KRESSER INSTITUTE
FOR FUNCTIONAL AND EVOLUTIONARY MEDICINE

Blood Chemistry Case Assignments

CASE #1: HYPERGLYCEMIA

Summary: 51-year-old male, active, practices mixed martial arts, and follows a strict Paleo diet, presents with concerns about his elevated blood glucose. He has no family history of diabetes, and no other complaints. At the Initial Consult, he reports that his fasting blood glucose frequently measures over 100 and hemoglobin A1c tends to be around 5.5.
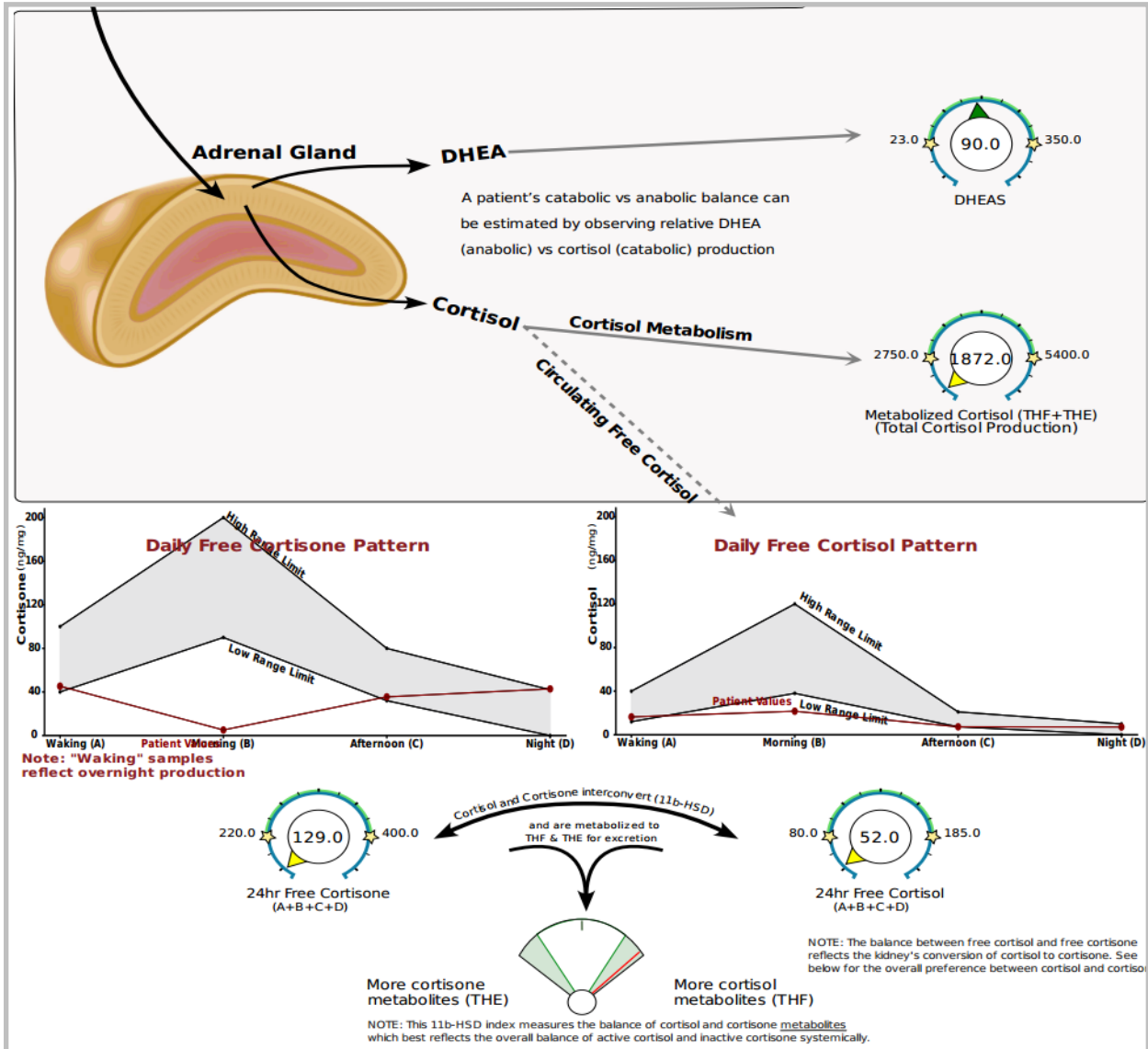
CASE #2: HYPOGLYCEMIA

Summary: 24-year-old male, working at a large tech company in Silicon Valley, presented with complaints of brain fog, fatigue, episodes of feeling light-headed and shaky between meals, difficulty staying asleep and difficulty waking up in the morning. He describes his day as follows: work bus from San Francisco to Palo Alto around 8am, work in front of a computer from approximately 9:30am to 8pm, bus back home around 9:30pm, a few hours on social media, and sleep around midnight. Most meals are eaten at work, and no known gluten though he is admittedly not overly cautious.

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL	LAB
CMP14+LP+TP+TSH+5AC+CBC/D/P...					
Glucose, Serum	64	Low	mg/dL	65 – 99	01
Hemoglobin A1c	5.6		%	4.8 – 5.6	01

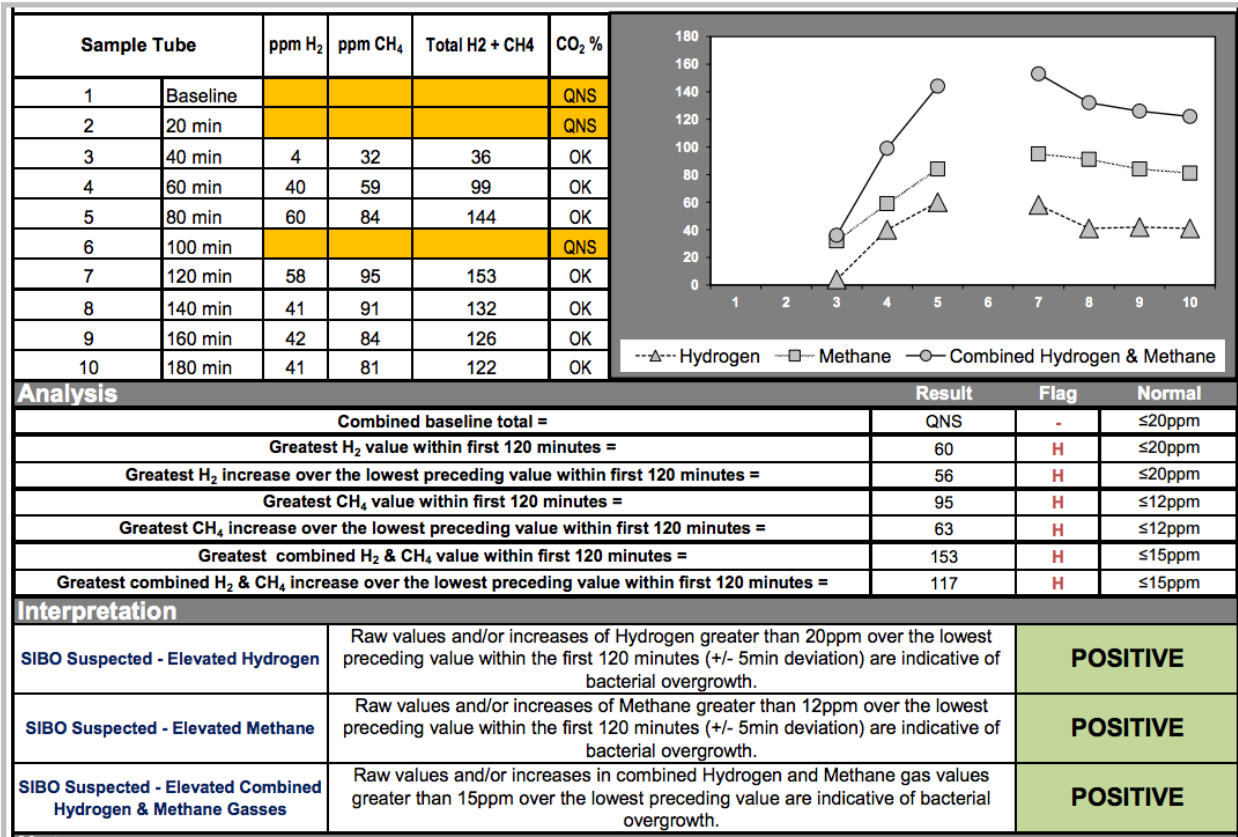**Also of note:**

- Magnesium, serum 1.7
- Iron 165
- Iron saturation 54%
- Ferritin 220
- Vitamin D 24

Advanced Adrenal Profile:

Adrenal Gland

DHEA

A patient's catabolic vs anabolic balance can be estimated by observing relative DHEA (anabolic) vs cortisol (catabolic) production

23.0 — 90.0 — 350.0
DHEAS

Cortisol

Cortisol Metabolism

2750.0 — 1872.0 — 5400.0
Metabolized Cortisol (THF+THE)
(Total Cortisol Production)

Circulating Free Cortisol

Daily Free Cortisone Pattern

High Range Limit
Low Range Limit
Patient Values
Waking (A) Morning (B) Afternoon (C) Night (D)

Note: "Waking" samples reflect overnight production

Daily Free Cortisol Pattern

High Range Limit
Patient Values Low Range Limit
Waking (A) Morning (B) Afternoon (C) Night (D)

220.0 — 129.0 — 400.0
24hr Free Cortisone
(A+B+C+D)

Cortisol and Cortisone interconvert (11b-HSD)
and are metabolized to THF & THE for excretion

80.0 — 52.0 — 185.0
24hr Free Cortisol
(A+B+C+D)

More cortisone metabolites (THE)

More cortisol metabolites (THF)

NOTE: The balance between free cortisol and free cortisone reflects the kidney's conversion of cortisol to cortisone. See below for the overall preference between cortisol and cortisone

NOTE: This 11b-HSD index measures the balance of cortisol and cortisone metabolites which best reflects the overall balance of active cortisol and inactive cortisone systemically.

SIBO breath test:

Sample Tube		ppm H_2	ppm CH_4	Total H2 + CH4	CO_2 %
1	Baseline				QNS
2	20 min				QNS
3	40 min	4	32	36	OK
4	60 min	40	59	99	OK
5	80 min	60	84	144	OK
6	100 min				QNS
7	120 min	58	95	153	OK
8	140 min	41	91	132	OK
9	160 min	42	84	126	OK
10	180 min	41	81	122	OK

--△-- Hydrogen   --□-- Methane   --○-- Combined Hydrogen & Methane

Analysis	Result	Flag	Normal
Combined baseline total =	QNS	-	≤20ppm
Greatest H_2 value within first 120 minutes =	60	H	≤20ppm
Greatest H_2 increase over the lowest preceding value within first 120 minutes =	56	H	≤20ppm
Greatest CH_4 value within first 120 minutes =	95	H	≤12ppm
Greatest CH_4 increase over the lowest preceding value within first 120 minutes =	63	H	≤12ppm
Greatest combined H_2 & CH_4 value within first 120 minutes =	153	H	≤15ppm
Greatest combined H_2 & CH_4 increase over the lowest preceding value within first 120 minutes =	117	H	≤15ppm

Interpretation		
SIBO Suspected - Elevated Hydrogen	Raw values and/or increases of Hydrogen greater than 20ppm over the lowest preceding value within the first 120 minutes (+/- 5min deviation) are indicative of bacterial overgrowth.	POSITIVE
SIBO Suspected - Elevated Methane	Raw values and/or increases of Methane greater than 12ppm over the lowest preceding value within the first 120 minutes (+/- 5min deviation) are indicative of bacterial overgrowth.	POSITIVE
SIBO Suspected - Elevated Combined Hydrogen & Methane Gasses	Raw values and/or increases in combined Hydrogen and Methane gas values greater than 15ppm over the lowest preceding value are indicative of bacterial overgrowth.	POSITIVE

CASE #3: IRON DEFICIENCY

Summary: Two-year-old boy was brought in because his mother reported he had a long history of diarrhea/loose stools, he became sick frequently when starting preschool (more frequently than his classmates), and threw tantrums that she related to fatigue.

Stool testing, urine organic acid testing and a limited blood panel were performed.

Comprehensive Stool Analysis / Parasitology x3

BACTERIOLOGY CULTURE		
Expected/Beneficial flora	**Commensal (Imbalanced) flora**	**Dysbiotic flora**
4+ Bacteroides fragilis group	2+ Pseudomonas citronellolis	3+ Citrobacter freundii complex
3+ Bifidobacterium spp.		3+ Klebsiella pneumoniae ssp pneumoniae
3+ Escherichia coli		
NG Lactobacillus spp.		
4+ Enterococcus spp.		
2+ Clostridium spp.		
NG = No Growth		

BACTERIA INFORMATION
Expected /Beneficial bacteria make up a significant portion of the total microflora in a healthy & balanced GI tract. These beneficial bacteria have many health-protecting effects in the GI tract including manufacturing vitamins, fermenting fibers, digesting proteins and carbohydrates, and propagating anti-tumor and anti-inflammatory factors.
Clostridia are prevalent flora in a healthy intestine. Clostridium spp. should be considered in the context of balance with other expected/beneficial flora. Absence of clostridia or over abundance relative to other expected/beneficial flora indicates bacterial imbalance. If *C. difficile* associated disease is suspected, a Comprehensive Clostridium culture or toxigenic *C. difficile* DNA test is recommended.
Commensal (Imbalanced) bacteria are usually neither pathogenic nor beneficial to the host GI tract. Imbalances can occur when there are insufficient levels of beneficial bacteria and increased levels of commensal bacteria. Certain commensal bacteria are reported as dysbiotic at higher levels.
Dysbiotic bacteria consist of known pathogenic bacteria and those that have the potential to cause disease in the GI tract. They can be present due to a number of factors including: consumption of contaminated water or food, exposure to chemicals that are toxic to beneficial bacteria; the use of antibiotics, oral contraceptives or other medications; poor fiber intake and high stress levels.

YEAST CULTURE	
Normal flora	**Dysbiotic flora**
1+ Cryptococcus diffluens	
1+ Rhodotorula mucilaginosa	

MICROSCOPIC YEAST		YEAST INFORMATION
Result:	**Expected:**	Yeast normally can be found in small quantities in the skin, mouth, intestine and mucocutaneous junctions. Overgrowth of yeast can infect virtually every organ system, leading to an extensive array of clinical manifestations. Fungal diarrhea is associated with broad-spectrum antibiotics or alterations of the patient's immune status. Symptoms may include abdominal pain, cramping and irritation. When investigating the presence of yeast, disparity may exist between culturing and microscopic examination. Yeast are not uniformly dispersed throughout the stool, this may lead to undetectable or low levels of yeast identified by microscopy, despite a cultured amount of yeast. Conversely, microscopic examination may reveal a significant amount of yeast present, but no yeast cultured. Yeast does not always survive transit through the intestines rendering it unvialble.
Mod	None - Rare	

The microscopic finding of yeast in the stool is helpful in identifying whether there is proliferation of yeast. Rare yeast may be normal; however, yeast observed in higher amounts (few, moderate, or many) is abnormal.

DIGESTION /ABSORPTION

	Within	Outside	Reference Range	
Elastase	> 500		> 200 µg/mL	
Fat Stain	Few		None - Mod	
Muscle fibers	None		None - Rare	
Vegetable fibers	Rare		None - Few	
Carbohydrates	Neg		Neg	

Elastase findings can be used for the diagnosis or the exclusion of exocrine pancreatic insufficiency. Correlations between low levels and chronic pancreatitis and cancer have been reported. **Fat Stain:** Microscopic determination of fecal fat using Sudan IV staining is a qualitative procedure utilized to assess fat absorption and to detect steatorrhea. **Muscle fibers** in the stool are an indicator of incomplete digestion. Bloating, flatulence, feelings of "fullness" may be associated with increase in muscle fibers. **Vegetable fibers** in the stool may be indicative of inadequate chewing, or eating "on the run". **Carbohydrates:** The presence of reducing substances in stool specimens can indicate carbohydrate malabsorption.

INFLAMMATION

	Within	Outside	Reference Range	
Lactoferrin	6.3		< 7.3 µg/mL	
Calprotectin*	13		<= 50 µg/g	
Lysozyme*		723	<= 600 ng/mL	
White Blood Cells	None		None - Rare	
Mucus	Neg		Neg	

Lactoferrin and **Calprotectin** are reliable markers for differentiating organic inflammation (IBD) from function symptoms (IBS) and for management of IBD. Monitoring levels of fecal lactoferrin and calprotectin can play an essential role in determining the effectiveness of therapy, are good predictors of IBD remission, and can indicate a low risk of relapse. **Lysozyme*** is an enzyme secreted at the site of inflammation in the GI tract and elevated levels have been identified in IBD patients. **White Blood Cells** (WBC) and **Mucus** in the stool can occur with bacterial and parasitic infections, with mucosal irritation, and inflammatory bowel diseases such as Crohn's disease or ulcerative colitis.

IMMUNOLOGY

	Within	Outside	Reference Range	
Secretory IgA*		592	51 - 204 mg/dL	

Secretory IgA* (sIgA) is secreted by mucosal tissue and represents the first line of defense of the GI mucosa and is central to the normal function of the GI tract as an immune barrier. Elevated levels of sIgA have been associated with an upregulated immune response.

0091 Organix® Comprehensive Profile - Urine

Methodology: LC/Tandem Mass Spectroscopy, Colorimetric

Bacterial - General

p-Hydroxybenzoate	High	Probiotics	Intestinal Bacterial Overgrowth
p-Hydroxyphenylacetate	High	Probiotics	Intestinal Bacterial Overgrowth
Indican	High	Probiotics	Intestinal Bacterial Overgrowth

L. acidophilus / general bacteria
No Abnormality Found

Clostridial Species
No Abnormality Found

Yeast/Fungal
No Abnormality Found

Marker	Value	Functional Range	Lab Range
TIBC	367	275 – 425	250 - 450
Iron	24	40 – 135	35 - 150
Iron saturation	7	17 – 45	20 - 55
Ferritin	10	30 - 200	10 - 300
Vitamin D, 25-hydroxy	34.3	35 - 60	30.0 - 80.0
TSH	2.620	0.5 – 2.0	0.35 - 5.50
T3, Total	152	100 – 180	60 - 181
T4, Free	1.2	1 - 1.5	0.7 - 1.7
Thyroid – TPO Ab	11		0 - 13
Thyroid – TGA	<1.0		0 - 0.9
WBC	9.0	5.0 – 8.0	6 - 17.5
RBC	4.67	4.4 – 4.9	4 - 5.3
Hemoglobin	11.8	14 - 15	10.5 - 15.5
Hematocrit	35.2	40 - 48	30 - 51.0
MCV	75	85 – 92	75 - 96
MCH	25.0	27.7 – 32.0	26.0 - 34.0
MCHC	33.5	32 – 35	32.0 - 36.0
RDW	14.6	11.5 – 15.0	11.5 - 15.0
Platelets	428	150 – 379	140 - 400
Neutrophils	53	40 – 60	25 - 49
Lymphocytes	35	25 – 40	33 - 54
Monocytes	9	4.0 – 7.0	< 12
Eosinophils	3	0.0 – 3.0	< 6
Basophils	0	0.0 – 3.0	0 - 3

CASE #4: IRON OVERLOAD

Summary: 56-year-old college professor who presented with complaints of frequent illness throughout the year.

TIBC	251	250 – 350	250 - 450
UIBC	165	150 - 375	150 - 375
Iron	86	85 – 135	40 - 155
Iron saturation	34	15 – 45	15 - 55
Ferritin	1071	30 - 150	30 - 400

CASE #5: B12 DEFICIENCY

Summary: 46-year-old university professor presented with a complaint of generalized muscle aches and plantar fasciitis. She was otherwise in good health without notable symptoms. She was found to have significantly elevated levels of mercury and arsenic shortly before leaving for a seven-month sabbatical in Chile. When she returned, we ran a comprehensive blood panel to establish a new baseline before moving forward with metal detoxification.

Marker	Value	Functional Range	Lab Range
Glucose	85	75 - 90	65 - 99
Hemoglobin A1c	5.2	4.4 – 5.4	4.8 - 5.6
Uric Acid	3.6	3.2 - 5.5	2.5 - 7.1
BUN	11	13 – 18	6 - 24
Creatinine	0.64	0.7 – 1.0	0.57 - 1.00
BUN/Creatinine Ratio	17	9 – 23	9 - 23
eGFR if Non-African American	107		> 59
eGFR if African American	124		> 59
Sodium	142	135 – 140	134 - 144
Potassium	4.4	4.0 – 4.5	3.5 - 5.2
Chloride	104	100 – 106	97 - 108
C02	22	25 – 30	18 - 29
Calcium	9.4	9.2 – 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	31	30 - 60	15 - 65
Phosphorus	3.3	3.0 – 4.0	2.5 - 4.5
Magnesium	2.1	2.0 – 2.6	1.6 - 2.3
Protein, total	6.6	6.9 – 7.4	6.0 - 8.5
Albumin	4.2	4.0 – 5.0	3.5 - 5.5
Globulin	2.4	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.8	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	54	42 – 107	39 - 117
LDH	160	140 - 180	119 - 226
AST	14	0 - 23	0 - 40
ALT	5	0 - 20	0 - 32
GGT	11	0 - 21	0 - 60
TIBC	295	275 – 425	250 - 450
UIBC	130	175 - 350	131 - 425
Iron	165	40 – 135	27 - 159
Iron saturation	56	17 – 45	15 - 55
Ferritin	209	30 - 100	15 - 150
Vitamin B-12	319	450 – 2000	211 - 946
Folate, Serum	16.2	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	51.2	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	23.8	35 - 60	30.0 - 100.0
Cholesterol, total	188	150 - 230	100 - 199
Triglycerides	56	50 – 100	0 - 149
HDL	84	55 – 85	> 39
LDL	93	0 - 140	0 - 99
T. Chol / HDL Ratio	2.2	< 3	0 - 4.4
Triglycerides / HDL Ratio	0.67	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	0.28	< 1.0	0.00 - 3.00
Homocysteine	10.1	< 7.0	0.0 - 15.0
TSH	1.730	0.5 – 2.0	0.45 - 4.500
T4, total	8.0	6.0 – 12	4.5 - 12.0
T3 Uptake	33	28 - 35	24 - 39
T3, Total	108	100 – 180	71 - 180
T3, Free	2.8	2.5 - 4.0	2 - 4.4
T4, Free	1.47	1 - 1.5	0.82 - 1.77
Reverse T3	22.1	9 - 21	9.2 - 24.1
Thyroid – TPO Ab	10		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
Copper	88	81 - 157	72 - 166
Zinc	75	64 - 126	56 - 134
Zinc / Copper Ratio	0.85	> 0.85	
Serum Methylmalonic Acid (MMA)	571	< 300	0 - 378
WBC	5.9	5.0 – 8.0	3.4 - 10.8
RBC	4.31	4.4 – 4.9	3.77 - 5.28
Hemoglobin	13.8	13.5 - 14.5	11.1 - 15.9
Hematocrit	40.9	37 - 44	34 - 46.6
MCV	95	85 – 92	79 - 97
MCH	32.0	27.7 – 32.0	26.6 - 33.0
MCHC	33.7	32 – 35	31.5 - 35.7
RDW	13.1	11.5 – 15.0	12.3 - 15.4
Platelets	239	150 – 379	150 - 379
Neutrophils	57	40 – 60	
Lymphocytes	31	25 – 40	
Monocytes	9	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

CASE #6: ZINC-COPPER IMBALANCE

Summary: 43-year-old female presenting with complaints of fatigue, weight loss resistance, abdominal distention and digestive issues characterized by alternating constipation and loose stools. When asked further, she described weight loss resistance as her primary concern and she described this feeling as "being thick, but not fat." She reports being unable to wear most of her rings for the past one to two years because they no longer fit on her fingers most days.

Marker	Value	Functional Range	Lab Range
CRP-hs	3.57	< 1.0	0.00 - 3.00
Homocysteine	12.0	< 7.0	0.0 - 15.0
TSH	1.970	0.5 – 2.0	0.45 - 4.50
T4, total	8.6	6.0 – 12	4.5 - 12
T3 Uptake	31	28 - 35	24 - 39
T3, Total	104	100 – 180	71 - 180
T3, Free	3.1	2.5 - 4.0	2 - 4.4
T4, Free	1.23	1 - 1.5	0.82 - 1.77
Reverse T3	19.1	9 - 21	9.2 - 24.1
Thyroid – TPO Ab	<6		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
Copper	117	81 - 157	72 - 166
Zinc	96	64 - 126	56 - 134
Zinc / Copper Ratio	0.82	> 0.85	
Serum Methylmalonic Acid (MMA)	171	< 300	0 - 378
WBC	7.1	5.0 – 8.0	3.4 - 10.8
RBC	5.07	4.4 – 4.9	3.77 - 5.28
Hemoglobin	15.4	13.5 - 14.5	11.1 - 15.9
Hematocrit	44.6	37 - 44	34 - 46.6
MCV	88	85 – 92	79 - 97
MCH	30.4	27.7 – 32.0	26.6 - 33.0
MCHC	34.5	32 – 35	31.5 - 35.7
RDW	13.3	11.5 – 15.0	12.3 - 15.4
Platelets	304	150 – 415	150 - 379
Neutrophils	71	40 – 60	
Lymphocytes	21	25 – 40	
Monocytes	5	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

CASE #7: MAGNESIUM DEFICIENCY

Summary: 52-year-old female presented with concerns of GI distress and osteopenia. Her primary care physician recommended that she take calcium and vitamin D to address her osteopenia, and she also took several supplements including zinc which she'd taken for the past two years for immune support.

Blood chemistry panel identified:
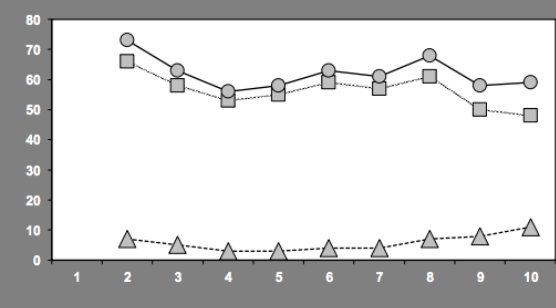
- Glucose 108

- Hemoglobin A1c 5.8

- Magnesium, serum 1.8

- Vitamin D 36.4

CASE #8: VITAMIN D IMBALANCE

Summary: 34-year-old male presented with episodes of severe GI pain, intermittent and unpredictable episodes of diffuse body aches and pains, and a concern that he increasingly had to cancel plans with his two young daughters because, "Daddy hurts again today." He had followed a strict Paleo diet for over two years, had tried a seven day water fast under medical supervision that provided transient relief, and practiced meditation daily. He reported a stressful job in tech.

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	5.8	3.7 – 6.0	3.7 - 8.6
BUN	10	13 – 18	6 - 20
Creatinine	0.81	0.85 – 1.1	0.76 - 1.27
BUN/Creatinine Ratio	12	8 – 19	8 - 19
eGFR if Non-African American	117		> 59
eGFR if African American	135		> 59
Sodium	143	135 – 140	134 - 144
Potassium	4.4	4.0 – 4.5	3.5 - 5.2
Chloride	103	100 – 106	97 - 108
C02	21	25 – 30	18 - 29
Calcium	9.5	9.2 – 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	24	30 - 60	15 - 65
Phosphorus	4.0	3.0 – 4.0	2.5 - 4.5
Magnesium	2.0	2.0 – 2.6	1.6 - 2.3
Protein, total	7.5	6.9 – 7.4	6.0 - 8.5
Albumin	4.5	4.0 – 5.0	3.5 - 5.5
Globulin	3.0	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.5	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.8	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	107	42 – 107	39 - 117
LDH	108	140 - 180	121 - 224
AST	16	0 - 25	0 - 40
ALT	11	0 - 26	0 - 44
GGT	15	0 - 29	0 - 65
TIBC	329	275 – 425	250 - 450
UIBC	267	175 - 350	111 - 343
Iron	62	40 – 135	38 - 169
Iron saturation	19	17 – 45	15 - 55
Ferritin	167	30 - 200	30 - 400
Vitamin B-12	402	450 – 2000	211 - 946
Folate, Serum	10.8	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	50.4	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	16.2	35 - 60	30.0 - 100.0
Cholesterol, total	170	150 - 220	100 - 199
Triglycerides	73	50 – 100	0 - 149
HDL	41	55 – 85	> 39
LDL	114	0 - 140	0 - 99
T. Chol / HDL Ratio	4.1	< 3	0 - 5.0
Triglycerides / HDL Ratio	1.78	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	6.09	< 1.0	0.00 - 3.00
Homocysteine	11.4	< 7.0	0.0 - 15.0
TSH	1.320	0.5 – 2.0	0.45 - 4.50
T4, total	7.4	6.0 – 12	4.5 - 12
T3 Uptake	29	30 - 38	24 - 39
T3, Total	99	100 – 180	71 - 180
T3, Free	3.0	2.5 - 4.0	2 - 4.4
T4, Free	1.23	1 - 1.5	0.82 - 1.77
Reverse T3	17.8	9 - 21	9.2 - 24.1
Thyroid – TPO Ab	9		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
Copper	117	81 - 157	72 - 166
Zinc	91	64 - 126	56 - 134
Zinc / Copper Ratio	0.78	> 0.85	
Serum Methylmalonic Acid (MMA)	195	< 300	0 - 378
WBC	6.1	5.0 – 8.0	3.4 - 10.8
RBC	5.20	4.4 – 4.9	4.14 - 5.8
Hemoglobin	14.1	14 - 15	12.6 - 17.7
Hematocrit	44.2	40 - 48	37.5 - 51.0
MCV	85	85 – 92	79 - 97
MCH	27.1	27.7 – 32.0	26.6 - 33.0
MCHC	31.9	32 – 35	31.5 - 35.7
RDW	13.1	11.5 – 15.0	12.3 - 15.4
Platelets	391	150 – 415	150 - 379
Neutrophils	51	40 – 60	
Lymphocytes	39	25 – 40	
Monocytes	7	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	1	0.0 – 3.0	

Data

H₂ = Hydrogen   CH₄ = Methane   CO₂ = Carbon Dioxide (valid results if over 1.4%)

Sample Tube		ppm H₂	ppm CH₄	Total H2 + CH4	CO₂ %
1	Baseline				QNS
2	20 min	7	66	73	OK
3	40 min	5	58	63	OK
4	60 min	3	53	56	OK
5	80 min	3	55	58	OK
6	100 min	4	59	63	OK
7	120 min	4	57	61	OK
8	140 min	7	61	68	OK
9	160 min	8	50	58	OK
10	180 min	11	48	59	OK

--△-- Hydrogen   --□-- Methane   —○— Combined Hydrogen & Methane

Analysis

	Result	Flag	Normal
Combined baseline total =	0	-	≤20ppm
Greatest H₂ value within first 120 minutes =	7	-	≤20ppm
Greatest H₂ increase over the lowest preceding value within first 120 minutes =	1	-	≤20ppm
Greatest CH₄ value within first 120 minutes =	66	H	≤12ppm
Greatest CH₄ increase over the lowest preceding value within first 120 minutes =	6	-	≤12ppm
Greatest combined H₂ & CH₄ value within first 120 minutes =	73	H	≤15ppm
Greatest combined H₂ & CH₄ increase over the lowest preceding value within first 120 minutes =	7	-	≤15ppm

Interpretation

SIBO Suspected - Elevated Hydrogen	Raw values and/or increases of Hydrogen greater than 20ppm over the lowest preceding value within the first 120 minutes (+/- 5min deviation) are indicative of bacterial overgrowth.	**NEGATIVE**
SIBO Suspected - Elevated Methane	Raw values and/or increases of Methane greater than 12ppm over the lowest preceding value within the first 120 minutes (+/- 5min deviation) are indicative of bacterial overgrowth.	**POSITIVE**
SIBO Suspected - Elevated Combined Hydrogen & Methane Gasses	Raw values and/or increases in combined Hydrogen and Methane gas values greater than 15ppm over the lowest preceding value are indicative of bacterial overgrowth.	**POSITIVE**

PARASITOLOGY/MICROSCOPY

Sample 1

Many	Blastocystis hominis
Many	Endolimax nana trophs
Mod	Iodamoeba butschlii cysts
Many	Iodamoeba butschlii trophs

Sample 2

Many	Blastocystis hominis
Few	Endolimax nana trophs
Mod	Iodamoeba butschlii cysts
Many	Iodamoeba butschlii trophs

Sample 3

Few	Blastocystis hominis
Few	Endolimax nana trophs
Few	Iodamoeba butschlii cysts
Few	Iodamoeba butschlii trophs

PARASITOLOGY INFORMATION

Intestinal parasites are abnormal inhabitants of the gastrointestinal tract that have the potential to cause damage to their host. The presence of any parasite within the intestine generally confirms that the patient has acquired the organism through fecal-oral contamination. Damage to the host includes parasitic burden, migration, blockage and pressure. Immunologic inflammation, hypersensitivity reactions and cytotoxicity also play a large role in the morbidity of these diseases. The infective dose often relates to severity of the disease and repeat encounters can be additive.

There are two main classes of intestinal parasites, they include protozoa and helminths. The protozoa typically have two stages; the trophozoite stage that is the metabolically active, invasive stage and the cyst stage, which is the vegetative inactive form resistant to unfavorable environmental conditions outside the human host. Helminths are large, multicellular organisms. Like protozoa, helminths can be either free-living or parasitic in nature. In their adult form, helminths cannot multiply in humans.

In general, acute manifestations of parasitic infection may involve diarrhea with or without mucus and or blood, fever, nausea, or abdominal pain. However these symptoms do not always occur. Consequently, parasitic infections may not be diagnosed or eradicated. If left untreated, chronic parasitic infections can cause damage to the intestinal lining and can be an unsuspected cause of illness and fatigue. Chronic parasitic infections can also be associated with increased intestinal permeability, irritable bowel syndrome, irregular bowel movements, malabsorption, gastritis or indigestion, skin disorders, joint pain, allergic reactions, and decreased immune function.

In some instances, parasites may enter the circulation and travel to various organs causing severe organ diseases such as liver abscesses and cysticercosis. In addition, some larval migration can cause pneumonia and in rare cases hyper infection syndrome with large numbers of larvae being produced and found in every tissue of the body.

One negative parasitology x1 specimen does not rule out the possibility of parasitic disease, parasitology x3 is recommended. This test is not designed to detect Cyclospora cayetanensis or Microsproridia spp.

GIARDIA/CRYPTOSPORIDIUM IMMUNOASSAY

	Within	Outside	Reference Range
Giardia duodenalis	Neg		Neg
Cryptosporidium	Neg		Neg

Giardia duodenalis (AKA *intestinalis* and *lamblia*) is a protozoan that infects the small intestine and is passed in stool and spread by the fecal-oral route. Waterborne transmission is the major source of giardiasis.
Cryptosporidium is a coccidian protozoa that can be spread from direct person-to-person contact or waterborne transmission.

DIGESTION /ABSORPTION

	Within	Outside	Reference Range	
Elastase	> 500		> 200 µg/mL	**Elastase** findings can be used for the diagnosis or the exclusion of exocrine pancreatic insufficiency. Correlations between low levels and chronic pancreatitis and cancer have been reported. **Fat Stain:** Microscopic determination of fecal fat using Sudan IV staining is a qualitative procedure utilized to assess fat absorption and to detect steatorrhea. **Muscle fibers** in the stool are an indicator of incomplete digestion. Bloating, flatulence, feelings of "fullness" may be associated with increase in muscle fibers. **Vegetable fibers** in the stool may be indicative of inadequate chewing, or eating "on the run". **Carbohydrates:** The presence of reducing substances in stool specimens can indicate carbohydrate malabsorption.
Fat Stain	Few		None - Mod	
Muscle fibers	None		None - Rare	
Vegetable fibers	Rare		None - Few	
Carbohydrates	Neg		Neg	

INFLAMMATION

	Within	Outside	Reference Range	
Lactoferrin	< 0.5		< 7.3 µg/mL	**Lactoferrin** and **Calprotectin** are reliable markers for differentiating organic inflammation (IBD) from function symptoms (IBS) and for management of IBD. Monitoring levels of fecal lactoferrin and calprotectin can play an essential role in determining the effectiveness of therapy, are good predictors of IBD remission, and can indicate a low risk of relapse. **Lysozyme*** is an enzyme secreted at the site of inflammation in the GI tract and elevated levels have been identified in IBD patients. **White Blood Cells** (WBC) and **Mucus** in the stool can occur with bacterial and parasitic infections, with mucosal irritation, and inflammatory bowel diseases such as Crohn's disease or ulcerative colitis.
Calprotectin*	< 10		<= 50 µg/g	
Lysozyme*	145		<= 600 ng/mL	
White Blood Cells	None		None - Rare	
Mucus	Neg		Neg	

IMMUNOLOGY

	Within	Outside	Reference Range	
Secretory IgA*		17.6	51 - 204 mg/dL	**Secretory IgA*** (sIgA) is secreted by mucosal tissue and represents the first line of defense of the GI mucosa and is central to the normal function of the GI tract as an immune barrier. Elevated levels of sIgA have been associated with an upregulated immune response.

CASE #9: THYROID HYPOFUNCTION

Summary: 24-year-old female presented with fatigue, constipation, low mood, anxiety and weight loss resistance. She reported that many of her symptoms began two years prior when she graduated from college and started working. She reports having a stressful job in tech and tries to follow a Paleo diet, but does occasionally eat gluten, particularly at work.

Initial labs identified the following thyroid panel:
- TSH 3.6
- T4, Total 10.3
- T3, Total 74
- T4, Free 1.68
- T3, Free 1.68
- Reverse T3 23

CASE #10: THYROID HYPERFUNCTION

Summary: 30-year-old female presented with anxiety increasing over the past year.

Her labs revealed the following thyroid markers:
- TSH <0.006
- T4, Free 1.9
- T3, Free 3.9
- TSI 229 (normal range 0-139)

Further testing identified SIBO and elevated cadmium and lead levels.

CASE #11: IMPAIRED KIDNEY FUNCTION

Summary: 45-year-old male presented with complaints of weakness, frequent micturition, inability to gain muscle and fatigue increasing over the past year.

Labs revealed:
- BUN 24
- Creatinine 1.4
- Uric acid 4.5
- Sodium 137
- Potassium 4.4
- Chloride 104

CASE #12: IMPAIRED LIVER FUNCTION

Summary: 62-year-old female presented with weight loss resistance, food cravings, constipation and fatigue. She had a commute of approximately 3 hours per day and ate many of her meals from Whole Foods and didn't feel she had the energy or motivation to follow a grain-free or even gluten-free diet. She also reported insomnia and upon further questioning, she did have several glasses of wine each night because she felt it helped her fall asleep.

Labs showed:

- Glucose 104
- Hemoglobin A1c 5.9
- AST 90
- ALT 52
- Cholesterol, total 243
- Triglycerides 116
- HDL 45
- LDL 138
- Vitamin D 22

CASE #13: IMPAIRED GALLBLADDER FUNCTION

Summary: 33-year-old male presented with complaints of abdominal distention, constipation, food intolerances, fatigue, eczema and seasonal allergies. He eats a standard American diet and takes a multivitamin, no prescription medications.

Significant lab findings:

- ALT 28
- AST 26
- Bilirubin 1.8
- Alkaline phosphatase 98
- LDH 151
- GGT 20

CASE #14: ANEMIA IRON DEFICIENCY

Summary: 42-year-old female presents with fatigue, extremely heavy menstrual bleeding (requiring changing her tampons and pads every one to two hours at least once every 28 days), and abdominal bloating.

Labs included:
- Iron 84
- Iron saturation 18%
- Ferritin 16
- RBC 4.2
- Hemoglobin 12.8
- Hematocrit 39.1
- MCV 90
- RDW 12.8
- Homocysteine 14.2
- MMA, serum 328

CASE #15: ANEMIA (B12 DEFICIENCY)

Summary: 33-year-old female presented with fatigue and depressed mood. She follows a vegetarian diet for religious reasons.

Labs included:
- Serum B12 314
- MMA, serum 428
- Homocysteine 14.2

CBC With Differential/Platelet		
WBC	4.8	
RBC	3.78	
Hemoglobin	12.9	
Hematocrit	38.7	
MCV	**102**	**High**
MCH	**34.1**	**High**
MCHC	33.3	
RDW	13.2	

```
Fe+TIBC+Fer
 Iron Bind.Cap.(TIBC)                   243      Low
 UIBC                                    47      Low
 Iron, Serum                            196      High
 Iron Saturation                         81      Alert
 Ferritin, Serum                         54
```

CASE #16: ANEMIA (CHRONIC DISEASE)

Summary: 44-year-old female presented with a long history of illness including Lyme disease, food intolerances with a very restricted diet and GI distress characterized by abdominal distention and alternating constipation and loose stools.
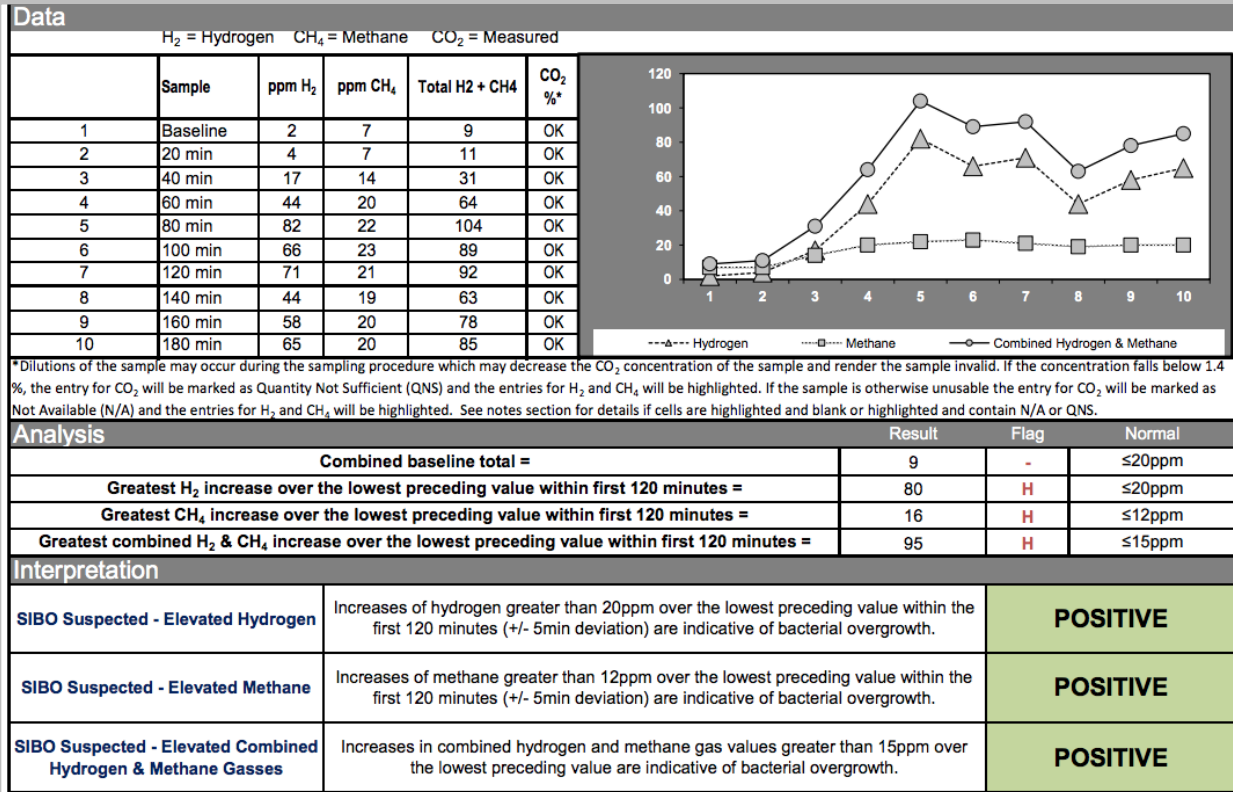
Labs included:

- RBC 4.04
- Hemoglobin 12.1
- Hematocrit 36.2
- MCV 86
- RDW 13.6
- Iron 87
- Iron saturation 24%
- TIBC 342
- UIBC 289
- Ferritin 154
- Vitamin B12 654
- Homocysteine 7.1
- MMA, serum 189

CASE #17: DYSLIPIDEMIA

Summary: 45-year-old male presented with a concern of high cholesterol. He otherwise reported no symptoms, no prior diagnoses and no medications. Since we knew from prior basic blood work we ran a True Health Diagnostics* Panel. And, as per our usual work up, we also ran a SIBO breath test and Doctor's Data stool test.

<* **Note:** *True Health Diagnostics is no longer in business. See* **this post** *for the latest updates.*>

Laboratory Test		Notes	High Risk	Intermediate Risk	Optimal	High Risk Range	Intermediate Risk Range	Optimal Range	Previous Results
Lipids	Total Cholesterol (mg/dL)		261			≥ 240	200 - 239	< 200	
	LDL-C Direct (mg/dL)		181			≥ 130 CHD & CHD risk eq. > 100	100 - 129 CHD & CHD risk eq. 70 - 100	< 100 CHD & CHD risk eq. < 70	
	HDL-C (mg/dL)				63	< 40		≥ 40	
	Triglycerides (mg/dL)				77	> 199	150 - 199	< 150	
	Non-HDL-C (mg/dL) (calculated)		198			≥ 160	130 - 159	< 130	
Lipoprotein Particles and Apolipoproteins	Apo B (mg/dL)		131			≥ 80	60 - 79	< 60	
	LDL-P (nmol/L)[§], by NMR		2124			≥ 1360	1020 - 1359	< 1020	
	Small LDL-P (nmol/L)[§], by NMR			979		> 1000	501 - 1000	< 501	
	sdLDL-C (mg/dL)[§]		34			> 30	21 - 30	< 21	
	Apo A-I (mg/dL)				149	< 114	114 - 131	> 131	
	HDL-P (μmol/L)[§], by NMR		33.7			≤ 34.0	34.1 - 38.0	> 38.0	
	HDL2-C (mg/dL)[§]				24	≤ 8	9 - 11	≥ 12	
	Apo B:Apo A-I Ratio (calculated)		0.88			≥ 0.81	0.61 - 0.80	≤ 0.60	
	Lp(a)-P (nmol/L)[§]				< 50	> 125	75 - 125	< 75	
Inflammation/ Oxidation	Fibrinogen (mg/dL)				388	< 126 or > 517	438 - 517	126 - 437	
	hs-CRP (mg/L)				0.3	> 2.9	1.0 - 2.9	< 1.0	
	Lp-PLA$_2$ (ng/mL)[§]			300		> 383	291 - 383	< 291	

Data

H₂ = Hydrogen   CH₄ = Methane   CO₂ = Measured

	Sample	ppm H_2	ppm CH_4	Total H2 + CH4	CO₂ %*
1	Baseline	2	7	9	OK
2	20 min	4	7	11	OK
3	40 min	17	14	31	OK
4	60 min	44	20	64	OK
5	80 min	82	22	104	OK
6	100 min	66	23	89	OK
7	120 min	71	21	92	OK
8	140 min	44	19	63	OK
9	160 min	58	20	78	OK
10	180 min	65	20	85	OK

---▲--- Hydrogen   ----□---- Methane   —○— Combined Hydrogen & Methane

*Dilutions of the sample may occur during the sampling procedure which may decrease the CO₂ concentration of the sample and render the sample invalid. If the concentration falls below 1.4 %, the entry for CO₂ will be marked as Quantity Not Sufficient (QNS) and the entries for H₂ and CH₄ will be highlighted. If the sample is otherwise unusable the entry for CO₂ will be marked as Not Available (N/A) and the entries for H₂ and CH₄ will be highlighted. See notes section for details if cells are highlighted and blank or highlighted and contain N/A or QNS.

Analysis

	Result	Flag	Normal
Combined baseline total =	9	-	≤20ppm
Greatest H_2 increase over the lowest preceding value within first 120 minutes =	80	H	≤20ppm
Greatest CH_4 increase over the lowest preceding value within first 120 minutes =	16	H	≤12ppm
Greatest combined H_2 & CH_4 increase over the lowest preceding value within first 120 minutes =	95	H	≤15ppm

Interpretation

SIBO Suspected - Elevated Hydrogen	Increases of hydrogen greater than 20ppm over the lowest preceding value within the first 120 minutes (+/- 5min deviation) are indicative of bacterial overgrowth.	**POSITIVE**
SIBO Suspected - Elevated Methane	Increases of methane greater than 12ppm over the lowest preceding value within the first 120 minutes (+/- 5min deviation) are indicative of bacterial overgrowth.	**POSITIVE**
SIBO Suspected - Elevated Combined Hydrogen & Methane Gasses	Increases in combined hydrogen and methane gas values greater than 15ppm over the lowest preceding value are indicative of bacterial overgrowth.	**POSITIVE**

Comprehensive Stool Analysis / Parasitology x3

BACTERIOLOGY CULTURE

Expected/Beneficial flora	Commensal (Imbalanced) flora	Dysbiotic flora
3+ Bacteroides fragilis group	2+ Alpha hemolytic strep	
NG Bifidobacterium spp.	1+ Lactococcus lactis	
3+ Escherichia coli	1+ Pseudomonas chlororaphis group	
3+ Lactobacillus spp.		
NG Enterococcus spp.		
3+ Clostridium spp.		
NG = No Growth		

BACTERIA INFORMATION

Expected /Beneficial bacteria make up a significant portion of the total microflora in a healthy & balanced GI tract. These beneficial bacteria have many health-protecting effects in the GI tract including manufacturing vitamins, fermenting fibers, digesting proteins and carbohydrates, and propagating anti-tumor and anti-inflammatory factors.
Clostridia are prevalent flora in a healthy intestine. Clostridium spp. should be considered in the context of balance with other expected/beneficial flora. Absence of clostridia or over abundance relative to other expected/beneficial flora indicates bacterial imbalance. If *C. difficile* associated disease is suspected, a Comprehensive Clostridium culture or toxigenic *C. difficile* DNA test is recommended.
Commensal (Imbalanced) bacteria are usually neither pathogenic nor beneficial to the host GI tract. Imbalances can occur when there are insufficient levels of beneficial bacteria and increased levels of commensal bacteria. Certain commensal bacteria are reported as dysbiotic at higher levels.
Dysbiotic bacteria consist of known pathogenic bacteria and those that have the potential to cause disease in the GI tract. They can be present due to a number of factors including: consumption of contaminated water or food, exposure to chemicals that are toxic to beneficial bacteria; the use of antibiotics, oral contraceptives or other medications; poor fiber intake and high stress levels.

YEAST CULTURE

Normal flora	Dysbiotic flora
No yeast isolated	

MICROSCOPIC YEAST

Result:	Expected:
Many	None - Rare

The microscopic finding of yeast in the stool is helpful in identifying whether there is proliferation of yeast. Rare yeast may be normal; however, yeast observed in higher amounts (few, moderate, or many) is abnormal.

YEAST INFORMATION

Yeast normally can be found in small quantities in the skin, mouth, intestine and mucocutaneous junctions. Overgrowth of yeast can infect virtually every organ system, leading to an extensive array of clinical manifestations. Fungal diarrhea is associated with broad-spectrum antibiotics or alterations of the patient's immune status. Symptoms may include abdominal pain, cramping and irritation. When investigating the presence of yeast, disparity may exist between culturing and microscopic examination. Yeast are not uniformly dispersed throughout the stool, this may lead to undetectable or low levels of yeast identified by microscopy, despite a cultured amount of yeast. Conversely, microscopic examination may reveal a significant amount of yeast present, but no yeast cultured. Yeast does not always survive transit through the intestines rendering it unvialble.

CASE #18: CHRONIC INFECTION AND IMMUNE DYSREGULATION

Summary: Seven-year-old boy was brought in by his parents for neurological impairment, namely tics that get worse/better depending on many different factors including diet, media exposure, mold (worst offender), etc. He also has night terrors on and off, which go hand in hand with the waves of sickness/tics. He also has GI distress with alternating diarrhea and constipation. He was in the bottom 10th percentile for height and weight for his age.

Testing for tick borne illness identified elevated antibodies to Borrelia hermsii. All coinfections normal.

Marker	Value	Functional Range	Lab Range
Glucose	64	75 - 90	65 - 99
Hemoglobin A1c	5.6	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.3	3.7 – 6.0	1.9 - 5.8
BUN	13	13 – 18	5 - 18
Creatinine	0.36	0.85 – 1.1	0.37 - 0.62
BUN/Creatinine Ratio	36	8 – 19	9 - 27
Sodium	141	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	17 - 27
Calcium	10.1	9.2 – 10.1	9.1 - 10.5
Phosphorus	5.1	3.5 – 4.0	2.8 - 6.2
Magnesium	2.1	2.0 – 2.6	1.6 - 2.3
Protein, total	7.2	6.9 – 7.4	6.0 - 8.5
Albumin	4.4	4.0 – 5.0	3.5 - 5.5
Globulin	2.8	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.6	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.2	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	130	42 – 107	134 - 349
LDH	287	140 - 180	166 - 291
AST	32	10 - 30	0 - 60
ALT	17	10 - 29	0 - 29
GGT	10	< 15	0 - 65
TIBC	327	275 – 425	250 - 450
UIBC	237	175 - 350	148 - 395
Iron	90	40 – 135	28 - 147
Iron saturation	28	17 – 45	15 - 55
Ferritin	156	30 - 100	16 - 77
Vitamin B-12	605	450 – 2000	211 - 946
Vitamin D, 25-hydroxy	38.3	35 - 60	30.0 - 100.0
Cholesterol, total	154	150 - 240	100 - 169
Triglycerides	168	50 – 100	0 - 74
HDL	70	55 – 85	> 39
LDL	50	0 - 175	0 - 109
T. Chol / HDL Ratio	2.2	< 3	0 - 5.0
Triglycerides / HDL Ratio	2.40	< 2	< 3.8
CRP-hs	0.06	< 1.0	0.00 - 3.00
Homocysteine	7.2	< 7.0	0.0 - 15.0

Marker	Value	Functional Range	Lab Range
TSH	2.470	0.5 – 2.5	0.60 - 4.84
T4, total	7.5	6.0 – 12	4.5 - 12
T3 Uptake	26	30 - 38	24 - 39
T3, Total	169	100 – 180	92 - 219
Copper	114		72 - 166
Zinc	80		56 - 134
Zinc / Copper Ratio	0.70	> 0.85	
Serum Methylmalonic Acid (MMA)	165	< 300	0 - 378
WBC	7.2	5.0 – 8.0	4.3 - 12.4
RBC	4.28	4.4 – 4.9	3.96 - 5.3
Hemoglobin	12.8	14 - 15	10.9 - 14.8
Hematocrit	37.1	40 - 48	32.4 - 43.3
MCV	87	85 – 92	75 - 89
MCH	29.9	27.7 – 32.0	24.6 - 30.7
MCHC	34.5	32 – 35	31.7 - 36.0
RDW	14.1	11.5 – 15.0	12.3 - 15.8
Platelets	506	150 – 415	190 - 459
Neutrophils	47	40 – 60	
Lymphocytes	42	25 – 40	
Monocytes	9	4.0 – 7.0	
Eosinophils	2	0.0 – 3.0	
Basophils	0	0.0 – 3.0	
CD8-/CD57+ Lymphs	2		2 - 17
Abs.CD8-CD57+ Lymphs	60		60 - 360
Anti-DNase B Strep Antibodies	<78		0 - 170
Antistreptolysin O Ab	164.1		0 - 200

Comprehensive Stool Analysis / Parasitology x3

BACTERIOLOGY CULTURE		
Expected/Beneficial flora	**Commensal (Imbalanced) flora**	**Dysbiotic flora**
4+ Bacteroides fragilis group	1+ Enterobacter cloacae complex	
NG Bifidobacterium spp.	1+ Klebsiella oxytoca	
3+ Escherichia coli		
NG Lactobacillus spp.		
3+ Enterococcus spp.		
4+ Clostridium spp.		
NG = No Growth		

BACTERIA INFORMATION

Expected /Beneficial bacteria make up a significant portion of the total microflora in a healthy & balanced GI tract. These beneficial bacteria have many health-protecting effects in the GI tract including manufacturing vitamins, fermenting fibers, digesting proteins and carbohydrates, and propagating anti-tumor and anti-inflammatory factors.

Clostridia are prevalent flora in a healthy intestine. Clostridium spp. should be considered in the context of balance with other expected/beneficial flora. Absence of clostridia or over abundance relative to other expected/beneficial flora indicates bacterial imbalance. If *C. difficile* associated disease is suspected, a Comprehensive Clostridium culture or toxigenic *C. difficile* DNA test is recommended.

Commensal (Imbalanced) bacteria are usually neither pathogenic nor beneficial to the host GI tract. Imbalances can occur when there are insufficient levels of beneficial bacteria and increased levels of commensal bacteria. Certain commensal bacteria are reported as dysbiotic at higher levels.

Dysbiotic bacteria consist of known pathogenic bacteria and those that have the potential to cause disease in the GI tract. They can be present due to a number of factors including: consumption of contaminated water or food, exposure to chemicals that are toxic to beneficial bacteria; the use of antibiotics, oral contraceptives or other medications; poor fiber intake and high stress levels.

YEAST CULTURE	
Normal flora	**Dysbiotic flora**
No yeast isolated	

MICROSCOPIC YEAST	
Result:	**Expected:**
Mod	None - Rare

The microscopic finding of yeast in the stool is helpful in identifying whether there is proliferation of yeast. Rare yeast may be normal; however, yeast observed in higher amounts (few, moderate, or many) is abnormal.

YEAST INFORMATION

Yeast normally can be found in small quantities in the skin, mouth, intestine and mucocutaneous junctions. Overgrowth of yeast can infect virtually every organ system, leading to an extensive array of clinical manifestations. Fungal diarrhea is associated with broad-spectrum antibiotics or alterations of the patient's immune status. Symptoms may include abdominal pain, cramping and irritation. When investigating the presence of yeast, disparity may exist between culturing and microscopic examination. Yeast are not uniformly dispersed throughout the stool, this may lead to undetectable or low levels of yeast identified by microscopy, despite a cultured amount of yeast. Conversely, microscopic examination may reveal a significant amount of yeast present, but no yeast cultured. Yeast does not always survive transit through the intestines rendering it unvialble.

PARASITOLOGY/MICROSCOPY

Sample 1

Few   Blastocystis hominis
Mod Yeast

Sample 2

Rare Blastocystis hominis
Few   Yeast

Sample 3

Rare Blastocystis hominis
Few   Yeast

PARASITOLOGY INFORMATION

Intestinal parasites are abnormal inhabitants of the gastrointestinal tract that have the potential to cause damage to their host. The presence of any parasite within the intestine generally confirms that the patient has acquired the organism through fecal-oral contamination. Damage to the host includes parasitic burden, migration, blockage and pressure. Immunologic inflammation, hypersensitivity reactions and cytotoxicity also play a large role in the morbidity of these diseases. The infective dose often relates to severity of the disease and repeat encounters can be additive.

There are two main classes of intestinal parasites, they include protozoa and helminths. The protozoa typically have two stages; the trophozoite stage that is the metabolically active, invasive stage and the cyst stage, which is the vegetative inactive form resistant to unfavorable environmental conditions outside the human host. Helminths are large, multicellular organisms. Like protozoa, helminths can be either free-living or parasitic in nature. In their adult form, helminths cannot multiply in humans.

In general, acute manifestations of parasitic infection may involve diarrhea with or without mucus and or blood, fever, nausea, or abdominal pain. However these symptoms do not always occur. Consequently, parasitic infections may not be diagnosed or eradicated. If left untreated, chronic parasitic infections can cause damage to the intestinal lining and can be an unsuspected cause of illness and fatigue. Chronic parasitic infections can also be associated with increased intestinal permeability, irritable bowel syndrome, irregular bowel movements, malabsorption, gastritis or indigestion, skin disorders, joint pain, allergic reactions, and decreased immune function.

In some instances, parasites may enter the circulation and travel to various organs causing severe organ diseases such as liver abscesses and cysticercosis. In addition, some larval migration can cause pneumonia and in rare cases hyper infection syndrome with large numbers of larvae being produced and found in every tissue of the body.

One negative parasitology x1 specimen does not rule out the possibility of parasitic disease, parasitology x3 is recommended. This test is not designed to detect Cyclospora cayetanensis or Microsproridia spp.

GIARDIA/CRYPTOSPORIDIUM IMMUNOASSAY				
	Within	Outside	Reference Range	
Giardia duodenalis	Neg		Neg	
Cryptosporidium	Neg		Neg	

Giardia duodenalis (AKA *intestinalis* and *lamblia*) is a protozoan that infects the small intestine and is passed in stool and spread by the fecal-oral route. Waterborne transmission is the major source of giardiasis.

Cryptosporidium is a coccidian protozoa that can be spread from direct person-to-person contact or waterborne transmission.

DIGESTION /ABSORPTION

	Within	Outside	Reference Range	
Elastase	> 500		> 200 µg/mL	Elastase findings can be used for the diagnosis or the exclusion of exocrine pancreatic insufficiency. Correlations between low levels and chronic pancreatitis and cancer have been reported. **Fat Stain**: Microscopic determination of fecal fat using Sudan IV staining is a qualitative procedure utilized to assess fat absorption and to detect steatorrhea. **Muscle fibers** in the stool are an indicator of incomplete digestion. Bloating, flatulence, feelings of "fullness" may be associated with increase in muscle fibers. **Vegetable fibers** in the stool may be indicative of inadequate chewing, or eating "on the run". **Carbohydrates:** The presence of reducing substances in stool specimens can indicate carbohydrate malabsorption.
Fat Stain	Mod		None - Mod	
Muscle fibers	None		None - Rare	
Vegetable fibers	Rare		None - Few	
Carbohydrates	Neg		Neg	

INFLAMMATION

	Within	Outside	Reference Range	
Lactoferrin	< 0.5		< 7.3 µg/mL	**Lactoferrin** and **Calprotectin** are reliable markers for differentiating organic inflammation (IBD) from function symptoms (IBS) and for management of IBD. Monitoring levels of fecal lactoferrin and calprotectin can play an essential role in determining the effectiveness of therapy, are good predictors of IBD remission, and can indicate a low risk of relapse. **Lysozyme*** is an enzyme secreted at the site of inflammation in the GI tract and elevated levels have been identified in IBD patients. **White Blood Cells** (WBC) and **Mucus** in the stool can occur with bacterial and parasitic infections, with mucosal irritation, and inflammatory bowel diseases such as Crohn's disease or ulcerative colitis.
Calprotectin*	< 10		<= 50 µg/g	
Lysozyme*		728	<= 600 ng/mL	
White Blood Cells	None		None - Rare	
Mucus	Neg		Neg	

IMMUNOLOGY

	Within	Outside	Reference Range	
Secretory IgA*		47.5	51 - 204 mg/dL	**Secretory IgA*** (sIgA) is secreted by mucosal tissue and represents the first line of defense of the GI mucosa and is central to the normal function of the GI tract as an immune barrier. Elevated levels of sIgA have been associated with an upregulated immune response.

CASE #19: IMPAIRED METHYLATION

Summary: 24-year-old female who works as a police dispatcher presented with an approximately three-year history of severe and persistent diarrhea, abdominal pain, fatigue and hair loss.

Marker	Value	Functional Range	Lab Range
Glucose	88	75 - 90	65 - 99
Hemoglobin A1c	5.3	4.4 – 5.4	4.8 - 5.6
Uric Acid	4.6	3.2 - 5.5	2.5 - 7.1
BUN	10	13 – 18	6 - 20
Creatinine	0.80	0.7 – 1.0	0.57 - 1
BUN/Creatinine Ratio	13	9 – 23	8 - 20
eGFR if Non-African American	100		> 59
eGFR if African American	115		> 59
Sodium	140	135 – 140	134 - 144
Potassium	4.0	4.0 – 4.5	3.5 - 5.2
Chloride	102	100 – 106	97 - 108
C02	23	25 – 30	18 - 29
Calcium	9.1	9.2 – 10.1	8.7 - 10.2
Parathyroid Hormone, Intact	24	30 - 60	15 - 65
Phosphorus	3.6	3.0 – 4.0	2.5 - 4.5
Magnesium	2.0	2.0 – 2.6	1.6 - 2.3
Protein, total	7.1	6.9 – 7.4	6.0 - 8.5
Albumin	4.4	4.0 – 5.0	3.5 - 5.5
Globulin	2.7	2.4 – 2.8	1.5 - 4.5
A/G ratio	1.6	1.5 – 2.0	1.1 - 2.5
Bilirubin, total	0.5	0.1 – 1.2	0.0 - 1.2
Alkaline Phosphatase	40	42 – 107	39 - 117
LDH	141	140 - 180	119 - 226
AST	17	0 - 23	0 - 40
ALT	7	0 - 20	0 - 32
GGT	26	0 - 21	0 - 60
TIBC	398	275 – 425	250 - 450
UIBC	269	175 - 350	131 - 425
Iron	129	40 – 135	27 - 159
Iron saturation	32	17 – 45	15 - 55
Ferritin	79	30 - 100	15 - 150
Vitamin B-12	288	450 – 2000	211 - 946
Folate, Serum	8.0	> 5.0	> 3.0
Calcitriol (1,25 di-OH Vitamin D)	72.9	19.9 - 79.3	19.9 - 79.3
Vitamin D, 25-hydroxy	56.1	35 - 60	30.0 - 100.0
Cholesterol, total	186	150 - 230	100 - 199
Triglycerides	111	50 – 100	0 - 149
HDL	51	55 – 85	> 39
LDL	113	0 - 140	0 - 99
T. Chol / HDL Ratio	3.6	< 3	0 - 4.4
Triglycerides / HDL Ratio	2.18	< 2	< 3.8

Marker	Value	Functional Range	Lab Range
CRP-hs	4.27	< 1.0	0.00 - 3.00
Homocysteine	16.0	< 7.0	0.0 - 15.0
TSH	0.612	0.5 – 2.0	0.45 - 4.50
T4, total	12.3	6.0 – 12	4.5 - 12
T3 Uptake	22	28 - 35	24 - 39
T3, Total	123	100 – 180	71 - 180
T3, Free	2.8	2.5 - 4.0	2 - 4.4
T4, Free	1.35	1 - 1.5	0.82 - 1.77
Reverse T3	26.6	9 - 21	9.2 - 24.1
Thyroid – TPO Ab	10		0 - 34
Thyroid – TGA	<1.0		0 - 0.9
Copper	138	81 - 157	72 - 166
Zinc	60	64 - 126	56 - 134
Zinc / Copper Ratio	0.43	> 0.85	
Serum Methylmalonic Acid (MMA)	97	< 300	0 - 378
WBC	6.8	5.0 – 8.0	3.4 - 10.8
RBC	4.76	4.4 – 4.9	3.77 - 5.28
Hemoglobin	14.6	13.5 - 14.5	11.1 - 15.9
Hematocrit	44.7	37 - 44	34 - 46.6
MCV	94	85 – 92	79 - 97
MCH	30.7	27.7 – 32.0	26.6 - 33.0
MCHC	32.7	32 – 35	31.5 - 35.7
RDW	12.9	11.5 – 15.0	12.3 - 15.4
Platelets	268	150 – 379	150 - 379
Neutrophils	50	40 – 60	
Lymphocytes	38	25 – 40	
Monocytes	3	4.0 – 7.0	
Eosinophils	9	0.0 – 3.0	
Basophils	0	0.0 – 3.0	