

Human Mass Cytometry (CyTOF) Panels

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Overview

The CIIA provides comprehensive, full-service mass cytometry (CyTOF) support from experimental design through to panel development, sample preparation, data acquisition, analysis, and interpretation. Our team uses CyTOF to measure >40 surface and intracellular markers simultaneously within a single sample, allowing for the evaluation of multiple immune cell types and their activation states (**Page 2, Table 1**).

Explore our established panels (**Pages 3-8**) or connect with us at ciiia@uhn.ca to design a custom panel that supports your discovery, translational and clinical research needs.

Sample Requirements

Please refer to our [Sample Requirements and Submission Guidelines](#).

Panel Selection and Costs

A subset of markers can be chosen from any panel to reduce costs and focus the analysis on the most relevant targets. Pricing is determined by the selected markers/panel(s), batch size, and level of analysis support required.

Instrument(s)

The panels listed in this document are compatible with the Standard BioTools [Helios](#) and [CyTOF XT](#).

Data Analysis Software

The CIIA uses [CyTOF Software](#) for sample de-barcoding and [FlowJo Software](#) for gating and routine data analysis. High-dimensional analysis, including cell clustering and visualization, is performed using [Omiq](#) and custom workflows in R.

Data Delivery and File Formats

Data can be delivered in a range of formats including summary reports, publication-ready figures, gated population statistics, and FCS files compatible with downstream analysis platforms, supporting both routine and advanced computational workflows.

Table 1. Immune Cell Types

Immune Cell Type ^(a)	CyTOF Markers	Main Functions
Conventional T cells (CD8)	CD3, CD8	Powerful effectors of adaptive immunity providing antigen-specific responses to intracellular pathogens and damaged/malignant host cells. Major function is through their antigen-dependent cytolytic activity after activation.
Conventional T cells (CD4)	CD3, CD4	Upon priming and activation, these cells can differentiate into a variety of distinct subsets that carry out an array of functions across the immune system providing help to CD8 T cells, B cells and other immune cells in an antigen-specific manner.
Regulatory T cells (Tregs)	CD3, CD4, FOXP3, CD127 ^{-low}	Suppress immune responses through cytokine secretion to maintain self-tolerance and prevent autoimmunity.
$\gamma\delta$ T cells	CD3, TCR- $\gamma\delta$	Innate-like T cells that respond to stress, infection, and malignant cells without classical MHC restriction.
B cells	CD19, CD20	Produce antibodies in response to antigen and differentiate into memory B cells or plasma cells.
Plasma cells	CD19 ^{-low} , CD38	Produce large quantities of antigen-specific antibodies.
NK cells	CD16, CD56, NKp46	Innate-like cells of lymphoid origin that kill infected and/or malignant cells that lack expression of MHC-I.
Monocytes	CD14, CD16, HLA-DR	Phagocytose pathogens, dead cells and debris, and produce inflammatory cytokines. Monocytes can differentiate into dendritic cells (DCs) and macrophages.
Macrophages	CD14, CD16, CD11b, CD68	Tissue-resident or monocyte-derived myeloid cells that phagocytose pathogens, dead cells and debris, produce immunomodulatory cytokines and support tissue repair.
DCs	CD11c, HLA-DR	Bridge innate and adaptive immune responses by efficiently priming CD4 and CD8 T cell responses through antigen presentation, co-stimulation and cytokine production. Uniquely specialized antigen presenting cells that can cross-present antigen to CD8 T cells.
pDCs	CD303	Specialized subset of DCs that are major producers of type I interferons.
Neutrophils ^(b)	CD15, CD16	Rapid innate effector response; phagocytosis and acute inflammation.

^(a) Please contact us at cija@uhn.ca regarding detection of immune cell types (e.g. ILC subsets, MAIT cells, iNKT cells) which are not listed in this table.

^(b) Fresh whole blood is required to accurately evaluate the proportions of circulating neutrophils.

General Immune Panel

Our general immune panel (40 markers) enables high-dimensional profiling of innate and adaptive immune populations as well as detailed characterization of T cell subsets and their expression of activation and immune checkpoint markers.

This panel has been optimized for PBMCs and single-cell suspensions from tissues and fluids, and is suitable for a range of applications including:

- General immune profiling in longitudinal patient samples across all disease settings.
- Assessment of the peripheral immune system using PBMCs.
- Assessment of the immune microenvironment in tissue samples (e.g. tumor resections and biopsies).
- Assessment of T cell activation and immune checkpoint marker expression.

General Immune Panel

Immune Lineage	T Cell Subsets	T Cell Phenotyping	Immune Checkpoint
CD45	TCR- $\gamma\delta$	CD28	CTLA-4
CD3	CD4	CD39	PD-1
CD19	CD8	CD69	PD-L1
CD14	FOXP3	CD80	TIGIT
CD11c	CD45RA	CD103	TIM3
NKp46	CD45RO	CD127	
CD57	CCR7	4-1BB	
CD15	CD95	Granzyme B	
CD16	CD127	Helios	
HLA-DR	CD27	ICOS	
CD163	CXCR3	Ki67	
CD303	CXCR5		
	TCF-1		

Select publications with data generated using our general immune panel:

1. Zheng EYF, Wang CH, Ochi T, Ohashi Y, Ihara F, Fukao S, Ito Y, Boukhale GM, Wang BX, Han DH, Wei X, Yolmo P, Burt BD, Saso K, Matsunaga Y, Ly D, Kagoya Y, Butler MO, Minden MD, Hirano N. [CAR T Cells Targeting an Intracellular Leukemia Antigen Promiscuously Presented by Diverse HLA-II Alleles](#). Blood Cancer Discov. 2026 Sep 3;7(5):813-828.
2. O'Kane GM, Mesci A, Jang RW, Barry A, Bocaya CM, Boukhale GM, Acton H, Doddington D, Rodrigo R, Chan LML, Noamani B, Harvey H, Elia A, Law R, Prince R, Doherty M, Dodd A, Wong DK, Wang L, Wang BX, Chen EX, Dawson LA, Knox JJ. [Pembrolizumab and stereotactic body radiotherapy combined in advanced hepatocellular carcinoma post sorafenib - A phase II trial \(PEMRAD\)](#). JHEP Rep. 2025 Nov 1;8(2):101658.
3. Wong MK, Boukhale GM, Armstrong E, Liu R, Heirali AA, Yee NR, Tsang J, Spiliopoulou P, Schneeberger PHH, Wang BX, Cochrane K, Sherriff K, Allen-Vercoe E, Siu LL, Spreafico A, Coburn B. [Microbial Ecosystem Therapeutics 4 \(MET4\) elicits treatment-specific IgG responses associated with changes in gut microbiota in immune checkpoint inhibitor recipients with advanced solid tumors](#). J Immunother Cancer. 2025 Mar 22;13(3):e010681.

Interferon-Stimulated Gene Panels 1 and 2

Interferons (IFN-type I, -type II and -type III) are a family of cytokines with pleiotropic effects on the immune system. IFN-I are broadly recognized for their anti-viral and anti-tumor activities; however, prolonged exposure to IFN-I can lead to immune suppression and T cell exhaustion.

Our IFN-stimulated gene (ISG) panels 1 and 2 (43 and 44 markers, respectively) measure the protein expression of several ISGs that are activated downstream of IFN signaling in addition to the phenotypic and activation markers that are included in the General Immune Panel. These proteins span the inflammatory, anti-viral and immunosuppressive functions of IFNs and therefore give an overview of the state that each immune subset exists in with respect to IFN signaling.

These panels have been optimized for PBMCs and single-cell suspensions from tissues, fluids, and *in vitro* cell cultures, and are suitable for a range of applications including exploring:

- The presence of ongoing IFN signaling in different tissue/disease contexts.
- Changes in IFN signaling following therapy or other interventions.
- Upregulation of ISGs after *in vitro* culture with recombinant IFNs.

Publications with data generated using ISG panel 1:

1. Boukhaled GM, Gadalla R, Elsaesser HJ, Abd-Rabbo D, Quevedo R, Yang SYC, Guo M, Wang BX, Noamani B, Gray D, Lau SCM, Taylor K, Aung K, Spreafico A, Hansen AR, Saibil SD, Hirano N, Guidos C, Pugh TJ, McGaha TL, Ohashi PS, Sacher AG, Butler MO, Brooks DG. [Pre-encoded responsiveness to type I interferon in the peripheral immune system defines outcome of PD1 blockade therapy](#). Nat Immunol. 2022 Aug;23(8):1273-1283.
2. Chua C, Salimzadeh L, Ma AT, Adeyi OA, Seo H, Boukhaled GM, Mehrotra A, Patel A, Ferrando-Martinez S, Robbins SH, La D, Wong D, Janssen HLA, Brooks DG, Feld JJ, Gehring AJ. [IL-2 produced by HBV-specific T cells as a biomarker of viral control and predictor of response to PD-1 therapy across clinical phases of chronic hepatitis B](#). Hepatol Commun. 2023 Dec 7;7(12):e0337.
3. Said BI, Boukhaled GM, Lok BH, Lukovic J, Mesci A, Waldron J, Wong P, Wang BX, Brooks DG, Milosevic M. [Cross-Cancer Analysis Reveals a Distinct Pattern of Immune Modulation During Curative Radiation Therapy](#). Int J Radiat Oncol Biol Phys. 2026 Feb 1;124(2):441-450.

ISG panel 2 was developed to include markers of fibroblasts, endothelial cells and tumor cells of epithelial origins to gain a better understanding of IFN signaling in non-immune cells present in the tumor microenvironment.

IFN-Stimulated Gene (ISG) Panel 1

Immune Cell Lineage

CD45
 CD3
 CD19
 CD14
 CD11b
 CD11c
 CD68
 NKp46
 CD57
 CD15
 CD16
 HLA-DR
 CD163
 CD303

T Cell Subsets

CD4
 CD8
 FOXP3
 CD45RA
 CD45RO
 CCR7
 CD103
 CD27
 CXCR5
 TCF-1

Activation & Proliferation

CD39
 CD80
 CXCL12
 CXCR4
 Granzyme B
 Ki67
 PD-1
 TOX

ISGs

ADAR
 BST2
 HLA-ABC
 IL-10
 PD-L1
 USP18
 IDO
 IRF7
 ISG15
 MX1
 PKR

IFN-Stimulated Gene (ISG) Panel 2

Immune Cell Lineage

CD45
 CD3
 CD19
 CD14
 CD11c
 NKp46
 CD57
 CD15
 CD16
 HLA-DR
 CD303
 CD31
 CD49e
 EpCAM
 FAP
 PDGFR- β

T Cell Subsets

CD4
 CD8
 FOXP3
 CD45RA
 CD45RO
 CCR7
 CD103
 CXCR5
 TCF-1

Activation & Proliferation

CD39
 CXCL12
 CXCR4
 Granzyme B
 Ki67
 PD-1
 TOX

Hypoxia

CA9

ISGs

ADAR
 BST2
 HLA-ABC
 IL-10
 PD-L1
 USP18
 IDO
 IRF7
 ISG15
 MX1
 PKR

Immune Metabolic Pathways Panel

Immune cell metabolism plays a central role in regulating immune responses by directing cell activation, differentiation, and effector function. Growing evidence supports the notion that preferential engagement of distinct metabolic pathways can dictate immune cell function and serve as checkpoints for immunity.

The immune metabolic pathways panel was adapted from [Hartmann et al. \(Nature Biotechnology\)](#) to measure the expression of key rate-limiting enzymes and transporters across five major metabolic pathways including 1) glucose metabolism, 2) oxidative phosphorylation, 3) the pentose phosphate pathway, 4) amino acid metabolism, and 5) fatty acid metabolism, as well as the mitochondrial fitness proteins, transcription factors and phospho-proteins that control many of these pathways.

This panel has been optimized for PBMCs and single-cell suspensions from tissues, fluids, and *in vitro* cell cultures, and is suitable for a range of applications including:

- Evaluating changes in metabolic pathways and cell activation in peripheral or tissue-resident immune cells.
- Evaluating the expression and changes in metabolic enzymes in relation to metabolic pathway intermediates.

Data generated using a version of our immune metabolic pathways panel was published in:

1. Hamidzada H, Pascual-Gil S, Wu Q, Kent GM, Massé S, Kantores C, Kuzmanov U, Gomez-Garcia MJ, Rafatian N, Gorman RA, Wauchop M, Chen W, Landau S, Subha T, Atkins MH, Zhao Y, Beroncal E, Fernandes I, Nanthakumar J, Vohra S, Wang EY, Sadikov TV, Razani B, McGaha TL, Andreazza AC, Gramolini A, Backx PH, Nanthakumar K, Laflamme MA, Keller G, Radisic M, Epelman S. [Primitive macrophages induce sarcomeric maturation and functional enhancement of developing human cardiac microtissues via efferocytic pathways](#). Nat Cardiovasc Res. 2024 May;3(5):567-593.

Immune Metabolic Pathways Panel

Immune Cell Lineage

CD45
CD3
CD19
CD14
CD11c
CD56
CD57
CD16
HLA-DR
CD303

T Cell Subsets

CD4
CD8
FOXP3
CD45RA
CD45RO

Activation & Proliferation

CD39
PD-1
TCF-1
TOX
Ki67

Signaling & Transcription

HIF-1A
KEAP1
NRF1
p-NRF2
p-PDK1
p-S6

Glucose Metabolism

HK2
GAPDH
GLUT1
LDHA
MCT1
PFKFB4

Oxidative Phosphorylation

ATP5A
CS
Cyt C
IDH1

Amino Acid Metabolism

CD98
GLS
GLUD12

Fatty Acid Metabolism

CD36
CPT1A
p-ACC

Pentose Phosphate Pathway

G6PD

Mitochondrial Fitness

ACADM
VDAC1
p-PGC1A