

INTENDED USE

The ZEUS ELISA Cardiolipin IgG Test System is an enzyme-linked immunosorbent assay (ELISA) designed for the semi-quantitative measurement of circulating IgG autoantibodies to cardiolipin. This test is for *In Vitro* diagnostic use.

SIGNIFICANCE AND BACKGROUND

Autoantibodies directed against phospholipids, and anti-cardiolipin (aCL) in particular, have been associated with recurrent thrombosis, thrombocytopenia, and spontaneous abortions (1,2,3). aCL is observed in patients with systemic lupus erythematosus and other connective tissue disease (4), individuals undergoing chlorpromazine treatment (5), as well as in persons who do not have chronic illness.

PRINCIPLE OF THE ASSAY

The ZEUS ELISA Cardiolipin IgG Test System is designed to detect IgG class antibodies to cardiolipin in human sera. Creation of sensitized wells of the plastic microwell strips occurred using passive adsorption with cardiolipin antigen. 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 is added to the wells and the plate is incubated. The Conjugate will react with IgG antibody 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 Sample Diluent.**

PLATE	1. Plate: 96 wells configured in twelve, 1x8-well, strips coated with Cardiolipin antigen from bovine heart. The strips are packaged in a strip holder and sealed in an envelope with desiccant.
CONJ	2. Conjugate: Conjugated (horseradish peroxidase) goat anti-human IgG (Fc chain specific - yellow solution). One, 15mL, white-capped bottle. Ready to use.
CONTROL +	3. Positive Control (Human Serum): One, 0.35mL, red-capped vial.
CAL	4. Calibrator (Human Serum): One, 0.5mL, blue-capped vial.
CONTROL -	5. Negative Control (Human Serum): One, 0.35mL, green-capped vial.
DIL SPE	6. Sample Diluent: One, 30mL, green-capped, bottle containing bovine serum albumin and phosphate-buffered-saline. Green solution, ready to use.
SOLN TMB	7. TMB: One, 15mL, amber-capped, amber bottle containing 3, 3', 5, 5' - tetramethylbenzidine (TMB). Ready to use.
SOLN STOP	8. Stop Solution: One, 15mL, red-capped, bottle containing 1M H ₂ SO ₄ , 0.7M HCl. Ready to use.
WASHBUF 10X	9. Wash Buffer Concentrate (10X): Dilute 1 part concentrate + 9 parts deionized or distilled water. One, 100mL, clear-capped, bottle containing a 10X concentrated phosphate-buffered-saline solution (clear 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 and Stop Solution.
2. Test System also contains a Component Label containing lot specific information inside the Test System box.

PRECAUTIONS

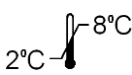
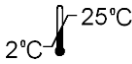
1. For *In Vitro* diagnostic use.
2. Follow normal precautions exercised in handling laboratory reagents. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves, and eye/face protection. Do not breathe vapor. Dispose of 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 (6).
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 Sample 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. Allowing 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 let 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

	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, Sample Diluent.	
	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 (7, 8). Do not use if there are any added anticoagulants or preservatives. Avoid using hemolyzed, lipemic, or bacterially contaminated sera. 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 48 hours. If a delay in testing is anticipated, store test sera at 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 (9).

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	

3. Prepare a 1:21 dilution (e.g.: 10µL of serum + 200µL of Sample Diluent) of the Negative Control, Calibrator, Positive Control, and each patient serum.
4. To individual wells, add 100µL of each diluted Control, Calibrator and patient specimen. Ensure that the samples are properly mixed. Use a different pipette tip for each sample.
5. Add 100µL of Sample Diluent to well A1 as a Reagent Blank. Check software and reader requirements for the correct Reagent Blank well configuration.
6. Incubate the plate at room temperature (20 - 25°C) for 25 ± 5 minutes.
7. Wash the microwell strips 5 times.
 - a. **Manual Wash Procedure:**

1. Vigorously shake out the liquid from the wells.
 2. Fill each microwell with Wash Buffer. Make sure no air bubbles are trapped in the wells.
 3. Repeat steps 1. and 2. for a total of 5 washes.
 4. 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.
- b. **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.
8. 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.
 9. Incubate the plate at room temperature (20 - 25°C) for 25 ± 5 minutes.
 10. Wash the microwells by following the procedure as described in step 7.
 11. Add 100µL of TMB to each well, including the Reagent Blank well, at the same rate and in the same order as the specimens.
 12. Incubate the plate at room temperature (20 - 25°C) for 10 - 15 minutes.
 13. 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.
 14. 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. \longrightarrow *Incubate 25 ± 5 minutes.*
4. Wash.
5. Add Conjugate - 100µL/well.
6. \longrightarrow *Incubate 25 ± 5 minutes.*
7. Wash.
8. Add TMB - 100µL/well.
9. \longrightarrow *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:

	<u>OD Range</u>
Negative Control	≤0.250
Calibrator	≥0.300
Positive Control	≥0.500

 - a. The OD of the Negative Control divided by the mean OD of the Calibrator should be ≤0.9.
 - b. The OD of the Positive Control divided by the mean OD of the Calibrator should be ≥1.25.
 - c. 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. The Positive and Negative Controls must meet the following additional criteria:
 - a. The Negative Control must be <20 GPL
 - b. The Positive Control must be >20 GPL
6. Additional Controls may be tested according to guidelines or requirements of local, state, and/or federal regulations or accrediting organizations.
7. Refer to CLSI document C24: Statistical Quality Control for Quantitative Measurement Procedures for guidance on appropriate QC practices.

INTERPRETATION OF RESULTS

1. **Calculations:**
Positive Calibrator: Based upon testing of normal and disease-state specimens, a maximum normal unit value has been determined by the manufacturer and correlated to the positive calibrator. The Calibrator will allow for the determination of the unit value of test samples, and to correct for slight day-to-day variations in test results. The Calibrator unit value is determined for each lot of kit components and is printed on the Component List.
2. **Interpretations:** Patient samples may be graded as normal, low positive, moderate, or high positive according to the following recommendations:

	<u>GPL</u>
Normal	< 20
Low Positive	20 - <30
Moderate	30 - <80
High Positive	≥ 80

3. **Conversion of Optical Density to GPL:** The conversion of OD to unit value (GPL) can be represented by the following equation:

$$\text{Test Specimen GPL} = (A \times B)/C$$

Where: GPL = Unknown unit value to be determined; A = OD of test specimen in question; B = Unit value of calibrator (GPL); C = The mean OD of calibrator.

Example: Test specimen OD for Cardiolipin = 0.946

Calibrator OD for Cardiolipin = 0.435

Calibrator unit value for Cardiolipin = 155 GPL

Test Specimen GPL = (0.946 x 155)/0.435

Test Specimen = 337 GPL for anti-Cardiolipin

LIMITATIONS OF THE ASSAY

1. Do not make a diagnosis based on the ZEUS ELISA Cardiolipin IgG Test System results alone. Interpret the test results for anti-cardiolipin in conjunction with clinical evaluation and results of other diagnostic procedures.
2. The performance characteristics of this device have not been established for lipemic, hemolyzed and icteric specimens; therefore, do not use these type specimens with this assay.

- Although aCL has been associated with certain SLE subsets (1 - 3), the clinical significance of aCL in SLE and other diseases remains under investigation.
- The range of "normal" aCL values may vary from population to population. The normal ranges shown above are those recommended by the manufacturer and are supported by studies of random blood donors from three geographic areas in the United States. Testing laboratories, however, are encouraged to establish normal ranges for their regions.
- The clinical significance of any test result depends upon its relationship to other medical patient data. Base disease diagnosis and management on an evaluation of all relevant patient information.

EXPECTED RESULTS

A study was conducted where 113 normal donor sera from Northeastern United States were evaluated for cardiolipin IgG autoantibodies. Of the 113 tested, five (4.4%) had results of 20 GPL or greater. In the same study a group of 28 uncharacterized SLE specimens were evaluated for cardiolipin IgG autoantibodies. Of these 28 specimens, 5 (17.9%) had results of 20 GPL or greater.

PERFORMANCE CHARACTERISTICS

1. Comparative Study

A comparative study was conducted to demonstrate the equivalence of the ZEUS ELISA Cardiolipin IgG Test System to another commercially available cardiolipin IgG ELISA test system. Performance was evaluated using 260 specimens as described in Table 1 below. The results of the investigation have been summarized in Table 2 below.

Table 1: Summary of Clinical Specimens

Quantity (n)	Comments
105	Disease state specimens obtained from rheumatology groups from two different university hospitals.
14	Specimens previously tested and found positive for anti-cardiolipin.
28	Uncharacterized SLE patient samples.
113	Normal donor samples collected in Northeastern United States.

Table 2: Relative Sensitivity, Specificity, and Agreement

ZEUS ELISA Cardiolipin IgG Test System		Commercial Cardiolipin IgG ELISA Result		
		Positive	Negative	Total
	Positive	44	51	95
	Negative	4	161	165
	Total	48	212	260

Relative Sensitivity = $44/48 = 91.7\%$ 95% Confidence Interval* = 83.8 to 99.4%

Relative Specificity = $161/212 = 75.9\%$ 95% Confidence Interval* = 70.2 to 81.7%

Relative Agreement = $205/260 = 78.8\%$ 95% Confidence Interval* = 73.8 to 83.8%

*95% confidence intervals calculated using the exact method.

2. Reproducibility

To evaluate both intra-assay and inter-assay reproducibility, six specimens were tested; eight replicates each, on each of three days. These results were then used to calculate mean unit values, standard deviations, and percent CV. Two of the specimens were strong positives, two were clearly negative, and two were near the assay cutoff. The results of the study have been summarized below.

Table 3: ZEUS ELISA Cardiolipin IgG Test System; Results of Precision Testing

Specimen	Intra-Assay									Inter-Assay		
	Day One			Day Two			Day Three			Mean Result (GPL)	Standard Deviation	% CV
	Mean Result (GPL)	Standard Deviation	% CV	Mean Result (GPL)	Standard Deviation	% CV	Mean Result (GPL)	Standard Deviation	% CV			
1	84	2.05	2.4	75	4.25	5.7	87	2.83	3.3	82	5.91	7.2
2	73	2.11	2.9	66	5.88	8.9	74	3.16	4.2	71	5.28	7.4
3	34	2.01	6.0	30	3.48	11.6	33	1.58	4.8	32	2.91	9.0
4	28	1.60	5.7	26	3.47	13.5	25	1.76	7.2	26	2.73	10.5
5	2	1.24	56.4	2	0.13	8.0	2	0.31	15.0	2	0.75	37.7
6	0	0.04	54.1	0	0.06	15.4	0	0.22	82.8	0	0.18	-77.5

3. Cross Reactivity:

To investigate the potential for positive reactions due to cross reactive antibodies, 14 specimens which were reactive for various auto-antibodies were tested on the anti-cardiolipin test system. Eleven of the 14 (78.6%) were negative for anti-cardiolipin IgG activity, while three of the 14 (21.4%) were in the Low Positive area. The results of this study indicate that the potential for a high degree of cross reactivity with such autoantibodies is not likely.

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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

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