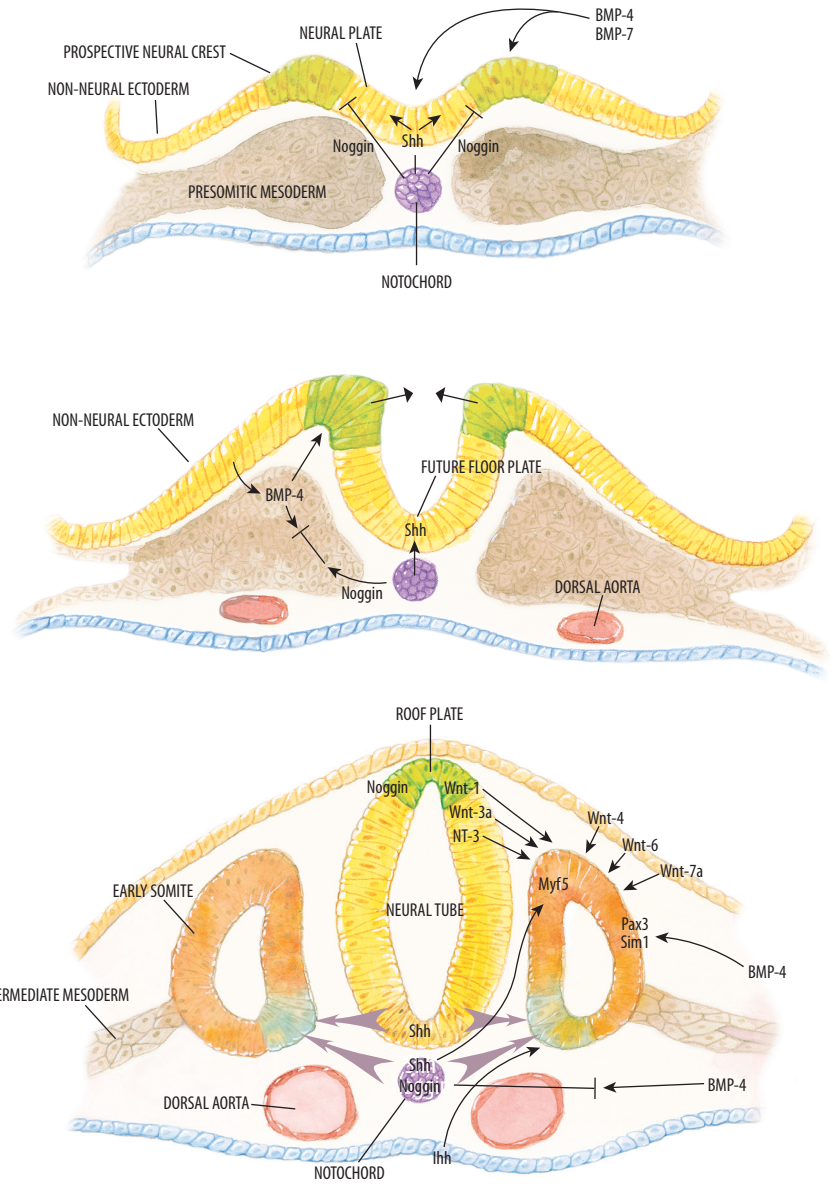
Products for Morphogen Research

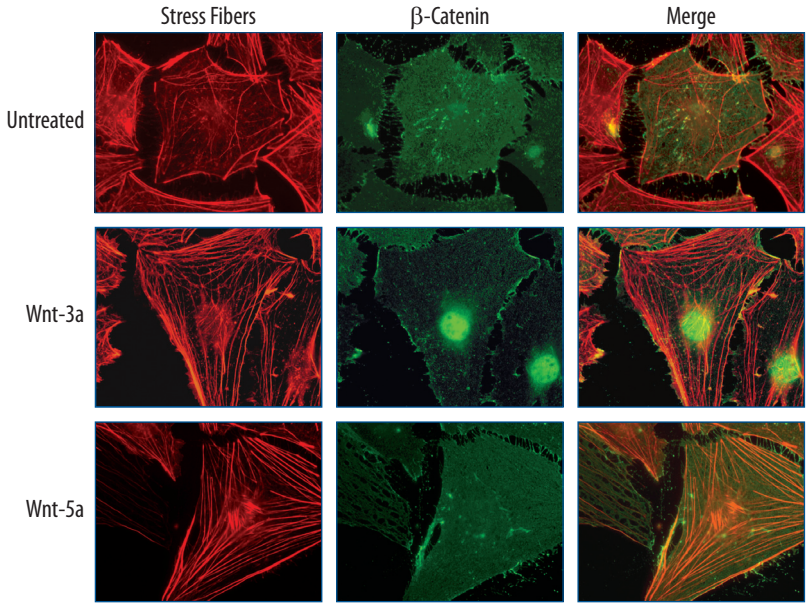


MORPHOGENS

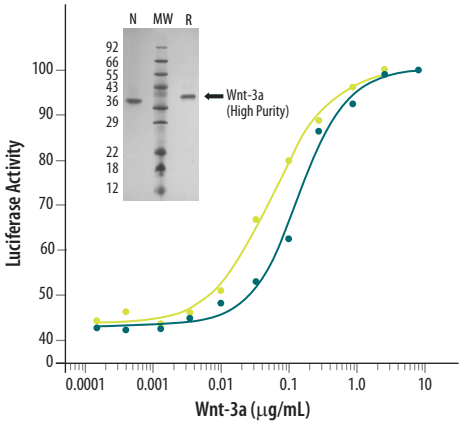
Morphogens are molecules that regulate cell fate during development. Formation of morphogen concentration gradients directs the biological responses of surrounding cells. Graded responses occur as a result of morphogens binding to specific cell surface receptors that subsequently activate intracellular signaling pathways and promote or repress gene expression at specific threshold concentrations. Activation or inactivation of these signaling pathways provides positional information that ultimately determines tissue organization and morphology. Research in model organisms has revealed that morphogens are involved in many aspects of development. For example, morphogens are required in *Drosophila* for patterning of the dorso-ventral and anterior-posterior axes, segment patterning, and positional signaling in the leg and wing imaginal discs. Proteins belonging to the Wingless/Wnt, Notch, Hedgehog, and TGF-β families have been identified as morphogens that direct a number of these processes. Research in higher organisms has demonstrated that homologues of these same signaling molecules regulate vertebrate axis formation, anterior/posterior polarity during limb development, mesoderm patterning, and numerous other processes that establish an organism's basic body structure. R&D Systems offers a wide selection of proteins, antibodies, and ELISAs for morphogen-related developmental research.

Wnt Family

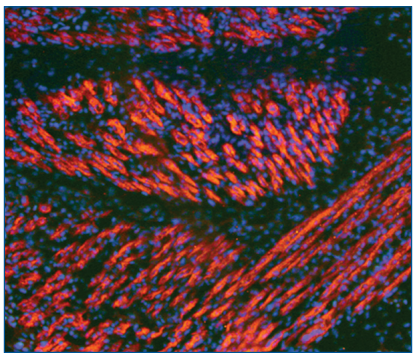
The molecular name Wnt is derived from *Wingless*, the *Drosophila melanogaster* segment polarity gene, and *Integrase-1*, the vertebrate homologue. Wnts are a large family of secreted glycoproteins that bind to seven transmembrane G protein-coupled receptors belonging to the Frizzled family. Frizzled proteins form co-receptor complexes with LRP, ROR, or Ryk molecules. Wnt binding to Frizzled receptors can activate both the canonical Wnt/β-Catenin signaling pathway and the non-canonical, β-Catenin independent pathways. Wnt signaling regulates multiple developmental processes, including anterior-posterior patterning, patterning of the neural tube and limbs, development of the reproductive system, somite development, and formation of the pituitary gland, adrenals, kidneys, and mammary tissues.



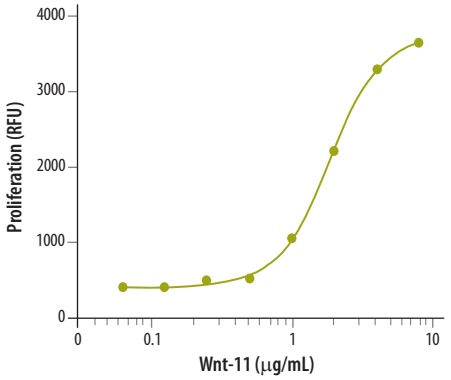
Demonstration of Wnt-3a and Wnt-5a Bioactivity in Mouse Fibroblasts. Recombinant Mouse Wnt-3a (Catalog # 1324-WN) and Recombinant Human/Mouse Wnt-5a (Catalog # 645-WN) promote stress fiber formation in NIH-3T3 mouse embryonic fibroblast cells, while only Wnt-3a promotes nuclear β-Catenin accumulation. *Images courtesy of Dr. Raymond Habas, Robert Wood Johnson School of Medicine.*



Wnt-3a Induces β-Catenin-responsive Transcriptional Activation. β-Catenin-responsive transcriptional activation was assessed using the TOPflash TCF reporter in the HEK293T human embryonic kidney cell line following treatment with Recombinant Human Wnt-3a (Catalog # 5036-WN; dark green line) or High Purity Recombinant Human Wnt-3a (Catalog # 5036-WNP; light green line). The purity of the High Purity Recombinant Human Wnt-3a protein is highlighted in a silver-stained, SDS-PAGE gel loaded with 1 μg of protein/lane under both non-reducing (N) and reducing (R) conditions (inset). MW = Molecular weight markers.



Detection of Wnt-5a Expression in Embryonic Mouse Muscle. Wnt-5a was detected in immersion-fixed frozen sections of embryonic mouse muscle (13 d.p.c.) using Rat Anti-Human/Mouse Wnt-5a Monoclonal Antibody (Catalog # MAB645). The tissue was stained using NorthernLights™ 557-conjugated Anti-Rat Secondary Antibody (Catalog # NL013; red) and nuclei were counterstained with DAPI (blue).

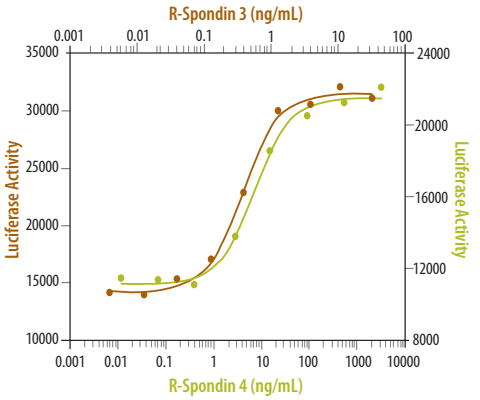


Wnt-11 Induces Proliferation of Rat Small Intestine Epithelial Cells. The IEC-18 rat small intestine epithelial cell line was treated with increasing concentrations of Recombinant Mouse Wnt-11 (Catalog # 6179-WN). Cell proliferation was assessed using Resazurin (Catalog # AR002).

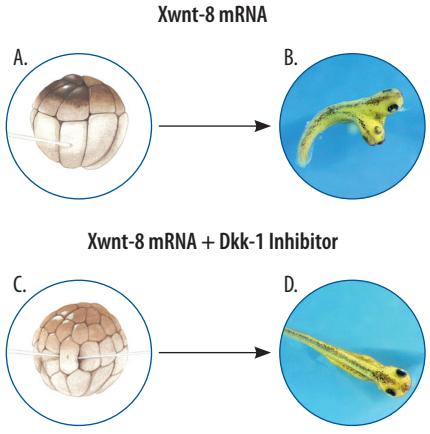
Products for Wnt Research

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
APC		H	
Axin-1		H M R	
Axin-2		H	
β-Catenin		H M R B Ch X	H
Bcl-9		H	
Bcl9-2		H	
CaM Kinase II		H M R X	
Casein Kinase 1α,1γ,1δ,1ε		H M R	
Casein Kinase 2β		H M R	
Ccd1/DIXDC1		M	
Dishevelled-1		H	
Dishevelled-2		H	
Dishevelled-3		H	
Dkk-1	H M R	H M R	H M
Dkk-2	M	M	
Dkk-3	H	H M	H
Dkk-4	H M	H M	H
Draxin	M	H M R	
Frizzled-1	H M	H M	
Frizzled-2	M	M	
Frizzled-3		H M	
Frizzled-4	H M	H M	
Frizzled-5	H	H	
Frizzled-6		H M	
Frizzled-7	H M	H M	
Frizzled-8	H M	M	
Frizzled-9		M	
Frizzled-10	H		
GSK-3α/β		H M R	H M R
GSK-3α		H M R	H
GSK-3β	H	H M R	H M R
ICAT		H	
JNK		H M R	H M R
JNK1/JNK2		H M R	
JNK1	M	H M R	H M R
JNK2		H M R	H M R
Kremen-1	M	H M	M
Kremen-2	H M R	H M	
LRP-1		H	
LRP-1 Cluster II	H	H	
LRP-1 Cluster IV	H		
LRP-4		H R	
LRP-6	H M	H M	
MESDC2	M	H M	
MFRP	H	H M	
MKK7		H	
Myocilin		H	
NeuroD1		H M	
Norrin	H M	H M	
Nucleoredoxin		H	
PKCα		H M R	
PKCβ1		H R	
PKCβ2		H M	
PKCγ		H M R	
PKCδ	H		
PKCε		H M R	
PKCι/λ		H M	
PKCι/λ/ζ		H M R	
PKCθ		H M	
Pygopus-1		H M	
Pygopus-2		H	
Renin R		H	
ROCK1	H		
ROCK2		H M R	
ROR1 Receptor Tyrosine Kinase		H	H
RTK-like Orphan Receptor 2/ROR2		H	H
R-Spondin 1	H M	H M	
R-Spondin 2	H	H	
R-Spondin 3	H M	H M	
R-Spondin 4	H M	M	
Ryk		H M	
sFRP-1	H	H	
sFRP-2	M	M	
sFRP-3	H M	H M	H
sFRP-4	H	H	
sFRP-5	H		
Shisa-4		H M	
Soggy-1	H M	H M	M
SOST/Sclerostin	H M	H M	
TAK1		H	
TCF-7/TCF-1		H	
TCF7L1		H M	
WIF-1	H	H M	H
Wnt-1		M	
Wnt-2		H	
Wnt-2b		M	
Wnt-3a	H M	M	
Wnt-4	H M	H M	
Wnt-5a	H M	H M R	
Wnt-5b	M	M	
Wnt-6		H	
Wnt-7a	H	H	
Wnt-7b		H	
Wnt-8a		M	
Wnt-8b		H M	
Wnt-9a		H	
Wnt-9b	M	H M	
Wnt-10a		M	
Wnt-10b		M	
Wnt-11	H	M	

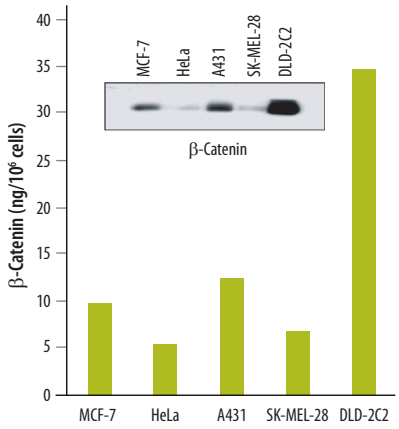
KEY: **H:** Human **M:** Mouse **R:** Rat **B:** Bovine **Ch:** Chicken **X:** *Xenopus*



R-Spondin 3 and R-Spondin 4 Induce β-Catenin-responsive Transcriptional Activation. In the presence of 5 ng/mL Recombinant Mouse Wnt-3a (Catalog # 1324-WN), increasing concentrations of Recombinant Mouse R-Spondin 3 (Catalog # 4120-RS; brown line) and Recombinant Mouse R-Spondin 4 (Catalog # 4106-RS; green line) stimulate transcriptional activation of the TOPflash β-Catenin/TCF reporter in the human kidney cell line, HEK293T.



Dkk-1 Antagonizes Wnt Activity during *Xenopus* Development. A. 16-cell stage *Xenopus* embryos were injected with *Xenopus* Wnt-8 mRNA into a ventral/vegetal blastomere. **B.** A representative *Xenopus* embryo (stage 35) injected with Xwnt-8 mRNA forms a secondary axis. **C.** To counter the effects of Xwnt-8 mRNA, a Wnt antagonist protein, Recombinant Human Dkk-1 (Catalog # 5439-DK), was injected into the spaces near the Xwnt-8 mRNA injection site at the 64-cell stage. **D.** A representative embryo injected with Xwnt-8 mRNA and then rescued by injection with Recombinant Human Dkk-1 prevents the development of a secondary axis.



Detection of Intracellular β-Catenin using the DuoSet® IC ELISA Development System. The levels of β-Catenin in lysates prepared from the MCF-7 human breast adenocarcinoma, HeLa human cervical epithelial carcinoma, A431 human epithelial carcincoma, SK-MEL-28 human malignant melanoma, and DLD-2C2 human colorectal adrenocarcinoma cell lines were assessed using the Human Total β-Catenin DuoSet IC ELISA (Catalog # DYC1329; bar graph). The results of the DuoSet IC ELISA are consistent with the relative levels of β-Catenin detected by Western blot analysis (inset).

For more information visit our website at www.RnDSystems.com/go/Wnt

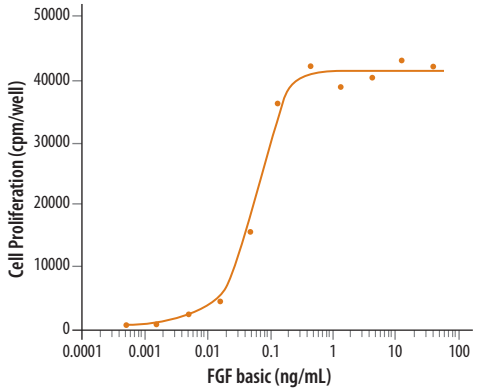
FGF Family

The Fibroblast Growth Factor (FGF) superfamily of proteins consists of at least 18 members that are grouped into six subfamilies based on sequence similarity and functional characteristics. A seventh group of numbered FGFs (FGF-11-14, known as FGF homologous factors) have high sequence and structural homology with the FGFs, but do not bind to FGF receptors. All FGF proteins have a characteristic 120 amino acid β-trefoil structure core region containing a heparan sulfate proteoglycan (HSPG) binding site. The activities of the FGF proteins are mediated by one of four type I transmembrane receptor tyrosine kinases (FGF R1-4). FGF receptors have multiple (2 or 3) extracellular Ig-like repeat domains, a single-pass transmembrane domain, and a split cytoplasmic tyrosine kinase domain. Alternative splicing in the Ig-like repeat domains generates receptor isoforms with different binding specificities. In addition, FGF receptors may require a co-receptor for activation in a cell- and context-dependent manner. Upon ligand and HSPG binding, FGF receptors dimerize, leading to autophosphorylation on multiple intracellular tyrosine residues on the C-terminal tail, kinase domain, and juxtamembrane region of the receptor. FGF receptor phosphorylation promotes the recruitment and docking of SH2 domain-containing adaptor proteins that activate downstream signaling cascades. These signaling cascades stimulate cell proliferation, growth, and differentiation. During development, FGF signaling regulates multiple processes, including patterning of the midbrain and hindbrain, branching morphogenesis, limb, lung, and heart formation, and kidney development.

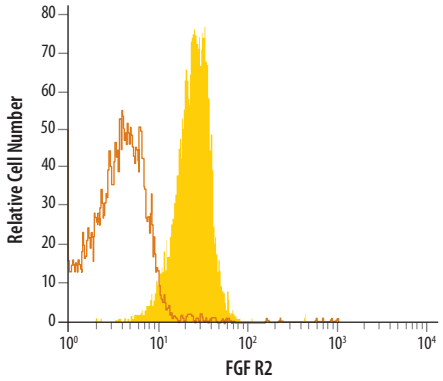
Products for FGF Research

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAS
α-2-Macroglobulin	H	H M	
FGF acidic	H M B	H B	H
FGF basic	H M R B	H B	H
FGF-3	H	H	
FGF-4	H M	H M	H
FGF-5	H	H	
FGF-6	H M	H M	
KGF/FGF-7	H M Ca	H Ca	H
FGF-8	H M	H M	
FGF-9	H	H	H
FGF-10	H M	H	
FGF-11		H	
FGF-12	H	H	
FGF-13		H	
FGF-16	H	H	
FGF-17	H	H	
FGF-19	H	H	H
FGF-20	H	H	
FGF-21	H	H M	H M
FGF-22	H	H	
FGF-23	H M	H M	
FGF-BP	H R	H R	
FGF R1-4		H	
FGF R1	H	H	H
FGF R1α	H		
FGF R1β	H		
FGF R2	H M	H M	H
FGF R2α	H M	H	H
FGF R2β	H M		
FGF R3	H M	H M	H
FGF R4	H	H M	H
FGF R5/FGFRL1	M	H M	
FRS2		H M R	H M R
Klotho	H M	M	
Klotho β	H M	M	
Pentraxin 3/TSG-14	H M	H M	H M
Shisa-4		H M	
SPRY1		H	
SPRY2		H M	
SPRY3		H	

KEY: **H:** Human **M:** Mouse **R:** Rat **B:** Bovine **Ca:** Canine



FGF basic Induces Mouse Fibroblast Proliferation. NR6R-3T3 mouse fibroblasts were treated with increasing concentrations of bovine FGF basic (Catalog # 133-FB). Cell proliferation was assessed by measuring ^{3}H-thymidine incorporation.



Detection of FGF R2 by Flow Cytometry. U937 human leukemic monocyte lymphoma cells were stained with APC-conjugated Mouse Anti-Human FGF R2 Monoclonal Antibody (Catalog # FAB684A; filled histogram) or APC-conjugated Mouse IgG_1 Isotype Control (Catalog # IC002A; open histogram).

For more information visit our website at www.RnDSystems.com/go/FGF

Notch Family

Organisms have four Notch receptors (Notch 1-4) that are bipartite, single-pass transmembrane proteins composed of a large extracellular domain noncovalently linked to a smaller transmembrane and intracellular domain. Activation of Notch receptors requires direct cell-cell interactions between the extracellular portion of the receptor and transmembrane ligands of the Jagged and Delta/Serrate/Lag-2 (DSL) families. Additional integral membrane, GPI-linked, and secreted proteins have also been reported to be Notch ligands. Notch activation results in the sequential proteolysis of Notch by TNF-converting enzyme (TACE/ADAM17) and Presenilin-dependent γ-secretase. These cleavage events promote the release of the Notch intracellular domain, which translocates to the nucleus to regulate the transcription of Notch target genes. Notch signaling is highly conserved in multicellular organisms and is important for specifying cell fates, regulating pattern formation, and defining boundaries between different cell types during early development. It is required for multiple developmental processes, including vasculogenesis, angiogenesis, hematopoiesis, somatogenesis, myogenesis, and neurogenesis.

Products for Notch Research

For more information visit our website at www.RnDSystems.com/go/DSLNotch

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
ADAM10	H M	H M	
TACE/ADAM17	H M	H	H
CBP		H M R	
Contactin-1	H	H	
Contactin-6	M		
CSL		H	
DLL1	H M R	H M R	H
DLL3		H	
DLL4	H M	H M	M
DNER		H M	

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
HES-1		H	
HES-4		H	
Jagged 1	H R	H R	R
Jagged 2	H M	H	
MAGP-1		M	
MAGP-2		H	
Nicastrin		H	
Notch-1	H M R	H M R	H
Notch-2	H M R	H M R	
Notch-3	H M	H M	

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
Notch-4		H	
NOV/CCN3	H M	H M	H M
NRARP		H M	
Numb		H	H M R
PEAR1/JEDI	H	H	
Pref-1/DLK-1/FA1		H	H
Presenilin-1		H	H
Presenilin-2		H	
Tsukushi/TSK	H	M	

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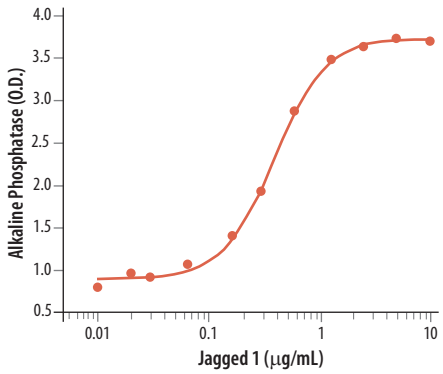
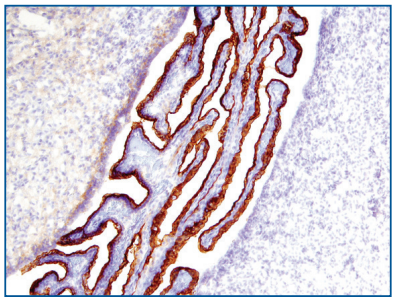
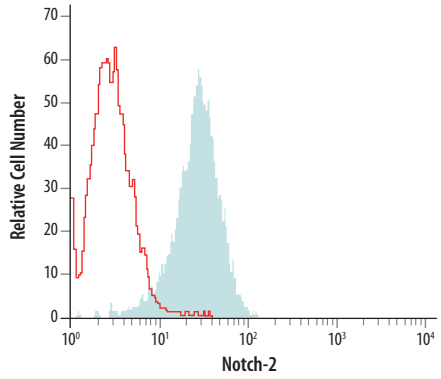


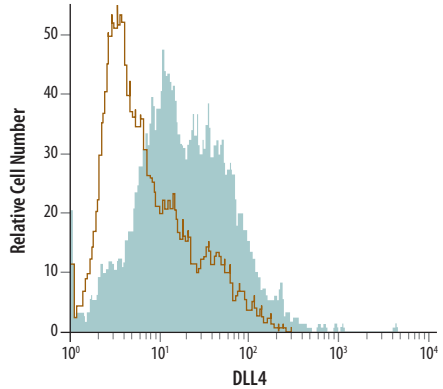
Jagged 1 Enhances Alkaline Phosphatase Production in the Presence of BMP-2. Alkaline phosphatase production was assessed in C3H10T1/2 mouse mesenchymal cells following treatment with Recombinant Human BMP-2 (Catalog # 355-BM; 150 ng/mL) and increasing concentrations of immobilized Recombinant Human Jagged 1 (Catalog # 1277-JG).



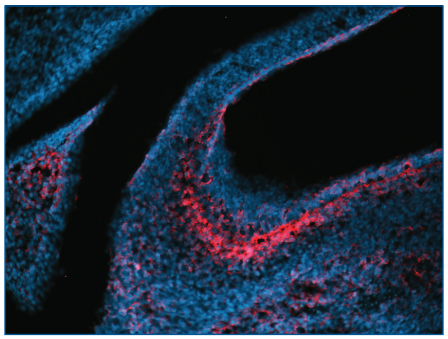
Detection of Notch-2 in Rat Brain. Notch-2 was detected in perfusion-fixed frozen sections of rat brain choroid plexus using Goat Anti-Rat Notch-2 Antigen Affinity-purified Polyclonal Antibody (Catalog # AF1190). The tissue was stained using the Anti-Goat HRP-DAB Cell and Tissue Staining Kit (Catalog # CTS008; brown) and counterstained with hematoxylin (blue).



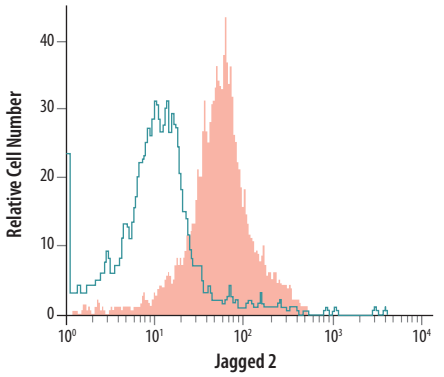
Detection of Notch-2 by Flow Cytometry. Rat splenocytes were stained with PE-conjugated Goat Anti-Rat Notch-2 Antigen Affinity-purified Polyclonal Antibody (Catalog # FAB1190P; filled histogram) or PE-conjugated Goat IgG Isotype Control (Catalog # IC108P; open histogram).



Detection of DLL4 by Flow Cytometry. Human umbilical vein endothelial cells (HUVECs) were stained with PE-conjugated Rat Anti-Human DLL4 Monoclonal Antibody (Catalog # FAB1506P; filled histogram) or PE-conjugated Rat IgG_{2A} Isotype Control (Catalog # IC006P; open histogram).



Detection of DLL1 Expression in Embryonic Mouse Stomach. Delta-like 1 (DLL1) was detected in immersion-fixed frozen sections of embryonic mouse stomach (E13.5) using Sheep Anti-Rat DLL1 Antigen Affinity-purified Polyclonal Antibody (Catalog # AF3970). The tissue was stained using NorthernLights 557-conjugated Anti-Sheep IgG Secondary Antibody (Catalog # NL010; red) and counterstained with DAPI (blue).



Detection of Jagged 2 by Flow Cytometry. Human umbilical vein endothelial cells (HUVECs) were stained with APC-conjugated Mouse Anti-Human Jagged 2 Monoclonal Antibody (Catalog # FAB1726A; filled histogram) or APC-conjugated Mouse IgG_{2B} Isotype Control (Catalog # IC0041A; open histogram).

Hedgehog Family

The *Hedgehog* gene was initially identified in *Drosophila* as a morphogen involved in segment polarity. In vertebrates, the Hedgehog family is represented by at least three members: Desert hedgehog (Dhh), Indian hedgehog (Ihh), and Sonic hedgehog (Shh). Hedgehog signaling occurs through two proteins, Patched (Ptc), a twelve-pass transmembrane protein that binds to the Hedgehog ligand, and Smoothened (Smo), a seven-pass transmembrane protein that transmits a downstream signal. In the absence of the Hedgehog ligand, Ptc inhibits Smo activity, and downstream target genes are inactivated by a processed form of the transcriptional repressor, Cubitus interruptus (Ci) in *Drosophila*, or Gli-1, -2, or -3 in vertebrates, which have context-dependent repressor/activator functions. Both the Fused and Suppressor of Fused proteins contribute to the inhibition of Ci/Gli-mediated transcriptional activation. Fused is a serine/threonine kinase that phosphorylates Ci/Gli to promote Ci/Gli processing, while Suppressor of Fused inhibits Ci/Gli by preventing its nuclear translocation. Upon ligand binding to Ptc, Smo is activated, phosphorylation and cleavage of Ci/Gli is inhibited, and full-length Ci/Gli translocates to the nucleus to activate the transcription of its target genes. Shh signaling in vertebrates is involved in diverse areas of development, including patterning of the central nervous system, somite, and limb.

Products for Hedgehog Research

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
BOC	H	H M	
CDO	H	H M	
Desert Hedgehog	H M	M	
DISP1		H	
Gas1	H M	H M	H M
GLI-1		H M	H
GLI-2		H M	H
GLI-3		H M	H
Glypican 3	H	H	
GSK-3α/β		H M R	H M R
GSK-3α		H M R	H
GSK-3β	H	H M R	H M R
Hip	M	M	M
Indian Hedgehog	M	H M	
LIN-41		H	
Patched 1		M	
Patched 2		H	
Sonic Hedgehog	H M	H M	M

KEY: **H:** Human **M:** Mouse **R:** Rat

For more information visit our website at www.RnDSystems.com/go/Hedgehog

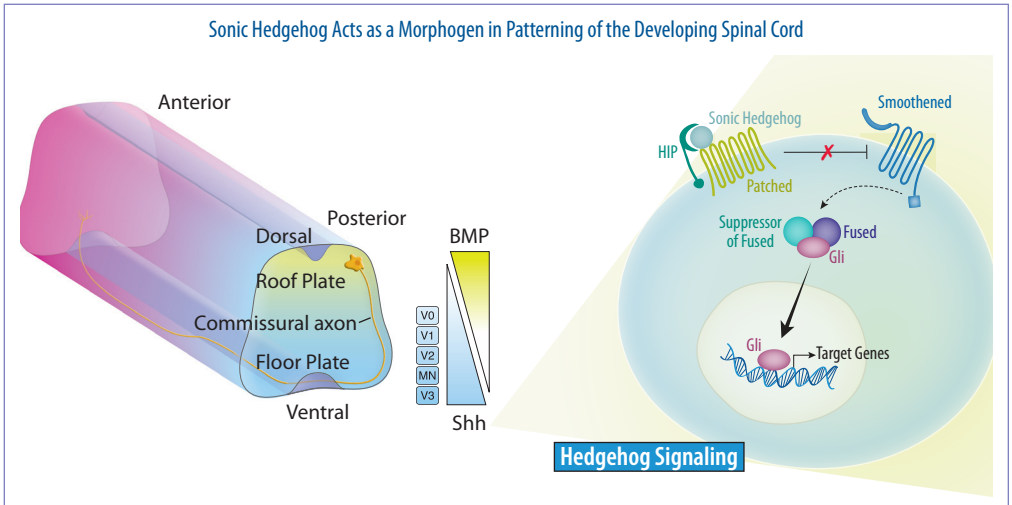
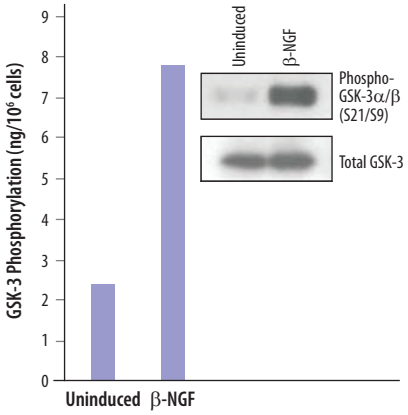
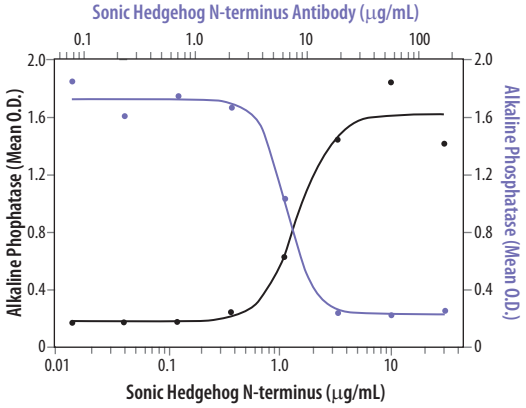


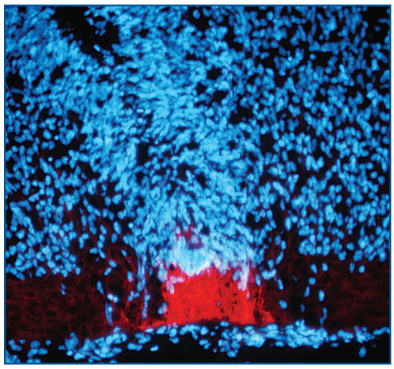
Figure 1. Following closure of the neural tube, commissural and association neurons develop in the dorsal half of the cord, while interneurons and motor neurons form in the ventral half of the cord. A gradient of Sonic Hedgehog (Shh) in the early neural tube specifies the development of the ventral neurons (V0-V3 and MN). Shh is secreted by the ventral floor plate. As the concentration of Shh diminishes dorsally, at least five distinct neuron cell types form along its gradient. Four interneuron cell types (V0-V3) plus lower motor neurons (MN) are induced through Shh-mediated activation or repression of homeodomain transcription factors at specific threshold concentrations. Shh activates transcription by binding to the Patched receptor to relieve inhibition of Smoothened. Full length Gli subsequently translocates to the nucleus and activates the transcription of its target genes. Inhibition of BMP signaling by Noggin, a BMP antagonist, may in part be involved in establishing the Shh gradient in the neural tube and sensitizing ventral cells to Shh activity.



Detection of β-NGF-induced GSK-3α/β Phosphorylation using the DuoSet IC ELISA Development System. Lysates from PC12 rat adrenal pheochromocytoma cells, uninduced or induced with Recombinant Rat β-NGF (Catalog # 556-NG) for 10 minutes, were assessed for GSK-3α/β phosphorylation using the Human/Mouse/Rat Phospho-GSK-3α/β (S21/S9) DuoSet IC ELISA Development System (Catalog # DYC2630; bar graph). The results obtained from the DuoSet IC ELISA were comparable to the relative levels of phosphorylated GSK-3α/β detected by Western blot (inset).



Sonic Hedgehog-induced Alkaline Phosphatase Production and Antibody Neutralization. The C3H10T1/2 mouse embryonic fibroblast cell line was treated with increasing concentrations of Recombinant Mouse Sonic Hedgehog N-terminus (Catalog # 461-SH) and alkaline phosphatase production was assessed (black line). The effect induced by 5 μg/mL Recombinant Mouse Sonic Hedgehog N-terminus was neutralized in a dose-dependent manner using Rat Anti-Mouse Sonic Hedgehog N-terminus Monoclonal Antibody (Catalog # MAB4641; purple line).



Detection of Patched 1 in Embryonic Mouse Spinal Cord. Patched 1 was detected in the floor plate region of immersion-fixed frozen sections of spinal cord in an E13 mouse embryo using Rat Anti-Mouse Patched 1 Monoclonal Antibody (Catalog # MAB41051; red). The nuclei were counterstained with DAPI (blue).

TGF-β Superfamily

The Transforming Growth Factor Beta (TGF-β) superfamily consists of the TGF-β proteins, Bone Morphogenetic Proteins (BMPs), Growth Differentiation Factors (GDFs), Glial-derived Neurotrophic Factors (GDNFs), Activins, Inhibins, Nodal, Lefty, and Müllerian Inhibiting Substance (MIS). Many of these molecules act as morphogens during embryonic development. Ligands of the TGF-β superfamily form dimers that bind to heterodimeric receptor complexes consisting of type I and type II receptor subunits with serine/threonine kinase domains. Following ligand binding, the type II receptor phosphorylates and activates the type I receptor, initiating a Smad-dependent signaling cascade that induces or represses transcriptional activity. During development, members of the TGF-β family are required for dorso-ventral patterning, mesoderm induction and patterning, limb bud formation, bone and cartilage formation, neuron differentiation, and the development of a variety of different tissues and organs.

For more information visit our website at www.RnDSystems.com/go/TGFbeta

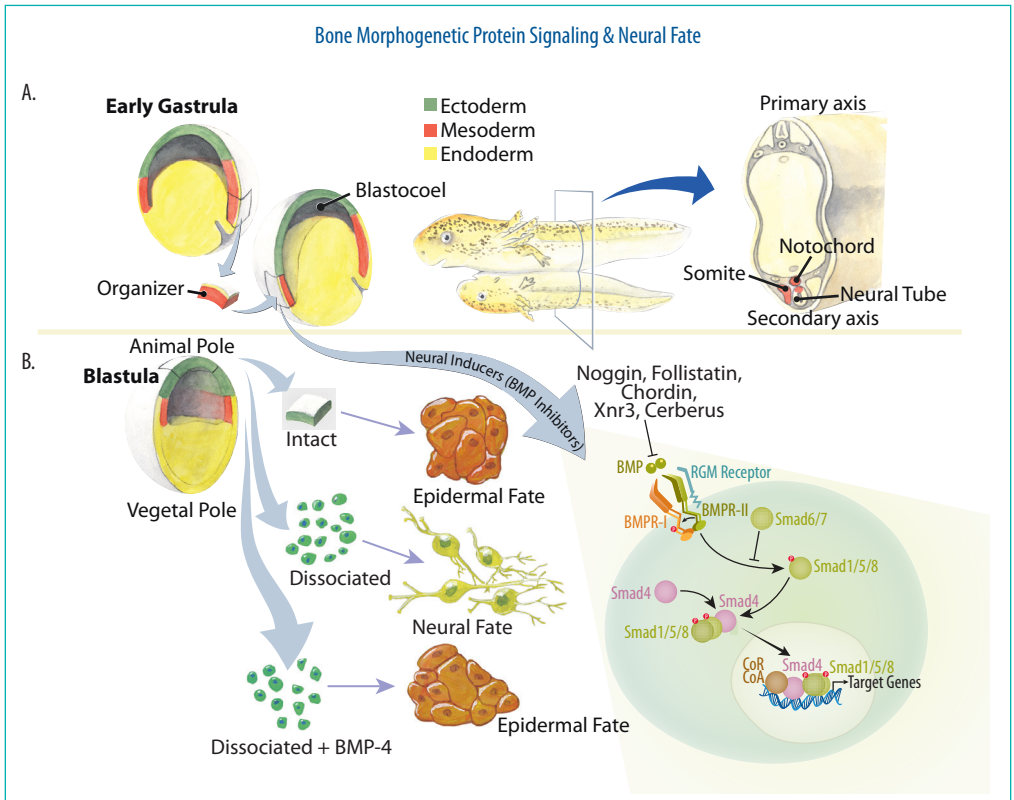
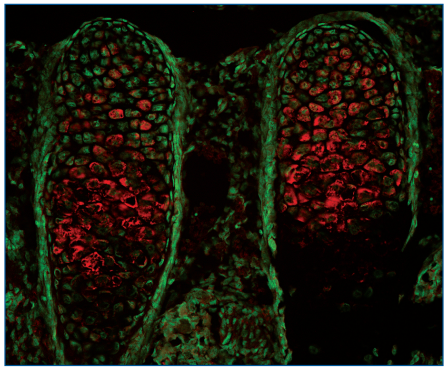
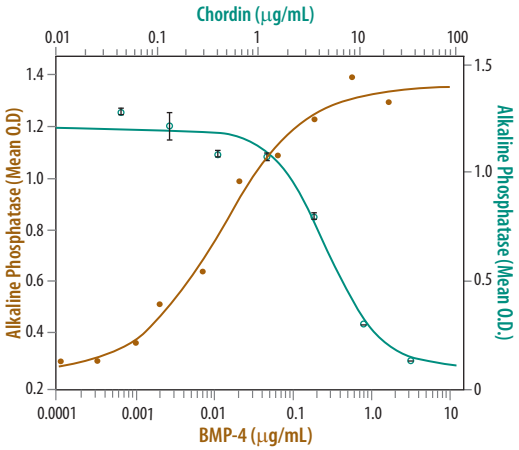


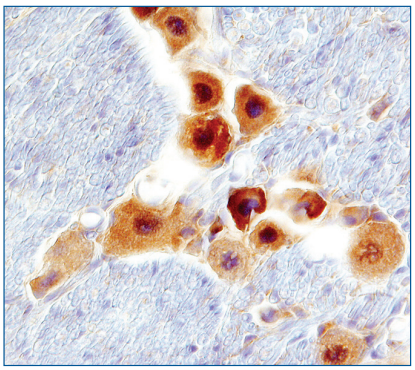
Figure 2. A. A seminal paper published by Spemann and Mangold in 1924 demonstrated that a graft taken from amphibian "organizer" tissue in the dorsal lip region of the blastopore induces a secondary body axis when transplanted into the ventral region of a second early gastrula stage embryo. The graft contributes primarily to mesodermal tissue of the somites and notochord, and also small portions of the ventral neural tube. Subsequent studies suggested that morphogens control the expression of transcription factors that regulate the formation of the "organizer". **B.** The Neural Default Model was generated from the observation that ectodermal cells dissociated from the animal pole of a developing blastula stage embryo form neural tissue, while intact ectoderm or dissociated ectoderm treated with Bone Morphogenetic Proteins (BMP-4) become epidermal tissue. These observations indicated that BMPs induce the development of epidermal tissue, while neural tissue forms by default in the absence of instructive factors. BMP binding to its receptors results in the activation and interaction of SMAD proteins, which subsequently activate transcription factors involved in generating epidermal tissues. The "organizer" was subsequently shown to secrete BMP inhibitors, such as Noggin, Chordin, Follistatin, Xnr3, and Cerberus that prevent BMP from binding to the ectoderm or mesoderm near the organizer to allow the development of neural tissue.



Detection of Twisted Gastrulation Expression in Embryonic Mouse Ribs. Twisted gastrulation (TSG) was detected in immersion-fixed frozen sections of embryonic mouse rib cartilage primordium (15 d.p.c.) using Goat Anti-Mouse TSG Antigen Affinity-purified Polyclonal Antibody (Catalog # AF756). The tissue was stained (red) and counterstained (green).



Chordin Inhibits BMP-4-induced Alkaline Phosphatase Production. Recombinant Human BMP-4 (Catalog # 314-BP) induces alkaline phosphatase production in the ATDC-5 mouse chondrogenic cell line (brown line). The effect induced by 30 ng/mL BMP-4 was inhibited in a dose-dependent manner using Recombinant Mouse Chordin (Catalog # 758-CN; green line).



Detection of RGM-B in Mouse Brain. Repulsive Guidance Molecule B (RGM-B) was detected in perfusion-fixed frozen sections of mouse brain trigeminal ganglia using Sheep Anti-Mouse RGM-B Antigen Affinity-purified Polyclonal Antibody (Catalog # AF3597). The tissue was stained using the Anti-Sheep HRP-DAB Cell and Tissue Staining Kit (Catalog # CTS019; brown) and counterstained with hematoxylin (blue).

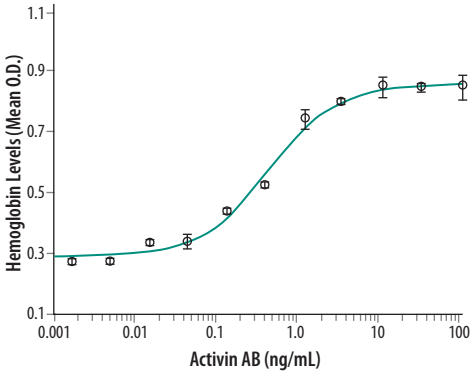
Products for TGF-β Research

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
Activin A	H M R	H M R	H M R
Activin AB	H		
Activin AC	H		
Activin B	H	H	
Activin C		H M	
Activin RIA/ALK-2	H	H	
Activin RIB/ALK-4	H M	H M	
Activin RIIA	H M	H	
Activin RIIA/B		H	
Activin RIIB	H M	H	
ALK-1	H M	H M	M
ALK-7	R	R	
BAMBI/NMA		H M	
BMP-1/PCP	H	H	
BMP-2	H Z	H Z	H M R
BMP-2/BMP-7 Heterodimer	H	H	
BMP-2/BMP-4		H Z	
BMP-2a	Z		
BMP-3	H	H	
BMP-3b/GDF-10	H	H	
BMP-4	H M Z	H Z	H
BMP-4/BMP-7 Heterodimer	H		
BMP-5	H M	H	H
BMP-6	H M	H	H
BMP-7	H M	H	H
BMP-8		H	
BMP-8a	H		
BMP-9	H M	H	H
BMP-10	H M	H	
BMP-15/GDF-9B	H	H M	
BMPR-IA/ALK-3	H M	H	
BMPR-IB/ALK-6	H M	H M	
BMPR-II	H	H	
Brorin/VWC2	H	H	
Caronte	Ch	Ch	
CD109	H	H	
Cerberus 1	M	H M	

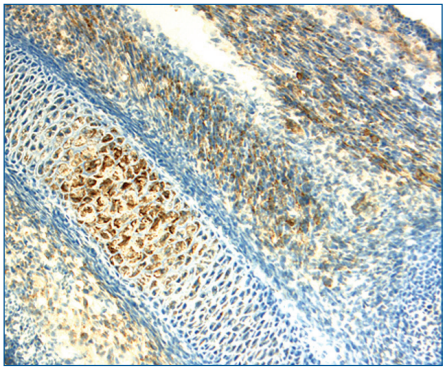
MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAS
Chordin	M	M	M
Chordin-like 1/CHRDL1	H	H	
Chordin-like 2/CHRDL2	M	H M	
COCO	H M	H M	H
CRIM1	H M	H	
Cripto	H M	H M	H
Crossveinless-2/CV-2	H M	H M	
Cryptic	H	H M	
DAN	H M	H M	H M
Decapentaplegic/DPP	D	D	
Endoglin/CD105	H M P	H M	H M
Follistatin-related Gene Protein/FLRG	H M	H M	H
Follistatin	H M	H M	H
Gas1	H M	H M	H M
GDF-1		M	
GDF-3	H M	M	
GDF-5	M	M	
GDF-6	M		
GDF-7/BMP-12	M	M	
GDF-8/Myostatin	H M R	H M R	
GDF-9	M	M	
GDF-11	H		
GDF-15	H	H	H
GDNF	H R	H R	H
GFRα-like		M	
Gremlin	H M	M	
Lefty		H M	
Lefty-1	M	M	
Lefty-A	H	H	
MIS/AMH	H	H M R	
MIS RII	H R	H R	
Neurturin	H M	H M	
Nodal	H M	M	
Noggin	H M	M	
NOMO		H	

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES	ELISAs
PRDC	M	M	M
Ret	H M	H M	H
RGM-A	H M	H M Ch	
RGM-B	H M	H M	
RGM-C	H M	H M	
Smad1		H	
Smad2		H M	H
Smad2/3		H M	H
Smad3		H M	H
Smad4		H	H
Smad5		H	
Smad7		H M R	
Smad8		H	
SOST/Sclerostin	H M	H M	
TGF-β		Ms	
TGF-β1	H P	H M Ms	H M R Ca P
TGF-β1, 2, 3		Ms	
TGF-β1.2	H	Ms	
TGF-β1/1.2		Ms	
TGF-β2	H P	Ms	H
TGF-β2/1.2		Ms	
TGF-β3	H	Ms	H
TGF-β5	A	Ms	
Latent TGF-β bp1		H	
Latent TGF-β bp2/LTBP-2		H	
Latent TGF-β bp4		M	
TGF-β RI/ALK-5	M	H M	
TGF-β RII	H M	H M	H
TGF-β RIIb	H	H	
TGF-β RIII	H M	H M	H
TMEFF1/Tomoregulin-1		H M	
TSG	M	M	
Tsukushi/TSK	H	M	
USAG1		H	
Vasorin/SLIT-like 2		H	

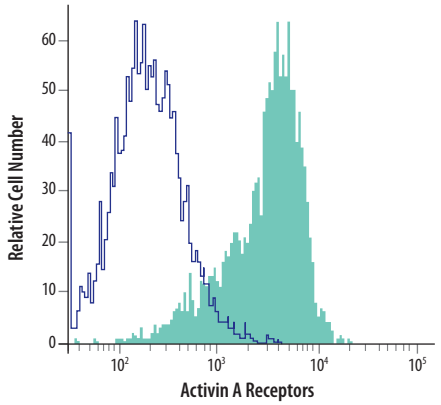
KEY: **H:** Human **M:** Mouse **R:** Rat **A:** Amphibian **Ca:** Canine **Ch:** Chicken **D:** *Drosophila* **Ms:** Multi-species **P:** Porcine **X:** *Xenopus* **Z:** Zebrafish



Activin AB Induces Hemoglobin Expression. The K562 human chronic myelogenous leukemia cell line was treated with increasing concentrations of Recombinant Human Activin AB (Catalog # 1066-AB). Hemoglobin levels in cell lysates were assessed by measuring its pseudoperoxidase activity.



Detection of Chordin-Like 2 in Embryonic Mouse Cartilage. Chordin-Like 2 (CHRDL2) was detected in immersion-fixed frozen sections of embryonic mouse cartilage (15 d.p.c.) using Rat Anti-Mouse CHRDL2 Monoclonal Antibody (Catalog # MAB2520). The tissue was stained using the Anti-Rat HRP-DAB Cell & Tissue Staining Kit (Catalog # CTS017; brown) and counterstained with hematoxylin (blue).



Detection of Cells Expressing Activin A Receptors by Flow Cytometry. The Human Activin A Biotinylated Fluorokine Kit (Catalog # NFACTA) was used to assess Activin A receptor positive cells in the PC3 human prostate cancer cell line. Cells were labeled with biotinylated recombinant human Activin A (filled histogram) or with biotinylated soybean trypsin inhibitor as a negative control (open histogram), and then stained with fluorescein-conjugated avidin. Fluorescently stained cells were detected by flow cytometry.

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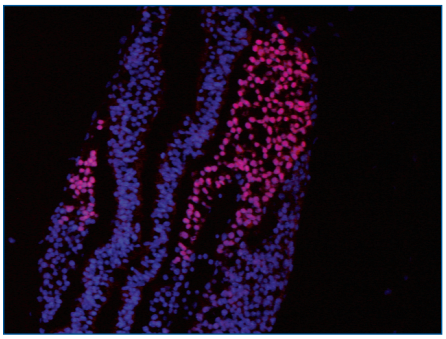
Other Morphogens

R&D Systems also offers a variety of products for morphogen-related molecules outside of the Wnt, FGF, Notch, Hedgehog, and TGF-β families. These include products for the TBX family of transcription factors involved in heart and limb development, the Twist basic helix-loop-helix transcription factors involved in skeletal development, Protogenin and the LRRTM proteins associated with formation of the central nervous system, and Epimorphin, a protein associated with morphogenesis.

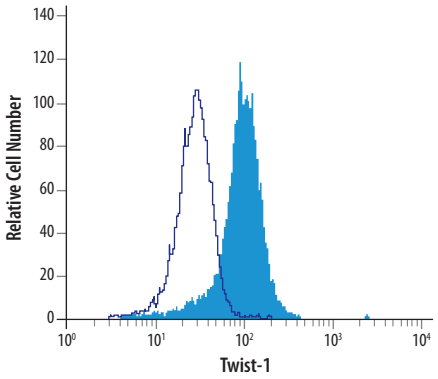
Products for Other Morphogens

MOLECULE	RECOMBINANT & NATURAL PROTEINS	ANTIBODIES
AP-2β		H
Epimorphin/Syntaxin 2		H M
LRRTM1	H	H
LRRTM2		H M
LRRTM3	H	H M
LRRTM4	H	H
NPDC-1		H
Olfactomedin-1/Noelin-1	M	M
Olfactomedin-2/Noelin-2	H	H
Protogenin		M
RXRα/NR2B1		H
RXRβ/NR2B2		H
RXRγ/NR2B3		H
TBX2		H
TBX3		H
TBX5		H M
TBX6		H
Twist-1		H
Twist-2		H

KEY: **H**: Human **M**: Mouse

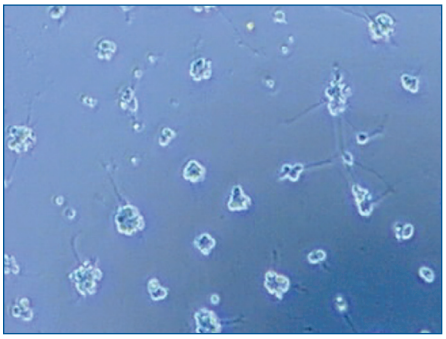


Detection of TBX6 in Embryonic Mouse Mesoderm. T-box protein 6 (TBX6) was detected in immersion-fixed frozen sections of embryonic mouse mesoderm (E9.5) using Goat Anti-Human TBX6 Antigen Affinity-purified Polyclonal Antibody (Catalog # AF4744). The tissue was stained using NorthernLights 557-conjugated Anti-Goat IgG Secondary Antibody (Catalog # NL001; red) and counterstained with DAPI (blue).

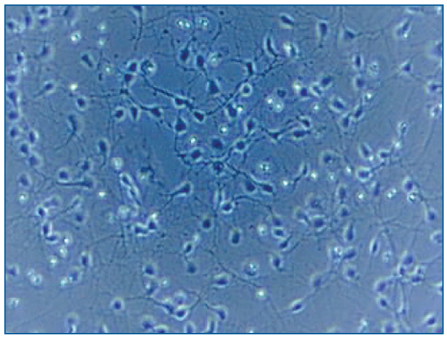


Intracellular Detection of Twist-1 by Flow Cytometry. The HeLa human cervical epithelial carcinoma cell line was stained with Fluorescein-conjugated Sheep Anti-Human Twist-1 Antigen Affinity-purified Polyclonal Antibody (Catalog # IC6230F; filled histogram) or Fluorescein-conjugated Sheep IgG Isotype Control (Catalog # IC016F; open histogram).

A.



B.



LRRTM3 Stimulates Neurite Outgrowth. Embryonic rat cortical neurons (E16) were cultured for 3 days in the absence (**A**) or in the presence (**B**) of immobilized Recombinant Human LRRTM3 (Catalog # 4898-LR) on a nitrocellulose-coated microplate. The presence of the LRRTM3 protein significantly enhanced neurite outgrowth.

For more information visit our website at
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