Innovative Peptide Solutions

Immunoology

Peptide Tools for

› Immunotherapy
› Immune Monitoring
› Vaccine Development
› Neo-Epitope Identification and Validation
› Antibody Signature Profiling
› Biomarker Discovery
History

JPT Peptide Technologies is a service provider located in Berlin, Germany that has achieved worldwide credibility for its commitment to rigorous quality standards and a reputation for developing and implementing innovative peptide-based services and research tools for various applications.

Together with its US-subsidiary in Boston, Massachusetts, JPT serves its clientele in the pharmaceutical and biotechnology industries as well as researchers in universities, governmental and non-profit organizations.

Technology & Application

Over the past decade JPT has developed a portfolio of proprietary technologies as well as innovative products and services that have helped to advance the development of new immunotherapies, proteomics and drug discovery.

Quality Assurance

JPT is DIN EN ISO 9001:2015 certified and GCLP audited.

JPT’s key technologies are:

PepMix™
Defined antigen spanning peptide pools to stimulate CD4+ and CD8+ T-cells.

PepTrack™
Peptide libraries offering various specifications and optimization for different types of assays.

GxP Peptides
Custom peptides for the stringent requirements of cellular therapy, vaccine and drug development.

TERS™
Technology to produce TCR-engineered reference samples for performance control of T-cell assays.

PepStar™
Peptide microarrays for epitope discovery, humoral immune monitoring and protein-protein interactions studies.

SPOT
High-throughput peptide synthesis for T-cell epitope and neo-epitope qualification and discovery.

SpikeTides™
Light and stable isotope-labeled or quantified peptides for mass spectrometry based proteomics assays.

Custom & Specialty Peptides
We are peptide experts and offer the largest variety of peptide chemistries, formats and modifications.
04 / Cellular Immunity
- 05 / Universal T-Cell Assay Standard TERS™ Kit
- 06 / PepMix™ Peptide Pools for T-Cell Assays
- 08 / PepTrack™ Peptide Libraries
- 10 / GxP Peptides
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24 / Bio- & Cheminformatics
Selected Application Notes by our Customers

“Developing Multi-HIV Antigen Specific T Cells as a Component of a Cure Strategy”
S. Lam, C. Russell Cruz and C. Bollard

“Peptide-Stimulated Expansion of Virus-Specific T-Cells for Preventative Treatment after Allogeneic Stem Cell Transplantation”
R. Gary, M. Aigner, A. Moosmann and A. Gerbitz

“Strategy for Identification of CD8 T-cell Epitopes in a Viral Protein”
R. Holtappels

“Multiple Sclerosis and Epstein-Barr Virus Infection – An Epitope Mapping Study”
U. Reimer, B. Wunderlich, C. Scheibenbogen and K. Ruprecht

“Characterization of the Aspergillus-Specific T-Cell Response by Using Crl1 and Catalase1 Overlapping Peptides”
H. Jolink and M. H. M. Heemskerk

“PepMix™ Peptide Pools for Clinical Applications: T-Cell Therapy for Viral Infections after Hematopoietic Stem Cell Transplant”
J. M. Keirnan, C. M. Rooney, and A. M. Leen

“Rapid Mimotope Optimization for Pharmacokinetic Analysis of the Novel Therapeutic Antibody IMAB362”

“BioTides™ as High Throughput Screening Tool for the Identification of Antibody Binding Sites”

“Qualification and Use of Peptide Libraries for Clinical Trial Immunomonitoring”
J.H. Cox and P. Hayes

Download full text at:
www.jpt.com/application-notes/

JPT – Specialists for Immunology

We are a regulated and innovative service and tool provider for all peptide related projects in immune and cellular therapy, vaccine development and immunomonitoring. Our proprietary technologies help to advance novel diagnostic and therapeutic approaches for cancer, infectious and autoimmune diseases as well as allergies.
Our Technologies & Products

Cellular Immunity

- **PepMix™ Peptide Pools & PepTrack™ Fast Track Peptide Libraries**
  - deep, antigen- and proteome spanning target identification
  - In-Silico Models for Library Design

- **Matrix Pools & PepTrack™ Research Track Peptide Libraries**
  - fast (neo-) epitope qualification

- **GxP Peptides & Pools**
  - adoptive cell transfer, dendritic cell pulsing and vaccination
  - In-Silico Peptide Selection

- **PepTrack™ Trial Track Peptide Libraries & PepMix™ Peptide Pools & Dextramer™ Multimers & Universal T-Cell Assay Standard TERS™ Kit**
  - clinical T-cell assays

Humoral Immunity

- **PepStar™ High Content Peptide Arrays**
  - deep antibody signature profiling
  - In-Silico Models for Library Design

- **RepliTope™ Peptide Microarrays & Peptide ELISA**
  - B-cell epitope and seromarker qualification

- **Antigen Peptides & MAP Peptides & Peptide Conjugates**
  - to proteins, adjuvants, PEG and more for antibody generation

- **Modular Humoral Immune Profiling**
  - using various platforms, peptide arrays, peptide ELISA and more
  - Bioinformatic Data Evaluation
Cellular Immunity

JPT offers the widest range of products and services to address cellular immunity. Those include PepTrack™ high content peptide libraries enabling fast target discovery and neo-epitope qualification, PepMix™ Peptide Pools for reliable clinical immune monitoring, GxP Peptides for cell- and immunotherapy and TERS™ to develop robust and validated T-cell assays.

Let’s talk about peptides for T-cell assays!

- **Peptide & Pool Design**
  There are many ways to design your peptide library or pool. Ask us for support!

- **Peptide Purity**
  Even small impurities may create huge problems in T-cell assays. However, the impact depends strongly on the application. Let us help to select your specification.

- **Solubility**
  Ever had the problem to dissolve a peptide or having limited solvent choices? We help to predict the solubility of a peptide and select the peptide sequences that work best.

- **Stability & Storage**
  About 20% of all peptides show a limited shelf stability. How do you recognize and handle potentially unstable peptides? We will support you.

- **Peptide Content & Net Weight**
  In addition to side products analyzed by HPLC, peptides contain non-peptidic components. The quantification of those is essential to accurately adjust peptide concentration.

- **Cross Contamination**
  Contamination with other peptides, causing false positive T-cell responses, represents a challenge for immunology products. Learn about our offers to warrant line clearance.

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**Benefit:** Lowest cost per peptide, ultra fast turnaround

**Benefit:** CD4⁺ and CD8⁺ detection, robust responses and assay validation

**Benefit:** Regulated production and know-how for clinical applications
Universal T-Cell Assay Standard TERS™ Kit

We offer an innovative, easy-to-use kit to produce TCR-engineered reference samples (TERS) for antigen-specific T-cell assays. A lack of standard control reagents for immunological T-cell assays has been limiting the comparability of antigen-specific test results. With the Universal T-Cell Assay Standard TERS™ Kit test results can be quantitatively compared across time points, platforms, or laboratories.

The TERS™ Technology

The TERS™ technology is based on a simple and efficient protocol for T-cell-receptor-engineered PBMC samples with a defined number of antigen-specific T-cells. These cells can be used in combination with MHC-multimer staining, ICS or ELISPOT assays and represent an ideal tool for validating and monitoring assay performance. TERS was developed in collaboration with TRON (Translational Oncology at the University Mainz).

Select Your TERS™ Kit

When used as an independent, internal reference standard, TERS specificity is immaterial. However, depending on the reagents that you already have (for example peptides for stimulation or MHC multimers) you may have a preference for one or the other. Please choose between these different T-cell receptor specifications: CMV, Influenza, Tyrosinase or NY-ESO1.

Applications

- Standardization of T-cell assays (ELISPOT, ICS, multimer staining)
- Performance control of T-cell assays
- Calibration of antigen-specific assays

Benefits

- Compare test results across time points, platforms or laboratories
- Quantify assay performance
- Scalable and robust
- Test one or more specificities per batch
- Easy production of TERS
- All required reagents in one kit

Selected Reference

PepMix™ Peptide Pools for T-Cell Assays

JPT’s PepMixes™ are synthetic peptide pools containing overlapping peptide scans through antigens or selected MHC restricted epitopes. PepMixes™ are used to stimulate antigen-specific T-cells in vaccine development, cell and immunotherapy and for immune monitoring.

Benefits
For reliable and validated T-cell assays such as ELISPOT, appropriate positive and negative controls are essential to confirm proper functionality of the assay and viability of the cells. Compared to commonly used controls like PHA, ConA or full length antigens, synthetic peptide pools offer the advantage of a high batch-to-batch reproducibility, application of reliable chemical and biochemical QC/QA measures, longer stability and extremely efficient immunostimulation.

Applications
Efficient in vitro stimulation of antigen-specific CD4⁺ and CD8⁺ T-cells
• For monitoring of cellular immune responses
• For vaccine efficacy testing
• For cell therapy approaches
• As positive and negative controls
• For vaccine target identification
• For T-cell epitope mapping

Specifications
• Length/Overlap: 15/11 aa
  (for pooled peptide scans)
• Purity: 70% to 95% (LC-MS)
• Amount: 25 tests/vial

Selected References
→ “Protective Efficacy of Multiple Vaccine Platforms Against Zika Virus Challenge in Rhesus Monkeys” Abbink et al., Science (2016)

→ “Self-Amplifying mRNA Vaccines Expressing Multiple Conserved Influenza Antigens Confer Protection against Homologous and Heterosubtypic Viral Challenge” Magini et al., PloS one (2016)

→ “A Phase I Study of Recombinant (r) Vaccinia-CEA (6D)-TRICOM and rFowlpox-CEA (6D)-TRICOM Vaccines with GM-CSF and IFN-α-2b in Patients with CEA-Expressing Carcinomas” Duggan et al., Cancer Immunology, Immunotherapy (2016)


The new CEFX Ultra SuperStim Pool is the most efficient positive control across all populations!
Select Your PepMix™

Cancer
Breast Cancer  Burkitt’s Lymphoma  Gastric Cancer  Genital Cancer  Glioma  Hodgkin’s Lymphoma  Leukemia  Liver Cancer  Melanoma  Merkel Cell Carcinoma  Nasopharyngeal Carcinoma  Ovarian Cancer  Prostate Cancer  Testicular Cancer

Controls
CEFX UltraSuperStim Pool  CEF Pool  CEF (ext.) Pool  CEFT Pool  EF Pool  HCMV (pp65)  HCMV (IE1)  HCMV (IE2)  Human (Actin)  Human (MOG)

Customized PepMix™
We offer fast and low priced production of tailored PepMixes™ from your specific antigen, neo-epitopes or peptide library. We help choose the appropriate peptide purity, specifications and pool layout.

Matrix Pools
Matrix pools offer an efficient way to map epitopes by presenting each peptide in two different pools. Have a look at the figure below! Our customer support team will assist you with the design.

A full up-to-date list can be found on: www.shop.jpt.com

“[...] we utilised the CEF Pool (extended) as well as a custom synthesized PepMix™ spanning the core region of HBV genotype D. [...] Our entire experience with JPT, from ordering/delivery to use in the lab was excellent. [...] JPT will remain our “go-to” company for purchasing peptides.”

L. Pallett, Infection and Immunity, University College London, UK

<table>
<thead>
<tr>
<th>Pool No.</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
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<td>IX</td>
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<td>XII</td>
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<td>63</td>
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</table>

Master Pool contains all 64 peptides.
Matrix Pool I contains peptides 1, 9, 17, 25, 33, 41 and 49.
Matrix Pool II contains peptides 2, 10, 18, 26, 34, 42, 50 and 58.
Matrix Pool IX contains peptides 1, 2, 3, 4, 5, 6, 7 and 8.
Matrix Pool X contains peptides 9, 10, 11, 12, 13, 14, 15 and 16.
PepTrack™ Peptide Libraries

Our customized peptide libraries offer unlimited flexibility. They are optimized for antigen-specific stimulation of T-cells in immune monitoring, T-cell epitope identification, and development of cellular therapies. We implemented specific parameters for synthesis, purification and analysis of peptide libraries that are important to avoid false positive T-cell responses or toxic inhibition of T-cells and increase shelf-life of peptides.

Specifications
- Tailored peptide libraries
- Different quality grades (see table)
- Optimized for cellular assays
- PTMs and labeling available
- Production ISO 9001:2015 certified

Benefits
- Post-translational modifications available
- Detection of CD4+ and CD8+ responses
- Full coverage of sequence diversity
- Fast: 10,000 peptides/3 weeks
- Low cost: from USD 4/peptide

Selected References
- “Identification of a Naturally Processed HLA-A*02:01-Restricted CTL Epitope from the Human Tumor-Associated Antigen Nectin-4”
  Lopez et al., Cancer immunology, immunotherapy (2016)
- “Deletion of A44L, A46R and C12L Vaccinia Virus Genes from the MVA Genome Improved the Vector Immunogenicity by Modifying the Innate Immune Response Generating Enhanced and Optimized Specific T-Cell Responses”
  Holgado et al., Viruses (2016)

“For reliable monitoring of tumor and virus specific T-cell responses, we have a permanent need for peptides and peptide pools that are produced in a regulated environment for application in a clinical environment. JPT has been a long term and dedicated partner in this regard which continuously works on improving it’s peptide based services.”

C. Scheibenbogen, Charité Berlin, Berlin, Germany

Left: PepTrack™ Peptide Libraries are delivered freeze-dried in multiwell plates or tube racks (micronics).

Below: Automated synthesis of PepSpots™ membranes.
PepTrack™ Options

<table>
<thead>
<tr>
<th>Purity</th>
<th>Scale</th>
<th>Applications</th>
<th>JPT’s Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Track</td>
<td>Unpurified</td>
<td>10-100 nmol</td>
<td>10000 peptides / 3 weeks</td>
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<td></td>
<td>Unpurified or</td>
<td>1-5 mg</td>
<td>1000 peptides / 3 weeks</td>
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<td>main product =</td>
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<tr>
<td>Research Track</td>
<td>target peptide</td>
<td></td>
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<tr>
<td>Discovery Track</td>
<td>&gt; 70%</td>
<td>1-5 mg</td>
<td>500 peptides / 4 weeks</td>
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<td>Trial Track</td>
<td>&gt; 80%</td>
<td>1-5 mg</td>
<td>500 peptides / 6 weeks</td>
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<td>&gt; 90%</td>
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<td>&gt; 95%</td>
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<td>&gt; 97%</td>
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<td>&gt; 97%</td>
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</table>

Please inquire for larger scales and further options!

Provision of high-content Fast Track peptide libraries or pools by SPOT technology.
Left: Overlapping peptide scan through one or several antigens. Right: Neo-epitope library from NGS results.

Proteins of interest or whole cell proteome
Peptide library design
High-throughput SPOT peptides

Antigen spanning peptide pools, matrix pools and/or peptide libraries with individual peptides

NEO-epitopes from NGS results
GxP Peptides

Our enhanced production environment for GxP Peptides goes beyond ISO 9001:2015 regulations to meet the more stringent product requirements of immunotherapy as well as vaccine and drug development. Thus, the resulting GxP Peptides and GxP Peptide Pools have been approved for several clinical trials in immuno and cellular therapy.

Why choose JPT for GxP projects?
- More than 20 years experience on peptides as drugs, vaccines and for cell therapies
- Comprehensive know-how and dedicated staff make us the peptide experts
- QC beyond ISO 9001:2015 regulations
- Publication record of clinical trials using JPT

Quality Assurance and Control
- Line clearance
- Cleaning validation
- Full traceability
- ADCF policy
- Incoming material inspection
- Vendor qualification
- QC/QA documentation
- Batch release control

Optional Chemical Analyses
- Residual solvent determination
- Water determination
- Peptide content determination
- Amino acid analysis
- UPLC measurement
- Stability and solubility testing
- Peptide sequencing

Optional Microbiological Analyses
- Bacterial endotoxin determination
- Sterility testing
- Bioburden determination
- Bacteriostatic and fungistatic effect of products

“We recently demonstrated the feasibility and clinical benefit associated with the infusion of rapidly generated single-culture VSTs, manufactured using JPT’s GxP PepMix™ Peptide Pools covering 12 immunogenic antigens from five viruses (EBV, AdV, CMV, BK, and HHV6). When administered to 11 allogeneic stem cell transplant recipients, 8 of whom had up to four active infections, these VSTs produced an overall 94% response rate.”

A. M. Leen, Baylor College of Medicine, Houston, TX, USA
Quality Levels

<table>
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<tr>
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<tbody>
<tr>
<td>Applications</td>
<td>Target/Epitope Discovery &amp; Immune Monitoring</td>
<td>Clinical Immune Monitoring &amp; Immune Diagnostics</td>
<td>Immuno- &amp; Cell Therapy</td>
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<td>Incoming Material Inspection</td>
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<td>Vendor Qualification</td>
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<td>Document Management &amp; LIM-Systems</td>
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<td>Documented Cleaning &amp; Calibration</td>
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<td>Batch Documentation &amp; CoA based on IND Requirements</td>
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<td>Delivery in Certified Vials</td>
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<td>Impurity ID &amp; Qualification</td>
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<td>Optional Services: Residual Solvents; Sterility, Endotoxin; Monitored Storage…</td>
<td>x</td>
<td>x</td>
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</tr>
</tbody>
</table>

* spatial separation of processes

Selected References

- "Human Parainfluenza Virus-3 can be Targeted by Rapidly Ex Vivo Expanded T Lymphocytes" McLaughlin et al., Cytotherapy (2016)
- "Broadly-specific Cytotoxic T Cells Targeting Multiple HIV Antigens Are Expanded From HIV+ Patients: Implications for Immunotherapy" Lam et al., Molecular Therapy (2015)
- "Expanded Cytotoxic T-cell Lymphocytes Target the Latent HIV Reservoir" Sung et al., Journal of Infectious Diseases (2015)
- "Ex vivo Expansion of Human T cells for Adoptive Immunotherapy Using the Novel Xeno-free CTS Immune Cell Serum Replacement" Smith et al., Clinical & Translational Immunology (2015)
- "Activity of Broad-Spectrum T Cells as Treatment for AdV, EBV, CMV, BKV, and HHV6 Infections After HSCT" Papadopoulou et al., Sci Transl Med. (2014)
Custom & Specialty Peptides

The exceptional quality and reliability of our service has been appreciated by customers worldwide for many years. JPT is the premier provider of custom peptides and specialty peptides, such as phosphopeptides, immunogenic peptides, cyclic peptides or peptide conjugates.

Options and Specialties

- Fluorescent and chromogenic peptides
- Internally quenched peptides (Abz/nitroTyr, EDANS/DABCYL, MCA/DNP) guaranteed without fluorescent impurities
- Immunogenic peptides (MAPs, palmitinylation, Pam3Cys labeling, etc.)
- Phospho-peptides and peptidomimetics (amide bond isosteres, non-natural amino acids, etc.)
- Non-commercial building blocks available
- Labeling (non-radioactive isotopes, chromophores, etc.)
- Site-directed conjugations with KLH, BSA, ovalbumin or other carriers
- Cyclic peptides (disulfide bridges, lactams, thioether-bridges, etc.)
- Long peptides (> 70 amino acids)
- Scales ranging from 1 mg to several grams

Benefits of JPT’s Custom Peptides

- Proprietary synthesis technologies warrant fastest turnaround and most competitive pricing
- Reliable and stringent QC/QA
- ISO 9001:2015 and GLP compliance
- Rapid order processing
- Large variety of chemistry protocols
- Fully automated pooling, aliquoting and vialing
- Solubility, stability and sterility testing optional
- Personal consultation with experienced scientists
- Highest purities available (> 95 %, > 97 %)
- Full range of analyses including LC-MS (trap and/or quad), MALDI-MS, HPLC, AAS, NMR, CE, UPLC, HR-MS, as well as peptide content determination to confirm the identity and demonstrate the high quality of our peptides
- Substantial, long-standing expertise in providing custom peptides
- Highly skilled and committed scientific staff

Need other modifications or specifications? We will give our best to make it happen! Contact us at peptide@jpt.com!

Freeze dried peptides are delivered with full analytical coverage.
**Quality Assurance**

- JPT’s entire peptide production, purification and analysis procedures are backed by a stringent DIN ISO 9001:2015 certified Quality Management System
- All quality relevant processes are well documented and regulated according to a comprehensive SOP system
- All peptide production is performed at JPT’s headquarters in Berlin, Germany under continuous quality measures
- All peptides assembled from components that are of non-animal origin

**Selected References**

> “Effect of HIV-1 Envelope Cytoplasmic Tail on Adenovirus Primed Virus Encoded Virus-Like Particle Immunizations”
> Andersson et al., Vaccine (2016)

> “Identification of Peptide Mimics of a Glycan Epitope on the Surface of Parasitic Nematode Larvae”
> Umair et al., PloS One (2016)

> “Safety, Immune and Clinical Responses in Metastatic Melanoma Patients Vaccinated With a Long Peptide Derived From Indoleamine 2,3-Dioxygenase in Combination With Ipilimumab”
> Bjoern et al., Cytotherapy (2016)

“...Our research relies heavily on developing robust high-throughput screens with fluorescent peptides. We have found that JPT’s are the best on the market because the signal-to-noise ratio is very high, providing the sensitivity we need for the screens. Their peptides always perform well. In addition, the knowledge, wonderful customer support, and fast turnaround time provided by JPT have been invaluable in helping us develop the best peptides for our assays.”

Carla Koehler, Professor, UCLA, Chemistry & Biochemistry, Los Angeles, CA
MHC Multimers & Antigen Peptides

Fluorescent-labeled MHC multimers are used to detect, quantify and isolate antigen-specific T-cells by flow cytometry, and for in situ detection by immunohistochemistry (IHC). The corresponding antigen peptides are available for T-cell stimulation.

MHC Multimers

Dextramers combine a dextran polymer backbone with a high number of MHC and fluorochrome molecules. Therefore, they show a stronger staining intensity than other multimers with minimal background staining.

Applications
- Detection, enumeration and isolation of antigen-specific T-cells by flow cytometry
- In vitro staining of tissue sections

Benefits
- More sensitive than conventional MHC multimers
- Applicable for low-affinity interactions (e.g. in cancer and autoimmune disease)

Selected References
- “Combination Immunotherapy after ASCT for Multiple Myeloma Using MAGE-A3/Poly-ICLC Immunizations Followed by Adoptive Transfer of Vaccine-Primed and Costimulated Autologous T Cells” Rapoport et al., Clin Cancer Res (2014)

Antigen Peptides

For each MHC Multimer we offer the corresponding antigen peptide to stimulate antigen-specific T-cells in functional T-cell assays such as ELISPOT.

Applications
- Stimulation of antigen-specific CD8+ T-cells
- Immune monitoring of cellular immune responses
- Validation of multimer assay results

Benefits
- Conveniently order the corresponding peptide for every multimer
- Freeze-dried for long shelf-stability
- Off-the-shelf for quick delivery

Selected References
- “Identification of Theileria lestoquardi Antigens Recognized by CD8+ T Cells” Goh et al., Plos One (2016)
- “Identification of a A naturally Processed HLA-A*02:01-Restricted CTL Epitope from the Human Tumor-Associated Antigen Nectin-4” Lopez et al., Cancer Immunology, Immunotherapy (2016)
Humoral Immunity

Our proprietary tools and services to study humoral immunity range from high content PepStar™ Peptide Microarrays, PepSpot™ Arrays and RepliTope™ Multiwell Microarrays to Peptide ELISA and peptides conjugated to carriers and adjuvants. The reliability of these papers allows not only the differential analysis of biological samples for immune profiling and epitope identification but also antibody generation and mimotope optimization at high efficiency.

Let’s talk about peptide arrays

- **Peptide or Protein Arrays**
  Epitope discovery and analysis of epitope spreading are only possible on peptide level. Additionally, short peptide binders enable development of robust diagnostic tests.

- **Sample Consumption**
  Only tiny amounts of your precious samples are needed for incubation. Our microarrays are applicable to serum, blood or cell lysate as well as purified antibodies or proteins.

- **Batch-to-Batch Consistency**
  A single synthesis batch yields in hundreds of identical microarrays. All peptides have the same flexible orientation due to a direct-ed immobilization to the slide surface.

- **Peptide Purity**
  Our proprietary PepStar™ technology includes a purification step for each peptide. We warrant that all peptides are free of deletion sequences that are a source for false positive results.

- **Validation of Identified Seromarkers**
  Use our Peptide ELISA platform as robust tool to confirm and validate protein-protein interactions such as antibody-epitope binding.

- **Sequence Diversity and PTMs**
  We address sequence diversity as found in cancers and viruses by combining our bioinformatic ULTRA approach with advanced chemistry protocols to assemble peptide libraries and arrays.

**Benefit:** Fast emergency response to zoonotic infections, differential analysis of similar pathogens (i.e Flaviviruses)

**Benefit:** High sample throughput, low cost per sample, low sample consumption

**Benefit:** Robust, reproducible and quantitative confirmation of discovery results
Immunology Tools

Humoral Immunity

PepStar™ Tailored Peptide Microarrays

Our unique PepStar™ Peptide Microarrays are used for target discovery, immune monitoring, antibody epitope mapping, multiplexed epitope mapping or for detection and validation of protein-protein interactions. They can display up to 21000 peptides from antigens or whole proteomes from pathogens, tumor associated antigens, or designed peptides.

What are PepStar™ Peptide Microarrays?

Large numbers (up to 21 000) of peptides are N-terminally attached to glass slides by directed and chemoselective immobilization. Patented high-throughput synthesis of peptides results in high-content peptide arrays. Yield of synthesis is sufficient to generate hundreds of identical slides. Incubation can be performed with proteins and patient samples. Read-out is achieved by fluorescence using validated protocols and commercial equipment.

Applications

- Target discovery
- Seromarker identification and validation
- Multiplexed immune monitoring in clinical trials
- Elucidation of antigen and epitope spreading during disease progression and therapeutic intervention
- Mapping of immunodominant regions in antigens
- QC/QA of therapeutic biologics
- Vaccine target identification
- Identification and optimization of enzyme substrates

Benefits

- Cost effective provision of hundreds of identical microarrays from a single synthesis batch
- Directed immobilization of purified peptides
- Flexible co-immobilization of controls
- Chemical synthesis and analysis warrant batch-to-batch reproducibility
- High shelf stability
- High assay sensitivity
- Defined posttranslational modifications are possible
- Commercial incubation and read-out equipment can be applied
- Low consumption of patient materials and proteins
- Incubation and read-out protocols available

We will be happy to discuss the design of your peptide microarray. Contact our support team at peptide@jpt.com!

Above:
Your PepStar™ microarrays are delivered with detailed QC/QA documentation and application protocol.

Right:
State-of-the-art printing devices support high accuracy and batch-to-batch reproducibility.
One focus of our group is to decipher the nature of immune responses by identification of biomarkers and indicators of immune protection. With the support of JPT’s high content peptide microarray platform, we created a peptide chip which contains 22,000 individual peptides. This enabled the visualization of the B-cell “signature” in individuals with TB-infection vs. non-infected individuals. In our hands, JPT’s peptide microarrays turned out to be very robust tools to identify novel peptide based biomarkers in the context of novel diagnostics and vaccine target identification.

Prof. Markus Maeurer, Karolinska Institute, Solna, Sweden

Selected References

- “Protective Efficacy of Multiple Vaccine Platforms Against Zika Virus Challenge in Rhesus Monkeys” Abbink et al., Science (2016)
- “Increased IgG Antibody Responses to Neoepitope and Native Peptides Containing High Affinity Domains for MHC-I Following Combination Cancer Immunotherapy” Hulett et al., Cancer Research (2016)
- “Development of a Genus-Specific Antigen Capture ELISA for Orthopoxviruses–Target Selection and Optimized Screening” Stern et al., PloS one (2016)

The PepStar™ Microarray layout depends on the number of peptides and can be adjusted to your needs.

Left: High density microarray with 3 subarrays.
Right: Multiwell microarray with 21 subarrays (3 copies each) that can be incubated separately with different samples using a multiwell array chamber.
RepliTope™ Catalog Peptide Microarrays

RepliTope™ combine all the advantages of PepStar™ Microarrays with the availability of a catalog product. We selected many common antigens from infectious pathogens and cancer types. The RepliTope™ Antigen Collections are high density peptide microarrays displaying large collections of antigens from, or even the whole proteome of a particular virus or bacterium.

### Applications
- Antibody epitope mapping and optimization
- Antibody signature profiling
- Seromarker discovery
- Immune monitoring
- Protein-protein interactions

### Benefits
- Premade microarrays available within days
- RepliTope™ display peptide scans through antigens or whole proteomes
- Each peptide is presented 2-4 times on each microarray to ensure reproducibility of results
- Economical access to many identical peptide microarrays

### Selected References
- “Superior Efficacy of an HIV Vaccine Combined with ARV Prevention in SHIV Challenged Non-human Primates”
  Le Grand et al., Journal of Virology (2016)
- “Protective Efficacy of Adenovirus-protein Vaccines Against SIV Challenges in Rhesus Monkeys”
  Barouch et al., Science (2015)
- “Structure of GPN-loop GTPase Npa3 and Implications for RNA Polymerase II Assembly”

### Selection of available RepliTope™

<table>
<thead>
<tr>
<th>Tumor Associated Antigens</th>
<th>Infectious Diseases</th>
<th>Antigen Collections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast/Prostate</td>
<td></td>
<td>Pan-Flavivirus Ultra (Zika)</td>
</tr>
<tr>
<td>- Mammaglobin A</td>
<td>Adenovirus</td>
<td>6253 peptides from antigenic proteins of Flaviviruses (Zika virus, Dengue virus, West Nile virus and more)</td>
</tr>
<tr>
<td>- NY-ESO-1</td>
<td>BKV</td>
<td></td>
</tr>
<tr>
<td>- PSA</td>
<td>Capsid proteins (VP1, VP2, VP3)</td>
<td></td>
</tr>
<tr>
<td>Epithelia</td>
<td>EBV</td>
<td></td>
</tr>
<tr>
<td>- CEA</td>
<td>EBNA (1, 2, 3a, 3b, 3c, LP)</td>
<td></td>
</tr>
<tr>
<td>- Claudin-6</td>
<td>LMP1 and LMP2</td>
<td></td>
</tr>
<tr>
<td>Melanoma</td>
<td>HCMVA</td>
<td></td>
</tr>
<tr>
<td>- MAGEA1, A3 and A4</td>
<td>IE-1, IE-2, pp65,</td>
<td></td>
</tr>
<tr>
<td>- Melan-A/MART-1</td>
<td>UL28, UL32, UL40</td>
<td></td>
</tr>
<tr>
<td>- Prame/OIP4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccinia virus</td>
<td>Influenza A</td>
<td></td>
</tr>
<tr>
<td>- MVA018L (Host range p. 2)</td>
<td>HA, MP1 and NC</td>
<td></td>
</tr>
<tr>
<td>- MVA093L (p53)</td>
<td>from different strains</td>
<td></td>
</tr>
<tr>
<td>Wilms tumor1</td>
<td>RSV</td>
<td></td>
</tr>
<tr>
<td>- WT33</td>
<td>Protein F, NC protein N</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>- Cyclin B1</td>
<td>HBV (Large envelope protein)</td>
<td></td>
</tr>
<tr>
<td>- Histone H1.2 and H4</td>
<td>HHV6 (US4)</td>
<td></td>
</tr>
<tr>
<td>- PS3_human</td>
<td>Yellow fever (NS24B)</td>
<td></td>
</tr>
<tr>
<td>A full up-to-date list can be found on: <a href="http://www.shop.jpt.com">www.shop.jpt.com</a></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Peptide ELISA

Enzyme-linked immunosorbent assay (ELISA) is a common analytical and highly sensitive immunological assay classically performed with proteins. Peptide ELISA is of additional value, because it enables analysis at the amino acid sequence level, e.g. mapping of epitopes or delineation of protein interaction sites.

What is Peptide ELISA?

Peptide ELISA is an economic and tailored ELISA platform. Peptides are synthesized according to your specifications and coated onto ELISA plates. It is a very flexible assay as you can choose the peptide sequences, number and purity of the peptides and plate format.

Applications

- Antibody epitope mapping
- Immune profiling
- Determination of antibody titers
- Analysis of protein-protein interactions
- Validation of microarray results

Benefits

- High batch-to-batch reproducibility
- Economic production of tailored ELISA plates
- Easy-to-use and compatible with standard ELISA protocols and equipment
- Generation of quantitative results
- High sensitivity
- Directed immobilization of purified peptides for reproducible results

Selected References

- “Identification of Novel Antiacetylated Vimentin Antibodies in Patients with Early Inflammatory Arthritis”
  Juarez et al., Ann Rheum Dis (2016)

- “Evaluating the Efficacy of Aluminium Phosphate Formulated L2 Based HPV Vaccine”

- “Development of β-Lactoglobulin-Specific Chimeric Human IgEx Monoclonal Antibodies for In Vitro Safety Assessment of Whey Hydrolysates”
  Knipping et al., PloS One (2014)

Have a look in our webshop for off-the-shelf Peptide ELISA plates such as our Histone Code Peptide ELISA!
shop.jpt.com
Microarray & ELISA Assay Services

We provide a comprehensive and modular seromarker and antibody profiling workflow ranging from high resolution epitope discovery and verification of identified epitopes by large sample cohorts to the validation of results using robust and well established assay systems. These three assay modules can be combined or utilized individually.

**Workflow & Applications**

- **Module I – Discovery:** High resolution epitope discovery (selection of relevant peptides from thousands of candidate peptides)
- **Module II – Verification:** Selective antigen profiling (verification of candidate peptides for a significant number of samples)
- **Module III – Validation:** Marker validation (validation of peptides in secondary assay)

Book modules individually or combine them as needed.

**Benefits**

- Modular workflow allows efficient and tailored planning of projects
- All processes controlled, validated and ISO 9001:2015 regulated for highest quality
- Each module optimized for specific purpose
- Experienced and dedicated team of scientists
- Assays compatible with antibodies, sera, whole blood and other fluids that contain antibodies

**Our Service Includes**

- Finding the optimal strategy for your project
- Help to design peptide sequences
- Production of PepStar™ high content peptide microarrays, PepStar™ multiwell peptide microarrays and/or peptide ELISA plates
- Screening and control experiments using your samples
- JPT’s biologists and computer scientists will perform data evaluation and analysis

**Our Reporting Includes**

- Experiment description
- Data evaluation and analysis
- Data visualisation
- Description of results
- Data file with raw-data used
- Reporting format can be adjusted to your needs

Save time and money by making use of our dedicated and experienced staff and state of the art equipment.
The three modules of our service vary in complexity and can be used individually or combined according to your project plans.

<table>
<thead>
<tr>
<th>Assay Format</th>
<th>High content peptide microarray</th>
<th>Multiwell peptide microarray</th>
<th>Peptide ELISA</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Peptides</td>
<td>Up to 6912 peptides in triplicates per sample</td>
<td>Up to 192 peptides in triplicates per sample</td>
<td>Up to 96 peptides per plate</td>
</tr>
<tr>
<td>No. of Samples</td>
<td>1 sample per slide</td>
<td>21 samples per slide</td>
<td>Up to 96 samples per plate</td>
</tr>
<tr>
<td>Principle</td>
<td>Large number of peptides tested against a limited number of samples</td>
<td>Selected peptides tested against a large number of samples</td>
<td>Flexible for low numbers of peptides &amp; samples</td>
</tr>
<tr>
<td>Advantages</td>
<td>Low cost per peptide, high peptide throughput</td>
<td>Low cost per sample, high sample throughput</td>
<td>Economic &amp; robust assay</td>
</tr>
<tr>
<td>Applications</td>
<td>Identification of relevant epitopes from thousands of candidate peptides</td>
<td>Verification of candidate peptides using a larger number of samples</td>
<td>Validation of epitopes in secondary assay</td>
</tr>
<tr>
<td>Sample consumption</td>
<td>200µl / microarray (1µg / ml antibody or serum 1:200)</td>
<td>100µl / microarray (1µg / ml antibody or serum 1:200)</td>
<td>100µl / vial (1µg / ml antibody or serum 1:200)</td>
</tr>
<tr>
<td>Batch Size</td>
<td>1000 identical microarrays from 1 synthesis batch</td>
<td>45 identical microarrays from 1 synthesis batch</td>
<td>200 ELISA vials coated from 1 synthesis batch</td>
</tr>
</tbody>
</table>

**Multiplexed Epitope Discovery**

**Selective Antigen Profiling**

**Marker Validation**

---

**Peptide Microarray**

**High Content:**
6912 peptides in 3 copies/sample

---

**Peptide Microarray**

**Multiwell:**
192 peptides in 3 copies/21 samples

---

**Peptide ELISA**

1-96 peptides/samples

---

The three modules of our service vary in complexity and can be used individually or combined according to your project plans.
PepSpots™ Peptide Arrays

Your customized membrane based peptide array could display peptide scans through antigens, random peptides, positional, alanine or D-amino acid scans or truncation libraries.

What are PepSpots™?

Peptides are synthesized on a cellulose membrane, c-terminally attached via a flexible linker. The membrane can be used directly for incubation with antibodies or other proteins and read-out via chemiluminescence. Membranes are delivered with a detailed application protocol.

Applications

- Antibody epitope mapping and characterization
- Characterization of protein-protein interactions
- Systematic optimization of peptide lead structures

Benefits

- Standard equipment and protocols are applicable
- Rapid, economical, and flexible synthesis of any set of peptides
- Hydrophilic cellulose membranes minimize unspecific interactions

Selected References

- “Structural and Functional Analysis of a Novel Interaction Motif within UFM1-Activating Enzyme 5 (UBAS) Required for Binding to Ubiquitin-like Proteins and Ufmylation” Habisov et al., Journal of Biological Chemistry (2016)
- “A Novel Sequence in API80 and CALM Promotes Efficient Clathrin Binding and Assembly” Moshkanbaryans et al., PloS One (2016)
- “TX1111: A Peptide Homologue of Topoisomerase-1 Sensitizes Pancreatic Cancer Cells to Gemcitabine” Gnanamony et al., Cancer Research (2016)

For a typical order we synthesize overlapping peptides of your protein of interest on cellulose membranes. Resulting PepSpots™ membranes can be incubated with your sample and binding region detected by chemiluminescence read-out.
BioTides™ Biotinylated Peptides

Biotinylated peptides for your biomedical assays using streptavidin coated beads, membranes, glass slides or microtiter plates.

What are BioTides™?
BioTides™ are custom synthesized inexpensive sets of small scale biotinylated peptides. Thousands of BioTides™ are available within days.
- Amounts of 50 – 250 nmol per peptide
- Peptide length up to 20 aa
- Ready-to-use soluble peptides in 96- or 384-well plates delivered freeze dried

Selected References


“Evaluation of Viral Peptide Targeting to Porcine Sialoadhesin Using a Porcine Reproductive and Respiratory Syndrome Virus Vaccination-Challenge Model” Ooms et al., Virus Research (2013)

“Human IgE Against the Major Allergen Bet v 1 – Defining an Epitope with Limited Cross-Reactivity Between Different PR-10 Family Protein” Levin et al., Clinical & Experimental Allergy (2013)

Applications
- Identification and optimization of kinase-, phosphatase-, acetyltransferase- and histone deacetylase-substrates via standard screening systems (AlphaScreen, FlashPlates, SPA-Beads, Luminex and many more)
- Mapping of protein/protein interaction sites
- Peptide ELISA assays
- Production of peptide microarrays
- Loading of columns for affinity chromatography

Benefits
- Thousands of unpurified biotinylated peptides for screening and peptide array production
- Unmatched turnaround times (10000 peptides per week!)
- Delivery in ready-to-use microtiter plates
- Lowest price in the industry due to patented technology
- Complete QC (LC-MS, MALDI etc.) and aliquotation service available

Your BioTides™ will be delivered in 96-well plates with detailed documentation and QC/QA report on a CD-ROM.

Use of BioTides™ for binding and enzymatic assays.
Bioinformatics & Cheminformatics

With our long term experience in Bioinformatics, Computational Chemistry and Modeling we are able to support your research projects at all stages. We offer this unique know-how and expertise as part of our high content peptide microarray and library services or in R&D collaborations focusing on peptide hit discovery and optimization.

Capabilities
- Library design based on all available and relevant data sources (sequence, structure, function, homology, literature, ligands, databases)
- Evaluation of experimental data (medium and high-throughput assays)
- Management of complex data sets
- Presentation of complex data sets
- Conversion of structure, sequence and other data to different formats
- Support for compound logistics
- Supply of compound data in any format (sequence or structure)
- Generation of homology models for peptide selection
- Prediction and modelling of data
- Scaffold design for native-like presentation of peptides
- Management and integration of data from different sources
- Customized data presentation

Benefits
- Long-term track record on the discovery and development of peptides in immunotherapy, drug discovery and diagnostic development
- State of the art prediction, data interpretation and data mining algorithms and software paired with chemical and biological know how
- Expertise available as a fee-for-service or in collaborative partnerships

Service Specifications
- Detailed discussion of your project and definition of a suitable strategy based on scientific feasibility and experience
- Receive project proposal on how our bio- and cheminformatic expertise can support your project
- Obtain detailed and comprehensive service reports

Discuss your project directly with our computer scientists. Contact us at peptide@jpt.com!

X-ray loop structure (left) and model (right) stabilized by scaffold.

Use of homology model for the selection of cytosolic loop peptides for a GPCR (MSH).
Meeting Sequence Diversity

Sequence diversity on DNA and protein level is abundant in organisms, often connected to disease. Pathogens exhibit tremendous sequence diversity to bypass the mechanisms of immune defense, individuals differ from each other by germline mutations and somatic mutations can cause diseases like cancer. More complexity is added by post-translational modifications which further alter proteins and give rise to potential neo-epitopes. Therefore, sequence diversity has to be taken into account when designing peptide libraries for development of immune monitoring and immunotherapy approaches. Our ULTRA-library concept covers sequence diversity in peptide libraries of optimal size.

Peptide Prioritization

Chemical peptide accessibility, stability and solubility vary largely based on their specific amino acid sequence, physicochemical properties and secondary structure propensities and need to be considered for selecting appropriate candidates for immunotherapy and vaccination. Backed by our experience in synthesizing hundreds of thousands of peptides and deducted prediction algorithms we provide assistance to select peptides with favorable properties regarding synthetic access, solubility and shelf life.

Selected References

- “Antibody Responses after Analytic Treatment Interruption in Human Immunodeficiency Virus-1-Infected Individuals on Early Initiated Antiretroviral Therapy” Stephenson et al., Open Forum Infect Dis. (2016)
- “Fine Specificity of the Antibody Response to Epstein-Barr Nuclear Antigen-2 and other Epstein-Barr Virus Proteins in Patients with Clinically Isolated Syndrome: A Peptide Microarray-Based Case-Control Study” Schlemm et al., J Neuroimmunol. (2016)
- “Protective Efficacy of Adenovirus/Protein Vaccines against SIV Challenges in Rhesus Monkeys” Barouch et al., Science (2015)
- “Multiple Sclerosis: the Elevated Antibody Response to Epstein-Barr Virus Primarily Targets, but is not Confined to the Glycine-Alanine Repeat of Epstein-Barr Nuclear Antigen-1” Ruprecht et al., J Neuroimmunol (2014)
We take pride in our competent service and swift response. Please do not hesitate to contact us for further information. We also very much welcome your feedback and comments.