



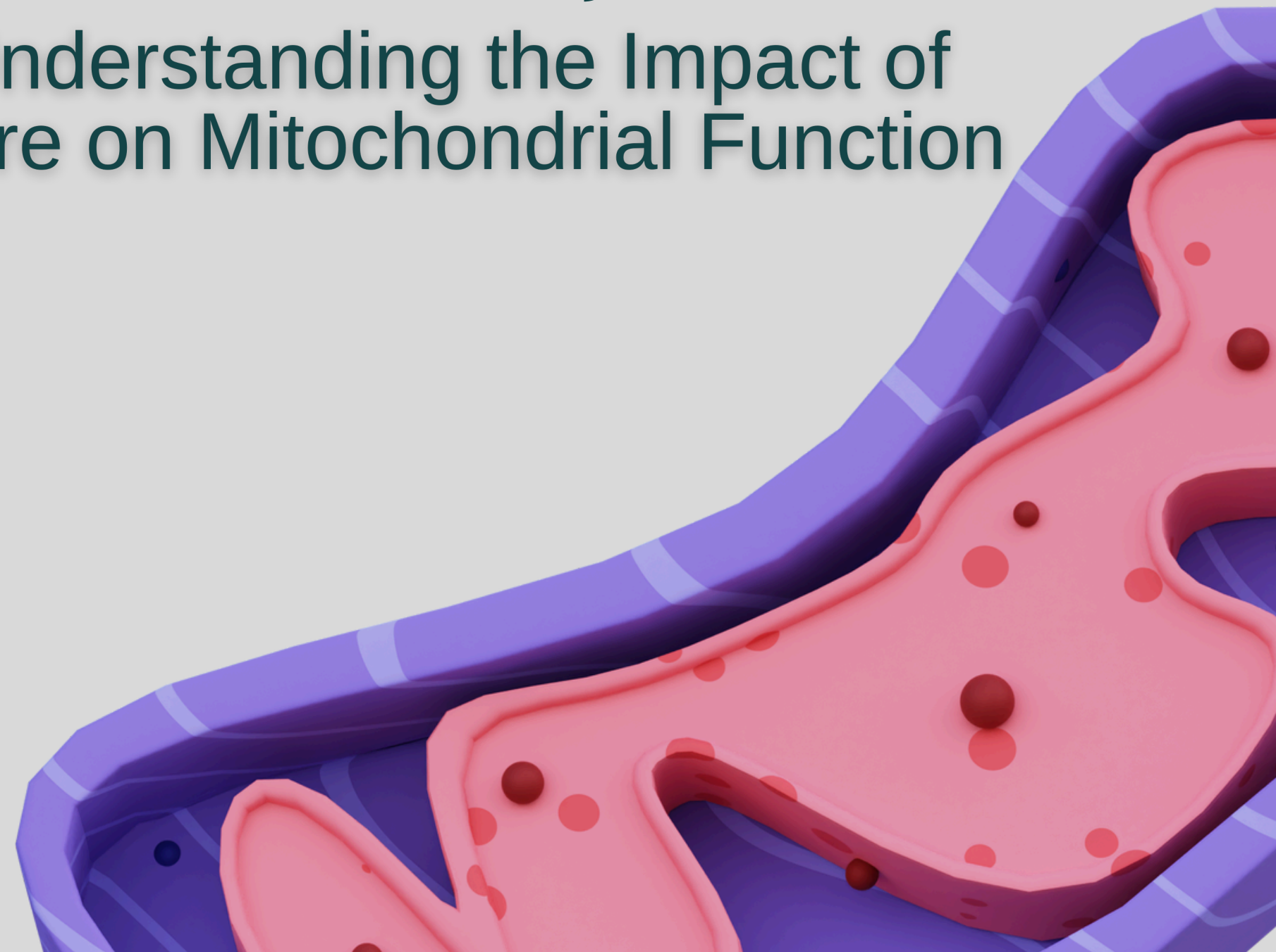
Dr. Jasmyne

Mitochondria & Mycotoxins

Identifying and Understanding the Impact of
Mycotoxin Exposure on Mitochondrial Function

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Dr. Jasmyne

Hi! I'm Dr. Jasmyne



Education

- Graduated from the University of Bridgeport in Naturopathic Medicine and Human Nutrition in 2017
- Bachelor Degree in Chemistry from Alabama Agricultural and Mechanical University

Experience

- Clinical Educator at Mosaic Diagnostics
- Current Naturopathic Doctor Consultant with Nutrafol
- Current Medical Science Liaison at Fullscript

Continued Growth

- Owner and operator of Natural Lyfe Health Consulting.
- I also engage in regular learning in the world of natural health

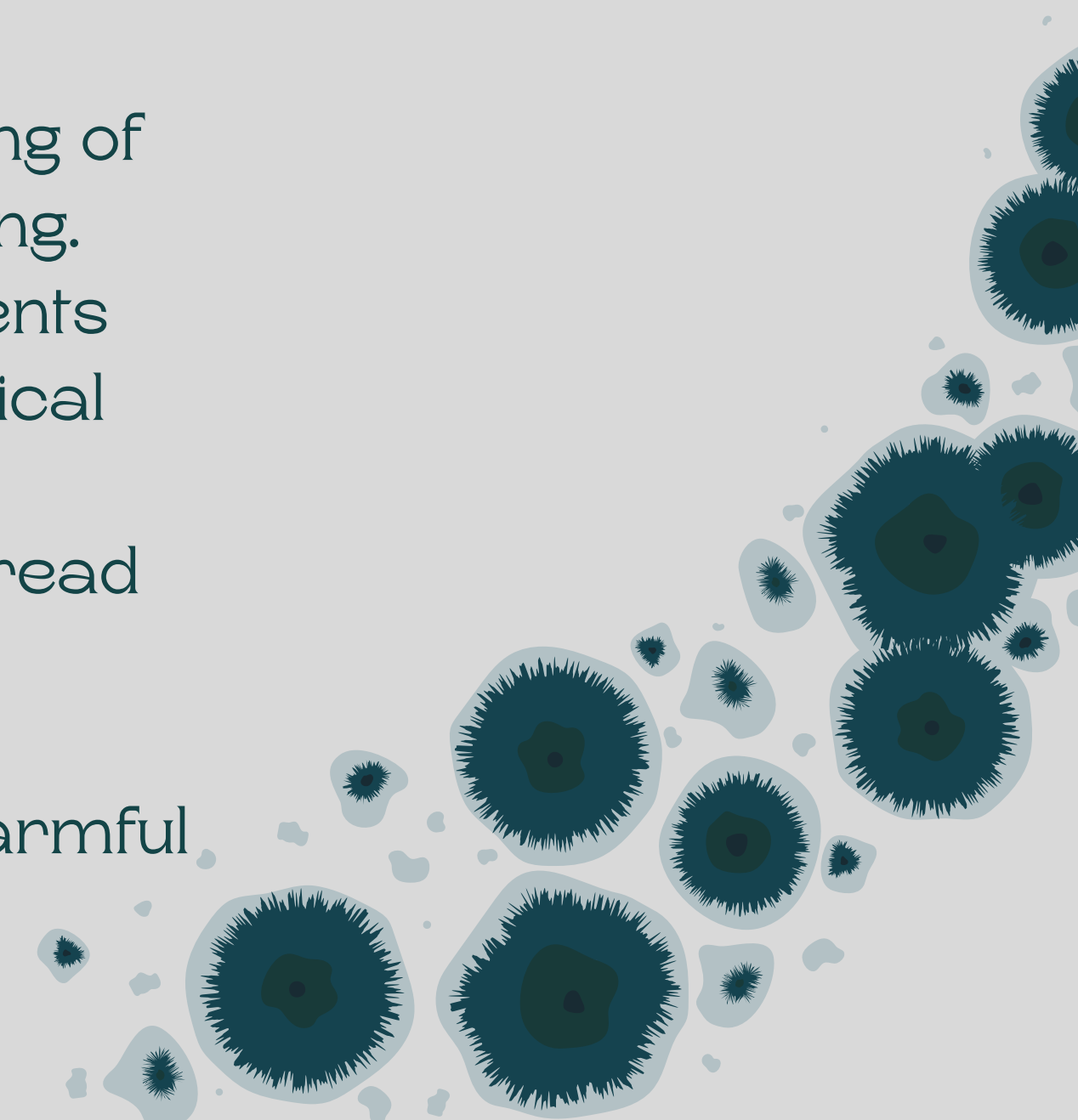
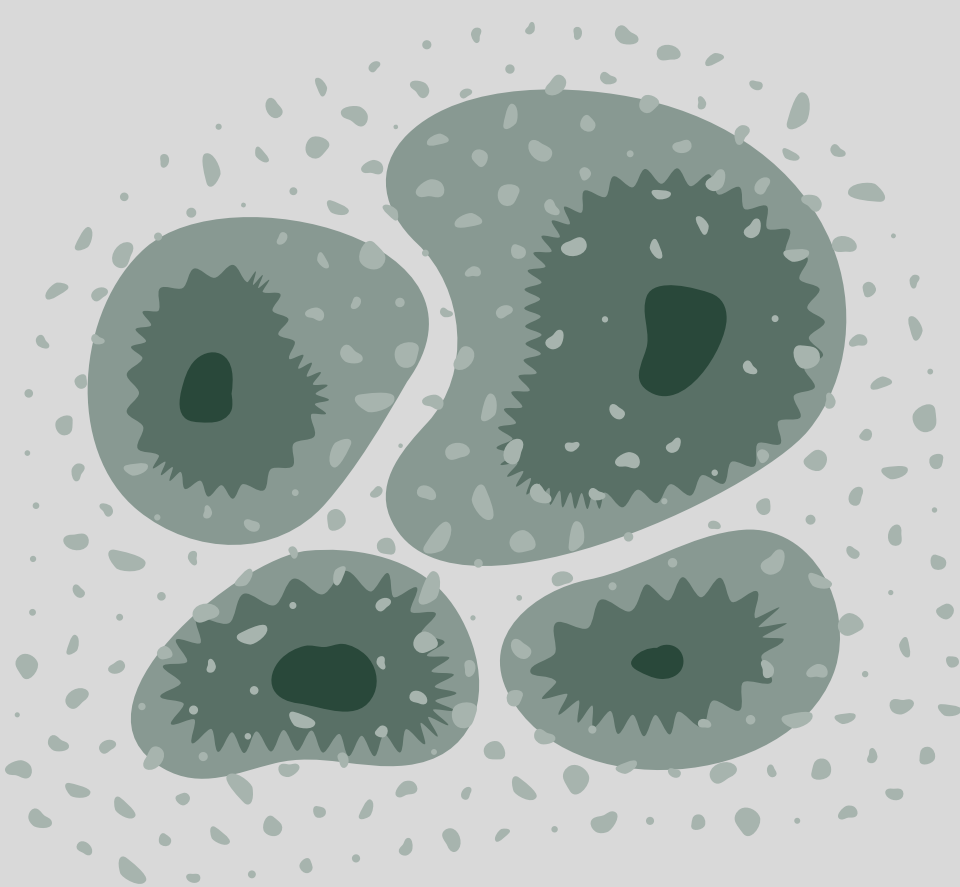
Objectives



- Define Mycotoxins and Their Sources
- Explain Mitochondrial Function and Its Importance
- Explore the Connection Between Mycotoxins and Mitochondrial Dysfunction
- Identify Symptoms and Health Impacts of Mitochondrial Dysfunction
- Discuss Diagnostic Methods for Mycotoxin Exposure and Mitochondrial Dysfunction
- Present Strategies for Mitigating Mycotoxin Exposure and Supporting Mitochondrial Health

What Are Mycotoxins?

- Toxic substances normally produced by mold
 - Molds are fungi similar to yeast
 - Yeast is unicellular and can be round, oval, or filamentous,
 - mold is multicellular and appears as masses of hyphae or mycelium
 - Yeasts are microscopic fungi consisting of solitary cells that reproduce by budding.
 - Molds, in contrast, occur in long filaments known as hyphae, which grow by apical extension
 - Appearance: Molds are fuzzy and spread across surfaces, while yeast forms smooth colonies.
 - Health Impact: Molds may produce harmful toxins; yeast can cause infections, especially in moist areas of the body.
 -



Sources of Mycotoxins

We can get exposed to mycotoxins from various sources

Foods

NUTS AND GRAINS

these foods go through a drying process that increases risk of mold growth
some are grown in the soil that exposes them to molds

COFFEE, WINE, CHEESE

production processes and fermentation increases risk of mold growth and mycotoxin exposure

Environment

BUILDINGS

any building with water supply has the potential for mold
high humidity can increase risk of growth
building material are food for molds

VEHICLES

flooded vehicles grow mold
faulty A/C can grow mold then blow it throughout the cabin
change air filters regularly





Mycotoxin Exposure

INHALATION

contaminated air and dust particles can increase exposure with every breath we take

INGESTION

eating too many mold contaminated foods

DERMAL CONTACT

brushing up against or using products that have mold growth on our skin- mold car seats, towels, clothes, books, etc

Toxic Effects of Mycotoxins

mycotoxins have a myriad of toxic effects. they do nothing positive to our bodies and over exposure is detrimental

1

NEUROTOXIN

disrupt nerve conduction leading to neuropathy and cognition issues

2

ENDOCRINE TOXIN

impairs hormonal balance by mimicking estrogen leading to premature puberty, infertility, PCOS

3

CARCINOGENS

increases risk of certain cancers like liver, kidney, esophageal, breast

4

IMMUNOTOXINS

immunosuppressive effects that disrupt immune activation, shift in autoimmune Th1 and Th2 imbalance

5

CARDIOTOXINS

vascular, muscular, endothelial, protein synthesis disruptions. Increased inflammation and fibrosis

Functions of the Mitochondria

Mitochondria are the cell's powerhouses, responsible for producing energy in the form of ATP (adenosine triphosphate) through the process of cellular respiration. They also regulate key cellular processes like apoptosis (cell death, calcium storage, and the generation of reactive oxygen species).

ENERGY PRODUCTION

ATP), the main energy currency of the cell, through a process called oxidative phosphorylation. This occurs in the inner mitochondrial membrane, where the electron transport chain creates a proton gradient that drives the synthesis of ATP.

CALCIUM HOMEOSTASIS

regulate intracellular calcium levels, which are critical for various cellular processes, including muscle contraction, neurotransmitter release, and cell signaling. They act as buffers, absorbing and releasing calcium as needed.

REGULATION OF CELLULAR METABOLISM

They are involved in the breakdown of carbohydrates (glycolysis), fats (beta-oxidation), and proteins to produce ATP.

APOPTOSIS

They release cytochrome c and other pro-apoptotic factors in response to cellular stress, triggering the apoptotic pathway.



Functions of the Mitochondria



Regulation of Cell Growth and Differentiation:

Mitochondria influence cell proliferation and differentiation by regulating energy production and the balance of metabolic intermediates. They play a role in signaling pathways that control cell cycle progression and differentiation.

PRODUCTION OF REACTIVE OXYGEN SPECIES (ROS)

generate reactive oxygen species (ROS), such as superoxide. While ROS play a role in cell signaling and defense against pathogens, excessive ROS can lead to oxidative stress and damage cellular components.

SYNTHESIS OF METABOLIC PRECURSORS

involved in the synthesis of several important molecules, including heme (a component of hemoglobin) and steroid hormones. They also contribute to the urea cycle and gluconeogenesis (glucose production).

REGULATION OF CELLULAR REDOX STATE

maintain the balance between oxidation and reduction (redox state) within cells, which is crucial for cellular function and defense against oxidative damage.

THERMOGENESIS

In brown adipose tissue, mitochondria are involved in thermogenesis, where they produce heat instead of ATP. This process is essential for maintaining body temperature, especially in newborns and during cold exposure.

Common Signs and Symptoms of Mitochondrial Dysfunction

MUSCLE WEAKNESS AND FATIGUE

decrease recovery of muscle tissue from simple movement or exercise intolerance

MEMORY AND SENSORY ISSUES

reduced cognition, hearing or vision issues

NEUROLOGIC

anxiety, depression, irritability, developmental, learning difficulties

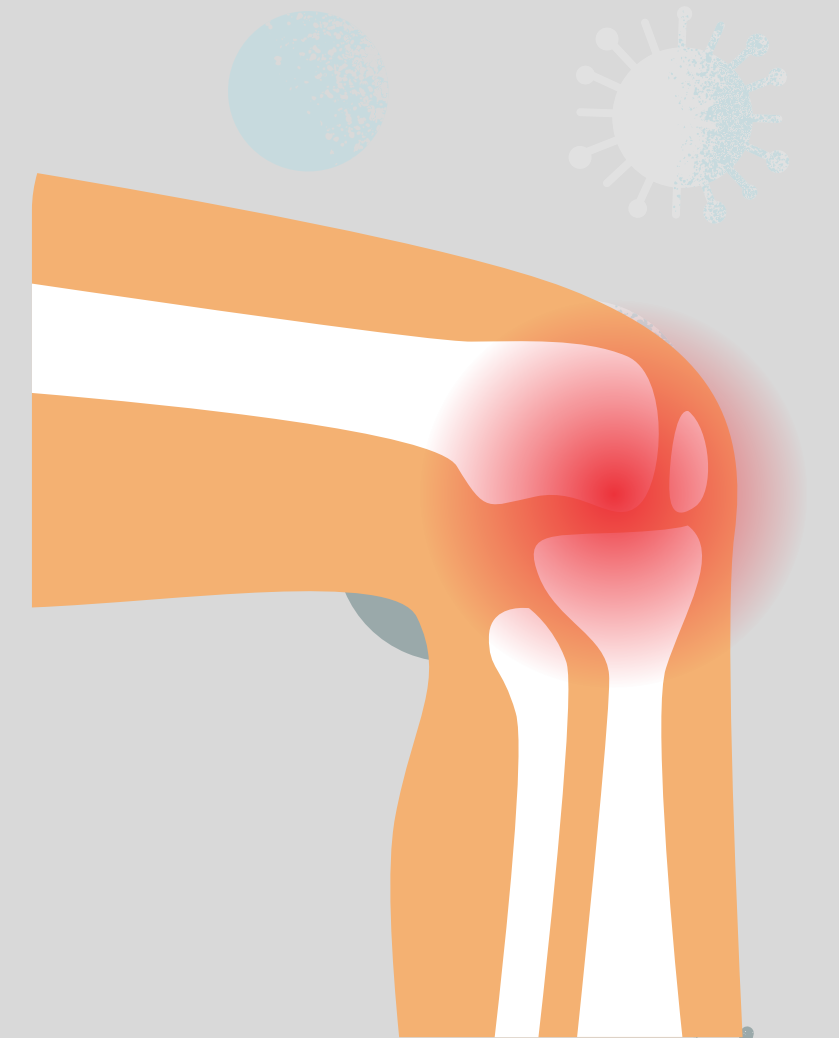
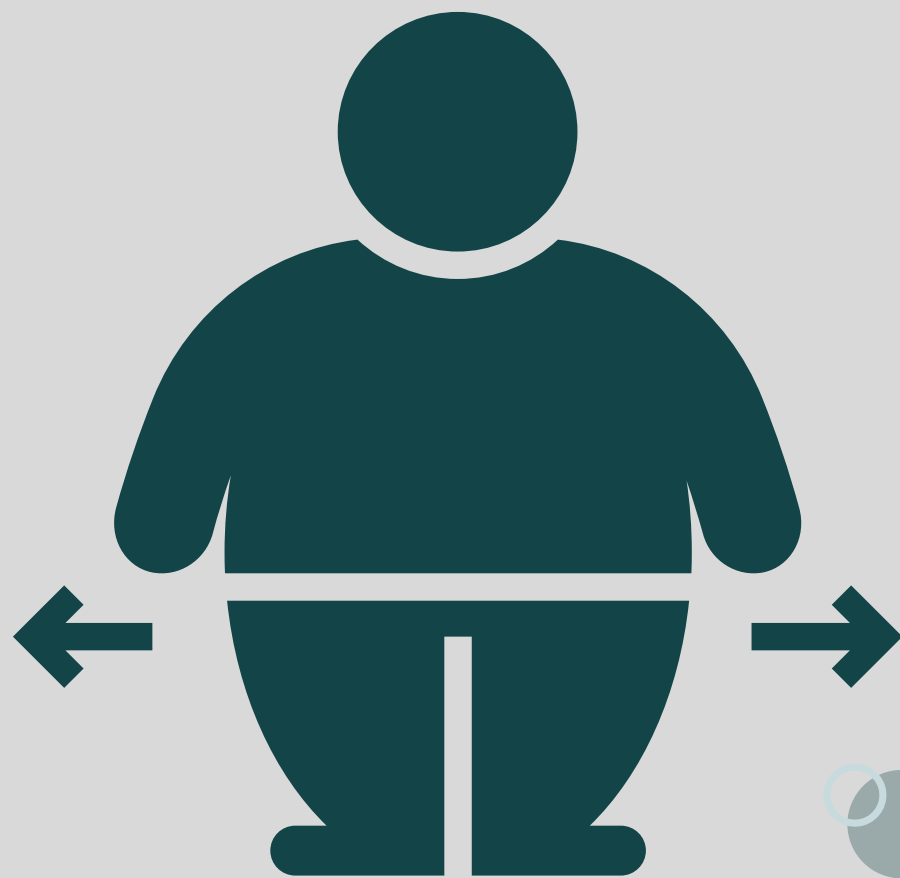
GI DISTRESS

nausea, vomiting, diarrhea, constipation



Conditions Associated with Mitochondrial Dysfunction

- Headaches
- Seizures
- Alzheimer's disease
- Parkinson's disease
- Obesity
- Type 2 Diabetes
- Chronic Fatigue Syndrome
- Fibromyalgia
- Osteoporosis and Sarcopenia
- NAFLD
- Cancer
- Peripheral Neuropathy





Mycotoxin--> Mitochondria

OCHRATOXIN

mitochondrial function disturbance, apoptotic and autophagic cell death and also induce mitochondrial biogenesis

ALFLATOXIN

disrupts the levels phospholipids, mitochondrial membrane which affect the mitochondrial membrane transport. reduces mitochondrial membrane potential and promotes mitochondrial permeability, induced oxidative stress and apoptosis

ZEARALENONE

increases cell division, autophagy, LDH activity



Mycotoxin--> Mitochondria

MYCOPHENOLIC ACID

induced hyperpolarization of the mitochondrial membrane potential and the translocation of Cytochrome C and Bax proteins from the cytoplasm to the mitochondria

CITRININ

inhibits several enzymes, including malate dehydrogenase and glutamate dehydrogenase, as well as the ATP synthase complex involved in the respiratory chain

How do we evaluate this?

Functional testing option support practitioners

ORGANIC ACID TEST

organic acids supply information about mitochondrial function as it relates to glucose, fat, and amino acid usage

MYCOTOXIN TESTS

urine test capture what mycotoxins are being excreted from the body. unbound mycotoxins help us understand what has not been conjugated by the liver and removed unchanged

ENVIRONMENTAL TESTS

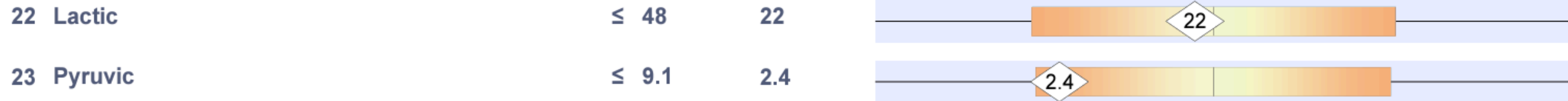
identifies environmental source of exposure. once you stop the exposure you can get on top of the detox process



Mitochondrial Function

Evaluation

Glycolytic Cycle Metabolites



- Low levels show proper usage of these metabolites for energy production
- Lactic Acid:
 - elevated: increased production with decreased transformation
 - lack of oxygen delivery to cells
 - iron deficiency
 - microorganism production
 - poor oxygenation states
- Pyruvate:
 - elevated increased production with decreased usage
 - poor B vitamin availability
 - B2, B1, B3
 - poor oxygenation

Glycolysis
(anaerobic)

Glucose



2 ATP

Pyruvic acid

Oxygen present?



Krebs cycle



Oxidative phosphorylation

Fermentation
(anaerobic)

No oxygen



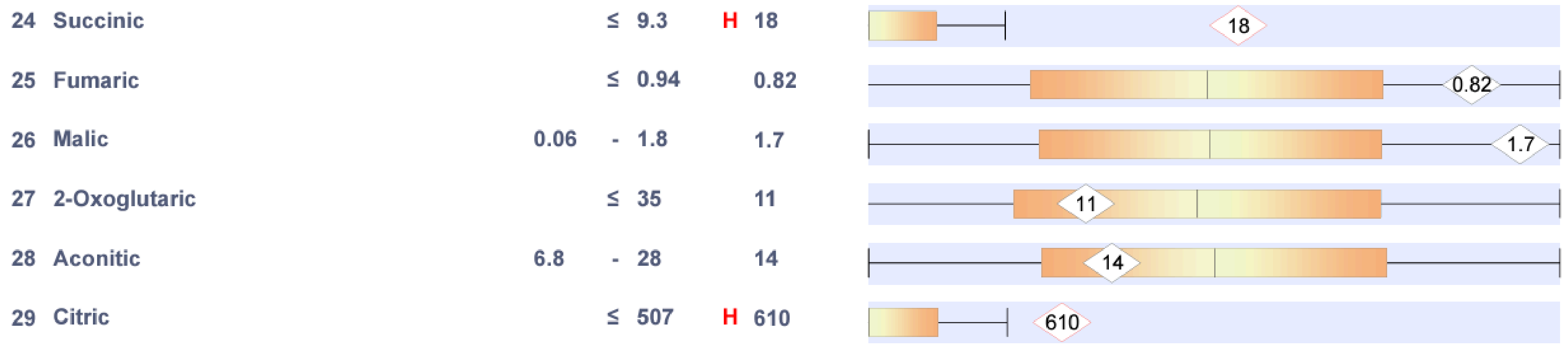
Lactic acid
(animals)

Ethanol
(yeast)

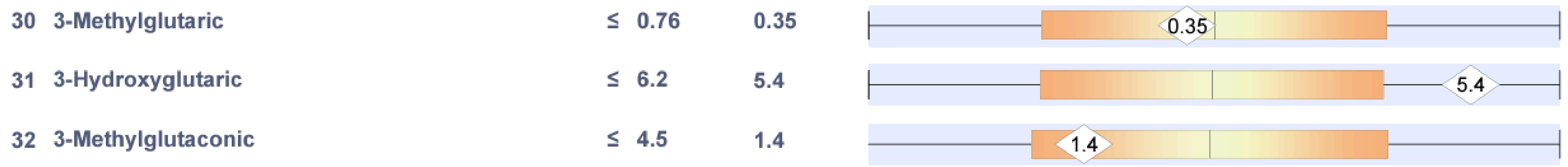
36 ATP

Aerobic respiration

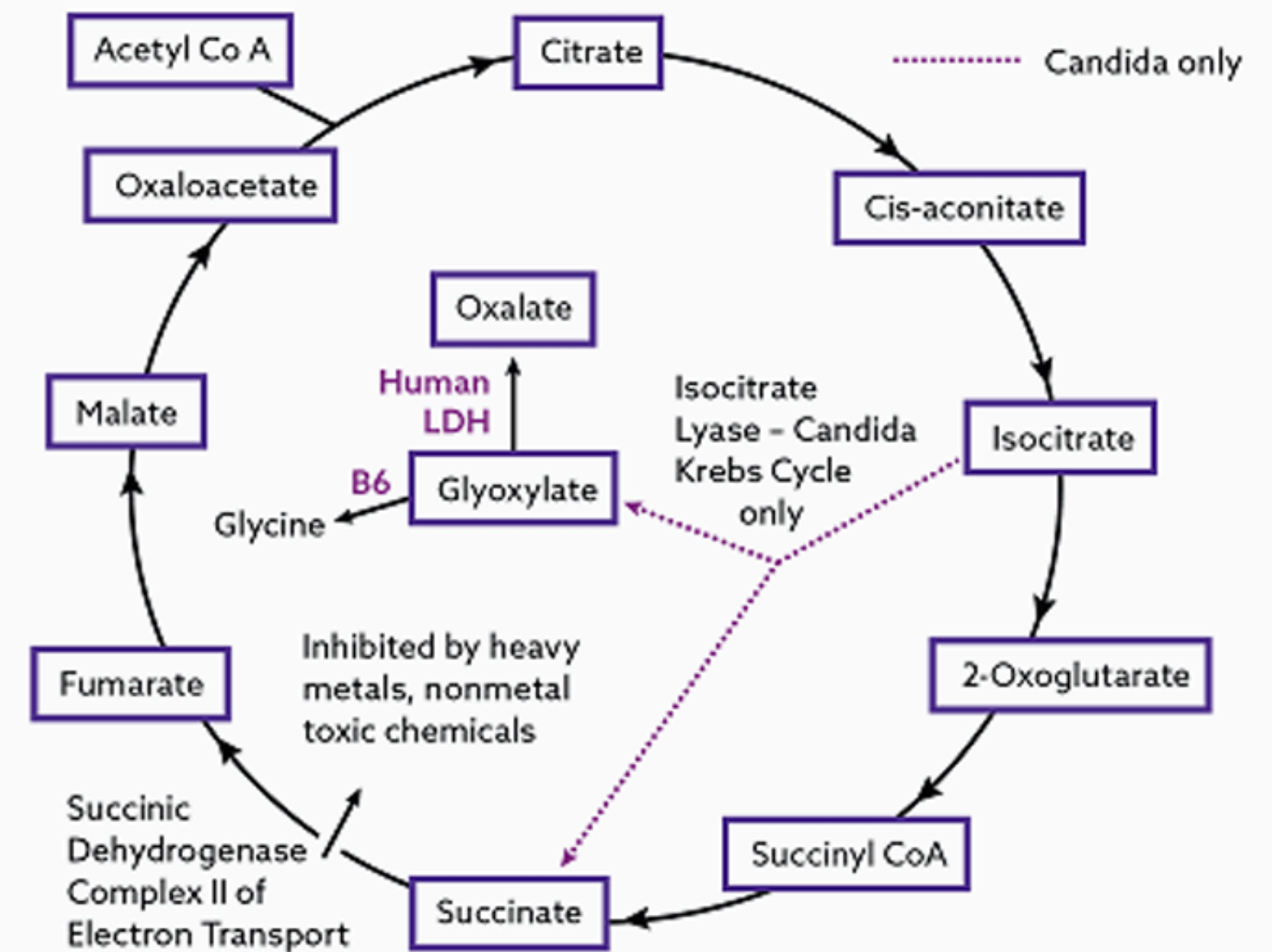
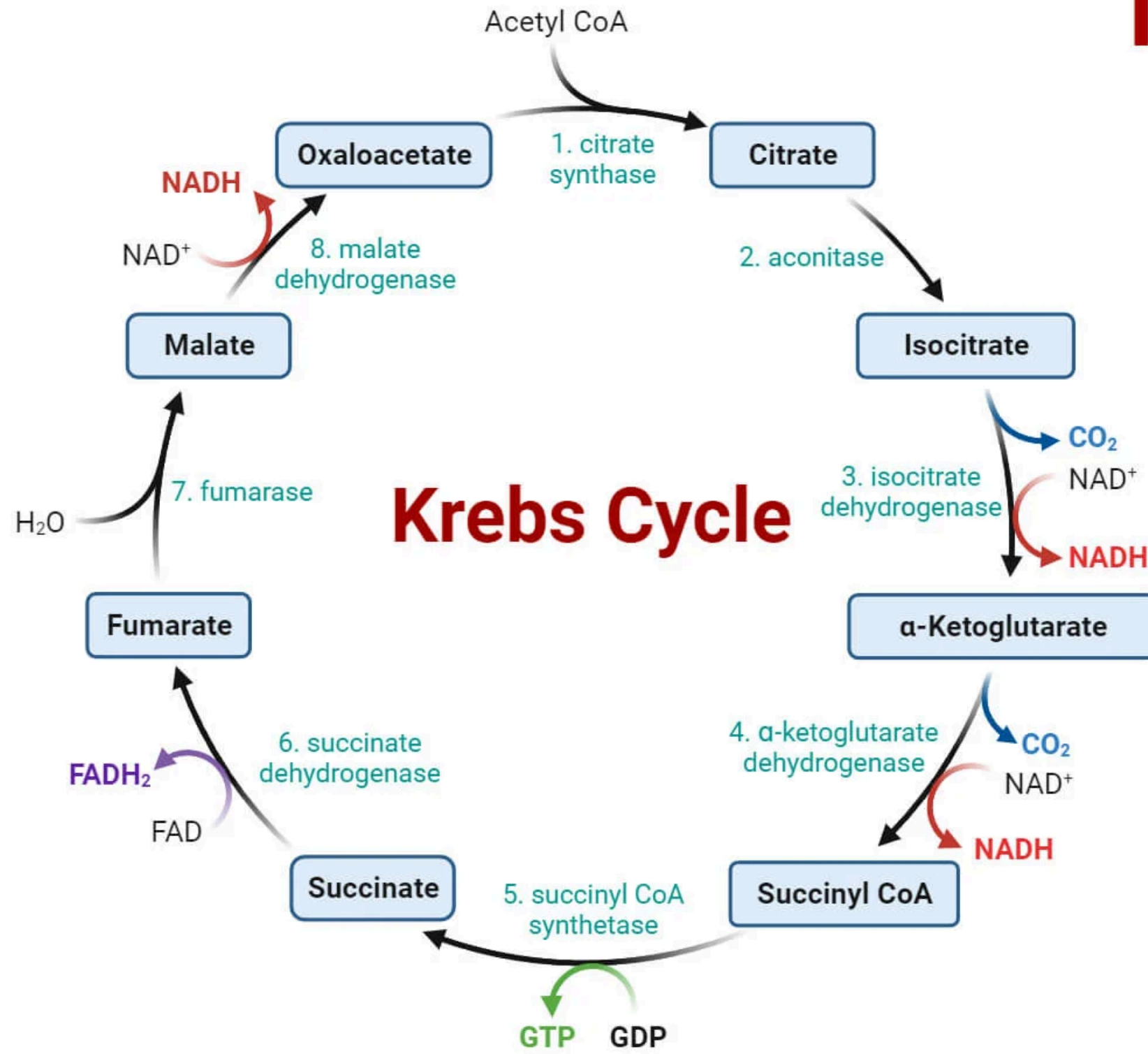
Mitochondrial Markers - Krebs Cycle Metabolites

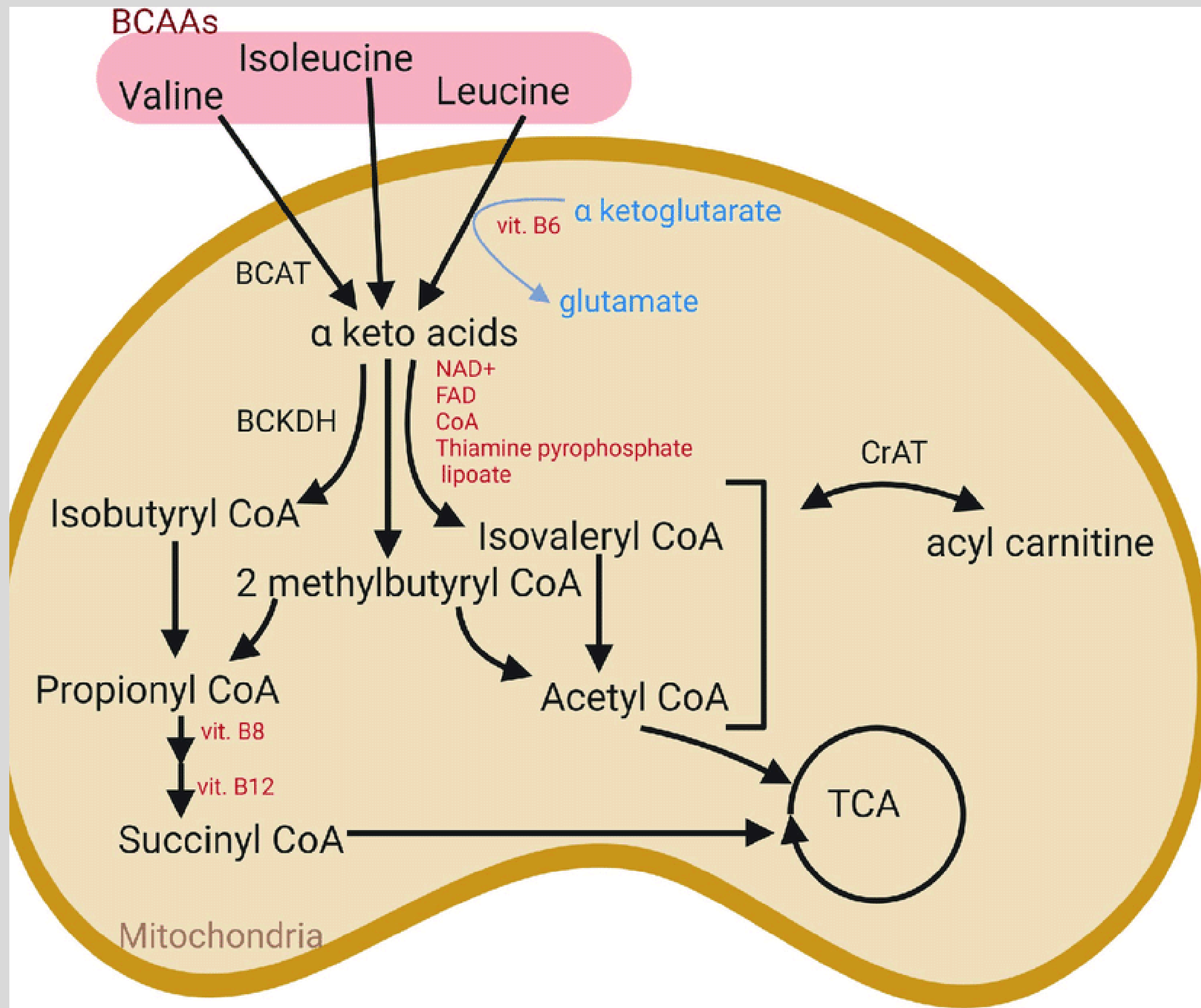


Mitochondrial Markers - Amino Acid Metabolites

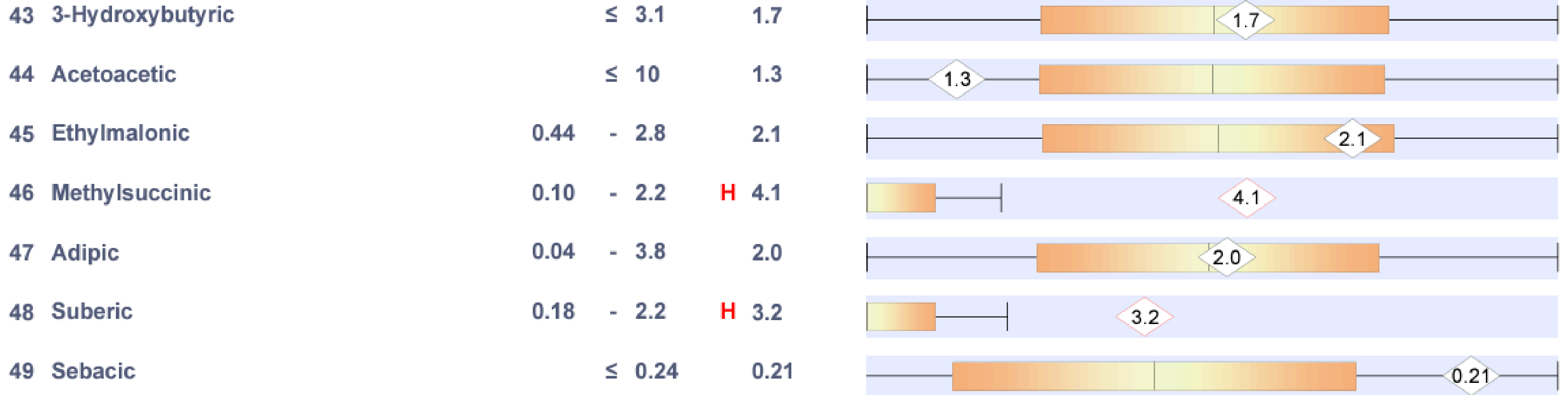


TCA Cycle



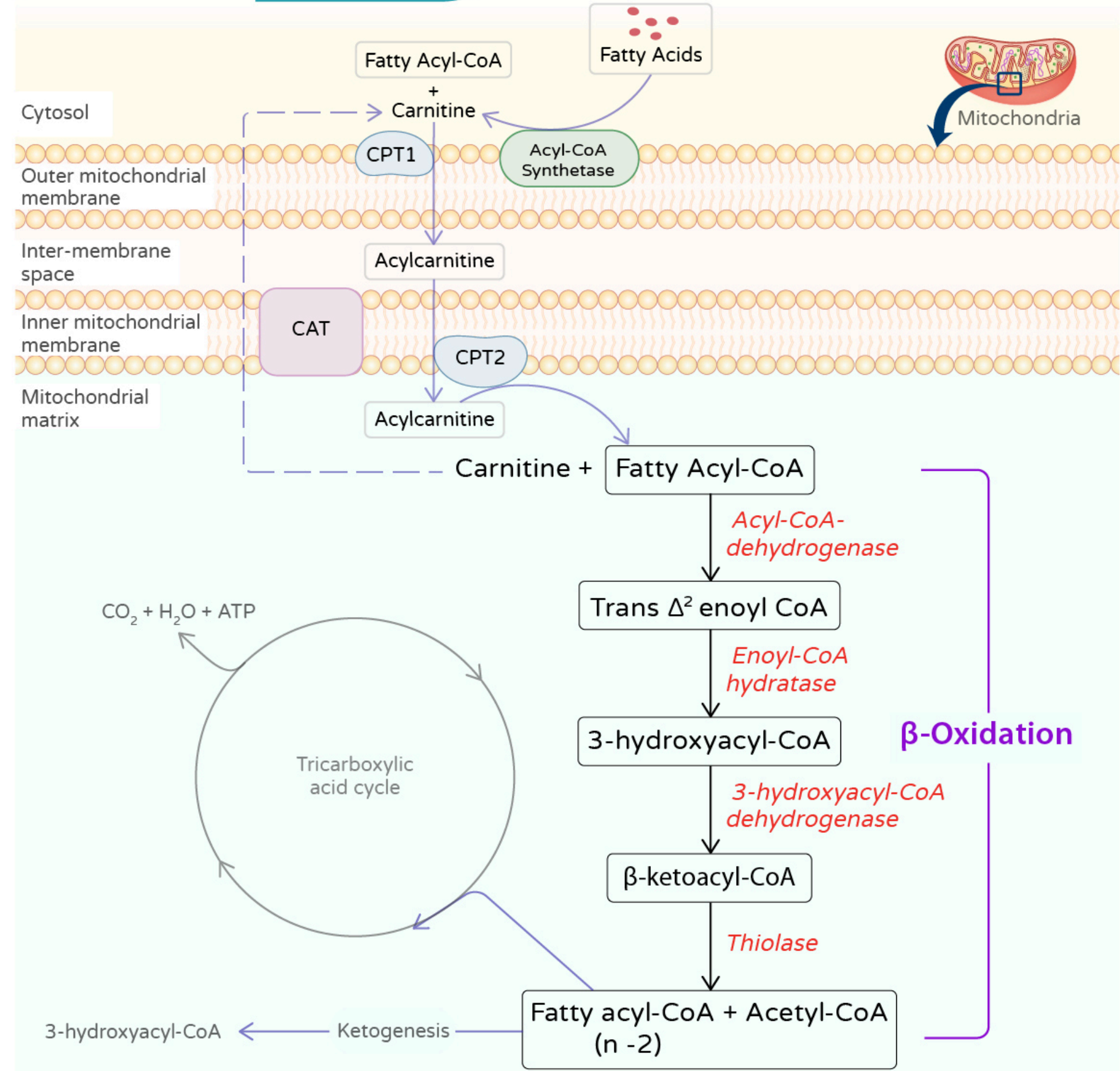


Ketone and Fatty Acid Oxidation



- 43 and 44 are ketones– by products of beta oxidation
 - used in Krebs cycle for energy production
- 45–49 are dicarboxylic acids
 - formed outside of the mitochondria and decreases efficiency of energy production from mitochondria
 - can be elevated with high intake of omega fatty acids–fatty fish, fish oil, avocado/olive oils.

FATTY ACID OXIDATION



Glossary

CPT 1: Carnitine Palmitoyltransferase 1

CPT 2: Carnitine Palmitoyltransferase 2

CAT: Carnitine Translocase

Nutritional Markers

Vitamin B12



Vitamin B6



Vitamin B5



Vitamin B2 (Riboflavin)



Vitamin C



Vitamin Q10 (CoQ10)



Glutathione Precursor and Chelating Agent



Biotin (Vitamin H)



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

Color Key



NORMAL



HIGH

Creatinine Value: 100.00 mg/dl

	NORMAL RANGE (ng/g creatinine)	RESULTS (ng/g creatinine) DL - Detectable Limit
Ochratoxin A (OTA)	< 7.5	54.00
Roridin E (ROE)	< 0.2	56.00
Verrucarin A (VRA)	< 1.3	97.00
Glotoxin (GTX)	< 200	205.00
Mycophenolic Acid (MPA)	< 37.4	40.00

So is it Food or a Water Damage Building (WDB)?

Food

certain toxins contaminate food
more often- OTA, AF, MPA, CIT,
ZEA, GLIO

amount of toxin present is
usually less than double the
upper limit



WDB

certain toxins are rarely
contaminating foods- roridin e,
verucarrin a, enniatin b,
chateoglobosin a

food contaminates are
usually more than
double the upper limit



Questions to Consider

DIET

excessive intake of coffee, teas, nut butters, homemade breads, grains, corn, cheese, wine

LENGTH OF TIME

how long has someone engaged in the behavior, do symptoms follow the pattern

CHANGES

if they were to stop do their symptoms subside

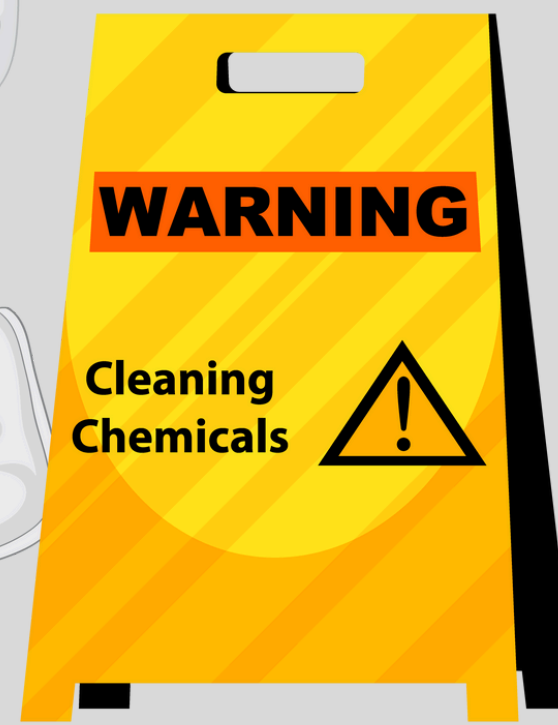
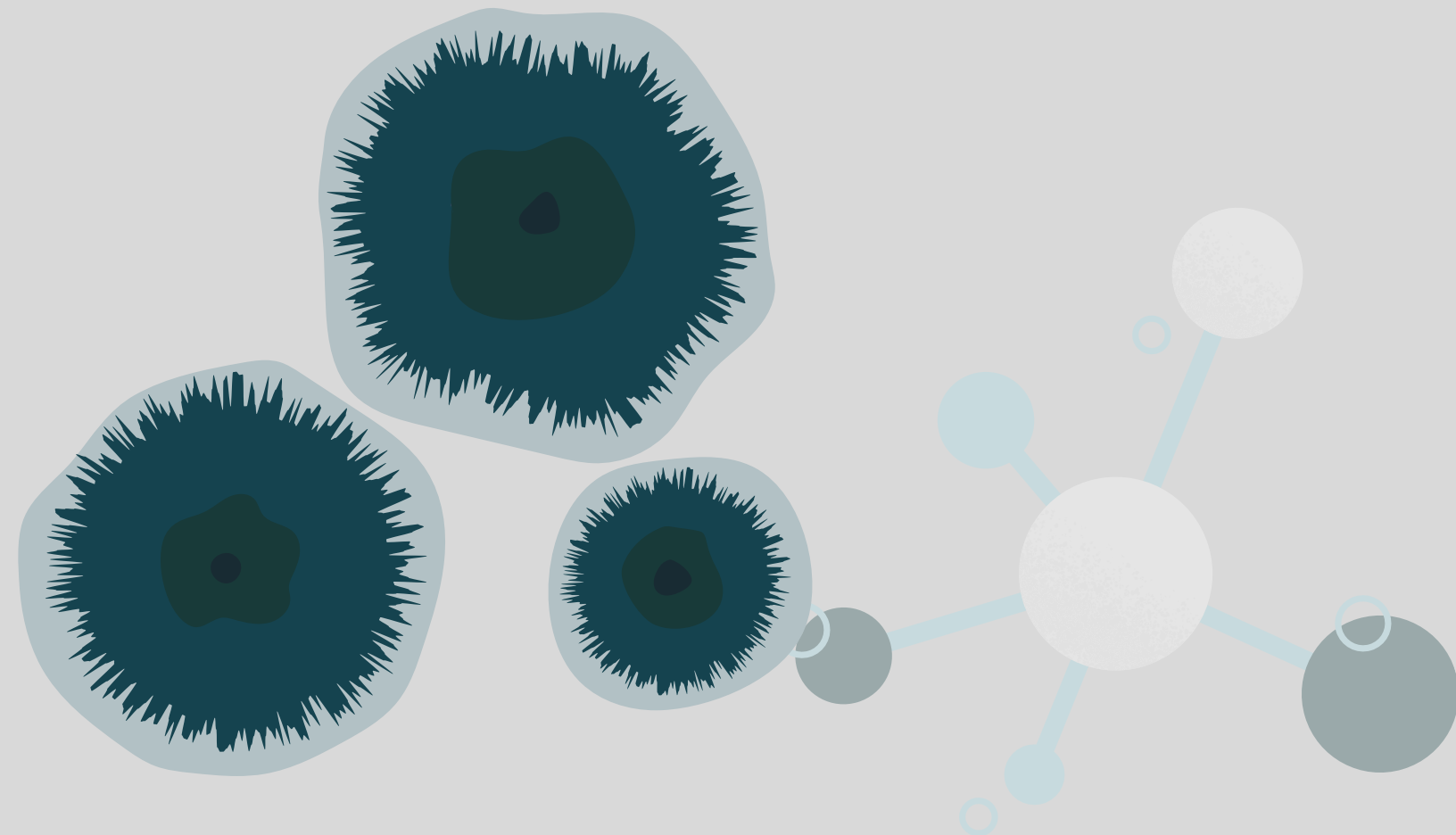
ORGANIC

is the food organic or a new brand you have switch to



Always consider WDB

Even if food seems to be the reason or a part of the picture, if mycotoxins are present in a severe clinical presentation, do not rule out WDB. These often occur together and progress can be limited by only changing the diet.





Home Testing Options

- Air testing- good go to as it is inexpensive, but may miss mold contamination
- Dust Collection- mold expensive initially but usually catches mold the first time
- Visual Inspection- usually best to have positive dust/air test before hiring someone to come in unless it is visible to the naked eye.



Mitochondrial Support

Mitochondrial health relies on key nutrients which support energy production, protect against oxidative stress, and facilitate enzymatic reactions. Deficiencies in these nutrients can impair mitochondrial function, leading to reduced ATP production and increased cellular damage.

1

B VITAMINS

Krebs cycle, glycolytic, amino acid and fatty acid oxidation rely on these

2

COQ10

ETC is reliant on CoQ10. Transfers electrons between complexes I-III to create proton gradient for ATP synthesis in Complex IV

3

MAGNESIUM

Involved in Krebs cycle and electron transport chain. Regulates calcium levels preventing excessive calcium accumulation that can lead to mitochondrial dysfunction.

4

L-CARNITINE

Transporter of fatty acids and amino acids into mitochondria for usage

5

ANTIOXIDANTS

protect the mitochondria from oxidative stress caused by ROS, byproducts of energy production in the electron transport chain. function and energy production.

Routes of Excretion

Kidneys

Conjugated toxins are excreted via kidneys into the urine

Stool

Toxin packaged in bile is excreted via the stool

Skin

heat and sweating increase toxin release via the skin



Binders for Stool Excretion

Enterohepatic circulation is the process by which bile acids, along with other substances like drugs and toxins, are secreted by the liver into the bile, stored in the gallbladder, and then released into the small intestine to aid in digestion. After their role in digestion, these substances are reabsorbed into the bloodstream from the intestine and returned to the liver, where they can be reused, creating a recycling loop.

Strong Binders

PRESCRIPTIONS

Wechol and cholestyramine

NON-RX

Charcoal, zeolite, bentonite clay

Weaker Binders

NATURAL PRODUCTS

humic and fulvic acid,
glucomannan, modified citrus
pectin, peach stone, micro
chitosan

DIETARY FIBER

fiber supplements, okra,
turnips, green beans, carrots,
and cauliflower

***non-discriminating

Urinary Excretion

Urine excretion is a primary pathway for the body to eliminate water-soluble toxins, including metabolic waste products, environmental chemicals, and certain medications. The kidneys filter toxins from the bloodstream, which are then diluted in urine and excreted, helping to maintain the body's internal balance and detoxification processes.

- GSH (Glutathione): A powerful antioxidant that helps neutralize mycotoxins and supports liver detoxification.
- NAC (N-Acetyl Cysteine): A precursor to glutathione, NAC aids in detoxifying mycotoxins by boosting antioxidant levels and protecting cells.
- Hydration: Ensures efficient toxin elimination through urine by promoting kidney function and maintaining optimal cellular detox.
- Sulforaphane: A compound found in cruciferous vegetables that enhances detoxification enzymes and protects against oxidative damage from mycotoxins.
- Resveratrol: A potent antioxidant that helps reduce inflammation and supports mitochondrial health during mycotoxin detox.
- ALA (Alpha-Lipoic Acid): An antioxidant that assists in detoxifying mycotoxins by regenerating other antioxidants and promoting liver function.



Lifestyle Detox Support

BLOOD FLOW/HEAT

sauna and exercise increases blood flow and release of toxins into the blood stream for excretion

DIET

Low carb diet, fasting, and ketogenic diet can increase fat burn and release of toxin from fat cells

DRY BRUSHING

stimulates lymphatic drainage, which helps remove toxins from the body by promoting circulation and the natural detoxification process

Summary

- Mycotoxins and Their Sources
 - Mycotoxins are toxic compounds produced by certain molds.
 - Mycotoxins contaminate food crops like grains, nuts, fruits, and sometimes occur in water-damaged buildings.
- Mitochondrial Function and Its Importance
 - Mitochondria generate energy (ATP) through cellular respiration.
 - Essential for maintaining muscle function, brain activity, immune response, and overall metabolic health.
- The Connection Between Mycotoxins and Mitochondrial Dysfunction
 - Mycotoxins disrupt mitochondrial function by increasing oxidative stress and damaging mitochondrial DNA.
 - Mycotoxins can lead to chronic fatigue, neurodegenerative issues, and metabolic disorders due to mitochondrial damage.
- Symptoms and Health Impacts of Mitochondrial Dysfunction
 - Chronic fatigue and muscle weakness
 - Hormonal imbalances, leading to thyroid dysfunction, adrenal fatigue, and reproductive issues.
 - Long-term impacts include neurodegenerative diseases, heart problems, and metabolic conditions like diabetes.
- Diagnostic Methods for Mycotoxin Exposure and Mitochondrial Dysfunction
 - Urine mycotoxin tests to detect exposure.
 - Environmental testing of air and surfaces for mold contamination.
 - Organic Acid tests for lactate and pyruvate levels, mitochondrial function, vitamin levels
- Strategies for Mitigating Mycotoxin Exposure and Supporting Mitochondrial Health
 - Avoid mold exposure by improving air quality, using dehumidifiers, and remediating mold in homes or workplaces.
 - Follow a clean diet, avoiding moldy or contaminated foods (like spoiled grains and nuts).
 - - Support mitochondrial health with nutrients like CoQ10, magnesium, B vitamins, and antioxidants to protect against oxidative stress.
 - Use detoxification strategies, such as consuming binders (e.g., activated charcoal) and increasing liver function support to eliminate mycotoxins.

Questions?



1. Yeasts are microscopic fungi consisting of oval cells, which reproduce asexually by budding or fission. [National Center for Biotechnology Information (NCBI)]
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3. Mycotoxins like aflatoxin disrupt mitochondrial functions, leading to oxidative stress and energy metabolism interference. [PMC]
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8. Overview of mitochondrial dysfunction due to AFB1 toxicity, highlighting oxidative stress and apoptosis pathways. [ScienceDirect]
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9. AFB1 toxicity in mitochondria, leading to oxidative stress and cell death. [ScienceDirect]
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11. Mitochondrial dysfunction linked to chronic exposure to mycotoxins, causing oxidative stress and apoptosis. [ScienceDirect]
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