

Primerdesign™ Ltd

# Adenovirus F41

Hexon gene

genesig® Advanced Kit

150 tests

GENESIG

Kits by Primerdesign

For general laboratory and research use only

# Introduction to Adenovirus F41

Adenoviruses are non-enveloped, icosahedral, 90–100 nm viruses with a linear, double-stranded DNA genome spanning 26–45 kb (Davison et al., 2003; Saha & Parks, 2020). Adenoviruses represent the largest nonenveloped viruses, because they are the maximum size able to be transported through the endosome (i.e. envelope fusion is not necessary). The virion also has a unique "spike" or fibre associated with each penton base of the capsid (see picture below) that aids in attachment to the host cell via the coxsackie-adenovirus receptor on the surface of the host cell. Divided into seven species (A to G), there are more than 100 subtypes of human adenovirus (Yang et al., 2021; Bányai et al., 2009).

Adenoviruses are unusually stable to chemical or physical agents and adverse pH conditions, allowing for prolonged survival outside of the body and water. Adenoviruses are primarily spread via respiratory droplets, however they can also be spread by fecal routes as well.

In October 2021, five paediatric patients in Alabama, US, were diagnosed with hepatitis. The cases tested positive for adenovirus and negative for hepatitis A, hepatitis B, and hepatitis C viruses. The cause of the infection was unknown at the time (CDC 2022). Subsequently, the CDC saw more paediatric patients of unknown causes in various countries. The UK reported 260 cases of acute non-A-E hepatitis in children under 16 between 1 January 2022 and 13 June 2022 (UK Health Security Agency 2022). Several working hypotheses for the cause of hepatitis are under investigation, including the role of adenoviruses, the potential role of SARS-CoV-2 and investigating toxicological studies (UK Health Security Agency 2022). Ongoing clinical investigations involve the NHS and public health departments (UK Health Security Agency 2022a). The current leading hypotheses involve adenovirus (UK Health Security Agency 2022b). Adenovirus was detected in 64.7% of the cases tested (156/241 cases) (UK Health Security Agency 2022b). Adenovirus species F serotype 41 was most commonly present in the blood samples of the hepatitis cases (found in 77% of cases; 27/35) and detected by sequencing of a partial region of the hexon gene (UK Health Security Agency 2022).

The Primerdesign genesig advanced kit for Adenovirus F41 kit is designed for the in vitro quantification of adenovirus species F serotype 41 genomes.

Bányai, Krisztián, Vito Martella, Edina Meleg, Péter Kisfali, Zoltán Peterfi, Mária Benkő, Béla Meleg, and György Szuics. 2009. "Searching for HAdV-52, the Putative Gastroenteritis-Associated Human Adenovirus Serotype in Southern Hungary." *New Microbiologica* 32 (2).

CDC. 2022. "Children with Hepatitis of Unknown Cause." CDC Website. 2022. <https://www.cdc.gov/ncird/investigation/hepatitis-unknown-cause/overview-what-to-know.html>.

Davison, Andrew J., Mária Benko, and Balázs Harrach. 2003. "Genetic Content and Evolution of Adenoviruses." *Journal of General Virology*. <https://doi.org/10.1099/vir.0.19497-0>.

Saha, Bratati, and Robin J. Parks. 2020. "Recent Advances in Novel Antiviral Therapies against Human Adenovirus." *Microorganisms*. <https://doi.org/10.3390/microorganisms8091284>.

UK Health Security Agency. 2022. "Investigation into Acute Hepatitis of Unknown Aetiology in Children in England May 2022." May 2022.

UK Health Security Agency. 2022. "Investigation into Acute Hepatitis of Unknown Aetiology in Children in England: Case Update Updated 17 June 2022." <https://www.gov.uk/government/publications/acute-hepatitis-technical-briefing/investigation-into-acute-hepatitis-of-unknown-aetiology-in-children-in-england-case-update>.

Yang, Chuanyu, Chunmei Zhu, Yuan Qian, Jie Deng, Baoyuan Zhang, Runan Zhu, Fang Wang, et al. 2021. "Application of Human Adenovirus Genotyping by Phylogenetic Analysis in an Outbreak to Identify Nosocomial Infection." *Virologica Sinica* 36 (3). <https://doi.org/10.1007/s12250-020-00299-y>.

# Specificity

The Primerdesign genesig Advanced Kit for Adenovirus F41 is designed for the quantitative and qualitative detection of the Adenovirus genome from DNA extracted from samples.

The Primerdesign genesig Advanced Kit for Adenovirus F41 is configured for use with any real-time PCR instrument equipped to detect amplification in the FAM and VIC/HEX channels.

The kit is designed to have a broad detection profile. Specifically, the primers represent 100% homology with over 95% of the NCBI database reference sequences of Adenovirus F41 available at the time of design (June 2022).

The dynamics of genetic variation mean that new sequence information may become available after the initial design. Primerdesign periodically reviews the detection profiles of our kits and when required releases new versions.

If you require further information or have a specific question about the detection profile of this kit then please send an email to [enquiry@primerdesign.co.uk](mailto:enquiry@primerdesign.co.uk) and our bioinformatics team will answer your question.

# Kit contents

**Adenovirus F41 specific primer/probe mix (150 reactions BROWN)**  
FAM labelled

**Adenovirus F41 positive control template (for Standard curve RED)**

**Internal extraction control primer/probe mix (150 reactions BROWN)**  
VIC labelled as standard

**Internal extraction control DNA (150 reactions BLUE)**

**Endogenous control primer/probe mix (150 reactions BROWN)**  
FAM labelled

**RNase/DNase-free water (WHITE)**  
for resuspension of primer/probe mixes

**Template preparation buffer (YELLOW)**  
for resuspension of internal control template, positive control template and standard curve preparation

## Reagents and equipment to be supplied by the user

**Real-time PCR Instrument**

### **Extraction kit**

This kit is recommended for use with genesig Easy DNA/RNA extraction kit. However, it is designed to work well with all processes that yield high-quality DNA with minimal PCR inhibitors.

### **oasig™ lyophilised or Precision® PLUS 2X qPCR Master Mix**

This kit is intended for use with oasig or PrecisionPLUS 2X qPCR Master Mix.

**Pipettors and Tips**

**Vortex and centrifuge**

**Thin-walled 0.1 ml PCR reaction tubes or plates compatible with instrument used**

## Kit storage and stability

This kit is stable at room temperature but should be stored at -20°C on arrival. Once the lyophilised components have been resuspended, they should not be exposed to temperatures above -20°C for longer than 30 minutes at a time and unnecessary repeated freeze/thawing should be avoided. The kit is stable for six months from the date of resuspension under these circumstances.

If a standard curve dilution series is prepared for quantitative detection, this can be stored frozen for an extended period. If you see any degradation in this serial dilution a fresh standard curve can be prepared from the positive control.

Primerdesign does not recommend using the kit after the expiry date stated on the pack.

## Suitable sample material

All kinds of sample material suited for PCR amplification can be used. Please ensure the samples are suitable in terms of purity, concentration, and DNA integrity. Always run at least one negative control with the samples. To prepare a negative control, replace the template DNA sample with RNase/DNase-free water.

## Dynamic range of test

Under optimal PCR conditions, genesig detection kits have very high priming efficiencies of >90% and can detect less than 100 copies of the target template.

## Notices and disclaimers

This product is developed, designed and sold for research purposes only. It is not intended for human diagnostic or drug purposes or to be administered to humans unless clearly expressed for that purpose by the Food and Drug Administration in the USA or the appropriate regulatory authorities in the country of use. During the warranty period, Primerdesign genesig detection kits allow precise and reproducible data recovery combined with excellent sensitivity. For data obtained by violation of the general GLP guidelines and the manufacturer's recommendations the right to claim under guarantee is expired. PCR is a proprietary technology covered by the several US and foreign patents. These patents are owned by Roche Molecular Systems Inc. and have been sub-licensed by PE Corporation in certain fields. Depending on your specific application you may need a license from Roche or PE to practice PCR. Additional information on purchasing licenses to practise the PCR process may be obtained by contacting the Director of Licensing at Roche Molecular Systems, 1145 Atlantic Avenue, Alameda, CA 94501 or Applied Biosystems business group of the Applera Corporation, 850 Lincoln Centre Drive, Foster City, CA 94404. In addition, the 5' nuclease assay and other homogeneous amplification methods used in connection with the PCR process may be covered by US Patents 5,210,015 and 5,487,972, owned by Roche Molecular Systems, Inc, and by U.S. Patent 5,538,848, owned by The Perkin-Elmer Corporation.

## Trademarks

Primerdesign™ is a trademark of Primerdesign Ltd. genesig® is a registered trademark of Primerdesign Ltd. The PCR process is covered by US Patents 4,683,195, and 4,683,202 and foreign equivalents owned by Hoffmann-La Roche AG. BI, ABI PRISM®, GeneAmp® and MicroAmp® have registered trademarks of the Applera Genomics (Applied Biosystems Corporation). BIOMEK® is a registered trademark of Beckman Instruments, Inc.; iCycler™ is a registered trademark of Bio-Rad Laboratories, Rotor-Gene is a trademark of Corbett Research. LightCycler™ is a registered trademark of the Idaho Technology Inc. GeneAmp®, TaqMan® and AmpliTaqGold® are registered trademarks of Roche Molecular Systems, Inc., The purchase of the Primerdesign reagents cannot be construed as an authorization or implicit license to practise PCR under any patents held by Hoffmann-La Roche Inc.

# Principles of the test

## Real-time PCR

An Adenovirus F41 specific primer/probe mix is provided and this can be detected through the FAM channel.

The primer/probe mix provided exploits with the so-called TaqMan® principle. During PCR amplification, forward and reverse primers hybridize to the Adenovirus F41 viral DNA. A fluorogenic probe is included in the same reaction mixture which consists of a DNA probe labelled with a 5'-dye and a 3'-quencher. During PCR amplification, the probe is cleaved, and the reporter dye and quencher are separated. The resulting increase in fluorescence can be detected on a range of qPCR platforms.

## Positive control – quantitative versus qualitative analysis

For copy number determination and as a positive control for the PCR set-up, the kit contains a positive control template. This can be used to generate a standard curve of the Adenovirus F41 copy number/Cq value. Alternatively, the positive control can be used at a single dilution where full quantitative analysis of the samples is not required, hence making the tests in that run purely qualitative.

Each time the kit is used, at least one positive control reaction must be included in the run. A positive result indicates that the primers/probes for detecting the target Adenovirus F41 genome worked properly in that particular experimental scenario. If a negative result is obtained the test results are invalid and must be repeated. Care should be taken to ensure that the positive control does not contaminate any other kit component which would lead to false-positive results. This can be achieved by handling this component in a Post PCR environment. Care should also be taken to avoid cross-contamination of other samples when adding the positive control to the run. This can be avoided by sealing all other samples and negative controls before pipetting the positive control into the positive control well.

## Negative control

To validate any positive findings a negative control reaction should be included every time the kit is used. For this reaction, RNase/DNase-free water should be used instead of the template. A negative result indicates that the reagents have not become contaminated while setting up the run.

## Internal DNA extraction control

When performing DNA extraction, it is often advantageous to have an exogenous source of DNA template that is spiked into the lysis buffer. This control DNA is then co-purified with the sample DNA and can be detected as a positive control for the extraction process. Successful co-purification and qPCR for the control DNA also indicate that PCR inhibitors are not present at a high concentration.

A separate primer/probe mix is supplied with this kit to detect the exogenous DNA using qPCR. The primers are present at PCR limiting concentrations which allows multiplexing with the target sequence primers. Amplification of the control DNA does not interfere with the detection of the Adenovirus F41 target DNA even when present at a low copy number. The Internal control is detected through the VIC channel and gives a Cq value of 28+/-3.

## Endogenous control

To confirm the extraction of a valid biological template, a primer/probe mix is included to detect an endogenous gene. Detection of the endogenous control is through the FAM channel, and it is NOT therefore possible to perform a multiplex with the Adenovirus F41 primers. A poor endogenous control signal may indicate that the sample did not contain sufficient biological material.

# Resuspension Protocol

To minimize the risk of contamination with foreign DNA, we recommend that all pipetting be performed in a PCR clean environment. Ideally, this would be a designated PCR lab or PCR cabinet. Filter tips are recommended for all pipetting steps.

**1. Pulse-spin each tube in a centrifuge before opening.**

This will ensure that the lyophilised primer/probe mix is in the base of the tube and is not spilt upon opening the tube.

**2. Resuspend the kit components in the RNase/DNase-free water supplied, according to the table below.**

To ensure complete resuspension, vortex each tube thoroughly

Component - resuspend in water	Volume
Adenovirus F41 primer/probe mix (BROWN)	165 µl
Internal extraction control primer/probe mix (BROWN)	165 µl
Endogenous control primer/probe mix (BROWN)	165 µl

**1. Resuspend the internal control template and positive control template in the template preparation buffer supplied, according to the table below:**

To ensure complete resuspension, vortex each tube thoroughly.

Component - resuspend in template preparation buffer	Volume
Internal extraction control DNA (BLUE)	600 µl
Adenovirus F41 Positive Control Template (RED) *	500 µl

\* This component contains a high copy number template and is a VERY significant contamination risk. It must be opened and handled in a separate laboratory environment, away from the other components.

## DNA extraction

The internal extraction control DNA can be added either to the DNA lysis/extraction buffer or to the DNA sample once it has been resuspended in the lysis buffer.

**DO NOT add the internal extraction control DNA directly to the unprocessed biological sample as this will lead to degradation and a loss in signal.**

**1. Add 4 µl of the Internal extraction control DNA (BLUE) to each sample in DNA lysis/extraction buffer per sample.**

**2. Complete DNA extraction according to the manufacturer's protocols.**

# qPCR detection protocol

- 1. For each DNA sample prepare a reaction mix according to the table below:**  
Include sufficient reactions for positive and negative controls.

Component	Volume
oasig or PrecisionPLUS 2X qPCR Master Mix	10 µl
Adenovirus F41 primer/probe mix (BROWN)	1 µl
Internal extraction control primer/probe mix (BROWN)	1 µl
RNase/DNase-free water (WHITE)	3 µl
<b>Final Volume</b>	<b>15 µl</b>

- 2. For each DNA sample prepare an endogenous control reaction according to the table below (Optional):**  
This control reaction will provide useful information regarding the quality of the biological sample.

Component	Volume
oasig or PrecisionPLUS 2X qPCR Master Mix	10 µl
Endogenous control primer/probe mix (BROWN)	1 µl
RNase/DNase-free water (WHITE)	4 µl
<b>Final Volume</b>	<b>15 µl</b>

- 3. Pipette 15 µl of each mix into individual wells according to your qPCR experimental plate set-up.**
- 4. Prepare sample DNA templates for each of your samples.**
- 5. Pipette 5 µl of DNA template into each well, according to your experimental plate set up.**  
For negative control, wells use 5 µl of RNase/DNase-free water. The final volume in each well is 20 µl.
- 6. If a standard curve is included for quantitative analysis, prepare a reaction mix according to the table below:**

Component	Volume
oasig or PrecisionPLUS 2X qPCR Master Mix	10 µl
Adenovirus F41 primer/probe mix (BROWN)	1 µl
RNase/DNase-free water (WHITE)	4 µl
<b>Final Volume</b>	<b>15 µl</b>

## 7. Preparation of a standard curve dilution series.

- Pipette 90 µl of template preparation buffer into 5 tubes and label 2-6
- Pipette 10 µl of Positive Control Template (**RED**) into tube 2
- Vortex thoroughly
- Change pipette tip and pipette 10 µl from tube 2 into tube 3
- Vortex thoroughly

Repeat steps d and e to complete the dilution series.

Standard Curve	Copy Number
Tube 1 Positive control ( <b>RED</b> )	$2 \times 10^5$ per µl
Tube 2	$2 \times 10^4$ per µl
Tube 3	$2 \times 10^3$ per µl
Tube 4	$2 \times 10^2$ per µl
Tube 5	20 per µl
Tube 6	2 per µl

## 8. Pipette 5 µl of the standard template into each well for the standard curve according to your experimental plate set-up.

The final volume in each well is 20 µl.

## qPCR amplification protocol

Amplification conditions using oasis or PrecisionPLUS 2X qPCR Master Mix.

	Step	Time	Temp
	Enzyme activation	2 min	95°C
Cycling x50	Denaturation	10 s	95°C
	DATA COLLECTION *	60 s	60°C

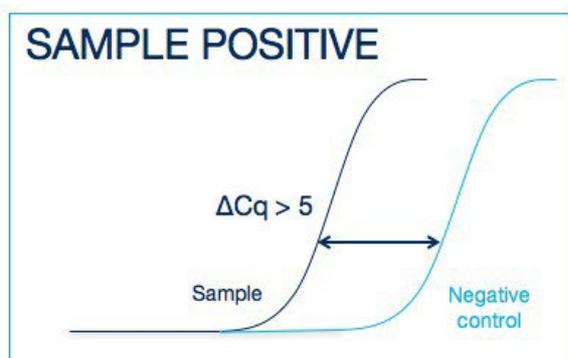
\* Fluorogenic data should be collected during this step through the FAM and VIC/HEX channels

## Interpretation of results

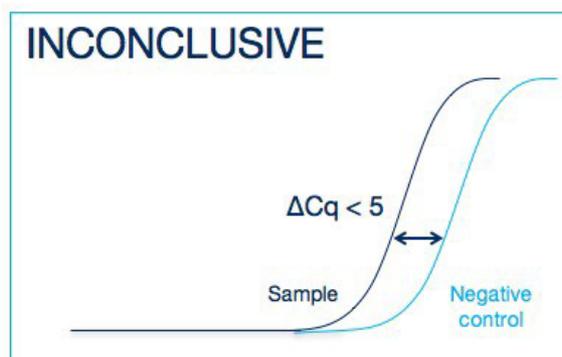
Target (FAM)	Internal control (VIC)	Positive control	Negative control	Interpretation
$\leq 30$	+ / -	+	-	<b>POSITIVE QUANTITATIVE RESULT</b> calculate copy number if standard curve used
$> 30$	+	+	-	<b>POSITIVE QUANTITATIVE RESULT</b> calculate copy number if standard curve used
$> 30$	-	+	-	<b>POSITIVE QUALITATIVE RESULT</b> do not report the copy number as this may be due to poor sample extraction
-	+	+	-	<b>NEGATIVE RESULT</b>
+ / -	+ / -	+	$\leq 35$	<b>EXPERIMENT FAILED</b> due to test contamination
+ / -	+ / -	+	$> 35$	*
-	-	+	-	<b>SAMPLE PREPARATION FAILED</b>
+ / -	+ / -	-	+ / -	<b>EXPERIMENT FAILED</b>

A positive control template (**RED**) is expected to amplify between Cq 16 and 23. Failure to satisfy this quality control criterion is a strong indication that the experiment has been compromised.

\*Where the test sample is positive and the negative control is positive with a Cq  $> 35$ , the sample must be reinterpreted based on the relative signal strength of the two results:



If the sample amplifies  $> 5$  Cq earlier than the negative control, then the sample should be reinterpreted (via the table above) with the negative control verified as negative.



If the sample amplifies  $< 5$  Cq earlier than the negative control, then the positive sample result is invalidated, and the result should be determined inconclusive due to test contamination. The test for this sample should be repeated.

**Internal PCR control**

The Cq value obtained with the internal control will vary significantly depending on the extraction efficiency, the quantity of DNA added to the PCR reaction and the individual machine settings. Cq values of  $28 \pm 3$  are within the normal range. When amplifying an Adenovirus F41 sample with a high genome copy number, the internal extraction control may not produce an amplification plot. This does not invalidate the test and should be interpreted as a positive experimental result.

**Endogenous control**

The signal obtained from the endogenous control primer/probe set will vary according to the amount of biological material present in a given sample. An early signal indicates the presence of a good yield of biological material. A late signal suggests that little biological material is present in the sample.