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## 1. Description

This product is for research use only.

<b>Components</b>	<b>6 nmol/peptide PepTivator SARS-CoV-2 Prot_S AY.1 Mutation Pool – research grade</b> Pool of 44 peptides covering all 13 mutations of the spike glycoprotein ("S") in the SARS-CoV-2 variant AY.1.
<b>Capacity</b>	6 nmol (approximately 10 µg) per peptide for stimulation of up to 10 <sup>8</sup> total cells.
<b>Product format</b>	Lyophilized peptides containing stabilizer.
<b>Purity</b>	Average purity of peptides >70% (HPLC).
<b>Storage</b>	Store lyophilized product at –20 °C. The expiration date is indicated on the vial label.

*This product contains no preservatives; always handle under aseptic conditions.*

### 1.1 Background information

SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) was first detected in December 2019 in Wuhan, China. Since that time the virus kept mutating, leading to new virus variants. The B.1.617.2 lineage, also known as Delta variant, is a SARS-CoV-2 subvariant that was first discovered in India in December 2020. In June 2021, first evidence was reported from Nepal that a B.1.617.2 lineage (Delta variant) with additional mutations appeared. The distinguishing feature of this new subvariant is a K417N substitution in the receptor binding domain of the spike protein. It was assigned to the AY.1 lineage, belongs to VOC Delta G/478K.V1 (B.1.617.2+AY.1+AY.2) and is also called "Delta plus". The mutations of this variant affect also immune-relevant parts of structural SARS-CoV-2 proteins and the respective sequences are available in GISAID, a genome data base. The mutations listed below are taken from sequence EPI\_ISL\_2645281. The AY.1 lineage (Delta plus

variant) has been found to evade a pre-existing antibody response and appears to be more infectious than other variants.

In total there are 13 mutations in the surface or spike glycoprotein ("S") of the AY.1 lineage (Delta plus variant) compared to the Wuhan variant (reference genome GenBank MN908947.3): T19R, T95I, G142D, E156G, deletion 157, deletion 158, W258L, K417N, L452R, T478K, D614G, P681R and D950N.

The PepTivator® SARS-CoV-2 Prot\_S AY.1 Mutation Pool covers selectively the mutated regions. It consists of 44 peptides of 15 aa length. The PepTivator® SARS-CoV-2 Prot\_S AY.1 Mutation Pool can be used to supplement PepTivators covering the sequence of the wild-type spike glycoprotein ("S") in order to detect immune responses towards both variants, Wuhan (wild-type) variant and AY.1 lineage (Delta plus variant). For control purposes, a respective wild-type (WT) reference pool consisting of the 44 homologous peptides of the Wuhan sequence is available. Comparison of the T cell immune response upon stimulation with mutation or reference pool can be used to analyze mutation-specific T cell responses.

The PepTivator Peptide Pools have been specially developed for efficient *in vitro* stimulation of antigen-specific CD4<sup>+</sup> and CD8<sup>+</sup> T cells, as peptides of 15 amino acid length with 11 amino acid overlap represent the optimized solution for stimulating both CD4<sup>+</sup> and CD8<sup>+</sup> T cells in various applications. Stimulation of T cells with PepTivator Peptide Pools causes the secretion of effector cytokines and upregulation of activation markers, which then allows the detection or isolation of antigen-specific T cells. Quantitative, phenotypical, or functional analysis of antigen-specific T cell immunity can provide important information on the natural course of immune responses in healthy or immunocompromised individuals.

### 1.2 Applications

- Detection and analysis of antigen-specific CD4<sup>+</sup> and CD8<sup>+</sup> effector/memory T cells, for example, in peripheral blood mononuclear cells (PBMCs), by MACS® Cytokine Secretion Assays, intracellular cytokine staining, or other technologies.
- Isolation of viable antigen-specific CD4<sup>+</sup> T cells with the CD154 MicroBead Kit, human.
- Isolation of viable antigen-specific CD4<sup>+</sup> and CD8<sup>+</sup> T cells using MACS Cytokine Secretion Assay – Cell Enrichment and Detection Kits or the CD137 MicroBead Kit, human for *in vitro* generation of T cell lines/clones.
- Generation of antigen-specific CD4<sup>+</sup> and CD8<sup>+</sup> effector/memory T cells from naive T cell populations for research on immunotherapy and vaccination.
- Pulsing of antigen-presenting cells for research on dendritic cell vaccination.

## 2. Recommendations for *in vitro* restimulation of antigen-specific T cells with PepTivator Peptide Pools

### 2.1 Cell preparation

For induction of cytokine secretion by antigen-specific T cells, best results are achieved by stimulation of fresh PBMCs, whole blood, or other leukocyte-containing single-cell preparations from tissues or cell lines. Alternatively, frozen cell preparations can be used.

▲ **Note:** Remove platelets after density gradient separation. Resuspend cell pellet, fill tube with buffer, and mix. Centrifuge at 200×g for 10–15 minutes at 20 °C. Carefully remove supernatant.

▲ **Note:** PBMCs may be stored overnight. The cells should be resuspended and incubated in culture medium as described in 2.4, steps 1–3, but without addition of antigen. The antigen is then added to the culture on the next day.

For details about cell preparation refer to the protocols section at [www.miltenyibiotec.com/protocols](http://www.miltenyibiotec.com/protocols).

### 2.2 Reagent requirements

- Culture medium, e.g., TexMACS™ Medium (# 130-097-196) or RPMI 1640 containing 5% human serum, e.g., autologous or AB serum.  
▲ **Note:** Do not use bovine serum albumin (BSA) or fetal bovine serum (FBS) because of non-specific stimulation.
- (Optional) Kits for the isolation and/or detection of cytokine-secreting T cells, e.g., IFN-γ Secretion Assay – Cell Enrichment and Detection Kit (PE), human (# 130-054-201) or TNF-α Secretion Assay – Cell Enrichment and Detection Kit (PE), human (# 130-091-269).
- (Optional) Antibodies or kits for intracellular cytokine staining, e.g., IFN-γ Antibody, anti-human, PE. For more information about antibodies refer to [www.miltenyibiotec.com/antibodies](http://www.miltenyibiotec.com/antibodies).
- (Optional) CD154 MicroBead Kit, human (# 130-092-658) or CD137 MicroBead Kit, human (# 130-093-476).
- (Optional) CytoStim™ (# 130-092-172, # 130-092-173) for restimulation of human T cells.
- (Optional) PepTivator CEF MHC Class I Plus – premium grade (# 130-098-426) as a peptide-specific positive control.

### 2.3 Recommendations for reconstitution of PepTivator® Peptide Pools

1. For reconstitution of the lyophilized peptide pool take the vial from –20 °C and warm-up to room temperature.  
▲ **Note:** Do not open the vial by removing the rubber plug.
2. To dissolve the 6 nmol PepTivator Peptide Pool fill a sterile syringe (0.5 mL) with 200 µL of sterile water.
3. Slowly inject the water with a sterile needle through the center of the rubber plug into the vial containing the lyophilized peptide pool.
4. Vortex the solution to completely dissolve the lyophilized peptide pool. The concentration of the stock solution of PepTivator Peptides is 30 nmol (approximately 50 µg) of each peptide per mL.
5. Remove the rubber plug and aspirate the stock solution with a pipette.

6. To avoid repeated freeze-thaw cycles prepare working aliquots from the stock solution.
7. Store the working aliquots at –80 °C.

### 2.4 Recommendations for *in vitro* restimulation of antigen-specific T cells

▲ **Coronavirus-specific T cells** are expected to be present only in certain individuals. Their frequency may be low compared to T cells with other specificities. The given protocol for *in vitro* T cell stimulation thus may only serve as a guideline.

▲ **Magnetic enrichment** of stimulated antigen-specific T cells according to cytokine secretion, e.g. IL-17, using the MACS® Secretion Assay technology or according to expression of activation markers, e.g. CD154, will enhance the sensitivity to detect rare cells.

▲ **Always include a negative control** (without antigen) in the experiment. As a positive control, a sample stimulated with, e.g., PepTivator CEF MHC Class I Plus or CytoStim may also be included.

1. Wash cells by adding medium, centrifuge at 300×g for 10 minutes. Aspirate supernatant.
2. Resuspend cells in culture medium at 10<sup>7</sup> cells per mL. Plate cells in dishes at a density of 5×10<sup>6</sup> cells/cm<sup>2</sup> (refer to 4. Appendix: Flask and dish sizes for *in vitro* T cell stimulation).
3. Mix the reconstituted PepTivator thoroughly. Add 20 µL of PepTivator stock solution per mL cell suspension. Mix carefully and incubate cells at 37 °C and 5% CO<sub>2</sub>.

The final concentration of PepTivator in the cell suspension is 0.6 nmol (approximately 1 µg) of each peptide/mL.

**Cytokine Secretion Assay:** Incubate cells for 3–6 hours.

**CD154 MicroBead Kit:** Incubate cells for 4–16 hours.

**CD137 MicroBead Kit:** Incubate cells for 16–24 hours.

**Intracellular cytokine staining with antibodies or kits:** Incubate cells for 2 hours, then add 1 µg/mL brefeldin A, and incubate for further 4 hours.

4. Collect cells carefully by using a cell scraper, or by pipetting up and down when working with smaller volumes. Rinse the dish with cold buffer. Check microscopically for any remaining cells, if necessary, rinse the dish again.

To proceed with the Cytokine Secretion Assay, the CD154 or CD137 MicroBead Kits, or intracellular cytokine staining, please refer to the respective data sheet.

▲ **Note:** When preparing cells for **intracellular cytokine staining**, fixed cells may be stored at 2–8 °C for up to 1 week.

### 3. Appendix: Flask and dish sizes for *in vitro* T cell stimulation

For *in vitro* T cell stimulation (refer to 2.4) the cells should be resuspended in culture medium, containing 5% of human serum, at a dilution of  $10^7$  cells/mL. The cells should be plated at a density of  $5 \times 10^6$  cells/cm<sup>2</sup>. Both the dilution and the cell density are important to assure optimal stimulation.

The following table lists culture plate, dish and flask sizes suitable for different cell numbers. It also indicates the appropriate amount of medium to add.

Total cell number	Medium volume to add	Culture plate	Well diameter
$0.15 \times 10^7$	0.15 mL	96 well	0.64 cm
$0.50 \times 10^7$	0.50 mL	48 well	1.13 cm
$1.00 \times 10^7$	1.00 mL	24 well	1.60 cm
$2.00 \times 10^7$	2.00 mL	12 well	2.26 cm
$5.00 \times 10^7$	5.00 mL	6 well	3.50 cm
Total cell number	Medium volume to add	Culture dish	Dish diameter
$4.5 \times 10^7$	4.5 mL	small	3.5 cm
$10.0 \times 10^7$	10.0 mL	medium	6 cm
$25.0 \times 10^7$	25.0 mL	large	10 cm
$50.0 \times 10^7$	50.0 mL	extra large	15 cm
Total cell number	Medium volume to add	Culture flask	Growth area
$12 \times 10^7$	12 mL	50 mL	25 cm <sup>2</sup>
$40 \times 10^7$	40 mL	250 mL	75 cm <sup>2</sup>
$80 \times 10^7$	80 mL	720 mL	162 cm <sup>2</sup>
$120 \times 10^7$	120 mL	900 mL	225 cm <sup>2</sup>

Refer to [www.miltenyibiotec.com](http://www.miltenyibiotec.com) for all data sheets and protocols. Miltenyi Biotec provides technical support worldwide. Visit [www.miltenyibiotec.com](http://www.miltenyibiotec.com) for local Miltenyi Biotec Technical Support contact information.

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