

MagMAX™ Viral RNA Isolation Kit

(Cat #AM1939)

Instruction Manual

I.	Introduction	1
	A. Product Description	
	B. Overview of the Procedure	
	C. Kit Components and Storage Conditions	
	D. Required Materials Not Provided With the Kit	
	E. Related Products Available from Ambion	
II.	MagMAX Viral RNA Isolation Protocol	5
	A. Equipment and Reagent Preparation	
	B. RNA Isolation Protocol	
	C. Analyzing Viral RNA and DNA	
III.	Troubleshooting	10
	A. Poor Viral Nucleic Acid Detection	
	B. Sample-to-Sample Variation in RNA/DNA Yield	
	C. RNA Binding Bead Carryover	
IV.	Appendix	13
	A. References	
	B. MagMAX Viral RNA Isolation Kit Specifications	
	C. Quality Control	

Manual 1939M Revision D

Revision Date: January 4, 2008

For research use only. Not for use in diagnostic procedures. By use of this product, you accept the terms and conditions of all applicable Limited Label Licenses. For statement(s) and/or disclaimer(s) applicable to this product, see below.

Information in this document is subject to change without notice. Applied Biosystems assumes no responsibility for any errors that may appear in this document.

Applied Biosystems disclaims all warranties with respect to this document, expressed or implied, including but not limited to those of merchantability or fitness for a particular purpose. In no event shall Applied Biosystems be liable, whether in contract, tort, warranty, or under any statute or on any other basis for special, incidental, indirect, punitive, multiple or consequential damages in connection with or arising from this document, including but not limited to the use thereof.

Literature Citation: When describing a procedure for publication using this product, we would appreciate that you refer to it as the MagMAX™ Viral RNA Isolation Kit.

If a paper that cites one of Ambion's products is published in a research journal, the author(s) may receive a free Ambion T-shirt by sending in the completed form at the back of this instruction manual, along with a copy of the paper.

Warranty and Liability: Applied Biosystems is committed to delivering superior product quality and performance, supported by industry-leading global service and technical support teams. Warranty information for the accompanying consumable product is available at www.ambion.com/info/warranty in "Limited Warranty for Consumables," which is subject to the exclusions, conditions, exceptions, and limitations set forth under the caption "EXCLUSIONS, CONDITIONS, EXCEPTIONS, AND LIMITATIONS" in the full warranty statement. Please contact Applied Biosystems if you have any questions about our warranties or would like information about post-warranty support.

Patents and Licensing Notifications: This product or portions thereof is manufactured and sold under license from GE Healthcare under U.S. Patent Nos. 5,523,231 and 5,681,946 and other foreign patents.

End User Terms And Conditions *Acceptance.* These terms and conditions shall govern the purchase, use, transfer and acceptance of the products described in the purchase order, quotation or invoice, which products are sold and distributed by Applera Corporation to the buyer/transferee of such products (the "End User"). The transfer/sale of products to the End User is expressly conditional upon End User's acceptance of these terms and conditions. *Restrictions on Use.* End Users are specifically not authorized to and are forbidden from reselling, transferring or distributing any products either as a stand alone product or as a component of another product. The right to use the products does not, in and of itself, include or carry any right of the End User to any GE Healthcare Bio-Sciences Corp.'s technology or intellectual property other than expressly provided herein. End Users may not attempt to reverse engineer parameters of any of GE Healthcare Bio-Sciences Corp. proprietary products or services. **DISCLAIMER OF WARRANTIES.** GE HEALTHCARE BIO-SCIENCES CORP. PROVIDES NO WARRANTIES TO END USER (STATUTORY OR IMPLIED), INCLUDING WITHOUT LIMITATION, AS TO PRODUCT QUALITY, CONDITION, DESCRIPTION, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND ALL SUCH WARRANTIES ARE HEREBY EXPRESSLY DISCLAIMED. GE HEALTHCARE BIO-SCIENCES CORP. HEREBY EXPRESSLY DISCLAIMS ANY WARRANTY REGARDING RESULTS OBTAINED THROUGH THE USE OF THE PRODUCTS, INCLUDING WITHOUT LIMITATION ANY CLAIM OF INACCURATE, INVALID OR INCOMPLETE RESULTS. *Exclusion of Liability.* GE Healthcare Bio-Sciences Corp. and its affiliates shall have no liability to an End User, including, without limitation, for any loss of use or profits, business interruption or any consequential, incidental, special or other indirect damages of any kind, regardless of how caused and regardless of whether an action in contract, tort, strict product liability or otherwise.

Ambion/AB Trademarks Applied Biosystems, AB (Design), Ambion, RNaseZap and RNAlater are registered trademarks, and ArrayScript, MagMAX, and MessageSensor are trademarks of Applera Corporation or its subsidiaries in the US and/or certain other countries.

I. Introduction

A. Product Description

The MagMAX™ Viral RNA Isolation Kit (patent pending) is designed for rapid purification of viral RNA and DNA from biofluid samples such as serum, plasma, nasal fluid, milk, and swab samples. For viral nucleic acid isolation from whole blood or cell culture and tissue samples we recommend the MagMAX-96 Blood Kit and MagMAX-96 Total RNA Isolation Kit.

The microspherical paramagnetic beads used in the kit have a large available binding surface and can be fully dispersed in solution, allowing thorough nucleic acid binding, washing, and elution. The procedure, therefore, delivers very consistent yields of high quality RNA and DNA with little sample-to-sample variation.

B. Overview of the Procedure

The MagMAX Viral RNA Isolation Kit employs a classic method for disrupting samples in a guanidinium thiocyanate-based solution that rapidly releases viral RNA and DNA while simultaneously inactivating nucleases in the sample matrix (Chirgwin, et al., 1979; Chomczynski and Sacchi, 1987) (Figure 1). Paramagnetic beads with a nucleic acid binding surface are then added to the sample to bind nucleic acids. The beads/nucleic acids are captured on magnets, and proteins and other contaminants are washed away. The beads are then washed again to remove residual binding solution. Nucleic acids are eluted in a small volume of elution buffer. Note that this procedure recovers total nucleic acids, so if cells are present in the sample, cellular DNA/RNA will be recovered along with the viral RNA.

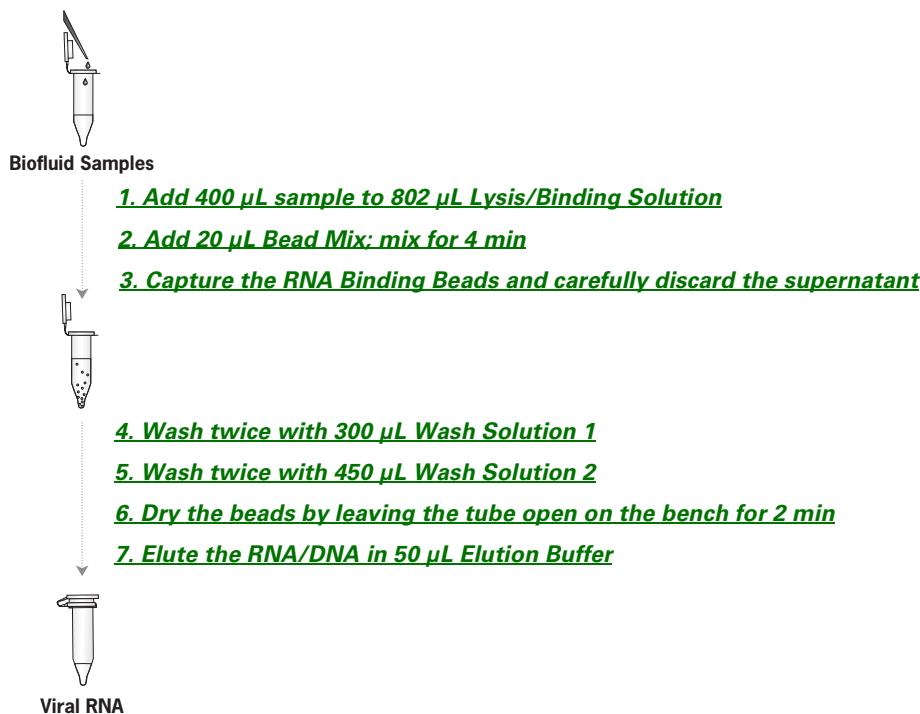


NOTE

For high throughput viral RNA and DNA isolation, we recommend using the MagMAX-96 Viral RNA Isolation Kit (Cat #AM1836).

The MagMAX Viral RNA Isolation Kit can efficiently isolate viral RNA and DNA from samples as large as 400 µL. RNA recovery is dependant upon sample type and is typically greater than 75%. The RNA recovered with the kit is of high quality and purity, and is suitable for real-time RT-PCR*. Figure 2 shows an example of qRT-PCR data that illustrates linear RNA recovery using several different sample types with a broad range of RNA inputs.

Figure 1. MagMAX Viral RNA Isolation Procedure



* This product is compatible with the 5' nuclease detection and dsDNA-binding dye processes covered by patents owned or licensable by Applied Biosystems. No license under these patents is conveyed expressly, by implication, or by estoppel to the purchaser by the purchase of this product. Further information on purchasing licenses may be obtained by contacting the Director of Licensing, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, California 94404, USA.

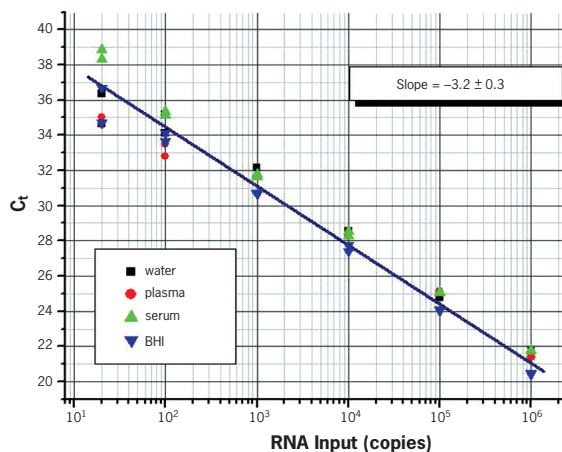


Figure 2. Linear Recovery of Viral RNA Using MagMAX™ Viral RNA Isolation Kit.

Serial dilutions of HIV Armored RNA® transcripts were spiked into water, plasma, serum, and BHI (brain heart infusion broth), and viral RNA was isolated using the MagMAX Viral RNA Isolation Kit according to the protocol. Equivalent volumes of recovered viral RNA (1/4 of eluted volume) were used in a 25 µL qRT-PCR to detect the HIV transcript.

C. Kit Components and Storage Conditions

The MagMAX Viral RNA Isolation Kit contains reagents to isolate RNA from 50 samples.

Amount	Component	Storage
50	Processing Tubes	room temp
44 mL	Lysis/Binding Soln Concentrate See section II.A.2 on page 6 before use	room temp*
36 mL	Wash Solution 1 Concentrate (Add 12 mL 100% isopropanol before use)	room temp
55 mL	Wash Solution 2 Concentrate (Add 44 mL 100% ethanol before use)	4°C or room temp
5 mL	Elution Buffer	4°C or room temp
550 µL	RNA Binding Beads	4°C*
110 µL	Carrier RNA	-20°C
550 µL	Lysis/Binding Enhancer	-20°C

* Do not freeze these kit components.

D. Required Materials Not Provided With the Kit

Reagents

- 100% ethanol, ACS grade or better
- 100% isopropanol, ACS grade or better

Equipment

- A vortex mixer (optional: a vortex adapter for hands-free mixing of several samples simultaneously, e.g., Ambion Cat #AM10024).
- Magnetic stand for 1.5 mL tubes, e.g., the Ambion 6 Tube Magnetic Stand (Cat #AM10055)

E. Related Products Available from Ambion

RNaseZap® Solution Cat #AM9780, AM9782, AM9784	RNaseZap RNase Decontamination Solution is simply sprayed, poured, or wiped onto surfaces to instantly inactivate RNases. Rinsing twice with distilled water will eliminate all traces of RNase and RNaseZap Solution.
6 Tube Magnetic Stand Cat #AM10055	Designed to hold up to six standard microcentrifuge tubes, the 6 Tube Magnetic Stand houses a strong magnet for fast, efficient separation of magnetic beads from solutions.
MagMAX™-96 Viral RNA Isolation Kit Cat #AM1836	The MagMAX™-96 Viral RNA Isolation Kit is designed for rapid high throughput purification of viral RNA in 96-well plates from biological fluids and cell-free samples such as serum, plasma, swabs, and cell culture media. As few as 20 copies of viral RNA can be detected from 50 µL of input sample.
MagMAX™-96 Blood RNA Isolation Kit Cat #AM1837	The MagMAX™-96 Blood RNA Isolation Kit is a magnetic bead-based system designed for rapid high throughput isolation of total and viral RNA in 96-well plates from mammalian whole blood and milk. The recovered viral RNA or total RNA can be used directly for quantitative reverse transcriptase PCR (qRT-PCR) for viral veterinary molecular diagnostics or gene expression profiling, respectively.
MagMAX™-96 Total RNA Isolation Kit Cat #AM1830	The MagMAX™-96 Total RNA Isolation Kit is a magnetic bead based total RNA purification system designed for rapid high throughput processing of cells in 96-well plates. High yield and high quality total RNA can be obtained from 100 to 500,000 cultured eukaryotic cells. The kit can also be used for total RNA isolation from small tissue samples.
MessageSensor™ RT Kit Cat #AM1745	The MessageSensor RT Kit for one-step qRT-PCR includes an optimized set of reagents for exceptionally sensitive reverse transcription. The kit is designed to be used for single-tube amplification of mRNA using either real-time or end-point amplification strategies.
ArrayScript™ Cat #AM2048, AM2049	ArrayScript is an M-MLV reverse transcriptase engineered to produce high yields of full-length cDNA. In RNA amplification with less than ~100 ng of total RNA, up to twice as much cRNA is synthesized when ArrayScript is used for the RT step compared to wild type M-MLV, AMV, or other engineered M-MLV reverse transcriptases. ArrayScript is also suitable for other RT and RT-PCR applications where high yields of full-length cDNA are required, such as cDNA library construction, 5' RLM-RACE, etc.

Vortex Adapter Cat #AM10024	The Vortex Adapter attaches to Vortex-Genie® 2 (Scientific Industries) vortex mixers to hold microcentrifuge tube for hands-free agitation.
RNAlater® Solution Cat #AM7020, AM7021	RNAlater Tissue Collection: RNA Stabilization Solution is an aqueous sample collection solution that stabilizes and protects cellular RNA in intact, unfrozen tissue and cell samples. RNAlater Solution eliminates the need to immediately process samples or to freeze samples in liquid nitrogen. Samples can be submerged in RNAlater Solution for storage at RT, 4°C, or –20°C without jeopardizing the quality or quantity of RNA that can be obtained.

II. MagMAX Viral RNA Isolation Protocol

A. Equipment and Reagent Preparation

1. RNase precautions

Lab bench and pipettors

Before working with RNA, it is always a good idea to clean the lab bench and pipettors with an RNase decontamination solution (e.g., Ambion RNaseZap® Solution).

Gloves and RNase-free technique

Wear laboratory gloves for this procedure; they protect you from the reagents, and they protect the RNA from nucleases that are present on skin.

Use RNase-free pipette tips to handle the kit reagents, and avoid putting used tips into the reagent containers.

2. Add Carrier RNA to the Lysis/Binding Solution Concentrate, mix, then add isopropanol



IMPORTANT

Shipment on dry ice may cause the Carrier RNA to become gelatinous and difficult to pipet. If you experience problems when attempting to pipet the Carrier RNA, we recommend heating it in a hybridization oven at 37°C for 10–15 min. A heat block may be used for this incubation, as long as the block accommodates the tube to uniformly heat the solution to 37°C. After heating, vortex vigorously, then spin briefly; you should now be able to easily pipette the solution accurately.

Prepared Lysis/Binding Solution is stable at room temperature for one month. Prepare only the amount of Lysis/Binding Solution needed for one month by scaling the reagent volumes down proportionally if necessary. We do not recommend storing the prepared Lysis/Binding Solution at 4°C or below as this may cause the Carrier RNA to precipitate; if the solution is inadvertently stored at 4°C, warm it at 37°C and shake to dissolve any precipitates before use.

Add Carrier RNA to Lysis/Binding Solution Concentrate according to the table below, and mix briefly. Then add 100% isopropanol and mix well. This mixture is called Lysis/Binding Solution in these instructions.



NOTE

If you have an internal positive control RNA to monitor viral RNA purification and detection, we recommend adding it to the Lysis/Binding Concentrate before adding the isopropanol.

We recommend including ~10% overage to cover pipetting error when preparing the Lysis/Binding Solution. Store at room temperature.

a. Combine the following:	Per Rxn	10 Rxn	Entire Bottle
Lysis/Binding Soln. Concentrate	400 µL	4.4 mL	22 mL
Carrier RNA	2 µL	22 µL	110 µL
b. Mix briefly, then add:			
100% Isopropanol	400 µL	4.4 mL	22 mL
c. Mix well by vortexing.			

3. Add 12 mL 100% isopropanol to Wash Solution 1 Concentrate

Add 12 mL 100% isopropanol to the bottle labeled Wash Solution 1 Concentrate and mix well. Mark the label to indicate that the isopropanol was added. Store at room temperature.

The resulting mixture is called Wash Solution 1 in these instructions.

4. Add 44 mL 100% ethanol to Wash Solution 2 Concentrate

Add 44 mL 100% ethanol to the bottle labeled as Wash Solution 2 Concentrate and mix well. Mark the label to indicate that the ethanol was added.

Store at room temperature.

The resulting mixture is called Wash Solution 2 in these instructions.

5. Prepare *Bead Mix*

Each isolation reaction requires 20 μ L of ***Bead Mix***. Although the mixture is stable at 4°C for up to 2 weeks, we recommend preparing Bead Mix on the day it will be used.

- Vortex the RNA Binding Beads at moderate speed to form a uniform suspension before pipetting.
- Prepare Bead Mix by combining the volumes of RNA Binding Beads and Lysis/Binding Enhancer shown in the table below appropriate for the number of isolation reactions to be performed that day. Mix thoroughly by gently vortexing. We recommend including ~10% overage to cover pipetting error when preparing the Bead Mix.

Component	Per Reaction	10 Rxns (+10%)	50 Rxns (+10%)
RNA Binding Beads	10 μ L	110 μ L	550 μ L
Lysis/Binding Enhancer	10 μ L	110 μ L	550 μ L

- Place the prepared Bead Mix on ice until it is needed in step [II.B.2](#).

B. RNA Isolation Protocol

Sample type

This kit is designed for isolation of viral RNA and DNA from cell-free, or nearly cell-free samples. For example, biological fluids such as serum, plasma, milk, urine, meconium, and nasal fluids can be used with the kit. Other common sample types such as spent culture medium and swab samples are also compatible.

Sample volume

With up to 400 μ L sample input, the MagMAX Viral RNA Isolation procedure can be completed in the 1.5 mL tubes provided in the kit. It is possible to process >400 μ L samples in a larger tube by proportionally scaling up the reaction; however, additional reagents, larger tubes, and an appropriate magnetic stand are required.

1. Add 400 µL sample to 802 µL Lysis/Binding Solution

- a. Pipet 802 µL prepared Lysis/Binding Solution (Carrier RNA and isopropanol added) into each Processing Tube.
- b. Transfer up to 400 µL of sample to the Lysis/Binding Solution in the Processing Tube.
When adding sample, immerse pipette tips slightly in the Lysis/Binding Solution to prevent creating aerosols that can lead to cross-contamination.
- c. Mix by gently vortexing for 30 sec or by flicking the tube several times. Then centrifuge briefly (~2 sec) to collect the contents at the bottom of the tube.

2. Add 20 µL Bead Mix; mix for 4 min

- a. Vortex the Bead Mix at moderate speed to create a uniform suspension before pipetting (prepared as described in step [II.A.5](#) on page 7).
- b. Add 20 µL Bead Mix to each sample.
- c. Gently shake the sample for 4 min on a vortex mixer to fully lyse viruses and bind RNA to the RNA Binding Beads.
- d. Centrifuge briefly (~2 sec) to collect tube contents.

3. Capture the RNA Binding Beads and carefully discard the supernatant

- a. Move the Processing Tube to a magnetic stand to capture the RNA Binding Beads. Leave the tube on the magnetic stand for at least 3 min. When capture is complete, the RNA Binding Beads will form a pellet against the magnet in the magnetic stand. The capture time depends on the magnetic stand used.
- b. Carefully aspirate and discard the supernatant without disturbing the beads, and remove the Processing Tube from the magnetic stand.

**IMPORTANT**

To obtain pure RNA, it is important to completely remove the supernatant at this step.

4. Wash twice with 300 µL Wash Solution 1

- a. Add 300 µL Wash Solution 1 (isopropanol added) to each sample and vortex at moderate speed for 30 sec.
- b. Centrifuge briefly (~2 sec) to collect tube contents.
- c. Capture the RNA Binding Beads on a magnetic stand for 3–5 min, or until the mixture becomes clear, indicating that capture is complete.
- d. Carefully aspirate and discard the supernatant without disturbing the beads and remove the Processing Tube from the magnetic stand.
It is critical to move the Processing Tube off the magnetic stand before the subsequent wash.
- e. Repeat steps [4.a–d](#) to wash a second time with 300 µL Wash Solution 1.

5. Wash twice with 450 μ L Wash Solution 2

- Add 450 μ L Wash Solution 2 (ethanol added) to each sample and vortex at moderate speed for 30 sec.
- Centrifuge briefly (~2 sec) to collect tube contents.
- Capture the RNA Binding Beads as in the previous wash.
- Carefully aspirate and discard the supernatant without disturbing the beads and remove the Processing Tube from the magnetic stand. As in the previous wash, it is critical to move the Processing Tube off the magnetic stand before the subsequent wash.
- Repeat steps [5.a-d](#) to wash with a second 450 μ L of Wash Solution 2. It is important to remove as much Wash Solution 2 from the samples as possible, because otherwise it could inhibit downstream applications such as RT-PCR.



IMPORTANT

To obtain pure RNA, it is important to completely remove the supernatant at this step.

6. Dry the beads by leaving the tube open on the bench for 2 min

- Leave the tube open at room temp for 2 min to allow any remaining alcohol from the Wash Solution 2 to evaporate.
- Inspect the tubes and if there is residual solution, remove as much as possible with a very fine-tipped pipettor. Then leave the tube open on the bench for another minute.

7. Elute the RNA/DNA in 50 μ L Elution Buffer

- Add 50 μ L Elution Buffer (room temp or warmed to 37–65°C, see section [III.B](#)) to each sample, and shake or vortex vigorously for 4 min.



NOTE

The elution volume is somewhat flexible; RNA/DNA can be eluted as little as 20 μ L, or in >50 μ L to achieve the desired final nucleic acid concentration. The volume of Elution Buffer supplied with the kit is enough for 50 samples at 100 μ L each.

- Capture the RNA Binding Beads as in the previous steps. ***The purified RNA will be in the supernatant.***
- Transfer the supernatant, which contains the RNA, to a nuclease-free container appropriate for your application, and store the purified RNA at –20°C.

C. Analyzing Viral RNA and DNA

Detect viral RNA by real-time RT-PCR and detect DNA by real-time qPCR

This kit is designed for purification of RNA for RT-PCR amplification, and purification of DNA for qPCR. Quantitative real-time RT-PCR/qPCR is a powerful method for viral RNA/DNA detection and is the recommended analysis tool.

Quantitate Carrier RNA recovered

The viral RNA recovered from most samples will be present in very limited amounts; the majority of RNA in the purified sample will be the Carrier RNA that was added to the Lysis/Binding Solution. RNA recovery is heavily dependent upon sample type (e.g., plasma vs. swab samples). With most sample types, up to 75% of the carrier RNA should be recovered. Using the recommended volume (802 µL) of prepared Lysis/Binding Solution, each sample will contain approximately 2 µg of Carrier RNA; therefore >10 ng/µL RNA should be recovered.

Quantitate the amount of Carrier RNA by UV absorbance at 260 nm (A_{260}). If you are using a NanoDrop® 1000 Spectrophotometer, 1.5 µL of nucleic acid solution can be measured without dilution.

Alternatively, the RNA concentration can be determined by diluting an aliquot of the preparation in TE (10 mM Tris-HCl, pH 8; 1 mM EDTA) and reading the absorbance in a traditional spectrophotometer at 260 nm. Find the concentration in µg/mL by multiplying the A_{260} by the dilution factor and the extinction coefficient. (1 A_{260} = 40 µg RNA/mL).

$$A_{260} \times \text{dilution factor} \times 40 = \mu\text{g RNA/mL}$$

III. Troubleshooting

A. Poor Viral Nucleic Acid Detection

If poor or no viral RNA or DNA signal is observed by RT-PCR (i.e., the C_t is higher than expected), it could be due to inhibitors in the nucleic acid recovered or poor nucleic acid recovery.

Inhibitors of RT-PCR

With most samples, the MagMAX Viral RNA Isolation protocol yields very pure nucleic acid; however, with samples that contain excessively high amounts of reaction inhibitors, enough may be carried over to affect RT-PCR.

Minimize the effect of inhibitors by using less RNA or DNA in the reaction

The effect of inhibitors can be minimized or eliminated by reducing the amount of RNA used in qRT-PCR or the amount of DNA used in qPCR. Try diluting the eluted nucleic acid 10-fold and repeating the RT-PCR or PCR; if a signal is observed using the diluted sample, this would indicate the presence of inhibitors in the eluted nucleic acid.

Detecting protein contamination

The UV absorbance at 260 and 280 nm can be used to determine if there is protein contamination in the sample. Proteins have an absorbance peak at ~280 nm, whereas nucleic acids have an absorbance peak at ~260 nm. The ratio of A_{260}/A_{280} should be ~2.0 for pure nucleic acid isolated from cell-free samples with the MagMAX Viral RNA Isolation Kit. An A_{260}/A_{280} ratio below this is indicative of protein carryover.

Poor RNA or DNA recovery: assess recovery of the Carrier RNA

Expected Carrier RNA recovery

Using the MagMAX Viral RNA Isolation protocol, 35–75% of the input RNA should be recovered (recovery is heavily dependent upon sample type). Using the recommended volume (802 μ L) of prepared Lysis/Binding Solution, each sample will contain approximately 2 μ g of Carrier RNA; therefore >10 ng/ μ L RNA should be recovered. Instructions for quantitating Carrier RNA are found in section [II.C. Quantitate Carrier RNA recovered](#) on page 10. Be aware that any cellular DNA or RNA in the prep will lead to an overestimation of yield, since all nucleic acids absorb at 260 nm.

Since the Carrier RNA is in great excess relative to viral RNA and DNA obtained from the sample, the contribution of viral nucleic acid to the absorbance is negligible. However, sample types containing small numbers of cells, such as urine and milk, will contain fairly significant amounts of cellular RNA and DNA.

Good recovery of Carrier RNA, but viral RNA or DNA cannot be detected

If the Carrier RNA was recovered at expected levels (>10 ng/ μ L RNA), but viral nucleic acid cannot be detected using a proven qRT-PCR or qPCR assay system, this would suggest the absence of virus in the original sample, poor lysis of viral particles, or problems with the RT-PCR or PCR. Consider the recommendation in the previous section for diluting your sample to minimize the effects of inhibitors.

Troubleshoot viral particle lysis: If diluting the viral nucleic acid does not help, the problem is most likely due to incomplete lysis of viral particles. Consider increasing the incubation time of the lysis/binding in step [II.B.1.c](#) on page 8 to 10–15 min.

Lower-than-expected Carrier RNA recovery

Poor recovery of the Carrier RNA (≤ 10 ng/ μ L) could indicate a problem with the nucleic acid isolation process. See section [B. Sample-to-Sample Variation in RNA/DNA Yield](#) below for suggestions that may help with nucleic acid recovery. If these suggestions do not improve Carrier RNA recovery, the procedure may require further optimization for use with different sample types; contact Ambion's Technical Services Department for more information on how to optimize the kit for use with various sample types.

B. Sample-to-Sample Variation in RNA/DNA Yield

The Carrier RNA yield should be fairly uniform among samples of the same type. However, the efficiency of RNA/DNA recovery may differ between different matrices. If large variations in nucleic acid yield are observed, consider the following suggestions:

RNA Binding Beads were not fully resuspended/dispersed

In general, the RNA Binding Beads will disperse more easily when the temperature of the mixture is warmer than 20°C.

- a. Make sure the Bead Mix is fully resuspended before adding it to the Processing Tube at the start of the procedure (step [II.B.2](#) on page 8).
- b. Make sure that the RNA Binding Beads are fully resuspended in Elution Buffer to efficiently elute nucleic acids from the beads in step [II.B.7](#) on page 9. Fully resuspended beads will produce a homogenous brown solution. If the solution is clear, with brown clumps, it means that the beads are not fully resuspended. Preheating the Elution Buffer to 60–65°C just before use will facilitate resuspension of the beads.

- c. Avoid overdrying the RNA Binding Beads before eluting the RNA/DNA (in step [II.B.6.a](#) on page 9) because this may make the beads more difficult to resuspend. If the beads are inadvertently overdried, increase the mixing time (to 10 min) during the elution step ([II.B.7](#)) to allow the beads to rehydrate.

RNA Binding Beads were unintentionally lost

Since the principle of this procedure is to immobilize nucleic acids on the RNA Binding Beads, any loss of beads during the procedure will result in loss of RNA/DNA. Avoid aspirating the RNA Binding Beads when removing supernatant from the captured beads. To determine whether RNA Binding Beads have been inadvertently aspirated with supernatant, it may be helpful to collect all supernatants (except the final RNA-containing supernatant) in a single container. Observe the color of the collected supernatant. If RNA Binding Beads are in the supernatant, they will color it light brown.

To prevent aspiration of RNA Binding Beads in subsequent experiments, observe the following precautions:

- Use sufficient magnetic capture time.
- Aspirate supernatant slowly.
- Keep pipette tip openings away from the captured RNA Binding Beads when aspirating supernatant.

C. RNA Binding Bead Carryover

If RNA Binding Beads are carried over into the eluate, they will cause the solution to be light brown in color. A small quantity of beads in the sample does not inhibit RT reactions or RT-PCR.

- See section [III.B. RNA Binding Beads were unintentionally lost](#) on page 13 for suggestions for avoiding bead carryover.
- To remove RNA Binding Beads from RNA samples, place the Processing Tube on a magnetic stand to capture the beads for ~1 min. Then transfer the nucleic acid solution(s) to a fresh nuclease-free plate or tubes.

IV. Appendix

A. References

Chirgwin J, Przybyla A, MacDonald A, and Rutter W (1979). Isolation of biologically active ribonucleic acid from sources enriched in ribonuclease. *Biochem.* **18**:5294.

Chomczynski P and Sacchi N (1987). Single-step method of RNA isolation by acid guanidinium thiocyanate-phenol-chloroform extraction. *Analyt. Biochem.* **162**:156–159.

B. Safety Information

The MSDS for any chemical supplied by Applied Biosystems or Ambion is available to you free 24 hours a day.



IMPORTANT

For the MSDSs of chemicals not distributed by Applied Biosystems or Ambion, contact the chemical manufacturer.

To obtain Material Safety Data Sheets

- Material Safety Data Sheets (MSDSs) can be printed or downloaded from product-specific links on our website at the following address:
www.ambion.com/techlib/msds
- Alternatively, e-mail your request to MSDS_Inquiry_CCRM@appliedbiosystems.com. Specify the catalog or part number(s) of the product(s), and we will e-mail the associated MSDSs unless you specify a preference for fax delivery.
- For customers without access to the internet or fax, our technical service department can fulfill MSDS requests placed by telephone or postal mail. (Requests for postal delivery require 1–2 weeks for processing.)

Chemical safety guidelines

To minimize the hazards of chemicals:

- Read and understand the Material Safety Data Sheets (MSDS) provided by the chemical manufacturer before you store, handle, or work with any chemicals or hazardous materials.
- Minimize contact with chemicals. Wear appropriate personal protective equipment when handling chemicals (for example, safety glasses, gloves, or protective clothing). For additional safety guidelines, consult the MSDS.
- Minimize the inhalation of chemicals. Do not leave chemical containers open. Use only with adequate ventilation (for example, fume hood). For additional safety guidelines, consult the MSDS.
- Check regularly for chemical leaks or spills. If a leak or spill occurs, follow the manufacturer's cleanup procedures as recommended on the MSDS.

- Comply with all local, state/provincial, or national laws and regulations related to chemical storage, handling, and disposal.

C. Quality Control

Functional testing

Kit components are tested functionally by isolating the carrier RNA and an Armored RNA using the protocol described in this manual. RNA recovery is assessed by absorbance measurements using the NanoDrop Spectrophotometer and by qRT-PCR. RNA integrity is evaluated using an Agilent® 2100 bioanalyzer.

Nuclease testing

Relevant kit components are tested in the following nuclease assays:

RNase activity

Meets or exceeds specification when a sample is incubated with 25 ng labeled RNA and analyzed by PAGE.

Nonspecific endonuclease activity

Meets or exceeds specification when a sample is incubated with 300 ng supercoiled plasmid DNA and analyzed by agarose gel electrophoresis.

Exonuclease activity

Meets or exceeds specification when a sample is incubated with 40 ng labeled *Sau3A* fragments of pUC19 and analyzed by PAGE.