "$ref": "#/components/schemas/listVaccineComponentResponse"
          }
        }
      },
      "description": "Vaccine components"
    }
  }
}

```

```
2231     },
    "summary": "List vaccine components in the database"
  }
},
"/list/vaccine_strain/{table}": {
  "get": {
    "operationId": "listVaccineStrain",
    "parameters": [
      {
2241         "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      }
    ],
    "responses": {
      "200": {
2251         "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listVaccineStrainResponse"
            }
          }
        },
        "description": "Vaccine strains"
      }
    },
    "summary": "List vaccine strains in the database"
2261  }
},
"/list/vaccine_type/{table}": {
  "get": {
    "operationId": "listVaccineType",
    "parameters": [
      {
2271         "in": "path",
        "name": "table",
        "required": true,
        "schema": {
          "$ref": "#/components/schemas/Table"
        }
      }
    ]
  }
}
```

```
    ],
    "responses": {
      "200": {
        "content": {
          "application/json": {
            "schema": {
2281         "$ref": "#/components/schemas/listVaccineTypeResponse"
            }
          }
        },
        "description": "Vaccine types"
      }
    },
    "summary": "List vaccine types in the database"
  }
},
2291 "/patient": {
  "get": {
    "operationId": "getPatients",
    "parameters": [
      {
        "description": "Patient ID",
        "in": "query",
        "name": "id",
        "schema": {
2301         "$ref": "#/components/schemas/IdType"
        }
      },
      {
        "description": "Infection year",
        "in": "query",
        "name": "infection_year",
        "schema": {
          "maximum": 2100,
          "minimum": 1967,
          "type": "integer"
2311        }
      }
    ],
    {
      "description": "Patient HLA ID",
      "in": "query",
      "name": "patient_hla_id",
      "schema": {
        "$ref": "#/components/schemas/IdType"
      }
    }
  }
}
```

```
    }  
  },  
  2321 {  
    "description": "Species ID",  
    "in": "query",  
    "name": "species",  
    "schema": {  
      "$ref": "#/components/schemas/IdType"  
    }  
  },  
  2331 {  
    "description": "Patient ethnicity",  
    "in": "query",  
    "name": "ethnicity",  
    "schema": {  
      "maxLength": 100,  
      "minLength": 2,  
      "type": "string"  
    }  
  },  
  2341 {  
    "description": "Patient note",  
    "in": "query",  
    "name": "note",  
    "schema": {  
      "maxLength": 100,  
      "minLength": 2,  
      "type": "string"  
    }  
  },  
  2351 {  
    "description": "Patient code",  
    "in": "query",  
    "name": "patient_code",  
    "schema": {  
      "maxLength": 100,  
      "minLength": 2,  
      "type": "string"  
    }  
  },  
  2361 {  
    "description": "Patient sex",  
    "in": "query",  
    "name": "patient_sex",
```

```

    "schema": {
      "maxLength": 10,
      "minLength": 2,
      "type": "string"
    }
  },
  {
    "description": "Patient HIV progression state code",
    "in": "query",
    "name": "progression",
    "schema": {
      "maxLength": 10,
      "minLength": 2,
      "type": "string"
    }
  },
  {
    "description": "Patient HIV risk factor code",
    "in": "query",
    "name": "risk_factor",
    "schema": {
      "maxLength": 10,
      "minLength": 2,
      "type": "string"
    }
  },
  {
    "description": "Restrict author search to first authors",
    "in": "query",
    "name": "patient_code_exact",
    "schema": {
      "nullable": true,
      "type": "boolean"
    }
  }
],
"responses": {
  "200": {
    "content": {
      "application/json": {
        "schema": {
          "$ref": "#/components/schemas/PatientResponse"
        }
      }
    }
  }
}

```

```

        },
        "description": "Patients"
    }
},
2411 "summary": "Finds patient records in the database"
    }
},
"/patient_list/ethnicity": {
    "get": {
        "operationId": "listPatientEthnicity",
        "responses": {
            "200": {
                "content": {
                2421 "application/json": {
                    "schema": {
                        "$ref": "#/components/schemas/listPatientEthnicityResponse"
                    }
                }
            },
            "description": "Ethnicity"
        }
    },
    "summary": "List ethnicities in the patient table"
},
2431 },
"/patient_list/hla": {
    "get": {
        "operationId": "listPatientHLA",
        "responses": {
            "200": {
                "content": {
                2441 "application/json": {
                    "schema": {
                        "$ref": "#/components/schemas/listPatientHLAResponse"
                    }
                }
            },
            "description": "HLAs"
        }
    },
    "summary": "List patient HLAs in the database"
},
"/patient_list/infection_country": {

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```

2451     "get": {
        "operationId": "listPatientInfectionCountry",
        "responses": {
            "200": {
                "content": {
                    "application/json": {
                        "schema": {
                            "$ref": "#/components/schemas/listPatientInfectionCountryResponse"
                        }
                    }
                }
            },
            "description": "Infection countries"
        }
    },
    "summary": "List infection countries in the database"
},
"/patient_list/infection_year": {
    "get": {
        "operationId": "listPatientInfectionYear",
2471     "responses": {
            "200": {
                "content": {
                    "application/json": {
                        "schema": {
                            "$ref": "#/components/schemas/listPatientInfectionYearResponse"
                        }
                    }
                }
            },
            "description": "Infection countries"
2481     }
    },
    "summary": "List infection years in the database"
},
"/patient_list/progression": {
    "get": {
        "operationId": "listPatientProgression",
        "responses": {
            "200": {
                "content": {
2491     "application/json": {
                    "schema": {
                        "$ref": "#/components/schemas/listPatientProgressionResponse"
                    }
                }
            }
        }
    }
}

```

```

        }
      },
      "description": "Patient HIV progression"
    }
  },
  "summary": "List patient HIV progression in the database"
},
"/patient_list/risk_factor": {
  "get": {
    "operationId": "listPatientRiskFactor",
    "responses": {
      "200": {
        "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listPatientRiskFactorResponse"
            }
          }
        }
      },
      "description": "Patient HIV risk factor"
    }
  },
  "summary": "List patient HIV risk factor in the database"
},
"/patient_list/sex": {
  "get": {
    "operationId": "listPatientSex",
    "responses": {
      "200": {
        "content": {
          "application/json": {
            "schema": {
              "$ref": "#/components/schemas/listPatientSexResponse"
            }
          }
        }
      },
      "description": "Sex"
    }
  },
  "summary": "List sexes in the patient table"
}

```

```
    },  
    "/patient_list/species": {  
2541      "get": {  
        "operationId": "listPatientSpecies",  
        "responses": {  
          "200": {  
            "content": {  
              "application/json": {  
                "schema": {  
                  "$ref": "#/components/schemas/listPatientSpeciesResponse"  
                }  
            }  
          }  
2551        },  
        "description": "Species"  
      }  
    },  
    "summary": "List species in the patient table"  
  }  
}  
},  
"servers": [  
2561   {  
    "url": "api/v1"  
  }  
]  
}
```