


## LDL-c direct FS\*

### Order Information

**Cat. No.**

1 4131 99 10 921

**Kit size**

 480 (4 x 120)

### Intended Use

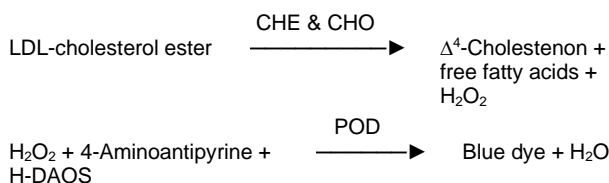
Diagnostic reagent for quantitative in vitro determination of LDL-C (low density lipoprotein cholesterol) in human serum or heparin plasma on automated respons<sup>®</sup>940.

### Summary

Cholesterol is usually obtained from the intestinal absorption of dietary and biliary cholesterol but can also be synthesized de novo in various tissues, predominantly in liver and intestine. An adult on a low-cholesterol diet typically synthesizes about 800 mg of cholesterol per day. Cholesterol is essential for all cells and is used extensively as a major structural component of cell membranes and as substrate for the synthesis of bile acids, vitamin D, and sex hormones (estradiol, progesterone, androsterone and testosterone) [1,2]. Cholesterol is insoluble in water and, therefore, must be transported bound to proteins. Lipoproteins are complex particles with a central core containing cholesterol esters and triglycerides (TG) surrounded by free cholesterol, phospholipids, and apolipoproteins, which facilitate lipoprotein formation and function. Plasma lipoproteins can be divided into different classes based on size, lipid composition, and apolipoproteins; the four major classes are: Chylomicrons, very low-density lipoproteins (VLDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL). Low-density lipoproteins are derived from VLDL and IDL (Intermediate Density Lipoprotein) in plasma and contain a large amount of cholesterol and cholesterol esters. The principal role of LDL is to deliver these two forms of cholesterol to peripheral tissues. At least two-thirds of circulating cholesterol can be found in LDL [1,2]. Evidence from epidemiologic, genetic, and clinical intervention studies have shown that LDL is causal in the process of developing atherosclerotic cardiovascular disease (ASCVD) [3,4]. High LDL-C is one of the major risk factors that contribute to the formation of atherosclerotic plaques within the arterial intima and is strongly associated with coronary heart disease (CHD) and related mortality. Results of recent clinical studies on lowering LDL-C indicate continued benefits at low concentrations. A direct linear relationship between the pharmacological lowering of LDL-C and the relative risk reduction in cardiovascular events has been observed for three different drug classes: statins, ezetimibe and proprotein convertase subtilisin/ kexin type 9 (PCSK9) inhibitors [5]. The standard lipid panel represents a well-established platform to assess risk, but this panel alone may be insufficient and/or misleading. By now, the majority of screening guidelines recommend the measurement of a full lipid profile including total cholesterol (TC), LDL-C, HDL-cholesterol (HDL-C) and TG [5].

### Method

Different methods exist to determine LDL-C. The reference method is ultracentrifugation, which is tedious and technically demanding, therefore, not suitable for routine. A common approach to determine LDL-C in clinical laboratory is the Friedewald calculation, which estimates LDL-C from measurements of TC, triglycerides (TG), and HDL-C but the method only approximates LDL-C and is subject to well-established limitations. At the end of the last century, homogeneous LDL-C methods for fully automated determination have been introduced. Those methods enable direct determination of LDL-cholesterol and show other advantages compared to previously used methods. LDL-c direct FS is a homogeneous method without centrifugation steps for direct measurement of LDL-cholesterol. Block polymer detergents protect HDL, VLDL and chylomicrons in a way that only LDL-cholesterol is selectively determined by an enzymatic cholesterol measurement. [6]



The intensity of the formed dye is directly proportional to the cholesterol concentration and is measured photometrically.

### Reagents

#### Components and Concentrations

<b>R1:</b>	Buffer	pH 6.65	20 mmol/L
	Peroxidase (POD)		≥ 2000 U/L
	N-(2-hydroxy-3-sulfopropyl)-3,5-dimethoxyaniline sodium salt (H-DAOS)		≥ 0.7 mmol/L
<b>R2:</b>	Buffer	pH 8.15	20 mmol/L
	Cholesterol esterase (CHE)		≥ 2000 U/L
	Cholesterol oxidase (CHO)		≥ 2000 U/L
	Peroxidase (POD)		≥ 15000 U/L
	4-Aminoantipyrine (4-AA)		≥ 1.5 mmol/L

### Storage and Stability

Reagents are stable up to the date of expiry indicated on the kit, if stored at 2 – 8°C and contamination is avoided. Do not freeze and protect from light.

The open-vial stability of the reagent is 18 months until expiry date.

### Warnings and Precautions

- Components contained in LDL-c direct FS are classified according to EC regulation 1272/2008 (CLP) as follows:



**⚠ Reagent 1: Warning.** Contains: Mixture of 5-chlorine-2-methyl-2H-isothiazol-3-on and 2-methylen-2H-isothiazol-3-on (3:1). H317 May cause an allergic skin reaction. P280 Wear protective gloves/protective clothing/eye protection. P302+P352 IF ON SKIN: Wash with plenty of water/soap.

- Reagent 2 contains sodium azide (0.95 g/L) as preservative. Do not swallow! Avoid contact with skin and mucous membranes.
- The reagents contain material of biological origin. Handle the product as potentially infectious according to universal precautions and good clinical laboratory practice.
- Artificial lipid mixtures (e.g. Intralipid<sup>®</sup>) may interfere with the test. Serum samples from patients treated with such solutions should not be used.
- Determination of samples from patients with a rare type of Hyperlipoproteinemia (Hyperlipoproteinemia Type III) may lead to false results.
- In very rare cases, samples of patients with gammopathy might give falsified results [7].
- Acetaminophen and metamizole medication leads to falsely low results in patient samples.
- In case of product malfunction or altered appearance that could affect the performance, contact the manufacturer.
- Any serious incident related to the product must be reported to the manufacturer and the competent authority of the Member State where the user and/or patient is located.
- Please refer to the safety data sheets (SDS) and take the necessary precautions for the use of laboratory reagents. For diagnostic purposes, the results should always be assessed with the patient's medical history, clinical examinations and other findings.
- For professional use only.

### Waste Management

Refer to local legal requirements for chemical disposal regulations as stated in the relevant SDS to determine the safe disposal.

Warning: Handle waste as potentially biohazardous material. Dispose of waste according to accepted laboratory instructions and procedures.

### Reagent Preparation

The reagents are ready to use. The bottles are placed directly into the reagent rotor.

### Materials Required

General laboratory equipment

## Specimen

Human serum or heparin plasma

Only use suitable tubes or collection containers for specimen collection and preparation.

When using primary tubes, follow the manufacturer's instructions.

Stability [8]:

1 day	at	20 – 25°C
7 days	at	4 – 8°C
3 months	at	-20°C

Only freeze once. Discard contaminated specimens.

## Calibrators and Controls

DiaSys TruCal Lipid is recommended for calibration. Calibrator values have been made traceable to NIST SRM 1951c Level 2. Use DiaSys TruLab L Level 1 and Level 2 for internal quality control. All target values of the controls are traceable to DiaSys reagent/calibrator system. Quality control must be performed after calibration. Control intervals and limits have to be adapted to the individual requirements of each laboratory. Results must be within the defined ranges. Follow the relevant legal requirements and guidelines. Each laboratory should establish corrective action in case of deviations in control recovery.

	Cat. No.	Kit size
TruCal Lipid	1 3570 99 10 045	3 x 2 mL
TruLab L Level 1	5 9020 99 10 065	3 x 3 mL
TruLab L Level 2	5 9030 99 10 065	3 x 3 mL

## Performance Characteristics

Measuring range from 4 mg/dL up to 500 mg/dL. Linearity  $\leq 30$  mg/dL is given within  $\pm 15\%$ , at  $> 30$  mg/dL within  $\pm 9\%$ . In case of higher concentrations re-measure samples after manual dilution with NaCl solution (9 g/L) or use rerun function.

Limit of detection**	4 mg/dL
Limit of quantitation**	4 mg/dL
Onboard stability	9 weeks
Calibration stability	8 weeks

Interference by	Interferences $\leq 9\%$ up to	Analyte concentration [mg/dL]
<b>Ascorbic acid</b>	500 mg/dL	75.6
	500 mg/dL	169
<b>Bilirubin (conjugated)</b>	60 mg/dL	76.5
	60 mg/dL	161
<b>Bilirubin (unconjugated)</b>	60 mg/dL	76.0
	60 mg/dL	159
<b>Hemolysis</b>	1000 mg/dL	79.6
	1000 mg/dL	164
<b>Lipemia (triglycerides)</b>	1500 mg/dL	92.6
	1500 mg/dL	162
<b>N-acetylcysteine (NAC)</b>	1600 mg/L	73.0
	1600 mg/L	167

For further information on interfering substances, refer to the literature [9,10].

Precision			
Repeatability (n=80)	Sample 1	Sample 2	Sample 3
Mean [mg/dL]	88.6	141	421
CV [%]	0.523	0.869	0.859
Within-laboratory (n=80)	Sample 1	Sample 2	Sample 3
Mean [mg/dL]	88.6	141	421
CV [%]	1.27	1.38	1.27
Reproducibility (n=75, no. of instruments=3)	Sample 1	Sample 2	Sample 3
Mean [mg/dL]	53.6	128	237
CV [%]	2.57	2.10	2.50

Method comparison (n=118)	
Test x	Competitor LDL-cholesterol (cobas c 501)
Test y	DiaSys LDL-c direct FS (respons <sup>®</sup> 940)
Slope	0.997
Intercept	1.28 mg/dL
Coefficient of correlation	0.998

\*\* according to CLSI document EP17-A2, Vol. 32, No. 8

## Conversion Factor

LDL-C [mg/dL] x 0.02586 = LDL-C [mmol/L]

## Reference Range [11]

Desirable	< 100 mg/dL	< 2.59 mmol/L
Above optimal	100 – 129 mg/dL	2.59 – 3.34 mmol/L
Borderline high risk	130 – 159 mg/dL	3.37 – 4.12 mmol/L
High risk	160 – 189 mg/dL	4.14 – 4.90 mmol/L
Very high risk	> 190 mg/dL	> 4.92 mmol/L

Patient risk classification, management and treatment therapies are described in the 2018 AHA/ACC Guideline on the Management of Blood Cholesterol [12].

Each laboratory should check if the reference ranges are transferable to its own patient population and determine own reference ranges if necessary.

## Clinical Interpretation

The lipid guidelines of the European Society of Cardiology (ESC)/European Atherosclerosis Society (EAS) 2019 have set targets for the reduction of low-density lipoproteins (LDL) as follows:

Very high-risk patients:

$\geq 50\%$  LDL-C reduction from baseline and an absolute LDL-C treatment goal of  $< 1.4$  mmol/L ( $< 55$  mg/dL)

High risk patients:

$\geq 50\%$  LDL-C reduction and a LDL-C goal of  $< 1.8$  mmol/L ( $< 70$  mg/dL)

## Literature

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\* Fluid Stable

## LDL-c direct FS

### Application for serum and plasma

Test Details		Test Volumes		Reference Ranges	
Test	: LDLCD			Auto Rerun	<input type="checkbox"/>
Report Name	: LDL-c direct			Online Calibration	<input type="checkbox"/>
Unit	: mg/dL	Decimal Places	: 2	Cuvette Wash	<input type="checkbox"/>
Wavelength-Primary	: 600	Secondary	: 700	Special Diluent	<input type="checkbox"/>
Assay Type	: 2-Point	Curve Type	: Linear	Warn after	: 20
M1 Start	: 24	M1 End	: 24	Reagents Used	: 2
M2 Start	: 57	M2 End	: 57	Reagent R1	: LDLCD R1
Sample Replicates	: 1	Standard Replicates	: 2	Reagent R2	: LDLCD R2
Control Replicates	: 1	Control Interval	: 0	<b>Consumables/Calibrators:</b>	
Reaction Direction	: Increasing	React. Abs. Limit	: 0.0000	Blank /Level 0	: 0
Prozone Limit %	: 0	Prozone Check	: Lower	Calibrator 1	: *
Linearity Limit %	: 0	Delta Abs./Min.	: 0.0000	Calibrator 2	
Technical Minimum	: 4.0000	Technical Maximum	: 500.0000	Calibrator 3	
Y = aX + b    a=	: 1.0000	b=	: 0.0000	Calibrator 4	
Reagent Abs Min	: 0.0000	Reagent Abs Max	: 0.0000	Calibrator 5	

Test Details		Test Volumes		Reference Ranges	
Test	: LDLCD				
Sample Type	: Serum				
<b>Sample Volumes</b>				<b>Sample Types</b>	
Normal	: 3.00 $\mu$ L	Dilution Ratio	: 1 X	<input checked="" type="checkbox"/> Serum <input type="checkbox"/> Urine <input type="checkbox"/> CSF <input checked="" type="checkbox"/> Plasma <input type="checkbox"/> Whole Blood <input type="checkbox"/> Other	
Increase	: 6.00 $\mu$ L	Dilution Ratio	: 1 X		
Decrease	: 3.00 $\mu$ L	Dilution Ratio	: 2 X		
Standard Volume	: 3.00 $\mu$ L				
<b>Reagent Volumes and Stirrer Speed</b>					
RGT-1 Volume	: 180.00 $\mu$ L	R1 Stirrer Speed	: High		
RGT-2 Volume	: 45.00 $\mu$ L	R2 Stirrer Speed	: High		

Test Details		Test Volumes		Reference Ranges	
Test	: LDLCD				
Sample Type	: Serum				
Reference Range	: DEFAULT				
Category	: Male				
<b>Reference Range</b>				<b>Sample Types</b>	
	Lower Limit (mg/dL)	Upper Limit (mg/dL)			
Normal	: #	: #	<input checked="" type="checkbox"/> Serum <input type="checkbox"/> Urine <input type="checkbox"/> CSF <input checked="" type="checkbox"/> Plasma <input type="checkbox"/> Whole Blood <input type="checkbox"/> Other		
Panic	: #	: #			

\* Enter calibrator value  
# Editable by user