

From Macros to Micros:
How to Make the Most of Your Nutritional Assessment

GENOVA DIAGNOSTICS®

Learning Objectives

- Evaluate macronutrient intake patterns in the context of individual metabolic and clinical needs
- Interpret micronutrient status and functional biomarker data to identify potential nutrient insufficiencies or imbalances
- Integrate nutritional assessment findings into personalized, evidence-informed nutrition strategies
- Apply a systems-based approach to nutritional assessment within functional and integrative care frameworks



Foundations of Nutritional Assessment

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Malnutrition is More Than Lack of Food

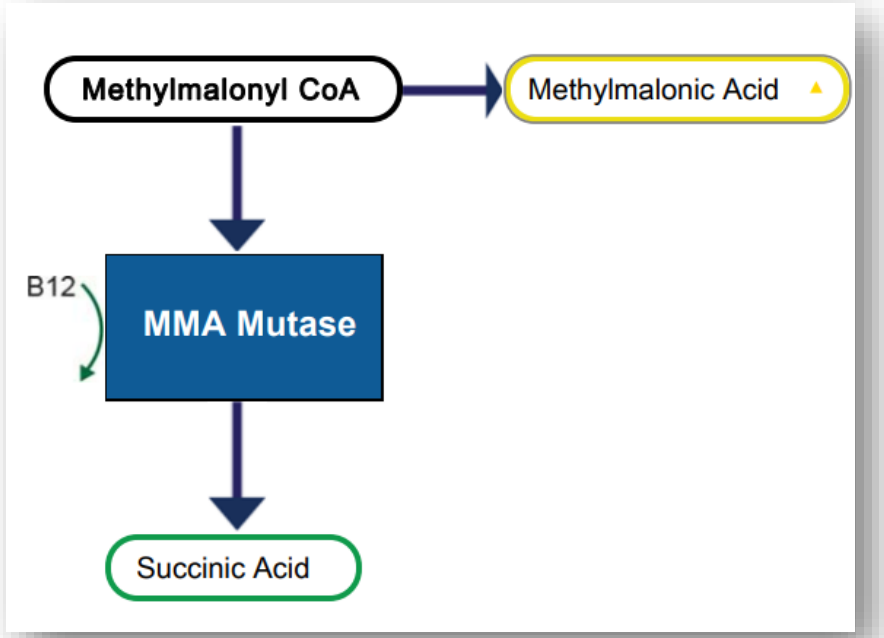
- Malnutrition includes both undernutrition and micronutrient deficiencies—not simply inadequate calories
- Vitamin and mineral deficiencies remain a major global health concern
- Micronutrient deficiencies contribute to impaired growth, cognitive dysfunction, immune dysregulation, and chronic disease
- Nutritional imbalances often exist long before clinical symptoms or conventional laboratory abnormalities appear
- Effective nutritional assessment requires evaluation of both nutrient status and functional metabolic consequences

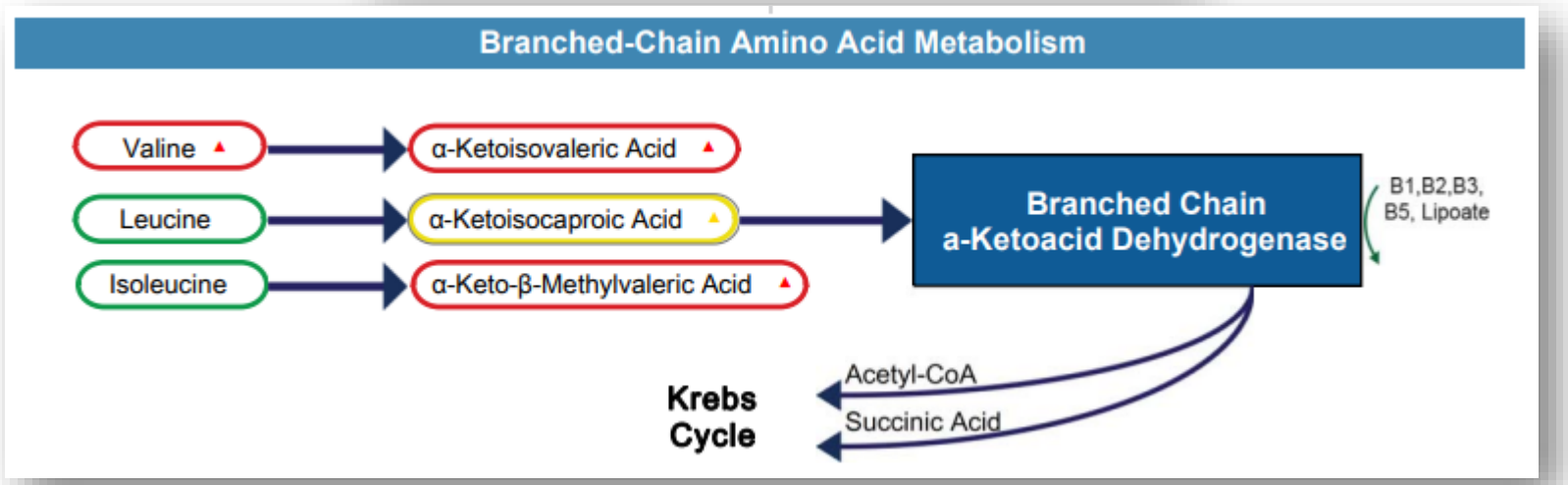
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World Health Organization Malnutrition 2024 Fact Sheet: https://www.who.int/news-room/fact-sheets/detail/malnutrition

Assessing Nutrient Status

- Location
  - Intracellular - WBC/RBC
    - i.e. Magnesium
  - Extracellular - Plasma/Serum
    - i.e. Vitamin D
- Type of Measurement
  - Direct measurement
  - Measuring biochemical pathway markers or functional indicators





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Determinants of Nutrient Status

Nutrient status is influenced by multiple factors along the path from food to function.

1 INTAKE



- Dietary quality
- Food variety
- Caloric adequacy

ASSESSMENT TOOL
Diet History

2 ABSORPTION



- Digestive capacity
- Microbiome balance
- Intestinal integrity

ASSESSMENT TOOL
Stool Testing
(GI Effects®)

3 UTILIZATION



- Mitochondrial function
- Enzyme activity
- Cofactor availability

ASSESSMENT TOOL
NutrEval®
(Metabolic Markers)

4 LOSSES / DEMAND



- Increased inflammation
- Stress
- Infection
- Medications / toxins
- Physical demand

ASSESSMENT TOOL
NutrEval® +
Clinical Context

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AI Image Generator

Clinical Factors Relevant to Micronutrient Testing

Clinical Conditions

- Fatigue
- Chronic stress
- Chronic inflammation
- Mitochondrial dysfunction
- Digestive problems
- Hormone imbalances
- Mood disorders
- Sleep disturbance

Lifestyle / Other

- Poor diet
- Sports fitness
- “Optimizers”
- Nutrient depletions 2° or 3° to other interventions
  - Medications
  - Special diets (vegan, keto, gluten-free, etc.)
  - GI surgeries (gastric bypass, gall bladder removal, etc.)

NutrEval and Metabolomix in Practice

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CEO of Several Companies

60-year-old male executive with fatigue, bloating, and D2M

- Chief Concerns
  - Obese
  - Bloating
  - Fatigue
  - Poorly controlled Type 2 DM
  - 5’11 and 192 pounds (27 BMI)
  - Nonalcoholic fatty liver
- Pertinent History
  - 60-year-old male, executive at tech companies
  - High stress working long hours
  - Healthy lunch at office; home diet is different
  - EtOH 1-2 times per week
  - Sedentary
  - Medications: insulin
  - FmHx: cardiovascular disease

The Fatigued Executive

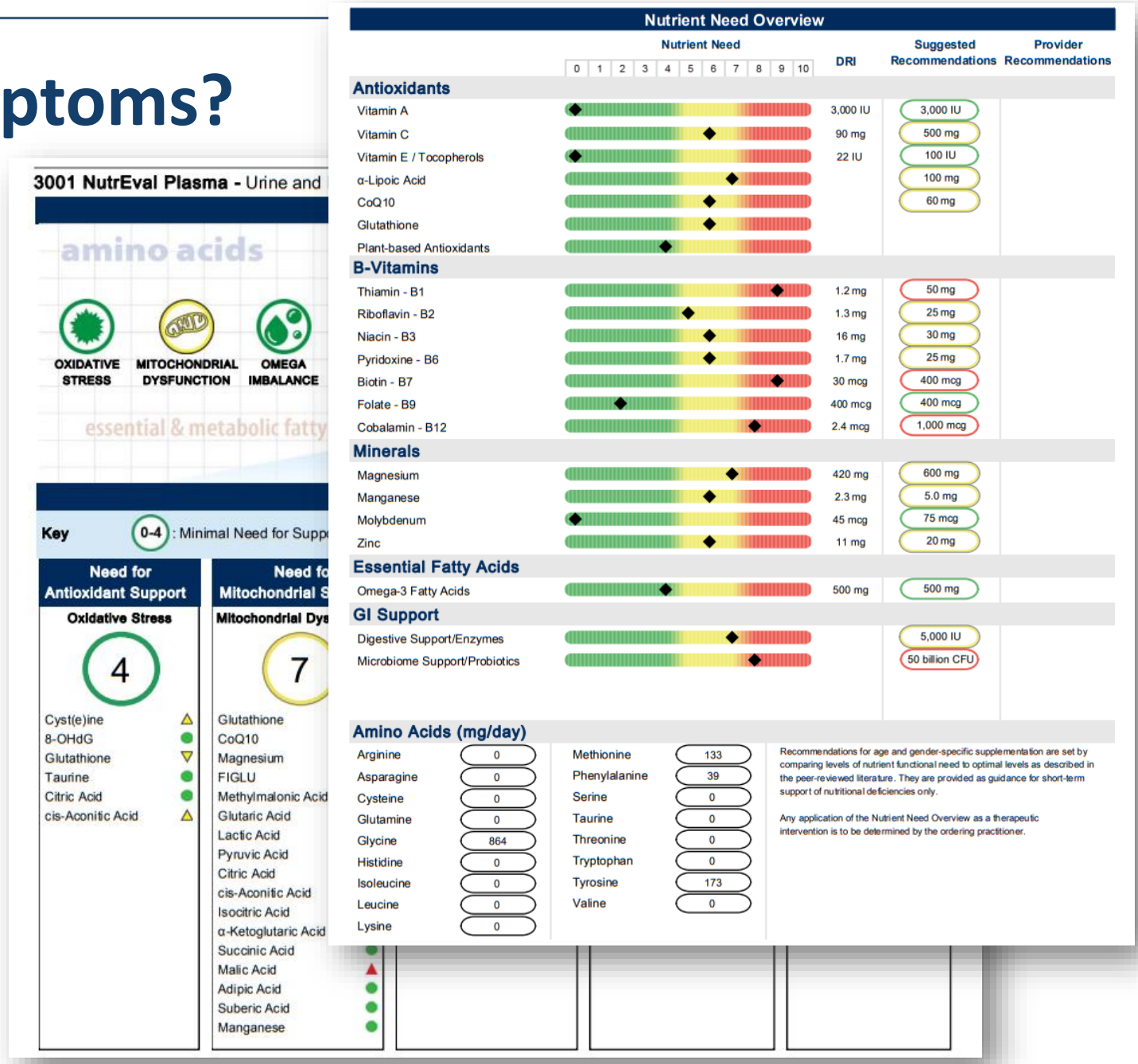
Marker	Result	Reference Range	Notes
CHO	281	<200 mg/dL	Dyslipidemia; increased cardiovascular disease risk
TG	463	<150 mg/dL	
HDL	35	> 60 mg/dL	
VLDL/LDL	Elevated		
HbA1C	12.5	< 5.7%	Chronic glucose dysregulation
ApoB	Elevated		Higher than normal risk for heart disease

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What's Behind the Symptoms?

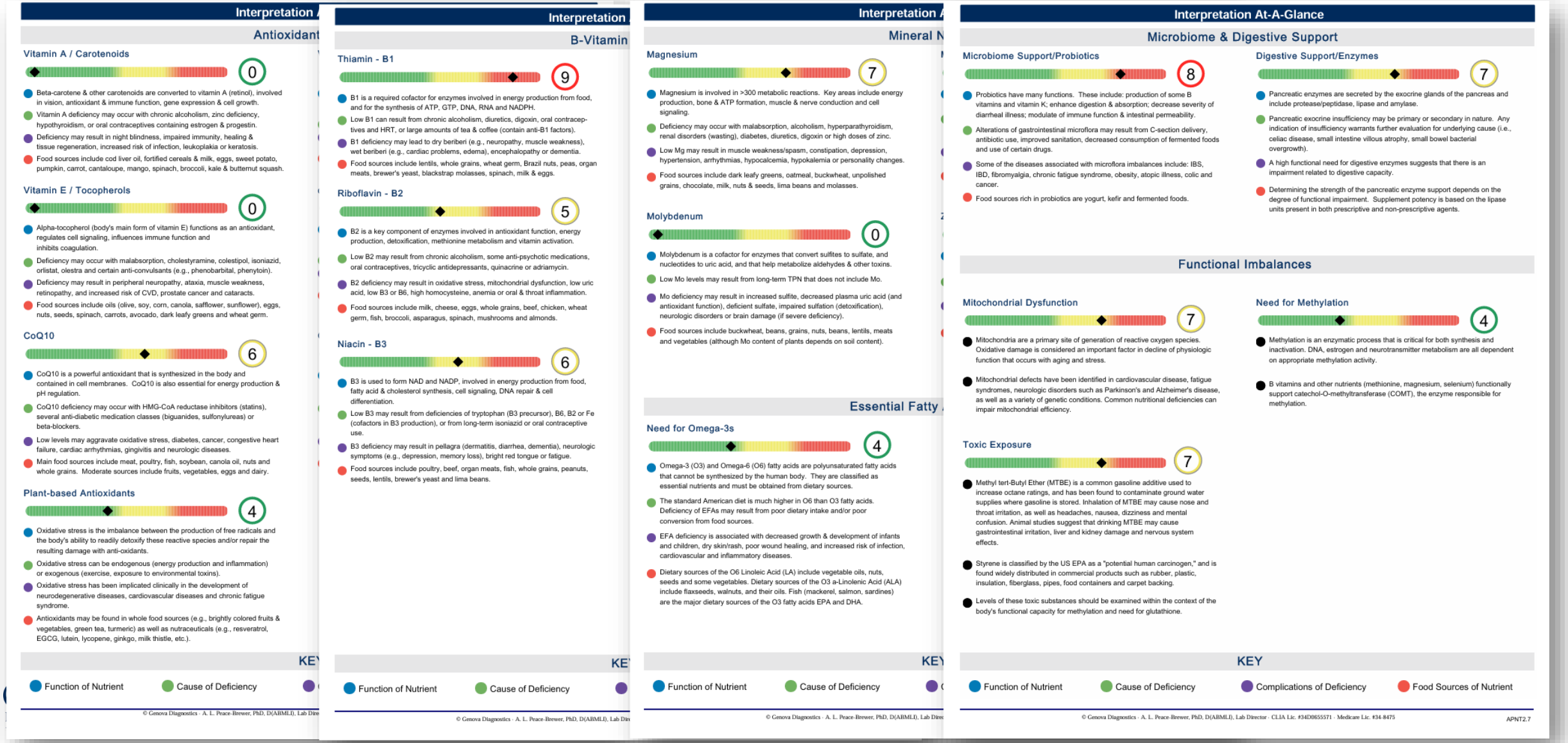
- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Moderate need for support for Mitochondrial dysfunction and Toxic Exposure
- Moderate to high need for antioxidants, B-vitamins, and Minerals
- Need to evaluate GI



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Interpretation-At-A-Glance



Interpretation A

Antioxidant

Vitamin A / Carotenoids

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- Beta-carotene & other carotenoids are converted to vitamin A (retinol), involved in vision, antioxidant & immune function, gene expression & cell growth.
- Vitamin A deficiency may occur with chronic alcoholism, zinc deficiency, hypothyroidism, or oral contraceptives containing estrogen & progestin.
- Deficiency may result in night blindness, impaired immunity, healing & tissue regeneration, increased risk of infection, leukoplakia or keratosis.
- Food sources include cod liver oil, fortified cereals & milk, eggs, sweet potato, pumpkin, carrot, cantaloupe, mango, spinach, broccoli, kale & butternut squash.

Vitamin E / Tocopherols

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- Alpha-tocopherol (body's main form of vitamin E) functions as an antioxidant, regulates cell signaling, influences immune function and inhibits coagulation.
- Deficiency may occur with malabsorption, cholestyramine, colestipol, isoniazid, orlistat, olestra and certain anti-convulsants (e.g., phenobarbital, phenytoin).
- Deficiency may result in peripheral neuropathy, ataxia, muscle weakness, retinopathy, and increased risk of CVD, prostate cancer and cataracts.
- Food sources include oils (olive, soy, corn, canola, safflower, sunflower), eggs, nuts, seeds, spinach, carrots, avocado, dark leafy greens and wheat germ.

CoQ10

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- CoQ10 is a powerful antioxidant that is synthesized in the body and contained in cell membranes. CoQ10 is also essential for energy production & pH regulation.
- CoQ10 deficiency may occur with HMG-CoA reductase inhibitors (statins), several anti-diabetic medication classes (biguanides, sulfonylureas) or beta-blockers.
- Low levels may aggravate oxidative stress, diabetes, cancer, congestive heart failure, cardiac arrhythmias, gingivitis and neurologic diseases.
- Main food sources include meat, poultry, fish, soybean, canola oil, nuts and whole grains. Moderate sources include fruits, vegetables, eggs and dairy.

Plant-based Antioxidants

4

- Oxidative stress is the imbalance between the production of free radicals and the body's ability to readily detoxify these reactive species and/or repair the resulting damage with anti-oxidants.
- Oxidative stress can be endogenous (energy production and inflammation) or exogenous (exercise, exposure to environmental toxins).
- Oxidative stress has been implicated clinically in the development of neurodegenerative diseases, cardiovascular diseases and chronic fatigue syndrome.
- Antioxidants may be found in whole food sources (e.g., brightly colored fruits & vegetables, green tea, turmeric) as well as nutraceuticals (e.g., resveratrol, EGCG, lutein, lycopene, ginkgo, milk thistle, etc.).

KEY

Function of Nutrient · Cause of Deficiency

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Interpretation

B-Vitamin

Thiamin - B1

9

- B1 is a required cofactor for enzymes involved in energy production from food, and for the synthesis of ATP, GTP, DNA, RNA and NADPH.
- Low B1 can result from chronic alcoholism, diuretics, digoxin, oral contraceptives and HRT, or large amounts of tea & coffee (contain anti-B1 factors).
- B1 deficiency may lead to dry beriberi (e.g., neuropathy, muscle weakness), wet beriberi (e.g., cardiac problems, edema), encephalopathy or dementia.
- Food sources include lentils, whole grains, wheat germ, Brazil nuts, peas, organ meats, brewer's yeast, blackstrap molasses, spinach, milk & eggs.

Riboflavin - B2

5

- B2 is a key component of enzymes involved in antioxidant function, energy production, detoxification, methionine metabolism and vitamin activation.
- Low B2 may result from chronic alcoholism, some anti-psychotic medications, oral contraceptives, tricyclic antidepressants, quinacrine or adriamycin.
- B2 deficiency may result in oxidative stress, mitochondrial dysfunction, low uric acid, low B3 or B6, high homocysteine, anemia or oral & throat inflammation.
- Food sources include milk, cheese, eggs, whole grains, beef, chicken, wheat germ, fish, broccoli, asparagus, spinach, mushrooms and almonds.

Niacin - B3

6

- B3 is used to form NAD and NADP, involved in energy production from food, fatty acid & cholesterol synthesis, cell signaling, DNA repair & cell differentiation.
- Low B3 may result from deficiencies of tryptophan (B3 precursor), B6, B2 or Fe (cofactors in B3 production), or from long-term isoniazid or oral contraceptive use.
- B3 deficiency may result in pellagra (dermatitis, diarrhea, dementia), neurologic symptoms (e.g., depression, memory loss), bright red tongue or fatigue.
- Food sources include poultry, beef, organ meats, fish, whole grains, peanuts, seeds, lentils, brewer's yeast and lima beans.

KEY

Function of Nutrient · Cause of Deficiency

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Interpretation A

Mineral N

Magnesium

7

- Magnesium is involved in >300 metabolic reactions. Key areas include energy production, bone & ATP formation, muscle & nerve conduction and cell signaling.
- Deficiency may occur with malabsorption, alcoholism, hyperparathyroidism, renal disorders (wasting), diabetes, diuretics, digoxin or high doses of zinc.
- Low Mg may result in muscle weakness/spasm, constipation, depression, hypertension, arrhythmias, hypocalcemia, hypokalemia or personality changes.
- Food sources include dark leafy greens, oatmeal, buckwheat, unpolished grains, chocolate, milk, nuts & seeds, lima beans and molasses.

Molybdenum

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- Molybdenum is a cofactor for enzymes that convert sulfites to sulfate, and nucleotides to uric acid, and that help metabolize aldehydes & other toxins.
- Low Mo levels may result from long-term TPN that does not include Mo.
- Mo deficiency may result in increased sulfite, decreased plasma uric acid (and antioxidant function), deficient sulfate, impaired sulfation (detoxification), neurologic disorders or brain damage (if severe deficiency).
- Food sources include buckwheat, beans, grains, nuts, beans, lentils, meats and vegetables (although Mo content of plants depends on soil content).

Essential Fatty

Need for Omega-3s

4

- Omega-3 (O3) and Omega-6 (O6) fatty acids are polyunsaturated fatty acids that cannot be synthesized by the human body. They are classified as essential nutrients and must be obtained from dietary sources.
- The standard American diet is much higher in O6 than O3 fatty acids. Deficiency of EFAs may result from poor dietary intake and/or poor conversion from food sources.
- EFA deficiency is associated with decreased growth & development of infants and children, dry skin/rash, poor wound healing, and increased risk of infection, cardiovascular and inflammatory diseases.
- Dietary sources of the O6 Linoleic Acid (LA) include vegetable oils, nuts, seeds and some vegetables. Dietary sources of the O3 a-Linolenic Acid (ALA) include flaxseeds, walnuts, and their oils. Fish (mackerel, salmon, sardines) are the major dietary sources of the O3 fatty acids EPA and DHA.

KEY

Function of Nutrient · Cause of Deficiency

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Interpretation At-A-Glance

Microbiome & Digestive Support

Microbiome Support/Probiotics

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- Probiotics have many functions. These include: production of some B vitamins and vitamin K; enhance digestion & absorption; decrease severity of diarrheal illness; modulate of immune function & intestinal permeability.
- Alterations of gastrointestinal microflora may result from C-section delivery, antibiotic use, improved sanitation, decreased consumption of fermented foods and use of certain drugs.
- Some of the diseases associated with microflora imbalances include: IBS, IBD, fibromyalgia, chronic fatigue syndrome, obesity, atopic illness, colic and cancer.
- Food sources rich in probiotics are yogurt, kefir and fermented foods.

Digestive Support/Enzymes

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- Pancreatic enzymes are secreted by the exocrine glands of the pancreas and include protease/peptidase, lipase and amylase.
- Pancreatic exocrine insufficiency may be primary or secondary in nature. Any indication of insufficiency warrants further evaluation for underlying cause (i.e., celiac disease, small intestine villous atrophy, small bowel bacterial overgrowth).
- A high functional need for digestive enzymes suggests that there is an impairment related to digestive capacity.
- Determining the strength of the pancreatic enzyme support depends on the degree of functional impairment. Supplement potency is based on the lipase units present in both prescriptive and non-prescriptive agents.

Functional Imbalances

Mitochondrial Dysfunction

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- Mitochondria are a primary site of generation of reactive oxygen species. Oxidative damage is considered an important factor in decline of physiologic function that occurs with aging and stress.
- Mitochondrial defects have been identified in cardiovascular disease, fatigue syndromes, neurologic disorders such as Parkinson's and Alzheimer's disease, as well as a variety of genetic conditions. Common nutritional deficiencies can impair mitochondrial efficiency.

Need for Methylation

4

- Methylation is an enzymatic process that is critical for both synthesis and inactivation. DNA, estrogen and neurotransmitter metabolism are all dependent on appropriate methylation activity.
- B vitamins and other nutrients (methionine, magnesium, selenium) functionally support catechol-O-methyltransferase (COMT), the enzyme responsible for methylation.

Toxic Exposure

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- Methyl tert-Butyl Ether (MTBE) is a common gasoline additive used to increase octane ratings, and has been found to contaminate ground water supplies where gasoline is stored. Inhalation of MTBE may cause nose and throat irritation, as well as headaches, nausea, dizziness and mental confusion. Animal studies suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage and nervous system effects.
- Styrene is classified by the US EPA as a "potential human carcinogen," and is found widely distributed in commercial products such as rubber, plastic, insulation, fiberglass, pipes, food containers and carpet backing.
- Levels of these toxic substances should be examined within the context of the body's functional capacity for methylation and need for glutathione.

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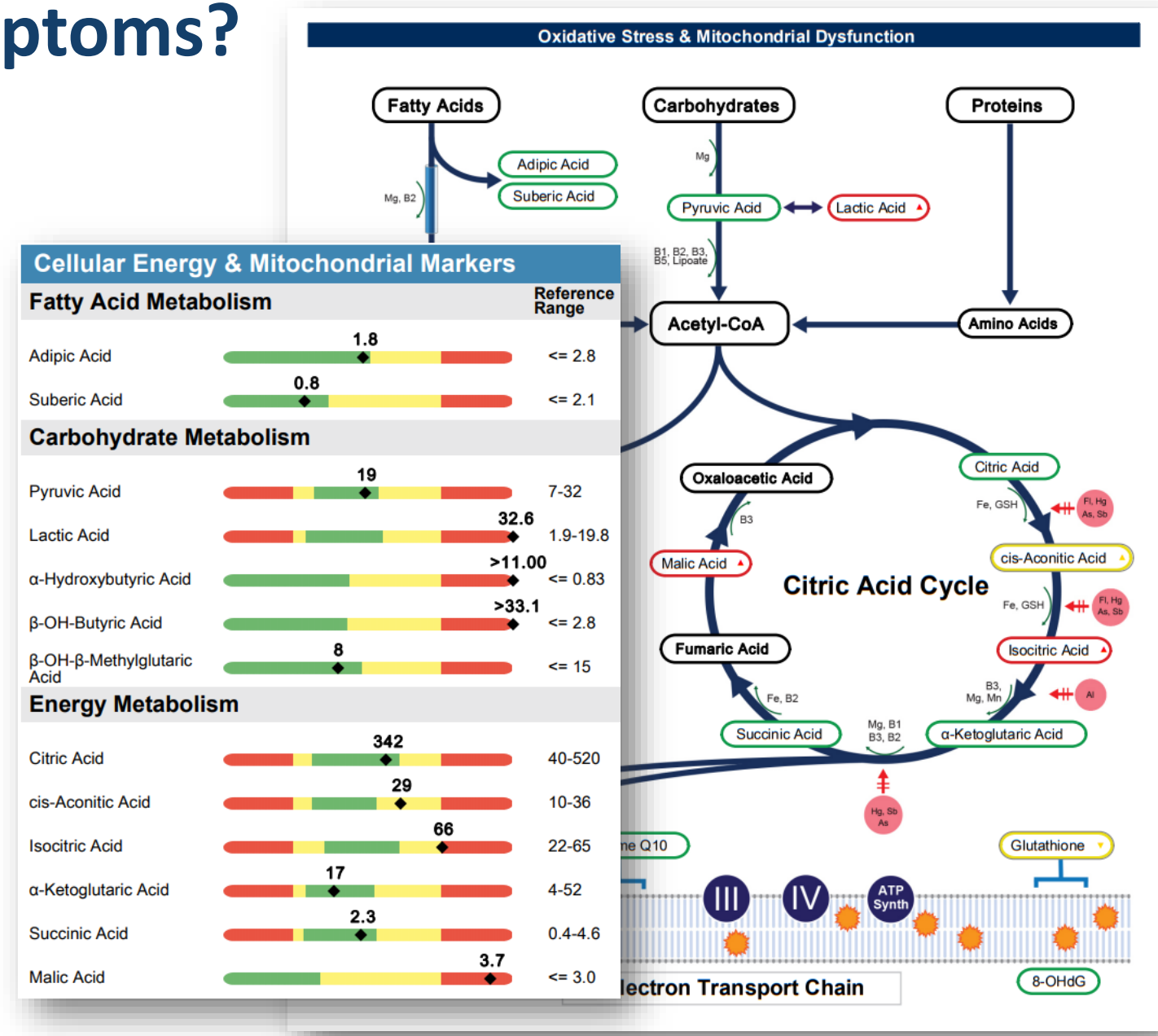
Function of Nutrient · Cause of Deficiency · Complications of Deficiency · Food Sources of Nutrient

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What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Need for B-vitamin, antioxidant, and mineral cofactors
- Increased ketone production
  - Low carbohydrate intake, ketogenic diet, fasting, anorexia, starvation, and insulin/glucose impairment

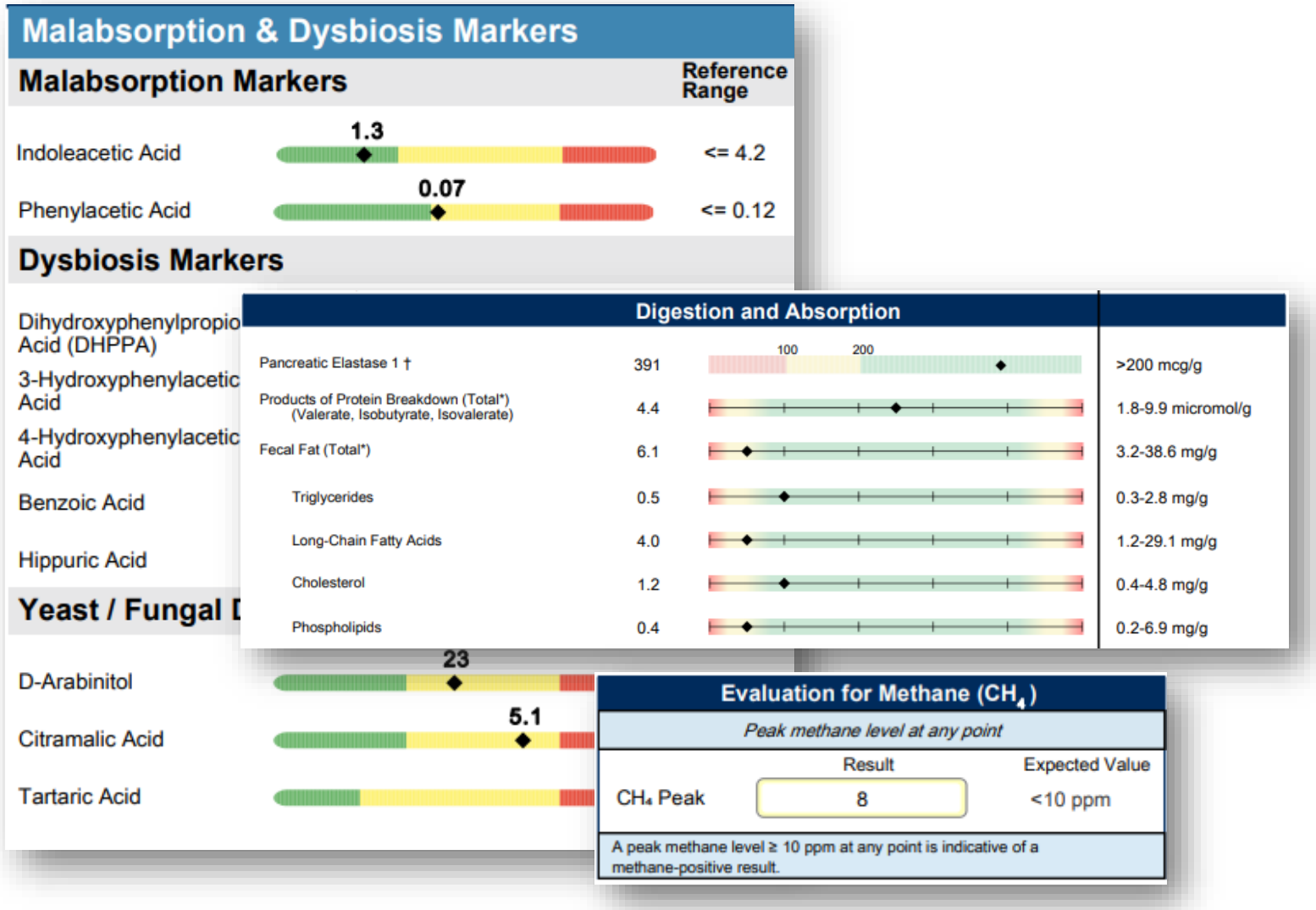


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What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Maldigestion/absorption
- Yeast overgrowth
- Methane SIBO

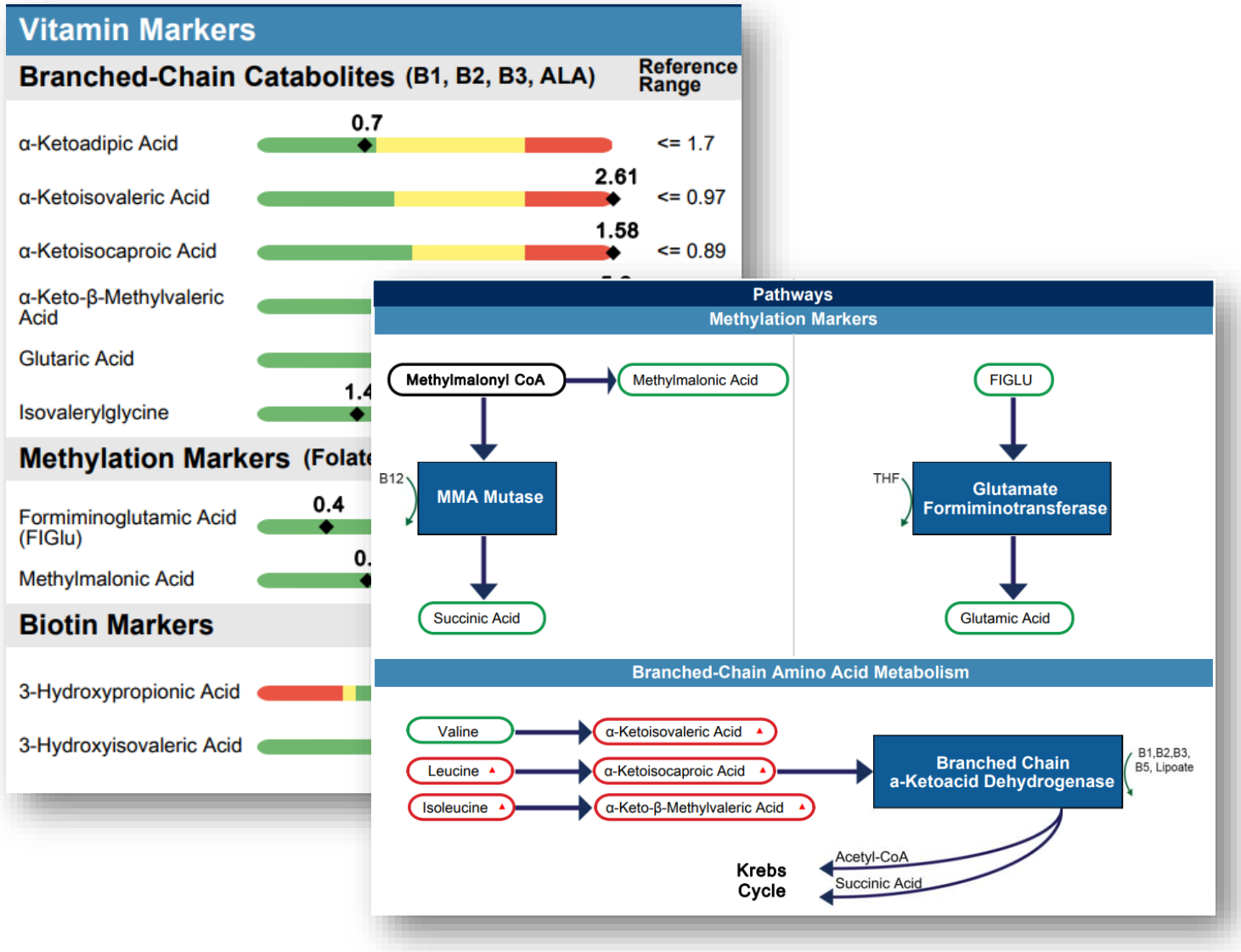


GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Need for B-vitamins and alpha-lipoic acid

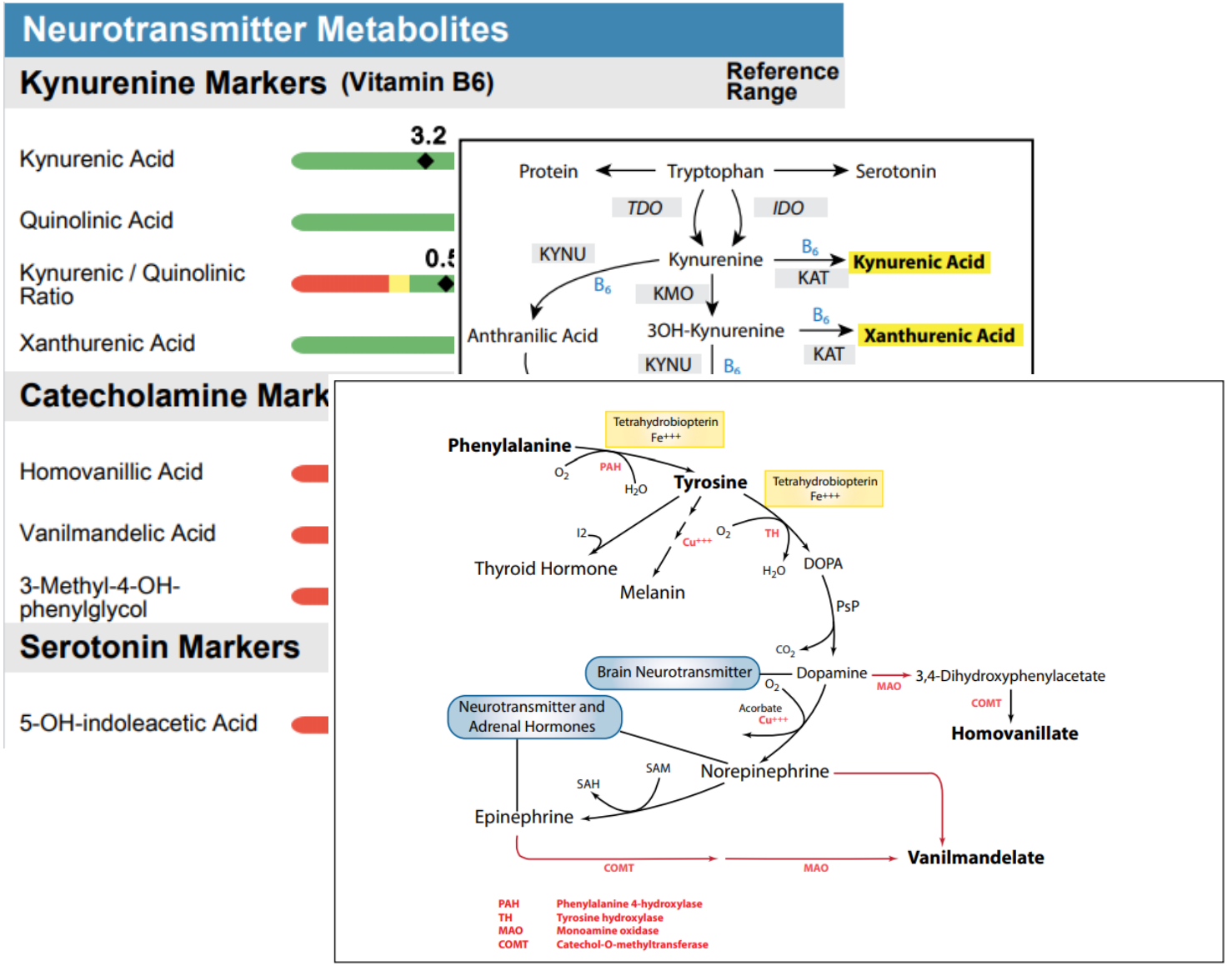


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What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Need for B-6
- Evaluate tyrosine; precursor to catecholamines

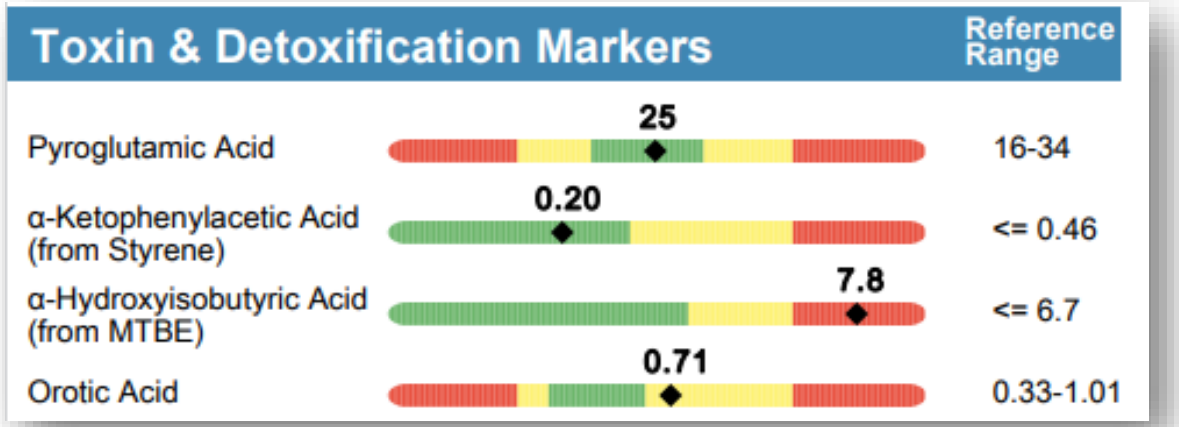


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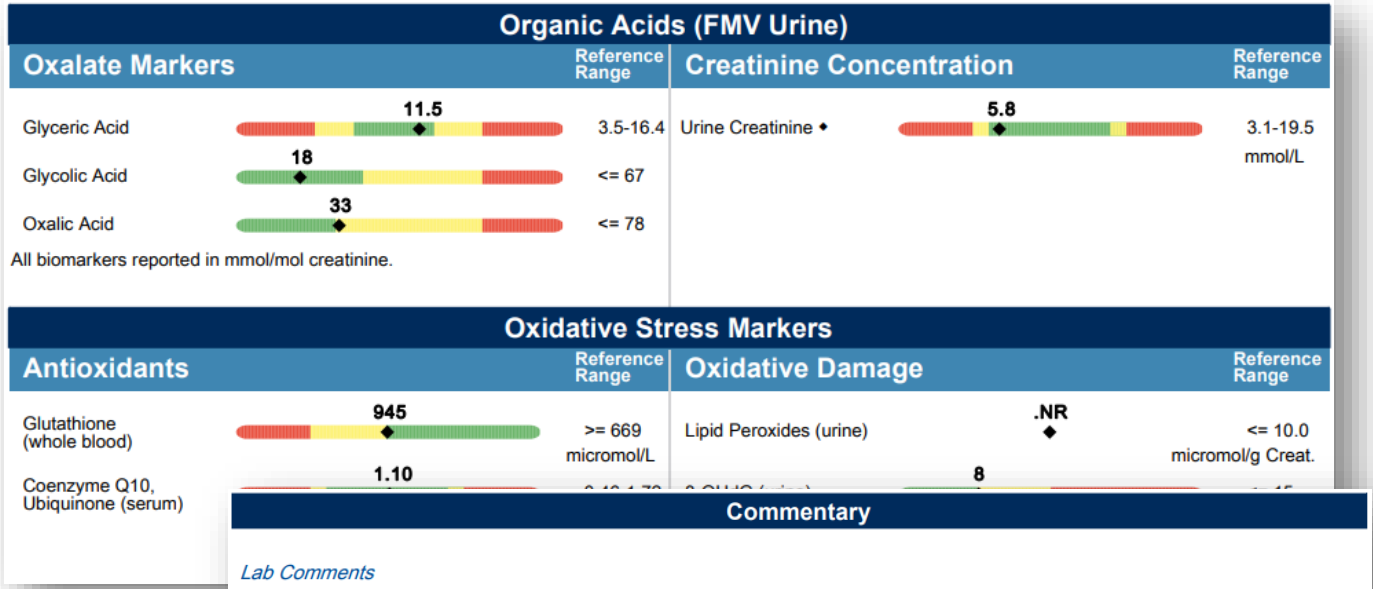
What's Behind the Symptoms?

- 60-year-old male executive
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- α-Ketophenylacetic acid is a metabolite of styrene, toluene, xylenes, and ethylbenzene
- Orotic acid apart of the urea cycle
- Lipid Peroxides is unreportable due to urinary glucose interference



Toxin & Detoxification Markers		Reference Range
Pyroglutamic Acid	25	16-34
α-Ketophenylacetic Acid (from Styrene)	0.20	<= 0.46
α-Hydroxyisobutyric Acid (from MTBE)	7.8	<= 6.7
Orotic Acid	0.71	0.33-1.01



Organic Acids (FMV Urine)

Oxalate Markers		Reference Range
Glyceric Acid	11.5	3.5-16.4
Glycolic Acid	18	<= 67
Oxalic Acid	33	<= 78

All biomarkers reported in mmol/mol creatinine.

Creatinine Concentration		Reference Range
Urine Creatinine	5.8	3.1-19.5 mmol/L

Oxidative Stress Markers

Antioxidants		Reference Range
Glutathione (whole blood)	945	>= 669 micromol/L
Coenzyme Q10, Ubiquinone (serum)	1.10	

Oxidative Damage		Reference Range
Lipid Peroxides (urine)	.NR	<= 10.0 micromol/g Creat.
	8	

Commentary

Lab Comments
Glucose is measured in part of this analysis. Urine sample was found to contain 7053.07 mg/dl glucose. 06/06/2025 mw

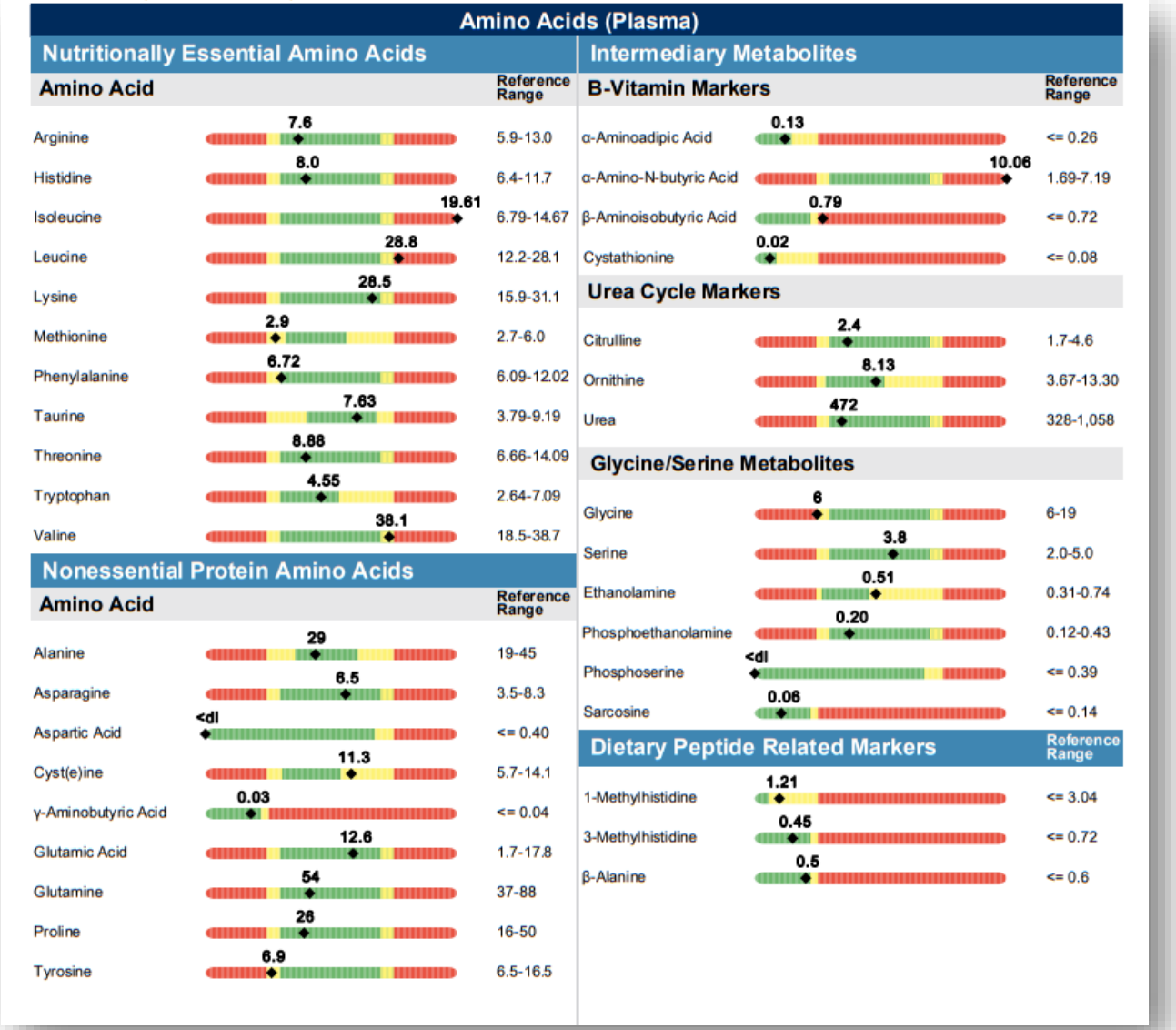
Lipid Peroxides are reported as NR due to excessive glucose interference. 06.10.25 SF.

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What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- High AA indicates need for B-vitamins
- Low methionine, phenylalanine, tyrosine, and glycine
- B-Vitamin Marker elevations indicating need for B-vitamins
- Dietary Peptide Related Markers suggesting potential maldigestion/absorption or reflecting intake

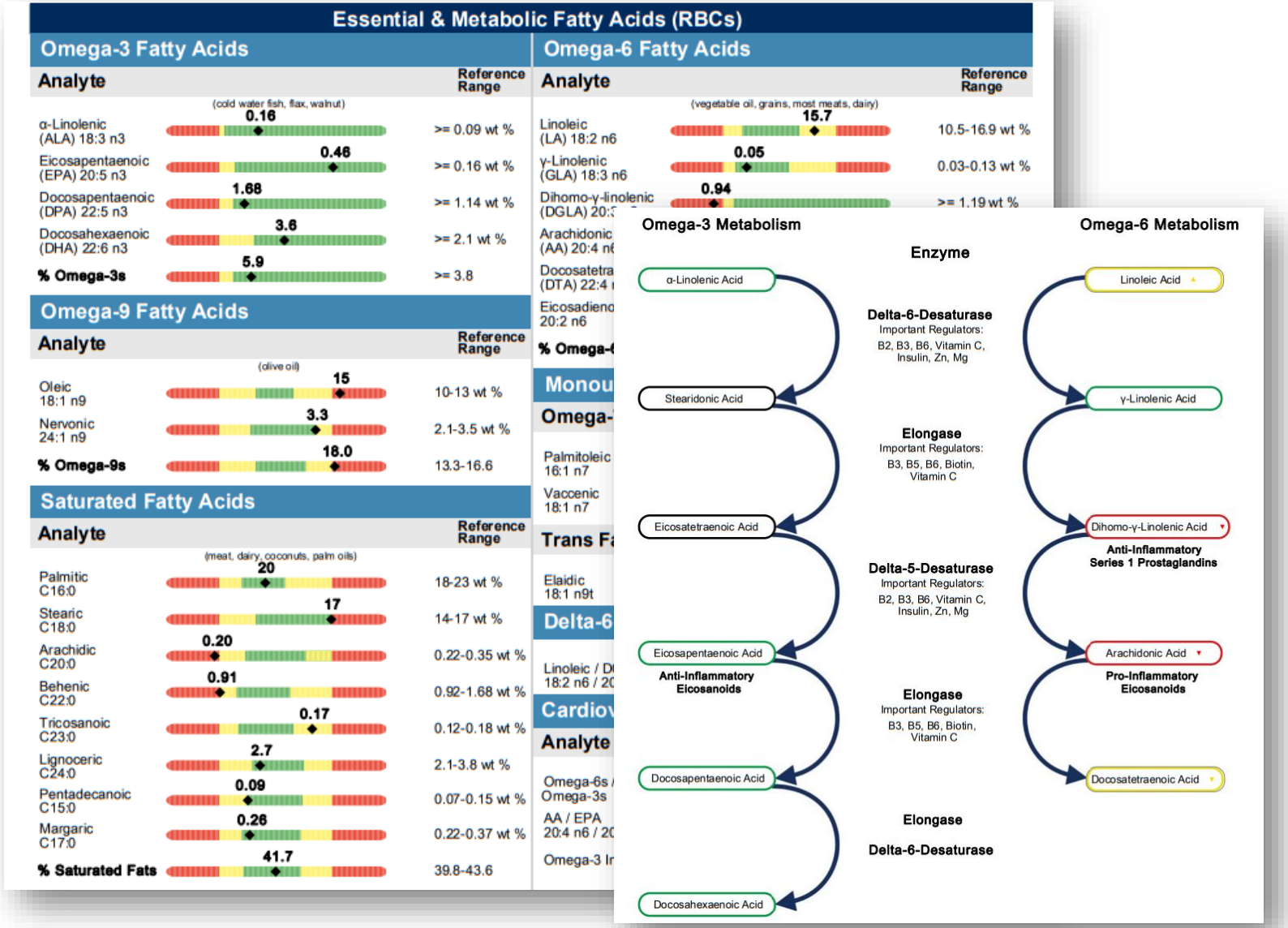


GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Need for omega-3 fatty acids

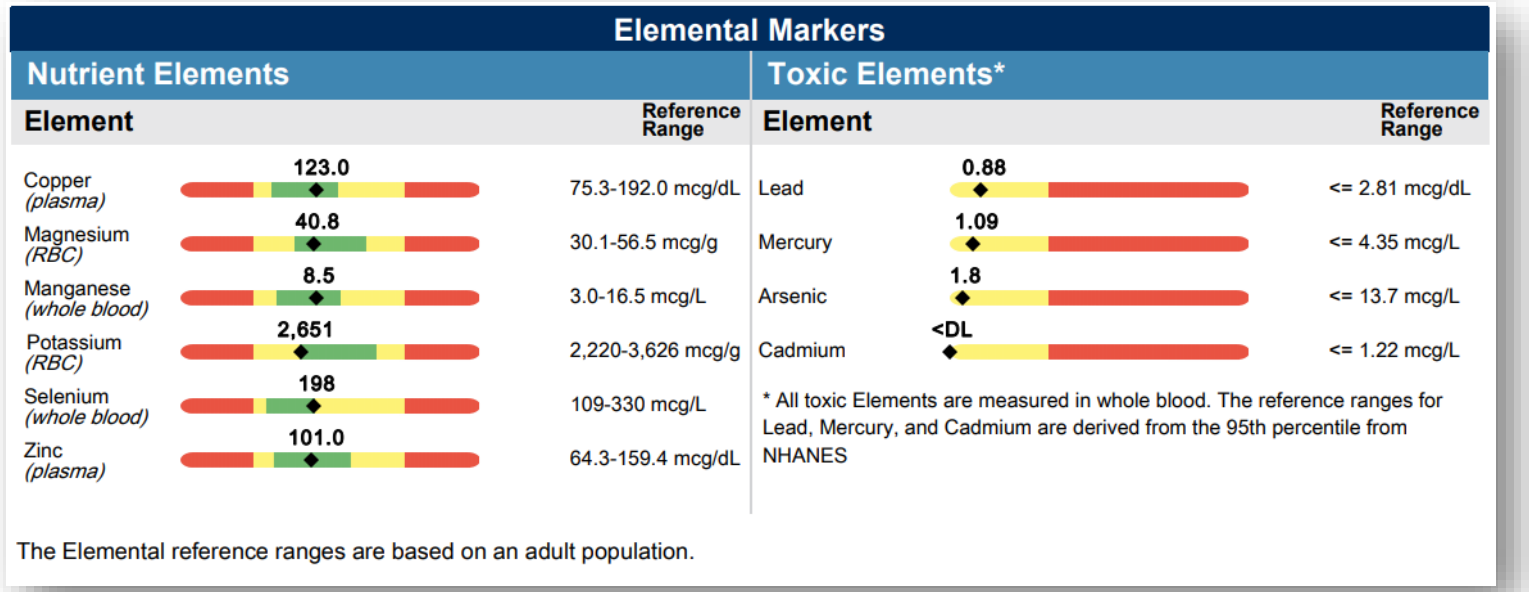


GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- Low/normal potassium



Elemental Markers

Nutrient Elements

Element		Reference Range
Copper *(plasma)*	123.0	75.3-192.0 mcg/dL
Magnesium *(RBC)*	40.8	30.1-56.5 mcg/g
Manganese *(whole blood)*	8.5	3.0-16.5 mcg/L
Potassium *(RBC)*	2,651	2,220-3,626 mcg/g
Selenium *(whole blood)*	198	109-330 mcg/L
Zinc *(plasma)*	101.0	64.3-159.4 mcg/dL

Toxic Elements*

Element		Reference Range
Lead	0.88	<= 2.81 mcg/dL
Mercury	1.09	<= 4.35 mcg/L
Arsenic	1.8	<= 13.7 mcg/L
Cadmium	<DL	<= 1.22 mcg/L

* All toxic Elements are measured in whole blood. The reference ranges for Lead, Mercury, and Cadmium are derived from the 95th percentile from NHANES

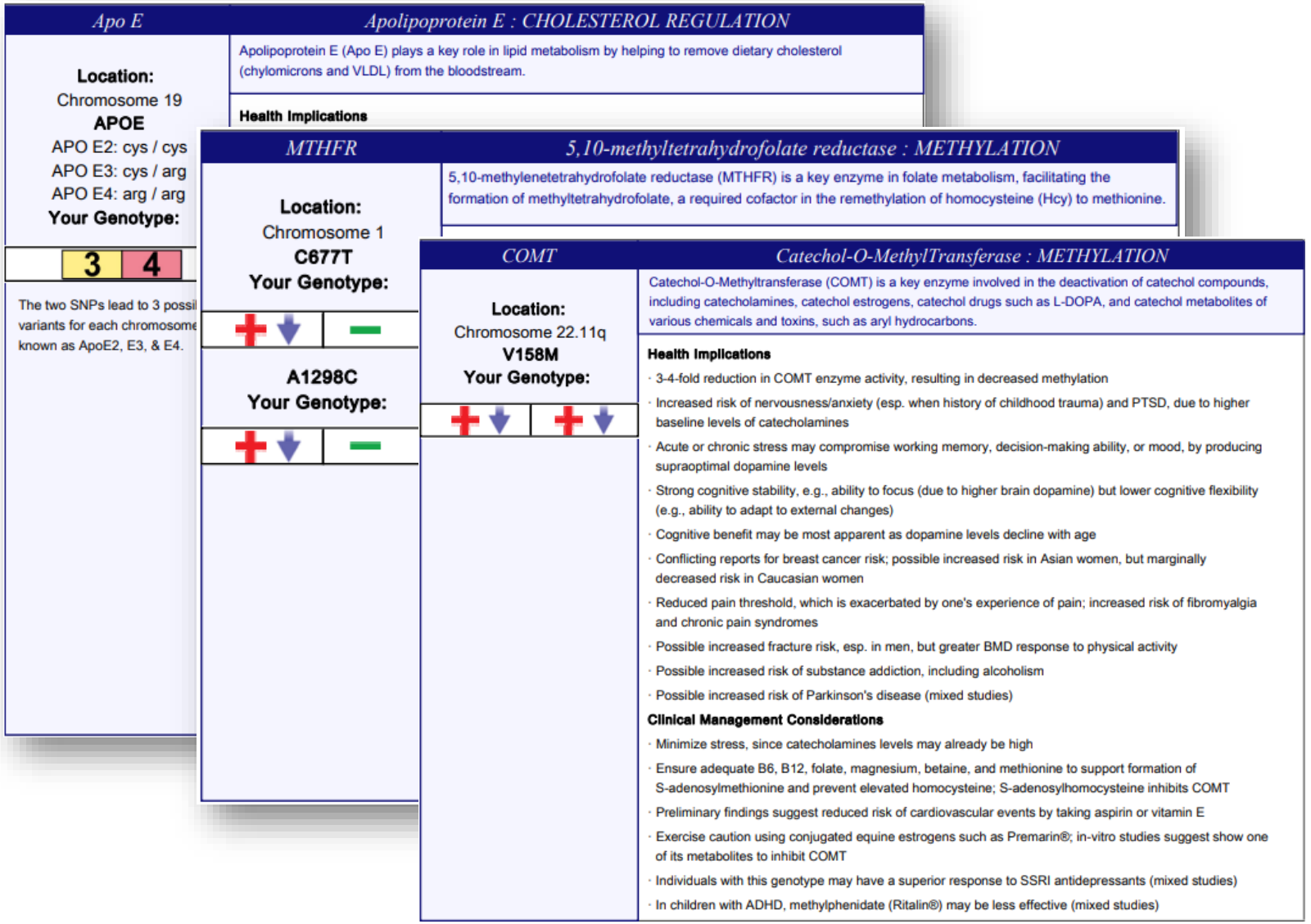
The Elemental reference ranges are based on an adult population.

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What's Behind the Symptoms?

- 60-year-old male executive
- Fatigue, bloating, and D2M
- Elevated HbA1C, CHO, and TGs
- NAFLD/MASLD

- ApoE3/4
- Heterozygous for MTHFR 677 and 1298
- Homozygous for COMT

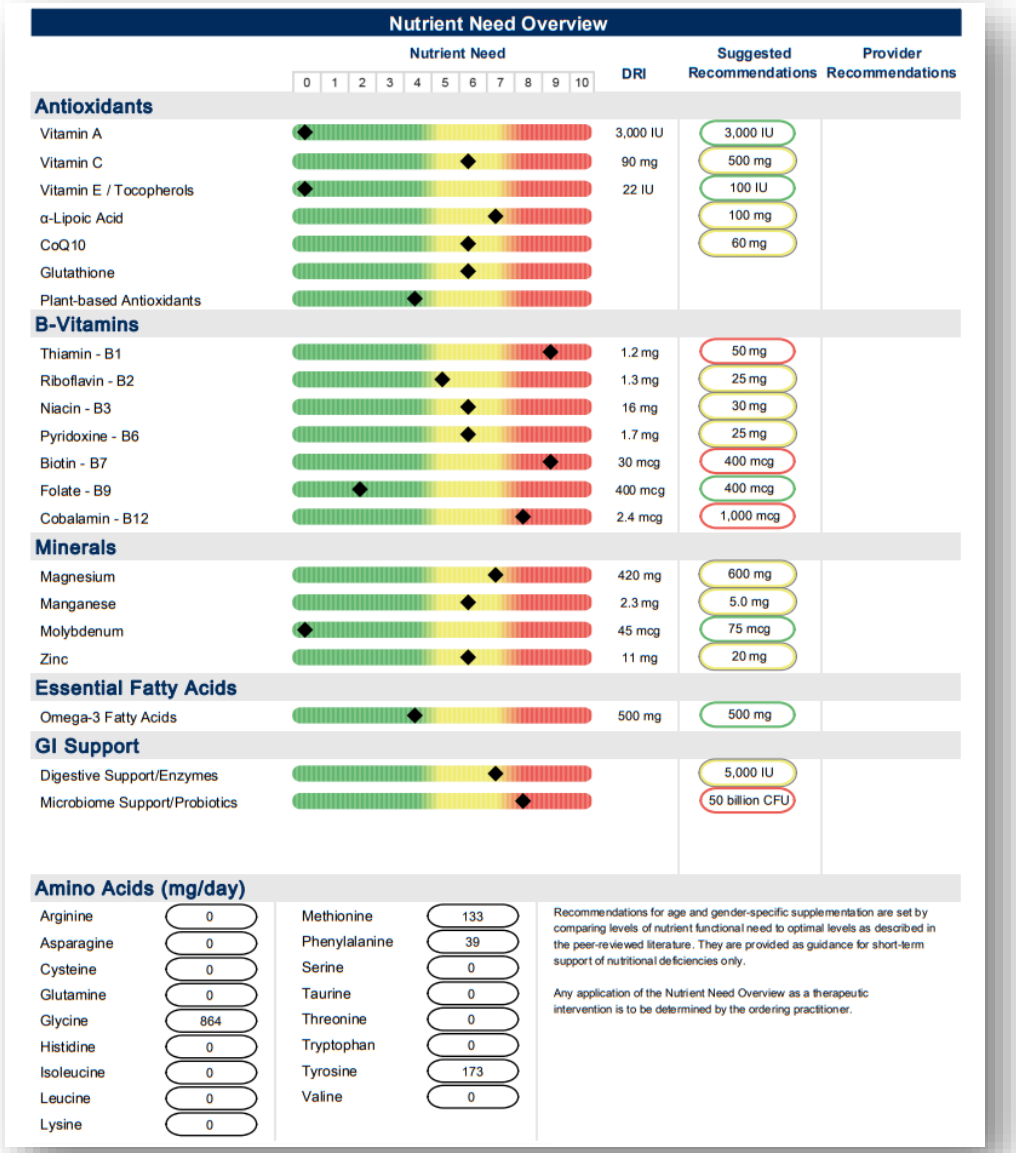


GENOVA DIAGNOSTICS

What's Behind the Symptoms?

60-year-old male executive cc Fatigue, bloating, and D2M

- Dyslipidemia, HbA1C 12.5, and CVD risk
  - Continuous glucose monitor, D2M medication adjustment, nutritionist referral
- Nutrient Support
  - Multivitamin, B-complex, Omega-3 Fatty Acids, and Antioxidants
- Other
  - Digestive support with meals
  - Elimination diet
  - Treat SIBO and yeast
- Diet/Lifestyle changes
  - Decrease EtOH
  - Exercise/Trainer
  - Stress Management



GENOVA DIAGNOSTICS

College Student

23-year-old female student with fatigue, headaches, and constipation

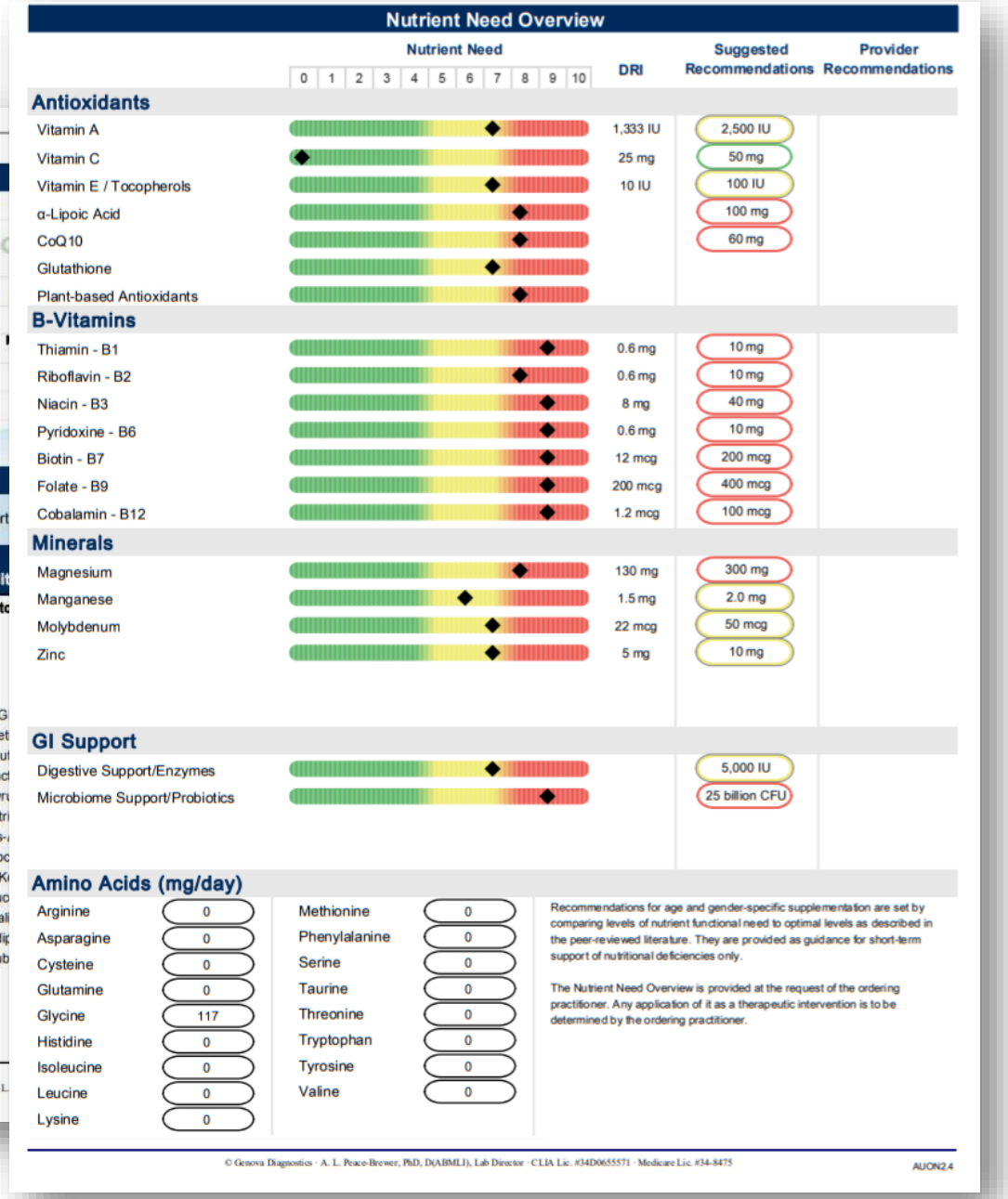
- Chief Concerns
  - Fatigue
  - Headaches
  - GI: Bloating, constipation, indigestion
  - Heavy menstrual cycle bleed
- Pertinent History
  - Full-time student and works part-time
  - Runs 2 miles 5 times/week
  - Diet: SAD (processed foods, fast foods, and minimal-at-home meals)
  - Rx: Thyroid (no updated testing)
  - Supplements: Gummy Vitamin OTC
  - Hx: anemia (not on iron and no updated testing)

What's Behind the Symptoms?

- 23-year-old female student
- Fatigue, headaches, and constipation
- Thyroid RX

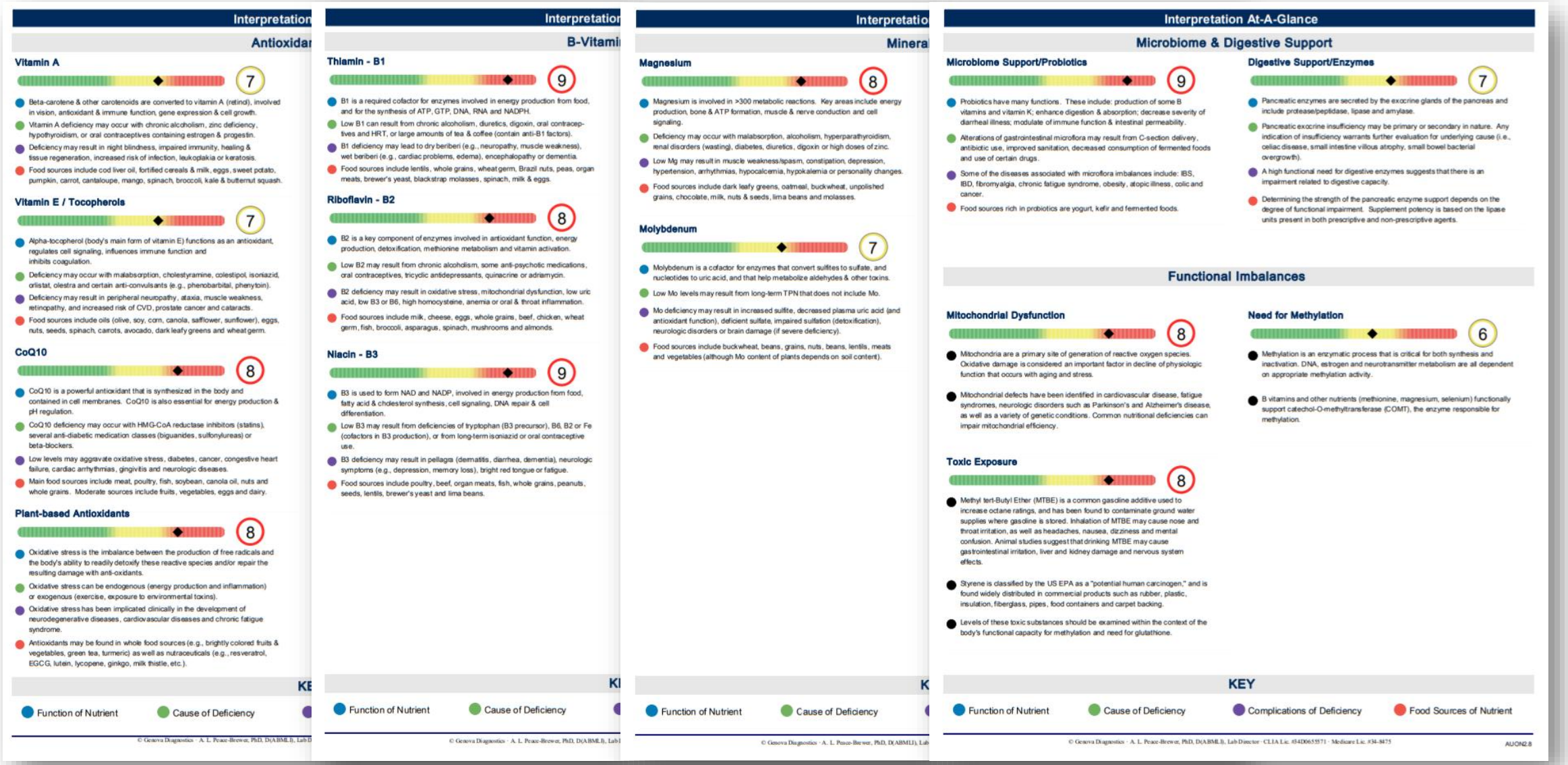
- Need for antioxidant, mitochondrial, and methylation support plus reducing toxic exposures
- High nutrient need for antioxidants, B-vitamins, and minerals
- Need to evaluate GI





GENOVA DIAGNOSTICS

Interpretation at-a-glance



Interpretation

Antioxidan

Vitamin A — 7

- Beta-carotene & other carotenoids are converted to vitamin A (retinol), involved in vision, antioxidant & immune function, gene expression & cell growth.
- Vitamin A deficiency may occur with chronic alcoholism, zinc deficiency, hypothyroidism, or oral contraceptives containing estrogen & progestin.
- Deficiency may result in night blindness, impaired immunity, healing & tissue regeneration, increased risk of infection, leukoplakia or keratosis.
- Food sources include cod liver oil, fortified cereals & milk, eggs, sweet potato, pumpkin, carrot, cantaloupe, mango, spinach, broccoli, kale & butternut squash.

Vitamin E / Tocopherols — 7

- Alpha-tocopherol (body's main form of vitamin E) functions as an antioxidant, regulates cell signaling, influences immune function and inhibits coagulation.
- Deficiency may occur with malabsorption, cholestyramine, colestipol, isoniazid, orlistat, olestra and certain anti-convulsants (e.g., phenobarbital, phenytoin).
- Deficiency may result in peripheral neuropathy, ataxia, muscle weakness, retinopathy, and increased risk of CVD, prostate cancer and cataracts.
- Food sources include oils (olive, soy, corn, canola, safflower, sunflower), eggs, nuts, seeds, spinach, carrots, avocado, dark leafy greens and wheat germ.

CoQ10 — 8

- CoQ10 is a powerful antioxidant that is synthesized in the body and contained in cell membranes. CoQ10 is also essential for energy production & pH regulation.
- CoQ10 deficiency may occur with HMG-CoA reductase inhibitors (statins), several anti-diabetic medication classes (biguanides, sulfonylureas) or beta-blockers.
- Low levels may aggravate oxidative stress, diabetes, cancer, congestive heart failure, cardiac arrhythmias, gingivitis and neurologic diseases.
- Main food sources include meat, poultry, fish, soybean, canola oil, nuts and whole grains. Moderate sources include fruits, vegetables, eggs and dairy.

Plant-based Antioxidants — 8

- Oxidative stress is the imbalance between the production of free radicals and the body's ability to readily detoxify these reactive species and/or repair the resulting damage with anti-oxidants.
- Oxidative stress can be endogenous (energy production and inflammation) or exogenous (exercise, exposure to environmental toxins).
- Oxidative stress has been implicated clinically in the development of neurodegenerative diseases, cardiovascular diseases and chronic fatigue syndrome.
- Antioxidants may be found in whole food sources (e.g., brightly colored fruits & vegetables, green tea, turmeric) as well as nutraceuticals (e.g., resveratrol, EGCG, lutein, lycopene, ginkgo, milk thistle, etc.).

KE

Function of Nutrient · Cause of Deficiency

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Interpretation

B-Vitami

Thiamin - B1 — 9

- B1 is a required cofactor for enzymes involved in energy production from food, and for the synthesis of ATP, GTP, DNA, RNA and NADPH.
- Low B1 can result from chronic alcoholism, diuretics, digoxin, oral contraceptives and HRT, or large amounts of tea & coffee (contain anti-B1 factors).
- B1 deficiency may lead to dry beriberi (e.g., neuropathy, muscle weakness), wet beriberi (e.g., cardiac problems, edema), encephalopathy or dementia.
- Food sources include lentils, whole grains, wheat germ, Brazil nuts, peas, organ meats, brewer's yeast, blackstrap molasses, spinach, milk & eggs.

Riboflavin - B2 — 8

- B2 is a key component of enzymes involved in antioxidant function, energy production, detoxification, methionine metabolism and vitamin activation.
- Low B2 may result from chronic alcoholism, some anti-psychotic medications, oral contraceptives, tricyclic antidepressants, quinacrine or adriamycin.
- B2 deficiency may result in oxidative stress, mitochondrial dysfunction, low uric acid, low B3 or B6, high homocysteine, anemia or oral & throat inflammation.
- Food sources include milk, cheese, eggs, whole grains, beef, chicken, wheat germ, fish, broccoli, asparagus, spinach, mushrooms and almonds.

Niacin - B3 — 9

- B3 is used to form NAD and NADP, involved in energy production from food, fatty acid & cholesterol synthesis, cell signaling, DNA repair & cell differentiation.
- Low B3 may result from deficiencies of tryptophan (B3 precursor), B6, B2 or Fe (cofactors in B3 production), or from long-term isoniazid or oral contraceptive use.
- B3 deficiency may result in pellagra (dermatitis, diarrhea, dementia), neurologic symptoms (e.g., depression, memory loss), bright red tongue or fatigue.
- Food sources include poultry, beef, organ meats, fish, whole grains, peanuts, seeds, lentils, brewer's yeast and lima beans.

KI

Function of Nutrient · Cause of Deficiency

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Interpretatio

Minera

Magnesium — 8

- Magnesium is involved in >300 metabolic reactions. Key areas include energy production, bone & ATP formation, muscle & nerve conduction and cell signaling.
- Deficiency may occur with malabsorption, alcoholism, hyperparathyroidism, renal disorders (wasting), diabetes, diuretics, digoxin or high doses of zinc.
- Low Mg may result in muscle weakness/spasm, constipation, depression, hypertension, arrhythmias, hypocalcemia, hypokalemia or personality changes.
- Food sources include dark leafy greens, oatmeal, buckwheat, unpolished grains, chocolate, milk, nuts & seeds, lima beans and molasses.

Molybdenum — 7

- Molybdenum is a cofactor for enzymes that convert sulfites to sulfate, and nucleotides to uric acid, and that help metabolize aldehydes & other toxins.
- Low Mo levels may result from long-term TPN that does not include Mo.
- Mo deficiency may result in increased sulfite, decreased plasma uric acid (and antioxidant function), deficient sulfate, impaired sulfation (detoxification), neurologic disorders or brain damage (if severe deficiency).
- Food sources include buckwheat, beans, grains, nuts, beans, lentils, meats and vegetables (although Mo content of plants depends on soil content).

K

Function of Nutrient · Cause of Deficiency

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Interpretation At-A-Glance

Microbiome & Digestive Support

Microbiome Support/Probiotics — 9

- Probiotics have many functions. These include: production of some B vitamins and vitamin K; enhance digestion & absorption; decrease severity of diarrheal illness; modulate of immune function & intestinal permeability.
- Alterations of gastrointestinal microflora may result from C-section delivery, antibiotic use, improved sanitation, decreased consumption of fermented foods and use of certain drugs.
- Some of the diseases associated with microflora imbalances include: IBS, IBD, fibromyalgia, chronic fatigue syndrome, obesity, atopic illness, colic and cancer.
- Food sources rich in probiotics are yogurt, kefir and fermented foods.

Digestive Support/Enzymes — 7

- Pancreatic enzymes are secreted by the exocrine glands of the pancreas and include protease/peptidase, lipase and amylase.
- Pancreatic exocrine insufficiency may be primary or secondary in nature. Any indication of insufficiency warrants further evaluation for underlying cause (i.e., celiac disease, small intestine villous atrophy, small bowel bacterial overgrowth).
- A high functional need for digestive enzymes suggests that there is an impairment related to digestive capacity.
- Determining the strength of the pancreatic enzyme support depends on the degree of functional impairment. Supplement potency is based on the lipase units present in both prescriptive and non-prescriptive agents.

Functional Imbalances

Mitochondrial Dysfunction — 8

- Mitochondria are a primary site of generation of reactive oxygen species. Oxidative damage is considered an important factor in decline of physiologic function that occurs with aging and stress.
- Mitochondrial defects have been identified in cardiovascular disease, fatigue syndromes, neurologic disorders such as Parkinson's and Alzheimer's disease, as well as a variety of genetic conditions. Common nutritional deficiencies can impair mitochondrial efficiency.

Need for Methylation — 6

- Methylation is an enzymatic process that is critical for both synthesis and inactivation. DNA, estrogen and neurotransmitter metabolism are all dependent on appropriate methylation activity.
- B vitamins and other nutrients (methionine, magnesium, selenium) functionally support catechol-O-methyltransferase (COMT), the enzyme responsible for methylation.

Toxic Exposure — 8

- Methyl tert-Butyl Ether (MTBE) is a common gasoline additive used to increase octane ratings, and has been found to contaminate ground water supplies where gasoline is stored. Inhalation of MTBE may cause nose and throat irritation, as well as headaches, nausea, dizziness and mental confusion. Animal studies suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage and nervous system effects.
- Styrene is classified by the US EPA as a "potential human carcinogen," and is found widely distributed in commercial products such as rubber, plastic, insulation, fiberglass, pipes, food containers and carpet backing.
- Levels of these toxic substances should be examined within the context of the body's functional capacity for methylation and need for glutathione.

KEY

Function of Nutrient · Cause of Deficiency · Complications of Deficiency · Food Sources of Nutrient

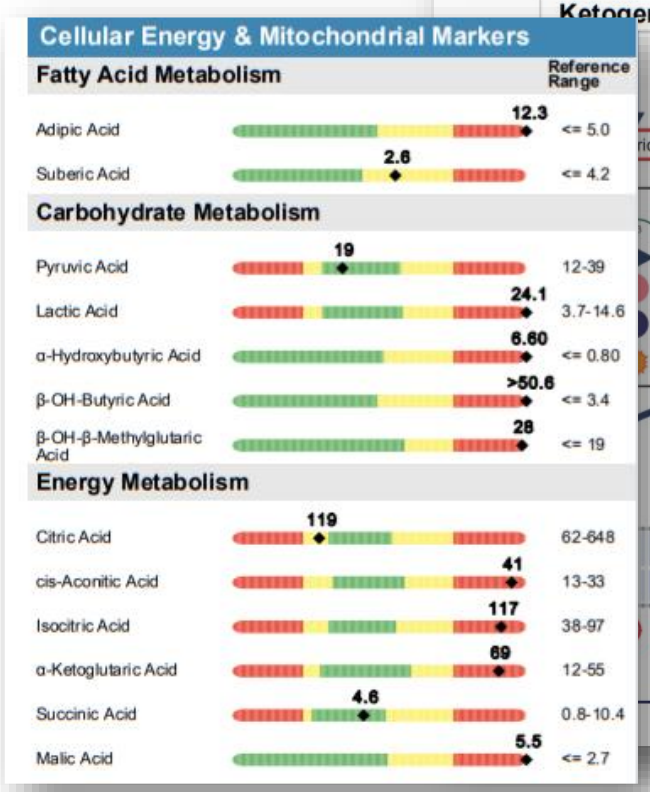
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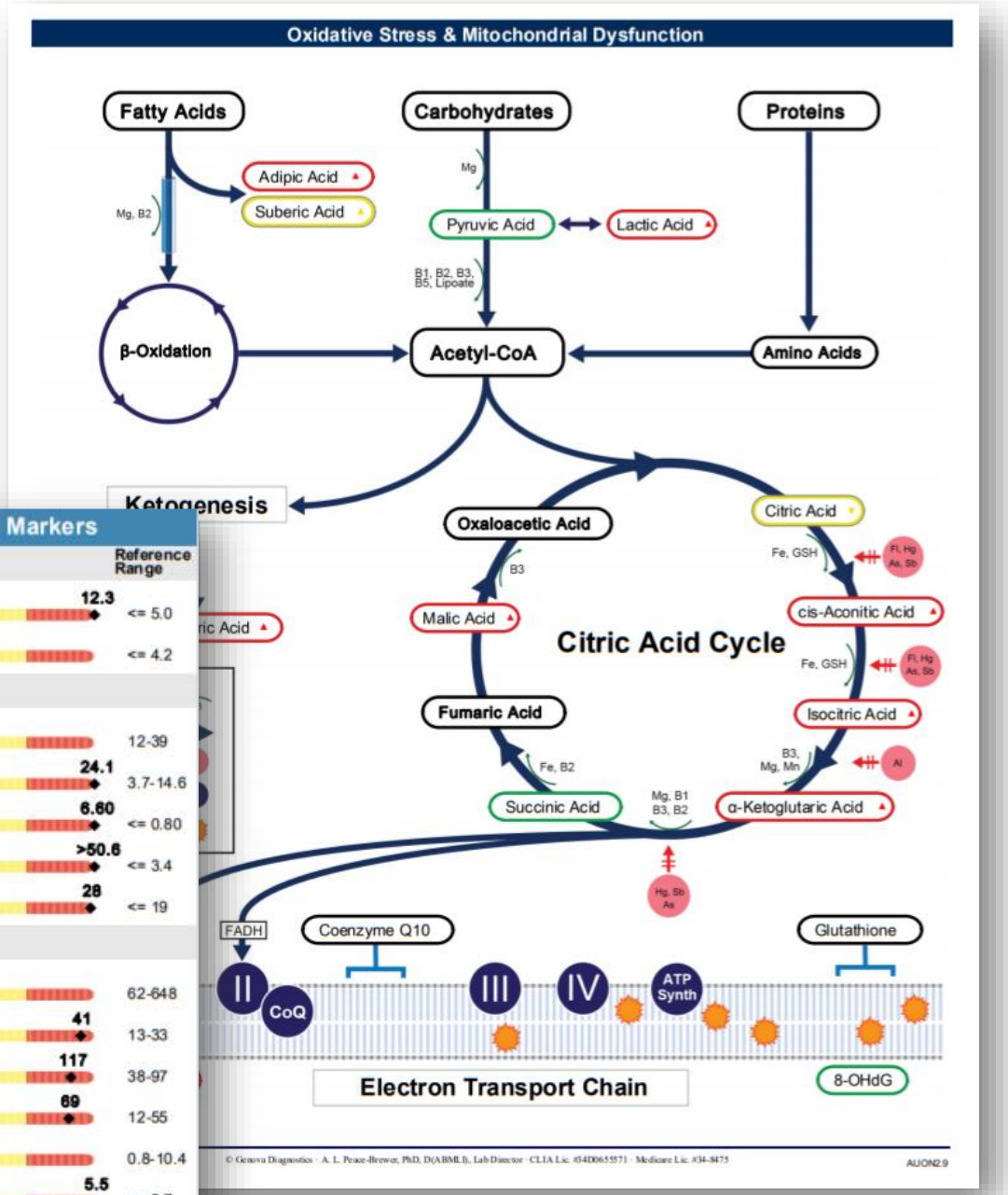
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What's Behind the Symptoms?

- 23-year-old female student
- Fatigue, headaches, and constipation
- Thyroid RX

- Fatty Acid Metabolism – need for Carnitine, Vitamin B2, and/or Magnesium
- Carbohydrate Metabolism - exercise, anemia, and/or zinc
- Energy Metabolism – evaluate iron and toxic exposures plus need for GSH, B3, and minerals
- Electron Transport Chain - oxidative stress



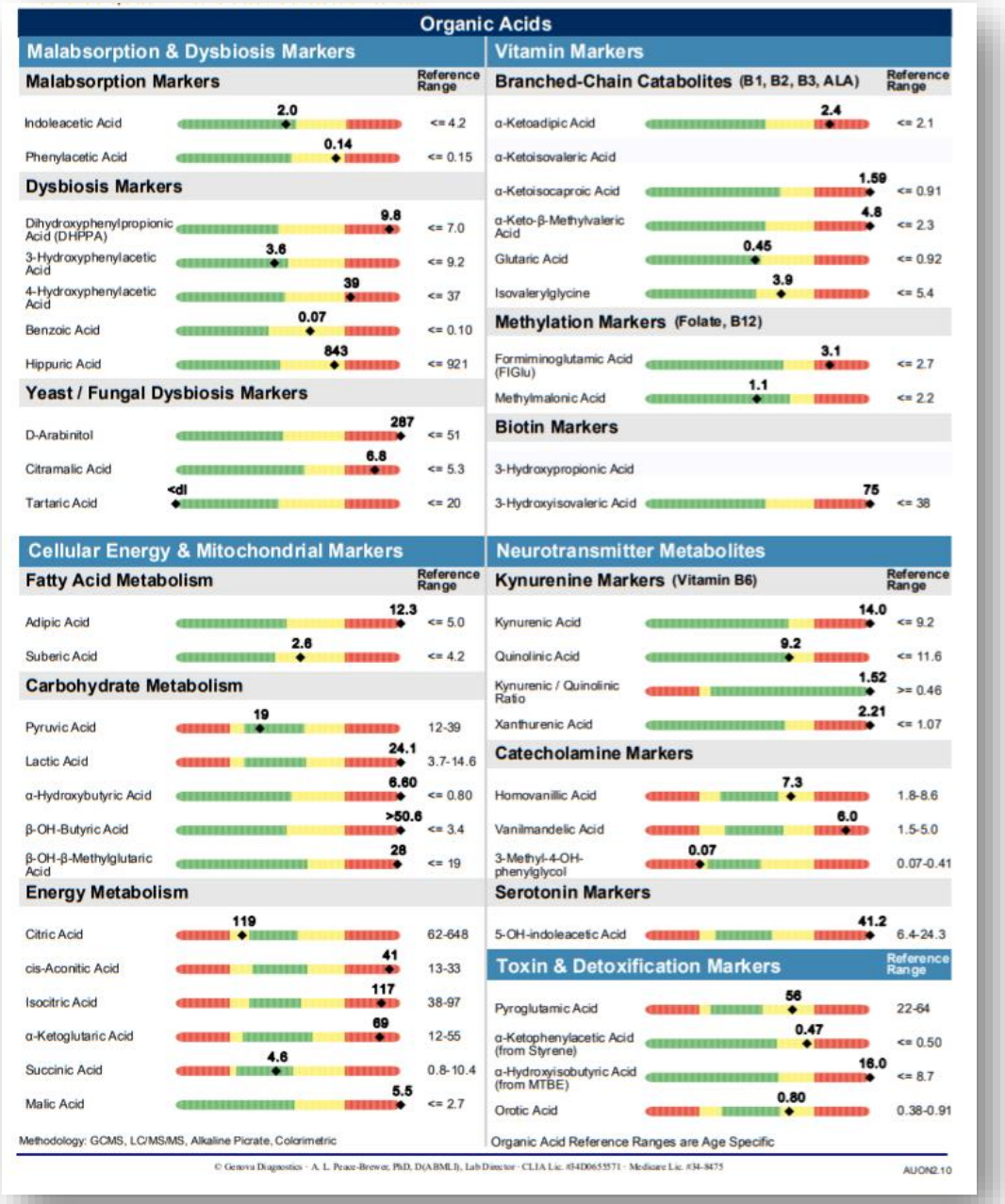


GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 23-year-old female student
- Fatigue, headaches, and constipation
- Thyroid RX

- Potential maldigestion/absorption and yeast dysbiosis
- Need for B-vitamins
- Address toxic exposures and/or support detoxification



Organic Acids

Malabsorption & Dysbiosis Markers

Malabsorption Markers		Reference Range
Indoleacetic Acid	2.0	<= 4.2
Phenylacetic Acid	0.14	<= 0.15
Dysbiosis Markers		
Dihydroxyphenylpropionic Acid (DHPPA)	9.8	<= 7.0
3-Hydroxyphenylacetic Acid	3.6	<= 9.2
4-Hydroxyphenylacetic Acid	39	<= 37
Benzoic Acid	0.07	<= 0.10
Hippuric Acid	843	<= 921
Yeast / Fungal Dysbiosis Markers		
D-Arabinitol	287	<= 51
Citramalic Acid	6.8	<= 5.3
Tartaric Acid	<dl	<= 20

Vitamin Markers

Branched-Chain Catabolites (B1, B2, B3, ALA)		Reference Range
α-Ketoadipic Acid	2.4	<= 2.1
α-Ketoisovaleric Acid		
α-Ketoisocaproic Acid	1.59	<= 0.91
α-Keto-β-Methylvaleric Acid	4.8	<= 2.3
Glutaric Acid	0.45	<= 0.92
Isovalerylglycine	3.9	<= 5.4
Methylation Markers (Folate, B12)		
Formiminoglutamic Acid (FIGlu)	3.1	<= 2.7
Methylmalonic Acid	1.1	<= 2.2
Biotin Markers		
3-Hydroxypropionic Acid		
3-Hydroxyisovaleric Acid	75	<= 38

Cellular Energy & Mitochondrial Markers

Fatty Acid Metabolism		Reference Range
Adipic Acid	12.3	<= 5.0
Suberic Acid	2.6	<= 4.2
Carbohydrate Metabolism		
Pyruvic Acid	19	12-39
Lactic Acid	24.1	3.7-14.6
α-Hydroxybutyric Acid	6.60	<= 0.80
β-OH-Butyric Acid	>50.6	<= 3.4
β-OH-β-Methylglutaric Acid	28	<= 19
Energy Metabolism		
Citric Acid	119	62-648
cis-Aconitic Acid	41	13-33
Isocitric Acid	117	38-97
α-Ketoglutaric Acid	69	12-55
Succinic Acid	4.6	0.8-10.4
Malic Acid	5.5	<= 2.7

Neurotransmitter Metabolites

Kynurenine Markers (Vitamin B6)		Reference Range
Kynurenic Acid	14.0	<= 9.2
Quinolinic Acid	9.2	<= 11.6
Kynurenic / Quinolinic Ratio	1.52	>= 0.46
Xanthurenic Acid	2.21	<= 1.07
Catecholamine Markers		
Homovanillic Acid	7.3	1.8-8.6
Vanilmandelic Acid	6.0	1.5-5.0
3-Methyl-4-OH-phenylglycol	0.07	0.07-0.41
Serotonin Markers		
5-OH-indoleacetic Acid	41.2	6.4-24.3

Toxin & Detoxification Markers		Reference Range
Pyroglutamic Acid	56	22-64
α-Ketophenylacetic Acid (from Styrene)	0.47	<= 0.50
α-Hydroxyisobutyric Acid (from MTBE)	16.0	<= 8.7
Orotic Acid	0.80	0.38-0.91

Methodology: GCMS, LC/MS/MS, Alkaline Picrate, Colorimetric

Organic Acid Reference Ranges are Age Specific

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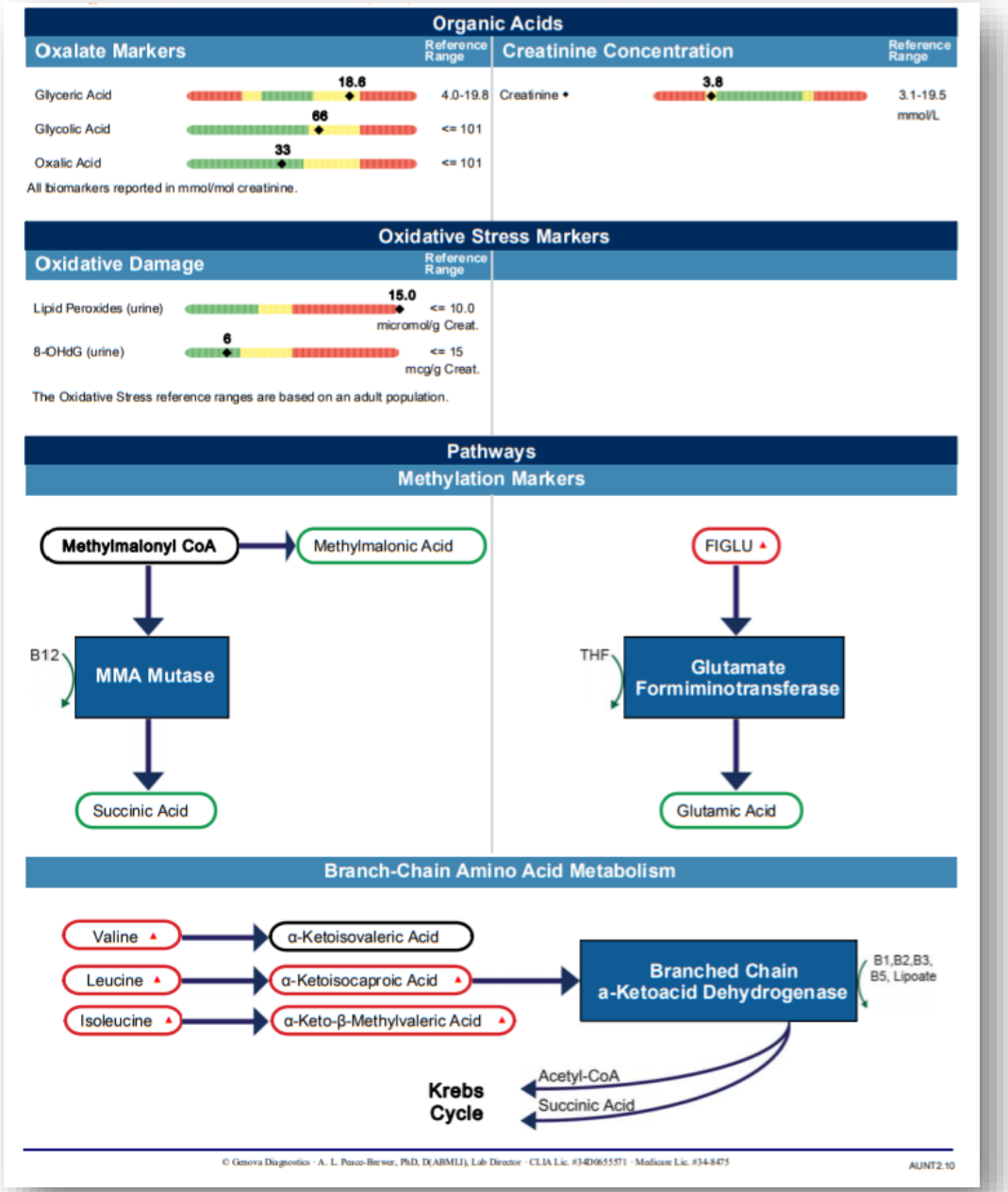
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GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 23-year-old female student
- Fatigue, headaches, and constipation
- Thyroid RX

- Oxalate Markers
  - Glyceric Acid: Vitamin B3 and Magnesium
  - Glycolic Acid: Oxidative Stress
- Oxidative Damage
  - Lipid Peroxides: oxidative damage to cell membranes

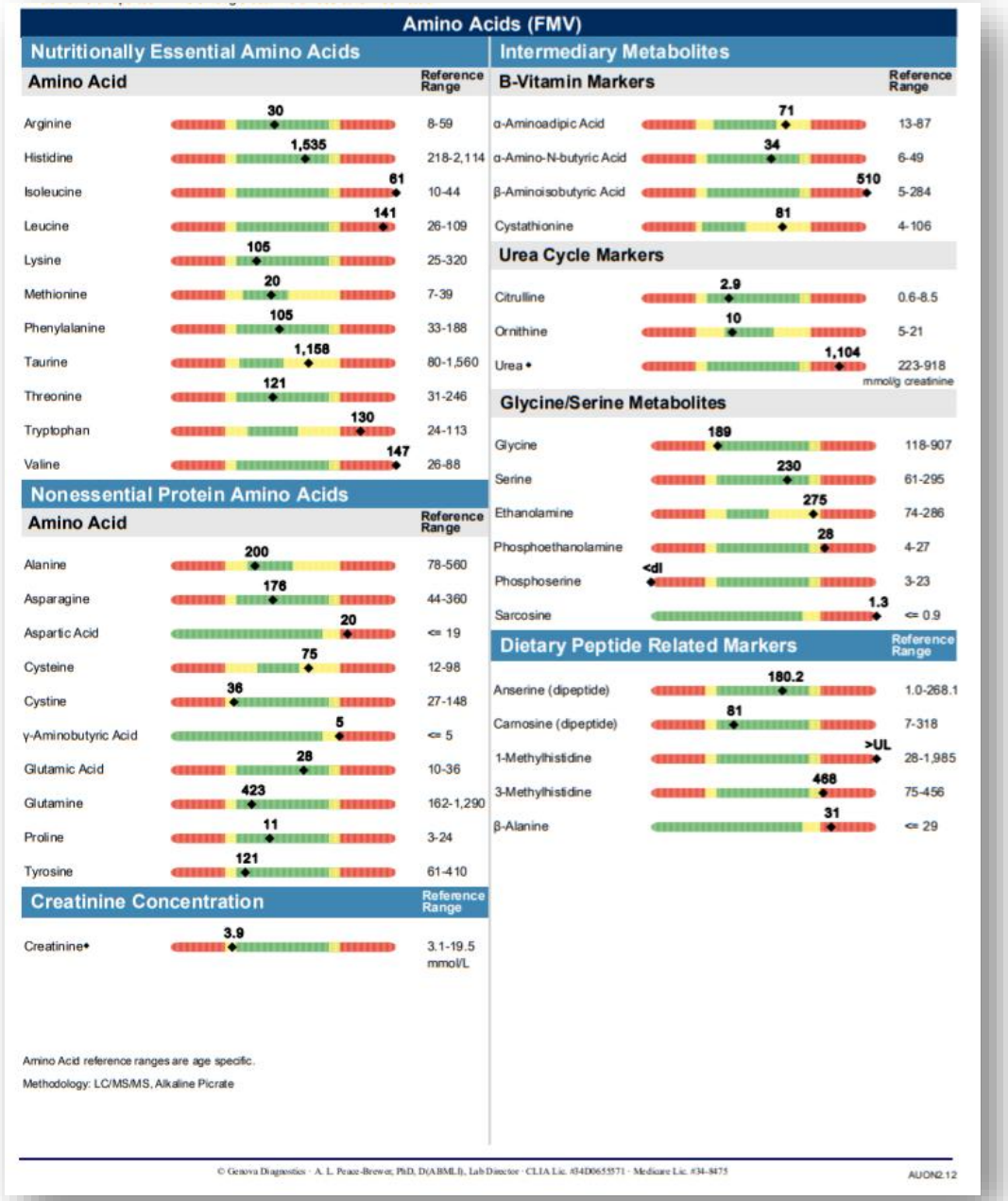


GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 23-year-old female student
- Fatigue, headaches, and constipation
- Thyroid RX

- Elevated Amino Acids indicate a need for B-vitamins
- Intermediary Metabolites indicate a need for B-vitamins and potentially methylation imbalances
- Elevated Dietary Peptide Markers can suggest maldigestion/absorption or reflect intake



Amino Acids (FMV)

Nutritionally Essential Amino Acids

Amino Acid		Reference Range
Arginine	30	8-59
Histidine	1,535	218-2,114
Isoleucine	61	10-44
Leucine	141	26-109
Lysine	105	25-320
Methionine	20	7-39
Phenylalanine	105	33-188
Taurine	1,158	80-1,560
Threonine	121	31-246
Tryptophan	130	24-113
Valine	147	26-88

Nonessential Protein Amino Acids

Amino Acid		Reference Range
Alanine	200	78-560
Asparagine	176	44-360
Aspartic Acid	20	<= 19
Cysteine	75	12-98
Cystine	36	27-148
γ-Aminobutyric Acid	5	<= 5
Glutamic Acid	28	10-36
Glutamine	423	162-1,290
Proline	11	3-24
Tyrosine	121	61-410

Creatinine Concentration

		Reference Range
Creatinine*	3.9	3.1-19.5 mmol/L

Amino Acid reference ranges are age specific.

Methodology: LC/MS/MS, Alkaline Picrate

Intermediary Metabolites

B-Vitamin Markers

		Reference Range
α-Aminoadipic Acid	71	13-87
α-Amino-N-butyric Acid	34	6-49
β-Aminoisobutyric Acid	510	5-284
Cystathionine	81	4-106

Urea Cycle Markers

Citrulline	2.9	0.6-8.5
Ornithine	10	5-21
Urea *	1,104	223-918 mmol/g creatinine

Glycine/Serine Metabolites

Glycine	189	118-907
Serine	230	61-295
Ethanolamine	275	74-286
Phosphoethanolamine	28	4-27
Phosphoserine	<dl	3-23
Sarcosine	1.3	<= 0.9

Dietary Peptide Related Markers

		Reference Range
Anserine (dipeptide)	180.2	1.0-268.1
Carnosine (dipeptide)	81	7-318
1-Methylhistidine	>UL	28-1,985
3-Methylhistidine	468	75-456
β-Alanine	31	<= 29

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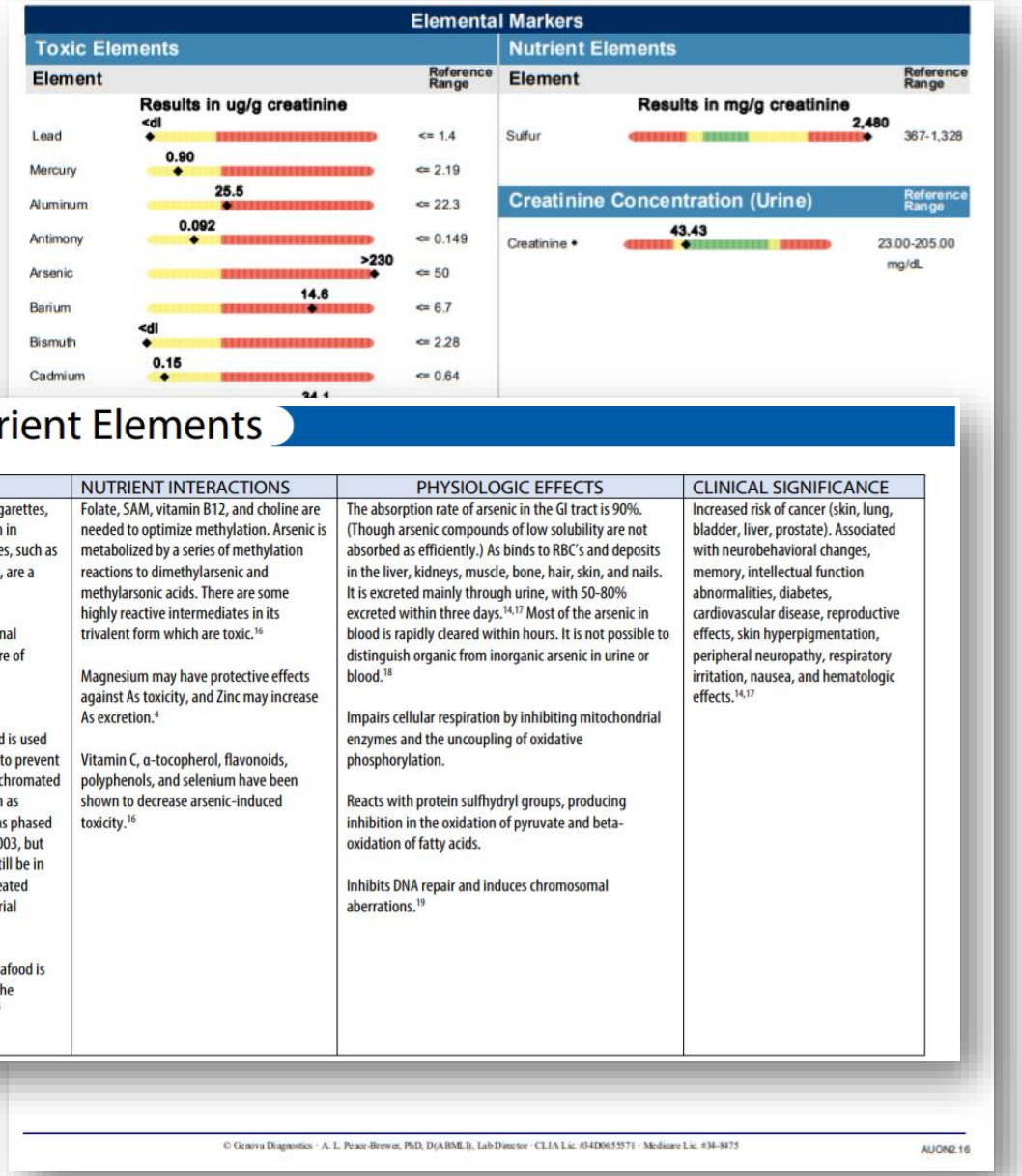
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GENOVA DIAGNOSTICS

What's Behind the Symptoms?

- 23-year-old female student
- Fatigue, headaches, and constipation
- Thyroid RX

- Current Exposure (random urine)
  - Identify Source and minimize
  - Support detoxification and elimination



Elemental Markers

Toxic Elements

Element	Results in ug/g creatinine	Reference Range
Lead	<dl	<= 1.4
Mercury	0.90	<= 2.19
Aluminum	25.5	<= 22.3
Antimony	0.092	<= 0.149
Arsenic	>230	<= 50
Barium	14.6	<= 6.7
Bismuth	<dl	<= 2.28
Cadmium	0.15	<= 0.64

Nutrient Elements

Element	Results in mg/g creatinine	Reference Range
Sulfur	2,480	367-1,328

Creatinine Concentration (Urine)		Reference Range
Creatinine •	43.43	23.00-205.00 mg/dL

Toxic and Nutrient Elements

ELEMENTS	SOURCES	NUTRIENT INTERACTIONS	PHYSIOLOGIC EFFECTS	CLINICAL SIGNIFICANCE
Arsenic (As)	Found in water, air, soil, cigarettes, and cosmetics. Food grown in contaminated water sources, such as rice and vegetables, or fish, are a common source.[13] Major sources of occupational exposure is the manufacture of pesticides, herbicides, and agricultural products.[14] 90% of all arsenic produced is used as a preservative for wood to prevent rotting and decay. Copper chromated arsenate (CCA), also known as pressure-treated wood, was phased out for residential use in 2003, but wood treated prior could still be in existing structures. CCA-treated wood is still used in industrial applications. Organic arsenic found in seafood is relatively nontoxic, while the inorganic forms are toxic.[15]	Folate, SAM, vitamin B12, and choline are needed to optimize methylation. Arsenic is metabolized by a series of methylation reactions to dimethylarsenic and methylarsonic acids. There are some highly reactive intermediates in its trivalent form which are toxic.[16] Magnesium may have protective effects against As toxicity, and Zinc may increase As excretion.[4] Vitamin C, α-tocopherol, flavonoids, polyphenols, and selenium have been shown to decrease arsenic-induced toxicity.[16]	The absorption rate of arsenic in the GI tract is 90%. (Though arsenic compounds of low solubility are not absorbed as efficiently.) As binds to RBC's and deposits in the liver, kidneys, muscle, bone, hair, skin, and nails. It is excreted mainly through urine, with 50-80% excreted within three days.[14,17] Most of the arsenic in blood is rapidly cleared within hours. It is not possible to distinguish organic from inorganic arsenic in urine or blood.[18] Impairs cellular respiration by inhibiting mitochondrial enzymes and the uncoupling of oxidative phosphorylation. Reacts with protein sulfhydryl groups, producing inhibition in the oxidation of pyruvate and beta-oxidation of fatty acids. Inhibits DNA repair and induces chromosomal aberrations.[19]	Increased risk of cancer (skin, lung, bladder, liver, prostate). Associated with neurobehavioral changes, memory, intellectual function abnormalities, diabetes, cardiovascular disease, reproductive effects, skin hyperpigmentation, peripheral neuropathy, respiratory irritation, nausea, and hematologic effects.[14,17]

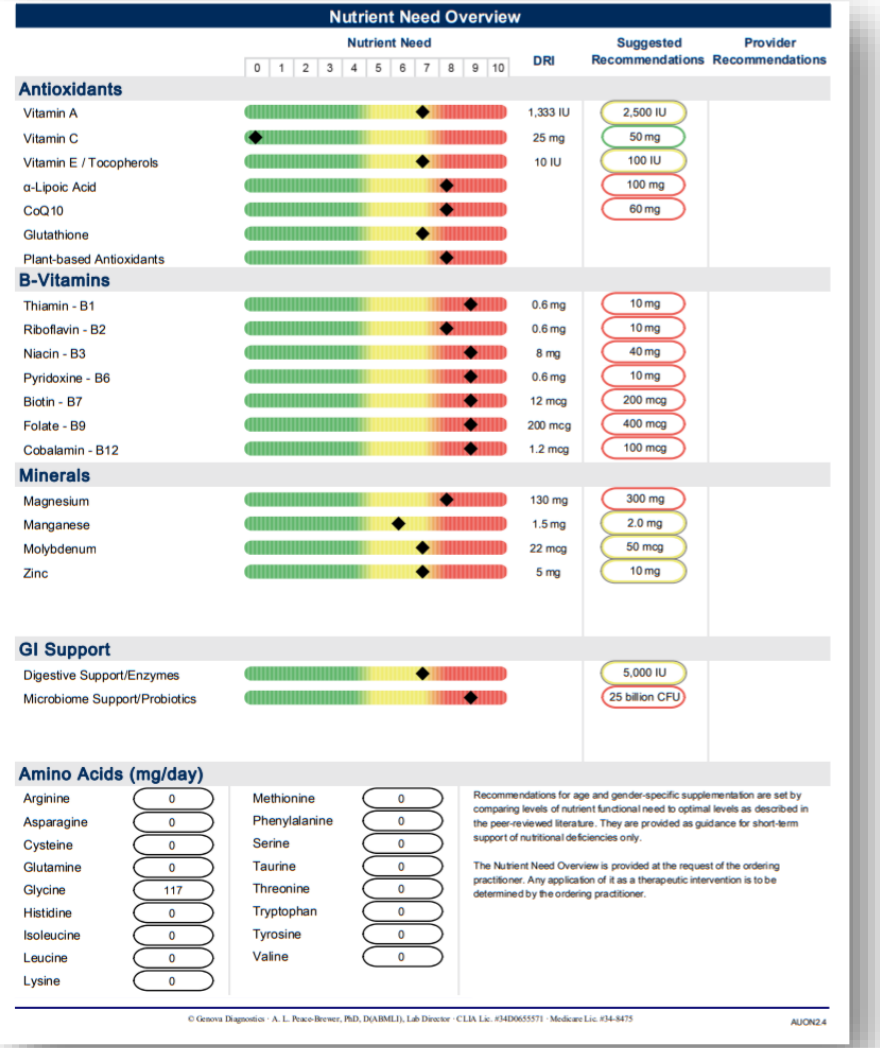
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GENOVA DIAGNOSTICS

What's Behind the Symptoms?

23-year-old female student cc fatigue, headaches, and constipation

- On thyroid rx and prior hx of iron deficiency anemia
- Nutrient Support
  - Multivitamin with additional B-complex, Magnesium, and CoQ10 supplement
    - discontinue gummy vitamin
- Detoxification
  - ID source and avoid heavy metals
  - Improve elimination (i.e. IR sauna)
  - Glutathione
- Diet
  - Increase plants, fiber, fruits, and fatty fish
- Further Assessment
  - Thyroid and iron studies
  - Stool Test (GI Effects) or SIBO
  - Salivary Hormones (Rhythm Plus)
- Continue physical activity



Nutrient Need Overview

	Nutrient Need (0 1 2 3 4 5 6 7 8 9 10)	DRI	Suggested Recommendations	Provider Recommendations
Antioxidants				
Vitamin A		1,333 IU	2,500 IU	
Vitamin C		25 mg	50 mg	
Vitamin E / Tocopherols		10 IU	100 IU	
α-Lipoic Acid			100 mg	
CoQ10			60 mg	
Glutathione				
Plant-based Antioxidants				
B-Vitamins				
Thiamin - B1		0.6 mg	10 mg	
Riboflavin - B2		0.6 mg	10 mg	
Niacin - B3		8 mg	40 mg	
Pyridoxine - B6		0.6 mg	10 mg	
Biotin - B7		12 mcg	200 mcg	
Folate - B9		200 mcg	400 mcg	
Cobalamin - B12		1.2 mcg	100 mcg	
Minerals				
Magnesium		130 mg	300 mg	
Manganese		1.5 mg	2.0 mg	
Molybdenum		22 mcg	50 mcg	
Zinc		5 mg	10 mg	
GI Support				
Digestive Support/Enzymes			5,000 IU	
Microbiome Support/Probiotics			25 billion CFU	

Amino Acids (mg/day)

Arginine	0	Methionine	0
Asparagine	0	Phenylalanine	0
Cysteine	0	Serine	0
Glutamine	0	Taurine	0
Glycine	117	Threonine	0
Histidine	0	Tryptophan	0
Isoleucine	0	Tyrosine	0
Leucine	0	Valine	0
Lysine	0		

Recommendations for age and gender-specific supplementation are set by comparing levels of nutrient functional need to optimal levels as described in the peer-reviewed literature. They are provided as guidance for short-term support of nutritional deficiencies only.

The Nutrient Need Overview is provided at the request of the ordering practitioner. Any application of it as a therapeutic intervention is to be determined by the ordering practitioner.

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GENOVA DIAGNOSTICS

Importance of Micronutrient Testing

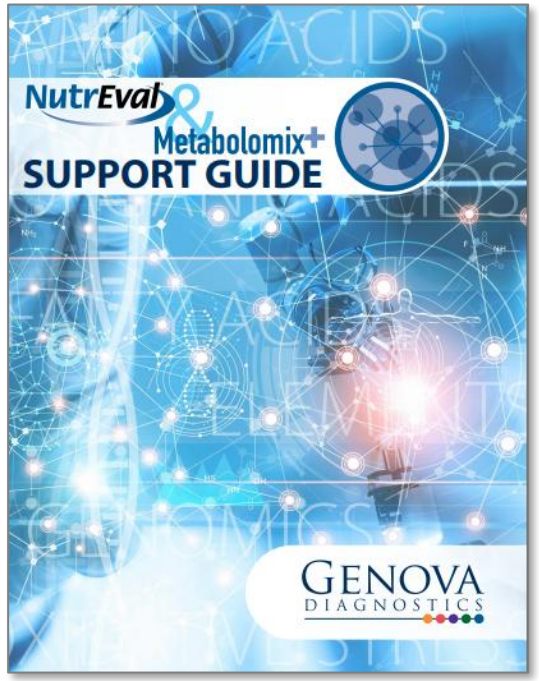
The BIG Picture

- Symptoms are multi-system
  - This patient's symptoms were not explained by one isolated marker
  - Instead, we identified patterns involving gut health, nutrient status, and detoxification/methylation
  - Functional testing added clinical context
  - Optimizing physiology may improve medication effectiveness, symptom resolution, and patient outcomes

Beyond “Normal”

- Normal ≠ Optimal
  - Traditional labs define disease absence, not functional balance. Many patients feel unwell long before conventional ranges shift
- Root Cause Visibility
  - Personalized labs reveal upstream drivers — nutrient deficits, hormone shifts, microbiome imbalance, mitochondrial dysfunction — that conventional testing misses
- Systems Integration
  - Conditions like depression, fatigue, or cognitive decline rarely belong to one system
  - Personalized labs illuminate how the gut, hormones, and mitochondria communicate
- Clinical Confidence
  - When you can read deeper patterns, you move from “symptom management” to “physiologic restoration”

Additional Educational Resources



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