Techne® qPCR test

**Methicillin-resistant Staphylococcus aureus**

mecA (penicillin binding protein 2) &
S. aureus FEMB gene (chromosomal gene)

150 tests

For general laboratory and research use only
Introduction to Methicillin-resistant Staphylococcus aureus

Methicillin-resistant Staphylococcus aureus (MRSA) is a specific strain of the Staphylococcus aureus bacterium that has developed antibiotic resistance to all penicillins, including methicillin and other narrow-spectrum β-lactamase-resistant penicillin antibiotics. [1] The resistant strain, MRSA was first discovered in the UK in 1961 and is now widespread, particularly in the hospital setting where it is commonly termed a superbug. MRSA may also be known as oxacillin-resistant Staphylococcus aureus (ORSA) and multiple-resistant Staphylococcus aureus, while non-methicillin resistant strains of S. aureus are sometimes called methicillin-susceptible Staphylococcus aureus (MSSA) if an explicit distinction must be made.

Although MRSA has traditionally been seen as a hospital-associated infection, community-acquired MRSA strains have appeared in recent years, notably in the US and Australia.[2] The abbreviations CA-MRSA (community-associated MRSA) and HA-MRSA (hospital-associated MRSA) are now commonly seen in medical literature.

Methicillin resistance arises by acquisition of a staphylococcal cassette chromosome SCCmec, and is conferred by the mecA gene. Expression of this gene yields PBP2a, a penicillin binding protein with reduced affinity for β-lactam rings (the primary active-site of the β-lactam antibiotics).[6]

Some strains of S. aureus over-express β-lactamase and appear to be resistant to oxacillin and, rarely, methicillin despite being mecA-negative. They have slightly raised minimum inhibitory concentrations (MICs) and may thus be described as "minimally resistant". Other strains express modified PBPs (not PBP2) and exhibit varying degrees of β-lactam antibiotic resistance.

Not only are MRSA strains resistant to the usual antibiotics, but a curious interbreeding with community staph has led to an additional worry. Many MRSA isolates found outside of medical facilities, and referred to as CAMRSA (community-acquired MRSA), have acquired the Panton-Valentine leukocidin factor,[7] a gene that produces a series of chemicals that make these MRSA particularly invasive as well as resistant.

Reference
The mecA gene is a plasmid based gene responsible for antibiotic resistance. FEMB is a chromosomal gene specific to S. aureus. A positive result for both markers has been validated as a reliable test for MRSA. The primers and probe have 100% homology with all reference sequences in the NCBI database including those listed below.

**MecA sequence specificity**
- AM292304
- AB266532
- AB266531
- AB245471
- AB245470
- AB236888
- AY894415
- DQ106887
- AY786579
- AY271717
- AB221124
- AB221123
- AB221122
- AB221121
- AB221120
- AB221119
- BA000017
- AP006716
- CP000046
- AM048803
- AM048802
- CP000255
- AJ810121
- AJ810120
- AB047089
- Y14051
- Y13095
- Y13096
- Y00688
- X52593
- BA000033
- BA000018
- AB121219
- CP000029
- X52592
- AB063172
- AB033763
- D86934
- AB096217
- AB063173
- AB037671

**FEMB sequence specificity**
- CP000703
- BA000017
- CP000046
- CP000253
- CP000255
- X17688
- X571857
- BA000033
- BA000018
- BX571856

If you require further information, or have a specific question about the detection profile of this kit then please send an e.mail to technehelp@bibby-scientific.com and our bioinformatics team will answer your question.
Kit Contents

- mecA (penicillin binding protein 2) primer/probe mix (150 reactions BROWN) FAM labelled
- FEMB gene (chromosomal gene) primer/probe mix (150 reactions BROWN) FAM labelled
- mecA (penicillin binding protein 2) positive control template (for Standard curve RED)
- FEMB gene (chromosomal gene) positive control template (for Standard curve RED)
- Internal extraction control primer/probe mix (150 reactions BROWN) VIC labelled as standard
- Internal extraction control DNA (150 reactions BLUE)
- Endogenous control primer/probe mix (150 reactions BROWN) FAM labelled
- RNAse/DNAse free water (WHITE) for resuspension of primer/probe mixes and internal extraction control DNA
- Template preparation buffer (YELLOW) for resuspension of positive control templates and standard curve preparation

Reagents and equipment to be supplied by the user

Real-Time PCR Instrument

DNA extraction kit
This kit is designed to work well with all processes that yield high quality DNA with minimal PCR inhibitors.

Lyophilised 2x qPCR Mastermix
This kit is designed to work well with all commercially available Mastermixes.

Pipettors and Tips

Vortex and centrifuge

Thin walled 1.5 ml PCR reaction tubes
Kit storage and stability
This kit is stable at room temperature but should be stored at -20°C on arrival. Techne does not recommend using the kit after the expiry date stated on the pack. Once the lyophilized components have been re-suspended, unnecessary repeated freeze/thawing should be avoided. The kit is stable for six months from the date of resuspension under these circumstances.
If a standard curve dilution series is prepared this can be stored frozen for an extended period. If you see any degradation in this serial dilution a fresh standard curve can be prepared from the positive control.

Suitable sample material
All kinds of sample material suited for PCR amplification can be used. Please ensure the samples are suitable in terms of purity, concentration, and DNA integrity (An internal PCR control is supplied to test for non specific PCR inhibitors). Always run at least one negative control with the samples. To prepare a negative-control, replace the template DNA sample with RNAse/DNAse free water.

Dynamic range of test
Under optimal PCR conditions Techne MRSA detection kits have very high priming efficiencies of >95% and can detect less than 100 copies of target template.

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This product is developed, designed and sold for research purposes only. It is not intended for human diagnostic or drug purposes or to be administered to humans unless clearly expressed for that purpose by the Food and Drug Administration in the USA or the appropriate regulatory authorities in the country of use. During the warranty period Techne® Prime Pro detection kits allow precise and reproducible data recovery combined with excellent sensitivity. For data obtained by violation to the general GLP guidelines and the manufacturer’s recommendations the right to claim under guarantee is expired. PCR is a proprietary technology covered by several US and foreign patents. These patents are owned by Roche Molecular Systems Inc. and have been sub-licensed by PE Corporation in certain fields. Depending on your specific application you may need a license from Roche or PE to practice PCR. Additional information on purchasing licenses to practice the PCR process may be obtained by contacting the Director of Licensing at Roche Molecular Systems, 1145 Atlantic Avenue, Alameda, CA 94501 or Applied Biosystems business group of the Applera Corporation, 850 Lincoln Centre Drive, Foster City, CA 94404. In addition, the 5’ nuclease assay and other homogeneous amplification methods used in connection with the PCR process may be covered by U. S. Patents 5,210,015 and 5,467,972, owned by Roche Molecular Systems, Inc, and by U.S. Patent 5,538,648, owned by The Perkin-Elmer Corporation.

Trademarks
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Principles of the test

The kit contains two primer and probe sets. The FEMB primer and probe set are designed to detect all Staphylococcus aureus sequences regardless of the antibiotic resistance profile. The MecA primer and probe set is specific to the mobile genetic element that contains the MecA antibiotic research gene. Samples that test positive for MecA and FEMB are confirmed to contain the MRSA stain. Samples that test positive for MecA but are negative for FEMB indicate that the MecA element has been detected in an alternative bacterial strain.

Real-time PCR

mecA and FEMB specific primer and probe mix is provided and this can be detected through the FAM channel.

The primer and probe mixes provided exploit the so-called TaqMan® principle. During PCR amplification, forward and reverse primers hybridize to the MRSA DNA. A fluorogenic probe is included in the same reaction mixture which consists of a DNA probe labeled with a 5`-dye and a 3`-quencher. During PCR amplification, the probe is cleaved and the reporter dye and quencher are separated. The resulting increase in fluorescence can be detected on a range of real-time PCR platforms.

Positive control

For copy number determination and as a positive control for the PCR set up, the kit contains a positive control template. This can be used to generate a standard curve of mecA or FEMB copy number / CT value. Alternatively the positive control can be used at a single dilution where full quantitative analysis of the samples is not required. Each time the kit is used, at least one positive control reaction must be included in the run. A positive result indicates that the primers and probes for detecting the target MRSA gene worked properly in that particular experimental scenario. If a negative result is obtained the test results are invalid and must be repeated. Care should be taken to ensure that the positive control does not contaminate any other kit component which would lead to false-positive results. This can be achieved by handling this component in a Post PCR environment. Care should also be taken to avoid cross-contamination of other samples when adding the positive control to the run. This can be avoided by sealing all other samples and negative controls before pipetting the positive control into the positive control well.

Negative control

To validate any positive findings a negative control reaction should be included every time the kit is used. For this reaction the RNAse/DNAsse free water should be used instead of template.

A negative result indicates that the reagents have not become contaminated while setting up the run. If a positive result is obtained the results should be ignored and the test samples repeated. Possible sources of contamination should first be explored and removed.
Internal DNA extraction control

When performing DNA extraction, it is often advantageous to have an exogenous source of DNA template that is spiked into the lysis buffer. This control DNA is then co-purified with the sample DNA and can be detected as a positive control for the extraction process. Successful co-purification and real-time PCR for the control DNA also indicates that PCR inhibitors are not present at a high concentration.

A separate primer and probe mix are supplied with this kit to detect the exogenous DNA using real-time PCR. The primers are present at PCR limiting concentrations which allows multiplexing with the target sequence primers. Amplification of the control DNA does not interfere with detection of the mecA or FEMB target DNA even when present at low copy number. The Internal control is detected through the VIC channel and gives a CT value of 28 +/- 3.

Endogenous control

To confirm extraction of a valid biological template, a primer and probe mix is included to detect an endogenous gene. Detection of the endogenous control is through the FAM channel and it is NOT therefore possible to perform a multiplex with the mecA or FEMB primers. A poor endogenous control signal may indicate that the sample did not contain sufficient biological material.

Carry-over prevention using UNG (optional)

Carry over contamination between PCR reactions can be prevented by including uracil-N-glycosylase (UNG) in the reaction mix. Some commercial mastermix preparations contain UNG or alternatively it can be added as a separate component. UNG can only prevent carry over from PCR reactions that include deoxyuridine triphosphate (dUTP) in the original PCR reaction. Primerdesign recommend the application of 0.2U UNG per assay with a 15 minute incubation step at 37°C prior to amplification. The heat-labile UNG is then inactivated during the Taq polymerase activation step.
Reconstitution Protocol

To minimize the risk of contamination with foreign DNA, we recommend that all pipetting be performed in a PCR clean environment. Ideally this would be a designated PCR lab or PCR cabinet. Filter tips are recommended for all pipetting steps.

1. **Pulse-spin each tube in a centrifuge before opening.**
   This will ensure lyophilised primer and probe mix is in the base of the tube and is not spilt upon opening the tube.

2. **Reconstitute the kit components in the RNase/DNase-free water supplied, according to the table below:**
   To ensure complete resuspension, vortex each tube thoroughly.

<table>
<thead>
<tr>
<th>Component - resuspend in water</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-PCR pack</td>
<td></td>
</tr>
<tr>
<td>meca primer/probe mix (BROWN)</td>
<td>165 µl</td>
</tr>
<tr>
<td>FEMB primer/probe mix (BROWN)</td>
<td>165 µl</td>
</tr>
<tr>
<td>Internal extraction control primer/probe mix (BROWN)</td>
<td>165 µl</td>
</tr>
<tr>
<td>Endogenous control primer/probe mix (BROWN)</td>
<td>165 µl</td>
</tr>
<tr>
<td>Pre-PCR heat-sealed foil</td>
<td></td>
</tr>
<tr>
<td>Internal extraction control DNA (BLUE)</td>
<td>600 µl</td>
</tr>
</tbody>
</table>

3. **Reconstitute the positive control templates in the template preparation buffer supplied, according to the table below:**
   To ensure complete resuspension, vortex each tube thoroughly.

<table>
<thead>
<tr>
<th>Component - resuspend in template preparation buffer</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-PCR heat-sealed foil</td>
<td></td>
</tr>
<tr>
<td>meca Positive Control Template (RED) *</td>
<td>500 µl</td>
</tr>
<tr>
<td>FEMB Positive Control Template (RED) *</td>
<td>500 µl</td>
</tr>
</tbody>
</table>

* This component contains high copy number template and is a VERY significant contamination risk. It must be opened and handled in a separate laboratory environment, away from the other components.

DNA extraction

The internal extraction control DNA can be added either to the DNA lysis/extraction buffer or to the RNA sample once it has been resuspended in lysis buffer.

**DO NOT add the internal extraction control DNA directly to the unprocessed biological sample as this will lead to degradation and a loss in signal.**

1. **Add 4µl of the Internal extraction control DNA (BLUE) to each sample in DNA lysis/extraction buffer per sample.**

2. **Complete DNA extraction according to the manufacturers protocols.**
Real-time PCR detection protocol

1. **For each DNA sample prepare a reaction mix according to the table below:**
   Include sufficient reactions for positive and negative controls.

<table>
<thead>
<tr>
<th>Component</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyophilised 2x qPCR MasterMix</td>
<td>10 µl</td>
</tr>
<tr>
<td>mecA or FEMB primer/probe mix (BROWN)</td>
<td>1 µl</td>
</tr>
<tr>
<td>Internal extraction control primer/probe mix (BROWN)</td>
<td>1 µl</td>
</tr>
<tr>
<td>RNAse/DNAse free water (WHITE)</td>
<td>3 µl</td>
</tr>
<tr>
<td><strong>Final Volume</strong></td>
<td><strong>15 µl</strong></td>
</tr>
</tbody>
</table>

2. **For each DNA sample prepare an endogenous control reaction according to the table below (Optional):**
   This control reaction will provide crucial information regarding the quality of the biological sample.

<table>
<thead>
<tr>
<th>Component</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyophilised 2x qPCR MasterMix</td>
<td>10 µl</td>
</tr>
<tr>
<td>Endogenous control primer/probe mix (BROWN)</td>
<td>1 µl</td>
</tr>
<tr>
<td>RNAse/DNAse free water (WHITE)</td>
<td>4 µl</td>
</tr>
<tr>
<td><strong>Final Volume</strong></td>
<td><strong>15 µl</strong></td>
</tr>
</tbody>
</table>

3. **Pipette 15µl of each mix into individual wells according to your real-time PCR experimental plate set up.**

4. **Prepare sample DNA templates for each of your samples.**

5. **Pipette 5µl of DNA template into each well, according to your experimental plate set up.**
   For negative control wells use 5µl of RNAse/DNAse free water. The final volume in each well is 20µl.

6. **If a standard curve is included for quantitative analysis prepare a reaction mix according to the table below:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyophilised 2x qPCR MasterMix</td>
<td>10 µl</td>
</tr>
<tr>
<td>mecA or FEMB primer/probe mix (BROWN)</td>
<td>1 µl</td>
</tr>
<tr>
<td>RNAse/DNAse free water (WHITE)</td>
<td>4 µl</td>
</tr>
<tr>
<td><strong>Final Volume</strong></td>
<td><strong>15 µl</strong></td>
</tr>
</tbody>
</table>
7. **Preparation of standard curve dilution series.**

1) Pipette 90µl of template preparation buffer into 5 tubes and label 2-6
2) Pipette 10µl of Positive Control Template (RED) into tube 2
3) Vortex thoroughly
4) Change pipette tip and pipette 10µl from tube 2 into tube 3
5) Vortex thoroughly

Repeat steps 4 and 5 to complete the dilution series

<table>
<thead>
<tr>
<th>Standard Curve</th>
<th>Copy Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube 1 Positive control (RED)</td>
<td>2 x 10^5 per µl</td>
</tr>
<tr>
<td>Tube 2</td>
<td>2 x 10^4 per µl</td>
</tr>
<tr>
<td>Tube 3</td>
<td>2 x 10^3 per µl</td>
</tr>
<tr>
<td>Tube 4</td>
<td>2 x 10^2 per µl</td>
</tr>
<tr>
<td>Tube 5</td>
<td>20 per µl</td>
</tr>
<tr>
<td>Tube 6</td>
<td>2 per µl</td>
</tr>
</tbody>
</table>

8. **Pipette 5µl of standard template into each well for the standard curve according to your experimental plate set up.**
The final volume in each well is 20µl.

**Amplification Protocol**

Amplification conditions using Lyophilised 2x qPCR MasterMix.

<table>
<thead>
<tr>
<th>Step</th>
<th>Time</th>
<th>Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNG treatment (if required)</td>
<td>15 mins</td>
<td>37 °C</td>
</tr>
<tr>
<td>Enzyme activation</td>
<td>2 mins</td>
<td>95 °C</td>
</tr>
<tr>
<td>Denaturation</td>
<td>10s</td>
<td>95 °C</td>
</tr>
<tr>
<td>DATA COLLECTION *</td>
<td>60s</td>
<td>60 °C</td>
</tr>
</tbody>
</table>

* Fluorogenic data for the control DNA should be collected during this step through the FAM and VIC channels
** Required if your Mastermix includes UNG to prevent PCR carryover contamination
Interpretation of Results

### Internal PCR control
The CT value obtained with the internal control will vary significantly depending on the extraction efficiency, the quantity of DNA added to the PCR reaction and the individual machine settings. CT values of 28±3 are within the normal range. When amplifying a MRSA sample with a high genome copy number, the internal extraction control may not produce an amplification plot. This does not invalidate the test and should be interpreted as a positive experimental result.

### Endogenous control
The signal obtained from the endogenous control primer and probe set will vary according to the amount of biological material present in a given sample. An early signal indicates the presence of a good yield of biological material. A late signal suggests that little biological material is present in the sample.

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**Table: Interpretation of Results**

<table>
<thead>
<tr>
<th>Target</th>
<th>Internal control</th>
<th>Negative control</th>
<th>Positive control</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ive</td>
<td>+ive</td>
<td>-ive</td>
<td>+ive</td>
<td>+ive</td>
</tr>
<tr>
<td>+ive</td>
<td>-ive</td>
<td>-ive</td>
<td>+ive</td>
<td>+ive</td>
</tr>
<tr>
<td>-ive</td>
<td>+ive</td>
<td>-ive</td>
<td>+ive</td>
<td>-ive</td>
</tr>
<tr>
<td>-ive</td>
<td>-ive</td>
<td>-ive</td>
<td>-ive</td>
<td>Experiment fail</td>
</tr>
<tr>
<td>+ive</td>
<td>+ive</td>
<td>+ive</td>
<td>+ive</td>
<td>Experiment fail</td>
</tr>
</tbody>
</table>

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Quantification of Methicillin-resistant *Staphylococcus aureus* genomes.
Advanced kit handbook HB10.07.07