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MACS® Technology: the complete alternative to flow sorting

Sorting out the benefits

MACS® Technology, the gold standard for cell separation, has impacted pioneering research for more than two decades. Over 14,500 publications demonstrate its quality and versatility. From small-scale to large-scale separations, from frequently occurring cells to rare cells and sophisticated cell subsets, Miltenyi Biotec offers perfect solutions for high-quality research.

Find out how cell separation with the autoMACS® Pro Separator, based on MACS Technology, can be utilized as a complete alternative to flow sorting or as the perfect complement. Here are just a few of MACS Technology's benefits highlighted in numerous publications and exemplified in the studies below:

- **Time-saving:** obtain high numbers of pure cells in less than 30 minutes
- **Easy:** simple protocols for manual and automated isolation can be performed by anyone
- **High cell viability:** gentle separation procedure and maintenance of cells at 4 °C
- **Cost-effective:** avoid long sorting times and resulting fees
- **Excellent purity:** well-suited for HLA-typing and microarray
- **High cell throughput:** 10^9–10^{10} cells/hour
- **Rapid isolation of rare cells:** reduced sorting time for maintenance of full functionality
- **Unique applications:** isolation of viable cytokine-secreting cells or isolation directly from whole blood

The autoMACS Pro Separator allows standardized, automated cell separation and walk-away magnetic labeling and cell sorting of multiple samples. Both automated and manual (e.g. MiniMACS™ and QuadroMACS™ Separators) systems provide all of MACS Technology's benefits.

The autoMACS Pro Separator is also an excellent tool for multi-user settings that require a fast, standardized protocol, as is often the case in clinical studies.

Willasch, A. *et al.* (2010) Bone Marrow Transplant 45: 181–189.

To perform lineage-specific PCR-based chimerism analysis as a follow-up after allogeneic stem cell transplantation, Willasch *et al.* enriched $CD3^+$, $CD14^+$, $CD15^+$, $CD19^+$, and $CD56^+$ cells directly from whole blood by using autoMACS® Cell Separation (referred to by the authors as "MACS technique") and Whole Blood MicroBeads. The authors assessed cell recovery and purity, as well as feasibility of PCR-based chimerism analysis.
Willasch* et al. *explicate, "FACS offers the highest enrichment purity of the isolated subpopulation, but this method is labour intensive and time consuming. MACS can be carried out applying the MiniMACS/QuadroMACS technique or the MACS technique (Miltenyi Biotec). Cell sorting by the latter approach is much easier to carry out, cheaper and faster compared with flow cytometry." The authors also state: "In summary, the isolation of cell subpopulations by automated cell enrichment applying 'Whole Blood MicroBeads' is feasible, providing a good purity and recovery of the respective isolates and giving the opportunity to perform reliable lineage-specific monitoring of chimerism after SCT."

Cohen, G.B. (2002) Virology 304: 474–484.

By using MACS Technology, Cohen *et al.* isolated two antigen-specific T cell populations that are specific for two different HIV epitopes. PBMCs were stimulated with the respective peptide antigen and processed by using Miltenyi Biotec's IFN-γ Secretion Assay – Cell Enrichment and Detection Kit, referred to by the authors as the "IFNγ-capture technique". In brief, IFN-γ secreted by the

antigen-specific T cells was captured on the cell surface and the viable IFN-γ–secreting T cells were magnetically labeled and isolated. Cells were then expanded for further characterization.
The authors state: "…, when the cell lines were tested for cytolytic activity or restimulated for IFNγ production, the lines were highly specific for the antigen against which they were raised (e.g., greater than 80% of T cells secreted IFNγ upon peptide stimulation) but did not recognize the alternative HLA-B14-restricted epitope." and "These cells were not purified by FACS because we do not sort HIV-infected samples at our facility."
The authors also point out that "Intracellular cytokine staining (ICS) (…), an alternative approach for isolating IFNγ-producing cells, was not utilized because it requires chemical fixation of cells prior to IFNγ staining. Fixation modifies cellular RNA, making it difficult to use the RNA for RT-PCR (…). In contrast, cells isolated by the IFNγ-capture technique are viable, and their RNA are intact."

Gomes, I. *et al.* (2001) Blood 98: 93–99.

The authors isolated $CD34^+$ cells from human and baboon bone marrows by MACS Technology and compared the global transcriptomes in the isolated cells from both species by using cDNA filter arrays.
Gomes* et al. *point out that "Expression studies on cDNA arrays require a fairly large number of cells to isolate an appropriate amount of RNA for probe preparation. Because of this constraint, it was necessary to purify the $CD34^+$ cells by immunomagnetic columns rather than FACS, which would require prolonged sorting. The stress imposed by the prolonged sorting time required to prepare this number of cells can dramatically reduce cell viability and yield of $CD34^+$ cells and may alter their gene expression profile."

Wang, J.Y. *et al.* (2000) Cytometry 39: 224–230.

Wang *et al.* isolated fetal nucleated red blood cells from maternal blood by using flow sorting or MACS Technology. To compare cell recovery achieved by the two techniques, they employed fluorescence in situ hybridization (FISH).
The authors conclude "despite the many differences among the two techniques (separation format, antibody specificity, and FISH method), the results for each sample are in good agreement with each other. However, some differences exist. MACS is a faster, less expensive bench-top technique that can be performed in most laboratories."
Wang* et al. *also explain "MACS allows simultaneous immunophenotyping and FISH of FNRBCs, and permanent stain of immunochemical reagents even after FISH, which provides an advantage for using an automated imaging system to localize dual positive cells".

De Wynter, E.A. *et al.* (1995) Stem Cells 13: 524–532.

The authors used MACS Technology, flow sorting (FACS®), and three other techniques based on positive selection to compare $CD34^+$ cell enrichment from different samples. The isolated cell populations were analyzed for purity, yield, and enrichment of colony-forming cells (CFC)-granulocyte-macrophage and burst-forming units-erythroid.
MACS Technology showed comparable purity to flow sorting and the CEPRATE system, and excellent $CD34^+$ cell yield: "… results with MiniMACS and the umbilical cord blood samples were outstanding giving an average yield of 86.1% …". Regarding colony forming cell-enrichment the authors state: "…it was clear that $CD34^+$ cells obtained using the MiniMACS system were greatly enriched in CFC."
The authors conclude "…, in this study, the best system was MiniMACS which proved to be rapid, efficient, reproducible, easy to use and yielded sufficiently enriched $CD34^+$ cell populations to facilitate FACS sorting of $CD34^+$ subsets for functional analysis."

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