



BIOFIT

BLUEPRINTBOOTCAMP

Blood Chemistry

CBC and Anemia

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CBC - Complete Blood Count

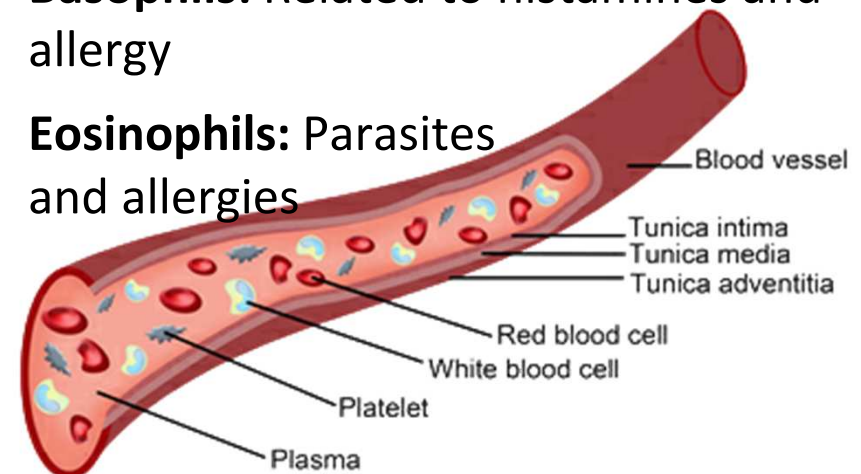
Anemia Markers

- ✓ **RBC:** Red blood cells - carry oxygen
- ✓ **Hemoglobin:** Transports oxygen and gives the red color to blood
- ✓ **Hematocrit:** Percentage of blood made up of red blood cells
- ✓ **MCV: Mean Corpuscular Volume** - Red blood cell size, as volume
- ✓ **MCH: Mean Corpuscular Hemoglobin** - the average amount of hemoglobin in red blood cells
- ✓ **MCHC: Mean Corpuscular Hemoglobin Concentration** - the average hemoglobin concentration in red blood cells
- ✓ **RDW:** Variation in the size of the RBC's

Platelets: Blood cell particles involved with the forming of blood clots

Immune System Markers

- ✓ **WBC:** White blood cells - primary defense against disease
- ✓ **Neutrophils:** Often elevated in bacterial infection
- ✓ **Lymphocytes:** Often elevated in viral infection
- ✓ **Monocytes:** Second line of defense – elevated in recovery stage and chronic infection
- ✓ **Basophils:** Related to histamines and allergy
- ✓ **Eosinophils:** Parasites and allergies



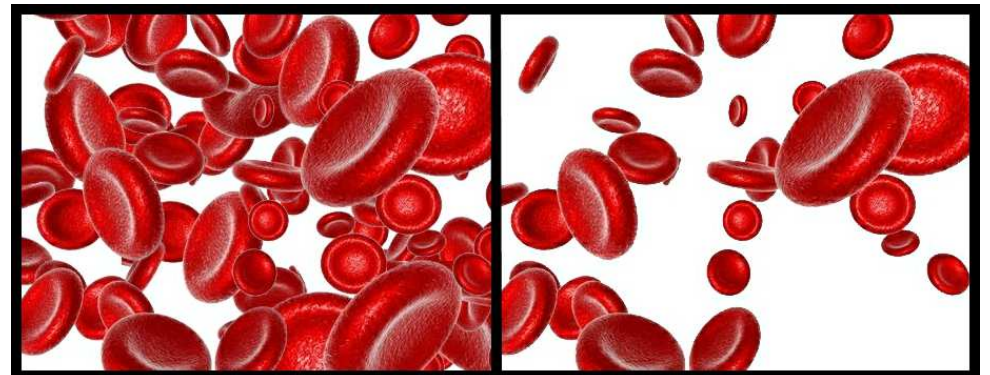
Symptoms of Anemia

- ✓ Fatigue
- ✓ Weakness
- ✓ Headache
- ✓ Shortness of breath after exercise
- ✓ Chest pain
- ✓ Pounding in ears
- ✓ Brittle nails
- ✓ Pallor
- ✓ Palpitations
- ✓ Dizziness
- ✓ Cold hands and feet



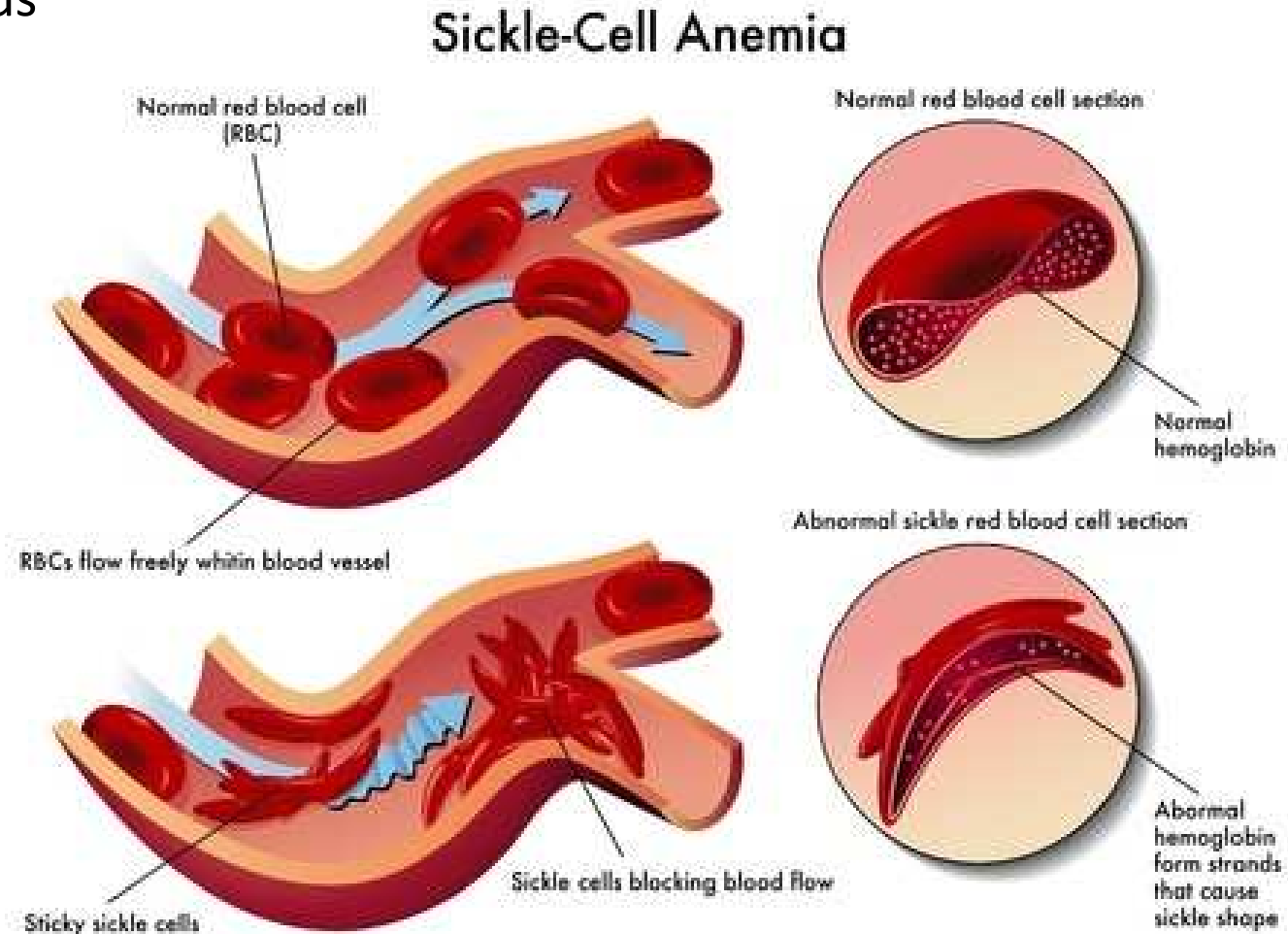
Causes of Anemia

- ✓ Insufficient dietary iron
- ✓ Insufficient dietary folate
- ✓ Insufficient dietary B12 or autoimmune disease resulting in poor absorption
- ✓ Malabsorption
- ✓ Essential fatty acid deficiency
- ✓ Low stomach acid
- ✓ Heavy menstrual bleeding
- ✓ Internal bleeding - ulcers, polyps, hemorrhoids, inflammatory bowel disease, cancer
- ✓ Pregnancy
- ✓ Worms and parasites
- ✓ Autoimmune disease
- ✓ Heart disease
- ✓ Chronic viral or bacterial infections
- ✓ Medications, i.e. NSAIDS
- ✓ Kidney disease
- ✓ Serious illness



Types of Anemia

- ✓ Iron deficiency
- ✓ B12 deficiency/pernicious
- ✓ Folate deficiency
- ✓ Vitamin B6 deficiency
- ✓ **Serious disease**
- needs to be evaluated
- ✓ Chronic disease
- ✓ **Internal bleeding (iron)**
- ✓ Hemolytic anemia
- ✓ Aplastic anemia
- ✓ Protein depletion
- ✓ Liver disease
- ✓ Polycythemia
- ✓ Hemochromatosis



Anemia Blood Markers #1

- ✓ **RBC:** (3.9 - 4.5 female, 4.2 - 4.9 male)
- ✓ **Hemoglobin:** (13.5 - 14.5 female, 14 - 15 male)
- ✓ **Hematocrit:** (37 - 44 female, 40 - 48 male) % of RBCs in plasma
- ✓ **MCV:** (82 - 89.9 microns)
- ✓ **MCH:** (27 - 32) Average weight of Hb in RBC (hemoglobin*10/RBC)
- ✓ **MCHC:** (32 - 35) Average hemoglobin in RBC (hemoglobin /hematocrit)
- ✓ **RDW:** Possibly earliest sign (11.7 - 13)
- ✓ **Reticulocyte Count:** Immature RBCs (.5 - 2.5 female, .5 - 1.5 male)



Anemia Blood Markers #2

- ✓ **Iron:** (85 - 130 ug/dl)
- ✓ **Ferritin:** (40 - 70 ng/ml)
- protein-bound form of iron
- ✓ **Transferrin:** main protein in the blood that binds to iron and transports it throughout the body.
- ✓ **Total Iron Binding Capacity (TIBC):**
(250 - 350) - available transferrin to bind iron
- ✓ **Transferrin Saturation:** (12 - 45 female, 15 - 50 male) $\text{Iron/TIBC} * 100$ – how much iron is actually bound to transferrin



Stages of Iron Deficiency Anemia

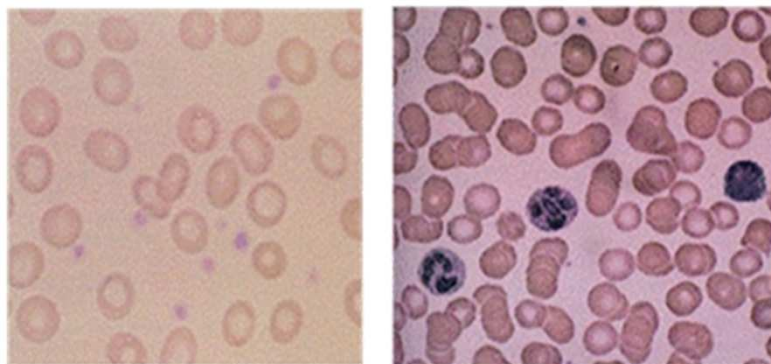
1: Decreased Iron Stores

- ✓ Decreased Ferritin
- ✓ Normal Serum Iron
- ✓ Normal Transferrin
- ✓ Normal MCV
- ✓ Normal Hemoglobin

2: Decreased Iron

- ✓ Decreased Ferritin
- ✓ Decreased Serum Iron
- ✓ Increased Transferrin
- ✓ Normal MCV
- ✓ Normal or low Hemoglobin

Iron Deficiency Anemia



anemia

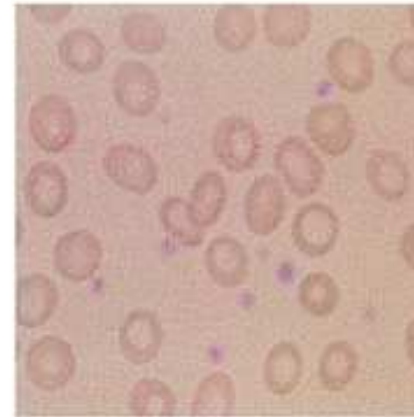
normal blood

Stages of Iron Deficiency Anemia

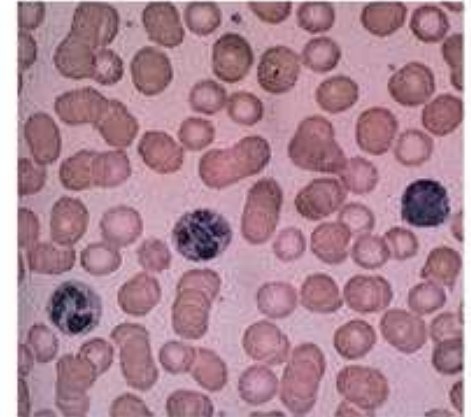
3: Iron Deficiency Anemia

- ✓ Decreased Hemoglobin
- ✓ Decreased Hematocrit
- ✓ Decreased RBC
- ✓ Decreased MCV
- ✓ Decreased MCH
- ✓ Decreased MCHC
- ✓ Decreased Iron, Serum
- ✓ Decreased Ferritin
- ✓ Decreased to Normal Iron Saturation
- ✓ Increased TIBC
- ✓ Increased Transferrin

Iron Deficiency Anemia



anemia

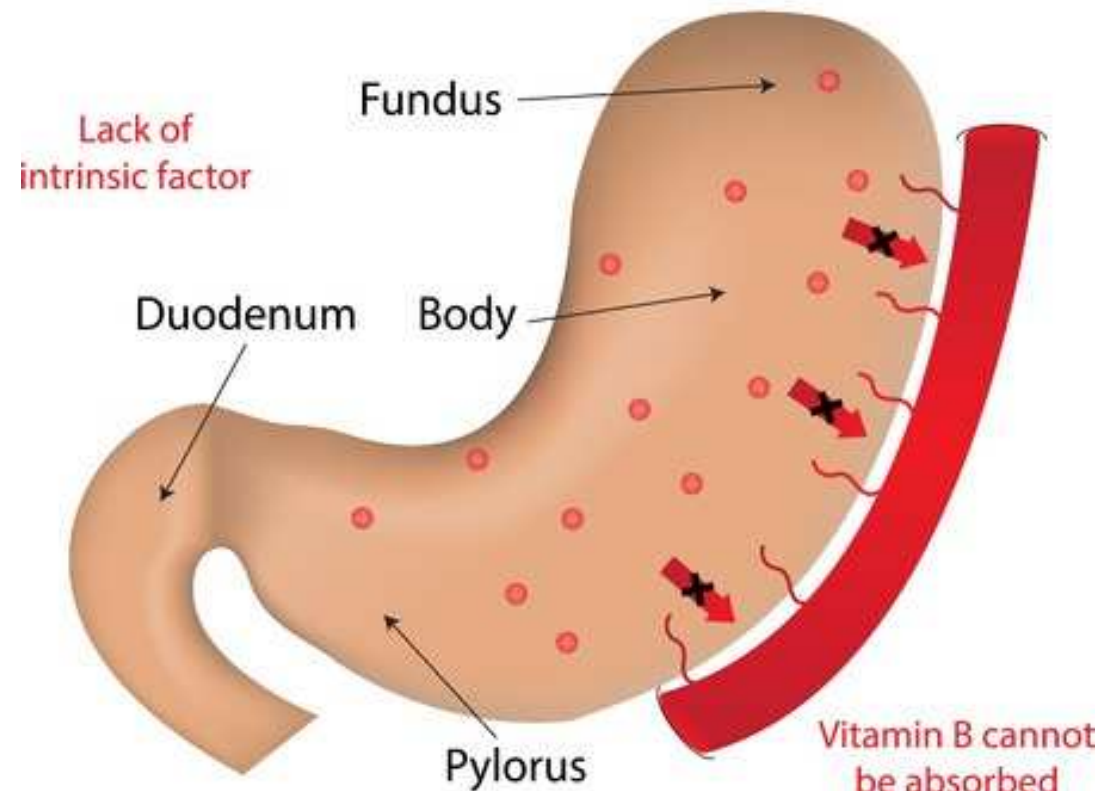


normal blood

B12 /Folate & Pernicious Anemia

- ✓ Decreased Hemoglobin
- ✓ Decreased Hematocrit
- ✓ Decreased RBC
- ✓ Increased MCV
- ✓ Increased MCH
- ✓ Increased MCHC
- ✓ Normal Iron, Serum
(or low if co-existing iron deficiency)
- ✓ Normal TIBC
- ✓ Normal Transferrin
- ✓ Normal Intrinsic Factor Antibody *(+ = Pernicious)

Pernicious Anemia



Anemia in Serious Illness

Similar pattern to Iron Deficiency Anemia except:

- **TIBC and Transferrin** may be normal to increased
- Distinguished by symptoms and other findings
- Includes
 - Chronic disease
 - Internal bleeding (iron)
 - Hemolytic anemia
 - Protein depletion
 - Liver disease
 - Kidney failure



SERIOUS and NEEDS to be Diagnosed by a Medical Practitioner



Anemias of Excess



Serious conditions requiring attention from a health care provider

Polycythemia

- ✓ RBC = Increased
- ✓ HCT = Increased
- ✓ HGB = Increased
- ✓ MCV = Normal to Decreased
- ✓ MCH = Normal to Decreased
- ✓ MCHC = Normal to Decreased
- ✓ Serum Iron = Normal to Decreased
- ✓ Total Bilirubin = Increased
- ✓ Alkaline Phosphatase = Elevated
- ✓ Basophils = Increased
- ✓ Total WBC = Increased
- ✓ Uric Acid = Increased

***Slightly elevated RBC in absence of other signs is probably due to dehydration*

Hemochromatosis

- ✓ RBC = Normal
- ✓ HCT = Normal
- ✓ HGB = Normal
- ✓ MCV = Decreased
- ✓ MCH = Decreased
- ✓ MCHC = Decreased
- ✓ Serum Iron = Increased
- ✓ Iron Saturation = Significantly Increased
- ✓ TIBC = Decreased
- ✓ Ferritin = Significantly
- ✓ Transferrin = Normal or Decreased Slightly
- ✓ SGOT = Normal or Increased

CBC Anemia Case 1: Iron Deficiency

48	CBC MARKERS						
49	WBC		4.0	10.5	5.0	8.0	5.6
50	RBC (Female)	-	3.9	5.1	3.9	4.5	3.9
51	RBC (Male)	-	3.9	5.1	4.2	4.9	
52	Hemoglobin (Female)	gm/dl	12.0	16.0	13.5	14.5	11
53	Hemoglobin (Male)	gm/dl	12.0	16.0	14.0	15.0	
54	Hematocrit (Female)	%	36.0	48.2	37.0	44.0	32.9
55	Hematocrit (Male)	%	36.0	48.2	40.0	48.0	
56	MCV	cu microns	82.0	103.0	85.0	92.0	84
57	MCH	g/cu microns	27.0	34.0	27.0	32.0	28.3
58	MCHC	g/cu microns	30.9	35.4	32.0	35.0	33.5
59	RDW	%	10.8	14.8	0.0	13.0	14.4
30	Iron, serum	ug/dl	40.0	180.0	85.0	130.0	67
80	Iron Saturation (calc) - Female	iron serum/TIBC			12.0	45.0	
81	Iron Saturation (calc) - Male	iron serum/TIBC			15.0	50.0	0
82	TIBC	ug/dl	250.0	390.0	250.0	350.0	
83	Transferrin	mg/dl			200.0	360.0	
84	Ferritin (pre-menopause)	-	33.0	236.0	10.0	122.0	
85	Ferritin (post-menopause)	-	33.0	236.0	10.0	263.0	

Follow-up Testing

- ❖ Vitamin B6 needed to make hemoglobin.
- ❖ Vitamin B6 increases the amount of oxygen carried by hemoglobin.
- ❖ Vitamin B6 deficiency can result in anemia similar to iron deficiency anemia.

CBC Anemia Case 2

3		Units	PATHOLOGICAL RANGE	FUNCTIONAL RANGE	12/22/09
4	Markers				
23	Iron	ug/dl	40-180	85-130	16
24	TIBC	ud/dl	250-390	250-350	
25	Ferritin (pre-menopause)	-	33-236	10-122	
26	Ferritin (post-menopause)	-	33-236	10-263	
27	Hgb (Female)	gm/dl	12-16	13.5-14.5	11.3
28	Hgb (Male)	gm/dl	12-16	14-15	-
29	Hct (Female)	%	36-48.2	37-44	33
30	Hct (Male)	%	36-48.2	40-48	-
31	RBC (Female)	-	3.9-5.1	3.9-4.5	3.79
32	RBC (Male)	-	3.9-5.1	4.2-4.9	-
33	MCV	cu microns	82-103	85-92	87
34	MCH	g/cu microns	27-34	27-32	29.9
35	MCHC	g/cu microns	30.9-35.4	32-35	34.2
36	RDW	%	10.8-14.8	<13	16.2
37	Platelets	-	150,000-400,000	150,000-450,000	238,000



- ❖ Iron deficiency – check ferritin.
- ❖ Suspected B12 anemia, too, because MCV is not decreased as it should be with such low iron.

CBC Anemia Case 3

3	CATEGORIES	Units	PATHOLOGICAL RANGE		FUNCTIONAL RANGE		CURRENT XX/XX/10
4			Min	Max	Min	Max	
48	CBC MARKERS						
49	WBC		4.0	10.5	5.0	8.0	3.5
50	RBC (Female)	-	3.9	5.1	3.9	4.5	4.49
51	RBC (Male)	-	3.9	5.1	4.2	4.9	
52	Hemoglobin (Female)	gm/dl	12.0	16.0	13.5	14.5	14.2
53	Hemoglobin (Male)	gm/dl	12.0	16.0	14.0	15.0	
54	Hematocrit (Female)	%	36.0	48.2	37.0	44.0	39.8
55	Hematocrit (Male)	%	36.0	48.2	40.0	48.0	
56	MCV	cu microns	82.0	103.0	85.0	92.0	89
57	MCH	g/cu microns	27.0	34.0	27.0	32.0	31.6
58	MCHC	g/cu microns	30.9	35.4	32.0	35.0	35.7
59	RDW	%	10.8	14.8	0.0	13.0	13.2
60	Platelets	(K)	150.0	400.0	150.0	450.0	190
30	Iron, serum	ug/dl	40.0	180.0	85.0	130.0	125

❖ Monitor RDW and check serum ferritin.

CBC Anemia Case 4

48	CBC MARKERS						
49	WBC		4.0	10.5	5.0	8.0	3.3
50	RBC (Female)	-	3.9	5.1	3.9	4.5	4.41
51	RBC (Male)	-	3.9	5.1	4.2	4.9	
52	Hemoglobin (Female)	gm/dl	12.0	16.0	13.5	14.5	14.3
53	Hemoglobin (Male)	gm/dl	12.0	16.0	14.0	15.0	
54	Hematocrit (Female)	%	36.0	48.2	37.0	44.0	41.1
55	Hematocrit (Male)	%	36.0	48.2	40.0	48.0	
56	MCV	cu microns	82.0	103.0	85.0	92.0	93
57	MCH	g/cu microns	27.0	34.0	27.0	32.0	32.3
58	MCHC	g/cu microns	30.9	35.4	32.0	35.0	34.7
59	RDW	%	10.8	14.8	0.0	13.0	13.2
60	Platelets	(K)	150.0	400.0	150.0	450.0	200
30	Iron, serum	ug/dl	40.0	180.0	85.0	130.0	169

- ❖ Probable B12 anemia.
- ❖ Iron excess with possible immune impairment.