 ***Borrelia* VlsE1/pepC10 IgG/IgM Test System**

**IVD**

**Rx Only**

 **3Z9661/SM3Z9661**

**REF**

 **3Z9661B**

|  |  |
| --- | --- |
| Institute Name | Date |
|  |  |

**SIGNIFICANCE AND BACKGROUND**

*Borrelia burgdorferi* is a spirochete that causes Lyme disease. The organism is transmitted by ticks of the genus *Ixodes*. In endemic areas, these ticks are commonly found on vegetation and animals such as deer, mice, dogs, horses, and birds. *B. burgdorferi* infection shares features with other spirochetal infections (diseases caused by three genera in humans: *Treponema, Borrelia,* and *Leptospira*). Skin is the portal of entry for *B. burgdorferi* and the tick bite often causes a characteristic rash called *erythema migrans* (EM). EM develops around the tick bite in 60 - 80% of patients. Spirochetemia occurs early with wide spread dissemination through tissue and body fluids. Lyme disease occurs in stages, often with intervening latent periods and with different clinical manifestations.

In Lyme disease there are generally three stages of disease often with overlapping symptoms. Symptoms vary according to the sites affected by the infection such as joints, skin, central nervous system, heart, eye, bone, spleen, and kidney. Late disease is most often associated with arthritis or CNS syndromes. Asymptomatic subclinical infection is possible and infection may not become clinically evident until the later stages. Patients with early infection produce IgM antibodies during the first few weeks after onset of EM and produce IgG antibodies more slowly (1). Although IgM only may be detected during the first month after onset of illness, the majority of patients develop IgG antibodies within one month. Both IgG and IgM antibodies can remain detectable for years.

Isolation of *B. burgdorferi* from skin biopsy, blood, and spinal fluid has been reported (2). However, these direct culture detection methods may not be practical in the large scale diagnosis of Lyme borreliosis. Serological testing methods for antibodies to *B. burgdorferi* include indirect fluorescent antibody (IFA) staining, immunoblotting, and enzyme immunoassay (EIA). *B. burgdorferi* is antigenically complex with strains that vary considerably. Early antibody responses often are to flagellin which has cross reactive components. Patients in early stages of infection may not produce detectable levels of antibody. Also, early antibiotic therapy after EM may diminish or abrogate good antibody response. Some patients may never generate detectable antibody levels. Thus, serological tests for antibodies to *B. burgdorferi* are known to have low sensitivity and specificity and because of such inaccuracy, these tests cannot be relied upon exclusively for establishing a diagnosis of Lyme disease (3, 4).

In 1994, the Second National Conference on Serological diagnosis of Lyme disease recommended a two-step testing system toward standardizing laboratory serologic testing for *B. burgdorferi*. Because EIA and IFA methods were not sufficiently specific to support clinical diagnosis, it was recommended that positive or equivocal results from a sensitive EIA or IFA (first step) should be further tested, or supplemented, by using a standardized Western Blot method (second step) for detecting antibodies to *B. burgdorferi* (Western Blot assays for antibodies to *B. burgdorferi* are supplemental rather than confirmatory because their specificity is less than optimal, particularly for detecting IgM). Two-step positive results provide supportive evidence of exposure to *B. burgdorferi*, which could support a clinical diagnosis of Lyme disease but should not be used as a sole criterion for diagnosis. This scenario is commonly referred-to as the standard two-tier testing (STTT) protocol. Recent studies (9,10,11) have demonstrated that using a second ELISA test in place of the *Borrelia* immunoblot can result in a modified two-tier testing (MTTT) protocol with performance that is comparable to the STTT protocol.

Various antigens have been tested in recent years to improve the serological diagnosis of Lyme disease. One such attempt has been to test for antibodies towards VlsE1 and pepC10 antigens. This assay detects IgG and IgM antibodies towards both VlsE1 and pepC10 antigens.

**PRINCIPLE OF THE ASSAY**

The ZEUS ELISA *Borrelia* VlsE1/pepC10 IgG/IgM Test System is designed to detect IgG and IgM class antibodies in human sera to VlsE1 and pepC10 antigens. The test procedure involves three incubation steps:

1. Test sera (properly diluted) are incubated in antigen coated microwells. Any antigen specific antibody in the sample will bind to the immobilized antigen. The plate is washed to remove unbound antibody and other serum components.
2. Peroxidase Conjugated goat anti-human IgG and IgM is added to the wells and the plate is incubated. The Conjugate will react with IgG and/or IgM antibodies immobilized on the solid phase in step 1. The wells are washed to remove unreacted Conjugate.
3. The microwells containing immobilized peroxidase Conjugate are incubated with peroxidase Substrate Solution. Hydrolysis of the Substrate by peroxidase produces a color change. After a period of time the reaction is stopped, and the color intensity of the solution is measured photometrically. The color intensity of the solution depends upon the antibody concentration in the original test sample.

**TEST SYSTEM COMPONENTS**

**Materials Provided:**

Each Test System contains the following components in sufficient quantities to perform the number of tests indicated on the packaging label. **NOTE: The following components contain Sodium Azide as a preservative at a concentration of <0.1% (w/v): Controls, Calibrator and SAVe Diluent®.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** |  | **96 Tests.bmp** | **480 Tests.bmp** | **Description** |
|  |  |  |  |  |  |
| **PLATE** |  |  1 |  5 | Plate: 96 wells configured in twelve, 1x8-well, strips coated with inactivated VlsE1 and pepC10 antigen. The strips are packaged in a strip holder and sealed in an envelope with desiccant. |
|  |  |  |  |  |  |
| **CONJ** |  |  1 |  5 | Conjugate: Conjugated (horseradish peroxidase) goat anti-human IgG and IgM in 15mL, white-capped bottle(s). Ready to use. |
|  |  |  |  |  |  |
| **CONTROL** | **+** |  | 1 | 2 | Positive Control (Human Serum): 0.35mL, red-capped vial(s). |
| **CAL** |  | 1 | 4 | Calibrator (Human Serum): 0.5mL, blue-capped vial(s). |
|  |  |  |  |  |  |
| **CONTROL** |  **-** |  | 1 | 2 | Negative Control (Human Serum): 0.35mL, green-capped vial(s). |
|  |  |  |  |  |  |
| **DIL** |  **SPE** |  | 1 | 4 | SAVe Diluent®: 30mL, green-capped, bottle(s) containing Tween-20, bovine serum albumin and phosphate-buffered-saline. Ready to use. **NOTE: The SAVe Diluent**® **will change color when combined with serum.** |
|  |  |  |  |  |  |
| **SOLN** | **TMB** |  | 1 | 5 | TMB: 15mL, amber-capped, amber bottle(s) containing 3, 3’, 5, 5’ - tetramethylbenzidine (TMB). Ready to use. |
|  |  |  |  |  |  |
| **SOLN** |  **STOP** |  | 1 | 3 | Stop Solution: 15mL, red-capped, bottle(s) containing 1M H2SO4, 0.7M HCl. Ready to use. |
| **WASHBUF** |  **10X** |  | 1 | 5 | Wash Buffer Concentrate (10X): Dilute 1 part concentrate + 9 parts deionized or distilled water. 100mL, clear-capped, bottle(s) containing a 10X concentrated phosphate-buffered-saline and Tween-20 solution (blue solution). **NOTE: 1X solution will have a pH of 7.2 ± 0.2.** |

**NOTES:**

1. **The following components are not Test System Lot Number dependent and may be used interchangeably with the ZEUS ELISA Test Systems: TMB, Stop Solution, and Wash Buffer. SAVe Diluent® may be used interchangeably with any ZEUS ELISA Test System utilizing Product No. 005CC.**
2. **Test System also contains a Component Label containing lot specific information inside the Test System box.**

**PRECAUTIONS**

1. For *In Vitro* diagnostic use.
2. Follow normal precautions exercised in handling laboratory reagents. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves, and eye/face protection. Do not breathe vapor. Dispose of waste observing all local, state, and federal laws.
3. The wells of the ELISA plate do not contain viable organisms. However, consider the strips **potentially biohazardous materials** and handle accordingly.
4. The Controls are **potentially biohazardous materials**. Source materials from which these products were derived were found negative for HIV-1 antigen, HBsAg and for antibodies against HCV and HIV by approved test methods. However, since no test method can offer complete assurance that infectious agents are absent, handle these products at the Biosafety Level 2 as recommended for any potentially infectious human serum or blood specimen in the Centers for Disease Control/National Institutes of Health manual “Biosafety in Microbiological and Biomedical Laboratories”: Current Edition; and OSHA’s Standard for Bloodborne Pathogens (5).
5. Adherence to the specified time and temperature of incubations is essential for accurate results. **All reagents must be allowed to reach room temperature (20 - 25°C) before starting the assay**. Return unused reagents to refrigerated temperature immediately after use.
6. Improper washing could cause false positive or false negative results. Be sure to minimize the amount of any residual wash solution; (e.g., by blotting or aspiration) before adding Conjugate or Substrate. Do not allow the wells to dry out between incubations.
7. The SAVe Diluent®, Controls, and Calibrator contain Sodium Azide at a concentration of <0.1% (w/v). Sodium Azide has been reported to form lead or copper azides in laboratory plumbing which may cause explosions upon hammering. To prevent, rinse sink thoroughly with water after disposing of solution containing Sodium Azide.
8. The Stop Solution is TOXIC if inhaled, has contact with skin or if swallowed. It can cause burns. In case of accident or ill feelings, seek medical advice immediately.
9. The TMB Solution is HARMFUL. It is irritating to eyes, respiratory system and skin.
10. The Wash Buffer concentrate is an IRRITANT. It is irritating to eyes, respiratory system and skin.
11. Wipe the bottom of the plate free of residual liquid and/or fingerprints that can alter optical density (OD) readings.
12. Dilution or adulteration of these reagents may generate erroneous results.
13. Do not use reagents from other sources or manufacturers.
14. TMB Solution should be colorless, very pale yellow, very pale green, or very pale blue when used. Contamination of the TMB with Conjugate or other oxidants will cause the solution to change color prematurely. Do not use the TMB if it is noticeably blue in color.
15. Never pipette by mouth. Avoid contact of reagents and patient specimens with skin and mucous membranes.
16. Avoid microbial contamination of reagents. Incorrect results may occur.
17. Cross contamination of reagents and/or samples could cause erroneous results.
18. Reusable glassware must be washed and thoroughly rinsed free of all detergents.
19. Avoid splashing or generation of aerosols.
20. Do not expose reagents to strong light during storage or incubation.
21. Allow the microwell strips and holder to equilibrate to room temperature prior to opening. The protective envelope will protect the wells from condensation.
22. Collect the wash solution in a disposal basin. Treat the waste solution with disinfectant (i.e.: 10% household bleach - 0.5% Sodium Hypochlorite). Avoid exposure of reagents to bleach fumes.
23. Caution: Neutralize any liquid waste at an acidic pH before adding to a bleach solution.
24. Do not use ELISA plate if the indicator strip on the desiccant pouch has turned from blue to pink.
25. Do not allow the Conjugate to come in contact with containers or instruments that may have previously contained a solution utilizing Sodium Azide as a preservative. Residual amounts of Sodium Azide may destroy the Conjugate’s enzymatic activity.
26. Do not expose any of the reactive reagents to bleach-containing solutions or to any strong odors from bleach-containing solutions. Trace amounts of bleach (sodium hypochlorite) may destroy the biological activity of many of the reactive reagents within this Test System.

**MATERIALS REQUIRED BUT NOT PROVIDED**

1. ELISA microwell reader capable of reading at a wavelength of 450nm. **NOTE: Use of a single (450nm), or dual (450/620 - 650nm), wavelength reader is acceptable. Dual wavelength is preferred, as the additional reference filter has been determined to reduce potential interference from anomalies that may absorb light.**
2. Pipettes capable of accurately delivering 10 - 200µL.
3. Multichannel pipette capable of accurately delivering 50 - 200µL.
4. Reagent reservoirs for multichannel pipettes.
5. Wash bottle or microwell washing system.
6. Distilled or deionized water.
7. One liter graduated cylinder.
8. Serological pipettes.
9. Disposable pipette tips.
10. Paper towels.
11. Laboratory timer to monitor incubation steps.
12. Disposal basin and disinfectant (i.e.: 10% household bleach - 0.5% Sodium Hypochlorite).

**STORAGE CONDITIONS**

|  |  |
| --- | --- |
| storage2-8.bmp | Coated Microwell Strips: Immediately reseal extra strips with desiccant and return to proper storage. After opening - strips are stable for 60 days, as long as the indicator strips on the desiccant pouch remains blue. |
| Conjugate – DO NOT FREEZE. |
| Unopened Test System, Calibrator, Positive Control, Negative Control, TMB, SAVe Diluent® |
| storage2-25.bmp | Stop Solution: 2 - 25°C Wash Buffer (1X): 20 - 25°C for up to 7 days, 2 - 8°C for 30 days.Wash Buffer (10X): 2 - 25°C |

**SPECIMEN COLLECTION**

1. ZEUS Scientific recommends that the user carry out specimen collection in accordance with CLSI document M29: Protection of Laboratory Workers from Infectious Disease (Current Edition).
2. No known test method can offer complete assurance that human blood samples will not transmit infection. Therefore, consider all blood derivatives potentially infectious.
3. Use only freshly drawn and properly refrigerated sera obtained by approved aseptic venipuncture procedures in this assay (6, 7). Do not use if there are any added anticoagulants or preservatives. Avoid using hemolyzed, lipemic, or bacterially contaminated sera.
4. Store sample at room temperature for no longer than 8 hours. If testing is not performed within 8 hours, sera may be stored between 2 - 8°C, for no longer than 10 days. If a delay in testing is anticipated, store test sera at –20°C or lower. Avoid multiple freeze/thaw cycles which may cause loss of antibody activity and give erroneous results. It is the responsibility of the individual laboratory to use all available references and/or its own studies to determine stability criteria for its laboratory (8).

**ASSAY PROCEDURE**

1. Remove the individual components from storage and allow them to warm to room temperature (20 - 25°C).
2. Determine the number of microwells needed. Allow for six Control/Calibrator determinations (one Reagent Blank, one Negative Control, three Calibrators and one Positive Control) per run. Run a Reagent Blank on each assay. Check software and reader requirements for the correct Controls/Calibrator configurations. Return unused strips to the resealable pouch with desiccant, seal, and return to storage between 2 - 8°C.

|  |
| --- |
| **EXAMPLE PLATE SET-UP** |
|  | 1 | 2 |
| A | Blank | Patient 3 |
| B | Negative Control | Patient 4 |
| C | Calibrator | Etc. |
| D | Calibrator |  |
| E | Calibrator |  |
| F | Positive Control |  |
| G | Patient 1 |  |
| H | Patient 2 |  |

1. Prepare a 1:21 dilution (e.g.: 10µL of serum + 200µL of SAVe Diluent®) of the Negative Control, Calibrator, Positive Control, and each patient serum. Ensure that the samples are properly mixed. **NOTE: The SAVe Diluent® will undergo a color change confirming that the specimen has been combined with the diluent.**
2. To individual wells, add 100μL of each diluted Control, Calibrator and patient specimen. Use a different pipette tip for each sample.
3. Add 100µL of SAVe Diluent® to well A1 as a Reagent Blank. Check software and reader requirements for the correct Reagent Blank well configuration.
4. Incubate the plate at room temperature (20 - 25°C) for 25 ± 5 minutes.
5. Wash the microwell strips 5 times.
	1. **Manual Wash Procedure**:
6. Vigorously shake out the liquid from the wells.
7. Fill each microwell with Wash Buffer. Make sure no air bubbles are trapped in the wells.
8. Repeat steps 1. and 2. for a total of 5 washes.
9. Shake out the wash solution from all the wells. Invert the plate over a paper towel and tap firmly to remove any residual wash solution from the wells. Visually inspect the plate to ensure that no residual wash solution remains. Collect wash solution in a disposable basin and treat with disinfectant at the end of the day’s run.
	1. **Automated Wash Procedure**:

If using an automated microwell wash system, set the dispensing volume to 300 - 350µL/well. Set the wash cycle for 5 washes with no delay between washes. If necessary, the microwell plate may be removed from the washer, inverted over a paper towel and tapped firmly to remove any residual wash solution from the microwells.

1. Add 100µL of the Conjugate to each well, including the Reagent Blank well, at the same rate and in the same order as the specimens.
2. Incubate the plate at room temperature (20 - 25°C) for 25 ± 5 minutes.
3. Wash the microwells by following the procedure as described in step 7.
4. Add 100µL of TMB to each well, including the Reagent Blank well, at the same rate and in the same order as the specimens.
5. Incubate the plate at room temperature (20 - 25°C) for 10 - 15 minutes.
6. Stop the reaction by adding 50µL of Stop Solution to each well, including the Reagent Blank well, at the same rate and in the same order as the TMB. Positive samples will turn from blue to yellow. After adding the Stop Solution, tap the plate several times to ensure that the samples are thoroughly mixed.
7. Set the microwell reader to read at a wavelength of 450nm and measure the optical density (OD) of each well against the Reagent Blank. Read the plate within 30 minutes of the addition of the Stop Solution.

|  |
| --- |
| **ABBREVIATED TEST PROCEDURE** |
|  1. Dilute Serum 1:21. |
|  2. Add diluted sample to microwell - 100µL/well. |
|  3. *Incubate 25 ± 5 minutes.* |
|  4. Wash. |
|  5. Add Conjugate 100µL/well. |
|  6.  *Incubate 25 ± 5 minutes.* |
|  7. Wash. |
|  8. Add TMB 100µL/well. |
|  9. *Incubate 10 - 15 minutes.* |
| 10. Add Stop Solution -50µL/well - Mix. |
| 11. READ within 30 minutes. |

**QUALITY CONTROL**

1. Each time the assay is performed, the Calibrator must be run in triplicate. A Reagent Blank, Negative Control, and Positive Control must also be included.
2. Calculate the mean of the three Calibrator wells. If any of the three values differ by more than 15% from the mean, discard that value and calculate the mean using the remaining two wells.
3. The mean OD value for the Calibrator, Positive Control, and Negative Control should fall within the following ranges:

OD Range

Negative Control ≤0.250

Calibrator ≥0.300

Positive Control ≥0.500

1. The OD of the Negative Control divided by the mean OD of the Calibrator should be ≤0.9.
2. The OD of the Positive Control divided by the mean OD of the Calibrator should be ≥1.25.
3. If the above conditions are not met the test should be considered invalid and should be repeated.
4. The Positive Control and Negative Control are intended to monitor for substantial reagent failure, but will not ensure precision at the assay Cutoff.
5. Additional Controls may be tested according to guidelines or requirements of local, state, and/or federal regulations or accrediting organizations.
6. Refer to CLSI document C24: Statistical Quality Control for Quantitative Measurement Procedures for guidance on appropriate QC practices.

**INTERPRETATION OF RESULTS**

1. **Calculations:**
2. *Correction Factor:* The manufacturer determined a Cutoff OD Value for positive samples and correlated it to the Calibrator. The Correction Factor (CF) allows for the determination of the Cutoff Value for positive samples. It will also correct for slight day-to-day variations in test results. The Correction Factor is determined for each lot of components and is printed on the Component Label located in the Test System box.
3. *Cutoff OD Value:* To obtain the Cutoff OD Value, multiply the CF by the mean OD of the Calibrator determined above.

*(CF x Mean OD of Calibrator = Cutoff OD Value)*

1. *Index Values/OD Ratios:* Calculate the Index Value/OD Ratio for each specimen by dividing its OD Value by the Cutoff OD from step b.

|  |  |  |  |
| --- | --- | --- | --- |
| Example: | Mean OD of Calibrator | = | 0.793 |
|  | Correction Factor (CF) | = | 0.25 |
|  | Cutoff OD | = | 0.793 x 0.25 = 0.198 |
|  | Unknown Specimen OD | = | 0.432 |
|  | Specimen Index Value/OD Ratio | = | 0.432/0.198 = 2.18 |

* 1. **Interpretations:** Index Values/OD Ratios are interpreted as follows.

|  |  |
| --- | --- |
|  | Index Value/OD Ratio |
| Negative Specimens | ≤0.90 |
| Equivocal Specimens | 0.91 to 1.09 |
| Positive Specimens | ≥1.10 |

1. An OD ratio <0.90 indicates no significant amount of antibodies to VlsE1 and pepC10 detected. If exposure to *B. burgdorferi* is suspected, a second sample should be collected and tested two to four weeks later.
2. An OD ratio >1.10 indicates that antibodies specific to *B.burgdorferi* were detected. This indicates presumptive evidence of probable exposure. The specimen should be tested by the second step IgG and/or IgM Western blot.
3. Specimens with OD ratio values in the equivocal range (0.91 - 1.09) indicate that antibodies specific to *B.burgdorferi* were detected. This indicates presumptive evidence of probable exposure. The specimen should be tested by the second step IgG and/or IgM Western blot.
	1. **MTTT (2-EIA) Interpretation for IgG/IgM:**

In addition to being used in the standard two-tier testing (STTT) method, this device may be used in the 2-EIA or modified two-tier testing (MTTT) protocol for the detection of IgG/IgM antibodies to *B. burgdorferi* in the following way.

1. The samples must be tested with the ZEUS ELISA *Borrelia* VlsE1/pepC10 IgG/IgM Test System.
2. All the positive and equivocal samples must then be tested with tlhe ZEUS ELISA *Borrelia burgdorferi* IgG/IgM Test System.
3. Positive and equivocal results from the second-EIA testing should be reported as positive and interpreted as supportive evidenceforthe presence of IgG/IgM antibodies and exposure to *B. burgdorferi.*
	1. **MTTT (2-EIA) Use and Interpretation for IgM Antibody Detection:**

In addition to being used in the standard two-tier testing (STTT) method, this device may be used in the 2-EIA or modified two-tier testing (MTTT) protocol for the detection of IgM antibodies to *B. burgdorferi* in the following way.

1. The samples must be tested with the ZEUS ELISA *Borrelia* VlsE1/pepC10 IgG/IgM Test System.
2. All the positive and equivocal samples must then be tested with the ZEUS ELISA *Borrelia burgdorferi* IgM Test System.
3. Positive and equivocal results from the second-EIA testing should be reported as positive and interpreted as supportive evidence for the presence of IgM antibodies and exposure to *B. burgdorferi.*
	1. **MTTT (2-EIA) Use and Interpretation for IgG Antibody Detection:**

In addition to being used in the standard two-tier testing (STTT) method, this device may be used in the 2-EIA or modified two-tier testing (MTTT) protocol for the detection of IgG antibodies to *B. burgdorferi* in the following way.

1. The samples must be tested with the ZEUS ELISA *Borrelia* VlsE1/pepC10 IgG/IgM Test System.
2. All the positive and equivocal samples must then be tested with the ZEUS ELISA *Borrelia burgdorferi* IgG Test System.
3. Positive and equivocal results from the second-EIA testing should be reported as positive and interpreted as supportive evidence for the presence of IgG antibodies and exposure to *B. burgdorferi.*

**LIMITATIONS OF THE ASSAY**

1. The MTTT study was conducted using the ZEUS ELISA *Borrelia* VlsE1/pepC10 lgG/IgM Test System as the first-tier assay and the ZEUS ELISA *Borrelia burgdorferi* IgG/IgM Test System or the ZEUS ELISA *Borrelia burgdorferi* IgM Test System or the ZEUS ELISA *Borrelia burgdorferi* IgG Test System as the second-tier assay with testing performed in that order. The performance characteristics of the device have not been established for the alternate order of testing or for the use of other EIA assays in the MTTT (2-EIA) procedure.
2. Interpret test results in conjunction with the clinical evaluation and the results of other diagnostic procedures.
3. Do not perform as a screening procedure for the general population. The predictive value of a positive or negative result depends on the prevalence of analyte (antibodies present to VlsE1 and pepC10 antigens) in a given patient population. Test only when clinical evidence suggests the diagnosis of *Borrelia* infection or related etiological conditions observed by the physicians.
4. Hemolytic, icteric, or lipemic samples and specimens with abnormal IgG and RF antibody concentrations may interfere with the outcome of this assay. Avoid the use of these types of specimens.
5. Interpret test results of specimens from immunosuppressed patients with caution.
6. Performance characteristics of this device have not been established for matrices other than serum.
7. Performance characteristics of this device have not been established with specimens containing heterophile antibodies, which are known to cause false positive results in various immunoassays.
8. Specimens known to contain potentially cross reactive antibodies to *B. burgdorferi* with infections to tick-borne relapsing fever, rickettsial diseases, ehrlichiosis, babesiosis, and leptospirosis have not been tested, therefore the performance of this device is unknown if there is any cross-reactivity with these antibodies.
9. No fresh samples were tested in the prospective studies.
10. This test will not distinguish results that are both IgG and IgM positive from results that are either IgG or IgM positive.

**REFERENCES**

1. Steere AC, Taylor E, Willson ML, Levine JF, Spielman A. Longitudinal assessment of the clinical and epidemiological features of Lyme Disease in a defined population. J Infect Dis **1986**; 154:295-300.
2. Rosenfeld ME, Nowakowski J, McKenna DF, Carbonaro CA, Wormser GP. Serodiagnosis in early Lyme disease. J Clin Microbiol **1993**; 31:3090-3095
3. Steere AC, Grodzicki RL, Komblatt AN, Craft JE, Barbour AG, Burgdorfer W, Schmid GP, Johnson E, Malawista SE. The spirochetal etiology of Lyme disease. N Engl J Med **1983**;308:733-740.
4. Bakken LL, Callister SM, Wand PJ, and Schell RF. Interlaboratory Comparison of Test Results for Detection of Lyme Disease by 516 Patients in the Wisconsin State Laboratory of Hygiene/College of American Pathologists Proficiency Testing Program. J. Clin. Microbiol. **1997**;35:537-543.
5. U.S. Department of Labor, Occupational Safety and Health Administration: Occupational Exposure to Bloodborne Pathogens. Final Rule, Fed. Register 56:64175-64182, 1991.
6. Procedures for the collection of diagnostic blood specimens by venipuncture. Second Edition; Approved Standard (1984). Published by National Committee for Clinical Laboratory Standards.
7. Procedures for the Handling and Processing of Blood Specimens. NCCLS Document H18-A, Vol. 10, No. 12. Approved Guideline 1990.
8. Procedures for the Handling and Processing of Blood Specimens for Common Laboratory Tests; Approved Guidelines – 4th Edition (2010). CLSI Document GP44-A4 (ISBN 1-56238-724-3). Clinical and Laboratory Standards Institute, 950 West Valley Road, Suite 2500, Wayne, PA 19087.
9. Branda JA, Linskey K, Kim YA, Steere AC, Ferrano MJ. Two-Tiered Antibody Testing for Lyme Disease With Use of 2 Enzyme Immunoassays, a Whole-Cell Sonicate Enzyme Immunoassay Followed by a VlsE C6 Peptide Enzyme Immunoassay. Clin Infect Dis **2011**; 53:541–547.
10. Mollins CR, Delorey MJ, Sexton C, Schriefer ME*.* Lyme Boreliosis Serology: Performance of Several Commonly Used Laboratory Diagnostic Tests and a Large Resource Panel of Well Characterized Patient Specimens. J Clin Microbiol **2016**; 54:2726-2734.
11. Branda JA, *et al.* Advances in Serodiagnostic Testing for Lyme Disease Are at Hand. Clin Infect Dis **2018** Mar 19;66(7):1133-1139

For US Customer Service contact your local distributor.

For US Technical Support contact ZEUS Scientific, call toll free or e-mail support@zeusscientific.com.

For Non-US Customer Service and Technical Support inquiries, please contact your local distributor.

**©2021 ZEUS Scientific, Inc. All Rights Reserved.**

****

**ZEUS Scientific, Inc.**

200 Evans Way, Branchburg, New Jersey, 08876, USA

Toll Free (U.S.): 1-800-286-2111, Option 2

International: +1 908-526-3744

Fax: +1 908-526-2058

Website: [www.zeusscientific.com](http://www.zeusscientific.com)

ZEUS ELISA and SAVe Diluent® are trademarks of ZEUS Scientific, Inc.

This product utilizes (in part) technology licensed to ZEUS Scientific from

 the The Board of Reagents of the University of Texas System. Such

technology is covered in the following US patents: 6,437,116/6,740,744

6,719,983/7,135,176/8,071,109/8,354,240/7,847,084/8,076,470/8,283,458.