Common Patterns seen on the OAT

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Objectives

- Big picture overview of OAT profile
- Investigate common patterns within the test
- Explore other nuanced patterns
- What additional testing can be considered?

Organic Acids

WHAT ARE ORGANIC ACIDS (OA)?

Organic acidic products of cellular metabolism that are excreted in urine (in mammals)

- Produced by living organisms including humans, bacteria, and fungi
- Evaluation of these downstream products of metabolic pathways provides insight into *potential nutrient deficiencies, inflammation, toxicity, and other imbalances that could be contributing to clinical complaints*

Origins of Organic Acid Testing

- To rule out rare Inborn Errors of Metabolism (IEM)- usually in infancy
- Elevations of these organic acids (OA) reflect dysfunction in specific metabolic pathways
  - Accumulation of these toxic metabolites can by life-threatening
  - Symptoms observed in the newborn period include poor feeding and weight gain; nausea and vomiting; neuromuscular issues (e.g., poor tone, seizures); and susceptibility to infection

Use of OAs have evolved from investigating IEM to providing insight into functional metabolic imbalances.

Overview: OAT Fundamentals

MOSAIC DIAGNOSTICS

MOSAIC DIAGNOSTICS

OAT ORGANIC ACIDS TEST

Requisition #:		Practitioner:	
Patient Name:		Date of Collection:	
Date of Birth:	Patient Age: 76	Time of Collection:	
Patient Sex:		Print Date:	
		Report Date:	

Organic Acids Test - Nutritional and Metabolic Profile

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Females Age 13 and Over
Intestinal Microbial Overgrowth			
Yeast and Fungal Markers			
1 Citramalic	≤ 3.6	1.1	1.1
2 5-Hydroxymethyl-2-furoic *(Aspergillus)*	≤ 14	1.2	1.2
3 3-Oxoglutaric	≤ 0.33	0.09	0.09
4 Furan-2,5-dicarboxylic *(Aspergillus)*	≤ 16	4.7	4.7
5 Furancarbonylglycine *(Aspergillus)*	≤ 1.9	0.17	0.17
6 Tartaric *(Aspergillus)*	≤ 4.5	0.23	0.23
7 Arabinose	≤ 29	11	11
8 Carboxycitric	≤ 29	27	27
9 Tricarballylic *(Fusarium)*	≤ 0.44	0.10	0.10
Bacterial Markers			
10 Hippuric	≤ 613	35	35
11 2-Hydroxyphenylacetic	0.06 - 0.66	0.38	0.38
12 4-Hydroxybenzoic	≤ 1.3	0.46	0.46
13 4-Hydroxyhippuric	0.79 - 17	7.7	7.7
14 DHPPA (Beneficial Bacteria)	≤ 0.38	0.14	0.14
Clostridia Bacterial Markers			
15 4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*	≤ 19	15	15
16 HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*	≤ 208	133	133
17 4-Cresol *(C. difficile)*	≤ 75	1.3	1.3
18 3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*	≤ 11	1.8	1.8

Fungus

Non-Specific Bacteria

Clostridia

Oxalates

Mitochondria Function

Neurotransmitter Pathways

Mosaic Diagnostics

Requisition #: *Practitioner:*

Patient Name: *Date of Collection:*

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Females Age 13 and Over
Oxalate Metabolites			
19 Glyceric	0.77 - 7.0	2.2	
20 Glycolic	16 - 117	75	
21 Oxalic	6.8 - 101	66	
Glycolytic Cycle Metabolites			
22 Lactic	≤ 48	14	
23 Pyruvic	≤ 9.1	0.35	
Mitochondrial Markers - Krebs Cycle Metabolites			
24 Succinic	≤ 9.3	1.3	
25 Fumaric	≤ 0.94	0.29	
26 Malic	0.06 - 1.8	0.63	
27 2-Oxoglutaric	≤ 35	19	
28 Aconitic	6.8 - 28	7.2	
29 Citric	≤ 507	245	
Mitochondrial Markers - Amino Acid Metabolites			
30 3-Methylglutaric	≤ 0.76	0.35	
31 3-Hydroxyglutaric	≤ 6.2	3.3	
32 3-Methylglutaconic	≤ 4.5	1.6	
Neurotransmitter Metabolites			
Phenylalanine and Tyrosine Metabolites			
33 Homovanillic (HVA) *(dopamine)*	0.80 - 3.6	3.4	
34 Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.46 - 3.7	1.3	
35 HVA / VMA Ratio	0.16 - 1.8	H 2.6	
36 Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.08 - 3.5	H 4.4	
37 HVA/ DOPAC Ratio	0.10 - 1.8	0.78	
Tryptophan Metabolites			
38 5-Hydroxyindoleacetic (5-HIAA) *(serotonin)*	≤ 4.3	1.7	
39 Quinolinic	0.85 - 3.9	3.5	
40 Kynurenic	≤ 2.2	1.1	

Pyrimidines

Ketones

Fatty Acid Oxidation

B Vitamins and Antioxidants

Requisition #:

Patient Name:

Practitioner:

Date of Collection:

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Females Age 13 and Over
Pyrimidine Metabolites - Folate Metabolism			
41 Uracil	≤ 9.7	4.3	
42 Thymine	≤ 0.56	0.17	
Ketone and Fatty Acid Oxidation			
43 3-Hydroxybutyric	≤ 3.1	0.49	
44 Acetoacetic	≤ 10	0.15	
45 Ethylmalonic	0.44 - 2.8	1.2	
46 Methylsuccinic	0.10 - 2.2	0.87	
47 Adipic	0.04 - 3.8	0.52	
48 Suberic	0.18 - 2.2	1.0	
49 Sebacic	≤ 0.24	0.05	
Nutritional Markers			
Vitamin B12			
50 Methylmalonic *	≤ 2.3	0.78	
Vitamin B6			
51 Pyridoxic (B6)	≤ 34	0.54	
Vitamin B5			
52 Pantothenic (B5)	≤ 10	1.1	
Vitamin B2 (Riboflavin)			
53 Glutaric *	0.04 - 0.36	H 0.40	
Vitamin C			
54 Ascorbic	10 - 200	78	
Vitamin Q10 (CoQ10)			
55 3-Hydroxy-3-methylglutaric *	0.17 - 39	6.8	
Glutathione Precursor and Chelating Agent			
56 N-Acetylcysteine (NAC)	≤ 0.28	0	
Biotin (Vitamin H)			
57 Methylcitric *	0.19 - 2.7	1.0	

** A high value for this marker may indicate a deficiency of this vitamin.*

Detoxification

Amino Acids

Minerals

Mosaic Diagnostics

Requisition #:

Patient Name:

Practitioner:

Date of Collection:

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Females Age 13 and Over
Indicators of Detoxification			
Glutathione			
58 Pyroglutamic ✱	10 - 33	24	
Methylation, Toxic exposure			
59 2-Hydroxybutyric ✱✱	0.03 - 1.8	0.81	
Ammonia Excess			
60 Orotic	0.06 - 0.54	0.26	
Aspartame, salicylates, or GI bacteria			
61 2-Hydroxyhippuric	≤ 1.3	0.26	

✱ *A high value for this marker may indicate a Glutathione deficiency.*
✱✱ *High values may indicate methylation defects and/or toxic exposures.*

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Females Age 13 and Over
Amino Acid Metabolites			
62 2-Hydroxyisovaleric	≤ 2.0	0.07	
63 2-Oxoisovaleric	≤ 2.1	0.06	
64 3-Methyl-2-oxovaleric	≤ 2.0	0.05	
65 2-Hydroxyisocaproic	≤ 2.0	0	
66 2-Oxoisocaproic	≤ 2.0	0.01	
67 2-Oxo-4-methiolbutyric	≤ 2.0	0.38	
68 Mandelic	≤ 2.0	0.07	
69 Phenyllactic	≤ 2.0	0.02	
70 Phenylpyruvic	≤ 2.0	0	
71 Homogentisic	≤ 2.0	0.03	
72 4-Hydroxyphenyllactic	≤ 2.0	0.23	
73 N-Acetylaspartic	≤ 38	1.0	
74 Malonic	≤ 9.7	4.8	
75 4-Hydroxybutyric	≤ 4.8	1.3	
Mineral Metabolism			
76 Phosphoric	1,000 - 5,000	2,166	

The Organic Acids Test (OAT)

Mosaic Diagnostics' OAT provides a comprehensive nutritional and metabolic snapshot of an individual's overall health.

These OAs provide insight into the functional capability of key physiologic areas: gut health, mitochondrial function, neurotransmitter status, detoxification, and macronutrient breakdown and nutritional status

By understanding these potential contributing factor to several diseases, and by correcting these imbalances, improvement in symptoms and optimization of the system may be achieved.

This **urine-based assay** assesses 76 organic acids grouped into clinically relevant functional classes:

Intestinal Microbial Overgrowth	Ketone and Fatty Acid Oxidation
Oxalate Metabolites	Nutritional Markers
Glycolytic Cycle Metabolites	Indicators of Detoxification
Mitochondrial Markers / Krebs Cycle Metabolites	Amino Acid Metabolism
Mitochondrial Markers / Amino Acid Metabolites	Mineral Metabolism
Neurotransmitter Metabolites	Indicator of Fluid Intake (Creatinine)
Pyrimidine Metabolites / Folate Metabolism	

OAT Patterns

Pattern recognition – Common findings

Clostridia and Neurotransmitter Metabolism

Yeast activity and Oxalates

Toxic Exposure


Evaluate
Reason
Analyze
Critical Thinking
Describe
Identify
Interpret

Clostridia and Neurotransmitter Metabolism

Clostridia Overgrowth

- Many different clostridia species – Some problematic, but not all
- Clostrida organic acids found on the OAT are known to have potential adverse health effects
  - **4-hydroxyphenylacetic** (C. difficile, C. stricklandii, C. lituseburense & others)
  - **HPHPA** (C. sporogenes, C. caloritolerans, C. botulinum & others)
  - **4-Cresol** (C. difficile)
  - **3-Indoleactic** (C. stricklandii, C. lituseburense, C. subterminale & others)

MOSAIC DIAGNOSTICS

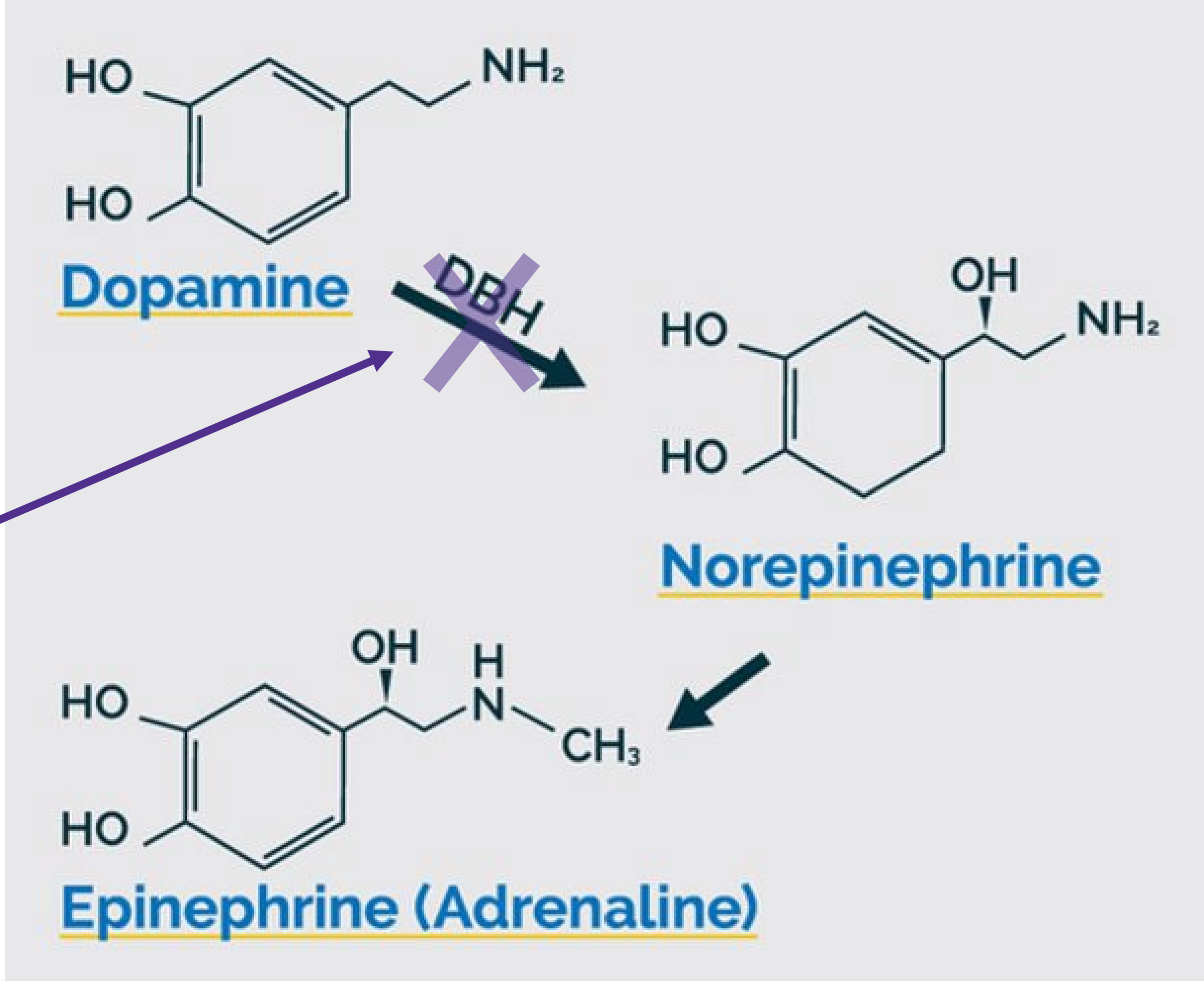
CDC. (n.d.). *Public domain - computer–generated image of a cluster of barrel-shaped, Clostridium perfringens bacteria.* Retrieved April 2, 2024, from https://www.rawpixel.com/image/2288362/free-photo-image-bacterium-bacteria-clostridium-perfringen

DBH Inhibition

HPHPA

4-cresol

4-HydroxyPhenylacetic



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Clostridia Bacterial Markers

15	4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*		≤ 30	H	40
16	HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*		≤ 227		214
17	4-Cresol *(C. difficile)*		≤ 76		1.1
18	3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*		≤ 11		1.8

This test was developed, and its performance characteristics determined by Mosaic Diagnostics Laboratory. It has not been cleared or approved by the US Food and Drug Administration.

Neurotransmitter Metabolites

Phenylalanine and Tyrosine Metabolites

33	Homovanillic (HVA) *(dopamine)*		≤ 14	H	15
34	Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.87	- 5.9		3.9
35	HVA / VMA Ratio	0.12	- 3.0	H	3.9
36	Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.07	- 4.0	H	5.7
37	HVA/ DOPAC Ratio	1.5	- 2.6	H	2.7

Clostridia Bacterial Markers

		Reference range		Result
15	4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*	≤ 18		8.9
16	HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*	≤ 102	H	159
17	4-Cresol *(C. difficile)*	≤ 39		4.9
18	3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*	≤ 6.8		0.30

Neurotransmitter Metabolites

		Reference range		Result
	Phenylalanine and Tyrosine Metabolites			
33	Homovanillic (HVA) *(dopamine)*	0.39 - 2.2	H	3.2
34	Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.53 - 2.2		0.75
35	HVA / VMA Ratio	0.32 - 1.4	H	4.2
36	Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.27 - 1.9	H	2.9
37	HVA/ DOPAC Ratio	0.17 - 1.6		1.1
	Tryptophan Metabolites			
38	5-Hydroxyindoleacetic (5-HIAA) *(serotonin)*	≤ 2.9		1.3
39	Quinolinic	0.52 - 2.4		1.0
40	Kynurenic	≤ 1.8		0.15

Clostridia Bacterial Markers

15	4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*	≤ 19	17
16	HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*	≤ 208	87
17	4-Cresol *(C. difficile)*	≤ 75	3.1
18	3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*	≤ 11	7.5

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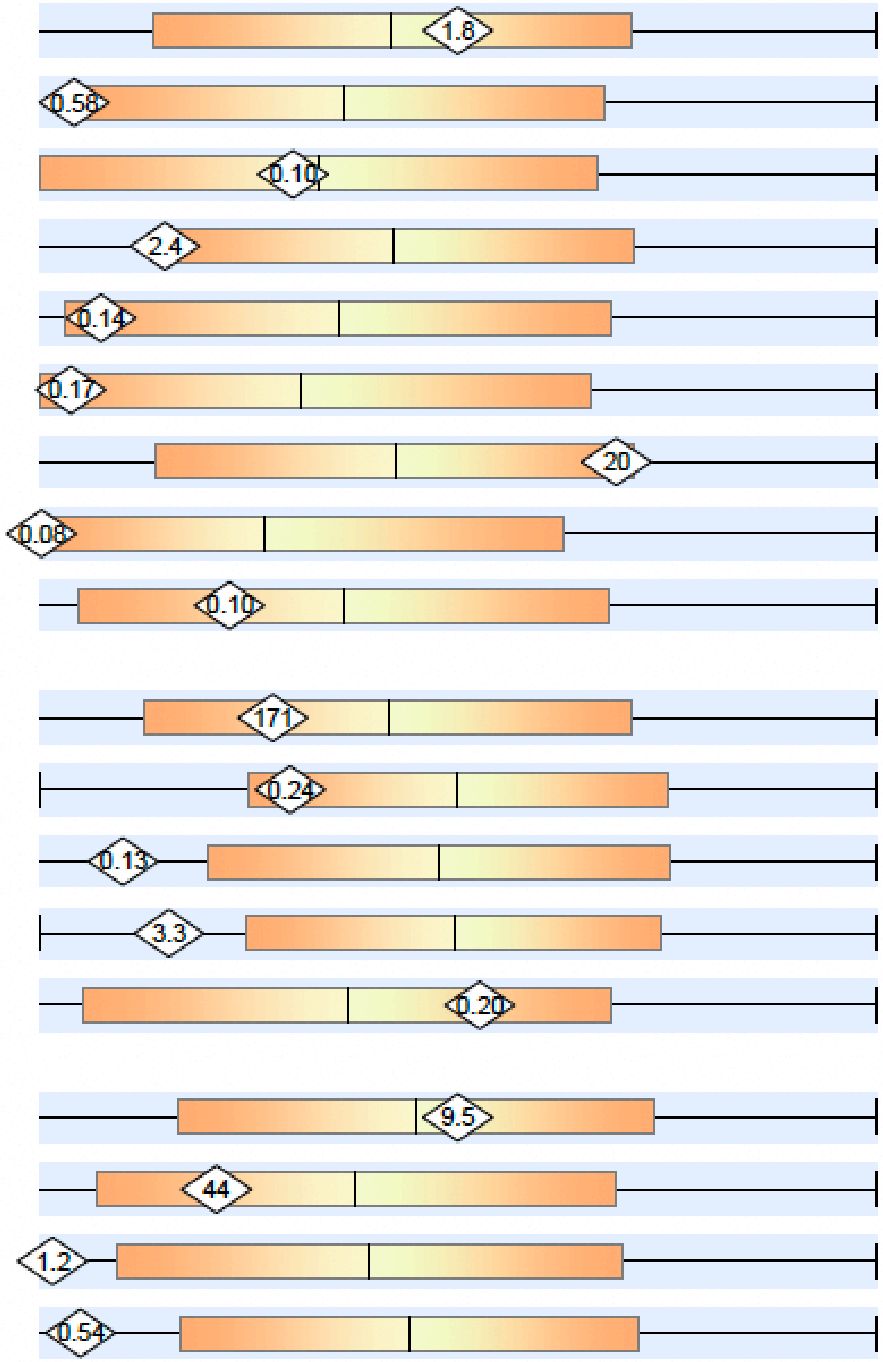
Neurotransmitter Metabolites

Phenylalanine and Tyrosine Metabolites

33	Homovanillic (HVA) *(dopamine)*	0.80 - 3.6	H	7.7
34	Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.46 - 3.7		2.6
35	HVA / VMA Ratio	0.16 - 1.8	H	2.9
36	Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.08 - 3.5	H	7.3
37	HVA/ DOPAC Ratio	0.10 - 1.8		1.1

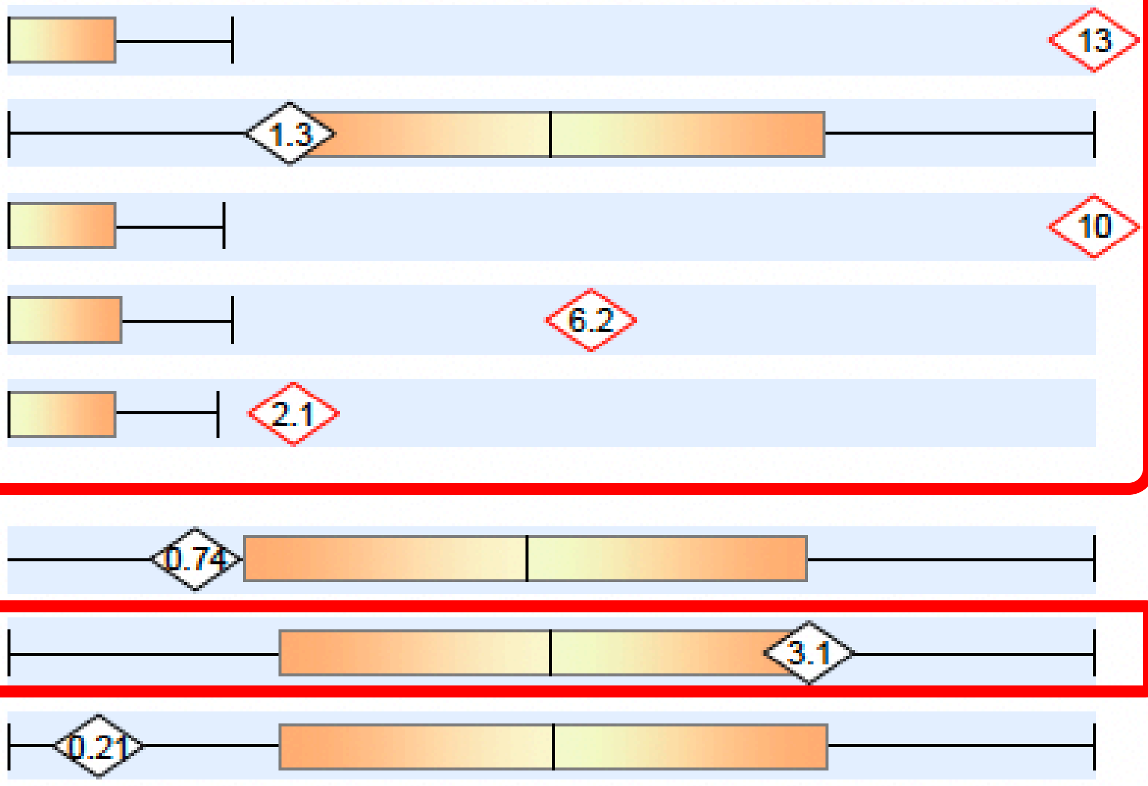
Yeast and Fungal Markers				
1	Citramalic		≤ 3.6	1.8
2	5-Hydroxymethyl-2-furoic *(Aspergillus)*		≤ 14	0.58
3	3-Oxoglutaric		≤ 0.33	0.10
4	Furan-2,5-dicarboxylic *(Aspergillus)*		≤ 16	2.4
5	Furancarbonylglycine *(Aspergillus)*		≤ 1.9	0.14
6	Tartaric *(Aspergillus)*		≤ 4.5	0.17
7	Arabinose		≤ 29	20
8	Carboxycitric		≤ 29	0.08
9	Tricarballylic *(Fusarium)*		≤ 0.44	0.10
Bacterial Markers				
10	Hippuric		≤ 613	171
11	2-Hydroxyphenylacetic	0.06	- 0.66	0.24
12	4-Hydroxybenzoic		≤ 1.3	0.13
13	4-Hydroxyhippuric	0.79	- 17	3.3
14	DHPPA (Beneficial Bacteria)		≤ 0.38	0.20
Clostridia Bacterial Markers				
15	4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*		≤ 19	9.5
16	HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*		≤ 208	44
17	4-Cresol *(C. difficile)*		≤ 75	1.2
18	3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*		≤ 11	0.54



MOSAIC DIAGNOSTICS

Neurotransmitter Metabolites

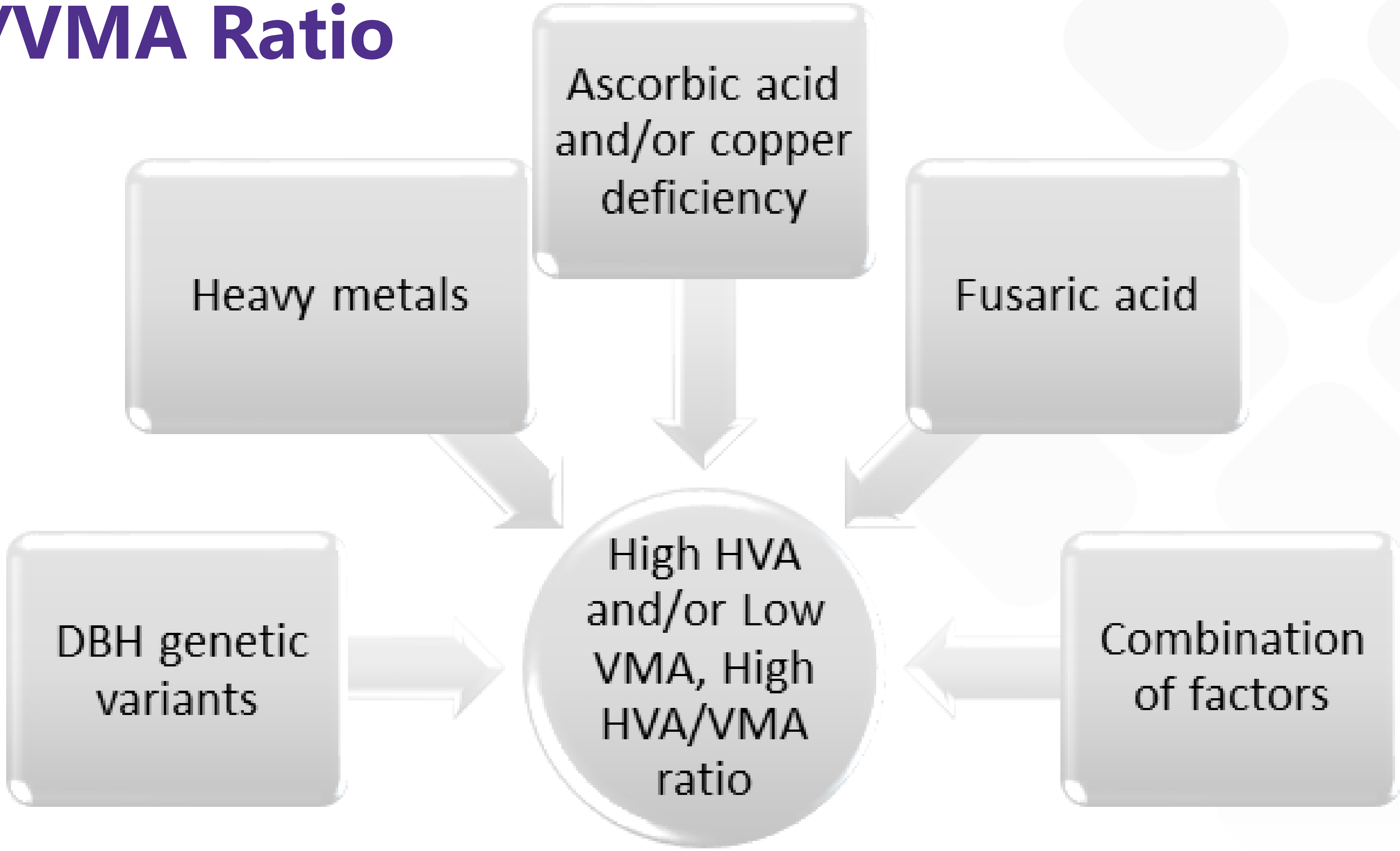
		Reference range		Result	
Phenylalanine and Tyrosine Metabolites					
33	Homovanillic (HVA) *(dopamine)*	0.80 - 3.6	H	13	
34	Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.46 - 3.7		1.3	
35	HVA / VMA Ratio	0.16 - 1.8	H	10.0	
36	Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.08 - 3.5	H	6.2	
37	HVA/ DOPAC Ratio	0.10 - 1.8	H	2.1	
Tryptophan Metabolites					
38	5-Hydroxyindoleacetic (5-HIAA) *(serotonin)*	≤ 4.3		0.74	
39	Quinolinic	0.85 - 3.9		3.1	
40	Kynurenic	≤ 2.2		0.21	



Neurotransmitter Nuances

• Nuanced Pattern: Non-Clostridia Factors

High HVA/VMA Ratio



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23675164
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https://doi.org/10.1136/jmg.2003.009282

Yeast activity and Oxalates

Production

Candida, and other yeast, can produce excess glyoxylate, liver has the potential to convert that to Oxalate

Molds have been shown to produce Oxalic Acid, directly

Yeast activity and Oxalates

Clinical Overview

Crystal-like structures associated with symptom of pain

- Pain without Etiology?

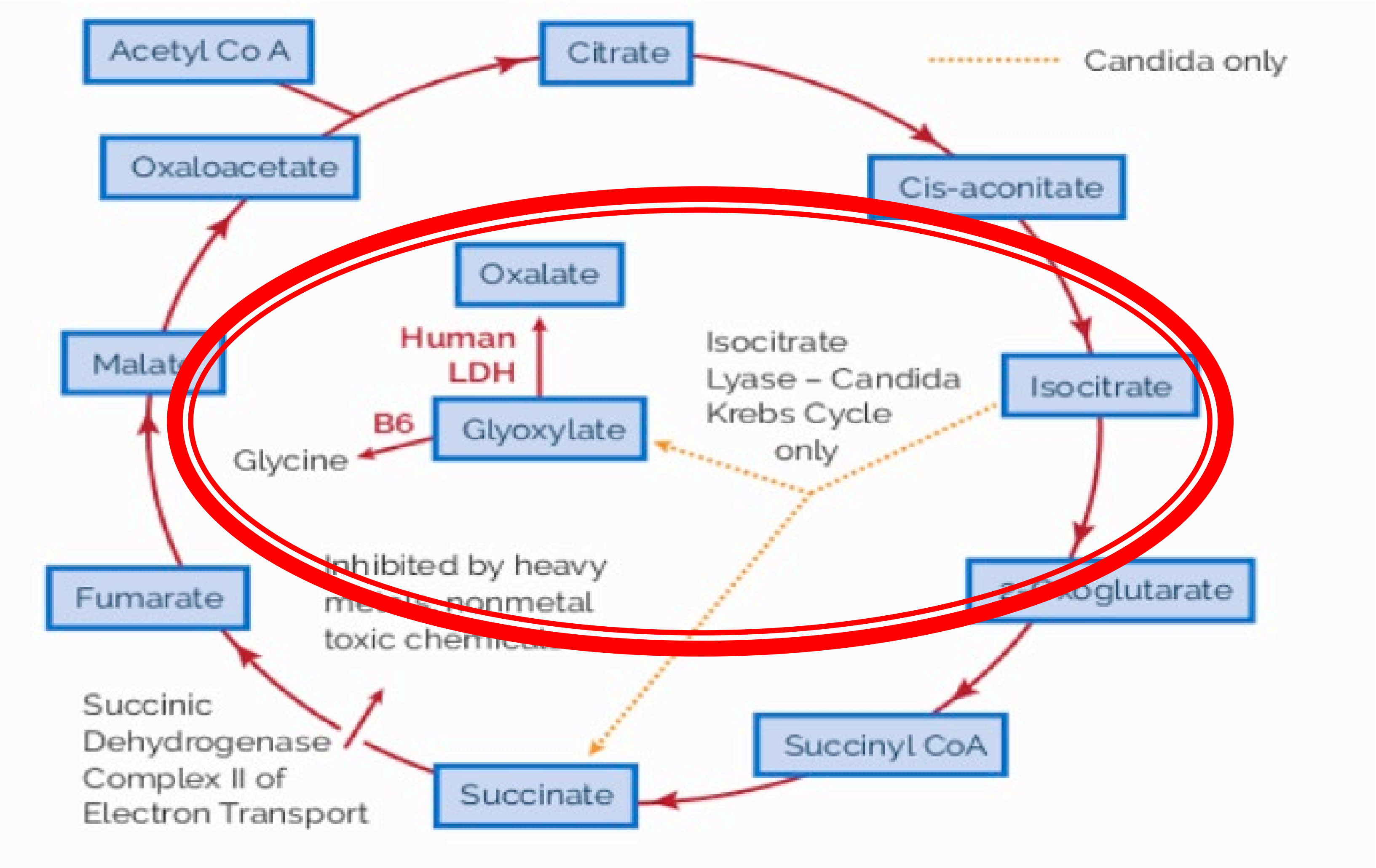
Three metabolites measured - Oxalic, glycolic, glyceric acids

- Focus on Oxalates

Important to evaluate due to:

- Connection to candida and mold exposure
- Association with B6 need,and/or mitochondrial dysfunction

Glyoxylate Cycle in Yeast



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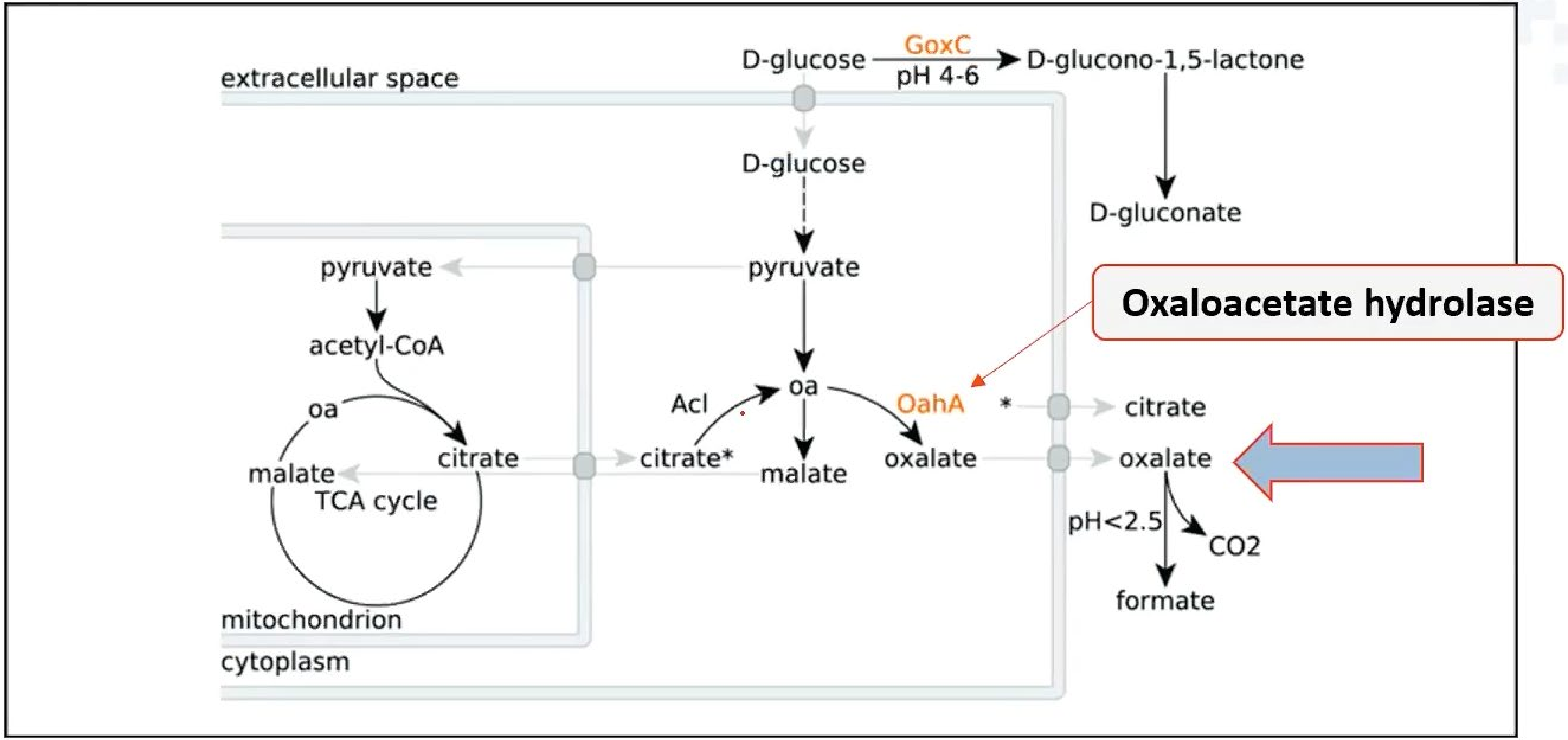
Aspergillus sp (niger) & Oxalate



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16047945
28824560

Intestinal Microbial Overgrowth

Yeast and Fungal Markers

	#	Marker	Reference range	Flag	Result
Yeast	1	Citramalic	0.11 - 2.0	H	2.3
Mold	2	5-Hydroxymethyl-2-furoic *(Aspergillus)*	≤ 18	H	33
	3	3-Oxoglutaric	≤ 0.11		0
Mold	4	Furan-2,5-dicarboxylic *(Aspergillus)*	≤ 13	H	26
	5	Furancarbonylglycine *(Aspergillus)*	≤ 2.3		0.15
	6	Tartaric *(Aspergillus)*	≤ 5.3		0.93
Candida	7	Arabinose	≤ 20	H	123
	8	Carboxycitric	≤ 20		6.1
	9	Tricarballylic *(Fusarium)*	≤ 0.58		0.11

Oxalate Metabolites

#	Marker	Reference range	Flag	Result
19	Glyceric	0.21 - 4.9		1.6
20	Glycolic	18 - 81		77
21	Oxalic	8.9 - 67	H	151

Intestinal Microbial Overgrowth

Yeast and Fungal Markers

		Reference range		Result
1	Citramalic	0.11 - 2.0		1.0
2	5-Hydroxymethyl-2-furoic *(Aspergillus)*	≤ 18		2.5
3	3-Oxoglutaric	≤ 0.11		0.03
4	Furan-2,5-dicarboxylic *(Aspergillus)*	≤ 13		2.0
5	Furancarbonylglycine *(Aspergillus)*	≤ 2.3		0.24
6	Tartaric *(Aspergillus)*	≤ 5.3		1.2
7	Arabinose	≤ 20	H	28
8	Carboxycitric	≤ 20		0.72
9	Tricarballylic *(Fusarium)*	≤ 0.58		0.07

Candida → 7 Arabinose

Oxalate Metabolites

		Reference range		Result
19	Glyceric	0.21 - 4.9	H	7.6
20	Glycolic	18 - 81	H	83
21	Oxalic	8.9 - 67		65

Yeast/Candida Nuances

Intestinal Microbial Overgrowth

#	Marker	Reference Range	Result
Yeast and Fungal Markers			
1	Citramalic	≤ 3.6	1.0
2	5-Hydroxymethyl-2-furoic *(Aspergillus)*	≤ 14	7.6
3	3-Oxoglutaric	≤ 0.33	0.14
4	Furan-2,5-dicarboxylic *(Aspergillus)*	≤ 16	11
5	Furancarbonylglycine *(Aspergillus)*	≤ 1.9	0.69
6	Tartaric *(Aspergillus)*	≤ 4.5	0.76
7	Arabinose	≤ 29	15
8	Carboxycitric	≤ 29	0.48
9	Tricarballylic *(Fusarium)*	≤ 0.44	0.28
Bacterial Markers			
10	Hippuric	≤ 613	63
11	2-Hydroxyphenylacetic	0.06 - 0.66	0.44
12	4-Hydroxybenzoic	≤ 1.3	0.74
13	4-Hydroxyhippuric	0.79 - 17	6.5
14	DHPPA (Beneficial Bacteria)	≤ 0.38	0.22
Clostridia Bacterial Markers			
15	4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*	≤ 19	17
16	HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*	≤ 208	87
17	4-Cresol *(C. difficile)*	≤ 75	3.1
18	3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*	≤ 11	7.5

Oxalate Metabolites

19	Glyceric	0.77	-	7.0	H	22	22
20	Glycolic	16	-	117	H	128	128
21	Oxalic	6.8	-	101	H	308	308

Nuances for high oxalate markers

- Threshold for Tolerance and Elimination is highly variable
- Address 1st page (if warranted) for major source
- B6 is needed to favor Oxalate to Glycine pathway
- Levels excreted not necessarily reflective of body burden.
- Low Oxalate Diet
  - Dependent on situation, and not dictated by numerical values on test
  - Rarely warranted or mild elevations
  - Evaluate symptom profile for severity

Yeast Activity and Riboflavin

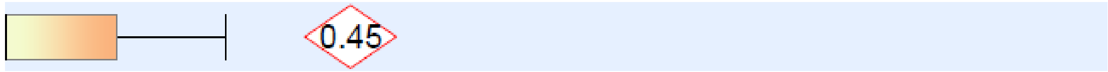
Common pattern linked to acetaldehyde detoxification

- Ethanol is an end product of yeast metabolism of glucose
- Acetaldehyde produced in the previous step
    - Requires NAD, B2, Fe, Molybdenum

Acetaldehyde +NAD+. + H20 → acetate + NADH + 2H

Vitamin B2 (Riboflavin)

53	Glutaric ✱	0.04	- 0.36	H	0.45



https://doi.org/10.1007/S10267-011-0110-Y

The dietary modification and treatment of intestinal Candida overgrowth - a pilot study

S Otašević [1], S Momčilović [2], M Petrović [3], O Radulović [4], N M Stojanović [3], V Arsić-Arsenijević [5]

Affiliations + expand

PMID: 30166063 DOI: 10.1016/j.mycmed.2018.08.002

Abstract

Objective: The aim of this study was to evaluate the effectiveness of an alternative treatment in a

"Results of this pilot study showed that patients who adhered to diet modification during and after treatment with nystatin had better outcomes of ICOG and strongly suggest the need for diet modification in these patients…"

symptomatic effect in 56 out of 80 (70.0%) patients and 29 out of 40 (72.5%) in CG, with no statistically significant difference. However, at the second control stool examination, significantly higher percent (85%) of cured patients was recorded after three months of the recommended diet comparing with CG-17 out of 40 (42.5%).

Conclusion: Results of this pilot study showed that patients who adhered to diet modification during and after treatment with nystatin had better outcomes of ICOG and strongly suggest the need for diet modification in these patients which recommendation could reduce excessive prescription of antifungals.

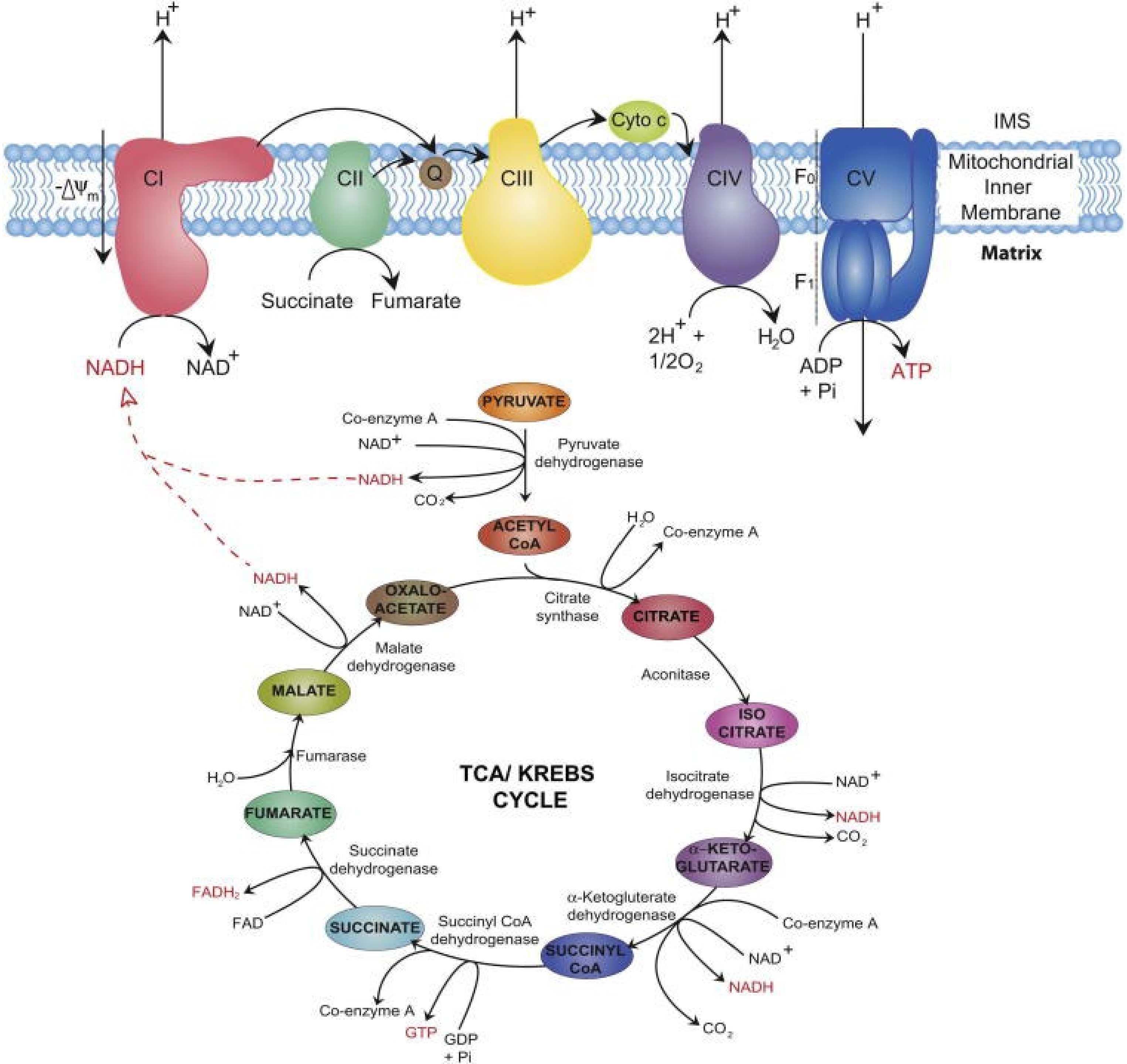
Keywords: Antifungal treatment; Dietary modification; Intestinal candidosis.

Toxic Exposure – Heavy Metals, Mold, Chemicals

TOXIC PATTERNS ON OAT

PMID: 37446354

MOSAIC DIAGNOSTICS



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Glycolytic Cycle Metabolites

22	Lactic	≤ 48		28
23	Pyruvic	≤ 9.1		3.5

Mitochondrial Markers - Krebs Cycle Metabolites

24	Succinic	≤ 9.3	H	16
25	Fumaric	≤ 0.94	H	1.5
26	Malic	0.06 - 1.8	H	3.6
27	2-Oxoglutaric	≤ 35		18
28	Aconitic	6.8 - 28		19
29	Citric	≤ 507	H	702

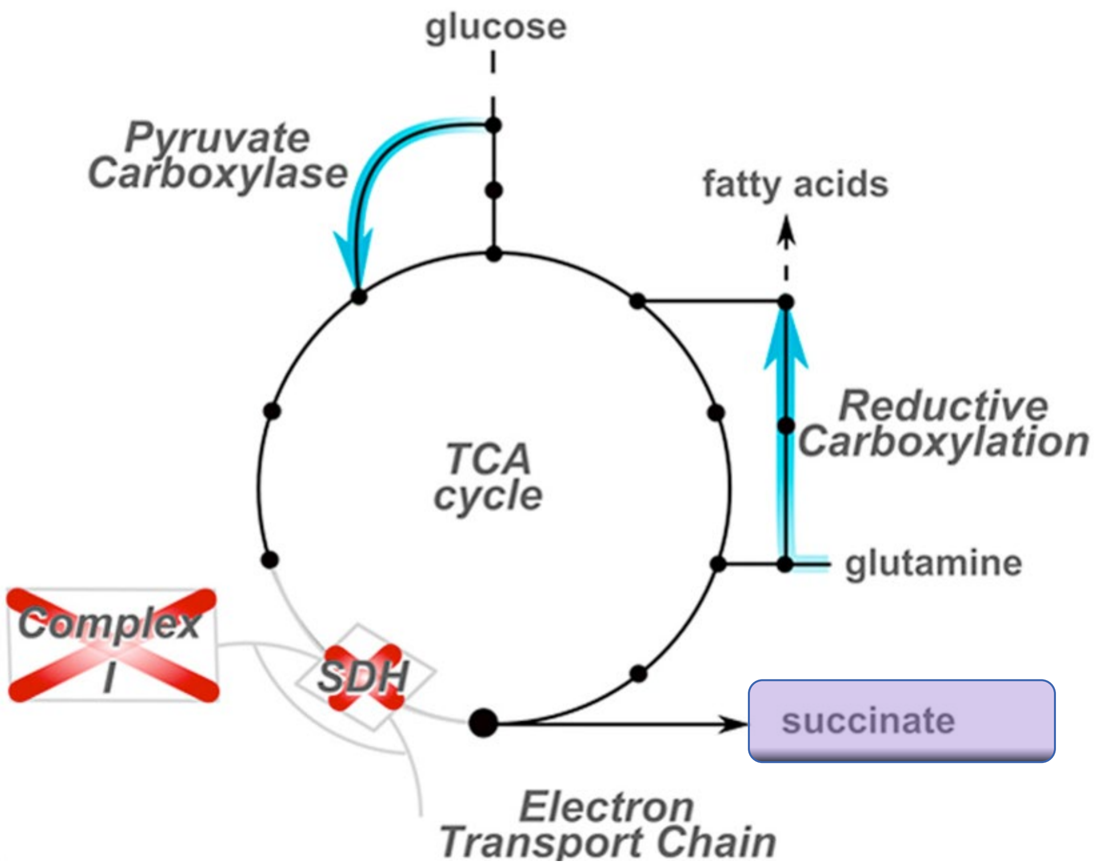
Mitochondrial Markers - Amino Acid Metabolites

30	3-Methylglutaric	≤ 0.76	H	1.3
31	3-Hydroxyglutaric	≤ 6.2	H	8.8
32	3-Methylglutaconic	≤ 4.5		3.1

Succinic acid

Elevations often associated with Fatigue and Brain Fog

Succinate is formed in the Krebs cycle from succinyl coA
In the body succinate is converted to fumarate via succinate dehydrogenase
This enzyme is the only one to participate in the Krebs cycle and ETC
Common concern with elevations: brain fog and fatigue
Look for possible toxins

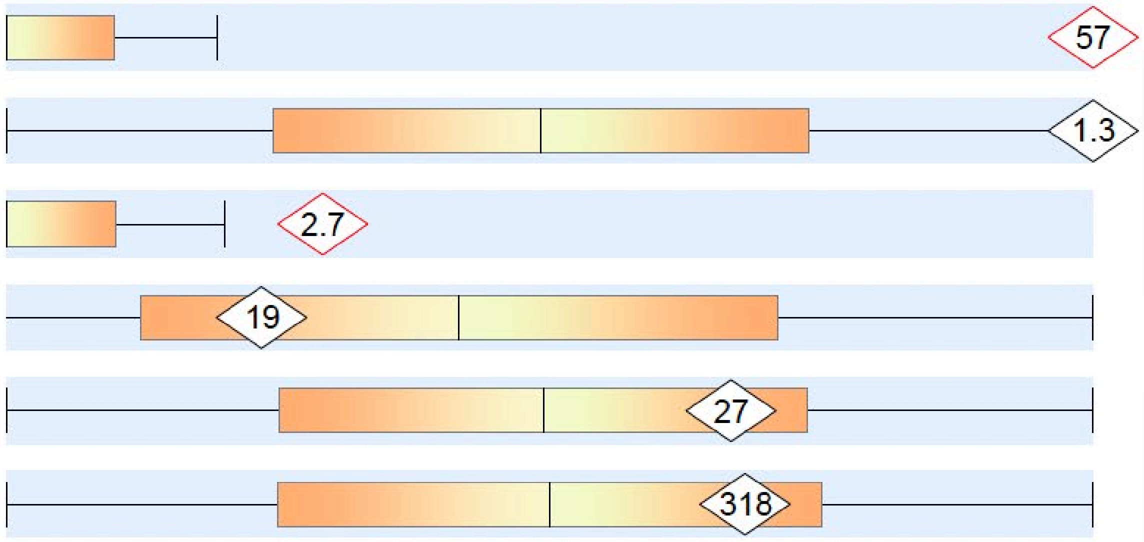


MOSAIC DIAGNOSTICS

PMID:
27847310
37446354

Mitochondrial Markers - Krebs Cycle Metabolites

24	Succinic		≤	15	H	57
25	Fumaric	0.04	-	1.3		1.3
26	Malic		≤	2.2	H	2.7
27	2-Oxoglutaric		≤	81		19
28	Aconitic	11	-	35		27
29	Citric	59	-	440		318

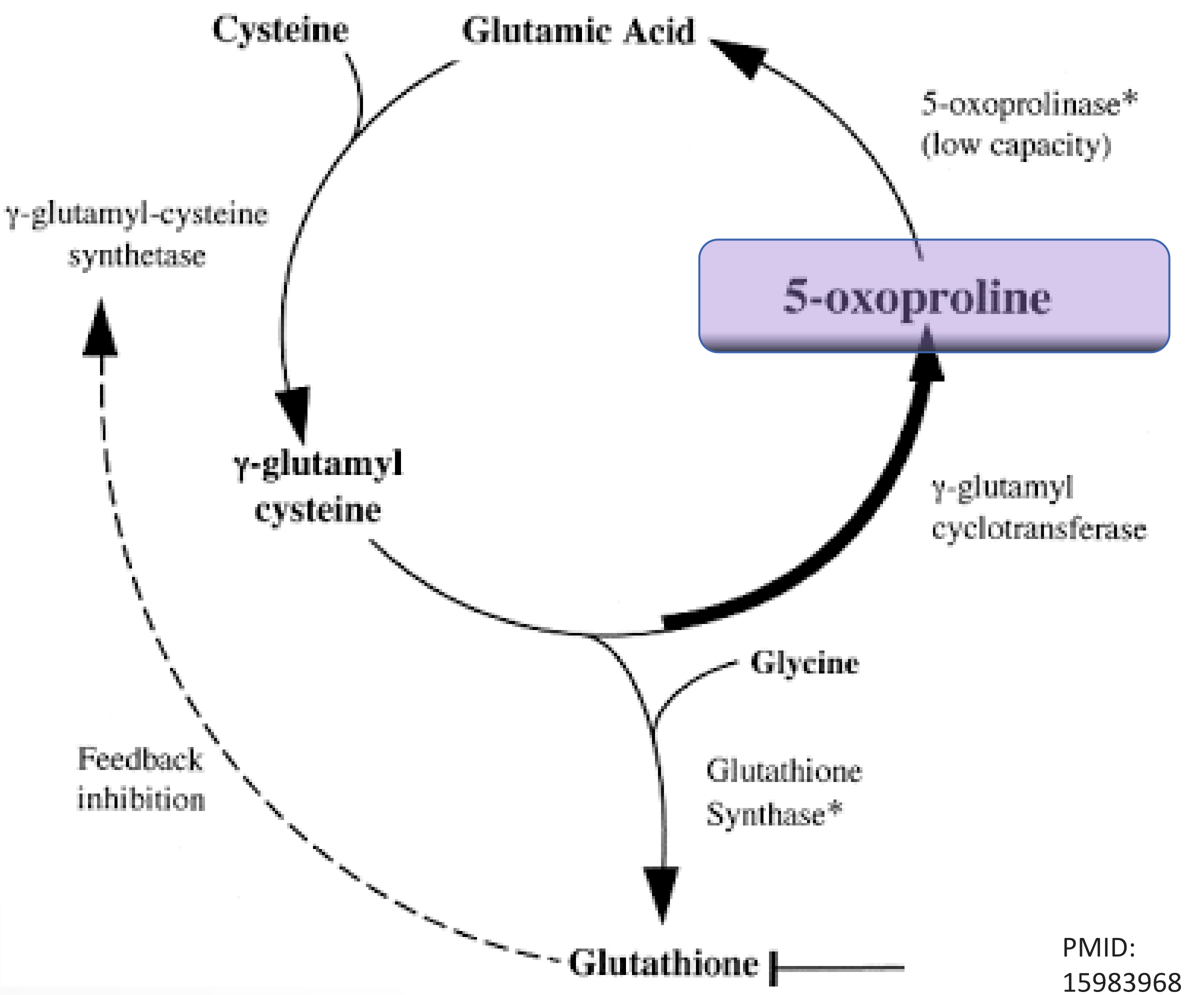


Pyroglutamic Acid Production

Gamma-Glutamyl Cycle

- Negative Feed back loop for Glutathione to inhibit gamma- glutamyl Cysteine synthase

- Without glutathione, the feedback inhibition is removed, and there is an upregulation of this enzyme, resulting in increased amounts of gamma-glutamyl cysteine, which itself is a precursor to the organic acid 5-oxoproline (pyroglutamic acid)

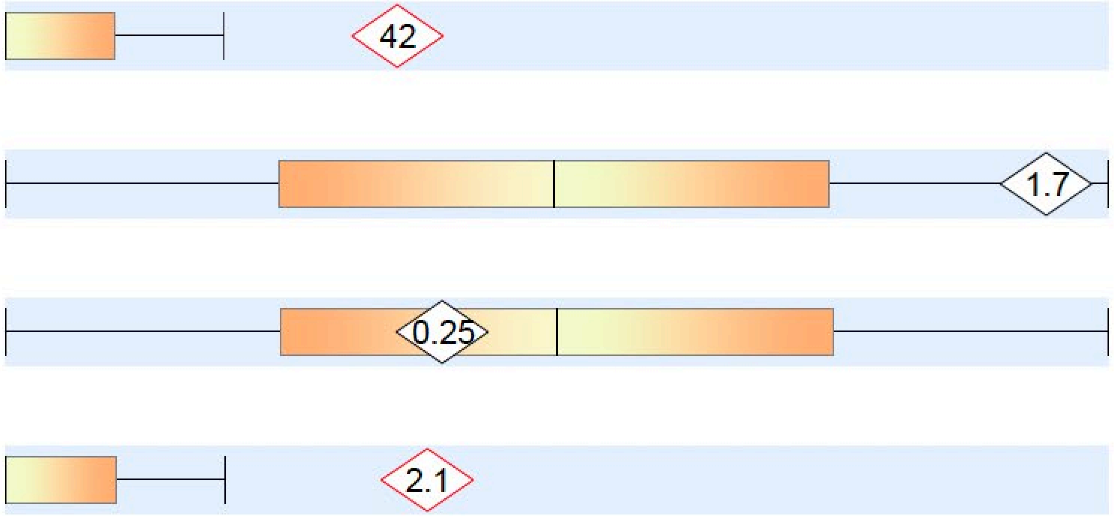


MOSAIC DIAGNOSTICS

PMID:
15983968
22658719

Indicators of Detoxification

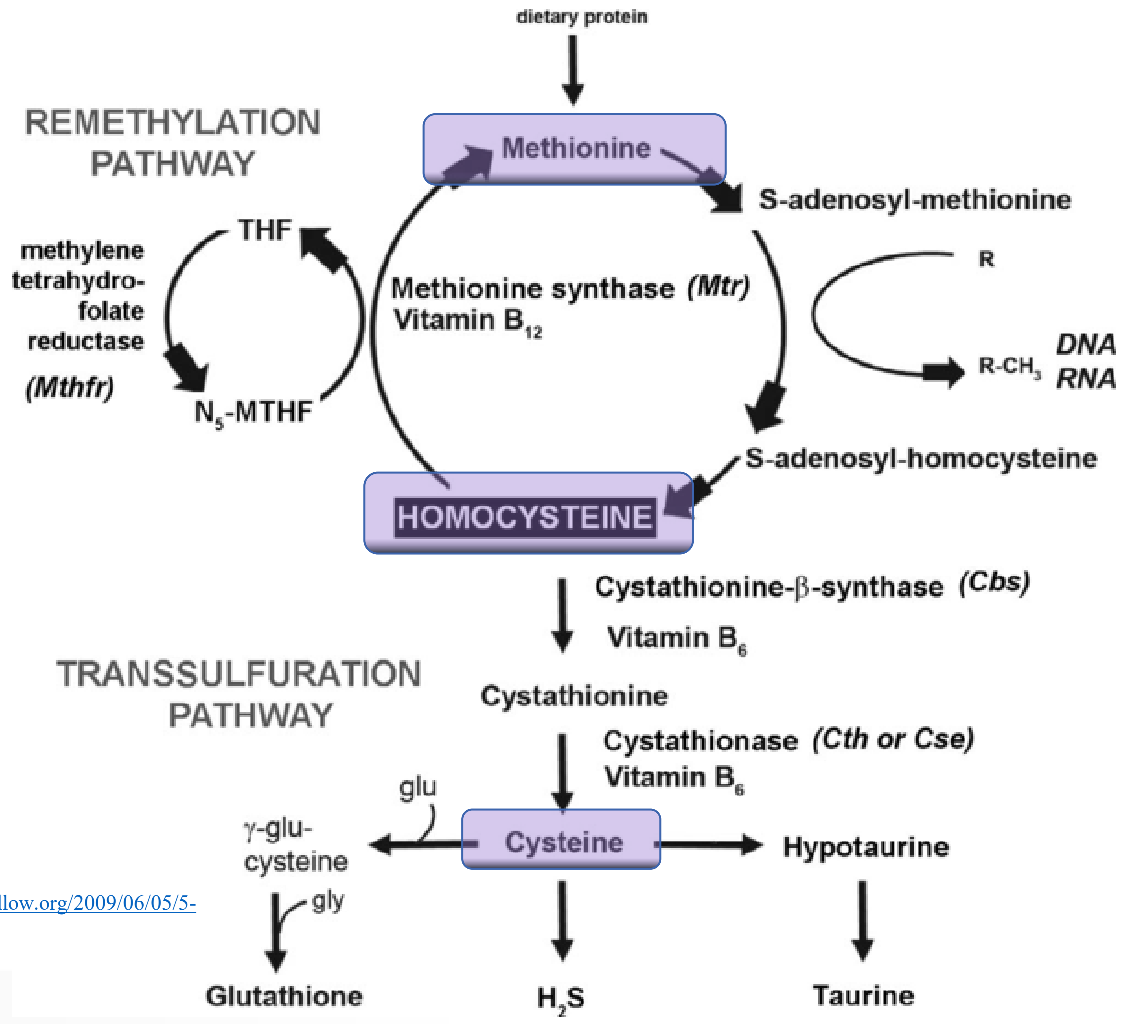
Glutathione						
58	Pyroglutamic ✱	10	-	33	H	42
Methylation, Toxic exposure						
59	2-Hydroxybutyric ✱✱	0.03	-	1.8		1.7
Ammonia Excess						
60	Orotic	0.06	-	0.54		0.25
Aspartame, salicylates, or GI bacteria						
61	2-Hydroxyhippuric		≤	1.3	H	2.1



2-Hydroxybutyric

Homocysteine has 2 choices

- Methionine via Methylation
- Cysteine via trans-sulfuration pathway



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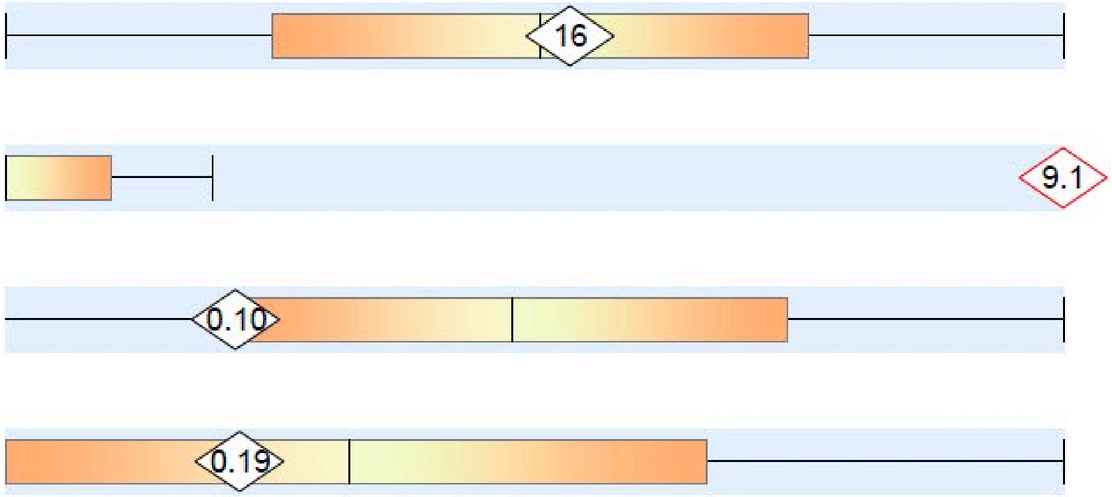
2. Hellman, N. (2009b, June 5). *5-Oxoprolinuria as a Cause for Metabolic Acidosis*. Renal Fellow Network. https://www.renalfellow.org/2009/06/05/5-oxoprolinuria-as-cause-for-metabolic/

MOSAIC DIAGNOSTICS

Indicators of Detoxification

Glutathione				
58	Pyroglutamic ✱	5.7 - 25		16
Methylation, Toxic exposure				
59	2-Hydroxybutyric ✱✱	≤ 1.2	H	9.1
Ammonia Excess				
60	Orotic	≤ 0.46		0.10
Aspartame, salicylates, or GI bacteria				
61	2-Hydroxyhippuric	≤ 0.86		0.19



Case Example

60-year-old female

- Chief complaint - Recurrent yeast infections
- Presenting with joint pain, skin rash and metabolic dysfunction and disrupted sleep
  - High TGs, CRP, hbA1c
- Previously treated with both herbals and nystatin

Intestinal Microbial Overgrowth

Yeast and Fungal Markers

No.	Marker	Reference Range	Flag	Result
1	Citramalic	≤ 3.6		0.81
2	5-Hydroxymethyl-2-furoic *(Aspergillus)*	≤ 14		1.5
3	3-Oxoglutaric	≤ 0.33	H	0.67
4	Furan-2,5-dicarboxylic *(Aspergillus)*	≤ 16		1.3
5	Furancarbonylglycine *(Aspergillus)*	≤ 1.9		0.64
6	Tartaric *(Aspergillus)*	≤ 4.5	H	7.0
7	Arabinose	≤ 29	H	334
8	Carboxycitric	≤ 29		0.17
9	Tricarballylic *(Fusarium)*	≤ 0.44		0.12

Bacterial Markers

No.	Marker	Reference Range	Flag	Result
10	Hippuric	≤ 613		144
11	2-Hydroxyphenylacetic	0.06 - 0.66		0.44
12	4-Hydroxybenzoic	≤ 1.3	H	6.9
13	4-Hydroxyhippuric	0.79 - 17		3.4
14	DHPPA (Beneficial Bacteria)	≤ 0.38		0.13

Clostridia Bacterial Markers

No.	Marker	Reference Range	Flag	Result
15	4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*	≤ 19		13
16	HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*	≤ 208		2.9
17	4-Cresol *(C. difficile)*	≤ 75		37
18	3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*	≤ 11		7.9

MOSAIC DIAGNOSTICS

Oxalate Metabolites

#	Metabolite	Reference Range		Result
19	Glyceric	0.77 - 7.0	H	8.5
20	Glycolic	16 - 117		48
21	Oxalic	6.8 - 101	H	243

Glycolytic Cycle Metabolites

#	Metabolite	Reference Range		Result
22	Lactic	≤ 48		12
23	Pyruvic	≤ 9.1		2.4

Mitochondrial Markers - Krebs Cycle Metabolites

#	Metabolite	Reference Range		Result
24	Succinic	≤ 9.3	H	9.4
25	Fumaric	≤ 0.94	H	1.2
26	Malic	0.06 - 1.8	H	2.3
27	2-Oxoglutaric	≤ 35		19
28	Aconitic	6.8 - 28		15
29	Citric	≤ 507		507

Mitochondrial Markers - Amino Acid Metabolites

#	Metabolite	Reference Range		Result
30	3-Methylglutaric	≤ 0.76		0.32
31	3-Hydroxyglutaric	≤ 6.2		4.8
32	3-Methylglutaconic	≤ 4.5		1.7

Neurotransmitter Metabolites

Phenylalanine and Tyrosine Metabolites

#	Metabolite	Reference Range		Result
33	Homovanillic (HVA) *(dopamine)*	0.80 - 3.6	H	8.7
34	Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.46 - 3.7		1.3
35	HVA / VMA Ratio	0.16 - 1.8	H	6.6
36	Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.08 - 3.5	H	8.1
37	HVA/ DOPAC Ratio	0.10 - 1.8		1.1

Pyrimidine Metabolites - Folate Metabolism

#	Marker	Reference Range	Flag	Value
41	Uracil	≤ 9.7		2.9
42	Thymine	≤ 0.56		0.13

Ketone and Fatty Acid Oxidation

#	Marker	Reference Range	Flag	Value
43	3-Hydroxybutyric	≤ 3.1	H	3.8
44	Acetoacetic	≤ 10		5.2
45	Ethylmalonic	0.44 - 2.8		1.2
46	Methylsuccinic	0.10 - 2.2		2.0
47	Adipic	0.04 - 3.8		2.8
48	Suberic	0.18 - 2.2	H	6.3
49	Sebacic	≤ 0.24	H	0.63

Nutritional Markers

#	Marker	Reference Range	Flag	Value
	Vitamin B12			
50	Methylmalonic ✱	≤ 2.3		1.4
	Vitamin B6			
51	Pyridoxic (B6)	≤ 34		3.4
	Vitamin B5			
52	Pantothenic (B5)	≤ 10		8.8
	Vitamin B2 (Riboflavin)			
53	Glutaric ✱	0.04 - 0.36	H	0.96
	Vitamin C			
54	Ascorbic	10 - 200	L	2.5
	Vitamin Q10 (CoQ10)			
55	3-Hydroxy-3-methylglutaric ✱	0.17 - 39		26
	Glutathione Precursor and Chelating Agent			
56	N-Acetylcysteine (NAC)	≤ 0.28		0.02
	Biotin (Vitamin H)			
57	Methylcitric ✱	0.19 - 2.7		1.0

MOSAIC DIAGNOSTICS

Indicators of Detoxification

Glutathione				
58	Pyroglutamic ✱	10 - 33		21
Methylation, Toxic exposure				
59	2-Hydroxybutyric ✱✱	0.03 - 1.8	H	2.1
Ammonia Excess				
60	Orotic	0.06 - 0.54		0.39
Aspartame, salicylates, or GI bacteria				
61	2-Hydroxyhippuric	≤ 1.3		0.10

MOSAIC DIAGNOSTICS

Pattern recognition – Common findings

- Clostridia and Neurotransmitter Metabolism
- Yeast activity and Oxalates
- Toxic Exposure


An OAT test is just the start

Complementary Testing with Other Mosaic Diagnostics Profiles

Glyphosate Test

- Clostridia, mitochondrial stress

MycoTOX

- Fungal activity, mitochondrial stress, detoxification

Metals – Toxic + Nutrient Elements (Hair vs Urine vs Blood)

- Mitochondrial stress, detoxification section, NT section

IgG FoodMap * Candida

- Microbial section

Complementary Testing with Other Mosaic Diagnostics Profiles

Comprehensive Stool Analysis

- Microbial section - Bacterial analytes

Saliva Hormone Profile

- NT section

DNA Methylation Pathway Profile

- NT section, detoxification section

Thank You
Q & A

MOSAIC DIAGNOSTICS