CD marker panel

CD is an abbreviation “for cluster of differentiation”. CD molecules are cell surface markers which are very useful for the identification and characterization of leukocytes and the different subpopulations of leukocytes. The HLDA (Human Leukocyte Differentiation Antigens) workshop, which started in 1982, developed the CD nomenclature and has maintained the list of CD Markers ever since. The initial idea behind the CD nomenclature was the classification of many different monoclonal antibodies against cell surface molecules of leukocytes which had been generated by different laboratories around the world. The number of CD markers has grown constantly and was expanded to other cell types. Today there are more than 320 CD clusters described in humans. For more information and a comprehensive list of CD markers please visit www.hcdm.org.

CD Markers are especially useful for identification of leukocyte population using flow cytometry. Our resource pages General flow cytometry protocol and What is flowcytometry? provide a short introduction into flow cytometry. The great advantage of flow cytometry is that it allows for the simultaneous detection of several markers on a single cells at the very same time. With a modern flow cytometer 8-10 different colors can easily be measured in one sample, the most advanced cytometers can even measure up to 18 channels at once.

Table of the most Common CD Markers for flow cytometry

Cell type	Human	Mouse	Rat	Cow	Horse	Pig	Dog	Monkey/ Primate
Leukocyte	CD45	CD45	CD45	CD45	CD45	CD45	CD45	CD45
T-Cells (generell)	CD3	CD3	CD3	CD3	CD3	CD3	CD3	CD3
T-Helper Cells	CD4	CD4	CD4	CD4	CD4	CD4	CD4	CD4
Cytotoxic T-Cells	CD8	CD8	CD8	CD8	CD8	CD8	CD8	CD8
Natural Killer Cells	CD56	CD335	(CD56)	(CD56)		(CD56)		(CD56)
B Cells	CD19	CD19	CD19	(CD20)		(CD20)	(CD19)	(CD20)
	CD20	CD20						
Dentritic Cells	CD11c	CD11c	(CD11c)				CD11c	(CD11c)
Monocytes / Macrophages	CD14	CD11b	(CD11b)	(Macro-phage marker)	(Macro-phage marker)	(Macro-phage marker)	(Macro-phage marker)	(CD33)
	CD33	F4/80	(Macro-phage marker)					(Macro-phage marker)
Granulocytes	CD66b	Ly6G						
		Ly6G/C						
Hematopoetic stem cells	CD34	CD34	(CD34)				(CD34)	(CD34)
Platelets	CD41	CD41	CD61	CD41	CD41	CD41	CD41	CD41
	CD61	CD61		CD61	CD61	CD61	CD61	CD61
Erythrocyte	CD235a	CD235a	CD235a					
Endothelial cells	CD146	CD146	(CD146)			(CD146)	(CD146)	

(links in bracket indicate that we cannot guarantee that the mentioned markers are the best defining marker of that cell population in the specific species)

CD marker panel

When using flow cytometry to determine certain leukocyte population usually a combination of several CD markers is used to determine a subpopulation, since one single marker usually falls short of defining the entire population. Usually research generate gating trees when evaluating flow cytometry experiments.

A very illustrative example is the distribution of CD8. While CD8 is the most prominent marker and namesake for CD8 positive ($CD8^+$) cytotoxic T cells, it is also expressed by natural killer cells (NK-cells) and dentritic cells (DCs). If all $CD8^+$ cells were gated from a leukocyte population of a blood sample the gated population would consist of $CD8^+$ T cells, NK cells and DCs.

In the following experiment the ratio of $CD4^+$ T helper vs. $CD8^+$ cytotoxic T cells was determined. First all $CD45^+$ cells (general leukocyte marker) of the peripheral blood sample were gated (Gate 1).
In the next panel all $CD45^+$ cells of Gate 1 were blotted for their expression of CD3. CD3 is the most common T cell marker which is only expressed by T cells and not by other $CD8^+$ cells such as NK cells or DC. By gating for CD3+ cells it is guaranteed that no $CD3^-$ but $CD8^+$ cells (e.g. NK cells or DCs) are counted as $CD8^+$ T cells.

The $CD3^+$ T cell population can be further differentiated into cytotoxic $CD8^+$ T cells and into $CD4^+$ T helper cells as shown in panel2 where the $CD3^+$ cells of Gate 2 were blotted for their expression CD4 and CD8. $CD4^+$ $CD8^-$ T helper cells are found in the upper left quadrant and $CD4^-$ $CD8^+$ cytotoxic T cells are shown in lower right quadrant of panel 3.

If needed a researcher interested in different T helper Population such as TH1, TH2, TH9, TH17 and Treg would stain for the respective extra or intracellular markers of those subpopulation.