

Quantikine[®]

Human RBP4 Immunoassay

Catalog Number DRB400

For the quantitative determination of human Retinol-Binding Protein 4 (RBP4) concentrations in cell culture supernates, serum, plasma, urine, and saliva.

This package insert must be read in its entirety before using this product.

**FOR RESEARCH USE ONLY.
NOT FOR USE IN DIAGNOSTIC PROCEDURES.**

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INTRODUCTION

Retinol-binding protein 4 (RBP4), also known as plasma retinol-binding protein, is a lipocalin superfamily molecule that transports vitamin A (retinol) in the serum (1 - 4). Dietary retinol is metabolized to retinaldehyde, multiple isomers of retinoic acid, and retinyl esters (1, 5). Retinaldehyde is the critical chromophore in the rhodopsin photoreceptor, while both it and retinoic acid regulate a multitude of cellular differentiation and proliferation effects through the intracellular receptors RAR and RXR (6 - 8). RBP4 adopts a β -barrel structure with a central cavity that accommodates either retinol or retinaldehyde (9). RBP4 is synthesized primarily by hepatocytes and adipocytes as a 21 kDa non-glycosylated, non-phosphorylated, and non-sulfated molecule (10 - 12). Its secretion into the blood requires the presence of retinol (10). Proteolytic processing of RBP4 removes one or both C-terminal leucine residues, resulting in 182 and 181 amino acid (aa) forms (12). Human RBP4 shares 100% aa sequence identity with chimpanzee, 91% - 93% aa sequence identity with bovine, porcine, and rabbit, and 83% - 86% aa sequence identity with chicken, mouse, and rat RBP4, respectively.

The RBP4-retinol complex interacts with transthyretin (TTR), also known as thyroxine-binding protein and prealbumin (2, 13). Formation of this complex increases the serum half-life of RBP4 by preventing RBP4 filtration through the kidney (14). The C-terminally processed forms of RBP4, which do not bind TTR, are normally excreted into the urine but accumulate in the serum during renal failure (12, 13). Glomerular re-uptake of RBP4 is mediated by the endocytic receptor megalin (15). RBP4 is internalized by extrahepatic tissues through a receptor mediated process (16). Vitamin A derivatives in the form of retinyl esters can also be transported in chylomicrons, consistent with the observation that RBP4 deficiency results in only minor clinical effects (5, 14, 17, 18).

RBP4 promotes hyperglycemia through downregulation of the glucose transporter GLUT4 in adipocytes, upregulation of the hepatic gluconeogenic enzyme PEPCK, and attenuation of insulin receptor signaling in skeletal muscle (19, 20). Serum RBP4 levels are elevated in type 2 diabetes and obesity, due primarily to increased production by visceral and liver adipocytes (19, 21, 22). Increases in serum RBP4 mirror changes in several other parameters linked with those diseases (20, 23). Polymorphisms within the RBP4 gene are also associated with increased serum levels and risk of type 2 diabetes (24). The expression and secretion of adipocyte RBP4 is inhibited by TNF- α and atrial natriuretic peptide, while PPAR γ agonists have been shown to have both positive and negative effects on RBP4 levels (19, 25, 26).

The Quantikine Human RBP4 immunoassay is a 2.5 hour solid phase ELISA designed to measure human RBP4 in cell culture supernates, serum, plasma, urine, and saliva. It contains NS0-expressed recombinant human RBP4 and has been shown to accurately quantitate the recombinant factor. Results obtained using natural human RBP4 showed linear curves that were parallel to the standard curves obtained using the Quantikine kit standards. These results indicate that the Quantikine Human RBP4 kit can be used to determine relative mass values for naturally occurring human RBP4.

PRINCIPLE OF THE ASSAY

This assay employs the quantitative sandwich enzyme immunoassay technique. A monoclonal antibody specific for RBP4 has been pre-coated onto a microplate. Standards and samples are pipetted into the wells and any RBP4 present is bound by the immobilized antibody. After washing away any unbound substances, an enzyme-linked monoclonal antibody specific for RBP4 is added to the wells. Following a wash to remove any unbound antibody-enzyme reagent, a substrate solution is added to the wells and color develops in proportion to the amount of RBP4 bound in the initial step. The color development is stopped and the intensity of the color is measured.

LIMITATIONS OF THE PROCEDURE

- FOR RESEARCH USE ONLY. NOT FOR USE IN DIAGNOSTIC PROCEDURES.
- The kit should not be used beyond the expiration date on the kit label.
- Do not mix or substitute reagents with those from other lots or sources.
- If samples generate values higher than the highest standard, further dilute the samples with the Calibrator Diluent and repeat the assay.
- Any variation in standard diluent, operator, pipetting technique, washing technique, incubation time or temperature, and kit age can cause variation in binding.
- This assay is designed to eliminate interference by ligands, proteins, and other factors present in biological samples. Until all factors have been tested in the Quantikine Immunoassay, the possibility of interference cannot be excluded.

MATERIALS PROVIDED

RBP4 Microplate (Part 893266) - 96 well polystyrene microplate (12 strips of 8 wells) coated with a mouse monoclonal antibody against RBP4.

RBP4 Conjugate (Part 893267) - 21 mL of a monoclonal antibody against RBP4 conjugated to horseradish peroxidase with preservatives.

RBP4 Standard (Part 893268) - 200 ng of recombinant human RBP4 in a buffered protein solution with preservatives; lyophilized.

Assay Diluent RD1-19 (Part 895467) - 2 vials (11 mL/vial) of a buffered protein solution with preservatives.

Calibrator Diluent RD5-50 (Part 895917) - 21 mL of a concentrated buffered protein base with preservatives and blue dye.

Wash Buffer Concentrate (Part 895003) - 21 mL of a 25-fold concentrated solution of buffered surfactant with preservatives.

Color Reagent A (Part 895000) - 12.5 mL of stabilized hydrogen peroxide.

Color Reagent B (Part 895001) - 12.5 mL of stabilized chromogen (tetramethylbenzidine).

Stop Solution (Part 895032) - 6 mL of 2 N sulfuric acid.

Plate Covers - 4 adhesive strips.

STORAGE

Unopened Kit	Store at 2 - 8° C. Do not use past kit expiration date.	
Opened/ Reconstituted Reagents	Diluted Wash Buffer	May be stored for up to 1 month at 2 - 8° C.*
	Stop Solution	
	Assay Diluent RD1-19	
	Calibrator Diluent RD5-50	
	Conjugate	
	Unmixed Color Reagent A	
	Unmixed Color Reagent B	
	Standard	
	Microplate Wells	Return unused wells to the foil pouch containing the desiccant pack, reseal along entire edge of zip-seal. May be stored for up to 1 month at 2 - 8° C.*

*Provided this is within the expiration date of the kit.

OTHER SUPPLIES REQUIRED

- Microplate reader capable of measuring absorbance at 450 nm, with the correction wavelength set at 540 nm or 570 nm.
- Pipettes and pipette tips.
- Deionized or distilled water.
- Squirt bottle, manifold dispenser, or automated microplate washer.
- 500 mL graduated cylinder.
- Test tubes for dilution.
- Horizontal orbital microplate shaker (0.12" orbit) capable of maintaining a speed of 500 ± 50 rpm.
- Collection device for saliva samples that has no protein binding or filtering capabilities such as Salivette[®] or equivalent.
- Human RBP4 Controls (optional; available from R&D Systems).

PRECAUTIONS

The Stop Solution provided with this kit is an acid solution. Wear protective gloves, clothing, eye, and face protection. Wash hands thoroughly after handling.

RBP4 is detectable in saliva. Take precautionary measures to prevent contamination of kit reagents while running this assay.

Salivette is a registered trademark of Sarstedt, Inc.

SAMPLE COLLECTION AND STORAGE

Cell Culture Supernates - Remove particulates by centrifugation and assay immediately or aliquot and store samples at $\leq -20^{\circ}$ C. Avoid repeated freeze-thaw cycles.

Serum - Use a serum separator tube (SST) and allow samples to clot for 30 minutes before centrifugation for 15 minutes at 1000 x g. Remove serum and assay immediately or aliquot and store samples at $\leq -20^{\circ}$ C. Avoid repeated freeze-thaw cycles.

Plasma - Collect plasma using heparin or EDTA as an anticoagulant. Centrifuge for 15 minutes at 1000 x g within 30 minutes of collection. Assay immediately or aliquot and store samples at $\leq -20^{\circ}$ C. Avoid repeated freeze-thaw cycles.

Note: *Citrate plasma has not been validated for use in this assay.*

Urine - Aseptically collect the first urine of the day (mid-stream), voided directly into a sterile container. Centrifuge to remove particulate matter, assay immediately or aliquot and store at $\leq -20^{\circ}$ C. Avoid repeated freeze-thaw cycles.

Saliva - Collect saliva using a collection device such as a Salivette or equivalent. Assay immediately or aliquot and store samples at $\leq -20^{\circ}$ C. Avoid repeated freeze-thaw cycles.

Note: *Saliva collector must not have any protein binding or filtering capabilities.*

SAMPLE PREPARATION

Serum and plasma samples require a 1000-fold dilution. A suggested 1000-fold dilution can be achieved by adding 20 μ L of sample to 980 μ L of Calibrator Diluent RD5-50 (1X). Mix well. Complete the 1000-fold dilution by adding 25 μ L of the diluted solution to 475 μ L of Calibrator Diluent RD5-50 (1X).

Urine samples require a 5-fold dilution. A suggested 5-fold dilution is 100 μ L of sample + 400 μ L of Calibrator Diluent RD5-50 (1X).

Saliva samples require a 2-fold dilution. A suggested 2-fold dilution is 50 μ L of sample + 50 μ L of Calibrator Diluent RD5-50 (1X).

Cell culture supernate samples may require dilution.

REAGENT PREPARATION

Bring all reagents to room temperature before use.

Note: *RBP4* is found in saliva. It is recommended that a face mask be used to protect kit reagents from contamination.

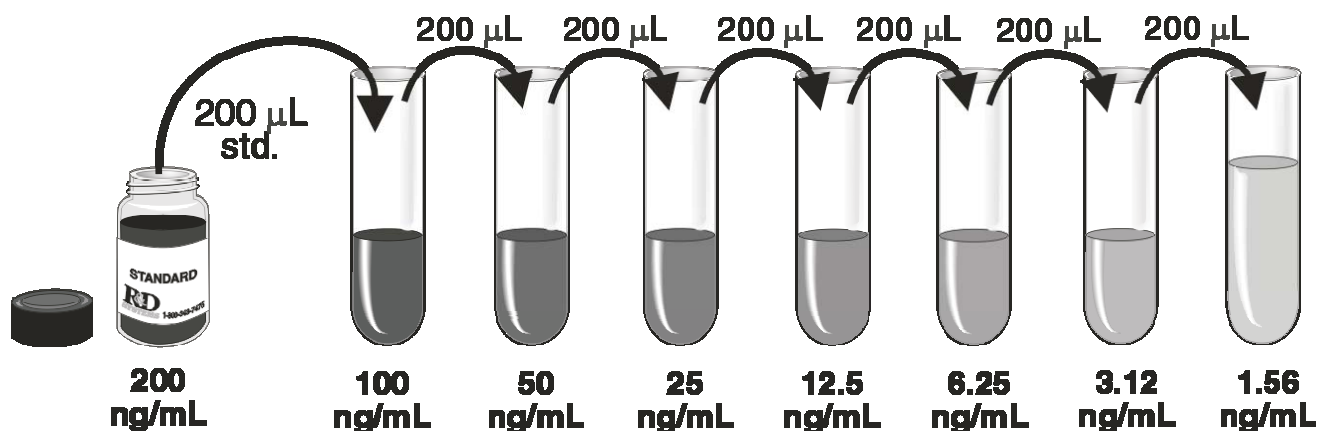
Wash Buffer - If crystals have formed in the concentrate, warm to room temperature and mix gently until the crystals have completely dissolved. Dilute 20 mL of Wash Buffer Concentrate into deionized or distilled water to prepare 500 mL of Wash Buffer.

Calibrator Diluent RD5-50 (1X) - Dilute 20 mL of Calibrator Diluent RD5-50 into 80 mL of deionized or distilled water to prepare 100 mL of Calibrator Diluent RD5-50 (1X).

Substrate Solution - Color Reagents A and B should be mixed together in equal volumes within 15 minutes of use. Protect from light. 200 μ L of the resultant mixture is required per well.

RBP4 Standard - Reconstitute the RBP4 Standard with 1.0 mL of deionized or distilled water. This reconstitution produces a stock solution of 200 ng/mL. Mix the standard to ensure complete reconstitution and allow the standard to sit for a minimum of 15 minutes with gentle agitation prior to making dilutions.

Pipette 200 μ L of Calibrator Diluent RD5-50 (1X) into each tube. Use the stock solution to produce a dilution series (below). Mix each tube thoroughly before the next transfer. The 100 ng/mL standard serves as the high standard. Calibrator Diluent RD5-50 (1X) serves as the zero standard (0 ng/mL).



ASSAY PROCEDURE

Bring all reagents and samples to room temperature before use. It is recommended that all samples, controls, and standards be assayed in duplicate.

Note: *RBP4 is found in saliva. It is recommended that a face mask be used to protect kit reagents from contamination.*

1. Prepare all reagents, working standards, and samples as directed in the previous sections.
2. Remove excess microplate strips from the plate frame, return them to the foil pouch containing the desiccant pack, and reseal.
3. Add 200 μ L of Assay Diluent RD1-19 to each well.
4. Add 20 μ L of Standard, control, or sample* per well. Cover with the adhesive strip provided. Incubate for 1 hour at room temperature on a horizontal orbital microplate shaker (0.12" orbit) **set at 500 rpm**. A plate layout is provided to record standards and samples assayed.

Note: *In order to obtain the correct signal, it is crucial that the shaker be set to 500 rpm.*

5. Aspirate each well and wash, repeating the process three times for a total of four washes. Wash by filling each well with Wash Buffer (400 μ L) using a squirt bottle, manifold dispenser, or autowasher. Complete removal of liquid at each step is essential to good performance. After the last wash, remove any remaining Wash Buffer by aspirating or decanting. Invert the plate and blot it against clean paper towels.
6. Add 200 μ L of RBP4 Conjugate to each well. Cover with a new adhesive strip. Incubate for 1 hour at room temperature on the shaker.
7. Repeat the aspiration/wash as in step 5.
8. Add 200 μ L of Substrate Solution to each well. Incubate for 30 minutes at room temperature **on the benchtop. Protect from light.**
9. Add 50 μ L of Stop Solution to each well. The color in the wells should change from blue to yellow. If the color in the wells is green or the color change does not appear uniform, gently tap the plate to ensure thorough mixing.
10. Determine the optical density of each well within 30 minutes, using a microplate reader set to 450 nm. If wavelength correction is available, set to 540 nm or 570 nm. If wavelength correction is not available, subtract readings at 540 nm or 570 nm from the readings at 450 nm. This subtraction will correct for optical imperfections in the plate. Readings made directly at 450 nm without correction may be higher and less accurate.

*Samples may require dilution as directed in the Sample Preparation section.

ASSAY PROCEDURE SUMMARY

1. Prepare reagents, samples, and standards as instructed.



2. Add 200 μL Assay Diluent RD1-19 to each well.



3. Add 20 μL Standard, control, or sample* to each well. Incubate 1 hour on the shaker at RT.



4. Aspirate and wash 4 times.



5. Add 200 μL Conjugate to each well. Incubate 1 hour on the shaker at RT.



6. Aspirate and wash 4 times.



7. Add 200 μL Substrate Solution to each well. Incubate 30 minutes **on the benchtop. Protect from light.**



8. Add 50 μL Stop Solution to each well. Read at 450 nm within 30 minutes.
 λ correction 540 or 570 nm

*Samples may require dilution. See Sample Preparation section.

CALCULATION OF RESULTS

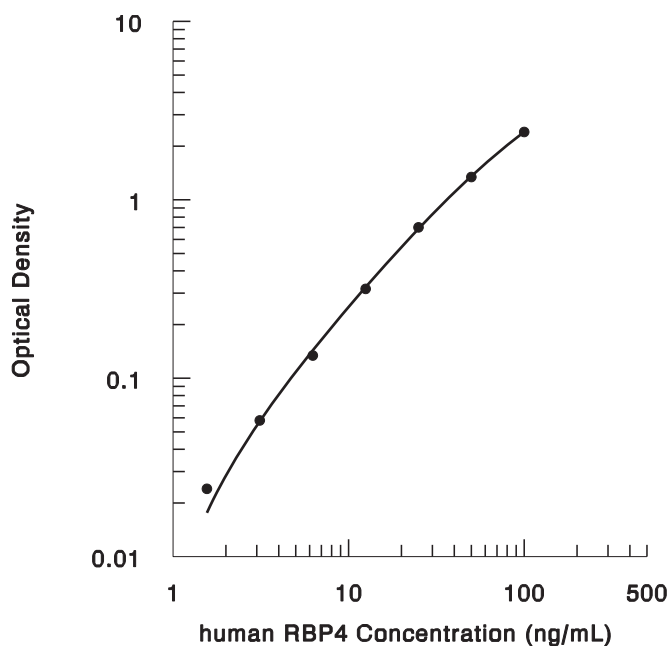
Average the duplicate readings for each standard, control, and sample and subtract the average zero standard optical density.

Create a standard curve by reducing the data using computer software capable of generating a four parameter logistic (4-PL) curve-fit. As an alternative, construct a standard curve by plotting the mean absorbance for each standard on the y-axis against the concentration on the x-axis and draw a best fit curve through the points on the graph. The data may be linearized by plotting the log of the RBP4 concentrations versus the log of the O.D. and the best fit line can be determined by regression analysis. This procedure will produce an adequate but less precise fit of the data.

If samples have been diluted, the concentration read from the standard curve must be multiplied by the dilution factor.

TYPICAL DATA

This standard curve is provided for demonstration only. A standard curve should be generated for each set of samples assayed.



ng/mL	O.D.	Average	Corrected
0	0.006 0.006	0.006	—
1.56	0.029 0.030	0.030	0.024
3.12	0.062 0.065	0.064	0.058
6.25	0.134 0.146	0.140	0.134
12.5	0.320 0.326	0.323	0.317
25	0.700 0.714	0.707	0.701
50	1.306 1.392	1.349	1.343
100	2.385 2.427	2.406	2.400

TECHNICAL HINTS

- When mixing or reconstituting protein solutions, always avoid foaming.
- To avoid cross-contamination, change pipette tips between additions of each standard level, between sample additions, and between reagent additions. Also, use separate reservoirs for each reagent.
- When using an automated plate washer, adding a 30 second soak period following the addition of wash buffer, and/or rotating the plate 180 degrees between wash steps may improve assay precision.
- To ensure accurate results, proper adhesion of plate sealers during incubation steps is necessary.
- Substrate Solution should remain colorless until added to the plate. Keep Substrate Solution protected from light. Substrate Solution should change from colorless to gradations of blue.
- Stop Solution should be added to the plate in the same order as the Substrate Solution. The color developed in the wells will turn from blue to yellow upon addition of the Stop Solution. Wells that are green in color indicate that the Stop Solution has not mixed thoroughly with the Substrate Solution.

PRECISION

Intra-assay Precision (Precision within an assay)

Three samples of known concentration were tested twenty times on one plate to assess intra-assay precision.

Inter-assay Precision (Precision between assays)

Three samples of known concentration were tested in forty separate assays to assess inter-assay precision.

Sample	Intra-assay Precision			Inter-assay Precision		
	1	2	3	1	2	3
n	20	20	20	40	40	40
Mean (ng/mL)	11.0	30.3	61.9	9.80	27.5	54.7
Standard deviation	0.77	1.73	5.01	0.84	1.60	4.00
CV (%)	7.0	5.7	8.1	8.6	5.8	7.3

RECOVERY

The recovery of RBP4 spiked to levels throughout the range of the assay was evaluated.

Sample	Average % Recovery	Range
Cell culture media (n=4)	102	86 - 115%

LINEARITY

To assess the linearity of the assay, samples containing and/or spiked with high concentrations of RBP4 were serially diluted with the Calibrator Diluent to produce samples with values within the dynamic range of the assay.

		Cell culture media (n=4)	Serum (n=4)	EDTA plasma (n=4)	Heparin plasma (n=4)	Urine (n=4)	Saliva (n=4)
1:2	Average % of Expected	103	101	96	103	95	99
	Range (%)	102 - 104	96 - 104	88 - 103	90 - 108	87 - 104	93 - 107
1:4	Average % of Expected	100	96	101	104	99	103
	Range (%)	96 - 113	91 - 102	92 - 106	95 - 113	88 - 106	99 - 106
1:8	Average % of Expected	95	92	95	97	98	100
	Range (%)	93 - 112	83 - 102	86 - 100	87 - 103	93 - 104	95 - 105
1:16	Average % of Expected	95	87	93	95	95	—
	Range (%)	91 - 107	86 - 102	89 - 99	84 - 108	85 - 112	—

SENSITIVITY

Fifty assays were evaluated and the minimum detectable dose (MDD) of RBP4 ranged from 0.053 - 0.628 ng/mL. The mean MDD was 0.224 ng/mL.

The MDD was determined by adding two standard deviations to the mean optical density value of twenty zero standard replicates and calculating the corresponding concentration.

CALIBRATION

This immunoassay is calibrated against a highly purified NS0-expressed recombinant human RBP4 produced at R&D Systems.

SAMPLE VALUES

Serum/Plasma/Urine/Saliva - Samples from apparently healthy volunteers were evaluated for the presence of RBP4 in this assay. No medical histories were available for the donors used in this study.

Sample Type	Mean (ng/mL)	Range (ng/mL)	Standard Deviation (ng/mL)
Serum (n=35)	26,500	12,700 - 48,600	7700
EDTA plasma (n=35)	25,200	11,900 - 48,300	7200
Heparin plasma (n=35)	25,000	12,200 - 43,000	7500
Urine (n=11)	85.2	16.4 - 252	66.8
Saliva (n=12)	14.9	3.11 - 29.6	10.0

Cell Culture Supernates -

Human peripheral blood mononuclear cells (PBMCs; 1×10^6 cells/mL) were cultured in DMEM supplemented with 5% fetal calf serum, 5 μ M β -mercaptoethanol, 2 mM L-glutamine, 100 U/mL penicillin, and 100 μ g/mL streptomycin sulfate. Cells were cultured unstimulated or stimulated with 10 μ g/mL PHA for 1 and 5 days. Aliquots of the cell culture supernates were removed and assayed for levels of natural RBP4. No detectable levels were observed.

Human liver hepatocellular epithelial carcinoma cells (HepG2; 1×10^6 cells/mL) were cultured in MEM supplemented with non-essential amino acids, 10% fetal calf serum, and 2 mM L-glutamine for 5 days. An aliquot of the cell culture supernate was removed, assayed for levels of natural RBP4, and measured 75.2 ng/mL.

SPECIFICITY

This assay recognizes recombinant and natural human RBP4. The factors listed below were prepared at 1 $\mu\text{g}/\text{mL}$ in Calibrator Diluent and assayed for cross-reactivity. Preparations of the following factors at 1 $\mu\text{g}/\text{mL}$ in a mid-range recombinant human RBP4 control were assayed for interference. No significant cross-reactivity or interference was observed.

Recombinant human:

Lipocalin-1

Lipocalin-2

Prealbumin (transthyretin)

Prealbumin + retinol

Prealbumin + retinol + thyroxine

Retinol

Recombinant mouse:

Lipocalin-2

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PLATE LAYOUT

Use this plate layout as a record of standards and samples assayed.

