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Review

T Cell Activation by Natural Mechanisms

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Abstract

T cell activation is a crucial step in the adaptive immune response, whereby T cells, a type of white blood cell, become stimulated to perform their functions effectively. T cells are activated when their T Cell Receptor (TCR) binds to a specific antigen presented by Antigen-Presenting Cells (APCs) such as dendritic cells. This interaction triggers a series of signaling events that lead to the activation and proliferation of the T cell. During T cell activation, co-stimulatory molecules and cytokines help regulate the process to ensure appropriate immune responses. Once activated, T cells can differentiate into specific subsets such as helper T cells that assist other immune cells, cytotoxic T cells that kill infected or abnormal cells, and regulatory T cells that help maintain immune tolerance. Overall, T cell activation is critical for the immune system to mount effective responses against pathogens, tumors, and other threats while maintaining tolerance to self-antigens. Recently, Electrocide, a nature-based dietary supplement has been shown to have significant antipathogenic properties against viruses, bacteria, and protozoa in laboratory studies. Furthermore, in 2 recent published pre-clinical studies (n=91) there were significant symptom recoveries compared to paired control measurements. Generally, changes in symptoms occurred rapidly indicating stimulation of T-Cell activation. It is postulated that this T-Cell activation mechanism may become an important therapeutic nutritional support pathway which is discussed in detail in this Review Article.

Keywords: Electrocide, Pathogen, T-cell activation, Acute inflammation, Therapeutics, Fibrosis, Stem cells, Exosomes, Medicinal stem cells, Immunotherapy, Cell treatments, and Chemotherapeutics

Acronyms: AICD- Activation Induced Cell Death; ALPS- Autoimmune Lympho-Proliferative Syndromes; APC- Antigen-Presenting Cells; ASCs- Adult Stem Cells; DCs- Dendritic Cells; ECM- Extra Cellular Matrix; ESCs- Embryonic Stem Cells; FSCs- Fetal Stem Cells; iPSCs- Induced Pluripotent Stem Cells; MSC- Medicinal Stem Cells; TME- Tumor Microenvironment

What is T Cell Activation?

By encountering an antigen, T cells become activated, leading to a series of quantitative and qualitative signals being received by receptors at the cell surface and successfully integrated with numerous intracellular signaling cascades that eventually dictate an appropriate immune response [1]. T cell activation is a process in which mature T cells, which express antigen-specific T cell receptors on their surfaces, recognize their cognate antigens and respond by entering into the cell cycle, secreting cytokines (lytic) enzymes, and initiating the cell-based immunity functions of the immune system including activating Helper T cells which are essential in adaptive immunity, as they are required for almost all adaptive immune responses. They not only help activate B cells to secrete antibodies and macrophages to destroy pathogens, but they also help activate cytotoxic T cells to kill infected target cells. Once activated, diverse inhibitory mechanisms are triggered to tune the T cells down over time. *Pentcheva-Hoang et al.*, [2] reported that these essential yet complex regulatory mechanisms prevent autoimmune reactivity and exacerbated immune responses that could be detrimental and permit tissue repair.

T-cell activation is a process that theoretically has been shown to begin within 1 hour after the use of Electrocide and has been observed through changes in neutrophil measurements, blood oxygen levels, and changes in characteristic symptoms as seen in recent Electrocide pre-clinical studies [3]-recognition of conversion from

chronic to acute inflammation. Inflammation is part of the body's defense mechanism. It is the process by which the immune system recognizes and removes harmful and foreign stimuli and begins the healing process. Inflammation can either be acute or chronic. Acute inflammation fibrosis processes are engaged cellularly with lymphatic, neural, and circulatory responses. Most of the features of acute inflammation continue as the inflammation becomes chronic, including the expansion of blood vessels (vasodilation), increase in blood flow, capillary permeability, and migration of neutrophils into the infected tissue through the capillary wall (diapedesis). However, the composition of the white blood cells changes soon, and the macrophages and lymphocytes begin to replace short-lived neutrophils. Thus, the hallmarks of chronic inflammation are the infiltration of the primary inflammatory cells, such as macrophages, lymphocytes, and plasma cells in the tissue site, producing inflammatory cytokines, growth factors, and enzymes and hence contributing to the progression of tissue damage and secondary repair including fibrosis and granuloma formation. When one consumes the Electrocide product, there is an immediate increase in the oxygen level, followed by unhealthy cell and pathogen destruction. The destroyed products activate T cell within one hour, initiating antigen and antibody response immediately. It has been shown that acute inflammation fibrosis processes are engaged cellularly verse selection *Kisielow et al*., 1988. Peripheral with lymphatic, neural, and circulatory responses, leading to healing, happiness, and hope engagement for 20 hours or longer after Electrocide consumption.

How T Cells are Activated

Mechanisms of Immune T Cell Tolerance

Maintaining immune homeostasis depends on the immune tolerance towards self-tissues. This complex process is necessary to avoid autoimmunity [4]. For T cells, central and peripheral tolerance is required. Central tolerance occurs during thymic maturation, leading to the deletion of autocorrective thymocytes by adverse selection *Kisielow et al*., 1988. Peripheral tolerance includes several mechanisms acting on the mature T cell in the peripheral tissues or circulation [5] and includes mechanisms such as the immunosuppressive activity of the regulatory T cells [6] if the antigen is presented by cells that are not professional Antigen-Presenting Cells (APC) or by immature APC, they do not provide a co-stimulation signals and induce T cell anergy (*Matzinger, et al*., 1994, 7,8], and when the regulated termination of T cell immune responses [9] which is dependent of various complex mechanisms. T cell activation leads to the induction of the expression of negative regulators of its activation, also called immune checkpoints. The termination of the immune responses is mediated by Activation-Induced Cell Death (AICD) of T cells. The primary regulator of AICD is the Fas/Fas Ligand (FasL) system [*Dhein, et al*., 1995,10], and mutations in Fas or FasL lead to the Autoimmune Lympho Proliferative Syndromes (ALPS) as reported by *Rieux-Laucat, et al*., [11].

Fibroblasts

Neutrophils are the primary mediators of the rapid innate host defense against most bacterial and fungal pathogens that occur before the complex humoral and lymphocyte cellular processes of acquired immunity can be brought to bear on an infection. Electrocide use immediately stimulates the neutrophil process and fibroblast production. Fibroblasts are critical in supporting routine wound healing. They are involved in crucial processes such as breaking down the fibrin clot and creating new Extracellular Matrix (ECM) and collagen structures to support the other cells associated with effective wound healing and contracting the wound [12]. Skin-derived fibroblasts are commonly used to produce Induced Pluripotent Stem Cells (iPSCs). iPSCs are a groundbreaking discovery in stem cell research [13]. iPSCs represent an essential platform in cell culture studies because they can propagate indefinitely and give rise to any cell type in the body (*Li, et al*., 2021). According to *Lawrence, et al.*, [14], iPSCs are generated by reprogramming adult cells, such as skin or blood cells, back into a pluripotent state, similar to embryonic stem cells [15]. Fibroblasts are known for their plasticity. The adipocytes, pericytes, endothelial and epithelial cells, or terminally differentiated cells can differentiate into fibroblasts. Stimulation of fibroblasts further increases susceptibility to epigenetic modifications [16]. Critical functions for fibroblasts and their mesenchymal lineages include ECM secretion and remodeling, secretion of signaling factors for surrounding cells, mechanical force generation, and regulation of tissue metabolism and metabolite secretion. Fibroblasts also function as progenitor cells for mesenchymal lineages, as "makers" of new tissue during organ morphogenesis, tissue repair, and upon various pathological conditions, as sources of positional information across distinct anatomical regions of the same organ, and as crucial signal contributors towards stem cell niches, as well as target cells and reciprocal modulators of diverse innate and adaptive immune functions.

Hypochlorous Pathway

Hypochlorous acid, generated through the hypochlorous pathway primarily by neutrophils are part of the innate immune response, and T cell activation, are the key process in adaptive immunity mediated by T lymphocytes. While these pathways typically operate independently, under certain conditions, interactions between hypochlorous acid and T cell activation may occur. Hypochlorous acid stimulation which is triggered by the Electrocide pathogen intersection potentially interacts with T cell activation by: Modulation of Antigen, changing the cytokine mileu, Influencing T Cell Signaling, Indirect micro-effects on T Cell Activity, and Potential for pathogencidal Immunomodulation.Modulation of Antigen Presentation caused by Electrocide or other degradation of pathogen(s) which stimulates Hypochlorous acid can potentially impact the antigen-presenting capacity of APCs (Antigen-Presenting Cells), such as dendritic cells and macrophages. By altering the processing or presentation of antigens, hypochlorous acid could influence the activation of T cells by APCs. This modulation could lead to changes in the quality or magnitude of T cell responses [17].

Hypochlorous acid may affect the cytokine milieu in the local microenvironment. Cytokines play crucial roles in T cell activation, differentiation, and function. Changes in cytokine profiles due to hypochlorous stimulation could influence the polarization of T cell

subsets, thereby impacting immune responses. It is possible that hypochlorous acid may directly or indirectly affect signaling pathways involved in T cell activation. Alterations in signaling molecules or pathways crucial for T cell activation and function could result in modifications to the T cell response. The consequences of the antimicrobial actions of hypochlorous acid may indirectly impact T cell activation. For example, by controlling pathogen load or altering the inflammatory milieu, hypochlorous acid could indirectly influence the overall immune response and subsequent T cell activation. Hypochlorous acid, through its antimicrobial properties and impact on immune cell function, could potentially exert immunomodulatory effects that indirectly shape T cell responses. This modulation could occur at different stages of the immune response influencing the balance between tolerance and immune activation. Overall, while the primary roles of hypochlorous acid and T cell activation are distinct, there is potential for cross-talk and interaction between these pathways within the complex network of immune responses. Further research is needed to fully elucidate the specific mechanisms and outcomes of any interactions between hypochlorous stimulation and T cell activation, as these interactions could have implications for immune regulation, host defense, and inflammatory responses.

Stem Cells

Stem cells are cells that self-renew and can differentiate into various types of cells [18]. These cells can come from many different tissues. Still, the most common include bone marrow, umbilical cord, and adipose tissue since they are easily accessible and have little to no immune rejection [19]. One of the most common types of stem cells used in therapies includes Medicinal Stem Cells (MSC), which have immunomodulatory properties and can treat various illnesses or injuries [20]. However, adverse effects after stem cell therapy have been noted to include skin conditions, gastrointestinal effects, fatigue, nausea, vomiting, and chills, to name a few [18].

According to *Becker, et al*., (1963) stem cells are primal cells common to all multicellular organisms, can renew themselves through cell divisions, and can differentiate into a wide range of specialized cell types. The mammalian stem cells are categorized into five categories. Embryonic cell lines are derived from the epiblast tissue of the blastocyst structure, which is aligned with the inner wall of the blastocyst [*Song, et al*., 2002, 21, 22]. Fetal Stem Cells (FSCs) are cell lines that are derived from fetal tissues, which can divide, proliferate, and differentiate into specialized cells that can be isolated from fetal hematopoietic stem cells, fetal mesenchymal stem cells, and neural crest stem cells (*O'Donoghue & Fisk, et al*., 2004). Infant (perinatal) stem cells can be derived from perinatal tissues, including placenta membranes, amniotic fluid, and umbilical cords [23]. These tissues consist of numerous types of stem cells that possess the characteristics of both Embryonic Stem Cells (ESCs) and Adult Stem Cells (ASCs) [23]. ASCs or somatic stem cells are undifferentiated cells found in post-natal adult tissues, which could be unipotent or multipotent [24,25]. However, sometimes ASCs are known as progenitor cells due to their low capability of cellular differentiation [24-26]. Induced Pluripotent Stem Cells (iPSCs) are generated from somatic stem cells reprogrammed into an ESC-like state. iPSCs have the properties of ESCs and can differentiate into the three primary germ layers. These cells have several advantages as they are derived from the patient's somatic cells, leading to lower rejection risks [27].

Additional Benefits Associated with T Cell Activation

Exosomes

Exosomes are tiny messengers essential in passing vital information between cells. Exosomes transport key nutrients and immune factors, helping build stem cell production and supporting tissue healing by transferring growth-promoting genetic materials. Exosomes are essential in restoring health. Exosome treatment offers the latest skin rejuvenation technology, tapping into biotechnological advances to promote healthy regeneration. Exosomes are applicable in anti-aging treatments as an excellent option for turning back the clock on the skin. Our cells have difficulty producing the proteins and enzymes needed to help keep our skin healthy, supple, and balanced when we age. Exosome therapy stimulates new protein generation within our skin, restoring balance and giving a youthful appearance. Exosomes reduce inflammation and help revive dull-looking skin by allowing it to stay hydrated, thus preserving the beautiful hue, texture, and luminosity that makes all skin ages look its best. Exosome treatments are fast-acting, safe, and non-invasive–making them an ideal option for those seeking instant rejuvenation without downtime [28].

How Do Exosomes Work?

Exosomes help bridge the communication gap between cells. The tiny vesicles transfer their contents from one cell to another, carrying instructions and supplies that allow recipient cells to change biology or behavior once they get inside. Through efficient uptake mechanisms like endocytosis and membrane fusion, exosome contents influence cellular decisions at an unseen level. They are like tiny couriers transporting vital molecules and genetic material throughout the body. From proteins to enzymes, microRNAs, and more – these microscopic particles play an essential role in regulating gene expression and how cells interact with their environment. They are packed with beneficial proteins and other molecules that can help skin and hair rejuvenation, such as collagen, elastin, and hyaluronic acid, formed when specific cells undergo endocytosis. Exosomes contain extracellular Messenger RNAs (mRNA). These mRNAs can transport genetic information from cell to cell by delivering packet instructions for making specific proteins that help fight off aging skin or hair loss. Exosomes have powerful anti-inflammatory properties that can shield the skin against factors that accelerate aging, like UV light and environmental pollutants. Thus, when exosome treatments are applied externally, they protect while simultaneously boosting the production of new cells internally. The result is improved overall complexion, hair revitalization, and increased skin or scalp health vitality, which is why exosome therapy is quickly becoming one of the leading treatments for beauty enhancement [4].

Exosomes in Immune Cells

According to *Gutiérrez-Vázquez et al*., [29], Exosomes are secreted through an extracellular membrane vesicle, with a particular lipid and protein composition, with size variation of between 30 and 120 nm. The Exosomes are stored in cytoplasmic multivesicular bodies as an intraluminal vesicle before secretion. Different cell types can secrete exosomes and have been described in other types of tumor cells where it has been proposed to play a key role in tumorigenesis and metastasis [30,31] as far as exosomes produced by activated T cells, proteomic and immunoblot studies [32, *Pérez-Hernández, et al*., 2013] have indicated the expression of proteins present in most exosomes. Using Electrocide eliminates side effects associated with exosomes, including decreased swellings, reduced inflammation, and minimal pain associated with injection while preventing infection that may arise due to the inflammation process. It is also postulated that Electrocide stimulates the production of stem cells by activating T cells.

Application of Exosomes in Cancer Immunotherapy

Yang et al., [33] reported that Cancer immunotherapy has gained more comprehensive application for its ability to stimulate the immune system to target tumors, unlike conventional treatments that affect both cancerous and healthy cells. Immunotherapy's success highlights the immune system's crucial role in eliminating malignant cells [34]. Precisely, tumor growth is controlled by innate and adaptive immune cells [35]. According to *Yan & Jiang, et al*., (2020) the innate immune cells destroy tumor cells to prompt the release of tumor-specific antigens, which are captured by APCs, such as Dendritic Cells (DCs), and presented to T cells to prime the adaptive immune response. The antigen-specific T cells evoke a specific immune response against cancer cells [36]. Cancer immunotherapies that harness the power of this immune system can specifically kill cancer cells with minimal influence on normal cells and trigger long-term memory that prevents tumor recurrence. Thus, developing methods to direct or harness the immune response can enhance the success of cancer immunotherapy. The immunotherapy field is exploring low-toxicity pathways and novel and biostable immunomodulators. Exosomes have been indicated to be able to modulate the antitumor immune response and, thus, an applicable avenue for cancer immunotherapy [37]. Exosomes can quickly help overcome challenges associated with cell therapy since they can readily infiltrate the extracellular matrix of tumor tissue, unaffected by the Tumor Microenvironment (TME), thereby overcoming the challenges of cell therapy [38]. Preconditioning of parental cells with cytokines that augment immune cell function enhances the secretion or antitumor efficacy of their exosomes [39], showing that exosomes can trigger higher levels of the immune response against cancer through various manipulations, thus paving the way for novel directions in cancer immunotherapy.

Electrocide™ and How It Works

"ELECTROCIDE™" is a novel nature-based dietary supplement that has been previously administered over 100,000 times without any adverse effects. It has been tested for efficacy of anti-pathogenesis with the combination of trace minerals [*Farooq & Dietz, et al*., 2015, 40, 41], activation complex [42], which allows for an increased solubility across cell membranes [42]. Scanning and transmitting electron microscopic images show that the pathogens are degraded from the electrical interface of negatively charged pathogens in response to the positively charged active minerals from the surfaces disintegrating the negatively charged pathogens. The inactive disintegrating pathogens could be associated with immune improvement [3]. An oxygen-rich environment is created through the Treated Energy Water in the Electrocide (liquid and capsules), which significantly increases and maintains higher dissolved oxygen content. This higher oxygen concentration increases oxidation/reduction cellular function (mitochondrial), creating energy elevation, increasing circulation and other organelle function protein metabolism, including hormone production, and other beneficial cellular actions, including mitochondrial and gut-brain activation [43].

Previous studies indicated "ELECTROCIDE™" supported claims related to improved general wellness, including fatigue, energy, diarrhea, and faster recovery towards COVID-19 [44,45]. Studies have also shown that cancer cells with a negative charge on the exterior surface [46, *Szasz, et al*., 2013] and internally may allow "ELECTROCIDE™" to destroy negatively charged cancer cells effectively and stimulates natural immune response to the neoplasm.

Additionally, it has been postulated that using an enhanced delivery system for chemotherapeutics may provide greater effectiveness to be achieved with chemotherapy without the high number of side effects due to the lower quantity of the products used while improving the resulting efficiency at the same time. Recent studies in immunotherapy have shown that many patients have a chronic level of inflammation when being treated can be made more efficient when moving the body toward an acute inflammatory metabolism, which may allow for synergistic effects from the immune support treatment, cell treatments, and chemotherapeutics, furthermore, if radiation is being used the combined healing effects from the immunotherapy treatments may not only further enhance the recovery from the radiation but also aide in additional healthy cell regeneration in the patient.

Conclusion

ELECTROCIDE™ has been shown to improve general wellness, including but not limited to nausea, fatigue, chills, diarrhea, and faster recovery to health. Recent studies in immunotherapy have shown that many patients have a chronic level of inflammation when being treated can be made more immune-efficient when moving the body toward an acute inflammatory metabolism for synergistic effects from the immune support treatment, cell treatments (if any) and chemotherapeutics, furthermore if radiation is being used the combined healing effects from ELECTROCIDE™ may not only further enhance the recovery from the radiation but may aide in additional healthy cell regeneration in the patient. Use of ELECTROCIDE™ eliminates side effects as associated with exosomes including decrease in swellings, reduction in inflammation, mini-

mum pain associated with injection while prevents infection that may arise due to the inflammation process. It is also postulated that ELECTROCIDE™ stimulates normal production of stem cells by activation of T cells.

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Conflict of Interest

None.

References

1. Smith Garvin JE, Koretzky GA, Jordan MS (2009) T Cell Activation. Annu Rev Immunol 27: 591-619.
2. Pentcheva Hoang T, Corse E, Allison JP (2009) Negative Regulators of T-Cell Activation: Potential Targets for Therapeutic Intervention in Cancer, Autoimmune Disease, and Persistent Infections. Immunol Rev 229(1): 67-87.
3. Sonnenschein L, Etyang T, Shah R, Frischer R, Rein G (2021) The Effect of An Aqueous Electricidal Solution on General Well Being. Am J Biomed Sci & Res 13(4).
4. Anel A, Gallego Lleyda A, de Miguel D, Naval J and Martínez Lostao L (2019) Role of Exosomes in the Regulation of T-cell Mediated Immune Responses and in Autoimmune Disease. Cells 8(2): 154.
5. Lenardo M, Chan FKM, Hornung F, MacFarland H, Siegel R, et al. (1999) Mature T lymphocyte apoptosis—Immune regulation in a dynamic and unpredictable antigenic enviroment. Annu Rev Immunol 17: 221-253.
6. Sakaguchi S, Yamaguchi T, Nomura T, Ono M (2008) Regulatory T Cells and Immune Tolerance. Cell 133(5): 775-787.
7. Schwartz RH (1990) A cell culture model for T lymphocyte clonal anergy. Science 248(4961): 1349-1356.
8. Steinman RM, Turley S, Mellman I, Inaba K (2000) The induction of tolerance by dendritic cells that have captured apoptotic cells. J Exp Med 191(3): 411-416.
9. Van Parijs L, Abbas AK (1998) Homeostasis and self-tolerance in the immune system: Turning lymphocytes off. Science 280(5361): 243-248.
10. Vignaux F, Golstein P (1994) Fas-based lymphocyte-mediated cytotoxicity against syngeneic activated lymphocytes: A regulatory pathway? Eur J Immunol 24(4): 923-927.
11. Rieux Laucat F, Le Deist F, Fischer A (2003) Autoimmune lymphoproliferative syndromes: Genetic defects of apoptosis pathways. Cell Death Differ 10(1): 124-133.
12. Plikus MV, Wang X, Sinha S, Forte E, Thompson SM, et al. (2021) Fibroblasts: Origins, definitions, and functions in health and disease. Cell 184(15): 3852-3872.
13. Rowe RG, Daley GQ (2019) Induced pluripotent stem cells in disease modelling and drug discovery. Nat Rev Genet 20(7): 377-388.
14. Lawrence M, Evans A, Moreau T, Bagnati M, Smart M, et al. (2021) Process analysis of pluripotent stem cell differentiation to megakaryocytes to make platelets applying European GMP. NPJ Regen Med 6(1): 27.
15. Chehelgerdi M, Behdarvand Dehkordi F, Chehelgerdi M, Kabiri H, Salehian Dehkordi H, et al. (2023) Exploring the promising potential of induced pluripotent stem cells in cancer research and therapy. Mol Cancer 22(1): 189.
16. Henning AN, Roychoudhuri R, Restifo NP (2018) Epigenetic control of CD8+ T cell differentiation. Nat Rev Immunol 18(5): 340-356.
17. Meng M, Tan J, Chen W, Du Q, Xie B, et al. (2019) The Fibrosis and Immunological Features of Hypochlorous Acid Induced Mouse Model of Systemic Sclerosis. Front Immunol 10: 1861.
18. Biehl Jesse K, Brenda Russell (2009) Introduction to stem cell therapy. The Journal of cardiovascular nursing 24(2): 98-103.
19. Nava, Michele M, Riccardo Pietrabissa (2012) Controlling self-renewal and differentiation of stem cells via mechanical cues. Journal of biomedicine & biotechnology 2012: 797410.
20. Zakrzewski Wojciech, Maciej Dobrzyński, Maria Szymonowicz, Zbigniew Rybak, et al. (2019) Stem cells: past, present, and future. Stem cell research & therapy 10(1): 68.
21. Gardner R (2002) Stem cells: potency, plasticity and public perception. Journal of anatomy 200(3): 277-282.
22. Takahashi K, Yamanaka S (2006) Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures by defined factors. cell 126(4): 663-676.
23. Abbaspanah B, Momeni M, Ebrahimi M, Mousavi SH (2018) Advances in perinatal stem cells research: a precious cell source for clinical applications. Regenerative medicine 13(5): 595-610.
24. Phinney DG, Prockop DJ (2007) Concise review: mesenchymal stem/multipotent stromal cells:the state of transdifferentiation and modes of tissue repair—current views. Stem cells 25(11): 2896-2902.
25. Rumman M, Dhawan J, Kassem M (2015) Concise review:quiescence in adult stem cells:biological significance and relevance to tissue regeneration. Stem cells 33(10): 2903-2912.
26. Lindvall O (2003) Stem cells for cell therapy in Parkinson's disease. Pharmacological research 47(4): 279-287.
27. Barzegar M, Kaur G, Gavins FNE, Wang Y, Boyer CJ, et al. (2019) Potential therapeutic roles of stem cells in ischemia-reperfusion injury. Stem Cell Research 37: 101421.
28. *https://glowmedspaencino.com/what-are-exosomes-and-how-do-they-work/ accessed February 16, 2024.*
29. Gutiérrez Vázquez C, Villarroya Beltri C, Mittelbrunn M, Sánchez Madrid F (2013) Transfer of extracellular vesicles during immune cell-cell interactions. Immunol Rev 251(1): 125-142.
30. Melo S, Luecke L, Kahlert C, Fernandez A, Gammon S, et al. (2015) Glypican-1 identifies cancer exosomes and detects early pancreatic cancer. Nature 523(7559): 177-182.
31. Peinado H, Alečković M, Lavotshkin S, Matei I, Costa Silva B, et al. (2012) Melanoma exosomes educate bone marrow progenitor cells toward a pro-metastatic phenotype through MET. Nat Med 18(6): 883-891.
32. Bosque A, Dietz L, Gallego Lleyda A, Sanclemente M, Iturralde M, et al. (2016) Comparative proteomics of exosomes secreted by tumoral Jurkat T cells and normal human T cell blasts unravels a potential tumorigenic role for valosin-containing protein. Oncotarget 7(20): 29287-29305.
33. Yang, Z, Ma, Y, Zhao H, Yuan Y, Kim BYS (2020) Nanotechnology platforms for cancer immunotherapy. Wiley Interdiscip Rev Nanomed Nanobiotechnol 12(2): e1590.
34. Yang YP (2015) Cancer immunotherapy: harnessing the immune system to battle cancer. J Clin Investig 125(9): 3335-3337.
35. Dunkelberger JR, Song WC (2010) Complement and its role in innate and adaptive immune responses. Cell Res 20(1): 34-50.
36. Zhang H, Simiao Wang, Man Sun, Yaxin Cui, Jianming Xing, et al. (2023) Exosomes as smart drug delivery vehicles for cancer immunotherapy. Front Immunol 13: 1093607.
37. Xu Z, Zeng S, Gong Z, Yan Y (2020) Exosome-based immunotherapy: a promising approach for cancer treatment. Mol Cancer 19(1): 160.

38. Choi SJ, Cho H, Yea K, Baek MC (2022) Immune cell-derived small extracellular vesicles in cancer treatment. BMB Rep 55(1): 48-56.

39. Yang PX, Yong Peng, Yuan Feng, Zhuoying Xu, Panfeng Feng, et al. (2021) Immune Cell-Derived Extracellular Vesicles - New Strategies in Cancer Immunotherapy. Front Immunol 12: 771551.

40. Rowlands DS, Shultz SP, Ogawa T, Aoi W, Korte M (2014) The effects of uniquely-processed titanium on biological systems: implications for human health and performance. Journal of functional biomaterials 5(1): 1-14.

41. Saper RB, Rash R (2009) Zinc: an essential micronutrient. American family physician 79(9): 768-772.

42. Sonnenschein L (2013) Understanding Cellular Metabolism: Nutrition, health, and beauty. Charleston: Create Space Independent Publishing Platform.

43. Sonnenschein L, Etyang T, Manga S, Wong E (2023) An Initial Evaluation of the Effectiveness of a Dietary Supplement Regimen on the Effects of Post-COVID Infection. Am J Biomed Sci & Res 18(6).

44. Sonnenschein L, Weinberg R, Cotter HT, Salvo LA, Etyang T, et al. (2020) Historical and Current Conditions Including COVID-19 Requiring Anti-Pathogenic Surveillance and Proper Immunogenic Support. Am J Biomed Sci & Res 8(4).

45. Sonnenschein L, Etyang T, Westermarck J (2023) The Future of Healthcare. Res & Rev Health Care Open Acc J 8(1).

46. Li, Zhiming, Jun Ruan, Xuan Zhuang (2019) Effective Capture of Circulating Tumor Cells from an S180-Bearing Mouse Model Using Electrically Charged Magnetic Nanoparticles. Journal of Nanobiotechnology 17(1): 59.