510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY ONLY TEMPLATE

A. 510(k) Number:

k053401

B. Purpose for Submission:

New device

C. Measurand:

Calcium, Blood Urea Nitrogen, Glucose, Albumin, Creatinine, Alkaline Phosphatase, Total Bilirubin, Total Protein, AST (GOT), and ALT (GPT)

D. Type of Test:

Quantitative, Colorimetric Methodology

E. Applicant:

Arkray, Inc.

F. Proprietary and Established Names:

Arkray SpotChem II Chemistry Basic 1
Arkray SpotChem II Chemistry Basic 2

G. Regulatory Information:

1. Regulation section:

Chemistry Basic 1	Calcium	Blood Urea Nitrogen	Glucose	Albumin	Creatinine
Device name	SpotChem II Chemistry Basic I test calcium	SpotChem II Chemistry Basic I test Blood Urea Nitrogen	SpotChem II Chemistry Basic I test Glucose	SpotChem II Chemistry Basic I test Albumin	SpotChem II Chemistry Basic I test Creatinine
Trade name	SpotChem II Chemistry Basic 1 test Calcium	SpotChem II Chemistry Basic 1 test Blood Urea Nitrogen	SpotChem II Chemistry Basic 1 test Glucose	SpotChem II Chemistry Basic 1 test Albumin	SpotChem II Chemistry Basic 1 test Creatinine

Chemistry Basic 1	Calcium	Blood Urea Nitrogen	Glucose	Albumin	Creatinine
Common name	Calcium	Urea Nitrogen	Glucose	Albumin	Creatinine
Classification name	Calcium test system	Urea Nitrogen Test System	Glucose Test System	Albumin Test System	Creatinine Test System
Regulation Number	21 CFR 862.1145	21 CFR 862.1770	21 CFR 862.1345	21 CFR 862.1035	21 CFR 862.1225
Panel	Chemistry	Chemistry	Chemistry	Chemistry	Chemistry
Device Classification	II	II	II	II	II
Product Code	CIC	JGZ	CGA	CIX	CGX

Chemistry Basic 2	ALP	Total Bilirubin	Total Protein	AST	ALT
Device name	SpotChem II Chemistry Basic I test ALP	SpotChem II Chemistry Basic I test Total Bilirubin	SpotChem II Chemistry Basic I test Total Protein	SpotChem II Chemistry Basic I test AST	SpotChem II Chemistry Basic I test ALT
Trade name	SpotChem II Chemistry Basic I test ALP	SpotChem II Chemistry Basic I test Total Bilirubin	SpotChem II Chemistry Basic I test Total Protein	SpotChem II Chemistry Basic I test AST	SpotChem II Chemistry Basic I test ALT
Common name	ALP	Total Bilirubin	Total Protein	AST	ALT
Classification name	Alkaline Phosphatase or isoenzyme test system	Bilirubin (total or direct) test system	Total Protein test system	Aspartate amino transferase (AST/SGOT) test system	Alanine amino transferase (ALT/SGPT) test system
Regulation Number	21 CFR 862.1050	21 CFR 862.1110	21 CFR 862.1635	21 CFR 862.1100	21 CFR 862.1030
Panel	Chemistry	Chemistry	Chemistry	Chemistry	Chemistry
Device Classification	II	II	II	II	II
Product Code	CJE	CIG	CEK	CIS	CKA

H. Intended Use:

1. Intended use(s):

   Arkray SPOTCHEM II Chemistry Basic I is intended for the *in vitro* quantitative determination of calcium, BUN, glucose, albumin, creatinine concentration in

human serum, or human plasma from whole blood samples. This product is intended for use with the SPOTCHEM EZ analyzer (SP-4430).

Arkray SPOTCHEM II Chemistry Basic II is intended for the *in vitro* quantitative determination of ALP, AST, and ALT activity and total bilirubin, and total protein concentration in human serum or human plasma from whole blood samples. This product is intended for use with the SPOTCHEM EZ analyzer (SP-4430).

2. Indication(s) for use:

The SPOTCHEM II Chemistry Basic 1 Calcium test is intended to measure the concentration of calcium in serum, plasma and whole blood. Serum calcium measurements are used in the diagnosis and treatment of parathyroid disease, a variety of bone diseases, chronic renal disease and tetany (intermittent muscular contractions or spasms).

The SPOTCHEM II Chemistry Basic 1 Blood Urea Nitrogen (BUN) test is intended to measure the concentration of urea nitrogen in serum, plasma and whole blood. Blood urea nitrogen measurements are used in the diagnosis and treatment of certain renal and metabolic diseases.

The SPOTCHEM II Chemistry Basic 1 Glucose test is intended to measure the glucose concentration in serum, plasma and whole blood. Glucose measurements are used in the diagnosis and treatment of carbohydrate metabolism disorders including diabetes mellitus, neonatal hypoglycemia, and idiopathic hypoglycemia, and of pancreatic islet cell carcinoma.

The SPOTCHEM II Chemistry Basic 1 Albumin test is intended to measure the albumin concentration in serum, plasma and whole blood. Measurements of albumin are used in the diagnosis and treatment of numerous diseases involving the liver or kidneys.

The SPOTCHEM II Chemistry Basic 1 Creatinine test is intended to measure the concentration of creatinine in serum, plasma and whole blood. Creatinine measurements are used in the diagnosis and treatment of renal diseases, in monitoring renal dialysis, and as a calculation basis for measuring other urine analytes.

The SPOTCHEM II Chemistry Basic 2 ALP test is intended to measure ALP activity in serum, plasma and whole blood. Measurements of alkaline phosphatase or its isoenzymes are used in the diagnosis and treatment of liver, bone, parathyroid, and intestinal diseases.

The SPOTCHEM II Chemistry Basic 2 Total Bilirubin test is intended to measure the levels of bilirubin in serum, plasma and whole blood. Measurements of the levels of bilirubin are used in the diagnosis and treatment of liver, hemolytic hematological and metabolic disorders, including hepatitis and gall bladder block.

The SPOTCHEM II Chemistry Basic 2 Total Protein test is intended to measure total protein in serum, plasma and whole blood. Measurements of total protein are used in the diagnosis and treatment of a variety of diseases involving the liver, kidney, or bone marrow, as well as other metabolic and nutritional disorders.

The SPOTCHEM II Chemistry Basic 2 AST test is intended to measure AST activity in serum, plasma and whole blood. Aspartate amino transferase measurements are used in the diagnosis and treatment of certain types of liver and heart disease.

The SPOTCHEM II Chemistry Basic 2 ALT test is intended to measure ALT activity in serum, plasma and whole blood. Alanine amino transferase measurements are used in the diagnosis and treatment of certain liver diseases (e.g., viral hepatitis and cirrhosis) and heart diseases.

3. Special conditions for use statement(s):

   For Prescription use only.

4. Special instrument requirements:

   Arkray SPOTCHEM EZ Analyzer (SP-4430) (Previously cleared under k040332)

I. Device Description:

The SPOTCHEM II Chemistry Basic 1 and Chemistry Basic 2 tests are in vitro diagnostic procedures intended to measure calcium, blood urea nitrogen, glucose, albumin and creatinine; and total bilirubin, total protein, ALP, AST, and ALT quantitatively in human serum and plasma (whole blood) on the SPOTCHEM EZ Analyzer (SP-4430). Note: Although the whole blood is placed on the instrument, the measurement is from plasma because there is a centrifuge on the SPOTCHEM EZ (SP-4430) that separates the whole blood, and the plasma is then analyzed.

The SPOTCHEM II Chemistry Basic 1 and Chemistry Basic 2 Reagent Strips are composed of a plastic strip to which five multi-layered test fields were affixed. The layers consist of a sample-retention layer, a layer containing the reagents and a support layer.
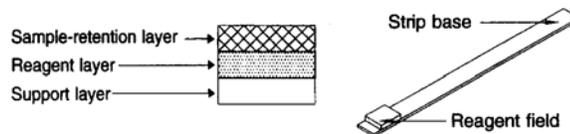
A fixed amount of serum or plasma is placed on the test field of the reagent strip and spreads in a uniform fashion across the entire surface of the sample retention layer. The serum or plasma then permeates into the reagent layer where the reaction is initiated.

J. Substantial Equivalence Information:

1. Predicate device name(s):

   - SPOTCHEM II ALT: k040332
   - SPOTCHEM EZ (SP-4430) Chemistry Analyzer: k040332
   - SPOTCHEM II Glucose, AST: k041427
   - SPOTCHEM II Calcium, BUN: k050077
   - SPOTCHEM II Creatinine, ALP: k050652
   - SPOTCHEM II Total Bilirubin, Total Protein, Albumin: k051432

2. Predicate 510(k) number(s):

   See Predicate device name(s) above.

3. Comparison with predicate:

Chemistry Basic 1	Calcium	BUN	Glucose	Albumin	Creatinine
Predicate Methodology	colorimetric **k50077**	Colorimetric **k050077**	Colorimetric **k041427**	Colorimetric **k051432**	Colorimetric **k050652**
Test Methodology	colorimetric	colorimetric	colorimetric	Colorimetric	colorimetric
Predicate Reagent Storage	2-8°C	2-8°C	2-8°C	2-8°C	2-8°C
Test Reagent Storage	2-8°C	2-8°C	2-8°C	2-8°C	2-8°C
Predicate Sample types	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood
Test Sample Types	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood
Correlation with Predicate device	N = 40. Samples spanned from 5.1 to 15.2	N = 40. Samples spanned from 7 mg/dL to 92	N = 40. Samples spanned from 30 mg/dL to	N = 40. Samples spanned from 1.9 g/dL to 5.8	N = 40. Samples spanned from 0.7 mg/dL to

Chemistry Basic 1	Calcium	BUN	Glucose	Albumin	Creatinine
	mg/dL. The regression equation was y = 0.97x + 0.14 and r = 0.993.	mg/dL. The regression equation was y = 1.08x – 0.43 and r = 0.997.	406 mg/dL. The regression equation was y = 1.07x – 7.19 and r = 0.997.	g/dL. The regression equation was y = 0.99x + 0.07 and r = 0.976.	15.3 mg/dL. The regression equation was y = 1.07x – 0.00 and r = 0.997.
Chemistry Basic 2	Total Bilirubin	Total Protein	ALP	AST	ALT
Predicate Methodology	colorimetric k051432	colorimetric k051432	colorimetric k050652	Colorimetric k041427	colorimetric k040332
Test Methodology	colorimetric	colorimetric	colorimetric	Colorimetric	colorimetric
Predicate Reagent Storage	2-8°C	2-8°C	2-8°C	2-8°C	2-8°C
Test Reagent Storage	2-8°C	2-8°C	2-8°C	2-8°C	2-8°C
Predicate Sample types	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood
Test Sample Types	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood	Serum/Plasma, Whole blood
Correlation with Predicate device	N = 40. Samples spanned from 0.3 mg/dL to 8.7 mg/dL. The regression equation was y = 1.00x – 0.09 and r = 0.999.	N = 40. Samples spanned from 3.3 g/dL to 10.4 g/dL. The regression equation was y = 0.98x – 0.03 and r = 0.986.	N = 40. Samples spanned from 62 IU/L to 685 IU/L. The regression equation was y = 1.04x – 9.34 and r = 0.998.	N = 40. Samples spanned from 11 IU/L to 267 IU/L. The regression equation was y = 0.95x + 2.62 and r = 0.999.	N = 40. Samples spanned from 12 IU/L to 738 IU/L. The regression equation was y = 1.03x – 1.65 and r = 0.998.

K. Standard/Guidance Document Referenced (if applicable):

None referenced

L. Test Principle:

Chemistry Basic 1, Calcium: Calcium in the sample is combined with *o*-cresolphthalein complexone (OCPC) under strong alkaline conditions to form a purple chelate.
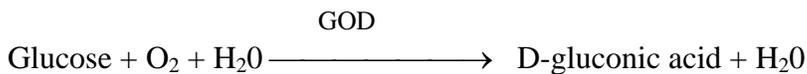
$$Ca^{2+} + OCPC \xrightarrow{OH^-} \text{blue-purple chromagen}$$

The intensity of the blue chromagen as measured at 575 nm by reflectance spectro-photometry is directly proportional to the concentration of calcium in the patient sample.

Chemistry Basic 1, BUN: Urea in the sample reacts with *o*-phthalaldehyde to produce 1,3-dihydroxyisoindoline (DHI). The carbonium ion of DHI reacts with *N*-1-naphthyl-*N'*-diethylethylenediamineoxalic acid under strong acidic conditions to form a blue purple color.

Urea + *o*-phthalaldehyde + *N*-1-naphthyl-*N'*-diethylethylenediamineoxalic acid

$$\xrightarrow{\text{H}^+} \text{blue-purple chromagen}$$
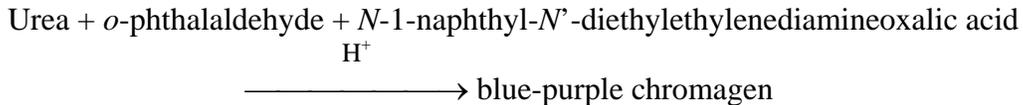
The intensity of the blue chromagen as measured at 610 nm by reflectance spectro-photometry is directly proportional to the concentration of blood urea nitrogen in the patient sample.

Chemistry Basic 1, Glucose: Glucose in the sample is oxidized in a concentration-dependent manner by glucose oxidase (GOD) found in the reagent layer. GOD oxidizes the glucose with the quantitative production of hydrogen peroxide. The hydrogen peroxide oxidizes and condenses 4-aminoantipyrine (4AAP) and 1-naphthol-3, 6-disulfonic acid disodium (NDD) by the catalytic action of peroxidase to form a reddish-purple color.

$$\text{Glucose} + O_2 + H_2O \xrightarrow{\text{GOD}} \text{D-gluconic acid} + H_2O$$

$$H_2O_2 + 4AAP + NDD \xrightarrow{\text{POD}} \text{reddish-purple chromagen} + H_2O$$

The intensity of the reddish-purple color measured at 550 nm by reflectance spectrophotometry is proportional to the concentration of glucose in the patient sample.

Chemistry Basic 1, Albumin: Albumin in the sample is combined with bromcresol green (BCG) in acidic conditions to form a blue-green complex.

$$\text{Albumin} + \text{bromcresol green} \xrightarrow{\text{H}^+} \text{blue-green chromagen}$$
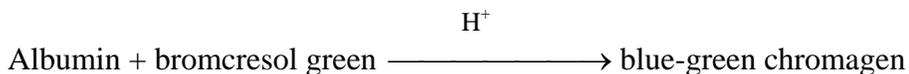
The intensity of the blue-green color, as measured at 610 nm by reflectance spectrophotometry, is proportional to the concentration of albumin in the patient sample.

Chemistry Basic 1, Creatinine: Creatinine in the sample is combined with 3, 5-dinitrobenzoic acid under alkaline conditions to form a red chromagen.

$$\text{Creatinine} + \text{3,5-dinitrobenzoic acid} \xrightarrow{\text{OH}^-} \text{red chromagen}$$

The intensity of the red chromagen as measured at 550 nm by reflectance spectro-photometry is directly proportional to the concentration of creatinine in the patient sample.

Chemistry Basic 2, Total Bilirubin: Both indirect and direct bilirubin in the sample react with diazonium salt in the presence of dyphylline and an acidic buffer to form a red azobilirubin as a final product.

$$\text{Total bilirubin} + \text{sulfanilic acid} + \text{nitrite} \xrightarrow{\text{dyphylline}} \text{red azobilirubin}$$
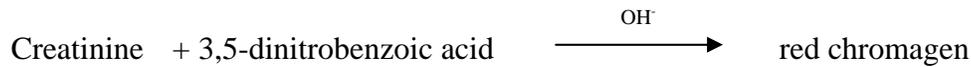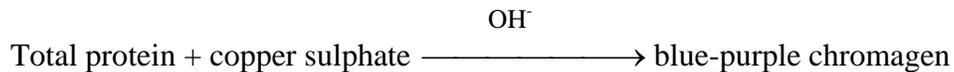
The intensity of the red color, as measured at 550 nm by reflectance spectrophotometry, is proportional to the concentration of total bilirubin in the patient sample.

Chemistry Basic 2, Total Protein: Protein in serum or plasma reacts with copper ion at high pH to form a blue-purple color.

$$\text{Total protein} + \text{copper sulphate} \xrightarrow{\text{OH}^-} \text{blue-purple chromagen}$$

The intensity of the blue-purple color, as measured at 550 nm by reflectance spectrophotometry, is proportional to the concentration of total protein in the patient sample.

Chemistry Basic 2, ALP: ALP in the sample reacts with *p*-nitrophenylphosphate and hydrolyzes it to form *p*-nitrophenyl and phosphate.

$$p\text{-nitrophenylphosphate} + \text{H}_2\text{0} \xrightarrow{\text{ALP}} \text{phosphate} + p\text{-nitrophenyl}$$
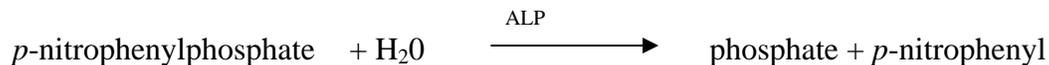
The rate, at which the yellow color is generated, as measured at 405 nm by reflectance spectrophotometry, is directly proportional to the ALP activity in the patient sample.

Chemistry Basic 2, AST: AST in the sample transfers amino group of L-aspartic to α-ketoglutaric acid to produce L-glutamic acid and oxalacetic acid. The pyruvic acid, in the presence of magnesium ion and thiamine pyrophosphoric acid, is oxidized by the catalytic action of pyruvate oxidase to produce hydrogen peroxide. The hydrogen

peroxide oxidizes and condenses 4-aminoantipyrine (4AAP) and DAOS by the catalytic action of peroxidase to form a blue color.

(absorbic acid + 1/2 O_2 $\xrightarrow{\text{AsOD}}$ dehydroascorbic acid + H_2O
: removal of ascorbic acid interference)

L-aspartic acid + α-ketoglutaric acid $\xrightarrow{\text{AST}}$ L-glutamic acid + oxalacetic acid

Oxalacetic acid $\xrightarrow{\text{OAC}}$ pyruvate + CO_2

Pyruvic + phosphate + O_2 $\xrightarrow[\text{Mg}^{2+}]{\text{POP, TPP}}$ acetylphosphoric acid+ H_2O_2 + CO_2

H_2O_2 + 4AAP + DAOS $\xrightarrow{\text{POD}}$ blue chromagen + H_2O
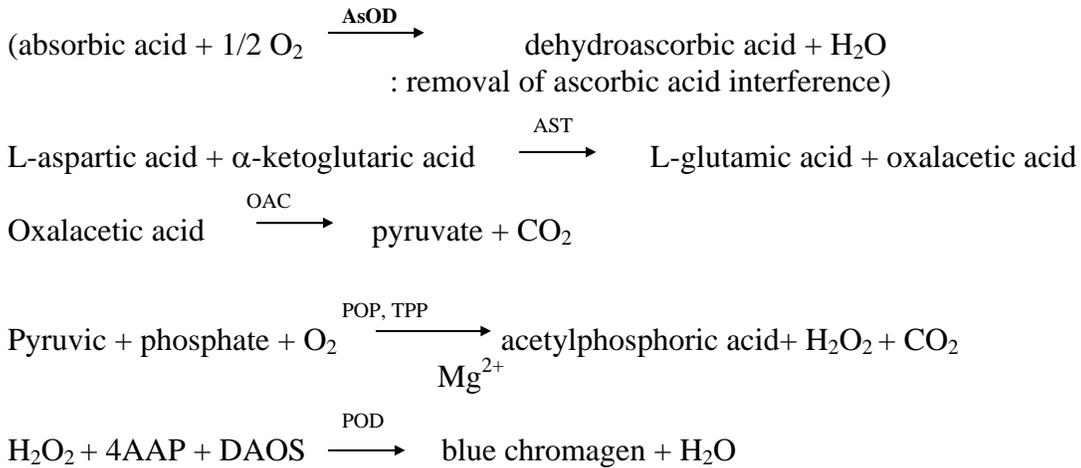
The rate at which the blue color is generated in this detection layer as measured at 610 nm by reflectance spectrophotometry is proportional to the AST activity in plasma.

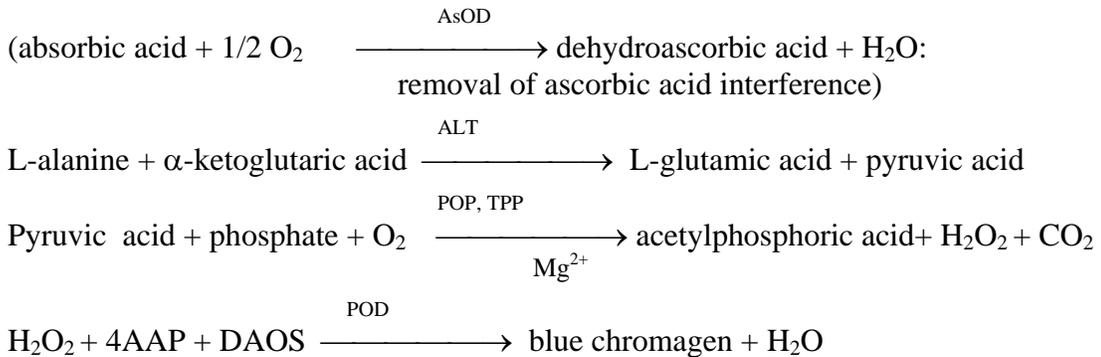**Chemistry Basic 2, ALT**: ALT in the sample transfers amino group of L-alanine to α-ketoglutaric acid and produces L-glutamic acid and pyruvic acid. The pyruvic acid, in the presence of magnesium ion and thiamine pyrroline, is oxidized by the catalytic action of pyruvic acid oxidase, to produce hydrogen peroxide. The hydrogen peroxide oxidizes and condenses 4-aminoantipyrine (4AAP) and DAOS by the catalytic action of peroxidase to form a blue color.

(absorbic acid + 1/2 O_2 $\xrightarrow{\text{AsOD}}$ dehydroascorbic acid + H_2O:
removal of ascorbic acid interference)

L-alanine + α-ketoglutaric acid $\xrightarrow{\text{ALT}}$ L-glutamic acid + pyruvic acid

Pyruvic acid + phosphate + O_2 $\xrightarrow[\text{Mg}^{2+}]{\text{POP, TPP}}$ acetylphosphoric acid+ H_2O_2 + CO_2

H_2O_2 + 4AAP + DAOS $\xrightarrow{\text{POD}}$ blue chromagen + H_2O

The rate at which the blue color is generated in this detection layer as measured at 610 nm by reflectance spectrophotometry is proportional to the ALT activity in plasma.

After the completion of the measurement, the SPOTCHEM EZ SP-4430 Analyzer calculates the concentration of analyte [D] as follows:

$$D = a \cdot (K/S)^3 + b \cdot (K/S)^2 + c \cdot (K/S) + d$$

Where (K/S) is the Kubelka-Munk value for reflectance and a, b, c and d are coefficients derived from the calibration curve.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

   a. *Precision/Reproducibility:*

      Intra assay Precision
      Intra assay precisions (within run) were assessed by twenty replicates of the same sample within one analytical run with three levels evaluated. The mean, standard deviation (SD) and coefficient of variation (CV) in percent were also calculated. The data are presented in the Tables below.

Intra Assay Precision for Chemistry Basic 1

Analyzer SPOTCHEM EZ		Level 1	Level 2	Level 3
Analyte	n	20	20	20
Calcium (mg/dL)	Mean	8.00	10.46	12.41
	SD	0.290	0.404	0.554
	%CV	3.6%	3.9%	4.5%
BUN (mg/dL)	Mean	15.3	23.4	69.4
	SD	0.47	0.67	2.30
	%CV	3.1%	2.9%	3.3%
Glucose (mg/dL)	Mean	64.3	107.3	267.0
	SD	0.73	2.49	8.71
	%CV	1.1%	2.3%	3.3%
Albumin (mg/L)	Mean	2.47	4.90	5.30
	SD	0.073	0.147	0.103
	%CV	3.0%	3.0%	1.9%
Creatinine (mg/dL)	Mean	1.23	1.51	4.45
	SD	0.055	0.060	0.076
	%CV	4.5%	4.0%	1.7%

Intra Assay Precision for Chemistry Basic 2

Analyzer SPOTCHEM EZ		Level 1	Level 2	Level 3
	N	20	20	20
Total Bilirubin (mg/dL)	Mean	0.69	1.68	6.5
	SD	0.031	0.062	0.266
	%CV	4.5%	3.7%	4.1%
Total Protein (mg/L)	Mean	5.19	7.57	9.49
	SD	0.107	0.232	0.290
	%CV	2.1%	3.1%	3.1%

Analyzer SPOTCHEM EZ		Level 1	Level 2	Level 3
ALP (IU/L)	Mean	59.7	223.6	431.2
	SD	1.95	7.95	14.12
	%CV	3.3%	3.6%	3.3%
AST (IU/L)	Mean	24.3	106.0	188.5
	SD	0.97	3.65	6.53
	%CV	4.0%	3.4%	3.5%
ALT (IU/L)	Mean	19.9	99.6	180.0
	SD	0.99	2.72	3.46
	%CV	5.0%	2.7%	1.9%

Intra assay Precision, Whole blood samples

Intra assay precisions (within run) were assessed using a whole blood sample with ten replicates of the same sample within one analytical run. The mean, standard deviation (SD) and coefficient of variation (CV) in percent were calculated. The data are presented in the Table below.

Intra Assay Precision with whole blood sample, N = 10

Analyzer SPOTCHEM EZ	Mean	SD	%CV
Chemistry Basic 1, Calcium (mg/dL)	11.52	0.220	1.9%
Chemistry Basic 1, BUN (mg/dL)	32.9	0.99	3.0%
Chemistry Basic 1, Glucose (mg/dL)	126.8	3.58	2.8%
Chemistry Basic 1, Albumin (g/dL)	5.37	0.263	4.9%
Chemistry Basic 1, Creatinine (mg/dL)	2.47	0.116	4.7%
Chemistry Basic 2, Total Bilirubin (mg/dL)	4.09	0.166	4.1%
Chemistry Basic 2, Total Protein (g/dL)	8.92	0.326	3.7%
Chemistry Basic 2, ALP (IU/L)	242.8	11.26	4.6%
Chemistry Basic 2, AST (IU/L)	49.7	1.49	3.0%
Chemistry Basic 2, ALT (IU/L)	69.8	3.26	4.7%

Inter Assay Precision
Inter assay (between run) precisions were determined by analyzing duplicates of three different samples in each of ten different runs over ten different occasions. The data are presented in the Table below.
Inter Assay Precision for Chemistry Basic 1

Analyzer SPOTCHEM EZ	Level 1	Level 2	Level 3
Days	5	5	5
N	20	20	20

Analyzer SPOTCHEM EZ		Level 1	Level 2	Level 3
Calcium	Mean	7.88	10.08	12.30
(mg/dL)	SD	0.346	0.309	0.453
	%CV	4.4%	3.1%	3.7%
BUN	Mean	14.9	23.3	67.5
(mg/dL)	SD	0.45	0.85	1.88
	%CV	3.0%	3.7%	2.8%
Glucose	Mean	63.0	106.2	261.8
(mg/dL)	SD	1.52	3.91	9.45
	%CV	2.4%	3.7%	3.6%
Albumin	Mean	2.45	4.84	5.31
(mg/L)	SD	0.061	0.135	0.112
	%CV	2.5%	2.8%	2.1%
Creatinine	Mean	1.29	1.50	4.40
(mg/dL)	SD	0.091	0.069	0.110
	%CV	7.1%	4.6%	2.5%

Inter Assay Precision for Chemistry Basic 2

Analyzer SPOTCHEM EZ		Level 1	Level 2	Level 3
	Days	5	5	5
	N	20	20	20
Total	Mean	0.70	1.64	6.28
Bilirubin	SD	0.000	0.088	0.231
(mg/dL)	%CV	0.0%	5.4%	3.7%
Total Protein	Mean	5.11	7.47	9.49
(mg/L)	SD	0.137	0.237	0.323
	%CV	2.7%	3.2%	3.4%
ALP	Mean	58.7	222.4	425.9
(IU/L)	SD	1.79	5.65	16.60
	%CV	3.0%	2.5%	3.9%
AST	Mean	24.8	107.0	180.4
(IU/L)	SD	2.17	2.79	6.23
	%CV	8.8%	2.6%	3.5%
ALT	Mean	20.6	103.2	173.2
(IU/L)	SD	0.88	6.22	3.90
	%CV	4.3%	6.0%	2.3%

b. *Linearity/assay reportable range:*

Linearity Studies
The linearity/calibration curve fit data were generated for a pool that

spanned the linear range of the test. Serial dilution sets were prepared using 7% BSA and made up fresh and assayed with each of three calibrated runs. The results at each level of analyte were averaged and the linear fit was assessed. The sponsor claims that the linearity was based on a percent deviation of $\leq$ 5% at the two highest analyte concentrations.

Chemistry Basic 1
Calcium: Calcium was found to be linear up to 16.9 mg/dL. The linear fit yielded a regression equation of $Y = 1.20X - 1.33$, $R^2 = 0.991$.
BUN: BUN was found to be linear up to 169.7 mg/dL. The linear fit yielded a regression equation of $Y = 1.03X - 1.18$, $R^2 = 0.9968$.
Glucose: Glucose was found to be linear up to 438 mg/dL. The linear fit yielded a regression equation of $Y = 1.00X + 3.78$, $R^2 = 0.9987$.
Albumin: Albumin was found to be linear up to 6.6 g/dL. The linear fit yielded a regression equation of $Y = 1.02X - 0.06$, $R^2 = 0.9956$.
Creatinine: Creatinine was found to be linear up to 37.9 mg/dL. The linear fit yielded a regression equation of $Y = 0.98X - 0.06$, $R^2 = 0.9988$.

Chemistry Basic 2
ALP: ALP was found to be linear up to 859.3 IU/L. The linear fit yielded a regression equation of $Y = 1.03X - 2.33$, $R^2 = 0.9988$.
Total Bilirubin: Total Bilirubin was found to be linear up to 16.4 g/dL. The linear fit yielded a regression equation of $Y = 1.03X - 0.02$, $R^2 = 0.9973$.
Total Protein: Total Protein was found to be linear up to 10.7 g/dL. The linear fit yielded a regression equation of $Y = 0.99X - 0.00$, $R^2 = 0.9964$.
AST: AST was found to be linear up to 733.7 IU/L. The linear fit yielded a regression equation of $Y = 0.98X + 3.66$, $R^2 = 0.9975$.
ALT: ALT was found to be linear up to 860.3 IU/L. The linear fit yielded a regression equation of $Y = 1.03X - 1.76$, $R^2 = 0.9995$.

c. *Traceability, Stability, Expected values (controls, calibrators, or methods):*

Calibration

The calibration set points are fixed by the manufacturer and are unique with each reagent lot and stored on a magnetic card provided with each kit lot.

The principle of the calibration is to fix a two-point calibration curve for a given lot into the memory of the instrument. The sample absorbances are then read off this fixed curve by the instrument and the concentration is calculated and the results are provided by the software.

Stability Summary

The sponsor's stability claim was determined by an internal stability study SOP. Accordingly the initial shelf-life determinations were conducted by accelerated aging studies and backed up with real time aging studies. The shelf life of the test strip was conducted after exposure to real shipping conditions and labeled (standard) storage conditions.

The sponsor's real time studies were conducted after performing baseline testing and study points were initiated at appropriate intervals during real time aging under labeled standard storage conditions, or to the nearest time point that is 25% beyond the claimed or desired shelf-life. The sponsor concluded from these studies that the reagent strips are stable through the labeled expiration date when stored at 2-8°C.

d. *Detection limit:*

The sponsor determined the minimum detectable value with an acceptable level of precision by diluting a pool to 10 different concentrations below the lower limit of the normal test range for each analyte. Each dilution was then assayed in replicates of ten. The mean, standard deviation and percent coefficient of variation were calculated for the ten replicates of each dilution. The defined results for each test are summarized below:

Test	Sensitivity	%CV
Calcium	4.9 mg/dL	3.3%
BUN	6.6 mg/dL	7.8%
Glucose	27 mg/dL	0.0%
Albumin	0.6 g/dL	0.0%
Creatinine	0.66 mg/dL	7.8%
ALP	25.4 IU/L	2.8%
Total Bilirubin	0.3 mg/dL	0.0%
Total Protein	2.7 g/dL	2.5%
AST	10 IU/L	0.0%
ALT	12 IU/L	6.7%

e. *Analytical specificity:*

Interference substances studies

The sponsor's acceptance criteria for determining common interference substances were that the acceptable established analyte recovery should not vary from the base recovery by less or more than 10%. The interfering

substances were evaluated in serum pools that had target analyte levels below normal, in the normal range, and above the normal range. A summary of the data for known interferents appears in the table below.

Chemistry Basic 1 Interfering Substances

	Calcium*	BUN	Glucose	Albumin	Creatinine
Sample	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**
Hemoglobin	300 mg/dL	300 mg/dL	150 mg/dL	150 mg/dL	300 mg/dL
Bilirubin	11.8 mg/dL	12.0 mg/dL	9.0 mg/dL	7.63 mg/dL	15.21 mg/dL
Triglycerides	394 mg/dL	285 mg/dL	200 mg/dL	436.1 mg/dL	285 mg/dL

*Calcium: Also, no interference was observed up to a level of 5.3 mg/dL magnesium.

Chemistry Basic 2 Interfering Substances

	ALP	Total Bilirubin	Total Protein	AST	ALT
Sample	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**	**Highest Level Tested with No Interference**
Hemoglobin	250 mg/dL	150 mg/dL	300 mg/dL	100 mg/dL	100 mg/dL
Bilirubin	7.6 mg/dL	NA	7.6 mg/dL	1.5 mg/dL	2.0 mg/dL
Triglycerides	423 mg/dL	302 mg/dL	334.6 mg/dL	200 mg/dL	150 mg/dL

f. *Assay cut-off:*

Not applicable for this type of device.

2. <u>Comparison studies:</u>

a. *Method comparison with predicate device:*

The sponsor performed correlation studies by comparing the Panel test results

generated on the SPOTCHEM EZ analyzer (SP-4430)against the results generated from predicate device.

Chemistry Basic 1

Calcium: The 40 serum samples spanned from 5.1 mg/dL to 15.2 mg/dL. The regression equation was y = 0.97x + 0.14 and r = 0.9927.

BUN: The 40 serum samples spanned from 7 mg/dL to 92 mg/dL. The regression equation was y = 1.08x – 0.43 and r = 0.9972.

Glucose: The 40 serum samples spanned from 30 mg/dL to 406 mg/dL. The regression equation was y = 1.07x – 7.19 and r = 0.9970.

Albumin: The 40 serum samples spanned from 1.9 g/dL to 5.8 g/dL. The regression equation was y = 0.99x + 0.07 and r = 0.9763.

Creatinine: The 40 serum samples spanned from 0.7 mg/dL to 15.3 mg/dL. The regression equation was y = 1.07x – 0.00 and r =0.9972.

Chemistry Basic 2

ALP: The 40 serum samples spanned from 62 IU/L to 685 IU/L. The regression equation was y = 1.04x – 9.34 and r = 0.9984.

Total Bilirubin: The 40 serum samples spanned from 0.3 mg/dL to 8.7 mg/dL. The regression equation was y = 1.00x – 0.09 and r = 0.9986.
Total Protein: The 40 serum samples spanned from 3.3 g/dL to 10.4 g/dL. The regression equation was y = 0.98x – 0.03 and r = 0.9863.

AST: The 40 serum samples spanned from 11 IU/L to 267 IU/L. The regression equation was y = 0.95x + 2.62 and r = 0.9991.

ALT: The 40 serum samples spanned from 12 IU/L to 738 IU/L. The regression equation was y = 1.03x – 1.65 and r = 0.9980.

b. *Matrix comparaison:*

The sponsor presented the below correlation studies comparing test results generated on the SPOTCHEM EZ SP-4430 analyzer for the specimen types of serum and whole blood.

Chemistry Basic 1 (Serum and Whole Blood)

Calcium: Twenty-two matched serum and whole blood samples were analyzed. The regression equation for the 22 serum and whole blood samples was y = 1.01x – 0.05 and r = 0.9437. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Calcium in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	8.132	1.322			7.0	12.9	
Whole blood	8.136	1.410	0.9437	0.8906	6.5	12.5	22

BUN: Twenty-three matched serum and whole blood samples were analyzed. The regression equation for the 23 serum and whole blood samples was y = 1.01x – 0.60 and r = 0.9972. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 BUN in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	18.957	21.242			8.0	102	
Whole blood	18.522	21.492	0.9972	0.9944	7.0	106	23

Glucose: Twenty-two matched serum and whole blood samples were analyzed. The regression equation for the 22 serum and whole blood samples was y = 0.98x + 4.24 and r = 0.9937. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Glucose in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	90.955	38.745			41	221	
Whole blood	93.818	38.401	0.9937	0.9875	45	219	22

Albumin: Twenty-two matched serum and whole blood samples were analyzed. The regression equation for the 22 serum and whole blood samples was y = 0.93x + 0.61 and r = 0.9476. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Albumin in g/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	4.191	0.732			1.6	5.4	
Whole blood	4.518	0.721	0.9476	0.8980	1.8	5.4	22

Creatinine: Twenty-one matched serum and whole blood samples were analyzed. The regression equation for the 21 serum and whole blood samples was y = 0.96x + 0.04 and r = 0.9997. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Creatinine in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	1.667	2.785	0.9997	0.9995	0.9	13.8	21
Whole blood	1.643	2.676			0.8	13.8	

Chemistry Basic 2 (Serum and Whole Blood)

ALP: Twenty-one matched serum and whole blood samples were analyzed. The regression equation for the 21 serum and whole blood samples was y = 1.02x + 1.67 and r = 0.9965. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 ALP in IU/L.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	117.286	65.275	0.9965	0.9929	48	244	21
Whole blood	121.238	66.784			51	251	

Total Bilirubin: Twenty matched serum and whole blood samples were analyzed. The regression equation for the 20 serum and whole blood samples was y = 0.99x – 0.03 and r = 0.9900. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 T. Bilirubin in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	0.635	0.415	0.9900	0.9801	0.3	1.8	20
Whole blood	0.600	0.415			0.3	1.8	

Total Protein: Twenty-two matched serum and whole blood samples were analyzed. The regression equation for the 22 serum and whole blood samples was y = 0.95x + 0.56 and r = 0.9670. The summary of the correlation data is presented in the below table.

Correlation Data Summary for Chemistry Basic 2 Total Protein in g/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	7.300	1.280	0.9670	0.9351	3.1	8.4	22
Whole blood	7.477	1.254			3.6	8.8	

AST: Twenty matched serum and whole blood samples were analyzed. The regression equation for the 20 serum and whole blood samples was y = 0.96x + 0.15 and r = 0.9958. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 AST. Results in IU/L.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	35.9	35.105	0.9958	0.9916	12	166	20
Whole blood	34.7	33.975			11	156	

ALT: Twenty matched serum and whole blood samples were analyzed. The regression equation for the 20 serum and whole blood samples was y = 0.99x + 0.39 and r = 0.9986. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 ALT. Results in IU/L.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Serum	45.200	46.616	0.9986	0.9973	12	220	20
Whole blood	45.050	46.118			12	217	

The sponsor presented correlation studies comparing test results generated on the SPOTCHEM EZ SP-4430 analyzer for the specimen types of plasma and whole blood. The results are presented below.

Chemistry Basic 1 (Plasma and Whole Blood)

Calcium: Twenty-one matched plasma and whole blood samples were analyzed. The regression equation for the 21 plasma and whole blood samples was y = 1.06x – 0.42 and r = 0.9702. The summary of the correlation data is presented in the below table.

Correlation Data Summary for Chemistry Basic 1 Calcium in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	7.848	0.953	0.9702	0.9413	6.9	11.4	21
Whole blood	7.929	1.044			6.5	11.7	

BUN: Twenty-two matched plasma and whole blood samples were analyzed. The regression equation for the 22 plasma and whole blood samples was y = 0.93x + 0.78 and r = 0.9969. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 BUN in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	14.591	9.106	0.9969	0.9938	8.0	52	22
Whole blood	14.318	8.476			8.0	49	

Glucose: Twenty-two matched plasma and whole blood samples were analyzed. The regression equation for the 22 plasma and whole blood samples was y = 1.00x + 0.98 and r = 0.9940. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Glucose in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	92.636	38.017	0.9940	0.9880	42	219	22
Whole blood	93.864	38.348			45	219	

Albumin: Twenty-two matched plasma and whole blood samples were analyzed. The regression equation for the 22 plasma and whole blood samples was y = 1.01x + 0.09 and r = 0.9574. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Albumin in g/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	4.359	0.747	0.9574	0.9166	1.4	5.2	22
Whole blood	4.495	0.789			1.4	5.3	

Creatinine: Twenty-one matched plasma and whole blood samples were analyzed. The regression equation for the 21 plasma and whole blood samples was y = 1.02x - 0.02 and r = 0.9997. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 1 Creatinine in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	1.686	2.895	0.9997	0.9994	0.8	14.3	21
Whole blood	1.705	2.959			0.8	14.6	

Chemistry Basic 2 (Plasma and Whole Blood)

ALP: Twenty-one matched plasma and whole blood samples were analyzed. The regression equation for the 21 plasma and whole blood samples was y =

0.97x + 2.96 and r = 0.9971. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 ALP. Results in IU/L.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	126.905	72.506	0.9971	0.9942	51	253	21
Whole blood	126.429	70.751			51	251	

Total Bilirubin: Twenty matched plasma and whole blood samples were analyzed.   The regression equation for the 20 plasma and whole blood samples was y = 0.97x   + 0.01 and r = 0.9908.   The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 T. Bilirubin in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	0.605	0.406	0.9908	0.9817	0.3	1.6	20
Whole blood	0.595	0.395			0.3	1.5	

Total Protein: Twenty-one matched plasma and whole blood samples were analyzed.   The regression equation for the 21 plasma and whole blood samples was y = 1.03x + 0.19 and r = 0.9699. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 T. Protein in mg/dL.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	7.586	1.050	0.9699	0.9406	3.4	8.6	21
Whole blood	7.600	1.112			3.3	8.8	

AST: Twenty matched plasma and whole blood samples were analyzed. The regression equation for the 20 plasma and whole blood samples was y =1.04x – 3.91 and r = 0.9973. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 AST in IU/L.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	36.300	31.787	0.9973	0.9946	12	150	20
Whole blood	34.000	33.291			11	156	

ALT: Twenty matched plasma and whole blood samples were analyzed. The regression equation for the 20 plasma and whole blood samples was y = 1.02x - 0.57 and r = 0.9991. The summary of the correlation data is presented in the table below.

Correlation Data Summary for Chemistry Basic 2 ALT in IU/L.

Variable X,Y	Mean	Std. Dv.	r(X,Y)	r^2	Min.	Max.	N
Plasma	45.900	46.057	0.9991	0.9982	12	214	20
Whole blood	46.050	46.824			12	217	

3. Clinical studies:

   a. *Clinical Sensitivity:*

   Not applicable**.**

   b. *Clinical specificity:*

   Not applicable**.**

   c. Other clinical supportive data (when a. and b. are not applicable):

4. Clinical cut-off**:**

   Not applicable**.**

5. Expected values/Reference range:

   The expected ranges presented in the proposed package insert were established from scientific literature with references listed below:

1. Henry, J.B., Clinical Diagnosis and Management by Laboratory Methods 20th ed. W.B. Saunders Co., Philadelphia (1976).
2. Tietz, N.W. Textbook of Clinical Chemistry 2nd ed. W.B. Saunders Co., Philadelphia (1994).

The normal values for each of the tests are listed in the tables below:

Chemistry Basic 1

Adult Calcium Levels in Serum

Specimen Type	**mg/dL**	**mmol/L**
Adult	8.10 - 10.4	2.02 - 2.60

Adult Urea Nitrogen Levels in Serum

Specimen Type	Mg/dL	mmol/L
Adult	8 - 20	2.9 – 7.1

Adult Glucose Levels in Serum

Impaired Fasting Glucose	Diabetic	Unit
110 – 126	> 126	mg/dL
6.1 – 7.0	> 7.0	mmol/L

Adult Albumin Levels in Serum

Specimen Type	g/dL	g/L
Serum	3.5 – 5.0	35 – 50

Adult Creatinine Levels in Serum

Specimen Type	mg/dL	mol/L
Adult male	0.7 – 1.3	62 – 115
Adult female	0.6 – 1.1	53 – 97

Chemistry Basic 2

Adult ALP Levels in Serum

Specimen Type	IU/L	kit/L
Adult (at 37ºC)	40 - 150	0.67 – 2.50

Adult Total Bilirubin Levels in Serum

Specimen Type	mg/dL	mmol/L
Serum	0.2 – 1.0	3.4 – 17.1

Adult Total Protein Levels in Serum

Specimen Type	g/dL	g/L
Serum	6.0 – 7.8	60 – 78

Adult ALT Levels in Serum (25ºC)

Specimen Type	IU/L	kit/L
Adult male	Up to 22	Up to 0.37
Adult female	Up to 17	Up to 0.28

Adult AST Levels in Serum

Specimen Type	IU/L	kit/L
Adult male	15 – 40	0.25 – 0.67
Adult female	13 – 35	0.22 – 0.58

N. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Part 809.10.

O. Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.