Miltenyi Biotec

Neuroscience

Integrated workflows for neuroscience research



Powerful tools to advance neuroscience

Neuroscience research is a dynamic and fast-paced field revolutionizing our understanding of the brain, uncovering the causes of neurological disorders, and developing effective therapies.

For over 35 years, Miltenyi Biotec has provided tools to decipher the brain's complexity using *in vivo* and *in vitro* neural models to explore cellular components and their three-dimensional (3D) interactions. We are committed to empowering neuroscientists with pioneering solutions for the gentle analysis of neural cells and the visualization of neural connections in 3D.

Gentle with neural cells

Advance your research program with integrated cellular analysis workflows from tissue dissociation and cell isolation to cell characterization and cultivation. Our high-quality reagents and instruments enable the gentle analysis of neural cells in brain tissue and pluripotent stem cell (PSC)-derived neural cells and organoids.

Simplified 3D imaging

Study complex neural networks with comprehensive 3D imaging workflows. Our imaging platforms include reagents for staining and clearing, automated 3D imaging, and seamless image processing, making light sheet microscopy accessible to experts and novices alike.

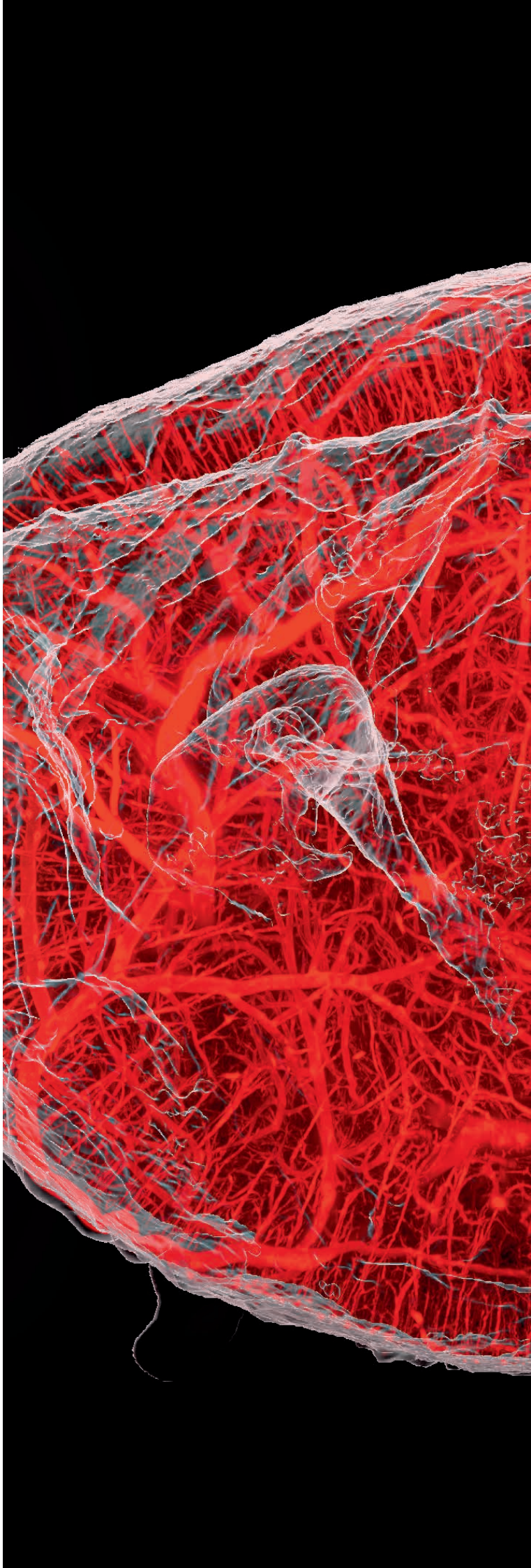
Versatile workflows across neural models

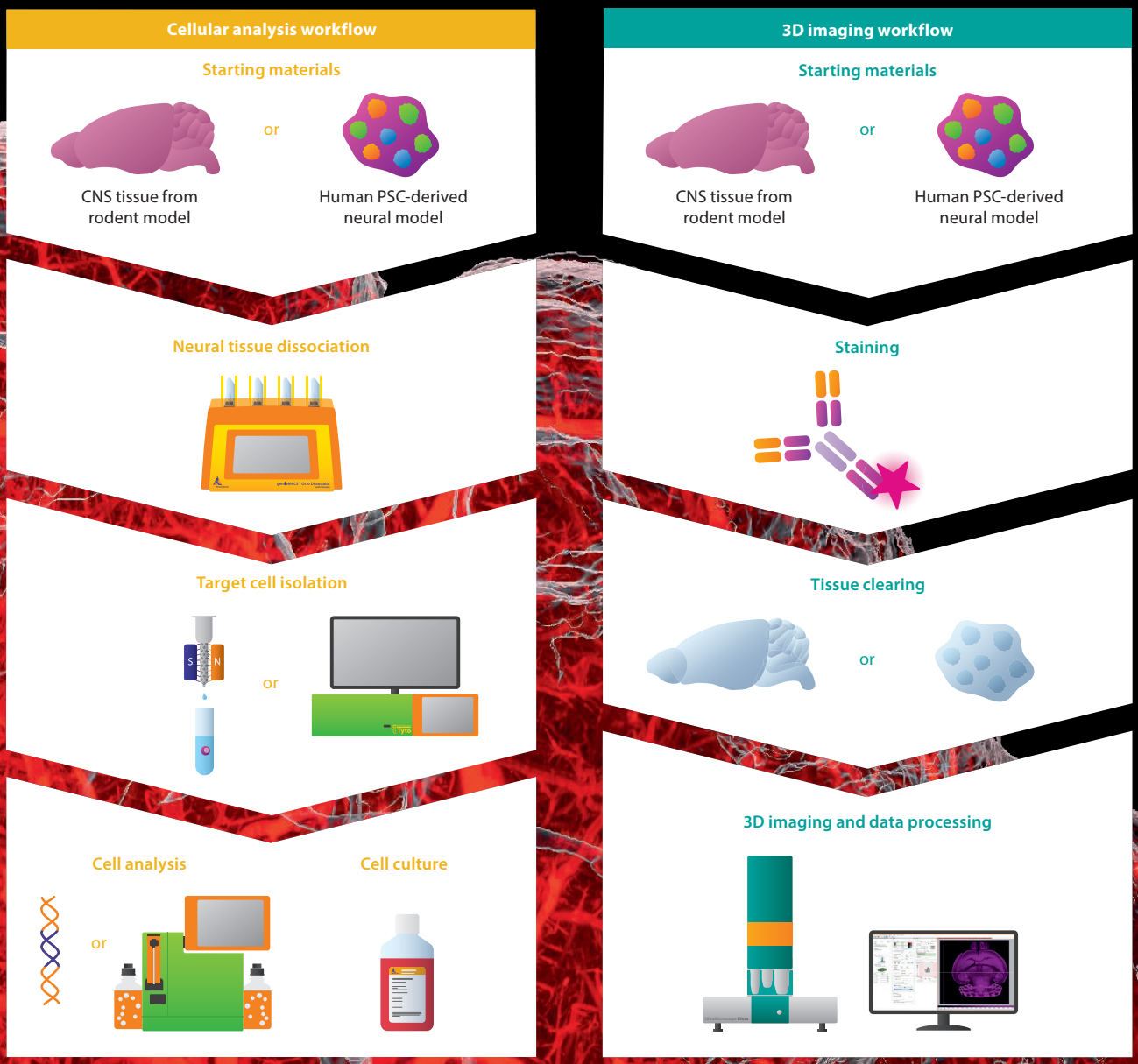
Our workflows apply to both rodent and PSC-derived neural models, allowing you to flexibly deploy diverse experimental setups.

VISIT

Discover our neuroscience workflows and specialized application pages.

▸ **miltenyibiotec.com/neuroscience**





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Cellular analysis workflow

From neural tissue dissociation to cell analysis

Discover our gentle solutions for an effective cellular analysis workflow using rodent brain and PSC-derived cerebral organoids.

Gently dissociate neural tissue into single cells

Streamlined tissue dissociation

Successful cellular analysis of brain tissue and PSC-derived cerebral organoids builds on effective but gentle processing of the starting material. Preserve the integrity and surface epitopes of neural cells with our MACS® Tissue Dissociation Kits and the gentleMACS™ Octo Dissociator with Heaters. Combining enzymatic and mechanical dissociation disrupts neural tissue effectively while being gentle on cells. The resulting single-cell suspension is immediately ready for downstream applications (fig. 1).

- Obtain high yields of viable single cells with material-specific dissociation kits (table 1).
- Boost reliability and reproducibility of results across samples and operators.
- Process eight samples in parallel or separately.

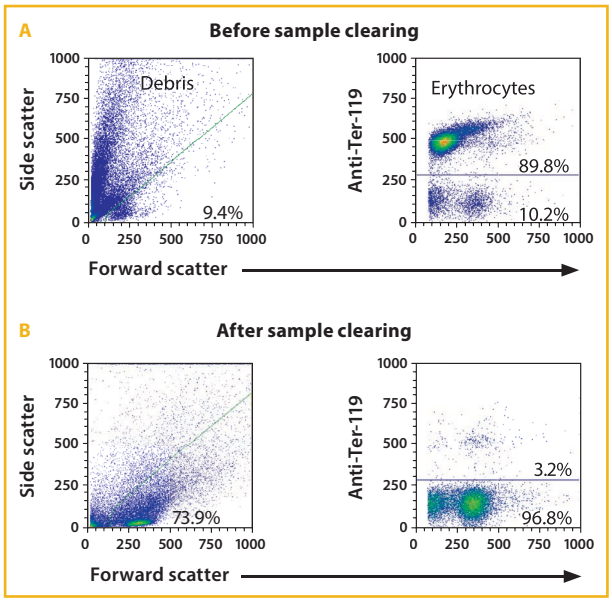


Figure 1: The Adult Brain Dissociation Kit, mouse and rat, yields highly viable and pure neural cells. The cell suspension from adult brain contains a significant amount of cell debris and erythrocytes (A), which hampers subsequent cell isolation, cultivation, and analysis. The Adult Brain Dissociation Kit, mouse and rat, optimizes the tissue dissociation process and, after sample clearing, yields living cells with much less cell debris and erythrocytes (B).

Application	Starting material	Kit* or reagent
Isolation of all neural cells	Mouse or rat, age >P7	Adult Brain Dissociation Kit, mouse and rat
	Animal, age ≤P7	Neural Tissue Dissociation Kit (P)
	PSC-derived cerebral organoids	Neural Tissue Dissociation Kit (T)
Isolation of neurons only	Animal, age ≤P7	Neural Tissue Dissociation Kit – Postnatal Neurons
Special applications	Human and rodent brain tumor tissue	Brain Tumor Dissociation Kit (P)
	Cultured neurospheres	Neurosphere Dissociation Kit (P)
	In vitro generated embryoid bodies	Embryoid Body Dissociation Kit, human and mouse
Extraction of intact cell organelles	Fresh, snap-frozen, and OCT embedded human and rodent tissues	Nuclei Extraction Buffer
	Human and rodent tissues	Mitochondria Extraction Kit – Tissue

Table 1: Ready-to-use MACS Tissue Dissociation Kits and reagents specific to your starting material.

* MACS Tissue Dissociation Kits contain papain (P) or trypsin (T), depending on epitope sensitivity. Follow kit recommendations on our webpage to find the optimal conditions for your antigen of interest.

Isolate your target neural cell population

Expertise in cell separation

After tissue dissociation, separating the target neural cells ensures consistent and reliable results from cell population analyses. Combining nano-sized MACS MicroBeads and specialized MACS Columns is an efficient means to isolate neural cells with minimal labeling.

- Isolate neural cells gently and efficiently.
- Recover high numbers of viable, pure cells.
- Use non-toxic, biodegradable reagents that are fully compatible with downstream applications.

Building on decades of experience in cell separation, we have developed fast and easy-to-use strategies to isolate neural cell populations, organelles, and extracellular vesicles.

Our manual cell separation solutions process up to eight samples in parallel. For higher throughput, our automated autoMACS® Neo Separator and the semi-automated MultiMACS Cell24 Separator Plus offer flexible workflows while generating consistent results across samples, regardless of operator. Finally, the MACSQuant® Tyto® Cell Sorter enables multiparameter flow sorting in a fully enclosed cartridge.

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See how the MACSQuant Tyto Cell Sorter safely and gently separates neural cells.

▸ **miltenyibiotec.com/tyto**

Magnetic isolation strategies

A positive selection strategy for cell isolation involves magnetically labeling target cells by binding specific cell surface markers with our MACS MicroBeads (fig. 2). In contrast, an untouched isolation strategy magnetically labels and depletes undesired cells, leaving the target cells behind (fig. 2). We offer a broad portfolio of MicroBeads, including Anti-IgG/IgM or Anti-Biotin/FITC/PE/APC MACS MicroBeads for customized cell separation by indirect labeling.

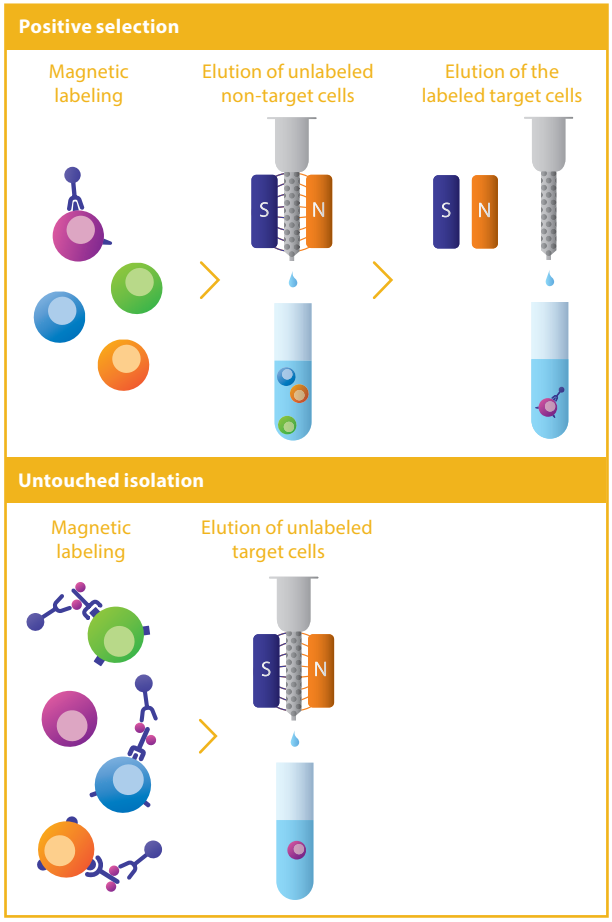


Figure 2: MACS Technology enables cell isolation based on two strategies. With positive selection, target cells are magnetically labeled and retained in a separation column. Unlabeled cells flow through. After washing, the column is removed from the magnetic field, and target cells are eluted. Untouched isolation labels non-target cells. The target cells flow through during separation, while non-target cells are retained.

Culture, probe, and analyze neural cells

Neural cell characterization

Flow cytometry uses specific surface or intracellular markers to precisely identify and quantify cells of interest within complex neural cell populations (fig. 3). Explore functional and phenotypic characteristics of neural cells with our MACS Flow Cytometry portfolio, a comprehensive toolkit of MACS Antibodies, ready-to-use kits, and software solutions for our MACSQuant® Analyzers.

- Automate high-throughput and multiparameter flow cytometric analysis.
- Simultaneously quantify intracellular and surface markers.
- Obtain reliable qualitative and quantitative data with our recombinant REAfinity® Antibody-fluorochrome conjugates.

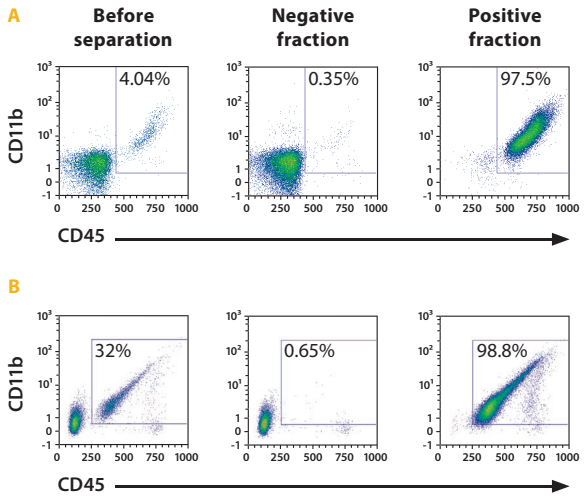


Figure 3: Flow cytometry enables the detailed characterization of microglia from neonatal and adult mouse brain. Single-cell suspensions were prepared from either P1 mouse brain using the Neural Tissue Dissociation Kit (P) (A) or from 2-month-old mouse brain using the Adult Brain Dissociation Kit, mouse and rat (B). Microglia were isolated from the single-cell suspension using CD11b (Microglia) MicroBeads, human and mouse through two MS Columns. Cells were fluorescently stained with antibodies recognizing the CD11b and CD45 antigens and analyzed on the MACSQuant Analyzer.

Cell culture is key

Culturing neural cells requires the right combination of nutrients and growth factors to mimic the *in vivo* environment and support neuronal growth and function. Our MACS Neuro Medium and MACS NeuroBrew®-21 supplements are optimized to support the propagation and long-term survival of neurons and glial cells. Use MACS Premium Grade Cytokines for fine-tuned and reproducible experiments.

- Increase consistency between experiments with serum-free media and supplements.
- Receive standardized information on lot-specific activity of cytokines.
- Flexibly adapt setups using supplements formulated with and without vitamin A.

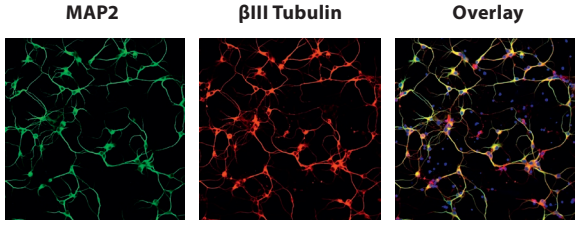
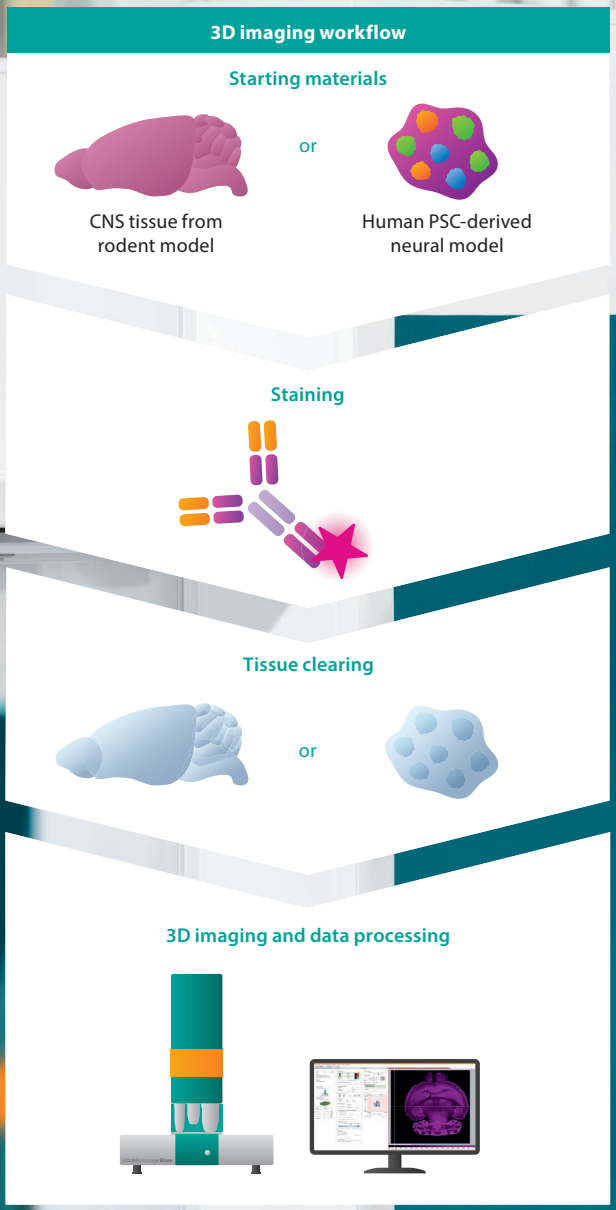


Figure 4: Neuron-specific staining demonstrates successful neuronal growth with Miltenyi Biotec dedicated cell culture media and supplements. Primary adult mouse neurons were cultured in MACS Neuro Medium, MACS NeuroBrew-21, 1% P/S, 0.5 mM L- glutamine, and BDNF (incubation for 3–6 hours with 50 µg/ml BDNF at day 3) on PLL-coated glass coverslips. After 7 days, cells were fixed and stained with the neuron-specific antibodies detecting MAP2 (green) and βIII Tubulin (red).

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Streamline your analysis of neural cells. Discover our MACS Flow Cytometry solutions.

▸ **miltenyibiotec.com/macsquant**



3D imaging workflow

Study the brain's complexity in a new dimension

Light sheet microscopy opens new possibilities to understand the complex neural connections within the brain. Accelerate insights in 3D with our workflow.

Easy staining with validated 3D-IF antibodies

Begin your 3D journey with engineered antibodies

Antibodies for 3D imaging must penetrate deeply into a specimen and provide specific binding with minimal background noise. Simplify your journey into light sheet microscopy with our recombinantly engineered REAfinity Antibodies (table 2). Specifically validated for 3D imaging of large samples, our 3D-immunofluorescence (3D-IF) antibodies let you see beyond the surface (fig. 5).

- Work with antibodies validated for tissues cleared with our MACS Tissue Clearing Kits and compatible with methods like iDISCO+.
- Streamline staining with fluorophore-conjugated primary antibodies.
- Get reproducible results and strong signal-to-background ratios for deeper insights.

Antibody validation for 3D-IF
β-Tubulin 3 staining, cerebral organoid (human)

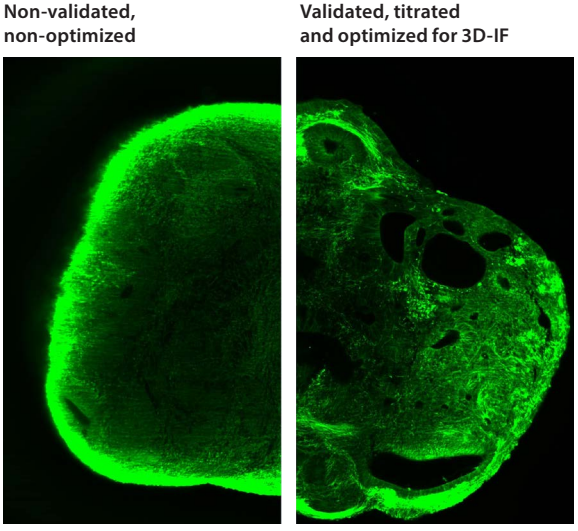


Figure 5: The validated and optimized 3D-IF antibodies fully penetrate samples, delivering more homogeneous and clear staining. The left image shows a PSC-derived cerebral organoid stained with a β-Tubulin 3 antibody that is not validated or optimized for 3D-IF. Sample penetration is incomplete, and the antibodies accumulated on the sample surface. In contrast, the right image shows the staining using our 3D-IF validated and optimized β-Tubulin 3 Antibody, anti-human/mouse, Vio® B515, REA1152. Staining is homogeneous throughout the organoid. Note that a slightly lower target signal is expected in the necrotic core of the organoid.

Target cell	Antibody*
Neural progenitor cells	Sox2 Antibody, anti-human/mouse
	PAX-6 Antibody, anti-human
	OTX2 Antibody, anti-human
Neuronal cytoskeleton	Neurofilament Antibody, anti-human/mouse
	β-Tubulin 3 Antibody, anti-human/mouse
Dopaminergic neurons	Tyrosine Hydroxylase Antibody, anti-human/mouse/rat
Interneurons	Parvalbumin Antibody, anti-human/mouse/rat
	Calretinin, anti-mouse/rat
Postmitotic neurons	NeuN Antibody, anti-human/mouse/rat
Astrocytes	GFAP Antibody, anti-human/mouse/rat
	GLAST (ACSA-1) Antibody, anti-human/mouse/rat
Oligodendrocytes	MBP Antibody, anti-human/mouse
Endothelial cells	CD31 Antibody, anti-mouse
	CD31 Antibody, anti-human
Protein expression	GFP Antibody

Table 2: Validated 3D-IF antibodies for neural cells.

* Some antibodies are available conjugated to different fluorophores.

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Our portfolio of 3D-IF antibodies is constantly growing.
Stay up-to-date on our offering!
▸ **miltenyibiotec.com/3D-IF-antibodies**

Streamlined and effective tissue clearing

Image clarity begins with tissue clarity

Light penetration is limited in naturally opaque biological tissues. Thus, imaging 3D structures requires clearing tissues, which is often time-consuming, complicated, and uses harmful chemicals. We have developed a fast, easy, and budget-friendly solution to clear neural samples. The MACS Clearing Kit prepares organoids and brain hemispheres for 3D imaging, while the MACS Deep Clearing Kit was developed for whole brain specimens (fig. 6).

Our non-toxic MACS Imaging Solution matches the refractive index of the resulting cleared tissues, so every image is sharp (fig. 7).

- Employ non-toxic and user-friendly tissue-clearing methods.
- Preserve tissue morphology and endogenous protein signals while efficiently clearing specimens.
- Benefit from easy-to-follow protocols for cerebral organoids and whole mouse brain.

VISIT

Find dedicated tissue-clearing protocols for cerebral organoids and whole and partial mouse brain.

▸ **miltenyibiotec.com/tissue-clearing-protocols**

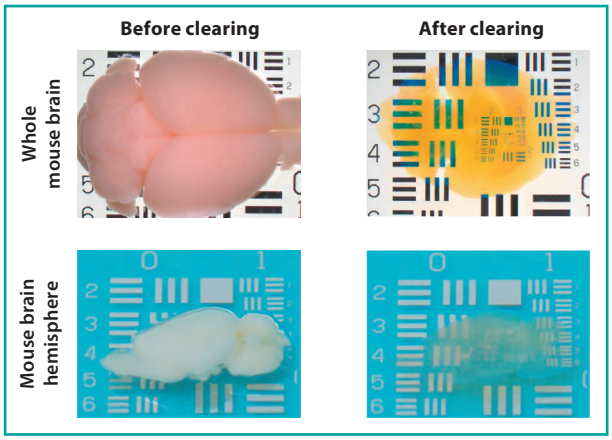


Figure 6: The MACS Tissue Clearing Kits are designed to generate high transparency for 3D imaging. The MACS Deep Clearing Kit (top row) penetrates deep into a whole mouse brain. The MACS Clearing Kit (bottom row) clears a mouse brain hemisphere. Both are non-toxic, gentle reagents that preserve tissue morphology.

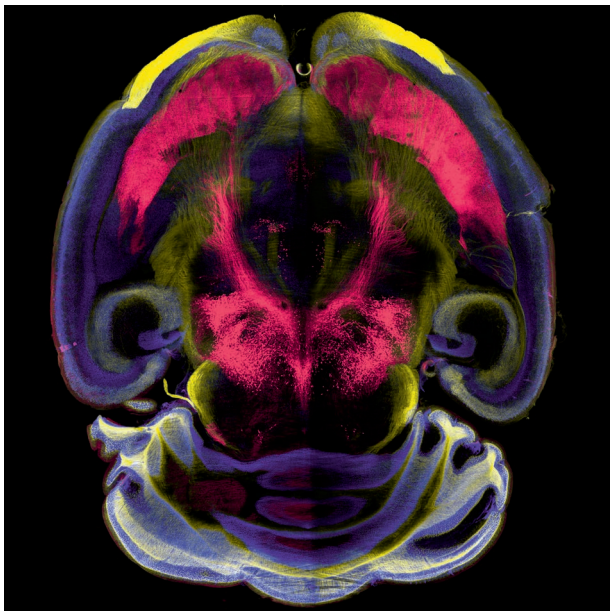


Figure 7: Homogeneous, multicolor staining of a highly transparent whole mouse brain. A whole mouse brain cleared with the MACS Deep Clearing Kit and immunostained with Tyrosine Hydroxylase Antibody, Vio G570 (magenta), NeuN Antibody, Vio R667 (purple) and Neurofilament Antibody, Vio 780 (yellow). Protein signals and 3D structures are faithfully preserved during clearing. Image was acquired on the UltraMicroscope Blaze™ Instrument.

Automated and scalable light sheet microscopy

Stunning 3D images with minimal hands-on time

The analysis of the 3D structures and neural cell interactions with light sheet microscopy pushed the boundaries of our understanding of brain physiology in health and disease. The UltraMicroscope Blaze Instrument is a powerful platform that automates image acquisition of unparalleled quality at high speed. Samples are moved through the instrument's focal plane so fluorophores are excited at each layer, keeping photodamage and bleaching to a minimum.

- Automate your high-resolution imaging of large samples.
- Reduce your acquisition time up to 60-fold with the LightSpeed Mode.
- Boost your throughput to eight mouse brains or 48 organoids with the MACS UltraMount Sample Holders (fig. 8).

Unlock the full potential of your data

MACS iQ View – 3D Large Volume is a comprehensive, user-friendly solution for processing images captured with the UltraMicroscope Platform. The software seamlessly integrates various processing algorithms (3D Crop, Destripe, Denoise, Deconvolution, Stitching, and Contrast Compression) into a unified workflow, making image processing straightforward and efficient.

- Image acquisition and processing is fully automated, saving you time and minimizing manual intervention.
- 3D mosaic stacks are created with a single click. No manual adjustments are needed.
- Deconvolution is optimized to the optical parameters of your UltraMicroscope Platform for enhanced image clarity.

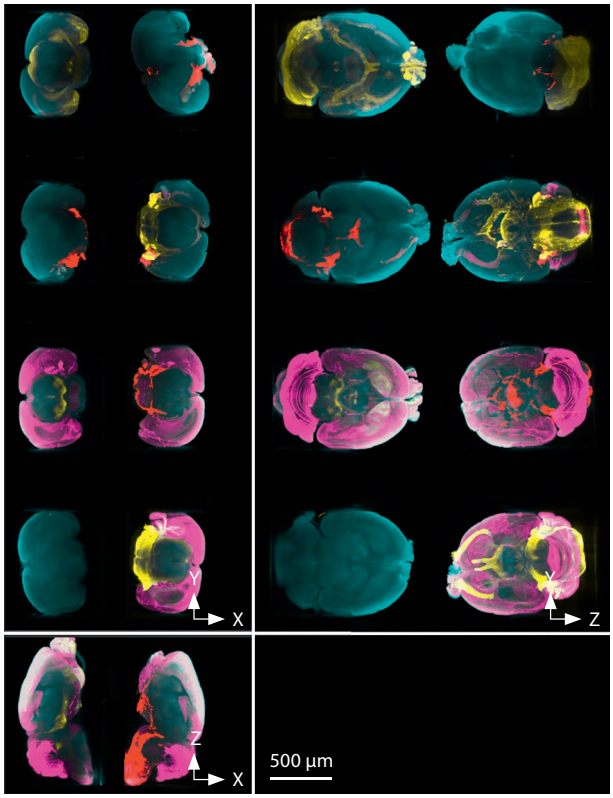


Figure 8: Automated, high-throughput imaging of eight mouse brains. Mouse brains mounted on the UltraMount 8 were prepared with the MACS Deep Clearing Kit to visualize calretinin, NeuN, CD31, neurofilament, tyrosine hydroxylase, MBP, and parvalbumin.

LEARN MORE

Learn more about the LightSpeed Mode:

▸ **miltenyibiotec.com/lightspeedmode**

LEARN MORE

Learn more about the MACS® UltraMount Sample Holders:

▸ **miltenyibiotec.com/MACS-UltraMounts**

Special focus: differentiation of PSCs into neural cells

PSC-derived neural models workflow

PSC culture and maintenance

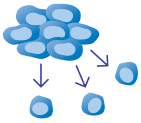
Optimized media formulations to maintain high-quality PSC cultures while allowing flexible feeding schedules.

Maintenance



- StemMACS™ PSC-Brew XF, human

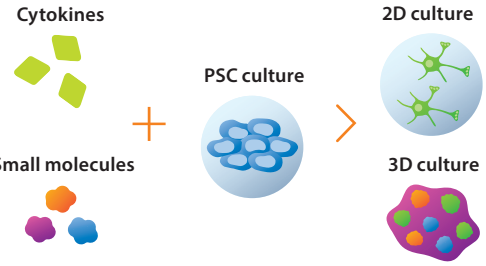
Passaging



- StemMACS PSC-Support XF, human
- StemMACS Passaging Solution XF, human

PSC differentiation

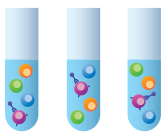
Efficient differentiation with serum-free media and supplements, recombinant cytokines, and chemically defined small molecules.



- MACS Neuro Medium
- MACS NeuroBrew-21
- StemMACS Small Molecules
- MACS Cytokines

Phenotyping

Fast and quantifiable phenotype and function assessment of your PSC-derived neural cells.



- PSC-mDA Neuron Phenotyping Kit, human
- MACSPlex EV Kit Neuro, human
- PAX-6 Antibody, anti-human, REAfinity
- CD11b Antibody, anti-human, REAfinity
- PSA-NCAM Antibody, anti-human/mouse/rat

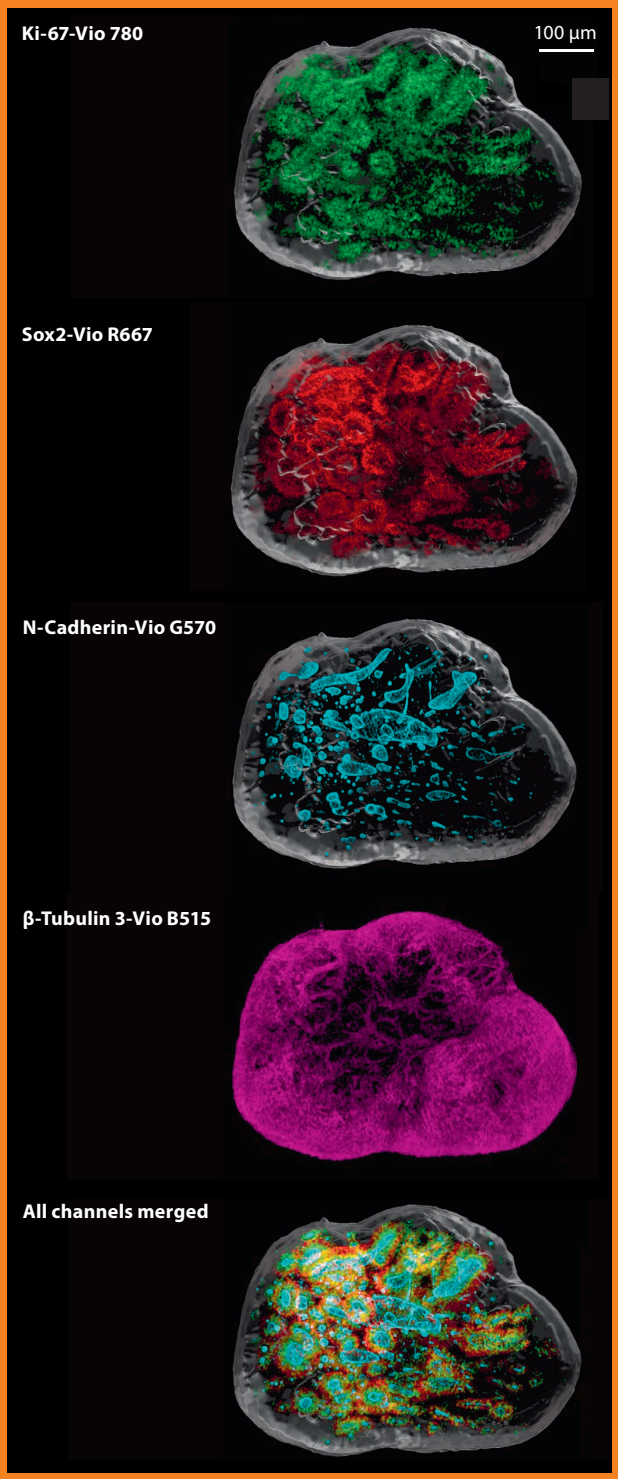
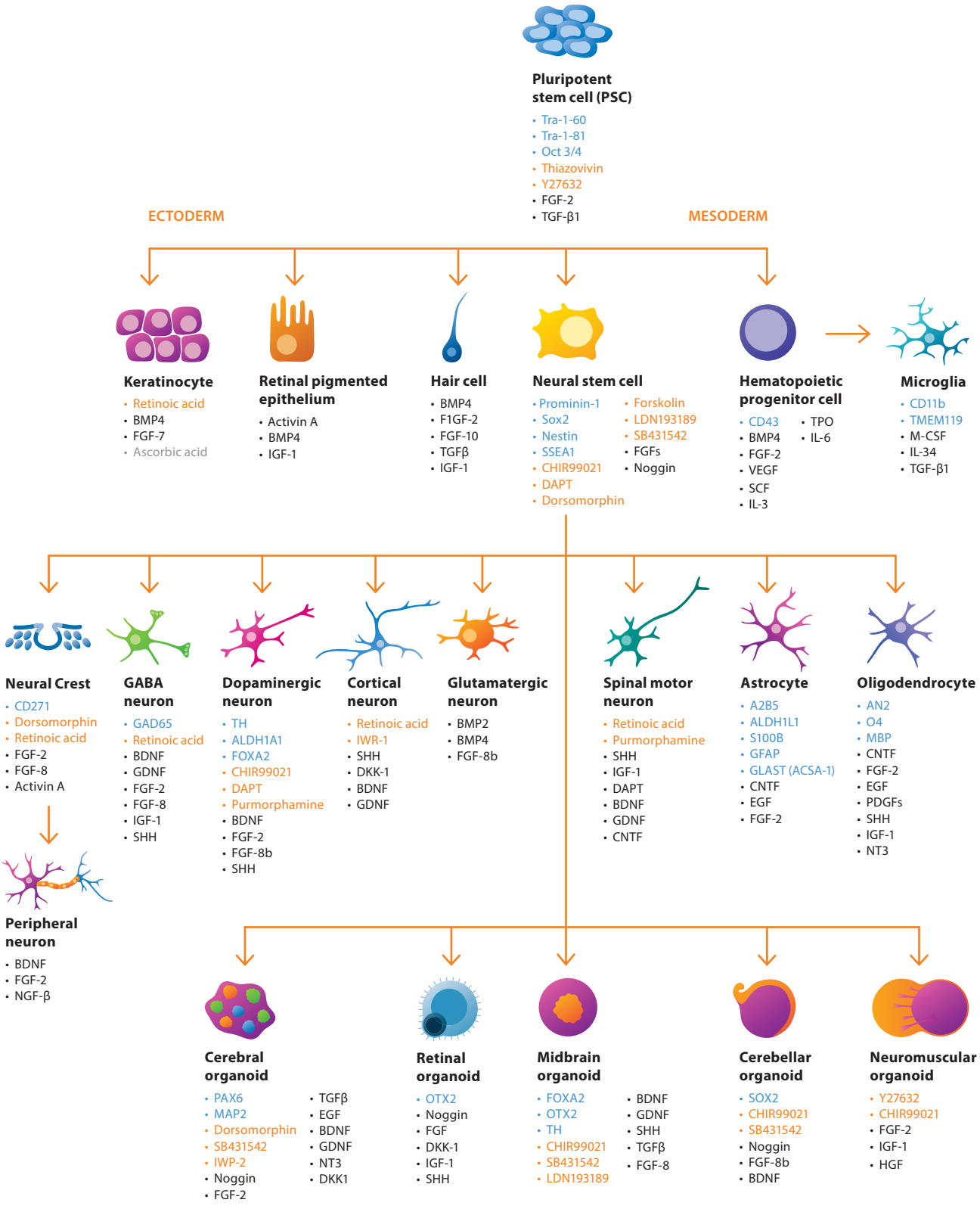


Figure 9: Multicolor imaging of a cerebral organoid. A human cerebral organoid was cleared with the MACS Clearing Kit and labeled with (top to bottom) Ki-67-Vio 780, Sox2-Vio R667, N-Cadherin-Vio G570, and β-Tubulin 3-Vio B515. The last image is all channels merged.

Cell culture reagents for stem cell differentiation into neural cells



■ Typical phenotype markers available from Miltenyi Biotec ■ StemMACS Small Molecules ■ MACS Cytokines ■ Product not available

Product list

Tissue dissociation/organelle extraction

Product	Order no.
gentleMACS Octo Dissociator with Heaters	130-134-029
gentleMACS Dissociator	130-093-235
gentleMACS C Tubes	130-093-237
gentleMACS M Tubes	130-093-236
gentleMACS Octo Coolers (4 pieces)	130-130-533
Adult Brain Dissociation Kit, mouse and rat	130-107-677
Neural Tissue Dissociation Kit (P)	130-092-628
Neural Tissue Dissociation Kit (T)	130-093-231
Neural Tissue Dissociation Kit – Postnatal Neurons	130-094-802
Brain Tumor Dissociation Kit (P)	130-095-942
Neurosphere Dissociation Kit (P)	130-095-943
Embryoid Body Dissociation Kit, human and mouse	130-096-348
Nuclei Extraction Buffer	130-128-024
Mitochondria Extraction Kit - Tissue	130-097-340
Myelin Removal Beads II, human, mouse, rat	130-096-733

Cell and organelle separation

Product	Order no.
Organelles	
Myelin Removal Beads II, human, mouse, rat	130-096-733
Anti-Nucleus MicroBeads	130-132-997
Mitochondria Isolation Kit, human	130-094-532
Mitochondria Isolation Kit, mouse tissue	130-096-946
Anti-TOM22 MicroBeads, mouse	130-127-693
EV Isolation Kits	See QR code
Stem cells	
Anti-Prominin-1 MicroBeads, mouse	130-092-333
Microglia	
CD11b (Microglia) MicroBeads, human and mouse	130-093-634
CD11b/c (Microglia) MicroBeads, rat	130-105-634
Astrocytes	
Anti-ACSA-2 MicroBead Kit, mouse	130-097-678
Anti-GLAST (ACSA-1) MicroBead Kit, human, mouse, rat	130-095-826
Astrocyte Isolation Starter Kit, rat < P7	130-096-052
Astrocyte Isolation Starter Kit, mouse < P7	130-096-054
AstroMACS Separation Buffer	130-117-336
Neurons	
Neuron Isolation Kit, mouse	130-115-389
Adult Neuron Isolation Kit	Multiple sizes
CD171 (L1CAM) MicroBead Kit, mouse	130-101-549
Retinal Ganglion Cell Isolation Kits, rat	130-096-209
Anti-PSA-NCAM MicroBeads, human, mouse, rat	130-092-966
Oligodendrocytes	
CD140a (PDGFRα) MicroBead Kit, mouse	130-101-502
Anti-AN2 MicroBeads, human and mouse	130-097-170
Anti-A2B5 MicroBeads, human, mouse, rat	130-093-388
Anti-O4 MicroBeads, human, mouse, rat	130-094-543

Cell analysis

Product	Order no.
Neural stem cell	
Prominin-1 Antibody, anti-mouse, REAfinity	Multiple labels
Sox2 Antibody, anti-human/mouse,REAfinity	Multiple labels
Nestin Antibody, anti-human, Vio B515, REAdye_lease	130-132-500
Adult Neural Stem Cell Analysis Cocktail Kit, anti-mouse	130-121-268
Microglia	
CD11b antibody, anti-human/mouse (clone: M1/70.15.11.5)	Multiple labels
CD11b Antibody, anti-mouse (clone: REA592)	Multiple labels
CD11b Antibody, anti-human	Multiple labels
CD11b/c Antibody, anti-rat (clone: REA325)	Multiple labels
CD68 Antibody, anti-mouse	Multiple labels
CD68 Antibody, anti-human (clone: Y1/82A)	Multiple labels
CD68 Antibody, anti-rat (clone: REA237)	Multiple labels
F4/80 Antibody, anti-mouse (clone: REA126)	Multiple labels
MHC Class II Antibody, anti-mouse (clone: M5/114.15.2)	Multiple labels
MACSPlex Cytokine 12 Kit, human	130-099-169
MACSPlex Cytokine 10 Kit, mouse	130-101-740
Astrocytes	
ACSA-2 Antibody, anti-mouse	Multiple labels
GLAST (ACSA-1) Antibody, anti-human/ mouse/rat	Multiple labels
GFAP Antibody, anti-human/mouse/rat	Multiple labels
ACSA-2 Antibody, anti-mouse	Multiple labels
Neurons	
CD171 (L1CAM) Antibody, anti-mouse	Multiple labels

CD171 (L1CAM) Antibody, anti-human (clone: REA163)	Multiple labels
CD271 (LNGFR) Antibody, anti-human/mouse (clone: REA648)	Multiple labels
PSA-NCAM Antibody, anti-human/mouse/rat (clone: 2-2B)	130-117-394
PAX-6 Antibody, anti-human, pure (clone: REA507)	Multiple labels
Oligodendrocytes	
O4 Antibody, anti-human/mouse/rat (clone: O4)	Multiple labels
CD140a Antibody, anti-mouse	Multiple labels
AN2 Antibody, anti-human/mouse	Multiple labels
A2B5 Antibody, anti-human/mouse/rat (clone: 105HB29)	Multiple labels

Cell culture

Product	Order no.
MACS Neuro Medium	130-093-570
MACS NeuroBrew-21 (50×)	130-093-566
MACS NeuroBrew-21 w/o Vitamin A (50×)	130-097-263
AstroMACS Medium	130-117-031
Human BDNF, research grade	Multiple sizes
Human GDNF, research grade	Multiple sizes
Human GDNF, premium grade	Multiple sizes
Human CNTF, research grade	Multiple sizes
Human PDGF-AA, research grade	Multiple sizes
Human NT-3, research grade	Multiple sizes
Mouse FGF-2, research grade	Multiple sizes
Human FGF-2, research grade	Multiple sizes
Human FGF-2, premium grade	Multiple sizes

3D imaging

Product	Order no.
Staining	
See page 9 for a list of staining antibodies	
Tissue clearing	
MACS Clearing Kit	130-126-719
MACS Deep Clearing Kit	130-136-470
3D Imaging	
UltraMicroscope Blaze	Contact us
MACS UltraMount 8	130-136-872
MACS UltraMount 48	130-135-488
MACS Imaging Solution	Multiple sizes

PSC differentiation into neural cells

Product	Order no.
PSC maintenance	
StemMACS PSC-Brew XF, human	130-127-865
StemMACS PSC-Support XF, human	130-127-287
StemMACS Passaging Solution XF	130-104-688
StemMACS Y27632	130-103-922
StemMACS Thiazovivin	130-104-461
StemMACS Cryo-Brew	130-109-558
PSC differentiation	
StemMACS DiffBase XF, human	130-126-015
MACS Neuro Medium	130-093-570
MACS NeuroBrew-21 w/o Vitamin A (50×)	130-097-263
MACS NeuroBrew-21 (50×)	130-093-566
StemMACS Small Molecules	See QR code
MACS Cytokines	See QR code
Cell separation	
Indirect CD133 MicroBeads Kit, human	130-091-895
Neural Crest Stem Cell MicroBeads, human	130-097-127
Anti-PSA-NCAM MicroBead Kit, human and mouse	130-097-859
Cell characterization	
PSC-mDA Neuron Analysis Kit, anti-human	130-127-439
MACSPlex EV Kit Neuro, human	Multiple sizes

VISIT

Get high yields of pure extracellular vesicles from various starting materials.

▸ **miltenyibiotec.com/ EV-isolation-kits**

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Use serum-free, xeno-free StemMACS Culture media for healthy PSCs

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Miltenyi Biotec

Germany/Austria
Miltenyi Biotec B.V. & Co. KG
Friedrich-Ebert-Straße 68
51429 Bergisch Gladbach
Germany
Phone +49 2204 8306-0
Fax +49 2204 85197
macsde@miltenyi.com

USA/Canada
Miltenyi Biotec, Inc.
1201 Clopper Road
Gaithersburg, MD 20878,
USA
Phone 800 FOR MACS
Phone +1 866 811 4466
Fax +1 877 591 1060
macsus@miltenyi.com

Australia
Miltenyi Biotec
Australia Pty. Ltd.
Unit 11, 2 Eden Park Drive
Macquarie Park, NSW 2113
Australia
Phone +61 2 8877 7400
Fax +61 2 9889 5044
macsau@miltenyi.com

Benelux
Miltenyi Biotec B.V.
Dellaertweg 9C
2316 WZ Leiden
The Netherlands
macsnl@miltenyi.com
Customer service for:
The Netherlands
Phone 0800 4020120
Fax 0800 4020100
Belgium
Phone 0800 94016
Fax 0800 99626
Luxembourg
Phone 800 24971
Fax 800 24984

China
Miltenyi Biotec Technology &
Trading (Shanghai) Co., Ltd.
Room A401, 4/F
No. 1077, Zhangheng Road
Pudong New Area
201203 Shanghai, P.R. China
Phone +86 21 6084 0210
Fax +86 21 6235 0953
macscn@miltenyi.com.cn

France
Miltenyi Biotec SAS
10 rue Mercoeur
75011 Paris, France
Phone +33 1 56 98 16 16
macsfr@miltenyi.com

Hong Kong
Miltenyi Biotec Hong Kong Ltd.
Unit 301, Lakeside 1
No. 8 Science Park West Avenue
Hong Kong Science Park
Pak Shek Kok, New Territories
Hong Kong
Phone +852 3751 6698
Fax +852 3619 5772
macshk@miltenyi.com.hk

India
Miltenyi Biotec India Pvt. Ltd.
Vatika Business Centre,
Floor No. 6
Divya Sree Omega
Kondapur, Serilingampally
K.V. Rangareddy
Telangana 500084, India
Phone +91 040 45175910
macsin@miltenyi.com

Italy
Miltenyi Biotec S.r.l.
Via Paolo Nanni Costa, 30
40133 Bologna, Italy
Phone +39 051 6 460 411
Fax +39 051 6 460 499
macsit@miltenyi.com

Japan
Miltenyi Biotec K.K.
NEX-Eitai Building 5F
16-10 Fuyuki, Koto-ku
Tokyo 135-0041, Japan
Phone +81 3 5646 8910
Fax +81 3 5646 8911
macsjp@miltenyi.com

Nordics and Baltics
Miltenyi Biotec Norden AB
Medicon Village
Scheeletorget 1
223 81 Lund, Sweden
macsse@miltenyi.com
Customer service for:
Sweden
Phone 0200 111 800
Fax +46 280 72 99
Denmark
Phone 80 20 30 10
Fax +46 46 280 72 99
Norway, Finland, Iceland,
and Baltic countries
Phone +46 46 280 72 80
Fax +46 46 280 72 99

Singapore
Miltenyi Biotec Asia Pacific Pte Ltd.
438B Alexandra Road, Block B
Alexandra Technopark
#06-01
Singapore 119968
Phone +65 6238 8183
Fax +65 6238 0302
macssg@miltenyi.com

South Korea
Miltenyi Biotec Korea Co., Ltd.
Donggeuk 7F,
562 Nonhyeon-ro
Gangnam-gu
Seoul 06136, South Korea
Phone +82 2 555 1988
Fax +82 2 555 8890
macskr@miltenyi.com

Spain
Miltenyi Biotec S.L.
C/Virgilio 2, Edificio II, Planta –1
28223 Pozuelo de Alarcón
Madrid, Spain
Phone +34 91 512 12 90
Fax +34 91 512 12 91
macses@miltenyi.com

Switzerland
Miltenyi Biotec Swiss AG
Soodstrasse 52
8134 Adliswil
Switzerland
Phone +41 32 623 08 47
Fax +49 2204 85197
macsch@miltenyi.com

United Kingdom
Miltenyi Biotec Ltd.
Almac House, Church Lane
Bisley, Surrey GU24 9DR, UK
Phone +44 1483 799 800
Fax +44 1483 799 811
macsuk@miltenyi.com

www.miltenyibiotec.com

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