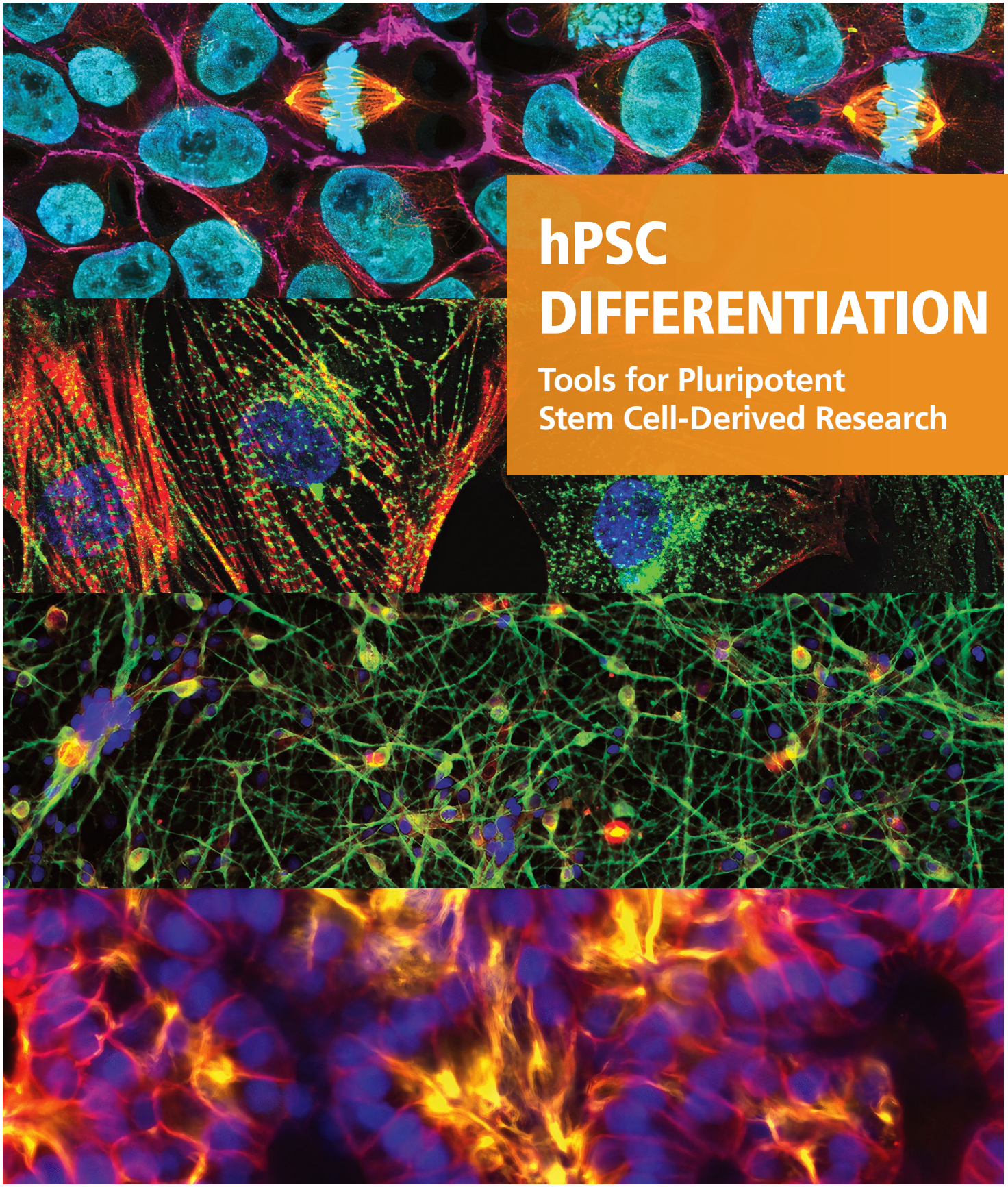


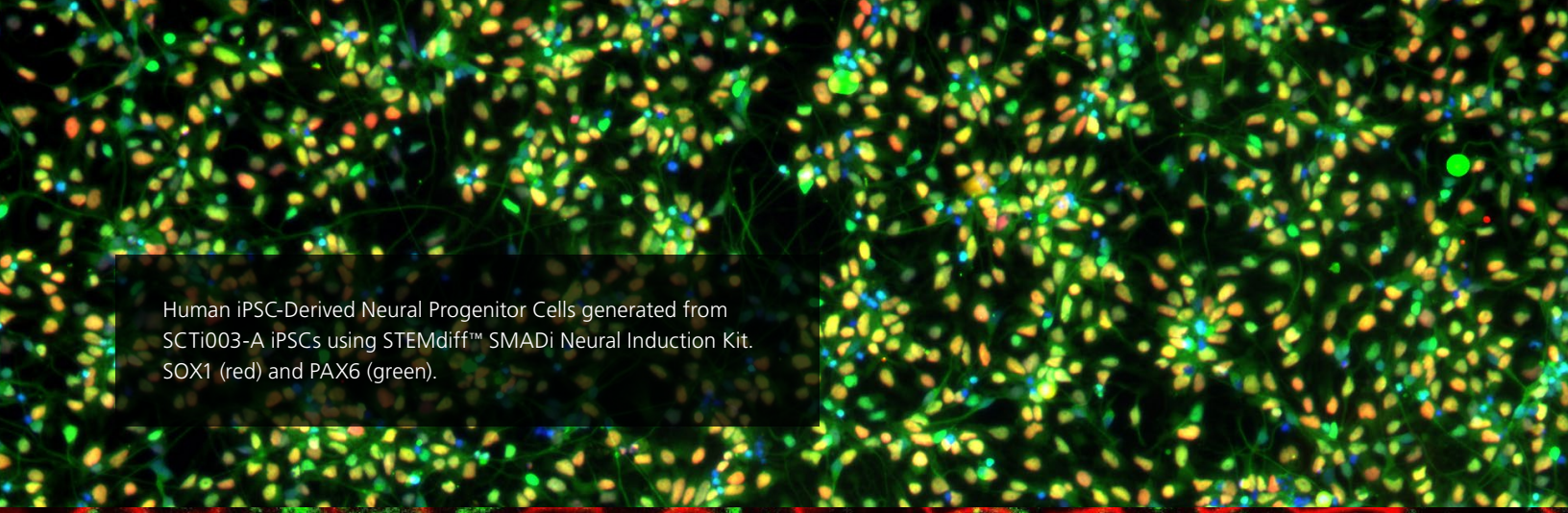
hPSC DIFFERENTIATION

Tools for Pluripotent Stem Cell-Derived Research

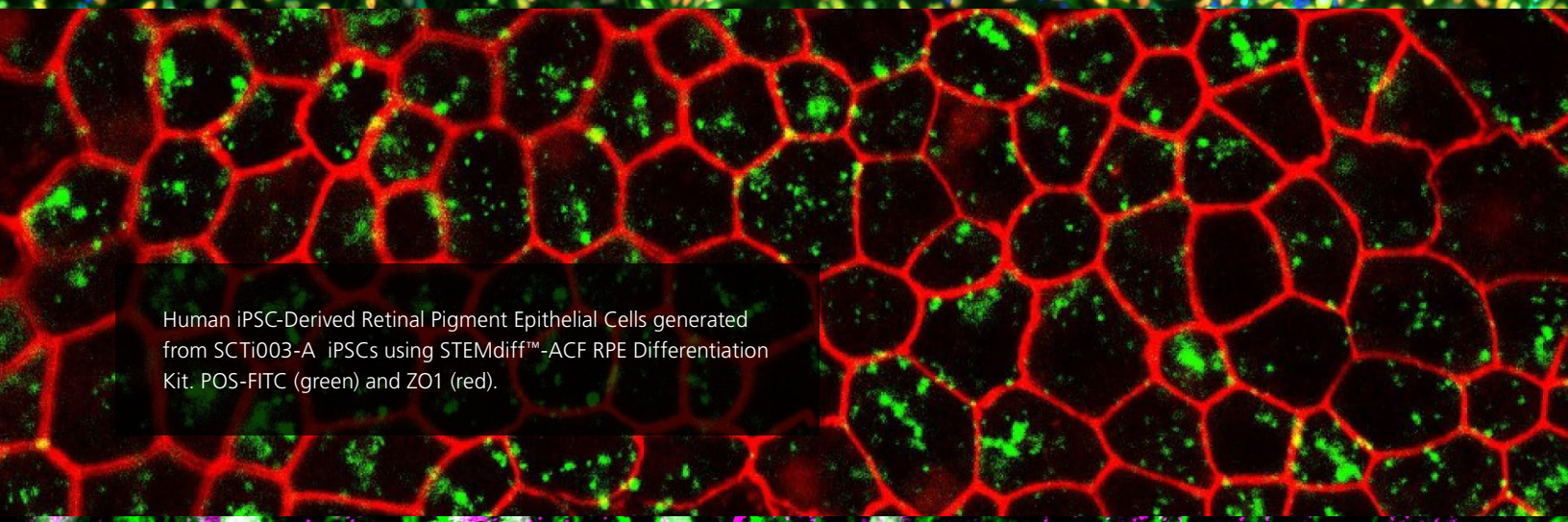
STEMCELL™ TECHNOLOGIES

Scientists Helping Scientists™ | WWW.STEMCELL.COM

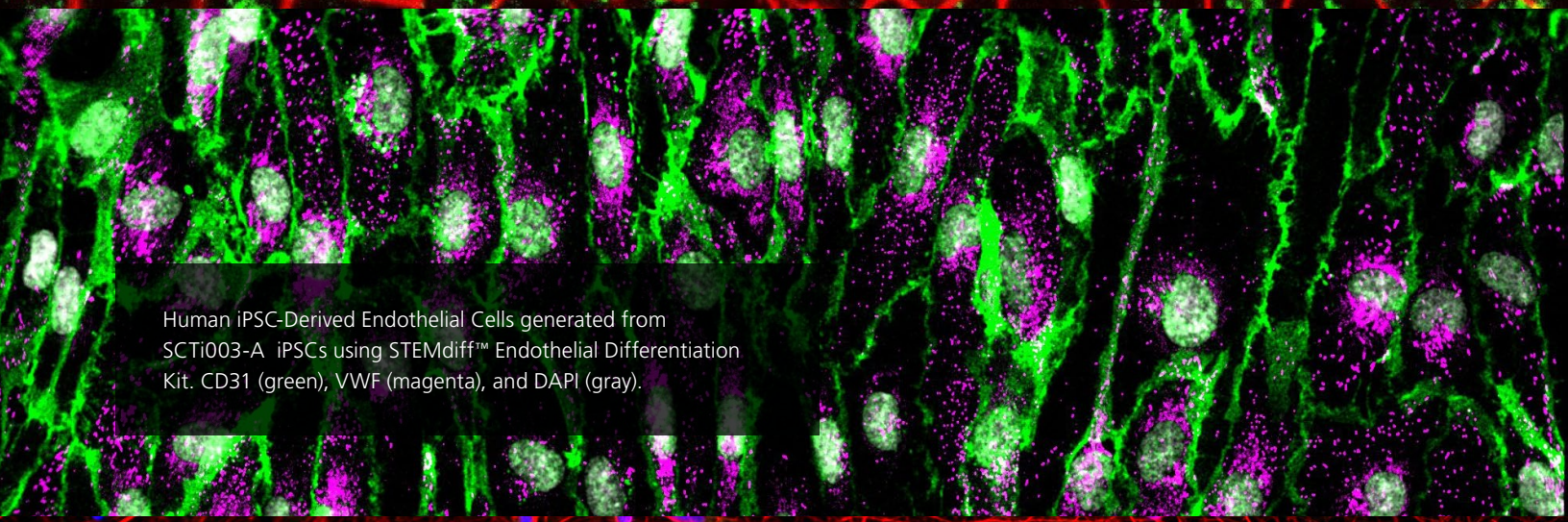
PDF



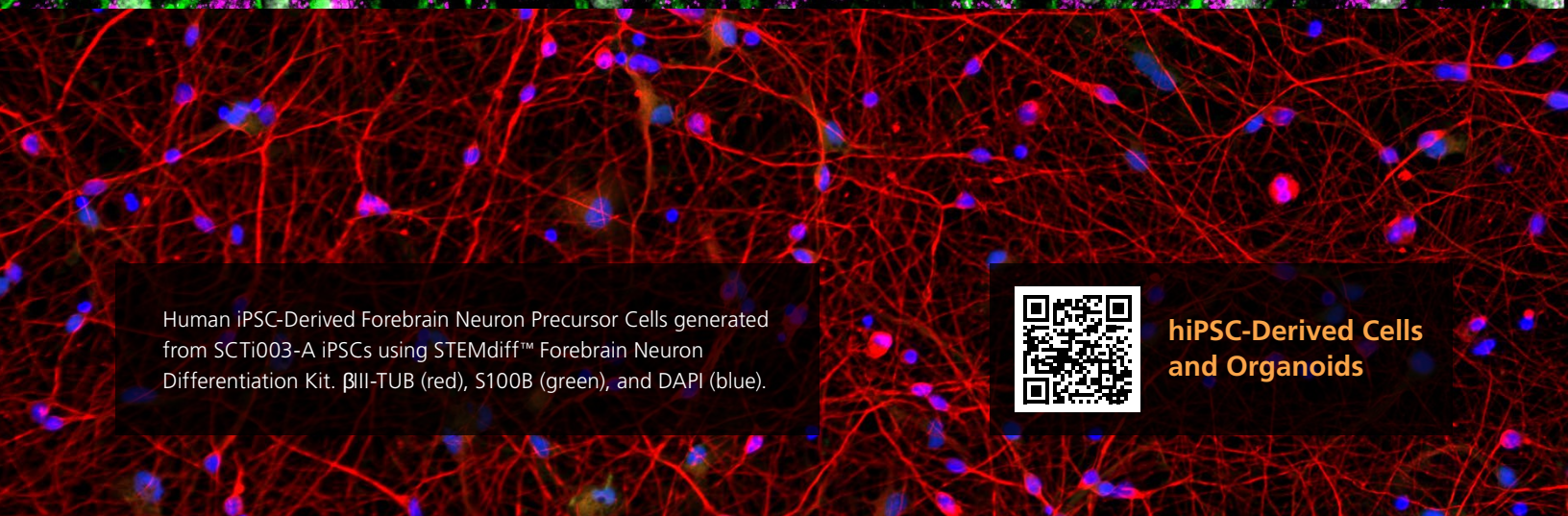
Human iPSC-Derived Neural Progenitor Cells generated from SCTi003-A iPSCs using STEMdiff™ SMADi Neural Induction Kit. SOX1 (red) and PAX6 (green).



Human iPSC-Derived Retinal Pigment Epithelial Cells generated from SCTi003-A iPSCs using STEMdiff™-ACF RPE Differentiation Kit. POS-FITC (green) and ZO1 (red).



Human iPSC-Derived Endothelial Cells generated from SCTi003-A iPSCs using STEMdiff™ Endothelial Differentiation Kit. CD31 (green), VWF (magenta), and DAPI (gray).



Human iPSC-Derived Forebrain Neuron Precursor Cells generated from SCTi003-A iPSCs using STEMdiff™ Forebrain Neuron Differentiation Kit. βIII-TUB (red), S100B (green), and DAPI (blue).

hiPSC-Derived Cells and Organoids

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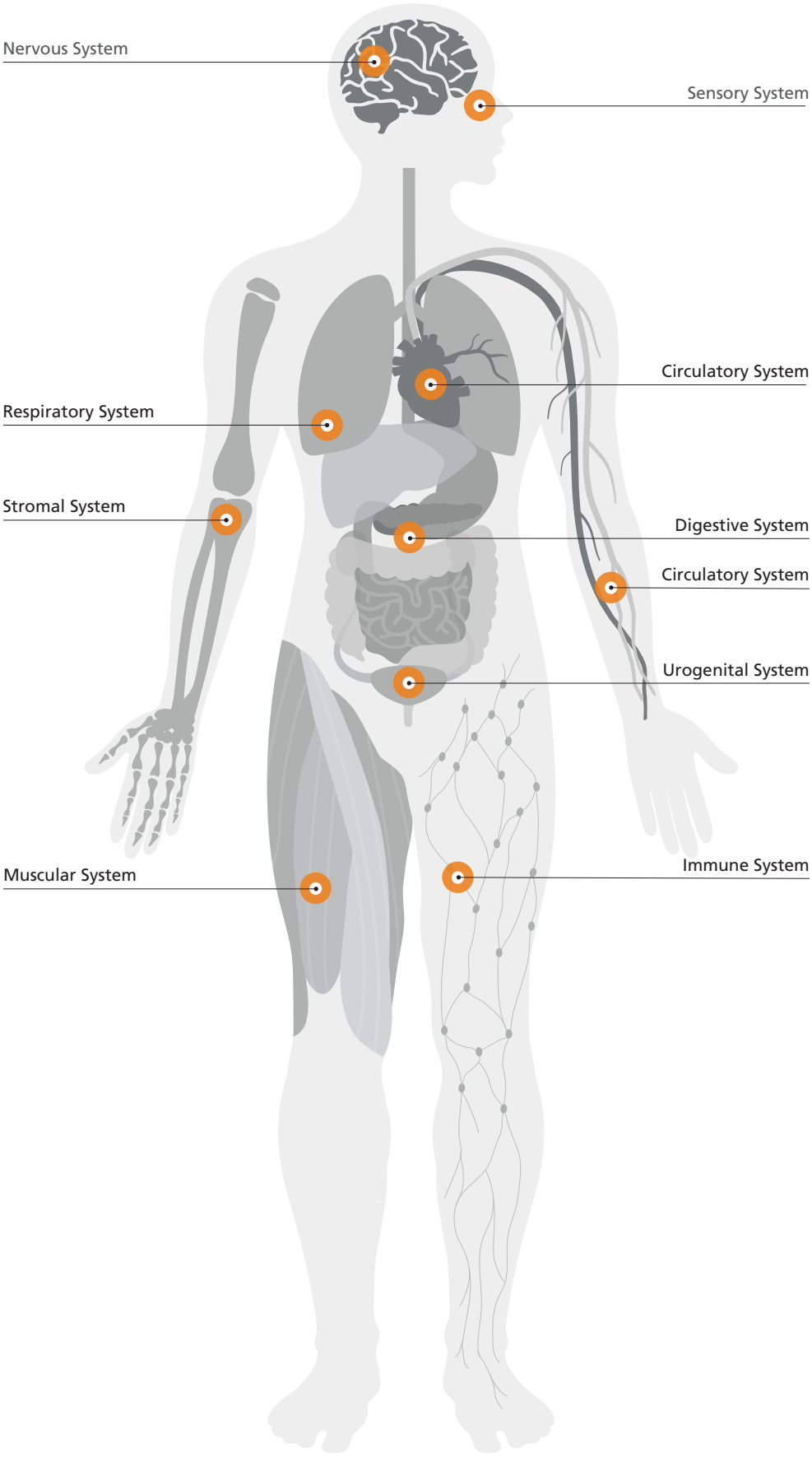

Nervous System
Sensory System
Circulatory System
Respiratory System
Stromal System
Digestive System
Circulatory System
Urogenital System
Immune System
Muscular System

STEMdiff™ Pluripotent Stem Cell Differentiation Media

Consistent human pluripotent stem cell (hPSC) differentiation is pivotal to high-quality results. Without standardized hPSC culture conditions, even the most detailed and rigorously followed stem cell differentiation protocols may still lead to inconsistent differentiation.[1,2] Use STEMdiff™ —a line of culture medium kits specifically optimized for hPSC differentiation to reproducibly differentiate multiple human embryonic stem cell (ESC) and induced pluripotent stem cell (iPSC) lines to 2D cell types and 3D organoid models originating from all three embryonic germ layers. Each easy-to-use kit comes with detailed, user-friendly protocols to standardize your differentiation protocols. For gene-edited or patient-derived hPSC lines, these optimized media and protocols enable the generation of a variety of cell types with the same genotype. The STEMdiff™ family of products is part of our complete system of reagents for hPSC culture and is compatible with TeSR™ maintenance media.

Explore the following pages for tools to support nervous system, circulatory system, respiratory system, digestive system, immune system, sensory system, muscular system, stromal system, urogenital system, and customizable cell and organoid differentiation.

Why Use STEMdiff™?

- Reduce experimental variability with formulations optimized under rigorous quality controls
- Differentiate across multiple human ESC and iPSC lines
- Standardize your differentiation to cells from all three germ layers with simplified kit formats
- Generate and bank progenitor cell types for experimental flexibility or as a reliable cell source for customized downstream differentiation

Learn more at www.STEMdiff.com

hPSC Maintenance: Start Your Cells Right

In order to maintain high-quality hPSCs that are capable of self-renewal and directed differentiation to specific cell types, appropriate culture conditions and best practices in hPSC maintenance are critical. You can trust our family of feeder-free TeSR™ media, produced using rigorously pre-screened materials, to provide the right support for your chosen culture method. Used alongside our xeno-free cell attachment substrates and chemically defined passaging reagents, TeSR™ media enables you to reproducibly culture high-quality hPSCs and minimize variation in your research. hPSC characterization tools are also available to assist with best practices for quality control and research transparency. For long-term storage, our suite of cryopreservation media is designed to maintain high viability and maximize hPSC recovery after thawing.

TeSR™ Product Finder

Find the right products to set up for success in your hPSC research with this interactive tool.

www.stemcell.com/pluripotent-product-finder

Human Induced Pluripotent Stem Cell Solutions

High-Quality hiPSC Lines and hiPSC-Derived Cells and Organoids

Start your research confidently with a reliable source of high-quality human induced pluripotent stem cell (hiPSC) lines, hiPSC-derived cells, and organoids. With the right starting materials, you can focus on innovation and discovery instead of troubleshooting cell quality issues. Developed in accordance with the Standards for Human Stem Cell Use in Research released by the International Society for Stem Cell Research (ISSCR), these tools support a wide range of applications, including disease modeling, drug discovery and toxicity testing, and regenerative medicine development.

Available Cell Lines and hiPSC-Derived Cells

Our hiPSC portfolio is continuously evolving to meet the diverse needs of researchers. Explore our range of highly characterized control cell lines, featuring a variety of genotypes and genetic backgrounds, and hiPSC-derived cells.

Note: *For research use or in vitro laboratory-based tissue culture work only. Not approved for application into humans under any circumstances.*

Description	Catalog #
Healthy Control Human iPSC Line, Female, SCTi003-A	200-0511
Healthy Control Human iPSC Line, Male, SCTi004-A	200-0769
Healthy Control Human iPSC Line, Female, SCTi005-A	200-0944
Healthy Control Human iPSC Line, Male, SCTi006-A	200-0945
Human iPSC Line, SCTi003-A-1, APOE e4/e4	200-0990
Human iPSC Line, SCTi003-A-2, APP K670N/M671L (Swedish Mutation)	200-0991
Human iPSC Line, SCTi003-A-3, ABCA4 Knockout	200-0992
Human iPSC-Derived Neural Progenitor Cells	200-0620 200-0621
Human iPSC-Derived Mesenchymal Progenitor Cells	200-0781
Human iPSC-Derived Retinal Pigment Epithelial Cells	100-2150 100-2151 200-0912 200-0913
Human iPSC-Derived Midbrain Organoids	200-0790 200-0791 200-0792 200-0793
Human iPSC-Derived Forebrain Neuron Precursor Cells	200-0770
Human iPSC-Derived Endothelial Cells	200-0907
Human iPSC-Derived Astrocytes	200-0980
iPSCdirect™	200-0510

Why Use STEMCELL's hiPSC Solutions?

- Enhance research transparency and integrity with hPSCreg®-certified cells manufactured to meet ISSCR standards
- Speed up discovery with validated, reliable cell sources and faster, data-driven insights
- Enable academic and commercial research with ethically sourced cells collected under IRB-approved protocols
- Integrate hiPSCs confidently into your research with cell lines that are compatible with TeSR™ media for maintenance and STEMdiff™ for differentiation

Ensuring Quality

Extensive quality control procedures are conducted at every stage of the hiPSC manufacturing process to ensure cell quality and reproducibility. These assessments may include:

- **Cell line identity** by short tandem repeat (STR) analysis
- **Viability and recovery** by thawing and culturing cells
- **Microbiological testing**, including sterility testing, mycoplasma testing, and viral screening
- **Genomic integrity and stability** by residual vector testing, T cell clonality, karyotyping, 20q FISH, SNP microarray, and whole genome sequencing
- **Undifferentiated status testing** by a three-passage assay and flow cytometry
- **Pluripotency** by in vitro trilineage differentiation

hiPSC Solutions

Browse Our Complete Portfolio
www.stemcell.com/ipsc-solutions

Certificate of Analysis

Example from the SCTi004-A Line
www.hpscreg.eu/cell-line/SCTi004-A

Coming Soon

Get Notified of New hiPSC Products
www.stemcell.com/upcomingproducts

Nervous System

BrainPhys™ Neuronal Medium

Culture Active Neurons Under Physiological Conditions

Neurons must be active to be functional, yet traditional culture media prioritize neuronal survival over neuronal activity. For more physiologically relevant research, it is essential to support both neuronal activity and maturity in culture. Optimized neuronal media can help achieve this balance. Promote, rather than inhibit, neuronal activity and maturity in your cultured hPSC-derived neurons using BrainPhys™ Neuronal Medium (Catalog #05790) to generate a more neurophysiologically active culture that better represents the human brain environment.[3]

Published protocols using a basal medium together with neural supplements, such as NeuroCult™ SM1 Neuronal Supplement (Catalog #05792; based on the published B27 formulation[4]) and N2 supplement (Catalog #05793),[5] as well as various cytokines and small molecules are available for the generation of many neuronal subtypes.

BrainPhys™ Neuronal Medium may also be used to culture induced neurons derived through lineage conversion of somatic cells (i.e. without transitioning through an hPSC intermediate) or through forced NGN2 expression in hPSCs.[3]

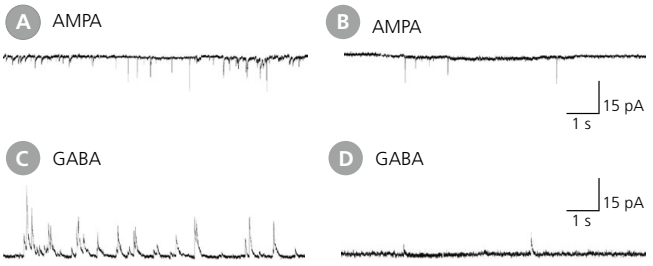


Figure 1. hPSC-Derived Neurons Matured in BrainPhys™ Neuronal Medium Show Improved Excitatory and Inhibitory Synaptic Activity

NPCs were generated from H9 cells using STEMdiff™ Neural Induction Medium (Catalog #05835) in an embryoid body-based protocol. Next, NPCs were cultured for 44 days in vitro in (A,C) BrainPhys™ Neuronal Medium, supplemented with 2% NeuroCult™ SM1 Supplement, 1% N2 Supplement-A, 20 ng/mL GDNF, 20 ng/mL BDNF, 1 mM db-cAMP, and 200 nM ascorbic acid to initiate neuronal differentiation, or (B,D) in DMEM/F-12 under the same supplementation conditions. (A,C) Neurons matured in BrainPhys™ Neuronal Medium showed spontaneous excitatory (AMPA-mediated; A) and inhibitory (GABA-mediated; C) synaptic events by voltage-clamp electrophysiology. The frequency and amplitude of spontaneous synaptic events are consistently greater in neuronal cultures matured in BrainPhys™ Neuronal Medium compared to neurons plated and matured in DMEM/F-12 (B,D). Traces are representative. NPCs = neural progenitor cells

Learn more at www.BrainPhys.com

Why Use BrainPhys™ Neuronal Medium?

- Choose a culture medium that mimics the extracellular environment of the brain
- Improve neuronal function and increase the proportion of synaptically active neurons
- Conduct functional assays without the need to perform medium changes
- Support the long-term culture of hPSC-derived neurons
- Achieve minimal lot-to-lot culture variability due to rigorous raw material screening and quality control

NeuroFluor™ NeuO

Selectively Label Live Neurons

NeuroFluor™ NeuO (Catalog #01801) is a membrane-permeable fluorescent probe that selectively labels primary and pluripotent stem cell-derived neurons in live cultures.[6] Labeling with this probe is non-permanent; it can be washed off, providing unlabeled, viable cells for downstream applications.

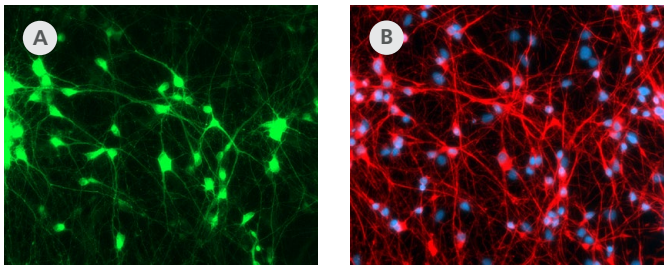


Figure 2. NeuroFluor™ NeuO Selectively Labels hPSC-Derived Neurons

(A) Neuronal precursors generated from hPSC-derived (XCL-1) NPCs were cultured in STEMdiff™ Neuron Maturation Medium. After 18 days of culture, hPSC-derived neurons were labeled with NeuroFluor™ NeuO (green). (B) The same culture was later fixed and immunostained for class III β-tubulin (red). Nuclei are counterstained with DAPI. The images show that NeuroFluor™ NeuO specifically labels class III β-tubulin-positive neurons.

Learn more at www.stemcell.com/NeuO-imaging

2D Neural Models

STEMdiff™-TF Forebrain Induced Neuron Differentiation Kit

Accelerate your neural differentiation workflows with the STEMdiff™-TF Forebrain Induced Neuron Differentiation Kit. In just five days, generate highly pure excitatory glutamatergic neurons with forebrain identity from human pluripotent stem cells (hPSCs). This serum-free kit uses transcription factor-mediated differentiation via lipid nanoparticle (LNP)-based delivery of non-integrating Neurogenin-2 (NGN2) mRNA, enabling you to produce highly pure neurons without genomic integration.

Designed for consistency across hPSC lines, this kit supports reproducible results and reduces variability—empowering reliable applications in disease modeling. These neurons also serve as a versatile and consistent human-based model suitable for incorporation into new approach methodologies (NAMs) for advancing drug discovery research.

For more information on gene expression levels in resulting forebrain neuron populations, contact your local sales representative for bulk RNA-sequencing data.

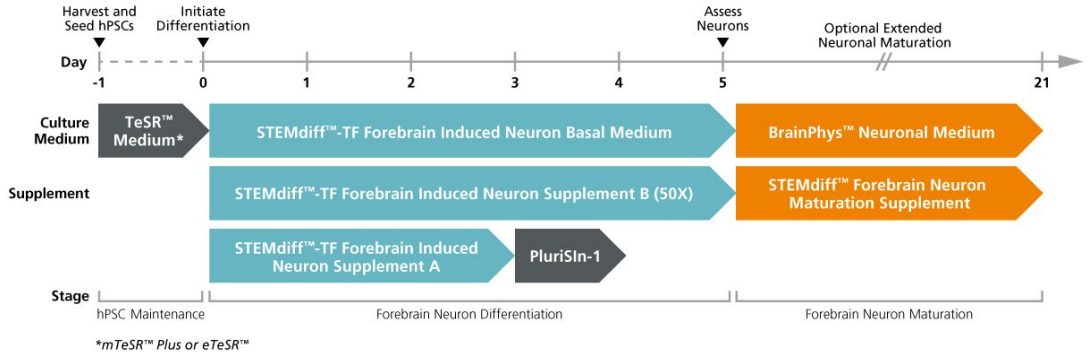


Figure 3. Schematic for the STEMdiff™-TF Forebrain Induced Neuron Differentiation Kit Protocol for Generating Excitatory Glutamatergic Forebrain Neurons

Excitatory glutamatergic forebrain neurons are generated from hPSCs within five days using STEMdiff™-TF Forebrain Induced Neuron Differentiation Kit. This forward programming protocol employs a synthetic mRNA-based system to deliver the transcription factor NGN2, without the use of viral vectors or genomic integration. All components of STEMdiff™-TF Forebrain Induced Neuron Differentiation Kit are indicated in teal. hPSCs = human pluripotent stem cells; NGN2 = Neurogenin 2.

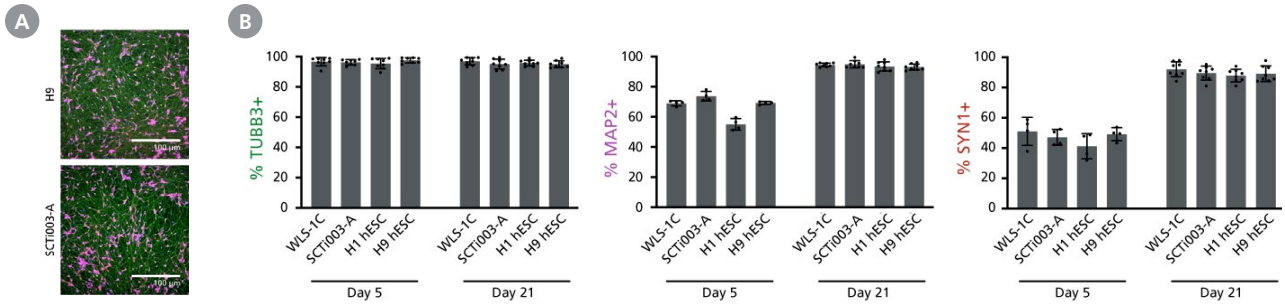


Figure 4. Highly Pure and Mature Excitatory Glutamatergic Forebrain Neuron Cultures Are Generated Using STEMdiff™-TF Forebrain Induced Neuron Differentiation Kit

(A) Representative ICC images of neurons from the H9 hESC line and Healthy Control Human iPSC Line, Female, SCTi003-A (Catalog #200-0511) on Day 5 of neuronal differentiation with STEMdiff™-TF Forebrain Induced Neuron Kit show widespread neuronal induction, with cells stained for TUBB3 (green), MAP2 (magenta), SYN1 (red), and nuclei labeled with DAPI (blue). Scale bars = 100 µm. (B) Quantification of ICC data of pan-neuronal markers on Days 5 and 21. Neurons generated with the STEMdiff™-TF Forebrain Induced Neuron Kit exhibit high expression of TUBB3 at Day 5 and increasing expression of intermediate/maturing (MAP2), and Late/post-synaptic (SYN1) markers by Day 21, consistent with progressive neuronal maturation. Data was collected from four hPSC lines, with 4 - 8 replicates per line. Bar graphs show mean ± SD. ICC = immunocytochemistry; hESC = human embryonic stem cell; iPSC = induced pluripotent stem cell; hPSC = human pluripotent stem cell

Learn more at
www.stemcell.com/stemdiff-tf-forebrain

STEMdiff™ Neural System

Differentiate hPSCs to Neural Progenitor Cells, Neurons, and Glia

The STEMdiff™ SMADi Neural Induction Kit (Catalog #08581) combines STEMdiff™ Neural Induction Medium (Catalog #05835) with STEMdiff™ SMADi Neural Induction Supplement, which directs differentiation by blocking TGF-β and BMP-dependent SMAD signaling, resulting in efficient neural induction of even hard-to-differentiate cell lines.

Neural progenitor cells (NPCs) can be generated using the STEMdiff™ SMADi Neural Induction Kit with either an embryoid body (EB) protocol or monolayer culture protocol. STEMdiff™ Neural Rosette Selection Reagent (Catalog #05832) allows rapid and efficient isolation of neural rosettes to enrich for CNS-type NPCs.

NPCs generated using the STEMdiff™ SMADi Neural Induction Kit can be efficiently expanded and cryopreserved in serum-free STEMdiff™ Neural Progenitor Medium (Catalog #05833) and STEMdiff™ Neural Progenitor Freezing Medium (Catalog #05838), respectively.

NPCs cultured in STEMdiff™ Neural Progenitor Medium display typical NPC morphology (Figure 5A) and can be consistently expanded three- to five-fold upon each passage to generate a large number of cells. NPCs generated using the STEMdiff™ SMADi Neural Induction Kit can be differentiated to functional neuronal subtypes using the lineage-specific STEMdiff™ differentiation and maturation kits.

For more information on gene expression levels in resulting NPC populations, contact your local sales representative for bulk RNA-sequencing data.

Learn more at
www.stemcell.com/STEMdiff-NIM-SMADi

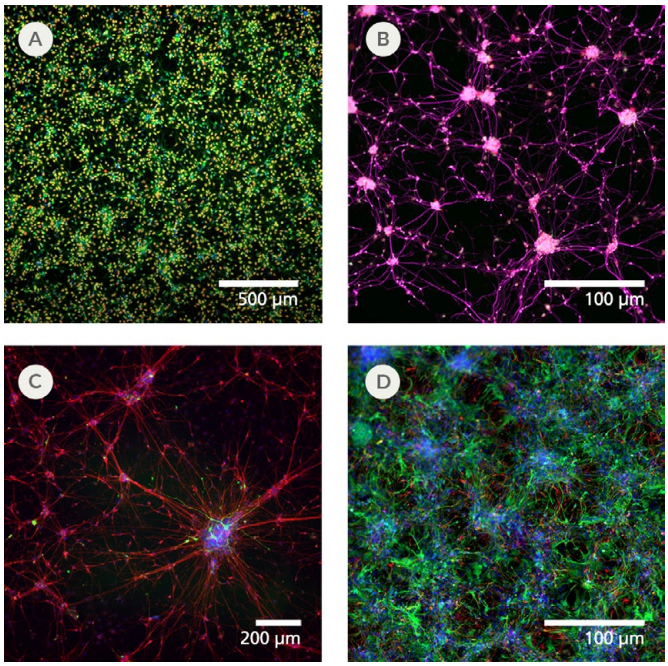


Figure 5. Human iPSC-Derived Neural Progenitor Cells Generated Using STEMdiff™ SMADi Neural Induction Kit Can Effectively Differentiate into Forebrain Neurons, Midbrain Neurons, and Astrocytes

Human iPSC-Derived Neural Progenitor Cells generated from SCTi003-A (Catalog #200-0511) hiPSCs using STEMdiff™ SMADi Neural Induction Kit were thawed, established in culture, and fixed for immunocytochemistry. (A) The NPCs express neural progenitor markers SOX1 (red) and PAX6 (green). (B) NPCs cultured with the STEMdiff™ Forebrain Neuron Kit produce forebrain neuron cell populations expressing neuronal identity marker βIII-TUB (magenta). (C) NPCs cultured with the STEMdiff™ Midbrain Neuron Kit produce midbrain neuron cell populations expressing neuronal identity marker βIII-TUB (red) and dopaminergic neuron marker TH (green). (D) NPCs cultured with the STEMdiff™ Astrocyte Kit produce astrocyte populations expressing astrocyte marker S100β (green) and GFAP (red).

Tech Tip

Designing Your Neural Induction and Differentiation Workflow

stemcell.com/Neural-Induction-Workflow

Training

Free Virtual On-Demand Neural Induction Course

stemcell.com/forms/Neural-Induction-on-Demand-Training

Human iPSC-Derived Neural Progenitor Cells

Save time by starting your workflow with a highly characterized, assay-ready neural progenitor intermediate. See page 6 for details.

STEMdiff™ Forebrain Neuron Kits

A mixed population of excitatory and inhibitory forebrain-type (FOXG1+) neurons can be generated using the serum-free STEMdiff™ Forebrain Neuron Differentiation Kit (Catalog #08600) and STEMdiff™ Forebrain Neuron Maturation Kit (Catalog #08605). The basal medium for the maturation kit is BrainPhys™ (Catalog #05790), a neuronal medium designed to support electrical activity and neuronal maturation for functional neurons.

For more information on gene expression levels in resulting forebrain neuron populations, contact your local sales representative for bulk RNA-sequencing data.

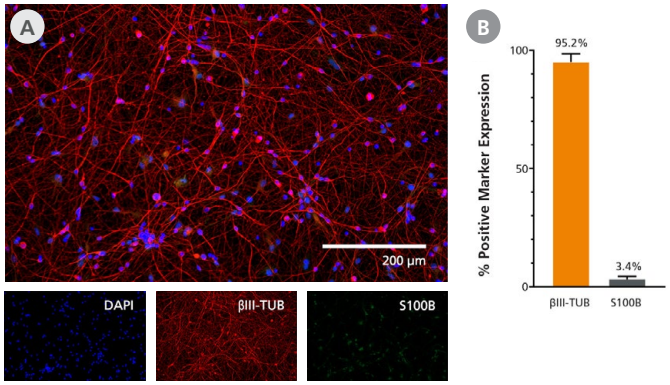


Figure 6. Matured Human iPSC-Derived Forebrain Neuron Precursor Cells Generated Using the STEMdiff™ Forebrain Neuron Kits Consist of a Highly Pure Neuronal Population

Human iPSC-Derived Forebrain Neuron Precursor Cells generated from SCTi003-A (Catalog #200-0511) hiPSCs using the STEMdiff™ Forebrain Neuron Kits were thawed, established in culture, and fixed for immunocytochemistry. (A) Day 14 neurons express high levels of neuronal marker βIII-TUB (red) with low expression of S100B (green). In addition, they display the typical neuronal morphology with healthy neurites and minimal cell clumping. (B) The percentage expression of these markers were quantified. Neuronal marker βIII-TUB was found to be expressed in 95% of neurons, while glial marker S100B was expressed in less than 4% of neurons. Error bars represent standard deviation (n = 2 biological replicates). hiPSC = human induced pluripotent stem cell

Learn more at
www.stemcell.com/STEMdiff-Neuron

Human iPSC-Derived Forebrain Neuron Precursor Cells

Save time by starting your workflow with a highly characterized, assay-ready mixed population of excitatory and inhibitory forebrain neuron precursor cells. See page 6 for details.

STEMdiff™ Midbrain Neuron Kits

Dopaminergic neurons can be generated using the serum-free STEMdiff™ Midbrain Neuron Differentiation Kit (Catalog #100-0038) and STEMdiff™ Midbrain Neuron Maturation Kit (Catalog #100-0041). The midbrain-patterned cell population produced contains DAT-, TH-positive neurons that can be maintained long-term in culture (Figure 7).

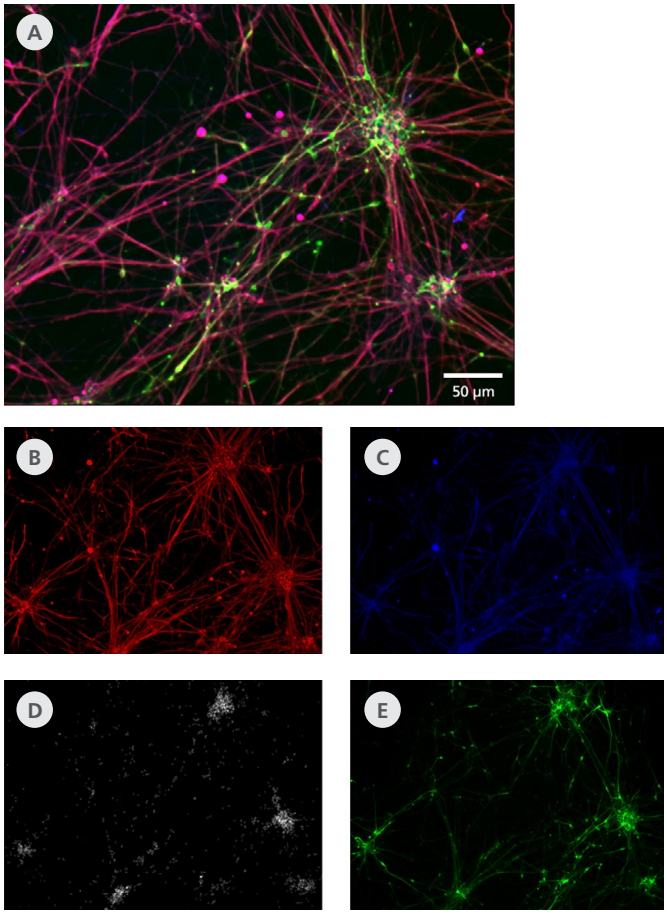


Figure 7. Midbrain-Type Neurons Express Tyrosine Hydroxylase and Dopamine Transporters (DAT) After Differentiation and Maturation in STEMdiff™ Midbrain Neuron Kits

(A) NPCs generated from H9 hPSCs in mTeSR™1 using the STEMdiff™ SMADi Neural Induction Kit monolayer protocol were differentiated and matured to midbrain-type neurons using the STEMdiff™ Midbrain Neuron Differentiation Kit for 12 days and STEMdiff™ Midbrain Neuron Maturation Kit for 14 days. The resulting cultures contain a population of (B) class III β-tubulin-positive neurons (red), which (C) express DAT in blue, and (E) more than 15% tyrosine hydroxylase-positive cells (green). (D) Nuclei are labeled with DAPI (white).

Learn more at
www.stemcell.com/STEMdiff-Dopa

STEMdiff™ Astrocyte Kits

Generate a highly pure population of astrocytes using the STEMdiff™ Astrocyte Differentiation Kit (Catalog #100-0013) and STEMdiff™ Astrocyte Serum-Free Maturation Kit (Catalog #100-1666). Matured astrocytes are functional, as assayed by calcium imaging (data not shown) and can be used for co-culture applications.

For more information on gene expression levels in resulting astrocyte populations, contact your local sales representative for bulk RNA-sequencing data.

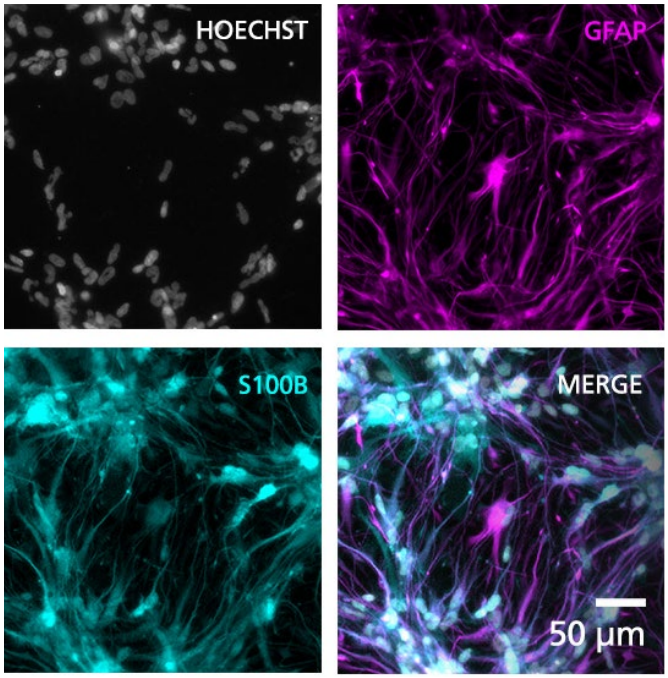


Figure 8. Pure Populations of Astrocytes Are Generated Using STEMdiff™ Astrocyte Differentiation Kit and Matured Using STEMdiff™ Astrocyte Serum-Free Maturation Kit

NPCs generated from SCTi003-A (Catalog #200-0511) hiPSCs were differentiated using STEMdiff™ Astrocyte Differentiation Kit for 3 weeks and matured using STEMdiff™ Astrocyte Serum-Free Maturation Kit for an additional 3 weeks. Nuclei are labeled with Hoechst (gray). The resulting cultures contain a highly pure population of astrocytes expressing astrocyte identity marker GFAP (magenta) and mature astrocyte marker S100B (cyan). NPC = neural progenitor cell; hiPSCs = human induced pluripotent stem cells

Learn more at
www.stemcell.com/STEMdiff-Astro

Human iPSC-Derived Astrocytes

Save time by starting your workflow with highly characterized, assay and co-culture-ready astrocytes.
See page 6 for details.

STEMdiff™ Motor Neuron Kits

Generate highly pure in vitro populations of motor neurons from hPSCs in only 14 days using the STEMdiff™ Motor Neuron Differentiation Kit (Catalog #100-0871). These motor neurons can be further matured with BrainPhys™-based STEMdiff™ Motor Neuron Maturation Kit (Catalog #100-0872). The resultant motor neuron populations exhibit high-level expression of expected motor neuron markers.

For more information on gene expression levels in resulting motor neuron populations, contact your local sales representative for bulk RNA-sequencing data.

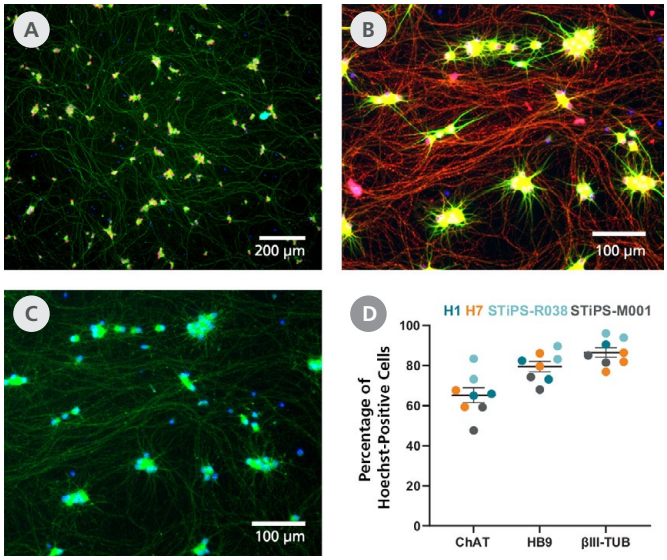


Figure 9. hPSC-Derived Motor Neurons Can Be Further Matured in STEMdiff™ Motor Neuron Maturation Medium

Motor neuron progenitors derived from a variety of lines were matured using the STEMdiff™ Motor Neuron Maturation Kit. (A) Mature motor neuron cultures contain a population of cells expressing neuronal identity marker βIII-TUB (green), mature motor neuron markers HB9 (red), (B) SYNAPSIN (red), and MAP2 (green), as well as (C) cholinergic neuron marker ChAT (green). Nuclei are labeled with Hoechst (blue). (D) The percentage expression of ChAT, HB9, and βIII-TUB in the resulting cultures, derived from 2 hES (H1 and H7) and 2 hiPS (STiPS-R038 and STiPS-M001) cell lines, were quantified. This differentiation generated ChAT+ (65.16% ± 3.737%, mean ± SEM; n = 4 cell lines, 2 replicates per condition), HB9+ (79.58% ± 2.570%, mean ± SEM), and βIII-TUB+ (86.56% ± 2.331%, mean ± SEM) motor neurons. Numbers are % positive of total Hoechst-positive cells.

Learn more at
www.stemcell.com/Motor-Neuron

STEMdiff™ Microglia Culture System

The STEMdiff™ Microglia Differentiation (Catalog #100-0019) and Maturation (Catalog #100-0020) Kits consist of a serum-free basal medium and supplements for highly efficient and reproducible generation of microglia from hPSCs via a hematopoietic progenitor cell (HPC) intermediate.

These kits are optimized for use on HPCs generated with the STEMdiff™ Hematopoietic Kit (Catalog #05310), taking 28 days to generate functional microglia.

Microglia produced using the STEMdiff™ Microglia Culture System, based on the protocol from the laboratory of Mathew Blurton-Jones,[7] are versatile tools for studying human neurological development, neuroimmune responses, and disease, in particular for modeling neuroinflammation and neurodegeneration. Cells can also be added to both 2D and 3D co-cultures with other neuronal cell types.

For more information on gene expression levels in resulting microglia populations, contact your local sales representative for bulk RNA-sequencing data.

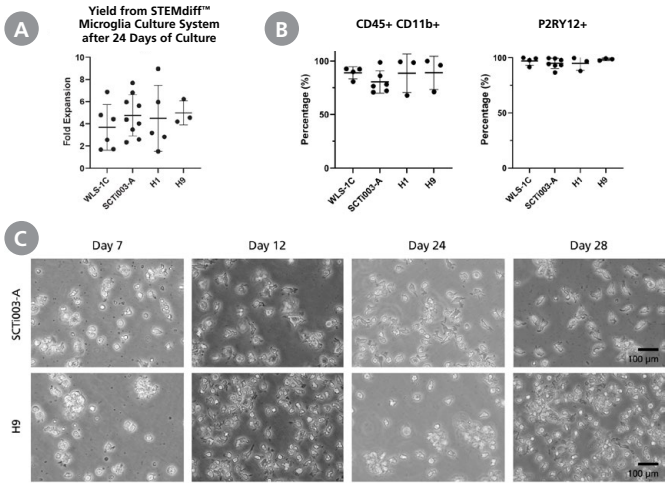


Figure 10. Microglia Generated Using the STEMdiff™ Microglia Culture System Exhibit Robust Expansion, Mature Phenotypic Markers, and Homeostatic Morphology

(A) Microglia generated using the STEMdiff™ Microglia Culture System undergo a four-fold expansion, on average, across four cell lines. The fold expansion was calculated by taking the total cell count at Day 24 and dividing it by the number of seeded cells at Day 0. The bars show the mean ± standard deviation. Technical replicates were averaged, n = 1 - 4 technical replicates, 1 - 9 experimental setups. (B) Microglia generated with STEMdiff™ Microglia Culture System have CD45+ CD11b+ co-expression and P2RY12+ expression as measured by flow cytometry on Day 24. The bars show the mean ± standard deviation. Technical replicates (n = 1 - 4) were averaged, and each dot in the graph represents an experimental replicate. (C) Normal microglial morphology, characterized by small cell bodies and ramified processes, is observed in cells generated using the STEMdiff™ Microglia Culture System. Images at Days 12 and 24 were captured prior to replate and harvest. Scale bar = 100 µm.

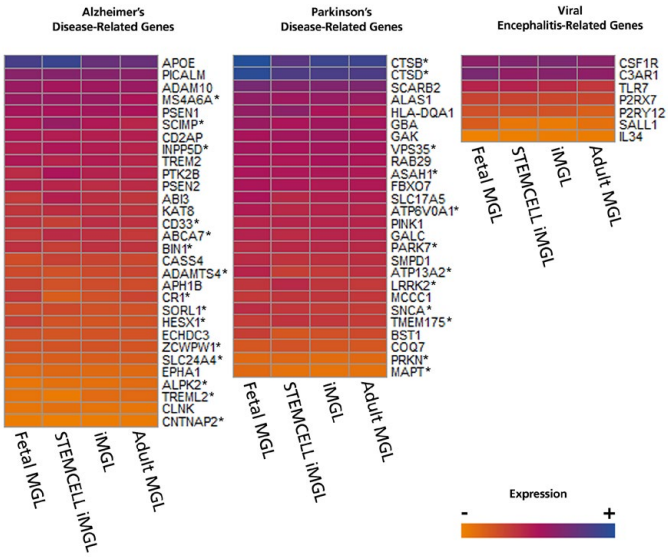


Figure 11. Microglia Generated with STEMdiff™ Microglia Culture System Express Disease-Relevant Genes Similar to Those from Published Differentiation and Maturation Protocols

Bulk RNA-seq datasets were extracted from 8 different publications that generated hPSC- (iMGL) and primary- (MGL) derived microglia and their transcriptional profiles compared to data from microglia generated with STEMdiff™ Microglia Culture System. The heat map displays absolute expression levels for select genes associated with Alzheimer's disease, Parkinson's disease, and viral encephalitis. Significant differences in gene expression between microglia generated with STEMdiff™ Microglia Culture System and any of the other 3 groups were identified by differential gene expression analysis. *= p<0.05 (DEseq2, adjusted). hPSC = human pluripotent stem cell

Protocol

How to Tri-Culture hPSC-Derived Forebrain Neurons, Astrocytes, and Microglia

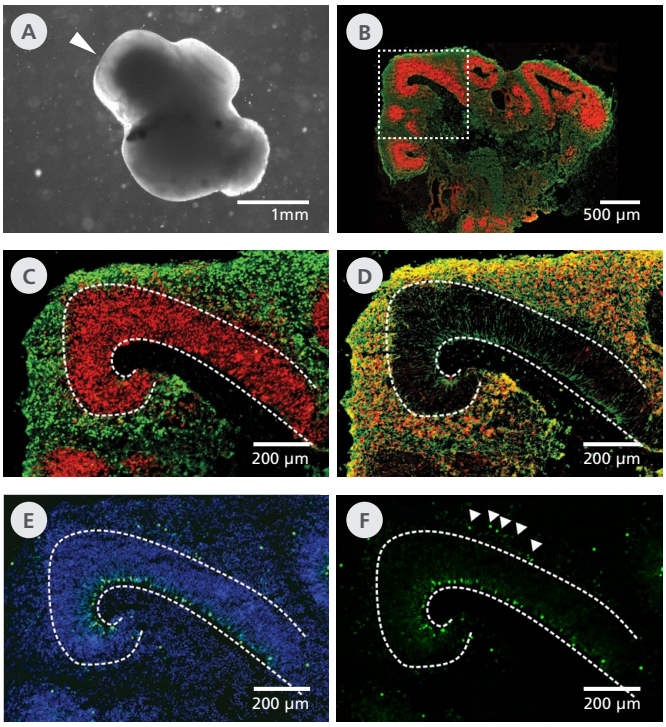
www.stemcell.com/triculture

For differentiation to neural crest cells or sensory neurons, please see page 31.

Learn more at www.stemcell.com/microglia

3D Neural Models
STEMdiff™ Cerebral Organoid Kits

Cerebral organoids are three-dimensional in vitro cultures that recapitulate the developmental processes and organization of the developing human brain. The STEMdiff™ Cerebral Organoid Kit (Catalog #08570) is designed to generate unpatterned, multi-layered neural organoids from human PSCs. For extended periods of organoid culture, the kit components required for organoid maturation are available separately as the STEMdiff™ Cerebral Organoid Maturation Kit (Catalog #08571). To facilitate embedding of 3D aggregates, this media is compatible with the Organoid Embedding Sheet (Catalog #08579).



For more information on gene expression levels in resulting cerebral organoids, contact your local sales representative for bulk RNA-sequencing data.

Why Use the STEMdiff™ Cerebral Organoid Kit?

- Generate unpatterned organoids capable of spontaneous differentiation to produce multiple brain regions within the same organoid
- Culture under flexible conditions with either matrix droplet embedding or liquid matrix
- Enjoy increased efficiency of organoid formation with a formulation based on a popular published protocol[8]
- Generate new or modified organoid models with this highly compatible platform

Learn more at www.stemcell.com/COKit

Figure 12. Cerebral Organoids Contain Multiple Layered Regions That Recapitulate the Cortical Lamination Process Observed During In Vivo Human Brain Development

(A) A representative phase-contrast image of a whole cerebral organoid at Day 40 generated using the STEMdiff™ Cerebral Organoid Kit. Cerebral organoids at this stage are made up of phase-dark structures that may be surrounded by regions of thinner, more translucent structures that display layering (arrowheads). (B) Immunohistological analysis on cryosections of cerebral organoids reveals cortical regions within the organoid labeled by the apical progenitor marker PAX6 (red) and neuronal marker β-tubulin III (green). (C-F) Inset of boxed region from (B). (C) PAX6+ apical progenitors (red, enclosed by dotted line) are localized to a ventricular zone-like region. β-tubulin III+ neurons (green) are adjacent to the ventricular zone. (D) CTIP2, a marker of the developing cortical plate, co-localizes with β-tubulin III+ neurons in a cortical plate-like region. Organization of the layers recapitulates early corticogenesis observed during human brain development. (E) Proliferating progenitor cells labeled by Ki-67 (green) localize along the ventricle, nuclei are counterstained with DAPI (blue). (F) An additional population of Ki-67+ cells is found in an outer subventricular zone-like region (arrowheads).

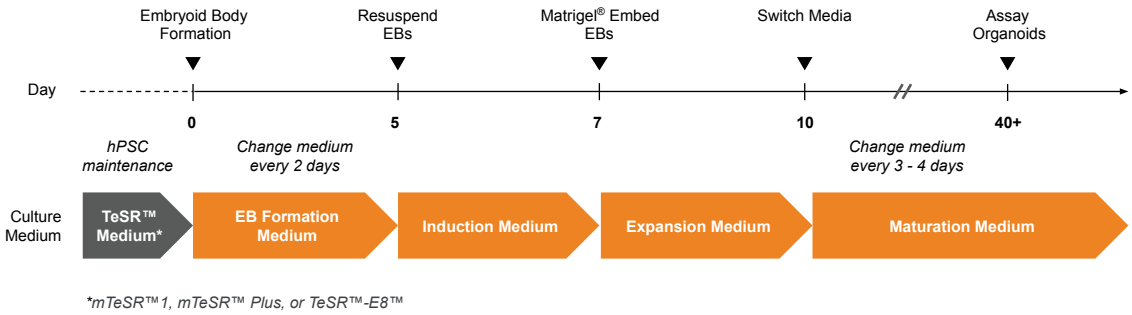


Figure 13. Schematic for Generating Unpatterned Neural Organoids Using the STEMdiff™ Cerebral Organoid Kit

The protocol for generating human cerebral organoids using the STEMdiff™ Cerebral Organoid Kit involves embryoid body (EB) formation followed by neural induction. After embedding in extracellular matrix, the neuroepithelia proliferate and expand. Organoids are then matured and can be maintained for extended periods over 40 days with the STEMdiff™ Cerebral Organoid Maturation Kit. Based on the protocol published by MA Lancaster and JA Knoblich.[8]

STEMdiff™ Dorsal and Ventral Forebrain Organoid Kits

Robustly generate three-dimensional, patterned brain organoid cultures from human pluripotent stem cells without matrix embedding. The STEMdiff™ Dorsal (Catalog #08620) and Ventral (Catalog #08630) Forebrain Organoid Differentiation Kits are serum-free cell culture media that work well with embryoid bodies (EBs) generated with AggreWell™ (Catalog #34811) to differentiate brain-region-specific organoids that are representative of the developing human forebrain.

The STEMdiff™ Dorsal Forebrain Organoid Differentiation Kit generates tissue of the early developing dorsal pallium, while the STEMdiff™ Ventral Forebrain Organoid Differentiation Kit generates tissue of the early developing ventral subpallium.

For extended periods of organoid culture (> 50 days), the components required for organoid maintenance are available as the STEMdiff™ Neural Organoid Maintenance Kit (Catalog #08571).

For more information on gene expression levels in resulting dorsal and ventral forebrain organoids, contact your local sales representative for bulk RNA-sequencing data.

Why Use the STEMdiff™ Dorsal and Ventral Forebrain Organoid Kits?

- Reduce handling and media waste with fusion-free growth media
- Obtain greater analytic sensitivity for disease phenotypes with reproducible morphology between lines and individual organoids
- Eliminate matrix embedding steps with the matrix-free formulation and protocol
- Achieve long-term culture survival and reduced caspase-3 expression for neurotoxicity and neurodegenerative models
- Combine modular region-patterned organoids to generate advanced AssemBloids™ for disease modeling and regenerative applications

Learn more at www.stemcell.com/DFOrganoid

Learn more at www.stemcell.com/VFOrganoid

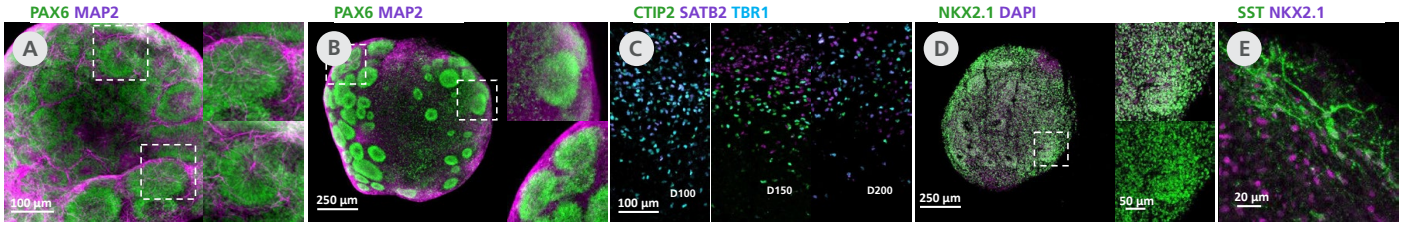


Figure 14. Dorsal Forebrain Organoids Exhibit Cortical Layering, and Both Dorsal and Ventral Organoids Express Markers Characteristic of Their Respective Brain Regions

(A) Day 25 dorsal forebrain organoids display multiple cortical-like regions marked by radialized PAX6+ cells surrounded by MAP2 neurons. (B) Day 50 dorsal forebrain organoids continue to display multiple cortical-like regions marked by PAX6 and MAP2. (C) Dorsal forebrain organoids cultured for 100 - 200 days show increasing separation of deep-layer neurons (CTIP2, TBR1) from upper-layer neurons (SATB2). (D) Ventral forebrain organoids at Day 25 exhibit a high level of expression of NKX2.1. (E) Somatostatin (SST)-positive GABAergic interneurons can be seen by Day 75.

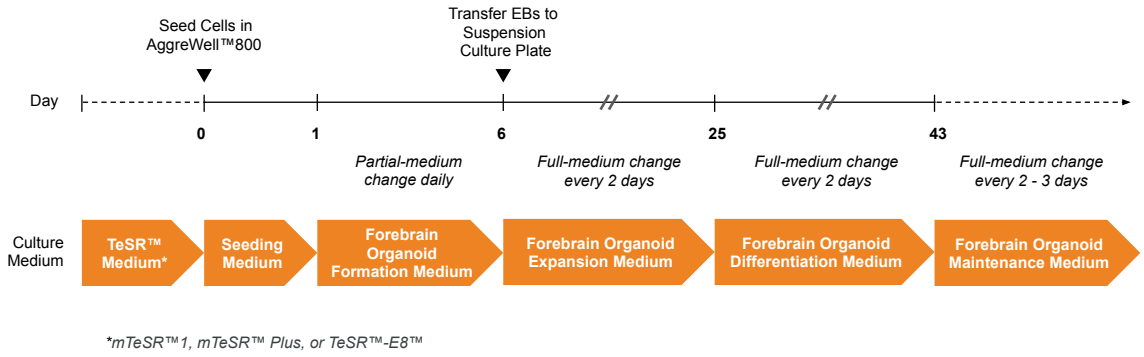


Figure 15. Schematic for the STEMdiff™ Dorsal and Ventral Forebrain Organoid Differentiation Kits

Human ES or iPS cell-derived dorsal forebrain or ventral organoids can be generated in 43 days. Embryoid bodies can be created in 6 days with AggreWell™800 plates. The EBs are then cultured in suspension, allowing growth and subsequent patterning to the dorsal forebrain. For patterning to ventral forebrain, the protocol differs only by a supplement added to Forebrain Organoid Expansion Medium. For the long-term maintenance and further maturation of dorsal and forebrain organoids, see the Product Information Sheet. Adapted from protocols by Sergiu Paşca.[9]

STEMdiff™ Midbrain Organoid Kit

Reliably generate midbrain organoids with the efficient and matrix-free STEMdiff™ Midbrain Organoid Differentiation Kit (Catalog #100-1096). When paired with AggreWell™800 (Catalog #34811) microwell culture plates, this serum-free cell culture media can prevent organoid fusion and support the generation of over 500 organoids per kit for higher-powered statistical replicates and more detailed longitudinal study.

Midbrain organoids can be combined with organoids generated using the STEMdiff™ Dorsal Forebrain Organoid Differentiation Kit (Catalog #08620) to generate cortico-striatal AssemBloid™ cultures. Organoids can be maintained with STEMdiff™ Neural Organoid Maintenance Kit (Catalog #08571) to support long-term culture survival (> 50 days) for predictive assays, high-throughput phenotypic screening, and neurotoxicity assays.

For more information on gene expression levels in resulting midbrain organoids, contact your local sales representative for bulk RNA-sequencing data.

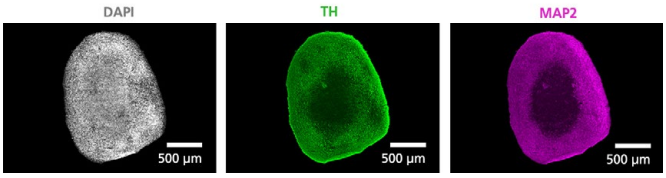


Figure 16. STEMdiff™ Midbrain Organoids Express Catecholaminergic Protein Tyrosine Hydroxylase

Midbrain organoids were generated using STEMdiff™ Midbrain Organoid Differentiation Kit. Organoids were further matured to Day 50 with STEMdiff™ Midbrain Organoid Maturation Kit. Midbrain organoids express the neuronal marker MAP2 and the catecholaminergic neuron-specific marker tyrosine hydroxylase (TH).

Learn more at www.stemcell.com/midbrain-org

Human iPSC-Derived Midbrain Organoids

Save time by starting your workflow with consistent, assay-ready midbrain organoids. See page 6 for details.

STEMdiff™ Spinal Cord Organoid Kit

Robustly generate patterned hPSC-derived spinal cord organoid cultures without matrix embedding using STEMdiff™ Spinal Cord Organoid Differentiation Kit (Catalog #100-1524). Based on protocols from Andersen J et al.[10], this system produces organoids that mimic the cellular composition and structure of the developing cervical spinal cord.

Organoids can be integrated into AssemBloids™ for multi-region modeling and maintained long-term (>50 days) with STEMdiff™ Neural Organoid Maintenance Kit (Catalog #100-0120), ideal for motor neuron studies, predictive assays, high-throughput screening, and neurotoxicity testing.

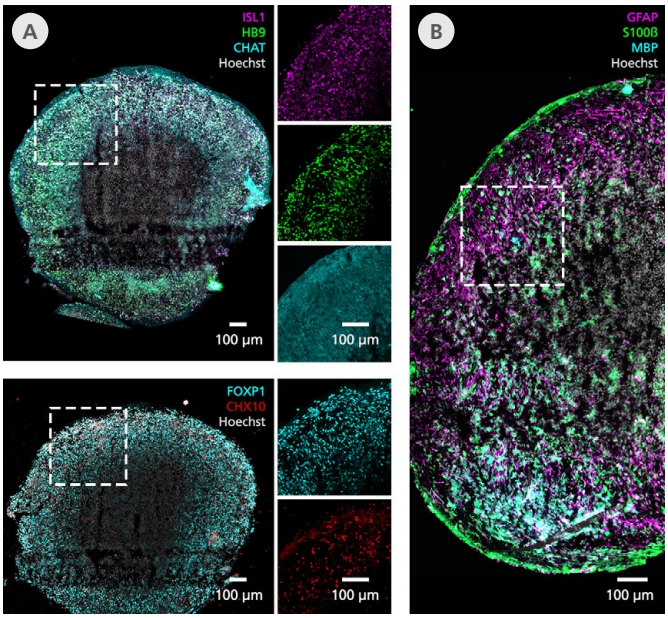


Figure 17. STEMdiff™ Spinal Cord Organoids Express Expected Markers

Spinal cord organoids generated from hPSCs with STEMdiff™ Spinal Cord Organoid Differentiation Kit express expected markers via immunostaining. (A) At Day 30, motor neuron markers ISL1 (magenta), HB9 (green), and CHAT (cyan) are expressed, as seen in the upper panel. Motor neuron marker FOXP1 (cyan) and V2a glutamatergic interneuron marker CHX10 (red) are also expressed, as seen in the lower panel. (B) From Day 75 onwards, the STEMdiff™ Spinal Cord Organoids display astrocyte markers GFAP (magenta) and S100β (green), as well as oligodendrocyte marker MBP (cyan). hPSCs = human pluripotent stem cells

Learn more at www.stemcell.com/spinal-cord-org

STEMdiff™ Choroid Plexus Organoid Kits

Take an in vitro approach to human neural biomarker discovery and CNS permeability with hPSC-derived organoids patterned to the choroid plexus. After a maturation period, organoids generated using the STEMdiff™ Choroid Plexus Differentiation Kit (Catalog #100-0824) feature cystic structures filled with a fluid resembling cerebrospinal fluid (CSF) and surrounded by an epithelial layer expressing ependymal markers (TTR, CLIC6, AQP1).

For extended periods of organoid culture (> 40 days), the components required for organoid maturation can be purchased as the STEMdiff™ Choroid Plexus Organoid Maturation Kit (Catalog #100-0825). To facilitate embedding of 3D aggregates, this media is compatible with the Organoid Embedding Sheet (Catalog #08579).

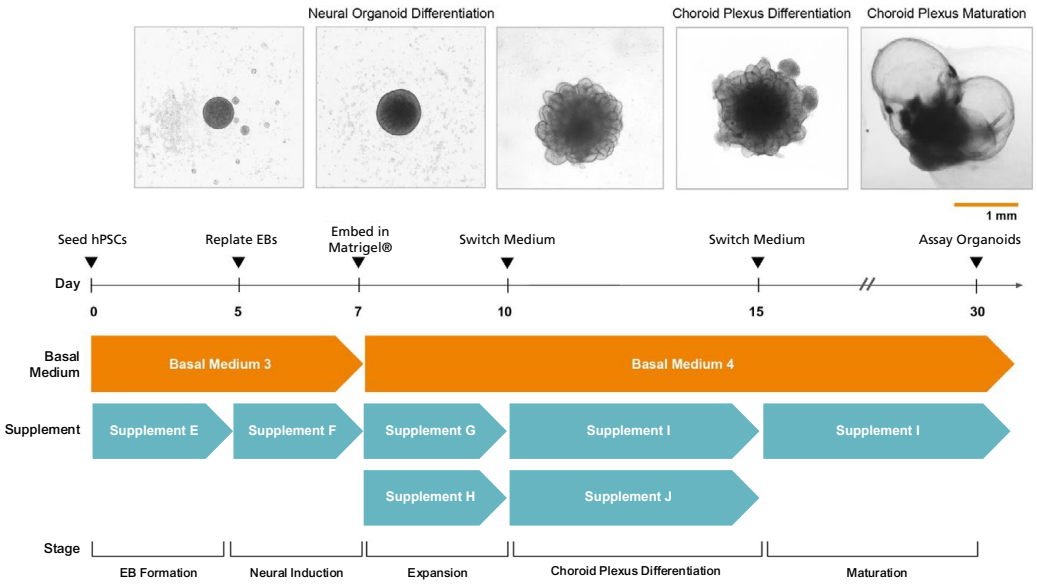


Figure 18. Schematic for the STEMdiff™ Choroid Plexus Organoid Differentiation and Maturation Kits

Choroid plexus organoids can be generated from human pluripotent stem cells (hPSCs) in 30 days. The protocol begins with embryoid body (EB) formation, followed by expansion of neuroepithelia and patterning to choroid plexus-like epithelium. After a period of epithelial maturation, including extensive bubbling, the organoids develop cystic structures surrounded by an ependymal epithelial layer and filled with a fluid resembling cerebrospinal fluid (CSF). Adapted from protocols published by Pellegrini et al.[11]

Learn more at www.stemcell.com/choroid-plexus-organoid

Visualization Tool for Neural Organoid Single-Cell RNA Sequencing Data

Accurately evaluating how well neural organoids model human brain development and function requires comprehensive analysis of gene expression and cell type data. Gene expression profiles reveal whether organoids perform key neural functions, while cell type data confirms the presence and proportion of physiologically relevant brain cells, such as neurons and glia.

Use this visualization tool to explore gene expression and cell type data from published organoid protocols. Compare these profiles with organoids generated using STEMdiff™ kits to help you choose the best product for your neural research.

Tool

Explore Gene Expression Data

www.stemcell.com/scrna

Circulatory System

Circulating Cells

STEMdiff™ Megakaryocyte Kit

STEMdiff™ Megakaryocyte Kit (Catalog #100-0901) is designed for the serum-free and feeder-free differentiation of human embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) to megakaryocytes expressing CD41a and CD42b. This optimized two-dimensional and two-stage protocol is capable of generating high yields of megakaryocytes per hPSC in 17 days. The resulting megakaryocytes show high ploidy and platelet-shedding ability and are also amenable to large-scale culture.

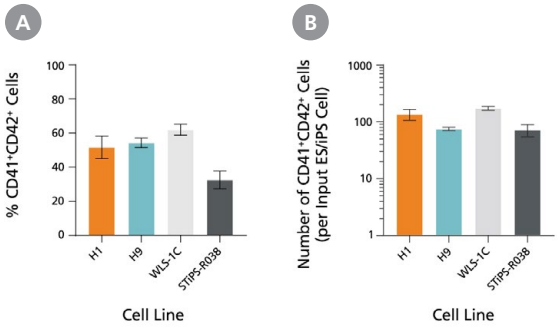


Figure 19. hPSC-Derived HPCs Efficiently Expand and Differentiate to CD41a+CD42b+ Megakaryocytes

hPSC-derived HPCs on Day 12 were cultured for 5 additional days in Medium MK2 to promote differentiation into mature MKs. The graph shows frequencies and numbers of CD41a+CD42b+ MKs per input cell for two hESC lines (H1 and H9) and two hiPSC lines (WLS-1C and STiPS-R038). The average frequency of viable CD41a+CD42b+ cells on Day 17 ranged between 56% and 77%. The average yield of CD41a+CD42b+ MKs generated per input cell ranged between 223 and 425. Data are shown as mean ± SEM (n = 12 for H1, n = 29 for H9, n = 27 for WLS-1C, n = 12 for STiPS-R038).

Learn more at
www.stemcell.com/megakaryocyte-diff

STEMdiff™ Erythroid Kit

Differentiate hPSCs to erythroid progenitor cells (erythroblasts) expressing Glycophorin A and CD71. hPSCs are induced toward erythroid-biased hematopoietic progenitor cells, and then further differentiated to erythroid progenitor cells (Day 10 - 24). Cells generated using the STEMdiff™ Erythroid Kit (Catalog #100-0074) can be further matured into normoblasts and reticulocytes once moved to appropriate culture conditions for maturation.

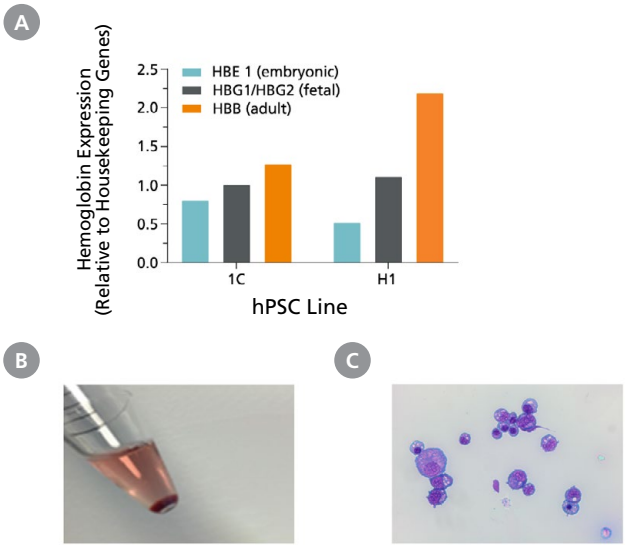


Figure 20. hPSC-Derived Erythroid Cells Are Hemoglobinized and Display Typical Erythroid Morphology

(A) Erythroid cells generated with the STEMdiff™ Erythroid Kit express a mix of primitive (embryonic) and definitive (fetal and adult) hemoglobin. Shown are the results of qPCR analysis for globin gene expression after 24 days of culture. (B) A picture of the cell pellet shows that cells produced in culture are hemoglobinized. (C) Cells display typical basophilic erythroblast morphology after 24 days of culture using the STEMdiff™ Erythroid Kit (40X magnification; May-Grunwald Giemsa stain).

Learn more at www.stemcell.com/erythro-diff

STEMdiff™ Hematopoietic Kit

Generate Hematopoietic Progenitor Cells, Immune Cells, and Blood Cells

The STEMdiff™ Hematopoietic Kit (Catalog #05310) consists of serum-free basal medium and supplements designed for the generation of hematopoietic progenitor cells (HPCs). Optimized for a standardized, 12-day differentiation protocol, this kit supports robust differentiation of hPSCs into HPCs that can be identified by the expression of CD34 and CD45, and by the ability to form hematopoietic colonies of multiple lineages in colony-forming unit (CFU) assays with MethoCult™ medium.

The resulting HPCs may be used for downstream assays or quantified in a CFU assay with MethoCult™ SF H4636 (Catalog #04636) medium, designed specifically for use with hPSC-derived HPCs, or MethoCult™ H4435 Enriched (Catalog #04435) medium. HPCs generated with the STEMdiff™ Hematopoietic Kit may be further differentiated using the STEMdiff™ Microglia Differentiation Kit (Catalog #100-0019) or STEMdiff™ Monocyte Kit (Catalog #05320). HPCs and downstream cells in the erythroid lineage may be obtained directly using the STEMdiff™ Erythroid Kit (Catalog #100-0074), and HPC and immune cell types in the lymphoid lineages may be obtained using the STEMdiff™ NK (Catalog #100-0170) and T Cell (Catalog #100-0194) Kits.

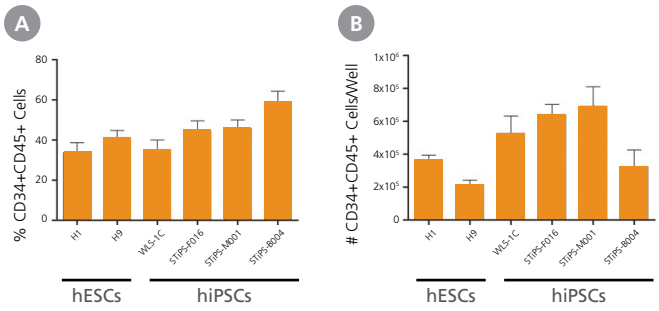


Figure 21. Efficient and Robust Generation of CD34+CD4+ HPCs

hESCs and hiPSCs were cultured for 12 days in single wells of 12-well plates using the STEMdiff™ Hematopoietic Kit. At the end of the culture period, cells in suspension were harvested, stained, and analyzed by flow cytometry for the expression of hematopoietic cell surface markers CD34 and CD45. (A) Percentages and (B) total numbers of CD34+CD45+ cells in cultures of hESCs or hiPSCs are shown for 6 cell lines. Data shown as mean ± SEM; n ≥ 3. hESCs = human embryonic stem cells; hiPSCs = human induced pluripotent stem cells

Learn more at www.stemcell.com/STEMdiffHeme

Webinar

Modeling the Structural and Functional Features of Blood Vasculature with Blood Vessel Organoids

www.stemcell.com/bvo

Vessels

STEMdiff™ Endothelial Kit

Efficiently Differentiate hPSCs to Endothelial Cells

The STEMdiff™ Endothelial Differentiation Kit (Catalog #08005) includes attachment substrate, animal component-free (ACF) endothelial induction medium, and endothelial expansion medium. It is optimized for differentiating hPSCs to endothelial-like cells on Corning® Matrigel®. This kit is designed to be used immediately after early mesoderm induction with STEMdiff™ Mesoderm Induction Medium (Catalog #05220).

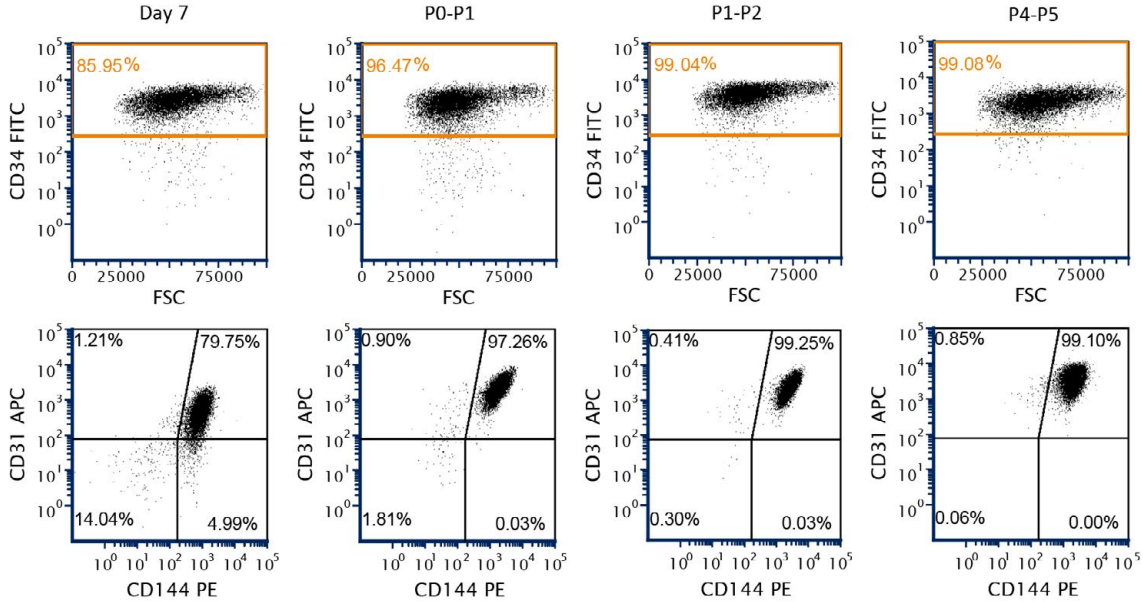


Figure 22. A Representative Flow Cytometric Analysis of Endothelial Marker Expression in hPSC-Derived Endothelial Cells

hPSC (H9 cell line)-derived endothelial cells were obtained at Day 7 using STEMdiff™ Endothelial Induction Medium. Greater than 85% of the cells were CD34+ and had high levels of CD31 and CD144 expression. With subsequent passages (up to passage 5), the proportion of cells expressing endothelial markers (CD34, CD31, and CD144) increased.

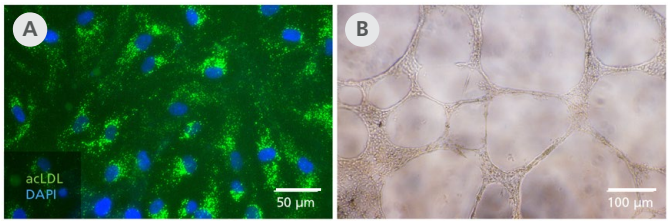


Figure 23. STEMdiff™ Endothelial Differentiation Kit Generates Functional hPSC-Derived Endothelial Cells

(A) Endothelial cells generated from hPSCs (F016 cell line) using the STEMdiff™ Endothelial Differentiation Kit take up acetylated LDL when plated at 10,000 cells/cm^2. (B) Cells are able to form tubular networks in vitro in a tube formation assay when plated at 20,000 cells/well in a 96-well plate for 24 hrs.

Learn more at www.stemcell.com/endo-diff

Human iPSC-Derived Endothelial Cells

Start your vascular research confidently with high-quality, ready-to-use Human iPSC-Derived Endothelial Cells. See page 6 for details.

STEMdiff™ Blood Vessel Organoid Kit

Blood vessels are a fundamental part of all organ systems and have critical roles in multiple diseases, including diabetes, Alzheimer's disease, and cancer. The blood vasculature is composed of endothelial cells that form luminal tubes and pericytes covering the endothelial wall. In vitro models of vascular biology involve co-culturing endothelial cells with pericytes but do not fully recapitulate their three-dimensional (3D) organization and functionality.

The STEMdiff™ Blood Vessel Organoid Kit (Catalog #100-0651) is a serum-containing kit for differentiation of hPSC-derived blood vessel organoids (BVOs) in a five-stage protocol, with the option to scale up for high-throughput screening in a 96-well format. BVOs generated using this kit have CD31+/CD34+/CD144+/KDR+ endothelial cells and PDGFR-β+/CD146+/SMA+/NG-2+ pericytes. These self-organizing hPSC-derived BVOs are able to form functional, perfusable blood vessels in vivo and can be used to study vascular dysfunction associated with various pathologies. The organoids can also be maintained in STEMdiff™ Blood Vessel Organoid Maturation Medium (Catalog #100-0658) for long-term assays*.

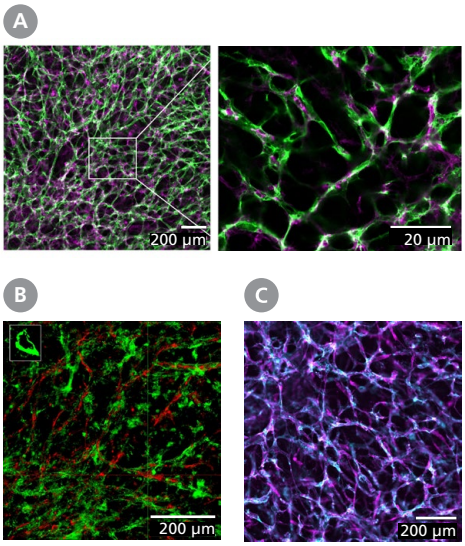


Figure 24. Vascular Networks Mature into Stable Blood Vessels When Cultured Within the Extracellular Matrix in STEMdiff™ Blood Vessel Maturation Medium

(A) hPSC-derived blood vessel organoids are composed of hCD31+ cells (green) and hPDGFRβ+ cells (magenta); small quadrant shows tight endothelial and pericyte interactions. (B) hPSC-derived blood vessel organoids are composed of hCD31+ cells (red) and deposited collagen IV (green; 3D reconstruction of optical Z stacks); small quadrant shows blood vessel lumen. (C) hPSC-derived blood vessel organoids are composed of hCD31+ cells (blue) and alpha-smooth muscle actin cells (magenta).

**STEMdiff™ Blood Vessel Organoid Maturation Medium is available for individual sale.*

Heart

STEMdiff™ Ventricular Cardiomyocyte System

Efficiently and reproducibly generate functional, phenotypically pure ventricular cardiomyocytes from hPSCs for use in downstream applications such as disease modeling, drug discovery, and cardiotoxicity screening. The STEMdiff™ Ventricular Cardiomyocyte Differentiation Kit (Catalog #05010) consists of defined, serum-free basal media optimized for a standardized, 15-day differentiation protocol. Achieve robust differentiation of hPSCs into ventricular cardiomyocytes, which can be identified by the expression of a key marker, cardiac troponin T (cTnT) (Figure 25). Contracting hPSC-derived cardiomyocytes can be seen as early as Day 8. This kit is formulated for use in feeder-free conditions, optimized for the differentiation of hPSCs maintained in mTeSR™1 (Catalog #05850) or TeSR™-E8™ (Catalog #05940), and compatible with multiple human embryonic stem cell (ESC) and induced pluripotent stem cell (iPSC) lines.

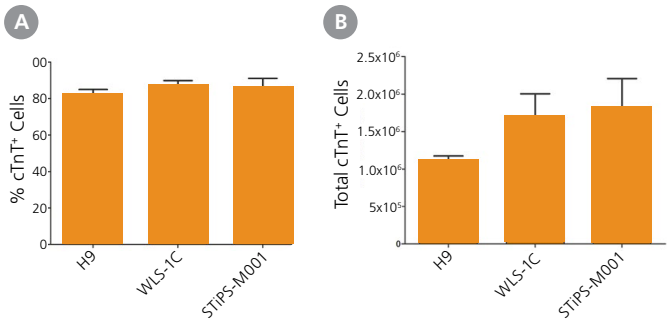


Figure 25. Efficient and Robust Generation of cTnT-Positive Ventricular Cardiomyocytes

hPSCs were cultured for 15 days in single wells of 12-well plates using the STEMdiff™ Ventricular Cardiomyocyte Differentiation Kit. At the end of the culture period, cells were harvested and analyzed by flow cytometry for expression of cell marker cTnT. (A) Percentages and (B) total numbers of cells expressing cTnT in cultures of human ES (H9) or iPS (WLS-1C and STiPS-M001) cells are shown. Data shown as mean ± SEM; n = 3.

Learn more at www.stemcell.com/cardio-diff

STEMdiff™ Cardiomyocyte Expansion Kit

Expand early-stage human pluripotent stem cell (hPSC)-derived cardiomyocytes consistently using the serum-free STEMdiff™ Cardiomyocyte Expansion Kit (Catalog #100-1109). This kit generates a large number of functional and highly pure hPSC-derived cardiomyocytes and is compatible with ventricular or atrial cardiomyocytes generated with STEMdiff™ Ventricular Cardiomyocyte Differentiation Kit (Catalog #05010) or STEMdiff™ Atrial Cardiomyocyte Differentiation Kit (Catalog #100-0215), respectively.

The STEMdiff™ Cardiomyocyte Expansion kit allows you to reach cardiomyocyte populations in the billions with a single round of cardiomyocyte differentiation. Early-stage hPSC-derived cardiomyocytes are expanded directly instead of the traditional method of PSC expansion, followed by differentiation. Using this kit, expanded early-stage hPSC-derived cardiomyocytes retain a stable electrical profile and have cTnT percentages over 90% at passage 5. The expanded hPSC-derived cardiomyocytes are ready for high-throughput drug testing, tissue engineering, and regenerative medicine research.

By using this first-to-market kit to efficiently expand cardiomyocytes, you can save time and resources.

Other STEMdiff™ Cardiomyocyte Products	Catalog #
STEMdiff™ Cardiomyocyte Expansion Kit	100-1109
STEMdiff™ Ventricular Cardiomyocyte Differentiation Kit	05010
STEMdiff™ Atrial Cardiomyocyte Differentiation Kit	100-0215
STEMdiff™ Cardiomyocyte Dissociation Kit	05025
STEMdiff™ Cardiomyocyte Support Medium	05027
STEMdiff™ Cardiomyocyte Freezing Medium	05030
STEMdiff™ Cardiomyocyte Maintenance Kit	05020

Respiratory System

2D Pulmonary Models

STEMdiff™ Lung Progenitor Kit

Generate hPSC-Derived Lung Progenitor Cells

The STEMdiff™ Lung Progenitor Kit (Catalog #100-0230) is a serum-free culture medium system for efficient and reproducible generation of lung progenitor cells from hPSCs. Differentiated cells will express NKX2.1, a key marker of lung progenitor cells. The resulting cells can be further matured toward proximal or distal airway cells, using published protocols, for the study of lung diseases and lung development.

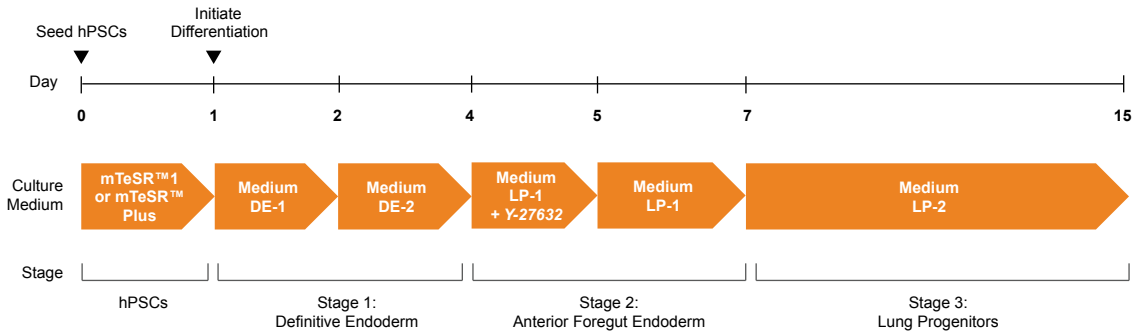


Figure 26. Schematic for Generating Lung Progenitor Cells from hPSCs Using STEMdiff™ Lung Progenitor Kit

hPSC cultures progress through a simple three-stage process to generate lung progenitor cells. hPSC clumps are first seeded in mTeSR™1. On Day 1, differentiation is initiated with Medium DE-1. Subsequently, on Day 2 and 3, the medium is changed to Medium DE-2 for definitive endoderm patterning. On Day 4, to initiate anterior foregut endoderm patterning, the endoderm monolayer is passaged in Medium LP-1 and Y-27632. Finally, at Day 7, the cells are differentiated into the lung progenitor stage with Medium LP-2. All media mentioned (DE-1, DE-2, LP-1, and LP-2) are included in the STEMdiff™ Lung Progenitor Kit.

3D Pulmonary Models

STEMdiff™ Branching Lung Organoid Kit

Generate hPSC-Derived Branching Lung Organoids

The STEMdiff™ Branching Lung Organoid Kit (Catalog #100-0195) supports the efficient and reproducible generation of branching lung organoids from human pluripotent stem cells (hPSCs) through four stages of differentiation: 1) definitive endoderm, 2) anterior foregut endoderm, 3) lung bud organoids, and 4) branching lung organoids. The resulting organoids develop proximal and distal-like branching airway epithelial structures expressing EPCAM, NKX2.1, SOX2, SOX9, MUC1, and P63. Extended periods of organoid culture results in increased expression levels of mature lung cell markers such as SFTPC, SFTPB, and ABCA3.

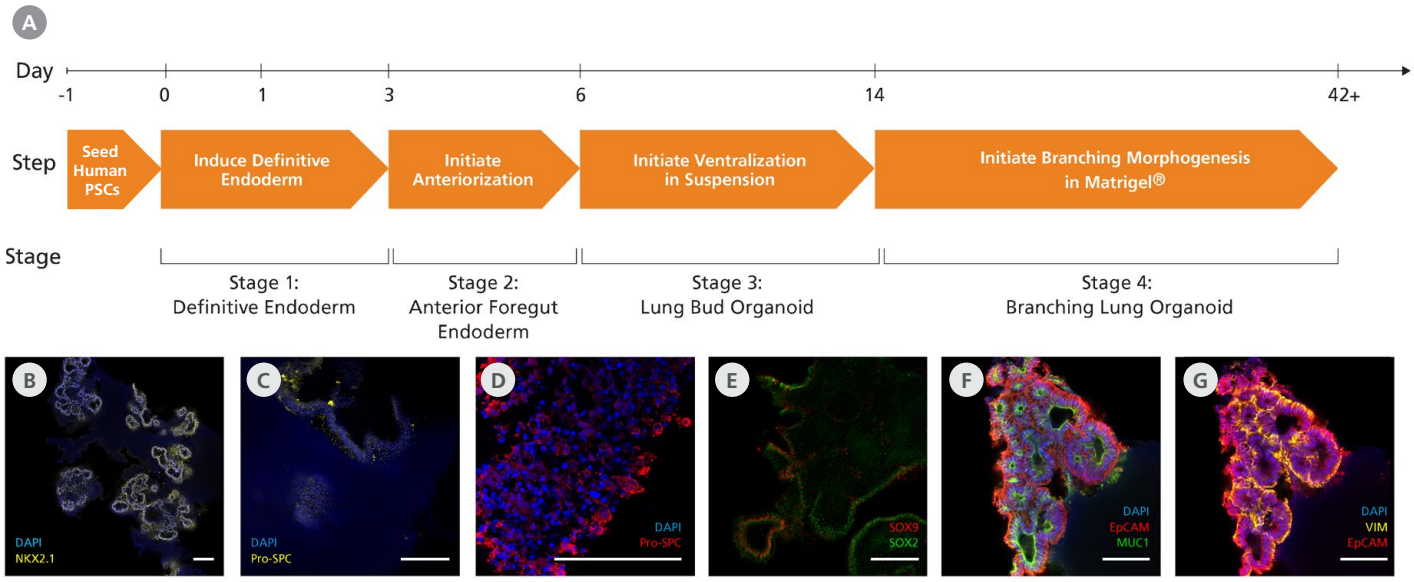


Figure 27. STEMdiff™ Branching Lung Organoid Kit Supports Generation of Branching Lung Organoids

(A) Human PSC cultures progress through a four-stage differentiation process to generate human branching lung organoids. By the end of stage 1 (Day 3), cultures exhibit characteristics typical of definitive endoderm and anterior foregut differentiation is initiated. During stage 2 (Days 3 - 6), anterior foregut endoderm buds are released from the monolayer and are then suspended to form ventralized lung bud organoids in stage 3 (Days 6 - 14). In stage 4, the lung bud organoids are embedded into Matrigel® sandwich cultures to mature into branching lung organoids. (B) Branching lung organoids express lung progenitor marker NKX2.1 throughout their branching structures and (C, D) demonstrate the presence of alveolar type II-like cells with pro-surfactant protein B and C expression. (E) These organoids undergo proximodistal differentiation demonstrated by the differential expression of SOX2 and SOX9. (F) MUC1 can be found luminally expressed while the (G) organoids are surrounded by VIM-expressing mesenchyme. Scale bar = 100 µm.

Learn more at www.stemcell.com/STEMdiff-Respiratory-Research

Digestive System

STEMdiff™ Definitive Endoderm Kit

Quickly and Easily Differentiate Definitive Endoderm

The STEMdiff™ Definitive Endoderm Kit (Catalog #05110) is a serum-free, animal component-free system that enables differentiation of hPSCs to multipotent definitive endoderm cells using a short and simple protocol. This product is available in formulations optimized for use with hPSCs cultured in mTeSR™ Plus (Catalog #100-0276), mTeSR™1 (Catalog #85850), or TeSR™-E8™ (Catalog #05990). Definitive endoderm cells generated with this kit can be further differentiated to multiple downstream endodermal cell types, including hepatic[12] and pancreatic[13] progenitor cells for drug development, toxicity testing, research for development of cell-based therapies, or studying developmental pathways.

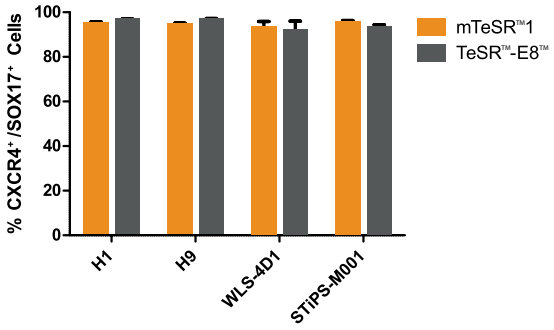


Figure 28. Definitive Endoderm Differentiation Is Efficient Across Multiple Human ESC and iPSC Lines, Regardless of hPSC Maintenance Medium

Quantitative analysis of definitive endoderm formation in multiple human ESC (H1 and H9) and iPSC (WLS-4D1 and STiPS-M001) lines, as measured by co-expression of CXCR4 and SOX17. Cells maintained in mTeSR™1 medium were differentiated using STEMdiff™ Definitive Endoderm Kit, and cells maintained in TeSR™-E8™ were differentiated using STEMdiff™ Definitive Endoderm Kit (TeSR™-E8™-Optimized). Data are expressed as the mean percentage of cells expressing both markers. Error bars indicate SEM; n = 4 to 18 per cell line.

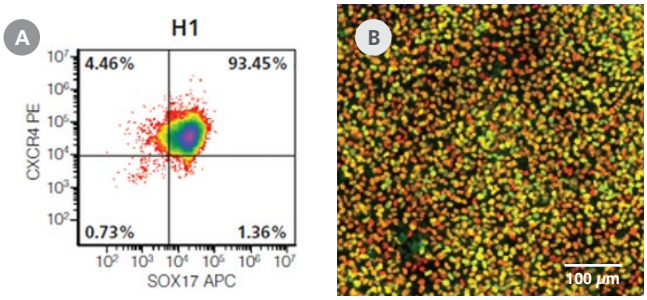


Figure 29. hPSCs Differentiated with STEMdiff™ Definitive Endoderm Kit Are Highly Enriched for Expression of Key Definitive Endoderm Markers

(A) Representative density plot showing CXCR4 and SOX17 expression in mTeSR™1-cultured H1 hESCs, following 5 days of differentiation (B) Representative image of FOXA2 (green) and SOX17 (red) in WLS-4D1 hiPSCs following 4 days of differentiation. Yellow indicates cells co-expressing FOXA2 and SOX17.

Learn more at www.stemcell.com/STEMdiff-DE

hPSC-Derived Endoderm qPCR Array

The hPSC-Derived Endoderm qPCR Array (Catalog #07531) provides a validated 90-gene assay to characterize definitive endodermal progenitor cells and their differentiated progeny, including pancreatic, hepatic, and intestinal cells. Housekeeping controls and a synthetic DNA positive control are included. Data analysis is streamlined with our flexible online app (**www.stemcell.com/qPCRanalysis**).

Learn more at www.stemcell.com/DE-array

Intestine

STEMdiff™ Intestinal Organoid Kit

Differentiate hPSC Lines to Intestinal Organoids

hPSC-derived organoids provide direct relevance to human tissues while retaining the genotype and phenotype of donor cells.

The STEMdiff™ Intestinal Organoid Kit (Catalog #05140) supports the efficient establishment of hPSC-derived small intestinal or colonic organoids within 30 days. These organoids incorporate the key cell types and features of the developing intestinal epithelium, including the incorporation of some mesenchymal components. Intestinal organoids can be expanded and maintained in culture through passaging, or cryopreserved for future experiments.

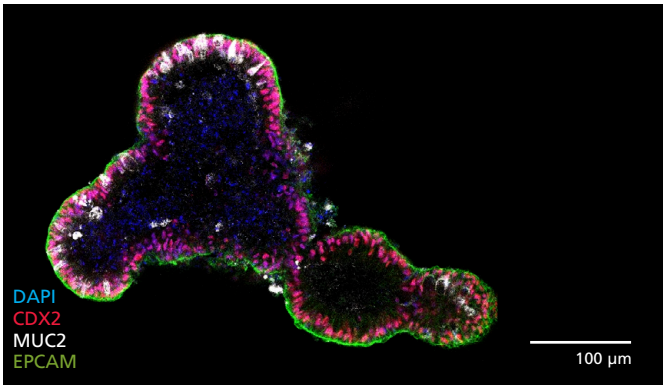


Figure 30. hPSC-Derived Intestinal Organoids Incorporate Features of the Intestinal Epithelium and Mesenchyme

Organoids grown using STEMdiff™ Intestinal Organoid Kit display markers of the intestinal epithelium (EPCAM, CDX2, MUC2). Organoids also exhibit markers for intestinal mesenchyme and intestinal progenitor cells.

Why Use the STEMdiff™ Intestinal Organoid Kit?

- Generate small intestinal organoid cultures that model the developing intestinal epithelium and associated mesenchyme
- Differentiate hPSC lines from multiple sources or donors with high efficiency
- Maintain intestinal organoids through long-term passaging while allowing cryopreservation for experimental flexibility
- Reduce experimental variability by removing serum-containing components

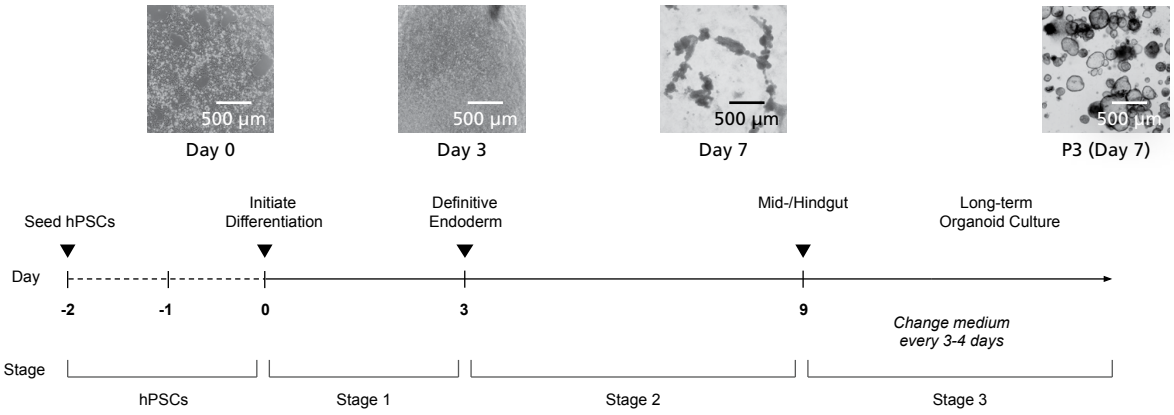


Figure 31. Schematic for Differentiating from hPSCs to Human Intestinal Organoids with the STEMdiff™ Intestinal Organoid Kit

hPSC cultures progress through a three-stage differentiation process to generate human intestinal organoids. By Day 3 of the protocol, cultures exhibit characteristics typical of definitive endoderm and mid-/hindgut differentiation is initiated. During mid-/hindgut differentiation (Days 5 - 7), cells form mid-/hindgut spheroids that are released from the cell monolayer into the culture medium. These spheroids are collected, embedded in extracellular matrix, and cultured in STEMdiff™ Intestinal Organoid Growth Medium to mature into intestinal organoids. Days in parentheses indicate days post-embedding in a given passage.

Learn more at www.stemcell.com/STEMdiff-HIO

Pancreas

STEMdiff™ Pancreatic Progenitor Kit

Produce Pancreatic Progenitor Cells from hPSCs

The STEMdiff™ Pancreatic Progenitor Kit (Catalog #05120) is a serum-free medium that supports efficient and reproducible generation of pancreatic progenitor cells from hPSCs. The kit directs efficient differentiation from multiple hPSC lines through definitive endoderm, primitive gut tube, and posterior foregut endoderm before transitioning to pancreatic progenitor cells. The differentiated cells are characterized by the expression of key transcription factors, including PDX-1, NKX6.1, and NEUROD1, and by the upregulation of insulin and glucagon (Figures 32 and 33). The resulting pancreatic progenitor cells can be further differentiated to both exocrine and endocrine cell fates, making them useful research tools for studying diabetes and β-cell maturation, disease modeling, and studying pancreatic cancer.

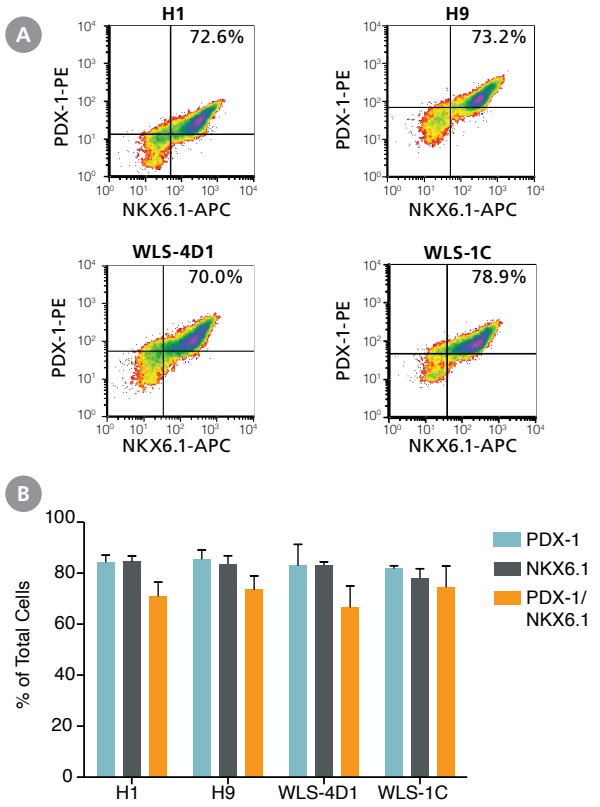


Figure 32. STEMdiff™ Pancreatic Progenitor Kit Efficiently Generates PDX-1, NKX6.1-Positive Progenitors Across Multiple hPSC Lines

PDX-1 and NKX6.1 expression measured in pancreatic progenitor cells derived from four different hPSC lines (H1, H9, WLS-4D1, and WLS-1C). (A) Representative flow cytometry plots for PDX-1 and NKX6.1 expression at the end of Stage 4. (B) Cumulative quantitative data for PDX-1 and NKX6.1 co-expression at the end of Stage 4 of differentiation (mean ± SD; n = 3 - 5 per cell line). The average efficiency of differentiation ranges from 66.5% to 74.5% depending on the cell line. The efficiency of conversion from definitive endoderm to pancreatic progenitor ranges from 77.3% to 96.3%. In addition, nearly all NKX6.1+ cells co-express PDX-1 as observed in the developing human pancreas.[14]

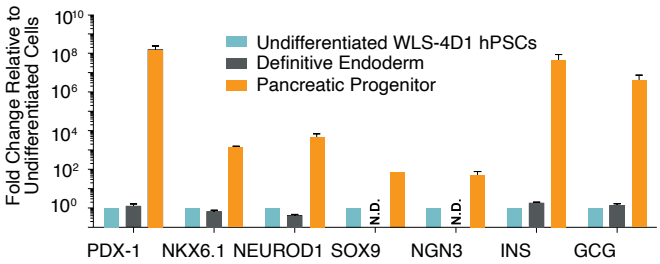


Figure 33. Gene Expression Profile Indicates Transition to Pancreatic Progenitor Cell

Gene expression profile of key transcription factors or hormones (INS: insulin, GCG: glucagon) expressed in pancreatic progenitor cells (mean ± SEM; n = 3 - 7 experiments on WLS-4D1 cells). Expression was first normalized to 18S ribosomal RNA and then to the expression level found in undifferentiated cells. Gene expression is shown for WLS-4D1 cells at the end of Stage 1 (Definitive Endoderm) and at the end of Stage 4 (Pancreatic Progenitor). Expression pattern is consistent with published data.[15] N.D.= Not Determined.

Learn more at
www.stemcell.com/STEMdiff-Pancreatic

Liver

STEMdiff™ Hepatocyte Kit

Differentiate Human PSCs to Hepatocyte-Like Cells

Generate a reliable supply of hepatocyte-like cells (HLCs) for your experiments by reproducibly differentiating hPSCs into HLCs. The serum-free formulation minimizes experimental variability by limiting the presence of undefined components, thus enabling you to robustly differentiate HLC cultures from a variety of hPSC lines. HLCs generated using the STEMdiff™ Hepatocyte Kit (Catalog #100-0520) are suitable for a variety of applications in liver research, disease modeling, and hepatotoxicity testing, and can be further expanded into 3D liver organoids for long-term maintenance, further differentiation, and cryopreservation.

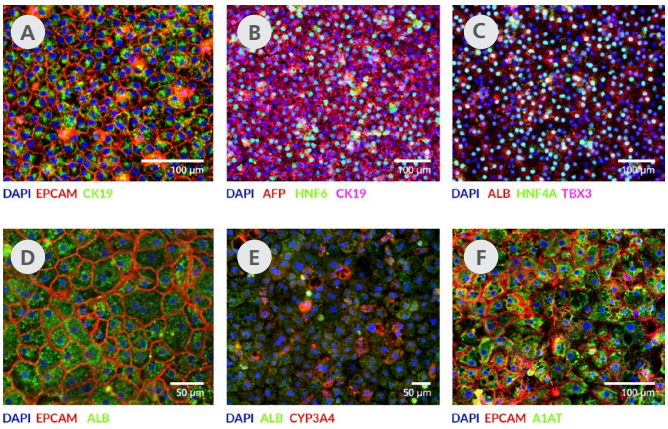


Figure 34. hPSC-Derived Hepatic Progenitor Cells and Hepatocyte-Like Cells Express Hepatic Markers As Confirmed by Immunocytochemistry Analysis

Cells cultured to Day 10 (HPs) and Day 21 (HLCs) were fixed with 4% paraformaldehyde and permeabilized before being stained with primary and secondary antibodies. (A-C) HPs expressed the epithelial marker EPCAM, ductal marker CK19, fetal serum protein AFP, the hepatic transcription factors HNF6 and HNF4a, and the stage-specific transcription factor TBX3. (C) By Day 10, some of the HPs also began to express the mature serum protein albumin. (D-F) Most HLCs expressed the mature hepatic markers ALB, CYP3A4, and A1AT by Day 21. HPs = Hepatic progenitors; HLCs = Hepatocyte-like cells; CK19 = Cytokeratin 19; AFP = Alpha fetoprotein; ALB = Albumin.

Why Use the STEMdiff™ Hepatocyte Kit?

- Generate mature hepatocyte-like cells (HLCs) that express key hepatic markers and demonstrate liver-specific activities
- Start from a variety of undifferentiated hPSC lines to efficiently establish HLC cultures
- Obtain HLCs that can be further expanded and differentiated in 3D organoid cultures using the HepatiCult™ Organoid Kit (Catalog #100-0386)
- Assess drug hepatotoxicity in HLC cultures, which have higher sensitivity than the immortalized cell line HepG2

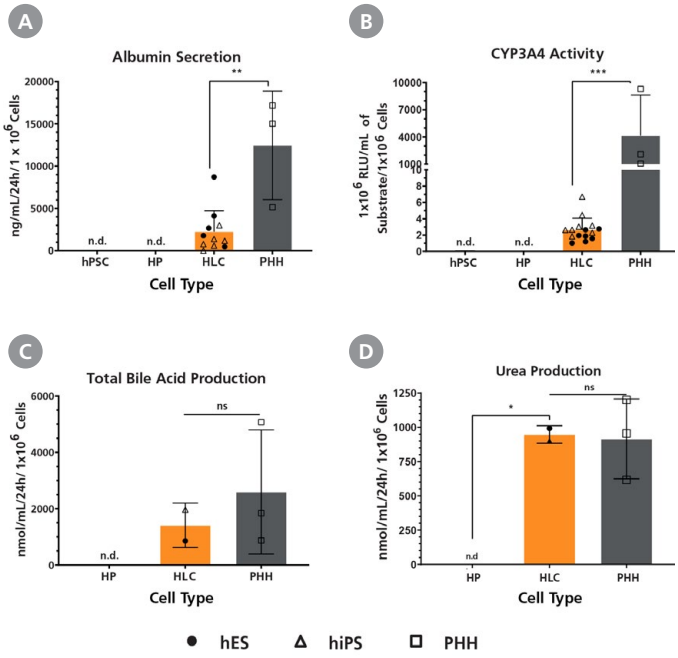


Figure 35. hPSC-Derived HLCs Exhibit Key Liver Functionalities

Upon maturation of HPs to HLCs, the cells acquired the ability to (A) synthesize and secrete serum protein albumin (n = 11), as detected by ELISA (Abcam Catalog #ab108788), (B) and exhibited CYP3A4 enzymatic activity (n = 15), as assessed using the P450-GloTM CYP3A4 Assay (Promega Catalog #V9002). (C) Day 21 HLCs were also capable of producing bile acids (n = 2) and (D) synthesizing and secreting urea (n = 2) at levels comparable to primary human hepatocytes (PHH; n = 3), as detected by colorimetric assays (Abcam Catalog #ab239702, ab83362, respectively). Error bars = SD. Ordinary one-way ANOVA used for statistical testing (*** represents an adjusted p-value of 0.0007, ** represents an adjusted p-value of 0.0011, * represents an adjusted p-value of 0.0179, ns = not significant). HPs = Hepatic progenitors; HLCs = Hepatocyte-like cells; PHH = Primary human hepatocyte.

Learn more at www.stemcell.com/STEMdiff-Hepatocyte

STEMdiff™ Hepatic Organoid Media (Human)

Differentiate hPSC-Derived Hepatocytes to Hepatic Organoids

Reliably establish, expand, and differentiate hepatic organoids from hPSC-derived hepatocyte-like cells with STEMdiff™ Hepatic Organoid Media. The STEMdiff™ Hepatic Organoid Media workflow includes two media products, available individually:

- STEMdiff™ Hepatic Organoid Growth Medium (Catalog #100-1773), for the establishment and expansion of fresh or cryopreserved hPSC-derived hepatic organoids for future experimenting or biobanking.
- STEMdiff™ Hepatic Organoid Differentiation Medium (Catalog #100-1774), for generating hPSC-derived organoids exhibiting a more mature hepatic phenotype.

When combined with the STEMdiff™ Hepatocyte Kit, STEMdiff™ Hepatic Organoid Media provide a complete workflow for the establishment, expansion, and differentiation of hepatic organoids using hPSC lines maintained in mTeSR™1, mTeSR™ Plus, or eTeSR™, alleviating the need for primary human liver tissue sourcing.

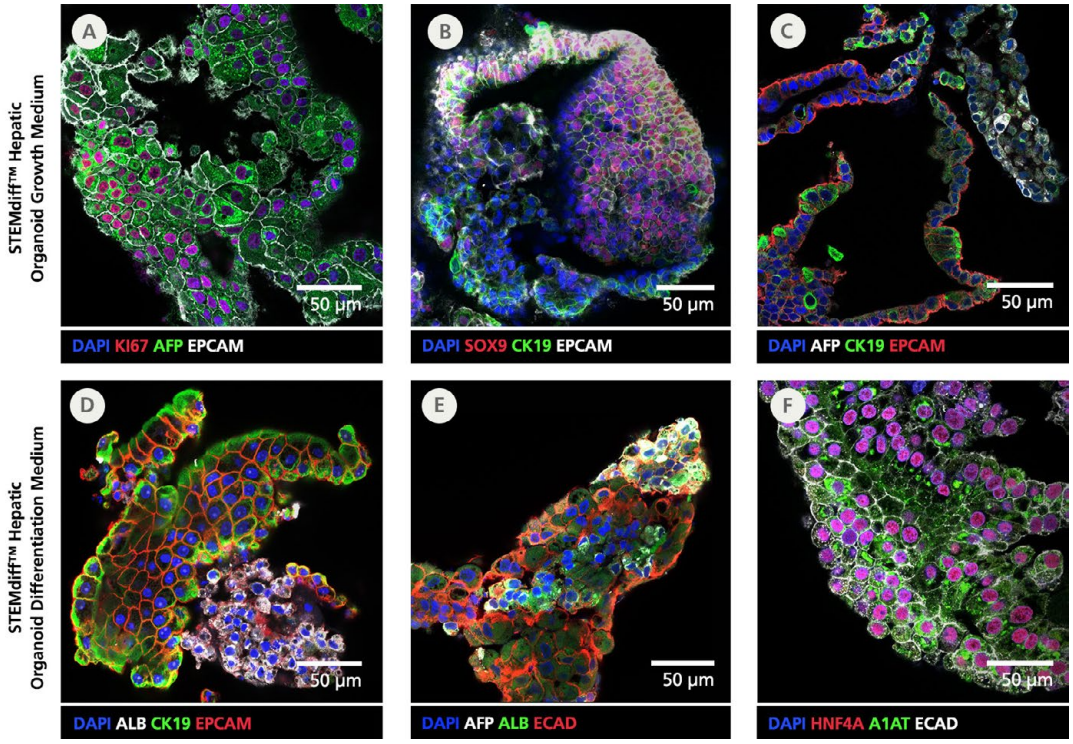


Figure 36. Proliferating Hepatic Organoids Display Characteristics of Hepatic Progenitors While Differentiated Hepatic Organoids Display Characteristics of Mature Hepatocytes

(A-C) Hepatic organoids cultured in STEMdiff™ Hepatic Organoid Growth Medium express epithelial marker EPCAM, proliferation marker KI67, ductal markers CK19 and SOX9, and the fetal serum protein marker AFP. (D-F) Differentiated hepatic organoids cultured in STEMdiff™ Hepatic Organoid Differentiation Medium express mature hepatocyte markers ALB and A1AT as well as hepatic transcription factor HNF4A. Some organoid regions also retain expression of hepatic progenitor/ductal markers AFP and CK19. Nuclei are counterstained with DAPI.

Learn more at www.stemcell.com/stemdiff-hepatic-org

Immune System

STEMdiff™ NK Cell Kit

Feeder-free and serum-free conditions provided by the STEMdiff™ NK Cell Kit (Catalog #100-0170) ensure a robust differentiation of hPSC-derived NK cells for developing adoptive immunotherapies in cancer patients as well as for research into the basic biology of these cells.

STEMdiff™ T Cell Kit

Obtain high yields of CD4+CD8+ double-positive (DP) T cells by differentiating from hPSCs in feeder-free and serum-free conditions with the STEMdiff™ T Cell Kit (Catalog #100-0194). Additionally, generate CD8+ single-positive (SP) T cells with an optional protocol.

Why Use the STEMdiff™ NK Cell and T Cell Kits?

- Differentiate hPSCs into T cells or NK cells with high yield and frequency
- Produce approximately 230 CD56+ NK cells or 60 CD4+CD8+ double-positive (DP) T cells per input hPSC-derived CD34+ cell
- Reduce variability by producing uniform aggregates for embryoid body (EB) formation with AggreWell™
- Eliminate variation introduced by serum and stromal cell lines by using serum- and feeder-free conditions
- Avoid extra passaging steps required with stromal cell-based culture

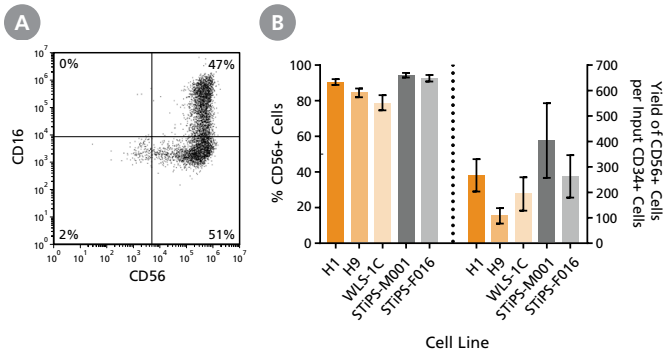


Figure 37. hPSCs Differentiate into CD56+ NK Cells After 40 Days of Culture

hPSCs were cultured using the STEMdiff™ NK Cell Kit for a total of 40 days. Cells were harvested and analyzed for expression of CD56 and CD16 by flow cytometry. (A) Representative flow cytometry plot is shown for ESC (H1)-derived cells. (B) After 40 days of culture, the average frequency of viable CD56+ NK cells from hPSC-derived CD34+ cells ranged between 79% and 94%. The average yield of CD56+ cells produced per hPSC-derived CD34+ cell was between 108 and 404. Data are shown as mean ± SEM (n = 7 - 18).

Technical Bulletin

Generation of Natural Killer Cells from Human Pluripotent Stem Cells

www.stemcell.com/STEMdiffProtocol-NK

Learn more at www.stemcell.com/STEMdiff-NK

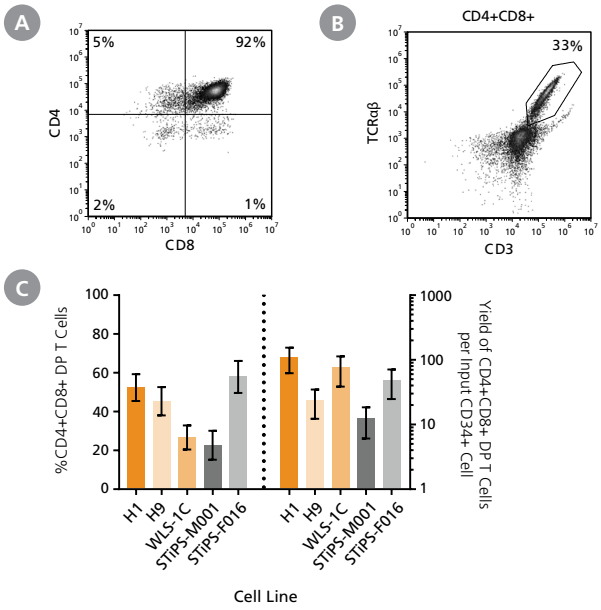


Figure 38. CD4+CD8+ DP T Cells Can Be Generated from Human hPSCs After a Total of 40 Days of Culture with the STEMdiff™ T Cell Kit

CD4+CD8+ DP T cells were differentiated from hPSCs using the STEMdiff™ T Cell Kit. Cells were harvested and analyzed for expression of CD3, CD4, CD8, and TCRαβ by flow cytometry. (A,B) Representative flow cytometry plots are shown for ESC (H1)-derived cells. (C) The average frequency of viable CD4+CD8+ DP T cells on Day 28 ranged between 23% and 58%, and the average yield of DP T cells produced per input hPSC-derived CD34+ cell was between 12 and 108. Data are shown as mean ± SEM (n = 6 - 17).

Learn more at www.stemcell.com/STEMdiff-T

Learn more at www.stemcell.com/STEMdiff-NK

Learn more at www.stemcell.com/STEMdiff-T

Why Use the STEMdiff™ Monocyte Kit?

- Generate up to 7 million CD14+ monocytes per plate in just 14 - 23 days
- Eliminate variation introduced by serum and feeder cells by using serum- and feeder-free conditions
- Produce monocytes in a simple monolayer culture for easier harvest of suspended cells

Learn more at www.stemcell.com/STEMdiff-Monocyte

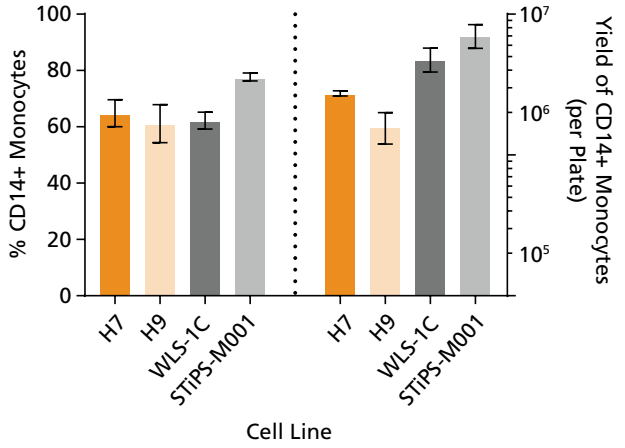


Figure 39. STEMdiff™ Monocyte Kit Enables Robust and Efficient Generation of CD14+ Monocytes

hPSCs were differentiated using the STEMdiff™ Monocyte Kit and harvested every 2 - 3 days between Days 17 and 23. The average frequency of viable CD14+ monocytes at the peak harvest was 61 - 78% and the average yield of CD14+ monocytes produced per 6-well plate was between 1.6 x 10^6 and 7.1 x 10^6 cells.

For differentiation to microglia, please see page 11.

Sensory System

Learn more at www.stemcell.com/DE-array

The STEMdiff™ Neural Crest Differentiation Kit (Catalog #08610) consists of a serum-free basal medium and supplement for highly efficient and reproducible differentiation of hPSCs into neural crest cells (NCCs).

Further expansion of the NCC population is possible for up to 3 passages using the STEMdiff™ Neural Crest Differentiation Kit or MesenCult™-ACF Plus Medium (Catalog #05445), depending on the desired downstream application.

The NCCs produced using this kit are multipotent and can be further differentiated to cell types of both the neural and ecto-mesenchymal lineages.

Passaging NCCs into MesenCult™-ACF Plus Medium allows for differentiation to the chondrogenic lineage using the MesenCult™-ACF Chondrogenic Differentiation Kit (Catalog #05455) (Figure 40E), to the osteogenic lineage using the MesenCult™ Osteogenic Differentiation Kit (Catalog #05465) (Figure 40F), and to the adipogenic lineage using the MesenCult™ Adipogenic Differentiation Kit (Catalog #05412).

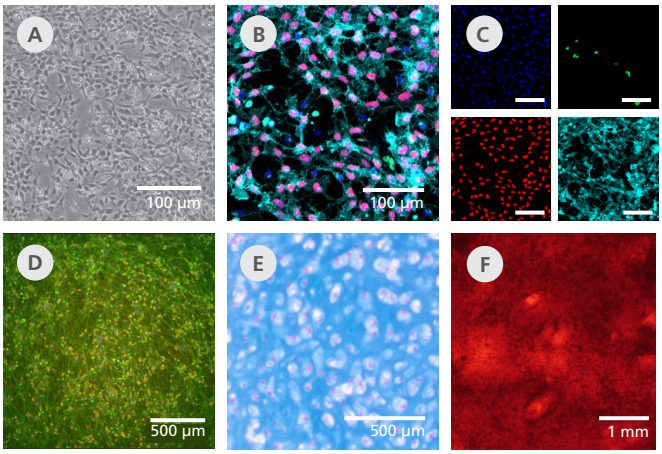


Figure 40. The STEMdiff™ Neural Crest Differentiation Kit Generates a Highly Pure Population of Multipotent NCCs

After 6 days in culture, NCCs (A) display typical morphology, (B) express relevant markers (SOX10+, red; CD271+, light blue, DAPI, dark blue), and outnumber central nervous system (CNS)-type progenitors (PAX6+, green), assayed 2 days after a Day 6 passage. (C) Individual immunofluorescence channels for (B). (D) Culturing NCCs using STEMdiff™ Sensory Neuron Kits generates peripheral neurons (PRPH, green; BRN3a, red; DAPI, blue). (E) Passaging NCCs into MesenCult™-ACF Plus Medium and then into the MesenCult™-ACF Chondrogenic Differentiation Kit generates a chondrocyte pellet (Alcian Blue, Nuclear Fast Red) with deposition of cartilage around the cells. (F) Passaging NCCs into MesenCult™-ACF Plus Medium and then into the MesenCult™ Osteogenic Differentiation Kit (Human) generates an osteoblast culture with high levels of alizarin red-positive mineral deposition. Scale bar = (A-C) 100 µm, (D-E) 500 µm, (F) 1 mm.

Learn more at www.stemcell.com/NCKit

Learn more at www.stemcell.com/STEMdiff-Pancreatic

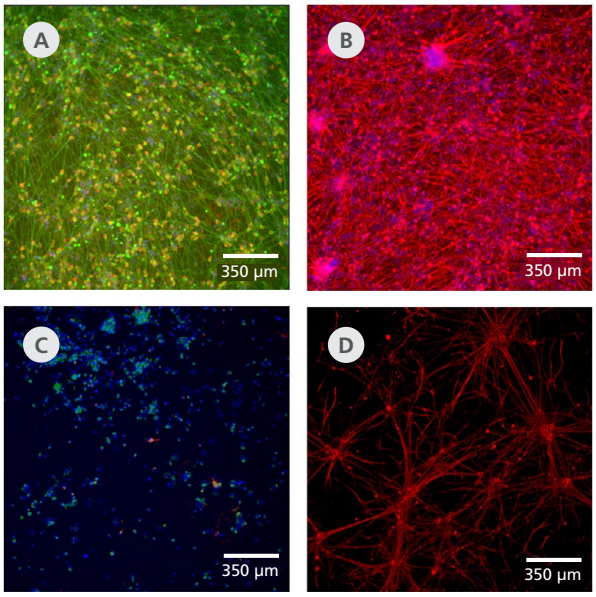


Figure 41. Sensory Neurons of the Peripheral Nervous System Can Be Generated Using STEMdiff™ Sensory Neuron Kits

NCCs generated from hPSCs in mTeSR™ Plus using the STEMdiff™ Neural Crest Differentiation Kit for 6 days were differentiated and matured to sensory neurons (SNs) using the STEMdiff™ Sensory Neuron Differentiation and Maturation Kits for 6 days each. (A) The resulting cultures contain a population of cells expressing SN markers peripherin (green) and BRN3A (red) along with (B) neuronal marker class III β-tubulin (TUJ1, red). (C) Midbrain neuron controls generated with STEMdiff™ Midbrain Neuron Differentiation and Maturation Kits do not have detectable peripherin (green) or BRN3A (red) expression, although they express (D) neuronal marker class III β-tubulin (TUJ1, red). Nuclei are labeled with DAPI (blue).

Learn more at www.stemcell.com/STEMdiff-Hepatocyte

For more information on gene expression levels in resulting neural crest cell and sensory neuron populations, contact your local sales representative for bulk RNA-sequencing data.

STEMdiff™-ACF Retinal Pigment Epithelium (RPE) Differentiation Kit

The STEMdiff™-ACF RPE Differentiation Kit (Catalog # 100-1367) enables the generation of hPSC-derived immature retinal pigment epithelium (RPE) in 14 days using a serum- and animal component-free kit. Immature RPE generated using the STEMdiff™-ACF RPE Differentiation Kit can be cryopreserved as an intermediate cell bank or matured further into functional RPE using STEMdiff™-XF RPE Maturation Medium (Catalog # 100-1365) without the need for manual selection or cell enrichment. The resulting RPE from this workflow can be used for modeling human retinal development and disease, drug screening, cell and gene therapy validation, and advanced tissue model development.

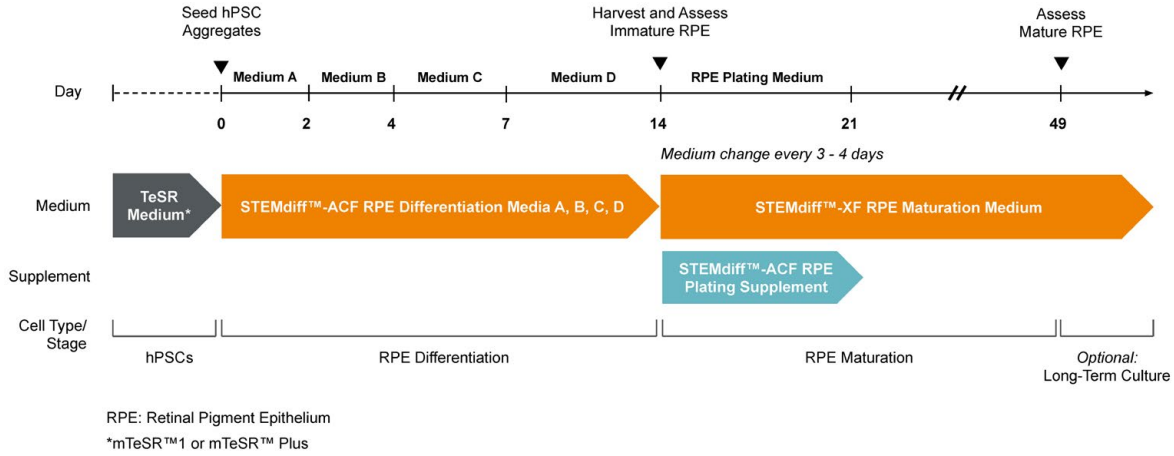


Figure 42. Workflow for the Differentiation of hPSCs into RPE with the STEMdiff™-ACF RPE Differentiation Kit

hPSC colonies, previously harvested and seeded as clumps, are added directly to STEMdiff™-ACF RPE Differentiation Medium A to induce immature RPE. A full medium change is performed on Day 1 with Medium A, then on Day 2 with Medium B. Medium C is used on Days 4 and 6, followed by Medium D on Day 7 and every second day thereafter. On Day 14, immature retinal pigment epithelial cells are enzymatically passaged and plated in STEMdiff™-XF RPE Maturation Medium with STEMdiff™-ACF RPE Plating Supplement (Days 14 - 21) to support survival. Over 5 weeks, retinal pigment epithelial cells mature in STEMdiff™-XF RPE Maturation Medium, acquiring key features such as polygonal shape, pigmentation, polarization, and phagocytic function. hPSC = human pluripotent stem cell; RPE = retinal pigment epithelium

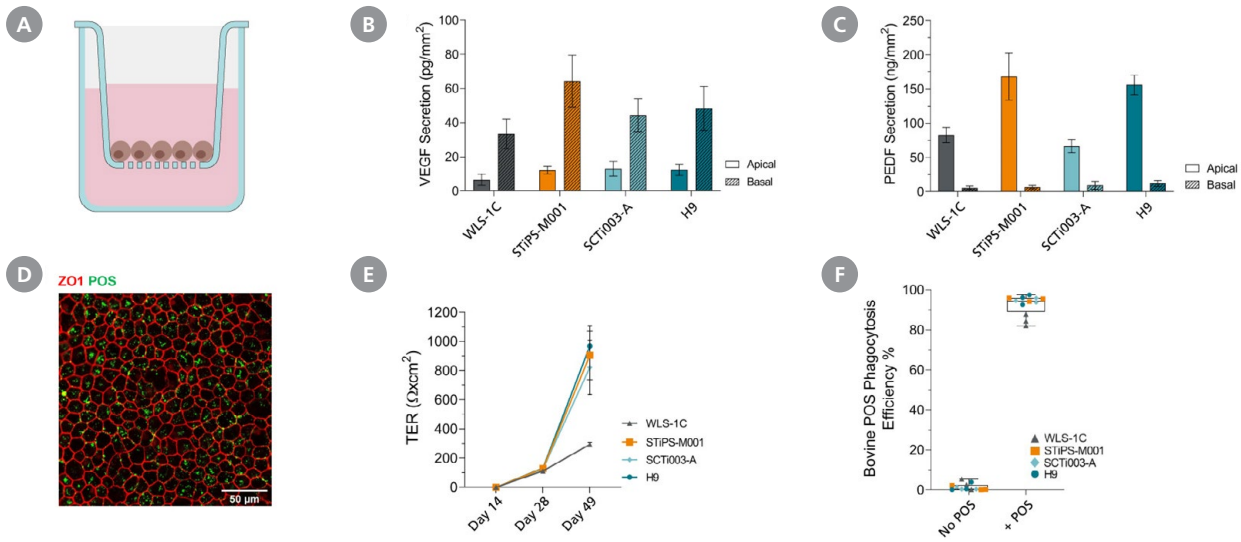


Figure 43. Mature Retinal Pigment Epithelial Cells Display Key Functionalities Corresponding to RPE Behaviour

hPSCs were cultured for 14 days using the STEMdiff™-ACF RPE Differentiation Kit and subsequently subcultured on cell culture inserts in STEMdiff™-XF RPE Maturation Medium for 5 weeks. Apical and basal conditioned medium were collected from Mature RPE, and a sandwich ELISA was performed to quantify vascular endothelial growth factor (VEGF) and pigment epithelium-derived factor (PEDF) secretion. (A, B) Mature RPE secreted more basal VEGF and apical PEDF, indicating that the retinal pigment epithelial cells displayed correct apicobasal polarity. Data shown as mean ± SEM; n = 3. (C) Mature RPE were able to generate a strong barrier with high transepithelial resistance (TER). Data shown as mean ± SEM; n = 3 - 6. (D) Mature RPE were fed FITC-labeled bovine photoreceptor outer segments (POS) for 4 to 5 hours prior to being enzymatically dissociated for flow cytometry analysis or fixed with paraformaldehyde for immunostaining. (E) Mature RPE efficiently internalized bovine POS. Data shown as mean ± SEM; n = 3. (F) A cross-sectional schematic of the cell insert culture system. hPSCs = human pluripotent stem cells; RPE = retinal pigment epithelium

Learn more at www.stemcell.com/stemdiff-acf-rpe

Muscular System

STEMdiff™ Myogenic Progenitor Supplement Kit

Generate hPSC-Derived Myogenic Progenitors and Myotubes

STEMdiff™ Myogenic Progenitor Supplement Kit (Catalog #100-0151) consists of serum-free supplements intended for use with DMEM/F12 to differentiate hPSCs to myogenic progenitor cells. The latter, which are characterized by myogenic cell markers such as CD56 and CD82, can be culture-expanded for more than five passages using the MyoCult™-SF Expansion Supplement Kit (Human; Catalog #05980) and further differentiated to functional multinucleated MyHC+ myotubes with high efficiency using the MyoCult™ Differentiation Kit (Human; Catalog #05965). These myotubes can be used for various downstream applications and analyses.

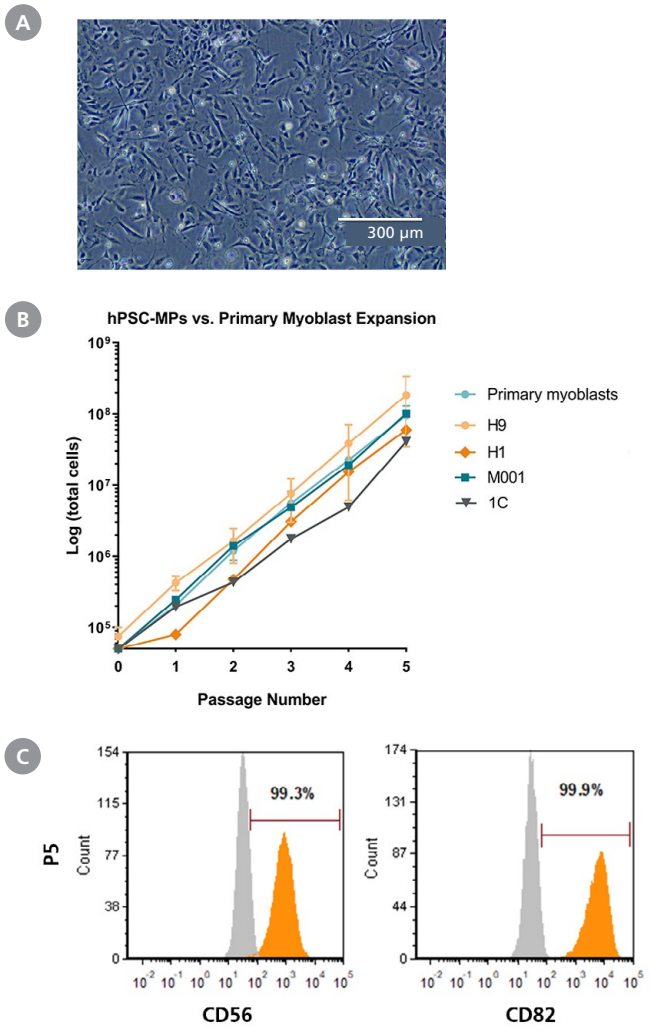


Figure 44. STEMdiff™ Myogenic Progenitor Kit Generates Expandable hPSC-Derived Myogenic Progenitors

(A) Representative image of proliferating sub-cultured hPSC-derived myogenic progenitors generated using the STEMdiff™ Myogenic Progenitor Kit. (B) Expansion rates of hPSC-derived myogenic progenitors (hSPC-MP) over 5 passages across multiple hPSC lines are comparable to human primary myoblasts. Error bars represent standard error of mean, n = 3. (C) hPSC-derived myogenic progenitors harvested at passage 5 expressed human myoblast markers CD56 and CD82.

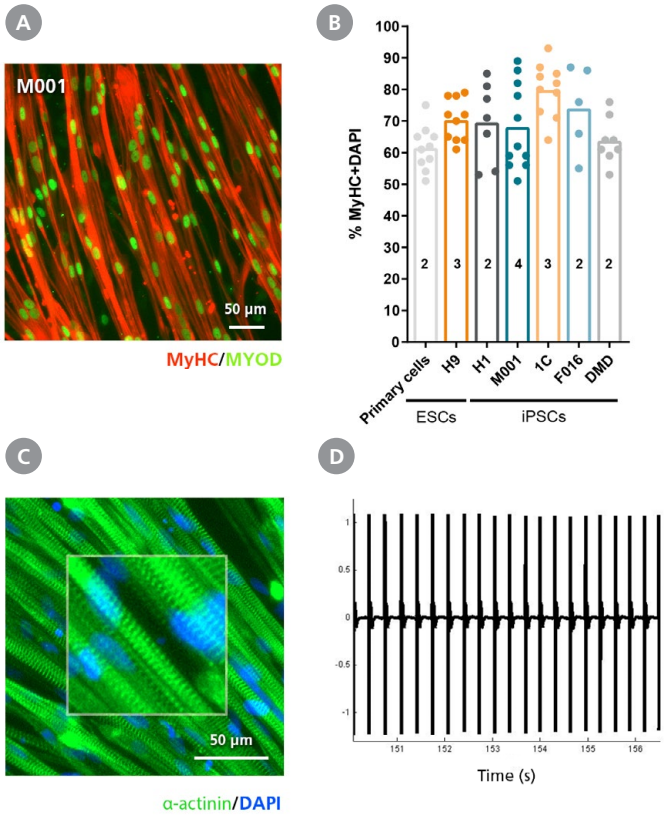


Figure 45. hPSC-Derived Myotubes Generated Using the STEMdiff™ Myogenic Progenitor Kit Are Efficiently Differentiated and Functionally Contractile

hPSC-derived myogenic progenitors were generated from the M001 cell line using the STEMdiff™ Myogenic Progenitor Kit and then induced to differentiate into myotubes using MyoCult™ Differentiation Medium (Human). (A) After 8 days, myotubes were fixed and stained for MyHC and MyoD. (B) Multiple hPSC lines differentiated and induced using this method exhibited high fusion indices similar to primary human myoblasts (numbers in bars represent the n number and dots represent technical replicates). (C) hPSC-derived myotubes were stained for alpha-actinin and displayed organized sarcomeric structures as indicated by the zoomed-in area. (D) Spontaneous field potential recordings of hPSC-derived myotubes using a microelectrode assay plate indicated that the derived myotubes are contractile.

Learn more at www.stemcell.com/myo-diff

Stromal System

STEMdiff™ Mesoderm Induction Medium

Differentiate to Early Mesoderm, Xeno-Free

STEMdiff™ Mesoderm Induction Medium (MIM; Catalog #05220) is a defined, xeno-free medium for generation of early mesoderm cells from human pluripotent stem cells (hPSCs). Protocols for mesodermal differentiation can be difficult and inconsistent. Using the short and simple STEMdiff™ MIM monolayer protocol enables efficient and reproducible differentiation of multiple hPSC lines.

STEMdiff™ MIM produces a cell population enriched for early mesoderm, as indicated by positive expression of Brachyury (T), MIXL1, and NCAM markers (Figure 46).

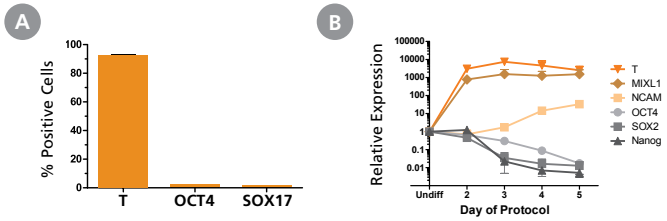


Figure 46. STEMdiff™ MIM Efficiently Generates a Homogenous Population of Early Mesoderm Cells

(A) Data showing marker expression characteristic of early mesoderm (positive Brachyury (T) expression and negative OCT4 and SOX17 expression) on Day 5 of the protocol. Data expressed as a mean percentage of cells expressing each marker ± SD, n = 33 (T, OCT4); n = 5 (SOX17). (B) Expression of undifferentiated cell markers (OCT4, SOX2, NANOG) and early mesoderm markers (T, MIXL1, NCAM), measured by qPCR and normalized to levels in undifferentiated cells; n = 2.

Learn more at www.stemcell.com/STEMdiff-MIM

STEMdiff™ Mesenchymal Progenitor Kit

Derive Functional Mesenchymal Progenitor Cells

The STEMdiff™ Mesenchymal Progenitor Kit (Catalog #05240) is optimized for the efficient and reproducible derivation of mesenchymal progenitor cells (MPCs) from hPSCs. This kit contains animal component-free (ACF) induction medium, expansion medium, and attachment substrate for the derivation and expansion of MPCs. It uses a simple monolayer protocol to generate MPCs under feeder-free conditions in three weeks. hPSC-derived MPCs are capable of long-term expansion (Figure 47). The derived MPCs are characterized by strong expression of cell-surface markers CD73, CD90, and CD105, and lack expression of CD45.

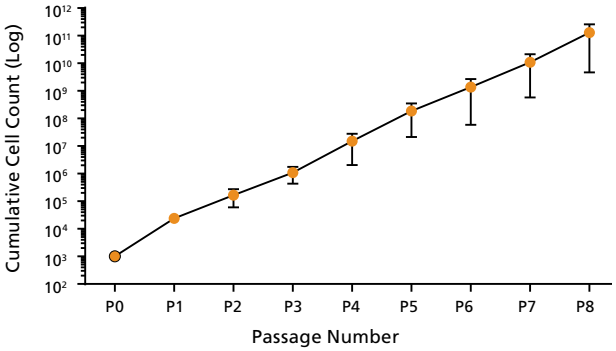


Figure 47. hPSC-Derived MPCs Generated Using the STEMdiff™ Mesenchymal Progenitor Kit Exhibit a High Rate of Cell Expansion in MesenCult™-ACF Plus Medium

The average cell expansion of human MPCs generated from hPSCs using the STEMdiff™ Mesenchymal Progenitor Kit. Error bars represent standard error of mean (SEM; n = 5).

Learn more at www.stemcell.com/STEMdiff-MPC

Urogenital System

STEMdiff™ Kidney Organoid Kit

Directed differentiation of hPSCs into kidney organoids allows researchers to work with an in vitro model culture system that has direct relevance to the developing human kidney. Kidney organoids form large (~150 - 400 µm), branched structures containing endothelial cells, podocytes, and epithelial cells of the proximal and distal tubules, mimicking nephron-like structure and segmentation. Kidney organoids modeling both health and disease in specific genetic backgrounds can be created by reprogramming patient-derived cells. These in vitro models can be further manipulated by introducing or correcting mutations through CRISPR-Cas9 gene editing prior to differentiation. This approach has successfully been used to model polycystic kidney disease and podocyte organization during development.[16,17] Like other hPSC-derived organoid systems, kidney organoids resemble the first trimester kidney and display markers of the developing kidney as well as markers of differentiation.[18,19]

The STEMdiff™ Kidney Organoid Kit (Catalog #05160) enables growth of tubular kidney organoids from hPSCs in 21 days. These organoids are suitable for a wide range of experimental contexts, including developmental and cell biology, disease modeling, drug screening and nephrotoxicity assessment, and cell therapy research.

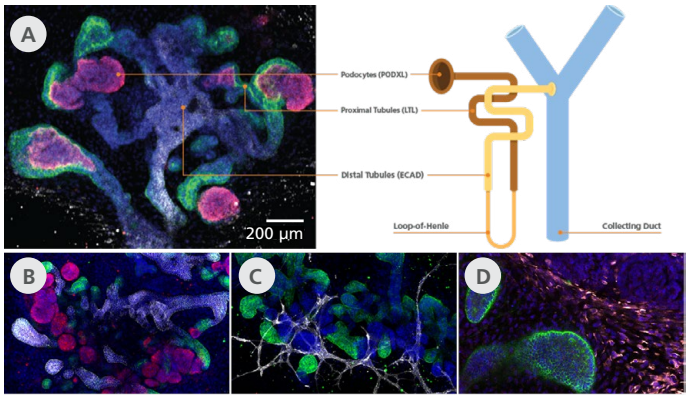


Figure 48. Kidney Organoids Display Distinct Domains of the Developing Nephron

hPSC-derived kidney organoids generated using the STEMdiff™ Kidney Organoid Kit incorporate cells and organization mimicking the structure and segmentation of the developing nephron. (A, B) Branched, tubular organoids display markers of proximal tubules (LTL, green), distal tubules (ECAD, white), and podocytes (PODXL, red), while DAPI (blue) shows the nuclei of all cells, including (C) endothelial cells (CD31, white) and (D) mesenchyme (VIM, white; Meis 1/2/3, red). Scale bar = 200 µm.

Learn more at www.stemcell.com/STEMdiffKidney

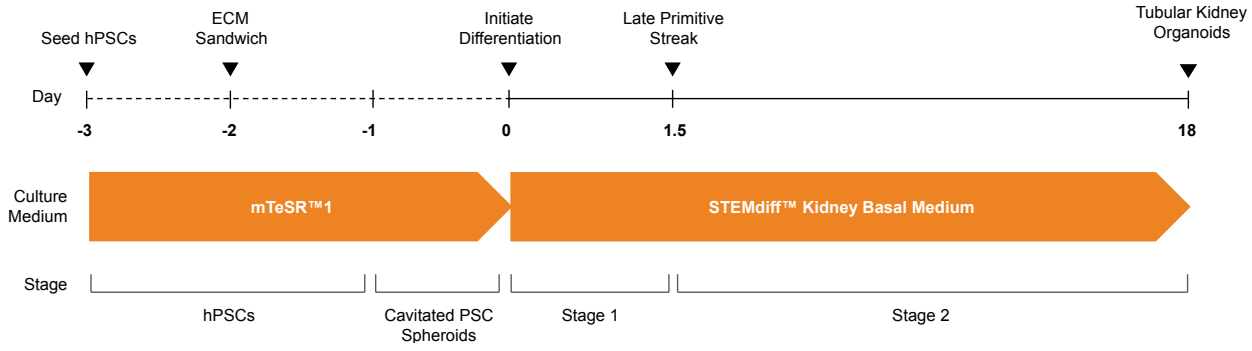


Figure 49. Schematic for Differentiation from hPSCs to Human Kidney Organoids with the STEMdiff™ Kidney Organoid Kit

hPSC cultures progress through a simple three-stage process to generate kidney organoids. hPSCs are plated and overlaid with Corning® Matrigel® to form cavitated spheroids. These are induced toward the late primitive streak and intermediate mesoderm, forming tubular kidney organoids by Day 18 of differentiation.

Flexible User-Directed Differentiation

STEMdiff™ APEL™2

STEMdiff™ APEL™2 Medium (Catalog #05270) is a fully defined, serum-free, and animal component-free medium for differentiation of human pluripotent stem cells (hPSCs). It is based on the APEL formulation published by Ng et al.[20] and lacks undefined components, such as protein-free hybridoma medium. This medium can be used in adherent or embryoid body (EB)-based protocols, such as with AggreWell™ plates (see page 39). Appropriate induction factors must be added before use.

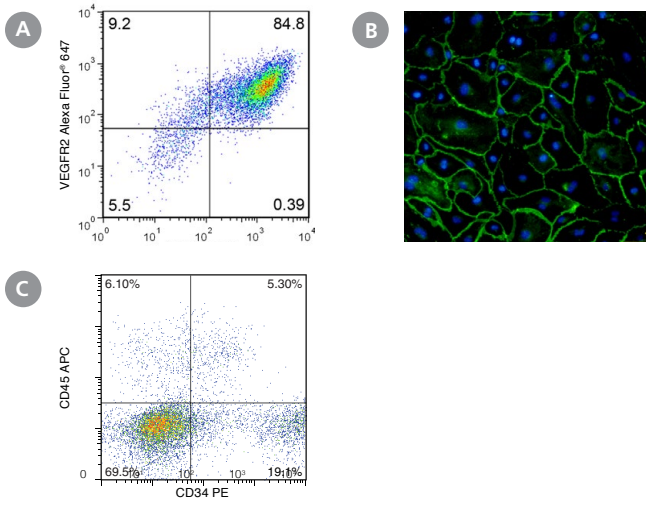


Figure 50. STEMdiff™ APEL™ Media Can Be Used for Customized Differentiation to Various Mesodermal Cell Lineages

(A) Endothelial differentiation of STiPS-F001 hiPSCs using STEMdiff™ APEL™ medium*, based on methods by Tan et al.[21] (B) Immunocytochemistry image of CD31 (green; nuclei shown in blue) in endothelial cells differentiated from H1 cells using STEMdiff™ APEL™ medium. Image courtesy of the Cao Tong lab, University of Singapore. (C) Hematopoietic differentiation of H9 cells, based on methods by Ng et al.[20] and Chadwick et al.[22] with the following changes: (1) STEMdiff™ APEL™ medium was used as the basal medium; (2) prior to differentiation, cells were maintained in mTeSR™1 on Matrigel®; (3) differentiation was performed in adherent cell culture on a Matrigel®-coated surface, instead of using an EB-based method.

*STEMdiff™ APEL™ has been updated to STEMdiff™ APEL™2, which lacks undefined components such as protein-free hybridoma medium.

Learn more at www.stemcell.com/APEL2

Why Use STEMdiff™ APEL™2?

- Ensure defined growth with this animal origin-free (AOF) formulation
- Tailor your differentiation protocols to your specific cells using this robust and published basal medium
- Differentiate to a variety of cell lineages, including hematopoietic, endothelial, and epithelial
- Benefit from versatility with adherent- or EB-based protocols

TeSR™-E5 and TeSR™-E6 Media

TeSR™-E5 (Catalog #05916) and TeSR™-E6 (Catalog #05946) are defined, serum-, and xeno-free media that are based on the formulation of TeSR™-E8™, but do not contain transforming growth factor b (TGFb) or basic fibroblast growth factor (bFGF). Additionally, TeSR™-E5 does not contain insulin. These formulations may be used as basal media for differentiation of hPSCs, or other applications where removal of the above cytokines and insulin is desirable.

Learn more at www.STEMdiff.com/#custom

Cell Quality Characterization

STEMdiff™ Trilineage Differentiation Kit

Validate Pluripotency with Directed Differentiation

The STEMdiff™ Trilineage Differentiation Kit (Catalog #05230) provides a simple cell culture assay to functionally and reproducibly validate the ability of hPSCs to differentiate to the three germ layers. This kit includes reagents and protocols to perform parallel in vitro directed differentiation experiments for each germ layer, clearly establishing trilineage differentiation potential within one week. Clear, quantitative assay results evaluated by immunocytochemistry, flow cytometry, or transcriptome analysis make the STEMdiff™ Trilineage Differentiation Kit a valuable tool for establishing the pluripotency of hPSCs lines.

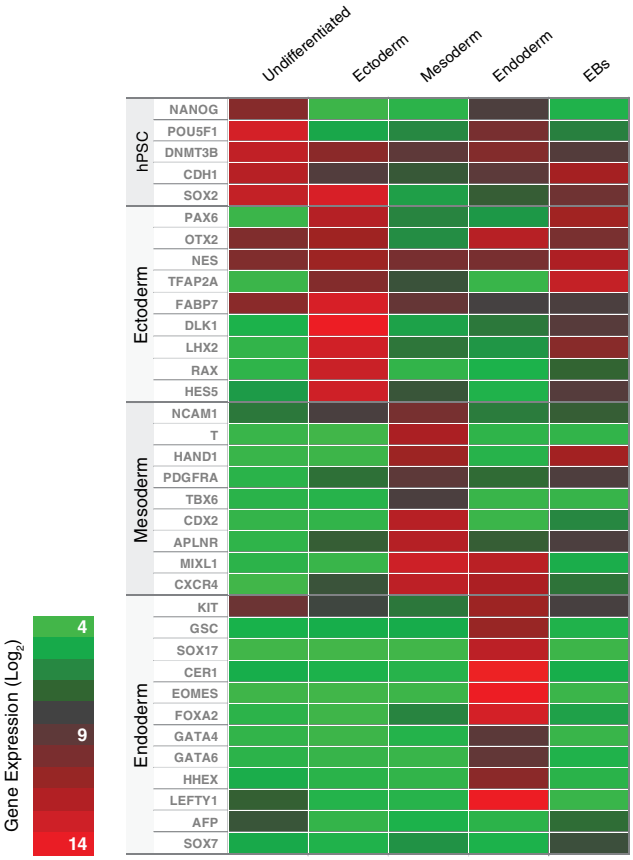


Figure 51. Molecular Analysis of Cultures Differentiated with the STEMdiff™ Trilineage Differentiation Kit Shows Strong Separation of Lineage-Specific Markers

H9 cells were maintained in mTeSR™1 and subsequently differentitated in vitro using either directed differentiation with the STEMdiff™ Trilineage Differentiation Kit or spontaneous differentiation in embryoid bodies (EBs) using a 10-day protocol in serum-containing medium. Undifferentiated cells, differentiated ectoderm, mesoderm, and endoderm cells from the directed differentiation kit and EBs were then subjected to a microarray-based transcriptome analysis to evaluate expression levels of key germ layer markers. Cells differentiated using the STEMdiff™ Trilineage Differentiation Kit showed clear upregulation of appropriate germ layer-specific markers, whereas the same cells differentiated spontaneously in EBs did not show significant upregulation of mesoderm or endoderm markers.

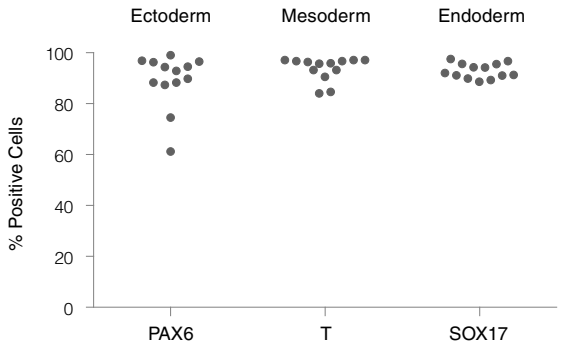


Figure 52. The STEMdiff™ Trilineage Differentiation Kit Promotes Efficient Differentiation to All Three Germ Layers

Pluripotent stem cells (both hiPSCs and hESCs represented) were maintained in mTeSR™1, differentiated using the STEMdiff™ Trilineage Differentiation Kit, and subjected to flow cytometry analysis (n = 13 biological replicates, including 5 distinct cell lines). The markers used for flow cytometry for each germ layer are listed below the x-axis.

hPSC Trilineage Differentiation qPCR Array

The hPSC Trilineage Differentiation qPCR Array (Catalog #07515) provides a validated 90-gene assay to assess gene expression associated with undifferentiated hPSCs or their derivatives undergoing the early stages of differentiation, plus housekeeping controls and a synthetic DNA positive control. Data analysis is streamlined with our flexible online app (**www.stemcell.com/qPCRanalysis**).

Learn more at www.stemcell.com/trilineage-array

Accessory Products

Small Molecules

Small molecules are increasingly being used as critical tools to understand stem cell biology. Whether used to affect reprogramming, self-renewal, or differentiation, the right small molecule can transform a research project. Choose from a wide variety of small molecules that are being widely used in high-impact research to target the key pathways in stem cell biology.

For a complete listing and more details on the small molecules available, and to see how they are being used in high-impact studies, visit **www.stemcell.com/smallmolecules**.

Most Popular Small Molecules

Molecule	Pathway/Target	Applications	Catalog #
CHIR99021	WNT pathway activator Inhibits GSK3	Reprogramming, Maintenance, Differentiation	72052
IWP-2	WNT pathway inhibitor Inhibits Porcupine	Differentiation	72122
LDN193189	BMP pathway inhibitor Inhibits ALK1, ALK2, ALK3, ALK6	Differentiation	72147
SB431542	Activin/BMP/TGF-β pathway inhibitor Inhibits ALK4, ALK5, ALK7	Reprogramming, Differentiation	72232
Purmorphamine	Hedgehog pathway activator Activates Smoothened	Differentiation	72202
DAPT	Notch pathway inhibitor Inhibits γ-secretase	Differentiation	72082
Prostaglandin E2	Prostanoid pathway activator Activates prostaglandin receptors EP1, EP2, EP3 and EP4	Differentiation	72192
Dibutyryl-cAMP	cAMP pathway activator Activates cAMP-dependent protein kinases	Differentiation	73882
SB202190	p38 MAPK inhibitor	Maintenance, Differentiation	72632
IWR-1-endo	WNT pathway inhibito AXIN2 stabilizer	Maintenance, Differentiation	72562
All-Trans Retinoic Acid	Retinoid pathway activator Activates retinoic acid receptor (RAR)	Differentiation	72262
BIO	WNT pathway activator Inhibits GSK3	Reprogramming, Maintenance, Differentiation	72032

Cytokines

Cytokines are commonly used tools in lineage-specific differentiation protocols, as well as for self-renewal of hPSCs. For a complete listing of cytokines available, including animal component-free (ACF) versions, please visit **www.stemcell.com/cytokines**.

Most Popular Cytokines

Product	Catalog #	
	Non-ACF	ACF*
Activin A[1]	78001	78132
B18R Protein	78075	-
bFGF	78003	78134
BMP-2	78004	78135
BMP-4	78211	-
DKK-1	78208.1	-
EGF[1]	78006	78136
EGFR	78171.1	-
Flt3/Flk-2 Ligand	78009	78137
Heregulin-beta 1	79071	-
IGF-I	-	78142
LIF	78055	78149
Noggin	78060	-
SCF	78062	78155
TGF-β1[1]	78067	-
VEGF-165	78073	78159
VEGF-121	78127	-
PDGF-DD	78222	-

**All ACF cytokines are human recombinant proteins produced in E. coli and are guaranteed free of animal or human components.*

*[1]International Units (IU) data available. Visit **www.stemcell.com/IU-data**.*

Organoid Culture Plates

Streamline your organoid research by reducing common challenges in organoid culture, such as variability and inconsistent growth found in standard matrix cultures. Organoid Culture Plates enhance consistency, ensure uniform matrix thickness, and reduce meniscus effects, leading to easier and quicker seeding, clearer imaging, and reliable experimental results. Organoid cultures will grow more predictably, helping you work more efficiently and increasing confidence in your data.

Organoid Culture Plates are available in two formats, 24-well (Catalog #200-0561) and 96-well (Catalog #200-0562), and are compatible with Corning® Matrigel® and other matrices, as well as automated systems. Organoids consistent in size, shape, growth, and maturation can help build physiologically relevant models more representative of in vivo environments.

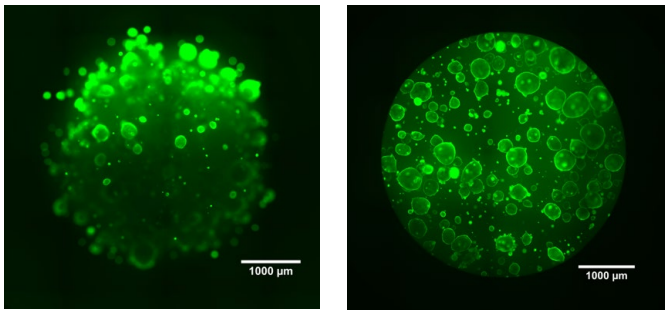


Figure 53. Organoid Culture Plates Enable Superior Imaging and Ease of Use Over Dome Culture in Standard Culture Plates

Organoid Culture Plates support more consistent growth of human hepatic organoids compared to standard culture plates. By reducing the meniscus and standardizing matrix depth, these plates promote more uniform organoid growth and positioning. This also results in clearer imaging than traditional dome culture methods.

AggreWell™ Plates

Many hPSC differentiation protocols begin with the formation of three-dimensional aggregates, either embryoid bodies (EBs) or spheroids. AggreWell™ plates provide an easy and standardized approach to the production of EBs and spheroids as each well contains microwells of defined size, making it easy to produce large numbers of highly uniform aggregates and to ensure reproducibility of differentiation experiments. AggreWell™ plates are avilable in 3 sizes of microwells and multiple plate formats to fit your research.

Product	Microwell Size	Cell Range	Plate Format	Number of Spheroids	Catalog #
AggreWell™400	400 µm	50 - 3,000 cells per spheroid	24-well plate	~ 1,200 per well	34411/34415
			6-well plate	~ 5,900 per well	34411/34415
AggreWell™800	800 µm	3,000 - 20,000 cells per spheroid	24-well plate	~ 300 per well	34411/34415
			6-well plate	~ 1,500 per well	34411/34415
AggreWell™HT	900 µm	50 - 20,000 cells per spheroid	96-well plate	~ 32 per well	200-0563/ 200-0570

Note: *AggreWell™ Rinsing Solution (Catalog #07010) is required for use with AggreWell™ plates to ensure optimal performance.*

Product

Learn More About AggreWell™ Plates

www.stemcell.com/AggreWell

Product

Learn More About Organoid Culture Plates

www.stemcell.com/OCP

Antibodies

For Human Pluripotent Stem Cells and Differentiated Cells

Be confident in your experimental results, save valuable research time, and ensure experimental reproducibility by choosing antibodies from STEMCELL Technologies. Our high-quality primary and secondary antibodies are verified to work with our pluripotent stem cell reagents in specific applications, ensuring that your downstream cell analysis, including phenotyping and purity assessments, works consistently.

Popular Antibodies for hPSC Research

Target Antigen	Clone	Isotype	Catalog #
OCT4 (OCT3)	3A2A20	Mouse IgG2b	60093
OCT4 (OCT3)	40	Mouse IgG1	60059
SSEA-1 (CD15)	MC-480	Mouse IgM	60060
SSEA-3	MC-631	Rat IgM	60061
SSEA-4	MC-813-70	Mouse IgG3	60062
SSEA-5	8e11	Mouse IgG1	60063
TRA-1-60	TRA-1-60R	Mouse IgM	60064
TRA-1-81	TRA-1-81	Mouse IgM	60065
TRA-2-49	TRA-2-49/6E	Mouse IgG1	60066
TRA-2-54	TRA-2-54/2J	Mouse IgG1	60067

For a complete listing of antibodies and conjugates available, visit **www.stemcell.com/antibodies**.

GloCell™ Fixable Viability Dyes

For Live/Dead Cell Staining

GloCell™ Fixable Viability Dyes are fluorescent amine-labeling dyes for live/dead staining of mammalian cells, allowing clear exclusion of dead cells from flow cytometry data. These dyes are resistant to washing and fixation and are compatible with intracellular antibody staining protocols. Stained cells can also be cryopreserved without loss of fluorescence intensity.

Learn more at www.stemcell.com/GloCell

Mitochondrial Kit & Dyes

Mitochondria maintain crucial energy balance and play important roles in regulating normal cell function, activity, as well as cellular senescence. Fluorescent-based dyes and kits for mitochondrial sample preparation are emerging as useful tools for elucidating mitochondrial activity in physiological and pathological conditions. Explore the following tools to study mitochondrial activity and cellular metabolism after culturing cells in our core media products.

Product	Catalog #
Mitochondrial Isolation Kit	100-0990
Mitochondrial Superoxide Dye	100-0991
TMRE (Perchlorate)	100-0992
JC-1 (Iodide)	100-0993
Rhod-2 AM (Bromide)	100-0994
Mitochondrial Tracking Dye, Deep Red	100-0995
Mitochondrial Tracking Dye, Blue	100-0996

Annexin V Dyes & Caspase 3/7 Assay Reagents

For Detection of Early-Stage Cell Apoptosis

Annexin V is a characteristic cell death marker that can be used to specifically detect early apoptotic mammalian cells. The Annexin V Apoptosis Detection Kit can be used for the combined detection of early-stage cell apoptosis using Annexin V and late-stage cell apoptosis or necrosis using both Annexin V and 7-Aminoactinomycin D (7-AAD).

Caspase 3/7 is widely accepted as a reliable indicator of apoptosis, since caspase 3 activation is a necessary step to initiate the apoptotic cascade in a broad spectrum of cell types.

STEMCELL's caspase 3/7 products can be used to detect caspase 3/7 activity in apoptotic cells, are robust in detecting caspase 3/7 activity, and can be easily adapted to be used as high-throughput assays for flow cytometry and microplates.

ThawSTAR® Automated Thawing Systems

Standardize Your Thawing Performance Through Automation

Increase confidence in your cell thawing workflow with consistent thawing performance and sample sterility by using the ThawSTAR® CFT2 Automated Thawing System (Catalog #100-0650). With a standardized thawing process that replaces manual, water bath-based thawing, ThawSTAR® CFT2 eliminates the risk of contamination and delivers controlled thawing profiles. Simply insert a frozen sample and retrieve it once the device alerts you at the end of the thaw cycle.

Utilize the ThawSTAR® CFT2 Confirmation Vials (Catalog #100-0643) and Transporter (Catalog #100-0642) within your workflow to document instrument performance as well as handle and transport frozen vials, respectively. Facilitate functional testing using the ThawSTAR® CFT2 IOPQ (Catalog #100-0730) Kit, which includes installation, operational, and performance qualification documentation and accessories.

Learn more at www.stemcell.com/thawstar

Cell Culture Matrices

STEMmatrix™ BME

Support feeder-free expansion and differentiation of hPSCs with STEMmatrix™ BME (Catalog #200-0960), a soluble, hPSC-qualified basement membrane matrix extracted from mouse Engelbreth-Holm-Swarm (EHS) sarcoma. Rich in key extracellular matrix proteins (e.g. collagen IV, entactin, heparan sulphate proteoglycans, laminin) and essential growth factors (e.g. EGF, bFGF, IGF-1, TGF-β, VEGF), STEMmatrix™ BME closely mimics in vivo conditions to support robust cell growth.

Pair with feeder-free hPSC maintenance media, such as mTeSR™ Plus, mTeSR™1, TeSR™-E8™, or eTeSR™, to successfully maintain hPSC lines in the undifferentiated state. These cells retain characteristic hPSC morphology, express undifferentiated cell markers such as OCT4 and TRA-1-60, and have the capacity to differentiate into all three germ layers. Use with Gentle Cell Dissociation Reagent (GCDR) or ReLeSR™ for routine passaging of hPSC aggregates, or ACCUTASE™ for single-cell passaging workflows.

Learn more at www.stemcell.com/STEMmatrix-BME

Protocol

How to Coat Cultureware with STEMmatrix™ BME for hPSC Culture

www.stemcell.com/stemmatrix-bme-protocol

Vitronectin XF™

Vitronectin XF™ (Catalog #07180), developed and manufactured by Nucleus Biologics, is a defined, xeno-free cell culture matrix that supports the growth and differentiation of hPSCs. Use with mTeSR™1, mTeSR™ Plus , TeSR™-E8™ , or TeSR™-AOF medium to provide a defined culture system for the maintenance of hPSCs and greater control over the culture environment, resulting in more consistent cell populations and reproducible results in downstream applications.

hPSCs cultured on Vitronectin XF™ retain pluripotency and normal colony morphology, without the need for an adaptation step. Pair with Gentle Cell Dissociation Reagent or ReLeSR™ when passaging to maintain high-quality cultures.

Learn more at www.stemcell.com/Vitronectin-XF

CellAdhere™ Laminin-521

CellAdhere™ Laminin-521 (Catalog #77003) is a defined and xeno-free cell culture matrix that supports the feeder-free growth and differentiation of hPSCs. Laminin 521 is naturally expressed and secreted by hPSCs in the inner cell mass of the embryo, therefore creating a biologically relevant hPSC culture environment in vitro.

For consistent, reproducible results in downstream applications, use CellAdhere™ Laminin-521 with TeSR™ maintenance media. Compared to other matrices, CellAdhere™ Laminin-521 increases single-cell attachment and survival without requiring apoptotic inhibitors during plating. For single-cell passaging, use CellAdhere™ Laminin-521 with eTeSR™ maintenance medium. Pair with Gentle Cell Dissociation Reagent or ReLeSR™ for routine passaging of hPSC aggregates, or ACCUTASE™ for single-cell passaging workflows.

Note: *If passaging hPSCs as single cells, check the karyotype frequently for genetic aberrations.*

Learn more at www.stemcell.com/Laminin-521

Lab Training Courses

Learn from Our Experienced Scientists

Performing an unfamiliar laboratory technique can be challenging. Increase your chances of success and perform your experiments with confidence by enrolling in one of our free on-demand training courses before you begin.

On-Demand Training

Access our free, self-paced, online training courses

Learn the techniques and protocols to move your research forward. Recorded lectures, step-by-step instructional videos, and libraries of curated resources will help guide you through entire workflows. Topics include hPSC maintenance and cell quality, neural induction, expansion of hPSCs in 3D suspension culture, and ISSCR standards for human stem cell use in research. From passaging to cryopreservation, learn fundamental laboratory skills from the comfort of your own home.

Learn more about our training courses and how we can support your research at www.stemcell.com/psc-training

References

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DOC#27242 VERSION 2.0.1 NOVEMBER 2025