

# EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit

*Enzyme Linked Immunosorbent Assay (ELISA) for the quantitative detection of the COVID-19 IgG in human serum.*

REF KTR-1034 RUO    

## INTENDED USE

This kit is for research use only. Not for use in diagnostic procedures. The kit is for the quantitative detection of COVID-19 IgG antibody in human serum. Individuals with suspected clustering cases require diagnosis or differential diagnosis of novel coronavirus infection. The assay is validated manually, but can be adapted to an automated instrument.

## SUMMARY OF PHYSIOLOGY

2019 novel coronavirus (COVID-19) is a single-stranded RNA coronavirus<sup>2</sup>. Comparisons of the genetic sequences of this virus have shown similarities to SARS-CoV and bat coronaviruses<sup>7</sup>. In humans, coronaviruses cause respiratory infections<sup>3</sup>. Coronaviruses are composed of several proteins including the spike (S), envelope (E), membrane (M), and nucleocapsid (N)<sup>4</sup>. Results suggest that the spike protein retains sufficient affinity to the Angiotensin converting enzyme 2 (ACE2) receptor to use it as a mechanism of cell entry<sup>6</sup>. Human to human transmission of coronaviruses is primarily thought to occur among close contacts via respiratory droplets generated by sneezing and coughing<sup>1</sup>. IgG is the most abundantly found immunoglobulin to be produced in response to an antigen and will be maintained in the body after initial exposure for long term response<sup>5</sup>.

## ASSAY PRINCIPLE

This ELISA kit is designed, developed, and produced for the qualitative measurement of the human anti-COVID-19 IgG antibody in serum. This assay utilizes the microplate based enzyme immunoassay technique.

Assay calibrators, controls, and 1:100 diluted human serum samples are added to the microtiter wells of a microplate that was coated with COVID-19 recombinant full length nucleocapsid protein. After the first incubation period, the unbound protein matrix is removed with a subsequent washing step. A horseradish peroxidase (HRP) labeled polyclonal goat anti-human IgG tracer antibody is added to each well. After an incubation period, an immunocomplex of "COVID-19 recombinant antigen – human anti-COVID-19 IgG antibody - HRP labeled anti-human IgG tracer antibody" is formed if there is specific coronavirus IgG antibody present in the tested specimen. The unbound tracer antibody is removed by the subsequent washing step. HRP-labeled tracer antibody bound to the well is then incubated with a substrate solution in a timed reaction and then measured in a spectrophotometric microplate reader. The enzymatic activity of the tracer antibody bound to the anti-COVID-19 IgG on the wall of the microtiter well is proportional to the amount of the anti-COVID-19 IgG antibody level in the tested specimen.

## REAGENTS: PREPARATION AND STORAGE

This test kit must be stored at 2 – 8°C upon receipt. For the expiration date of the kit refer to the label on the kit box. All components are stable until this expiration date.

### 1. COVID-19 antigen coated Microplate (31217)

Microplate coated with COVID-19 recombinant protein.

Qty: 1 x 96 well microplate

Storage: 2 – 8°C

Preparation: Ready to use.

### 2. COVID-19 IgG Sample Diluent (31218)

A ready-to-use sample dilution buffer.

Qty: 1 x 120 mL

Storage: 2 – 8°C

Preparation: Ready to use.

### 3. HRP labeled Anti-IgG Tracer Antibody (31220)

HRP labeled polyclonal goat anti-human IgG antibody in a stabilized protein matrix.

Qty: 1 x 11 mL

Storage: 2 – 8°C

Preparation: Ready to use.

### 4. ELISA Wash Concentrate (10010)

Surfactant in a phosphate buffered saline with non-azide preservative.

Qty: 1 x 30 mL

Storage: 2 – 25°C

Preparation: 30X Concentrate. The contents must be diluted with 870 mL distilled water and mixed well before use.

### 5. ELISA HRP Substrate (10020)

Tetramethylbenzidine (TMB) with stabilized hydrogen peroxide.

Qty: 1 x 15 mL

Storage: 2 – 8°C

Preparation: Ready to use.

### 6. ELISA Stop Solution (10030)

0.5 M sulfuric acid.

Qty: 1 x 15 mL

Storage: 2 – 25°C

Preparation: Ready to use.

### 7. COVID-19 IgG Calibrators Levels 1 - 5 (31250 - 31254)

Calibrators with a bovine serum albumin based matrix with non-azide preservative. Refer to vials for exact concentration.

Qty: 5 x 0.5 mL

Storage: 2 – 8°C.

Preparation: Ready to use.

### 8. COVID-19 IgG Controls (31255 – 31256)

Positive and negative controls with a bovine serum albumin based matrix with non-azide preservative.

Qty: 2 x 0.5 mL

Storage: 2 – 8°C.

Preparation: Ready to use.

## **SAFETY PRECAUTIONS**

The reagents are for research use only. Source material which contains reagents of bovine serum albumin was derived in the contiguous 48 United States. It was obtained only from healthy donor animals maintained under veterinary supervision and found free of contagious diseases. Wear gloves while performing this assay and handle these reagents as if they were potentially infectious. Avoid contact with reagents containing hydrogen peroxide, or sulfuric acid. Do not get in eyes, on skin, or on clothing. Do not ingest or inhale fumes. On contact, flush with copious amounts of water for at least 15 minutes. Use Good Laboratory Practices.

## **MATERIALS REQUIRED BUT NOT PROVIDED**

1. Precision single channel pipettes capable of delivering 10  $\mu\text{L}$ , 25  $\mu\text{L}$ , 100  $\mu\text{L}$ , and 1000  $\mu\text{L}$ , etc.
2. Repeating dispenser suitable for delivering 100  $\mu\text{L}$ .
3. Disposable pipette tips suitable for above volume dispensing.
4. Disposable 12 x 75 mm or 13 x 100 glass tubes.
5. Disposable plastic 1000 mL bottle with caps.
6. Aluminum foil.
7. Deionized or distilled water.
8. Plastic microtiter well cover or polyethylene film.
9. ELISA multichannel wash bottle or automatic (semi-automatic) washing system.
10. Spectrophotometric microplate reader capable of reading absorbance at 450 nm.

## **SAMPLE COLLECTION & STORAGE**

Only 10  $\mu\text{L}$  of human serum is required for measurement in duplicate. Samples should only be used on the same day. Severe hemolytic samples should not be used.

## **ASSAY PROCEDURE**

### **1. Reagent Preparation**

1. Prior to use, allow all reagents to come to room temperature. Reagents from different kit lot numbers should not be combined or interchanged.
2. ELISA Wash Concentrate (10010) must be diluted to working solution prior to use. Please see REAGENTS section for details.

### **2. Sample Preparation**

1. Dilute serum sample by a **1:100** dilution ratio with the COVID-19 IgG Sample Diluent (31218). For each 10  $\mu\text{L}$  of sample, 1000  $\mu\text{L}$  of COVID-19 IgG Sample Diluent (31218) is needed.
2. Mix well prior to performing the assay.

### **3. Assay Procedure**

1. Place a sufficient number of microwell strips (31217) in a holder to run the calibrators (31250 - 31254), controls (31255, 31256), and samples in duplicate.
2. Test Configuration

Row	Strip 1	Strip 2	Strip 3
A	Calibrator Level 1	Calibrator Level 5	SAMPLE 2
B	Calibrator Level 1	Calibrator Level 5	SAMPLE 2
C	Calibrator Level 2	Control 1	SAMPLE 3
D	Calibrator Level 2	Control 1	SAMPLE 3
E	Calibrator Level 3	Control 2	SAMPLE 4
F	Calibrator Level 3	Control 2	SAMPLE 4
G	Calibrator Level 4	SAMPLE 1	SAMPLE 5
H	Calibrator Level 4	SAMPLE 1	SAMPLE 5

3. Add **20  $\mu\text{L}$**  of calibrators (31250 - 31254), controls (31255, 31256), and 1:100 diluted samples into the designated microwells.
4. Add **100  $\mu\text{L}$**  of sample diluent into each microwell.
5. Mix gently and cover the plate with one plate sealer and aluminum foil. Incubate at **room temperature (20-25 °C)** for **30 minutes**.
6. Remove the plate sealer. Aspirate the contents of each well. Wash each well **5 times** by dispensing **350  $\mu\text{L}$**  of diluted wash solution (10010) into each well, and then completely aspirate the contents. Alternatively, an automated microplate washer can be used.
7. Add **100  $\mu\text{L}$**  of the HRP labeled Anti-hIgG Tracer Antibody (31220) into the microwells.
8. Mix gently and cover the plate with one plate sealer and aluminum foil. Incubate at **room temperature (20-25 °C)** for **30 minutes**.
9. Remove the plate sealer. Aspirate the contents of each well. Wash each well **5 times** by dispensing **350  $\mu\text{L}$**  of diluted wash solution (10010) into each well, and then completely aspirate the contents. Alternatively, an automated microplate washer can be used.
10. Add **100  $\mu\text{L}$**  of the substrate (10020) into the microwells.
11. Mix gently and cover the plate with aluminum foil. Incubate at **room temperature (20-25 °C)** for **20 minutes**.
12. Remove the aluminum foil and add **100  $\mu\text{L}$**  of stop solution (10030) into each of the microwells. Mix by gently by tapping the plate.
13. Read the absorbance at **450 nm** within **10 minutes** with a microplate reader.

## **PROCEDURAL NOTES**

1. It is recommended that all samples be assayed in duplicate. The average absorbance reading of each duplicate should be used for data reduction and the calculation of results.
2. Keep light-sensitive reagents in the original bottles and avoid unnecessary exposure to the light.
3. Store any unused antibody-coated strips in the foil Ziploc bag with desiccant to protect from moisture.
4. Careful technique and use of properly calibrated pipetting devices are necessary to ensure reproducibility of the test.
5. Incubation times or temperatures other than those stated in this insert may affect the results.
6. Avoid air bubbles in the microwell as this could result in lower binding efficiency and higher CV% of duplicate reading.
7. All reagents should be mixed gently and thoroughly prior to use. Avoid foaming.

## **QUALITY CONTROL**

To assure the validity of the results each assay should include adequate controls with known COVID-19 IgG levels. We also recommend that all assays include the laboratory's own controls in addition to those provided with this kit.

## **INTERPRETION OF RESULTS**

1. Calculate the average absorbance for each pair of duplicate test results.
2. The calibration curve is generated by the corrected absorbance of all calibrator levels on the ordinate against the calibrator concentration on the abscissa using point-to-point or log-log paper. Appropriate computer assisted data reduction programs may also be used for the calculation of results.
3. It is recommended to use following curve fits: (1) Point-to-Point, or (2) 4-Parameter or (3) CubicSpline.
4. The COVID-19 IgG concentrations for the controls and patient samples are read directly from the calibration curve using their respective corrected absorbance.

## LIMITATIONS OF THE PROCEDURE

1. This kit is for research use only. Not for use in diagnostic procedures.
2. Since there is no Gold Standard concentration available for COVID-19 IgG measurement, the values of the assay calibrators were established by diluting a highly purified human COVID-19 IgG in a protein matrix.
3. In the first week of the onset of the infection with the novel coronavirus (COVID-19), results may be negative for IgG. In addition, low immunity or diseases that affect immune function, important systemic organ failure, or use of drugs that suppress immune functions are conditions that may contribute to negative results of new coronavirus IgG. Previous infection of SARS or other coronavirus strains may cause light IgG positive results due to similarity to other strains.
4. Bacterial or fungal contamination of serum specimens or reagents, or cross-contamination between reagents may cause erroneous results.
5. Water deionized with polyester resins may inactivate the horseradish peroxidase enzyme.

## EXPECTED VALUES

One hundred and thirty-one donor serum samples from December 2019 were collected and tested. The range of COVID-19 IgG was from 0.2 U/mL to 25.3 U/mL. The average concentration is 3.9 U/mL with a median at 3.1 U/mL and a standard deviation at 3.1 U/mL. The manufacturer recommended  $P_{97.5}$  positive cut-off level is **10 U/mL**. If maximum clinical specificity is desired, the  $P_{99}$  positive cut-off level at 20 U/mL can be used.

It is highly recommended that each laboratory should establish their own normal range for COVID-19 IgG based on local populations.

## EXAMPLE DATA

This ELISA calculates the concentration values of the samples and the controls by a calibration curve (fitting method: four parameters or point-to-point) and the measured absorbance. The following is a typical calibration curve,

*Note: This curve should not be used in lieu of calibrator curve run with each assay.*

Microwell ID	Reading Absorbance (450 nm)		
	OD Readings	Average OD	Concentration (U/mL)
Calibrator Level 1: 0 U/mL	0.074	0.072	16.188
	0.070		
Calibrator Level 2: 6.9 U/mL	0.474	0.469	
	0.464		
Calibrator Level 3: 26.3 U/mL	1.030	1.029	
	1.028		
Calibrator Level 4: 100 U/mL	1.485	1.447	
	1.410		
Calibrator Level 5: 200 U/mL	2.008	1.992	
	1.976		
Control 1	0.720	0.737	
	0.754		
Control 2	1.323	1.288	71.893
	1.253		

## PERFORMANCE CHARACTERISTICS

### Reactivity/Inclusivity

Although mutations in the SARS-CoV-2 genome have been identified as the virus has spread, no serologically unique strains have been

described relative to the originally isolated virus. It is critical to note that this research is exceptionally limited at present.

### Limit of Detection

The limit of detection (LoD) was determined by 14 replicates of both zero standard and level 2 standard, which is to be 0.17 U/mL.

### Linearity

Linearity was determined by the duplicate determination of a clinical positive serum sample with a serial dilution using assay buffer.

Well ID	Average Concentration (U/mL)	Theoretical Concentration (U/mL)	Linear Recovery (%)	R <sup>2</sup>
Original	66.96	66.96	-	0.999
1:2	32.30	33.48	96.5%	
1:4	16.03	16.74	95.6%	
1:8	7.19	8.37	86.0%	
1:16	3.34	4.18	79.8%	

### Intra-assay Precision

The intra-assay precision was determined by the measurement of three serum samples in eight replicates. The results are summarized below with satisfactory precision.

Well ID	Average Concentration (U/mL)	SD	CV (%)
Sample 1	10.38	0.52	5.0%
Sample 2	21.93	0.66	3.0%
Sample 3	66.96	4.53	6.8%

### Inter-assay Precision

The inter-assay precision was determined by the measurement of the assay controls in three replicates over twelve runs of the assay. The results are summarized below with satisfactory precision.

Well ID	Average Concentration (U/mL)	SD	CV (%)
Control 1	17.9	1.223	6.8%
Control 2	71.1	6.535	9.2%

### Interference

Interference was determined by spiking two different concentrations of interferents into negative and positive samples and testing in duplicate. The interpretation of results did not change after spiking materials into the sample.

Interferent	Well ID	Concentration (U/mL)	Interpretation of Results	Bias (%)
Hemoglobin	Sample 1	5.53	-	-
	+100 mg/dL Hb	5.22	-	-5.6%
	+200 mg/dL Hb	5.85	-	5.8%
	Sample 2	53.67	+	-
	+100 mg/dL Hb	57.55	+	7.2%
	+200 mg/dL Hb	50.88	+	-5.2%
Lipid	Sample 3	4.29	-	-
	+100 mg/dL Lipid	4.34	-	1.2%
	+200 mg/dL Lipid	3.85	-	-10.3%
	Sample 4	21.00	+	-
	+100 mg/dL Lipid	18.25	+	-13.1%
	+200 mg/dL Lipid	22.22	+	5.8%

<b>Bilirubin</b>	Sample 5	4.29	-	-
	+100 mg/dL Bilirubin	4.15	-	-3.3%
	+200 mg/dL Bilirubin	3.97	-	-7.5%
	Sample 6	21.00	+	-
	+100 mg/dL Bilirubin	21.26	+	1.3%
	+200 mg/dL Bilirubin	23.37	+	11.3%
<b>Protein</b>	Sample 7	4.29	-	-
	+100 mg/dL Protein	3.71	-	-13.5%
	+200 mg/dL Protein	4.57	-	6.6%
	Sample 8	21.00	+	-
	+100 mg/dL Protein	18.03	+	-14.1%
	+200 mg/dL Protein	22.57	+	7.5%

### Cross-Reactivity

A large number of known negative samples (300 unique samples collected in the US prior to December 2019) were tested from a population with a high prevalence of infection with, and/or vaccinated against, the following viruses:

anti-influenza A (IgG and IgM)
anti-influenza B (IgG and IgM)
anti-HCV (IgG and IgM)
anti-HBV (IgG and IgM)
anti-Haemophilus influenzae (IgG and IgM)
anti-229E (alpha coronavirus)
anti-NL63 (alpha coronavirus)
anti-OC43 (beta coronavirus)
anti-HKU1 (beta coronavirus)
ANA
anti-respiratory syncytial virus (IgG and IgM)
anti-HIV

A specificity of 98.3% was observed. Cross-reactivity testing for the above listed viruses is not expected.

Confirmed Disease state samples were tested in the kit in duplicate. The viruses tested are as follows:

Virus	Confirmation Test	Sample ID	Concentration (U/mL)	Interpretation of Results
Respiratory Syncytial Virus (IgG)	EIA, Viron/Serion	1	5.9	-
		2	8.3	-
		3	3.6	-
		4	7.8	-
		5	6.0	-
Influenza A (IgG)	Viron/Serion	1	3.8	-
Influenza B (IgG)	Viron/Serion	1	4.4	-
HIV Hepatitis B Virus	Siemens	1	2.8	-
		1	4.8	-
		2	2.7	-
		3	2.3	-
		4	6.2	-
		5	2.9	-

This kit has not been tested against MERS-CoV or SARS-CoV strains.

### Class Specificity

This experiment was intended to differentiate between the IgG and IgM immunoglobulins. Five PCR confirmed COVID-19 patient serum samples were tested in duplicate in qualitative COVID-19 ELISA kits manufactured by Epitepe Diagnostics, Inc. (KT-1032 EDI™ Novel Coronavirus COVID-19 IgG, KT-1033 EDI™ Novel Coronavirus COVID-19 IgM). Samples were found to be originally positive for both IgG and IgM. Further testing conducted on these natural samples presented positive results in the EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit. Protein A/ProSep A gel was then used to remove the total IgG and the treated samples were tested. The results confirm the treated samples to be positive for IgM, but negative in the EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit. The results demonstrate that this EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit exclusively detects the IgG subtype and establishes antibody class specificity for IgG. The results are as follows:

Sample ID	Replicate	Concentration (Mean, NO Treatment)	Result (Natural, NO Treatment)	Result Agreement	Concentration (With Treatment)	Result (With Treatment)	Expected Result (With Treatment)	Result Agreement
190679	1	170.680	+	Yes	9.503	-	-	Yes
	2	168.405	+	Yes	8.808	-	-	Yes
190790	1	201.203	+	Yes	2.114	-	-	Yes
	2	198.568	+	Yes	1.687	-	-	Yes
190779	1	196.055	+	Yes	8.864	-	-	Yes
	2	189.925	+	Yes	7.079	-	-	Yes
190784	1	161.039	+	Yes	6.342	-	-	Yes
	2	163.284	+	Yes	5.527	-	-	Yes
190780	1	62.689	+	Yes	1.103	-	-	Yes
	2	64.646	+	Yes	0.666	-	-	Yes

### Clinical Testing

A study was performed to determine the clinical performance of the EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit using serum samples (N = 480) from donors in the United States.

The cohort used to estimate the positive percent agreement (PPA) were specimen with a confirmed positive disease state by a polymerase chain reaction (PCR) (N = 108) or serological test (N = 36). To estimate the positive percent agreement (PPA), the selected cohort specimen were confirmed positive disease state by a polymerase chain reaction (PCR) (N = 108) or serological test (N = 36).

The cohort used to estimate the negative percent agreement (NPA) were pre-COVID-19 specimen collected prior to November 2019 (N = 300) or specimen with a confirmed negative disease state by PCR (N = 16) or serological test (N = 20). To estimate the negative percent agreement (NPA), pre-COVID-19 specimen were selected prior to November 2019 (N = 300) or specimen with a confirmed negative disease state by PCR (N = 16) or confirmed negative disease state by serological test (N = 20).

Each specimen was tested in duplicate. The PPA, NPA, and the 95% confidence interval (CI) were calculated. This EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit successfully differentiates positive patients from normal population. The results are as follows:


		Confirmed Positive	Confirmed Negative
EDI™ COVID-19 Nucleocapsid IgG Quantitative ELISA Kit	Positive	130	9
	Negative	14	327
	Total	144	336
PPA	90.3	95% CI (Wilson's Score):	0.843 – 0.941
	NPA	97.3	95% CI (Wilson's Score):

### WARRANTY

This product is warranted to perform as described in its labeling and literature when used in accordance with all instructions. Epitepe Diagnostics, Inc. DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, and in no event shall Epitepe Diagnostics, Inc. be liable for consequential damages.

Replacement of the product or refund of the purchase price is the exclusive remedy for the purchaser. This warranty gives you specific legal rights and you may have other rights, which vary from state to state.

For technical assistance or place an order, please contact Epitepe Diagnostics, Inc. at (858) 693-7877 or fax to (858) 693-7678.

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Please visit our website at [www.epitopediagnostics.com](http://www.epitopediagnostics.com) to learn more about our products and services.

**REFERENCES**

1. CDC (2020). Transmission of Novel Coronavirus (COVID-19).
2. Chenjia Yuan , Shi Jinsong , Qiudong An , Liu Chang , Li Xin , Qiang , Ruanji Shou , mountains . Wuhan 2019 Bioinformatics coronavirus genome analysis [J / OL]. Bioinformatics : 1-10 [2020-02-10 ].
3. Fehr, A. R., & Perlman, S. (2015). Coronaviruses: An Overview of Their Replication and Pathogenesis. *Coronaviruses Methods in Molecular Biology*, 1–23. doi: 10.1007/978-1-4939-2438-7\_1
4. Li, F., Li, W., Farzan, M., & Harrison, S. (2005). Structure of SARS coronavirus spike receptor-binding domain complexed with its receptor. doi: 10.2210/pdb2ajf/pdb
5. Wu, L.-P., Wang, N.-C., Chang, Y.-H., Tian, X.-Y., Na, D.-Y., Zhang, L.-Y., ... Liang, G.-D. (2007). Duration of Antibody Responses after Severe Acute Respiratory Syndrome. *Emerging Infectious Diseases*, 13(10), 1562–1564. doi: 10.3201/eid1310.070576
6. Xu, X., Chen, P., Wang, J., Feng, J., Zhou, H., Li, X., ... Hao, P. (2020). Evolution of the novel coronavirus from the ongoing Wuhan outbreak and modeling of its spike protein for risk of human transmission. *Science China Life Sciences*. doi: 10.1007/s11427-020-1637-5
7. Zhou, P., Yang, X.-L., Wang, X.-G., Hu, B., Zhang, L., Zhang, W., ... Shi, Z.-L. (2020). A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature*. doi: 10.1038/s41586-020-2012-7

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**GLOSSARY OF SYMBOLS (EN 980/ISO 15223)**

 In Vitro Diagnostic Device	 European Conformity	 Lot Number
 Catalog Number	 Read instructions before use	 Number of Tests
 Store at	 Use by	 Keep away from heat and direct sun light
 Manufacturer	 Authorized Representative in Europe	

**TECHNICAL ASSISTANCE AND CUSTOMER SERVICE**