

## HIGH SENSITIVITY C-REACTIVE PROTEIN (hs-CRP) ELISA

EU:  IVD CAN:  USA: For Research Use Only. Not for Use in Diagnostic Procedures

REF: CAN-CRP-4360 Version: 6.1 (COMB)  
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### INTENDED USE

For the quantitative determination of C-Reactive Protein by an enzyme immunoassay in human serum.

### PRINCIPLE OF THE TEST

The principle of the following enzyme immunoassay test follows a typical two-step capture or 'sandwich' type assay. The assay makes use of two highly specific monoclonal antibodies: A monoclonal antibody specific for CRP is immobilized onto the microplate and another monoclonal antibody specific for a different region of CRP is conjugated to horse radish peroxidase (HRP). CRP from the sample and standards are allowed to bind to the plate, washed, and subsequently incubated with the HRP conjugate. After a second washing step, the enzyme substrate is added. The enzymatic reaction is terminated by addition of the stopping solution. The absorbance is measured on a microtiter plate reader. The intensity of the colour formed by the enzymatic reaction is directly proportional to the concentration of CRP in the sample.

A set of standards is used to plot a standard curve from which the amount of CRP in patient samples and controls can be directly read.

### CLINICAL APPLICATIONS

C-reactive protein (CRP) is a pentameric acute phase reactant that is synthesized by the liver. Its production is controlled primarily by interleukin-6. The serum CRP concentration may increase by up to 1000-fold with infection, trauma, surgery, and other acute inflammatory events. Chronic inflammatory disorders such as auto-immune diseases and malignancy can produce persistent high levels of serum CRP.

Traditionally, CRP has been used clinically for the diagnosis and monitoring of auto-immune and infectious disorders. Recent studies have shown that chronic inflammation is an important component in the development and progression of atherosclerosis. As a result, increased serum CRP concentration are positively associated with the risk of future coronary events.

### PROCEDURAL CAUTIONS AND WARNINGS

- Users should have a thorough understanding of this protocol for the successful use of this kit. Reliable performance will only be attained by strict and careful adherence to the instructions provided.
- Control materials or serum pools should be included in every run at a high and low level for assessing the reliability of results.
- When the use of water is specified for dilution or reconstitution, use deionized or distilled water.
- In order to reduce exposure to potentially harmful substances, gloves should be worn when handling kit reagents and human specimens.
- All kit reagents and specimens should be brought to room

temperature and mixed gently but thoroughly before use. Avoid repeated freezing and thawing of reagents and specimens.

- A calibrator curve must be established for every run.
- The controls should be included in every run and fall within established confidence limits.
- Improper procedural techniques, imprecise pipetting, incomplete washing as well as improper reagent storage may be indicated when assay values for the controls do not reflect established ranges.
- When reading the microplate, the presence of bubbles in the wells will affect the optical densities (ODs). Carefully remove any bubbles before performing the reading step.
- The substrate solution (TMB) is sensitive to light and should remain colourless if properly stored. Instability or contamination may be indicated by the development of a blue colour, in which case it should not be used.
- When dispensing the substrate and stopping solution, do not use pipettes in which these liquids will come into contact with any metal parts.
- To prevent contamination of reagents, use a new disposable pipette tip for dispensing each reagent, sample, standard and control.
- Do not mix various lot numbers of kit components within a test and do not use any component beyond the expiration date printed on the label.
- Kit reagents must be regarded as hazardous waste and disposed of according to national regulations.

### LIMITATIONS

- All the reagents within the kit are calibrated for the direct determination of CRP in human serum. The kit is not calibrated for the determination of CRP in saliva, plasma or other specimens of human or animal origin.
- Do not use grossly hemolyzed, grossly lipemic, icteric or improperly stored serum.
- Any samples or control sera containing azide or thimerosal are not compatible with this kit, as they may lead to false results.
- Only calibrator A may be used to dilute any high serum samples. The use of any other reagent may lead to false results.
- The results obtained with this kit should never be used as the sole basis for clinical diagnosis. For example, the occurrence of heterophilic antibodies in patients regularly exposed to animals or animal products has the potential of causing interferences in immunological tests. Consequently, the clinical diagnosis should include all aspects of a patient's background including the frequency of exposure to animals/products if false results are suspected.
- Some individuals may have antibodies to mouse protein that can possibly interfere in this assay. Therefore, the results from any patients who have received preparation of mouse antibodies for diagnosis or therapy should be interpreted with caution.

### SAFETY CAUTIONS AND WARNINGS POTENTIAL BIOHAZARDOUS MATERIAL

Human serum that may be used in the preparation of the standards and controls has been tested and found to be non-reactive for Hepatitis B surface antigen and has also been tested for the presence of antibodies to HCV and Human Immunodeficiency Virus (HIV) and found to be negative. No test method however, can offer complete assurance that HIV, HCV and Hepatitis B virus or any infectious agents are absent.

The reagents should be considered a potential biohazard and handled with the same precautions as applied to any blood specimen.

### CHEMICAL HAZARDS

Avoid contact with reagents containing TMB, hydrogen peroxide and sulfuric acid. If contacted with any of these reagents, wash with plenty of water. TMB is a suspected carcinogen.

### SPECIMEN COLLECTION AND STORAGE

Approximately 0.1 mL of serum is required per duplicate determination. Collect 4–5 mL of blood into an appropriately labelled tube and allow it to clot. Centrifuge and carefully remove the serum layer. Store at 4°C for up to 24 hours or at -10°C or lower if the analyses are to be done at a later date. Consider all human specimens as possible biohazardous materials and take appropriate precautions when handling.

### SPECIMEN PRETREATMENT

Dilute patient serum samples 1:20 with calibrator A before use. Example: To 190 µL of calibrator A add 10 µL of serum sample (1:20).

\*Do not dilute the standards and controls, they are ready for use.

### REAGENTS AND EQUIPMENT NEEDED BUT NOT PROVIDED

- Precision pipettes to dispense 10, 20, 50, 100, 190, 200 and 300 µL
- Disposable pipette tips
- Distilled or deionized water
- Plate shaker
- Microplate reader with a filter set at 450 nm and an upper OD limit of 3.0 or greater\* (see assay procedure step 13)

### REAGENTS PROVIDED

#### 1. Mouse Anti-CRP Antibody-Coated Break-Apart Well Microplate — Ready To Use

Contents: One 96-well (12x8) monoclonal antibody-coated microplate in a resealable pouch with desiccant.

Storage: Refrigerate at 2–8°C

Stability: 12 months or as indicated on label.

#### 2. Mouse Anti-CRP Antibody-Horseradish Peroxidase (HRP) Conjugate — Requires Preparation [X80](#)

Contents: Anti-CRP monoclonal antibody-HRP conjugate in a protein-based buffer with a non-mercury preservative.

Volume: 0.3 mL/vial

Storage: Refrigerate at 2–8°C

Stability: 12 months or as indicated on label.

Preparation: Dilute 1:80 in assay buffer before use (eg. 25 µL of HRP in 2 mL of assay buffer). If the whole plate is to be used dilute 150 µL of HRP in 12 mL of assay buffer. Discard any that is left over.

#### 3. CRP Calibrators — Ready To Use

Contents: Six vials containing CRP in a protein-based buffer with a non-mercury preservative. Prepared by spiking buffer with a defined quantity of CRP. Calibrated against World Health Organization (WHO) IS 85/506.

\* Listed below are approximate concentrations, please refer to bottle labels for exact concentrations.

| Calibrator   | Concentration | Volume/Vial |
|--------------|---------------|-------------|
| Calibrator A | 0 ng/mL       | 16 mL       |
| Calibrator B | 100 ng/mL     | 0.5 mL      |
| Calibrator C | 400 ng/mL     | 0.5 mL      |
| Calibrator D | 1000 ng/mL    | 0.5 mL      |
| Calibrator E | 4000 ng/mL    | 0.5 mL      |
| Calibrator F | 10,000 ng/mL  | 0.5 mL      |

Storage: Refrigerate at 2–8°C

Stability: 12 months in unopened vials or as indicated on label. Once opened, the standards should be used within 14 days or aliquoted and stored frozen. Avoid multiple freezing and thawing cycles.

#### 4. Controls — Ready To Use

Contents: Two vials containing CRP in a protein-based buffer with a non-mercury preservative. Prepared by spiking buffer with defined quantities of CRP. Refer to vial labels for the acceptable range.

Volume: 0.5 mL/vial

Storage: Refrigerate at 2–8°C.

Stability: 12 months in unopened vial or as indicated on label. Once opened, the controls should be used within 14 days or aliquoted and stored frozen. Avoid multiple freezing and thawing cycles.

#### 5. Wash Buffer Concentrate — Requires Preparation [X10](#)

Contents: One bottle containing buffer with a non-ionic detergent and a non-mercury preservative.

Volume: 50 mL/bottle

Storage: Refrigerate at 2–8°C

Stability: 12 months or as indicated on label.

Preparation: Dilute 1:10 in distilled or deionized water before use. If the whole plate is to be used dilute 50 mL of the wash buffer concentrate in 450 mL of water.

#### 6. Assay Buffer — Ready To Use

Contents: One bottle containing a protein-based buffer with a non-mercury preservative.

Volume: 40 mL/kit

Storage: Refrigerate at 2–8°C

Stability: 12 months or as indicated on label.

#### 7. TMB Substrate — Ready To Use

Contents: One bottle containing tetramethylbenzidine and hydrogen peroxide in a non-DMF or DMSO containing buffer.

Volume: 16 mL/bottle

Storage: Refrigerate at 2–8°C

Stability: 12 months or as indicated on label.

#### 8. Stopping Solution — Ready To Use

Contents: One bottle containing 1M sulfuric acid.

Volume: 6 mL/bottle

Storage: Refrigerate at 2–8°C

Stability: 12 months or as indicated on label.

## ASSAY PROCEDURE

Specimen Pretreatment:

**Dilute 1:20 With Calibrator A Before Use.**

All reagents must reach room temperature before use. Calibrators, controls and specimen samples should be assayed in duplicate. Once the procedure has been started, all steps should be completed without interruption.

1. Prepare working solutions of the anti-CRP-HRP conjugate and wash buffer.
2. Remove the required number of well strips. Reseal the bag and return any unused strips to the refrigerator.
3. Pipette 20 µL of each calibrator, control and diluted specimen sample into correspondingly labelled wells in duplicate.
4. Pipette 200 µL of assay buffer into each well. (We recommend using a multichannel pipette.)
5. Incubate on a plate shaker (approximately 200 rpm) for 30 minutes at room temperature.
6. Wash the wells 3 times with 300 µL of diluted wash buffer per well and tap the plate firmly against absorbent paper to ensure that it is dry. (The use of a washer is recommended.)
7. Pipette 100 µL of the conjugate working solution into each well. (We recommend using a multichannel pipette.)
8. Incubate on a plate shaker (approximately 200 rpm) for 15 minutes at room temperature.
9. Wash the wells again in the same manner as step 6.
10. Pipette 100 µL of TMB substrate into each well at timed intervals.
11. Incubate on a plate shaker for 10–15 minutes at room temperature (or until calibrator F attains dark blue colour for desired OD).
12. Pipette 50 µL of stopping solution into each well at the same timed intervals as in step 10.
13. Read the plate on a microplate reader at 450 nm within 20 minutes after addition of the stopping solution.

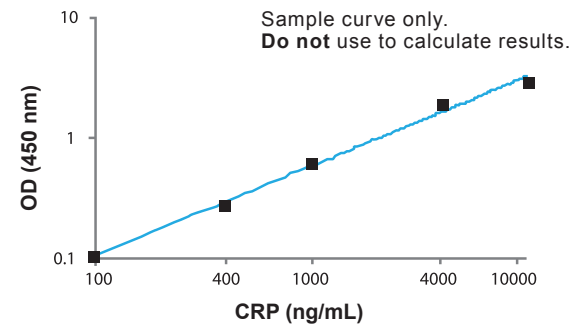
\* If the OD exceeds the upper limit of detection or if a 450 nm filter is unavailable, a 405 or 415 nm filter may be substituted. The optical densities will be lower, however, this will not affect the results of patient/control samples.

## TYPICAL TABULATED DATA

Sample data only. Do not use to calculate results.

| Calibrator | OD 1  | OD 2  | Mean OD | Value (ng/mL) |
|------------|-------|-------|---------|---------------|
| A          | 0.055 | 0.053 | 0.054   | 0             |
| B          | 0.105 | 0.103 | 0.104   | 100           |
| C          | 0.271 | 0.276 | 0.274   | 400           |
| D          | 0.607 | 0.633 | 0.620   | 1000          |
| E          | 1.964 | 1.894 | 1.929   | 4000          |
| F          | 2.829 | 2.827 | 2.828   | 10,000        |
| Unknown    | 1.035 | 1.048 | 1.042   | 1737          |

## TYPICAL CALIBRATOR CURVE



## PERFORMANCE CHARACTERISTICS

### SENSITIVITY

The lower detection limit is calculated from the standard curve by determining the resulting concentration of the mean OD of Calibrator A (based on 10 replicate analyses) plus 2 SD. Therefore, the sensitivity of the DBC hs-CRP ELISA kit is **10 ng/mL**.

### SPECIFICITY (CROSS-REACTIVITY)

The specificity of the hs-CRP ELISA kit was determined by measuring the apparent CRP value of samples spiked with the following compounds:

| Substance      | Apparent CRP Value (ng/mL) |
|----------------|----------------------------|
| Human Albumin  | Not Detected               |
| Human Globulin | Not Detected               |

### INTRA-ASSAY PRECISION

Three samples were assayed ten times each on the same calibrator curve. The results (in ng/mL) are tabulated below:

| Sample | Mean   | SD    | CV % |
|--------|--------|-------|------|
| 1      | 205.8  | 31.2  | 15.2 |
| 2      | 769.2  | 38.4  | 5.0  |
| 3      | 8437.8 | 700.4 | 8.3  |

### INTER-ASSAY PRECISION

Three samples were assayed ten times over a period of four weeks. The results (in ng/mL) are tabulated below:

| Sample | Mean   | SD    | CV % |
|--------|--------|-------|------|
| 1      | 227.0  | 22.4  | 9.9  |
| 2      | 1022.2 | 97.2  | 9.5  |
| 3      | 8791.8 | 685.8 | 7.8  |

## RECOVERY

Spiked samples were prepared by adding defined amounts of CRP to three patient serum samples. The results (in ng/mL) are tabulated below:

| Sample     | Obs. Result | Exp. Result | Recovery % |
|------------|-------------|-------------|------------|
| 1 Unspiked | 263         | -           | -          |
| + 358      | 760         | 621         | 122.4      |
| + 1430     | 1820        | 1693        | 107.5      |
| + 5720     | 6520        | 5983        | 109.0      |
| 2 Unspiked | 1352        | -           | -          |
| + 358      | 1880        | 1710        | 109.9      |
| + 1430     | 3020        | 2782        | 108.6      |
| + 5720     | 7720        | 7072        | 109.2      |
| 3 Unspiked | 5546        | -           | -          |
| + 358      | 6107        | 5904        | 103.4      |
| + 1430     | 6169        | 6976        | 88.4       |
| + 5720     | 10400       | 11266       | 92.3       |

## LINEARITY

Three patient serum samples were diluted with calibrator A. The results (in ng/mL) are tabulated below:

| Sample | Obs. Result | Exp. Result | Recovery % |
|--------|-------------|-------------|------------|
| 1      | 3662        | -           | -          |
| 1:5    | 894         | 732.4       | 122.1      |
| 1:25   | 136         | 146.5       | 92.8       |
| 1:50   | 62          | 73.2        | 84.7       |
| 2      | 6120        | -           | -          |
| 1:4    | 1922        | 1530        | 125.6      |
| 1:16   | 428         | 382.5       | 111.9      |
| 1:64   | 110         | 95.6        | 115.0      |
| 3      | 8800        | -           | -          |
| 1:4    | 2472        | 2200        | 112.4      |
| 1:16   | 614         | 550         | 111.6      |
| 1:64   | 148         | 137.5       | 107.6      |

## HIGH DOSE HOOK EFFECT

The hs-CRP ELISA kit did not experience a high dose hook effect when it was tested up to a CRP concentration of 160,000 ng/mL.

## EXPECTED VALUES


As for all clinical assays each laboratory should collect data and establish their own range of expected normal values.

|                               | Males     | Females   | Combined  |
|-------------------------------|-----------|-----------|-----------|
| N                             | 43        | 45        | 88        |
| Age                           | 17–87     | 12–79     | 12–87     |
| Abs. Range                    | 73–63,680 | 34–39,240 | 34–63,680 |
| 2.5 <sup>th</sup> Percentile  | 132       | 139       | 135       |
| 50 <sup>th</sup> Percentile   | 1197      | 1033      | 1104      |
| 97.5 <sup>th</sup> Percentile | 9710      | 6578      | 8910      |












## REFERENCES

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## SYMBOLS

|   |  |  |
|---|--|--|
|  European Conformity               |  In vitro diagnostic device |  Consult instructions for use |
|  Contains sufficient for <n> tests |  Storage Temperature        |  Legal Manufacturer           |
|  Use by                            |  Catalogue Number           |  Authorized representative    |
|  Lot number                        |  Dilute 1: # Before use     |  |

## CALCULATIONS

1. Calculate the mean optical density of each calibrator duplicate.
2. Calculate the mean optical density of each unknown duplicate.
3. Subtract the mean absorbance value of the "0" calibrator from the mean absorbance values of the calibrators, controls and serum samples.
4. Draw a calibrator curve on log-log paper with the mean optical densities on the Y-axis and the calibrator concentrations on the X-axis. If immunoassay software is being used, a 4-parameter or 5-parameter curve is recommended.
5. Read the values of the unknowns directly off the calibrator curve.
6. If a sample reads more than 10,000 ng/mL, then dilute it with calibrator A at a dilution of no more than 1:10 from the original 1:20 diluted serum (or 1:200 from neat serum). The result obtained should be multiplied by the dilution factor.