

---

March 2019

# QIAprep<sup>®</sup> Miniprep Handbook

For purification of molecular biology–grade DNA

Plasmids

Large plasmids (>10 kb)

Low-copy plasmids and cosmids

Plasmid DNA prepared by other methods

---

# Contents

|                                                                                                       |    |
|-------------------------------------------------------------------------------------------------------|----|
| Kit Contents.....                                                                                     | 4  |
| Storage .....                                                                                         | 6  |
| Intended Use .....                                                                                    | 6  |
| Safety Information.....                                                                               | 7  |
| Quality Control.....                                                                                  | 7  |
| Introduction .....                                                                                    | 8  |
| Principle .....                                                                                       | 9  |
| Using LyseBlue reagent.....                                                                           | 13 |
| Equipment and Reagents to Be Supplied by User .....                                                   | 15 |
| Important Notes.....                                                                                  | 16 |
| Guidelines for QIAvac manifolds.....                                                                  | 20 |
| QIAprep Spin procedure .....                                                                          | 24 |
| Protocol: Plasmid DNA Purification Using the QIAprep Spin Miniprep Kit<br>and a Microcentrifuge ..... | 25 |
| and 5 ml Collection Tubes .....                                                                       | 27 |
| and a Vacuum Manifold .....                                                                           | 28 |
| Protocol: Plasmid DNA Purification Using the QIAprep 96 Turbo Miniprep Kit .....                      | 31 |
| Troubleshooting Guide .....                                                                           | 34 |
| Appendix A: Background Information .....                                                              | 37 |
| Growth of bacterial cultures .....                                                                    | 37 |
| Preparation of cell lysates .....                                                                     | 40 |

---

|                                                            |    |
|------------------------------------------------------------|----|
| Appendix B: Agarose Gel Analysis of Plasmid DNA.....       | 42 |
| Appendix C: Special Applications .....                     | 43 |
| Purification of low-copy plasmids and cosmids .....        | 43 |
| Purification of plasmid DNA prepared by other methods..... | 44 |
| References .....                                           | 45 |
| Ordering Information .....                                 | 46 |
| Handbook Revision History .....                            | 51 |

# Kit Contents

| <b>QIAprep Spin Miniprep Kit</b> | <b>(50)</b>  | <b>(250)</b>         |
|----------------------------------|--------------|----------------------|
| <b>Catalog no.</b>               | <b>27104</b> | <b>27106</b>         |
| QIAprep 2.0 Spin Columns         | 50           | 250                  |
| Buffer P1                        | 20 ml        | 1 x 20 ml, 1 x 50 ml |
| Buffer P2                        | 20 ml        | 1 x 20 ml, 1 x 50 ml |
| Buffer N3*                       | 30 ml        | 140 ml               |
| Buffer PB*                       | 30 ml        | 150 ml               |
| Buffer PE (concentrate)          | 2 x 6 ml     | 55 ml                |
| Buffer EB                        | 15 ml        | 55 ml                |
| LyseBlue®                        | 20 µl        | 1 x 20 µl, 1 x 50 µl |
| Loading dye                      | 110 µl       | 550 µl               |
| RNase A†                         | 2 mg         | 1 x 2 mg, 1 x 5 mg   |
| Collection tubes (2 ml)          | 50           | 250                  |
| Quick-Start Protocol             | 1            | 1                    |

\* Buffers N3 and PB contain chaotropic salts which are irritants and not compatible with disinfecting agents containing bleach. Take appropriate laboratory safety measures and wear gloves when handling. See page 7 for safety information.

† Provided as a 100 mg/ml solution.

| <b>QIAprep 96 Turbo Miniprep Kit</b>   | <b>(4)</b>   | <b>(24)</b>            |
|----------------------------------------|--------------|------------------------|
| <b>Catalog no.</b>                     | <b>27191</b> | <b>27193</b>           |
| TurboFilter® 96 Plates                 | 4            | 24                     |
| QIAprep 96 Plates                      | 4            | 24                     |
| Buffer P1                              | 125 ml       | 1 x 150 ml, 3 x 250 ml |
| Buffer P2                              | 125 ml       | 1 x 150 ml, 3 x 250 ml |
| Buffer N3*                             | 2 x 80 ml    | 3 x 30 ml, 2 x 500 ml  |
| Buffer PB*                             | 500 ml       | 6 x 500 ml             |
| Buffer PE (concentrate)                | 2 x 100 ml   | 6 x 200 ml             |
| Buffer EB                              | 2 x 55 ml    | 1 x 55 ml, 2 x 250 ml  |
| RNase A†                               | 1 x 125 µl   | 1 x 15 mg, 3 x 25 mg   |
| Loading dye                            | 110 µl       | 550 µl                 |
| Tape pads                              | 1            | 6                      |
| Rack of collection microtubes (1.2 ml) | 4            | 24                     |
| Caps for collection microtubes         | 55 x 8       | 6 x 55 x 8             |
| S-Blocks                               | 4            | 24                     |
| Quick-Start Protocol                   | 1            | 1                      |

\* Buffers N3 and PB contain chaotropic salts which are irritants and not compatible with disinfecting agents containing bleach.

Take appropriate laboratory safety measures and wear gloves when handling. See page 7 for safety information.

† Provided as a 100 mg/ml solution.

---

## Storage

QIAprep Miniprep Kits should be stored dry at room temperature (15–25°C). Under these conditions, if no expiration date is mentioned on the kit label, QIAprep Miniprep Kits can be stored for up to 12 months without showing any reduction in performance and quality. For longer storage, these kits can be kept at 2–8°C. If any precipitate forms in the buffers after storage at 2–8°C, it should be redissolved by warming the buffers to 37°C before use.

After addition of RNase A and optional LyseBlue reagent, Buffer P1 is stable for 6 months when stored at 2–8°C. RNase A stock solution can be stored for 2 years at room temperature.


## Intended Use

QIAprep Miniprep Kits are intended for molecular biology applications. These products are not intended for the diagnosis, prevention or treatment of a disease.

All due care and attention should be exercised in the handling of the products. We recommend all users of QIAGEN® products to adhere to the NIH guidelines that have been developed for recombinant DNA experiments, or to other applicable guidelines.

# Safety Information

When working with chemicals, always wear a suitable lab coat, disposable gloves and protective goggles. For more information, please consult the appropriate safety data sheets (SDSs). These are available online in convenient and compact PDF format at [www.qiagen.com/safety](http://www.qiagen.com/safety) where you can find, view and print the SDS for each QIAGEN kit and kit component.

|                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>CAUTION</b></p>  | <p>DO NOT add bleach or acidic solutions directly to the sample-preparation waste.</p> <p>Buffers N3 and PB contain guanidine hydrochloride, which can form highly reactive compounds when combined with bleach.</p> <p>If liquid containing these buffers is spilt, clean with suitable laboratory detergent and water. If the spilt liquid contains potentially infectious agents, clean the affected area first with laboratory detergent and water, and then with 1% (v/v) sodium hypochlorite.</p> |
|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Quality Control

In accordance with QIAGEN's ISO-certified Quality Management System, each lot of the QIAprep Miniprep Kit is tested against predetermined specifications to ensure consistent product quality.

---

# Introduction

The QIAprep Miniprep system provides a fast, simple and cost-effective plasmid miniprep method for routine molecular biology laboratory applications. QIAprep Miniprep Kits use silica membrane technology to eliminate the cumbersome steps associated with loose resins or slurries. Plasmid DNA purified with QIAprep Miniprep Kits is immediately ready for use. Phenol extraction and ethanol precipitation are not required, and high-quality plasmid DNA is eluted in a small volume of Tris buffer or water. The QIAprep system consists of 2 products with different handling options to suit every throughput need.

## Low throughput

The QIAprep Spin Miniprep Kit is designed for quick and convenient processing of 1–24 samples simultaneously in less than 30 minutes. QIAprep 2.0 spin columns can be used in a microcentrifuge or on any vacuum manifold with luer connectors (e.g., QIAvac 24 Plus).

The QIAprep Spin Miniprep Kit can be fully automated on the QIAcube® Connect. The innovative QIAcube Connect uses advanced technology to process QIAGEN 2.0 spin columns, enabling seamless integration of automated, low-throughput sample prep into your laboratory workflow. Sample preparation using the QIAcube Connect follows the same steps as the manual procedure (i.e., lyse, bind, wash and elute), enabling you to continue using the QIAprep Spin Miniprep Kit for purification of high-quality plasmid DNA.

The QIAcube Connect is preinstalled with protocols for purification of plasmid DNA, genomic DNA, RNA, viral nucleic acids and proteins, plus DNA and RNA cleanup. The range of protocols available is continually expanding, and additional QIAGEN protocols can be downloaded free of charge at [www.qiagen.com/QIAcube-Connect](http://www.qiagen.com/QIAcube-Connect).



---

## High throughput

The QIAprep 96 Turbo Miniprep Kit enables up to 96 minipreps to be performed simultaneously in less than 45 minutes on the QIAvac 96. For automated high-throughput plasmid purification the QIAprep 96 Turbo BioRobot® Kit enables up to 96 minipreps to be processed in 70 minutes.

## Applications using QIAprep-purified DNA

Plasmid DNA prepared using the QIAprep system is suitable for a variety of routine applications, including:

- Restriction enzyme digestion
- Library screening
- In vitro translation
- Sequencing
- Ligation and transformation
- Transfection of robust cells

## Principle

The QIAprep Miniprep procedure is based on alkaline lysis of bacterial cells followed by adsorption of DNA onto silica in the presence of high salt (1). The unique silica membrane used in the QIAprep Miniprep Kit completely replaces glass or silica slurries for plasmid minipreps.

The procedure consists of 3 basic steps:

- Preparation and clearing of a bacterial lysate
- Adsorption of DNA onto the QIAprep membrane
- Washing and elution of plasmid DNA

---

All steps are performed without the use of phenol, chloroform, CsCl or ethidium bromide, and without alcohol precipitation.

## Preparation and clearing of bacterial lysate

The QIAprep miniprep procedure uses the modified alkaline lysis method of Birnboim and Doly (2). Bacteria are lysed under alkaline conditions, and the lysate is subsequently neutralized and adjusted to high-salt binding conditions in one step. After lysate clearing, the sample is ready for purification on the QIAprep silica membrane. For more details on growth of bacterial cultures and alkaline lysis, please refer to Appendix A, page 37. In the QIAprep Spin procedure, lysates are cleared by centrifugation, while the QIAprep 96 Turbo Miniprep Kit provides TurboFilter strips or plates for lysate clearing by filtration.

### LyseBlue reagent\*

Use of LyseBlue is optional and not required to successfully perform plasmid preparations. See “Using LyseBlue reagent” on page 13 for more information.

LyseBlue is a color indicator that provides visual identification of optimum buffer mixing. This prevents common handling errors that lead to inefficient cell lysis and incomplete precipitation of SDS, genomic DNA and cell debris. This makes LyseBlue ideal for use by researchers who have not had much experience with plasmid preparations, as well as experienced scientists who want to be assured of maximum product yield.

## DNA adsorption to the QIAprep membrane

QIAprep 2.0 columns, strips and plates use a silica membrane for selective adsorption of plasmid DNA in high-salt buffer and elution in low-salt buffer. The optimized buffers in the lysis

\* LyseBlue reagent is only supplied with the QIAprep Spin Miniprep Kit since multiwell or automated formats do not allow visual control of individual samples.

---

procedure, combined with the unique silica membrane, ensure that only DNA will be adsorbed, while RNA, cellular proteins and metabolites are not retained on the membrane but are found in the flow-through.

## Washing and elution of plasmid DNA

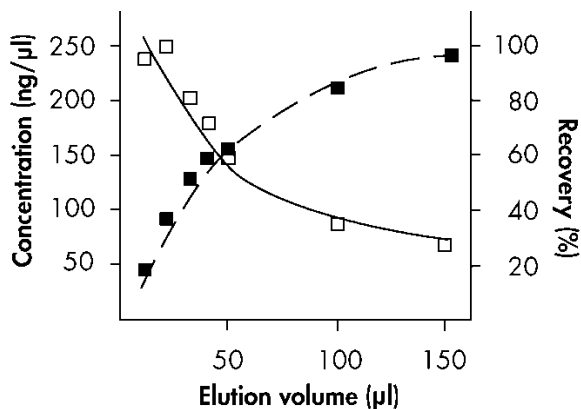
Endonucleases are efficiently removed by a brief wash step with Buffer PB. This step is essential when working with *endA+* strains such as the JM series, HB101 and its derivatives, or any wild-type strain, to ensure that plasmid DNA is not degraded. The Buffer PB wash step is also necessary when purifying low-copy plasmids, where large culture volumes are used.

Salts are efficiently removed by a brief wash step with Buffer PE. High-quality plasmid DNA is then eluted from the QIAprep 2.0 column with 50–100  $\mu$ l of Buffer EB or water. The purified DNA is ready for immediate use in a range of applications — no need to precipitate, concentrate or desalt.

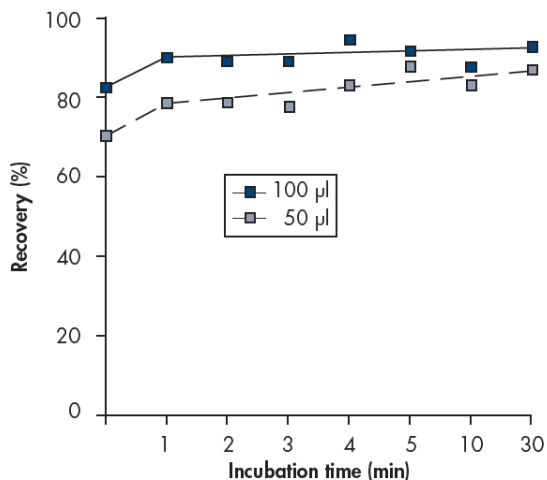
**Note:** Elution efficiency is dependent on pH. The maximum elution efficiency is achieved between pH 7.0 and 8.5. When using water for elution, make sure that the pH value is within this range. Store DNA at  $-20^{\circ}\text{C}$  when eluted with water, because DNA may degrade in the absence of a buffering agent.

## DNA yield

Plasmid yield with the QIAprep miniprep system varies depending on plasmid copy number per cell (see Appendix A, page 37), the individual insert in a plasmid, factors that affect growth of the bacterial culture (see page 37), the elution volume (Figure 1), and the elution incubation time (Figure 2). A 1.5 ml overnight culture can yield 5–15  $\mu$ g of plasmid DNA (Table 1, page 13). To obtain the optimum combination of DNA quality, yield and concentration, we recommend using Luria Bertani (LB) medium for growth of cultures (for composition see page Table 8, page 40), eluting plasmid DNA in a volume of 50  $\mu$ l and performing a short incubation after addition of the elution buffer.



**Figure 1. Elution volume versus DNA concentration and recovery.** Using the QIAprep Spin protocol, 10 μg pUC18 DNA was purified and eluted with the indicated volumes of Buffer EB. The standard protocol uses 50 μl Buffer EB for elution, because this combines high yield with high concentration. However the yield can be increased by increasing the elution volume.



**Figure 2. Incubation time versus DNA recovery.** Using the QIAprep Spin Miniprep protocol, 10 μg pBluescript DNA was purified and eluted after the indicated incubation times with either 50 μl or 100 μl Buffer EB. The graph shows that an incubation time of 1 min and doubling the elution buffer volume increase yield.

**Table 1. Effect of different compositions of growth medium LB on DNA yield**

| Culture media                   | Yield   |
|---------------------------------|---------|
| LB (containing 10 g/liter NaCl) | 11.5 µg |
| LB (containing 5 g/liter NaCl)  | 9.5 µg  |

QIAprep Spin Miniprep Kit was used to purify DNA from 1.5 ml LB overnight cultures of XL1-Blue containing pBluescript®. Elution was performed according to the standard protocol (50 µl Buffer EB and 1 min incubation). Use of the recommended LB composition (with 10 g/liter NaCl; see also Appendix A, page 37) provides optimal plasmid yield.

## Using LyseBlue reagent

Using a simple visual identification system, LyseBlue reagent prevents common handling errors that lead to inefficient cell lysis and incomplete precipitation of SDS, cell debris and genomic DNA.

LyseBlue can be added to the resuspension buffer (Buffer P1) bottle before use. Alternatively, smaller amounts of LyseBlue can be added to aliquots of Buffer P1, enabling single plasmid preparations incorporating visual lysis control to be performed.

LyseBlue reagent should be added to Buffer P1 at a ratio of 1:1000 to achieve the required working concentration (e.g., 10 µl LyseBlue into 10 ml Buffer P1). Make sufficient LyseBlue/Buffer P1 working solution for the number of plasmid preps being performed.

LyseBlue precipitates after addition into Buffer P1. This precipitate will completely dissolve after addition of Buffer P2. Shake Buffer P1 before use to resuspend LyseBlue particles.

The plasmid preparation procedure is performed as usual. After addition of Buffer P2 to Buffer P1, the color of the suspension changes to blue. Mixing should result in a homogeneously colored suspension. If the suspension contains localized regions of colorless

solution, or if brownish cell clumps are still visible, continue mixing the solution until a homogeneously colored suspension is achieved.

Upon addition of neutralization buffer (Buffer N3), LyseBlue turns colorless. The presence of a homogeneous solution with no traces of blue indicates that SDS from the lysis buffer has been effectively precipitated.

## Loading Dye

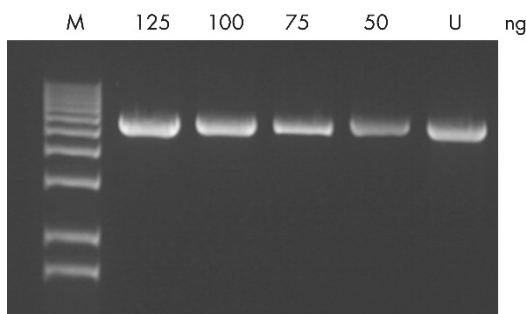
Loading Dye is provided for analysis of plasmid DNA samples using electrophoresis. It contains 3 marker dyes (bromophenol blue, xylene cyanol and orange G) that facilitate estimation of DNA migration distance and optimization of agarose gel run time. Refer to Table 2 to identify the dyes according to migration distance and agarose gel percentage and type. Loading Dye is supplied as a 5x concentrate; thus 1 volume of Loading Dye should be added to 5 volumes of purified DNA.

**Table 2. Migration distance of gel tracking dyes**

| <b>%TAE (TBE)<br/>agarose gel</b> | <b>Xylene cyanol<br/>(light blue)</b> | <b>Bromophenol blue<br/>(dark blue)</b> | <b>Orange G<br/>(orange)</b> |
|-----------------------------------|---------------------------------------|-----------------------------------------|------------------------------|
| 0.8                               | 5000 bp (3000 bp)                     | 800 bp (400 bp)                         | 150 bp (<100 bp)             |
| 1.0                               | 3000 bp (2000 bp)                     | 400 bp (250 bp)                         | <100 bp (<100 bp)            |
| 1.5                               | 1800 bp (1100 bp)                     | 250 bp (100 bp)                         | <100 bp (<100 bp)            |
| 2.0                               | 1000 bp (600 bp)                      | 200 bp (<100 bp)                        | <100 bp (<100 bp)            |
| 2.5                               | 700 bp (400 bp)                       | 100 bp (<50 bp)                         | <50 bp (<50 bp)              |

## Quantification of DNA fragments

DNA fragments can be quantified by running a sample alongside standards containing known quantities of the same-sized DNA fragment. The amount of sample DNA loaded can be estimated by visual comparison of the band intensity with that of the standards.



**Figure 3. Agarose gel analysis.** An unknown amount of a 5.5 kb DNA fragment (U) was run alongside known quantities (as indicated in ng) of the same DNA fragment. The unknown sample contained 75–100 ng DNA, as estimated by visual comparison with the standards. **M:** 1 kb DNA ladder.

## Equipment and Reagents to Be Supplied by User

When working with chemicals, always wear a suitable lab coat, disposable gloves and protective goggles. For more information, consult the appropriate safety data sheets (SDSs), available from the product supplier.

- Standard microbiological equipment for growing and harvesting bacteria (e.g., inoculating loop, culture tubes and flasks, and 37°C shaking incubator)
- Centrifuge with rotor for 96-well blocks. We recommend QIAGEN's Centrifuge 4-16S (cat. no. 80510) for room-temperature centrifugation; for refrigerated centrifugation, we recommend QIAGEN's Centrifuge 4-16KS (cat. no. 81610).
- 96–100% ethanol
- Vacuum pump (e.g., Vacuum Pump [cat. no. 84010])

- QIAvac 96 (cat. no. 19504)
- Elution Microtube Adapter (available from QIAGEN Technical Services) for QIAvac 96 for the elution step using the QIAvac 96. Alternatively, an empty microplate may be used to adjust the height of the elution microtubes; or the elution step could be performed in a suitable centrifuge, where no adapter is necessary.
- If the drying step is performed in a suitable centrifuge (optional), additional S-Blocks (Square-Well Blocks) or elution microtubes are required.
- If the complete procedure is performed using a centrifuge, additional S-Blocks are required.

## Important Notes

Please read the following notes before starting any of the QIAprep procedures.

### Growth of bacterial cultures in tubes or flasks

1. Pick a single colony from a freshly streaked selective plate and inoculate a culture of 1–5 ml LB medium containing the appropriate selective antibiotic. Incubate for 12–16 h at 37°C with vigorous shaking.

Growth for more than 16 h is not recommended, because cells begin to lyse and plasmid yields may be reduced. Use a tube or flask with a volume of at least 4 times the volume of the culture.

2. Harvest the bacterial cells by centrifugation at >8000 rpm (6800 × *g*) in a conventional table-top microcentrifuge for 3 min at room temperature (15–25°C).

The bacterial cells can also be harvested in 15 ml centrifuge tubes at 5400 × *g* for 10 min at 4°C. Remove all traces of supernatant by inverting the open centrifuge tube until all medium has been drained.



## Cell Cultivation in a 96-Well Block for QIAprep Turbo 96

1. Fill each well of a 96-well S-Block with 1.3 ml of growth medium containing the appropriate selective agent. Inoculate each well from a single bacterial colony. Incubate the cultures for 20–24 h at 37°C with vigorous shaking.

The wells in the block may be protected against spill-over by covering the block with a plastic lid or adhesive tape. AirPore microporous tape sheets promote gas exchange during culturing (see “Ordering Information”, page 46). If nonporous tape is used, use a needle to pierce 2–3 holes in the tape above each well for aeration.

2. Harvest the bacterial cells in the block by centrifugation for 5 min at 2100 x *g* in a centrifuge with a rotor for microtiter plates (e.g., QIAGEN Centrifuge 4K15C or Heraeus® Minifuge GL), preferably at 4–10°C. The block should be covered with adhesive tape during centrifugation. Remove media by inverting the block.

To remove the media, peel off the tape and quickly invert the block over a waste container. Tap the inverted block firmly on a paper towel to remove any remaining droplets of medium.

**WARNING:** Ensure that the buckets on the rotor have sufficient clearance to accommodate the 2 ml S-Blocks before starting the centrifuge.

### Buffer notes

- Add the provided RNase A solution to Buffer P1 before use. Use 1 vial RNase A (centrifuge briefly before use) per bottle Buffer P1 for a final concentration of 100 µg/ml. Mix and store at 2–8°C.
- Add ethanol (96–100%) to Buffer PE before use (see bottle label for volume).
- Check Buffers P2 and N3 before use for salt precipitation. Redissolve any precipitate by warming to 37°C. Do not shake Buffer P2 vigorously.
- Close the bottle containing Buffer P2 immediately after use to avoid acidification of Buffer P2 from CO<sub>2</sub> in the air.
- Buffers P2, N3 and PB contain irritants. Wear gloves when handling these buffers.

- **Optional:** Add the provided LyseBlue reagent to Buffer P1 and mix before use. Use 1 vial LyseBlue reagent per bottle Buffer P1 for a final dilution of 1:1000 (e.g., 10 µl LyseBlue into 10 ml Buffer P1). LyseBlue provides visual identification of optimum buffer mixing, thereby preventing the common handling errors that lead to inefficient cell lysis and incomplete precipitation of SDS, genomic DNA and cell debris. For more details, see “Using LyseBlue reagent” on page 13.

### Centrifugation notes

- All centrifugation steps are carried out at 13,000 rpm (~17,900 x g) in a conventional table-top microcentrifuge.

### Vacuum notes

- Switch off vacuum between steps to ensure that a consistent, even vacuum is applied during manipulations.
- Wear safety glasses when working near a manifold under pressure.
- For safety reasons, do not use 96-well plates that have been damaged in any way.
- For the QIAprep 96 Turbo miniprep procedure, the negative pressure (vacuum) should be regulated before beginning the procedure by applying the vacuum to the appropriate number of *empty* QIAprep modules (indicated in Table 3) on the QIAvac manifold.

The vacuum pressure is the pressure differential between the inside of the manifold and the atmosphere (standard atmospheric pressure: 1013 millibar, or 760 mm Hg) and can be measured using a vacuum regulator (see “Ordering Information”, page 46). Vacuum recommendations are given in negative units (Table 3) to indicate the required reduction in pressure with respect to the atmosphere. Table 4 provides pressure conversions to other units.

- Use of a vacuum pressure lower than recommended may reduce DNA yield and purity.

**Table 3. Regulation of vacuum pressures for QIAprep multiwell procedures**

| Procedure        | Vacuum manifold | Module used for checking pressure* | Vacuum pressure <sup>†</sup> |             |
|------------------|-----------------|------------------------------------|------------------------------|-------------|
|                  |                 |                                    | mbar                         | mm Hg       |
| QIAprep 96 Turbo | QIAvac 96       | QIAprep 96 plate                   | -200 to -40                  | -150 to -30 |

\* Pressure should be regulated using empty modules on the manifold.

† Values apply to empty modules on QIAvac. During the working procedure the vacuum may exceed the values indicated.

**Table 4. Pressure conversions**

| To convert from millibars (mbar) to | Multiply by |
|-------------------------------------|-------------|
| Millimeters of mercury (mm Hg)      | 0.75        |
| Kilopascals (kPa)                   | 0.1         |
| Inches of mercury (inch Hg)         | 0.0295      |
| Torr (Torr)                         | 0.75        |
| Atmospheres (atm)                   | 0.000987    |
| Pounds per square inch (psi)        | 0.0145      |

## Elution notes

- Ensure that the elution buffer is dispensed directly onto the center of the QIAprep membrane for optimal elution of DNA. Average eluate volume is 48 µl from an elution buffer volume of 50 µl (QIAprep spin procedures), and 60 µl from an elution buffer volume of 100 µl (QIAprep multiwell procedures).
- For increased DNA yield, use a higher elution-buffer volume. For increased DNA concentration, use a lower elution-buffer volume (see “DNA yield”, page 11).
- If water is used for elution, make sure that its pH is between 7.0 and 8.5. Elution efficiency is dependent on pH, and the maximum elution efficiency is achieved within this range. A pH <7.0 can decrease yield.

**Note:** Store DNA at -20°C when eluted with water, as DNA may degrade in the absence of a buffering agent.

- DNA can also be eluted in TE buffer (10 mM Tris-Cl, 1 mM EDTA, pH 8.0), but the EDTA may inhibit subsequent enzymatic reactions.

## Multichannel pipette recommendations

Many steps of the QIAprep 96 Turbo procedure require repeated pipetting, and a reservoir or multichannel pipette can greatly facilitate liquid handling. The E1-ClipTip™ electronic pipettes (cat. no. 4672100BT) can be purchased from Thermo Fisher Scientific: [www.thermofisher.com](http://www.thermofisher.com).

## Pipette tip recommendations

Some standard 1 ml pipette tips are not easily accommodated in the S-Blocks that are used in the QIAprep 96 Turbo Miniprep protocol. When pipetting into S-Blocks, we recommend using pipette tips with 1.25 ml or 1.5 ml fill volume, such as:

- ClipTip 1250 pipette tips for use with the E1-ClipTip pipet mentioned above. These can be purchased from the supplier listed above.
- Finntip™ Multistepper pipette tips for use with single-channel pipettes. These are available from Thermo Fisher Scientific: [www.thermofisher.com](http://www.thermofisher.com).

## Guidelines for QIAvac manifolds

QIAvac 24 Plus and QIAvac 96 facilitate DNA minipreps by providing a convenient modular vacuum manifold for use with the QIAprep system. The following recommendations should be followed when handling QIAvac manifolds:

- QIAvac manifolds operate with a house vacuum or Vacuum Pump (e.g., Vacuum Pump, cat. no. 84010 [USA and Canada], 84000 [Japan], or 84020 [rest of world]).
- Always store QIAvac manifolds clean and dry. To clean, simply rinse all components with water and dry with paper towels. Do not air dry, as the screws may rust and need to be replaced. Do not use abrasives or solvents.

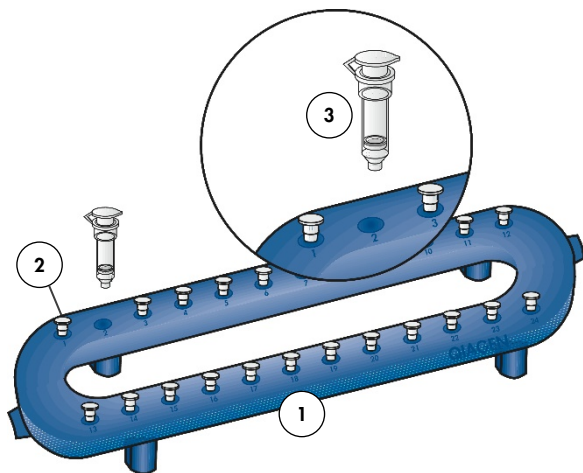
- Always place the QIAvac manifold on a secure bench top or work area. If dropped, the manifold may crack.
- The components of QIAvac manifolds are not resistant to ethanol, methanol or other organic solvents (Table 5). Do not bring solvents into contact with the vacuum manifold. If solvents are spilled on the unit, rinse thoroughly with distilled water. Ensure that no residual Buffer PE remains in the vacuum manifold.
- To ensure consistent performance, do not apply silicone or vacuum grease to any part of a QIAvac manifold. The spring lock on the top plate and the self-sealing gasket (QIAvac 96) provide an airtight seal when vacuum is applied to the assembled unit. To maximize product life, rinse the gasket free of salts and buffers after each use and dry with paper towels before storage.

**Table 5. Chemical-resistance properties of QIAvac manifolds**

| <b>Resistant to</b>   | <b>Not resistant to</b> |            |
|-----------------------|-------------------------|------------|
| Chlorine bleach (12%) | Acetic acid*            | Benzene    |
| Hydrochloric acid     | Acetone                 | Chloroform |
| Sodium chloride       | Chromic acid*           | Ethers     |
| Sodium hydroxide      | Phenol                  | Toluene    |
| Urea                  | Concentrated alcohols*  |            |

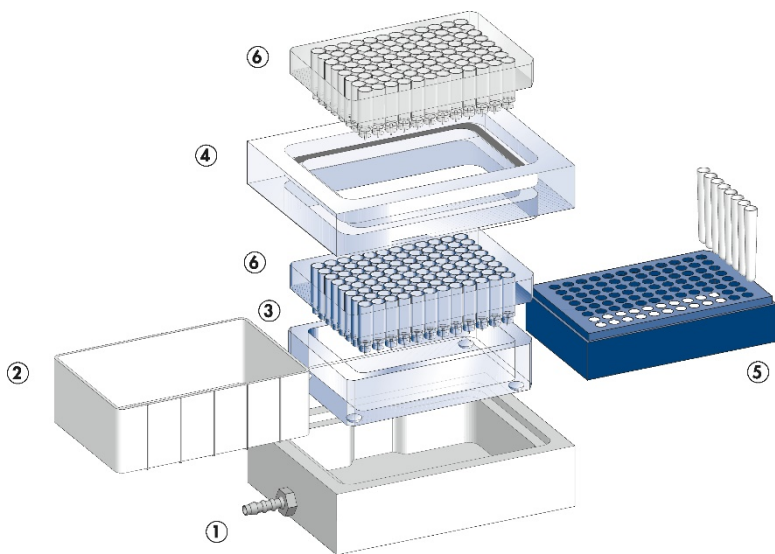
\* QIAvac 24 Plus is resistant to these chemicals.

## QIAvac vacuum manifolds



**Figure 4. Components of the QIAvac 24 Plus manifold.**

1. QIAvac 24 Plus vacuum manifold
2. Luer slot closed with luer plug
3. Spin column



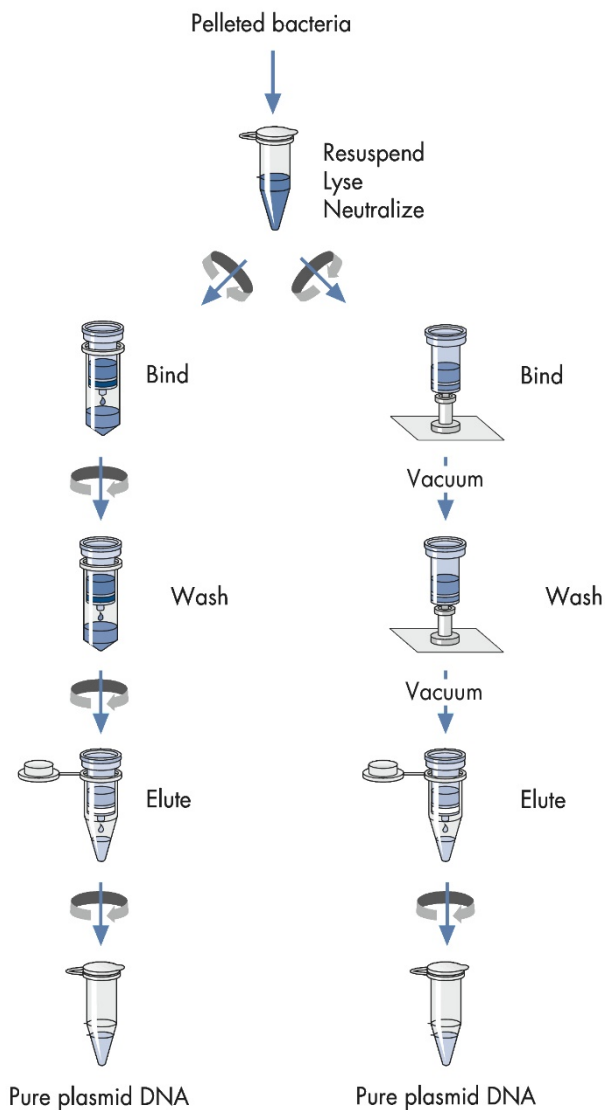
**Figure 5. Components of the QIAvac 96 manifold.**

1. QIAvac base, which holds a waste tray, a plate holder or a microtube rack
2. Waste tray
3. Plate holder (shown with 96-well plate)
4. QIAvac 96 top plate with aperture for 96-well plate
5. Microtube rack
6. 96-well plate (not included with QIAvac 96, included in QIAprep 96 Turbo Miniprep Kits)

# QIAprep Spin Procedure

in microcentrifuges      on vacuum manifolds

---





---

# Protocol: Plasmid DNA Purification Using the QIAprep Spin Miniprep Kit and a Microcentrifuge

This protocol is designed for the purification of up to 20 µg of high-copy plasmid DNA from 1–5 ml overnight cultures of *E. coli* in LB medium. For purification of low-copy plasmids and cosmids, large plasmids (>10 kb), and DNA prepared using other methods, refer to Appendix C, page 43.

Please read “Important Notes”, page 15, before starting.

**Note:** All protocol steps should be carried out at room temperature (15–25°C).

## Procedure

1. Resuspend pelleted bacterial cells in 250 µl Buffer P1 and transfer to a microcentrifuge tube.

Ensure that RNase A has been added to Buffer P1. No cell clumps should be visible after resuspension of the pellet.

If LyseBlue reagent has been added to Buffer P1, vigorously shake the buffer bottle to ensure LyseBlue particles are completely dissolved. The bacteria should be resuspended completely by vortexing or pipetting up and down until no cell clumps remain.

2. Add 250 µl Buffer P2 and mix thoroughly by inverting the tube 4–6 times.

Mix gently by inverting the tube. Do not vortex, because this will result in shearing of genomic DNA. If necessary, continue inverting the tube until the solution becomes viscous and slightly clear. Do not allow the lysis reaction to proceed for more than 5 min.

If LyseBlue has been added to Buffer P1, the cell suspension will turn blue after addition of Buffer P2. Mixing should result in a homogeneously colored suspension. If the suspension contains localized colorless regions, or if brownish cell clumps are still visible, continue mixing the solution until a homogeneously colored suspension is achieved.

3. Add 350  $\mu$ l Buffer N3. Mix immediately and thoroughly by inverting the tube 4–6 times. To avoid localized precipitation, mix the solution thoroughly, immediately after addition of Buffer N3. Large culture volumes (e.g.,  $\geq 5$  ml) may require inverting up to 10 times. The solution should become cloudy.

If LyseBlue reagent has been used, the suspension should be mixed until all trace of blue has gone and the suspension is colorless. A homogeneous colorless suspension indicates that the SDS has been effectively precipitated.

4. Centrifuge for 10 min at 13,000 rpm ( $\sim 17,900 \times g$ ) in a table-top microcentrifuge. A compact white pellet will form.
5. Apply 800  $\mu$ l of the supernatant from step 4 to the QIAprep 2.0 spin column by pipetting.
6. Centrifuge for 30–60 s. Discard the flow-through.
7. Recommended: Wash the QIAprep 2.0 spin column by adding 0.5 ml Buffer PB and centrifuging for 30–60 s. Discard the flow-through.

This step is necessary to remove trace nuclease activity when using *endA*<sup>+</sup> strains such as the JM series, HB101 and its derivatives, or any wild-type strain, which have high levels of nuclease activity or high carbohydrate content. Host strains such as XL-1 Blue and DH5<sup>®</sup> $\alpha$  do not require this additional wash step.

8. Wash QIAprep 2.0 spin column by adding 0.75 ml Buffer PE and centrifuging for 30–60 s.
9. Discard the flow-through, and centrifuge at full speed for an additional 1 min to remove residual wash buffer.

**IMPORTANT:** Residual wash buffer will not be completely removed unless the flow-through is discarded before this additional centrifugation. Residual ethanol from Buffer PE may inhibit subsequent enzymatic reactions.

10. Place the QIAprep 2.0 column in a clean 1.5 ml microcentrifuge tube. To elute DNA, add 50  $\mu$ l Buffer EB (10 mM Tris-Cl, pH 8.5) or water to the center of each QIAprep 2.0 spin column, let stand for 1 min and centrifuge for 1 min.

---

# Protocol: Plasmid DNA Purification Using the QIAprep Spin Miniprep Kit and 5 ml Collection Tubes

The QIAprep Spin Miniprep procedure can be performed using 5 ml centrifuge tubes (e.g., Greiner®, cat. no. 115101 or 115261) as collection tubes to decrease handling. The standard protocol on pages 25–26 should be followed with the following modifications:

- Step 4:** Place a QIAprep 2.0 spin column in a 5 ml centrifuge tube instead of a 2 ml collection tube.
- Step 6:** Centrifuge at  $3000 \times g$  for 1 min using a suitable rotor (e.g., Beckman® GS-6KR centrifuge at ~4000 rpm). (The flow-through does not need to be discarded.)
- Steps 7 and 8:** For washing steps, centrifugation should be performed at  $3000 \times g$  for 1 min. (The flow-through does not need to be discarded.)
- Step 9:** Transfer the QIAprep 2.0 spin column to a microcentrifuge tube. Centrifuge at maximum speed for 1 min. Continue with step 10 of the protocol.

---

# Protocol: Plasmid DNA Purification Using the QIAprep Spin Miniprep Kit and a Vacuum Manifold

This protocol is designed for purification of up to 20 µg high-copy plasmid DNA from 1–5 ml overnight cultures of *E. coli* grown in LB medium, using QIAprep 2.0 spin columns on QIAvac 24 Plus or other vacuum manifolds with luer connectors. For purification of low-copy plasmids and cosmids, large plasmids (>10 kb) and DNA prepared using other methods, refer to Appendix C, page 43.

Please read “Important Notes”, page 15, before starting.

**Note:** All protocol steps should be carried out at room temperature (15–25°C).

## Procedure

1. Resuspend pelleted bacterial cells in 250 µl Buffer P1 and transfer to a microcentrifuge tube.

Ensure that RNase A has been added to Buffer P1. No cell clumps should be visible after resuspension of the pellet.

If LyseBlue reagent has been added to Buffer P1, vigorously shake the buffer bottle to ensure LyseBlue particles are completely dissolved. The bacteria should be resuspended completely by vortexing or pipetting up and down until no cell clumps remain.

2. Add 250 µl Buffer P2 and mix thoroughly by inverting the tube gently 4–6 times.

Do not vortex, because this will result in shearing of genomic DNA. If necessary, continue inverting the tube until the solution becomes viscous and slightly clear. Do not allow the lysis reaction to proceed for more than 5 min.

If LyseBlue has been added to Buffer P1, the cell suspension will turn blue after addition of Buffer P2. Mixing should result in a homogeneously colored suspension. If the suspension contains localized colorless regions, or if brownish cell clumps are still visible, continue mixing the solution until a homogeneously colored suspension is achieved.

3. Add 350  $\mu$ l Buffer N3. Mix immediately and thoroughly by inverting the tube 4–6 times. To avoid localized precipitation, mix the solution gently but thoroughly immediately after addition of Buffer N3. Large culture volumes (e.g.,  $\geq 5$  ml) may require inverting up to 10 times. The solution should become cloudy.

If LyseBlue reagent has been used, the suspension should be mixed until all trace of blue has gone and the suspension is colorless. A homogeneous colorless suspension indicates that the SDS has been effectively precipitated.

4. Centrifuge for 10 min at 13,000 rpm ( $\sim 17,900 \times g$ ) in a table-top microcentrifuge. A compact white pellet will form.

During centrifugation, prepare the vacuum manifold and QIAprep 2.0 spin columns.

**For QIAvac 24 Plus (see pages 18, and 20–22):**

- Ensure that the vacuum source is connected to the upper threaded hole of the QIAvac 24 Plus and the lower threaded hole is tightly sealed using the screw cap.
- If using the QIAvac Connecting System, connect the system to the manifold and vacuum sourced as described in the QIAvac 24 Plus Handbook.
- Insert up to 24 spin columns into the luer slots of the QIAvac 24 Plus. Close unused luer slots with luer plugs.

**For other vacuum manifolds:** Follow the supplier's instructions. Insert each QIAprep 2.0 column into a luer connector.

5. Apply 800  $\mu$ l of the supernatant from step 4 to the QIAprep 2.0 spin column by pipetting.
6. Switch on vacuum source to draw the solution through the QIAprep 2.0 spin columns, and then switch off vacuum source.

- 
7. **Recommended:** Wash the QIAprep 2.0 spin column by adding 0.5 ml Buffer PB. Switch on vacuum source. After the solution has moved through the column, switch off the vacuum source.

This step is necessary to remove trace nuclease activity when using *endA+* strains such as the JM series, HB101 and its derivatives, or any wild-type strain, which have high levels of nuclease activity or high carbohydrate content. Host strains such as XL-1 Blue and DH5 $\alpha$  do not require this additional wash step.
  8. Wash the QIAprep 2.0 spin column by adding 0.75 ml Buffer PE. Switch on vacuum source to draw the wash solution through the column, and then switch off vacuum source.
  9. Transfer the QIAprep 2.0 spin columns to a microcentrifuge tube. Centrifuge for 1 min.

**IMPORTANT:** This extra spin is necessary to remove residual Buffer PE. Residual ethanol from Buffer PE may inhibit subsequent enzymatic reactions.
  10. Place the QIAprep 2.0 column in a clean 1.5 ml microcentrifuge tube. To elute DNA, add 50  $\mu$ l Buffer EB (10 mM Tris-Cl, pH 8.5) or water to the center of the QIAprep 2.0 spin column, let stand for 1 min and centrifuge for 1 min.

# Protocol: Plasmid DNA Purification Using the QIAprep 96 Turbo Miniprep Kit

This protocol is designed for high-throughput plasmid DNA minipreps using TurboFilter 96 and QIAprep 96 plates on QIAvac 96. The kit accommodates up to 96 parallel preparations of up to 20 µg of high-copy plasmid DNA from 1–5 ml overnight cultures of *E. coli* grown in LB medium. If 1.3 ml overnight cultures are used, up to 96 cultures can be grown in an S-Block (see page 17 for protocol). For purification of low-copy plasmids and cosmids, large plasmids (>10 kb), and DNA prepared using other methods, refer to the recommendations in Appendix C, page 43. DNA purification can be automated; please call QIAGEN for more details.

Please read “Important Notes”, page 15, before starting.

**Note:** All protocol steps should be carried out at room temperature (15–25°C).

## Procedure

1. Resuspend pelleted bacterial cells in 250 µl Buffer P1 and transfer to the S-Block (if cells were not harvested in this block) provided with the kit.

Ensure that RNase A has been added to Buffer P1. No cell clumps should be visible after resuspension of the pellet.

2. Add 250 µl Buffer P2 to each sample. Dry the top of the S-Block with a paper towel, seal the block with the tape provided, gently invert the block 4–6 times to mix, and incubate at room temperature for 5 min.

It is important to mix gently by inverting the block. Do not shake vigorously, as this will result in shearing of genomic DNA. If necessary, continue inverting the block until the solution becomes viscous and slightly clear.

**During incubation, prepare QIAvac 96 (see pages 18–23):**

- Place the TurboFilter 96 plate in the QIAvac top plate, and make sure that the plate is seated securely. Seal unused wells of the TurboFilter with tape.
  - Place the plate holder inside the QIAvac base. Place QIAprep 96 plate into the plate holder.
  - Place QIAvac 96 top plate squarely over base. The QIAprep plate should now be positioned under the TurboFilter plate. Attach QIAvac to a vacuum source.
3. Remove the tape from the block. Add 350  $\mu$ l Buffer N3 to each sample, dry the top of the S-Block with a paper towel, and seal the block with a new tape sheet. Gently invert the block 4–6 times.

To avoid localized precipitation, mix the samples gently but thoroughly, immediately after addition of Buffer N3. The solutions should become cloudy.

4. Remove the tape from the block. Pipet the lysates from step 3 (850  $\mu$ l per well) into the wells of the TurboFilter plate. Unused wells of the TurboFilter plate should be sealed with tape. Apply vacuum until all samples have passed through.

The optimal flow rate is approximately 1–2 drops per second, which can be regulated by using a 3-way valve or vacuum regulator (see “Ordering Information”, page 48) between the QIAvac and the vacuum source.

5. Switch off vacuum and ventilate the QIAvac 96 slowly. Discard the TurboFilter plate. Transfer the QIAprep plate containing the cleared lysates to the top plate of the manifold. Seal any unused wells of the QIAprep plate with tape. Replace plate holder in the base with waste tray. Place the top plate squarely over the base, making sure that the QIAprep plate is seated securely. Apply vacuum.

The flow-through is collected in the waste tray.

6. **Recommended:** Switch off vacuum, and wash QIAprep plate by adding 0.9 ml Buffer PB to each well and applying vacuum.

This step is necessary to remove trace nuclease activity when using *endA*<sup>+</sup> strains such as the JM series, HB101 and its derivatives, or any wild-type strain, which have high



levels of nuclease activity or high carbohydrate content. Host strains such as XL-1 Blue and DH5 $\alpha$  do not require this additional step.

7. Switch off vacuum. Wash QIAprep plate by adding 0.9 ml of Buffer PE to each well and applying vacuum. Repeat once.
8. After Buffer PE has been drawn through all wells, apply maximum vacuum for an additional 10 min to dry the membrane.

**IMPORTANT:** This step removes residual Buffer PE from the membrane. The removal is only effective when maximum vacuum is used (i.e., turn off vacuum regulator or leakage valves if they are used), allowing maximum airflow to go through the wells.

9. Switch off vacuum, and ventilate the QIAvac 96 slowly. Lift the top plate from the base (not the QIAprep plate from the top plate), vigorously tap the top plate on a stack of absorbent paper until no drops come out, and blot the nozzles of the QIAprep plate with clean absorbent paper. Proceed either to step 10a or 10b, as desired.

This step removes residual Buffer PE, which may be present around the outlet nozzles and collars of QIAprep plate. Residual ethanol from Buffer PE may inhibit subsequent enzymatic reactions.

**10a. For elution into provided collection microtubes:**

Replace waste tray with the blue collection microtube rack containing 1.2 ml collection microtubes. Place the top plate back on the base, making sure that the QIAprep plate is seated securely.

**10b. For elution into a 96-well microplate:**

Replace waste tray with an empty blue collection microtube rack (provided with the QIAvac 96). Place a 96-well microplate directly on the rack. Place the top plate back on the base, making sure that the QIAprep plate is positioned securely.

11. To elute DNA, add 100  $\mu$ l of Buffer EB (10 mM Tris-Cl, pH 8.5) or water to the center of each well of the QIAprep plate, let stand for 1 min, and apply maximum vacuum for 5 min. Switch off vacuum and ventilate QIAvac 96 slowly.

For increased DNA concentration, an elution volume of 75  $\mu$ l can be used.

# Troubleshooting Guide

This troubleshooting guide may be helpful in solving any problems that may arise. For more information, see also the Frequently Asked Questions page at our Technical Support Center: [www.qiagen.com/FAQ/FAQList.aspx](http://www.qiagen.com/FAQ/FAQList.aspx). The scientists in QIAGEN Technical Services are always happy to answer any questions you may have about either the information and/or protocols in this handbook or sample and assay technologies (for contact information, visit [www.qiagen.com](http://www.qiagen.com)).

---

## Comments and suggestions

---

### Low or no yield

#### General

Low yields may be caused by a number of factors. To find the source of the problem, analyze fractions saved from each step in the procedure on an agarose gel (e.g., Figure 6, page 42). A small amount of the cleared lysate and the entire flow-through can be precipitated by adding 0.7 volumes isopropanol and centrifuging at maximum speed (13,000 rpm or ~17,000 x g) for 30 minutes. The entire wash flow-through can be precipitated by adding 0.1 volumes of 3 M sodium acetate, pH 5.0, and 0.7 volumes of isopropanol.

### No DNA in the cleared lysate before loading

- |                                 |                                                                                                                          |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| a) Plasmid did not propagate    | Read "Growth of bacterial cultures" (page 37) and check that the conditions for optimal growth were met.                 |
| b) Lysate prepared incorrectly  | Check storage conditions and age of buffers.                                                                             |
| c) Buffer P2 precipitated       | Redissolve by warming to 37°C.                                                                                           |
| d) Cell resuspension incomplete | Pelleted cells should be completely resuspended in Buffer P1. Do not add Buffer P2 until an even suspension is obtained. |

### DNA is found in the flow-through of cleared lysate

- |                                |                                                                                                                                                                                                                                                      |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a) QIAprep membrane overloaded | If rich culture media such as TB or 2x YT are used, culture volumes must be reduced. It may be necessary to adjust LB culture volume if the plasmid and host strain show extremely high copy number or growth rates. See "Culture media" on page 39. |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

---

### Comments and suggestions

---

- |    |                                |                                                                                                                        |
|----|--------------------------------|------------------------------------------------------------------------------------------------------------------------|
| b) | RNase A digestion omitted      | Ensure that RNase A is added to Buffer P1 before use.                                                                  |
| c) | RNase A digestion insufficient | Reduce culture volume if necessary. If Buffer P1 containing RNase A is more than 6 months old, add additional RNase A. |

### DNA is found in the wash flow-through

|                                  |                                                                   |
|----------------------------------|-------------------------------------------------------------------|
| Ethanol omitted from wash buffer | Repeat procedure with correctly prepared wash buffer (Buffer PE). |
|----------------------------------|-------------------------------------------------------------------|

### Little or no DNA in eluate

- |    |                                                    |                                                                                                                                                                                                                                                                                             |
|----|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a) | Elution buffer incorrect                           | DNA is eluted only in the presence of low-salt buffer (e.g., Buffer EB [10 mM Tris-Cl, pH 8.5]) or water. Elution efficiency is dependent on pH. The maximum efficiency is achieved between pH 7.0 and 8.5. When using water for elution, make sure that the pH value is within this range. |
| b) | Elution buffer incorrectly dispensed onto membrane | Add elution buffer to the center of the QIAprep membrane to ensure that the buffer completely covers the surface of the membrane for maximum elution efficiency.                                                                                                                            |

### Low DNA quality

#### DNA does not perform well in downstream applications

- |    |                                  |                                                                                                                                                                                                                                                                                           |
|----|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a) | Eluate salt concentration        | For the QIAprep 2.0 spin column, modify the wash step by adding 0.75 ml of Buffer PE into the column, centrifuging, and then incubating the column for 5 min at room temperature (15–25°C). For QIAprep 96 Turbo preparations, ensure that 2 wash steps are carried out prior to elution. |
| b) | Nuclease contamination           | When using <i>endA+</i> host strains – such as HB101 and its derivatives, the JM series, or any wild-type strain – ensure that the wash step with Buffer PB is performed.                                                                                                                 |
| c) | Eluate contains residual ethanol | Ensure that step 9 in the QIAprep Spin Miniprep protocol (page 26) and step 9 (page 33) in the QIAprep 96 Turbo Miniprep protocol are performed.                                                                                                                                          |

### RNA in the eluate

- |    |                                |                                                                                                                        |
|----|--------------------------------|------------------------------------------------------------------------------------------------------------------------|
| a) | RNase A digestion omitted      | Ensure that RNase A is added to Buffer P1 before use.                                                                  |
| b) | RNase A digestion insufficient | Reduce culture volume if necessary. If Buffer P1 containing RNase A is more than 6 months old, add additional RNase A. |

---

### Comments and suggestions

---

#### Genomic DNA in the eluate

- |                                |                                                                                                                                                      |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| a) Buffer P2 added incorrectly | The lysate must be handled gently after addition of Buffer P2 to prevent shearing. Reduce culture volume if lysate is too viscous for gentle mixing. |
| b) Buffer N3 added incorrectly | Upon addition of Buffer N3 in step 3 (page 26), mix immediately but gently.                                                                          |
| c) Lysis too long              | Lysis in step 2 (page 25) must not exceed 5 minutes.                                                                                                 |
| d) Culture overgrown           | Overgrown cultures contain lysed cells and degraded DNA. Do not grow cultures for longer than 12–16 hours.                                           |

# Appendix A: Background Information

## Growth of bacterial cultures

Plasmids are generally prepared from bacterial cultures grown in the presence of a selective agent such as an antibiotic (3, 4). The yield and quality of plasmid DNA may depend on factors such as plasmid copy number, host strain, inoculation, antibiotic and type of culture medium.

### Plasmid copy number

Plasmids vary widely in their copy number per cell (Table 6), depending on their origin of replication (e.g., pMB1, ColE1 or pSC101), which determines whether they are under relaxed or stringent control; and depending on the size of the plasmid and its associated insert. Some plasmids, such as the pUC series and derivatives, have mutations that allow them to reach very high copy numbers within the bacterial cell. Plasmids based on pBR322 and cosmids are generally present in lower copy numbers. Very large plasmids and cosmids are often maintained at very low copy numbers per cell.

**Table 6. Origins of replication and copy numbers of various plasmids (3)**

| DNA construct          | Origin of replication | Copy number | Classification |
|------------------------|-----------------------|-------------|----------------|
| <b>Plasmids</b>        |                       |             |                |
| pUC vectors            | pMB1 *                | 500–700     | High copy      |
| pBluescript vectors    | ColE1                 | 300–500     | High copy      |
| pGEM® vectors          | pMB1 *                | 300–400     | High copy      |
| pTZ vectors            | pMB1 *                | >1000       | High copy      |
| pBR322 and derivatives | pMB1 *                | 15–20       | Low copy       |
| pACYC and derivatives  | p15A                  | 10–12       | Low copy       |
| pSC101 and derivatives | pSC101                | ~5          | Very low copy  |
| <b>Cosmids</b>         |                       |             |                |
| SuperCos               | ColE1                 | 10–20       | Low copy       |
| pWE15                  | ColE1                 | 10–20       | Low copy       |

\* The pMB1 origin of replication is closely related to that of ColE1 and falls in the same incompatibility group. The high-copy-number plasmids listed here contain mutated versions of this origin.

---

## Host strains

Most *E. coli* strains can be used successfully to isolate plasmid DNA, although the strain used to propagate a plasmid has an effect on the quality of the purified DNA. Host strains such as DH1, DH5 $\alpha$  and C600 give high-quality DNA. The slower-growing strain XL1-Blue also yields DNA of very high quality, which works extremely well for sequencing. Strain HB101 and its derivatives, such as TG1 and the JM series, produce large amounts of carbohydrates, which are released during lysis and can inhibit enzyme activities if not completely removed (4). In addition, these strains have high levels of endonuclease activity which can reduce DNA quality. The methylation and growth characteristics of the strain should also be taken into account when selecting a host strain. XL1-Blue and DH5 $\alpha$  are highly recommended for reproducible and reliable results.

## Inoculation

Bacterial cultures for plasmid preparation should always be grown from a single colony picked from a freshly streaked selective plate. Subculturing directly from glycerol stocks, agar stabs and liquid cultures may lead to uneven plasmid yield or loss of the plasmid. Inoculation from plates that have been stored for a long time may also lead to loss or mutation of the plasmid.

The desired clone should be streaked from a glycerol stock onto a freshly prepared agar plate containing the appropriate selective agent so that single colonies can be isolated. This procedure should then be repeated to ensure that a single colony of an antibiotic-resistant clone can be picked. A single colony should be inoculated into 1–5 ml of media containing the appropriate selective agent and grown with vigorous shaking for 12–16 hours. Growth for more than 16 hours is not recommended, because cells begin to lyse and plasmid yields may be reduced.

## Antibiotics

Antibiotic selection should be applied at all stages of growth. Many plasmids in use today do not contain the *par* locus that ensures that the plasmids segregate equally during cell division. Daughter cells that do not receive plasmids will replicate much faster than plasmid-containing cells in the absence of selective pressure, and can quickly take over the culture.

The stability of the selective agent should also be taken into account. Resistance to ampicillin, for example, is mediated by  $\beta$ -lactamase, which is encoded by the plasmid-linked *bla* gene and which hydrolyzes ampicillin. Levels of ampicillin in the culture medium are thus continually depleted. This phenomenon is clearly demonstrated on ampicillin plates, where “satellite colonies” appear as the ampicillin is hydrolyzed in the vicinity of a growing colony. Ampicillin is also very sensitive to temperature, and when in solution should be stored frozen in single-use aliquots. The recommendations given in Table 7 are based on these considerations.

**Table 7. Concentrations of commonly used antibiotics**

| Antibiotic               | Stock solutions     |         | Working concentration (dilution) |
|--------------------------|---------------------|---------|----------------------------------|
|                          | Concentration       | Storage |                                  |
| Ampicillin (sodium salt) | 50 mg/ml in water   | -20°C   | 100 $\mu$ g/ml (1/500)           |
| Chloramphenicol          | 34 mg/ml in ethanol | -20°C   | 170 $\mu$ g/ml (1/200)           |
| Kanamycin                | 10 mg/ml in water   | -20°C   | 50 $\mu$ g/ml (1/200)            |
| Streptomycin             | 10 mg/ml in water   | -20°C   | 50 $\mu$ g/ml (1/200)            |
| Tetracycline HCl         | 5 mg/ml in ethanol  | -20°C   | 50 $\mu$ g/ml (1/100)            |

## Culture media

LB broth is the recommended culture medium for use with QIAprep Kits, because richer broths such as TB (Terrific Broth) or 2x YT lead to extremely high cell densities, which can overload the purification system. It should be noted that cultures grown in TB may yield 2–5 times the number of cells compared to cultures grown in LB broth. If these media are used, recommended

culture volumes must be reduced to match the capacity of the QIAprep membrane. If excess culture volume is used, alkaline lysis will be inefficient, the QIAprep membrane will be overloaded, and the performance of the system will be unsatisfactory. Furthermore, the excessive viscosity of the lysate will require vigorous mixing, which may result in shearing of bacterial genomic DNA and contamination of the plasmid DNA. Care must also be taken if strains are used which grow unusually fast or to very high cell densities. In such cases, doubling the volumes of Buffers P1, P2 and N3 may be beneficial. It is best to calculate culture cell density and adjust the volume accordingly.

Please note that a number of slightly different LB culture broths containing different concentrations of NaCl are in common use. Although different LB broths produce similar cell densities after overnight culture, plasmid yields can vary significantly.

**Table 8. Recommended composition of Luria Bertani medium**

| Contents      | Per liter |
|---------------|-----------|
| Tryptone      | 10 g      |
| Yeast extract | 5 g       |
| NaCl          | 10 g      |

## Preparation of cell lysates

Bacteria are lysed under alkaline conditions. After harvesting and resuspension, the bacterial cells are lysed in NaOH/SDS (Buffer P2) in the presence of RNase A (2, 5). SDS solubilizes the phospholipid and protein components of the cell membrane, leading to lysis and release of the cell contents, while the alkaline conditions denature the chromosomal and plasmid DNAs, as well as proteins. The optimized lysis time allows maximum release of plasmid DNA without release of chromosomal DNA, while minimizing the exposure of the plasmid to denaturing conditions. Long exposure to alkaline conditions may cause the plasmid to become



---

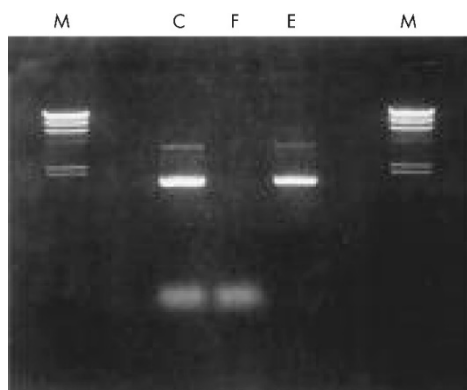
irreversibly denatured (2). This denatured form of the plasmid runs faster on agarose gels and is resistant to restriction enzyme digestion.

The lysate is neutralized and adjusted to high-salt-binding conditions in one step by the addition of Buffer N3. The high salt concentration causes denatured proteins, chromosomal DNA, cellular debris and SDS to precipitate, while the smaller plasmid DNA renatures correctly and stays in solution. It is important that the solution is thoroughly and gently mixed to ensure complete precipitation.

To prevent contamination of plasmid DNA with chromosomal DNA, vigorous stirring and vortexing must be avoided during lysis. Separation of plasmid from chromosomal DNA is based on coprecipitation of the cell-wall-bound chromosomal DNA with insoluble complexes containing salt, detergent and protein. Plasmid DNA remains in the clear supernatant. Vigorous treatment during the lysis procedure will shear the bacterial chromosome, leaving free chromosomal DNA fragments in the supernatant. Since chromosomal fragments are chemically indistinguishable from plasmid DNA under the conditions used, the 2 species will not be separated on QIAprep membrane and will elute under the same low-salt conditions. Mixing during the lysis procedure must therefore be carried out by slow, gentle inversion of the tube.

## Appendix B: Agarose Gel Analysis of Plasmid DNA

The QIAprep Miniprep procedure can be analyzed using agarose gel electrophoresis as shown in Figure 6. Samples can be taken from the cleared lysate and its flow-through, precipitated with isopropanol and resuspended in a minimal volume of TE buffer. In Figure 6, the cleared lysate shows closed circular plasmid DNA and degraded RNase A-resistant RNA. The flow-through contains only degraded RNA, and no plasmid DNA is present. The eluted pure plasmid DNA shows no contamination with other nucleic acids.



**Figure 6.** Agarose gel analysis of the QIAprep Miniprep procedure. **C:** cleared lysate; **F:** flow-through; **E:** eluted plasmid; **M:** markers.

---

# Appendix C: Special Applications

## Purification of low-copy plasmids and cosmids

All QIAprep miniprep protocols in this handbook can be used for preparation of low-copy-number plasmid or cosmids from 1–10 ml overnight *E. coli* cultures grown in LB medium.

Only 2 slight modifications to the protocols are required:

- The wash step with Buffer PB is required for all strains.
- When plasmid or cosmids are >10 kb, preheat Buffer EB (or water) to 70°C prior to eluting DNA from the QIAprep membrane. A 10 ml overnight LB culture typically yields 5–10 µg DNA.

**Note:** When using 10 ml culture volume, it is recommended to double the volumes of Buffers P1, P2 and N3 used.

## Purification of very large plasmids (>50 kb)

Plasmids that are >50 kb in size elute less efficiently from silica than smaller plasmids, but do elute efficiently from the QIAGEN anion-exchange resin. QIAGEN provides the anion-exchange-based QIAGEN Large-Construct Kit for efficient large-scale purification of ultrapure genomic DNA-free BAC, PAC, P1 or cosmid DNA. For high-throughput, small-scale purification of BACs, PACs and P1s, an optimized alkaline lysis protocol in R.E.A.L.<sup>®</sup> Prep 96 Kits yields DNA suitable for sequencing and screening. Call QIAGEN Technical Services or your local distributor for more information on these kits, or see “Ordering Information” on page 46.

---

## Purification of plasmid DNA prepared by other methods

Plasmid DNA isolated by other methods can be further purified using QIAprep modules and any of the QIAprep protocols in this handbook.

1. Add 5 volumes of Buffer PB to 1 volume of the DNA solution and mix (e.g., add 500  $\mu$ l Buffer PB to 100  $\mu$ l of DNA sample).
2. Apply the samples to QIAprep 2.0 spin columns or to the wells of a QIAprep 96-well plate. Draw the samples through the QIAprep membrane by centrifugation or vacuum, and continue the appropriate protocol at the Buffer PE wash step. The optional wash step with Buffer PB is not necessary.

---

# References

1. Vogelstein, B. and Gillespie, D. (1979) Preparative and analytical purification of DNA from agarose. *Proc. Natl. Acad. Sci. USA* **76**, 615–619.
2. Birnboim, H.C. and Doly, J. (1979) A rapid alkaline lysis procedure for screening recombinant plasmid DNA. *Nucleic Acids Res.* **7**, 1513–1522.
3. Sambrook, J. et al., eds. (1989) *Molecular cloning: a laboratory manual*. 2nd ed., Cold Spring Harbor Laboratory Press.
4. Ausubel, F.M. et al., eds. (1991) *Current protocols in molecular biology*. Wiley Interscience, New York.
5. Birnboim, H.C. (1983) A rapid alkaline extraction method for the isolation of plasmid DNA. *Methods Enzymol.* **100**, 243–255.

# Ordering Information

| Product                                 | Contents                                                                                                                                                                                     | Cat. no. |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| QIAprep Spin Miniprep Kit (50)          | For 50 plasmid minipreps:<br>50 QIAprep 2.0 Spin Columns, reagents, buffers, collection tubes (2 ml), loading dye                                                                            | 27104    |
| QIAprep Spin Miniprep Kit (250)         | For 250 plasmid minipreps:<br>250 QIAprep 2.0 Spin Columns, reagents, buffers, collection tubes (2 ml), loading dye                                                                          | 27106    |
| QIAprep 2.0 Spin Miniprep Columns (100) | For high-purity plasmid minipreps                                                                                                                                                            | 27115    |
| QIAprep 96 Turbo Miniprep Kit (4)*      | For 4 x 96 plasmid minipreps:<br>4 TurboFilter 96 Plates, 4 QIAprep 96 Plates, 4 S-Blocks, reagents, buffers, collection microtubes (1.2 ml), caps                                           | 27191    |
| QIAprep 96 Turbo Miniprep Kit (24)†     | For 24 x 96 plasmid minipreps:<br>24 TurboFilter 96 Plates, 24 QIAprep 96 Plates, 24 S-Blocks, reagents, buffers, collection microtubes (1.2 ml), caps                                       | 27193    |
| QIAprep 96 Turbo BioRobot Kit (4)       | For 4 x 96 plasmid minipreps,<br>4 each: TurboFilter 96 and QIAprep 96 Plates, S-Blocks, reagents, buffers, collection microtubes (1.2 ml), caps, 96-well microplates RB and lids, tape pads | 962141   |

\* Requires the use of QIAvac 96.

| Product                                                                                                                                | Contents                                                                                                                                                                                                                                                   | Cat. no. |
|----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>QIAGEN Plasmid <i>Plus</i> 96 Miniprep and BioRobot Kits — for purification of transfection grade plasmid DNA in 96-well format</b> |                                                                                                                                                                                                                                                            |          |
| QIAGEN Plasmid <i>Plus</i> 96 BioRobot Kit (4)                                                                                         | For 4 x 96 plasmid minipreps: TurboFilter 96 Plates and Plasmid <i>Plus</i> 96 Plates, buffers, reagents, S-Blocks, and elution microtubes; for use with the BioRobot Universal System                                                                     | 960241   |
| QIAGEN Plasmid <i>Plus</i> 96 Miniprep Kit (4)                                                                                         | For 4 x 96 plasmid minipreps: TurboFilter 96 Plates, Plasmid <i>Plus</i> 96 Plates, buffers, reagents, S-Blocks, and elution microtubes; requires use of QIAvac 96 and Elution Microtube Adapter, * or a centrifugation system suitable for 96-well blocks | 16181    |
| <b>DirectPrep® 96 Kits — for high-throughput plasmid DNA purification</b>                                                              |                                                                                                                                                                                                                                                            |          |
| DirectPrep 96 Miniprep Kit (4)†                                                                                                        | For 4 x 96 plasmid minipreps:<br>4 DirectPrep 96 Plates, reagents, buffers, S-Blocks, AirPore tape sheets, tape pads, elution microtubes RS, caps                                                                                                          | 27361    |
| DirectPrep 96 BioRobot Kit (4)‡                                                                                                        | For 4 x 96 plasmid minipreps:<br>4 DirectPrep 96 Plates, reagents, buffers, S-Blocks, 96-well microplates RB, AirPore tape sheets, tape pads                                                                                                               | 962341   |

\* Requires the use of QIAvac 96.

† Requires use of QIAvac Multiwell. Larger kit sizes available, please inquire.

‡ For use with BioRobot 3000 or 8000 workstations. Larger kit sizes available, please inquire.

| Product                                             | Contents                                                                                                                                                  | Cat. no. |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>Related products for BAC/PAC/P1 purification</b> |                                                                                                                                                           |          |
| QIAGEN Large-Construct Kit (10)                     | 10 QIAGEN-tip 500, reagents, buffers, ATP-dependent exonuclease*                                                                                          | 12462    |
| <b>QIAvac and accessories</b>                       |                                                                                                                                                           |          |
| QIAvac 24 Plus                                      | Vacuum manifold for processing 1–24 spin columns: includes QIAvac 24 Plus Vacuum Manifold, luer plugs, quick couplings                                    | 19413    |
| QIAvac 96                                           | Vacuum manifold for processing QIAGEN 96-well plates: includes QIAvac 96 Top Plate, Base, Waste Tray, Plate Holder Rack of Collection Microtubes (1.2 ml) | 19504    |
| QIAvac Luer Adapter Set†                            | For processing 1–24 QIAprep 2.0 Spin Columns: 6 adapters, each with 4 luer connectors, 24 plugs                                                           | 19541    |
| Vacuum Regulator                                    | For use with QIAvac manifolds                                                                                                                             | 19530    |
| Vacuum Pump (100 V, 50/60 Hz)                       | Universal vacuum pump                                                                                                                                     | 84000    |
| Vacuum Pump (115 V, 60 Hz)                          | Universal vacuum pump                                                                                                                                     | 84010    |
| Vacuum Pump (230 V, 50 Hz)                          | Universal vacuum pump                                                                                                                                     | 84020    |

\* ATP solution required for exonuclease digestion is not provided.

† Compatible only with QIAvac Top Plates containing flip-up lid.



| <b>Product</b>                                       | <b>Contents</b>                                                                                                                                                                                                         | <b>Cat. no.</b> |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>Automated low-throughput plasmid purification</b> |                                                                                                                                                                                                                         |                 |
| QIAcube Connect                                      | Robotic workstation for automated purification of DNA, RNA, or proteins using QIAGEN spin-column kits, includes tablet and Q-Base to connect to local network, bar code reader, and 1-year warranty on parts and labor* | 9002840         |
| <b>Individual buffers and accessories</b>            |                                                                                                                                                                                                                         |                 |
| Buffer N3                                            | 500 ml Buffer N3                                                                                                                                                                                                        | 19064           |
| Buffer PB                                            | 500 ml Buffer PB                                                                                                                                                                                                        | 19066           |
| Buffer PE (concentrate)                              | 100 ml Buffer PE (concentrate)                                                                                                                                                                                          | 19065           |
| RNase A                                              | 2.5 ml (100 mg/ml; 7000 units/ml solution)                                                                                                                                                                              | 19101           |
| Collection tubes (2 ml)                              | 1000 collection tubes (2 ml)                                                                                                                                                                                            | 19201           |
| Collection microtubes (racked)                       | Nonsterile polypropylene tubes (1.2 ml), 960 in racks of 96                                                                                                                                                             | 19560           |
| Collection microtube caps                            | Nonsterile polypropylene caps for collection microtubes (1.2 ml), 960 in strips of 8, loose in bag                                                                                                                      | 19566           |
| S-Blocks (24)                                        | 96-well blocks with 2 ml wells, 24 blocks per case                                                                                                                                                                      | 19585           |

\* Agreements for comprehensive service coverage are available; please inquire.

| Product                  | Contents                                                                                             | Cat. no. |
|--------------------------|------------------------------------------------------------------------------------------------------|----------|
| Tape Pads (5)            | Adhesive tape sheets for sealing multiwell plates and blocks: 25 sheets per pad, 5 pads per pack     | 19570    |
| AirPore Tape Sheets (50) | Microporous tape sheets for covering 96-well blocks during bacterial cultivation: 50 sheets per pack | 19571    |

For up-to-date licensing information and product-specific disclaimers, see the respective QIAGEN kit handbook or user manual. QIAGEN kit handbooks and user manuals are available at [www.qiagen.com](http://www.qiagen.com) or can be requested from QIAGEN Technical Services or your local distributor.

# Handbook Revision History

| Document    | Changes                                                                                                                                                                                                                                                                                 | Date       |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| HB-1206-004 | Changed “flat-bottom blocks” to “S-Blocks”. Updated pipette and pipette tip recommendations. Transferred Figure 6 into Appendix B, out of Appendix C. Updated “QIAcube” recommendations and links to “QIAcube Connect”. Added “Equipments and Reagents to Be Supplied by User” section. | March 2019 |

## Limited License Agreement for QIAprep Miniprep Kits

Use of this product signifies the agreement of any purchaser or user of the product to the following terms:

1. The product may be used solely in accordance with the protocols provided with the product and this handbook and for use with components contained in the kit only. QIAGEN grants no license under any of its intellectual property to use or incorporate the enclosed components of this kit with any components not included within this kit except as described in the protocols provided with the product, this handbook, and additional protocols available at [www.qiagen.com](http://www.qiagen.com). Some of these additional protocols have been provided by QIAGEN users for QIAGEN users. These protocols have not been thoroughly tested or optimized by QIAGEN. QIAGEN neither guarantees them nor warrants that they do not infringe the rights of third-parties.
2. Other than expressly stated licenses, QIAGEN makes no warranty that this kit and/or its use(s) do not infringe the rights of third-parties.
3. This kit and its components are licensed for one-time use and may not be reused, refurbished, or resold.
4. QIAGEN specifically disclaims any other licenses, expressed or implied other than those expressly stated.
5. The purchaser and user of the kit agree not to take or permit anyone else to take any steps that could lead to or facilitate any acts prohibited above. QIAGEN may enforce the prohibitions of this Limited License Agreement in any Court, and shall recover all its investigative and Court costs, including attorney fees, in any action to enforce this Limited License Agreement or any of its intellectual property rights relating to the kit and/or its components.

For updated license terms, see [www.qiagen.com](http://www.qiagen.com).

Trademarks: QIAGEN®, Sample to Insight®, QIAcube®, QIAprep®, BioRobot®, DirectPrep®, LyseBlue®, R.E.A.L.®, TurboFilter® (QIAGEN Group); DH5®, E1-ClipTip™, FinnTip®, Multistepper® (Thermo Fisher Scientific or its subsidiaries); Greiner® (Greiner Bio-One GmbH); Heraeus® (Heraeus Holding GmbH); pBluescript® (Agilent Technologies, Inc.); pGEM® (Promega Corp.); Beckman™ (Beckman Coulter, Inc.). Registered names, trademarks, etc. used in this document, even when not specifically marked as such, are not to be considered unprotected by law.

03/2019 HB-1206-004 © 2019 QIAGEN, all rights reserved.

---

Ordering [www.qiagen.com/shop](http://www.qiagen.com/shop) | Technical Support [support.qiagen.com](http://support.qiagen.com) | Website [www.qiagen.com](http://www.qiagen.com)