

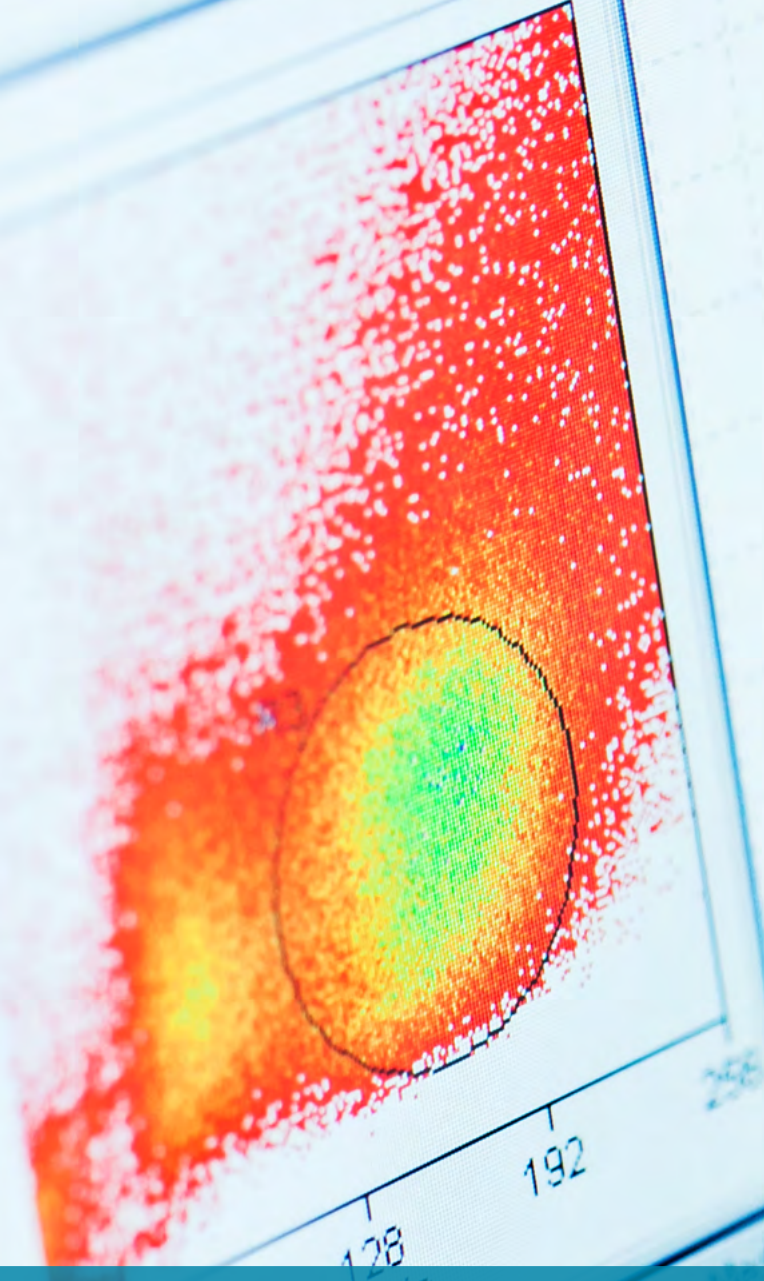
Precision Immune Monitoring

Get the Full Picture of the Antigen-Specific Cellular Immune Response

T Cells | B Cells | Non-Conventional T Cells | Antigen-Presenting Cells

- Flow Cytometry
- Single-Cell Multi-Omics
- GMP Reagents
- Customized Solutions

- Immuno-Oncology
- Infectious Diseases
- Autoimmunity
- Transplantation

A flow cytometry plot is displayed on a computer screen. The plot shows a large population of cells, with a specific cluster of cells highlighted by a black circle. This highlighted cluster is colored in shades of green and yellow, indicating a specific population of cells. The background of the plot is filled with red and orange dots, representing other cell populations. The x-axis is labeled with '128' and '192', and the y-axis is labeled with '256'. The plot is titled 'FS Lin'.

Most current FDA-approved and investigational immunotherapies for cancer are designed to augment, activate, or replace antigen-specific T-cell immunity.

The ability to experimentally detect antigen-specific responses in T cells is a critical readout in demonstrating efficacy and investigating side effects of these treatments.

Contents

| | |
|---|-----------|
| 1. Immudex Products at a Glance | 4 |
| 1.1. CD8 ⁺ and CD4 ⁺ T Cells..... | 4 |
| 1.2. B Cells..... | 5 |
| 1.3. Non-Conventional T Cells..... | 5 |
| 1.4. Why Study Antigen Specificity..... | 6 |
| 1.5. Applications of Immudex’s Technology..... | 7 |
| 1.6. Disease Areas..... | 8 |
| 1.7. Focus on Methods..... | 8 |
| 2. Dextramer® Technology | 9 |
| 2.1. Single-Cell Analysis of T Cells..... | 10 |
| 2.2. B-Cell Monitoring and Beyond..... | 10 |
| 2.3. U-Load Dextramer®..... | 11 |
| 2.4. Antigen-Presenting Cells..... | 12 |
| 3. Product Overview – Basic Research | 13 |
| 3.1. MHC Dextramer®..... | 13 |
| 3.2. MHC Dextramer® Controls..... | 14 |
| 3.3. CD1d Dextramer®..... | 15 |
| 3.4. MR1 Dextramer® and Monomers..... | 16 |
| 3.5. Dextramer® Disease Panels..... | 17 |
| 3.6. Dextramer® <i>In Situ</i> Staining..... | 18 |
| 3.7. dCODE Dextramer®..... | 19 |
| 3.8. Klickmer®..... | 21 |
| 3.9. U-Load Dextramer®..... | 22 |
| 3.10. MHC Monomers..... | 23 |
| 4. Product Overview – GMP & IVD Products | 24 |
| 4.1. MHC Dextramer® [GMP]..... | 24 |
| 4.2. Dextramer® CMV Kit [IVD]..... | 25 |
| 5. Immudex Services | 26 |
| 5.1. Custom Solutions and Services..... | 26 |
| 5.2. Immune Monitoring Proficiency Testing..... | 28 |
| 6. MHC Allele List | 29 |
| 7. Resources | 30 |

1. Immudex Products At a Glance

1.1 CD8⁺ and CD4⁺ T Cells

Ready-To-Use

MHC I and MHC II Dextramer®

[page 13]



GMP available

- Detect, isolate, expand antigen-specific T cells
- TCR validation
- Flow cytometry
- *In situ* staining

dCODE Dextramer®

[page 19]



- Gold standard barcoded MHC multimers
- Antigen-specific T cell NGS/single-cell multi-omics
- Epitope discovery and neo-antigen screening
- TCR discovery and validation
- Specificity profiling

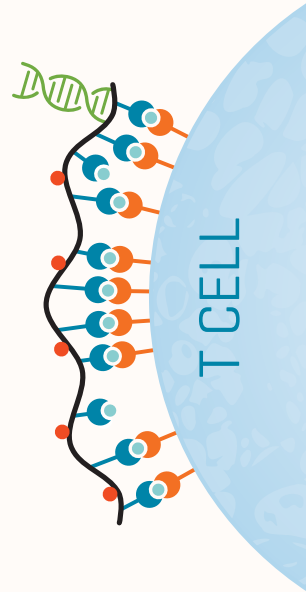
Ready-to-Use MHC Monomers

[page 23]



GMP available

- MHC I and II monomers
- T-cell stimulation
- TCR characterization and cross-reactivity screening
- Assess TCR:pMHC binding strength
- Development of TCR-like antibodies
- MHC multimer assembly



Loadable Solutions

U-Load Dextramer®

[page 22]



- Detect antigen-specific CD8⁺ and CD4⁺ T cells
- Loadable Dextramer® technology
- Flow cytometry

U-Load dCODE Dextramer®

[page 22]



- Antigen-specific T-cell monitoring with the power of multiplexing
- Loadable dCODE Dextramer® technology
- Epitope discovery and neo-antigen screening
- TCR discovery
- NGS/single-cell multi-omics [HiT, RiO, 10x]

Peptide-Receptive MHC Monomers

[page 23]



- easYmers® MHC I and U-Load® MHC II monomers
- MHC multimer assembly
- Assess pMHC binding affinity



Ready-To-Use

TCR Dextramer®

[page 27]



- Detect antigen-presenting cells
- Validate and characterize TCRs
- Quality control of cancer vaccines
- Flow cytometry
- *In situ* staining

Soluble TCR Monomers

[page 27]



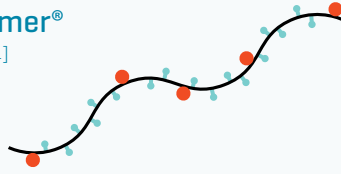
- Assess TCR:pMHC binding strength
- TCR cross-reactivity screening

1.2 B Cells

Loadable Solutions

Klickmer®

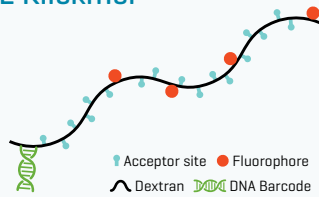
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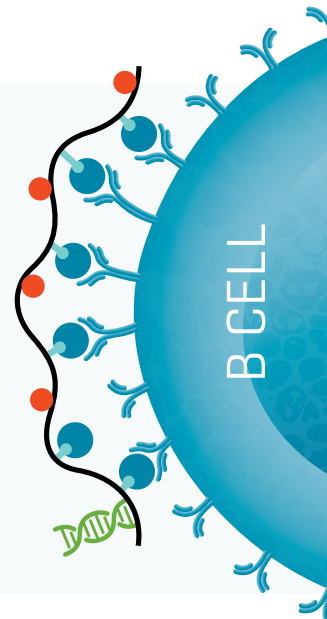
- Detect antigen-specific B-cells and more
- Build high-avidity multimers
- Attach your biotinylated molecule of choice
- Efficient protein-ligand interaction
- Flow cytometry

dCODE Klickmer®

[page 21]



- Antigen-specific B-cell monitoring with the power of multiplexing
- Loadable dCODE Klickmer® technology
- BCR sequencing
- Antibody discovery
- NGS/single-cell multi-omics [HiT, RiO, 10x]



1.3 Non-Conventional T Cells

Ready-To-Use

CD1d Dextramer®

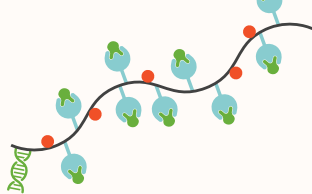
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- Detect CD1d-restricted Natural Killer T cells
- Flow cytometry
- *In situ* staining

CD1d dCODE Dextramer®

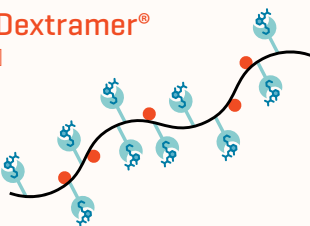
[page 15]



- NKT cell monitoring with the power of multiplexing
- NGS/single-cell multi-omics [HiT, RiO, 10x]

MR1 Dextramer®

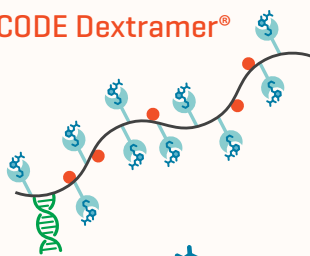
[page 16]



- Detect MAIT cells
- Flow cytometry
- *In situ* staining

MR1 dCODE Dextramer®

[page 16]



- MAIT cell monitoring with the power of multiplexing
- NGS/single-cell multi-omics [HiT, RiO, 10x]

MR1 Monomers

[page 16]



- T-cell stimulation and enrichment

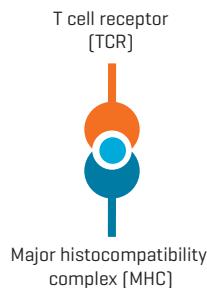


Don't find what you're looking for?

See our Custom Solutions and Services. Page 26

1.4 Why Study Antigen Specificity

Antigen Specificity is at the Heart of Immunotherapeutics



Most immunotherapies are designed to augment, activate, or replace antigen-specific T-cell immunity. An in-depth understanding of the antigen-specific cellular immune response is critical, not only to understand disease progression, but also for the development of effective immunotherapeutics.

At Immudex we are certain that **precision immune monitoring** – studying the antigen-specific cellular immune response in detail – can expand the boundaries of what’s possible in medicine and open new therapeutic and diagnostic opportunities.

By enabling a better understanding of the complexity of the immune response – scientists develop more effective immune-based therapeutics and diagnostics



Unravelling the Complexity of the Immune Response

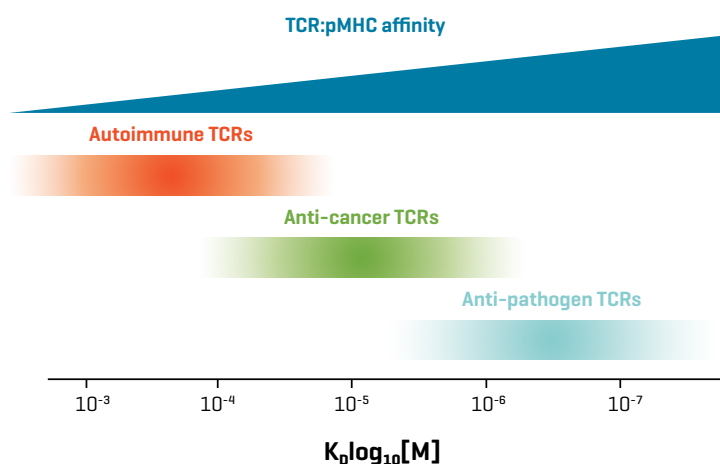
The immune system and its cellular response are highly complex, but with the right research tools, we can unravel that complexity.

One challenge is that TCR:pMHC complex affinities can vary. Self-reactive cells such as autoimmune T-cells tend to have low-affinity TCRs whereas anti-pathogen TCRs tend to bind to cognate pMHC with relatively high affinity.

High avidity Dextramer® technology ensures efficient binding to antigen-specific T cells, enabling T cells with a wide range of TCR affinities to be detected reliably and robustly, so you don’t risk missing out on important information.

We offer a broad product portfolio that allows scientists to investigate diverse types of immune cells, including T cells, non-conventional T cells and B cells, with reagents tailored to specific applications.

Our products are compatible with multiple platforms from flow cytometry to next generation sequencing and single-cell multi-omics. With our GMP manufacturing capabilities, it is easy to transition from basic research to clinical applications.



Adapted from Dolton G. et al, Front Immunol 2018

1.5. Applications of Immudex's Technology

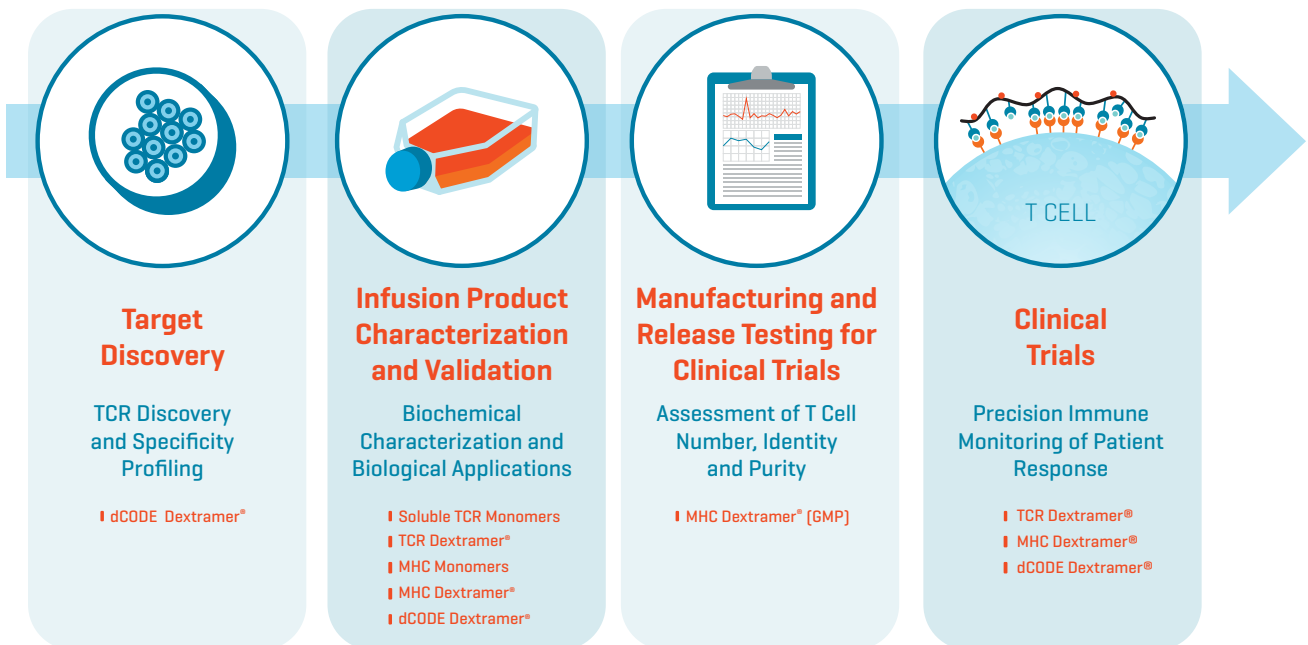
Cell Therapy

Immudex's technology supports the development and manufacturing of cellular immunotherapeutics, including TCR-T, CAR-T and dendritic cell vaccines.

Dextramer® [GMP] reagents are used in lot-release testing to ensure that the infusion product meets certain criteria for use in clinical trials. Dextramer® technology can also help to assess TCR specificity and minimize cross-reactivity.

“ The FDA recommended that we use a GMP-grade multimer for the purposes of lot-release testing our TCR-T based therapy.

— Scientist, Pharmaceutical Company



Epitope and TCR Discovery

dCODE Dextramer® reagents enable researchers to connect specific antigens with α , β , and/or paired $\alpha\beta$ TCR sequences. With up to 1,000 unique DNA barcodes available, dCODE Dextramer® is the gold-standard for high-throughput V(D)J sequencing of antigen-specific T cells, advancing the discovery of epitope and TCRs with therapeutic potential.

Vaccine Development

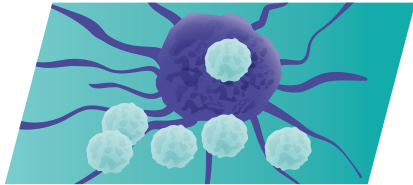
Precision Immune Monitoring of antigen-specific T and B cells using MHC Dextramer® reagents helps scientists to investigate vaccine efficacy – whether the vaccine candidate has induced a long-lasting memory response.

Antibody Discovery

dCODE Klickmer® enables the comprehensive multiplexed detection of antigen-specific B cells, revealing BCR sequences at single-cell resolution, and facilitating the identification of novel antibodies that bind to the target of interest. Furthermore, Immudex's technology can support the identification of antibodies targeting pMHC.

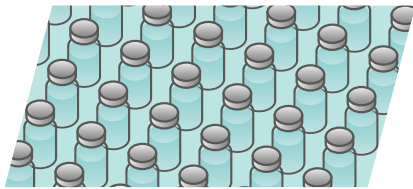
1.6. Disease Areas

The resolution and sensitivity of Immudex® Dextramer® technologies allow in-depth examination of disease-specific immunity.



Immuno-Oncology

Understand how treatments impact immune response and uncover markers of successful outcomes



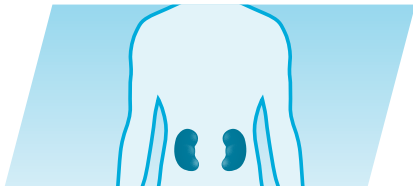
Infectious Diseases

Informed research on disease progression and vaccines, including novel viruses like SARS-CoV-2



Autoimmunity

Find signatures of immune cell activity that reveal mechanisms of autoimmune conditions



Transplantation

Evaluate immune reconstitution in transplant patients

1.7 Focus on Methods

Flow Cytometry

- Sensitively quantify target immune cells by flow cytometry with a strong signal-to-noise ratio

Single-Cell Multi-Omics

- Discover and characterize antigen-specific T-cell epitopes at single-cell resolution

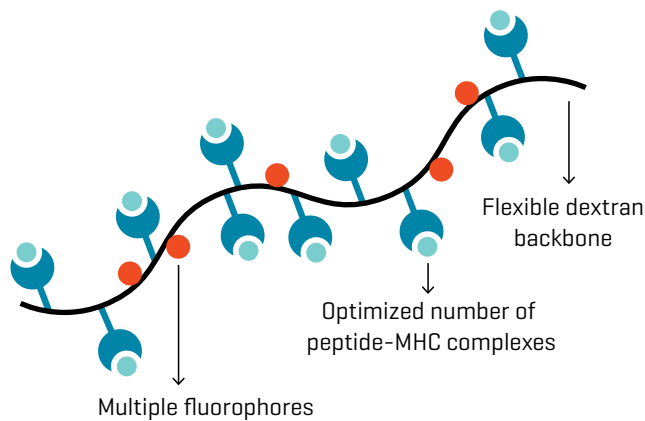
In Situ Immune Monitoring

- Track the spatial distribution of antigen-specific immune cells in tissue by direct or indirect staining

Cellular Immune Monitoring

- Source GMP-grade reagents and monomers for monitoring of one or more epitope-specific immune cell populations

2. Dextramer® Technology



Dextramer® reagents are designed to enable detection and characterization of immune cells by flow cytometry. They are based on a flexible backbone made of dextran polymer that can be charged with multiple copies of protein complexes and fluorophores. Even when probing weak protein-protein interactions these reagents are capable of binding with high avidity to cells by engaging with multiple surface proteins simultaneously.

This configuration is at the core of all Immudex products enabling analysis of a growing list of immune cells in the quest of unravelling complex immune responses.

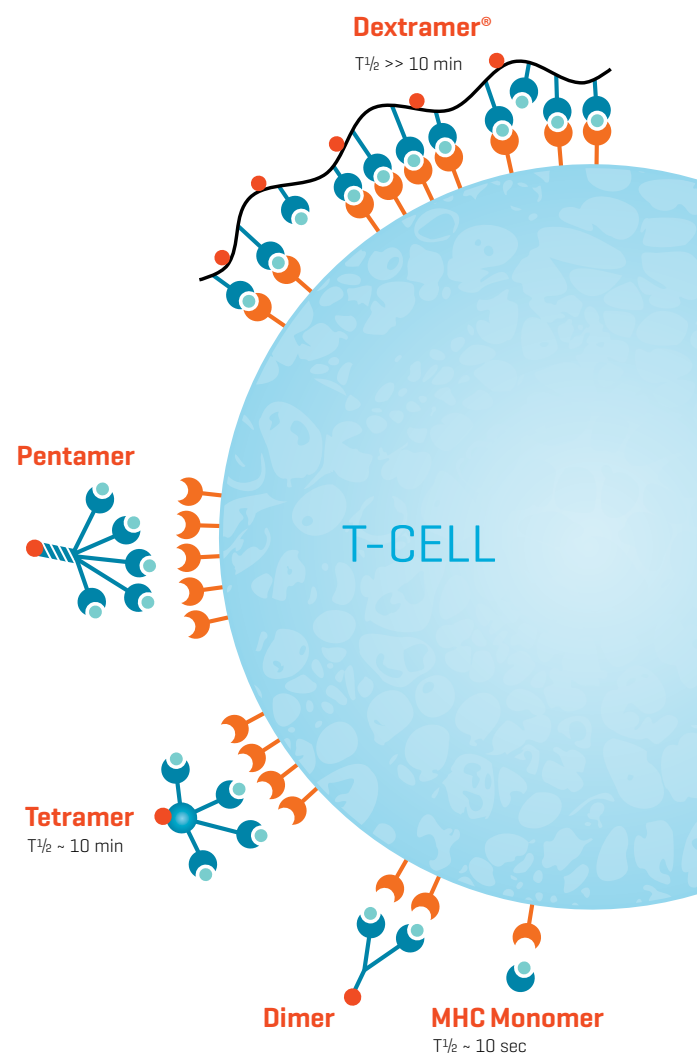
Dextramer® technology is ideal for monitoring T-cell responses

It is a feature of the immune synapse that TCR:pMHC interactions are weak and transient with half-lives measured in seconds. This makes detection of antigen-specific T cells challenging.

The dextran backbone of MHC Dextramer® reagents accommodates numerous peptide MHC complexes. Thus, each polymer presents several options to bind cell receptors in a flexible configuration that promotes multi-binding to increase avidity.

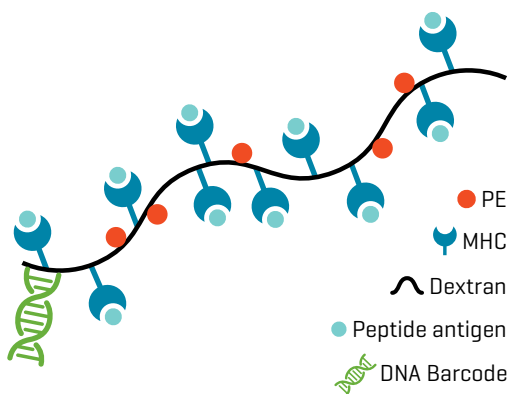
As a result, Dextramer® binding time is significantly longer than other multimers.

MHC Dextramer® enables sensitive flow cytometric detection of rare CD4⁺ and CD8⁺ T cells even with low-affinity receptors, helping researchers uncover T-cell populations that other multimer technologies miss.



2.1. Single-Cell Analysis of T Cells

dCODE Dextramer®



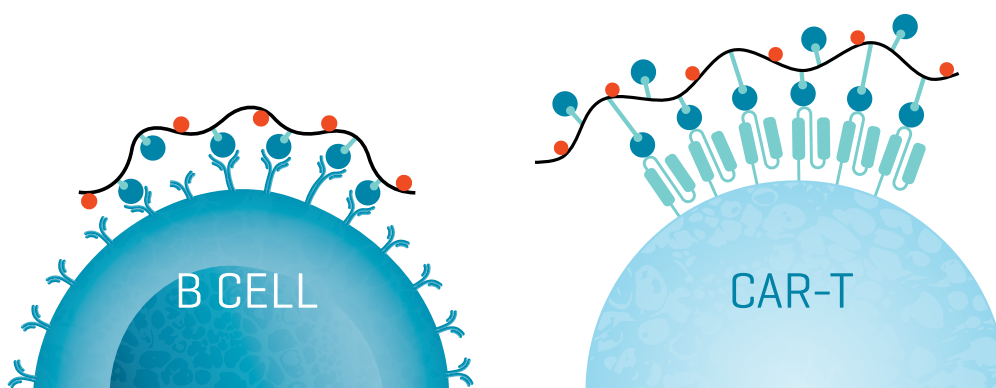
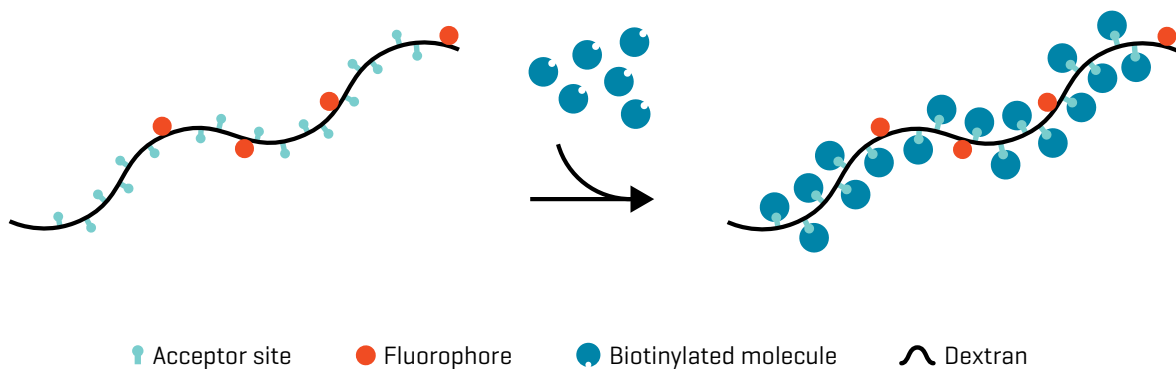
The addition of a DNA barcode to the dextran backbone transforms MHC Dextramer® into a powerful tool for indexing T cells according to their TCR specificity. It enables efficient screening of multiple T-cell specificities in a single sample by amplifying and sequencing DNA barcodes that are unique for each dCODE Dextramer®. Up to 1,000 unique DNA barcodes are available.

When combining these tools with DNA barcoded antibodies and powerful platforms for single cell collection and sequencing, high-throughput single-cell multi-omics analysis of antigen-specific T cells is within the realm of the possible.

2.2. B-Cell Monitoring and Beyond

Klickmer®

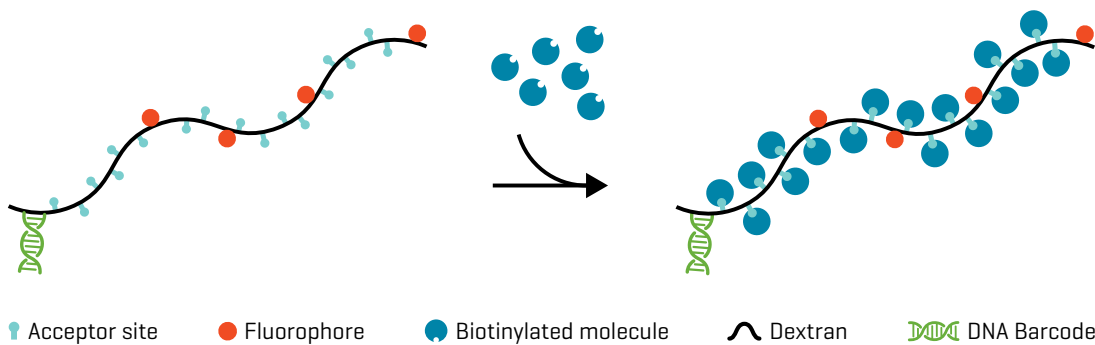
A version of Dextramer® technology where the backbone contains numerous agnostic acceptor sites that bind and display any biotinylated molecule. This multipurpose tool opens new possibilities to explore immunity, from sensitive detection of B cells and ligand/antibody discovery, to isolation of different types of immune cells, cancer cells and other special cell populations e.g. CAR-T cells.



dCODE Klickmer®

To support novel applications and creative research approaches, dCODE Klickmer® merges the boosted avidity facilitated by the Dextramer® technology, the multiplexing capacity of dCODE Dextramer®, and the customized loading of Klickmer®.

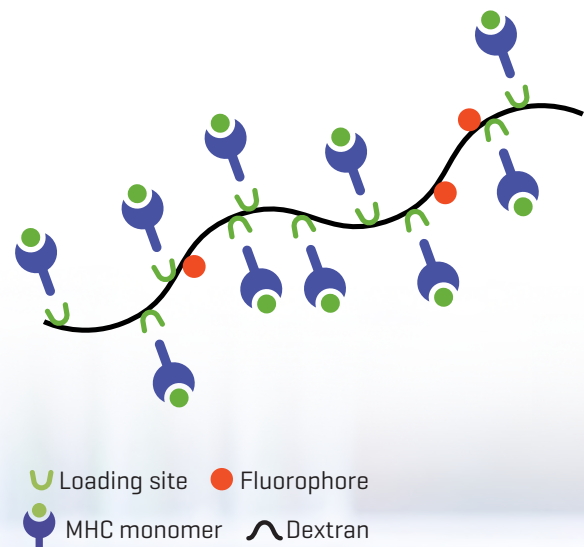
These reagents are highly customizable, top-quality tools to investigate uncharted immune responses and new cell population subsets. Leverage complete flexibility to create the reagent that can tackle your specific research question.



2.3. U-Load Dextramer® Technology

Taking flexibility to new levels while retaining the stability and sensitivity of Dextramer® technology, U-Load Dextramer® binds and displays your self-assembled biotinylated MHC I or MHC II allele-peptide complex. Using U-Load Dextramer® Kits for flow cytometry or U-Load dCODE Dextramer® Kits for single-cell multi-omics analysis, easily make custom reagents directly in your lab to boost specificity and streamline sample screening.

Simply bind your peptide of choice to an exceptional selection of MHC allotypes and load the complex onto U-Load Dextramer® or U-Load dCODE Dextramer®.



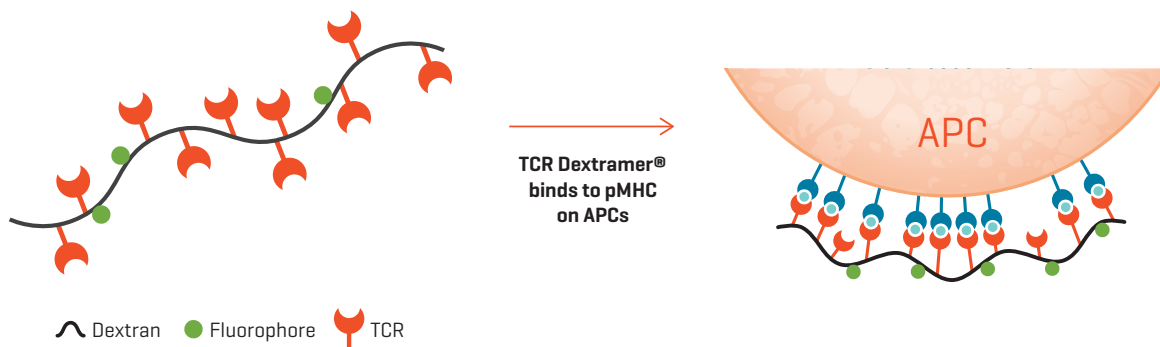
2.4. Antigen-Presenting Cells

When developing immunotherapies, the detection and quantification of Antigen-Presenting Cells (APCs) can be important to:

- Stratify and select patients with demonstrated expression of the target antigen
- Confirm if the target antigen is present predominantly in the target tissue [and absent in normal tissues], thus avoiding potential toxicity
- Monitor the presence of the target antigen during treatment and possible tumor escape.

TCR Dextramer®

Harnessing the power of the Dextramer® technology, TCR Dextramer® reagents are custom products, developed by Immudex's Custom Solutions and Services team, based on your candidate TCR sequences.



TCR Dextramer® reagents are novel reagents, ideally suited to develop techniques for APC detection, opening up new possibilities for studies, such as the detection of APCs and assessment of pMHC levels by flow cytometry, or the investigation of the frequency of target epitope in tumor or normal tissue. In the future, with the help of TCR Dextramer®, it may even be possible to localize APCs using *in situ* techniques.

3. Product Overview – Basic Research

The Immudex portfolio of products for precision cellular immunology research is based on the unique Dextramer® technology. Our research products are used in flow cytometry, *in situ* staining, NGS, and single-cell multi-omics applications.

3.1. MHC Dextramer®

MHC I & MHC II Dextramer®

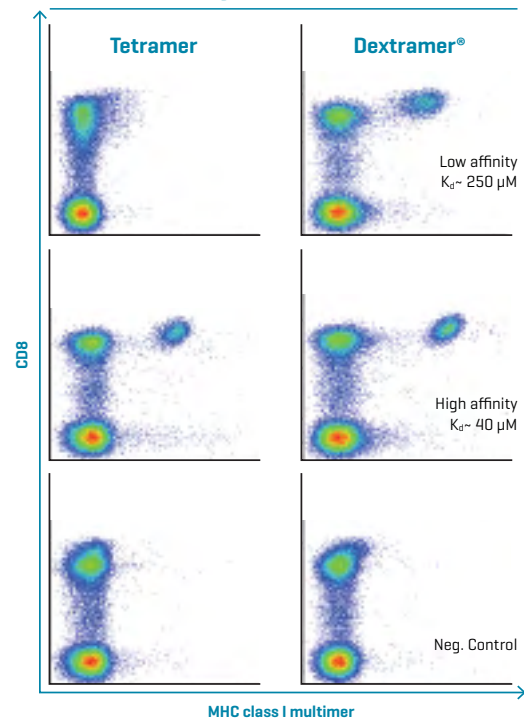
MHC I & MHC II Dextramer® are made up of a flexible dextran polymer decorated with multiple fluorophores and an optimized number of MHC-peptide complexes. They are designed for monitoring of antigen-specific T cells by flow cytometry with superior sensitivity.

MHC I Dextramer® reagents are also available as GMP products [page 24].

Applications of MHC Dextramer®

- Detection, isolation and enumeration of antigen-specific T cells by flow cytometry
- Epitope discovery
- Characterization of vaccine responses
- Longitudinal studies of immunity

Identify Low-Affinity CD8⁺ T Cells that Other Technologies Miss



Adapted from Dalton et al., Clin Exp Immunol. 2014.

Reasons why you should work with MHC Dextramer®

- High order multimers with exceptional avidity enabling sensitive detection and isolation of rare antigen-specific T cell populations, even challenging T cells with low affinity TCRs that go undetected with classical MHC multimers
- Ability to investigate the importance of MHC variability in disease with access to a growing and extensive list of MHC alleles (>90 MHC I alleles) and off-the-shelf epitopes
- Rigorous quality control ensuring reliable and reproducible results

Relevant Information

- Consult the selected list of **alleles** [page 29] and the full list of available alleles on our website [<https://www.immudex.com/resources/mhc-alleles-list/>]
- Fluorophores available (PE, APC, FITC, or none)
- Test size (50,150, 500, 1000 tests). One test is 10 µl reagent and sufficient to stain 1–3 x 10⁶ lymphoid cells or 1–3 x 10⁵ clonal antigen-specific T cells.

3.2. MHC Dextramer® Controls

Couple your Dextramer® reagents with the right positive and negative controls.

MHC Dextramer® Negative Controls

To create MHC I Dextramer® Negative Controls we have designed several peptides capable of fitting the binding groove of different MHC I alleles, but which align with very few known proteins and thus are expected to react only with TCRs of very rare naïve T cells. For MHC II we use Class II-associated invariant chain peptide [CLIP].

| Type | Allele | Antigen | Epitope | Cat. No. |
|--------------|---------------|-----------------------|-----------------|----------|
| Human MHC I | HLA-A*0101 | Neg. Control | STEGGGLAY | WA03579 |
| Human MHC I | HLA-A*0201 | Neg. Control | ALIAPVHAV | WB02666 |
| Human MHC I | HLA-A*0301 | Neg. Control | GLFGAGAFK | WC03191 |
| Human MHC I | HLA-B*0801 | Neg. Control | AAKGRGAAL | WI03233 |
| Mouse MHC I | H-2 Kb | SIY* | SIYRYYGL | JD02164 |
| Mouse MHC I | H-2 Kd | Neg. Control | AYAGSAGSI | JE03929 |
| Human MHC II | HLA-DRB1*0101 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FA10002 |
| Human MHC II | HLA-DRB1*0301 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FF10002 |
| Human MHC II | HLA-DRB1*0401 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FB10002 |
| Human MHC II | HLA-DRB1*0701 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FE10002 |
| Human MHC II | HLA-DRB1*1101 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FD10002 |
| Human MHC II | HLA-DRB1*1301 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FK10002 |
| Human MHC II | HLA-DRB1*1501 | CLIP [Endogenous Ag] | PVSKMRMATPLLMQA | FC10002 |
| Human MHC II | HLA-DQ2.5 | CLIP2 [Endogenous Ag] | PVSKMRMATPLLMQA | FI10188 |

MHC Dextramer® Positive Controls

Depending on the experimental setup, the ideal positive controls is:

- An MHC Dextramer® with an epitope derived from a widespread human virus [CMV, EBV or Flu]
- A pool of three Dextramer® with viral epitopes from CMV, EBV and Flu

| Type | Allele | Peptide | Antigen | Cat. No. |
|-------------|------------|-----------|---------|----------|
| Human MHC I | HLA-A*0201 | NLVPMVATV | CMV | WB02132 |
| Human MHC I | HLA-A*0201 | GLCTLVAML | EBV | WB02130 |
| Human MHC I | HLA-A*0201 | GILGFVFTL | Flu | WB02161 |
| Mouse MHC I | H-2 Kb | SIYRYYGL | SIY* | JD02164 |

Relevant Information

To order, specify the following information:

- Catalog number or desired MHC allele-peptide combination
- Fluorophore [PE, APC, FITC, None]
- Test size: 50, 150, 500, 1000 tests
- Custom Controls: the experimental setup may require an MHC allele that is not listed in our catalog or different specificities.

* SIY can be used as a positive or negative control, depending on the mouse model.

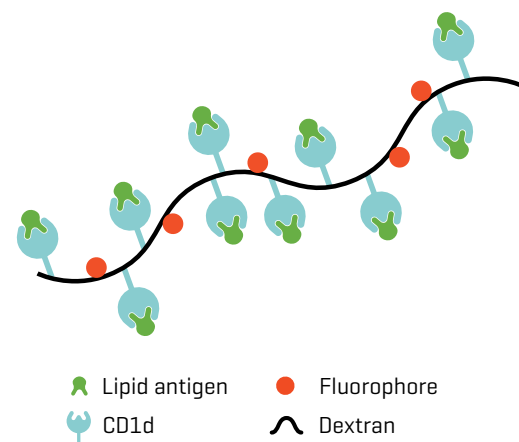
3.3. CD1d Dextramer®

Natural Killer Cells (NKT) comprise a family of specialized T cells with special TCRs that recognize lipid antigens presented by CD1d. They play an important role in modulating the immune response to microbial infections and tumors and are also involved in autoimmunity. Currently they are under investigation for use in cancer cell therapy since they are not alloreactive and able to invade solid tumor tissue where they orchestrate anti-tumor activity of multiple types of immune cells.

CD1d Dextramer® are made up of a flexible dextran polymer decorated with multiple fluorophores and an optimized number of CD1d molecules coupled with glycolipid alpha-Galactosyl Ceramide (α -GalCer). The result is a highly sensitive reagent to monitor CD1d restricted NKT cells by flow cytometry.

Applications of CD1d Dextramer®

- Detection, isolation and enumeration of CD1d restricted cells by flow cytometry
- Characterization of CD1d restricted cells in response to disease
- Monitoring of cell therapy derived NKT cells



Relevant Information

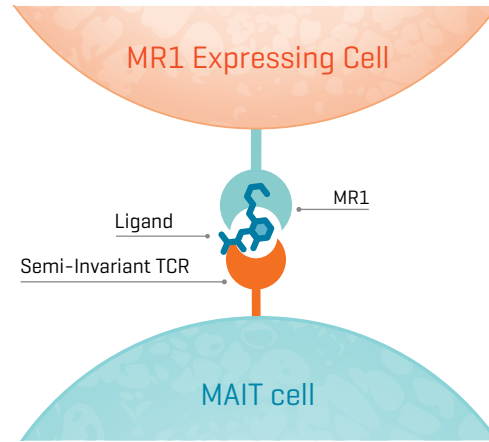
- Fluorophore (PE, APC, FITC, or none)
- Test size (50, 150, 500, 1000 tests)
- CD1d Dextramer® is also available empty, without a lipid, enabling loading lipid of choice, or creation of a negative control.
- Also available as CD1d dCODE Dextramer® (HiT, RiO and 10x) to characterize CD1d restricted cells down to the single-cell level by NGS or single-cell multi-omics [page 19].

| CD1d Dextramer® | Glycolipid | Cat. No. |
|-----------------|------------------|----------|
| Human CD1d | α -GalCer | XD8002 |
| Mouse CD1d | α -GalCer | YD8002 |
| Human CD1d | Empty | XD8001 |
| Mouse CD1d | Empty | YD8001 |

3.4. MR1 Dextramer® and Monomer

Mucosal-associated invariant T (MAIT) cells have a complex role in immunity but are proving attractive targets for immunotherapy. To understand their potential further, better research tools are needed.

With an optimized number of MR1-peptide complexes and a high number of fluorophores, MR1 Dextramer® reagents provide superior sensitivity and resolution.



Applications of MR1 Products

- Detection, isolation and enumeration ligand-specific MAIT cells by flow cytometry
- Characterization of ligand-specific MAIT cells phenotype, activity, and function
- Validate target recognition of your MAIT cell therapy or TCR-like antibody candidates for more specific cell therapies

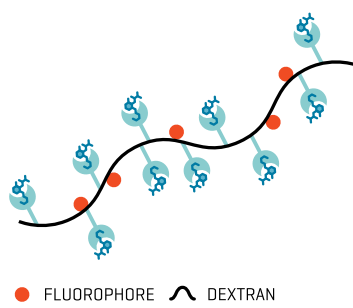
Relevant Information

- Choice of ligands:
 - 5-OP-RU: a potent activator of MAIT cells
 - 6-FP: non-stimulatory for most MAIT cells [negative control]



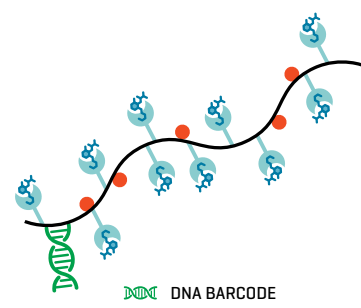
MR1 Monomer

| |
|-----------------|
| Optimizable |
| 20, 100, 200 µg |
| 5-OP-RU 6-FP |
| Biotin |



MR1 Dextramer®

| |
|----------------------------------|
| Flow Cytometry <i>In situ</i> |
| 50, 150 tests |
| 5-OP-RU 6-FP |
| FITC, PE, APC or NONE |



MR1 dCODE Dextramer®

| |
|---|
| Next generation sequencing Single-Cell Multi-Omics |
| 25, 50, 150 tests |
| 5-OP-RU 6-FP |
| DNA barcode [HiT, 10x, RiO] [page 19] |

3.5. Dextramer® Disease Panels

To support high-quality precision monitoring in cancer and infectious disease, Immudex has created disease-specific panels of selected Dextramer® reagents.

Immune Monitoring in Cancer

The Melanoma Dextramer® Panel (RX01)

The panel contains melanoma-specific MHC I Dextramer® reagents that display epitopes from **six** different melanoma-associated antigens [Tyrosinase, gp100, MART-1, and Cancer-Testis antigens like the MAGE proteins and NY-ESO-1].

Each specificity is provided as a PE- and APC conjugate, enabling for 2D-staining. The panel also includes two negative control Dextramer® reagents (25 tests each).

The Cancer-Testis Antigens Dextramer® Panel (RX02)

Identify immunity elicited by cancer-testis antigen (CTA) by quantifying CD8⁺ T cells that recognize these **three** antigens [NY-ESO-1, MAGE-A3, MAGE-A1].

Each specificity is provided as a PE- and APC conjugate, enabling for so-called 2D-staining. The panel also includes two negative control Dextramer® reagents (25 tests each).

Immune Monitoring in Infectious Diseases

COVID-19 Dextramer®

Unravel T-cell response to SARS-CoV-2 infection and/or vaccination with MHC Dextramer®. Create your own COVID panels by selecting from our extensive offering of Dextramer® available with a variety of different MHC I and MHC II alleles complexed with allele specific epitopes of several SARS-CoV-2 antigens, including the spike protein. For a full list of available COVID MHC Dextramer® please visit our website.

Virus Dextramer® Panel (RX03)

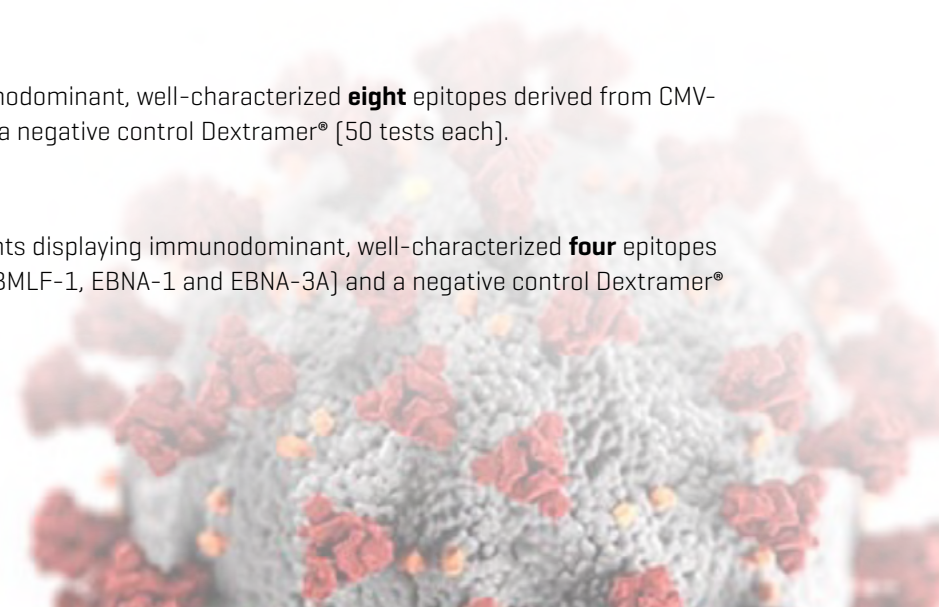
Dextramer® reagents that display immunodominant, well-characterized epitopes derived from **four** general and opportunistic viruses: Cytomegalovirus [CMV], Epstein-Barr [EBV], Influenza, and BK virus and a negative control Dextramer® (50 tests each).

CMV Dextramer® Panel (RX04)

Dextramer® reagents that display immunodominant, well-characterized **eight** epitopes derived from CMV-specific antigens [pp50, pp65, IE-1] and a negative control Dextramer® (50 tests each).

EBV Dextramer® Panel (RX05)

The panel consists of Dextramer® reagents displaying immunodominant, well-characterized **four** epitopes derived from EBV-associated antigens [BMLF-1, EBNA-1 and EBNA-3A] and a negative control Dextramer® (50 tests each).



3.6. Dextramer® *In Situ* Staining

Immune monitoring is typically performed by analyzing immune cells in blood samples. However, most T cells reside and function in tissue at sites where the actual disease manifests and establish tissue resident memory T cells for protective immunity.

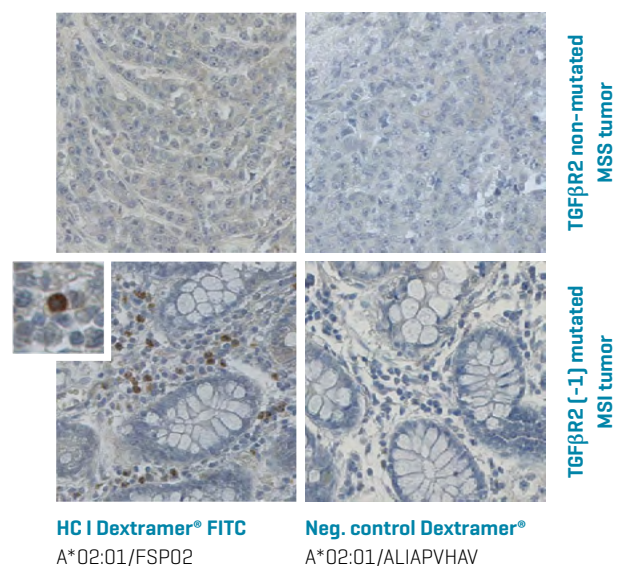
Tracking T cells in the tissue where they exert their function can advance our understanding of T-cell immunity. MHC Dextramer® used as *in situ* staining reagents on fresh frozen or FFPE samples can detect spatial distribution, localization, and abundance of antigen-specific T cells in normal tissue or at a site of disease.

Applications of MHC Dextramer® for *In Situ* Staining

- Detection of T-cells that are rare in blood
- Study of tissue-specific T cell responses in different models: mouse, primate, and humans
- Tracking distribution of cell therapy derived T cells

In situ staining of tumor-specific CD8⁺ T cells in FFPE sections of microsatellite-stable (MSS) or -unstable (MSI) tumors from HLA-A*0201 colorectal cancer patients, using FITC-labeled MHC I Dextramer® toward the TGFβR2 [-1] neoepitope [FSP02]

Adapted from Mlecnik *et al.*, 2016.



Relevant Information

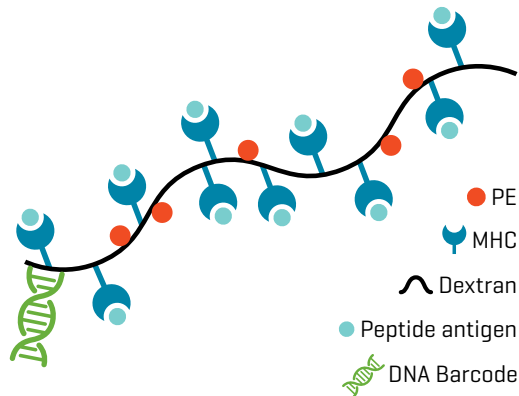
- Consult the list of available alleles [page 29]
- Fluorophore (PE, APC, or FITC) or no Fluorophore [None]
- Test sizes [50, 150, 500, 1000 tests]

References

- Lasrado N, *et al.* Mechanisms of sex hormones in autoimmunity: focus on EAE. *Biology of Sex Differences*, 2020; 11:50.
- Mlecnick B, *et al.* Integrative analyses of colorectal cancer show immunoscore is a stronger predictor of patient survival than microsatellite instability. *Immunity* 2016; 44(3):698–711.
- Kim YH, *et al.* *In situ* detection of HY-specific T cells in acute graft-versus-host disease-affected male skin after sex-mismatched stem cell transplantation. *Biol Blood Marrow Transplant*. 2012; 18(3):381–387.

3.7. dCODE Dextramer®

T-Cell Monitoring with the Power of Multiplexing



dCODE Dextramer® has a DNA barcode attached to the dextran backbone that is unique to its peptide MHC monomer. This enables indexing of antigen-specific T cells and multiplexing for many TCR specificities. Up to 1,000 unique barcodes are available.

Combined with DNA barcoded antibodies and powerful platforms for collection and processing of many thousands of single cells, detailed information about antigen-specific T cells can be gathered by NGS – such as V(D)J sequences, surface markers and whole transcriptome analysis.

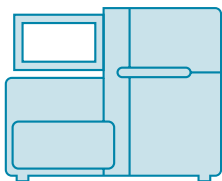
Adapted to Detect Your Target of Interest

Whether it is T cells, MAIT cells, NKT cells, B cells or beyond, there is a dCODE Dextramer® that suits your needs to explore further using NGS or single-cell multi-omics.

- **dCODE Dextramer®**: Ready-to-use gold-standard reagents for characterization of antigen-specific CD8⁺ and CD4⁺ T cells by single cell sequence-based methods.
- **dCODE Klickmer®**: Customizable detection of B cells or any other immune cells of interest, by NGS or single-cell multi-omics [page 21].
- **U-Load dCODE Dextramer®**: Reagents assembled in your own lab to detect CD4⁺ and CD8⁺ T cells with your specificity of choice [page 22].
- **MR1 dCODE Dextramer®**: Reagents for single-cell phenotypic characterization of ligand-specific MAIT cells [page 16].
- **CD1d dCODE Dextramer®**: Reagents for single-cell phenotypic characterization of type I and II NKT cells [page 15].

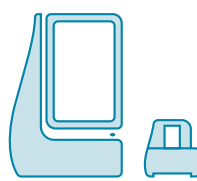
Adapted to Fit your Chosen Platform

All the different dCODE Dextramer® reagents can be made to fit your working platform, for NGS, or single-cell multi-omics [page 20].



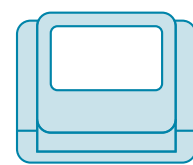
dCODE Dextramer® (HiT)

For bulk analysis of antigen-specific immune cells by NGS



dCODE Dextramer® (RiO)

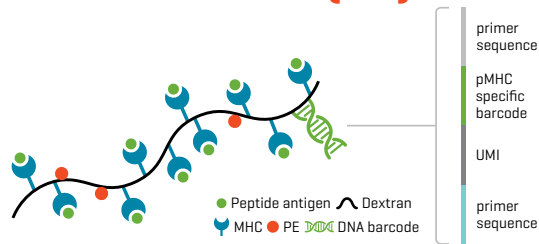
For single-cell multi-omic analysis of antigen-specific immune cells using the BD Rhapsody™ Single-Cell Analysis System



dCODE Dextramer® (10x)

For single-cell multi-omic analysis of antigen-specific immune cells using the 10x Chromium Single Cell Gene Expression System

dCODE Dextramer® (HiT)



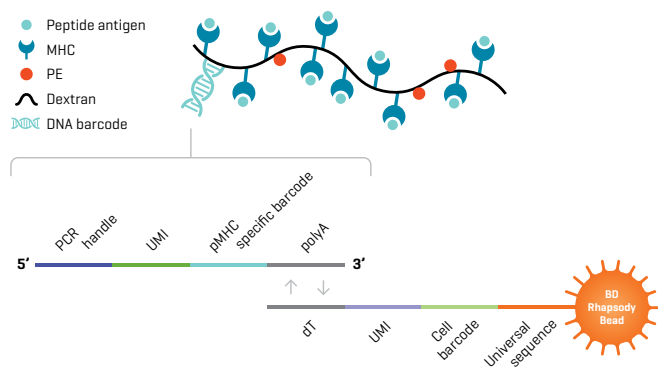
Epitope discovery

dCODE Dextramer® (HiT) reagents are designed for multiplexing, allowing the identification of many different T-cell specificities in the same sample and the discovery of immunodominant epitopes.

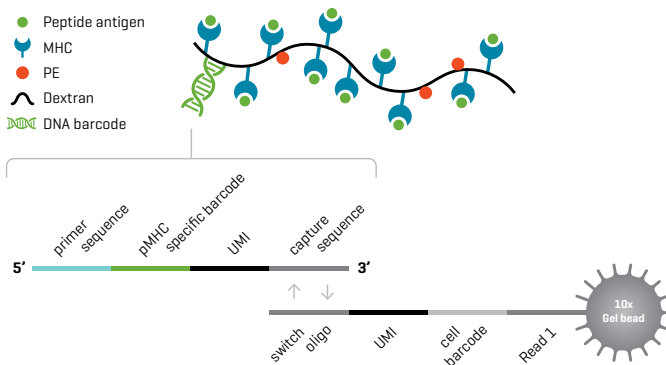
dCODE Dextramer® (RiO)

Designed to be compatible with the BD Rhapsody™ Single-Cell Analysis System, allowing you to obtain full immunological profiling in just one workflow.

Characterize antigen-specific CD8⁺ or CD4⁺ T cells by analysis of gene expression, surface markers and full length TCR sequences with applications in TCR discovery, cancer vaccine development and more.



dCODE Dextramer® (10x)



Designed to be compatible with the 10x Chromium System.

Couple information about gene expression, surface proteins, and VDJ sequences with antigen specificity at the single-cell level.

The peptide-specific barcodes enable multiplexing with many epitopes specific for one allele or combining dCODE Dextramer® with different alleles – for example analysis of both CD4⁺ and CD8⁺ T cells in the same sample.

How to Order dCODE Dextramer® Products

When ordering, please specify:

- The desired dCODE Dextramer® product [HiT, RiO or 10x]
- The dCODE Dextramer® Grade [Gold or Explore]
- Your choice of peptide MHC combinations. See our list of available MHC alleles [page 29]
- Test size
- If you require specific barcodes [up to 1,000 unique barcodes available]

Explore

- Reagent panels [16, 32, 48, 64, 80, 96, nx96 specificities] designed for large screenings
- Selected MHC I alleles available
- Peptide binding based on peptide-MHC affinity prediction, not validated by a quality control
- 25, 50 tests

Gold

- Single reagents designed for the analysis of few antigen specificities
- Broadest allele coverage: all MHC I and MHC II alleles from Immudex's catalog are available.
- Peptide binding validated by quality control
- 25, 50, 150 tests

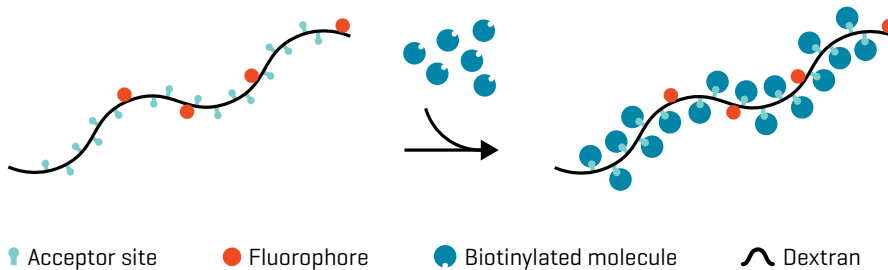
3.8. Klickmer®

Unravel Immunity Beyond T Cells

Based on the Dextramer® technology adapted to carry multiple universal acceptor sites, Klickmer® reagents offer unprecedented avidity for any well-defined binding target. Attach your biotinylated molecule of choice to Klickmer®.

Product Benefits

- Customized, sensitive, and efficient detection of your target of choice
- Stability and specificity characteristic of the Dextramer® technology
- High-resolution detection in numerous applications
- Short production turnaround time, save time searching and sourcing reagents



Relevant Information

- Fluorophore:** PE, APC, FITC or None
- Volume:** 60 µL, 200 µL, 1mL and 2 mL
- Catalog number:** DX01K-PE/APC/FITC/none

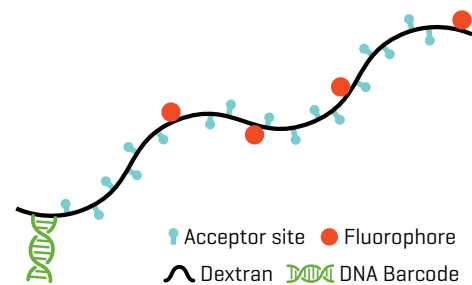
dCODE Klickmer® - Characterize Immune Responses Down to the Single-Cell Level

Through the application of DNA barcodes, you can identify your target of choice using NGS or single-cell multi-omics.

Get insights about gene expression, surface proteins, and VDJ sequences with single-cell antigen specificity.

Characterize your target of choice in one sample, one workflow, and without missing valuable information.

dCODE Klickmer® reagents are available in three options [HiT/RiO/10x] [page 20].



| dCODE Klickmer® [HiT /RiO/10x] | Volume | Number Specificities |
|-----------------------------------|-------------------|--------------------------------|
| Single Reagent | 30, 60, or 180 µl | 1-15 |
| Panel | 30 or 60 µl | 16, 32, 48, 64, 80, 96, 96 x n |

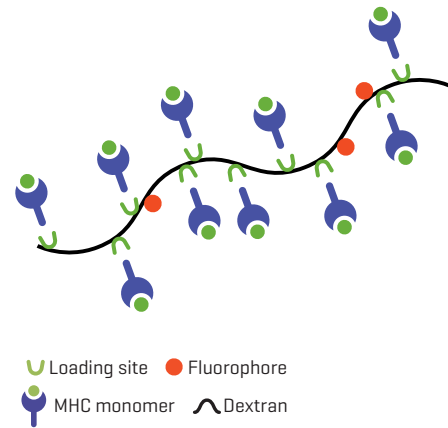
3.9. U-Load Dextramer®

Build Custom Dextramer® Reagents in Your Lab

Combine custom MHC-peptide complexes with the benefits of the Dextramer® technology. Build your multimer selecting from a broad range of peptide-receptive MHC I and MHC II alleles and use your own peptide sequence.

Product Benefits

- Create fit-for-purpose immune monitoring reagents
- Broadest allele coverage in the market
- Eliminate high reagent costs for high-throughput screening
- Fast and easy protocol with no UV-radiation



U-Load Dextramer® MHC I Kit

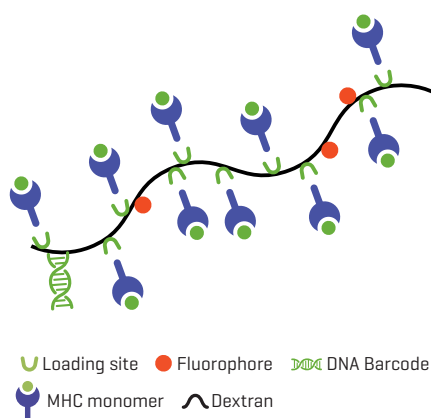
- Stabilizing dextran backbone [U-Load Dextramer®]
- Your choice of fluorophores: APC, PE, FITC, None
- Your selection of MHC I allele [page 29]
- Positive control peptide
- Test sizes available: 20, 50, 150 tests

U-Load Dextramer® MHC II Kit

- Stabilizing dextran backbone [U-Load Dextramer®]
- Your choice of fluorophore: APC, PE, FITC, None
- Your selection of MHC II allele [page 29]
- Test sizes available: 50, 150 tests

U-Load dCODE Dextramer®

Fully flexible targeted T-cell monitoring coupled to the power of Single-Cell Multi-Omics.



Define an antigen peptide of interest and assemble a custom MHC-peptide allele complex with your choice of a broad range of allotype monomers.

Relevant Information

The product will provide you with:

- Barcoded dextran backbone
- Your choice of dCODE Dextramer®: RiO, HiT or 10x [page 20]
- Your selection of MHC allele monomers [page 29]

U-Load dCODE Dextramer® is provided as:

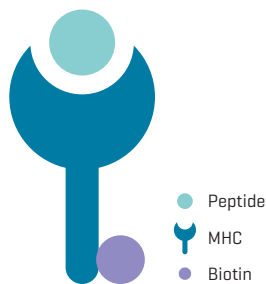
- Single reagents of 20 tests [24 µL], 50 tests [60 µL], or 150 tests [180 µL] each.
- Panels of 16, 32, 48, 64, 80, and 96 U-Load dCODE Dextramer® reagents for 20 tests [24 µL], or 50 tests [60 µL] each.

3.10. MHC Monomers

Whether ready-to-use or fully loadable, Immudex monomers are manufactured with the greatest attention to quality.

The Immudex Monomer portfolio covers a broad spectrum of monomer formats, alleles, and labeling options. The one thing that remains constant is quality.

MHC Monomers – Ready-to-Use Solutions



MHC I and MHC II biotinylated monomers with stringent quality control. Highly stable, they can be used whenever needed in your research.

Product Benefits

- Strict production and quality testing
- Biotinylated molecules, ready-to-use
- Broadest MHC allele coverage available
- Stable and robust in long-term storage

Relevant Information

- MHC I and MHC II available
- Volumes available: 2µg, 100µg, 200µg, 1mg and 2mg. Higher volumes upon request.
- If different alleles, specificity, volume or even a non-biotinylated monomer is needed, it can be done via Custom Solutions & Services [page 26].

easYmers® and U-Load® MHC II – Loadable Solutions

Biotinylated, MHC I easYmers® and U-Load® MHC II Monomers are peptide-receptive monomers that can be loaded onto U-Load Dextramer® [page 22]. This allows you to build your own Dextramer® or dCODE Dextramer® reagents or other MHC multimers with the epitope of your choice.



Relevant Information

easYmers®

Each easYmers® product contains the reagents necessary to:

- Load peptides into MHC I creating peptide-monomer complexes
- Validate proper refolding of peptide-loaded complexes via flow cytometry
- Protocol to load MHC-peptide onto U-Load Dextramer®
- Number of tests available: 20, 50, 150
- easYmers® MHC I are powered by immunAware.

U-Load® MHC II

Each U-Load® MHC II product contains the reagents necessary to:

- Load peptide into MHC II creating peptide-monomer complexes
- Peptide loading component
- Loading buffer
- Protocol to load MHC-peptide onto U-Load Dextramer®
- Number of tests available: 50, 150

4. Product Overview – GMP & IVD Products

Immune monitoring by flow cytometry is an increasingly important element in clinical research, cell therapy and vaccine development.

4.1. MHC Dextramer® [GMP]

Immudex offers MHC I Dextramer® [GMP] for applications that require excellent quality reagents produced with a high level of documentation, such as:

- Components for laboratory-developed tests (LDT)
- Reagents for medical devices governed by CLIA, FDA, and IVDD
- Tools for clinical trials and investigations in accordance with GC[L]P
- Materials for manufacturing and quality control of investigational and commercial pharmaceutical products

Accurate data rely on biological assays made with high quality reagents



MHC I Dextramer® produced according to current good manufacturing practices [cGMP]

Immudex is ISO 13485:2016 certified, registered with the FDA and audited regularly, which guarantees that MHC I Dextramer® [GMP] are produced in compliance with strict international cGMP standards for medical devices regarding quality control and product traceability. Every step of the manufacturing process described in our Quality Management System [QMS] includes:

- Documented procedures
- Documented employee training
- Material traceability
- Equipment maintenance and monitoring records
- In-process quality control
- Final product quality control
- Established shelf-life and expiry date
- Batch record review of released products
- Material traceability
- Batch specific certificate of analysis
- Change notifications
- Supplier evaluation, including on-site audit – upon request

Immudex can help you achieve your clinical goals

With deep knowledge of immune monitoring by flow cytometry and more than 10 years of experience with manufacturing we offer advice on experimental design. Contact our customer support to discuss your projects and needs for GMP reagents with our experienced scientists.

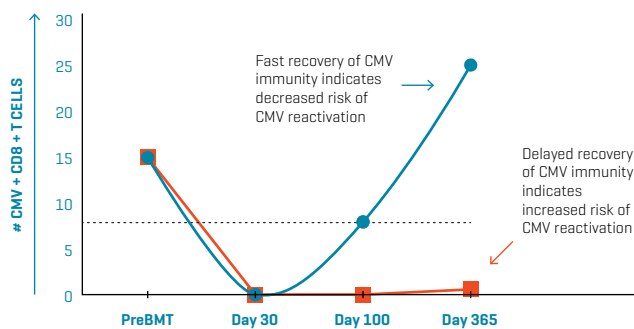
4.2. Dextramer® CMV Kit [IVD]

Several clinical trials have demonstrated the value of quantifying CMV-specific CD8⁺ T cells as a predictor of immune resistance to CMV after hematopoietic stem cell transplantation (HSCT).

The Dextramer® CMV Kit [IVD] is designed to enumerate CMV-specific CD8⁺ T cells in whole blood by flow cytometry. The kit is indicated in conjunction with other laboratory and clinical findings to assess CMV-specific immune status and risk of CMV reactivation in adult HSCT recipients following immunosuppression.

Identify Patients at Risk of CMV Infection

A semi-quantitative assay intended for the identification and enumeration of CMV-specific CD8⁺ T cells:



- Measure reconstitution of CMV-specific CD8⁺ T cells
- Manage patient stratification: Delayed recovery of T cells is associated with high-risk of CMV reactivation
- Guide therapeutic decision-making based on:
 - Cost-effective approach
 - Selection of optimal treatment

Model for CMV-specific T-cell immune monitoring in two post-transplant patients. The dashed line indicates the threshold for recovery of CMV T-cell immunity.

Relevant Information

The kit is for *in vitro* diagnostic [IVD] use in HSCT patients.

| Cat. Number | Content | Regulatory Status |
|-------------|---|---|
| CX01 | CMV-specific Dextramer® reagents: <ul style="list-style-type: none"> ■ HLA-A*0101/VTEHDTLTY ■ HLA-A*0201/NLVPMTATV ■ HLA-A*0301/KLGGALQAK ■ HLA-A*2402/QYDPVAALF ■ HLA-B*0702/RPHERNGFTVL ■ HLA-B*0702/TPRVTGGGAM ■ HLA-B*0801/ELRRKMMYM ■ HLA-B*3501/IPSINVHHY Negative control Dextramer® reagent | For <i>in vitro</i> diagnostic use in the EU |
| CX02 | CMV-specific Dextramer® reagents: <ul style="list-style-type: none"> ■ HLA-A*0101/VTEHDTLTY, ■ HLA-A*0201/NLVPMTATV ■ HLA-B*0702/TPRVTGGGAM ■ HLA-B*0801/ELRRKMMYM ■ HLA-B*3501/IPSINVHHY Negative control Dextramer® reagent Antibodies: Anti-CD8, Anti-CD3, Anti-CD4 | For <i>in vitro</i> diagnostic use in US [K153538 510(k) premarket notification] |

5. Immudex Services

Immudex is committed to empower scientists and clinicians worldwide to push the boundaries of their research.

5.1. Customs Solutions and Services

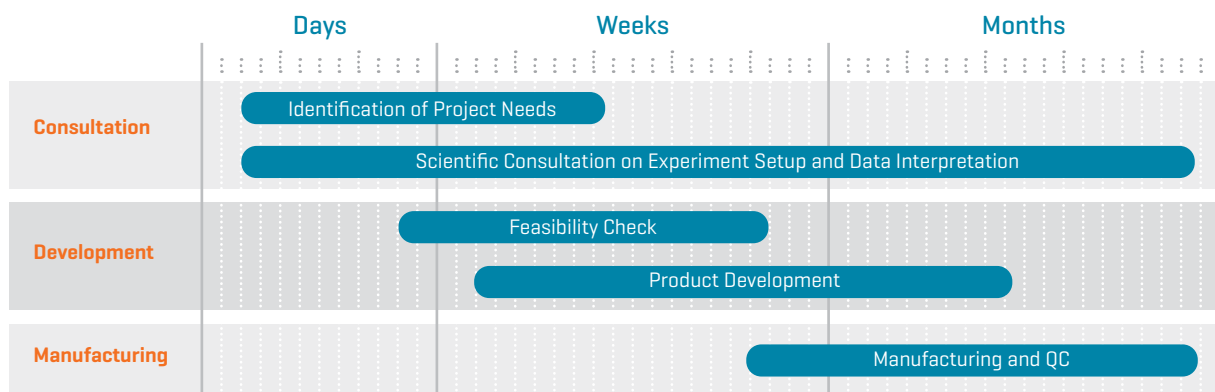
We offer custom solutions and services tailored to your needs providing unique Dextramer® products for unique research applications. Immudex experts accompany and see through every phase of the project. You will receive:

- A solution or service tailored specifically to your needs
- Access to extensive knowledge and expertise in immune monitoring
- Professional support and transparent communication
- The most advance scientific insights

| Custom Solutions | Custom Services |
|--|---|
| <p>Immudex's experts consult with your team to address the experimental requirements needed to succeed:</p> <ul style="list-style-type: none"> ■ Design of unique Dextramer® solutions suitable to your research ■ Custom protein expression and validation setup (TCR, MHC, or other) ■ Establishment of GMP production with stage-gate, stringent quality controls ■ Assistance in experimental design and data interpretation | <p>Immudex provides you with adaptations of the products offered in our standard portfolio adjusted to your experiment:</p> <ul style="list-style-type: none"> ■ Variation of the numbers of MHC monomers on the dextran backbone ■ Non-standard fluorophore labelling ■ QC assaying for reagent or monomer validation ■ Adjusted reagent concentration ■ Adjusted vial amount |

Relevant Information

Every project is assessed individually. Depending on scope, complexity and resource needs, a Custom Solution or a Custom Service is matched to your research needs.

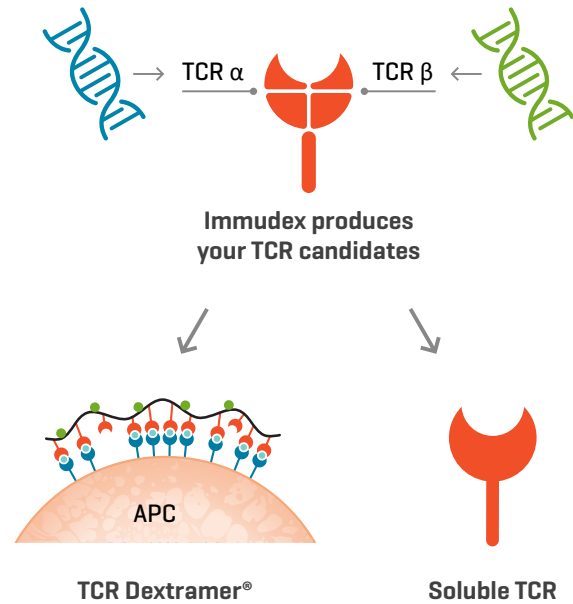


TCR Solutions

Immudex produces your TCR candidates, either as Soluble **TCR Monomers** or as **TCR Dextramer**[®] reagents.

Provide us with your candidate TCR sequences or discover them in your lab using dCODE Dextramer[®] reagents for single-cell multi-omics. Advance your research in:

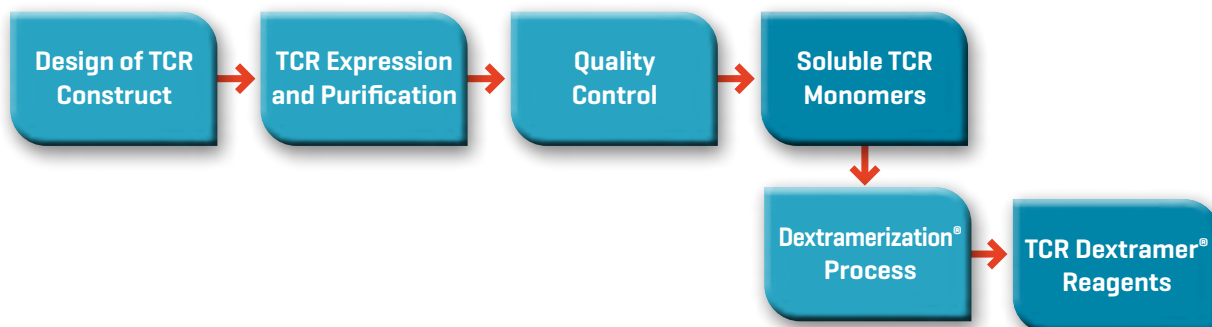
- ▮ Cross-reactivity screening
- ▮ TCR-like antibody applications
- ▮ Quantification of Antigen-Presenting Cells (APCs)
- ▮ Cell therapy e.g., TCR-T and CAR-T
- ▮ Analysis of TCR:pMHC complex affinity
- ▮ Validation and characterization of candidate TCRs
- ▮ Quality control of peptide or cell-based vaccines



| Soluble TCR Monomers | TCR Dextramer [®] |
|---|---|
| <p>Produced by expressing and refolding the TCR α and beta β chains.</p> <p>Soluble TCR Monomers are manufactured based on your candidate TCR sequences and undergo rigorous quality control to confirm specificity and functionality.</p> <ul style="list-style-type: none"> ▮ 20 μg, 100 μg, and 200 μg* | <p>Our experts combine your soluble TCR Monomers with the dextran backbone, enabling the reliable detection of pMHC complexes by flow cytometry or in-situ staining with high sensitivity.</p> <ul style="list-style-type: none"> ▮ 50, 150, or 500 tests* ▮ FITC, PE, or APC <p style="text-align: right; font-size: small;">*Larger sizes upon request.</p> |

Support from start to finish

TCR Solutions consist of different phases designed to meet the success criteria of your research. Immudex experts will accompany you through every phase of the project.



5.2. Immune Monitoring Proficiency Testing

We offer proficiency testing worldwide as a service to those laboratories interested in evaluating their immune monitoring performance with MHC multimer and T-cell ELISpot assays.

Why Participate

- **Evaluate and benchmark** your immune monitoring performance against fellow researchers and clinicians worldwide
- **CLIA and ISO 15189 certification** - support your accreditation process
- **Ensure alignment** with collaborators [e.g. multicenter trials]
- **Reinforce your credibility** with sponsors and regulatory agencies
- **Identify staff training** or protocol optimization needs

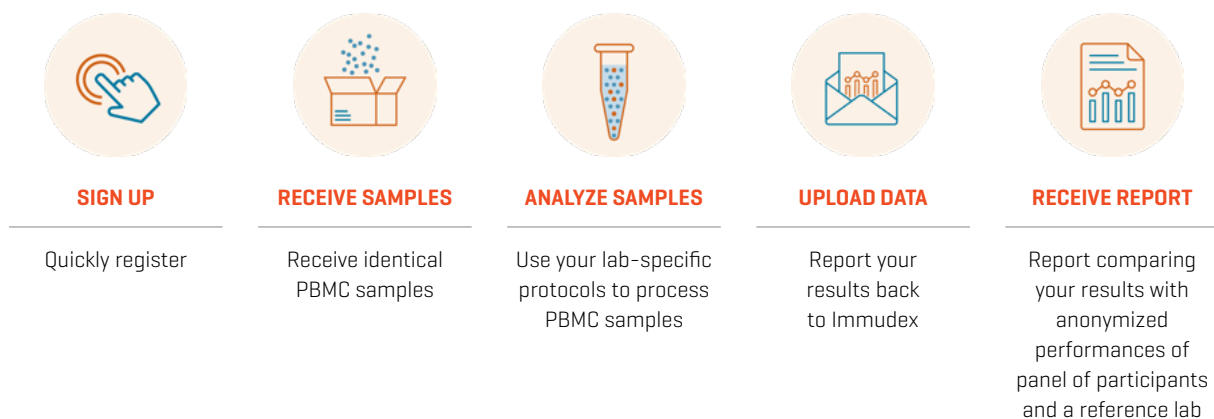
MHC Multimer Proficiency Testing

| Customers Receive | Customers Report |
|--|--|
| <ul style="list-style-type: none"> ■ PBMC samples: identical for all participants ■ If requested, MHC Dextramer® reagents free of charge ■ Assay instructions | <ul style="list-style-type: none"> ■ Total number of CD8⁺ T-cells in samples ■ Number of antigen specific CD8⁺ T-cells in samples ■ Percent antigen specific of T-cells compared to the total amount of CD8⁺ T-cells |

ELISpot Proficiency Testing

| Customers Receive | Customers Report |
|--|--|
| <ul style="list-style-type: none"> ■ PBMC samples: identical for all participants ■ Peptide pools: PepMix™ HCMV [pp65] + CEFX Ultra SuperStim Pool ■ Negative control reagent ■ Assay instructions | <ul style="list-style-type: none"> ■ Spot count per well after stimulation with either a peptide pool or a negative control reagent |

Proficiency Testing – Step by Step



6. MHC Alleles List

Our list of available MHC alleles is constantly expanding.

On our website you can select from **>90 available MHC alleles**, including human, mouse, and primates:

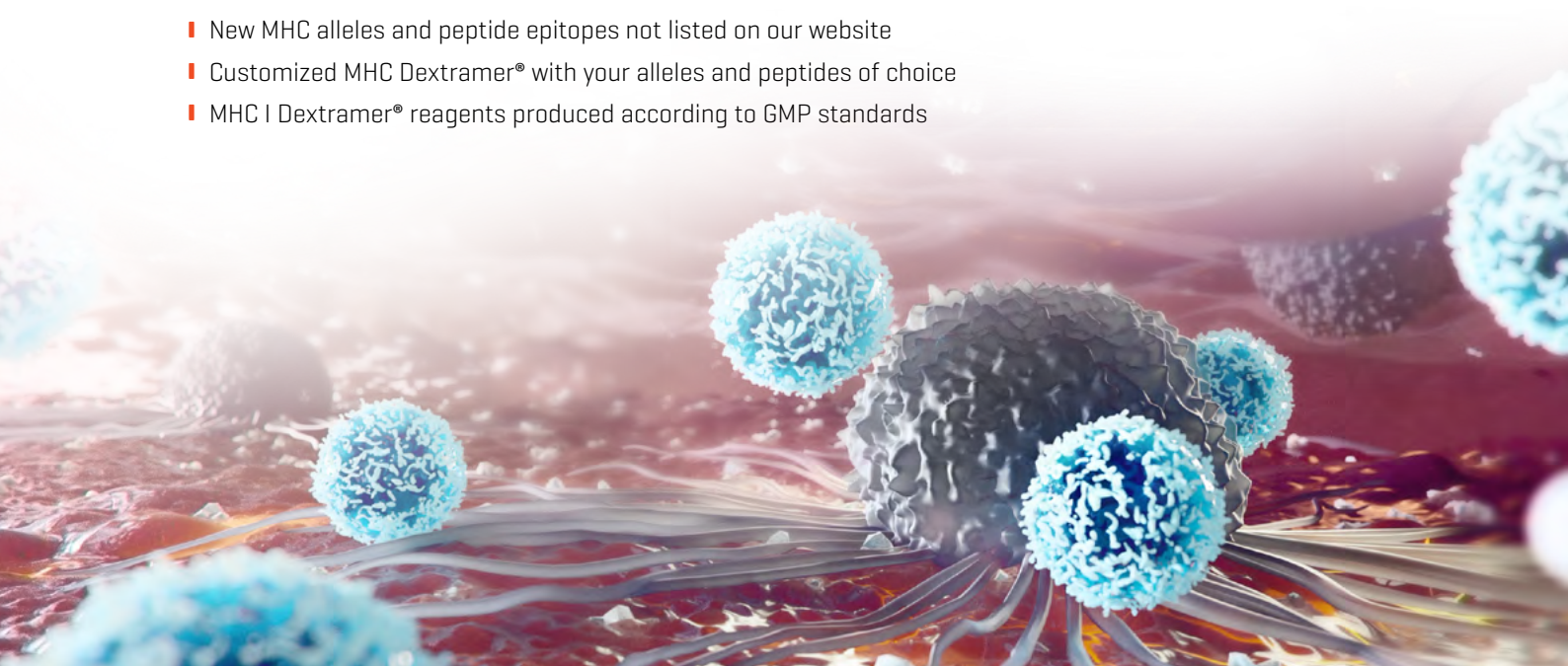
<https://www.immudex.com/resources/mhc-alleles-list/>

| Selected list of available MHC alleles | | | | |
|--|------------|--------|-----------|----------------|
| MHC I Alleles | | | | MHC II Alleles |
| Human | | Mouse | Primate | Human |
| HLA-A*0101 | HLA-B*2705 | H-2 Dd | Mamu-A*01 | HLA-DRB1*0101 |
| HLA-A*0201 | HLA-B*3501 | H-2 Dk | Mamu-A*08 | HLA-DRB1*0301 |
| HLA-A*0301 | HLA-B*4201 | H-2 Kb | Mamu-B*17 | HLA-DRB1*0401 |
| HLA-A*1101 | HLA-B*4403 | H-2 Kd | | HLA-DRB1*0701 |
| HLA-A*2301 | HLA-B*5101 | H-2 Kk | | HLA-DRB1*1101 |
| HLA-A*2402 | HLA-B*5701 | H-2 Ld | | HLA-DRB1*1501 |
| HLA-A*2902 | HLA-B*5703 | H-2 Db | | HLA-DPB1*0401 |
| HLA-A*6801 | HLA-C*0304 | | | |
| HLA-B*0702 | HLA-C*0602 | | | |
| HLA-B*0801 | | | | |

Customized Solutions for Your Research

Immudex offers customer-defined MHC Dextramer® reagents tailored to your needs:

- New MHC alleles and peptide epitopes not listed on our website
- Customized MHC Dextramer® with your alleles and peptides of choice
- MHC I Dextramer® reagents produced according to GMP standards



7. Resources

We are dedicated to empowering researchers and clinicians worldwide to push the boundaries of medicine through advanced antigen-specific immune-based tools.

Educational Material

Find a selection of posters, case studies, and application notes.

<https://www.immudex.com/resources/educational-material/>

Technical Support

Let us know if you have any questions. Our dedicated Technical Support team is here to help you.

customer@immudex.com

Custom Solutions and Services

Unique Dextramer[®] products for unique research applications. Find the most suitable and tailored solution for your research needs.

Contact us to discuss how we can help you: customer@immudex.com

Contact us

Immudex ApS [Headquarters]

Bredevej 2A, 2830 Virum, Denmark

Tel: +45 31 10 91 91

Immudex LLC

10300 Eaton Place Suite 440

Fairfax, Virginia 22030, USA

Email: customer@immudex.com

FAQs

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