Quick Reference Guide to Blood Chemistry and CBC Analysis from a Functional Perspective

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"The Perfect Companion to Our Blood Chemistry and CBC Analysis Book"

Blood Chemistry and CBC Analysis –
Clinical Laboratory Testing from a Functional Perspective

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BLOOD CHEMISTRY AND COMPLETE BLOOD COUNT QUICK REFERENCE GUIDE

Introduction

There are few diagnostic tests that are truly diagnostic all on their own. It is important to see the trends and patterns that exist between various tests. This section is organized to provide that information, and is broken into two sections.

Section One

The first section of the Quick Reference Guide is a list of the individual components of the blood chemistry screen and complete blood count. Beside each component, organized by high or low values, is a list of the most common conditions seen with deviations from normal.

COMPONENT	HIGH	LOW
Glucose	• Insulin resistance • Early stage hyperglycemia/Diabetes • Syndrome X/Metabolic Syndrome • Thiamine Need • Cortisol resistance • Fatty liver • Liver congestion	• Hypoglycemia- reactive • Hypoglycemia- Liver glycogen problem • Hyperinsulinism • Adrenal hypofunction
Hemoglobin A1C	• Diabetes mellitus • Insulin resistance	• Hypoglycemia
Triglycerides	• Syndrome X/Metabolic Syndrome • Fatty liver • Liver congestion • Insulin resistance • Cardiovascular disease • Atherosclerosis • Poor metabolism and utilization of fats • Early stage hyperglycemia/Diabetes • Hyperlipidemia/ Hyperlipoproteinemia • Primary hypothyroidism • Adrenal cortical dysfunction • Secondary hypothyroidism- anterior pituitary dysfunction • Alcoholism	• Liver/biliary dysfunction • Thyroid hyperfunction • Autoimmune processes • Adrenal hyperfunction

COMPONENT	HIGH	LOW
Cholesterol	• Primary hypothyroidism • Adrenal cortical dysfunction • Cardiovascular disease • Atherosclerosis • Biliary stasis • Insulin resistance • Poor metabolism and utilization of fats • Fatty liver • Early stage hyperglycemia/Diabetes • Syndrome X/Metabolic Syndrome • Hyperlipoproteinemia • Multiple sclerosis	• Oxidative stress • Heavy metal body burden • Liver/biliary dysfunction • Diet- malnutrition • Thyroid hyperfunction • Autoimmune processes • Adrenal hyperfunction
LDL		• Diet- high in refined carbohydrates • Syndrome X/Metabolic Syndrome • Atherosclerosis • Fatty liver/Hyperlipidemia • Oxidative stress
HDL	• Autoimmune processes	• Hyperlipidemia/Fatty Liver • Atherosclerosis • Syndrome X/Metabolic Syndrome • Oxidative stress • Heavy metals • Hyperthyroidism • Lack of exercise/sedentary lifestyle
BUN	• Renal disease • Renal insufficiency • Dehydration • Hypochlorhydria • Diet- excessive protein intake • Adrenal hyperfunction • Dysbiosis • Edema • Anterior pituitary dysfunction	• Diet- low protein • Malabsorption • Pancreatic insufficiency • Liver dysfunction

COMPONENT	HIGH	LOW
Creatinine	• BPH • Urinary tract congestion • Renal disease • Renal insufficiency • Uterine hypertrophy	• Muscle atrophy • Protein insufficiency or impaired digestion
Bun/Creatinine ratio	• Renal disease	• Diet- low protein • Posterior pituitary dysfunction
Uric Acid	• Gout • Atherosclerosis/Oxidative stress • Arthralgias • Renal insufficiency/Renal disease • Circulatory disorders • Leaky gut syndrome	• Molybdenum deficiency • Anemia- B12/folate deficiency • Copper deficiency
Potassium	• Adrenal hypofunction • Dehydration • Tissue destruction • Metabolic acidosis	• Adrenal hyperfunction • Drug diuretics • Benign essential hypertension
Sodium	• Adrenal hyperfunction • Cushing's disease • Dehydration	• Adrenal hypofunction • Addison's disease • Edema • Drug diuretics
Chloride	• Metabolic acidosis • Adrenal hyperfunction	• Hypochlorhydria • Metabolic alkalosis • Adrenal hypofunction
CO2	• Metabolic alkalosis • Adrenal hyperfunction • Hypochlorhydria • Respiratory acidosis	• Metabolic acidosis • Thiamine need • Respiratory alkalosis
Anion Gap	• Thiamine need • Metabolic acidosis	
Total Protein	• Dehydration	• Hypochlorhydria • Digestive dysfunction and/or inflammation • Liver dysfunction

COMPONENT	HIGH	LOW
Albumin	• Dehydration	• Hypochlorhydria • Liver dysfunction • Oxidative stress • Vitamin C need
Globulin	• Hypochlorhydria • Liver cell damage • Oxidative stress • Heavy metal toxicity	• Digestive dysfunction and/or inflammation • Immune insufficiency
Albumin/ Globulin ratio		• Liver dysfunction • Immune activation
Calcium	• Parathyroid hyperfunction • Thyroid hypofunction • Impaired membrane health	• Parathyroid hypofunction • Calcium need • Hypochlorhydria
Phosphorous	• Parathyroid hypofunction • Bone growth and/or repair • Diet- excessive phosphorous consumption • Renal insufficiency	• Parathyroid hyperfunction • Hypochlorhydria • Hyperinsulinism • Diet- high in refined carbohydrates
Magnesium	• Renal dysfunction • Thyroid hypofunction	• Epilepsy • Muscle spasm
Alkaline phosphatase	• Biliary obstruction • Liver cell damage • Bone: loss/increased turnover or bone growth and/or repair • Leaky gut syndrome • Herpes zoster • Metastatic carcinoma of the bone	• Zinc deficiency
LDH	• Liver/biliary dysfunction • Cardiovascular disease • Anemia- B12/folate deficiency, hemolytic • Non-specific tissue inflammation • Tissue destruction • Viral infection	• Reactive hypoglycemia

COMPONENT	HIGH	LOW
SGOT/AST	• Dysfunction located outside of the liver and Biliary tree • Developing Congestive Heart Failure • Acute MI • Cardiovascular dysfunction: Coronary artery insufficiency • Liver cell damage • Liver dysfunction • Excess muscle breakdown or turnover • Infectious mononucleosis, EBV, CMV	• B6 deficiency • Alcoholism
SGPT/ALT	• Dysfunction located in the liver • Fatty liver • Liver dysfunction • Biliary tract obstruction • Excessive muscle breakdown or turnover • Cirrhosis of the liver • Liver cell damage	• B6 deficiency • Fatty liver (early development) • Liver congestion • Alcoholism
GGTP	• Dysfunction located outside the liver and inside the biliary tree • Biliary obstruction • Biliary stasis/insufficiency • Liver cell damage • Alcoholism • Acute/chronic Pancreatitis • Pancreatic insufficiency	• B6 deficiency • Magnesium need
Total Bilirubin	• Biliary stasis • Oxidative stress • Thymus dysfunction • Biliary tract obstruction or calculi • Liver dysfunction • RBC hemolysis • Gilbert's syndrome	• Spleen insufficiency

COMPONENT	HIGH	LOW
Direct Bilirubin	• Biliary tract obstruction • Biliary calculi/obstruction (usually extra hepatic)	
Indirect Bilirubin	• RBC hemolysis • Gilbert's syndrome	
Serum Iron	• Liver dysfunction • Hemochromatosis/hemosiderosis/iron overload • Iron conversion problem • Viral infection • Excess iron consumption	• Anemia- iron deficiency • Hypochlorhydria • Internal/microscopic bleeding
Ferritin	• Hemochromatosis/hemosiderosis/iron overload • Excess iron consumption • Inflammation/liver dysfunction/oxidative stress	• Anemia- iron deficiency
TIBC	• Anemia- iron deficiency • Internal bleeding	• Hemochromatosis/hemosiderosis/iron overload • Microscopic bleeding • Diet- protein malnutrition
% Transferrin Saturation	• Hemochromatosis/hemosiderosis/iron overload	• Anemia- iron deficiency
TSH	• Primary hypothyroidism	• Hyperthyroidism • Secondary hypothyroidism- anterior pituitary dysfunction • Tertiary hypothyroidism- hypothalamic dysfunction • Heavy metal body burden
T-3	• Hyperthyroidism • Iodine deficiency	• Primary hypothyroidism • Selenium deficiency
T-4	• Hyperthyroidism • Thyroid hormone replacement	• Primary hypothyroidism • Iodine deficiency
T-3 Uptake	• Hyperthyroidism • Thyroid hormone replacement	• Primary hypothyroidism • Secondary hypothyroidism- anterior pituitary dysfunction • Selenium deficiency • Iodine deficiency
ESR	• Non-specific tissue inflammation or destruction	

COMPLETE BLOOD COUNT

COMPONENT	HIGH/LOW	CONDITION
White Blood Cell Count	• Childhood diseases (Measles, Mumps, Rubella, Chicken pox etc.) • Acute bacterial infection • Acute viral infection • Stress • Diet- High in refined carbohydrates	• Chronic viral infections • Chronic bacterial infections • Leukocytic auto-digestion • Systemic Lupus Erythematosis (SLE) • Decreased production from bone marrow • Diet- raw food diet
Red Blood Cell Count	• Respiratory distress: Asthma or emphysema • Polycythemia (relative or absolute) • Dehydration	• Anemia- Iron deficiency • Anemia- B12/folate deficiency • Anemia- Copper deficiency • Internal bleeding • Vitamin C need
Hemoglobin	• Respiratory distress: Asthma or emphysema • Polycythemia (relative or primary) • Dehydration	• Anemia- iron deficiency • Anemia- B12/folate deficiency • Anemia- B6 deficiency anemia • Anemia- Copper deficiency • Internal bleeding • Digestive inflammation • Vitamin C need
Hematocrit	• Respiratory distress: Asthma or emphysema • Polycythemia (relative or primary) • Spleen hyperfunction • Dehydration	• Anemia • Anemia- Iron deficiency • Anemia- B12/folate deficiency • Anemia- B6 deficiency • Anemia- Copper deficiency • Internal bleeding • Digestive inflammation • Thymus hypofunction • Vitamin C need
MCV	• Anemia- B12/folate deficiency • Vitamin C need	• Anemia- Iron deficiency • Anemia- B6 deficiency • Internal bleeding

COMPONENT	HIGH	LOW
MCH	• Anemia- B12/folate deficiency • Hypochlorhydria	• Anemia- Iron deficiency • Anemia- B6 deficiency • Internal bleeding • Heavy metal body burden • Vitamin C need
MCHC	• Anemia- B12/folate deficiency • Hypochlorhydria	• Anemia- Iron deficiency • Anemia- B6 deficiency • Heavy metal body burden • Vitamin C need
RDW	• Anemia- Iron deficiency • Anemia- B12/folate deficiency • Pernicious anemia	• Childhood diseases (Measles, Mumps, Rubella, Chicken pox) • Acute or chronic bacterial infection • Inflammation
Neutrophils		• Blood diseases (aplastic anemia, pernicious anemia etc.) • Chronic viral infection
Monocytes	• Recovery phase of infection • Liver dysfunction • Intestinal parasites • Benign Prostatic Hypertrophy (BPH)	
Lymphocytes	• Childhood diseases • Acute and chronic viral infection • Infectious mononucleosis • Inflammation • Systemic toxicity	• Chronic viral or bacterial infections • Free radical activity • Active bacterial infection • Suppressed bone marrow function
Eosinophils	• Intestinal parasites • Food and environmental allergies/sensitivities • Asthma	• Increased adrenal steroid production
Basophils	• Tissue inflammation • Intestinal parasites	
Platelet count	• Atherosclerosis	• Idiopathic thrombocytopenia • Heavy metal body burden • Free radical pathology

Section Two

The second section presents the common patterns arranged by conditions. Beside each condition is a list of the patterns organized by which components of the blood chemistry screen and complete blood count are high or low for any given condition. The optimal value changes are given for both the Standard US Units and Standard International Units.

CONDITION	HIGH	LOW
Adrenal hyperfunction	↑ Sodium (>142) ↑ Chloride (>106) ↑ CO2 (>30) ↑ BUN (>16 or 5.71 mmol/L)	↓ Potassium (<4.0) ↓ Cholesterol (<150 or 3.9mmol/L) ↓ Triglyceride (<70 or 0.79mmol/L)
Adrenal hypofunction	↑ Potassium (>4.5) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ Triglycerides (>110 or 1.24 mmol/L)	↓ Sodium (<135) ↓ Chloride (<100) ↓ Blood Glucose (<80 or 4.44 mol/L)
Anemia- B12/folate deficiency	↑ MCH (>31.9) ↑ MCV (>89.9) ↑ RDW (>13) ↑ MCHC (>35) ↑ Serum iron (>100 or >17.91 μmol/L) ↑ LDH (>200)	↓ RBCs (<3.9♀, <4.2♂) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ HGB (<13.5 or 135g/L in ♀ and <14 or 140 in ♂) ↓ WBCs (<5.0) ↓Neutrophils (<40) ↓ Uric acid (<3.5 or 208 μmol/dL)
Anemia- hemolytic	↑ LDH (>200) ↑ Reticulocytes (>1 or 00.1)	
Anemia- Iron deficiency	↑ TIBC (>350) ↑ Transferrin **If hypochlorhydria is present:** ↑ Globulin (>2.8 or 28 g/L)	↓ Serum iron (<50 or <8.96 μmol/L) ↓ Ferritin (<10 in ♀ and <33 in ♂) ↓ % transferrin saturation (<20%) ↓ or N RBCs (<3.9♀, <4.2♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or140 in ♂) ↓ or N HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ MCV MCV (<82), ↓ MCH (<28), ↓ MCHC (<32) ↓ Globulin (<2.4 or 24 g/L) ↓ Phosphorous (<3.0 or 0.97 mmol/L)
Anterior pituitary/secondary thyroid hypofunction	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ BUN (>16 or 5.71 mmol/L)	↓TSH (<2.0) ↓ T-3 uptake (<27)

CONDITION	HIGH	LOW
Arthralgias	↑ ESR (> 10 in ♀ and > 5 in ♂) ↑ C-reactive protein ↑ or **N** albumin (>5.0 or 50 g/L) ↑ Globulin (>2.8 or 28 g/L) ↑ Platelet (>385)	↓ or **N** albumin (<4.0 or 40 g/L)
Asthma	↑ HGB (>14.5 or 145 g/L in ♂ and >15 or 150 in ♂) ↑ Eosinophils (>3%) ↑ HCT (>44 or 0.44 in ♂ and >48 or 0.48 in ♂) ↑ Neutrophils (>60%) ↑ or **N** Total WBC (>7.5)	↓ Lymphocytes ↓ Plasma and salivary cortisol in the chronic phase.
Atherosclerosis	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ or **N** Cholesterol (>220 or 5.69mmol/L) ↑ LDL (>120 or 3.1 mmol/L) ↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Platelet (>385) ↑ C reactive protein	↓ HDL (<55 or 1.42 mmol/L)
Autoimmune processes- tissue destruction	↑ HDL (>70 or 1.81 mmol/L) ↑ LDH (>200)	↓ Triglyceride (<70 or 0.79 mmol/L) ↓ or **N** Cholesterol (<150 or 3.9 mmol/L)
B6 deficiency (confirm with a serum or urinary homocysteine)	**N** Serum iron	↓ or **N** SGPT/ALT (<10) ↓ SGOT/AST (<10) ↓ GGTP (<10) ↓ MCV (<82), ↓ MCH (<28) ↓ MCHC (<32) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂)
Biliary dysfunction	↑ Alkaline phosphatase (>100) ↑ GGTP (>30) ↑ SGPT/ALT (>30) ↑ LDH (>200)	↓ Triglyceride (<70 or 0.79 mmol/L) ↓ Cholesterol (<150 or 3.9 mmol/L)
Biliary obstruction/calculi	↑ Alkaline phosphatase (>100) ↑ SGPT/ALT (>30) ↑ GGTP (>30) ↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Direct bilirubin (>0.2 or 3.4 μmol/dL)	

CONDITION	HIGH	LOW
Biliary stasis/insufficiency	↑ Cholesterol (>220 or 5.69 mmol/L) ↑ GGTP (>30) ↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Alk Phos (>100)	
BPH	↑ Creatinine (>1.1 or 97.2 mmol/L) ↑ PSA (may be normal) ↑ Monocytes (>7%)	
Cardiovascular disease	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ LDL (>120 or 3.1 mmol/L) ↑ LDH (>200) ↑ SGOT/AST (>30)	↓ HDL (<55 or 1.42 mmol/L)
Childhood diseases	↑ Total WBC (>7.5) ↑ Neutrophils (>60%) (early) ↑ Lymphocytes (>44%)(later)	↓ Neutrophils (<40%) (later) ↓ Lymphocytes (<24%) (early)
Copper deficiency	Low high MCV (>89.9) ↑ to N MCH (>31.9),	↓ Uric acid (<3.5 or 208 μmol/dL) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂) ↓ RBCs (<3.9♀, <4.2♂)
Deficient Red Blood Cell production	↑ Serum iron (>100 or >17.91 μmol/L)	↓ RBCs (<3.9♀, <4.2♂) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂)
Dehydration	↑ RBCs (>4.5 in ♂ and >4.9 in ♂) ↑ HGB (>14.5 or 145 g/L in ♂ and >15 or 150 in ♂) ↑ HCT (>44 or 0.44 in ♂ and >48 or 0.48 in ♂) ↑ Total protein (> 7.4 or 74 g/L) (Chronic) ↑ Albumin (>5.0 or 50 g/L) (Chronic) ↑ Sodium (>142) ↑ Potassium (<4.0) ↑ BUN (>16 or 5.71 mmol/L) (Chronic)	
Diabetes/hyperglycemia	↑ Blood Glucose (>100 or 5.55 mmol/L) ↑ Hemoglobin A1C (>5.7% or 0.057) ↑ Cholesterol (>220 or 5.69 mmol/L) ↑ Triglycerides (>110 or 1.24 mmol/L) ↑ BUN (>16 or 5.71 mmol/L) ↑ Creatinine (>1.1 or 97.2 μmmol/dL)	↓ HDL (<55 or 1.42 mmol/L)

CONDITION	HIGH	LOW
Diet- fat deficient		↓ Cholesterol (<150 or 3.9mmol/L) ↓ Triglyceride (<70 or 0.79mmol/L)
Diet- high in refined carbohydrates	↑ LDL (>120 or 3.1 mmol/L)	↓ Phosphorous (<3.0 or 0.97 mmol/L) ↓ Total WBC count (<5.0)
Diet- low protein		↓ BUN (<10 or 3.57 mmol/L) ↓ Total protein (< 6.9 or 69 g/L) ↓ BUN-Creatinine ratio (<13) ↓ Creatinine (<0.8 or 70.7 μmmol/dL)
Digestive dysfunction/inflammation	↑ BUN (>16 or 5.71 mmol/L) ↑ Basophils (>1%) **With Ulceration or erosion:** ↑ Alk Phos intestinal isoenzyme	↓ Total protein (< 6.9 or 69 g/L) ↓ Total Globulin (<2.4 or 24 g/L) ↓ Albumin (<4.0 or 40 g/L) ↓ Phosphorous (<3.0 or 0.97 mmol/L) ↓ Creatinine (<0.8 or 70.7 μmol/dL)
Edema	↑ BUN (>16 or 5.71 mmol/L)	↓ Sodium (<135) ↓ albumin (<4.0 or 40 g/L)
Emphysema	↑ HCT (>44 or 0.44 in ♂ and >48 or 0.48 in ♂) ↑ RBCs (>4.5 in ♂ and >4.9 in ♂) ↑ or **N** $C0_2$ (>30)	↓↓ Alpha I globulin ↓ or **N** serum chloride (<100)
Excess consumption of iron	↑ Serum iron (>100 or >17.91 μmol/L) ↑ Ferritin (>122 in ♂ and >236 in ♂)	
Fatty Liver (steatosis)	↑ SGPT/ALT (>30) ↑ LDH (>200) ↑ Alk Phos (>100)	
Fatty liver- Early Stage	↑ Blood Glucose (>100 or 5.55 mmol/L) ↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ LDL (>120 or 3.1 mmol/L)	↓ HDL (<55 or 1.42 mmol/L) ↓ SGPT/ALT (<10)
Gilbert's syndrome	↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Indirect bilirubin (>1.0 or 17.1 μmol/dL)	
Gout	↑↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ BUN (>16 or 5.71 mmol/L) ↑ or **N** Creatinine (>1.1 or 97.2 μmmol/dL)	↓ Phosphorous (<3.0 or 0.97 mmol/L)

CONDITION	HIGH	LOW
Heavy metal burden (run a hair/urine analysis if this pattern comes up to rule this out)	↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Total Bilirubin (>1.2 or 20.5 μmol/dL) ↑ BUN (>16 or 5.71 mmol/L) **Cadmium toxicity:** ↑ Calcium (>10.5 or 2.5 mmol/L)	↓ MCHC (<32) and MCH (<28) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂) ↓ RBCs (<3.9♀, <4.2♂) ↓ 5th Isoenzyme of LDH **Cadmium toxicity:** ↓ Phosphorous (<3.0 or 0.97 mmol/L)
Heavy metals/chemical toxicity	↑ Total globulin (>2.8 or 28 g/L)	↓ Uric acid (<3.5 or 208 μmmol/L) ↓ Cholesterol (<150 or 3.9mmol/L) ↓ HDL (<55 or 1.42 mmol/L) ↓ MCH (<28) ↓ MCHC (<32) ↓ TSH (<2.0) ↓ Platelets (<155)
Hemochromatosis	↑ Serum iron (>100 or >17.91 μmol/L) ↑↑ Ferritin (>1000) ↑ % transferrin saturation (>35%) ↑ SGOT/AST (>30)	↓ TIBC (<250 or 44.8 μmol/dL)
Hyperinsulinemia	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L)	↓ Blood Glucose (<80 or 4.44 mol/L) ↓ HDL (<55 or 1.42 mmol/L) ↓ Phosphorous (<3.0 or 0.97 mmol/L)
Hyperlipidemia	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ LDL (>120 or 3.1 mmol/L)	↓ HDL (<55 or 1.42 mmol/L)
Hyperlipoproteinemia	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L)	
Hypochlorhydria	↑ BUN (>16 or 5.71 mmol/L) ↑ Total Globulin (>2.8 or 28 g/L)	↓ or **N** Total protein (< 6.9 or 69 g/L) ↓ or **N** albumin (<4.0 or 40 g/L) ↓ Phosphorous (<3.0 or 0.97 mmol/L)
Hypoglycemia- liver glycogen storage problem	↑ SGPT/ALT (>30)	↓ Blood Glucose (<80 or 4.44 mol/L) ↓ Hemoglobin A1C (<4.1% or 0.041) ↓ LDH (<140)

CONDITION	HIGH	LOW
Hypoglycemia-reactive		↓ Blood Glucose (<80 or 4.44 mol/L) ↓ Hemoglobin A1C (<4.1% or 0.041) ↓ LDH (<140)
Increased Red blood cell destruction	↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Indirect bilirubin (>1.0 or 17.1 μmol/dL)	↓ RBCs (<3.9♀, <4.2♂)
Infection: active	↑ Total WBC (>7.5) ↑ Neutrophils (>60%) ↑ Bands (>5%) ↑ ESR (> 10 in ♀ and > 5 in ♂)	↓ Lymphocytes (<24%)
Infection: Acute bacterial	↑ WBCs ↑ Neutrophils (>60%) ↑ Monocytes (recovery phase) (>7%) ↑ Bands (>5%) ↑ ESR (> 10 in ♀ and > 5 in ♂)	↓ or N Lymphocytes (<24%)
Infection: Acute viral	↑ Total WBC (>7.5) ↑ Lymphocytes (>44%) ↑ Monocytes (>7%) (recovery phase) ↑ Bands (>5%) ↑ ESR (> 10 in ♀ and > 5 in ♂) ↑ LDH (>200)	↓ or N Neutrophils (<40%)
Infection: Chronic viral	↑ Serum iron (>100 or >17.91 μmol/L)	↓ Total WBC count (<5.0) ↓ Lymphocytes (<24%)
Inflammation- non-specific	↑ LDH (>200) ↑ ESR (> 10 in ♀ and > 5 in ♂) ↑ Ferritin (>122 in ♂ and >236 in ♂) ↑ Basophils (>1%)	
Insulin Resistance	↑ Blood Glucose (>100 or 5.55 mmol/L) ↑ Hemoglobin A1C (>5.7% or 0.057) ↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L)	
Internal bleeding	↑ Reticulocyte count (>1%) ↑ TIBC (>350 or 62.7 μmol/dL) ↑ Transferrin.	↓ or **N** Serum iron (<50 or <8.96 μmol/L) ↓ or **N** serum Ferritin (<10 in ♀ and <33 in ♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂) ↓ or **N** HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ MCV (<89.9), ↓ MCH (<28)

CONDITION	HIGH	LOW
Internal microscopic bleeding	↑ Reticulocyte count (>1%)	↓ TIBC (<250 or 44.8 μmol/dL) ↓ Transferrin
Intestinal parasites	↑ Eosinophils (>3%) ↑ or **N** Basophils (>1%) ↑ or **N** Monocytes (>7%) ↑ IgE Stool positive for parasites or ova	↓ or **N** Serum iron (<50 or <8.96 μmol/L) ↓/**N** HGB (<13.5 or 135 g/L in ♂ & <14 or 140 in ♂) ↓ or **N** HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂)
Iodine deficiency	↑ T-3 (>230 or 3.53 nmol/L)	↓ T-3 uptake (<27) ↓ T-4 (<6 or 7.2 nmol/L)
Leaky gut syndrome	↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Alkaline phosphatase (>100)	
Liver cell damage	↑ Globulin (>2.8 or 28 g/L) ↑ Alkaline phosphatase (>100) ↑ SGOT/AST (>30) ↑ SGPT/ALT (>30) ↑ GGTP (>30)	
Liver dysfunction	↑ SGPT/ALT (>30) ↑ LDH (>200) ↑ SGOT/AST (>30) ↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Direct bilirubin (>0.2 or 3.4 μmol/dL) ↑ Serum iron (>100 or >17.91 μmol/L) ↑ Ferritin (>122 in ♂ and >236 in ♂) ↑ Monocytes (>7%)	↓ BUN (<10 or 3.57 mmol/L) ↓ Total protein (< 6.9 or 69 g/L) ↓ Albumin (<4.0 or 40 g/L) ↓ Albumin/globulin ratio ↓ Triglyceride (<70 or 0.79mmol/L) ↓ Cholesterol (<150 or 3.9mmol/L)
Malabsorption		↓ BUN (<10 or 3.57 mmol/L) ↓ GGTP (<10)
Metabolic acidosis	↑ Chloride (>106) ↑ Anion gap (>12) ↑ Potassium (>4.5)	↓ CO2 (<25)
Metabolic alkalosis	↑ CO2 (>30)	↓ Chloride (<100) ↓ Calcium (<9.2 or 2.3 mmol/L) ↓ Potassium (<4.0)
Microscopic bleeding	↑ Reticulocyte count (>1%)	↓ TIBC (<250 or 44.8 μmol/dL)

CONDITION	HIGH	LOW
Mononucleosis	↑ SGOT/AST (>30) ↑ Alkaline phosphatase (>100) ↑ LDH (>200) ↑ WBCs (2nd week) ↑ GGTP (>30) ↑ Lymphocytes (>44%)	↓ WBCs (1st week)
Muscle- atrophy or breakdown	↑ SGOT/AST (>30) ↑ SGPT/ALT (>30)	↓ Creatinine (<0.8 or 70.7 μmmol/dL)
Oxidative stress/Free radical activity	↑ LDL (>120 or 3.1 mmol/L) ↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Total Globulin (>2.8 or 28 g/L) ↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Ferritin (>122 in ♂ and >236 in ♂)	↓ Lymphocytes (<24%) ↓ Cholesterol (below historical average) ↓ Albumin (<4.0 or 40 g/L) ↓ Platelets (<150)
Pancreatic insufficiency	↑ GGTP (>30)	↓ Total WBC count ↓ BUN (<10 or 3.57 mmol/L)
Parasites- intestinal	↑ Monocytes (>7%) ↑ Basophils (>1%) ↑ Eosinophils (>3%)	
Parathyroid hyperfunction	↑ Calcium (>10.5 or 2.5 mmol/L)	↓ Phosphorous (<3.0 or 0.97 mmol/L)
Parathyroid hypofunction	↑ Phosphorous (>4.0 or 1.29 mmol/L	↓ Calcium (<9.2 or 2.3 mmol/L)
Polycythemia	↑ RBCs (>4.5 in ♂ and >4.9 in ♂) ↑ HCT (>44 or 0.44 in ♂ and >48 or 0.48 in ♂) ↑ HGB (>14.5 or 145 g/L in ♂ & >15 or 150 in ♂) ↑ Total Bilirubin (>1.2 or 20.5 μmol/dL) ↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Total WBC (>7.5) ↑ Basophils (>1%) ↑ Alk phos (>100)	↓ or **N** MCV (<82) ↓ or **N** MCH (<28 ↓ or **N** Serum iron (<50 or <8.96 μmol/L)
Poor fat metabolism	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69 mmol/L)	
Posterior pituitary dysfunction		↓ BUN (<10 or 3.57 mmol/L) ↓ BUN-Creatinine ratio

CONDITION	HIGH	LOW
Pregnancy	↑ Total Cholesterol (>220 or 5.69mmol/L) ↑ MCV (>89.9) and MCH (>31.9) ↑ Neutrophils (>60%) ↑ T-4 (>12 or 154.4 nmol/L) ↑ Total WBC (>7.5) (late)	↓ Calcium in late pregnancy (<9.2 or 2.3 mmol/L) ↓ Albumin (<4.0 or 40 g/L) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ T-3 uptake (<27) ↓ Lymphocytes (<24%) (late)) ↓ Total protein (< 6.9 or 69 g/L)
Renal insufficiency	↑ BUN (>16 or 5.71 mmol/L) ↑ or **N** Creatinine (>1.1 or 97.2 μmmol/dL) ↑ or **N** Uric acid (>5.9 or 351 μmol/dL) ↑ Phosphorous (>4.0 or 1.29 mmol/L	
Renal disease	↑ Creatinine (>1.1 or 97.2 μmmol/dL) ↑ BUN-Creatinine ratio ↑ BUN (>16 or 5.71 mmol/L) ↑ Uric acid (>5.9 or 351 μmol/dL) ↑ Phosphorous (>4.0 or 1.29 mmol/L ↑ LDH (>200) ↑ SGOT/AST (30)	
Respiratory distress	↑ RBCs (>4.5 in ♂ and >4.9 in ♂) ↑ HGB (>14.5 or 145 g/L in ♂ & >15 or 150 in ♂) ↑ HCT (>44 or 0.44 in ♂ and >48 or 0.48 in ♂) ↑ Eosinophils (>3%)	
Selenium deficiency		↓ T-3 (<100 or 1.54 nmol/L) ↓ T-3 uptake (<27)
Suppressed bone marrow production		↓ in all white blood cells ↓ RBCs (<3.9♀, <4.2♂) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂)
Syndrome X/Metabolic Syndrome	↑ Blood Glucose (>100 or 5.55 mmol/L) ↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ LDL (>120 or 3.1 mmol/L) ↑ Hemoglobin A1C (>5.7% or 0.057)	↓ HDL (<55 or 1.42 mmol/L)
Systemic toxicity	↑ Lymphocytes (>44%)	

CONDITION	HIGH	LOW
Thiamine deficiency	↑ Blood Glucose (>100 or 5.55 mmol/L) ↑ Anion Gap (>12)	↓ CO2 (<26)
Thymus dysfunction	↑ Bilirubin (>1.2 or 20.5 μmol/dL) ↑ HGB (>14.5 or 145 g/L in ♂ and >15 or 150 in ♂) ↑ HCT (>44 or 0.44 in ♂ and >48 or 0.48 in ♂) ↑ RBCs (>4.5 in ♂ and >4.9 in ♂)	
Thyroid hormone replacement	↑ T-4 (>12 or 154.4 nmol/L) ↑ T-3 uptake (>37)	
Thyroid hyperfunction	↑ T-3 (>230 or 3.53 nmol/L) ↑ T-4 (>12 or 154.4 nmol/L) ↑ T-3 uptake (>37)	↓ Triglyceride (<70 or 0.79mmol/L) ↓ Cholesterol (<150 or 3.9mmol/L) ↓ HDL (<55 or 1.42 mmol/L) ↓ TSH (<2.0)
Thyroid hypofunction-primary	↑ TSH (>4.4) ↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L)	↓ T-3 (<100 or 1.54 nmol/L) ↓ T-4 (<6 or 7.2 nmol/L) ↓ T-3 uptake (<27)
Thyroid hypofunction-secondary due to anterior pituitary dysfunction	↑ Triglycerides (>110 or 1.24 mmol/L) ↑ Cholesterol (>220 or 5.69mmol/L) ↑ BUN (>16 or 5.71 mmol/L)	↓ TSH (<2.0) ↓ T-3 uptake (<27)
Tissue destruction	↑ Potassium (>4.5) ↑ LDH (>200) ↑ ESR (> 10 in ♀ and > 5 in ♂)	
Tissue inflammation/ destruction (GI, tendon/bursa, phlebitis, sinusitis, musculoskeletal)	↑ ESR (> 10 in ♀ and > 5 in ♂) ↑ Potassium (>4.5) ↑ Basophils ↑ ALP increased with liver, bone or gastric inflammation (>100)	
Urinary tract congestion	↑ Creatinine (>1.1 or 97.2 μmmol/dL) ↑ Monocytes (>7%)	

CONDITION	HIGH	LOW
Vitamin B12/folate deficiency	↑ MCH (>31.9) ↑ MCV (>89.9) ↑ RDW (>13) ↑ Serum iron (>100 or >17.91 μmol/L) ↑ LDH (>200)	↓ RBCs (<3.9♀, <4.2♂) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂) ↓ Total WBC count (<5.0) ↓ Neutrophils (<40%) ↓ Uric acid (<3.5 or 208 μmol/dL)
Vitamin C need	↑ MCV (>89.9) ↑ Alk Phos (>100) ↑ Fibrinogen	↓ Albumin (<4.0 or 40 g/L) ↓ MCH (<28) ↓ MCHC (<32) ↓ HGB (<13.5 or 135 g/L in ♂ and <14 or 140 in ♂) ↓ HCT (<37 or 0.37 in ♂ and <40 or 0.4 in ♂) ↓ RBCs (<3.9♀, <4.2♂) ↓ Serum iron (<50 or <8.96 μmol/L)
Zinc deficiency		↓ Alkaline phosphatase (<70)

Stained Red Cell Examination

Discussion

The stained film examination provides information on red blood cell variation and abnormalities in red blood cell size, shape, hemoglobin content.

When would you run this test?

1. To help diagnose blood disorders: anemia, Thalassemia, and other hemoglobin disorders will have distinctive morphological changes that can be appreciated via a stained blood cell examination
2. As a guide to therapy: if therapy is effective the abnormalities will begin to clear up.
3. Often a Complete blood count (CBC) will include a stained red cell examination if gross abnormalities are seen

Clinical implications of abnormalities

Abnormality	Clinical Implication
Anisocytosis (abnormal variations in size)	Any severe anemia (iron deficiency, megaloblastic) Liver dysfunction
Microcytosis	Iron deficiency and iron loading anemia Thalassemia Lead poisoning
Macrocytosis	Megaloblastic anemia (Vitamin B12/foliate deficiency anemia) Liver disease
Macroovalocytosis	Megaloblastic anemia
Hypochromia (↓ concentration of hemoglobin)	Iron deficiency and iron loading anemia Thalassemia Lead poisoning
Nucleated red blood cells	Hemolytic anemia Leukemias Myeloproliferative diseases Multiple myeloma

Abnormality	Clinical Implication
Howell-Jolly bodies	Hyposplenism Pernicious anemia
Heinz bodies	Congenital hemolytic anemias Thalassemia
Siderocytes	Iron loading anemia Hyposplenism Hemolytic anemia
Cabot's rings	Pernicious anemia Lead poisoning
Basophilic stippling	Hemolytic anemia Lead poisoning
Rouleaux	Tissue hypoxia Ph imbalances and dysbiosis Poor protein metabolism Liver dysfunction Multiple myeloma
Poikilocytosis (abnormal variations in shape)	Digestive disorders especially dysbiosis Need for essential fatty acids Increased free radical activity Liver toxicity Poor circulation Any severe anemia

Degree of Poikilocytosis

Certain shapes are diagnostically helpful. The following are shapes seen on stained blood examination:

Abnormality	Clinical Implication
Ovalocytes	Iron deficiency B12/folate imbalances Hormonal imbalance
Sickle cells	Sickle cell disease
Target cells	Liver disease and bile insufficiency Dysbiosis Iron deficiency Thalassemia
Shistocytes	Increased toxins Spleen dysfunction Uremia
Burr cells	Hemolytic anemias Liver disease
Acanthocytes	Liver and spleen dysfunction Ph and overall terrain imbalance Vitamin E deficiency Hypercholesterolemia
Teardrop cells	Lack of assimilation Liver dysfunction