

### Intended Use

For the quantitative determination of Hemoglobin A1c (HbA1c) in human blood. The determination of HbA1c is most commonly performed for the evaluation of glycemic control in diabetes mellitus. HbA1c values provide an indication of glucose levels over the preceding 4-8 weeks. A higher HbA1c value indicates poorer glycemic control. For *in vitro* diagnostic use only.

### Summary and Explanation of Test

Throughout the circulatory life of the red cell, Hemoglobin A1c is formed continuously by the adduction of glucose to the N-terminal of the hemoglobin beta chain. This process, which is non-enzymatic, reflects the average exposure of hemoglobin to glucose over an extended period. In a classical study, Trivelli et al<sup>1</sup> showed Hemoglobin A1c in diabetic subjects to be elevated 2-3 fold over the levels found in normal individuals. Several investigators have recommended that Hemoglobin A1c serve as an indicator of metabolic control of the diabetic, since Hemoglobin A1c levels approach normal values for diabetics in metabolic control.<sup>2,3,4</sup>

Hemoglobin A1c has been defined operationally as the "fast fraction" hemoglobins (HbA<sub>1a</sub>, A<sub>1b</sub>, A<sub>1c</sub>) that elute first during column chromatography with cation-exchange resins. The non-glycosylated hemoglobin, which consists of the bulk of the hemoglobin has been designated HbA<sub>0</sub>. The present procedure utilizes a antigen and antibody reaction to directly determine the concentration of the HbA1c.

### Principle

This method utilizes the interaction of antigen and antibody to directly determine the HbA1c in whole blood. Total hemoglobin and HbA1c have the same unspecific absorption rate to latex particles. When mouse antihuman HbA1c monoclonal antibody is added (R2), latex-HbA1c-mouse anti human HbA1c antibody complex is formed. Agglutination is formed when goat anti-mouse IgG polyclonal antibody interacts with the monoclonal antibody. The amount of agglutination is proportional to the amount of HbA1c absorbed on to the surface of latex particles. The amount of agglutination is measured as absorbance. The HbA1c value is obtained from a calibration curve.

### Reagents

R1: Latex 0.13%, Buffer, stabilizer.

R2: Mouse anti-human HbA1c monoclonal antibody 0.05mg/ml, goat anti-mouse IgG polyclonal antibody 0.08mg/dl, Buffer, stabilizers.

### Reagent Storage

Store all reagents refrigerated at 2-8°C.

### Reagent Preparation

R1, R2 and Hemolysis reagents are supplied as ready to use liquids. Mix gently before use.

### Reagent Deterioration

Alterations in the physical appearance of the reagents or values of control materials outside of the manufacturer's acceptable range may be an indication of reagent instability.

### Instruments

Refer to specific instrument application for suggested settings.

### Precautions

1. This reagent is for *in vitro* diagnostic use only.
2. Not for internal or external use in humans or animals.

### Specimen Collection and Preparation

Special preparation of the patient is unnecessary. Fasting specimens are not required. No special additives or preservatives other than anticoagulants are required. Collect venous blood with EDTA using aseptic technique. All human specimens should be regarded as potentially biohazardous. Therefore, universal precautions should be used in specimen handling (gloves, lab garments, avoid aerosol production, etc.).

To determine HbA1c, a hemolysate must be prepared for each sample:

1. Dispense 1ml Hemolysis Reagent into tubes labeled: Control, Patients, etc. Note: Plastic or glass tubes of appropriate size are acceptable.
2. Place 20ul of well mixed whole blood into the appropriately labeled lyse reagent tube. Mix.

3. Allow to stand for 5 minutes or until complete lysis is evident. Hemolysates may be stored up to 10 days at 2-8°C.

### Storage and Stability

1. All reagents are stable to the expiration date stated on the labels. Do not use the reagents past their expiration date.
2. R1 and R2 are stable for at least one month after opening stored at 2-8°C.
3. Hemoglobin A1c in whole blood collected with EDTA is stable for one week at 2-8°C.<sup>5</sup>

### Interferences

1. Bilirubin to 50mg/dL, ascorbic acid to 50mg/dL, triglycerides to 2000mg/dL, carbamylated Hb to 7.5mmol/L and acetylated Hb to 5.0mmol/L do not interfere in this assay.
2. It has been reported that results may be inconsistent in patients who have the following conditions: opiate addiction, lead-poisoning, alcoholism, ingest large doses of aspirin.<sup>6, 7, 8, 9</sup>
3. It has been reported that elevated levels of HbF may lead to underestimation of HA1c.<sup>10</sup> Also, it has been reported that labile intermediates (Schiff base) are not detected and do not interfere with HbA1c determination by immunoassay.<sup>5</sup>
4. It has been determined that Hemoglobin variants HbA2, HbC and HbS do not interfere with this method.
5. Other very rare variants of hemoglobin (e.g. HbE) have not been assessed.

### Materials Provided

Refer to "Reagents"

### Materials Required but not Provided

1. Pipettes to dispense 20 ul and 1 ml and Test Tubes to hold 1.02 ml.
2. Hemoglobin A1c calibrator set and control set.

### Procedure

#### (Beckman Coulter AU™ 400 On Board Lyse application)

SPECIFIC TEST PARAMETERS									
TEST NUMBER: #	TEST NAME: HbA1c ▾	TYPE: Serum ▾	OPERATIONAL: Yes ▾						
SAMPLE VOL.: 8	DIL. VOL.: 0	PRE-DILUTION RATE: 100							
REAGENTS: R1 VOLUME: 150	DIL. VOL.: 0	MIN. OD	MAX. OD						
R2 VOLUME: 50	DIL. VOL.: 0	L -2.000	H 2.500						
REAGENT OD LIMIT:									
WAVELENGTH: PRI. 660 ▾	SEC. - ▾	FIRST L: -1.000	FIRST H: 2.000						
METHOD: END-1 ▾	LAST L: -1.000		LAST H: 2.000						
REACTION SLOPE: + ▾	DYNAMIC RANGE:								
MEASURING POINT 1: FIRST: 0	LAST: 27	L: #	H: #						
MEASURING POINT 2: FIRST:	LAST:	CORRELATION FACTOR:							
LINEARITY: # %	A: 1.000	B: 0.000							
NO LAG TIME: NO ▾	ON BOARD STABILITY PERIOD: #								

SPECIFIC TEST PARAMETERS										
VALUE FLAG: # ▾	LEVEL L:		LEVEL H:							
NORMAL RANGES:	AGE L	AGE H								
	SEX	YEAR	MONTH	YEAR	MONTH	L	H			
○ 1. # ▾ #	#	#	#	#	#	#	#			
○ 2. # ▾ #	#	#	#	#	#	#	#			
○ 3. # ▾ #	#	#	#	#	#	#	#			
○ 4. # ▾ #	#	#	#	#	#	#	#			
○ 5. # ▾ #	#	#	#	#	#	#	#			
○ 6. # ▾ #	#	#	#	#	#	#	#			
7. NONE SELECTED							#	#		
8. OUT OF RANGE	L	H					#	#		
PANIC VALUE:	#	#	UNIT: %	DECIMAL PLACES: 1						

# Hemoglobin A1c Reagent Set

## CALIBRATION SPECIFIC PARAMETERS

CAL TYPE: 5AB ▽ FORMULA:  $Y=AX3 + Bx2 + Cx + D$  ▽ COUNTS: 2

PROCESS: **CONC.** ▽

	CAL. NO.	OD	CONC.	FAC/OD-L	FAC/OD-H
POINT 1.	#		#	-2.0000	2.5000
POINT 2.	#		#	-2.0000	2.5000
POINT 3.	#		#	-2.0000	2.5000
POINT 4.	#		#	-2.0000	2.5000
POINT 5.	#		#	-2.0000	2.5000
POINT 6.					
POINT 7.					
1-POINT CAL. POINT:	○	WITH CONC-0			
MB TYPE FACTOR:		CALIBRATION STABILITY PERIOD: #			

#: User-Defined

## Limitations

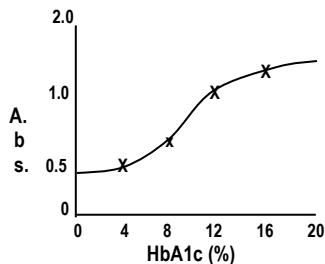
1. This assay should not be used for the diagnosis of diabetes mellitus.
2. Patient specimens should always be assayed using a calibration curve.
3. It has been reported that results may be inconsistent in patients who have the following conditions: opiate addiction, lead-poisoning, alcoholism, ingest large doses of aspirin.<sup>6, 7, 8, 9</sup>
4. It has been reported that elevated levels of HbF may lead to underestimation of HA1c and, that uremia does not interfere with HbA1c determination by immunoassay.<sup>10</sup> It has been reported that labile intermediates (Schiff base) are not detected and therefore, do not interfere with HbA1c determination by immunoassay.<sup>5</sup>
5. It has been determined that Hemoglobin variants HbA2, HbC and HbS do not interfere with this method.
6. Other very rare variants of hemoglobin (e.g. HbE) have not been assessed.

## Quality Control

The reliability of test results should be monitored whenever patient samples are assayed using a standard and quality control materials analyzed in the same manner employed for the unknowns. We suggest the use of commercially available Hemoglobin A1c controls with an assayed range. If controls do not fall into the assayed range patient values from that run should not be reported. The run should be repeated, making sure that all mixing and handling instructions are strictly followed. Linearity of the assay should be verified with a commercial linearity check set, or dilutions of a high specimen, at least every six months.

## Calculations / Results

HbA1c results for the unknowns and controls are determined using the prepared calibration curve. An example curve is illustrated below:



## Expected Values<sup>11</sup>

Recommended Values: less than 6% for a non-diabetic, less than 7% for glycemic control of a person with diabetes.

Each laboratory should establish its own expected values. In using Hemoglobin A1c to monitor diabetic patients, results should be interpreted individually. That is, the patient should be monitored against him or herself. There is a 3-4 week time lag before Hemoglobin A1c reflects changes in blood glucose level.

## Performance

1. Linearity: The Hemoglobin A1c assay range is 2.0%-16.0%.
2. Comparison: A study using 40 human specimens between this Hemoglobin A1c procedure and an automated HPLC procedure (Tosoh) yielded the following results:

Method	HbA1c
N	40
Mean HbA1c %	7.19
Range %	4.70-9.90
Standard Deviation %	1.5
Regression Analysis	$Y=0.983x + 0.140$
Correlation Coefficient	0.989

3. Precision:

Within Run: The within run precision was established by assaying three blood samples following NCCLS protocol EP10 on a Beckman AU400.

	Low	Med	High
N	20	20	20
Mean	3.82	9.48	16.89
SD	0.10	0.12	0.17
CV	2.6	1.2	1.0

4. Sensitivity: Sensitivity was investigated by reading the change in absorbance at 660nm for a saline sample and a whole blood sample with a known concentration. Ten replicates of each sample were performed. The results of this investigation indicated that, on the analyzer used (Beckman Coulter AU400), the HbA1c reagent showed little or no drift on the zero sample. Under the reaction conditions described, a 0.030 absorbance change is approximately equivalent to 1.0% HbA1c.

## References

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