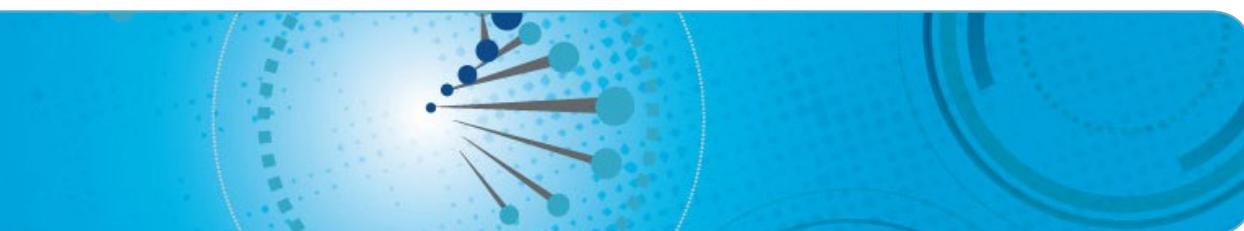


Hybridization capture of DNA libraries using xGen[®] Lockdown[®] Probes and Reagents



For use with:

- Illumina[®] TruSeq[®] adapter–ligated libraries
- xGen Universal Blockers—TS Mix
(Catalog # 1075474, 1075475, 1075476)
- xGen Lockdown Reagents

See what more we can do for you at www.idtdna.com.





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Introduction

This protocol includes the steps necessary for target enrichment of an Illumina adapter–ligated library (i.e., Illumina single-index or dual-index adapter-ligated library) prepared from genomic DNA, using xGen Lockdown Probes or Panels. If using an alternate platform, contact applicationsupport@idtdna.com for advice about PCR enrichment.

xGen Lockdown Probes or Panels

xGen Lockdown Probes are individually synthesized, 5'-biotinylated oligos for target capture applications in next generation sequencing. These probes are useful for creating custom capture panels that can be optimized, expanded, and combined with other panels. xGen Lockdown Probes can also be used to enhance the performance of existing capture panels, rescuing poorly represented regions, such as areas of high GC content. If you plan to use xGen Lockdown Probes for spike-ins into existing probe sets or panels, please contact our NGS technical support group at applicationsupport@idtdna.com, who will provide tailored recommendations for your specific experimental design.

xGen Lockdown Panels are inventoried enrichment panels for targeted next generation sequencing and are typically based on 1X tiling of xGen Lockdown Probes. Several research panels are available for the human genome, including panels for the whole exome, disease genes, and sample identification. Visit www.idtdna.com/LockdownPanels for a complete list.

xGen Universal Blockers—TS Mix

xGen Universal Blockers—TS Mix will bind to platform-specific adapter sequences on a designated strand (usually the inverse of the synthetic adapter) to help prevent non-specific binding, improve the number of reads on target, and increase the depth of enrichment. Universal Blockers—TS Mix works for HT and LT (6 nt and 8 nt) adapter libraries.

xGen Lockdown Reagents

The components of the xGen Lockdown Reagents kit have been optimized for the hybridization and wash steps in target capture protocols using xGen Lockdown Probes and Panels.



Protocol overview

| | Protocol step | Approximate time |
|---|---|-----------------------|
| A | Prepare capture probes | |
| | | 45 minutes |
|  B | Combine and dry blocking oligos, Cot-1 DNA, and genomic DNA library | |
| C | Hybridize capture probes with the library | 4 hours |
| D-E | Prepare buffers and streptavidin beads | |
| F | Bind hybridized targets to streptavidin beads | |
| | | 1.75 hours |
| G | Wash streptavidin beads to remove unbound DNA | |
| H | Perform PCR enrichment | |
|  I | Purify postcapture PCR fragments | |
| | | 2.5 hours |
|  J | Validate and quantify library | |
| | Ready for sequencing | Total: 9 hours |

 Optional stopping points



Reagents, kits, and equipment

Oligos and reagents from IDT

| | Size | Storage conditions | Ordering information |
|---|--------------------------|-------------------------|---|
| Target capture | | | |
| xGen Lockdown Probes | Varies | -20°C* | www.idtdna.com/xGen |
| xGen Lockdown Panels | 16 or 96 rxn | -20°C* | |
| xGen Universal Blockers—TS Mix | 16, 96, or 4 x 96 rxn | -20°C* | Cat # 1075474, 1075475, or 1075476 |
| xGen Lockdown Reagents | 16 or 96 rxn | -20°C | Cat # 1072280 or 1072281 |
| Custom DNA oligonucleotides | | | |
| Illumina P5 Primer: AATGATACGGCGACCACCGA | Varies | -20°C | Custom DNA Oligos (www.idtdna.com) |
| Illumina P7 Primer: CAAGCAGAAGACGGCATA CGA | Varies | -20°C | |
| Reagents | | | |
| IDTE pH 8.0 (1X TE Solution) | 10 × 2 mL | Room temp. (15–25°C) | Cat # 11-01-02-05 |
| Nuclease-Free Water | 10 × 2 mL | Room temp. (15–25°C) | Cat # 11-04-02-01 |

* See resuspension and storage instructions at www.idtdna.com/protocols.

Safety data sheets (SDSs) and certificates of analysis (COAs) for xGen products may be obtained by emailing applicationsupport@idtdna.com. For SDSs and COAs for other IDT products, go to www.idtdna.com.

Additional materials and equipment

| Materials | Ordering information |
|--|--|
| >80% Ethanol | General laboratory supplier |
| Agencourt® AMPure® XP – PCR Purification beads | Beckman-Coulter, Cat # A63880 |
| Digital electrophoresis chips, such as: | |
| Experion™ DNA IK Analysis Kit | Bio-Rad Laboratories, Cat # 700-7107 |
| Agilent High Sensitivity DNA Kit | Agilent Technologies, Cat # 5067-4626 |
| Agilent High Sensitivity D1000 ScreenTape® | Agilent Technologies, Cat # 5067-5584 |
| Dynabeads® M-270 Streptavidin | Life Technologies, Cat # 65305 |
| Invitrogen™ Human Cot-1 DNA® | Life Technologies, Cat # 15279-011 |
| KAPA HiFi HotStart ReadyMix | Kapa Biosystems, Cat # KK2601 |
| Library Quantification Kit – Illumina/Universal | Kapa Biosystems, Cat # KK4824 |
| MAXYmum Recovery® Microtubes, 1.7 mL | VWR, Cat # 22234-046 |
| MAXYmum Recovery PCR Tubes, 0.2 mL flat cap | VWR, Cat # 22234-056 |
| QIAGEN® Buffer EB (or equivalent: 10 mM Tris-Cl, pH 8.5) | QIAGEN, Cat # 19086 (or general laboratory supplier) |
| (Optional) Qubit® Assay Tubes | Life Technologies, Cat # Q32856 |
| (Optional) Qubit dsDNA HS Assay Kit | Life Technologies, Cat # Q32851 |
| Equipment | Ordering information |
| 96-well and 384-well thermal cyclers | General laboratory supplier |
| Digital electrophoresis system, such as: | |
| Experion Electrophoresis Station | Bio-Rad Laboratories, Cat # 700-7010 |
| Agilent 2100 Electrophoresis Bioanalyzer | Agilent Technologies, Cat # G2939AA |
| Agilent 2200 TapeStation | Agilent Technologies, Cat # G2965AA |
| Magnetic separation rack, such as: | |
| 6-tube magnetic separation rack | New England Biolabs, Cat # S1506S |
| 16-tube DynaMag™-2 Magnet | Life Technologies, Cat # 12321D |
| DiaMag02 magnetic rack | Diagenode, Cat # B04000001 |
| Microcentrifuge | General laboratory supplier |
| (Optional) Qubit 3.0 Fluorometer | Life Technologies, Cat # Q33216 |
| Vacuum concentrator or oven | General laboratory supplier |
| Vortex mixer | General laboratory supplier |
| Water bath or heating block | General laboratory supplier |



Protocol

A. Prepare capture probes

xGen Lockdown Probes

If you received the xGen Lockdown Probes as a hydrated solution:

1. Thaw at room temperature (15–25°C).
2. Mix thoroughly and briefly spin down.

If you received the xGen Lockdown Probes dry:

Resuspend in IDTE pH 8.0 to a final concentration of 0.75 pmol/μL.

If the concentration of your capture probe pool is <0.75 pmol/μL, we recommend the following:

1. Dry the portion of material for your capture.
2. Resuspend in nuclease-free water to a final concentration of 0.75 pmol/μL.

For additional support regarding resuspension of Lockdown Probes pools, visit www.idtdna.com/xGen ► **xGen Lockdown Probes** ► **Resources** section ► [Resuspension calculator](#)

xGen spike-in panels

Refer to the relevant protocol for your spike-in panel (e.g., *Expansion of xGen Lockdown Panels with xGen spike-in panels* for the xGen Human ID or Human mtDNA Research Panels) at www.idtdna.com/xGen for instructions on adding supplementary panels to your primary panel.

B. Combine blocking oligos, Cot-1 DNA, and genomic DNA library, and dry

- Mix the following in a low-bind 1.7 mL PCR tube (for example, MAXYmum Recovery tube):

| | illumina LT adapter-ligated libraries | illumina HT adapter-ligated libraries |
|---------------------------------|---------------------------------------|---------------------------------------|
| Pooled, barcoded library | 500 ng/library | 500 ng/library |
| Cot-1 DNA | 5 µg | 5 µg |
| xGen Universal Blockers—TS Mix* | 2 µL | 2 µL |

Important: If you are using individual blocking oligos or Ion Torrent or other adapter-ligated libraries, please refer to the protocol, *Hybridization capture of DNA libraries using xGen Lockdown Probes and Reagents v2*, for the appropriate xGen Blocking Oligo formulations to use for target capture.

- Dry the contents of the tube using a vacuum concentrator (e.g., SpeedVac® System or a similar evaporator device) set at 70°C or lower.



Optional stopping point: After drying, tubes can be stored overnight at room temperature (15–25°C).

C. Hybridize DNA capture probes with the library

- Thaw all xGen Lockdown Reagents buffers at room temperature.

Note: Inspect the tube of 2X Hybridization Buffer for crystallization of salts. If crystals are present, heat the tube at 65°C, shaking intermittently, until the buffer is completely solubilized; this may require heating for several hours.

- Add the following to the tube from Step B.2, and incubate at room temperature for 5–10 min:

| | Volume (µL) |
|-------------------------------|-------------|
| 2X Hybridization Buffer | 8.5 |
| Hybridization Buffer Enhancer | 2.7 |
| Nuclease-Free Water | 1.8 |

- Pipette up and down to mix, and transfer to a low-bind 0.2 mL PCR tube (for example, MAXYmum Recovery tube).
- Incubate in a thermal cycler at 95°C for 10 min.

- Remove samples from thermal cycler and immediately add 4 μL of the xGen Lockdown Probe pool.

Note: Final volume will be 17 μL . If using xGen spike-in panels, the final volume will be larger. Refer to the relevant protocol at www.idtdna.com/xgen for the spike-in panel you are using.

- Vortex and briefly spin down.
- Incubate samples in a thermal cycler at 65°C (with the heated lid at 75°C) for 4 hr.

D. Prepare wash buffers

- For a single capture reaction, dilute the following xGen buffers to create 1X working solutions as follows:

| | Concentrated buffer (μL) | Nuclease-free water (μL) |
|---------------------------|--|--|
| 2X Bead Wash Buffer | 250 | 250 |
| 10X Wash Buffer I* | 30 | 270 |
| 10X Wash Buffer II | 20 | 180 |
| 10X Wash Buffer III | 20 | 180 |
| 10X Stringent Wash Buffer | 40 | 360 |

* If necessary, heat 10X Wash Buffer I in a 65°C water bath or heating block to resuspend particulates.

- Prepare aliquots of Wash Buffer I and Stringent Wash Buffer from Step D.1, and store at the temperature specified in the following table:

| Buffer | Volumes of 1X working solution for each capture | Temperature for 1X working solution |
|-----------------------|--|--|
| Wash Buffer I | 100 μL | 65°C* |
| | 200 μL | room temp (15–25°C) |
| Stringent Wash Buffer | 400 μL | 65°C* |

* Important: Preheat buffers in a 65°C water bath for at least 2 hours before use in Step G.

- Keep the remaining 1X buffers at room temperature.

E. Prepare the streptavidin beads



Important: Beads should be prepared immediately before use. Do not allow beads to dry out.

1. Equilibrate Dynabeads M-270 Streptavidin beads at room temperature for approximately 30 min before use.



Important: We do not recommend using alternative streptavidin magnetic beads, because many of these have delivered significantly reduced capture yields.

2. Mix the beads thoroughly by vortexing for 15 sec.
3. Aliquot 100 μL of beads per capture into a single 1.7 mL low-bind tube.

For example: for 1 capture, prepare 100 μL of beads and for 2 captures, prepare 200 μL of beads. For more than 6 captures, you will need more than one tube.
4. Place the tube in a magnetic separation rack (magnetic rack), allowing beads to fully separate from the supernatant.
5. Remove and discard the clear supernatant, ensuring that the beads remain in the tube.
6. Perform the following wash:
 - a. Add 200 μL of 1X Bead Wash Buffer per capture, and vortex for 10 sec.
 - b. Place the tube in the magnetic rack, allowing beads to fully separate from the supernatant.
 - c. Carefully remove and discard the clear supernatant.
7. Perform a second wash by repeating Step E.6.
8. Add 100 μL of 1X Bead Wash Buffer per capture (refer to Step E.3) and vortex.
9. Transfer 100 μL of the resuspended beads into a new 0.2 mL low-bind tube for each capture reaction.
10. Place the tube in a magnetic rack, allowing beads to fully separate from the supernatant.
11. Carefully remove and discard the clear supernatant.

Note: Small amounts of residual Bead Wash Buffer will not interfere with downstream binding of the DNA to the beads.



Important: Proceed immediately to the next section, **Bind hybridized target to the streptavidin beads.**

F. Bind hybridized target to the streptavidin beads

1. Transfer the hybridization samples (from Step C.7) to the tube containing prepared beads (from Step E.11).
2. Mix thoroughly by pipetting up and down 10 times.
3. Bind the DNA to the beads by placing the tube into a thermal cycler set to 65°C (with the heated lid at 75°C) for 45 min.
4. Every 12 min during the 65°C incubation, vortex the tubes for 3 sec to ensure that the beads remain in suspension.

G. Wash streptavidin beads to remove unbound DNA

Note: Use the 1X wash buffers from Step D.

1. Perform 65°C washes.
 - 1) Add 100 µL preheated 1X Wash Buffer I to the tube from Step F.4.
 - 2)  **Important:** Vortex briefly, and spin to collect contents at the bottom of the tube.
 - 3) Transfer the mixture to a new low-bind 1.7 mL tube.
 - 4)  **Important:** Vortex briefly.
 - 5) Place the tube in the magnetic rack, allowing beads to fully separate from the supernatant.
 - 6) Pipet and discard the supernatant, which contains unbound DNA.
 - 7) Perform the following wash:
 - a. Add 200 µL of preheated 1X Stringent Wash Buffer, and slowly pipet up and down 10 times.
 **Important:** Do not create bubbles during pipetting.
 - b. Incubate in a water bath at 65°C for 5 min.
 - c. Place the tube in the magnetic rack, allowing beads to fully separate from the supernatant.
 - d. Pipet and discard the supernatant, which contains unbound DNA.
 - 8) Repeat Step 7.

2. Perform room temperature washes.
 - 1) Add 200 μ L of room temperature 1X Wash Buffer I and vortex for 2 min.
 - 2) Place the tube in the magnetic rack, allowing beads to fully separate from the supernatant.
 - 3) Pipet and discard the supernatant.
 - 4) Add 200 μ L of room temperature 1X Wash Buffer II and vortex for 1 min.
 - 5) Place the tube in the magnetic rack, allowing beads to fully separate from the supernatant.
 - 6) Pipet and discard the supernatant.
 - 7) Add 200 μ L of room temperature 1X Wash Buffer III and vortex for 30 sec.
 - 8) Place the tube in the magnetic rack, allowing beads to fully separate from the supernatant.
 - 9) Pipet and discard the supernatant.
3. Resuspend beads.
 - 1) Remove the tube containing the beads with captured DNA from the magnetic rack.
 - 2) Add 20 μ L of Nuclease-Free Water to the beads.
 - 3) Pipet up and down 10 times and ensure any beads stuck to the side of the tube have been resuspended.



Important: Do not discard the beads. Use the entire 20 μ L of resuspended beads with captured DNA in Step H.

H. Perform final, postcapture PCR enrichment

1. Prepare the PCR mix in 0.2 mL low-bind PCR tubes as follows:

| | Volume (μ L) |
|---|-------------------|
| 2X KAPA HiFi HotStart ReadyMix | 25 |
| 10 μ M Illumina P5 primer | 2.5 |
| 10 μ M Illumina P7 primer | 2.5 |
| Beads with captured DNA (from Step G.3) | 20 |
| Total volume | 50 |

2. Briefly vortex and spin the PCR mix, but ensure that the beads remain in solution.

- Place the PCR tube in the thermal cycler, and run the following program with the heated lid set at 105°C:

| | Number of cycles | Temperature (°C) | Time |
|------------------------------|------------------|------------------|--------|
| Polymerase activation | 1 | 98 | 45 sec |
| Amplification | 12 | | |
| Denaturation | | 98 | 15 sec |
| Annealing | | 60 | 30 sec |
| Extension | | 72 | 30 sec |
| Final extension | 1 | 72 | 1 min |
| Hold | 1 | 4 | Hold |

Cycling conditions recommended by Kapa Biosystems.



Optional stopping point: PCR-enriched captures may be stored at 4°C overnight.

I. Purify postcapture PCR fragments

- Add 75 µL (1.5X volume) of Agencourt AMPure XP beads to each PCR-enriched capture.
- Follow the binding and washing steps in the Agencourt AMPure protocol, **except use 80% ethanol for the washes.**
- Elute in 22 µL of Qiagen Buffer EB or equivalent (10 mM Tris-Cl, pH 8.5).
- Transfer 20 µL of eluted product to a fresh 1.7 mL low-bind tube, ensuring no beads are carried over.



Optional stopping point: Purified PCR fragments may be stored at -20°C for up to 1 week.

J. Validate and quantify library

- (Optional) Measure the concentration of the captured library using a Qubit Fluorometer and the Qubit dsDNA HS Assay Kit.

Note: This can be done to ensure that the concentration of the captured library is within the detection limits of the chip or tape used in Step J.2 (below) for your digital electrophoresis system.

2. Measure the average fragment length of the captured library on a digital electrophoresis system (e.g., the Bio-Rad Experion System, using a DNA 1K chip; the Agilent 2100 Bioanalyzer, using a high sensitivity DNA chip; or Agilent 2200 TapeStation, using a DNA tape).
3. Quantify libraries using the appropriate KAPA Library Quantification Kit (KAPA Biosystems) as directed by the manufacturer.



Optional stopping point: Library may be stored at -20°C overnight.

K. Sequencing

Perform sequencing according to the instructions for your Illumina instrument.

- Use the calculated concentration of undiluted library stock (from Step J.3) to prepare the library for sequencing.



Revision history

| Version | Date released | Description of changes |
|---------|----------------|--|
| 1.0 | September 2015 | Original protocol |
| 2.0 | March 2016 | Included instructions for solubilizing 2X Hybridization Buffer. Removed requirement to work quickly at Step G.1. Added instructional detail to bead resuspension steps. Removed KAPA library quantification tables. |
| 3.0 | October 2017 | Removed references to Ion Torrent adapter-ligated libraries. Updated instructions for use with xGen Universal Blockers—TS Mix, and removed instructions for xGen Universal Blocking Oligos. Added references to xGen spike-in panels. |
| 4.0 | February 2018 | Clarified library input amount. |

protocol

next generation sequencing

Hybridization capture of DNA libraries using
xGen Lockdown Probes and Reagents

Technical support:
applicationsupport@idtdna.com

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