

# BILIRUBIN

Total & Direct (Caffeine)

## INTENDED USE

Vitro bilirubin reagent is intended for the in vitro quantitative determination of total and direct bilirubin in serum or plasma on manual system.



## METHOD

Diazo method according to Jendrassik-Graf.<sup>1</sup>

## BACKGROUND

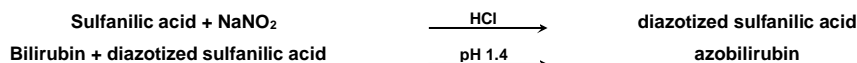
Bilirubin is formed in the reticuloendothelial system during the degradation of aged erythrocytes. The heme portion from hemoglobin and from other-containing proteins is removed, metabolized to bilirubin, and transported as a complex with serum albumin to the liver. This process accounts for about 80% of bilirubin formed daily. Other sources of bilirubin include the breakdown of myoglobin and cytochromes and the catabolism of immature red cells in the bone marrow. In the liver, bilirubin is conjugated with glucuronic acid for solubilization to form conjugated or direct bilirubin for subsequent transport through the bile duct into the digestive tract where it is metabolized by bacteria to a group of products collectively known as stercobilinogen. Total bilirubin is the sum of the conjugated and unconjugated fractions. Pre-hepatic diseases or conditions such as hemolytic disease or liver diseases resulting in impaired entry, transport or conjugation within the liver cause elevation of unconjugated (indirect) bilirubin. Monitoring of bilirubin in newborns, particularly if premature, has special importance since the hepatic handling of bilirubin is immature leading to elevated unconjugated bilirubin. If not bound to albumin, unconjugated bilirubin is able to cross the blood brain barrier more easily, increasing the risk of cerebral damage. Total bilirubin is elevated in conditions causing obstruction of the bile duct, hepatitis, cirrhosis, in hemolytic disorders and several inherited enzyme deficiencies. There is information indicating elevated levels of direct bilirubin in patients with liver or biliary tract disease, even though, total bilirubin levels are normal. Therefore, the greatest diagnostic value of direct bilirubin assays stem from their ability to indicate occult liver disease<sup>4</sup>.

## ASSAY PRINCIPLE

Most methods currently used for the quantitative determination of bilirubin are based on the reaction between bilirubin and diazotized sulfanilic acid. In aqueous solution only the direct bilirubin (conjugated) bilirubin will react in this manner. On the other hand, in order to estimate total bilirubin the unconjugated bilirubin must be freed from attachment to albumin and rendered water soluble. In Malloy-Evelyn method methanol is used while caffeine/sodium benzoate is used in the Jendrassik-Grof method<sup>1</sup>.

The series of reactions involved in the assay system is as follows:

1. Conjugated (direct) bilirubin in the sample react with diazotized sulfanilic acid to form the red colored azobilirubin
2. Conjugated (direct) and unconjugated (indirect) bilirubin in the sample react with diazotized sulfanilic acid to form the red colored azobilirubin in presence of caffeine.



The intensity of the color produced is directly proportional to bilirubin concentration. It is determined by measuring the increase in absorbance at 546 nm.

## EXPECTED VALUES

Direct Bilirubin	
Adults and infants	Up to 0.2 mg/dl Up to 3.4 $\mu\text{mol/l}$
Total Bilirubin	
Adults and infants > 1 month	0.2 – 1.0 mg/dl 3.4 - 17 $\mu\text{mol/l}$
Newborns premature (3-5 days)	10 - 14 mg/dl 171 - 239 $\mu\text{mol/l}$
Newborns (3-5 days)	4.0 – 8.0 mg/dl 68 - 137 $\mu\text{mol/l}$
Newborns (<48 hrs)	6.0 – 10.0 mg/dl 103 - 171 $\mu\text{mol/l}$
Newborns (<24 hrs)	2.0 – 6.0 mg/dl 34 - 103 $\mu\text{mol/l}$

Each laboratory should investigate the transferability of the expected values to its own patient population and if necessary determine its own reference range. For diagnostic purposes, the bilirubin results should always be assessed in conjunction with the patient's medical history, clinical examination, and other findings.

## REAGENTS

<b>R<sub>1</sub> Total Reagent</b>	Sulfanilic acid	30.0	mmol/l
	HCl	0.20	N
	Caffeine	260	mmol/l
	Sodium benzoate	520	mmol/l
<b>R<sub>1</sub> Direct Reagent</b>	Sulfanilic acid	30.0	mmol/l
	HCl	0.20	N
	<b>R<sub>2</sub></b>	Sodium nitrite	30.0

### • Reagent Preparation & Stability

All reagents are stable up to the expiry date given on label when stored at room temperature.

## SPECIMEN

Serum.

For direct bilirubin plasma specimen may be used, but the only accepted anticoagulants are heparin and oxalate.

### • Specimen Preparation & Stability

The specimen of choice is serum. Specimens should be assayed promptly after collection, since direct bilirubin is reportedly unstable<sup>5</sup>. If testing is delayed, specimens should be protected from exposure to light. Bilirubin remains stable in serum samples for 2 days at room temperature, 4 days at 4°C, or 3 months at -20°C, if care is taken to prevent exposure to light<sup>6</sup>.

## PROCEDURE

### Total Bilirubin

Wavelength	546 nm
Cuvette	1 cm light path
Temperature	20-25 °C
Zero adjustment	against specimen blank
Specimen	Serum

	Specimen blank	Specimen
<b>R<sub>1</sub></b>	1 ml	1 ml
<b>R<sub>2</sub></b>	.....	One drop
Specimen	100 $\mu\text{l}$	100 $\mu\text{l}$
Mix well, let stand 10 minutes at room temperature.		

Measure the absorbance of specimen ( $A_{\text{specimen}}$ ) against specimen blank. The color is stable for 30 minutes.

### • Direct Bilirubin

Wavelength	546 nm
Cuvette	1 cm light path
Temperature	20-25 °C
Zero adjustment	against specimen blank
Specimen	Serum

	Specimen blank	Specimen
<b>R<sub>1</sub></b>	1 ml	1 ml
<b>R<sub>2</sub></b>	.....	One drop
Specimen	100 $\mu\text{l}$	100 $\mu\text{l}$
Mix well, let stand for 5 minutes at room temperature		

Measure the absorbance of specimen ( $A_{\text{specimen}}$ ) against specimen blank.

## CALCULATION

Calculate the bilirubin concentration by using the following formulae:

Total Bilirubin Concentration = Specimen absorbance X 13 = mg/dl

Direct Bilirubin Concentration = Specimen absorbance X 13 = mg/dl

## Unit conversion

mg/dl x 17.1 =  $\mu\text{mol/l}$

## QUALITY CONTROL

It is recommended that controls (normal and abnormal) be included in:

- Each set of assays, or
- At least once a shift, or
- When a new bottle of reagent is used, or
- After preventive maintenance is performed or a clinical component is replaced.

Commercially available control material with established bilirubin values may be routinely used for quality control.

Failure to obtain the proper range of values in the assay of control material may indicate:

- Reagent deterioration,
- Instrument malfunction, or
- Procedure errors.

The following corrective actions are recommended in such situations:

- Repeat the same controls.
- If repeated control results are outside the limits, prepare fresh control serum and repeat the test.
- If results on fresh control material still remain outside the limits, then repeat the test with fresh reagent.
- If results are still out of control, contact Vitro Technical Services.

### INTERFERING SUBSTANCES

#### • Anticoagulants:

The only accepted anticoagulants are heparin and oxalate for direct bilirubin.

#### • Drugs:

Young<sup>7</sup> in 1990 has published a comprehensive list of drugs and substances, which may interfere with this assay.

#### • Hemolysis:

Avoid hemolyzed specimens. Even slight hemolysis interferes with the test. Haemoglobin interference is dependent on both analyte and hemoglobin concentration.

The interference becomes decreasingly significant with increasing concentration of total bilirubin.

#### • Lipemia:

Avoid lipemic specimens. Even slight lipemia interferes with the test.

### WARNING & PRECAUTION

- Vitro bilirubin reagent is for in vitro diagnostic use only. Normal precautions exercised in handling laboratory reagents should be followed.
- The reagent and sample volumes may be altered proportionally to accommodate different spectrophotometer requirements.
- Valid results depend on an accurately calibrated instrument, timing, and temperature control.
- All specimens must be protected from light. Serum bilirubin will decrease 50% in one hour if kept at room temperature and at direct sunlight.
- Don't use the reagent if it is turbid.

### PERFORMANCE CHARACTERISTICS

#### Imprecision

Reproducibility was determined using in an internal protocol. The following results were obtained.

Within Run		
I. Total Bilirubin		
Control	Level I	Level II
Number of samples	40	40
Mean (mg/dl)	1.15	4.22
SD (mg/dl)	0.02	0.04
CV (%)	2.02	1.05
II. Direct Bilirubin		
Number of samples	40	40
Mean (mg/dl)	0.78	2.28
SD (mg/dl)	0.015	0.01
CV (%)	1.31	0.65
Between Day		
I. Total Bilirubin		
Control	Level I	Level II
Number of samples	40	40
Mean (mg/dl)	1.15	4.27
SD (mg/dl)	0.02	0.13
CV (%)	1.91	3.2
II. Direct Bilirubin		
Control	Level I	Level II
Number of samples	40	40
Mean (mg/dl)	0.8	2.18
SD (mg/dl)	0.01	0.03
CV (%)	1.63	1.53

#### Method Comparison

Comparison studies were carried out using a similar commercially available Bilirubin reagent as a reference. Serum samples were assayed in parallel and the results compared by least squares regression. The following statistics were obtained.

Number of sample pairs 929  
Range of sample results 0.05-26 mg/dl

Mean of reference results 1.2 mg/dl

Mean of Bilirubin results 1.2 mg/dl

Slope 1.10

Intercept 0.12 mg/dl

Correlation coefficient 1.00

#### Sensitivity

The sensitivity is defined as the change of analytical response ( $\Delta A/\text{min}$ ) per unit change in analyte concentration at a pathlength of 1 cm.

When run as recommended the sensitivity of this assay is 0.01 mg/dl (0.17  $\mu\text{mol/l}$ ).

### LINEARITY










When run as recommended, the assay is linear up to 25 mg/dl (0.428 mmol/l).

If result exceeds 25 mg/dl (0.428 mmol/l), specimen should be diluted with 0.9% NaCl solution and reassayed. Multiply the result by the dilution factor

### BIBLIOGRAPHY

1. **Jendrassik, L and Grof, P (1938):** Biochem. Z. 297: 81.
2. **Balistreri, WF & Shaw, LM (1987):** Liver function. In Tietz NW, ed. Fundamentals of clinical chemistry. 3<sup>rd</sup> ed. Philadelphia: WB Saunders: 729-761.
3. **Tietz, NW. (1976):** Fundamentals of clinical chemistry. W.B. Saunders Co., Philadelphia, p.1028.
4. **Gambino, SR et al., (1967):** JAMA 201: 1047.
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6. **Winkelman, J, Cannon, DC and Jacobs, SL (1974):** Liver function tests, including bile pigments. In: Henry RJ, Cannon DC, Winkelman, JW, eds. Clinical chemistry, principles and technics. 2<sup>nd</sup> ed. New York: Harper & Row; 1042-1079.
7. **Young, DS (1990):** Effects of Drugs on Clinical Laboratory Tests. Third Edition. 1990: 3: 6-12.

### SYMBOL DECLARATION

	Manufacturer
	Consult instructions for use
	Batch code (Lot #)
	Catalog number
	Temperature limitation
	In vitro diagnostic medical device
	Use by
	Caution. Consult instructions
	Keep away from light

### ORDERING INFORMATION

Product	REF	SIZE
Bilirubin T&D	18001	2 x 100 ml

Article # :180 -EN  
Date of Revision :03/2021

