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Title: Primary Sample Manual - Haematology

***Changes made since previous version:** Missing unit for HCT has now been added. Deleted Retic Count reference ranges as they were duplicated on page 15.*

***Note**: Please refer to the document record on QPulse for the revision history of this document.*

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FULL BLOOD COUNT (FBC)

The Full Blood Count (FBC) is one of the most commonly requested laboratory tests, which focusses on the assessment of the cellular composition of peripheral whole blood. FBC results encompass the enumeration and specific characteristics of erythrocytes, leukocytes and platelets. Test results may provide insights into various clinical conditions, including anaemia, inflammatory response, specific neoplasms and bone marrow related disorders. The interpretation of FBC parameters should be considered in relation to the patient's overall health, medical history, and specific presentation.

Preparation of patients: There is no physical preparation for the FBC test.
Precautions: Frozen, clotted, or grossly haemolysed samples cannot be analysed.

Accredited	**Yes**
Method	Sysmex XN series SOP: BH18, H62
Sample Requirements	Tube Type: Whole Blood K2/K3 EDTA anticoagulated. Temperature: + 2-8ºC Miscellanous: N/A
Turn Around Time – Setup Schedule	24h Mon ✓ | Tue ✓ | Wed ✓ | Thu ✓ | Fri ✓ | Sat ✓
Stability	2 days @ + 2-8ºC
Rejection Criteria	Clotted sample, insufficient sample, grossly haemolysed sample, centrifuged specimens, unlabelled sample, mismatched patient ID, sample over 2 days of collection, wrong sample tube (EDTA tube only).

Haematological Values for Normal Adults

Parameter	Men	Women
Red blood cell count (x10^12/l)	5.0 ± 0.5	4.3 ± 0.5
Haemoglobin concentration (g/dl)	15.0 ± 2.0	13.5 ± 1.5
Packed cell volume (PCV)/ HCT (L/L)	0.45 ± 0.05	0.41 ± 0.05
Mean cell volume (MCV) (fl)	92 ± 9	
Mean cell haemoglobin (MCH) (pg)	29.5 ± 2.5	
Mean cell haemoglobin concentration (MCHC) (g/d.l)	33.0 ± 1.5	
Platelet count (x10^9/l)	280 ± 130	
White blood cell count (x10^9/l)	4.0–10.0	
Neutrophils (x10^9/l)	2.0–7.0 (40-80%)	
Lymphocytes (x10^9/l)	1.0–3.0 (20-40%)	
Monocytes (x10^9/l)	0.2–1.0 (2-10%)	
Eosinophils (x10^9/l)	0.02–0.5 (1-6%)	
Basophils (x10^9/l)	0.01–0.08 (<1-2%)	

Age	RBC ($x10^{12}$/l)	Hb (g/dl)	Hct (l/l)	MCV (fl)	MCH (pg)	MCHC (g/dl)	Reticulocytes ($x10^9$/l)	WBC ($x10^9$/l)	Neutrophils ($x10^9$/l)	Lymphocytes ($x10^9$/l)	Monocytes ($x10^9$/l)	Eosinophils ($x10^9$/l)	Platelets ($x10^9$/l)
Birth	6.0 ± 1.0	18.0 ± 4.0	0.60 ± 0.15	110 ± 10	34 ± 3	33.0 ± 3.0	120–400	18 ± 8	4–14	3–8	0.5–2.0	0.1–1.0	100–450
Day 3	5.3 ± 1.3	18.0 ± 3.0	0.56 ± 0.11	105 ± 13	34 ± 3	33.0 ± 4.0	50–350	15 ± 8	3–5	2–8	0.5–1.0	0.1–2.0	210–500
Day 7	5.1 ± 1.2	17.5 ± 4.0	0.54 ± 0.12	107 ± 19	34 ± 3	33.0 ± 5.0	50–100	14 ± 8	3–6	3–9	0.1–1.7	0.1–0.8	160–500
Day 14	4.9 ± 1.3	16.5 ± 4.0	0.51 ± 0.2	105 ± 19	34 ± 3	33.0 ± 5.0	50-100	14 ± 8	3–7	3–9	0.1–1.7	0.1–0.9	170–500
1 Month	4.2 ± 1.2	14.0 ± 2.5	0.43 ± 0.10	104 ± 12	33 ± 3	33.0 ± 4.0	20–60	12 ± 7	3–9	3–16	0.3–1.0	0.2–1.0	200–500
2 Months	3.7 ± 0.6	11.2± 1.8	0.35 ± 0.07	95 ± 8	30 ± 3	32.0 ± 3.5	30–50	10 ± 5	1.0–5	4–10	0.4–1.2	0.1–1.0	210–650
3–6 Months	4.7 ± 0.6	12.6 ± 1.5	0.35 ± 0.05	76 ± 8	27 ± 3	33.0 ± 3.0	40–100	12 ± 6	1–6	4–12	0.2–1.2	0.1–1.0	200–550

Age	RBC ($x10^{12}$/l)	Hb (g/dl)	Hct (l/l)	MCV (fl)	MCH (pg)	MCHC (g/dl)	Reticulocytes ($x10^9$/l)	WBC ($x10^9$/l)	Neutrophils ($x10^9$/l)	Lymphocytes ($x10^9$/l)	Monocytes ($x10^9$/l)	Eosinophils ($x10^9$/l)	Platelets ($x10^9$/l)
1 Year	4.5 ± 0.6	12.6 ± 1.5	0.34 ± 0.04	78 ± 6	27 ± 2	34.0 ± 2.0	30–100	11 ± 5	1–7	3.5–11	0.2–1.0	0.1–1.0	200–550
2–6 Years	4.6 ± 0.6	12.5 ± 1.5	0.37 ± 0.03	81 ± 6	27 ± 3	34.0 ± 3.0	30–100	10 ± 5	1.5–8	6-9	0.2–1.0	0.1–1.0	200–490
6–12 Years	4.6 ± 0.6	13.5 ± 2.0	0.40 ± 0.05	86 ± 9	29 ± 4	34.0 ± 3.0	30–100	9 ± 4	2–8	1-5	0.2–1.0	0.1–1.0	170–450

The new paediatric full blood count reference ranges (<12 years old), including the age groups have been extracted from Dacie and Lewis Practical Haematology (12th edition) By B. J. Bain, I. Bates and M. A. Laffan, Elsevier, London, 2017.

The Haematological Values for Normal Adults (Applicable from Age 12 and above) have been extracted from Dacie and Lewis Practical Haematology (12th edition) By B. J. Bain, I. Bates and M. A. Laffan, Elsevier, London, 2017.

Range of Basophils in Healthy Individuals

According to *Dacie and Lewis Practical Haematology, 12th Edition*, the normal basophil count in healthy individuals falls within the range of 0.01–0.08 × 10^9/l, as reported by Gilbert and Ornstein. Their findings, based on a 95% distribution among normal subjects, indicate no significant age or gender differences in basophil levels. However, serial counts—repeated measurements over time—have shown that lower basophil levels may occur during ovulation

ERYTHROCYTE SEDIMENTATION RATE (ESR)

The Erythrocyte Sedimentation Rate (ESR) is a blood test which measures the rate at which red blood cells (erythrocytes) settle at the bottom of a tube over a specific period, usually 1 hour. The ESR is affected by the presence of plasma proteins, such as fibrinogen, IgM, alpha2-macroglobulin and other acute phase proteins, which encourage erythrocyte agglomeration. It is important to note that while ESR is a useful tool, it is not specific to any particular disease. A high ESR can be seen in various conditions, and additional tests are often needed to achieve an accurate diagnosis. The ESR, therefore, forms a part of a broader spectrum of diagnostic tools which healthcare professions use to assess and monitor inflammatory and infectious disease.

Preparation of patients: There is no physical preparation for the ESR test.

Precautions: The ESR should not be used to screen healthy persons for disease.

Accredited	**Yes**
Method	Haematology – Capillary photometric-kinetic technology using Alifax Test 1. SOP: H09, H62
Sample Requirements	Tube Type: Whole Blood K2/K3 EDTA anticoagulated. Temperature: + 2-8ºC Miscellanous: N/A
Turn Around Time – Setup Schedule	Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓ Sat ✓ 24h
Stability	2 days @ + 2-8ºC
Rejection Criteria	Clotted sample, insufficient sample, unlabelled sample, mismatched patient ID, sample over 2 days of collection, wrong sample tube (EDTA tube only).
Units - Reference Ranges	mm/hr

ESR Ref Ranges	Male	Female
>50 Years	0 - 12	0 - 15
<50 Years	0 - 8	0 - 10

Source	Reference ranges for the ESR assay are derived in house. Data was obtained from a clinical normal population and statistics generated using the Graph Pad statistics module. Data was analysed for Gaussian distribution and reference ranges derived using either parametric or non-parametric statistics.

INFECTIOUS MONONUCLEOSIS

Infectious mononucleosis (glandular fever) is an acute infectious disease caused by the Epstein-Barr virus and primarily affects lymphoid tissue. It is characterized by the appearance of enlarged and often tender lymph nodes, enlarged spleen, and abnormal lymphocytes in the blood. Patients usually, but not always, develop a transient heterophile antibody response.
The detection of heterophile antibodies of Infectious Mononucleosis by the agglutination of sheep red cells was first reported by Paul and Bunnel in 1932[1]. Subsequent work identified the need for differential absorption of sera to remove non-infectious mononucleosis heterophile antibodies. Fetcher and Woolfolk showed
that antigens obtained from bovine erythrocytes were more effective than those antigens obtained from either sheep or horse erythrocytes.

[1]Israëls MC. Infectious Mononucleosis and Monocytic Leukaemia. Br Med J. 1937 Mar 20;1(3976):601-624.3. PMID: 20780547; PMCID: PMC2088424.

Preparation of patients: There is no physical preparation for the infectious mononucleosis test.

Precautions: IgG and IgM values obtained with different manufacturers' assay methods may not be used interchangeably. The magnitude of the reported IgG or IgM level cannot be correlated to an endpoint titre.

Accredited	No
Method	Haematology- Immunoassay SOP: H20, H62
Sample Requirements	Tube Type: Whole blood serum or plasma Temperature: + 2-8ºC Miscellaneous: N/A
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓
Stability	3 days @ + 2-8ºC
Rejection Criteria	Insufficient sample, unlabelled sample, mismatched patient ID, sample over 3 days of collection, wrong sample tube.
Result	Positive or negative
Source	'Clearview IM II' Kit Insert, Alere group.

SAMPLE REQUIREMENTS FOR COAGULATION TESTS

PROCEDURE

Sample Requirements and Collection

- Patients should be relaxed pre-venepuncture. Excessive stress and exercise will increase FVIII, vWF antigen and fibrinolysis. Venous occlusion should be avoided.
- Difficult venepuncture with trauma may lead to platelet activation with release of PF4 from alpha granules.
- Venous blood should be collected into coagulation tubes containing Sodium Citrate 3.2%, 0.105M.
- Specimens must be mixed immediately post venepuncture to avoid clot activation, by GENTLY inverting the tubes 5 to 10 times.
- The ratio of whole blood to anticoagulant is crucial to clotting times. A target blood to anticoagulant ratio of 9:1 is optimal. Under- or over- filled specimens will not be processed this can adversely affect results.
- Any warfarin treatment should be mentioned on the request form.
- Sample rejection Criteria: Clotted sample, grossly hemolyzed sample, underfilled/overfilled specimen, unlabeled sample, mismatched patient ID, aged samples, wrong sample tube (citrate tube only).

Transportation and Storage

- PT/INR specimens should be transported to the laboratory at room temperature.
- Coagulation specimens should ideally be analysed within 4 hours of collection. Where this is not possible, centrifuge specimens at room temperature (RT) @ 1500RCF for at least 15 minutes, and then carefully remove the plasma from the cells, transfer to a fresh plastic plain tube and freeze at -20^{o}C.
- Non-frozen coagulation specimens should be transported at RT ASAP to avoid deterioration of labile factors V and VIII.
- Collection of blood through intravenous lines that have been previously flushed with heparin should be avoided. In the event blood is drawn from an indwelling catheter, the line should be flushed with 5ml of saline, and the first 5ml of blood or 6 times the line volume be drawn off and discarded before coagulation tube is filled.
- Effect of freezing on Coagulation Specimens.

  A 14days in-house study on the effect of freezing, on coagulation specimens at -20^{o}C, showed that there was negligible and clinically non-significant effect of freezing on coagulation specimen results. Therefore frozen citrated coagulation samples are stable for 14 days at -20^{o}C, post centrifugation. This study is available in-house for reference.

FIBRINOGEN (CLAUSS METHOD)

Clauss developed a simple method for the quantitative determination of Fibrinogen by measuring the clotting time of dilute plasma after the addition of Thrombin. The clotting time is inversely proportional to the Fibrinogen concentration. The clotting time obtained in this manner is then compared with that of a standardised Fibrinogen preparation. The plasma must be diluted to provide a low level of potential inhibitors, e.g. FDP's and Heparin. A strong Thrombin solution is utilised in order to ensure that the clotting time is independent of Thrombin concentration over a broad range.

Preparation of patient: Patients should be relaxed pre-venepuncture. Excessive stress and exercise will increase Factor VIII, vWF antigen and fibrinolysis. Veno-occlusion should be avoided.

Precautions: This test is not recommended for patients with active bleeding, acute infection or illness, or in those patients who have received blood transfusions within four weeks. Drugs that may increase Fibrinogen levels include Oestrogens and oral contraceptives. Drugs that may cause decreased levels include anabolic steroids, androgens, Phenobarbital, Urokinase, Streptokinase, and Valproic acid.

Accredited	Yes
Method	Stago Compact Max, SOP: H60, H62
Sample Requirements	Tube Type: Sodium Citrate Plasma 3.2% 0.105M **Temperature**: 4 hours Room temperature or 2 weeks @ -20ºC. If an expected delay in transporting samples to the laboratory samples should be centrifuge, separated & send as frozen within 4 hours of blood collection. Miscellaneous: N/A **Collection: Cf. Special requirement for Coagulation test**
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓
Stability	Whole blood: 4 hours, unless centrifuged at room temperature at 1500 RCF, separated and the plasma frozen. Can only be thawed once. If an expected delay from collection time to receipt in the laboratory, suggest send frozen sample. Ref: CLSI H21-A5)
Rejection Criteria	Clotted sample, grossly hemolyzed sample, underfilled/overfilled specimen, unlabeled sample, mismatched patient ID, aged samples (>4 hours), wrong sample tube (citrate tube only).
Units - Reference Ranges	1.8 – 3.6 g/L
Source	Dacie and Lewis, Practical Haematology 12th edition, 2017

PROTHROMBIN TIME (PT)

The PT test (scientific name- tissue activated induced coagulation time) has been in clinical practice for over 60 years. The first standardised one-stage PT test was devolved by Dr. Armand Quick in 1932. It has now become the basic coagulation screening test for the diagnosis of acquired and congenital deficiencies of clotting factors in the Extrinsic pathway. The assay was designed to measure a coagulation defect before the introduction of oral anticoagulants, and later adapted for monitoring their dosage. The PT reflects changes in the Extrinsic factors II, VII and X, three of the principle clotting factors depressed by Coumarin drugs, and FV, not reduced by oral anticoagulation. It can also be used to assess the protein synthesis capability of the liver in chronic or acute hepatic disorders. The test depends on the activation of Factor X in the presence of Factor VII by Tissue Factor (TF) and bypassing of the Intrinsic clotting pathway. The speed of the reaction and the responsiveness of the PT to deficiencies of clotting factors depend upon the properties and concentration of the TF as well as on the clotting factor concentrations.

Preparation of patient: Patients should be relaxed pre-venepuncture. Excessive stress and exercise will increase Factor VIII, vWF antigen and fibrinolysis. Veno-occlusion should be avoided.

Precautions: The doctor should check to see if the patient is taking any medications that may affect test results. This precaution is particularly important if the patient is taking Warfarin, because there are a number of medications that can interact with Warfarin to increase or decrease the PT time.

Accredited	Yes
Method	Stago Compact Max, SOP: H60, H62
Sample Requirements	Tube Type: Sodium Citrate Plasma 3.2% 0.105M **Temperature**:24 hours Room Temperature or 2 weeks @ -20ºC Miscellaneous: N/A **Collection: Cf. Special requirement for Coagulation test**
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓
Stability	Whole blood: 24 hours at room temperature. If a longer delay is expected in transport to the laboratory, centrifuge at 1500 RCF for at least 15 minutes, separate, and freeze plasma. Can only be thawed once. Ref: CLSI H21-A5
Rejection Criteria	Clotted sample, grossly hemolyzed sample, underfilled/overfilled specimen, unlabeled sample, mismatched patient ID, aged samples >24 hours, wrong sample tube (citrate tube only).
Units - Reference Ranges	PT 11.0 – 16.0 Seconds INR – Not applicable
Source	Dacie and Lewis, Practical Haematology 12th edition, 2017

ACTIVATED PARTIAL THROMBOPLASTIN TIME (APTT)

This test is also known as the Partial Thromboplastin Time with Kaolin (PTTK) and the Kaolin Cephalin Clotting Time (KCCT) reflecting the methods used to perform the test. The APTT is the main screening test for the Intrinsic clotting system and is the second most common coagulation test being exceeded in frequency only by the prothrombin time.
The Partial Thromboplastin of the APTT is a phospholipid extract of animal tissue or from vegetable sources. The phospholipids act as a platelet substitute in the Intrinsic system. The test incorporates an activator, in the absence of added Thromboplastin, which shortens the test and increases the precision and reproducibility by eliminating the variable effects of contact from glass surfaces and by effecting maximum activation. The activator is used to stimulate the production of FXIIa by providing a surface for the function of high molecular weight Kininogen, Kallikrein and FXIIa. The contact activation occurs for a time at 37°C. Calcium is then added to trigger further reactions, and the time required for clot formation measured. Standardised Phospholipids are required to form complexes, which activate FX and Prothrombin, which allows the test to be conducted in patient Platelet poor plasma (PPP).
The test depends not only on the contact factors and factors VIII and IX, but also on the reactions with factors X, V, Prothrombin and Fibrinogen. It is also sensitive to the presence of circulating anticoagulants (inhibitors) and Heparin.

Preparation of patient: Patients should be relaxed pre-venepuncture. Excessive stress and exercise will increase Factor VIII, vWF antigen and fibrinolysis. Veno-occlusion should be avoided.
Precautions: APTT results may be affected by many commonly administered drugs and further studies should be made to determine the source of unexpected abnormal results. Oral contraceptive and Oestrogen therapy in males have been found to decrease APTT in vivo. Conversely, Heparin, Warfarin, Lupus anticoagulant and radio therapy have been found to increase APTT in vivo.

Accredited	Yes
Method	Stago Compact Max, SOP: H60, H62
Sample Requirements	Tube Type: Sodium Citrate Plasma 3.2% **Temperature:** 4 hours Room temperature or 2 weeks -20ºC Miscellaneous: N/A **Collection: Cf. Special requirement for Coagulation test**
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓
Stability	Whole blood: 4 hours, unless centrifuged at room temperature at 1500 RCF for 15 min, separated and the plasma frozen. Can only be thawed once. If an expected delay from collection time to receipt in the laboratory, suggest send frozen plasma. Ref: (BD Ref. VS5966 Evaluation of 0.109M BD Vacutainer® Plus Plastic and 0.105M BD Vacutainer® Glass Sodium Citrate Tubes for PT and APTT Using the Sysmex CA - 1500 Analyzer. BD, Franklin Lakes, NJ, USA June 2002; CLSI H21-A5)
Rejection Criteria	Clotted sample, grossly hemolyzed sample, underfilled/overfilled specimen, unlabeled sample, mismatched patient ID, aged samples >4 hours, wrong sample tube (citrate tube only).
Units - Reference Ranges	26.0 – 40 seconds
Source	Dacie and Lewis, Practical Haematology 12th edition, 2017

BLOOD PARASITOLOGY - MALARIA

Malaria is caused by a group of related intracellular protozoan pathogens of the genus Plasmodium. These species exhibit a complex life cycle reliant on a mammalian host and anopheles mosquito vector. In the human host they are obligate intracellular pathogens infecting initially the liver in the sporozoite form. In the liver the parasites replicate and develop into merozoites which are then released into the blood stream. These infect the erythrocyte and begin a restricted life cycle. Each parasite may develop into a schizont (a cluster of infectious units which may invade further erythrocytes) or a gametocyte (the sexual form which may be transferred to the anopheles mosquito upon taking a blood meal). Re-infection of the liver does not occur.

Suspected malaria is a medical emergency. Sampling and processing of the blood sample must not be delayed if malaria is suspected. Five primary species of malaria have been identified in humans: P.*falciparum*, P.*vivax*, P.*ovale* P.*malariae* and P.*knowlesi.* Their geographic distribution is unique for each species.
Blood should ideally be taken direct from the patient's finger or ear & the films prepared at the bedside or in the clinic. When this is not possible blood taken into anticoagulant (EDTA) can be used. Thick & thin blood films should be made as soon as possible, certainly less than 2 hours after the EDTA blood was drawn, to minimise morphological changes in the parasites. Parasite and red cell morphology can be seriously affected if the blood has been in anticoagulation for too long.
Where there is a strong clinical suspicion if the first films are negative, blood should be taken and films made and checked at least two times over the first 24 hours and further films examined every 12 hours after that if strongly clinically indicated.

Preparation of patients:
Travel history should be recorded, and any clinical details recorded on the request form.
In symptomatic patients please phone the laboratory prior to sending the sample.

Precautions: Global distribution of malaria is restricted to areas endemic to the anopheles mosquito. Latent infections of some species may occur due to hypnozoites stored in the liver. P. *knowlesi* is morphologically indistinguishable from P. *malariae* on blood film preparations.

Accredited	No
Method	Haematology – Thick & Thin Blood film & CareStart Malaria Rapydtest antigen kit (Kit Insert: APACOR CareStart RAPYDTEST- APA059 V7 04/2017) SOP: H47
Sample Requirements	Tube Type: Whole Blood K2/K3 EDTA anticoagulated Temperature: + 2-8ºC Miscellanous: Observe periodicity where applicable.
Turn Around Time – Setup Schedule	24h Mon ✓ | Tue ✓ | Wed ✓ | Thu ✓ | Fri ✓
Stability	Blood films Thick & thin need to be made less than 2 hours after the blood EDTA was drawn. 2 days @ 2 - 8ºC (CareStart RAPYDTEST Malaria Antigen Kit)
Rejection Criteria	Clotted sample, insufficient sample, grossly haemolysed sample, centrifuged specimens, unlabelled sample, mismatched patient ID, aged samples (sample should be sent to the lab within 2 hours of collection, wrong sample tube (EDTA tube only).
Units - Reference Ranges	% parasitaemia (applicable to P. *falciparum* & P. *knowlesi* infection) No reference ranges applicable. Genus and species reportable.
Source	WHO Guideline: 'The Laboratory Diagnosis of Malaria'. J.W Bailey, B.J Bain, J Parker-Williams and P.Chiodini for the General Haematology Task Force of the British Committee for Standards in Haematology. http://www.bcshguides.com/documents/malaria-bcsh.2005.pdf Malaria Reference Laboratory. www.malaria-reference.co.uk

D-DIMER

D-dimer is a degradation product of cross-linked fibrin. The D-dimer concentration is a measure of the fibrinolytic activity of plasmin in the vascular system. Elevated concentrations of D-dimer indicate increased coagulatory and fibrinolytic activity. With a normal D-dimer value, acute deep vein thrombosis and pulmonary embolisms may be ruled out with high reliability.

Preparation of patients: There is no physical preparation for the D-Dimer test.

Precautions: No modifications to change diet, medications, or activity required before this test. Phlebotomists should enquire about any blood thinners or anticoagulant medication any diseases like liver disease and rheumatoid arthritis. There are some herbs that are also able to replicate the effects of blood thinning medication.

Accredited	Yes
Method	Stago Compact Max SOP H60, H62
Sample Requirements	Tube Type: Sodium Citrate 3.2%, **Temperature:** 8 hours Room temperature or 2 weeks at -20ºC Miscellanous: N/A
Turn Around Time – Setup Schedule	Same Day Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓
Stability	Whole blood: 8 hours, unless centrifuged at room temperature at 1500 RCF for 15 min, separated and the plasma frozen. Can only be thawed once. If an expected delay from collection time to receipt in the laboratory, suggest send frozen plasma. Ref: (BD Ref. VS5966 Evaluation of 0.109M BD Vacutainer® Plus Plastic and 0.105M BD Vacutainer® Glass Sodium Citrate Tubes for PT and APTT Using the Sysmex CA - 1500 Analyzer. BD, Franklin Lakes, NJ, USA June 2002; CLSI H21-A5)
Rejection Criteria	Clotted sample, grossly hemolyzed sample, underfilled/overfilled specimen, unlabeled sample, mismatched patient ID, aged samples >8 hours, wrong sample tube (citrate tube only).
Units - Reference Ranges	0.0-0.50 µg/mL
Source	Konstantinides SV, Meyer G, Becattini C, Bueno H, Geersing GJ, Harjola VP, Huisman MV, Humbert M, Jennings CS, Jiménez D, Kucher N, Lang IM, Lankeit M, Lorusso R, Mazzolai L, Meneveau N, Áinle FN, Prandoni P, Pruszczyk P, Righini M, Torbicki A, Van Belle E, Zamorano JL; The Task Force for the diagnosis and management of acute pulmonary embolism of the European Society of Cardiology (ESC). 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS): The Task Force for the diagnosis and management of acute pulmonary embolism of the European Society of Cardiology (ESC). Eur Respir J. 2019 Oct 9;54(3):1901647. doi: 10.1183/13993003.01647-2019. PMID: 31473594.

RETICULOCYTES

The process of red blood cell production starts in the bone marrow, where cells pass through various stages of development, becoming increasingly mature. The reticulocyte is the final stage of the development of the red blood cell before full maturation. Reticulocyte is an immature red blood cell without a nucleus, having a granular or reticulated appearance when suitably stained. They are present in normal blood in very low numbers, increased numbers are maybe the product of a pathological process or could be the body's response to pregnancy, therapy with iron B12, or folate or to blood loss. Reticulocytes are not part of the full blood count, so they need to be specifically requested.

Preparation of patients: There is no physical preparation for the test.

Precautions: Frozen, clotted, or grossly haemolysed samples cannot be analysed.

Accredited	Yes
Method	Haematology – SYSMEX XN2000 SOP: BH18, H62
Sample Requirements	Tube Type: Whole Blood (Lavender cap) Temperature: + 2-8ºC Miscellanous: N/A
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓ Sat ✓
Stability	2 days @ + 2-8ºC
Rejection Criteria	Clotted sample, insufficient sample, grossly haemolysed sample, centrifuged specimens, unlabelled sample, mismatched patient ID, sample over 2 days of collection, wrong sample tube (EDTA tube only).
Source	Haematology, G. Moore, G. Knight & A. Blann, 2nd edition, Oxford 2016. The RR was derived from the Drogheda OLOL SYSMEX XN-1000 Analyser. The RR from OLOL Drogheda Our Ladys Hospital for Sick Children Crumlin, Great Ormond Street Hospital, Dacie & Lewis Practical Haematology 10th Edition and Pediatric Haematology 3rd Edition. This is based on the correlation study between OLOL hospital and Eurofins-Biomnis during validation and compatible platforms, reagents, calibrators and controls.

SICKLE CELL SCREENING TEST

Sickle cell disease is an inherited condition characterised by the presence of Haemoglobin S (HB-S). Hb-S exists in a homozygous state (S/S) known as Sickle Cell Anaemia or in a heterozygous state (A/S) known as Sickle Cell Trait. Homozygous individuals (S/S) commonly exhibit symptoms of severe haemolytic anaemia and/or vascular occlusions. Heterozygous individuals (A/S) are usually asymptomatic. Hb-S may be present with other haemoglobins, such as Haemoglonbin A, C or D, or with thalassemia, a condition that interferes with the synthesis of normal haemoglobin.
Under conditions of low oxygen tension, the heterozygous (A/S) form can cause erythrocytes to form the characteristic sickle-shaped tactoids. The formation of these irreversible sickled red blood cells causes the onset of the acute symptoms. Detection of both the homozygous and heterozygous condition is important so high-risk individuals can be identified, and their symptoms reduced.

SICKLEDEX® kit is a qualitative solubility test for testing the presence of sickling haemoglobins in human blood. Deoxygenated Hb-S is insoluble in the presence of a concentrated phosphate buffer solution and forms a turbid suspension that can be easily visualised. Normal Haemoglobin A and other haemoglobins remain in solution under these conditions. These different qualitative outcomes allow for

the detection of sickle cell disease and its traits.
SICKLEDEX uses Saponin to lyse the red blood cells. Sodium Hydrosulfite then reduces the released haemoglobin. Reduced Hb-S is insoluble in the concentrated phosphate buffer and forms a cloudy turbid suspension. Other sickling haemoglobin subtypes may also give a positive result.

Preparation of patients: There is no physical preparation for the test.

Precautions: Frozen, clotted, or grossly haemolysed samples cannot be analysed.

Accredited	No
Method	Haematology- qualitative solubility test for testing the presence of sickling haemoglobins SOP: H53
Sample Requirements	Tube Type: Whole blood EDTA Temperature: + 2-8ºC Miscellaneous: N/A
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓
Stability	3 days @ + 2-8ºC
Rejection Criteria	Clotted sample, insufficient sample, grossly haemolysed sample, centrifuged specimens, unlabelled sample, mismatched patient ID, sample over 2 days of collection, wrong sample tube (whole blood EDTA only).
Result	Positive or negative
Source	Sickledex kit insert, Streck – 350512-13, 05-2016.

BLOOD FILM REVIEW

Blood film review remains an indispensable diagnostic tool, despite advances in automated technologies. The blood film, or peripheral blood smear, allows for the direct visualisation of blood cells, providing insights that are often beyond the reach of automated analysers. Automated analysers, while efficient, can miss subtle morphological abnormalities such as dysplastic changes, reactive features, atypical cells, or early signs of malignancies. In some cases, the blood film review is the only reliable methodology to identify key disease associated markers. For instance, the presence of schistocytes in microangiopathic haemolytic anaemia can only be reliably identified through a manual smear review. Blood film review thus aids in the differential diagnosis of patients presenting with haematological abnormalities which cannot be detected through routine automated methods.

In addition to its role in patient diagnosis, blood film review plays an essential role in the detection of spurious FBC results caused by pre-analytical artefacts or sample handling. For example, the clumping of platelets in EDTA anticoagulated samples may lead to spurious reporting of thrombocytopaenia.

At Eurofins-Biomnis Ireland, blood film review is provided as part of the FBC package and is automatically requested based on FBC result criteria.

Preparation of patients: There is no physical preparation for the blood film review.
Precautions: Frozen, clotted, or grossly haemolysed samples cannot be analysed.

Accredited	Yes
Method	Manual microscopy SOP: H04
Sample Requirements	Sample type: Whole Blood K2/K3 EDTA anticoagulated or unstained blood smears prepared from such specimens. Temperature: + 2-8ºC for whole blood. Unstained slides can also be stored at room temperature. Miscellanous: N/A
Turn Around Time – Setup Schedule	24h Mon ✓ Tue ✓ Wed ✓ Thu ✓ Fri ✓ Sat ✓
Stability	48 hours @ + 2-8ºC for whole blood. 8 weeks for blood smear slides prepared from whole blood EDTA anticoagulated specimens meeting the above stability criteria.
Rejection Criteria	Clotted sample, insufficient sample, grossly haemolysed sample, centrifuged specimens, unlabelled sample, mismatched patient ID, sample over 48 hours of collection, wrong sample tube (EDTA tube only).