

SOX Family

SOX proteins make up a family of high-mobility group (HMG) domain transcription factors implicated in a variety of physiological and pathological processes, including development, cell reprogramming and tumorigenesis. So far, 20 different SOX genes have been discovered (see Schepers et al., 2002). Based on the HMG domain homology, SOX proteins are divided into different groups termed A to H (Figure 1). Within each group, individual SOX proteins share biochemical properties and have overlapping functions. In contrast, SOX factors from different groups have distinct biological functions despite recognizing the same DNA consensus motif (Wegner, 2010). The action of SOX proteins is often dependent on homo- or dimerization or interaction with other transcription factors.

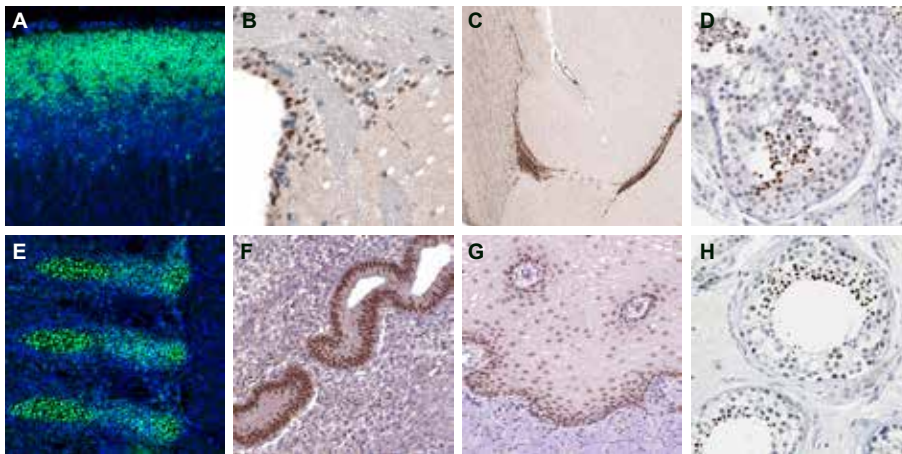


Figure 1.

Tissue expression of various SOX factors belonging to SOXB1-SOXH groups visualized using fluorescence or chromogenic immunohistochemistry: (A) SOX2 in mouse embryo E11 neural tube (AMAb91307), (B) SOX21 in mouse brain (AMAb91311), (C) SOX4 in mouse brain rostral migratory stream (AMAb91378), (D) SOX6 in human testis (HPA001923), (E) SOX9 in mouse embryo E14 cartilage, (F) SOX17 in human endometrium (HPA068399), (G) SOX15 in human esophagus (HPA067196), (H) SOX30 in human testis (HPA006159).

Nervous system

Many SOX factors are involved in the development of the nervous system. For example SOXB1 proteins are important for the early embryonic CNS development and are also expressed in adult neural stem cells. SOX2 is one of the essential transcription factors contributing to the embryonic stem cell state and further development of the central nervous system.

Figure 2 shows SOX2 immunoreactivity in the developing brain of the mouse embryo E11 (A) using Precisa Monoclonal antibody AMAb91307. The specificity of the antibody used for the staining was confirmed by WB (B) and ICC-IF (C) experiments.

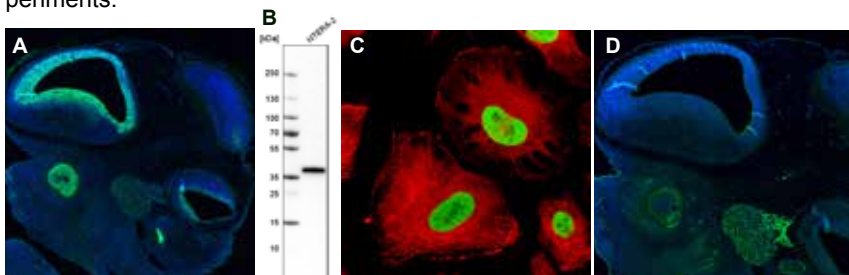


Figure 2.

SOX factors in nervous system development. (A) SOX2 expression in the developing forebrain, eye and trigeminal ganglion of mouse embryo E11 visualized by Anti-SOX2 antibody AMAb91307. (B) Western Blot with AMAb91307 displays a band of expected size in NTERA-2 cell lysate. (C) ICC-IF with AMAb91307 in U-251 MG cell line shows nuclear localization of the protein. (D) SOX10 expression in the developing trigeminal ganglion and sensory placodes of mouse embryo E11 visualized by Anti-SOX10 antibody AMAb91297.

SOXE proteins are involved in CNS gliogenesis, where for example SOX10 is essential for terminal oligodendrocyte differentiation in the CNS. In the peripheral nervous system, SOX10 is required for specification of all PNS glia.

Figure 2D shows SOX10 immunoreactivity in mouse embryo E11 (A) using Precisa Monoclonal antibody AMAb91297. Note that at this stage SOX10 is mainly expressed in the peripheral nervous system, e.g. trigeminal ganglion and sensory placodes.



The antibodies developed and characterized within the Human Protein Atlas project are made available to the scientific community by Atlas Antibodies under the brand name Triple A Polyclonals.

Precisa Monoclonals are developed by Atlas Antibodies, based on the knowledge from the Human Protein Atlas with careful antigen design and extended validation of antibody performance. With precise epitope information following all monoclonals, these precise, accurate and targeted antibodies are denoted Precisa Monoclonals.



Reproductive system

Another example of involvement of SOX factors in development is the reproductive system. SOX9 is expressed initially in the neural crest-competent cell population present in the dorsal neural tube (Cheung and Briscoe, 2003) (Figure 3A). Later in development, SOX9 is expressed in both male and female genital ridges up until the onset of Sry expression. Following this event, SOX9 expression becomes restricted to the male gonad, where it functions as a critical Sertoli cell differentiation factor (Figure 3B). Whereas SOX9 is restricted to somatic cells of the gonad, there is a second set of SOX proteins expressed in germ cells. Thus, group D proteins SOX5 and SOX6 are expressed in post-meiotic germ cells, with the highest levels in spermatids, as illustrated for SOX6 in Figure 3C.

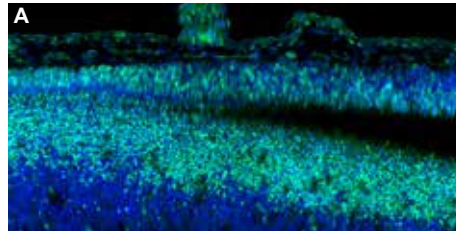
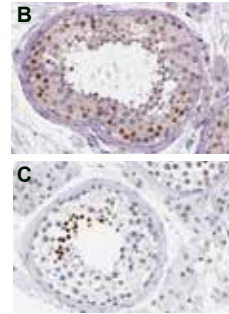


Figure 3. (A) SOX9 expression in the developing dorsal neural tube of mouse embryo E11 shown by IHC-IF with Anti-SOX9 AMAb90795. (B) SOX9 expression in adult human testis shown by IHC with Anti-SOX9 antibody HPA001758. (C) SOX6 expression in human testis visualized by Anti-SOX6 antibody HPA001923.



Tumorigenesis

Several SOX factors are also involved in tumorigenesis. For example upregulation of SOXD (SOX5, SOX6) proteins is observed in glioma (Figure 4A, SOX6), while mantle cell lymphoma can be diagnosed by overexpression of SOX11 protein (Figure 4B, C).

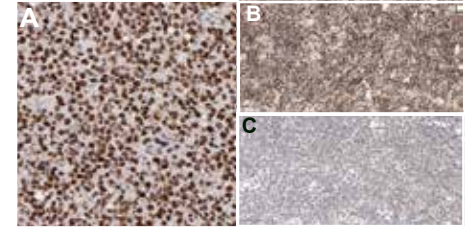


Figure 4. (A) IHC staining of human high grade glioma with Anti-SOX6 antibody HPA001923 shows strong nuclear immunoreactivity in tumor cells. (B) IHC staining of human mantle cell lymphoma with Anti-SOX11 antibody HPA000536 shows nuclear positivity in tumor cells. Compare to the absence of nuclear positivity in a control chronic lymphocytic leukemia shown in C.

Table 1.

Description of the SOX family antibodies available from Atlas Antibodies.

SOX Group	Product Name	Catalogue No	Application	Sequence Identity Mouse/Rat	Involved In
SOXB1	Anti-SOX2	AMAb91307	IHC, WB*, ICC-IF	99%/99%	Early embryonic development, Neural stem cells
	Anti-SOX2	HPA045725	WB*, ICC-IF	99%/99%	
	Anti-SOX3	AMAb91312	WB	82%/31%	Early neural development. Male sex development.
	Anti-SOX3	HPA054720	ICC-IF	93%/41%	
	Anti-SOX3	HPA075003	ICC-IF	76%/36%	
SOXB2	Anti-SOX21	AMAb91309	IHC, WB	100%/n.d.	Immature neurons. Progression of neuronal differentiation.
	Anti-SOX21	AMAb91311	IHC, WB	100%/n.d.	
	Anti-SOX21	HPA064084	ICC-IF	96%/37%	
SOXC	Anti-SOX4	HPA029901	IHC, ICC-IF	100%/39%	Neural lineage progression. Bone development. Tumorigenesis.
	Anti-SOX4	AMAb91378	IHC, ICC-IF	78%/n.d.	
	Anti-SOX4	AMAb91380	IHC, ICC-IF	78%/n.d.	
	Anti-SOX11	AMAb90501	IHC, WB*	82%/82%	CNS development. Tumorigenesis. Mantle cell lymphoma.
	Anti-SOX11	AMAb90502	IHC, WB	82%/82%	
	Anti-SOX11	HPA000536	IHC, WB	82%/82%	CNS, male and female tissues.
	Anti-SOX12	HPA055052	ICC-IF	96%/96%	
Anti-SOX12	HPA061627	ICC-IF	91%/91%		
SOXD	Anti-SOX5	HPA060499	WB, ICC-IF	91%/88%	Chondrogenesis. Tumorigenesis.
	Anti-SOX6	HPA001923	IHC, ICC-IF	96%/96%	Neural system development. Chondrogenesis. Maintenance of cardiac and skeletal muscle. Tumorigenesis.
	Anti-SOX6	HPA003908	IHC*, WB*	97%/95%	
	Anti-SOX6	AMAb91382	WB	84%/n.d.	
	Anti-SOX6	AMAb91383	IHC, ICC-IF	84%/n.d.	Embryonic development. Diabetes.
	Anti-SOX13	HPA051790	ICC-IF	87%/87%	
	Anti-SOX13	HPA054843	ICC-IF	93%/87%	
SOXE	Anti-SOX8	HPA058665	IHC*, ICC-IF	73%/70%	CNS, limb and facial development. Male sex determination.
	Anti-SOX9	AMAb90795	IHC, WB*, ICC-IF	97%/96%	Neural crest development, gliogenesis. Chondrocyte differentiation. Glioma.
	Anti-SOX9	HPA001758	IHC*, WB, ICC-IF	97%/96%	
	Anti-SOX10	AMAb91297	IHC, ICC-IF	98%/98%	Neural crest and peripheral nervous system development. Oligodendrocytes.
	Anti-SOX10	HPA068898	IHC*, ICC-IF	98%/98%	
SOXF	Anti-SOX7	HPA009065	IHC, WB	91%/91%	Hematopoietic/endothelial development. Suppression of tumorigenesis.
	Anti-SOX17	HPA068399	IHC*	89%/87%	Gut and heart development. Tumorigenesis.
	Anti-SOX18	HPA073703	ICC-IF	89%/89%	Hair, blood vessel, and lymphatic vessel development.
SOXG	Anti-SOX15	HPA067196	IHC*, ICC-IF	52%/52%	Muscle differentiation. Tumorigenesis.
	Anti-SOX15	HPA074049	ICC-IF	71%/36%	
SOXH	Anti-SOX30	HPA006159	IHC*, WB*	68%/70%	Differentiation of developing male germ cells.

* Products with enhanced validation for indicated application

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