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|---|---|---|---|
| PATIENT: XXXXXXXXXXXXXXXXXXX | | | TEST REF: TST-NL-XXXXX |
| TEST NUMBER: T-NL-XXXXXX | COLLECTED: 2026-XX-XX | | PRACTITIONER: XXXXXXXXXXXXXXXXXXXX |
| GENDER: XXXXX | | | |
| AGE: XX | | | |

## TEST NAME: Organic Acids Test (OAT)

# OAT
ORGANIC ACIDS TEST

## Summary of Results

KEY — IMBALANCE: UNREMARKABLE · MARGINAL · SIGNIFICANT

### Microbial Overgrowth
Results may indicate significant microbial imbalance.

**2** 5-Hydroxymethyl-2-furoic
**5** Furancarbonylglycine
**18** 3-Indoleacetic

11A

### Mitochondrial Health
Results may indicate marginal imbalances.

**22** Lactic
**31** 3-Hydroxyglutaric
**43** 3-Hydroxybutyric
**53** Glutaric
**54** Ascorbic
**74** Malonic

2B

### Neurotransmitter Metabolites
No imbalances detected.

3C

### Toxic Exposure
Results may indicate mold exposure.

**2** 5-Hydroxymethyl-2-furoic
**5** Furancarbonylglycine

5D

### Methylation/Detoxification
Results may indicate marginal detoxification and/or methylation imbalances.

**41** Uracil
**53** Glutaric
**38** 5-Hydroxyindoleacetic (5-HIAA)

2E

### Nutrient Needs
Results may indicate marginal nutrient needs.

**41** Uracil
**53** Glutaric
**54** Ascorbic
**22** Lactic
**38** 5-Hydroxyindoleacetic (5-HIAA)
**13** 4-Hydroxyhippuric

2F



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| AGE: XX | | | |

## TEST NAME: Organic Acids Test (OAT)

# OAT
ORGANIC ACIDS TEST

# Test Results

| | METABOLITE | REFERENCE RANGE | | RESULTS (mmol/mol creatinine) | REFERENCE POPULATION Females Age 13 and Over |
|---|---|---|---|---|---|
| **INTESTINAL MICROBIAL OVERGROWTH** | | | | | |
| YEAST AND FUNGAL | 1 Citramalic | ≤3.6 | | 0.58 | 0.58 |
| | 2 5-Hydroxymethyl-2-furoic *(Aspergillus)* | ≤14 | H | 16 | 16 |
| | 3 3-Oxoglutaric | ≤0.33 | | 0.02 | 0.02 |
| | 4 Furan-2,5-dicarboxylic *(Aspergillus)* | ≤16 | | 1.6 | 1.6 |
| | 5 Furancarbonylglycine *(Aspergillus)* | ≤1.9 | H | 4.8 | 4.8 |
| | 6 Tartaric *(Aspergillus)* | ≤4.5 | | 0.55 | 0.55 |
| | 7 Arabinose | ≤29 | | 22 | 22 |
| | 8 Carboxycitric | ≤29 | | 0.32 | 0.32 |
| | 9 Tricarballylic *(Fusarium)* | ≤0.44 | | 0.07 | 0.07 |
| BACTERIAL | 10 Hippuric | ≤613 | | 394 | 394 |
| | 11 2-Hydroxyphenylacetic | 0.06 - 0.66 | | 0.32 | 0.32 |
| | 12 4-Hydroxybenzoic | ≤1.3 | | 0.57 | 0.57 |
| | 13 4-Hydroxyhippuric | 0.79 - 17 | | 1.8 | 1.8 |
| | 14 DHPPA *(Beneficial Bacteria)* | ≤0.38 | | 0.09 | 0.09 |
| CLOSTRIDIA BACTERIAL | 15 4-Hydroxyphenylacetic *(C. difficile, C. stricklandii & others)* | ≤19 | | 7.7 | 7.7 |
| | 16 HPHPA *(C. sporogenes, C. botulinum & others)* | ≤208 | | 9.9 | 9.9 |
| | 17 4-Cresol *(C. difficile)* | ≤75 | | 9.4 | 9.4 |
| | 18 3-Indoleacetic *(C. stricklandii, C. subterminale & others)* | ≤11 | H | 16 | 16 |



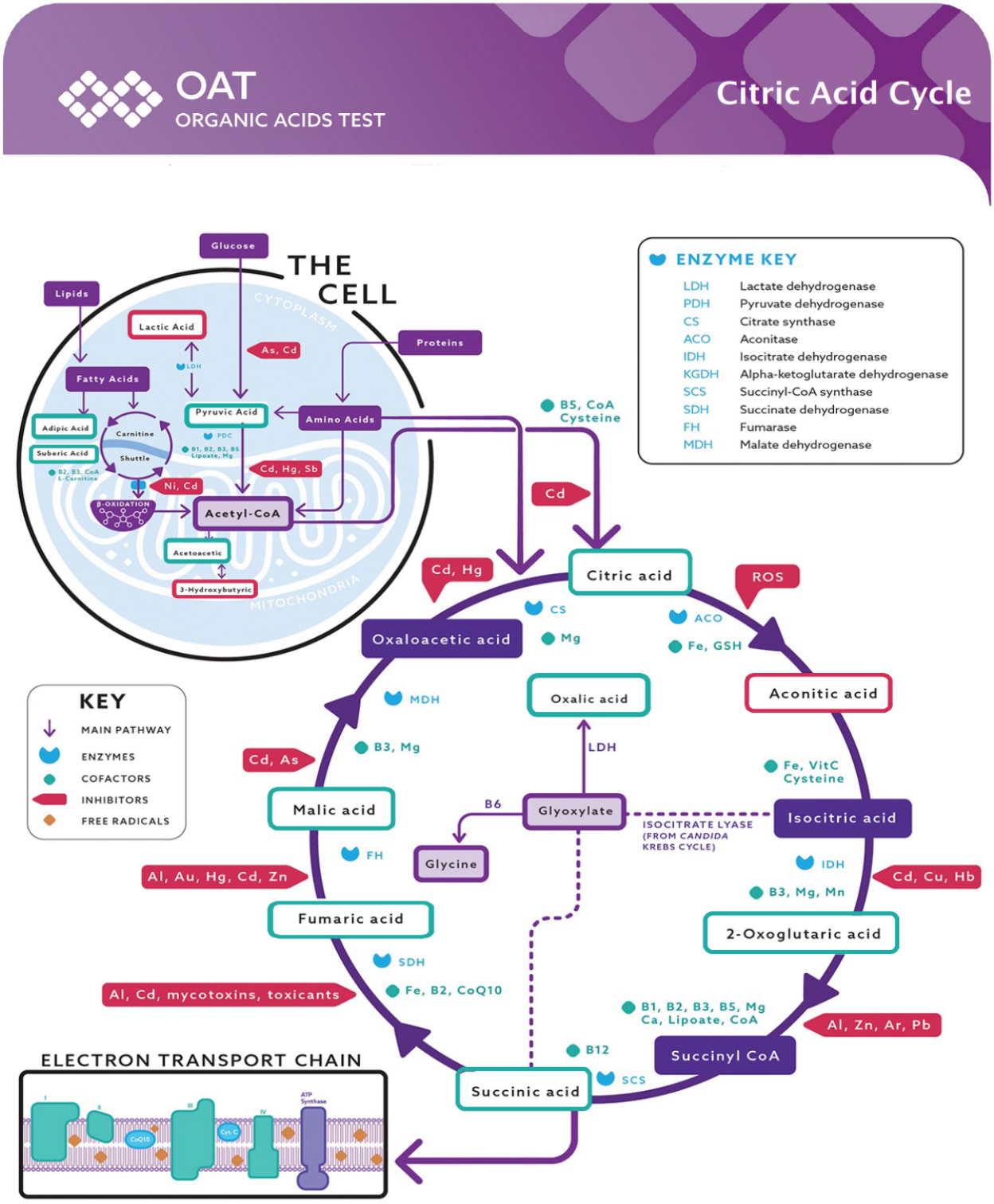
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## TEST NAME: Organic Acids Test (OAT)






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| TEST NUMBER: T-NL-XXXXXX | COLLECTED: 2026-XX-XX | PRACTITIONER: XXXXXXXXXXXXXXXXXXXX |
| GENDER: XXXXX | | |
| AGE: XX | | |

## TEST NAME: Organic Acids Test (OAT)

OAT
ORGANIC ACIDS TEST

### Test Results - continued

| | METABOLITE | REFERENCE RANGE | | RESULTS (mmol/mol creatinine) | REFERENCE POPULATION Females Age 13 and Over |
|---|---|---|---|---|---|
| **OXALATE METABOLITES** | | | | | |
| 19 | Glyceric | 0.77 - 7.0 | | 2.4 | 2.4 |
| 20 | Glycolic | 16 - 117 | | 63 | 63 |
| 21 | Oxalic | 6.8 - 101 | | 68 | 68 |
| **GLYCOLYTIC METABOLITES** | | | | | |
| 22 | Lactic | ≤48 | H | 130 | 130 |
| 23 | Pyruvic | ≤9.1 | | 1.3 | 1.3 |
| **MITOCHONDRIAL MARKERS** | | | | | |
| CITRIC ACID CYCLE | | | | | |
| 24 | Succinic | ≤9.3 | | 9.3 | 9.3 |
| 25 | Fumaric | ≤0.94 | | 0.38 | 0.38 |
| 26 | Malic | 0.06 - 1.8 | | 0.50 | 0.50 |
| 27 | 2-Oxoglutaric | ≤35 | | 17 | 17 |
| 28 | Aconitic | 6.8 - 28 | L | 6.6 | 6.6 |
| 29 | Citric | ≤507 | | 149 | 149 |
| **MITOCHONDRIAL MARKERS** | | | | | |
| AMINO ACIDS | | | | | |
| 30 | 3-Methylglutaric | ≤0.76 | | 0.23 | 0.23 |
| 31 | 3-Hydroxyglutaric | ≤6.2 | H | 8.7 | 8.7 |
| 32 | 3-Methylglutaconic | ≤4.5 | | 1.2 | 1.2 |
| **NEUROTRANSMITTER METABOLITES** | | | | | |
| PHENYLALANINE AND TYROSINE | | | | | |
| 33 | Homovanillic (HVA) *(dopamine)* | 0.80 - 3.6 | | 2.1 | 2.1 |
| 34 | Vanillylmandelic (VMA) *(norepinephrine, epinephrine)* | 0.46 - 3.7 | | 1.3 | 1.3 |
| 35 | HVA / VMA Ratio | 0.16 - 1.8 | | 1.6 | 1.6 |
| 36 | Dihydroxyphenylacetic (DOPAC) *(dopamine)* | 0.08 - 3.5 | | 2.1 | 2.1 |
| 37 | HVA/ DOPAC Ratio | 0.10 - 1.8 | | 0.98 | 0.98 |
| TRYPTOPHAN | | | | | |
| 38 | 5-Hydroxyindoleacetic (5-HIAA) *(serotonin)* | ≤4.3 | | 0.56 | 0.56 |
| 39 | Quinolinic | 0.85 - 3.9 | | 1.4 | 1.4 |
| 40 | Kynurenic | ≤2.2 | | 0.58 | 0.58 |



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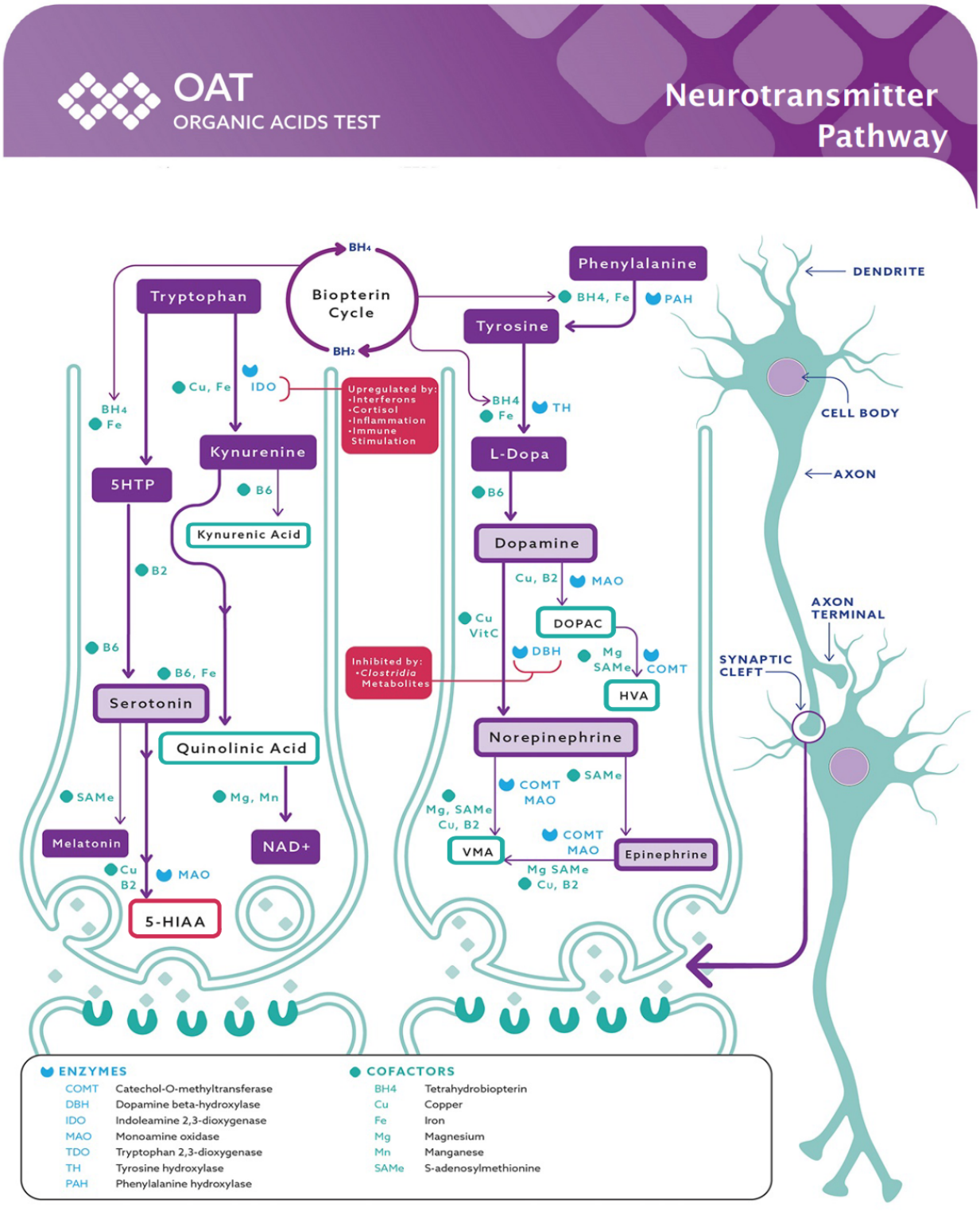
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| GENDER: XXXXX | | | |
| AGE: XX | | | |

## TEST NAME: Organic Acids Test (OAT)






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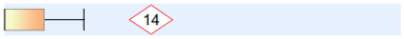
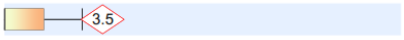
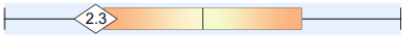
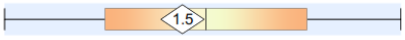
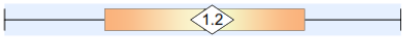
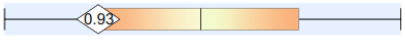
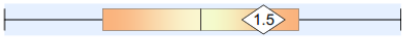
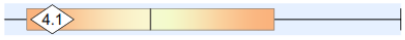
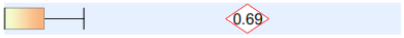
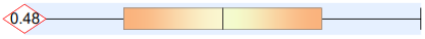
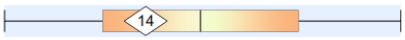
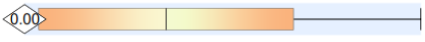
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| GENDER: XXXXX | | |
| AGE: XX | | |

## TEST NAME: Organic Acids Test (OAT)

OAT
ORGANIC ACIDS TEST

### Test Results - continued

| METABOLITE | REFERENCE RANGE | | RESULTS (mmol/mol creatinine) | REFERENCE POPULATION Females Age 13 and Over |
|---|---|---|---|---|
| **PYRIMIDINE METABOLITES - FOLATE METABOLISM** | | | | |
| (41) Uracil | ≤9.7 | H | 14 |   |
| (42) Thymine | ≤0.56 | | 0.43 |   |
| **KETONE AND FATTY ACID OXIDATION** | | | | |
| (43) 3-Hydroxybutyric | ≤3.1 | H | 3.5 |   |
| (44) Acetoacetic | ≤10 | | 2.3 |   |
| (45) Ethylmalonic | 0.44 - 2.8 | | 1.5 |   |
| (46) Methylsuccinic | 0.10 - 2.2 | | 1.2 |   |
| (47) Adipic | 0.04 - 3.8 | | 0.93 |   |
| (48) Suberic | 0.18 - 2.2 | | 1.5 |   |
| (49) Sebacic | ≤0.24 | | 0.07 |   |
| **NUTRITIONAL MARKERS** | | | | |
| Vitamin B12 (50) Methylmalonic * | ≤2.3 | | 1.1 |   |
| Vitamin B6 (51) Pyridoxic | ≤34 | | 4.1 |   |
| Vitamin B5 (52) Pantothenic | ≤10 | H | 20 |   |
| Vitamin B2 (Riboflavin) (53) Glutaric * | 0.04 - 0.36 | H | 0.69 |   |
| Vitamin C (54) Ascorbic | 10 - 200 | L | 0.48 |   |
| Vitamin Q10 (CoQ10) (55) 3-Hydroxy-3-methylglutaric * | 0.17 - 39 | | 14 |   |
| Glutathione Precursor and Chelating Agent (56) N-Acetylcysteine (NAC) | ≤0.28 | | 0 |   |
| Biotin (Vitamin H) (57) Methylcitric * | 0.19 - 2.7 | | 0.59 |   |

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



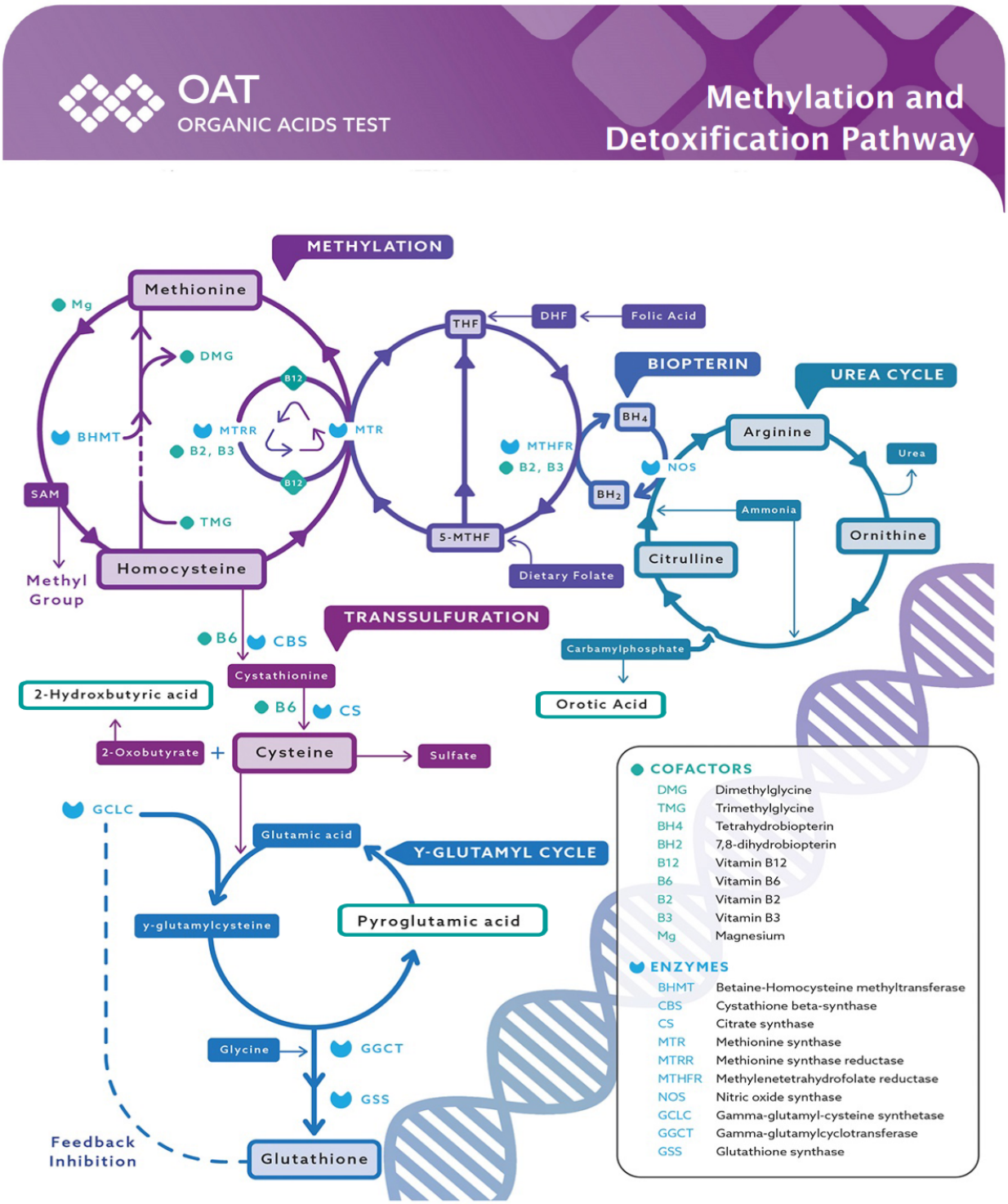
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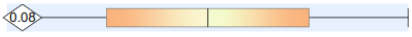
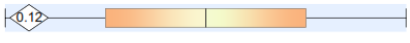
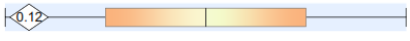
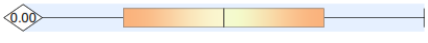
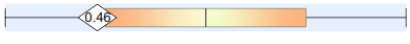
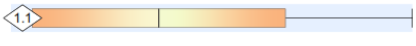
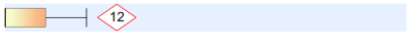
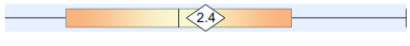
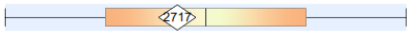
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PATIENT: XXXXXXXXXXXXXXXXXXXX
TEST REF: TST-NL-XXXXX
TEST NUMBER: T-NL-XXXXXX
GENDER: XXXXX
AGE: XX
COLLECTED: 2026-XX-XX
PRACTITIONER: XXXXXXXXXXXXXXXXXXXX

## TEST NAME: Organic Acids Test (OAT)

OAT
ORGANIC ACIDS TEST

### Test Results - continued

| METABOLITE | REFERENCE RANGE | RESULTS (mmol/mol creatinine) | REFERENCE POPULATION Females Age 13 and Over |
|---|---|---|---|
| **INDICATORS OF DETOXIFICATION** | | | |
| Glutathione | | | |
| (58) Pyroglutamic * | 10 - 33 | 29 |  |
| Methylation, Toxic exposure | | | |
| (59) 2-Hydroxybutyric ** | 0.03 - 1.8 | 1.2 |  |
| Ammonia Excess | | | |
| (60) Orotic | 0.06 - 0.54 | 0.23 |  |
| Aspartame, Salicylates, or GI Bacteria | | | |
| (61) 2-Hydroxyhippuric | ≤1.3 | 0.45 |  |
| * A high value for this marker may indicate a Glutathione deficiency. ** High values may indicate methylation defects and/or toxic exposure. | | | |
| **AMINO ACID METABOLITES** | | | |
| (62) 2-Hydroxyisovaleric | ≤2.0 | 0.31 |  |
| (63) 2-Oxoisovaleric | ≤2.1 | 0.08 |  |
| (64) 3-Methyl-2-oxovaleric | ≤2.0 | 0.32 |  |
| (65) 2-Hydroxyisocaproic | ≤2.0 | 0 |  |
| (66) 2-Oxoisocaproic | ≤2.0 | 0.09 |  |
| (67) 2-Oxo-4-methiolbutyric | ≤2.0 | 0 |  |
| (68) Mandelic | ≤2.0 | 0.12 |  |
| (69) Phenyllactic | ≤2.0 | 0.12 |  |
| (70) Phenylpyruvic | ≤2.0 | 0 |  |
| (71) Homogentisic | ≤2.0 | 0 |  |
| (72) 4-Hydroxyphenyllactic | ≤2.0 | 0.46 |  |
| (73) N-Acetylaspartic | ≤38 | 1.1 |  |
| (74) Malonic | ≤9.7 | H 12 |  |
| (75) 4-Hydroxybutyric | ≤4.8 | 2.4 |  |
| Low values are not necessarily associated with inadequate protein intake and have not been demonstrated to indicate specific amino acid deficiencies. | | | |
| **MINERAL METABOLISM** | | | |
| (76) Phosphoric | 1,000 - 5,000 | 2,717 |  |
| **INDICATOR OF FLUID INTAKE** | | | |
| (77) Creatinine | | 71.5 | mg/dL |



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## TEST NAME: Organic Acids Test (OAT)

OAT
ORGANIC ACIDS TEST

# Explanation of Report Format

The reference ranges for organic acids were established using samples collected from typical individuals of all ages with no known physiological or psychological disorders. The ranges were determined by calculating the mean and standard deviation (SD) and are defined as + 2SD of the mean. Reference ranges are age and gender specific, consisting of Male Adult (≥13 years), Female Adult (≥13 years), Male Child (<13 years), and Female Child (<13 years).

There are two types of graphical representations of patient values in the report format of both the standard Organic Acids Test and the Microbial Organic Acids Test.

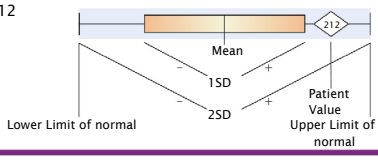
The first graph will occur when the value of the patient is within the reference (normal) range, defined as the mean plus or minus two standard deviations.

The second graph will occur when the value of the patient exceeds the upper limit of normal. In such cases, the graphical reference range is "shrunk" so that the degree of abnormality can be appreciated at a glance. In this case, the lower limits of normal are not shown, only the upper limit of normal is shown.

In both cases, the value of the patient is given to the left of the graph and is repeated on the graph inside a diamond. If the value is within the normal range, the diamond will be outlined in black. If the value is high or low, the diamond will be outlined in red.

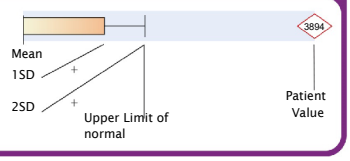
### EXAMPLE OF VALUE WITHIN REFERENCE RANGE

| METABOLITE | REFERENCE RANGE | RESULTS (mmol/mol creatinine) | REFERENCE POPULATION Males Under Age 13 |
|---|---|---|---|
| **INTESTINAL MICROBIAL OVERGROWTH** | | | |
| (16) **HPHPA** *(C. sporogenes, C. botulinum & others)* | ≤ 219.9 | 212 | |




### EXAMPLE OF ELEVATED VALUE

| METABOLITE | REFERENCE RANGE | RESULTS (mmol/mol creatinine) | REFERENCE POPULATION Males Under Age 13 |
|---|---|---|---|
| **INTESTINAL MICROBIAL OVERGROWTH** | | | |
| (16) **HPHPA** *(C. sporogenes, C. botulinum & others)* | ≤ 219.9 | H 3894 | |




Methodology: GC-MS.Creatinine by Jaffe Reaction. The creatinine test is performed to adjust metabolic marker results for differences in fluid intake. Urinary creatinine, from a random collection, has limited diagnostic value due to variability as a result of recent fluid intake.



Nordic Laboratories Aps
Nygade 6, 3.sal • 1164 Copenhagen K • Denmark
Tlf. +45 33 75 10 00

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11 Old Factory Buildings • Stonegate • E. Sussex TN5 7DU • UK
Tel: +44 (0)1580 201 687

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## TEST NAME: Organic Acids Test (OAT)

# OAT
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# Interpretations

ICON KEY

- Microbial Overgrowth
- Neurotransmitter Metabolites
- Methylation/Detoxification
- Mitochondrial Health
- Toxic Exposure
- Nutrient Needs

### 2 5-Hydroxymethyl-2-furoic

5-Hydroxymethyl-2-furoic acid (HMFA) is a normal human urinary metabolite in minor amounts, but has also been identified as both *Aspergillus* and *Cladosporium* by products, linking it to mold exposure. It is found to have antimicrobial activity, particularly on bacteria (*Staphylococcus aureus* and *Bacillus subtilis*), which could impact the microbiome. Additionally, HMFA can form during cooking processes such as "browning" food or during the breakdown process of certain sugars, negatively impacting human health, even from food.

### 5 Furancarbonylglycine

Furancarbonylglycine, also known as 2-furoylglycine, is a furan-derived acyl glycine that may be linked to the fungus *Aspergillus*, serving as a marker for mold exposure or overgrowth. Additionally, dietary intake of high-temperature processed foods and beverages, such as coffee, can influence its levels.

### 13 4-Hydroxyhippuric

4-Hydroxyhippuric acid is a urinary metabolite formed by the conjugation of glycine with 4-hydroxybenzoic acid, a compound produced from microbial metabolism of dietary polyphenols, amino acids, or parabens. Elevated levels may stem from gastrointestinal bacterial overgrowth, high intake of polyphenol-rich foods, or paraben exposure from personal care products, pharmaceuticals, and packaged foods. In the case of a low value, and if 4-hydroxybenzoic acid is elevated, and 4-hydroxyhippuric acid is low, it could be an indication of glycine insufficiency.



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# Interpretations - continued

### 14 DHPPA

3,4-Dihydroxyphenylpropionic acid (DHPPA), also known as dihydrocaffeic acid, is a metabolite produced by gut microbiota through the breakdown of certain dietary polyphenols. DHPPA is primarily associated with *Lactobacilli*, *Bifidobacteria*, *E. coli*, and some *Clostridium* species often identified as commensal. Elevated levels may indicate a polyphenol-rich diet or an abundance of these flora, while low levels suggest insufficient polyphenols or potentially reduced beneficial bacteria.

### 18 3-Indoleacetic

3-Indoleacetic acid (IAA) is a metabolite of tryptophan that is produced primarily through the indolic pathway. It is often linked to *Clostridia* though other bacteria and yeast, and may also contribute to its production. While IAA has been associated with systemic inflammation, increased virulence of fungus, and various conditions, including autism, cardiovascular disease, kidney dysfunction, and psychological disorders, it has also been shown to exhibit certain beneficial properties.

### 22 Lactic

Lactic acid is primarily produced in the cytoplasm, when mitochondrial oxidative phosphorylation is impaired, causing a shift toward anaerobic glycolysis. Elevations can indicate mitochondrial dysfunction, especially when seen with other mitochondrial metabolites. It may also be produced by various microbes—including *E. coli, Streptococcus,* and *Saccharomyces*—suggesting possible dysbiosis. Environmental toxins like cadmium, mercury, and mycotoxins can impair enzymes such as pyruvate dehydrogenase or lactate dehydrogenase, further contributing to lactic acid buildup. Nutrient insufficiencies in B vitamins, zinc, CoQ10, or iron may also drive elevations by impairing energy metabolism or increasing anaerobic glycolysis. In rare cases, genetic mitochondrial disorders or certain medications may be involved, while elevated levels are also associated with hypoxia, diabetes, and other chronic conditions.



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# Interpretations - continued

### 28 Aconitic

Aconitic acid is formed as an intermediate between citrate and isocitrate, where the enzyme, aconitase, catalyzes the conversion of citrate to aconitic acid and then aconitic acid to isocitrate. The enzyme requires variable cofactors, including an iron-sulfur cluster, for its activity and is sensitive to oxidative and nitrative stress, which can lead to elevated aconitic acid levels in the step from aconitic acid to isocitric acid. Elevated aconitic acid can indicate mitochondrial dysfunction, toxic exposures (such as arsenic, aluminum, or fluoride), or nutrient deficiencies, particularly in iron. Glutathione can protect aconitase from stress-induced inhibition, and iron deficiency can impair its function, leading to increased aconitic acid levels.

### 31 3-Hydroxyglutaric

3-hydroxyglutaric acid is produced during lysine degradation and relies on the enzyme glutaryl-CoA dehydrogenase for its breakdown. Elevated levels of this acid can indicate mitochondrial dysfunction and may act as both an acidogen and a metabotoxin, potentially causing acidosis and other health issues. Chronic elevations are linked to the rare genetic disorder glutaric aciduria type I, which results from a deficiency in glutaryl-CoA dehydrogenase. Dietary factors such as the ketogenic diet and medications such as valproate can also increase 3-hydroxyglutaric acid levels.

### 38 5-Hydroxyindoleacetic (5-HIAA)

5-Hydroxyindoleacetic acid (5-HIAA) is the primary metabolite of serotonin, formed when serotonin is enzymatically broken down by monoamine oxidase A (MAO-A) in the liver or synaptic cleft. It is used as a marker for serotonin levels and plays a role in various metabolic processes. Elevated 5-HIAA levels reflect increased serotonin breakdown, which can be influenced by factors such as dysbiosis, toxic exposure, nutritional status, medications and supplements, and conditions such as celiac disease and in more rare instances, carcinoid syndrome. On the other hand, disruptions in the microbiome, nutrient deficiencies, and downregulation of MAO can result in lower serotonin and 5-HIAA levels.



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OAT
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## Interpretations - continued

### 41 Uracil

Uracil is a pyrimidine primarily found in RNA, where it pairs with adenine during transcription and translation, and is replaced by thymine in DNA. It plays a vital role in enzyme synthesis, cellular function, and biochemical regulation by serving as a coenzyme, an allosteric regulator, and a precursor to phosphorylated nucleotides (UMP, UDP, and UTP), which influence carbamoyl phosphate synthetase II activity, polysaccharide biosynthesis, and sugar transport. The conversion of uracil to thymine is dependent on folate and the methylation of uracil, with 5,10-methylene tetrahydrofolate donating a methyl group via thymidylate synthase. Elevated uracil levels can indicate impaired methylation due to folate deficiency, and various genetic variants. Other contributing factors include liver dysfunction, and certain cancer treatments such as 5-fluorouracil.

### 43 3-Hydroxybutyric

3-Hydroxybutyric acid (β-hydroxybutyrate) and acetoacetic acid are two main ketones involved in fatty acid metabolism and energy production. Their levels increase during fasting, carbohydrate-restricted diets, diabetes, or metabolic disorders. Ketones serve as an essential alternative energy source, particularly for the brain and muscles, and play a role in lipid biosynthesis (e.g. cholesterol, phospholipids, etc.) and myelination. Elevated ketone levels can indicate metabolic shifts, such as prolonged fasting, vigorous exercise, or more serious conditions such as uncontrolled diabetes, or in rare cases, genetic disorders.

### 52 Pantothenic

Pantothenic acid (B5) plays a crucial role in metabolism, primarily through its involvement in Coenzyme A (CoA) synthesis, which is essential for energy production. Levels of B5 can be influenced by dietary intake, microbial activity, supplementation including products containing B5 derivatives or royal jelly. Rare genetic mutations, such as those in the PANK2 gene linked to PKAN, can lead to significantly elevated levels due to impaired conversion to CoA. Additionally, low B5 levels may have a significant influence on mitochondrial dysfunction, potentially affecting the Citric Acid Cycle and energy metabolism.



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# Interpretations - continued

### 53 Glutaric

Glutaric acid metabolism relies on riboflavin (B2) as a cofactor for glutaryl-CoA dehydrogenase, and a deficiency can lead to its accumulation, impacting amino acid and fatty acid metabolism. Riboflavin is essential for mitochondrial energy production, neurotransmitter synthesis, and detoxification through its role in FAD-dependent enzymes. Insufficient B2 levels can affect ATP synthesis, methylation, and oxidative stress balance, potentially contributing to metabolic dysfunction. Dietary restrictions, medications such as oral contraceptives, and inadequate riboflavin intake may further influence these processes, increasing the risk of deficiency-related complications.

### 54 Ascorbic

Ascorbic acid, also known as vitamin C, is a water-soluble nutrient found in citrus fruits and vegetables, essential for collagen synthesis, various biological functions, and antioxidant protection. Ascorbic acid levels are influenced by factors such as microbial imbalance, mitochondrial health, neurotransmitter metabolism, and nutritional needs such as iron or zinc deficiency. Foods rich in vitamin C and supplements, as well as medications, can increase its levels, while conditions such as critical illness, infections, and smoking raise the body's demand for it. Vitamin C levels are commonly low, due to its ability to be rapidly metabolized and excreted as well as its short half-life.

### 74 Malonic

Malonic acid is a dicarboxylic acid involved in fatty acid metabolism and energy production. Elevations may result from impaired mitochondrial function or acrolein exposure from polluted air or burning cooking oils past their smoke point. Markedly high levels are associated with malonyl-CoA decarboxylase deficiency, often alongside elevated methylmalonic acid.



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