

LDLC3

LDL-Cholesterol Gen.3

cobas[®]
Substrates

Order information

REF	CONTENT	Analyzer(s) on which cobas c pack(s) can be used
07005717 190	LDL-Cholesterol Gen.3 (200 tests)	System ID 07 7565 7
12172623 122	C.f.a.s. Lipids (3 × 1 mL)	System ID 07 6570 8
10781827 122	Precinorm L (4 × 3 mL)	System ID 07 9026 5
11778552 122	Precipath HDL/LDL-C (4 × 3 mL)	System ID 07 9028 1
05117003 190	PreciControl ClinChem Multi 1 (20 × 5 mL)	System ID 07 7469 3
05947626 190	PreciControl ClinChem Multi 1 (4 × 5 mL)	System ID 07 7469 3
05117216 190	PreciControl ClinChem Multi 2 (20 × 5 mL)	System ID 07 7470 7
05947774 190	PreciControl ClinChem Multi 2 (4 × 5 mL)	System ID 07 7470 7
20756350 322	NaCl Diluent 9 % (22 mL)	System ID 07 5635 0

English

System information

Test LDLC3, test ID 0-452

Intended use

In vitro test for the quantitative determination of LDL-cholesterol in human serum and plasma on COBAS INTEGRA systems.

Summary

Low Density Lipoproteins (LDL) play a key role in causing and influencing the progression of atherosclerosis and, in particular, coronary sclerosis.^{1,2} The LDLs are derived from VLDLs (Very Low Density Lipoproteins) rich in triglycerides by the action of various lipolytic enzymes and are synthesized in the liver. The elimination of LDL from plasma takes place mainly by liver parenchymal cells via specific LDL receptors. Elevated LDL concentrations in blood and an increase in their residence time coupled with an increase in the biological modification rate results in the destruction of the endothelial function and a higher LDL-cholesterol uptake in the monocyte/macrophage system as well as by smooth muscle cells in vessel walls. The majority of cholesterol stored in atherosclerotic plaques originates from LDL. The LDL-cholesterol value is the most powerful clinical predictor among all of the single parameters with respect to coronary atherosclerosis. Therefore, therapies focusing on lipid reduction primarily target the reduction of LDL-cholesterol which is then expressed in an improvement of the endothelial function, prevention of atherosclerosis and reducing its progression as well as preventing plaque rupture.

Various methods are available for the determination of LDL-cholesterol such as ultracentrifugation as the reference method, lipoprotein electrophoresis, HPLC and precipitation methods.^{3,4} In the precipitation methods apolipoprotein B-containing LDL-cholesterol is, for example, precipitated using either polyvinyl sulfate, dextran sulfate or polycyclic anions. The LDL-cholesterol content is usually calculated from the difference between total cholesterol and cholesterol in the remainder (VLDL and HDL-cholesterol) in the supernate after precipitation with polyvinyl sulfate and dextran sulfate.⁵ Lipid Research Clinics recommend a combination of ultracentrifugation and precipitation methods using polyanions in the presence of divalent cations. The precipitation methods are, however, time-consuming, cannot be automated and are susceptible to interference by hyperlipidemic serum, particularly at high concentrations of free fatty acids. A more recent method is based on the determination of LDL-cholesterol after the sample is subjected to immunoadsorption and centrifugation.⁶

The calculation of the LDL-cholesterol concentration according to Friedewald's formula is based on two cholesterol determinations (total cholesterol and HDL-cholesterol) and one triglyceride determination.⁷

Friedewald's formula for calculation of LDL-C presumes that a direct relationship exists between VLDL-cholesterol and triglycerides in fasting blood samples (VLDL-cholesterol = Trig./5 mg/dL, VLDL-cholesterol = Trig./2.2 mmol/L). The bias in calculating LDL-C using this assumption is only acceptable in samples with a triglyceride concentration < 2.0 mmol/L (177 mg/dL).^{8,9} Even in the presence of small amounts of chylomicrons or abnormal lipoproteins, the formula gives rise to artificially low LDL-cholesterol values. Non-fasting samples cannot be used for the calculation of LDL-C because they contain a high concentration of chylomicrons and in many cases the limit of acceptable triglyceride concentration is exceeded.

For these reasons, a simple and reliable method for routine measurement of LDL-cholesterol without any preparatory steps was developed. This automated method for the direct determination of LDL-cholesterol takes

advantage of the selective micellar solubilization of LDL-cholesterol by a nonionic detergent and the interaction of a sugar compound and lipoproteins (VLDL and chylomicrons). When a detergent is included in the enzymatic method for cholesterol determination (cholesterol esterase - cholesterol oxidase coupling reaction), the relative reactivities of cholesterol in the lipoprotein fractions increase in this order: HDL < chylomicrons < VLDL < LDL.

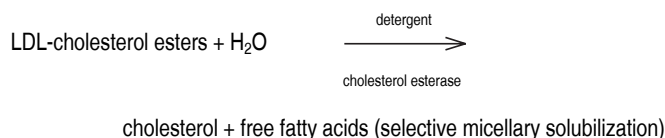
The combination of a sugar compound with detergent enables the selective determination of LDL-cholesterol in serum and plasma samples.

Non-fasting sample results are slightly lower than fasting results. Comparable non-fasting results were observed with the beta quantification method.¹⁰ This direct assay meets the 1995 NCEP goals of < 4 % total CV, bias ≤ 4 % versus reference method, and ≤ 12 % total analytical error.^{11,12,13,14}

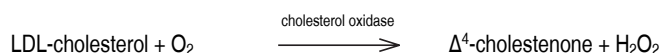
Test principle

Homogeneous enzymatic colorimetric assay

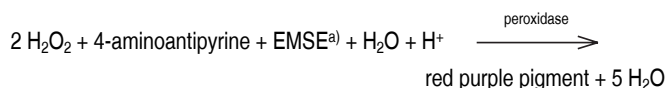
Cholesterol esters and free cholesterol in LDL are measured on the basis of a cholesterol enzymatic method using cholesterol esterase and cholesterol oxidase in the presence of surfactants which selectively solubilize only LDL. The enzyme reactions to the lipoproteins other than LDL are inhibited by surfactants and a sugar compound. Cholesterol in HDL, VLDL and chylomicron is not determined.



Cholesterol esters are broken down quantitatively into free cholesterol and fatty acids by cholesterol esterase.



In the presence of oxygen, cholesterol is oxidized by cholesterol oxidase to Δ^4 -cholestenone and hydrogen peroxide.



a) N-ethyl-N-(3-methylphenyl)-N-succinylethylenediamine

In the presence of peroxidase, the hydrogen peroxide generated reacts with 4-aminoantipyrine and EMSE to form a red purple dye. The color intensity of this dye is directly proportional to the cholesterol concentration and is measured photometrically.

Reagents - working solutions

R1 Bis-tris^{b)} buffer: 20.1 mmol/L, pH 7.0; 4-aminoantipyrine: 0.98 mmol/L; ascorbate oxidase (AOD, Acremonium spec.): ≥ 66.7 μkat/L; peroxidase (recombinant from Basidiomycetes): ≥ 166.7 μkat/L; BSA: 4.0 g/L; preservative

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SR MOPS[®] buffer: 20.1 mmol/L, pH 7.0; EMSE: 2.16 mmol/L; cholesterol esterase (Pseudomonas spec.): $\geq 33.3 \mu\text{kat/L}$; cholesterol oxidase (recombinant from *E. coli*): $\geq 31.7 \mu\text{kat/L}$; peroxidase (recombinant from Basidiomycetes): $\geq 333.3 \mu\text{kat/L}$; BSA: 4.0 g/L; detergents; preservative

b) bis(2-hydroxyethyl)-amino-tris-(hydroxymethyl)-methane

c) 3-morpholinopropane-1-sulfonic acid

R1 is in position B and SR is in position C.

Precautions and warnings

Pay attention to all precautions and warnings listed in Section 1 / Introduction of this Method Manual.

This kit contains components classified as follows in accordance with the Regulation (EC) No. 1272/2008:



Warning

H317 May cause an allergic skin reaction.

Prevention:

P261 Avoid breathing dust/fume/gas/mist/vapours/spray.

P272 Contaminated work clothing should not be allowed out of the workplace.

P280 Wear protective gloves.

Response:

P333 + P313 If skin irritation or rash occurs: Get medical advice/attention.

P362 + P364 Take off contaminated clothing and wash it before reuse.

Disposal:

P501 Dispose of contents/container to an approved waste disposal plant.

Product safety labeling follows EU GHS guidance.

Contact phone: all countries: +49-621-7590

Reagent handling

Ready for use

Storage and stability

LDLC3

Shelf life at 2-8 °C See expiration date on **cobas c** pack label

On-board in use at 10-15 °C 12 weeks

Diluent NaCl 9 %

Shelf life at 2-8 °C See expiration date on **cobas c** pack label

On-board in use at 10-15 °C 4 weeks

Specimen collection and preparation

For specimen collection and preparation only use suitable tubes or collection containers.

Only the specimens listed below were tested and found acceptable.

Serum

Plasma: Li-heparin, K₂- and K₃-EDTA plasma.

Fasting and non-fasting samples can be used.⁶

The sample types listed were tested with a selection of sample collection tubes that were commercially available at the time of testing, i.e. not all available tubes of all manufacturers were tested. Sample collection systems from various manufacturers may contain differing materials which could

affect the test results in some cases. When processing samples in primary tubes (sample collection systems), follow the instructions of the tube manufacturer.

Centrifuge samples containing precipitates before performing the assay.

Stability:^{15,16}

7 days at 2-8 °C

12 months at -20 °C

12 months at -70 °C

It is reported that EDTA stabilizes lipoproteins.¹³

Materials provided

See "Reagents – working solutions" section for reagents.

Materials required (but not provided)

NaCl Diluent 9 %, Cat. No. 20756350 322, system-ID 07 5635 0 for automatic postdilution. NaCl Diluent 9 % is placed in its predefined rack position and is stable for 4 weeks on-board the COBAS INTEGRA 400 plus analyzer.

Assay

For optimum performance of the assay follow the directions given in this document for the analyzer concerned. Refer to the appropriate operator's manual for analyzer-specific assay instructions.

Application for serum and plasma

COBAS INTEGRA 400 plus test definition

Measuring mode	Absorbance
Abs. calculation mode	Endpoint
Reaction mode	R1-S-SR
Reaction direction	Increase
Wavelength A/B	583/659 nm
Calc. first/last	33/69
Unit	mmol/L

Pipetting parameters

		Diluent (H ₂ O)
R1	150 μL	
Sample	2 μL	7 μL
SR	50 μL	
Total volume	209 μL	

Calibration

Calibrator	C.f.a.s. Lipids
	Use deionized water as zero calibrator.
Calibration mode	Linear regression
Calibration replicate	Duplicate recommended
Calibration interval	Each lot and as required following quality control procedures

Calibration interval may be extended based on acceptable verification of calibration by the laboratory.

Traceability: This method has been standardized against the beta quantification method as defined in the recommendations in the LDL Cholesterol Method Certification Protocol for Manufacturers.¹⁷

Quality control

Reference range	Precinorm L or PreciControl ClinChem Multi 1
Pathological range	Precipath HDL/LDL-C or PreciControl ClinChem Multi 2
Control interval	24 hours recommended

Control sequence	User defined
Control after calibration	Recommended

For quality control, use control materials as listed in the "Order information" section. In addition, other suitable control material can be used.

The control intervals and limits should be adapted to each laboratory's individual requirements. Values obtained should fall within the defined limits. Each laboratory should establish corrective measures to be taken if values fall outside the defined limits.

Follow the applicable government regulations and local guidelines for quality control.

Calculation

COBAS INTEGRA analyzers automatically calculate the analyte concentration of each sample. For more details, please refer to Data Analysis in the Online Help (COBAS INTEGRA 400 plus analyzer).

Conversion factors:	mmol/L × 38.66 = mg/dL
	mmol/L × 0.3866 = g/L

Limitations - interference

Criterion: Recovery within ± 0.40 mmol/L of initial values of samples ≤ 4.0 mmol/L and within ± 10 % for samples > 4.0 mmol/L.

Icterus:¹⁸ No significant interference up to an I index of 60 for conjugated and unconjugated bilirubin (approximate conjugated/unconjugated bilirubin concentration: 1026 µmol/L or 60 mg/dL).

Hemolysis:¹⁸ No significant interference up to an H index of 1000 (approximate hemoglobin concentration: 621 µmol/L or 1000 mg/dL).

Lipemia (Intralipid):¹⁸ No significant interference up to an L index of 1000. There is poor correlation between the L index (corresponds to turbidity) and triglycerides concentration.

No significant interference from HDL-C (≤ 3.03 mmol/L or ≤ 117 mg/dL), VLDL-C (≤ 3.63 mmol/L or ≤ 140 mg/dL), or chylomicrons (≤ 22.6 mmol/L or ≤ 2000 mg/dL triglycerides).

Drugs: No interference was found at therapeutic concentrations using common drug panels.^{19,20}

Nicotinic acid (Niacin), statins (Simvastatin) and fibrates (Clofibrate) tested at therapeutic concentration ranges did not interfere.

Acetaminophen intoxications are frequently treated with N-acetylcysteine. N-acetylcysteine at the therapeutic concentration when used as an antidote and the acetaminophen metabolite N-acetyl-p-benzoquinone imine (NAPQI) independently may cause falsely low LDL-C results. Venipuncture should be performed prior to the administration of metemazole. Venipuncture immediately after or during the administration of metemazole may lead to falsely low results.

Ascorbic acid up to 28.4 mmol/L (500 mg/dL) does not interfere.

Abnormal liver function affects lipid metabolism; consequently HDL and LDL results are of limited diagnostic value. In some patients with abnormal liver function, the LDL-cholesterol result is significantly negatively biased versus beta quantification results.

EDTA plasma may cause decreased values compared to serum.²¹

In very rare cases, gammopathy, in particular type IgM (Waldenström's macroglobulinemia), may cause unreliable results.²²

For diagnostic purposes, the results should always be assessed in conjunction with the patient's medical history, clinical examination and other findings.

ACTION REQUIRED

Special Wash Programming: The use of special wash steps is mandatory when certain test combinations are run together on COBAS INTEGRA analyzers. Refer to the CLEAN Method Sheet for further instructions and for the latest version of the Extra wash cycle list.

Where required, special wash/carry-over evasion programming must be implemented prior to reporting results with this test.

Limits and ranges

Measuring range

0.10-14.2 mmol/L (3.87-549 mg/dL)

Determine samples having higher concentrations via the rerun function. Dilution of samples via the rerun function is a 1:2 dilution. Results from

samples diluted using the rerun function are automatically multiplied by a factor of 2.

Lower limits of measurement

Limit of Blank, Limit of Detection and Limit of Quantitation

Limit of Blank	= 0.10 mmol/L (3.87 mg/dL)
Limit of Detection	= 0.10 mmol/L (3.87 mg/dL)
Limit of Quantitation	= 0.10 mmol/L (3.87 mg/dL)

The Limit of Blank, Limit of Detection and Limit of Quantitation were determined in accordance with the CLSI (Clinical and Laboratory Standards Institute) EP17-A2 requirements.

The Limit of Blank is the 95th percentile value from n ≥ 60 measurements of analyte-free samples over several independent series. The Limit of Blank corresponds to the concentration below which analyte-free samples are found with a probability of 95 %.

The Limit of Detection is determined based on the Limit of Blank and the standard deviation of low concentration samples.

The Limit of Detection corresponds to the lowest analyte concentration which can be detected (value above the Limit of Blank with a probability of 95 %).

The Limit of Quantitation for LDL-C is 0.10 mmol/L determined in accordance with the guidelines in CLSI document EP17-A2, based on a minimum of 48 determinations, and a total error goal of 10 % calculated using RMS error model.

Expected values²³

Levels in terms of risk for coronary heart disease.

Adult levels:

Optimal	< 2.59 mmol/L (< 100 mg/dL)
Near optimal/above optimal	2.59-3.34 mmol/L (100-129 mg/dL)
Borderline high	3.37-4.12 mmol/L (130-159 mg/dL)
High	4.14-4.89 mmol/L (160-189 mg/dL)
Very high	≥ 4.92 mmol/L (≥ 190 mg/dL)

Risk classification of patients and treatment therapies are described in international guidelines.²⁴

Each laboratory should investigate the transferability of the expected values to its own patient population and if necessary determine its own reference ranges.

Specific performance data

Representative performance data on the COBAS INTEGRA analyzers are given below. Results obtained in individual laboratories may differ.

Precision

Repeatability and intermediate precision were determined using human samples and controls in accordance with the CLSI (Clinical and Laboratory Standards Institute) EP5 requirements (4 aliquots per run, 1 run per day, 21 days). The following results were obtained:

Repeatability	Mean mmol/L (mg/dL)	SD mmol/L (mg/dL)	CV %
Precinorm L	2.56 (99.0)	0.03 (1.2)	1.3
Precipath HDL/LDL-C	4.94 (191)	0.06 (2)	1.3
Human serum 1	0.313 (12.1)	0.008 (0.3)	2.7
Human serum 2	3.02 (117)	0.04 (2)	1.3
Human serum 3	3.65 (141)	0.04 (2)	1.2
Human serum 4	8.20 (317)	0.10 (4)	1.2
Human serum 5	14.0 (541)	0.2 (8)	1.4

Intermediate precision	Mean mmol/L (mg/dL)	SD mmol/L (mg/dL)	CV %
Precinorm L	2.69 (104)	0.06 (2)	2.3
Precipath HDL/LDL-C	5.07 (196)	0.10 (4)	1.9

Intermediate precision	Mean mmol/L (mg/dL)	SD mmol/L (mg/dL)	CV %
Human serum 1	0.294 (11.4)	0.010 (0.4)	3.3
Human serum 2	3.02 (117)	0.06 (2)	2.1
Human serum 3	3.71 (143)	0.07 (3)	2.0
Human serum 4	8.38 (324)	0.17 (7)	2.0
Human serum 5	14.0 (541)	0.3 (12)	2.1

Method comparison

LDL-cholesterol values for human serum samples obtained on a COBAS INTEGRA 400 plus analyzer (y) were compared with those determined using the corresponding reagent on a Roche/Hitachi cobas c 501 analyzer (x).

Sample size (n) = 169

Passing/Bablok ²⁵	Linear regression
$y = 1.007x + 0.012 \text{ mmol/L}$	$y = 1.000x + 0.057 \text{ mmol/L}$
$r = 0.890$	$r = 0.999$

The sample concentrations were between 0.179 and 14.2 mmol/L (6.92 and 549 mg/dL).


References

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A point (period/stop) is always used in this Method Sheet as the decimal separator to mark the border between the integral and the fractional parts of a decimal numeral. Separators for thousands are not used.

Symbols

Roche Diagnostics uses the following symbols and signs in addition to those listed in the ISO 15223-1 standard (for USA: see <https://usdiagnostics.roche.com> for definition of symbols used):

CONTENT	Contents of kit
	Volume after reconstitution or mixing
GTIN	Global Trade Item Number

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