

TECHNICAL BULLETIN

# DNA IQ™ System— Database Protocol

Instructions for Use of Products  
DC6700 and DC6701



# DNA IQ™ System—Database Protocol

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## 1. Description

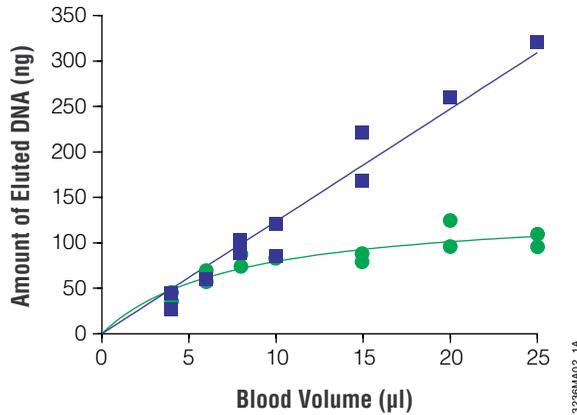
The development of human DNA databases is playing an increasingly important role in the forensic field. To this end, robust commercial STR-based systems have been developed for the analysis of standardized sets of loci. These systems can analyze sub-nanogram amounts of DNA but are limited to a well defined range of DNA. Thus, DNA must be purified, then quantitated accurately to reduce the risk of artifacts.

Two approaches have been used to purify DNA from blood for databasing purposes where sample quantities and nonhuman DNA contamination are not a concern. The first approach is to purify, then quantitate DNA using absorbance measurements or a DNA-specific dye. This approach requires an additional series of steps and is sensitive to the quality of DNA. The second approach is to deliver DNA from a set volume of blood usually attached to a solid support such as FTA® or S&S 903 paper. This approach yields variations in DNA content due to variations in white cell counts or variations on the filter due to sample wicking and differential drying. Additionally, the DNA is bound to the filters and must be removed for quantitation purposes. The high capacity of FTA® paper requires modification of the amplification protocol to prevent excessive amplification and allele imbalances.

The DNA IQ™ System<sup>(a)</sup> uses a novel approach for DNA isolation. A paramagnetic resin is used to capture a consistent amount of DNA (Figure 1). The resin has a defined DNA-binding capacity in the presence of excess DNA and will only bind a certain amount of DNA. Yields will be consistent within a single sample type but will differ with different sample types. The typical yield for FTA® blood-card punches is 50–100ng, for liquid blood, 50–200ng; and for buccal swabs,



100–500ng, as determined using the the Quant-iT™ PicoGreen® dsDNA reagent (liquid blood) or Quant-iT™ OliGreen® ssDNA Assay Kit (buccal swabs and FTA® blood-card punches). Since recovery depends on the sampling method, solid support and sample type, laboratories will need to determine the average yield for a single sample type. Once this average yield has been determined, the researcher can bypass the quantitation step typically necessary with other purification procedures.



**Figure 1. Effect of sample volume on the amount of DNA isolated.** DNA was isolated from increasing volumes of liquid blood using a high-capacity DNA-binding resin or the DNA IQ™ Resin. The high-capacity resin shows a linear relationship between eluted DNA and the volume (µl) of blood processed (represented by squares). In contrast, the DNA IQ™ Resin is saturated using the blood volumes tested and thus gives approximately the same amount of DNA regardless of sample size (represented by circles).

The DNA IQ™ System avoids the use of harmful organic solvents such as phenol and eliminates multiple centrifugation steps used in some DNA purification procedures. The DNA IQ™ System procedure is performed using a few simple steps (Figures 2 and 3):

- Extraction of sample (FTA® paper, S&S 903 paper, cotton swab) or lysis of sample
- DNA capture using resin
- Washing of resin
- Elution of DNA from resin

The DNA IQ™ System has been automated using the Beckman Coulter Biomek® 2000 and 3000 Laboratory Automation Workstations and Tecan Freedom EVO® 100 liquid handler. For more information, see the DNA IQ™ System product profile at: [www.promega.com/applications/hmuid/productprofiles/automation/](http://www.promega.com/applications/hmuid/productprofiles/automation/). For more information about implementing these methods, contact Promega Technical Services ([genetic@promega.com](mailto:genetic@promega.com)).

## 2. Product Components and Storage Conditions

| PRODUCT               | SIZE               | CAT.#         |
|-----------------------|--------------------|---------------|
| <b>DNA IQ™ System</b> | <b>400 samples</b> | <b>DC6700</b> |

This system includes:

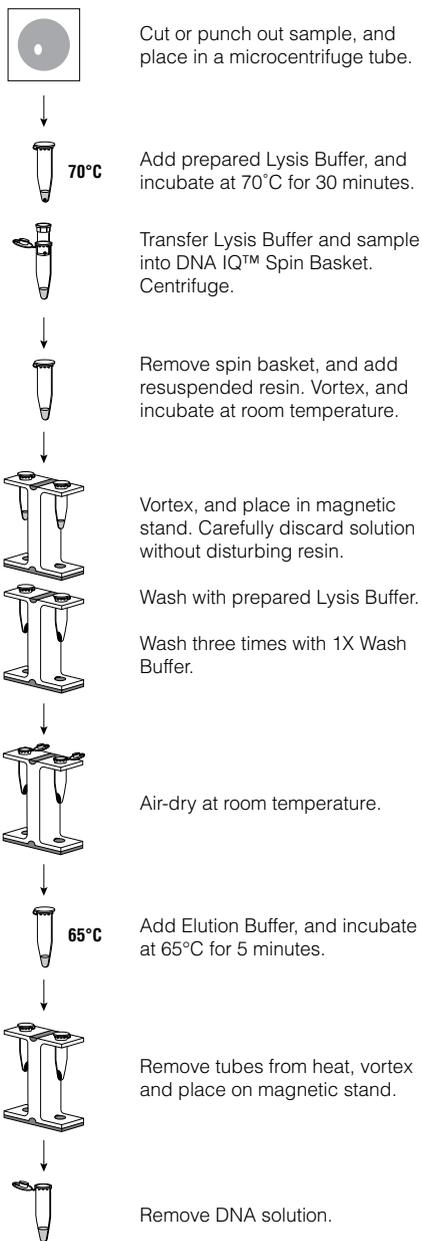
- 3ml Resin
- 150ml Lysis Buffer
- 70ml 2X Wash Buffer
- 50ml Elution Buffer

| PRODUCT               | SIZE               | CAT.#         |
|-----------------------|--------------------|---------------|
| <b>DNA IQ™ System</b> | <b>100 samples</b> | <b>DC6701</b> |

This system includes:

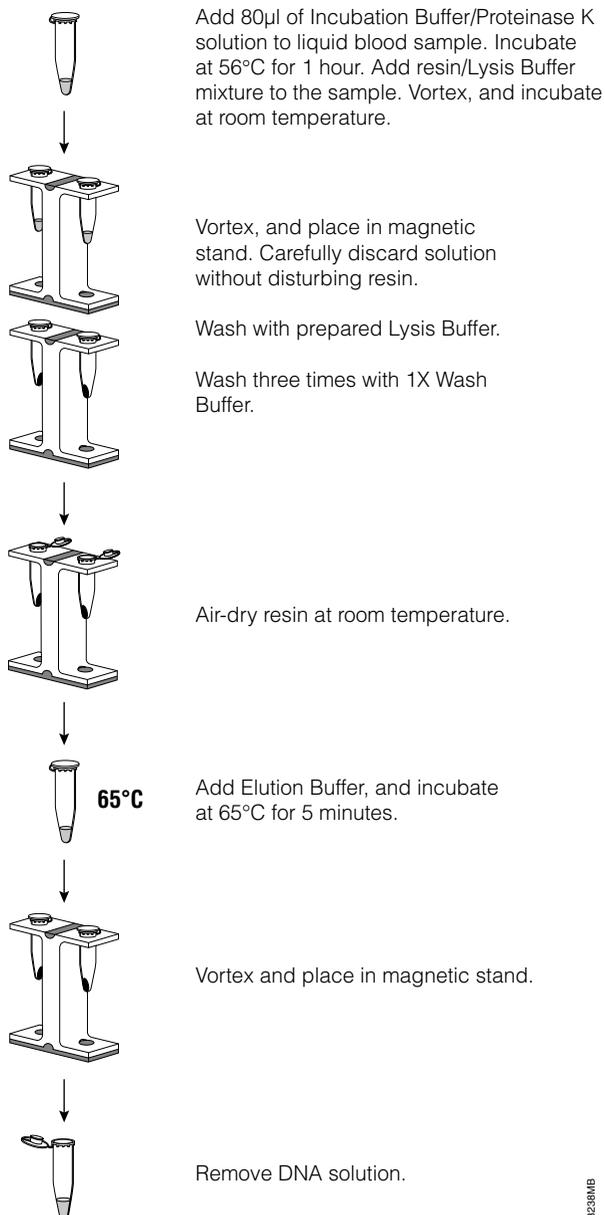
- 0.9ml Resin
- 40ml Lysis Buffer
- 30ml 2X Wash Buffer
- 15ml Elution Buffer

**Storage Conditions:** Store all DNA IQ™ System reagents at 15–30°C.



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**Figure 2. Schematic of DNA isolation from stains on solid material using the DNA IQ™ System. See Section 3.B for a detailed protocol.**



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**Figure 3. Schematic of DNA purification from liquid blood samples using the DNA IQ™ System.** See Section 3.C for a detailed protocol.



### 3. Protocol for the DNA IQ™ System

#### Materials to Be Supplied by the User

- 95–100% ethanol
- isopropyl alcohol
- 65°C heat block, water bath or thermal cycler
- 70°C heat block, water bath or thermal cycler (for stain or swab extraction)
- vortex mixer
- ClickFit Microtube, 1.5ml (Cat # V4745)
- DNA IQ™ Spin Baskets (Cat.# V1225)
- aerosol-resistant pipette tips
- MagneSphere® Technology Magnetic Separation Stand (twelve-position) (Cat.# Z5342)
- 1M DTT, for processing all samples except liquid blood
- Tissue and Hair Extraction Kit (for use with DNA IQ™) (Cat.# DC6740), for processing liquid blood samples
- nuclease-free water



We highly recommend the use of gloves and aerosol-resistant pipette tips.

#### 3.A. Preparation of Reagents

The 1X Wash Buffer, Lysis Buffer and 1M DTT are required for DNA purification from all samples described in this Technical Bulletin. The stock Proteinase K solution and Incubation Buffer/Proteinase K solution are required to purify DNA from liquid blood (Section 3.C). The DTT, Proteinase K and Incubation Buffer are supplied with the Tissue and Hair Extraction Kit (for use with DNA IQ™).

#### Preparation of 1X Wash Buffer

1. For DC6701 (100 samples) add 15ml of 95–100% ethanol and 15ml of isopropyl alcohol to the 2X Wash Buffer. For DC6700 (400 samples) add 35ml of 95–100% ethanol and 35ml of isopropyl alcohol to the 2X Wash Buffer.
2. Replace cap, and mix by inverting several times.
3. Mark label to record the addition of alcohols. Label bottle as 1X Wash Buffer. Solution can be stored at room temperature. Be sure bottle is closed tightly to prevent evaporation.

## Preparation of Lysis Buffer

- Determine the total volume of prepared Lysis Buffer to be used (Table 1), and add 1 $\mu$ l of 1M DTT for every 100 $\mu$ l of Lysis Buffer.

**Table 1. Volume of Prepared Lysis Buffer Required Per Sample.**

| Sample                                    | Lysis Buffer <sup>1</sup> | Lysis Buffer <sup>2</sup> | Total Volume    |
|-------------------------------------------|---------------------------|---------------------------|-----------------|
| Liquid blood (10–25 $\mu$ l)              | 195–225 $\mu$ l           | 100 $\mu$ l               | 295–325 $\mu$ l |
| 1 Cotton swab                             | 250 $\mu$ l               | 100 $\mu$ l               | 350 $\mu$ l     |
| 1/4th CEP swab                            | 250 $\mu$ l               | 100 $\mu$ l               | 350 $\mu$ l     |
| 1–2 4mm punches of S&S 903 paper          | 150 $\mu$ l               | 100 $\mu$ l               | 250 $\mu$ l     |
| 1–3 2mm punches of FTA <sup>®</sup> paper | 150 $\mu$ l               | 100 $\mu$ l               | 250 $\mu$ l     |
| Cloth, up to 25mm <sup>2</sup>            | 150 $\mu$ l               | 100 $\mu$ l               | 250 $\mu$ l     |

<sup>1</sup>For use in Section 3.B, Step 2, or Section 3.C, Step 1.

<sup>2</sup>For use in Section 3.B, Step 9, or Section 3.C, Step 8.

- Mix by inverting several times.
- Mark and date label to record the addition of DTT. This solution can be stored at room temperature for up to a month if sealed.

**Note:** If prepared Lysis Buffer forms a precipitate, warm solution to 37–60°C.

## Preparation of Stock Proteinase K Solution

- Add 5.5ml of Incubation Buffer to the bottle of lyophilized Proteinase K, and gently swirl to dissolve. The final concentration of Proteinase K will be 18mg/ml.
- Dispense the stock Proteinase K solution into smaller aliquots that reflect usage, and store at –20°C for up to 1 year. The Proteinase K can be frozen and thawed up to 5 times with no significant loss in activity. Prior to use, Proteinase K should be thawed and stored on ice.

## Preparation of 1M DTT

Dissolve 5g of DTT in nuclease-free water so that the final volume is 32.4ml. The final concentration of DTT will be 1M. Dispense the DTT into smaller aliquots that reflect usage, and freeze at –20°C.

### 3.A. Preparation of Reagents (continued)

#### Preparation of Incubation Buffer/Proteinase K Solution

1. Prepare the Incubation Buffer/Proteinase K solution by combining the Incubation Buffer, 1M DTT, and the stock Proteinase K solution in the proportions indicated below. Prepare 80 $\mu$ l of Incubation Buffer/Proteinase K solution for each liquid blood sample (see Section 3.C).

|                             |                               |
|-----------------------------|-------------------------------|
| Incubation Buffer           | 800 $\mu$ l                   |
| 1M DTT                      | 100 $\mu$ l                   |
| stock Proteinase K solution | 100 $\mu$ l                   |
| <b>total volume</b>         | <b>1,000<math>\mu</math>l</b> |

2. Mix gently, and store on ice during use.  
**Note:** The final concentration of Proteinase K will be 1.8mg/ml.

### 3.B. DNA Isolation from Stains and Buccal Swabs

1. Place the appropriate amount of sample (Table 1) in a ClickFit Microtube (Cat.# V4745).  
**Note:** The use of the ClickFit Microtube is specifically recommended to avoid any problem with tube caps opening during incubation.
2. Add the appropriate volume of prepared Lysis Buffer. Different samples require different volumes of Lysis Buffer; see Column 2 of Table 1 for the appropriate volume to add at this point. Close the lid, and incubate the tube at 70°C for 30 minutes.

For small stains, an alternative approach is to place the stained material in a DNA IQ™ Spin Basket (Cat.# V1225) seated in a ClickFit Microtube, and add 100–150 $\mu$ l of prepared Lysis Buffer to the basket. Carefully close the lid, and incubate at 70°C for 30 minutes. Most of the buffer should remain in the basket if the indicated tubes and spin baskets are used. Proceed to Step 4.

**Note:** This alternative approach does not work reliably with samples requiring more than 150 $\mu$ l of prepared Lysis Buffer.

3. Remove the tube from the heat source, and transfer the prepared Lysis Buffer and sample to a DNA IQ™ Spin Basket seated in a new ClickFit Microtube  
**Note:** Centrifuge the prepared Lysis Buffer with the stained matrix to obtain maximum recovery.
4. Centrifuge at room temperature for 2 minutes at maximum speed in a microcentrifuge. Remove the spin basket.
5. Vortex the stock resin bottle for 10 seconds at high speed or until resin is thoroughly mixed. Add 7 $\mu$ l of DNA IQ™ Resin to the sample. Keep the stock resin resuspended while dispensing to obtain uniform results.
6. Vortex the sample/Lysis Buffer/resin mixture for 3 seconds at high speed. Incubate at room temperature for 5 minutes. Vortex mixture for 3 seconds once every minute during this 5-minute incubation.
7. Vortex tube for 2 seconds at high speed. Place tube in the magnetic stand. Separation will occur instantly.  
**Note:** If resin does not form a distinct pellet on the side of the tube, vortex the tube and quickly place back in the stand.

8. Carefully remove and discard all of the solution without disturbing the resin pellet on the side of the tube.  
**Note:** If some resin is drawn up in tip, gently expel resin back into tube to allow re-separation.
9. Add 100µl of prepared Lysis Buffer. Remove the tube from the magnetic stand, and vortex for 2 seconds at high speed.
10. Return tube to the magnetic stand, and discard all Lysis Buffer.
11. Add 100µl of prepared 1X Wash Buffer. Remove tube from the magnetic stand, and vortex for 2 seconds at high speed.
12. Return tube to the magnetic stand, and discard all Wash Buffer.
13. Repeat Steps 11 and 12 two more times for a total of three washes. Be sure that all of the solution has been removed after the last wash.
14. With the tube in the magnetic stand and the lid open, air-dry the resin for 5 minutes.  
**!** Do not dry for more than 20 minutes, as this may inhibit removal of DNA.
15. Add 100µl of Elution Buffer.
16. Close the lid, and vortex the tube for 2 seconds at high speed. Incubate the tube at 65°C for 5 minutes.
17. Remove the tube from the heat source, and vortex for 2 seconds at high speed. Immediately place the tube on the magnetic stand.  
**!** Tubes must remain hot until placed in the magnetic stand or yield will decrease.
18. Carefully transfer the DNA-containing solution to a container of choice.  
**Note:** DNA can be stored at 4°C for short-term storage or at –20 or –70°C for long-term storage.

### 3.C. DNA Isolation from Liquid Blood

1. Vortex the stock resin bottle for 10 seconds at high speed or until resin is thoroughly mixed. For each sample, prepare the resin/Lysis Buffer mixture using 7µl of resin and the volume of prepared Lysis Buffer indicated below:

| <b>Volume of blood</b> | <b>Volume of DNA IQ™ Resin</b> | <b>Two volumes of prepared Lysis Buffer</b> |
|------------------------|--------------------------------|---------------------------------------------|
| 10µl                   | 7µl                            | 195µl                                       |
| 15µl                   | 7µl                            | 205µl                                       |
| 20µl                   | 7µl                            | 215µl                                       |
| 25µl                   | 7µl                            | 225µl                                       |

2. Mix blood gently, and place 10–25µl in a ClickFit Microtube (15µl of blood can be used routinely).
3. Add 80µl of the Incubation Buffer/Proteinase K solution to the liquid blood sample. Incubate at 56°C for 1 hour.

### 3.C. DNA Isolation from Liquid Blood (continued)

- Vortex the resin/Lysis Buffer mixture for 2 seconds at high speed to ensure suspension of resin. Add the volume of resin/Lysis Buffer mixture indicated below to the sample. The resin/Lysis Buffer mixture should be mixed again if the resin begins to settle while dispensing aliquots.

| Volume of blood | Volume of resin/Lysis Buffer Mix |
|-----------------|----------------------------------|
| 10µl            | 202µl                            |
| 15µl            | 212µl                            |
| 20µl            | 222µl                            |
| 25µl            | 232µl                            |

- Vortex the sample/resin/Lysis Buffer mixture for 3 seconds at high speed. Incubate for 5 minutes at room temperature. Vortex mixture for 3 seconds once every minute during this 5-minute incubation.
- Vortex tube for 2 seconds at high speed. Place the tube in the magnetic stand. Separation will occur instantly. **Note:** If resin does not form a distinct pellet on the side of the tube, vortex the tube and quickly place back in the stand.
- Carefully remove and discard all of the solution without disturbing the resin pellet on the side of the tube.
- Add 100µl of prepared Lysis Buffer. Remove tube from the magnetic stand, and vortex for 2 seconds at high speed.
- Return tube to the magnetic stand, and remove and discard all Lysis Buffer.
- Add 100µl of prepared 1X Wash Buffer. Remove tube from the magnetic stand, and vortex for 2 seconds at high speed.
- Return tube to the magnetic stand. Dispose of all Wash Buffer.
- Repeat Steps 10 and 11 two more times for a total of three washes. Be sure that all of the solution has been removed after the last wash.
- With the tube in the magnetic stand and the lid open, air-dry the resin for 5 minutes.
-  Do not dry for more than 20 minutes, as this may inhibit removal of DNA.
- Add 100µl of Elution Buffer.
- Close the lid, and vortex tube for 2 seconds at high speed. Incubate at 65°C for 5 minutes.
- Remove the tube from the heat source, and vortex for 2 seconds at high speed. Immediately place on the magnetic stand.
-  Tubes must remain hot until placed in the magnetic stand, or yield will decrease.
- Carefully transfer the DNA-containing solution to a container of choice.

**Note:** DNA can be stored at 4°C for short-term storage or at –20 or –70°C for long-term storage.

#### 4. Troubleshooting

For questions not addressed here, please contact your local Promega Branch Office or distributor. Contact information available at: [www.promega.com](http://www.promega.com). E-mail: [genetic@promega.com](mailto:genetic@promega.com)

| <b>Symptoms</b>                                                                     | <b>Causes and Comments</b>                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Poor yield                                                                          | Too much sample was used. Excessive amounts of sample can reduce the efficiency of DNA binding to the resin. Use less sample or more resin.                                                                                                                                                                                                                                             |
|                                                                                     | Poor extraction. After heating stain in prepared Lysis Buffer, centrifuge buffer with matrix. Be sure enough liquid is present to wash out the DNA.                                                                                                                                                                                                                                     |
|                                                                                     | Excessive drying of resin. Do not dry samples for more than 20 minutes, as overdrying the resin inhibits DNA elution.                                                                                                                                                                                                                                                                   |
| Poor resin pellet formed                                                            | The resin settled before tube was placed in the magnetic stand. Samples should be placed in the magnetic stand immediately after mixing. Repeat mixing, and place tube in stand.                                                                                                                                                                                                        |
|                                                                                     | Excessive input material was used relative to the recommended volumes of reagents. Use less initial sample. Consult protocols for recommended quantities of initial sample. Alternatively, use more resin per isolation. A proportional increase in resin will allow DNA capture from more initial sample. The increase in yield will be roughly proportional to the increase in resin. |
| Coloration in final wash or eluted<br>(may affect results in downstream assays)     | Insufficient washing. Remove all fluid during solution washes. Be sure that resin is completely resuspended during each wash step.                                                                                                                                                                                                                                                      |
|                                                                                     | Be sure a distinct resin pellet is formed during all washes.                                                                                                                                                                                                                                                                                                                            |
|                                                                                     | Use less initial sample.                                                                                                                                                                                                                                                                                                                                                                |
|                                                                                     | Perform additional washes with 1X Wash Buffer.                                                                                                                                                                                                                                                                                                                                          |
| Resin present in final eluted solution<br>(may affect results in downstream assays) | Resin is occasionally transferred by rapid pipetting or is caught in the meniscus of the final eluate. Vortex or mix solution, place in the magnetic stand and transfer eluate to new tube.                                                                                                                                                                                             |
| Low yield from FTA® blood card punches                                              | DNA can be difficult to extract from FTA® blood card punches. If yields are low, increase the incubation temperature to 90°C in Section 3.B, Step 2.                                                                                                                                                                                                                                    |



#### 4. Troubleshooting (continued)

##### Symptoms

Inconsistent yield (may affect results of downstream assays)

##### Causes and Comments

Inconsistent amounts of resin. Vortex resin stock just before making aliquots. Be sure to vortex the resin/Lysis Buffer mixture while dispensing aliquots.

Excessive drying of resin. Do not dry samples for more than 20 minutes, as overdrying the resin inhibits DNA elution.

Too little sample. Use more initial sample. Consult protocols for recommended quantities of initial sample. If concentration of DNA is consistent, volume of eluted solution used in downstream assays can be modified.

#### 5. References

1. Greenspoon, S. and Ban, J. (2002) Robotic extraction of mock sexual assault samples using the Biomek<sup>®</sup> 2000 and the DNA IQ<sup>™</sup> System. *Profiles in DNA* **5**, 3–5.
2. Gill, P. *et al.* (1985) Forensic application of DNA ‘fingerprints’. *Nature* **318**, 577–9.

#### 6. Composition of Buffer

##### Elution Buffer

10mM Tris (pH 8.0)  
0.1mM EDTA

## 7. Related Products

| Product                                                             | Size          | Cat.#  |
|---------------------------------------------------------------------|---------------|--------|
| MagneSphere® Technology Magnetic Separation Stand (two-position)    | 1.5ml         | Z5332  |
| MagneSphere® Technology Magnetic Separation Stand (twelve-position) | 1.5ml         | Z5342  |
| PolyAtract® System 1000 Magnetic Separation Stand                   | 1 each        | Z5410  |
| DNA IQ™ Spin Baskets*                                               | 50/pack       | V1225  |
| ClickFit Microtube, 1.5ml                                           | 100/pack      | V4745  |
| Slicprep™ 96 Device                                                 | 10 pack       | V1391  |
| Tissue and Hair Extraction Kit (for use with DNA IQ™)               | 100 reactions | DC6740 |
| DTT, Molecular Grade (Dry Powder)                                   | 5g            | V3151  |
|                                                                     | 25g           | V3155  |
| PowerPlex® 16 System*                                               | 100 reactions | DC6531 |
|                                                                     | 400 reactions | DC6530 |
| PowerPlex® 1.1 and 2.1 Systems*                                     | 100 reactions | DC6501 |
|                                                                     | 400 reactions | DC6500 |
| PowerPlex® 1.2 System*                                              | 100 reactions | DC6101 |

\*Not For Medical Diagnostic Use.

## 8. Summary of Changes

The following changes were made to the 9/16 revision of this document:

1. A note in Section 3 was updated for clarity.
2. Part number V1221 was changed to V1225, and part number V4741 was changed to V4745.

<sup>(a)</sup>U.S. Pat. Nos. 6,027,945, 6,368,800 and 6,673,631, European Pat. No. 1 204 741 and Japanese Pat. No. 4425513.

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