Influenza Virus Types A and B

Influenza – or flu – is a respiratory illness that is caused by influenza viruses. Influenza viruses type A and type B cause seasonal epidemics in human beings on an annual basis. Furthermore, influenza A is also responsible for the pandemics that periodically appear, the most recent one being that which was caused by a H1N1 strain in 2009.

The illnesses range from mild to severe. According to WHO, the annual epidemics result in several million cases of severe illnesses and approximately 250,000 to 500,000 deaths per year worldwide. Severe cases and deaths mostly occur among the people in high-risk groups, e.g. young children, pregnant women, people aged over 65 years and those who suffer from certain medical conditions.

Influenza diagnostic tests are based on various technologies from viral isolation to immunodiagnostic and molecular diagnostic methods. Immunodiagnostic tests, especially rapid influenza diagnostic tests (RIDTs) that utilize monoclonal antibodies (MAbs) are often the test of choice due to their ease-of-use and low cost, although the sensitivities of the tests do vary significantly.

Biochemistry of influenza viruses type A and type B

The influenza viruses type A and type B are negative-sense single-stranded RNA viruses that belong to the family of *Orthomyxoviridae*. These enveloped viruses are usually spherical and 30-100 nm in diameter. The ssRNA is found in ribonucleoparticle complexes that are associated with RNA-dependent polymerase and nucleoprotein (NP). NP is a structural protein that is one of the main determinants of the virus type (A, B or C). Two other important antigens are haemagglutinin (HA) and neuraminidase (NA). Both of these are glycoproteins and they are found on the surface of the virus.

The influenza A viruses are divided into subtypes based on the variations in the HA and NA proteins. There are 18 known types of hemagglutinin and 11 known types of neuraminidase. H1N1 and H3N2 strains are currently circulating as seasonal influenza A viruses.

The influenza B viruses are not divided into subtypes. They are instead named after the areas where they were first identified.

Reagents for the development of immunoassays for the detection of influenza viruses

We provide a broad selection of MAbs with different specificities that enable the detection of influenza A and influenza B from clinical samples.

INFLUENZA A MONOCLONAL ANTIBODIES

We provide several highly sensitive and specific monoclonal antibodies for the detection of the influenza A virus. MAbs are suitable for common immunoassays such as direct or indirect ELISA and sandwich immunoassays. The antibodies are specific to either different hemagglutinin proteins or influenza A nucleoprotein and can be used to detect these antigens from different biological samples such as nasal aspirates and swabs, cell lysates etc. As MAbs do not have cross-reactivity to the influenza B virus they can be used for differentiation between influenza A and influenza B.

Latest MAbs specific to influenza A NP (Cat.# 3IN5)

The latest influenza A group virus antibodies were derived from several animal species including mice, rabbits, rat, and sheep. Rat and sheep antibodies were transferred into the recombinant chimeric format with human IgG constant domains. MAbs are suitable for the LF assay format with sensitivity of 0.5-1 ng/ml recombinant NP of influenza A. Recommendations for antibody pairs can be found in Table 1. The calibration curves for the recommended MAb pairs are shown in Figure 1.

All of the latest antibodies were developed to provide broad specificity to influenza A group virus and are capable of recognizing the native antigen which was tested on the viral lysates samples. Antibodies FA17, FA32, FA35, FA38, FA52, FA58, FA91, FA94 could recognize the following strains of influenza A virus:

1. A/California/07/2009(H1N1), both recombinant Nucleoprotein and viral lysate
2. A/Taiwan/1/1986(H1N1), viral lysate
3. A/Beijing/262/1995(H1N1), viral lysate
4. A/New Caledonia/20/1999(H1N1), viral lysate
5. A/Solomon Islands/03/2006(H1N1), viral lysate
6. A/Hong Kong/45/2019(H3N2), recombinant Nucleoprotein
7. A/Panama/2007/1999(H3N2), viral lysate
8. A/Wisconsin/67/2005(H3N2), viral lysate
9. A/Texas/50/2012(H3N2), viral lysate
10. A/Brisbane/10/2007(H3N2), viral lysate
11. A/Singapore/1/1957(H2N2), viral lysate
12. A/Tern/South Africa/1961 H5N3), recombinant Nucleoprotein
13. A/Mexico/InDRE7218/2012(H7N3), recombinant Nucleoprotein
14. A/chicken/Nakorn-Patom/Thailand/CU K2/2004(H5N1), recombinant Nucleoprotein
15. A/chicken/Hong Kong/NT142/2003(H9N2), recombinant Nucleoprotein
16. A/Anhui/1/2013(H7N9), recombinant Nucleoprotein

Testing was carried out using corresponding recombinant nucleoproteins or lysates of purified viral preparations.

All influenza A antibodies of this group were developed to provide lowest possible cross-reaction with influenza B virus. All antibodies are not cross-reactive to influenza B virus (Table 2).

Antibodies FA17, FA32, FA35, FA38, FA52, FA58, FA91, FA94 were also tested in indirect ELISA with preabsorbed 100 ng/well SARS-CoV-2 Nucleoprotein and demonstrated no cross-reaction (<0.05%).

Table 1.
Recommended pairs for influenza A NP sandwich immunoassay and lateral flow (capture-detection). Sensitivity to recombinant NP of Influenza A/California/07/2009(H1N1) is shown.

	Lateral flow (gold nanoparticles for detection); Sensitivity, ng/ml	Sandwich immunoassay (CLIA); Sensitivity (LOD), pg/ml
FA32-FA17	0.5	1.90
FA58-FA17	1	3.34
FA35-FA17	1	1.72
FA38-FA17	1	0.58
FA52-FA17	1	0.72
FA91-FA17	1	12.46
FA94-FA17	1	3.59

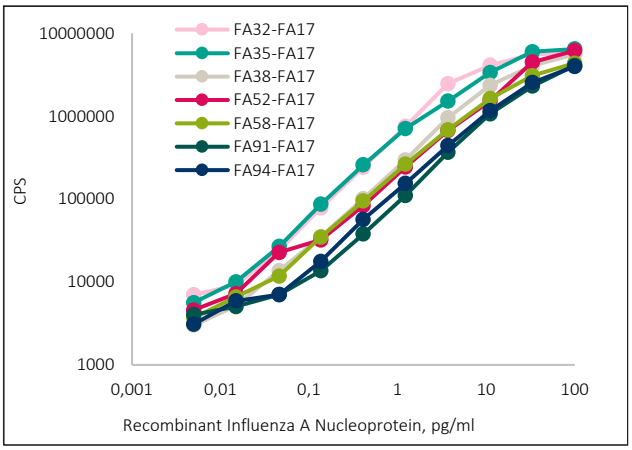

Figure 1.
Calibration curve for the recommended MAb pairs in plate-sandwich CLIA format. Recombinant Nucleoprotein of Influenza A/California/07/2009(H1N1) has been used as a calibrator. Detection MAbs were biotinylated. Streptavidin-polyHRP was used for detection. Incubation time with the antigen is 30 minutes.

Table 2.
Cross-reaction of the influenza A antibodies with influenza B virus. Cross-reaction was tested with lysates of purified viral preparations of Influenza B/Colorado/06/2017 in plate-sandwich CLIA format.
Detection MAb were biotinylated. Streptavidin-polyHRP was used for detection.

Recommended influenza A MAb pairs	Cross-reactivity to influenza B virus (%)
FA35-FA17	0.027%
FA52-FA17	0.042%
FA32-FA17	0.065%
FA38-FA17	0.059%
FA94-FA17	0.064%
FA58-FA17	0.052%
FA91-FA17	0.072%

Previous antibodies specific to influenza A NP (Cat.# 3IN5)

The antibodies were raised against a H1N1 strain. All of the MAbs detect NP with high specificity and do not cross-react with influenza B NP.

The original MAbs equally detect different strains of influenza A in ELISA. An example of a titration curve with the MAb InA108 is provided in Figure 2.

Quantitative NP sandwich immunoassays. We tested all the original MAbs as capture and detection antibodies in sandwich immunoassays. All of the pairs detect nucleoprotein of different influenza A strains. The recommended pairs InA108–InA245 and InA180–InA245 are able to detect the nucleoprotein equally in strains H1N1 and H3N2. The calibration curve for InA108–InA245 is provided in Figure 3.

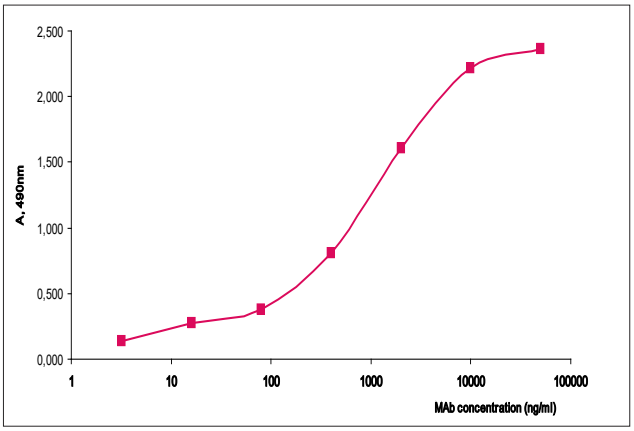

Figure 2.
Titration curve of the MAb InA108 that is specific to NP of the influenza A virus in indirect ELISA. Antigen: Influenza A/New Caledonia/20/99 (H1N1); 0.2 µg/well.

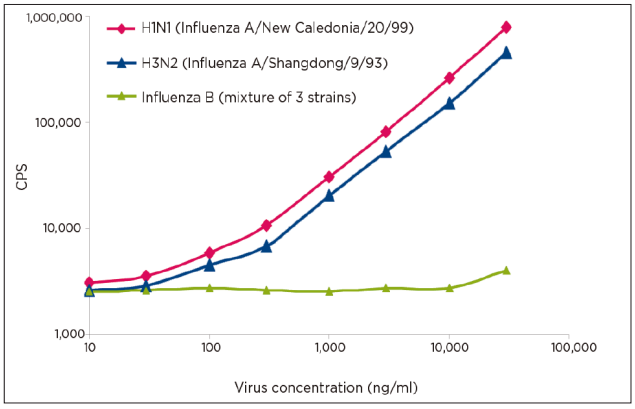

Figure 3.
A calibration curve for the influenza A sandwich fluoroimmunoassay using the MAb pair InA108-InA245 that is specific to the nucleoprotein of influenza A (Cat.# 3IN5). The antibody pair recognizes different influenza type A strains but does not detect influenza B strains.

MAb F8. Based on our studies, the MAb F8 recognizes an epitope that can be found in nucleoproteins of influenza type A with different antigenic structure and species origin. We investigated 25 strains of human and avian influenza virus A that had been isolated during different epidemics between 1934 and 1993 and a specific reaction was observed in all of the cases. In addition, we investigated 265 samples of nasal washings from children during influenza outbreaks using direct immunofluorescence. Sensitivity and specificity of the influenza virus A detection was 60% and 98.2% respectively. The titration curve of MAb F8 is shown in Figure 4.

NP immunodetection in Western blotting. The MAb InA108 can be used for the detection of NP in Western Blotting after SDS-PAGE in reducing conditions. The detection of two different influenza A strains with the MAb InA108 is shown in Figure 5.

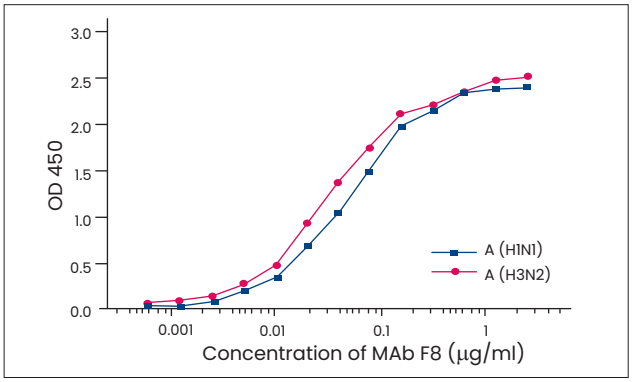

Figure 4.
Specific activity of the MAb F8 in ELISA with the purified virus antigens A H1N1 and H3N2.

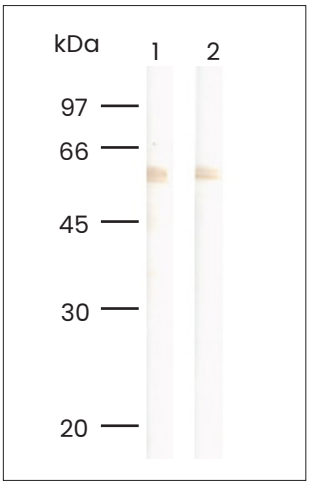

Figure 5.
Immunodetection of the influenza A viruses using anti-NP monoclonal antibody InA108 in Western blotting after SDS-PAGE in reducing conditions. Antigens 1 µg/well, MAb InA108 5 µg/ml. Anti-mouse IgG conjugated with HRP was used as the secondary antibody.
Lane 1 – Influenza A/NewCaledonia/20/99 (H1N1).
Lane 2 – Influenza A/Shangdong/9/93 (H3N2).

Antibodies specific to influenza A H3 (Cat.# 3HG3)

We provide two MAbs that are specific to hemagglutinin H3. The antibodies were raised against the purified influenza A strain A/Shangdong/9/93 (H3N2).

MAbs that are specific to H3 are able to detect a H3N2 strain in direct and indirect ELISA but do not detect a H1N1 strain. Titration curves of the MAb InA246 with two different influenza A strains are provided in Figure 6.

Antibodies specific to influenza A H7 (Cat.# 3HI7)

We provide three MAbs that are specific to H7. The antibodies were raised against purified influenza A/Netherlands/219/03 H7N7 virus. All of the MAbs detect influenza A H7 hemagglutinin in direct and indirect ELISA. We investigated the cross-reactivity of the MAbs to other influenza A H subtypes: influenza A H1N1 (strain A/New Caledonia/20/99), influenza A H2N2 (strain A/Japan/305/57), influenza A H3N2 (strain A/Panama/2007/99), as well as to the parainfluenza virus (type 1 Sendai). All of the MAbs demonstrated high specificity to H7 and did not bind to other tested viruses. Cross-reactivity data with the MAb InA334 is provided in Figure 7 and show that the antibody only reacts with H7.

H7 quantitative sandwich immunoassay. All of the MAbs were tested in sandwich type immunoassays as either capture or detection MAbs. The best pairs of MAbs were selected based on their ability to detect influenza A H7 with high sensitivity using the purified strain of Influenza A/Netherlands/219/03 H7N7 and recombinant H7 as antigens. We recommend using the pairs InA334–InA331 and InA334–InA414. The calibration curves for InA334–InA331 are provided in Figure 8.

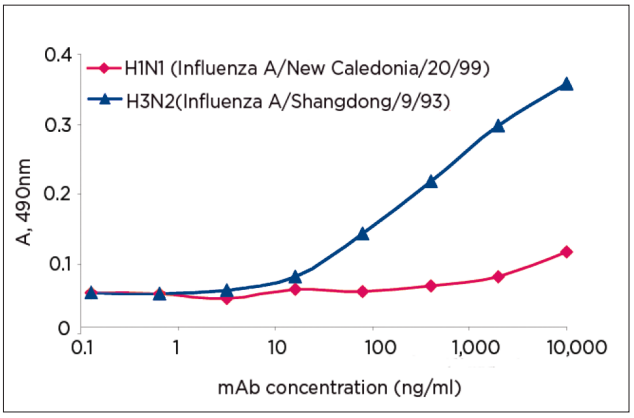

Figure 6.
Titration curves of the MAb InA246 that is specific to hemagglutinin H3.

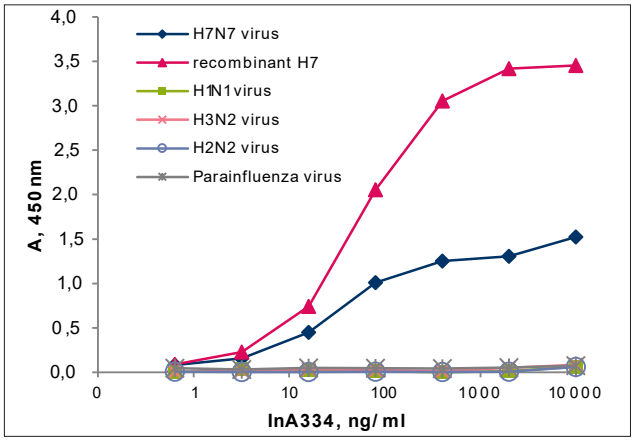

Figure 7.
Titration curve of the MAb InA334 that is specific to haemagglutinin H7 in indirect ELISA. Viral antigens 200 ng/well and recombinant H7 (A/Chicken/Netherlands/1/03; a.a.r. 17-527) 10 ng/well.

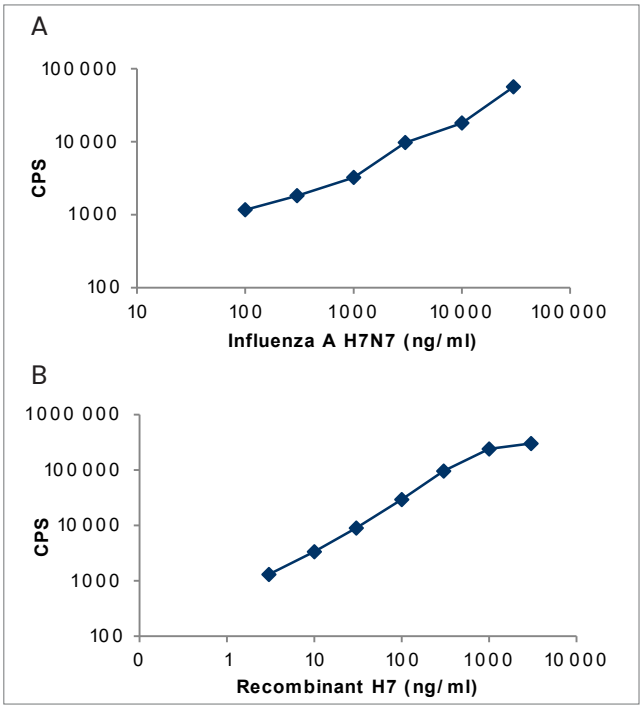

Figure 8.
Calibration curves for influenza A haemagglutinin H7 in sandwich fluoroimmunoassays.
Capture MAb: InA334 (1 µg/well)
Detection MAb: Eu^{3+} labelled InA331 (0.1 µg/well)
Incubation time: 45 min
A) Influenza A/Netherlands/219/03 (H7N7)
B) Recombinant H7 (A/Chicken/Netherlands/1/03; a.a.r. 17-527)

ORDERING INFORMATION

MONOCLONAL ANTIBODIES

Product name	Cat. #	MAb	Subclass	Remarks
Influenza A nucleoprotein	3IN5	FA17	IgG1	In vitro, EIA, LF, CLIA, WB
		FA32	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		FA35	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		FA38	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		FA52	IgG1	EIA, LF, CLIA, WB, recombinant chimeric antibody
		FA58	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		FA91	IgG1	EIA, LF, CLIA, WB, recombinant chimeric antibody
		FA94	IgG1	EIA, LF, CLIA, WB, recombinant chimeric antibody
		F8	IgG2a	EIA, IHC
		InA108	IgG1	EIA, WB
		InA180	IgG3	EIA
		InA224	IgG1	EIA
		InA245	IgG2b	EIA, WB
Influenza A haemagglutinin	3IH4	C102	IgG1	EIA, IF, HIT, IHC, haemagglutinin H1
Influenza A haemagglutinin H1	3AH1	InA97	IgG1	EIA, WB
		InA134	IgG1	EIA, WB
		InA139	IgG1	EIA, WB
Influenza A haemagglutinin H3	3HG3	InA227	IgG1	EIA, WB
		InA246	IgG2a	EIA, WB
Influenza A haemagglutinin H7	3HI7	InA331	IgG1	EIA
		InA334	IgG1	EIA
		InA414	IgG2b	EIA

INFLUENZA B MONOCLONAL ANTIBODIES

The influenza B virus genome encodes 11 viral proteins. Among these proteins, nucleoprotein (NP) is one of the most conserved between different species of the influenza B subfamily which makes it a good target for the diagnosis of influenza B viral infection. The influenza B NP sequence possesses up to 40% identity with its closest relative – NP of influenza A – and at the same time the NP B has a unique N-terminal part containing 50 amino acids. Together, this makes it possible to create highly specific MAbs that are capable of only detecting influenza B NP.

Hytest offers two series of MAbs that target the influenza B NP.

Latest MAbs specific to influenza B NP (Cat. # 3IF18)

The latest antibodies were derived from several kinds of animals, specifically mice, rats, and sheep. All of them except the mouse MAbs are transferred into the recombinant chimeric format with human IgG constant domains. MAbs are suitable for the lateral flow (LF) assay format with sensitivity against the recombinant antigen below 0,5 ng/ml. Recommendations for antibody pairs can be found in Table 4. The calibration curve for the MAb pair IB91-IB57 is shown in Figure 9. Additionally, Figure 10 displays the calibration curves for three MAb pairs, which are respectively from the latest series and the original series of MAbs specific to influenza B NP. All of the latest antibodies are capable of recognizing the native antigen which was tested on the viral lysates samples; the viral lysates titration graph of MAb pair IB44-IB91 is shown in Figure 11. Finally, the cross-reactivity of new MAb pairs is below the level of 0.15% (typically 0.06-0.04%) when comparing the signals for the 10 μg/ml of influenza A NP and influenza B NP.

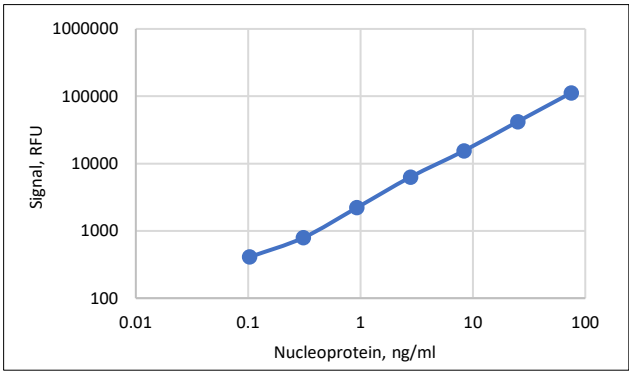

Figure 9.
Calibration curve for MAb pair IB91-IB57 taken in plate-sandwich immunoassay format. Detection MAb was conjugated with Eu^{3+}-chelate. Recombinant influenza B nucleoprotein has been used as a calibrator. Incubation time with antigen is 5 minutes.

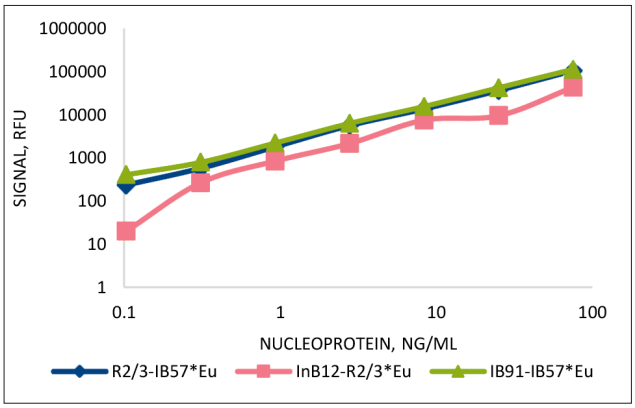

Figure 10.
Calibration curve for MAb pairs R2/3-IB57, InB12-R2/3 and IB91-IB57 taken in plate-sandwich immunoassay format. Detection MAbs were conjugated with Eu^{3+}-chelate. Recombinant influenza B nucleoprotein has been used as a calibrator. Incubation time with the antigen is 5 minutes.

Table 4.
Recommended pairs for influenza B NP sandwich immunoassay.

	Lateral Flow (Gold nanoparticles for detection	Sandwich immunoassay
IB76-IB71	++	++
IB70-IB71	++	++
IB71-IB91	++	++
IB87-IB91	+	++
IB91-IB71	++	++
IB44-IB91	++	++
IB91-IB57	+	++
InB12-InB27		+
InB12-InB64		+
InB36-InB64		+

*The presence of a greater number of '+' symbols signifies increased efficacy in the corresponding assay platform.
*Other effective combinations are also possible.

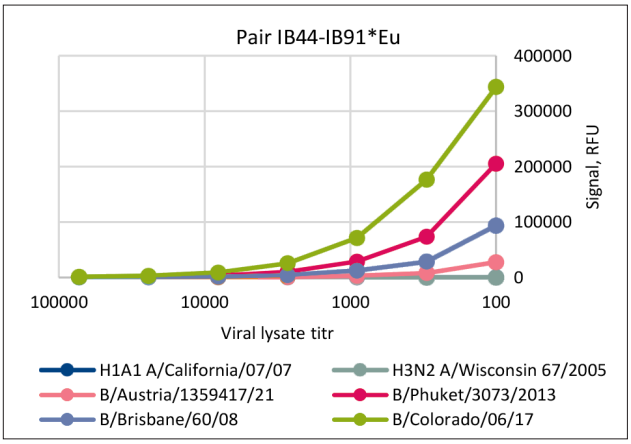

Figure 11.
Titration curves of the viral lysate samples of different strains of influenza A and influenza B viruses, obtained in sandwich immunoassay. For the MAb pair IB44-IB91, detection MAbs are conjugated with Eu^{3+}-chelates. Diluted samples of viral lysates were added together with the detection MAbs in the wells with preabsorbed capture MAbs. Incubation time with the antigen is 30 min.

Original antibodies specific to the influenza B NP (Cat. # 3IF18 and RIF17)

MAbs (Cat. # 3IF18) raised against the purified influenza virus type B are highly specific to the influenza B NP, showing no cross-reactivity with the influenza A NP or other viral proteins tested. The low detection limit of our MAbs enables the detection of the virus even in samples with a low influenza B titer. Furthermore, these MAbs are suitable for use in LF. Recommendations for MAb pairs are provided in Table 5. These are selected for their ability to detect various influenza B strains and recombinant influenza B NP with equal specificity and high sensitivity. The strains tested include Influenza B/Leningrad/86/93, Influenza B/Tokyo/53/99 and Influenza B/Victoria/504/00.

MAb R2/3 (Cat. # RIF17) is produced *in vitro*. The antibody detects the NP of the virus, and it has been tested with several influenza B strains (see Figure 12). No cross-reactivity was detected when it was tested with nine influenza A strains, three parainfluenza strains, adenovirus (type 6) or respiratory syncytial virus.

The original antibodies from Cat.# 3IF18 and RIF17 detect the NP of influenza B in Western blotting after SDS-PAGE in reducing and non-reducing conditions.

Table 5.
Antibody pair recommendations for influenza B NP sandwich immunoassays.

Capture	Detection
InB12	InB27
InB12	InB64
InB36	InB64

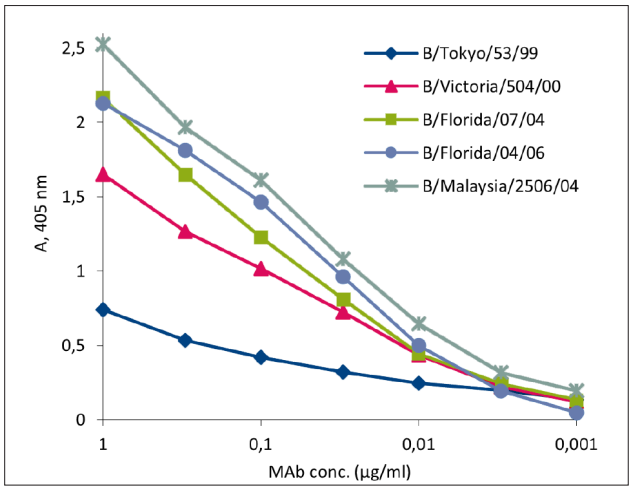

Figure 12.
A direct ELISA analysis of the anti-influenza B group antigen (Cat.# RIF17) with different influenza B strains. Antigens were absorbed to the plate in 5 µg/ml concentration and antibody binding was tested using a dilution series of the antibody from 1 µg/ml to 1 ng/ml concentration.

ORDERING INFORMATION

MONOCLONAL ANTIBODIES

Product name	Cat. #	MAb	Sub-class	Remarks
Influenza B group antigen	3IF18	IB44	IgG1	EIA, LF, CLIA, WB, recombinant chimeric antibody
		IB57	IgG1	EIA, LF, CLIA, WB, recombinant chimeric antibody
		IB70	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		IB71	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		IB76	IgG1	*In vitro*, EIA, LF, CLIA, WB
		IB87	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		IB91	IgG	EIA, LF, CLIA, WB, recombinant rabbit antibody
		InB12	IgG2b	EIA, WB, nucleoprotein
		InB27	IgG1	EIA, WB, nucleoprotein
		InB36	IgG1	EIA, WB, nucleoprotein
		InB64	IgG1	EIA, WB, nucleoprotein
		InB114	IgG1	EIA, WB, nucleoprotein
		InB204	IgG1	EIA, WB, nucleoprotein
		InB210	IgG1	EIA, WB, nucleoprotein
		InB213	IgG1	EIA, WB, nucleoprotein
	RIF17	R2/3	IgG2a	*In vitro*, EIA, WB, nucleoprotein
Influenza B haemagglutinin	3BH9	InB18	IgG2a	EIA, WB, haemagglutinin 2 (HA2)
		InB190	IgG2b	EIA, WB, haemagglutinin 2 (HA2)
Influenza B matrix protein M1	3BM17	InB4	IgG1	EIA, WB

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