

# B12 Deficiency - Part Three

Okay, now let's look at some cases.

Marker	Value	Functional Range	Lab Range
Glucose	95	75 - 90	65 - 99
Hemoglobin A1c	6.0	4.4 - 5.4	4.8 - 5.6
Uric Acid	5.8	3.2 - 5.5	2.5 - 7.1
BUN	23	13 - 18	8 - 27
Creatinine	1.01	0.85 - 1.1	0.57 - 1
BUN/Creatinine Ratio	23	9 - 23	9 - 23
Sodium	141	135 - 140	134 - 144
Potassium	4.4	4.0 - 4.5	3.5 - 5.2
Chloride	100	100 - 106	97 - 108
CO2	25	25 - 30	18 - 29
Calcium	9.5	9.2 - 10.1	8.7 - 10.3
Phosphorus	4.0	3.5 - 4.0	2.5 - 4.5
Magnesium	2.0	2.0 - 2.6	1.6 - 2.6
Protein, total	6.9	6.9 - 7.4	6.0 - 8.5
Albumin	4.3	4.0 - 5.0	3.6 - 4.8
Globulin	2.6	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.7	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.8	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	48	42 - 107	39 - 117
LDH	182	140 - 180	119 - 226
AST	29	10 - 30	0 - 40
ALT	19	10 - 22	0 - 32
GGT	43	0 - 28	0 - 60
TIBC	339	250 - 350	250 - 450
UIBC	191	150 - 375	150 - 375
Iron	148	85 - 135	35 - 155
Iron saturation	44	15 - 45	15 - 55
Ferritin	44	MW: 30 - 150	15 - 150
Cholesterol, total	217	150 - 250	100 - 199
Triglycerides	59	50 - 100	0 - 149
HDL	105	55 - 85	> 39
LDL	100	0 - 175	0 - 99
T. Chol / HDL Ratio	2.1	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.56	< 2	< 3.8
TSH	3.000	0.5 - 2.5	0.450 - 4.500
T4, total	4.7	6.0 - 12	4.5 - 12.0
T3 Uptake	41	28 - 35	24 - 39
T3, Total	68	100 - 180	71 - 180
Vitamin D, 25-hydroxy	30.5	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
<b>WBC</b>	<b>4.2</b>	<b>5.0 – 8.0</b>	3.4 - 10.8
RBC	4.60	4.4 – 4.9	3.77 - 5.28
Hemoglobin	13.7	13.5 - 14.5	11.1 - 15.9
Hematocrit	41.1	37 - 44	34.0 - 46.6
MCV	89	85 – 92	79 - 97
MCH	29.8	27.7 – 32.0	26.6 - 33.0
MCHC	33.3	32 – 35	31.5 - 35.7
RDW	14.0	11.5 – 15.0	12.3 - 15.4
Platelets	180	150 – 415	150 - 379
Neutrophils	49	40 – 60	
Lymphocytes	40	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	3	0.0 – 3.0	
Basophils	1	0.0 – 3.0	
<b>Additional Tests:</b>			
CRP-hs	0.83	< 1.0	0.00 - 3.00
Homocysteine	17.8	< 7.0	0.0 - 15.0
<b>Vitamin B-12</b>	<b>363</b>	<b>450 – 2000</b>	211 - 946
Copper	97		72 - 166
Zinc	100		56 - 134
Zinc / Copper Ratio	1.03	> 0.85	
<b>Serum Methylmalonic Acid (MMA)</b>	<b>359</b>	<b>0 - 325</b>	0 - 378
eGFR If NonAfrican Am	59		> 59

The first patient is a 65-year-old female with long-time insomnia and chronic hamstring injuries from running. Her serum B12 is 363, which is below the 406 cutoff defined for optimal function. Her serum MMA is 359, which is above the 300 cutoff. Her homocysteine is 17.8, above the lab range. In terms of underlying causes, she had SIBO, fungal overgrowth, dysbiosis, and Cryptosporidium. In her case, it's likely that GI malabsorption is leading to low B12 levels. You can also see low levels of vitamin D, glutathione, and iodine in other testing.

Marker	Value	Functional Range	Lab Range
Glucose	92	75 – 90	65 - 99
Hemoglobin A1c	5.1	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.9	3.2 - 5.5	2.5 - 7.1
BUN	11	13 – 18	6 - 20
Creatinine	0.92	0.85 – 1.1	0.57 - 1
Sodium	138	135 – 140	134 - 144
Potassium	4.4	4.0 – 4.5	3.5 - 5.2
Chloride	102	100 – 106	97 - 108
C02	22	25 – 30	18 - 29
Calcium	9.7	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.8	3.5 – 4.0	2.5 - 4.5
Magnesium	2.2	2.0 – 2.6	1.6 - 2.6
Protein, total	6.9	6.9 – 7.4	6.0 - 8.5
Albumin	4.5	4.0 – 5.0	3.5 - 5.5
Globulin	2.4	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.9	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.7	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	46	42 – 107	39 - 117
LDH	109	140 - 180	119 - 226
AST	15	10 - 30	0 - 40
ALT	9	10 - 22	0 - 32
GGT	14	0 - 28	0 - 60
TIBC	330	250 – 350	250 - 450
UIBC	141	150 - 375	150 - 375
Iron	189	85 – 135	35 - 155
Iron saturation	57	15 – 45	15 - 55
Ferritin	91	15 - 120	15 - 150
Cholesterol, total	212	150 – 250	100 - 189
Triglycerides	76	50 – 100	0 - 149
HDL	87	55 – 85	> 39
LDL	110	0 – 175	0 - 119
T. Chol / HDL Ratio	2.4	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.87	< 2	< 3.8
TSH	2.330	0.5 – 2.5	0.45 - 4.50
T4, total	9.2	6.0 – 12	4.5 - 12.0
T3 Uptake	31	28 - 35	24 - 39
T3, Total	102	100 – 180	71 - 180
Vitamin D, 25-hydroxy	34.2	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	5.2	5.0 – 8.0	3.4 - 10.8
RBC	4.43	4.4 – 4.9	3.77 - 5.28
Hemoglobin	13.8	13.5 - 14.5	11.1 - 15.9
Hematocrit	41.7	37 - 44	34.0 - 46.6
<b>MCV</b>	<b>94</b>	<b>85 – 92</b>	79 - 97
MCH	31.2	27.7 – 32.0	26.6 - 33.0
MCHC	33.1	32 – 35	31.5 - 35.7
RDW	12.3	11.5 – 15.0	12.3 - 15.4
Platelets	215	150 – 415	150 - 379
Neutrophils	50	40 – 60	
<b>Lymphocytes</b>	<b>41</b>	<b>25 – 40</b>	
Monocytes	7	4.0 – 7.0	
Eosinophils	1	0.0 – 3.0	
Basophils	1	0.0 – 3.0	
<b>Additional Tests:</b>			
CRP-hs	1	< 1.0	0.00 - 3.00
<b>Homocysteine</b>	<b>10.8</b>	<b>&lt; 9.0</b>	0.0 - 15.0
<b>Vitamin B-12</b>	<b>244</b>	<b>450 – 2000</b>	211 - 946
Copper	133		72 - 166
Zinc	114		56 - 134
Zinc / Copper Ratio	0.86	> 0.85	
Serum Methylmalonic Acid (MMA)	72	0 - 325	0 - 378

The next patient is a 25-year-old female with chief complaint of digestive issues and brain fog. Her serum B12 is 244, which is almost out of the lab range and certainly below the 406 optimal range. Homocysteine is 10.8, which is above the cutoff of 7. Her MCV is starting to creep up a bit. It's 94. This is another marker of B12 deficiency that we'll discuss more in the anemia section, but note that her serum MMA is completely normal, and this highlights the importance of not relying on a single marker for diagnosis. This patient also had high lysozyme and sIgA, indicating gut inflammation as well as SIBO and fungal overgrowth. She had iron overload, although I don't think that is related here.

Marker	Value	Functional Range	Lab Range
Glucose	84	75 – 90	65 - 99
Hemoglobin A1c	5.3	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.8	3.2 - 5.5	2.5 - 7.1
BUN	11	13 – 18	6 - 24
Creatinine	0.76	0.85 – 1.1	0.57 - 1
Sodium	143	135 – 140	134 - 144
Potassium	4.3	4.0 – 4.5	3.5 - 5.2
Chloride	103	100 – 106	97 - 108
CO2	26	25 – 30	18 - 29
Calcium	8.9	9.2 – 10.1	8.7 - 10.2
Phosphorus	4.1	3.5 – 4.0	2.5 - 4.5
Magnesium	2.2	2.0 – 2.6	1.6 - 2.6
Protein, total	7.0	6.9 – 7.4	6.0 - 8.5
Albumin	4.2	4.0 – 5.0	3.5 - 5.5
Globulin	2.8	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.5	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.4	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	68	42 – 107	39 - 117
LDH	150	140 - 180	119 - 226
AST	16	10 - 30	0 - 40
ALT	17	10 - 22	0 - 32
GGT	10	0 - 28	0 - 60
TIBC	282	250 – 350	250 - 450
UIBC	205	150 - 375	150 - 375
Iron	77	85 – 135	35 - 155
Iron saturation	27	15 – 40	15 - 55
Ferritin	85	MW: 30 - 150	15 - 150
Cholesterol, total	183	150 – 250	100 - 199
Triglycerides	35	50 – 100	0 - 149
HDL	59	55 – 85	> 39
LDL	117	0 – 175	0 - 99
T. Chol / HDL Ratio	3.1	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.59	< 2	< 3.8
TSH	1.830	0.5 – 2.5	0.45 - 4.50
T4, total	5.9	6.0 – 12	4.5 - 12
T3 Uptake	30	28 - 35	24 - 39
T3, Total	89	100 – 180	71 - 180
Vitamin D, 25-hydroxy	13.2	35 - 60	30 - 100

Marker	Value	Functional Range	Lab Range
WBC	5.8	5.0 – 8.0	3.4 - 10.8
RBC	4.18	4.4 – 4.9	3.77 - 5.28
Hemoglobin	12.8	13.5 - 14.5	11.1 - 15.9
Hematocrit	40.2	37 - 44	34 - 46.6
MCV	96	85 – 92	79 - 97
MCH	30.6	27.7 – 32.0	26.6 - 33.0
MCHC	31.8	32 – 35	31.5 - 35.7
RDW	13.1	11.5 – 15.0	12.3 - 15.4
Platelets	254	150 – 415	150 - 379
Neutrophils	52	40 – 60	
Lymphocytes	36	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	4	0.0 – 3.0	
Basophils	1	0.0 – 3.0	
<b>Additional Tests:</b>			
T3, Free	2.7	2.5 - 4.0	2 - 4.4
T4, Free	1.04	1 - 1.5	0.82 - 1.77
Thyroid – TPO Ab	6		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
CRP-hs	1.1	< 1.0	0.00 - 3.00
Homocysteine	6.9	< 9.0	0.0 - 15.0
Vitamin B-12	645	450 – 2000	211 - 946

The next patient is a 52-year-old female with gut and digestive issues since her teenage years and also brain fog and hypothyroidism. Note that her serum B12 and homocysteine are optimal. We didn't have a serum MMA on her because this was before I was running that test, but if you look at her hemoglobin, red blood cells, MCV, and MCHC, they all are suggestive of functional macrocytic anemia, which could be caused by either B12, B6, or folate deficiency.

**0091 Organix® Comprehensive Profile - Urine**

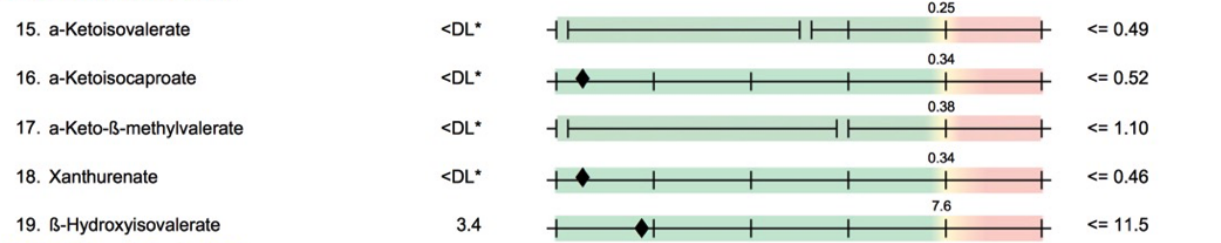
Methodology: LC/Tandem Mass Spectroscopy, Colorimetric

This report is not intended for the diagnosis of neonatal inborn errors of metabolism.

Ranges are for ages 13 and over

**B-Complex Vitamin Markers**

(B1, B2, B3, B5, B6, Biotin)



**Methylation Cofactor Markers**

(B12, Folate)



**BACTERIOLOGY CULTURE**

Expected/Beneficial flora	Commensal (Imbalanced) flora	Dysbiotic flora
4+ Bacteroides fragilis group	2+ Alpha hemolytic strep	3+ Aeromonas hydrophila
1+ Bifidobacterium spp.	1+ Gamma hemolytic strep	4+ Citrobacter freundii complex
4+ Escherichia coli		4+ Klebsiella pneumoniae ssp pneumoniae
1+ Lactobacillus spp.		
NG Enterococcus spp.		
3+ Clostridium spp.		
NG = No Growth		

If we look at her urine MMA, it's 1.8, which is above the 1.5 threshold defined for optimal B12 status. The root cause in this case is likely dysbiosis. She had high levels of dysbiotic flora and low levels of beneficial bacteria, which could impair B12 absorption.

Marker	Value	Functional Range	Lab Range
Glucose	84	75 – 90	65 - 99
Hemoglobin A1c	5.5	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.5	3.2 - 5.5	2.5 - 7.1
BUN	13	13 – 18	6 - 24
Creatinine	0.90	0.85 – 1.1	0.57 - 1
Sodium	139	135 – 140	134 - 144
Potassium	4.4	4.0 – 4.5	3.5 - 5.2
Chloride	99	100 – 106	97 - 108
CO2	23	25 – 30	18 - 29
Calcium	9.1	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.8	3.5 – 4.0	2.5 - 4.5
Magnesium	1.8	2.0 – 2.6	1.6 - 2.6
Protein, total	6.7	6.9 – 7.4	6.0 - 8.5
Albumin	4.5	4.0 – 5.0	3.5 - 5.5
Globulin	2.2	2.4 – 2.8	1.5 - 4.5
A/G ratio	2.0	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	41	42 – 107	39 - 117
LDH	134	140 - 180	119 - 226
AST	20	10 - 30	0 - 40
ALT	22	10 - 22	0 - 32
GGT	10	0 - 28	0 - 60
TIBC	267	250 – 350	250 - 450
UIBC	163	150 - 375	150 - 375
Iron	104	85 – 135	35 - 155
Iron saturation	39	15 – 45	15 - 55
Ferritin	70	15 - 120	15 - 150
Cholesterol, total	197	150 – 250	100 - 199
Triglycerides	55	50 – 100	0 - 149
HDL	56	55 – 85	> 39
LDL	130	0 – 175	0 - 99
T. Chol / HDL Ratio	3.5	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.98	< 2	< 3.8
TSH	2.150	0.5 – 2.5	0.45 - 4.50
T4, total	7.6	6.0 – 12	4.5 - 12.0
T3 Uptake	31	28 - 35	24 - 39
T3, Total	80	100 – 180	71 - 180
Vitamin D, 25-hydroxy	44.5	35 - 60	30.0 - 100.0

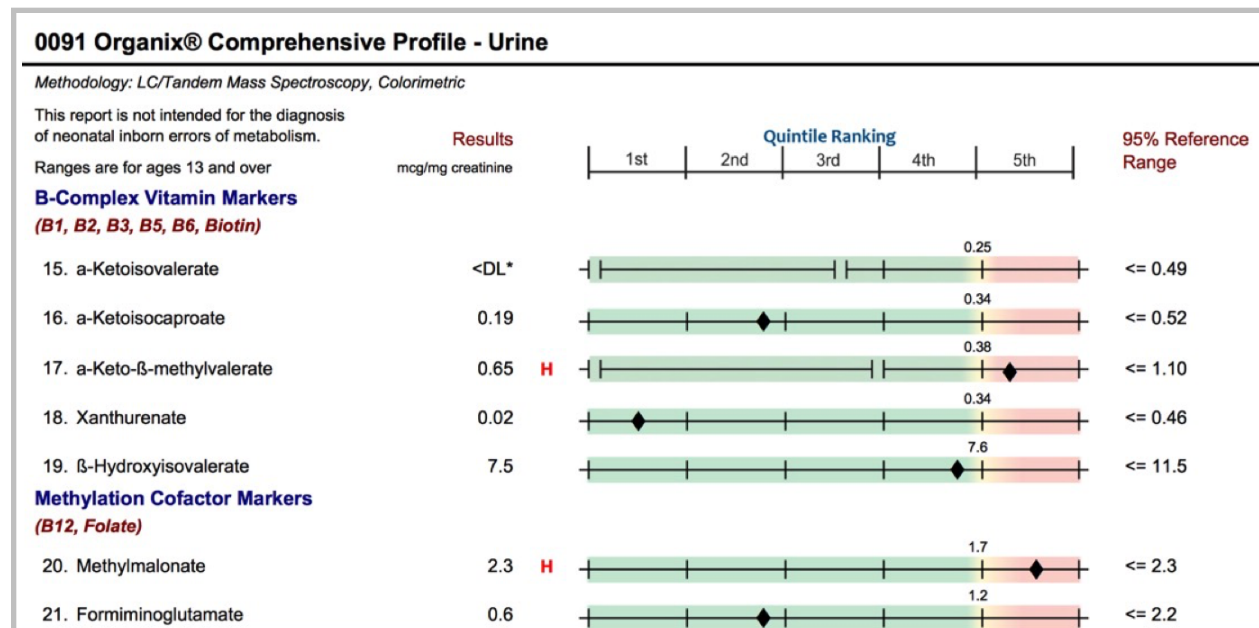


Marker	Value	Functional Range	Lab Range
WBC	5.0	5.0 – 8.0	3.4 - 10.8
RBC	4.53	4.4 – 4.9	3.77 - 5.28
Hemoglobin	13.3	13.5 - 14.5	11.1 - 15.9
Hematocrit	41.5	37 - 44	34.0 - 46.6
MCV	92	85 – 92	79 - 97
MCH	29.4	27.7 – 32.0	26.6 - 33.0
MCHC	32	32 – 35	31.5 - 35.7
RDW	13.3	11.5 – 15.0	12.3 - 15.4
Platelets	219	150 – 415	150 - 379
Neutrophils	66	40 – 60	
Lymphocytes	23	25 – 40	
Monocytes	8	4.0 – 7.0	
Eosinophils	3	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

Additional Tests:			
CRP-hs	1.3	< 1.0	0.00 - 3.00
Homocysteine	6.9	< 9.0	0.0 - 15.0
Vitamin B-12	342	450 – 2000	211 - 946
Copper	107		72 - 166
Zinc	103		56 - 134
Zinc / Copper Ratio	0.96	> 0.85	
Serum Methylmalonic Acid (MMA)	166	0 - 325	0 - 378

The next patient is a 43-year-old female with chief complaint of fertility support. She had low ovarian reserve, lichen sclerosus, and had some general complaints about her health and well-being. Her serum B12 was below the 406 cutoff. It was 342. Serum MMA and homocysteine are optimal, and hemoglobin was a little below the optimal range.



Her urine MMA, however, was well above the 1.5 cutoff at 2.3. This patient had dysbiosis, SIBO, and Blastocystis hominis, indicative of GI malabsorption. Once we addressed her GI system and dysbiosis, she was able to get pregnant again.

Marker	Value	Functional Range	Lab Range
Glucose	87	75 - 90	65 - 99
Hemoglobin A1c	5.8	4.8 - 5.4	4.8 - 5.6
Uric Acid	4.4	3.2 - 5.5	2.5 - 7.1
BUN	12	13 - 18	6 - 24
Creatinine	0.92	0.85 - 1.1	0.57 - 1
BUN/Creatinine Ratio	13	9 - 23	9 - 23
Sodium	141	134 - 140	134 - 144
Potassium	4.5	4.0 - 4.5	3.5 - 5.2
Chloride	102	100 - 106	97 - 108
CO2	23	25 - 30	18 - 29
Calcium	9.5	9.2 - 10.1	8.7 - 10.2
Phosphorus	4.2	3.5 - 4.0	2.5 - 4.5
Magnesium	2.3	2.0 - 2.6	1.6 - 2.3
Protein, total	6.9	6.9 - 7.4	6.0 - 8.5
Albumin	4.3	4.0 - 5.0	3.5 - 5.5
Globulin	2.6	2.4 - 2.8	1.5 - 4.5
A/G ratio	1.7	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.6	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	57	42 - 107	39 - 117
LDH	142	140 - 180	119 - 226
AST	15	10 - 30	0 - 40
ALT	11	10 - 22	0 - 32
GGT	15	0 - 28	0 - 60
TIBC	351	250 - 350	250 - 450
UIBC	194	150 - 375	131 - 425
Iron	157	85 - 135	27 - 159
Iron saturation	45	15 - 45	15 - 55
Ferritin	28	15 - 120	15 - 150
Vitamin B-12	222	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	9.7	35 - 60	30.0 - 100.0
Cholesterol, total	157	150 - 250	100 - 199
Triglycerides	59	50 - 100	0 - 149
HDL	54	55 - 85	> 39
LDL	91	0 - 175	0 - 99
T. Chol / HDL Ratio	2.9	< 3	0 - 4.4
Triglycerides / HDL Ratio	1.09	< 2	< 3.8
CRP-hs	0.09	< 1.0	0.00 - 3.00
Homocysteine	18.2	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	1.790	0.5 – 2.5	0.45 - 4.50
T4, total	6.8	6.0 – 12	4.5 - 12
T3 Uptake	26	28 - 35	24 - 39
T3, Total	104	100 – 180	71 - 180
Copper	92		72 - 166
Zinc	65		56 - 134
Zinc / Copper Ratio	0.71	> 0.85	
Serum Methylmalonic Acid (MMA)	645	0 - 325	0 - 378
WBC	3.6	5.0 – 8.0	3.4 - 10.8
RBC	4.44	4.4 – 4.9	3.77 - 5.28
Hemoglobin	12.5	13.5 - 14.5	11.1 - 15.9
Hematocrit	38.5	37 - 44	34 - 46.6
MCV	87	85 – 92	79 - 97
MCH	28.2	27.7 – 32.0	26.6 - 33.0
MCHC	32.5	32 – 35	31.5 - 35.7
RDW	14.2	11.5 – 15.0	12.3 - 15.4
Platelets	261	150 – 415	150 - 379
Neutrophils	49	40 – 60	
Lymphocytes	34	25 – 40	
Monocytes	9	4.0 – 7.0	
Eosinophils	7	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

The next patient was a 41-year-old female with chief complaint of exercise intolerance, leg cramps, alopecia, and digestive issues. She had been diagnosed with anemia by a previous clinician who prescribed high-dose iron therapy. It really drives me nuts how often this occurs. So many clinicians see low hemoglobin and just assume that it is iron deficiency without even looking at iron, B12, or folate levels. In this case, iron therapy made her GI complaints significantly worse and didn't improve her anemia symptoms, and that's not surprising because she doesn't have iron deficiency, as you can see. In fact, her B12 levels were almost below the lab range at 222. Her serum MMA and homocysteine were both well above the lab range. This patient had not yet completed her Organix test in our work together, so we don't know her urine MMA level, but the underlying cause with her was definitely nutritional. She had been a vegetarian for 20 years, so she had inadequate intake of B12. She also had one of the lowest vitamin D levels I've ever seen, at 9.7, which was also due to low intake and not enough sun exposure. This is a patient of East Indian descent who used sunblock routinely, even when she went outside for just a half hour.

Marker	Value	Functional Range	Lab Range
Glucose	79	75 – 90	65 - 99
Hemoglobin A1c	5.3	4.4 – 5.4	4.8 - 5.6
Uric Acid	3.1	3.2 - 5.5	2.5 - 7.1
BUN	20	13 – 18	6 - 20
Creatinine	0.80	0.85 – 1.1	0.57 - 1
Sodium	140	135 – 140	134 - 144
Potassium	4.5	4.0 – 4.5	3.5 - 5.2
Chloride	101	100 – 106	97 - 108
CO2	26	25 – 30	18 - 29
Calcium	9.4	9.2 – 10.1	8.7 - 10.2
Phosphorus	3.7	3.5 – 4.0	2.5 - 4.5
Magnesium	2.0	2.0 – 2.6	1.6 - 2.6
Protein, total	6.7	6.9 – 7.4	6.0 - 8.5
Albumin	4.9	4.0 – 5.0	3.5 - 5.5
Globulin	1.8	2.4 – 2.8	1.5 - 4.5
A/G ratio	2.7	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.7	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	51	42 – 107	39 - 117
LDH	126	140 - 180	119 - 226
AST	16	10 - 30	0 - 40
ALT	11	10 - 22	0 - 32
GGT	12	0 - 28	0 - 60
TIBC	277	250 – 350	250 - 450
UIBC	157	150 - 375	150 - 375
Iron	120	85 – 135	35 - 155
Iron saturation	43	15 – 45	15 - 55
Ferritin	109	15 - 120	15 - 150
Cholesterol, total	165	150 – 250	100 - 199
Triglycerides	56	50 – 100	0 - 149
HDL	59	55 – 85	> 39
LDL	95	0 – 175	0 - 99
T. Chol / HDL Ratio	2.8	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.95	< 2	< 3.8
TSH	2.440	0.5 – 2.5	0.45 - 4.50
T4, total	7.0	6.0 – 12	4.5 - 12.0
T3 Uptake	28	28 - 35	24 - 39
T3, Total	71	100 – 180	71 - 180
Vitamin D, 25-hydroxy	25.1	35 - 60	30.0 - 100.0

Marker	Value	Functional Range	Lab Range
WBC	3.2	5.0 – 8.0	3.4 - 10.8
RBC	4.40	4.4 – 4.9	3.77 - 5.28
Hemoglobin	13.6	13.5 - 14.5	11.1 - 15.9
Hematocrit	40.4	37 - 44	34.0 - 46.6
MCV	92	85 – 92	79 - 97
MCH	30.9	27.7 – 32.0	26.6 - 33.0
MCHC	33.7	32 – 35	31.5 - 35.7
RDW	13.0	11.5 – 15.0	12.3 - 15.4
Platelets	235	150 – 415	150 - 379
Neutrophils	54	40 – 60	
Lymphocytes	36	25 – 40	
Monocytes	6	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	2	0.0 – 3.0	
<b>Additional Tests:</b>			
T3, Free	2.4	2.5 - 4.0	2 - 4.4
T4, Free	1.2	1 - 1.5	0.82 - 1.77
Thyroid – TPO Ab	19		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
CRP-hs	0.2	< 1.0	0.00 - 3.00
Homocysteine	9.4	< 9.0	0.0 - 15.0
Vitamin B-12	391	450 – 2000	211 - 946
Copper	71		72 - 166
Zinc	84		56 - 134
Zinc / Copper Ratio	1.18	> 0.85	
Serum Methylmalonic Acid (MMA)	186	0 - 325	0 - 378

The next patient is a 36-year-old female with chief complaints of PMS, anxiety, nausea, dizziness, irritability, and hypotension. She was about 100 pounds. She also had gastritis, which is a clue for B12 deficiency, and had been hypothyroid since about 20 years old. She was diagnosed with Hashimoto's in 2013 when she had a TSH of over 1,000, and then she was diagnosed with SIBO in 2014, which could be another clue for potential B12 deficiency. Her serum B12 was 391, which is below the 406 cutoff. Homocysteine of 9.4 is elevated functionally. It's above 7. Serum MMA is normal. Note that her copper and vitamin D are also low, which is suggestive of nutrient malabsorption.

**0091 Organix® Comprehensive Profile - Urine**

Methodology: LC/Tandem Mass Spectroscopy, Colorimetric

This report is not intended for the diagnosis of neonatal inborn errors of metabolism.

Ranges are for ages 13 and over

**B-Complex Vitamin Markers**

(B1, B2, B3, B5, B6, Biotin)

	Results	Quintile Ranking	95% Reference Range
	mcg/mg creatinine	1st   2nd   3rd   4th   5th	
15. a-Ketoisovalerate	<DL*	0.25	<= 0.49
16. a-Ketoisocaproate	<DL*	0.34	<= 0.52
17. a-Keto-β-methylvalerate	0.20	0.38	<= 1.10
18. Xanthurenate	<DL*	0.34	<= 0.46
19. β-Hydroxyisovalerate	4.6	7.6	<= 11.5

**Methylation Cofactor Markers**

(B12, Folate)

20. Methylmalonate	2.0 <b>H</b>	1.7	<= 2.3
21. Formiminoglutamate	0.2	1.2	<= 2.2

Her urine MMA was 2.0, well above the 1.5 cutoff. She didn't have SIBO when I tested her, but she had significant insufficiency gut dysbiosis, which was likely a cause of malabsorption.

Note that in many of the cases that we've discussed so far, these are patients who are consuming a nutrient-dense, Paleo-type diet, so it goes to show that B12 deficiency can and does occur in omnivorous patients, just less frequently than vegetarians and vegans.

Marker	Value	Functional Range	Lab Range
Glucose	84	75 - 90	65 - 99
Hemoglobin A1c	4.8	4.8 - 5.4	4.8 - 5.6
Uric Acid	5.5	3.2 - 5.5	2.5 - 7.1
BUN	10	13 - 18	6 - 20
Creatinine	0.63	0.85 - 1.1	0.57 - 1
BUN/Creatinine Ratio	16	9 - 23	8 - 20
Sodium	139	134 - 140	134 - 144
Potassium	3.7	4.0 - 4.5	3.5 - 5.2
Chloride	102	100 - 106	97 - 108
CO2	26	25 - 30	18 - 29
Calcium	9.3	9.2 - 10.1	8.7 - 10.2
Phosphorus	3.5	3.5 - 4.0	2.5 - 4.5
Magnesium	1.7	2.0 - 2.6	1.6 - 2.3
Protein, total	6.4	6.9 - 7.4	6.0 - 8.5
Albumin	4.4	4.0 - 5.0	3.5 - 5.5
Globulin	2.0	2.4 - 2.8	1.5 - 4.5
A/G ratio	2.2	1.5 - 2.0	1.1 - 2.5
Bilirubin, total	0.7	0.1 - 1.2	0.0 - 1.2
Alkaline Phosphatase	60	42 - 107	39 - 117
LDH	159	140 - 180	119 - 226
AST	19	10 - 30	0 - 40
ALT	21	10 - 22	0 - 32
GGT	17	0 - 28	0 - 60
TIBC	267	250 - 350	250 - 450
UIBC	58	150 - 375	131 - 425
Iron	209	85 - 135	27 - 159
Iron saturation	78	15 - 45	15 - 55
Ferritin	86	15 - 120	15 - 150
Vitamin B-12	1083	450 - 2000	211 - 946
Vitamin D, 25-hydroxy	29.1	35 - 60	30.0 - 100.0
Cholesterol, total	161	150 - 250	100 - 199
Triglycerides	104	50 - 100	0 - 149
HDL	48	55 - 85	> 39
LDL	92	0 - 175	0 - 99
T. Chol / HDL Ratio	3.4	< 3	0 - 4.4
Triglycerides / HDL Ratio	2.17	< 2	< 3.8
CRP-hs	0.23	< 1.0	0.00 - 3.00
Homocysteine	5.5	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	2.850	0.5 – 2.5	0.45 - 4.50
T4, total	6.1	6.0 – 12	4.5 - 12
T3 Uptake	28	28 - 35	24 - 39
T3, Total	87	100 – 180	71 - 180
Copper	99		72 - 166
Zinc	79		56 - 134
Zinc / Copper Ratio	0.80	> 0.85	
Serum Methylmalonic Acid (MMA)	179	0 - 325	0 - 378
WBC	3.7	5.0 – 8.0	3.4 - 10.8
RBC	4.28	4.4 – 4.9	3.77 - 5.28
Hemoglobin	14.5	13.5 - 14.5	11.1 - 15.9
Hematocrit	43.1	37 - 44	34 - 46.6
MCV	101	85 – 92	79 - 97
MCH	33.9	27.7 – 32.0	26.6 - 33.0
MCHC	33.6	32 – 35	31.5 - 35.7
RDW	12.3	11.5 – 15.0	12.3 - 15.4
Platelets	158	150 – 415	150 - 379
Neutrophils	50	40 – 60	
Lymphocytes	36	25 – 40	
Monocytes	9	4.0 – 7.0	
Eosinophils	5	0.0 – 3.0	
Basophils	0	0.0 – 3.0	

That said, let's look at another case of plant-based diet causing B12 deficiency. You might be surprised that I have vegans and vegetarians in my practice given that I wrote a book about the Paleo diet, but I do have several. This patient had chronic back and knee pain that was so severe she was on crutches. She tested negative for rheumatoid arthritis, and the question here is could it be B12 deficiency causing an increase in iNOS, inducible nitric oxide synthase-mediated inflammation and pain? That's definitely one possibility. Her serum B12, though, was high. Her serum MMA and homocysteine were completely normal, but then her MCV and her MCH are well outside of the lab range. Magnesium, vitamin D, and zinc were all on the low side, so what's going on here?



TEST	RESULT			REFERENCE (ELISA Index)
	IN RANGE (Normal)	EQUIVOCAL*	OUT OF RANGE	
<b>Array 5 – Multiple Autoimmune Reactivity Screen **</b>				
Parietal Cell + ATPase	0.53			0.1-1.4
Intrinsic Factor			1.25	0.1-1.2
ASCA + ANCA	0.61			0.2-1.4
Tropomyosin	0.61			0.1-1.5
Thyroglobulin	0.27			0.1-1.3
Thyroid Peroxidase	0.60			0.1-1.3
21-Hydroxylase (Adrenal Cortex)	0.32			0.2-1.2
Myocardial Peptide	0.57			0.1-1.5
Alpha-Myosin	0.56			0.3-1.5
Phospholipid	0.81			0.2-1.3
Platelet Glycoprotein	0.23			0.1-1.3
Ovary/Testis ***	0.74			0.1-1.2
Fibulin	0.49			0.4-1.6
Collagen Complex	0.66			0.2-1.6
Arthritic Peptide	0.37			0.2-1.3
Osteocyte	0.61			0.1-1.4
Cytochrome P450 (Hepatocyte)	0.48			0.3-1.6
Insulin + Islet Cell	0.94			0.4-1.7
Glutamic Acid Decarboxylase 65	0.66			0.2-1.6
Myelin Basic Protein	1.05			0.1-1.4
Asialoganglioside	0.64			0.1-1.4
Alpha-Tubulin + Beta-Tubulin	0.68			0.4-1.4
Cerebellar	0.69			0.2-1.4
Synapsin	0.58			0.1-1.2

I did an antibody panel to see if autoimmunity was playing a role in her chronic pain, and she was producing antibodies to intrinsic factor, which impaired B12 absorption. She was taking a multivitamin with B12, but the dose was not high enough, and if antibodies are present, GI absorption will be impaired. She may need a higher dose, and it would probably need to be sublingual. I referred her out for a complete workup for pernicious anemia, and she was diagnosed with it. Pernicious anemia and a vegan diet are a very bad combination. That said, she would need supplementation even if she was on an omnivorous diet because she can't absorb B12 orally. She would have to take it sublingually or get injections.

<b>Vitamin B12</b>	384	pg/mL	211 - 946	01	
01 SO LabCorp San Diego Dir: Kelli Chase, MD 13112 Evening Creek Dr So Ste 200, San Diego, CA 92128-4108 For inquiries, the physician may contact Branch: 800-762-4344 Lab: 858-668-3700					
<b>TESTS</b>	<b>RESULT</b>	<b>FLAG</b>	<b>UNITS</b>	<b>REFERENCE INTERVAL</b>	<b>LAB</b>
<b>Methylmalonic Acid, Urine</b>					
Methylmalonic Acid, U	7.8		umol/L	1.6 - 29.7	01
MMA-Normalized (Crt)	0.4		umol/nmol cr	0.4 - 2.5	01
Tests Ordered					
Homocyst(e)ine, Plasma; Venipuncture					
<b>TESTS</b>	<b>RESULT</b>	<b>FLAG</b>	<b>UNITS</b>	<b>REFERENCE INTERVAL</b>	<b>LAB</b>
<b>Homocyst(e)ine, Plasma</b>	6.3		umol/L	0.0 - 15.0	01
01 SO LabCorp San Diego Dir: Kelli Chase, MD 13112 Evening Creek Dr So Ste 200, San Diego, CA 92128-4108 For inquiries, the physician may contact Branch: 800-762-4344 Lab: 858-668-3700					
<b>TESTS</b>	<b>RESULT</b>	<b>FLAG</b>	<b>UNITS</b>	<b>REFERENCE INTERVAL</b>	<b>LAB</b>
<b>C-Reactive Protein, Cardiac</b>	19.00	High	mg/L	0.00 - 3.00	01
	Relative Risk for Future Cardiovascular Event				
			Low	<1.00	
			Average	1.00 - 3.00	
			High	>3.00	
<b>Cystatin C</b>	0.71		mg/L	0.53 - 0.95	02
<b>Intrinsic Factor Abs, Serum</b>	Positive	Abnormal		Negative	02

Here is a 32-year-old male with chief complaint of digestive issues. Serum B12 was 384 on the initial test. Urine MMA and homocysteine were optimal. However, he had a history of low B12 and gastritis and tested positive for antibodies to intrinsic factor. I again referred him out for a more complete workup, and he did have pernicious anemia. You can see here he also had very high C-reactive protein. He had some other inflammatory issues going on.

It's important to be aware that not all patients with pernicious anemia will present with significantly low serum B12 levels. You may see only functionally low B12 or just below the lab range, and it could be, in that case, recent onset, or it could be that they are still able to absorb some B12.