Glutathione: Functions and Importance in the Body

1. Antioxidant Defense

- Glutathione is a **primary intracellular antioxidant** that neutralizes free radicals and **reactive oxygen species (ROS)**, protecting cells from oxidative stress (Pizzorno, 2014).
- It works synergistically with other antioxidants like **vitamin C, vitamin E, and CoQ10** by regenerating their reduced (active) forms (Forman et al., 2009).

2. Detoxification & Liver Function

- Heavily concentrated in the liver, glutathione binds to and helps eliminate **toxins, heavy metals (mercury, lead, cadmium), and environmental pollutants** (Wu et al., 2004).
- It is required for **phase II liver detoxification**, particularly in **glucuronidation and conjugation reactions**, which make toxins water-soluble for excretion (Lu, 2013).
- Supports the metabolism of **alcohol and drugs**, reducing toxic byproducts (García-Ruiz et al., 2013).

3. Immune System Regulation

- Essential for the **activation and proliferation of immune cells** like T cells and macrophages (Dröge & Breitkreutz, 2000).
- Supports **natural killer (NK) cells**, helping the body fight infections, viruses, and even cancer (Hagen et al., 1990).
- Regulates inflammation, preventing excessive immune activation or autoimmunity (Morris et al., 2013).

4. Mitochondrial Protection & Energy Production

- Protects **mitochondria** from oxidative damage, ensuring efficient ATP production (Pizzorno, 2014).
- Deficiency in glutathione can lead to mitochondrial dysfunction, a key factor in neurodegenerative diseases, chronic fatigue, and aging (Kidd, 2005).

5. Brain Health & Neuroprotection

- Acts as a key antioxidant in the brain, protecting neurons from oxidative damage and excitotoxicity (excess glutamate activity) (Ballatori et al., 2009).
- Plays a role in preventing **neurodegenerative diseases** like Parkinson's, Alzheimer's, and multiple sclerosis (Sian et al., 1994).

- Supports neurotransmitter balance by aiding in the metabolism of **dopamine and serotonin** (Bains & Shaw, 1997).

6. Cardiovascular Protection

- Reduces **oxidized LDL (bad cholesterol)**, lowering the risk of **atherosclerosis** (Ghezzi, 2011).
- Improves **endothelial function** by reducing oxidative stress in blood vessels (Ashfaq et al., 2006).
- Helps regulate **blood pressure and inflammatory markers** associated with cardiovascular disease (Martínez-Ruiz et al., 2011).

7. Supports DNA Repair & Cellular Function

- Maintains **genomic stability** by reducing DNA damage caused by oxidative stress (Franco et al., 2007).
- Essential for **proper cell cycle regulation, apoptosis (programmed cell death), and cancer prevention** (Traverso et al., 2013).
- Inhibits chronic inflammation, a major driver of **cellular aging and degenerative diseases** (Ballatori et al., 2009).

8. Helps with Heavy Metal Chelation

- Binds to **mercury, arsenic, and lead**, facilitating their safe removal from the body (James et al., 2005).
- Works in synergy with sulfur-based detox compounds like **N-acetylcysteine (NAC), alpha-lipoic acid (ALA), and MSM (methylsulfonylmethane)** (Aposhian et al., 2004).

9. Skin Health & Anti-Aging

- Glutathione helps **reduce melanin production**, which is why it's used in some skin-lightening treatments (Handog et al., 2016).
- Protects against **UV-induced damage and photoaging** (Duarte et al., 2009).
- Slows down **collagen breakdown**, keeping the skin firm and youthful (Sugita et al., 2018).

10. Gut & Digestive Support

- Reduces **intestinal inflammation** and supports gut barrier integrity, preventing leaky gut (Zhong et al., 2017).
- Helps maintain a **healthy microbiome** by reducing oxidative stress in the gut environment (Jones et al., 2012).
- Plays a role in reducing **H. pylori overgrowth and other gut infections** (Wang et al., 2019).

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