# QuickGel®
# Acid Hemoglobin

**Cat. No. 3419, 3519**

## INTENDED USE

The QuickGel Acid Hemoglobin method is intended for the qualitative determination of abnormal hemoglobins using agar in acidic buffer on the SPIFE 3000 or the QuickGel Chamber systems.

For *In Vitro* Diagnostic Use.

Rx Only

## SUMMARY

Hemoglobins (Hb) are a group of proteins whose chief functions are to transport oxygen from the lungs to the tissues and carbon dioxide in the reverse direction. They are composed of polypeptide chains, called globin, and iron protoporphyrin heme groups. A specific sequence of amino acids constitutes each of four polypeptide chains. Each normal hemoglobin molecule contains one pair of alpha and one pair of non-alpha chains. The non-alpha chains of fetal hemoglobin are called gamma. A minor (3%) hemoglobin fraction called $HbA_2$ contains alpha and delta chains. Two other chains are formed in the embryo.

The major hemoglobin in the erythrocytes of the normal adult is HbA, but there are small amounts of $HbA_2$ and HbF. In addition, over 400 mutant hemoglobins are now known, some of which may cause serious clinical effects, especially in the homozygous state or in combination with another abnormal hemoglobin. Wintrobe[1] divides the abnormalities of hemoglobin synthesis into three groups:

(1) Production of an abnormal protein molecule (e.g. sickle cell anemia)
(2) Reduction in the amount of normal protein synthesis (e.g. thalassemia)
(3) Developmental anomalies (e.g. hereditary persistence of fetal hemoglobin (HPFH)

The two mutant hemoglobins most commonly seen in the United States are HbS and HbC. Hb Lepore, HbE, HbG-Philadelphia, HbD-Los Angeles and HbO-Arab may be seen less frequently.[2]

Electrophoresis is generally considered the best method for separating and identifying hemoglobinopathies. The protocol for hemoglobin electrophoresis involves stepwise use of two systems.[3-8] Initial electrophoresis is performed in alkaline buffers. Cellulose acetate was the major support medium used because it yields rapid separation of HbA, F, S and C and many other mutants with minimal preparation time. However, because of the electrophoretic similarity of many structurally different hemoglobins, the evaluation must be supplemented by citrate agar electrophoresis which measures a property other than electrical charge.

This method is based on the complex interactions of the hemoglobin with an acid electrophoretic buffer and the agar support. The QuickGel Acid Hemoglobin method is a simple procedure requiring minute quantities of hemolysate to provide a screening method for the presence of abnormal hemoglobins such as HbS, HbC and HbF.

## PRINCIPLE

Very small samples of hemolysates prepared from washed, packed cells are automatically applied to the QuickGel Acid Hb gel. The hemoglobins in the sample are separated by electrophoresis using a citrate buffer and are stained with Acid Blue Stain.

## REAGENTS

1. **QuickGel Acid Hemoglobin Gel**
   **Ingredients:** Each gel contains agar in citrate buffer with 0.25% EDTA and thimerosal as a preservative.
   **Preparation for Use:** The gels are ready for use as packaged.
   **Storage and Stability:** The gels should be stored horizontally at room temperature (15 to 30°C) and are stable until the expiration date indicated on the package. The gels must be stored in the protective packaging in which they are shipped. **DO NOT REFRIGERATE OR FREEZE THE GELS.**
   **Signs of Deterioration:** Any of the following conditions may indicate deterioration of the gel: (1) crystalline appearance indicating the agarose has been frozen, (2) cracking and peeling indicating drying of the agarose, (3) bacterial growth indicating contamination, (4) thinning of the gel blocks.
2. **Acid Blue Stain**
   **Ingredients:** When dissolved as directed, the stain contains 0.5% (w/v) acid blue stain.
   **WARNING: FOR IN-VITRO DIAGNOSTIC USE ONLY. DO NOT INGEST.**
   **Preparation for Use:** Dissolve the dry stain (entire contents of vial) in 1 L of 5% glacial acetic acid. Mix thoroughly for 30 minutes.
   **Storage and Stability:** The dry stain should be stored at 15 to 30°C and is stable until the expiration date indicated on the package. The diluted stain is stable six months when stored at 15 to 30°C.
   **Signs of Deterioration:** The diluted stain should be a homogeneous mixture free of precipitate. Discard if precipitate forms. The stain must be replaced after processing ten gels to avoid contamination.
3. **Hemolysate Reagent**
   **Ingredients:** The reagent contains deionized water with 0.005 M EDTA, 0.175% saponin and 0.07% potassium cyanide.
   **WARNING: FOR IN-VITRO DIAGNOSTIC USE ONLY. DO NOT PIPETTE BY MOUTH.** The reagent contains potassium cyanide.
   **Preparation for Use:** The reagent is ready for use as packaged.
   **Storage and Stability:** The reagent should be stored at room temperature (15 to 30°C) and is stable until the expiration date indicated on the vial.
   **Signs of Deterioration:** Discard if solution has precipitates or flocculent.
4. **Citric Acid Destain**
   **Ingredients:** After dissolution, the destain contains 0.3% (w/v) citric acid.
   **WARNING: FOR IN-VITRO DIAGNOSTIC USE. DO NOT INGEST - IRRITANT.**
   **Preparation for Use:** Pour 11 L of deionized water into the Destain vat. Add the entire package of Destain. Mix well until completely dissolved.
   **Storage and Stability:** Store the Destain at 15 to 30°C. It is stable until the expiration date on the package.
   **Signs of Deterioration:** Discard if solution becomes cloudy.

## INSTRUMENT

A SPIFE 3000 or QuickGel Chamber must be used to apply samples, electrophorese, stain, destain and dry the gels. Refer to the appropriate Operator's Manual for detailed instructions.

## SPECIMEN COLLECTION AND HANDLING

**Specimen:** Whole blood collected in EDTA tubes is the specimen of choice.

**Specimen Storage:** If storage is necessary, whole blood and packed cells may be stored up to 1 week at 2 to 8°C. Frozen samples may produce an artifact band between HbF and HbA.

**Specimen Preparation:** Washed, packed cell hemolysates must be prepared for each patient specimen.

a) Whole Blood sample
   1. Centrifuge anticoagulated blood for 10 minutes to separate cells from plasma.
   2. Remove plasma.
   3. Wash packed cells 3 times by resuspending in 5 to 10 volumes of normal saline solution (0.85% NaCl), centrifuging and aspirating supernatant.
   4. After washing the samples, prepare the lysates by mixing 10 µL sample to 100 µL Hemolysate Reagent*. Vortex or shake vigorously for 15 seconds.

b) Control

   AFSC (Cat. No. 5331) 1:2 (1 part control + 1 part Hemolysate Reagent)

   Alternate control preparation 2:3 (2 parts control + 1 part Hemolysate Reagent).*

   *See LIMITATIONS: The relative migration of hemoglobins is concentration dependent.

## PROCEDURE FOR SPIFE 3000

**Materials provided:** The following materials needed for the procedure are contained in the QuickGel Acid Hb Kit (Cat. No. 3419). Individual items are not available.

QuickGel Acid Hemoglobin Gels (10)
Acid Blue Stain (1 vial)
Hemolysate Reagent (25 mL)
Citric Acid Destain (1 pkg)
QuickGel Blotter C (10)
Applicator Blade Assembly (10)

**Materials available but not contained in the kit:**

| ITEM | CAT. NO. |
|---|---|
| SPIFE 3000 Analyzer | 1088 |
| AFSC Hemo Control | 5331 |
| REP Prep | 3100 |
| SPIFE Gel Block Remover | 1115 |
| Applicator Blade Weights | 3387 |
| Disposable Sample Cups | 3369 |
| QuickGel Dispo Cup Tray | 3354 |
| SPIFE QuickGel Electrode | 1111 |
| SPIFE QuickGel Holder | 3358 |
| SPIFE QuickGel Chamber Alignment Guide | 86541003 |
| Chamber Cover | 8JP34012 |
| SPIFE Applicator Blades | 3450 |

**Materials needed but not provided:**

5% glacial acetic acid
0.85% NaCl

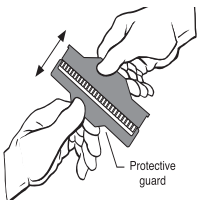
## STEP BY STEP METHOD

### I. Chamber Preparation

1. The SPIFE QuickGel Chamber Alignment Guide must be used to mark the location for gel placement on the chamber floor if not marked previously. It is recommended that the markings be placed directly on the copper floor under the contact sheet.
2. Remove the contact sheet and clean the chamber floor according to instructions in the Operator's Manual.
3. Place the round hole in the guide over the left chamber pin and the obround hole over the right pin.
4. Using an indelible marker, outline the rectangular open area onto the copper floor. Allow marking to dry, and apply another contact sheet.

### II. Sample Preparation

1. Prepare hemolysates of patient specimens and controls as instructed in the "Specimen Preparation" section.
2. Remove one Disposable Applicator Blade from the packaging. If testing more than 10 samples, remove two Applicator Blades from the packaging. Additional blades must be ordered (Cat. No. 3450) if testing 11 to 20 samples per gel. Remove the protective guard from the blades by gently bending the protective piece back and forth until it breaks free.
3. Place the Applicator Blade into the vertical slots numbered 8 in the Applicator Assembly. If using two Applicator Blades, place them into the vertical slots numbered 8 and B.




**NOTE: The Applicator Blade will only fit into the slots in the Applicator Assembly one way; do not try to force the Applicator Blade into the slots.**

4. Place an Applicator Blade Weight on top of each blade assembly.
5. Slide the Disposable Sample Cups into the top row (numbered 1 to 10) of the appropriate cup tray. If testing more than 10 samples, place cups into both rows.
6. Pipette 17 µL of the patient or control hemolysate into cups 1 to 5 and 6 to 10. If testing more than 10 samples, pipette sample into cups 11 to 15 and 16 to 20. Cover the tray until ready to use.

### III. Gel Preparation

1. Carefully open one end of the pouch and remove one gel from the protective packaging. Reseal the pouch with tape to prevent drying of the gel. Remove the gel from the plastic mold and discard the mold.
2. Using a QuickGel Blotter C, gently blot the entire gel using slight fingertip pressure on the blotter. Remove the blotter.
3. Dispense approximately 1 mL of REP Prep onto the left side of the electrophoresis chamber.
4. Place the gel over the REP Prep inside the rectangle of the chamber floor. Hold the gel so that the samples numbered 1 to 10 are turned to the left side of the chamber. Gently lay the gel down on the REP Prep, starting from the left side and ending on the right side. Use lint-free tissue to wipe around the edges of the gel backing to remove excess REP Prep. Make sure the gel remains in place and that no bubbles remain under the gel.
5. Clean the QuickGel Electrodes with deionized water before and after each use. Wipe with a lint-free tissue.
6. Place a QuickGel Electrode on the outside ledge of each gel block inside the magnetic posts. Improper contact between the electrodes and the gel blocks may cause skewed patterns. Close the chamber lid.
7. Press the **TEST SELECT/CONTINUE** button located on the Electrophoresis and Stainer sides of the instrument until the **ACID HEMOGLOBIN** or **QG-ACID HEMOGLOBIN** option appears on the display.

### IV. Electrophoresis/Staining

Using the instructions provided in the appropriate Operator's Manual, set up parameters as follows for the SPIFE 3000:

**A "Dry 1" time of 6 minutes and a "Dry 2" time of 5 minutes are recommended. However, due to variations**

**in environmental conditions, the following ranges are acceptable:**

*** Dry 1 = 5 to 7 minutes**

**** Dry 2 = 3 to 7 minutes**

**Electrophoresis Unit**

| | | | | |
|---|---|---|---|---|
| 1) No Prompt | | | | |
| Load Sample 1 | 00:30 | 20°C | SPD4 | |
| 2) No Prompt | | | | |
| Apply Sample 1 | 00:30 | 20°C | SPD4 | LOC 1 |
| 3) To Continue, (Continue) | | | | |
| Electrophoresis 1 | 25:00 | 20°C | 120V | 40 mA |
| 4) Remove gel blocks, (continue) | | | | |
| Dry 1 | *6:00 | 62°C | | |
| 5) No prompt | | | | |
| END OF TEST | | | | |

**Stainer Unit**

| | | | |
|---|---|---|---|
| 1) No Prompt | | | |
| Stain 1 | 4:00 | REC=OFF | VALVE=3 |
| 2) No Prompt | | | |
| Destain 1 | 1:00 | REC=ON | VALVE=2 |
| 3) No Prompt | | | |
| Dry 1 | *6:00 | 63°C | |
| 4) No Prompt | | | |
| Destain 2 | 2:00 | REC=ON | VALVE=2 |
| 5) No Prompt | | | |
| Destain 3 | 2:00 | REC=ON | VALVE=2 |
| 6) No Prompt | | | |
| Dry 2 | **5:00 | 63°C | |
| 7) No Prompt | | | |
| END OF TEST | | | |

1. Open the chamber lid and place the Cup Tray with samples on the SPIFE 3000. Align the holes in the tray with the pins on the instrument. Close the chamber lid.
2. With the appropriate test name on the display, press the **START/STOP** button. An option to either begin the test or skip the operation will be presented. Press **START/STOP** to begin. The SPIFE 3000 will apply the samples and beep. Dispose of blades and cups as biohazardous waste.
3. Open the chamber lid and insert a Chamber Cover in the grooves of the chamber. Close the chamber lid.
4. Press **TEST SELECT/CONTINUE** to start electrophoresis.

**V. Visualization**

1. After electrophoresis is complete, open the chamber lid and remove the Chamber Cover. Use the Gel Block Remover to remove the gel blocks. Place one electrode across each end of the gel to prevent curling during drying. Rinse the Chamber Cover before reuse.
2. Close the chamber lid and press the **TEST SELECT/ CONTINUE** button to dry the gel.
3. After the gel has been dried, carefully remove the gel from the electrophoresis chamber.
4. Remove the SPIFE QuickGel Holder from the stainer chamber. While holding the gel agarose side down, slide one side of the gel backing under one of the metal bars. Bend the gel backing so that the gel is bowed, and slip the other side under the other metal bar. The two small notches in the backing must fit over the small pins to secure the gel to the holder.
5. Place the SPIFE QuickGel Holder with the attached gel facing backwards into the stainer chamber.
6. With the appropriate test name on the display, press the **START/STOP** button. An option to either begin the test or skip the operation will be presented. Press **START/STOP** to begin. The instrument will stain, destain and dry the gel.
7. When the process is completed, the instrument will beep. Carefully remove the SPIFE QuickGel Holder from the stainer because the metal piece on the holder will be hot. Take the gel off of the holder and replace the holder. Refer to **Evaluation of the Hemoglobin Bands.**

## PROCEDURE FOR QuickGel® CHAMBER

The following instructions are for using the QuickGel Chamber (Cat. No. 1284) for electrophoresis.

**Materials Provided:** The following materials needed for the procedure are contained in the QuickGel Acid Hemoglobin Kit (Cat. No. 3519). Individual items are not available.

QuickGel Acid Hemoglobin Gels (10)
Acid Blue Stain (1 vial)
QuickGel Blotter C (10)
Citric Acid Destain (1 pkg)
Hemolysate Reagent (25 mL)
QuickGel Applicator Blades (10)
QuickGel Dispo Sample Cups (10)

**Materials available but not contained in the kit:**

| ITEM | CAT. NO. |
|---|---|
| AFSC Hemo Control | 5331 |
| REP Prep | 3100 |
| QuickGel Chamber | 1284 |
| QuickGel Applicator | 1265 |
| QuickGel Applicator Base | 1266 |
| QuickGel Applicator Weights | 1267 |
| QuickGel Dispo Cup Tray | 1268 |
| QuickGel Dispo Sample Cups | 1269 |
| QuickGel Applicator Blades | 1270 |
| QuickGel Gel Block Remover | 1262 |
| QuickGel Applicator Kit (Includes Applicator, Applicator Base, Weights and Cup Tray) | 1274 |

**Materials needed but not provided:**

Power Supply capable of providing at least 140 Volts.
5% glacial acetic acid
0.85% NaCl

## STEP BY STEP METHOD

**I. Chamber Preparation**

1. The QuickGel Chamber must be plugged into a power supply. Set a timer for *23:00 minutes and the power at 140 Volts. ***An electrophoresis time of 21 to 25 minutes is acceptable.**
2. Snap the Electrophoresis Lid into place on the chamber.
3. Ensure that the chamber floor is cool (room temperature) before starting the test.

**II. Sample Preparation**

1. Prepare hemolysates of patient specimens and controls as instructed in the “Specimen Preparation” section.
2. Slide the appropriate number of QuickGel Disposable Sample Cups into either or both Row B and Row D of the Dispo Cup Tray. Pipette 17 µL of the patient or control hemolysate into the Sample Cups and cover tray until ready to use. When ready, place the Dispo Cup Tray into the Applicator Base.

**III. Gel Preparation**

1. Carefully cut open one end of the gel pouch. Remove one gel from the protective packaging. Fold and tape the open end of the pouch to prevent drying of the remaining gel. Remove the gel to be used from the plastic mold and discard the mold.
2. Dispense approximately 1 mL of REP Prep onto the cathode (left) side of the electrophoresis chamber.

3. Hold the gel so that the samples numbered 1 to 10 are turned to the left side of the chamber. Place the left notch of the gel so that it fits the left pin of the chamber floor and gently roll the gel to the right side fitting the right notch to the right pin of the chamber floor. Use a lint free tissue to wipe around the edges of the gel backing to remove any excess REP Prep. Make sure that no bubbles remain under the gel.
4. Using a QuickGel Blotter C, gently blot the entire gel using slight fingertip pressure on the blotter. Remove the blotter.

**IV. Sample Application**

1. Remove one QuickGel Applicator Blade from the packaging. If testing more than 10 samples, remove two Applicator Blades from the packaging. Additional blades must be ordered (Cat. No. 1270) if testing 11 to 20 samples per gel.
2. Place an Applicator Weight on top of each Applicator Blade. If using two Applicator Blades, place them into the vertical slots B and D of the Applicator. If using only one blade, it should be placed into the slot corresponding to cup placement.
3. While holding the white Applicator Knob up, place the Applicator into the designated slots on the Applicator Base aligning the small red dots on the Applicator with those on the Base.
4. Slowly lower the Applicator Knob allowing the blades to enter the sample cups and immediately start a timer for 30 seconds.
5. After 30 seconds, lift the Applicator Knob and immediately place the Applicator into the slot on the chamber floor, aligning the red dots.
6. Slowly lower the Applicator Knob to apply sample to the gel. Set a timer for 30 seconds.
7. After the 30 seconds application, lift the Applicator Knob and remove the Applicator from the chamber.
8. Close the lid, press the power switch to turn on the chamber.

**V. Electrophoresis and Staining**

1. Electrophorese the gel for *23:00 minutes at 140 Volts.
2. Turn off the Power Supply and the QuickGel Chamber.
3. Using the Gel Block Remover, remove the two gel blocks from the gel. Use a lint free tissue to wipe around the edges of the gel backing to remove any excess moisture.
4. Replace the Electrophoresis Lid with the Drying Lid. Clean the two electrodes on the Electrophoresis Lid with deionized water after each use. Wipe with a lint-free tissue. Close the Drying Lid.
5. Dry the gel for 15 minutes or until dry by turning on only the QuickGel Chamber. After drying, turn the Chamber off.
6. Fill a Staining Dish with prepared stain. Fill another container with Destain solution.
7. Place the gel into the stain for 4 minutes. Remove the gel from the stain and allow it to drain on a blotter.
8. Place the gel into Destain Solution for 1 minute, using a gentle alternately rocking and swirling technique. Remove the gel and allow it to drain on a blotter.
9. Carefully place the gel in the chamber and close the Drying Lid.
10. Turn on the QuickGel chamber and dry the gel for 15 minutes or until dry.
11. Remove the gel from the chamber. Place it in the Destain Solution for two more consecutive rinses at 2 minutes each. Again use a gentle rocking and swirling technique. The gel background should be completely clear. Tap the gel to remove the excess Destain Solution.
12. Ensure that the chamber floor is clean. Replace the gel onto the QuickGel Chamber floor.
13. Turn on the QuickGel chamber and dry the gel for 5 minutes or until dry. When drying is complete, turn off Chamber and remove the gel.

**Evaluation of the Hemoglobin Bands**

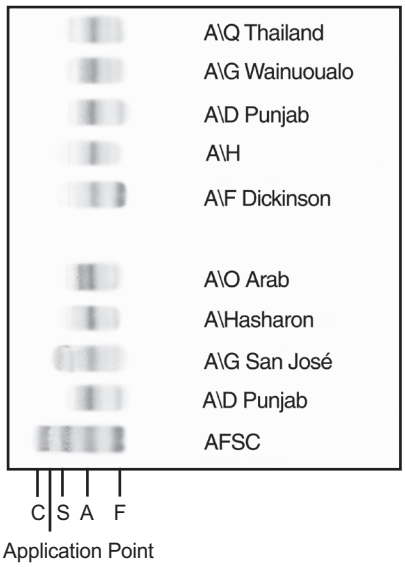
The hemoglobin gels should be inspected visually for the presence of abnormal hemoglobin bands. Glycated hemoglobin migrates with HbF. The Helena AFSC Hemo Control provides a marker for band identification.

**Stability of End Product:** The dried gels are stable for an indefinite period of time.

**Quality Control:** The Helena AFSC Hemo Control (Cat. No. 5331) should be run on each QuickGel Acid Hemoglobin Gel. The control verifies all phases of the procedure and acts as a marker to aid in the identification of the hemoglobins in the unknown samples.

## RESULTS

Figure 1 illustrates the electrophoretic mobility of bands on the QuickGel Acid Hemoglobin Gel.




## LIMITATIONS

Some abnormal hemoglobins have similar electrophoretic mobilities and must be differentiated by other methodologies.

Further testing required:

1. Globin chain analysis (both acid and alkaline) and structural studies may be necessary in order to positively identify some of the more rare hemoglobins.
2. *The relative migration of a hemoglobin variant is concentration dependent, with variants at a lower concentration (g/dL) migrating further from the application point. The migration difference between control vs. sample can be mitigated by either preparing the hemoglobin control at a higher concentration (two parts control to one part hemolysate) or diluting the patient sample with hemolysate to normalize the concentration between the two.

## REFERENCE VALUES

At birth, the majority of hemoglobin in the erythrocytes of the normal individual is fetal hemoglobin, HbF. Some of the major adult hemoglobin, HbA, and a small amount of $HbA_2$ are also present. At the end of the first year of life and through adulthood, the major hemoglobin present is HbA with up to 3.5% $HbA_2$ and less than 2% HbF.

## INTERPRETATION OF RESULTS

Most hemoglobin variants cause no discernible clinical symptoms, so are of interest primarily to research scientists. Variants are clinically important when their presence leads to sickling disorders, thalassemia syndromes, life long cyanosis, hemolytic anemias, erythrocytosis or if the heterozygote is of sufficient prevalence to warrant genetic counseling. The combinations of HbSS, HbSD-Los Angeles and HbSO-Arab lead to serious sickling disorders.[2] Several variants including HbH, E-Fort Worth and Lepore cause a thalassemic blood picture.[2] The two variant hemoglobins of greatest importance in the U.S., in terms of frequency and pathology, are HbS and HbC.[2] Sickle cell anemia (HbSS) is a cruel and lethal disease. It first manifests itself at about 5 to 6 months of age. The clinical course presents agonizing episodes of pain and temperature elevations with anemia, listlessness, lethargy and infarct in virtually all organs of the body. The individual with homozygous HbCC suffers mild hemolytic anemia which is attributed to the precipitation or crystallization of HbC within the erythrocytes. Cases of HbSC disease are characterized by hemolytic anemia that is milder than sickle-cell anemia.

The thalassemias are a group of hemoglobin disorders characterized by hypochromia and microcytosis due to the diminished synthesis of one globin chain (the $\alpha$ or $\beta$) while synthesis of the other chain proceeds normally.[9,10] This unbalanced synthesis results in unstable globin chains. These precipitate within the red cell, forming inclusion bodies that shorten the life span of the cell. In $\alpha$-thalassemias the $\alpha$-chains are diminished or absent, and in the $\beta$-thalassemia the $\beta$-chains are affected. Another quantitative disorder of hemoglobin synthesis, hereditary persistent fetal hemoglobin (HPFH), represents a genetic failure of the mechanisms that turn off gamma chain synthesis at about four months after birth which results in a continued high percentage of HbF. It is a more benign condition than the true thalassemias and persons homozygous for HPFH have normal development, are asymptomatic and have no anemia.[10]

The most common hemoglobin abnormalities:

Sickle Cell Trait

This is a heterozygous state showing HbA and HbS and a normal amount of $HbA_2$ on cellulose acetate. Results on citrate agar show hemoglobins in the HbA and HbS migratory positions (zones).

Sickle Cell Anemia

This is a homozygous state showing almost exclusively HbS, although a small amount of HbF may also be present.

Sickle-C Disease

This is a heterozygous state demonstrating HbS and HbC.

Sickle Cell-Thalassemia Disease

This condition shows HbA, HbF, HbS and $HbA_2$.

In Sickle Cell $\beta^{\circ}$-Thalassemia HbA is absent.

In Sickle Cell $\beta^{+}$-Thalassemia HbA is present in reduced quantities.

Thalassemia-C Disease

This condition shows HbA, HbF and HbC.

C Disease

This is a homozygous state showing almost exclusively HbC.

Thalassemia Major

This condition shows HbF, HbA and $HbA_2$.

## BIBLIOGRAPHY


1. Wintrobe, Maxwell M. Clinical Hematology, 6th Edition, LeFebiger, Philadelphia, 1967.
2. Fairbanks, V.F., Diagnostic Medicine, Nov/Dec., 53-58, 1980.
3. Schneider, R.G., et al., Laboratory Identification of the Hemoglobins, Lab Management, August, 29-43, 1981.
4. Center for Disease Control, Laboratory Methods for Detecting Hemoglobinopathies, U.S. Department of Health and Human Services/Public Health Service, 1984.
5. Schneider, R.G., Methods for Detection of Hemoglobin Variants and Hemoglobinopathies in the Routine Clinical Laboratory, CRC Critical Reviews in Clinical Laboratory Sciences, 1978.
6. Schneider, R.G., et al., Abnormal Hemoglobins in a Quarter Million People, Blood, 48(5):629-637, 1976.
7. Huisman, T.H.J. and Schroeder, W.A., New Aspects of the Structure, Function, and Synthesis of Hemoglobins, CRC Press, Cleveland, 1971.
8. Schmidt, R.M., et al, The Detection of Hemoglobinopathies, CRC Press, Cleveland 1974.
9. Weatherall, D.J. and Clegg, J.B., The Thalassaemia Syndromes, Blackwell Scientific Publications, Oxford, 1972.
10. Lehman, H. and Huntsman, R.G., Man's Haemoglobins, J.B. Lippincott Co., Philadelphia, 1974.


For Sales, Technical and Order Information and Service Assistance, call 800-231-5663 toll free.

HELENA LABORATORIES
1530 Lindbergh Dr.
Beaumont, Texas 77707 USA

Shaded areas indicate that text has been modified, added or deleted.

Pro. 191
7/23(10)