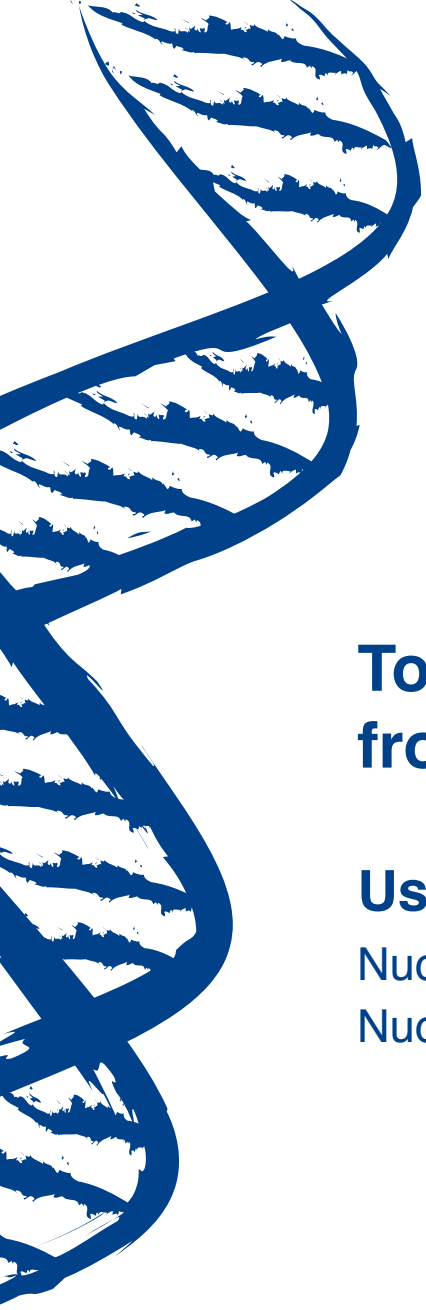

Total RNA isolation from FFPE samples

User manual

NucleoSpin® totalRNA FFPE
NucleoSpin® totalRNA FFPE XS

September 2013 / Rev. 01

MACHEREY-NAGEL
www.mn-net.com

Total RNA from FFPE samples

Protocol-at-a-glance (Rev. 01) – page 1

		NucleoSpin® totalRNA FFPE	NucleoSpin® totalRNA FFPE XS
1	**Sample preparation**	Insert FFPE section(s) in a microcentrifuge tube	Insert FFPE section(s) in a microcentrifuge tube
2	**Deparaffinize sample**	1 mL Paraffin Dissolver 56 °C, 5 min Vortex hot sample 16,000 x *g*, 2 min 170 µL MLF 16,000 x *g*, 2 min Remove Paraffin Dissolver	1 mL Paraffin Dissolver 56 °C, 5 min Vortex hot sample 16,000 x *g*, 2 min 140 µL MLF 16,000 x *g*, 2 min Remove Paraffin Dissolver
3	**Lyse sample – A** (perform method 3A or 3B)	15 µL Proteinase K Mix gently 56 °C, 15 min 15 µL MKA Vortex 0 °C, 5 min 16,000 x *g*, 5 min Transfer sample 80 °C, 15 min	12 µL Proteinase K Mix gently 56 °C, 15 min 12 µL MKA Vortex 0 °C, 5 min 16,000 x *g*, 5 min Transfer sample 80 °C, 15 min
	Lyse sample – B (perform method 3A or 3B)	15 µL Proteinase K Mix gently 56 °C, 90 min 15 µL MKA Vortex 0 °C, 5 min 16,000 x *g*, 5 min Transfer sample	12 µL Proteinase K Mix gently 56 °C, 90 min 12 µL MKA Vortex 0 °C, 5 min 16,000 x *g*, 5 min Transfer sample
4	**Adjust binding conditions**	500 µL MX Vortex RT, 1 min	400 µL MX Vortex RT, 1 min

To continue the procedure, please see back page.

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Total RNA from FFPE samples

Protocol-at-a-glance (Rev. 01) – page 2

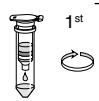
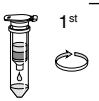
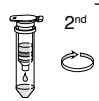
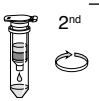
		NucleoSpin® totalRNA FFPE	NucleoSpin® totalRNA FFPE XS
5	**Bind RNA**	 Load sample 16,000 x *g*, 15 s	 Load sample 16,000 x *g*, 15 s
6	**Wash and dry silica membrane**	 1st 700 µL MW2 16,000 x *g*, 15 s	 1st 400 µL MW2 16,000 x *g*, 15 s
		 2nd 250 µL MW2 16,000 x *g*, 1 min	 2nd 200 µL MW2 16,000 x *g*, 1 min
7	***Optional: Digest DNA***	 50 µL rDNase RT, 15 min	 25 µL rDNase RT, 15 min
		 100 µL MX RT, 1 min 16,000 x *g*, 15 s	 50 µL MX RT, 1 min 16,000 x *g*, 15 s
		 1st 700 µL MW2 16,000 x *g*, 15 s	 1st 400 µL MW2 16,000 x *g*, 15 s
		 2nd 250 µL MW2 16,000 x *g*, 1 min	 2nd 200 µL MW2 16,000 x *g*, 1 min
8	**Elute highly pure RNA**	 30–50 µL RNase-free H_2O RT, 1 min 16,000 x *g*, 1 min	 5–30 µL RNase-free H_2O RT, 1 min 16,000 x *g*, 1 min

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Table of contents

1 Components

1.1 Kit contents

	NucleoSpin® totalRNA FFPE		
	10 preps	**50 preps**	**250 preps**
REF	**740982.10**	**740982.50**	**740982.250**
Paraffin Dissolver	15 mL	60 mL	300 mL
Lysis Buffer MLF	10 mL	10 mL	50 mL
Precipitation Buffer MKA	1 mL	1 mL	5 mL
Binding Buffer MX	15 mL	35 mL	180 mL
Reaction Buffer for rDNase	3 mL	3 mL	30 mL
Wash Buffer MW2 (Concentrate)*	6 mL	25 mL	100 mL
RNase-free H_2O	15 mL	15 mL	15 mL
rDNase, RNase-free (lyophilized)*	1 vial (size A)	1 vial (size C)	5 vials (size C)
Liquid Proteinase K	0.6 mL	0.8 mL	5 mL
NucleoSpin® RNA Columns (light blue rings)	10	50	250
Collection Tubes (2 mL)	10	50	250
Collection Tubes (1.5 mL)	10	50	250
User manual	1	1	1

* For preparation of working solutions and storage conditions see section 3.

1.1 Kit contents *continued*

	NucleoSpin® totalRNA FFPE XS		
	10 preps	**50 preps**	**250 preps**
REF	**740969.10**	**740969.50**	**740969.250**
Paraffin Dissolver	15 mL	60 mL	300 mL
Lysis Buffer MLF	10 mL	10 mL	50 mL
Precipitation Buffer MKA	1 mL	1 mL	5 mL
Binding Buffer MX	15 mL	35 mL	180 mL
Reaction Buffer for rDNase	3 mL	3 mL	20 mL
Wash Buffer MW2 (Concentrate)*	6 mL	25 mL	100 mL
RNase-free H_2O	15 mL	15 mL	15 mL
rDNase, RNase-free (lyophilized)*	1 vial (size A)	1 vial (size C)	3 vials (size C)
Liquid Proteinase K	0.2 mL	0.8 mL	3 x 1.25 mL
NucleoSpin® RNA FFPE XS Columns (light blue rings)	10	50	250
Collection Tubes (2 mL)	10	50	250
Collection Tubes (1.5 mL)	10	50	250
User manual	1	1	1

1.2 Reagents, consumables, and equipment to be supplied by user

Reagents

- 96–100 % ethanol (preferably undenaturated ethanol)

Consumables

- 1.5 mL microcentrifuge tubes (for sample lysis)
- Disposable pipette tips

Equipment

- Manual pipettors
- Centrifuge for microcentrifuge tubes
- Vortex mixer
- Thermal heating-block (adjustable to 56 °C and 80 °C)
- Personal protection equipment (lab coat, gloves, goggles)

1.3 About this user manual

It is strongly recommended that first-time users of **NucleoSpin® totalRNA FFPE (XS)** kit read the detailed protocol sections of this user manual. Experienced users, however, may refer to the Protocol-at-a-glance instead. The Protocol-at-a-glance is designed to be used only as a supplemental tool for quick referencing while performing the purification procedure.

All technical literature is available on the internet at ***www.mn-net.com***.

Please contact Technical Service regarding information about changes of the current user manual compared to previous revisions.

2 Product description

Formalin-fixed and paraffin-embedded (FFPE) tissue is commonly used in histopathological analysis. Recently, there is more and more interest in also investigating DNA modifications, RNA expression or miRNA profiles of old, archived FFPE samples. However, fixation, embedding and storage lead to crosslinking and fragmentation of RNA. Especially crosslinks cannot be detected by standard quality control assays, such as gel electrophoresis, spectrophotometry or microfluidic analysis, but the efficiency of enzymatic reactions is significantly reduced, for example in RT-PCR. Standard RNA purification procedures do not remove these chemical modifications and therefore result in low RNA yield or poor downstream application performance. The **NucleoSpin® totalRNA FFPE (XS)** procedure implements buffers and procedural steps to efficiently decrosslink nucleic acids and yield high quality RNA for the most demanding applications.

2.1 The basic principle

The **NucleoSpin® totalRNA FFPE (XS)** kits provide a convenient, reliable, and fast method to isolate RNA from formalin-fixed, paraffin-embedded (FFPE) tissue. Odorless and non-toxic Paraffin Dissolver (patent pending) replaces the flammable and odorous xylene or d-limonene commonly used for deparaffinization.

The tissue sample is then heat incubated with Proteinase K to digest the fixed tissue, release nucleic acids, and gently remove crosslinks. Optimal binding conditions for even small RNA (e.g., miRNA) are adjusted and the lysate is applied to the **NucleoSpin® RNA Column / NucleoSpin® RNA FFPE XS Column**. RNA is bound to the silica membrane. Residual DNA remaining on the membrane is removed by convenient on-column rDNase digestion. Washing steps remove salts, metabolites, and macromolecular cellular components. Pure RNA is finally eluted in a small volume of RNase-free water, yielding highly concentrated RNA.

Nucleic acid preparation using **NucleoSpin® totalRNA FFPE (XS)** can be performed at room temperature. The eluate, however, should be treated with care. RNA is very sensitive to trace contaminations of RNases, often found on general lab ware, fingerprints, and dust. To ensure RNA stability keep RNA frozen at -20 °C for short-term or -70 °C for long-term storage.

2.2 Kit specifications

NucleoSpin® totalRNA FFPE (XS) is recommended for the isolation of total RNA from formalin-fixed, paraffin-embedded (FFPE) tissue samples, typically as thin sections (approx. 3–20 µm thickness). Formalin-fixed samples which are not embedded in paraffin can also be used as sample material by omitting the deparaffinization steps.

The sample size can be up to ~10 sections (1–20 µm) of FFPE. The amount of embedded tissue can be up to 50 mg for **NucleoSpin® totalRNA FFPE** or up to 5 mg for **NucleoSpin® totalRNA FFPE XS** (1x 10 µm section with 1 cm^2 tissue is approximately 1 mg).

RNA yield strongly depends on sample type, quality, and amount. Furthermore, the procedures of tissue sampling, post sampling delay before fixation, fixation time, embedding, and storage conditions have a high impact on RNA quality and yield. For more details see, for example, Chung J.Y. *et al.* (2008); van Maldegem F. *et al.* (2008); von Ahlfen S. *et al.* (2007); Castiglione F. *et al.* (2007); Leyland-Jones B.R. *et al.* (2008).

RNA concentration: RNA can be eluted highly concentrated and ready-to-use in a small volume of 30–50 µL (**NucleoSpin® totalRNA FFPE**) or even 5–30 µL (**NucleoSpin® totalRNA FFPE XS**).

RNA size distribution: RNA isolated from formalin-fixed, paraffin-embedded tissue shows size distribution from 15 to 5,000 bases. Often short sized RNA from ca. 100–300 bases predominate, especially when the sample material is old. However, samples which were subjected to good tissue fixation, embedding, and storage conditions can yield RNA even larger than 5,000 bases.

RNA integrity: RNA Integrity Numbers (RIN) according to Agilent 2100 Bioanalyzer assays depend on sample type and quality. In general the quality of RNA extracted from FFPE samples is poor. Typical RIN of RNA isolated with NucleoSpin® totalRNA FFPE (XS) kits are in range of 2–6.

rDNase is supplied with the kit for a convenient removal of DNA by on-column digestion. For more demanding downstream applications, DNA can also be digested in solution as described in section 5.2.

Table 1: Kit specifications at a glance

Parameter	NucleoSpin® totalRNA FFPE	NucleoSpin® totalRNA FFPE XS
Technology	Silica-membrane technology	Silica-membrane technology
Format	Mini spin columns	Mini spin columns – XS design
Sample material	Up to ~10 sections with up to 50 mg of tissue	Up to ~10 sections with up to 5 mg of tissue
Typical yield	Strongly depends on sample quality and amount	Strongly depends on sample quality and amount
Elution volume	30–50 µL	5–30 µL
Preparation time	70 min/6 preps (90 min including optional rDNase digest)	70 min/6 preps (90 min including optional rDNase digest)

3 Storage conditions and preparation of working solutions

Storage conditions:

- Store lyophilized rDNase and Proteinase K at 4 °C upon arrival (stable for at least 1 year).
- All other kit components should be stored at room temperature (18–25 °C) and are stable for at least one year. Storage at lower temperatures may cause precipitation of salts. If precipitation occurs, incubate the bottle for several minutes at about 30–40 °C and mix well until the precipitate is redissolved.

Before starting any **NucleoSpin® totalRNA FFPE (XS)** protocol prepare the following:

- **RNase-free rDNase:** Add the indicated volume of Reaction Buffer for rDNase to the rDNase vial and incubate for 1 min at room temperature. Gently swirl the vial to completely dissolve the rDNase. Be careful not to mix the enzyme too vigorously as rDNase is sensitive to mechanical agitation. Dispense into aliquots and store at -20 °C. The frozen working solution is stable for at least 6 months. Do not freeze/thaw the aliquots more than three times.
- **Wash Buffer MW2:** Add the indicated volumes of 96–100 % ethanol to the MW2 concentrate. Stored at room temperature (18–25 °C), the buffer is stable for at least one year.

	NucleoSpin® totalRNA FFPE		
	10 preps	**50 preps**	**250 preps**
REF	**740982.10**	**740982.50**	**740982.250**
Wash Buffer MW2 (Concentrate)	6 mL Add 24 mL 96–100 % ethanol	25 mL Add 100 mL 96–100 % ethanol	100 mL Add 400 mL 96–100 % ethanol
RNase-free rDNase (lyophilized)	1 vial (size A) Add 0.75 mL **Reaction Buffer for rDNase**	1 vial (size C) Add 3 mL **Reaction Buffer for rDNase**	5 vials (size C) Add 3 mL **Reaction Buffer for rDNase** to each vial

	NucleoSpin® totalRNA FFPE XS		
	10 preps	**50 preps**	**250 preps**
REF	**740982.10**	**740982.50**	**740982.250**
Wash Buffer MW2 (Concentrate)	6 mL Add 24 mL 96–100 % ethanol	25 mL Add 100 mL 96–100 % ethanol	100 mL Add 400 mL 96–100 % ethanol
RNase-free rDNase (lyophilized)	1 vial (size A) Add 0.75 mL **Reaction Buffer for rDNase**	1 vial (size C) Add 3 mL **Reaction Buffer for rDNase**	3 vials (size C) Add 3 mL **Reaction Buffer for rDNase to each vial**

4 Safety instructions

The following components of the **NucleoSpin® totalRNA FFPE (XS)** kits contain hazardous contents.

Wear gloves and goggles and follow the safety instructions given in this section.

4.1 Risk and safety phrases

Component *Inhalt*	Hazard contents *Gefahrstoff*	Hazard symbol *Gefahrstoff-symbol*	Risk phrases *R-Sätze*	Safety phrases *S-Sätze*
rDNase, RNase-free	rDNase, lyophilized *rDNase, lyophilisiert*	Xn	R 42/43	S 22-24
Liquid Proteinase K	Proteinase K, liquid (1–10 %) *Proteinase K, flüssig (1–10 %)*	Xn	R 42-43	S 24
Paraffin Dissolver**	Mineral oil distillate 90–100 % *Dest. Mineralöl 90–100 %*	Xn*	R 65-66	

Risk phrases

R 42	May cause sensitization by inhalation *Sensibilisierung durch Einatmen möglich.*
R 42/43	May cause sensitization by inhalation and skin contact *Sensibilisierung durch Einatmen und Hautkontakt möglich.*
R 43	May cause sensitization by skin contact *Sensibilisierung durch Hautkontakt möglich.*
R 65	Harmful: May cause lung damage if swallowed. *Gesundheitsschädlich: Kann beim Verschlucken Lungenschäden verursachen.*
R 66	Repeated exposure may cause skin dryness or cracking. *Wiederholter Kontakt kann zu spröder oder rissiger Haut führen.*

Safety phrases

S 22	Do not breathe dust. *Staub nicht einatmen.*
S 24	Avoid contact with the skin. *Berührung mit der Haut vermeiden.*

* Hazard labeling not necessary if quantity per bottle below 125 g or mL (certificate of exemption according to 67/548/EEC Art. 25, 1999/45/EC Art. 12 and German GefStoffV § 20 (3) and TRGS 200 7.1). For further information see Material Safety Data Sheet.

** Disposal considerations for Paraffin Dissolver: Please observe local regulations for collection and disposal of waste and contact waste disposal company, where you will obtain information on disposal (waste code number 16 05 06).

4.2 GHS classification

Only harmful features do not need to be labeled with H and P phrases up to 125 mL or 125 g.

Mindergefährliche Eigenschaften müssen bis 125 mL oder 125 g nicht mit H- und P-Sätzen gekennzeichnet werden.

Component *Inhalt*	Hazard contents *Gefahrstoff*	GHS symbol *GHS Symbol*	Hazard phrases *H-Sätze*	Precaution phrases *P-Sätze*
rDNase, RNase-free	rDNase, lyophilized *rDNase, lyophilisiert*	 Danger *Gefahr*	317, 334	261, 280, 302+352, 304+341, 333+313, 342+311, 363
Liquid Proteinase K	Proteinase K *Proteinase K*	 Danger *Gefahr*	317, 334	261, 280, 302+352, 304+340, 333+313, 342+311, 362
Paraffin Dissolver	Mineral oil distillate *Dest. Mineralöl*	No labeling		

Hazard phrases

H 317	May cause an allergic skin reaction. *Kann allergische Hautreaktionen verursachen.*
H 334	May cause allergy or asthma symptoms or breathing difficulties if inhaled. *Kann bei Einatmen Allergie, asthmaartige Symptome oder Atembeschwerden verursachen.*

Precaution phrases

P 261	Avoid breathing dust. *Einatmen von Staub / Dampf vermeiden.*
P 280	Wear protective gloves / eye protection. *Schutzhandschuhe / Augenschutz tragen.*
P 302+352	IF ON SKIN: Wash with plenty of soap and water. *BEI BERÜHRUNG MIT DER HAUT: Mit viel Wasser und Seife waschen.*
P 304+340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. *Bei Einatmen: Bei Atembeschwerden an die frische Luft bringen und in einer Position ruhigstellen, die das Atmen erleichtert.*
P 304+341	IF INHALED: If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. *BEI EINATMEN: An die frische Luft bringen und in einer Position ruhigstellen, die das Atmen erleichtert.*
P 333+313	If skin irritation occurs: Get medical advice / attention. *Bei Hautreizung oder -ausschlag: Ärztlichen Rat einholen / ärztliche Hilfe hinzuziehen.*
P 342+311	If experiencing respiratory symptoms: Call a POISON CENTER or doctor / physician. *Bei Symptomen der Atemwege: GIFTINFORMATIONSZENTRUM oder Arzt anrufen.*

Precaution phrases

P 362	Take off contaminated clothing. *Kontaminierte Kleidung ausziehen.*
P 363	Wash contaminated clothing before reuse. *Kontaminierte Kleidung vor erneutem Tragen waschen.*

For further information please see Material Safety Data Sheets ***(www.mn-net.com).***
Weiterführende Informationen finden Sie in den Sicherheitsdatenblättern ***(www.mn-net.com)****.*

⚠ The symbol shown on labels refers to the precaution phrases of this section.
Das auf Etiketten dargestellte Symbol weist auf die P-Sätzen dieses Kapitels hin.

5 Protocols

5.1 NucleoSpin® totalRNA FFPE

Before starting the preparation:

- Check that rDNase and Buffer MW2 were prepared according to section 3.
- Set incubator(s) to 56°C (for paraffin melting and lysis step) and 80°C (for decrosslink step).

1 Sample preparation

Insert FFPE section(s) in a microcentrifuge tube (not provided with the kit).

2 Deparaffinize sample

Add **1 mL Paraffin Dissolver** to the sample.

+ 1 mL Paraffin Dissolver

Incubate **5 min** at **56 °C** (to melt the paraffin).

56 °C, 5 min

Vortex the hot sample.

Vortex hot sample

Make sure that paraffin completely melts during the heat incubation step and mix well after melting to completely dissolve the paraffin.

16,000 x *g*, 2 min

Centrifuge sample for **2 min** at **16,000 x *g***.

! *Attention: Check Buffer MLF prior to use! If a white precipitate is visible, heat the buffer for several minutes at 30–40 °C until the precipitate is completely dissolved and mix thoroughly.*

+ 170 µL MLF

Add **170 µL Buffer MLF**. Do not mix!

16,000 x *g*, 2 min

Centrifuge sample for **2 min** at **16,000 x *g***.

Remove and discard Paraffin Dissolver by pipetting it off.

Remove Paraffin Dissolver

Note: Slight residues of Paraffin Dissolver do not affect the following steps.

3 A Lyse sample – method A (perform method 3 A or 3 B)

+ 15 µL Proteinase K

Add **15 µL Proteinase K**.

Mix gently

Mix by gently shaking or pipetting up and down. Do not vortex!

Incubate for **15 min** at **56 °C** to lyse sample tissue.

56 °C, 15 min

If tissue is still visible, continue incubation until sample is digested.

Add **15 µL Buffer MKA** and vortex briefly.

+ 15 µL MKA

Vortex

Incubate for **5 min** on **ice.**

0 °C, 5 min

Centrifuge for **5 min** at **16,000 x *g*.**

16,000 x *g*, 5 min

Transfer clear supernatant to a new 1.5 mL microcentrifuge tube (not provided).

Transfer sample

Incubate at **80 °C** for exactly **15 min**.

80 °C, 15 min

Shorter incubation or lower temperature leads to incomplete decrosslinking. Longer incubation might lead to degradation of RNA.

---

3 B **Lyse sample – method B** (perform method 3 A or 3 B)

Add **15 µL Proteinase K**.

+ 15 µL Proteinase K

Mix by gently shaking or pipetting up and down. Do not vortex!

Mix gently

Incubate for **90 min** at **56 °C** to lyse sample tissue.

56 °C, 90 min

If tissue is still visible, continue incubation until sample is digested.

Add **15 µL Buffer MKA** and vortex briefly.

+ 15 µL MKA

Vortex

Incubate for **5 min** on **ice.**

0 °C, 5 min

Centrifuge for **5 min** at **16,000 x *g*.**

16,000 x *g*, 5 min

Transfer clear supernatant to a new 1.5 mL microcentrifuge tube (not provided).

Transfer sample

---

4 Adjust binding conditions

+ 500 µL MX

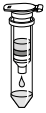
Add **500 µL Buffer MX** and **mix** by vortexing (2 x 5 s).

Vortex

Incubate for **1 min** at **room temperature** (18–25 °C).

RT, 1 min

5 Bind RNA



Place a **NucleoSpin® RNA Column** in a new **Collection Tube (2 mL)**.

Load sample

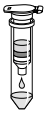
Load sample onto the column and centrifuge for **15 s** at **16,000 x *g***.

16,000 x *g*, 15 s

Discard flow-through and place the column back into the collection tube.

6 Wash and dry silica membrane

1st wash



Add **700 µL Buffer MW2** to the NucleoSpin® RNA Column.

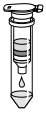
+ 700 µL MW2

Centrifuge for **15 s** at **16,000 x *g***.

16,000 x *g*, 15 s

Discard flow-through and place the column back into the collection tube.

2nd wash



Add **250 µL Buffer MW2** to the NucleoSpin® RNA Column.

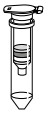
+ 250 µL MW2

Centrifuge for **1 min** at **16,000 x *g*** to dry the membrane completely.

16,000 x *g*, 1 min

If the flow-through in the collection tube has touched the NucleoSpin® RNA Column after 2nd wash, discard flow-through and centrifuge again.

7 *Optional*: Digest DNA



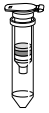
+ 50 µL rDNase

Add **50 µL rDNase** directly onto the silica membrane of the NucleoSpin® RNA Column.

RT, 15 min

Incubate at **room temperature** (18–25 °C) for **15 min**.

Add **100 µL Buffer MX.**



+ 100 µL MX

Incubate for **1 min** at **room temperature** (18–25 °C).

RT, 1 min

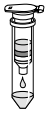
Centrifuge for **15 s** at **16,000 x *g***.

16,000 x *g*, 15 s

Discard flow-through and place the column back into the collection tube.

1st wash

Add **700 µL Buffer MW2** to the NucleoSpin® RNA Column.



+ 700 µL MW2

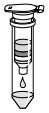
Centrifuge for **15 s** at **16,000 x *g***.

16,000 x *g*, 15 s

Discard flow-through and place the column back into the collection tube.

2nd wash

Add **250 µL Buffer MW2** to the NucleoSpin® RNA Column.



+ 250 µL MW2

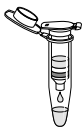
Centrifuge for **1 min** at **16,000 x *g*** to dry the membrane completely.

16,000 x *g*, 1 min

If the flow-through in the collection tube has touched the NucleoSpin® RNA Column after 2nd wash, discard flow-through and centrifuge again.

8 Elute highly pure RNA

Place the NucleoSpin® RNA Column in a new **Collection Tube (1.5 mL)**.



+ 30–50 µL RNase-free H_2O

Add **30 µL** (for high concentration) **or 50 µL** (for high yield) **RNase-free H_2O** to the column.

Incubate for **1 min** at **room temperature** (18–25 °C).

RT, 1 min

Centrifuge for **1 min** at **16,000 x *g***.

16,000 x *g*, 1 min

Keep the eluted RNA on ice or freeze at -20 °C (short-term storage) or -70 °C (long-term storage).

5.2 NucleoSpin® totalRNA FFPE XS

Before starting the preparation:

- Check that rDNase and Buffer MW2 were prepared according to section 3.
- Set incubator(s) to 56°C (for paraffin melting and lysis step) and 80°C (for decrosslink step).

1 Sample preparation

Insert FFPE section(s) in a microcentrifuge tube (not provided with the kit).

2 Deparaffinize sample

Add **1 mL Paraffin Dissolver** to the sample.

+ 1 mL Paraffin Dissolver

Incubate **5 min** at **56 °C** (to melt the paraffin).

56 °C, 5 min

Vortex the hot sample.

Vortex hot sample

Make sure that paraffin completely melts during the heat incubation step and mix well after melting to completely dissolve the paraffin.

16,000 x *g*, 2 min

Centrifuge sample for **2 min** at **16,000 x *g***.

Attention: Check Buffer MLF prior to use! If a white precipitate is visible, heat the buffer for several minutes at 30–40 °C until the precipitate is completely dissolved and mix thoroughly.

+ 140 µL MLF

Add **140 µL Buffer MLF**. Do not mix!

16,000 x *g*, 2 min

Centrifuge sample for **2 min** at **16,000 x *g***.

Remove and discard Paraffin Dissolver by pipetting it off.

Remove Paraffin Dissolver

Note: Slight residues of Paraffin Dissolver do not affect the following steps.

3 A Lyse sample – method A (perform method 3 A or 3 B)

Add **12 µL Proteinase K**.

+ 12 µL Proteinase K

Mix by gently shaking or pipetting up and down. Do not vortex!

Mix gently

Incubate for **15 min** at **56 °C** to lyse sample tissue.

If tissue is still visible, continue incubation until sample is digested.

56 °C, 15 min

Add **12 µL Buffer MKA** and vortex briefly.

Incubate for **5 min** on **ice.**

Centrifuge for **5 min** at **16,000 x *g*.**

+ 12 µL MKA

Vortex

0 °C, 5 min

16,000 x *g*, 5 min

Transfer clear supernatant to a new 1.5 mL microcentrifuge tube (not provided).

Incubate at **80 °C** for exactly **15 min**.

Shorter incubation or lower temperature leads to incomplete decrosslinking. Longer incubation might lead to degradation of RNA.

Transfer sample

80 °C, 15 min

---

3 B **Lyse sample – method B** (perform method 3 A or 3 B)

Add **12 µL Proteinase K**.

Mix by gently shaking or pipetting up and down. Do not vortex!

Incubate for **90 min** at **56 °C** to lyse sample tissue.

If tissue is still visible, continue incubation until sample is digested.

+ 12 µL Proteinase K

Mix gently

56 °C, 90 min

Add **12 µL Buffer MKA** and vortex briefly.

Incubate for **5 min** on **ice.**

Centrifuge for **5 min** at **16,000 x *g*.**

+ 12 µL MKA

Vortex

0 °C, 5 min

16,000 x *g*, 5 min

Transfer clear supernatant to a new 1.5 mL microcentrifuge tube (not provided).

Transfer sample

---

4 Adjust binding conditions

Add **400 µL Buffer MX** and **mix** by vortexing (2 x 5 s).

Incubate for **1 min** at **room temperature** (18–25 °C).

+ 400 µL MX

Vortex

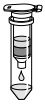
RT, 1 min

5 Bind RNA

Place a **NucleoSpin® RNA FFPE XS Column** in a new **Collection Tube (2 mL)**.

Load sample onto the column and centrifuge for **15 s** at **16,000 x *g***.

Discard flow-through and place the column back into the collection tube.



Load sample

16,000 x *g*, 15 s

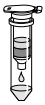
6 Wash and dry silica membrane

1st wash

Add **400 µL Buffer MW2** to the NucleoSpin® RNA FFPE XS Column.

Centrifuge for **15 s** at **16,000 x *g***.

Discard flow-through and place the column back into the collection tube.



+ 400 µL MW2

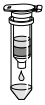
16,000 x *g*, 15 s

2nd wash

Add **200 µL Buffer MW2** to the NucleoSpin® RNA FFPE XS Column.

Centrifuge for **1 min** at **16,000 x *g*** to dry the membrane completely.

If the flow-through in the collection tube has touched the NucleoSpin® RNA FFPE XS Column after 2nd wash, discard flow-through and centrifuge again.



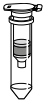
+ 200 µL MW2

16,000 x *g*, 1 min

7 *Optional*: Digest DNA

Add **25 µL rDNase** directly onto the silica membrane of the NucleoSpin® RNA FFPE XS Column.

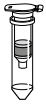
Incubate at **room temperature** (18–25 °C) for **15 min**.



+ 25 µL rDNase

RT, 15 min

Add **50 µL Buffer MX.**



+ 50 µL MX

Incubate for **1 min** at **room temperature** (18–25 °C).

RT, 1 min

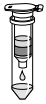
Centrifuge for **15 s** at **16,000 x *g***.

16,000 x *g*, 15 s

Discard flow-through and place the column back into the collection tube.

1st wash

Add **400 µL Buffer MW2** to the NucleoSpin® RNA FFPE XS Column.



+ 400 µL MW2

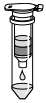
Centrifuge for **15 s** at **16,000 x *g***.

16,000 x *g*, 15 s

Discard flow-through and place the column back into the collection tube.

2nd wash

Add **200 µL Buffer MW2** to the NucleoSpin® RNA FFPE XS Column.



+ 200 µL MW2

Centrifuge for **1 min** at **16,000 x *g***.

16,000 x *g*, 1 min

Discard flow-through and place the column back into the collection tube.

Centrifuge for **5 min** at **16,000 x *g*** to dry the membrane.

16,000 x *g*, 5 min

8 Elute highly pure RNA

Place the NucleoSpin® RNA FFPE XS Column in a new **Collection Tube (1.5 mL)**.

+ 5–30 µL RNase-free H_2O

Add **5 µL** (for high concentration) to **30 µL** (for high yield) **RNase-free H_2O** to the column.

Incubate for **1 min** at **room temperature** (18–25 °C).

RT, 1 min

Centrifuge for **1 min** at **16,000 x *g***.

16,000 x *g*, 1 min

Keep the eluted RNA on ice or freeze at -20 °C (short-term storage) or -70 °C (long-term storage).

5.3 DNA digestion in the RNA eluates

Comments on DNA removal:

Although the on-column rDNase digest in the standard protocol is very efficient, there are still certain applications which require even lower quantities of residual DNA.

For example, RT-PCR reactions with primers that do not differentiate between cDNA (derived from RNA) and contaminating genomic DNA.

DNA digestion in solution can efficiently degrade contaminating DNA. This requires stringent RNase control and optionally repurification of the RNA (in order to remove buffer, salts, DNase, and digested DNA).

The high quality, RNase-free, recombinant DNase (rDNase) provided with the kit facilitates such a digestion in solution.

A **Digest DNA (Reaction setup)**

Add **1 / 10 volume of rDNase** (dissolved in Reaction Buffer for rDNase) to the eluted RNA (e.g., add 3 µL enzyme to 30 µL RNA eluate).

B **Incubate** for **10 min** at **37°C**.

C **Inactivate rDNase**

Incubate the sample for **5 min** at **75 °C** to inactivate the rDNase. Put the sample on ice.

In most cases a further purification (in order to remove inactivated rDNase, buffer and salts) is not necessary. If nevertheless a repurification is required, NucleoSpin® RNA Clean-up XS is recommended (see ordering information).

6 Appendix

6.1 Troubleshooting

Problem	Possible cause and suggestions
Poor RNA quality or yield	*RNase contamination* • Create an RNase-free working environment. Wear gloves during all steps of the procedure. Change gloves frequently. Use sterile, disposable polypropylene tubes and filter strips. Keep tubes closed whenever possible during the preparation. Glassware should be oven-baked for at least 2 hours at 250 °C before use. *Poor sample quality* • Sample quality very much influences the obtainable RNA amount and quality. For aspects concering sample harvest, fixation, embedding, and storage refer to: Castiglione F. *et al.* (2007), Chung J.Y. *et al.* (2008), Leyland-Jones B.R. *et al.* (2008), von Ahlfsen S. *et al.* (2007), von Maldegem F. *et al.* (2008). *Reagents not applied or restored properly* • Always dispense exactly the buffer volumes given in the protocols! • Always follow the given instructions closely, with specific attention paid to order and mode of mixing (shaking, vortexing, etc). • Add the indicated volume of 96–100% ethanol to Buffer MW2 Concentrate and mix thoroughly. • Store kit components at room temperature (18–25 °C). Storage at lower temperatures may cause salt precipitation. If precipitation occurs, incubate the bottle for several minutes at about 30–40 °C and mix well until the precipitate is redissolved. • Keep bottles tightly closed in order to prevent evaporation or contamination.

Poor RNA quality or yield *(continued)*	*Ionic strength and pH influence A_{260} absorption as well as ratio A_{260}/A_{280}* • For absorption measurement, use 5 mM Tris pH 8.5 as diluent. Please also see: Manchester K.L. (1995) and Wilfinger W.W. *et al.* (1997). *Proteinase digestion time* • Depending of the nature of the sample, an optimal digestion time from 15 min to 3 hours has to be determined empirically. If tissue residues are still visible after 15 min continue the incubation for up to 3 hours. If a large portion of the sample still remains undigested, continue digestion overnight. An overnight incubation is not recommended if the tissue digested well within 3 hours.
Contamination of RNA with genomic DNA	*rDNase not active* • Reconstitute and store lyophilized rDNase according to instructions given in section 3. *rDNase solution not properly applied* • Pipette rDNase solution directly onto the center of the silica membrane and close the lid in order to press the solution into the membrane. *Too much cell material used* • Reduce quantity of cells or tissue used. • Use larger PCR targets (e.g., > 500 bp) or intron spanning primers for RNA analysis. • Use support protocol for subsequent rDNase digestion in the eluate (section 5.2).

Suboptimal performance of RNA in downstream experiments	*Carry-over of ethanol or salt* • Do not let the column flow-through touch the column outlet after the second Buffer MW2 wash. Be sure to centrifuge at the recommended speed and time in order to remove ethanolic Buffer MW2 completely. • Check that Buffer MW2 has been equilibrated to room temperature before use. Washing at lower temperatures lowers efficiency of salt removal. • Depending on the robustness of the RT-PCR system used, RT-PCR might be inhibited if complete eluates are used as template for RT-PCR. Use less eluate as template. *Store isolated RNA properly* • Eluted RNA should always be kept on ice for optimal stability since trace contaminations of omnipresent RNases (general lab ware, fingerprints, dust) will degrade the isolated RNA. For short term storage freeze at -20 °C, for long term storage freeze at -70 °C.
Discrepancy between A_{260} quantification values and PCR quantification values	*Silica abrasion from the membrane* • Due to the typically low RNA content in very small samples and the resulting low total amount of isolated RNA, a RNA quantification via A_{260} absorption measurement is often hampered due to the low sensitivity of the absorption measurement. When performing absorption measurements close to the detection limit of the photometer, the measurement may be influenced by minor amounts of silica abrasion. In order to prevent incorrect A_{260}-quantification of small RNA amounts centrifuge the eluate for 30 s at >11,000 x *g* and take an aliquot for measurement without disturbing any sediment. Alternatively, use a silica abrasion insensitive RNA quantification method (e.g., RiboGreen® fluorescent dye).
Unexpected A_{260}/A_{280} ratio	*Measurement not in the range of photometer detection limit* • In order to obtain a reliable A_{260}/A_{280} ratio it is necessary that the initially measured A_{260} and A_{280} values are significantly above the detection limit of the photometer used. An A_{280} value close to the background noise of the photometer will cause non reliable A_{260}/A_{280} ratios.

6.2 Ordering information

Product	REF	Pack of
NucleoSpin® totalRNA FFPE	740982.10/.50/.250	10/50/250 preps
NucleoSpin® totalRNA FFPE XS	740969.10/.50/.250	10/50/250 preps
NucleoSpin® RNA XS	740902.10/.50/.250	10/50/250 preps
NucleoSpin® RNA Clean-up XS	740903.10/.50/.250	10/50/250 preps
NucleoSpin® RNA	740955.10/.50/.250	10/50/250 preps
NucleoSpin® RNA/Protein	740933.10/.50/.250	10/50/250 preps
NucleoSpin® TriPrep*	740966.10/.50/.250	10/50/250 preps
rDNase Set	740963	1
Paraffin Dissolver	740968.25	25 mL
Collection Tubes (2 mL)	740600	1000

Visit ***www.mn-net.com*** for more detailed product information.

6.3 References

Castiglione F. *et al.* (2007): Real-time PCR analysis of RNA extracted from formalin-fixed and paraffin-embeded tissues: effects of the fixation on outcome reliability. Appl Immunohistocehm Mol Morphol 15(3): 338-342.

Chung J. Y. *et al.* (2008): Factors in tissue handling and processing that impact RNA obtained from formalin-fixed, paraffin-embedded tissue. Journal of Histochemistry & Cytochemistry. 56(11): 1033-1042.

Leyland-Jones B. R. *et al.* (2008): Recommendations for collection and handling of specimens from group breast cancer clinical trials. J. Clin. Oncol 26(34): 5638-5644.

* DISTRIBUTION AND USE IN THE USA IS PROHIBITED FOR PATENT REASONS.

Manchester K.L. (1995): Value of A_{260}/A_{280} ratios for measurement of purity of nucleic acids. Biotechniques 19, 208–209.

von Ahlfen S. *et al.* (2007): Determinants for RNA quality from FFPE samples. PLoS ONE. Issue 12, e1261.

von Maldegem F. *et al.* (2008): Effects of processing delay, formalin fixation, and immunohistochemistry on RNA recovery from formalin-fixed paraffin-embedded tissue sections. Diagn Mol Pathol. 17(1): 51-58.

Wilfinger W.W. *et al.* (1997): Effect of pH and ionic strength on the spectorophotometric assessment of nucleic acid purity. Biotechniques 22, 474–481.

6.4 Product use restriction/warranty

NucleoSpin® totalRNA FFPE/NucleoSpin® totalRNA FFPE XS kit components are intended, developed, designed, and sold FOR RESEARCH PURPOSES ONLY, except, however, any other function of the product being expressly described in original MACHEREY-NAGEL product leaflets.

MACHEREY-NAGEL products are intended for GENERAL LABORATORY USE ONLY! MACHEREY-NAGEL products are suited for QUALIFIED PERSONNEL ONLY! MACHEREY-NAGEL products shall in any event only be used wearing adequate PROTECTIVE CLOTHING. For detailed information please refer to the respective Material Safety Data Sheet of the product! MACHEREY-NAGEL products shall exclusively be used in an ADEQUATE TEST ENVIRONMENT. MACHEREY-NAGEL does not assume any responsibility for damages due to improper application of our products in other fields of application. Application on the human body is STRICTLY FORBIDDEN. The respective user is liable for any and all damages resulting from such application.

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ONLY MACHEREY-NAGEL products specially labeled as IVD are also suitable for *IN VITRO*-diagnostic use. Please pay attention to the package of the product. *IN VITRO*-diagnostic products are expressly marked as IVD on the packaging.

IF THERE IS NO IVD SIGN, THE PRODUCT SHALL NOT BE SUITABLE FOR *IN VITRO*-DIAGNOSTIC USE!

ALL OTHER PRODUCTS NOT LABELED AS IVD ARE NOT SUITED FOR ANY CLINICAL USE (INCLUDING, BUT NOT LIMITED TO DIAGNOSTIC, THERAPEUTIC AND/OR PROGNOSTIC USE).

No claim or representations is intended for its use to identify any specific organism or for clinical use (included, but not limited to diagnostic, prognostic, therapeutic, or blood banking). It is rather in the responsibility of the user or - in any case of resale of the products - in the responsibility of the reseller to inspect and assure the use of the DNA/RNA/protein purification products of MACHEREY-NAGEL for a well-defined and specific application.

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