S. aureus/CNS PNA FISH®
Staphylococcus aureus/
Coagulase-negative staphylococci
Culture Identification Kit

Intended Use
S. aureus/CNS PNA FISH is a multicolor, qualitative nucleic acid hybridization assay intended for the identification of Staphylococcus aureus and/or selected other Staphylococcus species on smears made from positive blood cultures containing Gram-positive cocci in clusters observed on Gram stain.

Sub-culturing of positive blood cultures is necessary for susceptibility testing and/or differentiation of mixed growth.

S. aureus/CNS PNA FISH is intended as an aid in the diagnosis of S. aureus bacteremia.

Summary and Explanation
S. aureus is well-recognized as a leading cause of both community- and hospital-acquired bacteremia, whereas selected other Staphylococcus species, commonly referred to as coagulase-negative staphylococci (CNS) are common blood culture contaminants.

Both S. aureus and CNS in blood cultures are presumptively identified as Gram-positive cocci in clusters; final identification and differentiation must await subculture and biochemical analysis (1).

The S. aureus/CNS PNA FISH is a fluorescence in situ hybridization (FISH) method using PNA probes hybridizing to S. aureus-specific ribosomal RNA sequences and PNA probes hybridizing to ribosomal RNA of selected other Staphylococcus species (CNS).

The test provides rapid identification of S. aureus and selected other Staphylococcus species (CNS) on smears made from positive blood cultures (5). By selected other staphylococci means all Staphylococcus species other than S. aureus, except for S. felis and S. simulans.

The test provides rapid (within 90 min) identification of S. aureus and/or CNS on smears made from positive blood cultures leading to improved patient therapy and management (2, 4).

Principle of the Procedure
A fluorescein-labeled, S. aureus-specific PNA probes and Texas Red-labeled PNA probes targeting other staphylococci (CNS) is added to a smear prepared from a blood culture. Hybridization is performed at 55°C for 30 min. The hybridization is followed by a post-hybridization wash at 55°C for 30 min. with Wash Solution. Finally, the smear is mounted with Mounting Medium and examined by fluorescence microscopy.

Reagents
S. aureus/CNS PNA FISH is comprised of the following kit components:

- **Fixation Solution**: 3 mL phosphate-buffered saline with detergent.
- **S. aureus/CNS PNA**: 1.5 mL PNA probes in hybridization solution. Contains 30% formamide.
- **60x Wash Solution**: 50 mL Tris-buffered saline with detergent
- **Mounting Medium**: 3 mL photobleaching inhibitor in glycerol.

Precautions
For professional use only, by personnel trained in laboratory techniques and experienced in fluorescence microscopy.

Safety Precautions

<table>
<thead>
<tr>
<th>Component</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus/CNS PNA</td>
<td><strong>Danger</strong> Contains 30% Formamide. May cause harm to the unborn child. Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid exposure - obtain special instructions before use. Safety Data Sheet is available upon request.</td>
</tr>
<tr>
<td>Fixation Solution</td>
<td><strong>Warning</strong> Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid exposure - obtain special instructions before use. Safety Data Sheet is available upon request.</td>
</tr>
<tr>
<td>60X Wash Solution</td>
<td><strong>Danger</strong> Contains polyethylene glycol octylpheno ether. Causes skin irritation. Causes serious eye damage. Toxic to aquatic life with long lasting effects. Avoid exposure - obtain special instructions before use. Safety Data Sheet is available upon request.</td>
</tr>
<tr>
<td>Mounting Medium</td>
<td><strong>Warning</strong> Propyl 3,4,5-trihydroxybenzoate. May cause an allergic reaction. Avoid exposure - obtain special instructions before use. Safety Data Sheet is available upon request.</td>
</tr>
</tbody>
</table>

Establish precautions against microbiological hazards.

Do not eat, drink, smoke, apply cosmetics, store or prepare foods within the designated work area.

Dispose of reagents in accordance with federal, state and local regulations.

Technical Precautions

Reagents must not be used after the expiration dates printed on the labels.

Reagents are provided at fixed concentrations. Assay performance may be affected if the reagents are modified in any way or are not stored under the recommended conditions as detailed in “Storage of Kit Components”.

Avoid microbial contamination of reagents.
Avoid any cross-contamination of samples and reagents, as this may give rise to erroneous results.

Do not allow dropper bottle tip to touch the smear as this may cause cross contamination of material between slides, or cause contamination of the reagent.

Do not use filters other than the Dual Band Filter (AC003 or AC007). Do not use microscope slides other than the Microscope Slides (AC001).

It is important that the microscope is functioning properly. Make sure that the microscope bulb is correctly adjusted and has not aged beyond its specified lifetime.

### Storage and Preparation of Kit Components

To ensure optimal kit performance, it is important that kit components are stored and prepared according to the following instructions:

#### Storage

Store kit components at 2-8°C. Place kit components at room temperature prior to use and return the kit components to 2-8°C after use.

#### Preparation of Wash Solution

Prepare working strength Wash Solution by adding 4 mL of 60x Wash Solution followed by 240 mL of fresh deionized or distilled water directly to the Staining Dish. Store remaining concentrate at 2-8°C.

#### Preparation of Mounting Medium

The Mounting Medium should be left at room temperature for at least 5 min. before use.

### Specimen Collection and Preparation

#### Preparation of Smears

- Follow the blood culture system manufacturer’s instruction to properly mix the blood culture bottle before smear preparation. Follow established laboratory procedures on sub-culturing of positive blood culture.
- Place one drop of Fixation Solution on a well on the microscope slide.
- Transfer 10 μL or a small drop from a ventilation needle of a blood culture to the Fixation Solution and mix gently to emulsify.
- Fix the smears by either heating them for 20 min. at 55-80°C or allow the smears to dry and fix them by methanol-fixation or by flame-fixation.

### Test Procedure

#### Material Provided

- S. aureus/CNS PNA FISH®

Each kit contains sufficient material for 50 tests. Reagents are supplied ready for use except where indicated. The expiration date of the kit is as indicated on the outer box label.

#### Material Required and Available from AdvanDx

<table>
<thead>
<tr>
<th>Component</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microscope Slides</td>
<td>AC001</td>
</tr>
<tr>
<td>Coverslips</td>
<td>AC002</td>
</tr>
<tr>
<td>Dual Band Filter</td>
<td>AC003 or AC007</td>
</tr>
<tr>
<td>Staining Dish</td>
<td>AC004</td>
</tr>
<tr>
<td>PNA FISH Workstation</td>
<td>AC005</td>
</tr>
<tr>
<td>Water Bath</td>
<td>AC006</td>
</tr>
<tr>
<td>S. aureus/CNS Control Slide</td>
<td>CS005</td>
</tr>
</tbody>
</table>

Positive Control well contains a mixture of S. aureus ATCC#29213, and S. epidermidis ATCC#14990, and a Negative Control well contains S. agalactiae ATCC#13813.

#### Material Required but Not Provided

- Water, deionized or distilled.
- Fluorescence microscope equipped with a 60x or 100x oil objective.
- Immersion oil. Must comply with the microscope objective and be non-fluorescent.

### Assay Procedure

All steps are performed at room temperature unless otherwise stated.

Before starting the assay procedure, prepare working strength Wash Solution in the Staining Dish, add cover and start preheating in the water bath (55 ± 1°C). Do not reuse Wash Solution, but prepare fresh working strength Wash Solution for each run.

#### Hybridization

- Add one drop of S. aureus/CNS PNA to the well on the microscope slide with the smear.
- Add coverslip. Avoid air bubbles. Use a sterile loop to remove resin beads if needed.
- Incubate for 30 ± 5 min. at 55 ± 1°C.

#### Stringent Wash

- Immerse slide in preheated Wash Solution at 55°C and carefully remove the coverslip. Often, the coverslip slides off by gently agitating the slide in the Wash Solution. Occasionally, the coverslip must be pushed off with forceps.
- Incubate for 30 ± 5 min. at 55 ± 1°C.
- Allow the slide to air dry

#### Mounting

- Add one drop of Mounting Medium to the smear.
- Add coverslip. Avoid air bubbles.
- Examine slide as described below within 2 hours.
- Do not expose the slides to direct sun light or other strong light sources as this may lead to fluorescence quenching.

#### Quality Control

Control material should be tested in accordance with guidelines or requirements of local, state, and/or federal regulations or accrediting organizations, including controls grown in liquid media.

Quality control for fluorescent testing should be done each time testing is performed. The QC results should be able to monitor for appropriate testing conditions, particularly those affecting hybridization stringency and cell wall penetration, since PNA methodology is designed to optimize cell wall penetration.

Use S. aureus/CNS Control Slide (CS005) or prepare smears from liquid cultures of laboratory or reference strains of S. aureus and S. epidermidis as Positive Control either on separate slides or mixed on one slide and Streptococcus agalactiae as a Negative Control as described above under Specimen Collection and Preparation. The smears may be stored for up to 1 month at room temperature. When using an AdvanDx S. aureus/CNS Control Slide (Cat. No. CS005), simply remove slide from pouch and follow the PNA FISH procedure starting with the hybridization step.

S. aureus must test green-positive, and S. epidermidis must test red-positive in accordance with the “Interpretation of Results”.

#### Procedural Notes

**Preparation of Smears:**

It is recommended to use the same type of fixation (heat, methanol or flame fixation) that is used for Gram-staining. To reduce the reporting time, smears for PNA FISH may be prepared in parallel with smears for Gram-staining.

**Note:** Fixation Solution is designed for optimal performance in the identification of Gram-positive bacteria and Yeast and must not be
interchanged with GN Fixation Solution from other PNA FISH tests for Gram-negative bacteria.

Temperature Control:
It is important that the temperature of the PNA FISH Workstation has reached 55°C prior to starting the hybridization and that Water Bath Solution has reached 55°C prior to immersion of the slides. The temperature of the Water Bath should be checked using a thermometer as outside temperature readings may not always be accurate.

Parallel Testing Using Different PNA FISH Tests:
The PNA FISH kits are designed for parallel testing. Fixation Solution, 60x Wash Solution and Mounting Medium are identical and may be interchanged between different tests.

Major Blood Culture Systems and Bottle Type Compatibility:
The PNA FISH platform is compatible with the commercially available continuously monitoring blood culture systems and bottle types, including those which are supplemented with charcoal, resins and/or sodium polyanetholesulfonate.

Interpretation of Results
Examine slides using a fluorescence microscope. The blood culture smear appears in general reddish. *S. aureus* is identified as multiple bright green fluorescent clusters of cocci in multiple fields of view. CNS is identified as multiple bright red fluorescent clusters of cocci in multiple fields of view. Non-*Staphylococcus* cells appear non-fluorescent.

Definitive identification is pending subculture and additional microbiological evaluation.

Representative examples of green-positive *S. aureus* (top-left), red-positive CNS (top-right), mixture of green-positive *S. aureus* and red-positive CNS (bottom-left), and negative (bottom-right) test results.

Troubleshooting
False positive Control and Sample test results may occur if the Dual Band Filter (AC003 or AC007) is not used, or by contamination of the specimens.

False negative Control or Sample test results may occur if AdvanDx Microscope Slides (AC001) are not used or if the temperature is not accurately controlled during hybridization and washing.

Please refer to the Precautions and Limitations sections in this product insert or contact AdvanDx.

Limitations

The following species are negative by *S. aureus/CNS PNA FISH*: 
Macrococcus caseolyticus (formerly *Staphylococcus cohnii* subspp. *cohnii* ATCC 35662, *Staphylococcus simulans*, *Staphylococcus telis*, and *Macrococcus equipericanes* (formerly *Staphylococcus equipericanes*).

The analytical specificity data demonstrated weak green fluorescence with *Candida krusei*.

The clinical data demonstrated false positive-red with *Micrococcus* spp from the VERSA TREK REDOX1 blood culture bottles.

Insufficient pediatric bottles have been tested in clinical studies; therefore, the performance of the *S. aureus/CNA PNA FISH* assay with pediatric bottles is unknown.

False positive green autofluorescence may occur if a standard FITC filter is used instead of the Dual Band Filter.

False negative results may infrequently occur due to mixed growth or due to error in assay technique.

The type and condition of the instrumentation used will influence the visual appearance of the image obtained. The fluorescence may vary due to the type of microscope employed, the light source and the level of rRNA in the cells. Each laboratory should establish its own criteria for reading the results using appropriate controls.

Isolation on solid media is needed to differentiate mixed growth with other organisms and to identify positive blood cultures yielding a negative result.

The product has not been validated with specimens other than blood cultures.

Expected Results

The expected *S. aureus* and CNS positive result rate from Gram-positive cocci positive blood culture bottles is approximately 21% and 55%, respectively, but may vary depending on institution and patient population (3).

Performance Characteristics

Clinical Studies
A total of 402 routine GPCC positive blood culture bottles were included in the studies, which showed 99.5% (400/402) agreement between *S. aureus/CNS PNA FISH* and conventional routine methods. These studies included three commercially available, continuously monitoring blood culture systems (BacT/ALERT, bioMérieux, NC, BACTEC, Becton Dickinson, MD and VersaTREK, Magellan Biosciences, OH).

Performance Data for *S. aureus/CNS PNA FISH* (New) vs. Routine Identifications on GPCC-Positive Blood Culture Bottles

<table>
<thead>
<tr>
<th>Study</th>
<th><em>S. aureus</em></th>
<th>CNS</th>
<th>Other</th>
<th>Blood Culture System</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100% (32/32)</td>
<td>100% (91.1-100)</td>
<td>100% (1/1)</td>
<td>BACTEC</td>
</tr>
<tr>
<td>B</td>
<td>95% CI (91.1-100)</td>
<td>95% CI (95.6-100)</td>
<td>95% CI (5.0-100)</td>
<td>BacT/ALERT</td>
</tr>
<tr>
<td>C</td>
<td>100% (17/17)</td>
<td>100% (82/82)</td>
<td>100% (4/4)</td>
<td>BACTEC</td>
</tr>
<tr>
<td>D</td>
<td>95% CI (83.8-100)</td>
<td>95% CI (96.4-100)</td>
<td>95% CI (47.3-100)</td>
<td>VersaTREK</td>
</tr>
<tr>
<td></td>
<td>100% (32/32)</td>
<td>100% (65/65)</td>
<td>100% (4/4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI (91.1-100)</td>
<td>95% CI (95.5-100)</td>
<td>95% CI (47.3-100)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100% (32/32)</td>
<td>100% (64/64)</td>
<td>0% (0/2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI (91.9-100)</td>
<td>95% CI (95.4-100)</td>
<td>95% CI (0 - 77.6)</td>
<td></td>
</tr>
</tbody>
</table>
Summary of Reproducibility Results by Site Across 3 Days

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Agreement Green</td>
<td>36/36</td>
<td>36/36</td>
<td>36/36</td>
</tr>
<tr>
<td>Positive Agreement Red</td>
<td>18/18</td>
<td>18/18</td>
<td>18/18</td>
</tr>
<tr>
<td>Negative Agreement</td>
<td>36/36</td>
<td>36/36</td>
<td>36/36</td>
</tr>
<tr>
<td>Total Agreement</td>
<td>100% (90/90)</td>
<td>100% (90/90)</td>
<td>100% (90/90)</td>
</tr>
</tbody>
</table>

Summary of Reproducibility Results by Day Across 3 Sites

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Agreement Green</td>
<td>36/36</td>
<td>36/36</td>
<td>36/36</td>
</tr>
<tr>
<td>Positive Agreement Red</td>
<td>18/18</td>
<td>18/18</td>
<td>18/18</td>
</tr>
<tr>
<td>Negative Agreement</td>
<td>54/54</td>
<td>54/54</td>
<td>54/54</td>
</tr>
<tr>
<td>Total Agreement</td>
<td>100% (90/90)</td>
<td>100% (90/90)</td>
<td>100% (90/90)</td>
</tr>
</tbody>
</table>

Bibliography


Definitions

<table>
<thead>
<tr>
<th>REF</th>
<th>Product code/catalog number</th>
<th>LOT</th>
<th>Batch code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consult the instructions for use</td>
<td>![Exclamation Mark]</td>
<td>![Health Hazard]</td>
</tr>
<tr>
<td></td>
<td>Contains sufficient for &lt;n&gt; tests</td>
<td>![Corrosion]</td>
<td>![Environment]</td>
</tr>
</tbody>
</table>

Technical Advice and Customer Service

For all inquiries, please contact OpGen or your local distributor.

OpGen, Inc.
708 Quince Orchard Rd
Gaithersburg, MD 20878
USA
Tel: +1 301 869 9683
Fax: +1 301 869 9684

OpGen A/S
Gungevej 2, 2. Sal
2650 Hvidovre
Denmark
Tel: +45 45 16 07 99
Fax: +45 45 16 07 98

techsupport@opgen.com www.OpGen.com

PN1714F-EN
DCN 26-18

Produced under license from Boston Probes, Inc.

The product must not be used for Slide-based human Cytchemistry, ISH-based Cancer Cytogenetics and Flow Cytometry.

27 March 2018