

Version 3a Last updated 25 January 2022

ab190808 Human Protein S SimpleStep ELISA[®] Kit

For the quantitative measurement of Protein S in human serum and plasma samples.

This product is for research use only and is not intended for diagnostic use.

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1. Overview

Protein S *in vitro* SimpleStep ELISA® (Enzyme-Linked Immunosorbent Assay) kit is designed for the quantitative measurement of Protein S protein in human serum and plasma samples.

The SimpleStep ELISA® employs an affinity tag labeled capture antibody and a reporter conjugated detector antibody which immunocapture the sample analyte in solution. This entire complex (capture antibody/analyte/detector antibody) is in turn immobilized via immunoaffinity of an anti-tag antibody coating the well. To perform the assay, samples or standards are added to the wells, followed by the antibody mix. After incubation, the wells are washed to remove unbound material. TMB Development Solution is added and during incubation is catalyzed by HRP, generating blue coloration. This reaction is then stopped by addition of Stop Solution completing any color change from blue to yellow. Signal is generated proportionally to the amount of bound analyte and the intensity is measured at 450 nm. Optionally, instead of the endpoint reading, development of TMB can be recorded kinetically at 600 nm.

Protein S (vitamin K-dependent protein S) is an anticoagulant plasma protein. Protein S is a cofactor to activated protein C in the degradation of coagulation factors Va and VIIIa. It helps to prevent coagulation and stimulating fibrinolysis. Protein S deficiency causes autosomal dominant (THP5) [MIM: 612336] and autosomal recessive (THP6) [MIM: 614514] thrombophilia. The autosomal dominant thrombophilia due to Protein S deficiency (THPH5) is hemostatic disorder characterized by impaired regulation of blood coagulation and a tendency to recurrent venous thrombosis. Based on the plasma levels of total and free Protein S as well as the serine protease-activated protein C cofactor activity, three types of THPH5 have been described: type I, characterized by reduced total and free Protein S levels together with reduced anticoagulant activity; type III, in which only free Protein S antigen and Protein S activity levels are reduced; and the rare type II which is characterized by normal concentrations of both total and free Protein S antigen, but low cofactor activity. The autosomal recessive thrombophilia due to Protein S deficiency (THPH6) is a very rare and severe hematologic

disorder resulting in thrombosis and secondary hemorrhage usually beginning in early infancy. Some affected individuals develop neonatal purpura fulminans, multifocal thrombosis, or intracranial hemorrhage.

2. Protocol Summary

Prepare all reagents, samples, and standards as instructed



Add 50 μ L standard or sample to appropriate wells



Add 50 μ L Antibody Cocktail to all wells



Incubate at room temperature for 1 hour



Aspirate and wash each well three times with 350 μ L 1X Wash Buffer
PT



Add 100 μ L TMB Development Solution to each well and incubate
for 10 minutes.



Add 100 μ L Stop Solution and read OD at 450 nm

3. Precautions

Please read these instructions carefully prior to beginning the assay.

- All kit components have been formulated and quality control tested to function successfully as a kit.
- We understand that, occasionally, experimental protocols might need to be modified to meet unique experimental circumstances. However, we cannot guarantee the performance of the product outside the conditions detailed in this protocol booklet.
- Reagents should be treated as possible mutagens and should be handled with care and disposed of properly. Please review the Safety Datasheet (SDS) provided with the product for information on the specific components.
- Observe good laboratory practices. Gloves, lab coat, and protective eyewear should always be worn. Never pipet by mouth. Do not eat, drink or smoke in the laboratory areas.
- All biological materials should be treated as potentially hazardous and handled as such. They should be disposed of in accordance with established safety procedures.

4. Storage and Stability

Store kit at +4°C immediately upon receipt. Kit has a storage time of 1 year from receipt, providing components have not been reconstituted.

Refer to list of materials supplied for storage conditions of individual components.

5. Limitations

- Assay kit intended for research use only. Not for use in diagnostic procedures.
- Do not mix or substitute reagents or materials from other kit lots or vendors. Kits are QC tested as a set of components and performance cannot be guaranteed if utilized separately or substituted.

6. Materials Supplied

Item	Quantity	Storage Condition
Human Protein S Capture Antibody 10X	600 µL	+4°C
Human Protein S Detector Antibody 10X	600 µL	+4°C
Human Protein S Lyophilized Recombinant Protein	2 Vials	+4°C
Antibody Diluent 5BI	6 mL	+4°C
Sample Diluent NS	50 mL	+4°C
Wash Buffer PT 10X	20 mL	+4°C
TMB Development Solution	12 mL	+4°C
Stop Solution	12 mL	+4°C
SimpleStep Pre-Coated 96-Well Microplate	96 Wells	+4°C
Plate Seal	1	+4°C

7. Materials Required, Not Supplied

These materials are not included in the kit, but will be required to successfully perform this assay:

- Microplate reader capable of measuring absorbance at 450 or 600 nm.
- Method for determining protein concentration (BCA assay recommended).
- Deionized water.
- Multi- and single-channel pipettes.
- Tubes for standard dilution.
- Plate shaker for all incubation steps.
- Optional: Phenylmethylsulfonyl Fluoride (PMSF) (or other protease inhibitors).

8. Technical Hints

- Samples generating values higher than the highest standard should be further diluted in the appropriate sample dilution buffers.
- Avoid foaming or bubbles when mixing or reconstituting components.
- Avoid cross contamination of samples or reagents by changing tips between sample, standard and reagent additions.
- Ensure plates are properly sealed or covered during incubation steps.
- Complete removal of all solutions and buffers during wash steps is necessary to minimize background.
- As a guide, typical ranges of sample concentration for commonly used sample types are shown below in Sample Preparation (section 11).
- All samples should be mixed thoroughly and gently.
- Avoid multiple freeze/thaw of samples.
- Incubate ELISA plates on a plate shaker during all incubation steps.
- When generating positive control samples, it is advisable to change pipette tips after each step.

- To avoid high background always add samples or standards to the well before the addition of the antibody cocktail.
- This kit is sold based on number of tests. A 'test' simply refers to a single assay well. The number of wells that contain sample, control or standard will vary by product. Review the protocol completely to confirm this kit meets your requirements. Please contact our Technical Support staff with any questions.

9. Reagent Preparation

- Equilibrate all reagents to room temperature (18-25°C) prior to use. The kit contains enough reagents for 96 wells. The sample volumes below are sufficient for 48 wells (6 x 8-well strips); adjust volumes as needed for the number of strips in your experiment.
- Prepare only as much reagent as is needed on the day of the experiment. Capture and Detector Antibodies have only been tested for stability in the provided 10X formulations.

9.1 1X Wash Buffer PT:

Prepare 1X Wash Buffer PT by diluting Wash Buffer PT 10X with deionized water. To make 50 mL 1X Wash Buffer PT combine 5 mL Wash Buffer PT 10X with 45 mL deionized water. Mix thoroughly and gently.

9.2 Antibody Cocktail:

Prepare Antibody Cocktail by diluting the capture and detector antibodies in Antibody Diluent 5BI. To make 3 mL of the Antibody Cocktail combine 300 μ L 10X Capture Antibody and 300 μ L 10X Detector Antibody with 2.4 mL Antibody Diluent 5BI. Mix thoroughly and gently.

10. Standard Preparation

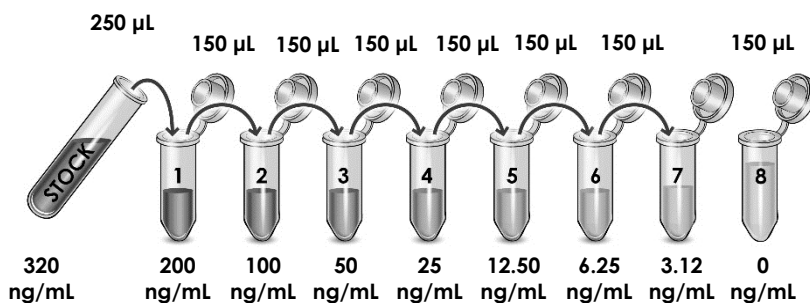
- Always prepare a fresh set of standards for every use.
- Discard working standard dilutions after use as they do not store well.
- The following section describes the preparation of a standard curve for duplicate measurements (recommended).

10.1.1 **IMPORTANT:** If the protein standard vial has a volume identified on the label, reconstitute the Protein S standard by adding that volume of Sample Diluent NS indicated on the label. Alternatively, if the vial has a mass identified, reconstitute the Protein S standard by adding 500 μL Sample Diluent NS. Hold at room temperature for 10 minutes and mix gently. This is the 320 ng/mL **Stock Standard Solution**.

10.1.2 Label eight tubes, Standards 1– 8.

10.1.3 Add 150 μL Sample Diluent NS into tube number 1 and 150 μL of Sample Diluent NS into numbers 2-8.

10.1.4 Use the Stock Standard to prepare the following dilution series. Standard #8 contains no protein and is the Blank control:



11. Sample Preparation

Typical Sample Dynamic Range	
Sample Type	Range
Serum	1: 24,300 – 1: 3,200
Plasma – Citrate	1: 24,300 – 1: 3,200
Plasma – EDTA	1: 24,300 – 1: 3,200
Plasma – Heparin	1: 8,100 – 1: 1,600

11.1 Serum:

Samples should be collected into a serum separator tube. After clot formation, centrifuge samples at 2,000 x g for 10 minutes and collect serum. Dilute samples at least 1: 3,200 into Sample Diluent NS and assay. Store un-diluted serum at -20°C or below. Avoid repeated freeze-thaw cycles.

11.2 Plasma:

Collect plasma using citrate, EDTA or heparin. Centrifuge samples at 2,000 x g for 10 minutes. Dilute citrate and EDTA samples at least 1: 3,200 and heparin samples at least 1: 1,600 into Sample Diluent NS and assay. Store un-diluted plasma samples at -20°C or below for up to 3 months. Avoid repeated freeze-thaw cycles.

12. Plate Preparation

- The 96 well plate strips included with this kit are supplied ready to use. It is not necessary to rinse the plate prior to adding reagents.
- Unused plate strips should be immediately returned to the foil pouch containing the desiccant pack, resealed and stored at 4°C.
- For each assay performed, a minimum of two wells must be used as the zero control.
- For statistical reasons, we recommend each sample should be assayed with a minimum of two replicates (duplicates).
- Differences in well absorbance or “edge effects” have not been observed with this assay.

13. Assay Procedure

- Equilibrate all materials and prepared reagents to room temperature prior to use.
 - We recommend that you assay all standards, controls and samples in duplicate.
- 13.1** Prepare all reagents, working standards, and samples as directed in the previous sections.
 - 13.2** Remove excess microplate strips from the plate frame, return them to the foil pouch containing the desiccant pack, reseal and return to 4°C storage.
 - 13.3** Add 50 µL of all sample or standard to appropriate wells.
 - 13.4** Add 50 µL of the Antibody Cocktail to each well.
 - 13.5** Seal the plate and incubate for 1 hour at room temperature on a plate shaker set to 400 rpm.
 - 13.6** Wash each well with 3 x 350 µL 1X Wash Buffer PT. Wash by aspirating or decanting from wells then dispensing 350 µL 1X Wash Buffer PT into each well. Wash Buffer PT should remain in wells for at least 10 seconds. Complete removal of liquid at each step is essential for good performance. After the last wash invert the plate and tap gently against clean paper towels to remove excess liquid.
 - 13.7** Add 100 µL of TMB Development Solution to each well and incubate for 10 minutes in the dark on a plate shaker set to 400 rpm.

Given variability in laboratory environmental conditions, optimal incubation time may vary between 5 and 20 minutes.

Note: The addition of Stop Solution will change the color from blue to yellow and enhance the signal intensity about 3X. To avoid signal saturation, proceed to the next step before the high concentration of the standard reaches a blue color of O.D.600 equal to 1.0.
 - 13.8** Add 100 µL of Stop Solution to each well. Shake plate on a plate shaker for 1 minute to mix. Record the OD at 450 nm. This is an endpoint reading.
 - 13.9** Alternative to 13.7 – 13.8: Instead of the endpoint reading at 450 nm, record the development of TMB Substrate kinetically. Immediately after addition of TMB Development Solution begin recording the blue color development with elapsed

time in the microplate reader prepared with the following settings:

Mode	Kinetic
Wavelength:	600 nm
Time:	up to 20 min
Interval:	20 sec - 1 min
Shaking:	Shake between readings

Δ Note: that an endpoint reading can also be recorded at the completion of the kinetic read by adding 100 μ L Stop Solution to each well and recording the OD at 450 nm.

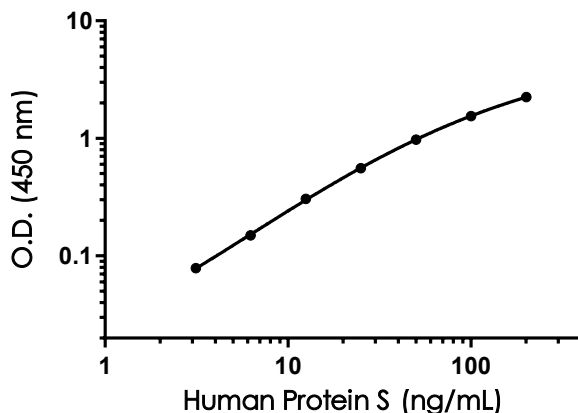
13.10 Analyze the data as described below.

14. Calculations

- 14.1 Calculate the average absorbance value for the blank control (zero) standards. Subtract the average blank control standard absorbance value from all other absorbance values.
- 14.2 **Create a standard curve** by plotting the average blank control subtracted absorbance value for each standard concentration (y-axis) against the target protein concentration (x-axis) of the standard. Use graphing software to draw the best smooth curve through these points to construct the standard curve.
 - Δ **Note:** Most microplate reader software or graphing software will plot these values and fit a curve to the data. A four parameter curve fit (4PL) is often the best choice; however, other algorithms (e.g. linear, semi-log, log/log, 4 parameter logistic) can also be tested to determine if it provides a better curve fit to the standard values.
- 14.3 Determine the concentration of the target protein in the sample by interpolating the blank control subtracted **absorbance values against the standard curve**. Multiply the resulting value by the appropriate sample dilution factor, if used, to obtain the concentration of target protein in the sample.
- 14.4 Samples generating absorbance values greater than that of the highest standard should be further diluted and reanalyzed. Similarly, samples which measure at an absorbance values less than that of the lowest standard should be retested in a less dilute form.

15. Typical Data

Typical standard curve – data provided for demonstration purposes only. A new standard curve must be generated for each assay performed.



Standard Curve Measurements			
Concentration (ng/mL)	O.D 450 nm		Mean O.D
	1	2	
0	0.054	0.054	0.055
3.12	0.136	0.130	0.133
6.25	0.196	0.211	0.204
12.50	0.350	0.369	0.360
25	0.610	0.611	0.611
50	1.027	1.034	1.031
100	1.595	1.596	1.596
200	2.293	2.309	2.302

Figure 1. Example of human Protein S standard curve in Sample Diluent NS. The Protein S standard curve was prepared as described in Section 10. Raw data values are shown in the table. Background-subtracted data values (mean +/- SD) are graphed.

16. Typical Sample Values

SENSITIVITY –

The calculated minimal detectable dose (MDD) is 0.4 ng/mL. The MDD was determined by calculating the mean of zero standard replicates (n=27) and adding 2 standard deviations then extrapolating the corresponding concentration.

RECOVERY –

Three concentrations of purified Protein S protein were spiked in duplicate to the indicated biological matrix to evaluate signal recovery in the working range of the assay.

Sample Type	Average % Recovery	Range (%)
Serum (1: 3,200)	89	86 – 93
Plasma – Citrate (1: 3,200)	90	87 – 94
Plasma – EDTA (1: 3,200)	89	87 – 93
Plasma – Heparin (1: 1,600)	86	79 – 91

Linearity of Dilution

Linearity of dilution is determined based on interpolated values from the standard curve. Linearity of dilution defines a sample concentration interval in which interpolated target concentrations are directly proportional to sample dilution.

Native Protein S was measured in the following biological samples in a 1.5-fold dilution series. Sample dilutions are made in Sample Diluent NS.

Dilution Factor	Interpolated value	1: 3,200 Human Serum	1: 3,200 Human Plasma (Citrate)	1: 3,200 Human Plasma (EDTA)	1: 1,600 Human Plasma (Heparin)
Undiluted	ng/mL	8.48	6.05	7.05	6.31
	% Expected value	100	100	100	100
1.5	ng/mL	5.83	4.39	4.78	4.46
	% Expected value	103	109	102	106
2.25	ng/mL	3.88	2.79	3.28	2.94
	% Expected value	103	104	105	105
3.38	ng/mL	3.33	2.49	2.86	2.61
	% Expected value	132	139	137	140
5.06	ng/mL	1.85	1.39	1.60	1.49
	% Expected value	111	116	115	120
7.59	ng/mL	1.21	0.94	1.01	NL
	% Expected value	109	119	109	NL

NL – Non-Linear

PRECISION –

Mean coefficient of variations of interpolated values of Protein S from three concentrations of plasma (EDTA) within the working range of the assay.

	Intra- Assay	Inter- Assay
n =	5	3
CV(%)	1.8	2.5

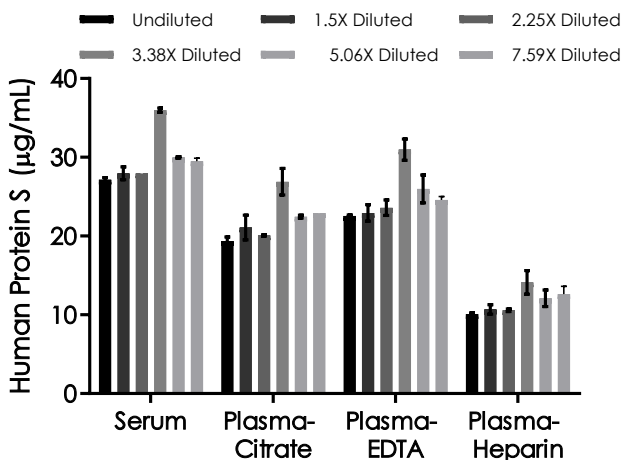


Figure 2. Interpolated concentrations of native Protein S in human serum, plasma and cell culture supernatant samples. The concentrations of Protein S were measured in duplicates, interpolated from the Protein S standard curves and corrected for sample dilution. Undiluted samples are as follows: serum 1: 3,200, plasma (citrate) 1: 3,200, plasma (EDTA) 1: 3,200, and plasma (heparin) 1: 1,600. The interpolated dilution factor corrected values are plotted (mean +/- SD, n=2). The mean Protein S concentration was determined to be 29.75 µg/mL in serum, 22.13 µg/mL in plasma (citrate), 25.10 µg/mL in plasma (EDTA), and 11.70 µg/mL in plasma (heparin).

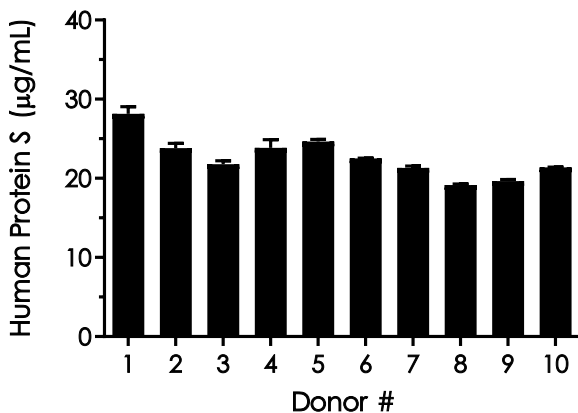


Figure 3. Serum from ten individual healthy human male donors was measured in duplicate. Interpolated dilution factor corrected values are plotted (mean +/- SD, n=2). The mean Protein S concentration was determined to be 22.62 µg/mL with a range of 19.14 – 28.15 µg/mL.

17. Assay Specificity

This kit recognizes both native and recombinant human Protein S protein in serum and plasma samples only.

Cell culture supernatant and cell and tissue extract samples have not been tested with this kit.

18. Species Reactivity

This kit recognizes human Protein S protein.

Other species reactivity was determined by measuring 1: 200 serum samples of various species, interpolating the Protein S protein concentrations from the human standard curve, and expressing the interpolated concentrations as a percentage of the Protein S protein concentration in human serum assayed at the same dilution.

Reactivity < 3% was determined for the following species:

- Mouse
- Rat
- Hamster
- Guinea Pig
- Rabbit
- Dog
- Goat
- Pig
- Cow
- Chicken

Please contact our Technical Support team for more information.

19. Troubleshooting

Problem	Reason	Solution
Poor standard curve	Inaccurate Pipetting	Check pipettes
	Improper standard dilution	Prior to opening, briefly spin the stock standard tube and dissolve the powder thoroughly by gentle mixing
Low Signal	Incubation times too brief	Ensure sufficient incubation times; increase to 2 or 3 hour standard/sample incubation
	Inadequate reagent volumes or improper dilution	Check pipettes and ensure correct preparation
	Incubation times with TMB too brief	Ensure sufficient incubation time until blue color develops prior addition of Stop solution
Large CV	Plate is insufficiently washed	Review manual for proper wash technique. If using a plate washer, check all ports for obstructions.
	Contaminated wash buffer	Prepare fresh wash buffer
Low sensitivity	Improper storage of the ELISA kit	Store your reconstituted standards at -80°C, all other assay components 4°C. Keep TMB Development Solution protected from light.
Precipitate in Diluent	Precipitation and/or coagulation of components within the Diluent.	Precipitate can be removed by gently warming the Diluent to 37°C.

Technical Support

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